ANATOMY FOR ARTISTS

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BY

JOHN MARSHALL, F.R.S., F.R.C.S.

PROFESSOR OF ANATOMY, ROYAL ACADEMY OF ARTS; LATE LECTURER ON ANATOMY AT THE GOVERNMENT SCHOOL OF DESIGN, SOUTH KENSINGTON; PROFESSOR OF SURGERY IN UNIVERSITY COLLEGE, LONDON; SENIOR SURGEON TO THE UNIVERSITY COLLEGE HOSPITAL; ETC. ETC.

ILLUSTRATED BY TWO HUNDRED ORIGINAL DRAWINGS

BY

J. S. CUTHBERT

ENGRAVED BY J. AND G. NICHOLLS

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PREFACE.

I DESIRE to express, on this page, my indebtedness to my friend Mr. J. S. CUTHBERT, for his zealous co-operation, his clear and artistic drawings, and his persistent reference to Nature for every detail of structure and form. The skill and obliging disposition of Messrs. NICHOLLS also demand my acknowledgments. Lastly, I have to express my obligations to another friend, Mr. JOHN CASTANEDA, for long-continued and most valued assistance, involving the collation and verification of numerous statements.

As to the Anatomical and Physiological data herein set forth, they may be regarded, generally, as familiar to every Anatomist; but for the arrangement and description of those facts, for their exposition and application, and for the introduction of various novel details, as well as for the character of the Illustrations, and the accuracy of the Drawings, I am alone responsible.

Owing to the time which I have taken before publishing this work, certain thoughts, scattered through it, have been first communicated in my Lectures, and have thus been already diffused and made common property, as, indeed, can be testified by many of those, to whom I now, finally, dedicate my labours, namely—

'*To my past, present, and future Pupils in Art Anatomy.*'

JOHN MARSHALL.

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INTRODUCTION.

There are, as there always have been, certain thinkers and workers in the world, who have studies and pursuits, which incline them to the investigation of the mind, and others whose bent and calling lead them, on the other hand, to the observation of the body, of man.

The Metaphysician and the Moral Philosopher, the Logician and the Philologist, the Sociologist and the Jurist, the Dogmatist and the Theologian, the Historian, and to a large extent the Poet, all of whom have their attention chiefly directed to the gifts and acquirements, the thoughts, sayings, doings and aspirations of Humanity, are necessarily prone to dissociate man from animals, rather than to associate him with them. They are accustomed to contemplate man as a being completely, or almost completely, set apart from the dumb animals, from the creatures over which he is supreme, from the brutes which he generally supposes will wholly perish.

On the other hand, the Natural Philosopher, whether a Physicist or a Biologist, a Botanist or a Zoologist, inclining to generalisations founded upon facts, and seeking for affinities, strives to associate, rather than to dissociate, correlated phenomena and kindred existences, and grants an instant and full recognition of the position of man, not beyond the limits, but at the head, of the animal kingdom.

With this latter view, the Anthropologist entirely coincides; and, furthermore, aided by the Anatomist, Physiologist, and Psychologist, he compares man with animals, and endeavours to estimate justly the distance which intervenes between him and the highest of them, to determine with accuracy their points of resemblance and of difference, and thus to ascertain the true nature of their association, alliance, and affinity.

The sculptor and the painter may yield or refuse their adhesion to any particular Biological speculations; but, within the bounds of their respective arts, so far as these are imitative or representative, they must of necessity regard man as a being, having a distinctive animal form, subject to numberless individual variations, according to differences of sex, age, character, and race.

Feebly comprehending, it may be, but strongly sympathising with the moral and intellectual nature of his fellow-men, with their emotions and thoughts, and with the actions by which these are revealed, the artist is compelled to realise his ideas and conceptions concerning man, as well as those concerning all other surrounding objects, both animate and inanimate, in some material form. In regard to much that occupies his highest thoughts, and requires his most earnest devotion, the form he has to represent is the human form; and thus he is committed to the most minute study, and the most intimate observation of the shape and actions of the Human Body.

In pursuing this line of research, from an artistic point of view, it is impossible that the painter, and especially the sculptor, should long avoid comparing the form of man with that of such animals as approach him more or less closely in organisation; and, in such a comparison, they must undoubtedly, from an æsthetic standpoint, at once agree in assigning to man, above all other animate beings, the incontestable palm of beauty.

It is, no doubt, true that by far the greater number of animals, whether high or low in the scale of creation, are intrinsically beautiful,—many of them exceedingly beautiful; and, on the other hand, man's own estimate of the perfection and beauty of form of his own species, may be, and must be influenced by the fact that his intellectual and moral ties bind him specially to his fellow-creatures. But it would be strange, inconsistent, and contrary to the harmony of Nature, if man—having especial sympathies with himself, and with his own species, and, moreover, alone possessing, of all living beings on this earth, not merely senses agreeably acted upon by whatsoever is lovely and pleasing, but an abstract idea, a mental conception of Beauty in itself, an elevated sense, a pure *æsthesis* of the Beautiful, and, even, an intellectual insight into its principles and causes,—should find himself to be, in any degree, bereft of that quality in comparison with other living creatures, or to be incorporated in a shape inferior to that of any one of the animal forms with which he is here associated, or to be less favoured in regard to those essential qualities of proportion, modelling, and grace of movement, which constitute to him the physically Beautiful, and serve at once to excite and test, to please and satisfy, his æsthetic perceptions.

In symmetry of construction and outward form, animals generally, being living machines intended for locomotive action, requiring the power of balancing and moving themselves upon or in the earth, on the surfaces of trees or plants, upon or in the water, or through the air, as the case may be, are, as a rule, quite upon an equality with man. So also they resemble him in exhibiting axial simplicity, serial repetition and manifold homologies, with contrasts, of parts. But, in refined proportions of length, breadth, and depth, in the well-balanced ratios of different parts to each other and to the whole, in subtilty and grace of outline, in fulness of detail, in ever-varying undulations of surface, in richness of local modelling, in the exquisite hue and lustre of the skin, and in the peculiar capillary adornment of the head, the human form, when met with in perfection, whether in infancy, youth, manhood, womanhood, or age, far transcends that of even the most elegant and beautiful of the mammalian group to which man himself belongs.

It might, indeed, be urged that the very nakedness of the body in man, by which he is distinguished from animals generally, whose integument is for the most part provided with scales, horny plates, feathers, or hair, covering the greater portion of their surface, constitutes, as it were, a sort of pledge for the perfection and finish of his outward superficies. For, such a proposition is in entire agreement with a principle almost universally recognisable and recognised in the organic world, whether vegetable or animal, according to which, whatsoever is exposed to view is more finished and beautiful than what is hidden. Foliage and flowers and fruit are more beautiful than the boughs, stalks and stems, which support them, and which are in a measure concealed by them; whilst these again are more beautiful than the roots which are buried in the earth. The stripped body of a bird, or of one of the well-covered mammalia—take for examples, the barn-door cock, the cat, and the rabbit—is hideous and ghastly to behold; but, in their covered condition, they are beautiful in outward form, their beauty depending entirely on the amount, arrangement, and colour of the flowing plumage or of the soft, abundant, hairy investment, or fur. In other cases, however, where the hairy coat is thinner and more compact, as in the greyhound, and in the finest breed of horses, the underlying forms of the body are, in themselves, much more attractive, although, even in these, the characters are modified, and the beauty is heightened, by the fine, close, hairy coat. In certain exceptional cases, again, as in the hog, tapir, elephant and rhinoceros, where the integument is almost destitute of hair, either the subjacent structures are partly concealed by an unusual amount of fat beneath the skin, or they are still more effectually masked by scuta, or by irregular folds of thick integument, massive, inelegant, of inferior beauty, but yet less unpleasing to the sight than would be the naked flesh, and less so than a rabbit or bird denuded of its hair or feathers. But in contrast with all these, and far surpassing them, man possesses a soft smooth integument which, with a limited quantity of fatty tissue, conceals and yet reveals the underlying structures, which in themselves, moreover, present extremely fine local form; whilst, in the more highly favoured races, the skin itself, from its proper delicate colour, its partial translucency, its qualified transmission of the tint of the blood and of the subjacent tissues, has a fair and pearly lustre, or a darker and warmer tone, incomparable in quality, and almost or quite inimitable in effect, when contrasted with the stripped or naked skin of any of the animals with which, in this respect, he can properly be compared.

The beauty of the human form, however, does not by any means reside entirely in its superficial covering, but it depends essentially on that of the structures situated beneath the integument; and the special development of these in mass and shape, is connected with the higher capacities of the human, as compared with the animal body. The erect attitude of man, so perfectly, easily, and gracefully maintained by him alone, necessitates breadth of foot, a columnar position and arrangement of the leg, thigh, trunk, and neck, with a concomitant breadth, roundness, and curvature, in those parts. The manifold uses served by the freer upper limbs, now entirely emancipated from the less noble task of locomotion, and devoted to the endless work of man's hands, demand a corresponding complexity of structural contrivance, and fulness of local form; and lastly the due protection of man's highly developed brain, the arrangements adapted for speech, and those which are suited for the facial expression of his varied and more complex emotions, necessitate a larger and rounder head and neck, a fuller face, and more mobile features, in the forms and proportions of which, in the nose, ears, eyes, and lips, is to be traced an especial and lavish evolution of beauty, for beauty's sake. In all these respects, man presents wide departures from, and a marked pre-eminence over the mammalia generally—even over the group most closely resembling or approximating to him, the anthropoid apes. In these peculiarities is to be found the explanation of the superior beauty of the human form, which, it is obvious, must ultimately and entirely depend, as regards general proportion and local quantities, on the size and shape of the structures immediately beneath the skin.

Now, it is undeniably true that the artist, if highly gifted, may comprehend and appreciate the singularly complex surface-forms of the human body, with their subtile undulations and changes, as these may be observed in the living man, whether he be at rest, or moving in response to his emotions, his desires, or his will. It is also possible that, by continued instruction and practice, a skilled eye and hand may combine to imitate or reproduce such forms in works of art of elevated style. But, in all ages and nations, the most highly gifted artist must have, at least, desired to know with certainty, the causes and conditions concealed beneath the surface, of the numerous and often fleeting swellings and hollows, ridges and depressions, and of other markings which he can perceive, but some of which he is frequently able to detect only during a passing moment. Probably even, he may have endeavoured, by close inspection and examination, to determine their real significance. At first, he would have recourse to the simplest methods of observation. In his own person, or on that of his models, the length, position, and general shape of the bones, their effect on the proportion and forms of the several parts, especially on those of the limbs, the points where they are least, and those where they are most thickly, covered, could all be easily investigated. Nevertheless, although some knowledge of this kind could be readily attained by watching and manipulating the living body, yet, when opportunities offered themselves, and these would certainly arise, the results so reached might and would be occasionally verified by the inspection and handling of persons emaciated by age, disease or starvation; for, from the examination of the human body, under such conditions, much knowledge concerning the deeper structures may be gained. With this view, they might also have studied the recent corpse, or sun-dried, sand-buried or mummified bodies, or even the separated bones themselves. So too, as regards the fleshy parts, and the sinews, or nerves as they were formerly called, an outward examination of these, as they swelled and sank, as they tightened or relaxed, would yield, on the living figure, much real information; and this again would early be supplemented by facts obtained in the slaughtering of animals for the purposes of sacrifice or for food, or by those from time to time acquired, in relation to the human structure, through accident, or on the battle-field, or in the execution of punishment.

But sooner or later the old chirurgeons of the time would probably be consulted; and the knowledge which they could supply both from fact and inference, derived from the study of the entire skeletons of man and animals, or from the actual dissection of the bodies of the latter, would come to be taken advantage of. By a combination of the materials thus collected,—by observation on himself and models, on the well-developed and attenuated frame, on the human bones, and on the soft parts of animals,—a large amount of sound information would be attained; and the dawn of a scientific interpretation of the mechanism of the human body, and of the relation of this to its outward form, would thus commence. At length, by chance or design, the opportunity would present itself, at what period cannot now be told, when it would become possible to dissect the fleshy and tendinous parts of the human body itself, and then the true relations of these and their influence on the surface-forms of the living frame, would sooner or later be determined. When this was done, the science and the art became associated, and a primitive artistic anatomy was founded. Such a step having once been taken, it would manifestly be impossible to retrace it. The knowledge thus acquired could not be ignored, much less despised; on the contrary, as time ran on, it would certainly appear more desirable that it should be thoroughly matured, and widely diffused.

Now, history tells us that such has been the case.

It is indeed open to doubt, whether the Egyptians ever prosecuted regular dissections, beyond such as they performed in the art of embalming both animals and men. The great artists of that Hamitic people, who were, however, amongst the earliest to treat the human form in an isolated and elevated manner, and even in a state approaching to the nude, needed but little or no anatomical knowledge; for, in the execution of their sedate and emotionless images or statues, they evinced no more acquaintance with structural form than could easily have been obtained from the study of the living types around them, or from the examination of their embalmed and withered dead; whilst in their lowly relieved sculptures, their intaglj or incised figures, and their flat painted outlines of man, which latter are indeed mere diagrammatic representations, their attention to detailed form became even less noticeable. It would, however, be as little necessary to assume that the execution of these demanded anatomical learning, as to suppose that such scientific knowledge was possessed by their Semitic and Aryan brethren, the artists of Chaldæa and India, or by those of our own prehistoric ancestry, who carved characteristic and vivid delineations of the horse and reindeer on fragments of bone or horn, by aid of a flint chip, and towards whom we nevertheless may well turn with something like filial respect and regard, as amongst the earliest prosecutors of the graphic art.

As to the practice of human anatomy by the Greeks during the time of Pericles, and the actual acquaintance of such artists as Pheidias with human structure, conjecture has been always rife. In the absence of direct proof, it is, by some, maintained that, not even the Greek physicians and surgeons, much less the Greek artists, can be assumed to have dissected, or assisted at the dissection of, the human body; and it must be admitted that certain departures from strict anatomical accuracy, which are met with here and there in their statues, might seem to strengthen such an opinion. By some, on the other hand, it has been suggested that Greek artists were not necessarily restricted within the limits which, by law or custom, bound their contemporaries who practised the healing art; they were certainly wealthy enough and influential enough to have done, unmolested, many things usually forbidden; the dead body of a criminal might have been accessible to them, for rude dissection; and the minuteness of some of their observations on the figure, the exactitude of most of their best work, and the soundness of their methods of generalisation of form, might seem to justify the belief that they studied, more profoundly than would have been possible on the living model only, the structural details of the human frame. The question at issue must, however, be left undecided; but if, in the Pheidian age, the Greek artists were absolutely precluded from systematic or surreptitious examination of the anatomy of the human body, they certainly dissected animals, and applied the knowledge, so acquired, to the anatomy of man; they, doubtless, availed themselves of the accidents of life and death, which, in peace or war, would afford them transitory glimpses of human structure; and they would supplement and test any scraps of information thus obtained, and subsequently handed down in sketches on walls or tablets, or by models in their workshops and studios, by the close and intelligent study of the living figure. Herein, indeed, lay their chief and exceptional means of education; for the living figure they could constantly observe, at all periods of life, and especially in its noblest forms of youth and early manhood, draped, partly draped, and even nude, in public processions, in dramatic performances, in military exercises with spear and sword, and in the civil contests of boxers, quoit throwers and charioteers.

At a later period, when, if it be true, as is asserted, that Erasistratus and Herophilus really performed dissections of the human body, the Greek artists would certainly avail themselves of the researches of those early devotees of anatomical science, perhaps the earliest prosectors. It is said that, after their time, prohibitive laws were passed in reference to dissection ; if so, this would establish the fact that it had been pursued, unless such edicts related merely to useless mutilations or to ordinary autopsies. Finally, it requires no straining of the imagination to conceive that, by the Greeks at least, any anatomical knowledge thus gathered together would be tenaciously and traditionally preserved, and would be taught orally to successive generations of pupils, in their academies, without, or with, graphic or plastic illustrations.

The emigrant Greek artists who, attracted by the wealth and patronage of Rome, passed over from time to time, and established, by degrees, the Græco-Roman schools of sculpture and of painting, would, undoubtedly, follow the precepts and methods of their mother school of Athens. The Græco-Roman physicians and surgeons do not appear to have openly practised, nor confess to having practised, human anatomy, even on the bodies of slaves, barbarians, or criminals. Galen himself, who in his day incorporated the professional wisdom of the past, as far as this was attainable by him, with that of his own time, based his descriptions of the internal organs of the human body upon the facts of mere animal anatomy, employing for this purpose, not only domestic creatures, but apes. Even for the bones, he used the last-named animals. At the same time, he advised his pupils, to do as he himself had done, to have recourse to Alexandria for human skeletons. Can we doubt that artists also would follow his advice, and would avail themselves of the knowledge possessed by their scientific brethren ; for, at all times, there has been a freemasonry between them ? In Imperial Rome, the gladiatorial shows furnished opportunities for the study of the living figure, in some respects resembling, though not equalling, those offered by the Olympian Games and by the daily life of the Greeks ; and these shows would, moreover, supply, as we know, touching subjects for the artist's mind and hand.

During the period when all learning was remitted once more to Orientals, and fell into the hands of the teachers of the Arabian schools, the prosecution of practical human anatomy ceased ; for it was altogether repugnant to the sentiments, precepts and customs, if not opposed to the positive enactments, of the early Mahommedans.

Then came the vacant roll of the dark centuries.

Ultimately, we reach the era of the revival of learning and the re-instatement of the arts. It is well known that, as early as the beginning of the

14th century, human dissections began to be regularly practised by Mondini of Bologna (1315). It is interesting to remember that the subsequent invention of engraving on wood, about the commencement of the 15th century (1400–1420), and that of its still more potent offspring, printing, rendered it, henceforth, easy to record and diffuse the results of anatomical research. Artists and anatomists soon became intimately associated in their lives and labours. Community of objects to be attained, and a growing sympathy, led to frequent and earnest co-operation. Each became, in a large measure, essential to the other ; by progressive stages, more and more perfect knowledge, and better and better illustrations, not only of the facts of pure anatomy, but of those which belong to artistic anatomy, came to prevail : and there has never been wanting, at least since the latter part of the 16th century, a succession of useful guides in this interesting study.

The amount of time and wealth of talent which have been expended on the study of anatomy as applied to art, are sufficiently proved by the History of Anatomical Illustrations, compiled by Ludwig Choulant.[1]

This author furnishes us with a list of works nearly all of them illustrated, devoted especially to art-anatomy, amounting in number to 62, and ranging, in date of publication, from 1585 to 1850.

Of this number, three, including the very earliest work, were published in Spanish, five in English,—seven belong to the Netherlands,—twelve are in Italian,—sixteen appeared in Germany,—and, lastly, nineteen in France. To this it must be added, that anatomical statuettes, or statues, displaying the muscles of the body, were first modelled and cast, in Spain, and afterwards in Italy, Germany, France, and England. Since 1850, two new anatomical figures, and a few special treatises on art-anatomy have been published on the Continent.

But any retrospect as to the past relations of anatomy to art, would be very incomplete, were it limited to the record of actual publications ; for some of the greatest artists of all countries, especially, however, those of the Italian schools, have devoted themselves, more or less energetically, to the subject of human anatomy, without having left any proof of their labours, in the shape of books or plates. Some evidence, in the form of sketches and of finished drawings, they have left behind, of which a few have since been engraved. Such drawings of the bones and muscles, would doubtless have been used in their studios, academies, and schools, and would serve as daily means of instruction, and as examples to be copied or followed, by successive generations of pupils. In this way, a large amount of gradually acquired knowledge would be handed down, even before the arts of wood-cutting and copper-plate engraving came to aid in its preservation and diffusion. It

[1] *Geschichte und Bibliographie der Anatomischen Abbildung*, &c. Von Dr. Ludwig Choulant, &c. Leipzig, 1852.

is impossible not to speculate, in regard to still more remote historic times, and to imagine Egyptian, Greek or Græco-Roman masters, making more or less rude plans, sketches, or models, of proportion, form and anatomy, it may have been in perishable materials, for their own use and for that of their pupils. Nevertheless, a simple estimate of the facts known to us, may more justly lead to the inference, that whilst Egyptian art displays chiefly a knowledge of *proportion*, and Greek art, of *proportion* and *form*, modern art has superadded to these, an insight into *structure*; so that, in reference to the artistic treatment of the human form, we may recognise in the Egyptian, Greek, and Modern Epochs, respectively, an anthropometric, an anthropomorphic, and an anthropotomic method.

It is easy to perceive that the works of eminent anatomists, though devoted to pure anatomy and not to artistic anatomy, must have been consulted by contemporary and succeeding artists, and thus must have powerfully contributed to the dissemination of anatomical knowledge amongst the latter. Moreover, independently of the effects of their published plates and writings, the personal influence of anatomists, whether of the pure or of the artistic class, exercised during intercourse with artists or with others, by criticism, by counsel, or by direct teaching, would aid in an unrecorded manner, in the dissemination of a more exact anatomical knowledge amongst artists.

Lastly, it has often happened that artists and anatomists have combined their efforts towards a common end; and, indeed, few facts are more interesting in connection with this subject, than the constantly recurring examples met with, of the warmest personal friendship, as well as of the most cordial co-operation between contemporary workers, in the domain common to science and art. Relations of this kind, for example, existed between Della Torre and Leonardo da Vinci, Colombo and Michael Angelo Buonarroti, Da Carpi and Benvenuto Cellini, Vesalius and Titian and Calcar, Hamusco and Becerra, Cheselden and Vandergucht, Santorini and Battista Piazzetta, Albinus and Ladmiral, Sömmerring and Höck, and between Mascagni and Serantoni. The mutual connexion which has now so long existed between anatomy and the art of design, attests the intimate nature and increasing strength of their relations. It does more; it establishes in the mind, a complete conviction of their firm and indissoluble alliance. Artists and anatomists, as we have seen, very early united their efforts towards one object; and, whilst the more accurate representative faculty of the former served better to record the results attained by the latter, and thus assisted the progress of anatomy, so the arts of design and modelling acquired an accuracy and certainty, not a little due to the fuller investigations and closer criticism of the anatomist. So far as art-anatomy is concerned, the most remarkable and satisfactory works of each epoch, have been those in the production of which, artists and anatomists, of equally great reputation, have been jointly engaged: or else the artist and anatomist have met in the same person, the artist himself having dissected, or the anatomist having been his own draughtsman.

Two questions arise here for discussion: namely, which has profited more, anatomy or art, from their prolonged co-operation? and, what is the effect of a knowledge of anatomy upon art?

As to the first, every anatomist will gladly admit the advantages conferred upon his science, by a faithful and permanent transcription of the innumerable details of organic form and structure, which it is his vocation to discover and explain. Words, without illustrations, would have utterly failed to keep the accumulating knowledge in memory or in use. The definite record of a single fact may serve as the starting-point of fresh discovery; whilst the spread of accurate knowledge, by means of the pencil, may lead to the creation of new centres of observation and research. Hence, by the absence of anatomical illustrations, the precision, diffusion and advance of anatomical science would have been restricted.

Whether art has gained as much in return, is a question, on which opposite opinions have been entertained, and it is not difficult to find arguments by which to sustain either. Appealing to the supposed, and, it must be admitted, the possible ignorance of the ancients as regards the anatomy of man, some have regarded a scientific knowledge of this science, as needless; others, appealing to the disastrous effects of a possession of that knowledge by certain moderns, declare their belief in its positively evil influence. Now it is idle, for it is too late, to appeal to the example of the ancients. If they studied anatomy in a practical manner, it may be a heresy to say it, but it is a truth, that they not unfrequently violated, or, at least, departed from its strict teachings; and, if they did not, it is certainly marvellous how much of correct anatomical detail may be traced in their surface-work. But, whether they did or not, practically, since the revival of art, the moderns have laboured to acquire more and more exact anatomical knowledge of the human, and animal, frame; and art cannot again be divorced from anatomy. The effort now should be to make the latter of real utility to the former.

The value of a knowledge of anatomy on the part of an artist, may be over-rated; from insufficiency, rather than proficiency of acquirement, it has sometimes been a snare; to some it has proved absolutely hurtful. But it need not be paraded, obtruded, or misemployed. It should be the artist's help, not his hindrance. It must not be allowed to become the trick of a school, the basis of a conventional method, or the substitute for a knowledge of the living figure. A placid generalisation of form, a smooth negation of underlying structural details, are compatible with a certain amount of beauty, sentiment and grace, and are preferable to bringing such details too near to the surface represented, and too plainly into view. The eye of the educated observer should not be offended by an absence of the living and the substitution of the dead form, by the appearance of action, where there should be repose, or of spasm, where there should be action. There must be no substitution, by the aid of mechanical methods and rules, of conventional lines and masses, for a perfect harmony of form and action, in every part, with the conception of the artist, which must itself be subordinated to, and compatible with, the true purposes of art. A defective acquaintance with anatomical facts, or, still worse, with their relation to the outward surface, is even more dangerous than an absolute ignorance of anatomy; for, in the former case, errors are sure to be committed, whilst in the latter, the artist must rely entirely on what he sees in his model,—no unsafe guide.

But a sound knowledge of art-anatomy properly employed, is a most useful aid in practice; it confers keener powers of observation; it necessitates a closer analysis of, and leads to a clearer insight into the nature of the forms, which the artist must study and represent. The human form is undoubtedly the most difficult of all to understand, to follow in its complex changes, and to represent either in the solid, or upon a flat surface. The artist who masters it with his eye and mind, and thoroughly subjects it to his hand, need fear no other task of representative work which can be set before him. Hence it is the highest aim, the acme of all artistic training, so far as practical drawing and modelling are concerned, to draw and model the human figure correctly.

Anatomy alone cannot teach anyone to do this; but it will serve after the manner of a rule and plumb-line, a square and quadrant, to save one from committing egregious error; it will elucidate many a doubt concerning a passing or phenomenal form, now recognisable and now lost to sight. It will not only enable an artist to discern these, but to distinguish from them other more permanent or less modifiable forms; it will explain their differences and meanings, and assign to each its right interpretation, in every action of the living frame. Anatomy further throws light on the various changes or peculiarities of form, dependent on sex, age, individual attributes, character, and race. It constitutes the only safe test by which to estimate correctly the strivings of ancient art, the triumphs or failures of the antique, in its attempts to create for all time, distinctive types of the human or the deified human form, such, for example, as a Cupid, an athlete, a Hercules or a Faun, an Apollo or a Jupiter, a Diana or a Venus. With the aid of anatomy alone, can the artist safely advance from the individual to the ideal, and attain to special or general conceptions of form. It is the only means by which he can determine the true relations of the human to the animal type, and realise to himself what is more human and what is more animal, in any individual example of humanity.

Finally, as a mere element of education, an adequate acquaintance with anatomical science, both human and comparative, will contribute to the training of the artist's mind, and keep it abreast of modern progress. The artist of the future must be scientific; and provided that he retains those great gifts, an innate love of the Beautiful, a true sympathy with nature, and the creative faculty of the poet, then no amount of scientific knowledge can ever over-burden him; but, on the contrary, it will contribute powerfully to strengthen his ability to embody his conceptions, and will thus assist in elevating him to the highest position in his art.

In the Lectures, which I have for more than twenty years delivered on Anatomy to Art Students, as Lecturer in the Government Schools of Design, and as Professor in the Royal Academy of Arts, I have endeavoured to inculcate and exemplify these principles; and in the present volume, I trust, to reach a wider circle than I have hitherto addressed.

An attempt is herein made in three successive divisions of the work, to give such thoroughness to the anatomical descriptions of the several Bones, and of the Joints, and Muscles, as will enable the artist really to understand the Form, Mechanism, and Actions of the Human Body. These three subjects are introduced, respectively, by a general account of the Skeleton, the Articulations, and the Muscular System. In the particular description of the Bones, every curve and surface, every eminence, ridge or groove, which may explain the use of a part, or may influence the surface form, is fully noticed. In reference to the Joints, the character of the articular surfaces, the mode of connexion between the bones, the kind and degree of movement permitted between them, and the means by which these are limited, are duly explained. In the description of the Muscles, not only the origin, insertion, and action, of each is stated, but the individual shapes of their fleshy and tendinous portions, and their effect on the surface, are carefully pointed out.

There remain, nevertheless, many things concerning the Evolution of Organic Forms generally, the Qualities of these, the Vertebrate Form and its variations, the Statics and Kinetics of the Human Body, and its means and mode of Locomotion and Expression, which must be reserved for future consideration. In this treatise, *Structure and Form* chiefly receive attention. As a parting word of advice, it must be emphatically recommended that, whenever it is possible, reference should be made continually to the life, for the purpose of learning how to translate the facts of the dead structure into the appearances of the living form.

THE BONES.

THE SKELETON.

The human body consists of a hard internal bony framework, named the *skeleton*, more properly the *endo-skeleton* (ἔνδον, within; σκελετον, a dry body), of certain surrounding and enclosed soft parts, including the muscles or flesh, the viscera or various organs, the blood-vessels, absorbents and nerves, and of the general integument or skin, with which are associated the external organs of the senses. Certain tegumentary parts, such as the teeth, nails and hair, are representatives of the *exo-* or *dermo-skeleton* of animals (ἔξω, without; δέρμα, skin); whilst in the muscular and tendinous systems, situated between the exo- and endo-skeletons, are found certain bony nodules, such as the sesamoid bones of the foot and hand, and the patella or knee-pan, which constitute representatives of the *sclero-skeleton* (σκληρός, hard). The part of the science of anatomy which relates to the bones is named *Osteology* (ὀστέον, a bone; λόγος, a discourse).

The skeleton is composed of a large number of separate *bones*, which are connected together at the *joints* or *articulations* (*articulus*, a joint), and which thus form certain *cavities* for the protection of the viscera, and their maintenance in their due position, and also form fulcra and levers, for the *support* and *movement* of the body and of the limbs. The muscles clothe the skeleton, whilst the skin covers all.

The Parts of the Skeleton.—The Names and Connexions of the Bones.

The entire skeleton, like the body of which it forms the solid internal framework, presents for the purposes of description, a central portion, which comprises the *head*, *neck*, and *trunk*, and four *appendages*, two on each side, the upper and lower *limbs*.

Fig. 1 shows these parts, and is intended, moreover, to serve as a *key or* *refercnee figurc,* by aid of which, the names, position, and connexions of the several bones may be learnt.

The Bones of the Head.—The *head* comprises an upper smooth roundish and hollow part, which lodges the brain and the organ of hearing, and is termed the *cranium,* and a lower more rugged part, which is irregularly excavated, which contains the organs of sight, smell, and taste, and gives, in the jaws, support to the teeth, named the *faee.* The term *skull* is really applicable to all the bones of the head, including those both of the face and the cranium; but very often, in common language, this word is applied to the bones of the head, without including the lower jaw.

The *cranium* (*κρανίον,* the skull) is composed of eight bones. Of these, some only are seen upon the surface, to which the attention of art-anatomists is specially required. They include the *oeeipital bone,* or *oeeiput* (*ob,* against or behind; *eaput,* the head), fig. 1, O; two *parictal* bones (*paries,* wall of a house), left and right, P; the *frontal* bone (*frons,* the forehead), F; the two *temporal* bones (*tempus,* time, [?] because age first whitens the hair in this region), left and right, T; the *sphenoid* or *wedge-like* bone (*σφήν, sphēn,* a wedge; *εἶδος, eidos,* likeness, form), of which only a very small part, S, known as the great wing or ala (*ala,* a wing), reaches the side of the cranium; and lastly, the *ethmoid* or *sieve-like* bone (*ἠθμός, ēthmos,* a sieve; *εἶδος,* form), which is placed beneath the frontal bone, between the eye sockets or orbits, and behind the bridge of the nose, and so is not visible on the surface of the cranium; it is accordingly not indicated in the key figure. All the cranial bones, except the two parietal, contribute to the formation of the under side or base of the cranium; but it is by the occipital bone that the head is connected with the neck. All these bones meet at their edges, the lines of junction being called *sutures* (*sutura,* a seam). The cranial cavity formed by their union, contains the brain, a prolongation from which passes through a large aperture in the occipital bone, downwards into the neck. The opening leading into the deep parts of the ear, and these parts likewise, are situated in the corresponding temporal bone.

The *face* is composed of fourteen bones, several of which, like the ethmoid amongst the cranial bones, do not reach the surface. On the surface, there are two *check-bones* or *malar* bones (*mala,* the cheek), left and right, M; two *superior maxillary* bones, or *maxillæ,* or *upper jaw-bones* (*maxilla,* a jaw), left and right, J, which contain the upper teeth; two *nasal bones* (*nasus,* the nose), left and right, N, which unite to form the bridge of the nose; two *laerymal boncs* (*lacruma,* a tear), left and right, L, which are placed on the inner wall of the corresponding orbit, and assist in forming certain bony canals for the passage of the tears; lastly, on the surface there is the *lower jaw-bone,* or *inferior maxilla,* or *maxillary bonc* (*maxilla,* a aw), J′, sometimes called the *mandible* (*mandere*, to chew), which supports the lower teeth. Hidden from view, are two *palate* bones, left and right (*palatum*, the palate), which, with the upper jaw-bones, form the hard palate or roof of the mouth; two *inferior turbinated bones* (*turbo*, a whorl), left and right, which are situated within the *nasal fossæ*, or cavities of the nose; and finally, a single median bone, named from its shape, the *vomer* or *ploughshare bone* (*vomer*, a ploughshare), which helps to partition off the right from the left nasal fossa. These fossæ, which contain the organ of smell, are situated beneath the base of the cranium, between the orbits, and above the roof of the mouth, and open in front by apertures called the anterior nasal openings, or *anterior nares* (*naris*, a nostril), which are bounded by the two nasal bones, N, and the two superior maxillary bones, J. The *orbits* or sockets for the eyeballs (*orbita*, a track) have their borders formed by the frontal, malar, and upper maxillary bones, besides which, the sphenoid, ethmoid, lacrymal and palate bones serve to complete their walls. The mouth, which contains the organ of taste, is placed beneath the hard palate, and between the upper and lower maxillary bones. With the exception of the lower jaw-bone, J′, the facial bones are joined firmly to each other, and to the under side or base of the cranium, by *sutures*; but the lower jaw is articulated with the two temporal bones, just in front of the openings leading into the ears, by a very moveable joint on each side, for the purposes of mastication.

The Trunk with the Neck.—The *trunk* together with the *neck*, is very nearly equivalent to the *torso* of artists; but the fragment of a statue thus named, frequently, and, indeed, usually comprises small portions of the limbs, which it is not here intended to include. Anatomically considered, the bony trunk consists, first, of a central or *axial* part or *column*, which extends from the base of the skull, down to the lower end of the body, named, for reasons to be presently mentioned, the *vertebral column*, *spinal column*, or *spine*; secondly, of the *ribs*, which extend sideways from this column, and of the *sternum*, to which they reach in front; and, lastly, of two sets of bones or *bony girdles*, which form, opposite the shoulder and the hip, the bases of support for the arms and legs.

The median or *axial* part of the skeleton of the trunk, extends from the under side of the occipital bone, O, to the lower end of the trunk itself, C; it is named the *spine* (*spina*, thorn), from the series of projecting bony processes, hence called *spinous processes*, which are found along the middle line behind; it is composed of a series of irregularly shaped bones, piled one upon another, very strongly held together by peculiar joints, and yet capable, for the most part, of undergoing slight intermediate movements, amongst others, a limited movement of rotation or *turning*, and hence they are named *vertebræ* (*vertere*, to turn), the entire column being named the *vertebral column*. The part of this column which is situated in the *neck*, is called the *cervix* or *cervical* portion (*cervix*, the neck); its component vertebræ, *seven* in number, are named the *cervical vertebræ*, C7. The part which corresponds with the *back*, is called the *dorsum*, or *dorsal portion*, and its *twelve* component bones, the *dorsal vertebræ* (*dorsum*, the back), D1 to D12; the portion situated in the *loins*, is known as the *lumbar portion*, and contains *five lumbar vertebræ*, L5 (*lumbi*, the loins). These three portions, *cervical*, *dorsal* and *lumbar*, comprising in all, twenty-four vertebræ, constitute the *moveable* portion of the vertebral column, the component bones themselves being distinguished as the *moveable*, or *true vertebræ*. Below the loins, is the *sacral portion* of the vertebral column, or *sacrum*, S5 (*sacer*, sacred), so named in animals, it is said, because this part was formerly specially offered in sacrifices; it is composed of *five* bones, the *sacral vertebræ*, originally separate, but consolidated, when the growth of the body is fully complete, at about the twenty-fifth year, into a single bone. Lastly, below the sacrum, the axial part of the skeleton of the trunk, is prolonged for a short distance only, as the so-called *caudal* or *coccygeal* portion of the vertebral column (*cauda*, the tail; *κόκκυξ*, *kokkux*, a cuckoo, the bony termination of the spine being compared with the bill of that bird); this is composed of *four* separate bones, or imperfect vertebræ, which become rapidly reduced in size, and are named the *caudal* or *coccygeal vertebræ*, C. The sacral and coccygeal parts of the spine, comprising *nine* vertebræ, constitute the so-called *immoveable* portion of the vertebral column, —the bony elements themselves being termed the *immoveable* or false *vertebræ*; this designation is true of the five sacral vertebræ, for they speedily become immoveable, although they are not united by bone till growth is complete; but it is not quite so descriptive of the coccygeal vertebræ, which retain a slight degree of movement on each other till very late in life, when they at length form a single mass, properly termed the *coccyx*. Enclosed within the vertebral column or spine, is a longitudinal canal, formed by a series of bony rings, belonging to the several vertebræ, and named the *vertebral* or *spinal* canal; it lodges the prolongation from the brain, named the *spinal cord*, together with the roots of the spinal nerves.

Extending *laterally*, from the dorsal portion of the vertebral column, are the well-known bones, the *ribs* or *costæ* (*costa*, a rib), *twenty-four* in number, twelve on each side, left and right, R1 to R12. The ribs are attached strongly, but moveably, behind, to the sides of the dorsal vertebræ; whilst, in front, each is tipped with, and continued by a corresponding piece of firm, elastic gristle or cartilage, named a *costal cartilage*. The upper *seven* ribs on each side, are prolonged by their respective cartilages, and fixed by proper joints, to the borders of a flat bone, placed longitudinally in the middle line of the trunk in front, named the *sternum* (*στέρνον*, the breast or chest), St; hence, as they form true or complete arches on either side, they are called the *true* ribs, otherwise the *vertebro-sternal ribs.* The lower *five* ribs, the cartilages of which do not reach the sternum, are named the *false* ribs; of these, the cartilages of the upper three turn upwards, and are attached to the next cartilage above, they are therefore called the *vertebro-costal* ribs; but the two lower ribs, viz. the *eleventh* and *twelfth* on each side, have their tips free in the soft parts, and are named, accordingly, the *floating ribs,* and from their being connected with the vertebræ only, the *vertebral* ribs. The sternum, which is interposed between, and attached to, the upper seven costal cartilages, is originally composed of separate bony pieces; it extends from the *root of the neck* down to the so-called *pit of the stomach.* The twelve dorsal vertebræ, the twenty-four ribs with their cartilages, twelve on each side, and the sternum, enclose together a large cavity named the *thorax* or *chest* (*θώραξ*, a breastplate); in this cavity, during life, are lodged the heart and large blood-vessels, the two lungs, a portion of the windpipe, a part of the gullet, and certain other structures. Above the thorax, that is, in the neck as high as the floor of the mouth, are found the continuations of the large blood-vessels going to the head and upper limbs, the rest of the windpipe with the larynx or organ of voice placed at its upper end, and behind that, supported on the cervical vertebræ, the upper part of the gullet, with the pharynx or throat-sac. Above the larynx, and just beneath the base of the tongue, both of which it supports, is a small transversely placed bone, the *lingual bone* (*lingua,* the tongue) or *hyoid bone,* named from its being shaped like the small Greek letter upsilon (*υ*; *εἶδος,* form). The cavity of the thorax is bounded below by a special structure or partition, composed of muscle and tendon, named the *diaphragm* (*διά,* between; *φράσσω,* I fence); by this, it is separated from the lower cavity of the trunk, named the *abdomen* (*abdere,* to hide). The abdomen is placed opposite the lumbar region of the vertebral column, which is its only bony support behind; the lower ribs above, and the hip-bones below, bound it in those directions; the rest of its walls are formed by certain broad muscles and fasciæ; it is occupied, almost entirely, by the digestive and the excretory apparatus. It will be observed that the cranium, which contains the brain, has bony walls; the walls of the thorax are partly bony and partly muscular or tendinous; whilst the abdomen has its front and sides, and also its diaphragmatic boundary above, composed of muscle or tendon only.

The two sets of bones, or bony *girdles,* which serve as bases of attachment for the upper and lower limbs, and may be regarded as the roots of those limbs, although they also enter, as structural elements, into the formation of the trunk, require next to be noticed. The *upper set* consists of the two *clavicles* or *collar-bones,* left and right, *Cl,* and of the two *scapulæ, shoulder-bones,* or *blade-bones,* left and right, *Sc.* The clavicles, or collar-bones, so named from their shape and situation (*clavicula,* a small key or latch; *collum,* the neck), are two long, doubly curved bones, which extend from the upper part of the sternum, one on each side, towards the corresponding shoulder-bone, being attached by a moveable joint at either end. The scapulæ (*scapula*, the shoulder-blade, or spade-bone, because, in certain animals, as in the ox and horse, the scapula resembles the flattened end of a spade, and has probably been used for purposes of digging) are two broad bones, which are suspended to the outer ends of the collar-bones, and are supported on the back and sides of the thorax. The two clavicles and the two scapulæ together, constitute a sort of arch or girdle known as the *scapular arch, shoulder-girdle,* or *pectoral girdle,* which supports the upper limbs. The only point of direct articulation of this girdle with the rest of the skeleton, is at the attachment of the inner ends of the two small clavicles, to the upper part of the sternum. The *lower set* of girdle-bones consists of the two large broad bones, named the *hip-bones, haunch-bones,* or *innominate bones,* I, right and left (from *in,* the negative prefix, and *nomen,* a name, because the old anatomists failed to give a name to these bones, founded on a general likeness to any known object). Each innominate bone consists of an expanded upper part named the *ilium* (*ilia,* the flanks), *i*; of the *ischium,* the Sitz-bein or sitting-bone of the Germans (*ἴσχειν, ischein,* to hold, as it is the bone on which the weight of the body is supported in the sitting posture), *s*; and of the *pubes* or *pubic bone* (os pubis), *p*. These three parts of the bone, though for a long time separate, are eventually united into one piece by consolidation with an intermediate Y-shaped bone, at or about the period of puberty. The right and left innominate bones are joined very firmly together in front, by the meeting of the two pubic bones at a special articulation; whilst, behind, each is articulated by a broad surface, also very firmly, to the corresponding side of the sacrum. The two hip-bones form a very strong bony arch or girdle, named the *hip-girdle, pelvic arch,* or *pelvic girdle,* which rests on, and gives attachment to, the lower limbs; this is much stronger than the shoulder-girdle, which supports the smaller upper limbs; moreover, instead of being open behind, it is completed in that direction by its junction with the vertebral column, that is, with the sacrum, so as to form a complete and massive bony ring, which is the base of support of the whole trunk, transmitting its weight to the lower limbs, and constituting the so-called *pelvis* (*pelvis,* a shallow basin). Hence, the hip-girdle is both larger and more fixed than the scapular girdle. The cavity inside the pelvis, or *pelvic cavity,* is continuous with that of the abdomen, and contains the lower portions of the digestive and excretory apparatus, with parts of the reproductive system.

The Limbs.—The *two pairs* of *lateral appendages* called the *limbs,* viz. the *upper* or *anterior,* and the *lower* or *posterior limbs,* consist of a series of bony segments, which bear a general resemblance to each other in the two limbs.

In the *upper limb*, the first long single bone is named the *humerus* or *arm-bone*, H. It is connected, at its upper end, by a very moveable joint, with the scapula, and, at its lower end, with the two succeeding long bones of the *forearm*. One of these latter is named the *ulna*, or *elbow-bone* (*ulna*, the elbow), U, and the other the *radius* or *spoke-bone* (*radius*, a ray or spoke), R. The ulna is placed at the back and inner border of the forearm, as the limb hangs by the side with the palm forwards; whilst the radius is situated along the outer border of the forearm. Both bones are connected, very moveably, with the humerus, above; but the ulna alone, as its name implies, forms the bony prominence of the elbow. Below, they are both articulated with the hand, at the wrist, the radius more particularly and completely, the ulna being separated from the wrist-bones by a small fibro-cartilage. Lastly, the two bones are articulated, at both their upper and lower ends, by peculiar joints, so arranged that the radius can roll on its long axis, upon the ulna. The *wrist* or *carpus* (*καρπός*, the wrist), C8, consists of eight small short bones, named the *carpal bones*, which are arranged in two rows. The *first* or *upper* row contains, proceeding from the inner or ulnar border, the *cuneiform bone* (*cuneus*, a wedge; *forma*, shape), figs. 2 and 3, *c*, on which rests the *pisiform* or *pea-shaped bone* (*pisum*, a pea; *forma*, shape), *p*, which, by some, is regarded, not as a proper carpal element, but rather as an example of a bone developed in a tendon, like the sesamoid bones; next, the *semilunar bone* (*semi*, half; *luna*, moon), *sr*; and then, the *scaphoid*, *navicular*, or *boat-shaped bone* (*σκάφη*, *navicula*, a boat or wherry), *s*. The *second* or *lower* row includes, in the same order, the *unciform* or *hook-shaped bone* (*uncus*, a hook; *forma*, shape), *u*; the *os magnum* or *great bone* (*os*, bone; *magnus*, great), *m*; the *trapezoid* bone, (*τράπεζα*, a table), *d*; and lastly, the *trapezium* (*τραπέζιον*, a little table), *t*. The carpal bones of each row are so connected as to permit of but very slight movements on each other; but between the two rows there is somewhat more movement. The upper row, as already stated, is articulated above, directly, with the lower end of the radius, but only indirectly, by means of an intervening fibro-cartilage, with the ulna. The lower row is articulated firmly with *four long* bones, and more loosely with a *fifth* similar bone; these succeed to the carpus, and constitute the *metacarpus* (*μετά*, beyond; *καρπός*, the wrist), fig. 1, Mc5. Of the *five metacarpal* bones, which, for the purposes of description, are numbered from the radial to the ulnar border of the hand, the fifth and fourth rest, above, on the unciform bone, and, below, support the little and ring fingers; the third is connected with the os magnum, and supports the middle finger; the second is attached to the trapezoid bone, and carries the fore- or index-finger. These four metacarpal bones are arranged side by side, parallel with each other; but the first metacarpal bone stands out from the rest, is articulated, more loosely, with the trapezium, to which it is attached, and serves to support the thumb. On the palmar aspect of the distal end of the metacarpal bone of the thumb, are placed two small roundish bones, developed in the double tendon of a muscle, and named *sesamoid* bones (σήσαμον, the sesame seed; εἶδος, form). The proper bones of the *digits*, or the fingers and thumb, form the series of long bones named the *phalanges* (φάλαγξ, a rank of soldiers); they are fourteen in number, Ph, viz., three for each finger, and two only for the thumb. They are named, in each case, *first* or *proximal*, *second* or *middle*, and *third*, *distal*, or *terminal*: this last phalanx is also called the *ungual phalanx* (*unguis*, a nail), because it supports the nail. The joints between the phalanges and the metacarpal bones, and between the phalanges themselves, are freely moveable. The carpus, metacarpus, and the phalanges constitute the *hand*; the metacarpus corresponds with the broad part of the hand, and the phalanges with the digits. The thumb is a specialised digit, and, consequently, has received special names in different languages (ἀντίχειρ, or opponent of the fingers; *pollex*, perhaps from *pollere*, to be strong; pollice, pulgar, pouce; daumen, thumb, *tumere*, to swell). The upper limb is, as compared with the lower, more slight in its whole construction; it is intended for purposes of prehension and manipulation of all kinds (*manipulus*, a handful).

In the *lower* pair of appendages or *limbs*, the first long bone is named the *femur*, or *thigh-bone* (*femur*, thigh-bone), F*e*. It is the longest, heaviest, and strongest of the so-called long bones, and is articulated, very moveably above, with the corresponding innominate or hip-bone, and below, at the knee joint, with the larger only of the two long bones of the leg. This larger bone is named the *tibia* (*tibia*, a pipe or flute; so named from its supposed resemblance to such an instrument), T*i*. It occupies the front and inner side of the leg; whilst the other and smaller bone in this part of the lower limb, which is placed somewhat posteriorly and along the outer aspect of the leg, is named the *fibula* (*fibula*, a clasp; because this bone forms a sort of tie or brace to the tibia), F*i*. The tibia is a massive bone, which alone enters, with the lower end of the femur, into the formation of the knee joint; the fibula, a comparatively slender bone, does not reach so high as the knee, but is connected, by a very slightly moveable joint, with the side of the upper end of the tibia. The knee-joint itself is completed in front by a peculiar, short, flattened bone, which does not belong to the proper osseous system or endoskeleton, but to the muscular and tendinous system, or sclero-skeleton, and is named the *patella* or knee-pan (*patella*, a little plate), *pt*. Below, at the ankle, where motion is free, it is the tibia also which enters mainly into the formation of the joint (the fibula contributing only to the completion of its outer side), whilst the tibia forms its upper surface and inner side. The two bones of the leg are fastened together below, as well as above, so securely, that there is no rolling movement of one upon the other, like that of the radius on the ulna in the forearm, but only a limited gliding movement. In the upper limb, as already stated, both bones of the forearm touch the humerus at the elbow; but only one, the radius, touches the carpus at the wrist. In the lower limb, however, one bone only, the tibia, touches the femur at the knee; whilst both bones touch the upper bone of the foot, at the ankle. The foot, like the hand, is divisible into three component parts, which are here named the *tarsus*, the *metatarsus*, and the *phalanges* of the *toes*. The *tarsus* (ταρσός, the broad portion of the foot), T7, which includes the ankle, heel and instep, is much more massive than the carpus or wrist; the *metatarsus* (μετά, *meta*, beyond; ταρσός, *tarsos*, the instep), Mt5, is longer and stronger than the metacarpus in the hand; whilst the phalanges of the toes (φάλαγξ, *phalanx*, a rank of soldiers), P′14, are shorter than those of the fingers and thumb, and in the case of the four outer toes, though not in that of the great toe, much smaller and more slender. The tarsus is composed of *seven* bones, not of eight like the carpus, which are short and strong; they are not arranged in two distinct rows, as in the carpus, but rather in two groups. The first or highest bone is named the *astragalus* (ἀστράγαλος, *astragalos*, the ankle-bone, or a die; perhaps because these bones, in the sheep, were, when marked with spots or stars, on four sides, used in a Greek game, as dice, ἀστήρ, *aster*, a star, and ἀγάλλειν, *agallein*, to mark), figs. 4 and 5, *a*; it alone of the tarsal bones, enters with the tibia and fibula, into the formation of the strong ankle-joint. Immediately below the astragalus, supporting it, and articulated with it, very firmly, is the largest bone of the tarsus, the *os calcis*, *calcaneum* or *heel-bone* (*calx*, *calcaneum*, the heel), *c*; through this characteristic bone of the foot, the weight of the body is mainly transmitted from the astragalus downwards to the ground. The astragalus and os calcis form the hinder of the two groups of tarsal bones. Next in order, on the inner or tibial border of the foot, is found the *scaphoid* or *navicular* bone (σκάφη, *skaphe*, *navicula*, a boat or wherry), *s*, which is connected by a freely moveable joint with the astragalus behind, sometimes with the so-called cuboid bone on its outer side, and very closely with three other tarsal bones in front; moreover, it lies across the upper surface of the foot, where it forms the highest part of the instep. The three bones immediately in front of the scaphoid, and connected firmly with it, are named from their shape the *cuneiform* or *wedge-shaped* bones (*cuneus*, a wedge; *forma*, form), and, moreover, are designated, beginning on the inner or tibial border of the foot, either *first*, *second*, and *third*, or *internal* *c‴*, *middle* *c″*, and *external* *c′*, *cuneiform*; they serve to support, respectively, the metatarsal bones of the first, second, and third toes. On the outer side of the third or external cuneiform bone, is the remaining bone of the tarsus, named the *cuboid* bone (κύβος, a cube; εἶδος, form), *cu*, which forms the fibular border of this part of the foot, and is connected behind, by a slightly moveable joint, with the os calcis, sometimes, at one corner, with the scaphoid, and in front, very firmly, with the fourth and fifth metatarsal bones. The cuboid, the three cuneiform, and the scaphoid bones, form the anterior group of the tarsal bones, being all firmly connected together, but moving in mass, with some freedom, on the os calcis and astragalus, which form the hinder group. The metatarsus, which succeeds to the tarsus, has five bones, numbered as in the hand, one for the support of each toe, but, unlike the metacarpal bones, they are all arranged side by side, parallel with each other, the adjacent lateral surfaces of their hinder ends being articulated together. They are firmly connected behind, three with the three cuneiform bones, and two with the cuboid bone; but, in front, they form very moveable joints with the first or proximal phalanges of the several toes; beneath this joint, in the great toe, are two *sesamoid* bones. The *phalanges* of the *toes*, P′14, fourteen in number, as in the thumb and fingers, two for the great toe, and three for each of the other toes, are named as in the hand, *first*, *second*, and *third*, or *proximal*, *middle*, and *distal* or *terminal*; whilst the last or *nail-bearing* phalanx is here also named the *ungual* phalanx. The second phalanges of the fourth and fifth toes, and the ungual phalanges of all but that of the great toe, are very small bones. The *great toe* is named the *hallux* (ἅλλομαι, *hallomai*, to bound or spring). Although the phalanges of the four outer toes are much smaller than the corresponding phalanges of the hand, yet those of the great toe are larger than those of the thumb. The bones of the lower limbs are, with the exception of these phalanges, larger than the corresponding bones of the upper limbs; they are employed in standing, and in locomotion.

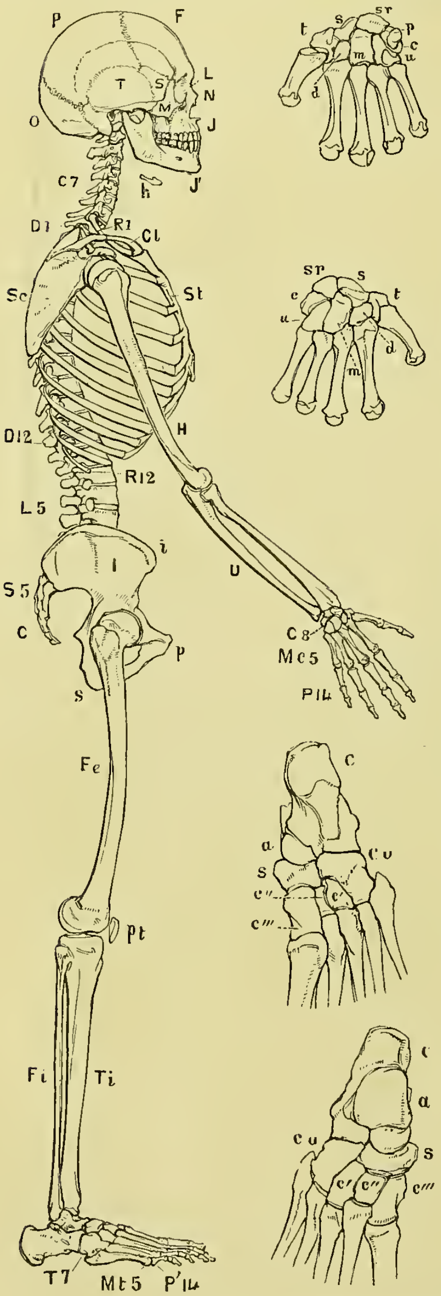


Fig. 1.—Key-figure of the Skeleton, showing the Limbs of the right side only.

Figs. 2 and 3.—The front and back of the Carpus and Metacarpus.

Figs. 4 and 5.—The under and upper surfaces of the Tarsus and Metatarsus.

Table of the Bones.

The following table constitutes a reference to the key-figures, 1 to 5, and will help the memory as regards the names of the bones, and their position in the skeleton; it also gives the number of the bones in each great subdivision of the body, as well as the total number in the whole skeleton. The shoulder-girdle and hip-girdle are here placed in conjunction with their respective extremities. The two patellæ are not enumerated as bones of the skeleton proper; nor are certain little *ossicles*, six in number, belonging to the ears, though these latter deserve to be so considered.

The Head		22
The Cranium, 8, viz.—		
Occipital, O	1	
Parietal, P	2	
Frontal, F	1	
Temporal, T	2	
Sphenoid, S	1	
Ethmoid	1	
The Face, 14, viz.—		
Malar, M	2	
Superior Maxillary, J	2	
Nasal, N	2	
Lacrymal, L	2	
Inferior Maxillary, J′	1	
Palate	2	
Turbinated	2	
Vomer	1	
The Spine		26
Vertebræ, Cervical, C_7	7	
,, Dorsal, D_1 to D_{12},	12	
,, Lumbar, L^5	5	
Sacrum, S_5	1	
Coccyx, C	1	
The Ribs or Costæ, R_1 to R_{12}		24
The Sternum, S*t*		1
The Hyoid Bone, *h*		1
The Upper Extremities		64
Clavicle, C*l*	2	
Scapula, Sc	2	
Humerus, H	2	
Carried forward		138

Brought forward		138
The Upper Extremities (*continued*)—		
Ulna, U	2	
Radius, R	2	
Carpus, C^8, viz.—	16	
Semilunar, *sr*		
Cuneiform, *c*		
Pisiform, *p*		
Scaphoid, *s*		
Trapezium, *t*		
Trapezoid, *d*		
Os magnum, *m*		
Unciform, *u*		
Metacarpus, Mc_5	10	
Phalanges, P_{14}	28	
The Lower Extremities		60
Innominate, I	2	
Ilium, *i*		
Ischium, *s*		
Pubes, *p*		
Femur, F*e*	2	
Tibia, T*i*	2	
Fibula, F*i*	2	
Tarsus, T_7	14	
Astragalus, *a*		
Os calcis, *c*		
Scaphoid, *s*		
Three Cuneiform, *c*′, ″, ‴		
Cuboid, *cu*		
Metatarsus, Mt_5	10	
Phalanges, P_{14}	28	
Total		198

The Influence of the Skeleton on the General and Local Forms.

The skeleton obviously constitutes the *hard* basis of the Human Form. This hardness is due to the chemical composition of the bones, which consist of no less than about 66 per cent. of earthy matter, chiefly phosphate and carbonate of lime, and of 33 per cent. of an animal substance which is convertible into gelatine or glue on being boiled. The intimate admixture of these two constituents, even in the minutest particles of the bone substance, contributes to its combined firmness and elasticity. If the animal matter be removed by careful burning, the residual earthy matter still retains the form of the bone, but crumbles under very slight pressure or force. When the earthy matter is dissolved out by a dilute acid, the residual animal matter, also retaining the form of the bone, may be bent in any direction, but recovers its shape on being left alone; thus, a long bone, like the fibula, may be tied into a knot, whilst a flat bone, like the scapula, may be squeezed through the narrow neck of a wide bottle. The earthy basis is hard and brittle; the animal basis is soft and elastic; combined, they are very hard, and very strong. Bone resists local pressure, so that it cannot without great difficulty be indented; it resists local force or strain, so as not very easily to be broken. Weight for weight it is the strongest material known to us. It is even stronger, because more elastic, when moist and living, than when dry and dead. The absolute resistance of bone to breakage, as compared with that of other materials, has been expressed by the following numbers: Wrought Iron 580, Copper 440, *Bone* 270, Wood 120, Marble 20, Lead 19.

As regards general *form*, the most readily distinguished bones in the skeleton, are the so-called *long* or *cylindrical* bones, such as the femur, humerus, tibia and fibula, radius and ulna, the ribs, the collar-bones, the metacarpal and metatarsal bones, and the phalanges of the fingers and toes; others again are called *broad, flat*, or *tabular*, such as the bones of the upper part and sides of the cranium, and the scapula and innominate bones; others again are *short*, such as the bones of the tarsus and carpus; and lastly, the remainder are termed *mixed* or *irregular* bones, such as the bones of the face and the base of the cranium, the moveable vertebræ, the sacrum, the coccyx, and the sternum. Speaking generally, the long bones form central levers, as in the limbs, the broad or flat bones protect the cavities of the body, such as those of the pelvis and cranium; whilst the short bones are found where great strength, combined with both elasticity and a limited capacity of movement is required, as in the spine, the wrist, and the hinder part of the foot.

The long bones are always curved. Some, like the femur, present a single curve; others are curved in two directions, like the collar-bone, whilst others, again, like the ulna and the ribs, present complex curves, accompanied often with a twist or torsion. All such curvatures increase the elasticity and, so far, the resisting power of the bone; they also serve to enlarge the surface of attachment for muscles, and to furnish the means of giving special direction to certain portions of a muscle. Instances of this kind are to be found in many long bones, and in parts of broad bones, as in the femur, ulna, radius, and collar-bone ; in the crest of the ilium, and the spinous process of the scapula.

In the living body, the bones have a pinkish-white *colour*, are always *moist*, and are provided with blood-vessels, absorbents, and nerves, being full of large and small channels for their passage. They are, besides, covered closely with a vascular fibrous membrane, which should never be dissociated mentally from them, through the vessels of which they are partly nourished, and from which they are chiefly formed. This membrane, named the *periosteum*, covers every part of a bone, excepting those portions which enter into a joint; it serves to soften or tone down any asperities of the surface. In the interior of the bones there also exists a soft vascular tissue, named the *medullary membrane*, or *endosteum*, which in the long bones contains fat, and constitutes the *medulla* or *marrow*.

As to their *structure*, the bones are composed of an outer dense layer of *compact* tissue, varying in thickness, and of an inner open or porous tissue, called the *cancellated* tissue. The cancellated structure presents, on a section, numerous little bars or beams, named *trabeculæ* (*trabs*, a beam), which coalesce with each other. They are in reality the edges of scattered and perforated *laminæ*, which, by becoming flattened and fused together, give rise to the compact tissue; and even this, when examined closely, is found to be laminated. In some bones, as in the long bones of the limbs, where great strength is needed, the outer compact layer is very thick, especially in the middle of the bones; but towards the ends of these bones, where they expand to form the articular extremities, this layer becomes thinner, and the interior of the bone is filled with cancellated tissue. This latter, on the other hand, gradually becomes more open towards the shaft of the bone, when it disappears, leaving an actual cavity, the medullary cavity, occupied by the marrow. This cylinder-like construction of the long bones, adds virtually to their strength, both as regards the support of perpendicular weight, and the resistance to lateral force or strain. This statement, it is obvious, refers to the total amount of bone substance; for, as is well known, an equal quantity of any solid material, arranged in a hollow cylindrical form of a given length, is stronger than the same quantity disposed in a solid form, of equal length. The quills of a bird are often quoted as admirable examples of this fact; and the hollow expanded cylindrical bones of the bird's wing, with their thin compact walls, filled with air, afford another illustration of it. In the broad bones, the short bones, and the irregular bones, the outer compact layer is relatively thin, the bulk of the bone being made up of cancellated tissue, without a distinct medullary cavity. In those cases, as well as at the ends of the long bones, the osseous tissue is spread out, in order to give broader surfaces of contact and support, and to resist weight, rather than to withstand a cross strain from muscular action. It is remarkable that the laminæ

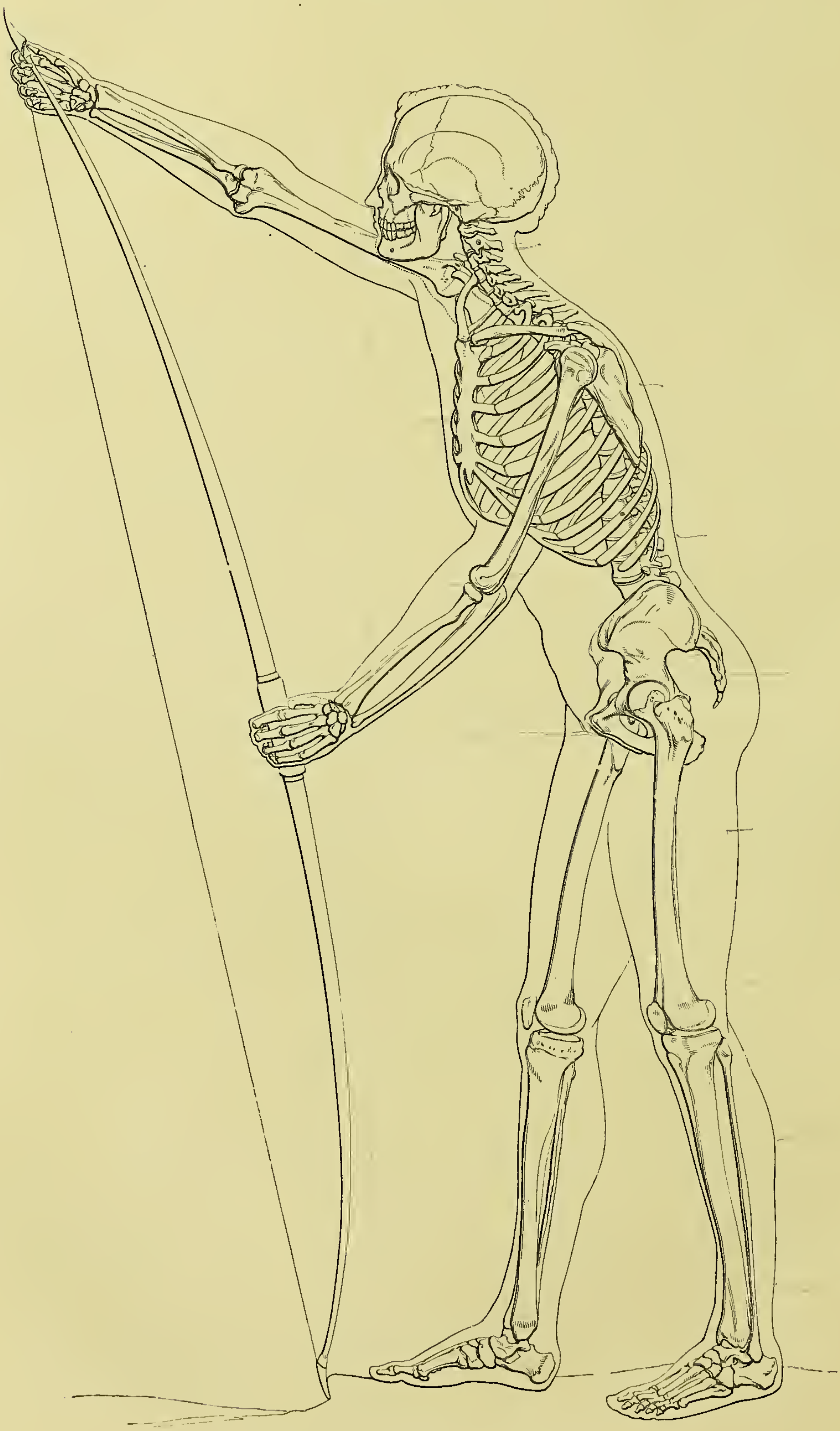


Fig. 6.—The entire Skeleton, as in action.

and trabeculæ of the cancellated tissue, are arranged in planes and lines, more or less curved, and having an exact conformity to the direction of the weight, pressure, or muscular force, to which any given bone or part of a bone is subjected in the body, when at rest or in motion. These facts are illustrated in the *sections* of the foot, knee, head and neck of the femur, and elbow, given subsequently in the figures of the Joints, which show the course of some of the trabeculæ and laminæ, and their passage into the compact, but also laminated, tissue. As might be expected, the laminæ and trabeculæ are larger, more boldly marked, and more definitely arranged in the bones of the lower than in those of the upper limb, and in the bodies of the lumbar than in those of the cervical vertebræ.

Collectively, as we have seen, in studying the position and connexion of the bones in the skeleton, these parts determine substantially the three dimensions of the body, viz. its length, breadth, and depth from front to back. Collectively, too, they support all the other parts of the frame, hold each part in its proper and relative position, and afford protection to the various organs, viscera, vessels and nerves, even in situations where no distinct cavities exist; for example, at the inner side and aspect of flexion of the limbs, and especially in the palms of the hands and the soles of the feet. Collectively, too, they determine the different attitudes, the balance and the general movements of the whole body, these being maintained and accomplished by the agency of the muscles, under the control of the nervous system.

But individually, also, the bones are concerned in yielding support and protection to adjacent parts, in determining the local movements, and in regulating the local proportions, and, to a certain extent, the local forms, of the body. In these respects, accordingly, the bones must be studied individually by the artist, but, especially, in reference to their effect on local form, proportion and movement. Their dimensions, shapes, surfaces, articular extremities, direction, connexions, mechanical uses, and movements, must all be examined, sometimes one, sometimes another point more carefully. Especially the mode in which they affect the *surface forms* of the body, must here be studied. In certain cases, the bones, or parts of bones, are so deeply seated, and so much covered and concealed, that they influence the superficial form in a remote and very general manner only; in other cases, however, parts of them, at least, approach the surface so nearly that they determine its local form, though not its actual finish. The length of one bone, the breadth or thickness of another, the straightness of this bone, the curvature of that,—the shaft of one bone, the ends of another,—in this place, a curved or rounded surface, here a ridge, and there a prominence, reveal themselves, more or less evidently, beneath the integuments, amidst other neighbouring forms, which depend on the presence of subjacent tendons, muscles or fat; and it is necessary particularly to bear in mind, that all surface forms and local proportions which are due to bony structures, of whatever kind or character they may be, whether prominent or depressed, are more determinate and less variable and fleeting, than those which are produced by softer and more yielding tissues. The deep-seated and well-covered parts of bones are usually marked with lines, ridges, or depressions, bounded with flattened or uneven surfaces, or roughened, for the attachment of ligaments, tendons and muscles; or they present grooves, notches, or foramina, for the lodgment of tendons or the passage of vessels or nerves; but in the subcutaneous parts of bones, these irregularities disappear, and the surface is smoother or even polished, and so gently modelled, that its outlines and contours compose and harmonise with the lines and forms of the neighbouring soft parts, all being covered by the skin. The frontal bone, the collar-bone, and the inner surface of the tibia, furnish the best illustrations of this harmony of form between adjacent hard and soft parts of the body, which, though resulting from a consentaneous development and growth, and of course adapted to the structural requirements of those parts, seems indicative of a special design, having reference to beauty of form.

Nevertheless, throughout the whole skeleton, all parts of the bones, the most uneven as well as the smoothest, present to close observation, forms of singular elegance, remarkable variety, and, very frequently, of admirable finish. This is especially true of the human skeleton. If we call to mind the flattened or disc-like plates of the bones of the fish's head, the simple curved bars of its jaws, and the slender thorn-like or needle-like character of its ribs,—the smooth unmodelled bones of the frog,—the sameness of the surfaces of the bones of the crocodile,—and even the somewhat varied but yet simple forms of the sternum, wing-bones, ribs, and leg-bones of the bird,—the fact soon becomes evident that, in none of these, is there manifested that intricacy of contour, form, and modelling, which strikes the eye so quickly in studying the bones of most of the mammalia. In these latter, especially, the limbs acquire a greater play of movement, the muscular system is necessarily increased in complexity, and the muscles themselves multiplied in their lines of action; and, accordingly, the bones, the developement of which is always in accordance with the forces acting upon them, become more varied in their prominences and depressions. But it is in Man, whose body is balanced erect on his lower limbs, or even, as in the alternate movements in walking or running, on one, whilst the upper limbs are devoted to so many special uses, that the relations of the muscles to the bones, and of the bones to the muscles, become most complex; and in the human skeleton, therefore, the greatest variety and richness of modelling of the osseous surfaces is met with. A finely-formed, perfect, and well-prepared human skeleton is, indeed, an object of great intrinsic beauty; it is the best example of what might truly be called 'still life;' and its careful representation is one of the best exercises for the pencil of a youthful draughtsman.

It is to be noted, lastly, that the bones, as we have already mentioned, were not originally hard and opaque, nor made of compact and cancellated tissue, with the laminæ of the former and the trabeculæ of the latter specially and definitely arranged; nor were they at first possessed of the varieties of form, so remarkable in the adult state. On the contrary, with the exception of some of the bones of the head, those especially of the sides and upper part of the cranium, which are developed from membrane,—the various pieces of the skeleton in their primordial condition, are very simply shaped and comparatively soft, semi-transparent, homogeneous nodules, bars, or plates of cartilage or gristle. Even at an early period of growth, when ossification has begun at one or several points within them, their outline and surfaces retain much of their original simplicity; but when growth is fully completed, and they are truly bones, they assume their special morphological characters; instead of being homogeneous, they acquire their cancellated internal, and compact external, structure, whilst the primitive cartilage is retained, though slightly modified, upon the articular surfaces of the joints. During the whole period of growth, however, they are not merely influenced by their own developmental tendencies, due to an organising force, but they are incessantly subjected to gravity, to local pressure, and to the strain and pull of the muscles surrounding them, and everywhere attached to, or bearing upon, them. They are formed, indeed, under such conditions that, comparatively soft and simple at first, they grow not merely in strict harmony with the muscles and tendons connected or associated with them, but are gradually shaped, in dependence upon, and under the control of, the muscular force, and the influence of local pressure and weight. To these agencies, the curves and torsions, prominences and grooves must be mainly due; they must continue to operate during the whole of life; hence, even in the adult state, the bones, which are continually having their substance changed and renovated, very often, owing to special circumstances of pressure or muscular strain, or to excess or want of use, undergo actual alterations in their form. The proper forms of the skeleton, however rigid and unchangeable their shape after death, have thus owed their production to processes dependent upon life. It is this which is evidenced in their subtle contours; it is this which always imparts to them an interest they would not otherwise possess. They are organic; they grow, they are not simply moulded or manufactured; though dead, the history of a past life is written in indelible characters upon them.

THE SEPARATE BONES.

In anatomical works generally, including those intended for artists, the description of the Bones commences with that of some part of the central axis of the body, and concludes with that of the limbs. But, if the skeleton is to be regarded as a machine of absolute perfection, or as the basis of a perfect plastic form, then it is not unfitting to study its individual parts, as they are built up into an erect figure, supported on the lower limbs, with the trunk carried upon them, the upper limbs set free for prehensile or manipulative purposes, and the head, in which are situated the organs of the senses and that of the mind, surmounting the whole. Accordingly, in describing the Bones in detail, and likewise in the subsequent account of the individual Joints and Muscles, the order adopted in the following pages is not 'a capite ad calcem,' but 'a calcaneo ad caput.'

It has further been decided to omit all letters of reference in the Illustrations of the bones, except in the key-figures of the skeleton, and in the representations of the skull. The numerous minute points which demand the attention of the anatomist and the surgeon, necessitate such aids; but the Art-student's mind should be left unencumbered by such unnecessary details; and, moreover, the pure forms of the bones, represented on so small a scale, in black and white, would have been seriously marred by such references. So far as is possible, all the facts to be noted are represented in these drawings; and by their assistance the descriptions may be followed. The absence of letters of reference may somewhat strain the attention; but the knowledge of the forms described will probably be as accurate, and the recollection of them more lasting, on the part of the student. To read the descriptions, with the bones themselves, would, of course, be preferable.

In the account of each separate bone, the points with which the muscles or tendons are connected, are invariably mentioned, as well as the attachments of almost all the ligaments. In learning the muscular attachments, much assistance will be obtained by referring to the illustrations of the muscles, in which each muscle is numbered; for those parts are so much more numerous than the bones, and so much more inaccessible to the Art-student, that they, obviously, need this special and ready means of identification.

The principal figures, as well as the descriptions, of the bones, are to be understood as drawn strictly from the male skeleton. The differences observable in that of the female will be, hereafter, illustrated and explained.

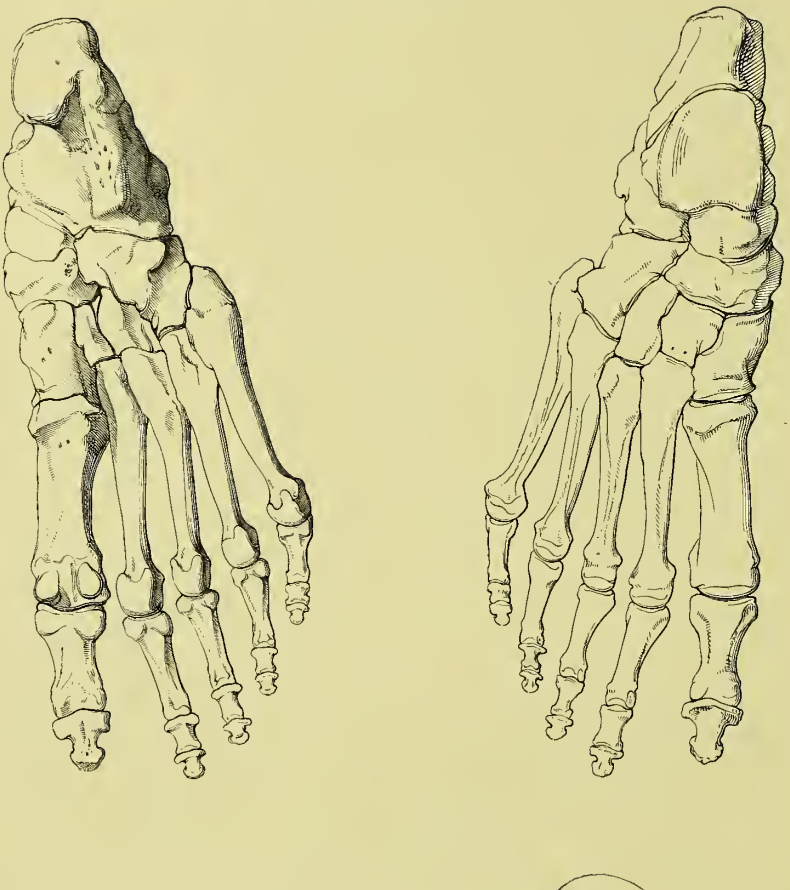
The bones of the foot, hand, and head, are drawn to a scale of two-fifths of the natural size; those of the long bones of the limbs, of the pelvic and shoulder girdles, and trunk, are about one-third the size of nature; the separate vertebræ and the patella are two-thirds; and lastly, the entire skeletons are about one-eighth, the key-figure of the same being one-tenth. It may be added that the scale adopted for the joints is always one-third ; and that, in nearly all cases, the one used for the illustrations of the muscles, agrees with that employed for the bones of the same part; hence they may easily be compared.

The Bones of the Foot.

The *sole* of the foot, the part which is turned towards, and rests upon, the ground (*solea*, a sandal; *solum*, that which is set or solid), presents to view, in the skeleton, the under surface of every bone in the foot, except of the astragalus, a small portion only of which is here visible, on the inner side of the sole (fig. 7). The bones seen are the phalanges, the metatarsal bones, the three cuneiform bones, the scaphoid, the cuboid, and the os calcis. The *dorsum* or *back* of the foot, exhibits the whole of the upper surface of all these bones, excepting that of the os calcis, a great part of which is seen behind, but only small portions at the sides of the foot (fig. 8). In the sole the astragalus is nearly hidden by the os calcis ; on the dorsum, the os calcis is partly hidden by the astragalus, which rests almost exclusively upon it. The astragalus is the highest bone of the foot, and the one which alone articulates with the bones of the leg. As to the *inner* or *tibial border* of the foot, it is formed, proceeding from behind forwards, by the os calcis, a portion of the astragalus, the scaphoid, the internal cuneiform, the first metatarsal bone, and the two phalanges of the first or great toe (fig. 9). The *outer* or *fibular border* of the foot, examined in the like order, is composed of the os calcis, a small portion of the astragalus, the cuboid, the fifth metatarsal bone, and the three phalanges of the fifth or little toe (fig. 10).

The Phalanges of the Toes.—The phalanges, figs. 7 to 10, considered generally, are much shorter, smaller, and more slender than the phalanges of the fingers, those of the great toe being, however, larger than those of the thumb. They are miniature long bones, each having a shaft and two extremities.

The *terminal* or *ungual* phalanges of the four outer toes are very small bones ; that of the second toe is usually the broadest ; that of the third, the longest of the four. They present, at the fore-part of their plantar surface, a rough horseshoe-shaped eminence for the attachment and support of the pulp of the corresponding toe; the dorsal surface is smooth and convex, terminating behind in a transverse ridge, both the surface and ridge supporting the nail; behind the ridge is a small tubercle, for the insertion of the terminal portion of the extensor tendon ; on the plantar aspect, is a broader ridge, for the insertion of the end of the long flexor tendon ; at the sides, are small tubercles, for the lateral ligaments. Their hinder end presents



Figs. 7, 8.—The under and upper surfaces of the Bones of the Foot.
Figs. 9, 10.—The inner and outer borders of the Bones of the Foot.

a broad, double, concave articular surface, which is adapted to the distal extremity of the second phalanx.

The *second* or *middle phalanges* of the four outer toes, being interposed between the ungual and the proximal phalanges, are necessarily provided with articular surfaces at each end; the anterior one is an indistinctly marked trochlear surface, which is fitted to the double cup and intermediate ridge of the corresponding ungual phalanx; the hinder one is a concave surface, divided into two by an intermediate ridge, so as to fit the trochlear surface of the distal end of the first phalanx. The second phalanges of the second and third toes only, present a distinct shaft and extremities; those of the fourth and fifth being not longer, and sometimes even shorter than they are wide. They have lateral and other tubercles, for the attachment of ligaments or tendons, but these are feebly pronounced; their articular surfaces, at each end, are indistinct; indeed the second and third phalanges of the fifth toe, are, frequently, and those of the fourth toe, occasionally, joined together by bone. The second phalanges have the expanded tendons of the long and short extensor muscles attached to their dorsal surface, but the little toe receives no slip from the short extensor; those of the short flexor muscle, are inserted into their plantar surface.

The *first* or *proximal* phalanges, placed at the roots of the toes, are the *longest*. Their shafts are convex on their dorsal surface, flattened from side to side, and narrow and slightly concave longitudinally on their plantar aspect. Their anterior ends are provided with a more or less well-formed trochlear, or pulley-like articular surface, consisting of two eminences or little lateral condyles, and an intermediate hollow; to these, the hinder ends or bases of the second phalanges are more or less accurately fitted, so as to form hinge-joints. Their hinder ends are widened, and furnished with comparatively deep, concave, articular surfaces, wider from side to side than from above downwards, which are adapted to the convex anterior extremities or heads of the metatarsal bones, the joints thus formed, being ball-and-socket joints. On their under surfaces, are two lateral, longitudinal, ridges, to which the strong sheaths of the flexor tendons of the toes are fixed at the sides; just behind their anterior extremities, are tubercles for the attachment of the lateral ligaments; near their proximal ends, lateral rough surfaces are found, also for the attachment of ligaments and for the tendons of the interosseous and other short muscles connected with the toes.

The two phalanges of the *great toe* are larger than those of the thumb. The *second* phalanx of the great toe, is its terminal or ungual phalanx; it is, of course, much longer, broader, and thicker, than the ungual phalanges of the other four toes; its shaft is provided with a smooth dorsum, for the support of its large nail; and its tip is provided with a large rough horseshoe-shaped eminence, for the attachment of the pulp of the toe; at its hinder end or base, it has a broad, articular surface, divided into two, by a blunt vertical ridge, so as to be adapted to the pulley-like surface, on the head of the first phalanx; near this end, it has a broad tubercle on its dorsal aspect, for the insertion of the proper extensor tendon, and a rough surface, on its plantar aspect, for that of the long flexor tendon. Its *first* phalanx is not only the largest of those of the foot, but it is at least twice, or more than twice, as broad as any of the others, which diminish in size from the second to the fifth. Its articular surfaces are very broad; the posterior one is deeply concave. The inter-phalangeal joint of the great toe is, like those of the other toes, a hinge-joint; the metatarso-phalangeal joint, at the base of this toe, is also a ball-and-socket joint.

The Metatarsal Bones.—The five *metatarsal bones*, figs. 7 to 10, are placed behind the phalanges, between them and the bones of the tarsus. They are small, but characteristic long bones, having, comparatively, slender shafts, and expanded extremities, for connexion with other bones. They are arranged nearly parallel with each other, but diverge somewhat at their anterior ends, so that the quadrangular form of the entire tarsus is not quite regular. The tarsal ends of the metatarsal bones are in actual contact, except the first and second, which, although close together, do not quite touch each other; but their phalangeal extremities are all of them, and especially the first and second, apart, being merely held together by intermediate ligamentous bands; hence this part of the foot itself is broader in front. Between these bones, are four narrow spaces, named the *interosseous* spaces, which become wider in front. The entire *metatarsus* is nearly quadrilateral in shape, but its individual bones are of unequal length, so that their anterior extremities correspond with a curved line, the most convex part of which is opposite the head of the second metatarsal bone, and which passes obliquely, backwards and outwards, to that of the fifth. They are also unequal in size. The first, or innermost, is the shortest and thickest, and, therefore, the strongest, being intended to support the great toe, towards the ball of which it descends; but it is too short to reach the level of the other metatarsal bones, and is here supported on two *sesamoid bones*, placed beneath its anterior end, figs. 7, 9. The second, third, and fourth metatarsals are all very slender. The second is the longest, its anterior end projecting forwards, to approach the ground opposite the ball of the second toe, without the intervention of sesamoid bones, whilst its hinder end passes backwards, beyond the first and second metatarsal bones, to meet the shortest of the cuneiform bones. The third is shorter than the second, but longer than the first. The fourth closely resembles the third, but is somewhat smaller. Lastly, the fifth has its shaft a little shorter than the fourth, but much thicker, and also slightly curved outwards at its fore-part, as if to afford additional strength and width to the outer border of the foot; moreover, it is distinguished by its slanting outer surface, its great breadth at its tarsal end, which rests against the cuboid bone, and also by its remarkable process, named the *tuberosity*, which projects backwards beyond the cuboid bone, and forms a very important prominence on the outer border of the foot. To this tuberosity, besides the plantar fascia, the tendon of the peroneus brevis is attached; to the dorsal surface of the base of the bone, that of the peroneus tertius; the under side of the base of the bone gives origin to the short flexor of the little toe.

The *shafts* of the five metatarsal bones gradually diminish in size from behind forwards; they are smooth on their opposed surfaces, which give origin to the dorsal interosseous muscles; from the under and inner surfaces of the third, fourth, and fifth, the plantar interossei arise. They are slightly convex from before backwards, on their dorsal surface, and, on the contrary, slightly concave on their plantar aspect, so that they form the fore-part of the so-called *antero-posterior arch* of the foot, the hinder portion consisting of the tarsus. The dorsal surfaces of these bones, with the exception of that of the first, are turned somewhat outwards; they are, moreover, wider than the under surfaces, which more nearly resemble an edge, so that, the sides of the bones being flattened, their transverse sections are somewhat prismatic or wedge-shaped; they likewise form a sort of transverse arch, as bound together in the foot.

The *dorsum* and the *inner surface* of the *first* metatarsal bone, the former being turned a little inwards, are rounded and smooth, like other bony surfaces which are subcutaneous, or covered only, or chiefly, by skin. The anterior end of the bone is much expanded, especially in a lateral direction, and terminates in a large, rounded eminence or *head*, convex in all directions, but much broader than deep, and articulating in front, with the wide deeply concave base of the first phalanx of the great toe. This articular surface is continued further backwards on the plantar than on the dorsal aspect, and there presents two longitudinal grooves, with a sharp intermediate ridge, or a double pulley-like surface, for the reception and play of the two sesamoid bones, which are here articulated with it; lastly, the hinder part, or *base* of the bone is chiefly expanded in the vertical direction, and is somewhat narrower on the dorsal than on the plantar aspect; it has no lateral articular facet on its outer side, but, at its end, it presents a semilunar, ear-shaped, or kidney-shaped surface, elongated vertically, and slightly concavo-convex, to articulate with an oppositely shaped facet on the anterior surface of the internal cuneiform bone. Hence, like the thumb, its representative in the hand, it does not articulate with the neighbouring bone on its outer side, and has an independent joint at its base. The plane of this joint, as regarded from above, slants a little backwards and inwards, so that the shaft of the bone is directed slightly inwards, away from the second metatarsal bone; viewed from the inner side, the articular plane slants downwards and backwards, so that the bone itself is directed downwards and forwards, from the tarsus towards the ground. The under border of the base of this bone is prolonged towards the middle of the sole of the foot, so as to meet the tendon of the peroneus longus muscle, which is inserted into a rough, oval prominence on this part of the bone. On the side of the bone, next to the second metatarsal bone, is a flat or slightly hollowed surface for the origin of the inner head of the first dorsal interosseous muscle. The under surface is broad and concave, and, at its hinder end, presents a prominence for the attachment of a part of the tendon of the tibialis anticus; this surface is separated from the inner subcutaneous surface by a curved ridge.

The anterior extremities or *heads* of the four outer metatarsal bones are very nearly alike; they decrease in size from the second to the fifth, the latter presenting great irregularity of surface. They are compressed laterally, and terminate in smooth, convex, articular eminences, which are prolonged further on the plantar than on the dorsal aspect, that is, more on the aspect of flexion or bending of the joint, than on that of extension or straightening. These surfaces articulate with the somewhat deeply concave bases of the first phalanges of the corresponding toes; they bifurcate posteriorly, and end in two little eminences which serve to support certain cartilaginous plates belonging to these joints, and, moreover, they are slightly grooved in the middle, for the reception of the long flexor tendons. Behind the articular surfaces, are certain symmetrical prominences for the attachment of the plantar fascia and ligaments, and, in the case of the fifth metatarsal bone, for the partial origin of the transverse muscle of the foot.

The wide *tarsal ends* or *bases* of the second, third and fourth metatarsal bones, are broad and rough on the dorsal surface, and somewhat narrower, but also rough, on the plantar surface, for the attachment of ligaments and of fibrous expansions from the tendon of the tibialis posticus muscle, and also for the origin of the adductor pollicis muscle. They resemble each other in form, being more or less wedge-shaped, and they articulate, by somewhat triangular and flattened surfaces, with their appropriate tarsal bones, and, by nearly plane surfaces, with each other, at their contiguous sides. The *second* metatarsal, narrow on its under surface, and reaching further backwards to articulate with the middle cuneiform bone, is dovetailed in, between the internal and external cuneiform bones, with both of which it is also articulated. It likewise forms a small joint on its outer side, with the third metatarsal bone, so that it articulates with four bones. This wedge-like reception of the second metatarsal bone, strengthens this part of the foot. The *third* metatarsal articulates, by its posterior extremity, with the external cuneiform bone, and, laterally, with the second and fourth metatarsal bones. The *fourth* articulates posteriorly, by a nearly quadrilateral surface, with the cuboid bone; on its inner side, with the third metatarsal and the external cuneiform bones, and on its outer side, with the fifth metatarsal bone. The *fifth* metatarsal bone itself also articulates behind with the cuboid, by a triangular surface, which is broader from side to side than from above downwards, contrary to the condition characteristic of all the other metatarsal bones; moreover, this articular surface is slightly concave from above downwards, and very slightly convex from side to side.

The line of junction of the three outer metatarsal bones with the tarsus, runs obliquely outwards and backwards across the foot, the part corresponding with the fifth bone being the most oblique, and appearing on the outer border of the foot, in front of the cuboid bone. The articular surfaces of the three outer metatarsal bones, as viewed from above, are not at right angles with the shafts, but are oblique, so that the bones are directed forwards, sometimes even slightly inwards, never in the same direction as the external cuneiform and cuboid bones, which look forwards and outwards.

All five metatarsal bones necessarily slant more or less downwards and forwards, as they extend from the tarsus towards the ground. But these bones do not all incline at the same angle; the second, which is connected with the middle cuneiform bone at the highest part of the tarsus, inclines the most; the first would incline more, were it not for the sesamoid bones beneath it; the third slants nearly as much as the second, the fourth still less, whilst the fifth approaches nearly to a horizontal line. This is due to the gradual lowering of the transverse tarsal arch of the foot, from the second cuneiform bone outwards to the cuboid bone. The backward inclination of the planes of the articular surfaces at the bases of the metatarsal bones, diminishes as the bones themselves become less inclined.

The lengths of the five metatarsal bones are so adjusted that their anterior extremities or heads, which correspond with the balls of the respective toes, form a curved line on the sole of the foot, which, commencing at the head of the first metatarsal bone, or ball of the great toe, may be traced, passing abruptly forward, to the head of the second metatarsal bone, or ball of the second toe, and then, gradually backward, through the heads of the third, fourth, and fifth bones, or the balls of the corresponding toes; this line may be called the *anterior metatarsal curve.*

The Tarsal Bones.—Of the *three cuneiform* bones, figs. 7 to 9, the *first*, or inner one, less regularly wedge-shaped than the other two, is the longest and the largest. The *second*, or middle one, is the shortest and the smallest; it is, indeed, the smallest of the tarsal bones. In front they are articulated respectively, with the first, second, and third metatarsal bones; their articular surfaces are much elongated from above downwards, that for the first bone being semilunar, whilst the others are triangular in outline.

Behind, they all articulate with the scaphoid, by triangular and slightly concave or undulating surfaces elongated from above downwards. The middle cuneiform is in contact, on either side, with the internal and external cuneiform bones; and the latter, again, on its inner side, not only with the middle cuneiform, but, by a small facet, with the side of the base of the second metatarsal bone, and on its outer side, by an oval facet, with the cuboid bone. All the articular surfaces concerned in these joints, with the exception of those of the first metatarsal and the internal cuneiform bone, which are slightly concavo-convex, are nearly plane or flat. Those in front of and behind the cuneiform bones, are inclined somewhat backwards and downwards; and these bones themselves, placed on a lower level than the scaphoid behind them, prolong the slope of the instep, downwards and forwards, to the metatarsal region of the foot. The *dorsal* surface of the internal cuneiform is narrow, and slants inwards very rapidly; that of the middle cuneiform, rectangular and flattened, is placed opposite the highest part of the scaphoid, and stands higher than the rest; that of the external cuneiform, oblong and broader, slopes more gradually outwards and downwards, to the cuboid bone. The inner subcutaneous surface of the internal cuneiform, is rhomboidal in outline, and is very deep, much deeper than that of the scaphoid, and presents in front and below, a smoother part over which the tibialis anticus tendon glides. The outer surface, as we have seen, articulates not only with the middle cuneiform, but in front of this, by a small facet, with the side of the base of the second metatarsal bone. Its plantar surface is much broader than the dorsal, so that, in regard to this cuneiform bone, the thin edge of the wedge is turned upwards, whilst, in the other two, it is turned downwards; this surface, in front and towards its inner border, is roughened for the insertion of a portion of the tendon of the tibialis anticus, and behind presents a prominent tubercle for a portion of the tibialis posticus tendon; it also receives fibres from the tendon of the peroneus longus. The plantar surfaces of the middle and external cuneiform bones form narrower ridges, which are seen, deeply sunk, between the internal cuneiform and the cuboid bone; they receive slips from the tibialis posticus tendon. The flexor brevis pollicis muscle partly arises from the plantar surface of the external cuneiform bone.

The *cuboid* bone, figs. 7, 8, 10, occupies the outer side of the foot, in a line with the os calcis behind, and fills up the triangular interval, bounded in front by the fourth and fifth metatarsal bones, on the inner side by the outer surface of the external cuneiform and the outer end of the scaphoid, and behind by the os calcis. With the last-named bone, it articulates by an undulating surface, sending a sort of spur-shaped process, from its inner and lower angle, beneath the os calcis. With the other bones, it articulates by more or less plane surfaces, but frequently it is connected with the scaphoid by ligamentous bands only. The articular surface for the fourth and fifth metatarsal bones, is divided by an oblique ridge, passing downwards and inwards, into two facets, an inner smaller and quadrangular, and an outer larger and triangular facet, the latter being broader transversely than vertically, and slightly concave from above downwards. The articular surface for the external cuneiform bone, occupies only a small portion of the inner and longer side of the cuboid bone, the rest being roughened for the attachment of ligaments, sometimes, however, also articulating with the scaphoid bone. The articular surface for the os calcis behind, is oblong from side to side, and undulating or slightly concavo-convex; it is prolonged, at its inner angle, beneath the os calcis. The outer side of the cuboid, by far the shortest, is comparatively thin, and, being free, forms a small portion of the outer border of the foot; owing to the shortness of this side, as compared with that turned towards the external cuneiform, the cuboid bone appears to be wedged in between the os calcis and the fourth and fifth metatarsal bones. Commencing, on this border, is a notch, which ends in a deep groove, running, obliquely, inwards and forwards, on the under surface of the bone, for the lodgment of the tendon of the peroneus longus muscle; behind this groove, is a very prominent oblique ridge for the attachment of ligaments, sometimes marked by a smooth surface, against which a sesamoid bone, occasionally present in that tendon, glides. The inner border of the plantar surface gives partial origin to the flexor brevis pollicis; and the plantar surface also receives an expansion from the tendon of the tibialis posticus. Lastly, the upper surface of the cuboid bone, roughened and sloping downwards, outwards, and forwards, completes the framework of the foot in this situation.

The *scaphoid*, or, as it is sometimes called, the *navicular* bone, figs. 7 to 10, is situated on the inner side of the foot, behind the three cuneiform bones, being placed transversely between them and the astragalus, the convex head of which is received into a deep articular concavity on the hinder surface of the scaphoid. The upper surface of the scaphoid, somewhat roughened for the attachment of ligaments, shows most plainly, the boat-like shape of the bone; it is convex from side to side, having its highest part, however, nearer to its outer than to its inner border, so that it slopes gradually, and for some distance, towards its inner, but more suddenly towards its outer border; it forms the highest portion of this part of the tarsus, but the head of the astragalus, immediately behind it, constitutes the highest point of the instep, from which the scaphoid slopes forwards and downwards. The under surface of the scaphoid, narrower than the upper, is hollow, and roughened for the attachment of the strong ligament which partly sustains the head of the astragalus.

Its inner sloping border projects prominently downwards, so as to form a remarkable *tuberosity*, situated on the inner border of the foot, about one inch and a half in front of the inner ankle: this tuberosity is of great importance, in reference to the form of this part of the foot; a portion of the tibialis posticus tendon is inserted into it. The outer abrupt border of the bone, thick and rough, overhangs the adjacent margin of the cuboid bone, with which it is sometimes articulated, by a small facet, and is always firmly attached to it by ligaments. In front, the scaphoid presents an oblong, articular surface, convex in its general form, but marked off, by two nearly perpendicular ridges, into three undulating facets elongated from above downwards, for articulation with the cuneiform bones; behind, is a deep transversely oval articular concavity, broader in its outer half, for articulation with the astragalus.

The *os calcis* or *calcaneum*, figs. 7 to 10, the largest and, by far, the longest of the tarsal bones, and therefore the largest bone in the foot, is of great relative size in Man. Elongated and flattened at the sides, and expanded posteriorly, it occupies the hinder and lower portion of the foot, is placed obliquely to the leg, and forms the heel. Its under surface presents behind, a broad rough prominent part, terminating anteriorly by two flat *tuberosities*, outer and inner, which are separated by a small depression. These afford attachment to the strong plantar fascia, and likewise give origin to several of the short muscles of the foot, namely the abductor of the little toe, that of the great toe, the short flexor of the toes, and the flexor accessorius. The inner and larger tuberosity, specially concerned in bearing the weight of the body, is covered by a closely adherent pad of thick skin and fat. In front of these tuberosities, the bone inclines upwards, forwards, and outwards, becomes narrower and excavated, so as to recede from the integument, and give space for, and attachment to, ligaments, muscles, and fascia. The fore-part of this surface presents a prominence named the *tubercle*. In front, the os calcis, occupying the outer side of the tarsus, comes into contact, by a triangular and undulating articular facet, with the posterior surface of the cuboid bone, which hooks under it slightly at its inner corner. Behind, it expands into a broad and deep projecting mass, longer from above down than from side to side, and wider below than above, which extends, obliquely backwards and downwards, beyond the leg-bones, and forms the characteristic prominence of the heel. The tendo Achillis descending from the muscles of the calf, passes over the upper part of this surface, which is smooth and polished, and in the recent state covered with cartilage. The tendon is attached to its lower half, chiefly above the inner tuberosity. The plantaris tendon also usually reaches the upper and inner part of the back of the os calcis. The outer surface of the os calcis is comparatively flat and subcutaneous; near its middle, is a well-marked eminence, the hinder part of which serves for the attachment of the middle portion of the external lateral ligament of the ankle-joint; whilst on the fore-part is a ridge or narrow tubercle, named the *peroneal tubercle*, to which is attached a portion of the external annular ligament; this tubercle separates two shallow grooves, an upper one for the tendon of the peroneus brevis, and a lower one for that of the peroneus longus, as these pass forwards, from the lower end of the fibula to the outer border of the foot; near the fore-part of this surface, is another tubercle, for the origin of the short extensor muscle of the toes. The inner surface of the os calcis, is deeply hollowed, in front of the internal tuberosity of the heel, for the reception and protection of tendons, vessels, and nerves, passing obliquely from the leg into the sole of the foot; but in front of, and above, this hollowed part, its upper margin presents a remarkable, and very strong process, projecting inwards, named the *sustentaculum tali* (the support of the astragalus), or lesser process of the os calcis. The sustentaculum is curved upwards and inwards, receives the under part of the head of the astragalus, and gives attachment to a very strong ligament which here passes forwards to the scaphoid bone. Into it, also, a slip of the tendon of the tibialis posticus is inserted; whilst,

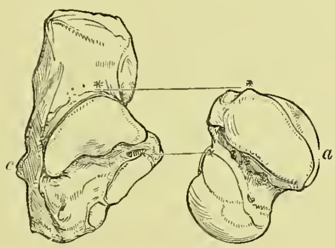


Fig. 11.—The upper surface of the Os calcis, *c*, and the under surface of the Astragalus, *a*. Right foot.

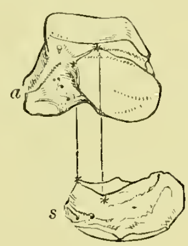


Fig. 12.—The front view of the Astragalus, *a*, with the Scaphoid, *s*, removed from it and seen from above.

The asterisks and lines, indicate the points of contact of the bones when in their natural position.

beneath it, are special well-marked grooves for the tendon of the long flexor of the great toe, and that of the long flexor of the other toes.

Lastly, upon its *upper* aspect, fig. 11, *c*, the os calcis presents two articular surfaces separated by a deep groove, namely, a hinder larger one, situated about the middle of the bone, oblong from behind forwards and outwards, convex from before backwards, but nearly flat from side to side; and an anterior internal smaller one, placed over the sustentaculum tali, narrow, lengthened and concave from behind forwards and outwards, and sometimes divided by a slight ridge into two parts. To these two articular surfaces, are adapted two corresponding surfaces on the under aspect of the astragalus, *a*. The groove between them, lodges and gives attachment to a very strong interosseous ligament. Behind these surfaces, the os calcis projects downwards and backwards towards the prominence of the heel, presenting a slight concavity above, in front of the tendo Achillis.

The *astragalus*, figs. 7 to 10, which is next, in point of size, to the os calcis, rests on and covers rather more than the anterior part of that bone, with which it articulates by two complex facets, fig. 11, *a*. One, posterior and larger, is oblong, and deeply concave from before backwards; the other, anterior, internal and narrower, is elongated, slightly convex from behind forwards and outwards, and sometimes subdivided into two parts; between them is a deep groove, running obliquely outwards and forwards. By these two surfaces, the *under side* of the astragalus comes into contact posteriorly with the body of the os calcis, and anteriorly and internally with the sustentaculum tali. The outer or anterior end of the intervening groove widens out, as it passes to the outer side of the tarsus. This groove, together with the corresponding one on the os calcis, forming the so-called *sinus of the foot*, contains the strong interosseous ligament which ties the two bones securely together.

The posterior border of the astragalus, which projects slightly behind the tibia, is narrow, shallow, and grooved obliquely downwards and inwards, for the tendon of the long flexor of the great toe. The *upper surface* of the bone presents a broad, quadrangular, slightly grooved articular surface, which is nearly horizontal, but has its outer edge sharper, longer, and a little more elevated than the inner one; it is considerably wider in front than behind, a form which is due to its outer edge being directed obliquely forwards and outwards, and not straight forwards, like the inner one. This articular surface is very convex from before backwards, but slightly concave or depressed from side to side, so as to form a shallow *trochlear* surface, the outer edge of which, as just stated, stands up a little higher than the inner one. This surface is the highest part of the tarsus, and therefore of the foot, and upon it the broad lower end of the tibia is supported. Its forms are of the utmost interest in reference to the movements of the ankle-joint. On the inner side of the bone, and continuous with its upper surface, is a small, oblong, articular facet, which, directed a little upwards and backwards, articulates with a smooth surface on the internal malleolus of the tibia; below this, is a roughened part for the attachment of the strong, internal, lateral ligament of the ankle. On the outer side of the astragalus, is a much larger articular facet, also continuous above with the upper or trochlear surface of the bone; this facet, triangular in outline, with its apex turned downwards, and concave from above downwards, is directed a little upwards and backwards, and articulates with a corresponding surface on the external malleolus of the fibula. This external facet of the astragalus reaches further back than the internal one, in correspondence with the more backward position of the external malleolus. The anterior part of the external lateral ligament of the ankle is attached to the bone in front of this facet.

In front and towards the inner side, figs. 8, 9, the astragalus is prolonged forwards and slightly outwards, and is somewhat narrowed, so as to form the *neck*. Immediately in advance of the trochlear surface of the bone, there is a deep depression, which receives the anterior border of the lower end of the tibia, when the foot is completely flexed upon the leg; it gives attachment to ligament. Anteriorly, the neck terminates in a smooth, transversely oblong, convex, articular surface called the *head*; the fore-part of this surface, fig. 12, *a*, directed downwards and inwards, is received into the deep articular concavity on the posterior surface of the scaphoid, *s*; but it also becomes continuous, on the under aspect of the bone, with the anterior, inferior, articular facet, which, as already stated, rests on the sustentaculum tali of the os calcis. Only a small portion of the under surface of the head of the astragalus, is visible in the sole, between the os calcis and the scaphoid, where it is supported by the calcaneo-scaphoid ligament which passes from one bone to the other. The head of the astragalus reaches a little further forwards on the inner border of the tarsus, than the os calcis does on the outer border; but the two bones take part in the formation of a joint across the foot, between the os calcis and the cuboid bone on the outer side, and between the astragalus and the scaphoid bone on the inner side, the line of the articulation being nearly straight in the former situation, and convex anteriorly in the latter. This is the median or transverse *tarsal articulation.* The astragalus is distinguished from the other bones of the foot, by having no tendon or muscle attached to it.

The Arches of the Foot.—Regarded generally, the bones of the foot, as already indicated, form an antero-posterior or *longitudinal arch,* extending from the os calcis behind, to the anterior ends of the metatarsal bones in front. It is elliptical in form, having its summit at the astragalus, and, therefore, its hinder part shorter, and descending more abruptly to the ground, and its fore-part longer, and sloping more gently; its hinder *bearing surface,* corresponding with the os calcis, is narrow; whilst its anterior or metatarsal surface of support, is much wider; its inner border, thick, and somewhat concave, is more elevated from the ground, than its outer border, which is thinner, straighter, and nearly horizontal. The highest part of this arch, in front of the leg, is named the *instep,* and the under excavated part, the *plantar arch.* Besides this longitudinal arch, the foot is said to present a *transverse arch,* which, however, is only clearly recognisable, across the anterior part of the tarsus, and hinder part of the metatarsus, the arched form disappearing behind and in front of those parts. As the inner end of this transverse arch is elevated from the ground, whilst the outer end touches the base of support, and as its form is likewise influenced by the existence of the longitudinal arch, the hollow of the foot, viewed from its inner side, resembles a half-dome, or the top of a rounded niche, rather than an arch.

Surface-forms dependent on the Bones of the Foot.

The general breadth of the entire foot, both on its upper and its under surface, and especially across the metatarsus, depends essentially on the bony framework, and is particularly characteristic of Man. The height of the instep, and the elevation of the plantar arch, equally dependent on its osseous fabric, are also special characters in the human foot. The hollow under part of the foot, widening from the heel to the heads of the metatarsal bones, but afterwards becoming narrower at the toes, is, almost throughout, covered with soft parts, so that but few bony prominences affect the surface directly.

The position of the broad, nearly oval, weight-bearing portion of the os calcis, of the hinder end and tuberosity of the fifth metatarsal bone, and of the heads of all the metatarsal bones, the sesamoid bones concealing the head of the first metatarsal, can be readily recognised even through the thick pad of integument which covers them. Certain tendons however pass over all these parts, except over the tuberosities of the os calcis, and that of the fifth metatarsal bone. In advance of the well-padded anterior metatarsal curve, the foremost part of which corresponds with the head of the second metatarsal bone, are seen the projecting but flattened pads or pulps of the toes, which correspond with the horseshoe-shaped under surfaces of the ungual phalanges, the other phalanges being recessed in the deep transverse groove in front of the anterior metatarsal curve, dependent on the extremely flexed position of the second on the first phalanges.

At the back of the foot, is the rounded projection produced by the underlying subcutaneous part of the os calcis, bounded by the attachments to it of the tendo Achillis, and other soft parts.

On the outer thinner border of the foot, which is overhung by the outer ankle, commencing from behind, the prominent bony points are the external tuberosity of the os calcis and the ridge between its hinder and outer surfaces; just beneath the ankle-bone, the peroneal tubercle, when this is present; much further forward, the tuberosity of the fifth metatarsal bone, and then the head of the bone with the base of the first phalanx of the little toe.

On the inner thicker and rounded border of the foot, which is overhung by the inner ankle, are, commencing from behind, the ridge between the hinder and inner surfaces of the os calcis; only very indistinctly seen, the prominence of the sustentaculum tali, and a small adjacent part of the head of the astragalus, below the inner ankle-bone; in front of this, the well-marked tuberosity of the scaphoid bone; much more obscurely seen, the slight prominence formed by the internal cuneiform and the base of the first metatarsal bone; beyond this, the projection indicating the position of the enlarged head of the first metatarsal and the base of the adjoining phalanx of the great toe, with the internal sesamoid bone beneath; and, finally, the much smaller projection opposite the last joint of the great toe.

On the dorsum of the foot, the bones are entirely concealed, as far forward as the head of the astragalus, by ligaments, tendons, and loose skin; but from that part, the form of this surface, which slants downwards, forwards, and outwards, is chiefly dependent on the convex surfaces of most of the tarsal, and of all the metatarsal bones; the highest part of the head of the astragalus, with the adjacent parts of the scaphoid, the middle cuneiform bone, and the base of the second metatarsal bone, constitute the highest and most prominent longitudinal ridge of the instep, from which the surface inclines more rapidly inwards, but more gradually outwards. The smooth dorsal surfaces of the metatarsal bones, covered partly by the flat extensor tendons, correspond, either with linear depressions or prominences, according as the muscles between those bones are in action or at rest. The dorsal surface of the first metatarsal bone is, however, always prominent, and precisely determines the form of this part of the foot. The heads of the metatarsal bones sinking in beneath the tendons and other soft parts which pass across to the toes, form a curved depression, which passes obliquely-outwards and backwards. Of the interphalangeal joints of the toes, the first only are prominent. In a well-formed human foot, considerable differences as regards the relative length of the first and second toes, are met with in different individuals. As a rule, the second toe is slightly longer than the great toe, and, therefore, the longest of all. The length of the three outer toes rapidly declines to the fifth, the tip of which corresponds nearly with the level of the interphalangeal joint of the great toe, and of the first phalangeal joint of the second toe. But, in a number of instances, the great toe is longer than the second, and so becomes the longest toe; and, moreover, in a certain number of instances, these two toes are of equal length. Numerous observations seem to me to indicate that the condition in which the great toe is the longest, occurs more frequently in persons of tall stature or slender frame, whilst shorter and more stoutly built individuals usually have the great toe shorter than the second. The Greeks evidently adopted this latter form as the typical one; it certainly gives a fuller contour to the end of the foot, and imparts a character of strength to it. On the contrary, the relative elongation of the great toe, although it may produce a certain elegance of form, suggests the idea of feebleness, from the unsupported position of the great toe itself. The relatively greater separation between the heads of the first and second metatarsal bones, occasions the greater interval between the first and second toes, so characteristic of the human foot. The high instep, or so-called *mons pedis*, likewise a characteristic beauty of the well-formed human foot, is much less marked in the negro races, and almost disappears in the ill-formed flat foot.

The Bones of the Leg. The Tibia and Fibula.

The two leg-bones, the *tibia* and the *fibula*, are long bones, each consisting of a shaft and two more or less expanded extremities. The tibia or *shin-bone*, the larger bone of the two, is on the front and inner side, and the fibula or *clasp-bone*, the smaller one, is on the outer side of the leg. The tibia

The right Tibia and Fibula.
Fig. 13.—Front view. Fig. 14.—Back view. Fig. 15.—Outer view. Fig. 16.—Inner view.

enters into the formation of both the ankle-joint and the knee-joint, but the fibula into that of the ankle-joint only, not entering into, and, in fact, not reaching so high as, the knee-joint.

The Tibia.—The shaft of the tibia is placed vertically in the leg. Being largest at its upper end, and smallest or narrowest three or four inches above its lower end, it is, as seen from its outer or inner side, slightly arched forwards. It is, in the greater part of its extent, three-sided, its surfaces, named posterior, external, and internal, meeting each other along three edges, named anterior, external, and internal; its cross section is accordingly, for the most part, triangular, but this form is lost at the upper larger end, and also at the lower end, the bone in each situation becoming especially expanded transversely, in the latter situation being even quadrangular on a section. The thinnest part of this bone, namely, at about one-fourth of its length from the lower end, has to support the weight of the whole body. Of its three surfaces, the *posterior*, fig. 14, is marked by a prominent *oblique line* for the origin of a portion of the soleus muscle, above which, is the triangular surface for the insertion of the popliteus muscle, and, below, are the surfaces for the tibialis posticus and the long flexor muscle of the toes, the former lying nearest to the fibula. This part of the back of the tibia is thus entirely concealed; lower down, where it becomes smooth, it is also covered by the above-named muscles, and by the flexor longus pollicis muscle. The *external* surface, figs. 13, 15, is directed a little forwards so as to look across the front of the fibula; it is excavated for about the upper half or two-thirds of its length, for the reception and attachment of the tibialis anticus muscle; but, at its lower end, it looks directly forwards, and becomes broad, rounded and smooth for the passage of the tendons of this and other muscles, as they proceed to the foot. The *internal* and broadest surface, fig. 16, smooth and convex, is directed a little forwards as well as inwards; at its upper part, it widens out, and turns somewhat more forwards, and is thinly covered by the expanded tendons of the semi-tendinosus, gracilis, and sartorius muscles, which descend from the thigh, and are here attached to its somewhat roughened surface, the gracilis being higher up, the semi-tendinosus lower down, and the sartorius covering the two. Below the tendinous expansions, this surface becomes entirely subcutaneous, being covered, in addition to its periosteum, only by fascia and skin. It continues subcutaneous to the lower end of the bone, gradually turning so as to look directly inwards. This surface is the largest subcutaneous bony surface met with in the body; it is, like all such surfaces, comparatively smooth, free from prominences, ridges, or depressions, slightly rounded or convex from border to border, and even undulating in its form,—in short, altogether unlike the surfaces of bone which are covered by, or give origin to, muscles, being so gently modelled in its general and detailed shape, as to readily compose with the rounded contours and surfaces of the adjacent muscles, notwithstanding its own rigidity of substance.

Of the three edges or *borders* of the tibia, the *external* one, fig. 15, turned towards the fibula, reaches from near the outer part of the head almost along the whole length of the bone; it is very sharp, especially at the middle of the bone, for the attachment of the strong interosseous membrane, which connects the two bones; it ends below in a small, triangular, rough surface for the attachment of an interosseous ligament, beyond which, the bone becomes smooth and usually covered with cartilage, to form a small facet for articulation with the fibula. The *internal* border, rounded above and below, but sharper in the middle of the bone, extends from the back of the so-called internal tuberosity to the back of the internal ankle, and gives partial insertion to the popliteus muscle, and partial origin to the soleus muscle; it corresponds with the long waved furrow seen between the subcutaneous part of the tibia, and the muscles of the calf. The *anterior* edge, fig. 13, the most elevated, constitutes the *crest* of the tibia, which, consisting of compact tissue only, adds greatly to the strength of the bone; it forms, throughout nearly three-fourths of the length of the tibia, the sharp *shin*, so easily felt under the skin. When traced upwards, this edge curves outwards to the outer side of a marked eminence to be presently described, named the *anterior tuberosity* of the tibia, and becomes lost on the outer side of the expanded head of the bone. Below, in the lower fourth of the bone, it subsides or is effaced; or, it may be described as becoming rounded, turning inwards, and forming a slightly marked ridge, between the anterior and the internal surfaces of the lower part of the bone. Seen from the front, this sharp anterior edge of the shin-bone appears waved, being concave towards the fibula, in its upper half, as if yielding to the growth by pressure of the belly of the tibialis anticus muscle, thus affording space for it, and harmonising with its convex surface. Viewed from the inner side, fig. 16, this edge, immediately below the anterior tuberosity, is concave, but along the greater length of the bone, it is gently convex or prominent, and then subsides, so that the profile of the bone becomes again slightly concave. The upper concavity, during life, is filled by the bulging of the tibialis anticus, which, and not the tibia, determines the profile of the leg in well-made and well-nourished persons. In the emaciated condition, it is the bone which governs the impoverished outline. The lower concavity is obliterated by the thick tendon of the tibialis anticus. The waving line of this edge is readily recognised as the anterior border of the subcutaneous surface of the tibia, in front and to the outer side of which, are the muscles situated between this bone and the fibula.

The *lower extremity* of the tibia, smaller than the upper one, is expanded chiefly in the transverse direction, so that it presents broader anterior and posterior surfaces, and narrower outer and inner ones. Its outer surface is wider than the inner one; it presents a deep triangular depression, the upper part of which forms a rough excavation for the reception of a part of the fibula, which is here very closely bound to it by ligaments, whilst the lower part is, for a short space, smooth and articular, corresponding with a small opposed articular portion of the fibula. The anterior surface, a continuation of the outer surface, smooth and convex for the support of the extensor tendons, is bevelled off, so as to form a transverse roughened depression for the attachment of the anterior ligament of the ankle-joint, and at the same time to permit of a more complete flexion of the foot upon the leg. Below this depression, is a sharp curved ridge, which forms the margin of the inferior articular surface of the tibia ; it is prolonged downwards on each side, to embrace the astragalus, and presents a median elevation corresponding with a depression in the neck of that bone. The posterior surface is broad, and marked by a shallow groove, passing downwards and slightly inwards, for the tendon of the long flexor of the great toe. This surface ends below in a sharp wavy border, which forms the hinder margin of the inferior articular surface of the bone ; it is adapted to the form of the back of the astragalus, and, in man, descends lower down than the anterior border. The lower end of the tibia is prolonged downwards, on its inner side, for more than half an inch below the articular surface, to form the broad, square process, named the *internal malleolus* or *inner ankle-bone* (figs. 13, 14, 16). This process is wider from before backwards, than it is thick from within outwards; its inner surface, slightly convex, but strongly inclined from above downwards and inwards, is almost wholly subcutaneous, and is continuous with the inner subcutaneous surface of the shaft of the bone ; its outer surface, smooth and slightly concave, and directed a little forwards and downwards, as well as inwards, towards the astragalus, is articular, and is contiguous with the inner articular facet of that bone, in the ankle-joint; its anterior border is nearly vertical, and rough for the attachment of the annular and the internal lateral ligament; whilst its posterior border is curved forwards, owing to the deep, oblique groove, which passes downwards and inwards on its hinder surface, for the tendons of the long flexor of the toes and the tibialis posticus. The apex of the subcutaneous surface of the inner malleolus, therefore, appears to be directed a little forwards and downwards; it is bevelled off in front, to provide a surface of attachment for the internal lateral ligament of the ankle-joint. The inner malleolus, in the skeleton-foot, is more than two inches from the ground. The lower end of the tibia, which rests on the astragalus, presents a somewhat quadrangular and nearly horizontal *articular surface*, wider transversely than from before backwards, but, like the corresponding surface on that bone, considerably wider in front than behind. It is concave from before backwards, but uneven from side to side, being divided by a slight antero-posterior ridge into two parts, of which the inner one is the narrower, and somewhat the deeper. The entire surface is adapted to fit accurately on to the trochlea of the astragalus, to which it transmits the weight of the body. As already stated, this articular surface is continuous with that on the adjacent surface of the internal malleolus, which itself articulates with the inner side of the astragalus.

The *upper extremity* or *head* of the tibia is enlarged in all directions, chiefly transversely and especially behind, so as to form a broad and horizontal surface for the reception of the expanded lower end of the femur, which is also wider transversely, especially behind, and which, in the standing position, transmits the weight of the body to the tibia. The transverse axis of the upper end of the tibia, does not lie in the same plane as the transverse axis of its lower end, for the shaft of the bone is, as it were, twisted on its long axis, so that when the transverse plane of the upper end of the bone is directed forwards, that of its lower end is turned somewhat outwards, the astragalus and the entire foot following the same direction. In front of the tibia, just where the shaft begins to expand, to form the head, about an inch or so below its upper articular surface, and to the inner side of the upper part of the anterior edge or crest, is the large, vertical, oval eminence, directed a little outwards as well as forwards, named the *anterior tuberosity* or *tubercle* of the tibia, figs. 13, 15. Into the lower roughened half of this tuberosity, and into a small part of the bone below it, is inserted the strong tendon, known as the ligamentum patellæ; a closed sac or synovial bursa, intended to facilitate movement, is interposed between the ligament and the smooth upper half of the tuberosity; just above this eminence, a smooth triangular surface slopes backwards to the anterior border of the upper end of the tibia, leading to a pit or depression in that situation. The projecting and overhanging mass of the outer part of the head of the tibia is named the *external tuberosity*, fig. 13; on the under side of the back of this tuberosity, is a small oval plane articular facet, directed obliquely downwards, outwards and backwards, to which the upper end of the fibula is adapted; the small joint thus formed, is about half an inch below the knee itself. The external tuberosity of the tibia surmounts the interosseous space between that bone and the fibula, and gives partial origin to the tibialis anticus and the extensor longus digitorum. The overhanging projection on the inner side of the tibia, named the *internal tuberosity*, is larger than the external one, especially in the antero-posterior direction. Around its border, it is roughened for the attachment of the internal lateral ligament, and it is marked, behind, by a deep transverse groove for the insertion of the tendon of the semi-membranosus muscle. The posterior border of the head of the tibia presents a broad oblique depression, named the *popliteal notch*, for the lodgment and attachment of the posterior crucial ligament. To the surface of both these tuberosities, the fascia of the thigh is attached.

The large *upper articular* surface of the tibia, on the summit of its two broad tuberosities, the great size of which is thus explained, is much wider transversely than from before backwards; it presents two shallow facets, separated from each other by an eminence and two depressions, and intended to receive the two prominent condyles of the lower end of the femur. The outer facet, for the external femoral condyle, is wider and shallower, and nearly circular; the inner one, for the internal condyle, is deeper, especially near its central part, and more or less oval, having its long diameter, like the tuberosity on which it rests, from before backwards. Between the two facets, but nearer to the hinder margin of the head of the bone, projects a bifid process, named the *spine* of the tibia, immediately in front of, and behind which, are found the two depressions already mentioned, as seen on the anterior and posterior borders of the head of the bone. This spine fits into the intercondyloid fossa or pit, found on the back of the lower end of the femur; its inner edge rises higher, and more abruptly, from the inner articular facet of the tibia; whilst its outer edge descends more gently towards the outer articular facet; to it, but especially to the rough depressions in front of and behind it, are fixed the lower ends of the two crucial ligaments of the knee-joint, and also the ends of the two semilunar cartilages, which rest upon the two articular facets of the tibia, and serve to deepen the shallow surfaces for the reception of the femoral condyles.

The Fibula.—The outer and more slender leg-bone, the *fibula*, figs. 13 to 16, which is proportionally the thinnest of all the long bones, is about of the same length as the tibia; but, as its upper end does not reach so high as the tibia, its lower end projects below that bone. It is, for the most part, situated on a plane further back in the leg, especially so towards its upper end, although at its lower end, it lies more nearly in the same plane as the tibia; but, as the middle part of its shaft is arched backwards as well as inwards, whilst that of the tibia is a little curved in the forward direction, the backward position of the fibula is more evident in the middle of the leg. Hence also, whilst the internal malleolus appears to point slightly backwards, the external malleolus is directed a little forwards.

The *shaft* of the fibula is irregularly three-sided, but towards its upper end its edges are rounded off, and the bone becomes constricted to form the *neck*, the narrowest part of the fibula. Below this point, the bone presents several narrow longitudinal, or oblique, surfaces, intercepted by ridges, chiefly in consequence of the number of muscles which arise from it. The *inner* surface, figs. 14, 15, of the fibula, turned a little forwards towards the tibia, is marked by a sharp ridge, the *interosseous ridge*, for the attachment of the interosseous ligament which connects the two bones; behind this ridge, is an elongated surface for the partial origin of the tibialis posticus muscle; in front of it, commencing from above, are the surfaces of origin of the common extensor of the toes, the proper extensor of the great toe, and the peroneus tertius muscle. The *posterior* surface, or back of the fibula, fig. 14, gives origin above, to a part of the soleus muscle, and below, to the long flexor of the great toe. Nearly the whole of its *outer* surface, figs. 13, 15, is grooved and clothed by the long and the short peronei muscles, which arise from, and embrace, it; at its upper end, forming a portion of the outer side of the head of the bone, there is a small triangular subcutaneous surface; at its lower end, the outer surface of the fibula appears to turn gradually backwards, and becomes smooth and somewhat hollowed, so as to guide the tendons of the two peronei muscles just mentioned to the back of the lower part of the bone, which ends in the strongly projecting, but somewhat flattened and pointed process named the *external malleolus* or *outer ankle-bone*, figs. 13, 14, 15. This process, shaped like an inverted pyramid, descends on the outer side of the astragalus, thus completing the ankle-joint. Its apex, situated further back, or nearer to the heel, than the internal malleolus, reaches about half an inch nearer to the ground than that process; its broad posterior border is nearly vertical, and is slightly grooved downwards and outwards, for the tendons of the long and short peronei muscles, for which it forms a long fulcrum; its anterior border, roughened for the attachment of the annular and other ligaments, is prominently angular. To its apex, is fixed the middle bundle of the external lateral ligament of the ankle-joint; and deeply seated behind it, is a strongly marked indentation, for the attachment of the outer end of the posterior transverse ligament of that joint. The inner surface of the external malleolus presents a triangular articular facet, with its base upwards; it is slightly convex from above downwards, directed a little forwards and downwards, and is adapted to the triangular and slightly concave outer articular facet of the astragalus, and, above that bone, to a narrow articular portion of the tibia. Immediately above this, is a rough and somewhat convex surface, which fits into the vertical depression on the adjacent part of the tibia, to which it is firmly fixed by ligament. The outer convex surface of the external malleolus is subcutaneous. Continued upwards from it, is a narrow triangular, likewise subcutaneous, surface, which ends in a point about three inches above the apex of the malleolus; this surface is bounded by two convergent lines, meeting above at the *anterior border* of the bone; throughout the rest of the shaft, this border separates the attachments of the long and short peronei muscles, from that of the peroneus tertius below, and that of the common extensor of the toes above, these two groups of muscles, with their tendons, bounding the subcutaneous surface of the bone in question, behind and in front.

Lastly, the *upper end* of the fibula, enlarging slightly, so as to form the *head*, terminates posteriorly in a short pointed process, sometimes named the *styloid process* of the fibula, to which, but especially to the rough surface of the head of the bone, the external lateral ligaments of the knee are fixed. Into the head, the two parts of the tendon of the biceps muscle of the thigh, or outer hamstring muscle, are also inserted; otherwise this part of the fibula is subcutaneous, having, however, the fascia of the thigh attached to it. Immediately below the head, is the small subcutaneous triangular surface already mentioned. On the upper and inner aspect of the enlarged head of the fibula, is the oblique, oval, articular surface, which, directed upwards, inwards, and forwards, articulates with the corresponding facet on the back of the overhanging external tuberosity of the tibia, a little below the level of the knee-joint. Around this, the bone gives attachment to the ligaments of that joint ; it gives partial origin in front to the peroneus longus, and behind to the soleus muscle.

Surface-forms dependent on the Bones of the Leg.

As in the case of the foot, so in the leg, the great breadth, or, as it may here be termed, the roundness of the human limb, is in striking contrast with the comparative flatness noticeable in the limbs even of the highest vertebrate animals. This is due, not only to the existence of two distinct bones throughout the whole length of this part of the lower limb, but to their relatively wide separation from each other ; for, in those vertebrata, they are either more closely compressed together, or the fibula is more or less undeveloped below, and becomes adherent to, or, as it were, fused with, the tibia above.

The *tibial* surface-forms, commencing from below, are, first, the prominence due to the internal malleolus, which is broad, somewhat triangular, but has its upper angle truncated, and continuous upwards with the long subcutaneous inner surface of the bone. The base of this malleolar triangle, which is directed downwards, is not straight, but is bounded by a broken or bent line passing obliquely downwards and forwards ; hence the lower part of this surface-form points a little forwards. The anterior side of this irregular triangle is nearly straight, but the posterior one is somewhat convex. The internal malleolar eminence is, of course, like the bony projection to which it is due, larger, and placed further forward and higher up, than that of the external malleolus. It overhangs the inner border of the arch of the foot. Secondly, the long subcutaneous inner surface of the shaft of the tibia, slightly trespassed upon by the muscles in front and to its outer side, and by those behind and to its inner side, may be traced from the malleolus below, to the wide expanded head of the bone above; it is slightly convex from side to side, and undulating when followed along its length ; it presents behind, at its upper part, a curved boundary line, dependent on the soleus muscle, below this, a less marked curved border due to the long flexor of the toes, and still lower, a straighter line corresponding with the tendons of that muscle and of the tibialis posticus ; in front, it is bounded by the undulating line, which corresponds both with the thin anterior edge or crest of the tibia, and the fleshy portion of the tibialis anticus muscle above, and with the smoother border of the bone, and the straighter line of the tendon of that muscle below. As already stated, the smooth surface of this part of the tibia, with its waved borders, more or less concealed or overlapped, blends in composition with the soft parts adjacent to it ; and, most frequently, and especially when the muscles are in strong action, it corresponds with a depression on the general surface of the leg. Its anterior undulating boundary line might be termed the *anterior tibial furrow*, and the posterior undulating boundary, the *posterior tibial furrow.* Thirdly, at the upper end of the bone, is the anterior tuberosity, forming, when obscured by the attachment of the lower end of the ligamentum patellæ, and covered by the integuments, a nearly vertical ovoid eminence, wider above than below, directed outwards as well as forwards, and marked off, by slight depressions on either side, from the prominences of the two lateral tuberosities. It is on the anterior tuberosity, that the weight of the body is mainly sustained, in kneeling upon a firm substance without any support for the body in front, and not on the knee-pan, as might be supposed. Lastly, the lateral tuberosities constitute parts of the recognisable surface-forms, just below the knee. The internal tuberosity is broader and smoother, crowns the subcutaneous part of the shaft below, and is softened in its outline and surface, by the expanded tendons of the inner hamstring muscles. The external tuberosity is narrower but more prominent, and is less obscured, having merely ligament, fascia, and skin, covering it; it overhangs the somewhat pointed united origins of the tibialis anticus and extensor communis digitorum muscles, which, when in action, change the otherwise projecting form produced by the tuberosity into a depression. The rest of the tibia is concealed by muscles, and has no direct relation to the surface-forms.

The lower end of the *fibula*, or external malleolus, presents, unlike the internal one, a narrow elongated prominence, which tapers upwards about three or four inches, and then disappears, where the peroneus tertius diverges from the two other peronei muscles ; it is much more projecting and ridge-like than the internal malleolus; it lies nearer to the hinder border of the leg, and therefore closer to the large tendo Achillis, and it reaches nearer to the ground ; its posterior boundary is straight, corresponding with the vertical portion of the tendons of the long and short peronei muscles, which are in immediate contact with it, whilst its anterior limit is more curved ; the lower end of this surface-form points a little backwards. It will be noted that it differs from the internal malleolus in size, shape, degree of prominence, height from the ground, and in the general direction of its apex. The small, prominent, head of the fibula, is also near the surface, being both felt and seen behind and to the outer side of the head of the tibia, slightly above the level of the anterior tuberosity of that bone. Although partly covered by the origins of the peronei and soleus muscles, in front and behind, it forms, when these are relaxed, a decidedly marked, short, and somewhat triangular eminence, with its base uppermost; when, however, the muscles are in action, this eminence is replaced by a correspondingly shaped depression, which terminates below in a linear groove between them. The continuation of this groove downwards between the soleus and the peronei muscles, towards the hinder border of the external malleolus, may be designated the *peroneal furrow*.

The head of the fibula is a certain guide to the position of the tendon of the biceps muscle, as the tendon also is to that of the bone. The rest of the fibula is hidden by muscles, but, as already stated, it is concerned in producing the characteristic width and general form of the human leg.

The Patella or Knee-Pan.

Attached below, to the upper end of the so-called ligament of the patella, above, to the tendon of the rectus femoris muscle, and, at the sides, to the tendons of the external and internal vasti muscles with the crureus muscle, is found the *patella*, or *knee-pan*, figs. 17, 18, 21. From its connexion with the extensor muscles, it has been compared with the olecranon process at the upper end of the ulna, which, though rarely, may be detached from that bone. As already stated, it may be regarded as a sesamoid bone developed in the tendon of the rectus, as this passes over the pulley-like surface of the lower end of the femur, and therefore similar, in character and office, to other sesamoid bones ; but it is placed on the aspect of extension of a joint, and not on the side of flexion ; its likeness to a detached olecranon is remarkable. The patella is a small, short, broad bone, composed chiefly of cancellated tissue, having a general triangular outline, with blunted angles, its apex being directed downwards. Its *anterior surface*, fig. 18, is subcutaneous, a large bursa, however, intervening between it and the skin ; it is somewhat convex and marked by faint longitudinal lines, indicating traces of the attachment of tendinous fibres. Its upper border or base, fig. 18, horizontal and thick, is slightly bevelled off in front, and thus affords a large surface for the insertion of the tendon of the rectus muscle, whilst the *apex* is deeply bevelled off behind, and roughened at its lower part, for the attachment of the ligamentum patellæ, which in a manner encloses it. The two *lateral borders*, fig. 21, of the bone, which receive fibres from the tendons of the vasti and crureus muscles, are somewhat curved, and are not so thick as the base or apex ; but the outer border is thinner and much less prominent than the inner one. The deep or *posterior surface*, figs. 17, 18, is articular, and forms part of the knee-joint ; it has a somewhat oval shape, being broader than it is long; it is traversed by a well-marked slightly oblique ridge, inclined from above downwards and inwards, which divides it into two chief articular facets; of these, the outer one, larger than the inner one, being both wider and longer, is concave in all directions ; the inner one is both narrower and shorter, and, though concave from above downwards, is convex from side to side. The former rests upon the

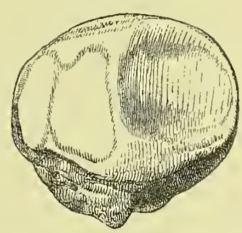


Fig. 17.—Posterior or articular surface of the right Patella, showing its seven subordinate facets.

comparatively large articular surface of the external condyle of the femur; the latter, upon that of the internal condyle; the intermediate slightly oblique ridge between them, corresponds with the trochlear groove of the femur. Each lateral facet is seen, when very closely examined, to be again subdivided into three parts, namely, a middle, much the largest part, which is oval, and upper and lower, narrower transverse parts. The middle part of the outer facet, which is much larger than the middle part of the inner facet, extends quite to the thin, outer border of the bone; but, along the thicker, inner border, is an additional, narrow longitudinal facet, continuous with the posterior surface.

Surface-forms dependent on the Patella.

The patella causes a distinct triangular prominence in front of the knee, having its base upwards and its apex downwards, both parts, as well as the lateral borders, being more or less obscured by their connexion with surrounding tendons, fasciæ, and ligaments. The base and the inner border, as well as the angle at which they unite, are more prominent than the apex and outer border, which are thinner, and lost in the surrounding soft parts. The remarkable breadth of the knee-pan, in man, is entirely in accordance with the characteristic breadth or roundness of the human form generally. It is said to be broader in the European than in the lower races of mankind.

The Femur or Thigh-Bone.

The Femur.—The single bone of the thigh, figs. 19, 20, 22, 23, is the longest and largest of the long bones, and, indeed, the heaviest and the strongest of all the bones in the body. It is a typical long bone, distinctly presenting a more slender part or *shaft*, and *two* expanded *extremities*, of which the lower one is much the larger, for articulation with other bones. In proportion to the length of the tibia, it is comparatively long in man, and it constitutes a main element, in determining the human stature. From its great size, it presents the best illustration in the skeleton, of the combined influence of gravity and muscular force, in determining the production of the curvatures, twists, prominences, and grooves of bones.

The position of the femur in the skeleton is not vertical on the head of the tibia, but more or less oblique, fig. 19, inclining upwards and outwards, towards the outer side of the corresponding hip-bone, to reach the deep socket or acetabulum of that bone, into which its upper end or head is received, and so transmits the superincumbent weight of the body. The relative obliquity of the femur is increased by a disproportionate length of the part known as its 'neck,' which passes inwards from the upper end of the shaft, and supports the head of the bone; it is also increased by a greater width of the pelvis, and by a diminution in the length of the bone itself. The degree of obliquity accordingly varies in different individuals.

The *shaft* of the femur, smooth, excepting behind, is decidedly curved with an anterior convexity, figs. 22, 23, the most prominent point of the curve being about opposite the junction of the upper and middle thirds of the bone, so that the lower part appears less curved than the upper, and, indeed, becomes flattened in front. The shaft of the femur is also slightly twisted, so that, whilst the anterior surface looks forwards and a little inwards in the lower two thirds of the bone, it looks forwards and outwards in the upper third. The concavity of the femoral curve behind, is less pronounced than the convexity in front, owing to the presence of a projecting longitudinal roughened ridge, named the *linea aspera.* The existence of this ridge causes the middle third of the shaft of the femur, to be somewhat three-sided, but the posterior rough edge alone is well marked or prominent, the rest of the bony surface, including what may be called its outer and inner borders, being smooth, and rounded in front, though a little hollowed on its sides. This is seen on a transverse section of the bone, which further shows that the ridge of the linea aspera is formed by a special accumulation of compact bony tissue along the concave posterior aspect of the femur, the medullary cavity retaining its more or less oval outline, but having more compact bone behind it than in front or at the sides; a longitudinal section displays the same structure. The linea aspera, fig. 20, presents, in the middle part of the bone, two raised edges or lips, and an intermediate longitudinal narrow space. These two lips diverge as they pass downwards, and are continued on either side, curving likewise backwards, down to the back of the *external* and *internal tuberosities*, on the sides of the lower end of the femur; the outer diverging lip is here distinctly marked throughout, and, between the two, is a broad flat triangular surface, named the *popliteal* surface. From a little below the upper third of the femur, the two lips of the linea aspera also diverge, so as to leave a wider space between them, and may be traced upwards towards the bases of the two bony processes, named the *external* and *internal*, or *greater* and *lesser trochanters* (τροχὸς, a wheel). The shaft of the femur has the following muscles connected with it. Excepting for a distance of about three inches above the knee-joint, this part being free from muscular attachments, the crureus muscle occupies the rounded anterior, and the slightly hollowed outer surface of the bone; beneath it, from a small part of the lower fourth of the anterior surface, arises the subcrureus; to the upper third of the inner smooth side of the shaft, and to nearly the whole length of the inner edge of the linea aspera, is fixed the broad vastus internus muscle; behind this, along the depression between the two lips, are inserted, at special points along the upper two thirds of the shaft, the adductor longus, adductor brevis, and pectineus muscles, the first to the middle third of the linea aspera, the second to the line leading from the linea aspera to the small trochanter, and the third to the upper part of that line; behind this, again, throughout the entire distance from the base of the greater trochanter to a tubercle on the internal tuberosity, including a part of the so-called *linea quadrati*, an oblique

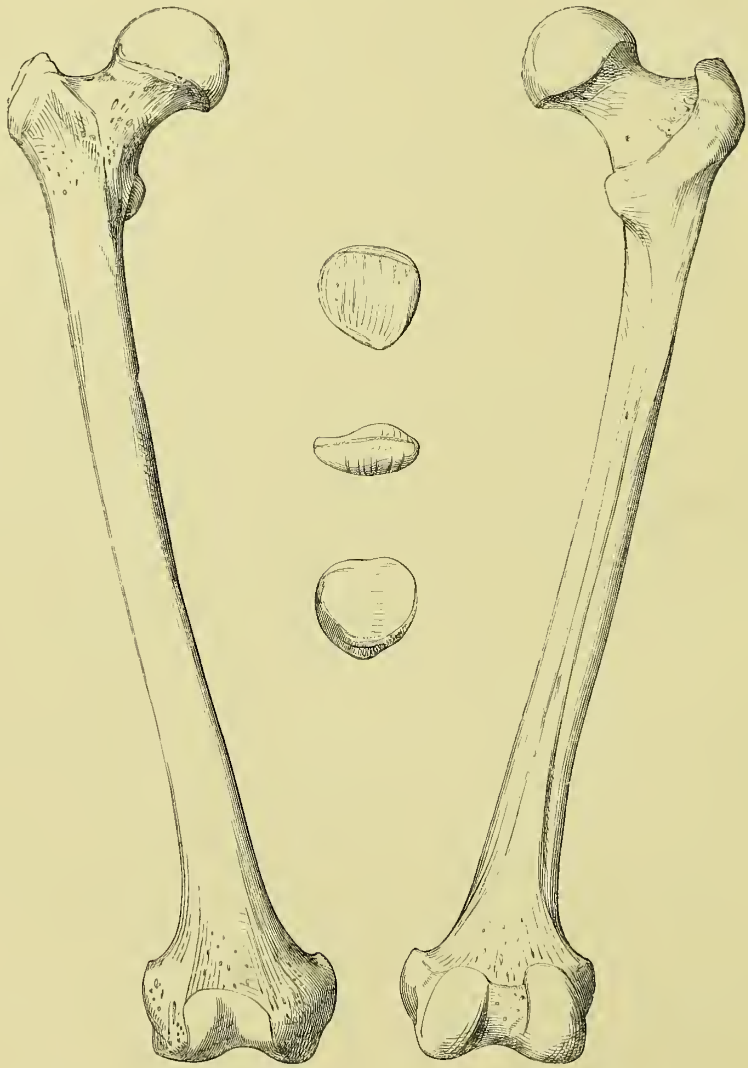


Fig. 18.—Anterior surface, upper border or base, and posterior or articular surface of the right Patella.
Fig. 19.—Front view of the Femur or Thigh-Bone.
Fig. 20.—Back view of the Femur or Thigh-Bone.

line leading to the linea aspera, the linea aspera itself, and its internal diverging line below, is attached the adductor magnus; to the outer lip of the linea aspera, along the whole distance from the front and outer surface of the base of the great trochanter to about an inch above the external tuberosity is fixed the broad vastus externus; behind this, in the narrow longitudinal space between the lips, the short head of the biceps muscle occupies the middle part of the linea aspera, and also about half of the line diverging from it to the

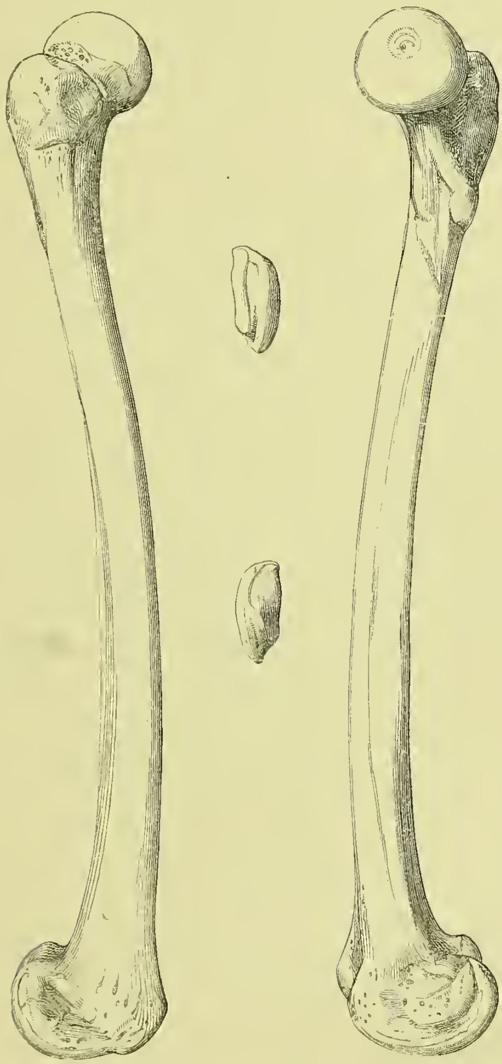


FIG. 21.—The outer border, and the inner border, of the Patella.
FIG. 22.—The outer side of the Femur.
FIG. 23.—The inner side of the Femur.

outer condyle; lastly, along the lower part of the upper diverging line, which leads to the great trochanter, is found a somewhat rough linear surface for the attachment of the gluteus maximus.

The *lower end* of the femur expands in all directions, but especially from side to side, to form the broad masses named the *external* and *internal condyles*, which project backwards from the bone, and rest below upon the head of the tibia, the two semilunar interarticular cartilages intervening. Between these condyles is a smooth depression in front, which leads into a deep cavity behind, named the *intercondyloid notch* or *fossa*. The internal condyle is longer by more than half an inch than the external one, so that, if the thigh-bone be suspended vertically, the inner condyle will first touch a horizontal plane; or again, if both condyles are made to rest together on such a plane, the shaft of the bone becomes directed, as in the skeleton, upwards and outwards. The greater length of the internal condyle serves to give a horizontal direction to the plane of the lower end of the inwardly inclined femur, so that it rests securely on the horizontally disposed articular surface of the tibia. If the condyles were of equal length, the upper surface of the tibia must have been sloped outwards and downwards to meet them, and the joint would thus have been weakened by the constant tendency of the lower end of the femur to be displaced outwards; the ligaments would have been unable to resist so continuous a strain. The increased length of the inner condyle, bears a relation to the degree of obliquity of the shaft of the bone. The inner condyle is not only longer than the outer one, but it is narrower, and more prominent internally, that is, it projects much more away from the axis of the shaft of the bone. The outer condyle is not merely broader, and flatter at the side, but it is deeper from before backwards than the internal condyle, so that its anterior border is more prominent than that of the latter, figs. 22, 23; it is also placed more directly beneath the shaft of the bone, fig. 19 If the outline of the two condyles be studied, each from its own side, it will be found that they differ in the curvature of their lower borders. That of the inner condyle, fig. 23, is shallower, more gentle, and more even; that of the outer condyle is deeper, more abrupt, and apparently uneven or notched below, fig. 22. This notch indicates the existence of a depression on the inferior articular surface, for the lodgment of the anterior extremity of the corresponding interarticular fibro-cartilage, whereas, on the inner condyle, the corresponding interarticular cartilage reaches much further forwards, and requires a much slighter depression, into which it may be received. The *articular surface* at the lower end of the femur, is by far the largest in the body; it is much larger than that formed by the two articular facets on the head of the tibia, even together with that on the back of the patella, with which it enters into the formation of the knee-joint. It presents an irregular horseshoe shape, having its open ends directed backwards; it is turned and continued upwards a certain distance, on both the anterior and posterior aspects of the bone. Its fore-part is deeply grooved from side to side, to form the so-called *trochlea* or *pulley*, fig. 19, on which the hinder surface of the patella rests. The outer inclined part of this groove is broader and extends higher up than the inner part, thus corresponding with the broader and longer facet on the articular surface of the patella. The outer margin of the groove, moreover, projects forwards more than the inner margin, as may be best seen by looking directly at the lower end of the bone. This greater elevation of the outer trochlear border, which is owing to the greater depth of the outer condyle from before backwards, corresponds with the greater breadth and depth of the outer facet on the back of the patella; it increases the leverage action of that bone, and offers special resistance to any tendency to outward displacement, caused by the action of the extensor muscles in front of the thigh, particularly by that of the vastus externus muscle, which is connected with the outer border of the knee-pan. The groove of the trochlea does not follow the direction of the axis of the shaft of the femur; neither is it in a line with the long axis of the tibia, which is vertical in reference to the ground. On the contrary, the centre of the groove passes, from below, inwards and upwards, fig. 19, obliquely across the axis of the femur, and slightly so, even in regard to the tibia. This entirely coincides with and, indeed, explains the fact that the patella moves, not directly upwards, but upwards and inwards, when the knee is extended after having been bent. The trochlear surface inclines from below, a little forwards as well as outwards; in other words, it becomes gradually deeper from above downwards; but, opposite to two faintly marked slightly oblique lines, it somewhat abruptly turns backwards, to become nearly horizontal. These oblique lines bound two corresponding shallow depressions, that on the outer side being the deeper, for the reception of the anterior part of the two interarticular cartilages. It is on the trochlear surface above these oblique lines, that the patella almost entirely rests, in the straight position of the knee. In this position, the femoral articular surface, below the lines, is in contact with the cartilages and the tibia; but, during flexion, the patella descends below these lines, and comes in contact with a part of the articular surface below and behind them. The slightly oblique ridge on the patella corresponds with the bottom of the trochlear groove, and the two facets on either side of the ridge, the larger outer one and the smaller inner one, with the sides of that groove. In the straight position of the knee, the central oval parts of the two facets of the patella, are applied to the trochlear surface, above the transverse oblique lines; whilst, in the bent position, those parts descend below these lines, and there touch the femur. In the former case, the upper narrow semilunar facets are free above the trochlear surface; in the latter, the lower ones are free in the interior of the joint. In flexion, the longitudinal facet on the inner border of the patella touches the inner condyle of the femur, along the margin of the intercondyloid fossa; but, in extension of the joint, it is free, and projects slightly beyond the edge of the corresponding margin of the trochlear surface. Below or behind the oblique lines, just described, the articular surface of the lower end of the femur becomes wider, and branches out, to form the somewhat flattened under surfaces of the two condyles, which are here separated by the deep intercondyloid fossa, already mentioned. The under surface of the outer condyle, broader and less convex than the other, passes somewhat obliquely backwards and slightly outwards; it rests on the corresponding tibial facet, which is also broad and nearly circular. The under surface of the inner condyle is narrower and more convex, especially at one part; it passes backwards and inwards, and presents a curved form, when seen from below, having its concavity turned towards the other condyle; its rounded prominent surface rests upon the inner, narrower, oval, tibial facet, which has its long axis directed from before backwards. The weight of the body, passing chiefly through the outer condyle of the femur, is transferred to the external and anterior part of the tibia; the remainder, passing through the inner condyle, descends to the internal and hinder part of that bone. In extension of the leg at the knee-joint, the tibia is turned a little outwards, so that the anterior part of the head of that bone is placed more directly beneath the outer condyle, and the hind part more completely under the inner condyle. These condyloid articular surfaces are both prolonged upwards behind the lower end of the femur, fig. 20, and become more convex, the outer one remaining broader and flatter, and extending a little higher up than the inner one. It is against these prolongations of the condyloid articular surfaces, that the tibia is applied when the leg is bent, in which position alone can the tibia be rotated on the thigh at the knee-joint, the axis of the rotatory movement passing down between the condyles, but nearer to the inner one, so that the external circular facet of the tibia moves backwards and forwards on the outer condyle more freely, than the internal oval tibial facet does on the inner condyle. The deep *intercondyloid notch* or *fossa*, fig. 20, bounded in front by the lower margin of the trochlear surface, and on either side by the diverging condyloid surfaces, is seen on the under and posterior aspect of the bone; it serves for the lodgment and attachment of the upper ends of the deep-seated crucial ligaments, which are fixed below to the head of the tibia. The *external* and *internal tuberosities* of the femur, figs. 22, 23, already mentioned as the points, to which the two lower diverging lines of the linea aspera extend, are situated one on each side of the bone, a short distance above the curved margins of the outer and inner condyloid articular surfaces, and behind the centre of the knee-joint. To these tuberosities, the strong lateral ligaments of the knee are fixed, and also the so-called intermuscular septa, derived from the fascia lata; the inner one is broader and much more prominent than the outer one, and immediately above it, is a small pointed tubercle for the attachment of the rounded tendon of the adductor magnus. Posterior to each tuberosity, at the back of the condyle, above its articular surface, is a rough depression for the origin of the corresponding head of the gastrocnemius muscle; the outer head of this muscle arises also from the external surface of the condyle; the depression behind it, is, moreover, extended upwards, to give origin to the plantaris muscle; on the outer condyle, just below and behind the external tuberosity, is a small pit for the origin of the tendon of the popliteus muscle, a sort of groove extending backwards from it, for the lodgment of that tendon, when the knee is fully bent.

At the *upper end* of the femur, at the junction of the shaft with the so-called neck of the bone, are placed the two characteristic eminences named the *trochanters*, figs. 19, 20, the larger one, situated on the outer side of the neck of the bone, being named the *trochanter major*, or *greater trochanter*, and the smaller one, situated on the inner posterior aspect of the bone, being called the *trochanter minor*, or *lesser trochanter*; they are also known as the *great* and *small* trochanters. The *greater trochanter* reaches to within three quarters of an inch of the level of the top of the head of the femur, and may be said to surmount the outer part of the shaft of the bone, from which it stands up as a blunt quadrilateral prominence, having its broad, square, convex, rough outer surface bevelled off obliquely above, so as to be directed upwards, outwards, and a little backwards, away from the pelvis. It serves for the attachment of various muscles. The upper narrower portion of the vastus externus, arises from the base of the trochanter in front, on its outer side, and slightly behind. Into the thick sides of the trochanter, is inserted the so-called trochanteric group of muscles. Thus, into its broad anterior surface, is inserted the gluteus minimus; into the inner side of its summit, the obturator internus with the two gemelli; behind these, the pyriformis, and to the thick and bevelled outer surface of the trochanter, the gluteus medius. Below and behind this attachment, but separated from it by an oblique line running downwards and forwards, is a smooth surface, over which the strong tendon of the gluteus maximus glides, to reach its destination lower down along the outer diverging edge of the linea aspera. At the inner and upper part of the root of the trochanter, where its very prominent posterior border overhangs the neck of the bone, is the *digital* or *trochanteric fossa* for the insertion of the obturator externus; to a small eminence seen on the posterior intertrochanteric line, from which descends a short ridge quite at the upper end of the shaft, named the *linea quadrati*, is attached the quadratus femoris muscle, reaching as low as the upper border of the adductor magnus, the quadratus occupying the upper part of that line, and the adductor magnus the lower part; lastly, immediately below and in front of its lower border or base, is attached the highest point of the vastus externus. Thus it is seen, that only a very small portion of the surface of the greater trochanter, namely, that bounded by the attachments of the gluteus medius behind and above, by the gluteus minimus in front, and by the upper end of the vastus externus below, is really subcutaneous, or uncovered by muscle and tendon; this is of great importance in reference to the surface-forms.

The *lesser trochanter* is best seen from behind, fig. 20; it is a small pyramidal eminence of variable size, situated lower down than the greater trochanter, and projecting directly inwards from the back of the upper part of the shaft, having its base connected, by three strong, diverging, bony ridges, with the shaft, the greater trochanter, and the neck of the femur; whilst its apex is bent a little forwards and upwards, for the attachment of the upper part of the common tendon of the iliacus and psoas muscles, which descend from the interior of the pelvis. A part of the apex is smooth and covered by a bursa; below this trochanter, is a triangular surface for the lower part of the iliacus muscle. Between the two trochanters, at the back of the bone, is a well-marked oblique ridge, curved with its concavity turned inwards and upwards; this is the *posterior intertrochanteric line*, fig. 20; its upper part forms the prominent posterior border of the great trochanter, and serves to support both trochanters, and strengthen the bone; it also constitutes the base line of the neck of the femur behind. In front of the bone, a little below the junction of the great trochanter with the upper border of the neck, is a prominence named the *tubercle*. From it, a less distinctly marked oblique line passes downwards and inwards, to a point below the lesser trochanter, forming the *anterior intertrochanteric line*, fig. 19; it is the line of insertion of the capsular ligament, and of certain accessory bands placed in front of the hip-joint; it ends in the *spiral line* of the femur, fig. 23, which may be traced to the inner lip of the linea aspera.

The *neck* of the femur is the short part of the bone which juts obliquely upwards, inwards, and likewise a little forwards, from the upper end of the shaft. In consequence of this forward direction of the neck of the femur, its plane differs from that, even of the upper part of the shaft of the bone, and, considerably, from that of the plane passing through the condyles, which, owing to the twist already described as existing in the shaft of the bone, is more or less transverse, according to the position of the limb. It commences by a wider part or base, opposite the two intertrochanteric lines, and, having become somewhat constricted, again enlarges to end in, and support the rounded eminence, which constitutes the head of the femur. The neck usually forms an obtuse angle of about 125° with the shaft. The great relative length, and the obliquity of the neck of the femur, are both characteristic of the human form. In the infant, the neck is very short; in childhood it is longer, but still proportionally short, and, moreover, deviates so slightly from the direction of the shaft, that it forms, with it, a very obtuse angle, or very open curve, whilst the two trochanters, especially the greater one, are much less prominent. In the aged, the neck of the femur again becomes shorter, wastes, and appears to sink, so as to approach nearer to a right angle with the shaft, the head of the bone descending to, or below, the level of the trochanter, and thus contributing to a diminution of the stature. The neck of the femur serves obviously to separate the upper part of the thigh from the middle line, to increase the freedom of the movements of the lower limbs, to give greater space for the muscles on the inside of the thigh, and greater leverage to those which pass from the pelvis to the thigh. The neck of the femur is compressed from before backwards, being thinner in that direction than from above downwards; its upper and lower borders are continuous, the one with the greater, the other with the lesser trochanter. The upper border, slightly concave, is shorter and less oblique than the lower border, which is less concave, longer, and more oblique; it is also somewhat thicker, owing, as is seen on a section, to an accumulation of compact bony tissue along the under side of the junction of the neck with the shaft. The anterior surface of the neck is somewhat flattened, but the hinder surface is slightly hollowed, and at its upper and outer part, just beneath an overhanging portion of the greater trochanter, is seen the *digital fossa*, already mentioned; near this, on the upper border of the neck, is an even surface, over which the tendon of the obturator externus glides.

The *head* of the femur is the smooth rounded part, which surmounts the neck. It forms the upper articular end of the bone, being its highest point, rather more than half of it being placed above the level of the summit of the greater trochanter. It is said to form about two-thirds of a spheroidal ball; but, more exactly, its upper and its anterior surfaces are somewhat flatter, or form parts of a larger spheroid than the lower and the posterior surfaces. Its margin extends further on to the neck of the bone above than below; and also further in front than behind; hence, the articular surface has an uneven or waving border, and presents a pointed prolongation, both in front and behind. The head of the femur is almost entirely received into the acetabulum, a deep socket of the hip-bone, thus forming the largest and most complete ball-and-socket joint in the body. At a point on the inner side of the head of the femur, a little below and also behind its centre, is a small rough, bifid, depression, for the attachment of the ligamentum teres of the hip-joint. Opposite this point, the head of the bone is, however, more prominent than elsewhere, and corresponds with a non-articular depressed portion of the acetabulum.

Surface-forms dependent on the Femur.

Although the shaft of the femur is everywhere covered by muscles, and is, therefore, at no part directly subcutaneous, yet it imparts its own curved form to the thigh, which is evidently more convex in front than on any other aspect. This form gives an appearance of great strength to the human thigh, notwithstanding its unusual length as compared with that of mammalia generally.

As to the lower end of the femur, the broad lateral surface of its outer condyle produces a breadth and flatness of the corresponding part of the limb, just above the knee. The prominence of the external tuberosity can be more or less easily recognised here, at some distance above the elevation or depression, which, according to circumstances, indicates the position of the head of the fibula. The lateral surface of the inner condyle is more thickly covered than that of the outer condyle; but its internal tuberosity and, indeed, its whole mass are more prominent, so that here the general form is more convex, especially when the knee is flexed. In certain actions of the limb, the apex of the internal tuberosity, and the rounded lower tendon of the adductor magnus running down to it, become momentarily visible. In the straight position of the knee, it is impossible, owing to the presence of the patella, and to the folds of the loose integument, to trace, with the eye alone, the lateral borders of the articular surfaces of the condyles; but, when the knee is bent, and the patella retreats into the interval then formed between the lower end of the femur and the head of the tibia, and at the same time glides a little outwards, the curvature of the margin of the internal condyle becomes very evident, though softened by the integument and subjacent tissues, now stretched more or less tightly over it.

At the upper end of the femur, nearly the whole of the outer surface of the greater trochanter, is deeply seated, and thoroughly concealed by muscles, or by their tendinous attachments. But, in the standing position, especially when the thigh is rotated outwards, the small flattened subcutaneous surface of this trochanter is directed slightly backwards as well as outwards, and is depressed below the level of the neighbouring soft parts, which now leave a larger *trochanteric depression* amongst the surrounding muscles. When, however, the limb is made to approach the opposite one, as in standing with the hip prominent, or in crossing the limbs, or when it is flexed, as in stooping, then the greater trochanter produces a broad blunt *eminence* on the surface. In standing equally on both limbs, the upper surfaces of the heads of the thigh bones are nearly an inch above the summits of the greater trochanters. In leaning backwards, the thigh being then powerfully extended, and the muscles and ligaments in front of the hip-joint stretched, the head, with the immediately adjoining part of the neck of the femur, produces a marked fulness where the hollow is usually seen in the groin.

The Innominate Bone or Hip-Bone.

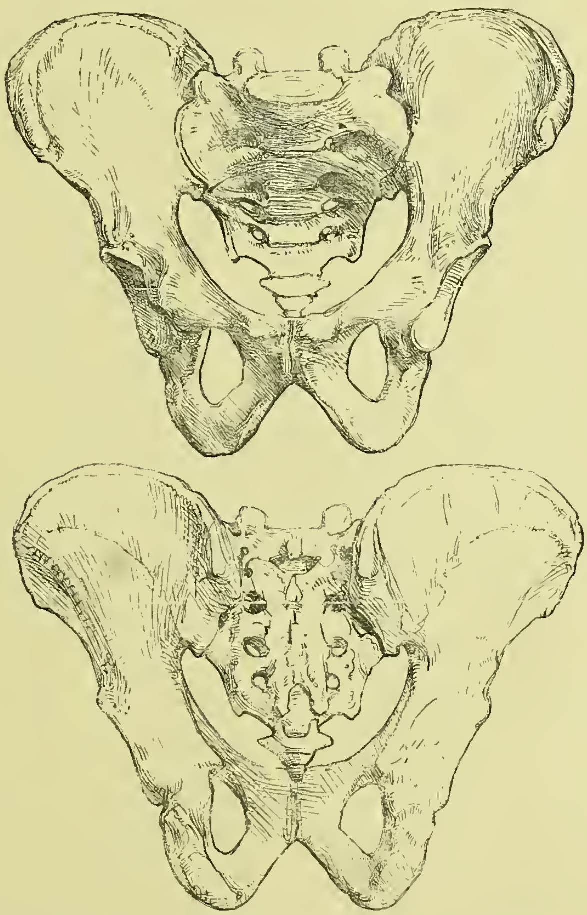
The *innominate* bones or *hip*-bones, right and left, are the largest of the so-called flat bones in the skeleton. They are very irregular in shape, but are expanded in different directions, and are placed, one on each side of the lower part of the trunk, with their longest diameter slanting downwards and forwards, from the sides of the sacrum behind, to the middle line in front, where they meet. These two bones, with the sacrum and the coccyx, constitute the *pelvis*, the innominate bones forming the front and sides of that cavity.

On the outer surface of each innominate bone, somewhat below its centre, is the deep circular cup-shaped cavity, named the *acetabulum*, into which the head of the thigh bone is partially received, fig. 27. In infancy and childhood, the hip-bone is composed of three distinct bony pieces, which surround and meet at the acetabulum, a sort of Y-shaped piece of cartilage intervening between them in the floor of that cavity. In the adult, at about twenty-five years of age, the three pieces coalesce, leaving, however, certain traces of their original independence. The lowest piece, which forms the under, and part of the outer or hinder, border of the acetabulum, is named the *ischium*; the anterior piece, the smallest of the three, which forms the anterior or internal border of the acetabulum, is called the *pubes* or *os pubis*; and the highest piece, the largest of the three, which forms the upper, and part of the hinder, border of the acetabulum, is named the *ilium*. The ischium forms rather more than $\frac{2}{5}$ths of the socket, the pubes about $\frac{1}{5}$th, and the ilium rather less than $\frac{2}{5}$ths. From the acetabulum, each of these bones proceeds in the form of a three-sided column, that formed by the ischium passing downwards, that by the pubes forwards, and that by the ilium upwards and backwards.

On looking at the outer surface of the innominate bone, its plane is seen to be bent, and otherwise changed, opposite to the acetabulum; for, whilst the acetabulum itself is directed downwards, outwards, and a little forwards, the outer surfaces of the ischium and pubes, situated below and in front, are turned downwards and forwards, whilst the outer surface of the ilium, situated above and behind, is turned backwards and outwards. This change of direction between the parts of the bone below and above the acetabulum, somewhat resembles that between the two blades of a screw propeller, fig. 27; but it is complicated by a bend across the acetabulum, in the centre, which gives a general convexity to the outer surface of the entire hip-bone. Its inner concave surface is turned towards the pelvic cavity.

The *acetabulum*, or *cotyloid cavity*, fig. 27 (*acetabulum*, a vinegar cup; κοτύλη, a cup), forms so deep a cup, as nearly to equal half of a *spheroidal cavity*, whilst, as we have seen, the head of the femur, on which it rests, forms more than half of a solid spheroid; so that the two together constitute the most perfect ball-and-socket joint in the body. It is situated above, and slightly in front of, the tuberosity of the ischium. The *rim* or border of the acetabulum, which is sharp, and of unequal prominence at different parts, is incomplete or interrupted for rather more than half an inch, between its anterior and its inferior borders, namely, opposite to the place of junction of its ischiatic and pubic portions: this interrupted part is named the cotyloid notch, or *notch of the acetabulum*, fig. 27. In the natural position of the innominate bone, this notch is placed a little anterior to the lowest part of the acetabulum; hence it furnishes a guide for placing the separated bone in its due position. The ligamentum teres, which is attached by one end to the head of the femur, descends within the hip-joint, to be attached to the margins of this notch; continuous with the notch, is a broad, shallow excavation, of a circular form, the *fovea* or *pit* of the acetabulum, which extends into the floor of the socket, and lodges that ligament, together with some fatty tissue and blood-vessels. Owing to the presence of this pit or excavation, the floor of the acetabulum is comparatively thin, and often translucent in the dried bone; but it has no weight to bear, and merely protects the ligamentum teres and other soft parts. The articulating portion of the acetabulum is placed outside or around the circular fovea; but, like the rim of the socket itself, it is interrupted, opposite to the notch; hence the articular portion of the acetabulum, which is in contact with the head of the femur, does not form a complete cup, but consists of a wide crescentic zone, or semilunar surface, smoothed for the incrusting articular cartilage, and intervening between the slightly roughened circular excavation and the rim of the socket; its widest part is above, where the greatest weight has to be borne; the narrower parts of the crescent extend in front of and behind the notch, where little or no weight has to be supported. Although the centre of the socket is thin, the articulating portion is so much strengthened by surrounding bone, that its borders are very thick, especially below, in front, and above, that is to say, in the direction of the three primitive component pieces of the acetabulum, namely, the ischiatic, the pubic, and the iliac, each being respectively the thickest part of the bone to which it belongs. It has already been mentioned that the cotyloid notch is placed between the ischiatic and the pubic portions of the margin of the acetabulum. Between the pubic and the iliac portions, is also found a slight depression, giving an undulating outline to this part of the rim, and corresponding with an overlying groove in the adjacent surface of the bone, for the tendon of the iliacus and psoas muscles. The pubic portion of the acetabulum between the notch and the depression, presents a well-marked elevation, named the *ilio-pectineal eminence*, figs. 24, 27. Between the ischiatic and the iliac portions, there is no distinct depression of the margin of the acetabulum, but, merely a slight undulation, as compared with the prominence of the ischiatic portion, and with that of the most projecting or overhanging part, the middle of its uppermost or iliac portion. The cotyloid ligament is fixed to the margin of the socket, and the transverse ligament crosses between the edges of the cotyloid notch.

The Ischium.—The ischiatic portion of the innominate bone, or *ischium*, figs. 25, 27, is continued downwards from the acetabulum, by a slightly and gradually contracted but strong three-sided column, named the *body*, which ends below in the massive and uneven prominence, named the *tuberosity* of the ischium. The weight of the body, transmitted from above, is supported in the sitting posture on this tuberosity, which, however, as seen from behind, is narrower than the body of the bone. In front of this, the ischium becomes narrow and flattened, and curves forwards, inwards, and upwards, to form the *ramus* or *branch* of the ischium, sometimes named its *ascending ramus*, because it is continued upwards to meet and join, by bony



FIGS. 24, 25.—Front and Back views of the Pelvis, showing the Innominate Bones, right and left, the Sacrum and the Coccyx.

union, with the descending ramus of the pubic bone, so assisting to form the part of the lower border of the pelvis named the ischio-pubic arch. It here bounds, behind and below, the large aperture in the hip-bone, placed below and in front of the acetabulum, named the *foramen ovale*, the *obturator foramen*, or *thyroid foramen*. The margin of the ramus next to the foramen, is sharp; whilst that which forms part of the lower border of the pelvis, is thick, uneven and somewhat everted. This aperture, which is completed in front and above by the pubic bone, is oval in shape. It is called obturator, because it is closed by a membrane, the *obturator membrane* (*obturo,* I stop up) ; more correctly, the membrane is the obturator, the foramen is obturated. The term thyroid (*θυρεός,* a shield; *εἶδος,* form) refers to the shape of the aperture. Parts of the margins of this foramen, both on its outer and inner aspects, and also the two surfaces of the membrane, give origin to the external and internal obturator muscles. On the outer and anterior aspect of the body of the ischium, beneath the acetabulum and above the tuberosity, is a slightly excavated surface, ending in a groove for the passage of the former muscle and its tendon; whilst another deep groove, extends from the slightly excavated inner surface of the bone to its outer border, where, above the tuberosity but beneath a prominent process, named the *spine* or *spinous process* of the ischium, it transmits the divided tendons of the latter muscle, the surface over which these pass being channeled and, in the recent state, covered with cartilage. The spine of the ischium is a sharp, flat and pointed eminence, which projects downwards, inwards and backwards. Above it, the inner border of the hinder surface of the ischium, assists in forming the *greater sacro-sciatic notch*; whilst below it, between it and the tuberosity, is the *lesser sciatic notch.* To this spine is attached the lesser sacro-sciatic ligament, and to the rough elevated inner border of the tuberosity, the great sacro-sciatic ligament. Besides certain muscles, which help to close the outlet of the pelvis, the spine gives origin to the superior gemellus muscle, the inferior gemellus arising from the upper and hinder part of the tuberosity. To the lower of two impressions on the broad roughened hinder surface of this tuberosity, is attached the common origin of the semitendinosus and biceps muscles; that of the semimembranosus muscle, is fixed to the higher and more external impression on the upper and outer part of this process; the quadratus femoris arises from ts outer lip or border; the lower part of this border, the adjacent under surface, and also the under border of the entire length of the ramus, afford the chief surface of origin of the adductor magnus. Between the places of origin of these several muscles, a certain portion of the very lowest part of the tuberosity remains free, but it is overlapped by the lower border of the gluteus maximus muscle in the standing position, although it escapes from below the muscle in the act of sitting. The inner surface of the ischium, turned towards the pelvic cavity, is slightly excavated and smooth, and is partly occupied, as already mentioned, by the obturator internus muscle.

The Os Pubis.—The *pubic* portion of the innominate bone, *os pubis, pubic bone,* or *pubes,* figs. 24, 27, is prolonged from the acetabulum, forwards inwards, and a little downwards, as a rapidly and much contracted three-sided column, named the *horizontal ramus* or *branch* of the pubic bone, also commonly named the *body* of the pubes; strictly speaking, in the standing position, this part is not placed horizontally, but obliquely. At its inner and anterior end, it expands into a broad flattened portion, sometimes regarded as the body of the pubes, which meets, at the so-called *symphysis*, the corresponding portion of the opposite pubic bone, thus completing the hip girdle in front. From this part, the bone again becomes more slender, and is prolonged, in a gently curved direction, downwards, outwards and backwards, as the *descending ramus* of the pubes. The end of this ramus meets, and coalesces firmly, along an oblique elevation running downwards, outwards and backwards, with the ascending ramus of the ischium. The two rami of the pubes, horizontal and descending, bound the obturator foramen above and in front; the descending ramus forms, with the ascending ramus of the ischium, the corresponding side of the pubic arch, the free margin of which, is more or less everted. The ilio-pectineal eminence, indicating the line of junction of the pubes with the ilium, above the upper and inner part of the acetabulum, is continuous with a smooth surface, slightly excavated from without inwards, forming the horizontal ramus of the upper side of the pubes, and bounded posteriorly by a sharp ridge, named the *pecten* (*pecten*, a comb). This ridge, becoming blunter, may be traced on to the inner surface of the ilium, the entire line being called the *ilio-pectineal* line, and corresponding with the *brim* of the true pelvis. The under side or surface of the horizontal ramus overhangs the obturator foramen, and presents, on its otherwise sharp margin, a deep groove for blood-vessels; the hinder surface is turned towards the pelvic cavity. On tracing the upper or pectineal surface inwards towards the symphysis, a well-marked, although small eminence is met with, named the spinous process or *spine* of the pubes; extending from this inwards, is a part of the upper border of the bone, named the *crest*, which again terminates, at its inner end, in the *angle*. From the angle downwards, is an oval articular surface, marked by irregular transverse grooves and ridges, which, encrusted by a closely fitting interarticular fibro-cartilage, is united by that, and by ligaments, to a correspondingly grooved, ridged and fibro-cartilaginous surface on the fellow bone, forming the junction known as the *symphysis of the pubes*. The symphysis is about $1\frac{1}{2}$ inch in depth ; below it, the descending rami of the two pubic bones form the *arch of the pubes*. The posterior surface of the pubic bones is directed backwards and upwards.

The pubic bone has numerous muscles and tendons connected with it. The obturator internus, and the obturator externus, the one within, the other outside the pelvis, arise partly from the pubic portion of the border of the obturator foramen ; a very small portion of the adductor magnus takes origin from nearly the whole of the descending ramus; from the inner or lower border of the ramus, arises the gracilis ; above this, and parallel with the ramus and symphysis, is the thin origin of the adductor brevis; from just beneath the spine and crest, proceeds the narrow tendon of the adductor longus;

and outside this, from the pecten, and from the adjacent upper surface of the horizontal ramus as far as the spine, the pectineus muscle. Besides these muscles belonging to the thigh, others, connected with the trunk, are attached to the pubic bone; the psoas parvus, when present, is inserted into a small part of the ilio-pectineal line close to the eminence so called; the rectus abdominis muscle is fixed to the upper border of the crest of the pubes and front of the symphysis; in front of this, is the attachment of the pyramidalis abdominis, and of the linea alba of the abdominal aponeurosis; in front of that, and extending as far as the pubic crest and pecten, is the insertion of the thin conjoined tendon of the transversalis and internal oblique muscles of the abdomen; lastly, to the angle is attached a portion of the tendon of the external oblique muscle, and to the spine, another portion, forming the inner end of the strong band known as Poupart's ligament, which constitutes the boundary between the thigh and the abdomen.

The Ilium.—The *iliac portion* of the hip-bone, or *ilium*, figs. 24, 27, the largest portion of the innominate bone, forms the most projecting lateral part of the pelvis, and the prominent crest which overhangs the hip-joint. From the upper part of the acetabulum, the ilium extends upwards, outwards, and backwards, as a broad three-sided column, and then speedily widening out, and becoming thin, spreads, upwards and outwards, a little forwards, but much further backwards and downwards, thus forming a wing-like expansion, named the *ala* or *wing*, which again becomes thicker at its margins. The whole bone slants upwards and outwards, and presents an external and an internal surface, an anterior, a superior and a posterior border. The anterior border, jutting obliquely outwards and forwards, from the acetabulum to the outer side of the small depression opposite to the ilio-pectineal eminence, is first slightly concave, but soon rises into a distinct projection, named the *anterior inferior spine*, or *spinous process*, figs. 24, 27; above this, is a well-marked notch; and above that, a second bony projection, named the *anterior superior spinous process*, or spine of the ilium, to which the outer end of Poupart's ligament is fixed. At this process, the thick superior border, called the *crest*, begins; convex from before backwards, but undulating from side to side, fig. 27, it rises up, as its name implies, and, at a distance of about two-thirds of its length from the anterior superior spine, again descends, until it terminates in the large *posterior superior spinous process*, or *spine*, figs. 25, 26. The crest is at first directed outwards, then inwards, and then outwards again. Moderately thick in front, it increases rapidly in thickness, then becomes thinner, but finally thickest behind, where it forms the posterior superior spine. Below this process, the posterior border of the bone begins, first presenting a small notch, beneath which, is the thinner and less prominent *posterior inferior* spine; below that, is a very deep incurvation, which extends on to the back of the ischium, as far as its spine, forming the *greater sacro-sciatic* or *sciatic notch,* fig. 26. The external surface or *dorsum* of the ilium, figs. 25, 26, or rather of its ala or wing, is directed outwards, downwards, and backwards; it is convex in its anterior part, but very concave in its hinder part, fig. 27, a form which corresponds with, and explains, the undulating or sigmoid course of the crest just mentioned, and is more readily seen when looking directly down upon it. The surface is further marked by two curved lines, having their convexity turned upwards and backwards; the lower, shorter, inferior curved *line* extends from the notch between the two anterior spinous processes, in a direction downwards and backwards, to the fore part of the greater sciatic notch behind; the *superior curved line,* much longer and more distinct, extends from near the anterior superior spine, backwards and downwards, to the upper part of the greater sciatic notch. A very short, nearly vertical, slightly marked ridge passes down some distance behind this, from near the hinder end of the crest towards the root of the inferior posterior spine; this has been sometimes described as the superior curved line, the proper superior curved line being then designated the middle curved line. These lines, severally, have reference to the origins of the gluteal muscles.

The part of the outer surface of the ilium situated between the acetabulum and the inferior curved line, is free from muscle, but in a groove-like depression above the margin of that socket, is fixed one of the tendons of origin of the rectus muscle, which runs forwards along the groove, to join with the other tendon of origin proceeding from the anterior inferior spine; to the upper half of the notch above this, and to the anterior superior spine, is attached the sartorius muscle; from the outer border of this latter process, and also from a small adjacent portion of the crest, arises the tensor vaginæ femoris muscle. To this process, likewise, the outer end of Poupart's ligament is fixed in front, and the fascia lata of the thigh below. From the broad surface of the bone, between the inferior and superior curved lines, convex from before backwards, though concave from above downwards, arises the gluteus minimus, the muscle extending as far back as the great sciatic notch; the still larger concave surface, situated between the superior curved line, a part of the outer margin of the crest, and the nearly vertical line just mentioned, affords origin to the gluteus medius; lastly, the gluteus maximus partly arises from the rough triangular portion of the outer surface of the ilium, situated behind the vertical line, and from the adjacent part of the thick, posterior border of the bone. The multifidus spinæ muscle is connected with a small part of the inner side of the posterior superior iliac spine. A small portion of the pyriformis muscle arises from the upper part of the greater sciatic notch. The thickened edge or crest of the ilium, presents an outer lip, an inner lip, and an intermediate space. To the anterior two-thirds of the inner lip, is attached a part of the transversalis abdominis; behind this, a part of the quadratus lumborum; to a very thick and rough surface on the posterior fourth of this lip, a part of the erector spinæ muscle. To the middle space of the crest, is attached, along its anterior two-thirds, a part of the internal oblique muscle of the abdomen; to the anterior half or more of the outer lip, a part of the external oblique muscle, and to nearly all of the posterior half, a part of the latissimus dorsi muscle. The tensor vaginæ femoris also arises, in part, from the anterior portion of the outer lip. To the entire length of this lip, the fascia lata is firmly fixed.

The only subcutaneous parts of the ilium, are those small portions of the anterior superior spine and of the broader posterior superior spine, which are not covered by muscle or tendon, and the uneven thin margin of the crest, which intervenes between the muscles descending from it to the gluteal region, and those ascending from it to the sides of the trunk.

The anterior two-thirds of the inner surface of the ala of the ilium, fig. 24, corresponding with the convex portion of the outer surface, are excavated and smooth, and give origin to and space for the iliacus muscle, which, moreover, occupies the groove on the bone, seen between the anterior inferior spine and the ilio-pectineal eminence. This surface is called the *iliac fossa* or *venter* of the ilium; its deepest part is a little above and behind its centre, at which point the ilium is thinnest and often translucent when dry. Towards the lower border of this fossa, between the upper or iliac portion of the acetabulum, and the articular surface which joins the sacrum, the ilium becomes very thick, this being the thickest and strongest part of the bone. The lower border of the iliac fossa presents a curved ridge, which constitutes the iliac portion of the ilio-pectineal line, at the brim of the true pelvis. This ridge becomes widened behind, so as to meet, and be adapted in form to, the rounded prominent anterior border of the upper surface of the sacrum. Below it, the internal surface of the ilium is slightly excavated, and forms a part of the inner wall of the acetabulum, the Y-shaped line of junction between the ischium, pubes and ilium, being there frequently visible. A part of this surface affords attachment to the internal obturator muscle.

Behind the iliac fossa, the internal surface of the ilium abruptly loses its smooth character, and becomes extremely rugged up to its posterior border. The fore part of this rough portion of the bone presents a broad, very unevenly excavated, ear-shaped *articular surface*, having its convex border turned forwards and downwards, and following the form of the widened posterior end of the ilio-pectineal line. This articular surface is adapted to one of similar shape on the side of the sacrum, at the *sacro-iliac junction.* It is concavo-convex from above downwards, and also from before backwards, so that it forms an undulating, as well as an uneven, surface for articulation with the sacrum. Behind and above this articular surface, the bone becomes still more rugged for the attachment of the strong interosseous ligaments, which here tie the bones together.

The surface-forms dependent upon the innominate bones, will be best understood after the description of the pelvis, which must be preceded by an account of the sacrum and coccyx.

The Sacrum and Coccyx.

The Sacrum.—The *sacral portion* of the vertebral column, figs. 24 to 27, consists of the five immoveable and specially shaped sacral vertebræ, consolidated into one massive wedge-shaped bone, which is placed in the middle line of the skeleton, at the back of the pelvis. It is connected laterally, at its upper part only, with the right and left innominate bones, to complete the *pelvic arch* or *girdle.* Its lower part, ending in the apex, is directed downwards and forwards, and becomes continuous with the coccyx; its broad upper surface, or base, is articulated with the last lumbar vertebra, the lowest of the moveable vertebræ.

The sacrum is curved from above downwards, with the concavity in front, and the convexity behind ; but, as it is fixed between the hip-bones with a certain inclination downwards and backwards, the anterior concavity, or so-called *sacral curve,* is directed downwards and forwards, and the posterior convexity somewhat upwards and backwards. The anterior concavity increases the space in the pelvic cavity, whilst the posterior convex surface being partially subcutaneous, though chiefly covered by muscle, determines certain particular surface-forms, as well as the general inclination of that part of the back of the trunk. The curvature of the sacrum is subject to considerable variety.

The anterior concave surface, fig. 24, which, excepting along its upper border, is also slightly concave from side to side, presents four transverse ridges, placed between the slightly excavated bodies of its five conjoined vertebræ. Of the bodies, the first or upper one, is somewhat larger than that of the last lumbar vertebra; the second and third are considerably smaller : the fourth and fifth diminish rapidly in size. Four apertures or foramina, for the passage of nerves, are seen on each side. External to these, the lateral portions of the sacral vertebræ are completely fused, perhaps including representatives of ribs. From a part of this surface, between and outside the foramina, the pyriformis muscle arises.

On the *posterior* or *dorsal* surface of the sacrum, figs. 25, 26, which is narrower than the anterior, is a median ridge or *crest,* formed by the series of the spines of the upper four sacral vertebræ, which are more or less connected together. The highest spine is usually distinct and prominent; the third and fourth constitute a rounded eminence, the *tuberosity* of the sacrum; the lowest, or sometimes the two lowest, are rudimentary, and often cleft, the vertebral arches remaining open behind; consequently, this, the lowest, part of the sacral portion of the vertebral canal, is not completely enclosed by bone. At each side of the crest, is a broad and somewhat excavated surface, formed by the united arches of the upper four sacral vertebræ, on which are four posterior foramina for nerves. Close to the inner side of these, are four small tubercles, which, descending in the same line, on each side, as the articular processes of the vertebræ of the loins, are regarded as representatives of those processes. Between the two rows of tubercles and the median crest, are the right and left *vertebral* or *sacral grooves*, here comparatively shallow, which give partial origin to the multifidus spinæ muscle and to the lower narrow portion of the corresponding erector spinæ muscle, the lateral tubercles and median crest furnishing them with special points of attachment. The two lowest tubercles approach each other, and usually combine to form two oblique ridges, sometimes named the *sacral cornua*, which articulate with the cornua of the coccyx.

The *lateral masses* of the sacrum, fig. 24, composed of the conjoine ele- ments of this bone, present each, opposite the fourth and fifth sacral vertebræ, which take no part in the formation of the pelvic girdle, a free border, which becomes much narrower below. To this part, the sacro-sciatic ligaments are attached; the adjacent posterior surface of the bone gives partial origin to the gluteus maximus muscle. Opposite the upper three vertebræ, which alone enter into the formation of the pelvic girdle, the lateral masses of the sacrum, sometimes called the *alæ* or wings, are much enlarged, so as to transmit the weight of the trunk from above, downwards and outwards, to the innominate bones. The *articular surface*, on each side of the sacrum, like that on the opposed surface of the ilium, is ear-shaped, uneven and undulating; encrusted with fibro-cartilage, it is connected with that bone at the sacro-iliac junction. Though the upper part of the sacrum is wider in front than behind, so that the entire bone is here wedge-shaped from before backwards, as well as from above downwards, yet the fore part of each undulating lateral articulating surface is suddenly turned, so as to become directed forwards and outwards; hence this part of the sacrum is wedge-shaped from behind forwards, as well as from above downwards. Behind the articular surfaces, the rugged bone gives attachment to the strong interosseous ligaments passing from the iliac bones to the sacrum.

The base of the sacrum, fig. 24, which, owing to the oblique or tilted position of the bone, is directed upwards and a little forwards, projects anteriorly into the pelvis, forming the so-called *promontory of the sacrum*, and, with the last lumbar vertebra, the *sacro-vertebral angle*, fig. 27. This is an important point, in reference to the centre of gravity of the body. From each side of the promontory, the alæ of the sacrum present a curved and rounded prominent border, which extends outwards, and a little downwards, and ends at the margin of the auricular surface, and together with the promontory, forms the hinder part of the brim of the true pelvis. Just above this, it approaches the iliac fossa, and gives origin to a few fibres of the iliacus muscle. A broad, oval or kidney-shaped surface on the middle of the base of the sacrum, is adapted, by means of an intervertebral cartilage, to a corresponding surface on the under side of the body of the lowest lumbar vertebra. Behind this articular surface, is the large triangular opening leading into the sacral portion of the vertebral canal. On each side of the borders of this opening, project upwards the *articular processes*, right and left, of the first sacral vertebra; these are wide apart, their surfaces are smooth, concave from side to side, and directed inwards and backwards, so as to meet the two inferior articular processes of the lowest lumbar vertebra; outside these, separated by a deep notch, are the massive *transverse processes*. At the back of the sacrum, and nearly corresponding with the level of the promontory in front, a decided re-entering angle, which might be called the *posterior sacro-vertebral angle*, fig. 26, is formed between it and the lumbar portion of the spine. The broad surface below this, may be called the *sacral plane*; it slopes backwards and downwards, as low as the fourth sacral spine, or *sacral tuberosity*, which is the most prominent part of the sacrum behind. From this point, the bone curves often suddenly forwards, and articulates with the coccyx by a transversely oval surface.

The Coccyx.—This bone, figs. 24 to 27, requires but brief notice. It is the rudimentary caudal portion of the vertebral column. More or less developed, as regards length and the number of its vertebral elements, it constitutes the tail in different animals. The human coccyx, convex behind and below, slightly concave in front and above, usually contains four rudimentary vertebræ, closely articulated with each other. The first has a wide and flattened body, presenting on its upper surface an oval facet, which, by means of an intervening fibro-cartilage, is connected with the lower end or apex of the sacrum; behind, it has two blunt articular processes, named the *cornua*, which join the cornua of the sacrum; it also has two small transverse processes. The remaining three elements of the coccyx, represent the bodies of vertebræ only; they become smaller, and rounder, the last being only a small roundish nodule. After middle life, the coccygeal vertebræ have a tendency to become consolidated into one bone, which is sometimes, in old age, even anchylosed to the sacrum. The coccyx bends forwards, so that its anterior concave surface prolongs the curve of the sacrum beneath the pelvic cavity, where it serves to support the viscera. It gives origin to neighbouring muscles, including a part of the gluteus maximus, from its posterior convex surface.

The Pelvis.

The *pelvis* or *basin*, figs. 24 to 27, composed, as we have seen, of the two hip-bones, the sacrum and the coccyx, is divided into the upper or *false* pelvis, and the lower or *true* pelvis, the ilio-pectineal line, and the curved anterior borders of the lateral masses of the sacrum, together with the promontory of that bone, forming the limits between them, and constituting the *brim* of the true pelvis. The false pelvis, more capacious than the true pelvis, accordingly consists almost entirely of the widely spread and relatively broad wings of the two ilia; it has no bony walls in front. The bony margin of the pelvis, between the anterior superior spinous processes, constitutes the *abdomino-pelvic arch.* The true pelvis is composed of the lower parts of the ilia, the two ischia, the two pubic bones, the sacrum, except a small part above, and the coccyx. The upper border or *inlet* of the true pelvis, fig. 24, corresponding with the crest and spine of the pubes, the ilio-pectineal line, and the prominent anterior border of the base and promontory of the sacrum, is described as somewhat heart-shaped; it is wider across, than it is long from before backwards. The lower border or *outlet,* fig. 25, is irregular, and deeply notched in front, beneath the pubic arch, and on each side, by the sacro-sciatic notches found between the tuberosities of the ischia, and the sacrum and coccyx; its antero-posterior, exceeds its transverse diameter. When a pelvis is placed upon a table, it rests on the tuberosities of the two ischia, and on the coccyx, and the plane of the inlet of the true pelvis is nearly horizontal. From this fact, noted in studying the pelvis separately, the very oblique position of this part of the skeleton in the body, is sometimes overlooked. Owing to the many variations in the size and position of the expanded wings of the ilia, it is difficult to estimate accurately the degree of obliquity of the entire pelvis. The position of the plane of the inlet is more easily determined, being parallel with a line extending from the top of the symphysis pubis, to the base of the sacrum. This plane, on an average, is placed at an angle of about 62° or 63° from the horizon, in the male, in the standing position.

Surface-forms dependent on the Bones of the Pelvis.

By far the greater part of the outer surface of the pelvis, is so thickly clad with muscles, fasciæ, and subcutaneous adipose tissue, that it, only in a general and remote way, influences the surface-forms; but, at certain points, the bony framework does approach the surface, and, considered from an artistic point of view, these points are of the very first importance as safe guides to the eye, in determining the form of so large an area of the body.

In front, the position of the upper border of the symphysis pubis may be fixed, by remembering that it is practically on a level with the upper part of the greater trochanter of the femur. The only two bony eminences coming close up to the skin, on this aspect of the pelvis, are the small strictly subcutaneous portions of the anterior superior spinous processes of the innominate bones, which indicate the anterior ends of the iliac crests; these processes sometimes produce slight elevations of the surface, but at others, they correspond with slight oblong oblique depressions amongst the surrounding soft parts; they are guides to the position of the outer end of Poupart's ligament and to the corresponding folds of the groin, the surface-forms of both of which become obscured at their inner ends; they also indicate the level of the promontory of the sacrum, which corresponds very nearly with them, but is placed somewhat lower. Proceeding a little upwards and outwards, and then backwards from each anterior spine, is, in most positions of the body, a deep undulating groove, the *iliac furrow*, situated between the gluteal region below, and the abdomen above; this is the line of the outer margin of the crest of the ilium, so overlapped by the muscles of the abdominal walls, especially by the fleshy external oblique muscle, that its harder outlines are much softened, at the same time that it no longer forms a prominent ridge as in the skeleton, but a deep groove which gradually disappears posteriorly. Its hinder third is almost completely concealed by the latissimus dorsi muscle above, and the gluteus maximus below. At the back of the pelvis, the two posterior superior spinous processes of the ilia, or rather the portions of them which are strictly subcutaneous, usually form more or less easily recognisable prominences or depressions, one on either side, in the lower part of the trunk, a short distance below the level of the posterior sacro-vertebral angle. They are placed a little lower than the promontory of the sacrum, and almost on the same horizontal plane, as the anterior superior spines. In the skeleton, these points project boldly, beyond the corresponding part of the back of the sacrum; but the powerful erector spinæ muscle on the inner side, the latissimus dorsi on the outer side, and the gluteus maximus below, are, especially when in action, more prominent around them, and so their small subcutaneous portion is sunk deeply amongst the muscles. In the middle line, but a little lower than the two posterior superior spinous processes of the ilium, is a third point on the surface, sometimes raised, but often also depressed, which corresponds with the most prominent part of the sacral plane or posterior surface of the sacrum, namely, the tuberosity of that bone, formed by the conjoined spinous processes of its third and fourth vertebræ. This surface-point, together with the two previously described, complete a triangle, which may be named the *sacro-iliac triangle*, the apex of which, turned downwards, sinks in between the two prominent great gluteal muscles. These three points are always fixed in reference to each other, however much their relative position, as regards the bones and the muscles of the adjacent femoral and lumbar regions, may undergo change. Indeed, all the pelvic points, whether behind or in front, owing to the unyielding character of the connexions between the bones forming the pelvic girdle, retain their mutual relations as to distance and position, in all postures of the body, whether vertical, horizontal, or inclined. Hence, when the depressions corresponding with the two posterior superior spinous processes of the innominate bones, are in the samehorizontal line, as in standing equally on both legs on a level surface, the points corresponding with the anterior superior spinous processes, must also be in a horizontal line. Any inclination, downwards and sideways, of one anterior or posterior superior spinous process, such as occurs in standing on one leg, must be associated with a corresponding degree of elevation of the other. A depression of the two anterior processes, as in leaning forwards, must be accompanied by a relative elevation of the two posterior ones. The pelvis, indeed, moves on the thighs as a whole, forming a firmly united and practically solid mass amongst the soft parts, occupying the middle of the body, between the moveable thighs below, and the flexible lumbar region above. Its exact position can always be accurately determined, by referring to its two subcutaneous points in front, and its three subcutaneous points behind. The sculptor will remember that, under all circumstances, the distances between those points must remain unchanged, and must be equal on the two sides of the body; and, moreover, that the relative positions, between those of one side, must correspond with the relative positions of those of the other. For example, a given inclination of the two anterior points from the horizontal line, when seen from the front, must be associated with a precisely similar inclination of the two posterior points at the base of the sacro-iliac triangle, as seen from behind. A disregard of these necessary conditions is not uncommon.

The Moveable Vertebræ. The Moveable Part of the Vertebral Column.

The lower, *immoveable* part of the vertebral column or spine, consisting of the sacrum and the coccyx, having been described as parts of the pelvis, it remains here to examine the upper, *moveable* part, extending from the base of the sacrum to that of the skull, occupying the regions of the loins, back, and neck, and consisting of twenty-four vertebræ, lumbar, dorsal, and cervical, each set being numbered from above downwards, namely, the *first* to the *seventh cervical*, the *first* to the *twelfth dorsal*, and the *first* to the *fifth lumbar*. They are arranged one upon the other, and held together, so as to form a strong, curved, flexible, elastic column, fig. 26. In the natural skeleton, they are chiefly connected by a series of interposed *fibro-cartilaginous discs*, the *intervertebral substances*, replaced, in the artificial skeleton, by discs of cork, covered with leather, fig. 27.

Each vertebra consists of several parts. Of these a central massive part, directed forwards, is named the *centrum, centre*, or *body*, fig. 27; behind this, is an *arch*, the so-called *neural arch*, composed of two equal and lateral halves, right and left, each of which again consists of a short piece, next to the centrum or body, called the *pedicle*, and of a longer piece, reaching from this, backwards and inwards, to the middle line, named the *lamina*, fig. 26. The body and the arch together form a *ring*, which surrounds a large open space, the *spinal* or *vertebral foramen* ; this forms part of the *spinal* or *vertebral canal.* From the back of the arch, that is, from the place where the two laminæ meet, projects the *spinous process* ; and from the two sides of the arch, opposite the place of union of the corresponding pedicle and lamina, proceed the *transverse processes,* right and left. Lastly, there are four *articular processes,* two of which, the *inferior,* spring from the lower margin, and two, the *superior,* from the upper margin of the lamina, one on each side. A series of indentations on the lower and upper borders of each pedicle, are named the vertebral *notches.*

Each of these parts has its special mechanical office. Thus, the *body* or *centrum,* fig. 27, supports the superincumbent weight; accordingly, it is the largest part; it is composed essentially of cancellated tissue, the laminæ and trabeculæ of which, are arranged concentrically, the whole being covered by a thin layer of compact bone. Seen from above, or below, the centrum has a convex outline in front, and at the sides; viewed from the front, or in profile, it is convex from side to side, but concave from above downwards, so as to appear constricted across the middle, and enlarged towards its lower and upper surfaces, on which the weight is borne; these are further protected and strengthened by slightly elevated rims of denser bone, within which, the surface is depressed and roughened. Piled one upon the other, and connected by their firmly attached intervertebral discs, the bodies of the vertebræ give a jointed columnar appearance to the front of the vertebral column. The bodies of the vertebræ thus united, not only impart strength, flexibility and elasticity to the median axis of the trunk, but also protect the spinal cord and its nerves, not merely covering them in front, but maintaining the continuity of the spinal column, the other parts of the vertebræ not being adequate to offer the necessary resistance, especially in the longitudinal direction. The *arch* of each vertebra, composed of its strong *pedicles,* and somewhat broader *laminæ,* the former directed backwards, and the latter turning in and joining in the middle line, closes the *foramen* behind; and the several arches, placed closely together or even overlapping, in conjunction with the bodies, the back part of each of which is slightly excavated, complete the *spinal canal,* for holding the spinal cord and the roots of the spinal nerves. The intervertebral notches in the pedicles, meeting together, form the *intervertebral foramina,* for the transmission and protection of the spinal nerves, as these issue from the spinal canal. Lastly, the arch of each vertebra affords a half-ring-like base, from which the spinous process projects backwards, fig. 26, the two transverse processes laterally, and the four articular processes, two downwards and two upwards. The arch, which requires to be very strong, contains much compact bony tissue. The *spinous* and the *two transverse processes,* provide surfaces of attachment and points of leverage, to numerous muscles; whilst the *articular processes,* with their smooth

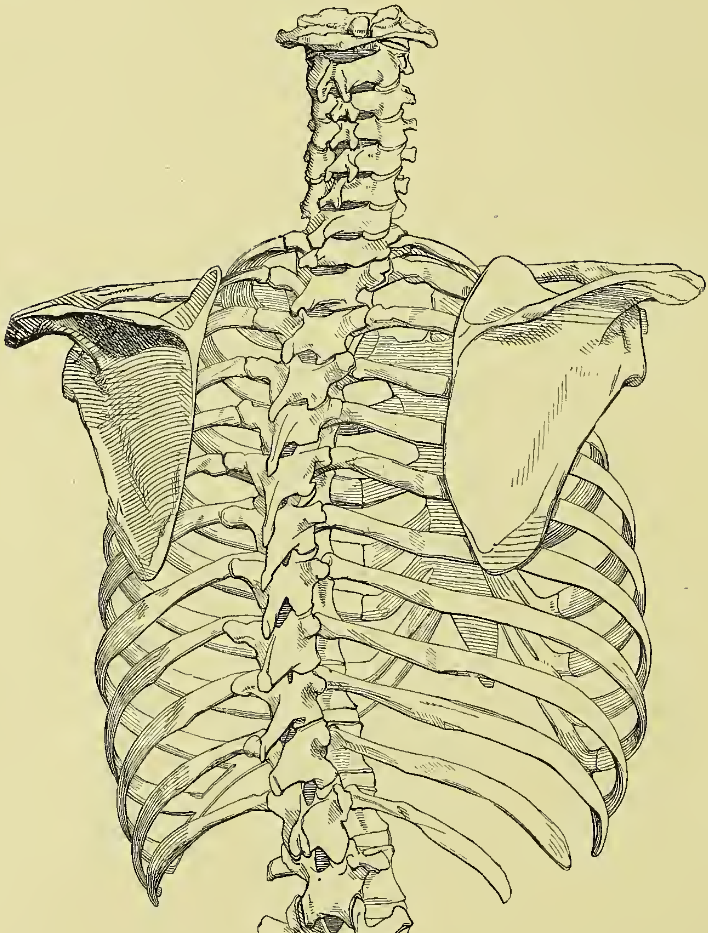


Fig. 26.—Three-quarter back view of the Bones of the Trunk, including the Pelvic and Shoulder-girdles.

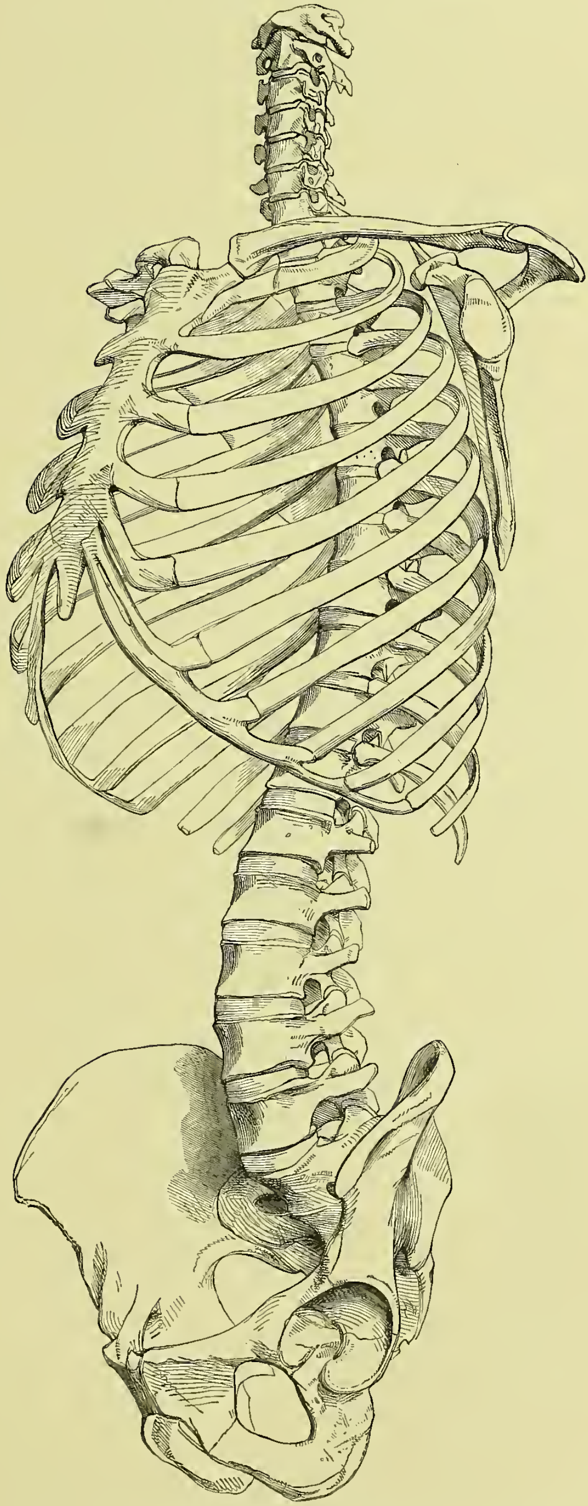


Fig. 27.—Three-quarter front view of the Trunk, including the Pelvic and Shoulder-girdles.

facets covered with cartilage, and their ligamentous connexions, determine the character of the movements between any two neighbouring vertebræ.

The size and shape of the several component parts of a vertebra, necessarily vary, as the uses to which they are put, are modified in each region of the spine. There is, however, no sudden change, but rather a transition, from one form of vertebra to another, at the limits of the different regions, and the middle vertebræ of each region are typical of that region. Nevertheless, the twelve dorsal vertebræ are quite peculiar, in being connected each with a pair of moveable ribs; and the cervical vertebræ, with the exception of the lowest, are distinguished by having their transverse processes perforated at the base.

The *centra* or *bodies* of the vertebræ may be said, in general terms, though the statement requires to be accepted with reserve as regards the dorsal region, to diminish in size from the lower to the upper end of the column, more especially in their height and transverse sectional area. This is in evident relation to the proportionately diminishing weight which they have to carry. In the *lumbar* region, figs. 32, 33, the bodies are much the largest in all their dimensions; their broad under and upper surfaces are oval or somewhat kidney-shaped, and much widened transversely. This part of the spine, being unsupported at the sides by ribs, possessed of a considerable range of movement, and capable of much lateral inclination, requires special support in that direction. The lumbar bodies, moreover, are relatively more constricted across their middle, so as to project considerably at their upper and under margins; they are, likewise, thicker, from below upwards, in front than at the back, thus assisting in the production of the lumbar spinal curve, which is convex anteriorly. This peculiarity is especially noticeable in the body of the fifth or lowest lumbar vertebra, the under surface of which is very oblique, to fit the slanting upper surface of the sacrum, just above its promontory, opposite the sacro-vertebral angle. In the *dorsal* region, figs. 30, 31, the bodies diminish in size up to the fourth vertebra, above which they again increase up to the first. They are smaller than the bodies of the lumbar vertebræ, as they carry less weight. They are compressed laterally, so that their bearing surfaces are deeper from before backwards, than they are wide from side to side, evidently in relation to the fact, that, in this part of the spine, which is supported on each side by the ribs, and has its lateral movements limited by them, the characteristic motion is forwards and backwards, that is, precisely in the direction of the longest diameter of the centra. The lateral compression of the dorsal bodies, also increases the accommodation for the lungs. They are somewhat thicker, from below upwards, behind than in front, in harmony with the dorsal curve which is concave anteriorly. In accordance with the general fact, that the vertebræ of different regions exhibit transitional characters, the bodies of the lower dorsal approach, in form and size, those of the upper lumbar vertebræ. Lastly, each dorsal vertebra has on its body, articular facets for the heads of the ribs with which it is connected. There are usually two small facets on each side, shaped like a half cup, one on each margin of the body, close to its junction with the

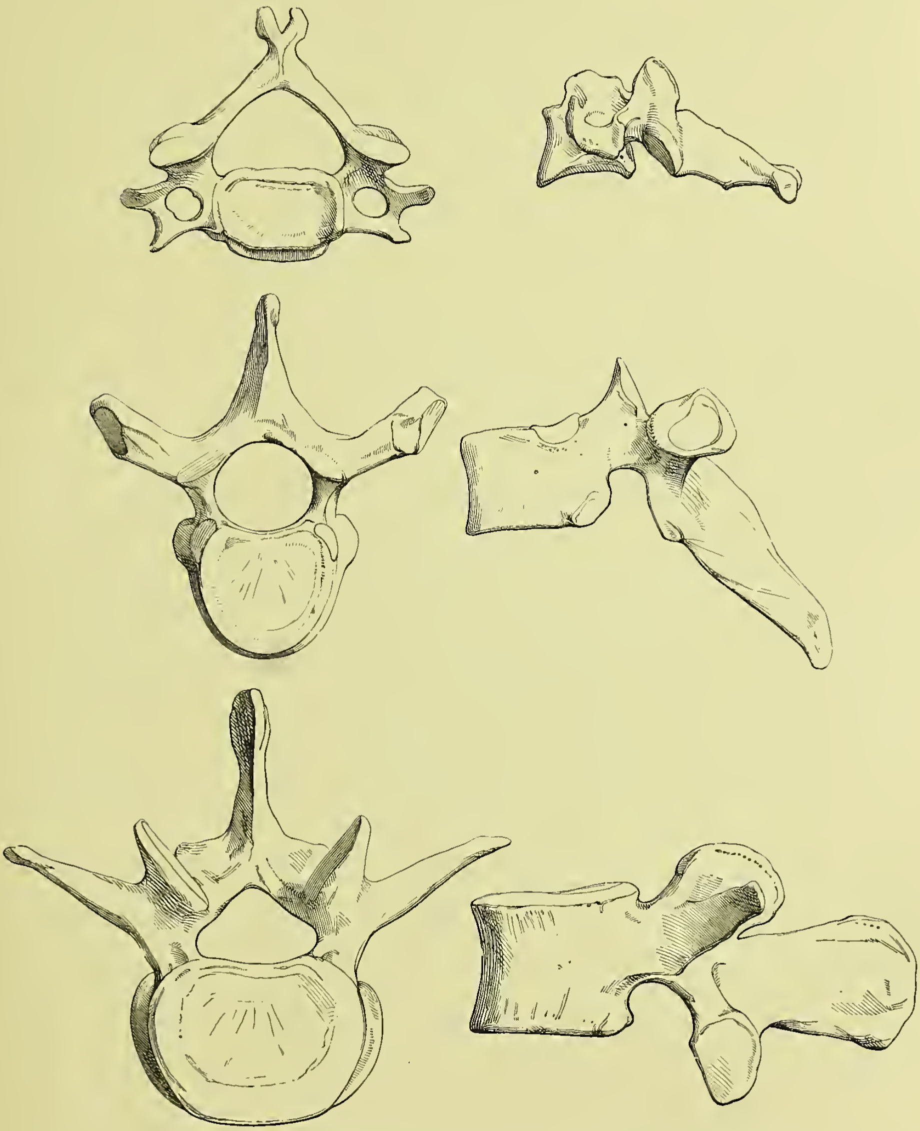


Fig. 28, upper view, and Fig. 29, left side of the fourth Cervical Vertebra.
Fig. 30, upper view, and Fig. 31, left side of the sixth Dorsal Vertebra.
Fig. 32, upper view, and Fig. 33, left side of the third Lumbar Vertebra.

pedicle ; but in the twelfth, eleventh and tenth dorsal vertebræ, there is only a single, whole cup-shaped facet on each side of the body; in the ninth*, there is but one half-facet at the upper margin; and in the first or highest dorsal vertebra, there is, on each side, a half-facet on the lower margin, and a complete facet on the body higher up. In the *cervical* vertebræ, figs. 28, 29, the bodies, speaking generally, are smaller than those of the back, the weight to be carried by them being less. Their transverse is in excess of their antero-posterior diameter, thus providing the required support, in lateral inclination of the neck, which is sometimes very considerable. The bodies of the lower five cervical vertebræ have, moreover, their upper surface shaped, from before backwards, like a shallow gutter, bounded on each side by a well-marked elevated lip, the surface of the vertebra next above, being bevelled off at each side, so that it fits into the recess on the one below. This peculiarity, which also exists on the upper surface of the body of the first dorsal vertebra, renders safer the free movements of this part of the vertebral column. The cervical bodies are rather thicker in the vertical direction in front, than at the back, in correspondence with the cervical curve, which is convex anteriorly. Not only the bodies, but all the other parts of the *second* and *first* cervical vertebræ, are so modified, that they will require special description.

The *arches* of the moveable vertebræ, composed of the pedicles and laminæ, are also thickest, deepest, and strongest in the lumbar region, fig. 32, and, speaking generally, they gradually become less massive in the dorsal, fig. 30, and cervical, fig. 28, vertebræ, in accordance with the less need of strength in the upper than in the lower parts of the spinal column; nevertheless, the laminæ are very deep in the dorsal region, and very wide quite at the upper part of the neck. Throughout the whole moveable portion of the spine, the upper and lower borders of the laminæ are somewhat rough, and give attachment to the yellow ligaments. The spinal or vertebral *foramen*, or canal, (*see* figs. 28, 30, 32), does not follow the same general rule as the bodies, in reference to its size at different parts of the spine. Thus, it is large in the loins and lower part of the back, where it lodges the long and large roots of the spinal nerves of the lower limbs, and the corresponding enlargement of the spinal cord; it is smallest in the middle of the back, where it contains the smallest part of the spinal cord, and the roots of the comparatively small spinal nerves of the trunk; it is again much larger in the neck, where it encloses the cervical enlargement of the cord, and the large roots of the spinal nerves of the upper limbs. In the loins, the canal is bluntly triangular, in the back, nearly circular, and again three-sided in the neck. Its dimensions and shape have an evident relation, not only to the size and form of its contents, but also to the necessity for affording to these, greater space in those regions of the spine, where the movements are freest, namely in the neck and loins. This explains the very large size of the canal opposite the upper two cervical vertebræ.

The *spinous processes* of the *lumbar* vertebræ, figs. 32, 33, are somewhat square in outline, being long, and yet very broad; they are thick and rough along their upper edge and posterior surface, but especially so on their under surface; they are nearly horizontal in direction, and leave decided interspaces between them. Their broad surfaces, great strength, and projection backwards, are well adapted to afford attachment and leverage to the powerful muscles occupying this region of the spine, where the weight of the trunk, upper limbs and head, has to be balanced. Their horizontal direction offers no impediment to lateral inclination, whilst the interspaces between them permit a very free movement of the loins backwards. The lowest lumbar spinous process, situated just above the *posterior sacro-vertebral angle*, is smaller than the others. In the *dorsal* vertebræ, figs. 30, 31, the spinous processes are strongly developed, but they are longer and narrower than in the loins, and three-sided, not flattened laterally. They are not horizontal, with comparatively wide interspaces; but from below upwards they gradually become more and more slanting, and leave smaller spaces between them, so that they become imbricated, their under borders and surfaces being even grooved or hollowed longitudinally, so as to aid their close approximation. Their elongated apices are somewhat tuberculated, and, at the lower part of the back, are slight bifid. Owing to their great length, they increase the leverage for the muscles inserted into them, especially at the moment when this is most needed, namely, when the dorsal region is bent forward and has to be restored to the upright position; then it is, that these processes are most prominent. Their length, their closeness of adaptation, and their imbrication, all serve to give firmness to the thorax generally, and to limit the movement of extension backwards, whilst they in no way interfere with flexion forwards, nor with the restoration of the spine to the upright posture, which are the chief and characteristic movements of the dorsal region. The spinal processes of the twelfth, eleventh and tenth dorsal vertebræ, are decidedly shorter, wider apart, and more nearly horizontal, than the others, in these respects resembling lumbar vertebræ; and it is in this region that a certain amount of backward extension and lateral inclination, is permitted; so likewise, the spinous process of the first dorsal vertebra, is very long, strong, and nearly horizontal, somewhat like those of the neck. In the *cervical* region, figs. 28, 29, the spinous processes, generally, are smaller, shorter, less oblique, some being almost horizontal, and leave more marked spaces between their apices. These characters are especially noticeable in regard to the sixth, fifth, fourth, and third, cervical vertebræ; they are favourable to great freedom, in lateral inclination, rotation, and backward extension. Though the cervical spinous processes are proportionally small, in accordance with the diminished weight here to be balanced, yet, with the exception of the lowest and highest, they are bifurcated at their summits, which end in two small, sometimes unsymmetrical, tubercles. This is a provision for the attachment of the more numerous and more subdivided muscles here present, in conformity with the greater complexity of movement in the neck, which, as the immediate support of the head, has to assume so many different positions. The spinous process of the lowest cervical vertebra resembles a dorsal spine, being long, strong, somewhat oblique, imbricated, not bifurcated, and above all very prominent, so that this vertebra has received the name of the *prominent vertebra*, figs. 6, 26, (*vertebra prominens*); it gives attachment, not only to muscles, but also to the *ligamentum nuchæ*.

The *transverse processes* of the *lumbar* vertebræ, figs. 32, 33, are long, thin, and pointed, so as to afford surface and leverage for the powerful muscles attached to them in front, at their apices, and behind. They project not quite laterally, but outwards and a little backwards, and thus increase the space for the abdominal viscera. They are usually said to be horizontal in direction, but this is true only in regard to the middle vertebra; for the two transverse processes of the fifth, and those of the fourth, incline upwards, following the line of the corresponding parts of the sacrum and of the crests of the ilia; whilst those of the second and first vertebræ incline slightly downwards, obeying, as it were, the line of the transverse processes of the lowest dorsal vertebræ and the ribs, figs. 26, 27. These parts, indeed, exhibit a mutual relation as to position, which permits a greater freedom of lateral inclination in the loins; for, when the trunk is bent over to one side, the transverse processes of the lower and upper lumbar vertebræ approach that of the middle one; whereas, if these processes had been horizontal, even a slight lateral inclination of the trunk would have brought them speedily into contact with the iliac crest on the one hand, or with the last rib on the other. The transverse processes of the third and fourth lumbar vertebræ, are longer than the rest, but those of the fifth are very short and broad for the attachment of the strong ilio-lumbar ligaments, which connect this vertebra with the pelvis. At the back of the arches of all the lumbar vertebræ, near the roots of the transverse processes, are four small tubercles, two superior and two inferior, to which certain spinal muscles are attached. In the *dorsal* region, figs. 30, 31, the transverse processes are especially modified, to suit the presence of ribs in this part of the trunk; they are very strong, being both longer and thicker than in the lumbar region, yet, as they do not project directly sideways, but outwards, backwards, and slightly upwards, their length is not so obvious when they are viewed from behind; moreover, they are enlarged or clubbed at their ends, on the fore part of each of which, is a small shallow facet, for articulation with the tuberosity of a rib. The transverse processes of the twelfth and eleventh dorsal vertebræ are shorter, and have no facets at their apices. Near their roots, they present small tubercles similar to, but less developed than those found in the lumbar region. The length and strength of the dorsal transverse processes, and their backward projection, enable them to afford suitable points of insertion and leverage to the longissimus dorsi, a part of the erector muscle of the spine, which is thus attached well behind the centre of movement in the bodies of the vertebræ. These processes not only furnish a second basis of support to the ribs, except to the two lowest, but their backward projection permits of the ribs being more curved, and therefore stronger, and better adapted to the movements of respiration; it further increases the backward space in the thoracic cavity; and, lastly, by throwing the hinder part of the thorax, and even the scapulæ and their muscles, backwards, it brings more of the weight of the trunk over the base of support, the upper surface of the sacrum. The lateral projection of the dorsal tranverse processes, increases from below upwards; but their backward extension is greater in the lower and middle part of the region, and diminishes in the upper part. The transverse processes of the twelfth vertebra, incline downwards; those of the eleventh, and tenth, are nearly horizontal; whilst, from and above the ninth, they gradually incline more and more upwards, a direction which enables them better to meet the ribs with which they articulate, for these are always attached to the upper margin of the body of the same vertebra, and, except the twelfth, eleventh and first ribs, to the lower margin of the body of the vertebra above. In the *cervical* region, figs. 28, 29, the transverse processes are short and slender, project outwards and a little forwards, on each side, and are nearly horizontal, inclining, however, slightly downwards. Excepting those of the seventh, second and first vertebræ, they are grooved on their upper surface, and bifurcated at their ends, where they present two tubercles for the attachment of the muscles, which here become more complex. The base of the transverse processes of the seventh cervical vertebra, usually has a small perforation in it, but, in all the other vertebræ, these processes have a large foramen through their base, for the transmission of the vertebral artery, which ascends to the brain. The larger part of the process, behind this foramen, springs from the vertebral arch, and resembles the transverse process of a dorsal or lumbar vertebra; but the smaller part, in front of the foramen, proceeds from the body of the vertebra, like a rib, of which it has been regarded as the capitular portion or head, whilst the portion of bone which completes the foramen externally, has been supposed to represent the tubercle of the rib. That the part of each transverse process of the seventh cervical vertebra, situated in front of the small foramen, contains, at least, parts of a rudimentary rib, seems certain; for, sometimes, supernumerary ribs are found attached to this vertebra, one on each side, replacing the parts of the transverse processes situated in front of the foramina. It is presumable that this may also be true, in regard to the other cervical transverse processes.

The four *articular processes* belonging to each vertebra, two *inferior* and two *superior*, differ very much in the different regions of the spine. In the *lumbar* vertebræ, figs. 32, 33, they are placed further than elsewhere, behind the bodies or centres of motion; they are broad and strong, and project, almost vertically downwards and upwards, from the arch, here strengthened by the small tubercles above mentioned. The two lower ones, on each vertebra, are a little nearer the middle line than the upper ones; their articular surfaces are turned forwards and outwards, and are convex from front to back. The two upper ones, placed a little further apart, have their articular surfaces turned backwards and inwards, and concave from front to back. Hence the two lower articular processes of any one vertebra, are received between the two upper ones of the vertebra below it, the two separate joints representing interrupted parts of a single joint, the movements of which are thus performed securely. The advantage of this, in the comparatively unsupported lumbar region, where the entire upper part of the body is balanced upon the pelvis, is sufficiently obvious. The two lower, convex and outwardly directed articular processes of the lowest lumbar vertebra, are wider apart than the rest, and are received between the two upper, still more widely separated concave and inwardly directed articular surfaces of the sacrum,—the surfaces of articulation being here wider apart than elsewhere. The articular processes of the first sacral vertebra approach in character those of the last lumbar vertebra. The two inferior articular processes of the twelfth *dorsal* vertebra, also resemble those of the first lumbar vertebra, in being convex, and directed forwards and outwards, thus giving great security to the most moveable of the joints in this region. In the dorsal region, generally, figs. 30, 31, the articular processes are smaller, stand nearly upright, and have their co-adapted surfaces flat, and vertical in the lower half of the series, but slanting downwards and backwards, in the upper half. Moreover, the lower ones look not only forwards, but slightly inwards, and the upper ones backwards and somewhat outwards, conditions which necessarily regulate the movements of different parts of the back. In the *cervical* region, figs. 28, 29, the articular processes become gradually shorter, somewhat broader, and are situated further behind the transverse processes. Their surfaces, large, oval, and nearly flat, exhibit a gradual change in their direction, so that, whilst in the lower part of the neck, they resemble those in the upper dorsal region, namely in slanting backwards and downwards, they become nearly horizontal, in the upper part, a condition which obviously favours freedom of motion in the neck.

The Axis and Atlas.—These vertebræ, the *second* and the *first* cervical, are thus modified. The body of the *second* cervical vertebra, figs. 37, 38, is somewhat deeper in front, from above downwards, than the one below it, and its upper surface is not flattened for the attachment of an intervertebral disc, to connect it with the under surface of the vertebra above, but, on the contrary, is prolonged upwards, in the form of a very strong toothed-shaped process, named the *odontoid*, or *dentate* process (*ὀδούς*, *dens* ; a tooth), the vertebra itself being designated the *vertebra dentata*. This process ascends into and occupies the anterior part of the ring formed by the first cervical vertebra, which, with the head supported upon it, partially rotates around the odontoid process, so that this latter serves as a pivot or *axis* of rotation, fig. 36. Hence the second cervical vertebra has been named the *axis*. The odontoid process presents a contracted part or *neck*, which is strengthened, in front, by a vertical ridge, and is embraced behind by the so-called transverse

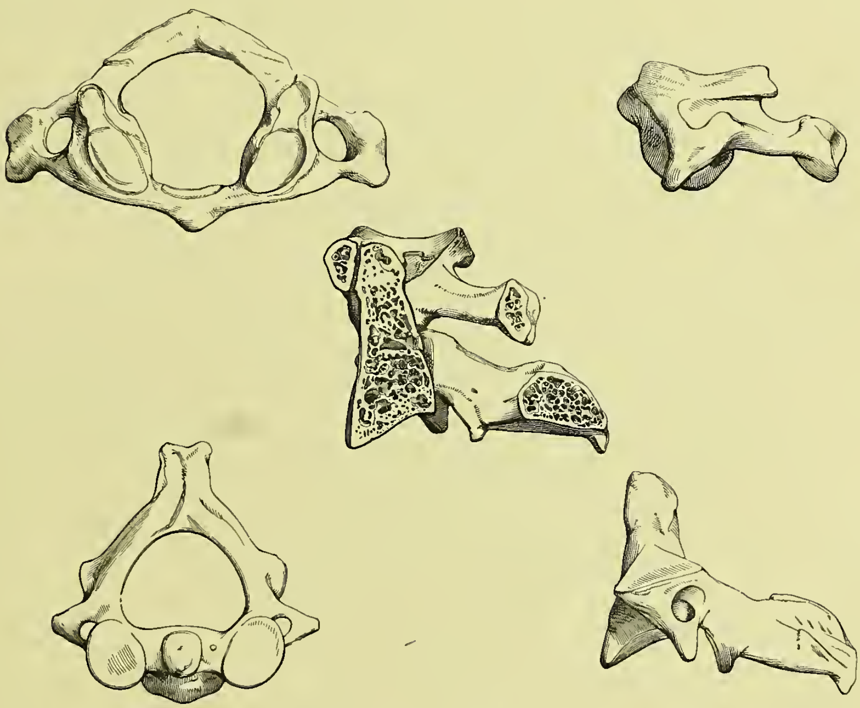


Fig. 34, upper view, and Fig. 35, the left side of the atlas. Fig. 36, vertical median section through the axis and atlas, showing the right halves of those bones in their due relation to each other. Fig. 37, upper view, and Fig. 38, the left side of the axis.

ligament ; its head is club-shaped, having its apex bevelled and its sides roughened, for the attachment of the odontoid ligaments. In front, it has a small oval articular facet, for adaptation to the inner surface of the ring of the first vertebra, and another also oval but somewhat larger, behind, for contact with the transverse ligament just mentioned. The *pedicles* of the axis are slender, but the *laminæ* of its arch are very thick, and deep from above downwards. The spinous process is also long, deep, massive, rugged, nearly horizontal, but somewhat curved upwards, and deeply bifurcated at its apex ;

so that in size, and in its amount of projection backwards, it greatly exceeds the spinous processes of the vertebræ below and above it; it also affords broader surfaces of attachment, and better and more definite points of leverage, to the numerous muscles here present. The *transverse processes*, on the other hand, are small, and neither grooved nor bifurcated; but they are perforated at their base. Of the *articular* processes, the two inferior ones resemble those of the cervical vertebræ generally, in their size, flatness, position behind the transverse processes, and their slightly sloping direction backwards. The two superior ones, on the contrary, figs. 37, 38, are remarkably modified. Thus, they are much larger than the inferior articular processes, occupying the greater part of the space between the base of the odontoid process and the roots of the two transverse processes, on which, as well as on the pedicles and body of the vertebra, they may be said to rest. Hence, they are placed, not behind the transverse processes, as usual, but in a line with them, and also further forward and nearer to the median plane. Their articular surfaces are nearly circular, slightly convex and almost horizontal from before backwards, but sloping obliquely downwards and outwards towards the sides. These two large surfaces, right and left, form a very wide base of support, thrown well forward in the spine, for the reception of the two inferior articulating processes of the first vertebra, and thus for the transmission of the superincumbent weight of the head, which, above this point, is no longer borne by the vertebral centres. The odontoid process itself receives no weight, but acts merely as a pivot, around which the first vertebra partially rotates.

The *first cervical* vertebra, or *atlas*, figs. 34, 35, so named because it supports the head, as the hero Atlas supported the earth, is still further modified. It has no longer a thick anterior part or body, but, in its place, a slender anterior arch, which, with the proper posterior arch, forms a strong bony ring, widened out transversely by two large lateral masses, but having its enclosed space larger from before backwards than it is wide from side to side. In front of the anterior arch, is a small prominence standing forward from it, named the *anterior tubercle*; on its concave posterior surface, is a smooth facet for articulation with the odontoid process of the axis, which projects up into the fore part of the ring of the atlas, fig. 36. The transverse ligament, which crosses behind that process, is fixed to two small *internal tubercles*, placed one on each side of the ring, just in front of the middle of the two superior articular processes. Behind that ligament, between it and the proper posterior arch of the vertebra, is the true *vertebral foramen*, the large, oval space, which contains and protects the spinal cord and its membranes. This separation of the part occupied by the odontoid process of the axis, from that which lodges the spinal cord, renders the partial rotation of the atlas with the skull, around the pivot of the axis, safe, without the risk of pressure on the nervous centres. The spinous process of the atlas is so reduced in size, as to appear quite rudimentary, being represented only by a small posterior eminence, named the *posterior tubercle,* which serves for the attachment of two small muscles, but does not interfere with the backward movement of the skull in the act of looking upwards. The transverse processes are long and strong; they project considerably beyond those of the subjacent cervical vertebræ, affording advantageous leverage for the oblique muscles of the head, and reach out, beneath the skull, towards the mastoid processes of the temporal bones; they are largely perforated at their base, by the foramen for the vertebral artery, but they are blunted, not bifid, at their apex. The two *lower articular* processes are adapted in situation and form, to the two upper articular processes of the axis; accordingly, they are large, nearly circular, situated in a line with, not behind, the transverse processes, very slightly concave, nearly horizontal from before backwards, and directed downwards, inwards, and somewhat backwards. Together, the two serve to transmit the weight of the head from above, to the sides of the second vertebra, whence it passes obliquely forwards along two converging lines, to the body of that vertebra, and then downwards along a single line, from the body of the axis, to that of the vertebra beneath, and so on through the rest, the articular processes bearing less and less weight, in proceeding from above downwards. No part of the weight of the head can be transmitted through the slender anterior arch of the atlas, but the two *superior articular* surfaces of the atlas, one on each side, perform this office. They are large and peculiarly shaped; sometimes described as oval, they are rather ear-shaped, having their incurved margins turned inwards, towards the vertebral foramen or canal; they are placed obliquely on each side of the ring of the vertebra, their anterior extremities being nearer together than the posterior. Their surfaces are very concave from before backwards, but only slightly so from side to side; their outer margins are much higher than their inner ones; hence they form two rather deep ear-shaped cups, for the reception of the two convex condyles of the occipital bone, which are situated on the base of the skull. Besides receiving the superincumbent weight of the head, the two superior articular surfaces of the atlas, furnish a double socket, for the backward and forward rolling movements of the occipital condyles, in the nodding motions of the head. On the other hand, the proper rotatory movements of the head take place, not between the occipital condyles and the atlas, but between the atlas and the axis, the atlas carrying the occiput with it, and moving around the odontoid process. This process, which is developed separately from the body of the axis, and becomes united to it only after a certain time, might be regarded as a part of the body of the atlas, which, apparently deficient, may be supposed to have been transferred to the vertebra beneath it.

The moveable vertebræ afford points of attachment to numerous ligaments and muscles. Most of the latter are situated at the *back* of the spine. To the rows of transverse and spinous processes are fixed many short, both straight and oblique, muscular slips, which constitute the deepest layer of the vertebral muscles. The transverse processes afford insertion, throughout, to the longissimus dorsi muscle and its cervical prolongations, and give origin, in the back, to the levatores costarum and to the complexus, and some of those in the neck to the levator anguli scapulæ. The spinous processes, as might be expected, give rise to many muscles, viz. to the longissimus and spinalis dorsi from the lumbar spines, to the two serrati postici from certain spines in the loins and back, and from the lowest in the neck, to the splenius colli and splenius capitis in the back and lowest part of the neck, to the latissimus dorsi from all the lumbar and the six lower dorsal spines, to the two rhomboid muscles from the five upper dorsal and seventh cervical spines, and to the trapezius from the last cervical and all the dorsal spines. At the upper part of the neck, the obliquus capitis inferior, and the rectus capitis posticus major, arise from the spine of the axis; the rectus capitis posticus minor, from the posterior arch of the atlas.

At the *sides* of the spine, the aponeurosis of the transversalis abdominis, and the quadratus lumborum are attached to the transverse processes of the lumbar vertebræ; the three scaleni muscles and also the obliquus superior, the rectus capitis lateralis and recti antici major and minor, are connected with the transverse processes of certain cervical vertebræ.

In *front* of the spine, the psoas magnus is attached to the bodies and transverse processes of the last dorsal, and all the lumbar vertebræ, and the psoas parvus to the body of the last dorsal and first lumbar vertebræ; the pillars of the diaphragm are connected with the front of the three or four upper lumbar vertebræ; whilst, lastly, in the neck, the longus colli is attached to the bodies or transverse processes of the two upper dorsal, and of six of the cervical vertebræ.

The Vertebral Column considered as a Whole.

In considering the general form of the vertebral column or spine, it is desirable to include its immoveable sacral and coccygeal portion, as well as its moveable part.

Viewed from the front, fig. 64, or from behind, fig. 65, the entire spine forms a vertical column, which theoretically and artistically, may be regarded as perfectly upright, but which, in fact, most frequently presents a long and gentle lateral dorsal curve, opposite the third, fourth and fifth vertebræ, having its concavity turned towards the left side, and compensated by a slight lumbar curve, in the opposite direction. This deviation is said to be due to the long-continued preferential use of the right upper limb, which gives rise to a leaning over of the trunk to the left side, and to a counter curve in the loins. This lateral dorsal curve has been found to take an opposite direction in a left-handed person. The vertebral column, as seen in front, is not of uniform width throughout its moveable part, being widest in the lumbar, narrower in the cervical, and narrowest in the dorsal region; in its immoveable part, the sacrum is wider, and the coccyx narrower than the widest and narrowest regions of its moveable portion. The central part of the column, which is composed of the *bodies* of the vertebræ, and, in the moveable part, of the intervertebral discs also, piled one upon the other, does not diminish uniformly in width from the sacrum upwards and downwards, but presents four pyramidal portions, superimposed one upon the other. The *lowest* pyramid, inverted and nearly complete in form, consists of the conjoined sacrum and coccyx; it, at first, gradually, and then, rapidly, diminishes from above downwards, as the weight it has to bear, and the muscular force it has to resist, decrease in the same direction; the widest part of this pyramid, the upper part of the sacrum, is the solid mass, which enters into the formation of the pelvis. The *second* pyramid, erect, and truncated at its summit, is composed of the bodies of all the lumbar vertebræ, and of the nine lower dorsal vertebræ; for, up to the fourth dorsal vertebra, the central part of the vertebral column gradually diminishes in width, and thus affords more lateral space in the thoracic cavity, on each side. From the third dorsal to the seventh or lowest cervical vertebra, a *third* pyramid is observable, for the bodies of the vertebræ here again widen gradually to form a broader base at the bottom of the neck, for the support and balance of the head. The *fourth* pyramid lies between the seventh and the second cervical vertebræ, in which part of the neck, the bodies become gradually narrower upwards, as they have less and less weight to carry; the first cervical vertebra, or atlas, as already stated, has no body, but presents here its wide though thin anterior arch.

On viewing the spine from behind, fig. 65, it is seen that the *transverse processes* spread out more widely, on each side, in the lower part of the lumbar region, gradually less so, as high as the twelfth or lowest dorsal vertebra, again project backwards as well as outwards, and are much enlarged at their ends, up to the first dorsal, and then once more diminish in lateral projection, as high as the axis; the atlas, however, suddenly becomes as wide as the highest dorsal vertebra, thus overlapping the more slender column beneath, and leading the eye to the still broader crowning mass of the head, which it supports. These differences are associated with differences in the size of the muscles in each region, and with the provision of proper support to the ribs. The two series of *articular processes*, right and left, as seen from behind, are wide apart at the lower end of the lumbar region, but approach each other rather rapidly, up to the highest lumbar vertebra; from this point, they gradually become wider apart throughout the whole dorsal region, being especially far asunder at the articulations between the second and first dorsal vertebræ; in the neck, they very slightly approximate again, as high as the superior articular processes of the axis, but the superior processes of the atlas become once more widely separated. In the middle line of the vertebral column behind, is seen the longitudinal row of *spinous processes*, which have given the name to the spine itself. In the sacral region, the spines are short, depressed, or wanting; in the lumbar region, they are thick, deep, and horizontal; in the dorsal region, they are long, more slender, triangular, and overlapping, excepting that of the first dorsal, which is short and blunt; in the cervical region, that of the seventh is long and thick, but the others are short, deep and nearly horizontal, that of the axis being very large indeed, whilst that of the atlas is reduced to a mere tubercle. The free ends or apices of these, up to the seventh cervical, are covered only by ligament, fascia, and skin. Their subcutaneous surfaces are both widest, and deepest from above downwards, in the lumbar region; in the back, they are more pointed or tuberculated; in the neck, their more concealed apices are bifurcated or double, excepting those of the seventh and first. The spinous processes project furthest backwards in the loins, next in the back, and least of all in the neck, excepting always that of the lowest cervical, or prominent vertebra, and that of the axis, which stands very boldly out from the one below it.

At the sides of the entire series of spinous processes, between them and the transverse processes, are seen, in the skeleton, two well-marked longitudinal depressions named the *vertebral grooves*. These are very shallow along the sacrum; deepest in the lumbar region; much shallower in the back, especially in its upper third, where, however, they become broader, increasing in width up to the highest dorsal vertebra; in this region, the vertebral grooves appear to spread out as far as the angles of the ribs, where, accordingly, they might be named *vertebro-costal*; in the neck, they become still more shallow, and also narrower. These grooves accommodate, on each side, parts of the oblique, and longitudinal muscles of the back, and are completely filled by them. At the bottom of the grooves, are seen the laminæ of the several vertebræ, narrow, and somewhat excavated from above downwards in the loins; deep, wide, flat, and having an oblique direction downwards and inwards, in the back; not so deep, and horizontal, in the neck. These laminæ connect and support the transverse, spinous and articular processes. Between the parts of the laminæ, from which the several spinous processes spring, are slight intervals, where there is no bony protection to the spinal cord; the interval is large between the sacrum and the loins; it is smaller in the lumbar region itself and in the upper part of the neck; but between the atlas and the occipital bone, there is a large unprotected gap. These intervals favour the backward bending of the loins and neck, and the backward movement of the skull. In the upright posture, there are no such intervals in the dorsal region, and even in the stooping posture, they are covered by the deep laminæ and the long overlapping spinous processes.

The four well-known, alternating, *antero-posterior curves* of the spine, named the *sacral, lumbar, dorsal* and *cervical* curves, may be recognised on both the back and front views of the vertebral column (see figs. 26, 27). In front, there may be easily distinguished, the concavity of the sacral curve, below the promontory of the sacrum; above that promontory, are seen the convexity of the lumbar, the concavity of the dorsal, and, lastly, the convexity of the cervical curve. Behind, on the other hand, the sacrum is convex, the loins are concave, the back is convex, and the neck again concave. But these curves, and especially their lengths, depths, and other peculiarities, are better seen from their lateral aspect, fig. 6. It is then apparent that the sacral curve is the shortest and most abrupt; that the lumbar curve is longer and somewhat flatter, and, indeed, extends slightly into the lower part of the back; that the dorsal curve is the longest, and is well pronounced; and, lastly, that the cervical curve is shorter and comparatively gentle. The change of form at the promontory of the sacrum, is sudden, and hence the term, *sacro-vertebral angle*, fig. 27, applied to the junction of the sacral and lumbar regions; above this angle, the different curves pass gradually into each other. The spinal curves depend chiefly on the differences, already mentioned, between the thickness of the fore part and hind part of the bodies of the vertebræ in each region; but they are also partly due to concurrent differences in the thickness of the intervertebral discs, which, for example, are somewhat thicker before than behind in the cervical and lumbar regions, but thicker behind than before in the back. The contours of the spinal curves, as seen from the side, are not equal before and behind, that is, as traced along the bodies of the vertebræ, and along the spinous processes. Thus, the sacral concavity in front, is more pronounced than its convexity behind; the lumbar convexity in front, has a higher degree of curvature than its concavity behind; the dorsal concavity and convexity, before and behind, are more equal; and, lastly, the cervical anterior convexity is less evident than its posterior concavity.

Surface-forms dependent on the Vertebræ.

The anterior surface and the sides of the vertebral column turned towards the viscera in the interior of the body, towards the ribs in the back, and towards the muscles in the loins and neck, are entirely concealed; this is true also of the greater part of its posterior surface, which, especially in the loins and neck, is deeply embedded in, or covered by, muscles. The only parts of this long central bony axis, which come closely up, beneath the skin, and so directly influence the surface forms, are the spinous processes ; and, of these, only the apices are really subcutaneous, their edges and surfaces being entirely hidden, like the rest of the vertebræ, by muscular or tendinous structures. The prominent, longitudinal, but interrupted ridge, formed by the succession of spinous processes, as seen in the skeleton, and extending from the back of the sacrum, up to the occiput, is no longer visible as a ridge, in the living figure, excepting in emaciated persons. The apices of these processes are, however, always distinguishable along the bottom of a more or less evident furrow passing down the middle of the back. This furrow, the *spinal furrow*, is deepest in the region of the loins, partly on account of the lumbar posterior concavity, but also because the lumbar muscles are very large, and project backwards on each side, much beyond the spinous processes. It gradually becomes shallower in the dorsal region, because of the posterior convexity of that part of the spine, and the comparative flatness of the muscles on each side ; but, it is still visible, when the trunk is upright, although, in stooping, it disappears, and then, the spinous processes become more or less traceable. In the neck, the spinous process of the seventh vertebra or *vertebra prominens*, forms a conspicuous projection. Sometimes, the first dorsal spine is nearly as prominent. Above the seventh, the cervical spinous processes are sunk in, and the median furrow of the back is there replaced by a broad, oval depression, along which, in the upright posture, no trace of the spinous processes can be seen, unless it be that of the sixth. It is along the spinal furrow, from the upper part of the sacrum to the vertebra prominens, or to the vertebra above it, that the tips of the spinous processes are recognisable, if not always to the eye, at least to the touch. They are not necessarily arranged in a perfectly regular, vertical line, some one or more of the dorsal spines especially, being, usually, a little divergent. This fact furnishes a good illustration of the difference between Nature and the Ideal. The artist, in many cases, even in the domain of High Art, requires to be strictly naturalistic ; but, in others, he must eliminate the deviations or varieties met with in his models, and follow an ideal standard. This, however, must always, in the case of the human or other organic form, be based, in the last resort, on anatomical fact. Nevertheless, unless for the most absolutely realistic purpose, no artist would be justified in retaining, in his representations of the human form, accidental deviations from anatomical symmetry in the spine, however frequently such may be exhibited by Nature. The æsthetic sense would necessarily be outraged by such a blemish.

In the *lumbar* region particularly, not only are the situations of the spinous processes, plainly discernible on the surface, but also the intervals between them, which, however, are bridged over by the supra-spinous ligament. The apices are, here, of considerable vertical depth, and so are the interspaces between the apices ; but, besides this, the deep fascia which covers in the muscles, is attached around the borders of the flattened subcutaneous surfaces of the spines, and the general integument is also fixed somewhat more closely over them, than it is upon the surrounding fascia, so that the skin is drawn in, or dimpled, opposite the tips of each lumbar spine. The positions of these are not always indicated by prominences, but sometimes by depressions, especially when the loins are much incurved. The markings, whether prominent or indented, caused by the lumbar spines, are much larger than those produced by the tips of the dorsal spines, which are smaller and much closer together, or nearly overlap one another. As to the vertebra prominens, it forms a well-defined and useful point of departure and comparison, in the region in which it is placed, namely, the junction of the back with the neck. It is sometimes unduly prominent, in which case, it imparts an animal character to this part of the figure ; because, in quadrupeds generally, and even in the anthropoid apes, this and the adjacent dorsal spines are much longer than they are in Man, for the attachment of the powerful ligaments and muscles necessary for supporting and moving the head and neck, in the horizontal, oblique, or semi-erect position of their bodies; whereas, in Man, the vertical carriage of the neck and head, diminishes the necessity for similar provisions in the bones, ligaments, and muscles. In the antique, the elevation due to the vertebra prominens, is never plainly shown ; nor is the upper dorsal region, immediately below it, made too rounded. Either the Greeks appreciated the obvious teachings of comparative anatomy, or their fine sense of the fitness of form, kept them in the path of truth and beauty.

The elegant curves, so characteristic of the human back, and not to be paralleled in any animal, are dependent on the curvatures of the vertebral column itself. Whatever value we attach to any theoretical notions concerning the importance of alternating curves, as an element of the Beautiful, it cannot be denied that, were the human spine straight, as well as erect, the grace of form and carriage, now so conspicuous in the human torso, would be seriously impaired. That, not only the existence of the several curves, sacral, lumbar, dorsal, and cervical, but also their relative proportions, are of material importance in an æsthetic sense, is shown in the deterioration of form, produced by the increase, diminution, or obliteration of any one of them, as the result of deformity or disease.

The Bones of the Thorax. The Ribs, Costal Cartilages, and Sternum.

The *thorax* or *chest*, figs. 26, 27, has for its osseous and cartilaginous framework, the twelve dorsal, rib-bearing vertebræ behind, the twenty-four *ribs* with their cartilages, at the sides, and the sternum or breast-bone in front. The ribs not only form the sides of the thorax, but assist in completing its walls, both in front and behind.

The Ribs or Costæ.—These are long, flat, curved bones, arranged twelve on each side, one below the other, so as to leave the *intercostal spaces*, eleven in number, between them. They vary in length, breadth, thickness, degree of curvature, and direction. All are fixed behind, to the dorsal vertebræ, and all are extended forwards, by the bluish-white, elastic, *costal cartilages*, which may be regarded as unossified portions of the primitive cartilaginous ribs. Sometimes, there is an additional pair of ribs in the neck, and, sometimes, in the loins; occasionally, the twelfth pair is wanting. It almost requires an apology for stating that the normal number of the ribs is the same on both sides of the chest, in both sexes.

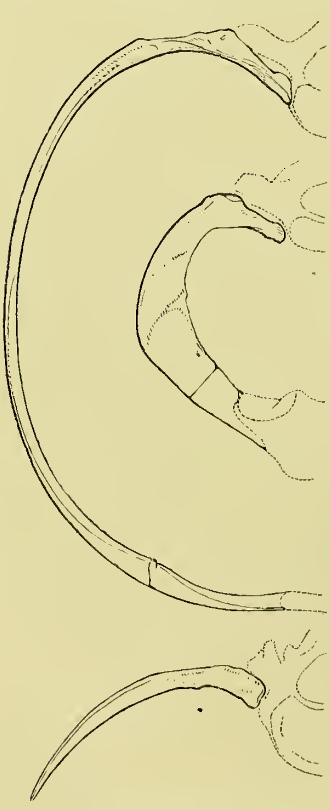


Fig. 39.—Upper view of sixth Rib, with its cartilage.
Fig. 40.—Upper view of first Rib, with its cartilage.
Fig. 41.—Upper view of last Rib.

Setting aside the three lower and the two upper ribs, the general form of these bones, fig. 39, may be thus described. Each has, at its hinder or vertebral end, a slightly enlarged part, named the *head*, which is adapted, by means of two small, oblique, articular surfaces, to two corresponding facets, situated on the upper and lower margins of the bodies of two adjacent dorsal vertebræ; the rib facets are separated by a rough intervening ridge, which is connected, by a strong ligament, with the corresponding intervertebral disc. To the head, succeeds a short, narrower, prismatic part, somewhat compressed from before backwards, called the *neck*; this is smooth on its thoracic aspect, but is roughened along its upper margin, and also behind, for the ligaments tying it to the transverse processes of the two dorsal vertebræ, with which it is connected. The neck is about an inch long, and ends behind in the prominent *tubercle*, which is partly roughened for the attachment of ligaments, but also presents a small oval surface, turned downwards, backwards, and inwards, for articulation with the facet on the tip of the transverse process of the lower of the two vertebræ, with which the rib is connected. A short distance beyond the tubercle, the rib, instead of continuing outwards, backwards, and somewhat downwards, describing a short portion of a rather small circle, now bends forwards, and proceeds downwards, outwards, forwards, and then inwards, describing a much longer and more gentle curve, until it ends, in front of the thorax, at its corresponding cartilage. The place where the rib thus changes its direction, is named the *angle*, at which a slight ridge passes obliquely downwards and outwards across the bone, for the attachment of the corresponding tendon of the sacro-lumbalis muscle, and of the strong fascia which covers it. The angles, fig. 26, are situated further and further outwards, in descending from the second to the tenth or eleventh rib. The longer, curved part of the rib beyond the tubercle, is named the *body* or *shaft* of the rib. The portion between the tubercle and the angle, is somewhat rounded, and uneven behind, for the attachment of the slips of the longissimus dorsi muscle; the succeeding portion of the body is thinner, being flattened both on its outer convex and inner concave surfaces; it gradually becomes a little broader, and more flattened, towards its anterior part, where it expands slightly; at its end, it is excavated and fitted directly, without an intervening joint, to its proper costal cartilage. Towards the middle and fore part, the inner surface of the rib turned towards the thoracic cavity, is directed a little downwards, and the outer surface, which is covered by muscles, a little upwards. The upper border is rounded, and has attached to it both the external and internal intercostal muscles; the lower edge is sharp, and, on its inner aspect, presents a deep groove for blood-vessels and a nerve. The groove commences near the tubercle, where it is bounded above by a strong ridge; it gradually disappears towards the fore part of the rib; the two intercostal muscles are fixed to the outer and inner margins of this groove.

When a rib is detached and examined apart, the abrupt curvature of its shorter, posterior portion, and the gentle curve of its longer, anterior part, are more readily observed. Though the whole bone is bent, like a bow, its curvature is not uniform. Moreover, the curve of the rib does not all lie in the same plane; for, if the bone be placed, on its lower edge, on a horizontal surface, it will not rest flat, its hinder part within the angle, being tilted upwards, a condition owing, partly, to a slight twist, and, partly, to a slight upward bend near the angle of the rib. The necks of the three upper ribs, however, are directed slightly downwards and inwards; the tilting upwards of the necks of the succeeding ribs, increases down to the seventh or eighth, and then diminishes.

The *twelfth rib*, fig. 41, is very short and slender, slightly and nearly uniformly curved, and has only one flattened facet on its head, for articulation with the body of the twelfth dorsal vertebra. It has no tubercle, and does not articulate with, or even touch, the transverse process of that vertebra. Its angle, when present, is very feebly marked and situated very far outward. The free anterior end of the rib is tapering. The *eleventh* rib is distinguished by similar characters; but it is much longer and larger than the twelfth, and its angle is more pronounced. The *tenth* rib resembles more closely those above it, but it usually has only one articular facet at its vertebral extremity. The *second* rib has a slightly marked angle; its shaft is not twisted, and is intermediate in character, between the first and the other ribs. The surfaces are turned more upwards and more downwards, than the corresponding surfaces of the ribs below. Near its middle, its outer surface is roughened for the attachment of a part of the serratus magnus muscle. The *first* rib, fig. 40, is the most peculiar of all. With the exception, sometimes, of the twelfth, it is the shortest rib; it is always the broadest, flattest, and most strongly curved. It is not twisted on its axis; its broad surfaces are turned, not outwards and inwards, but upwards and downwards, with a slight inclination forwards and backwards; its borders are directed outwards and inwards, instead of obliquely upwards and downwards. The body is wide, especially at its anterior end; its outer border is convex and thick; its inner margin, thin and concave. Its head is small, and has but one articular facet, as it is connected with the first dorsal vertebra only; its neck is slender; its tubercle, larger and more projecting than that of the others, is situated on the external border of the rib, and is very strongly attached to the transverse process of the same vertebra, so that this rib is very firmly fixed. Its angle is very slightly marked or absent; it has no groove on its concave margin; and, lastly, its upper surface is marked by a special ridge, with a tubercle, named the *scalene tubercle*, for the attachment of the anterior scalenus muscle, the middle scalenus being connected with the bone further back, and the posterior scalenus, with the back of the second rib. The upper part of the serratus magnus muscle also arises partly from the first rib.

The Costal Cartilages.—These, fig. 27, are as variable amongst each other, as the ribs. They are less flattened than the ribs, having a decidedly oval section. The *twelfth* and *eleventh* merely form little short, pointed tips to their respective ribs, in the direction of which they extend. The *tenth*, *ninth*, and *eighth* are much longer, the eighth being the longest of the three, and, sometimes, even longer than the seventh, which is usually the longest of the whole series. These three cartilages are comparatively slender, and their narrow, tapering, upturned ends are connected with the under surface of the cartilage next above them. At a sort of angle near their costal extremity, they present a sudden enlargement, which is either articulated or consolidated with the cartilage beneath.

The succeeding costal cartilages, fig. 27, from the *seventh* upwards, belonging to the true or vertebro-sternal ribs, are wider, and gradually become shorter and shorter up to the *first*, which is the shortest of all. With the exception of the first, their costal extremities are somewhat wider than their sternal ends; these, however, present a slight rounded enlargement, which is fitted into a corresponding notch in the border of the sternum. The seventh and sixth cartilages are attached very closely together, whilst the intervals between the others gradually increase in width, up to the third or second cartilage, between which the widest interspace exists. The cartilage of the *first* rib, fig. 40, is, like that rib itself, the shortest, thickest, and broadest; it is of nearly uniform breadth throughout, and is not so much articulated, as actually continuous, with the upper part of the sternum; it has the subclavius muscle, and costo-clavicular ligament, attached to its upper surface close to the rib, and the sterno-hyoid and -thyroid muscles behind.

When the entire series of ribs with their cartilages, is viewed *in sitû*, fig. 27, it is seen that even the first rib is not quite horizontal, nor even at right-angles with the spine, which is itself curved forwards, but is inclined a little downwards and forwards. This inclination becomes progressively more and more marked in the other ribs, down to the lowest, which is the most slanting. The obliquity is partly due to the slight twist and bend in each rib, near its angle, but is also dependent on the mode in which the ribs are severally fixed. Some of the lower ribs, from about the tenth to the seventh, present near their anterior end, a slight upward inclination. The costal cartilages, with the exception of the twelfth and eleventh, ascend obliquely from the ends of their respective ribs to reach the cartilages next above them, or the sternum. The degree of obliquity gradually diminishes, however, from the tenth to the third cartilage; the direction of the second is nearly horizontal, whilst the first descends slightly, as it passes forwards to the sternum.

Of the *intercostal spaces*, the first and second are shorter and wider than those which immediately follow, the first being the wider and the shorter of the two; the third and fourth are the next in width; below the fourth, the remaining spaces diminish in width. Some of the lower ribs almost touch each other, and the spaces between them are very narrow, but the two lowest spaces are both wide and short. Most of the interspaces are wider in front than behind; but below the fifth space, they become more uniform in width, the eighth and ninth being even narrower in front, whilst the two last spaces are again wider in that direction.

The bony portions of the ribs increase in length, from the first to the seventh or eighth; then they gradually diminish in length, to the tenth; whilst the eleventh and twelfth become suddenly shorter. But, although the upper seven ribs thus become longer, in passing from the first to the eighth, yet, as the respective costal cartilages become longer also, the places of junction of the two, become more and more widely separated from the middle line in front. This is true likewise of the places of junction of the succeeding ribs and their cartilages, which continue to diverge laterally. The gradually increasing length of both the osseous and the cartilaginous portions of the seven true ribs, is associated with the progressively increasing obliquity of both portions, namely, of the ribs downwards, forwards, and inwards, and of the cartilages downwards and outwards, to meet them. It also explains the increased girth or circumference of the thorax, in its lower part. Compared with one another, in the complete thorax, the ribs increase slightly in breadth, from the lowest to the first; they also describe parts of smaller circles, from below upwards, the changes being most rapid in the upper ribs.

Besides the muscles already mentioned, as being attached to the ribs, the pectoralis minor arises from the third, fourth, and fifth ribs, externally to their cartilages; the pectoralis major takes origin from the sixth to the second costal cartilage; the rectus muscle of the abdomen is attached to the cartilages of the fifth, sixth, and seventh ribs; the external and internal intercostal muscles are connected with the upper and lower borders of the costal cartilages, as well as with the ribs. The external oblique muscle of the abdomen arises from the eight lower ribs; the serratus magnus from the eight upper ribs; and the latissimus dorsi from the three or four lower ones.

The diaphragm is attached to the lower border of the last rib, and to those of the cartilages of the succeeding ribs, up to the seventh, that is, to the entire lower free margin of the thorax. The internal oblique and transversalis muscles of the abdomen, and the triangularis sterni, are connected with certain of the cartilages and ribs. The quadratus lumborum is inserted into the twelfth rib. With some of the ribs, also, the two posterior serrati muscles, and the accessory muscles of the erector spinæ, are connected. Lastly, each rib has its special little levator muscle attached to it behind, near its vertebral end; some of them have an infra-costalis muscle also.

The Sternum, or Breast Bone.—This flattened, median bone fits in between the cartilages of the upper seven ribs, so as to close in the chest, in front, fig. 27. It also serves to support the clavicles above, and consequently furnishes a base of support for the upper limbs. The entire bone, fig. 42, has been compared to a short, straight sword, like a Roman sword, and its lower, middle, and upper parts, have been named, respectively, the *point*, the *blade*, and the *handle*. In an early state, as many as five or six separate pieces may be recognised.

The *lowest* and smallest part of the sternum, situated just above the pit of the stomach, is pointed downwards, and remains cartilaginous to a late period of life, when it becomes gradually ossified from above. This is the *xiphoid* or *ensiform cartilage* or *appendix* (*ξίφος*; *ensis*; a sword). It is foliated in shape, flattened before and behind, broad from side to side, but thin from back to front. It varies much in shape and size. It is rarely quite straight, being more frequently bent, either forward, so as to produce a marked prominence, or backward so as to cause a depression, or to one side. Sometimes, it is perforated, and, sometimes, bifurcated. It is attached, at the sides, to the aponeurosis of the abdominal muscles, and, below, to the longitudinal fibrous band, known as the linea alba. Above, it is joined to the lower end of the middle piece of the sternum, where it furnishes, on each side, a half facet for the seventh costal cartilage. The triangularis sterni muscle, the rectus abdominis, and the diaphragm, are all connected slightly with the xiphoid appendix.

The *middle part* of the sternum is named the *body*, also the *gladiolus* (*gladius*, a sword), and *mucro*, or point of the sword. Somewhat narrower below, where it joins the xiphoid cartilage, it speedily widens out, and then gradually contracts towards its upper end, where it joins the highest piece of the sternum. It always presents, both in front and behind, three slightly raised transverse ridges, which mark the lines of junction of four of its original component pieces. Each piece is slightly concave from above downwards, though flattened or somewhat convex from side to side. Sometimes there is a trace of a fourth line, across the lowest piece, which would indicate the existence of five pieces, or one to each interval between the seventh and second costal cartilages. These cartilages are attached to small angular notches in the borders of the sternum, fig. 43, situated opposite the transverse lines of junction of its several component pieces.

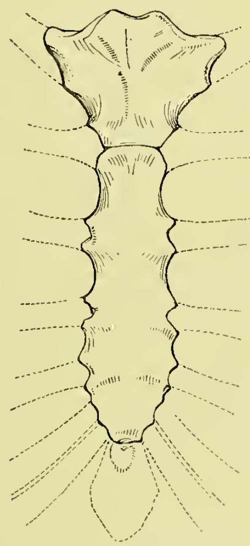


Fig. 42.—Front view of the Sternum.

Fig. 43.—Right border of the Sternum.

The half notch for the partial reception of the seventh, and the complete notch for articulation with the sixth costal cartilage, are small, and placed very near each other, on the lowest piece of this part of the sternum; the notch for the fifth cartilage, is placed between the fourth and third piece; that for the fourth cartilage, between the third and second piece; and that for the third, between the second and highest pieces. The lower half of the notch for the second costal cartilage, is placed on the highest part of the border of this portion of the sternum, at its line of junction with the upper portion of the bone. Sometimes this middle piece of the sternum is perforated along its centre, as if it were composed of a double row of conjoined pieces. Its anterior surface gives attachment to both of the great pectoral muscles, a narrow portion of bone between them, being subcutaneous. Behind, near its lower end, are the origins of the triangulares sterni muscles.

The upper part of the sternum, shorter, broader, thicker, and stronger than the rest of the bone, keeping in view the comparison of the whole bone with a sword, is named the *manubrium* or *handle*. It is shaped like an inverted triangle, with its corners truncated. Its lower and narrower part is joined, by an oval, roughened surface, thinly encrusted with cartilage, to the upper end of the middle part of the bone, contributing, on the two sides, the upper halves of the notches for the second costal cartilages, which are always attached opposite the prominent transverse ridges, formed at the line of junction of the first and second parts of the sternum. At the summit of the diverging borders of the manubrium, which here becomes wider and thicker, are the two slightly concave surfaces of junction, not of articulation, with the costal cartilages of the first rib, these cartilages usually coalescing, and very rarely forming a joint, with the manubrium. To the anterior surface of the manubrium, is fixed the sternal tendon of origin of the sterno-cleido-mastoid muscle; below this tendon, is a curved ridge or line, marking the border of a portion of the pectoralis major muscle, which arises from the remaining lower part of this surface; between the muscles of the two sides, there is, however, a lozenge-shaped, subcutaneous portion of the manubrium. The upper border of the manubrium, which is directed slightly backwards, presents a deep notch, named the *supra-sternal notch* or *furcula* (*furca*, a fork), which enables the neck to be bent forward more freely, without causing pressure on the windpipe. On each side of the furcula, is an obliquely placed, smooth, and nearly flat oval articular surface, directed upwards, outwards, and a little backwards, slightly concave from above downwards, and convex from before backwards, on which the inner articular end of the corresponding clavicle rests; it thus furnishes the sole osseous basis of support, for the shoulder-girdle and upper limb. The concave posterior surface of the manubrium, gives origin to the sterno-thyroid and sterno-hyoid muscles.

The *entire sternum*, fixed in between the upper seven costal cartilages, has its anterior surface turned a little upwards as well as forwards, and its posterior surface, accordingly, a little downwards as well as backwards; moreover, the bone is directed obliquely, downwards and forwards, so as to aid in increasing the capacity of the thorax. Besides this, it is to be noted that the anterior surfaces of the manubrium, of the body, and of the xiphoid cartilage, respectively, are in different planes, so that a slight bend is recognisable, opposite the junction of the manubrium and body of the bone, whilst the entire bone is slightly convex in front, and distinctly concave behind. The plane of the manubrium is the most inclined forwards, that of the body less so, the direction of the xiphoid cartilage being very nearly vertical, fig. 43.

The *thorax*, considered as a whole, figs. 26, 27, is shaped like a truncated cone, somewhat flattened before and behind, and having its base cut off obliquely from before, downwards and backwards ; it is, accordingly, much longer behind than in front. It is characteristic of the human thorax, as compared with that of quadrupeds, that its width from side to side exceeds its depth from back to front. Owing to the projection into it, behind, of the vertebral column, its horizontal section presents a cordiform or heart-shaped outline. Its smaller upper aperture, bounded by the first dorsal vertebra, the first rib, and the sternum, gives passage, amongst other parts, to the windpipe. Its lower aperture, much larger than the upper, formed by the last dorsal vertebra, the lower border of the last rib, the cartilages of the succeeding ribs, up to the seventh, and the xiphoid cartilage, is closed by the diaphragm, which gives passage to important parts, and is a chief agent in respiration.

Surface-forms dependent on the Ribs, Costal Cartilages, and Sternum.

At the back of the thorax, on each side of the perpendicular row of dorsal spines, the vertebral grooves, as already stated, are extended laterally, by shallower depressions reaching as far as the angles of the ribs. These angles, which afford attachment to the strong vertebral fascia, form a slightly marked oblique line, which diverges, more or less, from the spines, in passing down, the entire space between it and the spinous processes, being filled by the longitudinal and oblique muscles of the back. The projection of the curved portions of the ribs, near the angles, produces a broad, convex, longitudinal prominence, situated at some distance from the middle line, and thinly covered by muscles. The rounded longitudinal forms, one on each side in the back, are quite characteristic of the broad and flat human thorax.

On each side of the chest, from the region of the *axilla* or *arm-pit* above, downwards and forwards, and between the muscles which form the anterior and posterior boundaries of that space, the flattened surfaces of the bodies of the ribs, form softly marked, oblique, linear elevations or ridges, with slightly depressed intervals between them, corresponding with the several intercostal spaces, which are filled in by the intercostal muscles. All these parts, however, are covered by other, more superficial, muscles, so that, in only one small place, are they strictly subcutaneous.

In front of the chest, the markings formed by the flat and broad continuations of the ribs, as these begin to ascend, by the obliquely directed and more rounded costal cartilages, and by the chondro-sternal articulations, are often visible, more so, however, below the great pectoral muscle down to the lower border of the thorax. This lower border, or *abdomino-thoracic arch*, somewhat prominent, and deeply notched, in front, is formed by the ends of the twelfth and eleventh ribs or their cartilages, by the free part of the cartilages of the remaining false ribs, and of the seventh or lowest true rib, and by the border of the xiphoid cartilage. This arch is more distinctly seen, as well as all the rib forms, during certain movements of the chest necessary for breathing, and also during efforts, and particularly in arching the body backwards. It often presents an everted or elevated border, especially at the end of expiration and the commencement of inspiration. This arch is represented of greater width in the antique, than it is found to be in our living models, probably owing to peculiarities of Race, but also to the absence, in ancient costumes, of any tight girdles, waistbands or stays, such as are worn at the present time. In short persons, the arch is, proportionately, wider than in tall persons ; for, in the former, the thorax itself is usually wide and short, but, in the latter, long and narrow. In determining, on the living figure, the position or identity of any given rib, the transverse ridge between the manubrium and the body of the sternum, is a certain guide to the second, the costal cartilage of which is invariably wedged into the notch situated opposite that ridge. The second rib being found, it is easy to count downwards, and find any other. The difference in the width of the several intercostal spaces in front, and even the widening of the upper spaces, and the narrowing of the lower ones, as they approach the sternum, may sometimes be recognised on the surface. Of those that are visible on the surface generally, the second space is the widest, next, the third and fourth, the others being comparatively narrow, except the two last. They all vary as the chest expands or contracts during breathing.

In the majority of cases, the circumference of the right side of the chest, measured horizontally across its middle, is larger than the left, to the extent even of an inch. This may be due to the preferential use of the right upper limb, which, as may easily be observed, often necessitates an inclination of the trunk over to the left side, so that this half of the thorax is more or less compressed. This affords another example of a want of symmetry of form, which, though it might be indicated in a strictly naturalistic subject, must nevertheless be eliminated in ideal work.

The different directions of the planes of the three component parts of the sternum, must obviously influence the corresponding parts of the surface of the body. Hence, indeed, in the upright posture, a straight rod placed flat against the part corresponding with the front of the manubrium, will be found to strike the ground, at least four or five feet in front of the toes ; if the rod be brought in contact with the front of the body of the sternum, it will touch the ground, only two feet in front of the toes ; lastly, if placed along the xiphoid cartilage, it will fall between the toes. This imparts to the anterior surface of the median line of the chest, in the living model, a general convexity, the most prominent part of which, is at the ridge caused by the change of plane at the junction between the manubrium and the body of the sternum. Opposite the xiphoid cartilage, there is usually a somewhat sudden depression between the cartilages of the seventh ribs, named the *pit of the stomach*, or *scrobiculus cordis* (*scrobs*, a furrow; *cor*, the heart).

Like many other prominent portions of the skeleton, the sternum corresponds with a median longitudinal furrow, on the surface of the living figure. This *sternal furrow*, like that over the crest of the ilium, has not the shape of the bone itself. On the contrary, it is wider at its upper and lower part, but narrower in the middle; moreover, it presents on each side, a festooned border. This is due to the mode of origin of the two great pectoral muscles, the muscular and tendinous attachments of which, overlap portions of the anterior surface of the sternum, so as to leave between them a comparatively narrow depression with festooned borders. Above and below, these thick muscles recede from the bone, and the sternal furrow on the surface becomes much wider. The broad upper part of the manubrium, however, is partly covered by the long, cord-like, tendinous origins of the two sterno-mastoid muscles, which obscure its forms, and appear like two narrow oblique ridges, converging below, between which, only the central part of the bony furcula or supra-sternal notch, is visible, this notch being not only much narrowed, but deepened by the projecting tendons.

The Shoulder-Girdle; the Clavicle and the Scapula.

The Clavicle.—The *clavicles* or *collar-bones*, the well-known bones which pass across the front of the upper part of the thorax, and the lower part of the neck, fig. 27, are placed nearly horizontally, one on each side, between the top of the sternum, just above the first costal cartilage and rib, and the acromion process of the scapula. They are, however, not strictly horizontal, but nearly always, when the shoulders are held in their ordinary position, a little higher at their outer ends. If the shoulders are allowed to drop, then the collar-bones may become more nearly horizontal. When, on the other hand, the arms are raised, especially above the horizontal line, the collar-bones assume an oblique direction. The collar-bones do not pass directly outwards from the sternum, but outwards and somewhat backwards. Moreover, their inner ends do not reach the middle line of the body; neither do their outer ends extend so far as to constitute the extreme point of the shoulder girdle; for the acromion process of the scapula, on each side, lies beyond them, and really forms the outermost point of this portion of the trunk.

Each collar-bone, figs. 44, 45, is familiarly described as being shaped like a long italic letter ʃ, so that it has a double alternating curve, of the two parts of which, the scapular portion is somewhat shorter, and more abrupt than the sternal portion. When the clavicle is *in situ*, the curves are turned forwards and backwards, and so disposed, that along rather more than the inner half of the bone, the anterior curvature is convex, whilst along the remaining outer part, it is concave; at the posterior border, the sternal portion is concave, and the scapular portion convex.

The *shaft* of the clavicle, for it is a long bone, is smaller in the middle than at the ends, which are expanded differently from each other, the inner two-thirds being prismatic, and the outer third, widened and flattened from above downwards. The central, smaller part is composed almost entirely of compact bony tissue, but the ends contain much cancellated tissue. The *under surface*, more varied in its character than the upper surface, is turned, not only downwards, but a little backwards, especially where it overhangs and crosses the first costal cartilage and rib, sometimes touching the former, by a small articular facet; near its thickened sternal end, the under surface presents an oval rough impression, for the attachment of part of the costo-clavicular ligament, which ties the bone to that rib and its cartilage; behind this, is a small surface of origin for the sterno-hyoid muscle; along the succeeding slender part of the shaft, beneath, is the long, shallow subclavian groove, for the insertion of the subclavius muscle; still further outwards, under the expanded and flattened acromial end of the bone, there is, first, the *conoid tubercle*, and, then, a rough *oblique ridge*, for the conoid and trapezoid portions of the coraco-clavicular ligament, which ties the collar-bone to the coracoid process of the scapula. The inner two-thirds of the *upper surface*, fig. 45, of the collar-bone, which is directed a little forwards, is comparatively narrow, nearly uniform in width, almost flat, and very smooth. On the concave posterior curve of its thicker sternal portion, is a narrow surface for the origin of the flat clavicular part of the sterno-cleido-mastoid muscle; whilst, on the convex anterior curve, is another rather broader and longer surface, spreading on to both the upper and lower aspects of the bone, for one origin of the pectoralis major muscle. On the convex posterior border of the thinner scapular end, is a part of the insertion of the trapezius muscle, which largely overlaps the upper surface of the bone; and on the corresponding, but shorter part of the concave anterior border, on which a rough and pointed ridge usually exists, is the anterior part of the origin of the deltoid

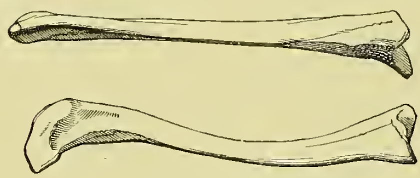


Fig. 44.—Front view of right Clavicle.
Fig. 45.—Upper view of the same.

muscle, which also overlaps the upper surface. Between the parts thus covered by muscular attachments, this, the narrowest part of the bone, is practically subcutaneous, having no muscle lying over it, excepting the thin cutaneous muscle known as the platysma, which has some slight connexion with the periosteum of the clavicle and the deep fascia of the neck.

The *inner* or *sternal end* of the collar-bone, is thick and clubbed, much larger than the part of the sternum on which it rests, with which, as well as with its fellow of the opposite side, it is connected by very strong ligaments; its articular surface which is directed inwards, with a slight inclination downwards and forwards, is oblong from above downwards and backwards, and slightly concave from before backwards, whilst, from above downwards, it is somewhat convex. It is thus adapted, especially at its lower part, to the oppositely modelled articular surface of the sternum; but, in the living state, both bones are thickly covered with cartilage, and an inter-articular fibro-cartilage exists between them. The projecting border of this end of the clavicle, which overlaps the sternal facet, gives attachment to very strong ligaments; the joint permits of a rolling, as well as of a gliding movement, whilst it is very strong. The *outer* or *acromial extremity* of the clavicle, which is broad, and flattened from above downwards, and, for the most part, subcutaneous, curves forwards, and ends in a narrow oval articular surface, which looks obliquely downwards, forwards and outwards, to meet the thin inner border of the acromion process of the scapula, with which it is articulated, but above the level of which, it is important to note that it slightly projects, sometimes even as a rounded eminence.

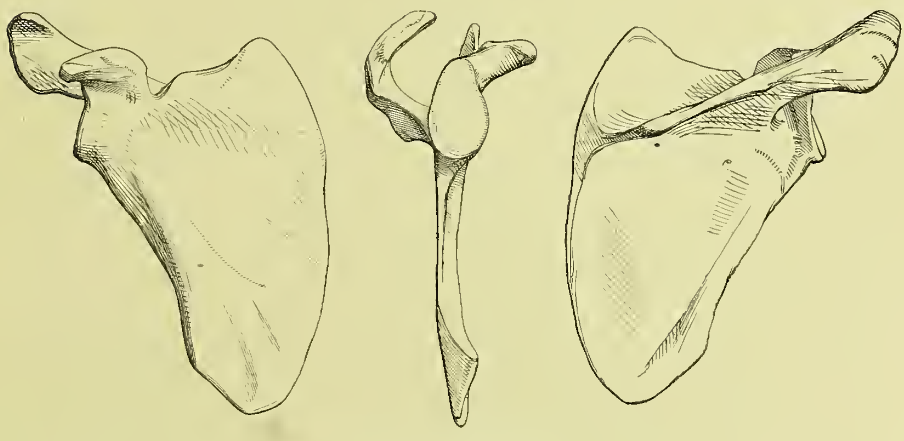
The *curves* of the collar-bone vary in different persons, even in the adult. It becomes more strongly curved, as well as thicker, in those who do much laborious work; and the right collar-bone, for the same reason, is often more curved than the left one; in left-handed persons, the reverse is the case. The increased curvature has been said to affect chiefly the scapular portion of the bone, but the enlarged sternal end also becomes increased in size, by unusual labour.

The Scapula.—The *scapulæ* or *shoulder-bones* proper, figs. 26, 27, the two remarkable, broad, flat, thin, triangular bones, which are articulated to the outer ends of the clavicles, are also suspended by various muscles, which reach them from the trunk, and even from the head. They form the outer and the posterior prominences of the shoulder, being placed, like two wings, on the back of the thorax, covering a space, on each side, extending, longitudinally, from near the first, to a little below the seventh rib, and, transversely, from just outside the angles of the ribs, beyond the sides of the thorax, to the back and upper part of the arm-pits, where they furnish the sockets for the arm-bones. As the deep surface of the scapula is not so concave as the thorax is convex, this bone, especially at its upper and outer part, is removed a short distance from the thoracic walls. Of the three margins of the triangular scapula, the *posterior*, or *base*, is the longest, and, being turned towards the spine, is named the *vertebral border*; when the arm hangs passively, at the side, this border is not vertical, or parallel with the spine, but diverges slightly from it and from the opposite bone, below, the direction of this border being oblique, downwards and a little outwards. The *anterior* or *axillary* border, the next in length, and turned towards the arm-pit, ascends obliquely from below, upwards and outwards. Lastly, the *upper* or *clavicular* border, the shortest of the three, lies behind the collar-bone, and descends obliquely, from within outwards. The junction between the collar-bone and the scapula, does not take place, either at the borders, or at the angles of the latter, but, by a very small narrow surface, at the anterior end of the acromion process, which is the continuation outwards of the spinous process of the scapula, a prominent ridge, situated on the back of the bone. The acromion forms the outermost point of the shoulder-girdle, on each side, and overhangs the shoulder-joint. As the collar-bones spring from the front of the thorax, whilst the scapulæ are placed behind it, these bones, in passing outwards to meet and articulate together above the shoulder-joint, approach each other at an acute angle, the collar-bones passing somewhat backwards, and the scapulæ forwards; this may best be seen, on looking at the skeleton from above. Hence, too, the planes of the flat scapulæ are placed somewhat obliquely on the thoracic walls, and their outer angles, on which the sockets for the arm-bones are found, are directed, not outwards, but outwards and forwards.

As, in examining the innominate bone, it was found convenient to take the acetabulum, which is articulated with the femur, as a point of departure, so, in describing the scapula, its very peculiar configuration, figs. 46, 47, 48, may be traced, by starting at the glenoid cavity or socket for the humerus; but the description of that cavity will be reserved to the last.

The *glenoid cavity* is supported upon a somewhat constricted part of the bone, named the *neck*, immediately beyond which, the bone widens out, to assume its characteristic triangular form. This expanded part of the scapula named its *ala*, or wing, is, in places, so thin as to be translucent. It is usually described as presenting, besides its three borders already mentioned, three *angles*, three *fossæ*, and three bony *processes*. The neck itself is comparatively thick, being strengthened by three bony ridges, one passing downwards, along the front of the axillary border; one upwards, to the root of the coracoid process, to be immediately described, and then along the clavicular border; and one, backwards, which blends with the base of the spinous and acromion processes.

The *coracoid process*, figs. 46, 47, rudely compared with a raven's bill (*κόραξ*, a raven), is a strong hook-like projection, which arises by a thick, flattened root, from the upper part of the neck of the bone, and points, at first inwards, forwards and upwards, and then outwards, forwards and upwards, beneath the outer part of the collar-bone, terminating in a blunt point in front, and to the inner side of the shoulder-joint, below the level of the apex of the acromion process, towards which it seems to tend, but which it does not reach. The coracoid process is more curved than the acromion process. Along its inner or anterior border, close to its root, is a roughened surface, consisting of a tubercle and an adjoining ridge, for the insertion of the conoid and trapezoid portions of the coraco-clavicular ligament, by which the scapula is here strongly tied to, or moveably suspended from the collar-



The right Scapula.

Fig. 46.—Front view. Fig. 47.—Axillary border. Fig. 48.—Back view.

bone. From the outer border of the coracoid process, a strong flat band, the coraco-acromial ligament, passes above the shoulder-joint to the acromion process, thus filling in the interval between these two bony processes. Into the front of the coracoid process, near its apex, is inserted the lesser pectoral muscle, which connects it with the front of the thorax; whilst, from the apex itself, proceed the conjoined tendons of origin of the coraco-brachialis and of the short head of the biceps muscle of the arm.

The upper, or *clavicular border* of the scapula, figs. 46, 48, is not only the shortest, but the thinnest. Upon it, close to the root of the coracoid process, is the *supra-scapular* notch for the passage of a nerve, and just beyond that, a small eminence for the origin of the slender omo-hyoid muscle; beyond this, again, the border continues sharp, and curves upwards, to the *superior angle* of the scapula. Commencing at this angle, is the posterior and longest border of the bone, named the *vertebral border*, or *base*; this is thicker than the upper border, and, in a well-formed bone, is somewhat convex, or even presents an obtuse angle at the junction of its upper and middle thirds; it is often slightly crenated, and tipped with cartilage; it reaches down to the *inferior angle*, which is of considerable thickness. From this point, the anterior or *axillary border* ascends to the under side of the neck of the bone; it is the thickest and strongest, and, spreading out at the neck, forms a ridge-like buttress for the support of the glenoid cavity.

In front of the scapula, fig. 46, its anterior, deep, or *thoracic* surface, named also the *venter*, or *ventral surface*, is concave, and forms the *subscapular fossa*; it is marked by oblique ridges for the attachment of the tendinous intersections of the subscapular muscle, which arises from and fills up the fossa, except near the neck of the bone; this fossa is deepest at its upper and outer part, where the muscle is thickest, and the bone is thinnest. Upon this surface, at the upper and lower angles of the ala of the scapula, are attached the upper and lower parts of the great serratus magnus muscle, the middle part being connected with the intermediate portion of the inner lip of the posterior border.

On the dorsal surface or *dorsum* of the scapula, fig. 48, there is seen, on the posterior border, at about one-third of the distance down from the upper to the lower angle, a small, smooth, triangular surface, from which the spinous process commences. To the part of the posterior border, between this surface and the superior angle, is inserted the levator anguli scapulæ muscle; to the part corresponding with the base of the smooth triangular surface, is fixed the lesser rhomboid muscle; and to the remaining longer portion of the posterior border, downwards to the inferior angle, by means of a slightly curved fibrous band, the greater rhomboid muscle. These muscles aid in suspending the scapula from the spine. From the apex of the smooth triangular surface just mentioned, commences a narrow ridge, which speedily rises into a more and more projecting, flattened, triangular plate. One edge of this is united to the back of the scapula, as far outwards as its neck; another, free and partly subcutaneous, forms a strong irregular crest passing obliquely upwards and outwards, across the dorsum of the bone, for about three-fourths of its width, and then, curving forwards, ends in the broad, expanded acromion process, which overhangs the shoulder; the remaining edge, also free, is the shortest, and forms a strong curved ridge, which rises behind the neck of the bone, and passes backwards, outwards, and upwards, to terminate on the under part of the acromion. This strong, oblique, bony plate, is the *spine* or *spinous process* of the scapula, fig. 48, which is continued above the shoulder-joint, as the acromion process. Its upper and under surfaces are oblique, the upper one being directed inwards and forwards, and the lower one, outwards and backwards. It occupies about three-fourths of the width of the convex dorsum of the scapula, its base of attachment corresponding with the deepest part of the venter of the bone. It divides the dorsum, unequally, into an upper smaller, and a lower larger part, each of which is triangular, and broader towards the posterior border of the bone; the smaller one, the *supra-spinous fossa*, gives origin to, and lodges, the supra-spinatus muscle; the larger one, the *infra-spinous fossa*, gives origin, over the greater portion of its more or less convex surface, to the infra-spinatus muscle, this muscle occupying a deep oblique groove, which runs parallel with the axillary border of the bone. At the lower part of the infra-spinous fossa, near the inferior angle of the bone, is a smooth, triangular surface, over which the upper border of the latissimus dorsi muscle passes, sometimes a few fibres being here attached.

At the outer part of the infra-spinous fossa, along the lower third of the axillary border, is a flat rhomboidal surface, continuous, above, with the ridge already described as existing along the axillary border, which gives origin to the teres major muscle; to a narrow surface, external to the upper two-thirds of the ridge, the teres minor muscle is attached; immediately below the neck, from a tubercle, surrounded by an elongated rough depression, arises the long head of the triceps muscle; the fascia, which separates these muscles, is attached to the ridge itself.

The upper and under surfaces of the *spinous process* form part of the supra- and infra-spinous fossæ. The borders, or lips, of its crest, are both more or less indented or waved; the upper lip becomes the inner concave border of the acromion process, and into it and the adjacent surface, along its whole length, the greater part of the trapezius muscle is inserted, a tendinous slip connected with the lowermost fibres of the muscle gliding over the smooth triangular surface situated at the commencement of the spinous process, to reach its upper margin, a small bursa intervening; this muscle also assists powerfully in suspending the scapula and the clavicle. The lower lip of the crest of the spinous process becomes the outer convex border of the acromion process, from both of which, as well as from the adjacent surfaces of the processes, the greater part of the deltoid muscle arises. The two lips of the crest diverge from each other, about an inch or more from the smooth triangular surface at its commencement, so as to present two prominences, opposite the common point of attachment of the margins of the trapezius and deltoid muscles. The intermediate crest of the spinous process, between the lips, is partly covered, as just stated, by the trapezius and deltoid muscles, but between these, it is subcutaneous; this subcutaneous part is narrowest in the middle of the spine, but it becomes widened at its outer end, and continuous with the oblong, flattened, or slightly convex upper surface of the *acromion process*.

This process, figs. 46, 47, 48 (ἄκρος, the highest; ὦμος, the top of the shoulder), the highest and outermost bony point of the shoulder bone, has its upper surface directed upwards and backwards, and its under surface, concave and smooth, turned downwards and forwards, towards the upper end of the humerus. The apex, somewhat thinner than the rest, is turned forwards, and gives attachment to the coraco-acromial ligament. Along its inner concave border, is found the narrow, obliquely cut, smooth, oval, articular surface, directed inwards, forwards, and a little upwards, by which it is articulated with the thin, flattened acromial end of the clavicle. The free outer border of the acromion process is marked by indentations for the origin of the subdivisions of the deltoid muscle, whilst its inner border is roughened for the attachment of the trapezius; between them, is a triangular subcutaneous portion of the bone.

The *glenoid cavity*, fig. 47, to which the description returns, is supported on the neck of the scapula, at the junction of the clavicular and axillary borders, at the part where the three fossæ meet, where the dorsal and ventral surfaces come together, and between the roots of the coracoid, acromion, and spinous processes. It forms, indeed, a sort of central point, from which the bone expands, inwards, backwards, and downwards, and around which are placed, as if for its protection, the strong beak-like, coracoid process, in front and within; the broad, arch-like, acromion process above; and the outer curved, free edge of the spinous process, behind. The glenoid cavity (γλήνη; the eye) is a shallow, ovoid, depression, having its long diameter almost vertical, and its larger end turned downwards. Its inner border presents a slight indentation, a little above its middle, and is somewhat more prominent than the outer border; its lower edge is decidedly projected beyond the upper one. If it be looked at, with its long diameter placed horizontally, its shape resembles that of the opening between the eyelids, the narrow end being prolonged, so as to resemble the inner corner of the eye-lids, which likewise extends beyond their general elliptical aperture. The slightly elevated margin of the glenoid cavity has, attached to it, a yellowish fibrous rim, called the glenoid ligament, which serves slightly to deepen the socket; at the top of the cavity, this rim becomes continuous with the tendon of the long head of the biceps muscle, which arises from a slight prominence of the bone at that point. As already stated, the long head of the triceps takes origin from the neck of the scapula, just below the glenoid cavity; but, with these two exceptions, the neck of the bone is free from muscular attachments; so also is a small adjacent part of the subscapular, infra-spinous, and supra-spinous fossæ. The glenoid cavity is so shallow, and is so limited in extent, when compared with the size of the head of the humerus, which moves within it, that it offers a remarkable contrast, in both these respects, with the large and deep acetabulum, into which the head of the femur is received. Whilst, too, the axis of the acetabulum is directed downwards, with a very slight inclination outwards and forwards, the axis of the glenoid cavity is directed outwards, with a decided inclination forwards and a little upwards. The lower lip of the cavity, which corresponds with the broader part of the socket, projecting beneath the head of the humerus, serves to support it. The glenoid cavity is completely lined with cartilage, whereas, as previously described, the acetabulum is only partly so covered.

Surface-forms dependent on the Clavicle and Scapula.

The extreme moveability of the bones of the shoulder-girdle, beneath the integuments, makes it difficult to recognise the varying effects, which they produce upon the surface-forms.

The *clavicle* forms a natural boundary line, between the trunk and the neck, in front; but it is sinuous, and changeable in its position. Sometimes, as when the arms are dependent, it is transverse and nearly horizontal, though more frequently it is slightly inclined upwards at its outer end, which is always thrown backwards ; at other times, with movement of the shoulder forwards, backwards, or upwards, the direction of the line of the clavicle changes accordingly. The *inner* enlarged *end*, forms, outside the sterno-clavicular articulation, a prominence, seen more plainly in thin persons, running obliquely downwards and outwards, just above the angle of the manubrium of the sternum ; it also overhangs the furcula of the sternum, which is converted by it, and by the long narrow tendon of the sterno-cleido-mastoid muscle, into a deep V-shaped depression. The flat *outer end* of the clavicle, lies within the prominence of the acromion process, on a plane very little higher, but sometimes distinctly elevated above it, just behind the line of the joint between them.

The most prominent part of the *shaft* of the collar-bone, is opposite the middle of the anterior convexity of its sternal portion ; it produces a characteristic form in this situation. It is over this part, that a *collar*, suspended round the neck, hangs down. The *subcutaneous portion* of the shaft of this bone, here, and along its whole length, by no means corresponds in form, with the upper surface of the dried bone ; for this latter is so infringed upon by the sterno-mastoid and pectoral muscles, above and below, that only a much narrower, actually subcutaneous, part produces a special form beneath the skin ; this, however, owing to the gentle curvatures and perfectly smooth modelling of this portion of the bone, composes harmoniously with the sweeping lines and surfaces of the soft parts, in which the bone is embedded. A marked and interesting contrast is noticeable, as elsewhere, in the sharpness of line and roughness of form, of the deeper concealed surfaces of the clavicle, to which ligaments and muscles are attached. As already mentioned, the effect of manual labour is to increase the curvature, and to enlarge the shaft and extremities of the collar-bone ; and, in this way, a want of symmetry between the two sides, may result from the more frequent use of the right limb. It is scarcely necessary to add that, in determining the typical characters of this part of the human frame, the artist must not only restore the condition of symmetry, but must avoid the exaggerated forms produced by the excessive labour, to which so many human beings are destined.

There can be no doubt, that the relative length of the collar-bones, is a main element in determining the breadth or narrowness of the shoulders; but the width and depth of the upper part of the thorax, also concur in this effect. If the chest be shallow, and narrow at its summit, the collar-bones with the scapulæ must drop, and so the horizontal distance between the two shoulders, will be lessened; whereas, if the thorax is wide, and deep above, the scapulæ and the collar-bones are elevated to their full height, the latter become horizontal, and the shoulders are carried widely out. Nevertheless, the length of the collar-bones must assist in determining this part of the form. At the same time, in tall men, whose collar-bones, like the other long bones, are lengthy, the shoulders may be comparatively narrower than in short men, whose clavicles would be relatively shorter. This must depend on tall men having long, narrow, flat chests, whilst short men have the thorax relatively short, wide and deep. It is evident, however, that long, strong and well-curved collar-bones are characteristic of vigour of frame. As these bones are absent in certain quadrupeds, the fore limbs of which are used for locomotion only, and are possessed by those mammalia which have prehensile anterior limbs, it is evident that their presence is indicative of the higher purposes to be served by the anterior limbs of the latter. It is remarkable, also, that the cartilages from which they are developed, are the first parts of the skeleton, which begin to be ossified, at least in man. These facts point to the great anatomical and physiological significance of the clavicles, which bones form a secure basis of support and movement for the shoulders, and, at the same time, thrust them out so as to give freedom of action to the arms, and greater leverage to the muscles of the shoulder-joint.

Their value, in regard to the beauty of this part of the human form, is very great. Though they are long, they are very slender, and only slightly and inelegantly curved in the anthropoid apes. The numerous variations of length and curvature, which they present in man, must not be lost sight of. To put strongly curved collar-bones, to a young and delicately formed figure, or nearly straight and slender ones, to a mature and vigorous frame, must be wrong, even if individual varieties may be met with in models, which might appear to justify such a treatment of the figure. In the creation of special ideal forms, as for example, of an Angel or a Demon, an Apollo or a Hercules, the characteristic peculiarities of these remarkable bones, must be observed; and their occasional asymmetry, due to the disproportionate use of one arm, must be eliminated, as an accidental and individual peculiarity, incompatible with the most beautiful conception of the human form.

The effects of the *scapula* on the surface-forms, require first to be understood, as seen when the bone is in its normal position, with the upper limb hanging down by the side of the trunk. In thin persons, the forms of the bone are disagreeably prominent; sometimes it projects out at its base, so as to resemble a sort of wing. In the well-formed figure, the convex dorsum of the scapula, with its spinous process, assists in producing the general elevation of the corresponding region of the back, level with, and below, the shoulders. As to its individual parts, the subscapular fossa is turned towards the thorax; the neck, and the supra- and infra-spinous fossæ, are completely covered, and concealed, by the proper scapular muscles; the upper border is also hidden, along its whole length, by the trapezius muscle; so also is the short upper part of the posterior border, as low down as the triangular smooth surface opposite the commencement of the spinous process. This *triangular surface*, as already mentioned, is crossed by a slip from the tendon of the trapezius muscle; but, as that is very thin, though strong, the position and even the shape of the surface in question, are revealed through the skin, usually by a slight and small *three-sided depression* on the surface, having its base turned towards the vertebral column, and its apex upwards and outwards, in the direction of the spinous process of the scapula, towards the apex of the shoulder. Below this point, the *base* of the scapula may often be traced, a little to the inner side of a long, narrow furrow, the *vertical scapular furrow*, formed between the adjacent muscles, and running obliquely downwards and outwards, diverging from the vertebral column, until it reaches the lower angle of the bone. This *inferior angle* is usually recognised as a blunted point turned downwards, lifted up from the more convex thoracic walls, on which it rests, and constituting the lower end of a broad triangular surface, corresponding with the greater portion of the infra-spinous fossa and its muscles. From this angle, the *axillary border* of the scapula, extending upwards and hidden by a thick mass of muscle, nevertheless determines the direction and position of the great fold, which forms the posterior boundary of the armpit, as high up as the hinder border of the deltoid muscle, above which it is completely lost. The only parts of the scapula, which are truly subcutaneous, are the long and prominent spinous process, and the broader acromion process, which is continuous with it. In the normal position of the scapula, with its muscles quiescent, as when the arm depends by the side of the trunk, the *spinous process* gives rise to a gently convex, oblique, elevated ridge, extending from the triangular surface at its inner end or commencement, and reaching up towards the point of the shoulder, where it becomes flattened, and even depressed. On the slightest action of the muscles above and below it, or even in muscular individuals, when the muscles are at rest, this oblique ridge is replaced by a much narrower waved furrow between them, which may be named the *oblique scapular furrow*; for here, as with the crest of the ilium and the front of the sternum, what is a prominent ridge in the skeleton, becomes concealed at the bottom of a soft intermuscular space or furrow, in the living figure. Moreover, as occurs in those instances, the muscles attached to the spinous process and also to the acromion, infringe, more or less, upon the margins of the surface of these processes, which looks towards the skin, so that the furrow left between the muscles, over the bony eminences, is narrower, and has softer outlines, than the bone itself. About the middle of this scapular furrow, is a slight bend downwards, depending upon an undulation of the under lip of the spinous process at this point, where also a slight downward prominence is met with, to which a tendinous slip of the deltoid muscle is attached.

The flattened or slightly convex surface-form, due to the subcutaneous part of the *acromion*, when the muscles are at rest, is changed into a semi-lunar curved depression, or *acromial furrow*, when the muscles are in action; both forms are concave on the inner border, which is turned towards the neck, and is overlapped by the trapezius muscle, but convex on the outer border, which is turned towards the rounded prominence of the shoulder and is characterised by being gently festooned, or indented, owing to the forms of the subdivisions of the deltoid muscle, which arise from it. The outer end of the clavicle produces a small but special elevation, found to the inner side, but a little in front, of the broad and somewhat more depressed acromial furrow, which, however, in thin persons, is itself very prominent.

It deserves again to be noted, that it is the convex outer border of the acromion process of the scapula, and not the outer end of the clavicle, which constitutes the outermost lateral point of the skeleton of the *trunk*, in this region. It will, however, be observed, that the enlarged upper end or head of the humerus, when it is *in sitû* and dependent, projects still further outwards; and that, accordingly, it is the humerus, and not the acromion, which forms the extreme point of bone opposite to, or across the shoulders, in the living figure. Although the apex of the coracoid process, is not, properly speaking, subcutaneous, its position, just opposite to the inner edge of a small oblique triangular depression, formed below the collar-bone, and between the deltoid and great pectoral muscles, and, therefore, just under cover of the latter, is quite determinate, and useful to remember. The depression itself might be designated the *coracoid furrow*.

The chief changes produced during the movements of the shoulder, in the surface-forms dependent on the scapula and clavicle, will be mentioned with the description of the Muscles.

The Humerus.

The *humerus*, or *arm-bone*, reaching from the shoulder to the elbow, is the longest, largest, and strongest bone of the upper limb. It represents the femur in the lower limb, and, as it both resembles and differs from that bone, its peculiarities of form acquire additional interest, when the two bones are contrasted.

Like the femur, it is a typical long bone, figs. 49 to 52, having, therefore, a shaft and two articular ends; but it is shorter and more slender. The

The right Humerus.

Fig. 49.—Front view. Fig. 50.—Back view. Fig. 51.—Outer side. Fig. 52.—Inner side.

shaft, almost cylindrical above, more or less prismatic in the greater part of its extent, but flattened from before backwards, below, is very nearly straight, being, however, slightly bent forwards towards its lower end; its thinnest part, is a little below the middle. Owing, chiefly, to the direction of an oblique groove, which passes down from its posterior to its outer surface, the shaft appears to be rotated inwards; but, if the vertical transverse plane passing through the centre of the head, be compared with the vertical transverse plane passing through the lower end of the bone, it will be found that this latter is really twisted slightly outwards. The shaft of the femur, on the other hand, is strongly bent backwards, and its lower end is rotated inwards.

The *upper end*, or *head*, of the humerus, much wider than the shaft, presents a smooth, convex, articular surface, consisting of about one-third of a spheroid, figs. 49, 50, 52, placed obliquely on the inner side of the expanded shaft; it has its axis directed upwards, inwards, and somewhat backwards, to meet the glenoid cavity, which has an almost opposite direction, but which can only partially receive it, and the lower edge of which, in the dependent position of the arm, projects beneath it. The head of the femur forms two-thirds of a spheroid, and is received deeply and almost entirely into the acetabulum, which projects above it. The articular surface extends further upwards than downwards, and also further towards the posterior than towards the anterior aspect of the bone; it measures somewhat more from above downwards, than it does from before backwards. Beyond the borders of the articular surface, between it and the shaft, is a very short, somewhat constricted part of the bone, named the *neck*, which is evidently the counterpart of the neck of the femur. This latter, however, is of much greater relative length, so that, to employ a botanical phrase, the head of the femur may be said to be pedunculated, whilst that of the humerus might be described as being sessile, on its shaft. The axis of the neck is oblique, in reference to that of the shaft, and forms, as is the case with the femur, a very obtuse angle, of about 120°, with it. The neck itself is longest just beneath the head, that is, on the inner side of the bone; it becomes gradually shorter, both behind and in front; above, it forms merely a narrow groove, which is lost opposite the base of two short, broad eminences, named the *tuberosities* of the humerus. These tuberosities, figs. 49, 52, blend below with the shaft, and are evidently comparable with the trochanters of the femur, but they are smaller and less prominent. The larger and broader one, placed to the outer side of the head of the bone, projects outwards beyond the acromion process, and here forms the extreme outer point of the skeleton; it is named the *greater tuberosity*, and has, upon its upper blunt oblong surface, three flattened impressions, namely, an anterior one, for the attachment of the tendon of the supra-spinatus, a middle one, for that of the infra-spinatus, and a posterior one, for that of the teres minor muscle. The smaller, but somewhat more prominent, tuberosity, named the *lesser tuberosity*, is situated in front, and to the inner side, of the other, and gives attachment to the tendon of the subscapular muscle. The greater tuberosity is said to represent the lesser trochanter, and the lesser tuberosity, the greater trochanter of the femur.

Between the two tuberosities, is the upper end of a deep and narrow groove, which passes downwards and a little inwards, for nearly one-third of the length of the bone; it is named the *bicipital groove*, fig. 49, because it lodges the tendon of the long head of the biceps muscle. There is no analogous groove in the femur. Its upper part, deeper and narrower than the rest, is lined with cartilage, and communicates with the shoulder joint. Above it, the spheroidal surface of the head of the bone, is slightly flattened where the tendon of the biceps passes over it, in its course from the top of the glenoid cavity of the scapula to the bicipital groove. From the inner side of the neck of the humerus, and from the base of each tuberosity, three buttress-like ridges descend upon the shaft; the inner one soon disappears on the smooth, rounded, inner surface of the bone; the one from the lesser tuberosity, descends, as a thin ridge, along the front of the bone, forming the inner margin of the bicipital groove; whilst the much broader buttress, proceeding downwards from the greater tuberosity, presents a more elevated and rougher ridge along its anterior border, which forms the outer margin of that groove. External to this, and lower down, is a broad, linear, rough elevation, somewhat triangular and pointed downwards, which, about the middle of the outer side of the shaft, receives the insertion of the deltoid muscle, and is named the *deltoid impression*. Still lower, and towards the front of the bone, is a smoother, median ridge, which gives the bone a three-sided form, and may be followed down the humerus, until it terminates, by expanding laterally at the flattened lower end of the bone. The irregular ridges, thus traceable from the greater tuberosity to the lower end of the bone, constitute the *anterior border* of the humerus. The gradual change in direction of this border, from the outer to the anterior surface of the bone, assists in making the humerus appear twisted inwards at its lower end. The roughened part of this border represents, in the humerus, the linea aspera of the femur. Besides lodging the long tendon of the biceps, the lower part of the bicipital groove gives attachment, along its floor, to the tendon of the latissimus dorsi muscle; to its inner thin margin, is fixed the teres major, and to its outer more elevated and roughened margin, the greater pectoral muscle. Lower down than the deltoid impression, and on the inner side of the shaft, is a longer and smoother impression, into which the coraco-brachialis muscle is inserted; whilst immediately below the deltoid impression, and embracing its pointed extremity, is a broad plain surface, traversed longitudinally by the median smooth ridge already described, which affords origin down to near the elbow-joint, to the brachialis anticus muscle.

The back of the shaft of the humerus, is almost entirely occupied by two very large surfaces of origin of two of the heads of the triceps muscle, the only muscle at the back of the humerus; between those surfaces, is an oblique groove, the *musculo-spiral groove*, along which a large nerve, with an artery, passes. This groove is directed from the posterior to the outer side of the shaft, and, as already stated, gives a twisted appearance to the bone.

Below the groove, the bone widens out, to form the broad, triangular surface at the back of the flattened lower end of the humerus, here almost twice as wide as the shaft. This surface is bounded by two lateral ridges, one internal, and the other external, which end in two bony eminences, often called the *internal* and *external condyles*, the ridges themselves, which may be compared with the two lower diverging lines given off from the linea aspera of the femur, being named the *internal* and *external condyloid ridges*. The term, condyle, is, however, more appropriately applied, as in the case of the femur, to the whole of the inner or outer part of the lower end of the humerus, including its articular portion. On this understanding, the two above described eminences are named the *external* and *internal epi-condyles*; since the latter of these is situated above the trochlear portion of the articulating surface of the bone, it is more precisely distinguished as the *epi-trochlea.*

The *internal condyle*, using the term in its wider sense, is larger, and more prominent laterally, than the *external* one; it is also decidedly longer, so that the transversely widened articular portion of the lower end of the humerus, slants downwards and inwards, its inner part reaching lower down than its outer part. The articular surface is, moreover, prolonged chiefly on the front of the bone, that is, on the aspect of flexion. It is much more complex than the articular surface on the lower end of the femur, which articulates with only one bone, the tibia, the humerus being adapted to two. The inner and larger part of the humeral articular surface, consists of a pulley-like portion, named the *trochlea*, which is concavo-convex from side to side, and convex from behind forwards, to which, the upper, concave articular surface of the ulna, or inner bone of the fore-arm, is fitted, so as to complete the most perfect hinge-joint in the body; the outer and smaller portion, continuous with this, forms a smooth, rounded, convex eminence, sometimes named the *capitellum* or *little head* of the humerus, fig. 49, which is adapted to the cup-shaped cavity at the upper end of the radius, or outer bone of the fore-arm. The outer border of the trochlea fits into the interval between the ulna and the radius; it is separated from the capitellum by a distinct groove on the articular surface, into which the rim of the cup on the head of the radius, is received. The *trochlear surface* extends further upwards on the back of the humerus, on its inner, more elevated and more rounded margin, than on its outer and sharper margin; it is both wider and deeper than in front of the bone, and it ends, above, in a concave border. Above this, situated between the diverging condyloid ridges, is a large, wide, and deep triangular fossa, the *olecranon fossa*, fig. 50, into which, during complete extension of the fore-arm, the olecranon process of the upper end of the ulna is received. In front of the bone, the trochlear surface is also continued upwards, its inner and outer margins being prominent though rounded, the inner one being longer, and also more elevated, than the outer one. On this aspect, the trochlea is bounded above, by a slightly concave border; and, above that, is an oval fossa, much smaller and shallower than the olecranon fossa behind, named the *coronoid fossa*, fig. 49, which receives the coronoid process of the ulna, during complete flexion of the fore-arm. The coronoid fossa and the olecranon fossa approach each other so closely, that the bone between them is extremely thin and translucent; it is usually not thicker than parchment (see fig. 108), and is sometimes even deficient or perforated. On the back of the humerus, the trochlea is inclined upwards, and a little to the outer side of the axis of the shaft; but, in front, its inclination upwards is towards the inner side of that axis. The *capitellum*, or outer part of the articular surface, does not reach the back of the humerus, but commences only on the under surface, and is especially prolonged upwards on the front of the bone, so that it supports the radius most completely, in the position of semi-flexion of the fore-arm; it ends above in a convex border. Above that, is a small, transversely disposed, depression, separated from the coronoid fossa by a distinct ridge of bone, named the *radial fossa*, into which the border of the head of the radius is received, during complete flexion of the fore-arm.

To the inner side of, and somewhat above the trochlear portion of the inner condyle, and directed slightly backwards, is the very prominent *epi-trochlea*. To the outer side of, and above the capitellum, on a lower level than the epi-trochlea, and bent slightly forwards, is the smaller and less prominent *epi-condyle*. The internal condyloid ridge, or *epi-trochlear ridge*, figs. 49, 52, is strongly curved, so as to become very prominent below, as is best seen from the front, but it is nearly straight when viewed on its inner aspect. It, somewhat rarely, presents a spur-like process, which may even join the bone again below, so as to form a foramen, a structure, which, it is interesting to note, existed more frequently in ancient races of men, and is natural in certain mammalia. This epi-trochlear ridge affords attachment to the internal intermuscular septum, a layer of fascia placed between the muscles lying in front, and at the back, of the humerus; to its anterior lip, the brachialis anticus is partly attached, and to its posterior lip, a small portion of the triceps muscle. To the large and prominent epi-trochlea itself, is fixed the internal lateral ligament of the elbow-joint; it also gives origin to some of the muscles in front of the fore-arm, namely, passing from above downwards and inwards, the pronator radii teres, the flexor carpi radialis, the palmaris longus, the flexor digitorum sublimis, and the flexor carpi ulnaris. The *external condyloid ridge*, or *epi-condyloid ridge*, fig. 51, is slightly curved, when seen from the front, but is very decidedly bent forwards, when seen from the side, following, as it were, the direction of the capitellum; it gives attachment by its prominent margin, not only to the external intermuscular septum, but also, by its anterior lip, to two muscles of the fore-arm, namely the supinator radii longus, and the extensor carpi radialis longior, and, by its posterior lip, to a small part of the triceps muscle. To the epi-condyle itself, is fixed the external lateral ligament of the elbow; it likewise gives origin to some of the muscles at the back of the fore-arm, namely, the extensor carpi radialis brevior, the extensor communis digitorum, and the extensor minimi digiti; lastly, the small anconeus muscle arises from its hinder surface.

Surface-forms dependent on the Humerus.

The humerus is almost entirely covered by the muscles which invest it on all sides. It is, indeed, more completely concealed than the femur, for at the upper end of the bone, even its outer, larger, and more conspicuous tuberosity, which forms the most prominent bony point of the shoulder, extending much beyond the acromion process, is completely covered by the deltoid muscle. Nevertheless, it influences, most materially, the surface-forms of that muscle, for, as the glenoid cavity looks, not straight outwards, but outwards and forwards, so that its axis is directed towards the fore part of the acromion, the head of the humerus projects more in front of than behind that process; hence, it is much more prominent beneath the anterior than beneath the posterior portion of the deltoid muscle, which accordingly is thrust out and is more convex in front, but is relatively flattened behind. The lesser tuberosity, directed forwards, is so covered, as to be recognisable only by the touch.

The general straightness of the shaft of the humerus, as contrasted with the antero-posterior arching of the femur, produces a significant difference in the general form of the arm, as compared with that of the thigh, the arm, however variously modified in its surface-forms by the muscles, being essentially a straight segment of the upper limb, appearing to have a direct, solid axis, and not a curved axis, as is the case with the thigh. The awkwardness of an arm, bent like the thigh, would be equalled only by its inelegance. The observation of the two limbs, will satisfy the spectator, not only of the appropriateness of the structure of each limb, on mechanical grounds,—the one being destined for precision of action in all directions, the other for moving under great weight chiefly in two directions,—but also of the beauty of each form, from an æsthetic point of view.

At the lower end of the humerus, its widened anterior and posterior surfaces are both concealed by muscles; but they may be said to determine the general flatness of that part of the limb. On the outer side, a very small portion only of the epi-condyle is, strictly speaking, subcutaneous; this corresponds sometimes with a slight depression, sometimes with a slight prominence, amongst the attachments of the adjacent muscles, according as these are at rest, or in action. The upper sharper portion of the more prominent and more elevated epi-trochlea, is the only other subcutaneous part of the humerus; it is always distinctly recognisable, during extension of the fore-arm, as the most projecting point on the inner side of the elbow; but it forms a less prominent point, or is even placed in a depression, when the muscles are folded up around it, in the position of flexion. Thus, it will be seen that the only parts of this very large bone, which are covered by the integument alone, so that they directly influence the surface-forms, are small portions of the free surfaces of the epi-condyle and the epi-trochlea.

The Bones of the Fore-arm. The Ulna and the Radius.

The Ulna.—The *ulna*, also named the *cubit* (cubitus, the bow or bend of the arm; *κύπτειν*, to bend), is the bone on which the weight of the trunk is supported in leaning on the elbow, as in assuming or leaving the recumbent posture, or in the half reclining attitude of the Roman people, and others, at their meals (whence *recumbere* and *cubare*). The inner of the two parallel long bones of the fore-arm, it extends from the elbow to the wrist, and is placed a little behind the other bone, the radius, figs. 53 to 57. The ulna is longer than the radius, reaching considerably higher up than it, at the back of the elbow, but not quite so low down at the wrist. Its upper end is, by far, the largest part of the bone, which becomes gradually smaller or tapering towards its lower end; whereas, the radius is smaller above, and much the broadest at its lower end. Of the two bones, the ulna contributes much the larger share to the elbow-joint, but the radius alone takes part in the formation of the wrist-joint, with which the ulna is not directly connected. In the leg, both bones enter into the ankle-joint, whilst the tibia alone is concerned in the formation of the knee. Lastly, whereas the tibia and fibula are so firmly articulated, that the latter merely glides on the former, the radius is very peculiarly articulated with the ulna, so as to be able to be rotated freely, on its longitudinal axis, upon that bone.

The *upper* expanded *end* of the ulna, presents, anteriorly, a deep and wide smooth notch, bounded, in front and behind, by two remarkable processes, to be immediately described. The outline of this notch, as seen from the side, is semicircular, like the old Greek S, or *sigma*, C; hence it is named the *sigmoid notch*, figs. 53, 55, 56. It is further distinguished as the *greater sigmoid notch*, there being another much smaller, more simple, and shallower crescentic excavation, close beneath it on its outer side, which is called the *lesser sigmoid notch*. These notches are continuous, and, when lined with cartilage, form parts of a common joint. The greater notch receives the trochlear portion of the lower end of the humerus; and the lesser notch, the side of the head of the radius, which rotates within it. The greater notch, deeply concave from above downwards, has a smooth vertical ridge, which fits into the groove of the trochlea, and divides the cavity of the notch itself into two unequal lateral parts, of which the outer one, nearer to the radius, is smaller and shallower than the inner one, the two thus corresponding with the smaller outer part, and the larger and longer inner part of the trochlea. In this way, the mutually adapted surfaces of the ulna and humerus, form the hinge-joint of the elbow. Near the deepest part of the greater sigmoid notch, its outer and inner borders are indented, so that the articular surface is constricted; sometimes it is interrupted quite across, no cartilage existing there; the indentation or space is occupied by fat and blood-vessels. The eminence in front of the greater sigmoid notch, named the *coronoid process*, figs. 53, 55 (*κορώνη*, tip of a bow), is curved backwards, and somewhat pointed; when the fore-arm is bent, it is received into the coronoid fossa, in front of the lower end of the humerus. The eminence sur-

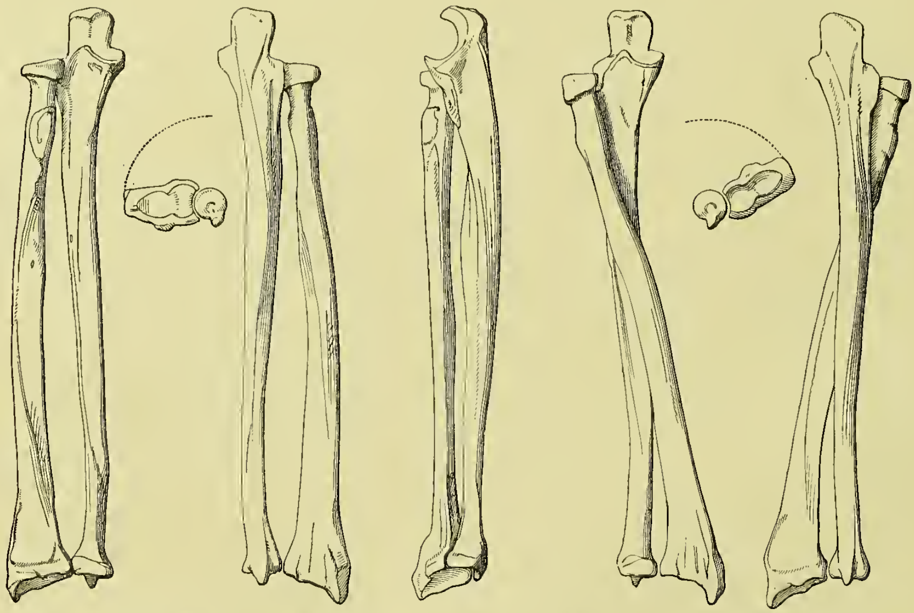


Fig. 53, front view, Fig. 54, back view, and Fig. 55, inner side of the right Radius and Ulna, placed parallel with each other, in the position of supination.
Fig. 56, front view, and Fig. 57, back view of the same bones, with the Radius across the Ulna, in the position of pronation.

The two small sketches belong, respectively, to Figs. 53 and 56, and show the lower ends of the Radius and Ulna, in supination and pronation; the direction of movement of the Radius is indicated by the dotted lines.

mounting the notch behind, and reaching much higher than the coronoid process, is named the *olecranon process* or *olecranon*, figs. 54, 55 (*ὠλένη*, the elbow; *κράνος*, a helmet), because it forms the cap of the elbow. It is broad and square at its upper end, not pointed like the coronoid process, and, during extension of the fore-arm, is received into the deep and wide olecranon fossa, at the back of the lower end of the humerus; it is nearer to the inner than to the outer condyle of that bone. Its broad, truncated, and roughened upper end, and also its sides and margins, afford insertion to the triceps muscle of the arm; below this, it becomes constricted to join the shaft of the bone, and presents, behind, a smooth triangular surface, which has its apex directed downwards, and is subcutaneous, being covered only by skin, a bursa intervening. Along the entire inner margin of the greater sigmoid notch, from the olecranon to the coronoid process, is fixed the internal lateral ligament of the elbow-joint. Into the front roughened surface of the coronoid process, and into the part of the bone just below it, is inserted the brachialis anticus muscle; near this, is a slight eminence, named the *tubercle*, for the attachment of the oblique ligament which passes down to the radius; on the inner side of the coronoid process, is a narrow ridge for the origin of a part of the pronator radii teres; above that, is a slight eminence, from which a portion of the flexor sublimis digitorum arises; lastly, behind this, is a depression for the origin of the upper end of the flexor profundus digitorum. The *lesser sigmoid notch*, figs. 54, 56, placed upon the outer side of the coronoid process, below the outer border of the greater one, with which it is continuous, is a narrow oblong facet, widest in the middle, and having its long diameter from before backwards, so as to fit the side of the head of the radius. To its anterior and posterior margins, the orbicular ligament, which embraces the head of the radius, is attached; immediately below this, is a small depression for a part of the origin of the supinator brevis muscle. The several ridges of bone in the neighbourhood of the coronoid and olecranon processes, which give origin to muscles, also serve to strengthen the processes with which they are continuous.

The *shaft* of the ulna is three times slightly curved, first bending backwards towards the radius, then backwards away from it, and, finally, in its lower part, again turning forwards towards that bone. Hence it is slightly convex behind, in its upper two-thirds, and convex internally, lower down. In the greater part of its extent, it is three-sided or prismatic, but, towards its lower end, it tapers, and becomes somewhat cylindrical. The *outer border* of the three-sided shaft, or that turned directly towards the radius when the bones are parallel, is most evident along the middle portion of the bone, is undulating and sharp, presents an upper shorter, and a lower longer incurvation, and has the interosseous membrane, which ties the two bones together, attached to it. The *anterior surface* of the ulna, fig. 53, continued downwards from the base of the coronoid process, is somewhat excavated, becomes narrower as it descends, and, from the greater part of its extent, gives origin to the flexor profundus digitorum; this muscle also covers most of the rounded *inner border*, and arises likewise from the upper two-thirds of the broad and smooth *inner* surface of the bone, the lower third of which, however, also smooth, is subcutaneous. The lower fourth of the anterior surface, likewise concave, and separated from the rest by an oblique line, affords origin to the pronator quadratus muscle. The *posterior border* of the ulna, most marked in the upper two-thirds of the bone, begins above, at the apex of the triangular subcutaneous surface found on the back of the shaft, just below the base of the olecranon. It may be said to commence by the meeting of the two well-marked borders of that surface, or else to bifurcate upwards, in order to enclose it. It descends in a sinuous course, along the back of the bone, first turning rather suddenly towards the radius, then more gently away from that bone, and lastly curving towards it again, as it subsides on the smooth, tapering lower end of the ulna, on which, however, it may be traced indistinctly to the very end. This posterior border is sometimes specially designated the *posterior ridge* of the ulna, fig. 54. To it, and to the innermost line of its upward bifurcation, is fixed a strong tendinous expansion or aponeurosis, which embraces the adjacent muscles of the fore-arm, and also gives partial origin, on its deep surface, to the flexor profundus digitorum and the flexor carpi ulnaris in front, and to the extensor carpi ulnaris behind. This posterior ridge of the ulna, is a most important part in reference to the surface forms. The *posterior surface* of the shaft of the ulna, turned somewhat outwards, towards the radius, broad above, but much narrower below, is somewhat undulating from above downwards, and comparatively uneven, being marked in its upper three-fourths by several oblique ridges and surfaces, for the origin of muscles; but it becomes narrow, smooth, and rounded, lower down. Thus, immediately to the outer side of the upper part of the posterior ridge and its external line of bifurcation along the olecranon, is a triangular surface for the insertion of the anconeus muscle; between that and the radial border of the bone, is the *oblique line of the ulna*, for the origin of a part of the supinator brevis; below these, are surfaces of origin for two of the extensor muscles of the thumb, namely, the extensor ossis metacarpi pollicis and the extensor secundi internodii pollicis, and for the extensor of the index finger.

At its *lower end*, the ulna, having tapered down to a slender part or neck, again enlarges to form the small rounded *head*, the back of which projects subcutaneously behind the inner border of this part of the fore-arm, just above the wrist. It has two continuous *articular surfaces*. One of these, situated on the radial side of the bone, fig. 53, forms an expanded, but narrow, smooth, convex rim, cut obliquely downwards and away from the radius, and extending half way around the head of the bone, on which, by a suitable concave facet, the side of the lower end of the radius rests, or plays in its rotatory movements. The other articular surface occupies the under aspect of the head of the ulna (see the small sketches near figs. 53, 56); it is continuous with the one just described, and is almost circular and nearly flat; it is turned downwards, towards the wrist-joint, but is separated from it, by an inter-articular fibro-cartilage. At the inner and back part of the head of the ulna, in a line with the posterior ridge, is the small, pointed, downward projecting *styloid process*, fig. 54 (στῦλος, the ancient style used in writing on papyri). Between its base or root and the inferior articular surface of the head of the bone, is a small depression for one end of the inter-articular fibro-cartilage ; its apex affords attachment to the internal lateral ligament of the wrist-joint ; its posterior surface is subcutaneous, and is continuous upwards with the lower and somewhat rounded part of the posterior subcutaneous ridge of the ulna ; on the back of the styloid process and to its radial side, is a slightly marked groove for the tendon of the extensor carpi ulnaris muscle. The point of the styloid process is the lowest part of the ulna, but neither this, nor the articular end, or head, reaches so low down as the styloid process, and the lower articular surface of the radius.

The Radius.—The *radius*, figs. 53 to 57, the outer of the two bones of the fore-arm, is remarkably adapted, both by its form and connexions, to its special office of rotating against the ulna, around its own longitudinal axis, which conforms with a line passing vertically through the capitellum of the humerus, and the lower end, or head of the ulna. In this movement, it carries the hand into the two positions, named *pronation* and *supination*, pronation being when the palm, and supination, when the back of the hand is turned downwards.

The upper end, or *head* of the radius, figs. 53, 54, 56, is fashioned, above, into a shallow, circular *cup-shaped cavity*, which articulates with the capitellum, on the outer part of the complicated lower articular surface of the humerus, the two bones being in most complete contact in the semi-flexed position of the fore-arm. Below the rim of this cup, and extending all round the bone, is a smooth, flattened, annular border, which is continuous with the cup-like surface above. On its inner half, this convex border, turned towards the ulna, deepest at its middle part, is nearly vertical, and fits into the concave, transversely oblong, lesser sigmoid notch of the ulna, with which it articulates, and in which it is easily rotated ; the outer half, less deep, and having its convex surface inclined obliquely inwards as it descends, is adapted to the inner surface of the orbicular ligament, which embraces it, and ties it to the ulna. Below this articular border, the radius becomes constricted, to form the *neck*, which is straight, nearly cylindrical, but slightly flattened in front and behind, smooth, and inclined inwards and forwards as it descends. Below the neck, begins the *shaft*, and at the junction of the two, on the ulnar aspect of the bone, when the fore-arm and hand are in the midposition between pronation and supination, is the large oblong *bicipital tubercle*, or *bicipital tuberosity*, figs. 53, 55, which affords insertion, by its posterior and more prominent part, to the flattened tendon of the biceps muscle of the arm, a bursa being interposed between the tendon and the anterior smoother portion of the tuberosity. When the hand is pronated, and the radius rotated inwards, its tuberosity is turned backwards, so that, in the skeleton, it becomes visible at the back of the fore-arm; but when the hand is supine, and the radius rotated forwards and outwards, the tuberosity is turned towards the anterior aspect of the fore-arm. From this tubercle, opposite which the radius approaches the ulna very closely, the *shaft* curves boldly outwards, away from the ulna, as low as the middle of the fore-arm, when it again curves inwards, to meet that bone just above the wrist, the radius here becoming larger, and especially wider at its lower end, where it has to support the hand. At its upper part, the shaft of the radius is nearly cylindrical, but as it gradually widens, it becomes, like the ulna, slightly excavated in front and behind, remaining well rounded on its outer side; hence, it is, like the ulna, somewhat prismatic, or three-sided. Like the ulna, too, its *anterior* and *posterior* hollowed *surfaces* meet at a sharp, undulating edge, named the *inner border*, which is well marked only along the middle portion of the shaft; it presents a short upper, and a longer lower incurvation, and has the inter-osseous membrane attached to it. Traced upwards, this edge is lost before reaching the tuberosity; below, it bifurcates into two slight ridges, which embrace a small articular cavity on the inner side of the lower end of the radius, into which the side of the head of the ulna is received. On the *anterior surface* of the radius, fig. 53, commencing below the bicipital tuberosity, is the *oblique line* of the radius, which passes obliquely downwards to the outer surface of the bone, and forms the upper limit of the hollowed anterior surface. Just above this line, is the elongated surface of insertion of the supinator brevis muscle, which is situated partly on the shaft, and partly on the neck of the bone, but also passes round to the back of the bone. From the oblique line itself, a portion of the flexor sublimis digitorum muscle arises; below it, the excavated surface of the bone gives origin to the powerful long flexor muscle of the thumb; below this, where the bone becomes much widened, is the broad surface of insertion of the pronator quadratus. Upon the *outer surface* of the middle of the shaft, and reaching round to the back of the bone, is found an elongated rough impression for the attachment of the pronator radii teres; above this, along the back of the bone, is the posterior surface of attachment for the supinator brevis; below it, on the somewhat excavated *posterior surface* of the bone, are the origins of two of the extensor muscles of the thumb, namely, the extensor ossis metacarpi and the extensor primi internodii pollicis. The lower third of the back of the radius, becoming broad and convex, is free from muscular attachments, and so is its rounded outer surface; nevertheless, the bone is here covered by muscles, or crossed by tendons, excepting at a small lozenge-shaped portion of the outer surface, quite at the lower end of the bone, just above the point of the styloid process.

This *styloid process*, figs. 54, 56, conical in shape, is both broader and longer, though less prominent than that of the ulna; it is situated just above the outer side of the wrist, a little behind the root of the thumb, reaching lower down than, but not so far back on the posterior aspect of the fore-arm as, the styloid process of the ulna. To a short ridge, terminating below in a small tubercle situated at the base of this process, is inserted the flattened tendon of the supinator longus muscle; to the apex, is fixed the external lateral ligament of the wrist-joint.

The *lower end* of the radius is smooth and excavated, in front; just above the lower articular surface, is an irregular transverse ridge, for the attachment of the anterior ligament of the wrist-joint; the margin of the articular surface runs obliquely downwards and outwards, towards the apex of the styloid process. On the back of the bone, there are many ridges, and grooves, figs. 54, 56, 110, 111, for the numerous tendons found in this situation and passing down to the hand. On the outer side, close behind the styloid process, is a nearly vertical groove, running a little forwards, and indistinctly separated into two parts, for the tendons of two of the extensors of the thumb, namely, the extensor ossis metacarpi and the extensor primi internodii pollicis; next to this, is another broader and shallower vertical groove, subdivided by a slight median ridge, which gives passage to the long and the short radial extensors of the wrist; then a narrow deep oblique groove is seen for the tendon of the extensor secundi internodii pollicis; and, lastly, there is a fourth, well-marked, broad, vertical groove, for the extensor of the index finger, and the common extensor of the fingers. A small channel for the extensor of the little finger, is formed between the radius and the ulna, on this aspect of the wrist; whilst on the ulna itself, as already mentioned, is the groove for the tendon of the extensor carpi ulnaris. Below all these grooves, is the hinder convex margin of the lower articular surface of the radius, to which the loose posterior ligament of the wrist-joint is attached. At the lower end of the bone, fig. 53, two distinct articular surfaces are found. One of these, situated on the ulnar side of the bone, named the *sigmoid cavity* of the radius, is a small, shallow, almost semi-lunar facet, elongated from before backwards, and oblique from above downwards and inwards, the radius itself here curving in the same direction. This cavity rests upon the smooth, convex, and obliquely cut articular surface on the radial side of the head of the ulna, and, by its means, the radius rotates easily on the lower end of its companion bone. The other and larger articular surface, upon the lower end of the bone, (see the small sketches near figs. 53, 56), enters into the formation of the wrist-joint. It is turned obliquely downwards and inwards, towards the upper part of the carpus, and is oblong in its general form, being, like the radius itself, wider from side to side than it is deep from before backwards; it is slightly concave, both from before backwards and from side to side, and is subdivided, opposite to a constriction in its anterior and posterior borders, by a slight ridge passing from before backwards, into two parts; one, inner, smaller and square, articulates with the semi-lunar bone, the central bone of the first row of the carpus; the other, outer, larger and somewhat triangular, articulates with the outermost of that row of bones, namely, the scaphoid bone. At its inner border, this carpal articular surface of the radius is completely cut off from the sigmoid cavity for the ulna, by a roughened edge, to which is firmly attached the triangular inter-articular fibro-cartilage, which passes from it to the base of the styloid process of the ulna, and which is interposed between the lower end of that bone and the cuneiform bone, or innermost bone of the first row of the carpus.

Surface-forms dependent on the Ulna and Radius.

The existence of two bones of nearly equal size in the fore-arm, imparts a flattened form to this segment of the upper limb.

As already mentioned, it is not the humerus, but the olecranon process or upper end of the *ulna*, which, in all positions of the fore-arm, forms the point of the elbow; whereas, the prominence of the knee, is formed either by the lower end of the femur or by the patella, and not by the tibia or fibula. In the ordinary straight position of the elbow-joint, the upper border of the olecranon corresponds with a line drawn just above the level of the epi-trochlea of the humerus; when the fore-arm is bent at a right angle, this border corresponds with the plane of the flattened posterior surface of the lower end of the humerus; lastly, when the fore-arm is completely flexed, the olecranon passes forwards, so as to be placed in front of, but on a much lower level than, the epi-trochlea, around which, in fact, it revolves in these movements, always, however, constituting the apex or point of the elbow, figs. 121–3. Between the inner border of the olecranon and the epi-trochlea, there is, during extension of the fore-arm, a well-marked surface-furrow, which might be called the *epi-trochlear furrow*, and which is easily explained by reference to the skeleton-forms; as the fore-arm approaches semi-flexion, this furrow is gradually replaced by a surface more or less prominent, and, in complete flexion, this part becomes quite convex.

The broad, truncated, upper surface of the olecranon is covered by the insertion of the tendon of the triceps; so, likewise, nearly the whole shaft of the ulna is so embedded in muscles, that it does not immediately affect the surface-forms. But the posterior border of the upper surface of the olecranon, is free and subcutaneous, and is the part which really constitutes the apex of the elbow; in over-extension of the fore-arm, however, it ceases to project, but is found at the bottom of a shallow, transverse, crescentic depression, the *olecranon furrow*. This border of the olecranon is somewhat convex, and inclined obliquely downwards and outwards; when the fore-arm is extended, its point is much nearer to the epi-trochlea than to the epi-condyle of the humerus, that is nearer to the inner than to the outer side of the elbow; a line prolonged upwards from it, would cross over the middle of the epi-trochlear ridge of the humerus. The inner end of this border is rounded off abruptly, but, externally, it turns more gently outwards and downwards, where it forms the upper limit of the triangular surface on the back of the expanded upper end of the ulna, which is here really subcutaneous. This subcutaneous surface is defined above, by the tendinous insertion of the triceps; its inner and outer borders corresponding with the oblique lines on the bone, which converge from the sides of the olecranon to the upper end of the posterior ridge of the ulna, are bounded by the slightly curved borders of the flexor carpi ulnaris and the anconeus. When these muscles are relaxed, this triangular surface appears nearly on a level with them, but when they are in a state of contraction, it is depressed. Below this surface, the posterior ridge of the ulna forms a narrow, sinuous, linear depression, which may be termed the *ulnar furrow*, and which runs downwards and outwards, at first between the two above-named muscles, and then between the flexor and the extensor carpi ulnaris; the upper part of this furrow turns towards the radius, but the lower part bends away from that bone; it gradually becomes effaced below, because the muscles become smaller, and then tendinous, and the bony ridge itself is more rounded. Finally, it may be traced, as a slightly rounded elevation running down between the tendons of the flexor and extensor carpi ulnaris, towards the back of the inner border of the wrist, to the small subcutaneous part of the styloid process; immediately behind that, is the posterior prominent portion of the head of the ulna, which forms a very marked and characteristic rounded projection at the back of the inner border of the fore-arm, just above the wrist; it is more prominent in pronation than in supination of the fore-arm. The point of the styloid process bends towards the wrist-joint, and does not protrude on the surface.

The *radius* is even much more completely invested by overlying muscles than the ulna. A small part only, of the circular border of the head of the bone, lies closely beneath the integuments, just below, and a little in front of, the epi-condyle, where it is covered, however, by the external lateral and the orbicular ligaments, and partially also by the supinator longus muscle. When the arm is dependent, and the hand is supinated, that is, with the palm turned forwards, then, the outermost part of the acromion process of the scapula, the most prominent part of the great tuberosity of the humerus, the epi-condyle of that bone, the head of the radius, the styloid process of that bone, and the root of the thumb, are nearly in the same vertical line, deflected slightly backwards, however, at a very obtuse angle, opposite the elbow-joint.

In the skeleton, the head of the radius projects out beyond the capitellum of the humerus, when the fore-arm is extended; but it is level with it, when the fore-arm is flexed; it is also prominent during pronation, but depressed during supination. When, however, the bones are covered with the soft parts, there is a depression below the epi-condyle of the humerus, which corresponds with the head of the radius, and constitutes the pit or *dimple*, seen, and regarded as a beauty, in well-formed, and especially in children's arms; it is plainest when the arm is extended, but is replaced by a slight elevation when the fore-arm is flexed. The exact position of the head of the radius can be determined by the touch, provided that the bone be rotated, by grasping the hand and alternately pronating and supinating the fore-arm; it becomes more prominent during pronation.

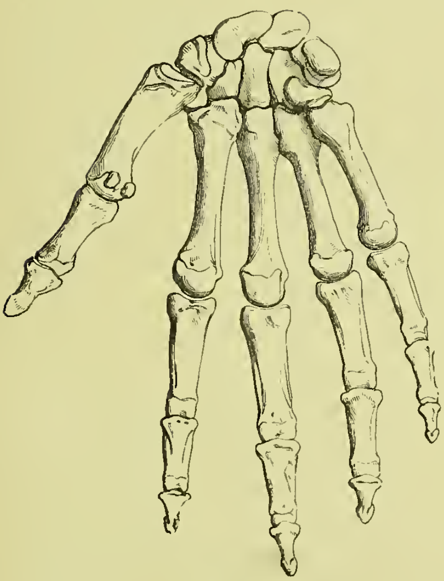
The only really subcutaneous part of the radius, is a lozenge-shaped, somewhat convex surface, on the outer side of the base of the styloid process. This is seen or felt, precisely at the outer border of the fore-arm, immediately above the wrist, not on the back of the fore-arm like the head of the ulna; it is situated lower down and is much broader than the prominence of the styloid process of the ulna. Its apex bends in towards the wrist, and, so, does not protrude. Above the subcutaneous part of the styloid process, and for a short distance upwards, the rounded outer border of the radius, though near the integument, is covered by tendons; whilst, still higher up, it is overlapped by muscles. At the back of the fore-arm, just above the wrist, the numerous grooves in the bone are concealed by the tendons lying in them, and the intermediate ridges by the posterior annular ligament, which binds down those tendons.

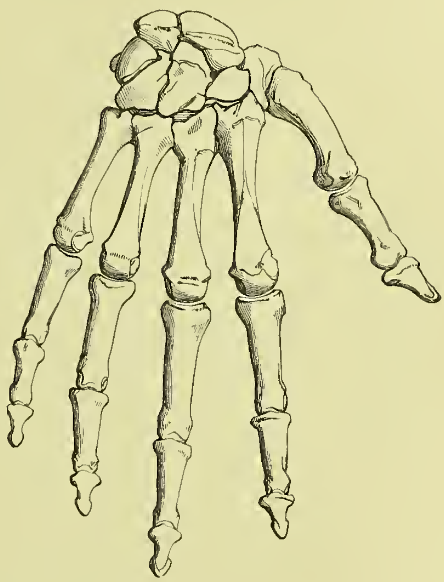
The Bones of the Hand.

All the bones of the *hand* are visible in the skeleton, on its *palmar* aspect, fig. 58, *carpal, metacarpal,* and *phalangeal*; but the pisiform bone is concealed from view, on the *dorsal* aspect, fig. 59.

The Carpal Bones.—The eight bones which are clustered together, so as to form two groups, in the *carpus,* are much smaller than those of the tarsus, and have individually much less influence on the shape of the slender wrist, than the tarsal bones have on that of the instep and hinder part of the foot. Nevertheless, in their construction, they are as obviously adapted for their respective uses. If the pisiform bone be regarded as a sesamoid bone belonging to the sclero-skeleton, there are only seven bones in the carpus, as in the tarsus.

The *semi-lunar* bone, figs. 58, 59, which corresponds with the astragalus in the tarsus, and so may here claim precedence, occupies the centre of the first row, and is crescentic in shape, its convexity being turned upwards, and its concavity downwards. Its dorsal and palmar surfaces, non-articular, are slightly roughened for the attachment of ligaments, the palmar surface being the larger of the two. Its lateral surfaces, both articular, more or less semilunar, and nearly plane, articulate with the adjacent cuneiform and scaphoid bones. Its upper and under surfaces, also both articular, are, the former, broad, single and very convex, articulating with the inner square part of the concave inferior articular surface of the radius; the latter, narrower, deeply concave and almost always divided into two facets, one, for articulation with





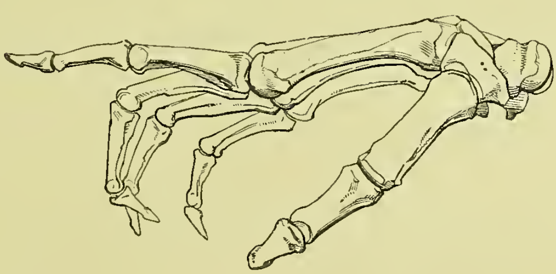


Fig. 58.—Palmar view of the Bones of the Right Hand.
Fig. 59.—Back view of the same.
Fig. 60.—Outer Border of the same.

the os magnum, and the other, for adaptation to the upper edge of the unciform bone. As is the case with the astragalus, no muscle or tendon is attached to the semilunar bone.

The *cuneiform bone*, figs. 58, 59, placed on the ulnar side of the semilunar, and occupying the ulnar border of the wrist, is wedge-shaped, fitting in between the last-named bone and the unciform, and articulating with both by means of suitable smooth facets, that for the semi-lunar being plane, and that for the unciform concavo-convex, that is, concave towards the middle of the wrist, and convex towards its ulnar border. The upper surface of the cuneiform is also chiefly articular, being turned towards the lower end of the ulna, but separated from that bone by the inter-articular fibro-cartilage. Its inner border is roughened, and has a small prominent tubercle on it, for the attachment of part of the internal lateral ligament of the wrist-joint. Its roughened dorsal surface also has ligaments connected with it; lastly, its palmar surface, otherwise rough for ligaments, is marked on its inner half by an oval, smooth facet, slightly convex from above downwards, for articulation with the little pisiform bone. The cuneiform bone has no muscle or tendon directly attached to it; but through the intervention of the pisiform bone, it is connected with the flexor carpi ulnaris. It is the representative of at least a part of the os calcis in the tarsus.

The *pisiform* bone, fig. 58, rather egg-shaped than pea-shaped, has a slightly concave facet behind, oblong from above downwards, which is articulated with the cuneiform bone. The rest of its surface is roughened, and connected firmly with many structures; internally, with a part of the lateral ligament of the wrist, and with the *posterior annular* ligament; in front, with the anterior annular ligament; and above, with the strong tendon of the flexor carpi ulnaris. Below, it affords origin to the abductor muscle of the little finger.

The *scaphoid* bone, figs. 58, 59, the largest of the first row, and corresponding with the scaphoid in the tarsus, is placed on the radial side of the semi-lunar bone, and reaches downwards and forwards, much below its level. It is a long, irregularly-shaped bone, having a convex upper articular surface, which fits into the outer triangular portion of the concave inferior articular surface of the radius; an oblong, concave, and somewhat *boat-like* inner articular surface, marked off into an upper flattened part, for articulation with the outer side of the semi-lunar bone, and a lower, larger concave portion, for the reception of the outer side of the head of the os magnum; and, lastly, a lower articular surface, also convex, and divided into an inner, quadrilateral, narrow part, for articulation with the trapezoid bone, and an outer, triangular, broader portion, for adaptation to the trapezium. The rest of the bone is non-articular and roughened; it is narrow and convex behind; in front, it is, at first, concave just beneath the wrist-joint, but lower down presents a *tuberosity*, which affords attachment to the anterior annular ligament, and from which the abductor muscle of the thumb arises.

Of these three bones, forming, with the pisiform, the *first row* of the carpus, the cuneiform bone articulates below, only with the unciform of the second row, just as the os calcis articulates only with the cuboid in the tarsus; the semi-lunar bone articulates slightly with the unciform, but chiefly with the os magnum; lastly, the scaphoid articulates with three bones of the second row, namely, the os magnum, trapezoid, and trapezium, just as the scaphoid, in the tarsus, is connected with the three cuneiform bones.

The *unciform* bone, figs. 58, 59, the innermost bone of the second carpal row, is placed on the inner side of the os magnum, and below the cuneiform bone; it completes the inner border of the wrist, supports the fourth and fifth metacarpal bones, and thus corresponds with the cuboid bone of the tarsus, which occupies a similar position, and supports the same metatarsal bones. It has an inclined pyramidal form, its base being turned downwards, towards the metacarpus, its apex upwards, towards the semi-lunar bone, the central bone of the first row. In front, it presents the remarkable hook-like or *unciform process,* fig. 58, from which the bone receives its name. The apex of the bone presents a narrow facet, which articulates with a part of the concave under side of the semi-lunar bone; its radial side chiefly articulates, by a slightly convex surface, with the os magnum, but is elsewhere rough for ligaments; its longer, oblique, ulnar side has a large undulating, triangular facet above, for articulation with the concavo-convex under surface of the cuneiform bone, below which it is roughened for the internal lateral ligament; its base presents two contiguous and continuous smooth facets, separated by a ridge and placed at an obtuse angle with each other, one, internal and larger, concave from before backwards, but convex from side to side, forming a somewhat saddle-shaped surface, for the base of the fifth metacarpal bone; the other smaller, and slightly concave, for the base of the fourth metacarpal bone. The triangular back of the unciform bone, and its ulnar edge, free between the cuneiform and the fifth metacarpal bones, are rough for ligaments; the anterior surface, also triangular and rough, is distinguished by its unciform process, which projects from the lower and inner part of the bone, is flattened on each side, and bends over, at its point, towards the middle of the wrist. By its apex, this process gives attachment to the anterior annular ligament of the wrist; the ulnar surface and the tip of the process give origin to the flexor brevis, and the opponens muscles of the little finger; its radial surface is deeply grooved for the tendons of the flexor sublimis and profundus digitorum muscles, which glide past it.

The *os magnum,* figs. 58, 59, the largest of the *second row,* and of all the carpal bones, is situated in the centre of the carpus; it represents, wholly or in part, the external cuneiform tarsal bone. It is proportionally long, and is described as having a *head, neck,* and *body.* The *head* is the expanded upper end of the bone, rounded and convex, especially from before backwards, somewhat flattened on its radial, but slightly concave on its ulnar side; it is received into the deep socket formed for it, above, by the concavity of the semi-lunar bone, on the radial side, by the lower part of the concave inner surface of the scaphoid, and on the ulnar side, by the somewhat convex articular surface of the unciform bone. Below the narrow part, or *neck*, of the bone, the outer side of the os magnum presents a rough surface, for the attachment of an interosseous ligament, and a flat, quadrangular facet, for articulation with the trapezoid bone. Lastly, the lower end of its *body* has three articular facets, one, median, and much the largest, indistinctly concavo-convex, for articulation with the base of the metacarpal bone of the middle finger, and two others, lateral and much smaller, for articulation, respectively, with small portions of the bases of the second and fourth metacarpal bones. The rest of this comparatively large bone is non-articular, and more or less roughened behind, in front, and on its sides, for the attachment of ligaments. The posterior surface of the bone is broad, convex, and only slightly roughened; whilst the anterior is much narrower, and presents a marked prominence for the attachment of strong, radiating ligamentous bands; it also gives origin to a portion of the inner head of the short flexor muscle of the thumb.

The *trapezoid* bone, figs. 58, 59, the smallest of the second row, is the representative of the middle cuneiform bone, which is the smallest bone in the tarsus. It has four articular facets; namely, an upper one, quadrilateral and slightly concave, for the scaphoid; an inner slightly concave one, for the os magnum; an outer slightly convex facet, for the trapezium; and, lastly, a lower one, concave from behind forwards, but convex, or even obtusely ridged from side to side, for articulation with the greater part of the base of the second metacarpal bone. The posterior surface, broader than the anterior, convex, and roughened for the attachment of ligaments, usually presents a pointed process, which overlaps the middle of the base of the second metacarpal bone, where a notch is found to receive it; sometimes the inner angle of this surface touches the third metacarpal bone. The anterior surface, smaller, but also rough for ligaments, gives origin to a part of the inner head of the short flexor of the thumb.

The *trapezium*, figs. 58, 59, less regular in shape than the trapezoid, is the outermost bone of the second carpal row; it completes the radial border of the wrist, and supports the metacarpal bone of the thumb, in the same manner as its representative, the internal cuneiform bone of the foot, completes the tibial border of the tarsus, and supports the metatarsal bone of the great toe. It is placed a little in advance of the trapezoid bone, and just reaches, at its inner and lower border, the side of the base of the second metacarpal bone. The upper articular facet of the trapezium is concave, and is in contact with the scaphoid bone; the internal surface is chiefly articulated with the trapezoid, by a large concave facet, but it also touches the base of the second metacarpal bone, by an additional narrow facet; the lower articular surface, for the support of the metacarpal bone of the thumb, is very peculiar, being distinctly saddle-shaped, that is, convex from behind forwards, but concave from side to side. The posterior surface of the bone, narrow and convex, is roughened for ligamentous attachments; its outer surface, likewise non-articular, presents a tubercle for the attachment of some of the fibres of the external lateral ligament of the wrist-joint; its anterior surface is distinguished by an *oblique ridge,* running downwards and inwards, to the inner border of which, the anterior annular ligament of the carpus is attached, and from which the abductor, the outer head of the short flexor, and the opponens muscles of the thumb arise; on the inner side of this ridge, is a deep groove, along which the tendon of the flexor carpi radialis muscle passes.

The *entire carpus,* figs. 58, 59, is oblong in shape, its long diameter being transverse. Its *upper* compound articular border, oblong, narrow, and smoothly convex, articulates with the radius, and with the inter-articular fibro-cartilage beneath the ulna, forming a limited ball-and-socket joint; its *lower* border, also articular, is wider, less convex, but uneven or notched, and supports, by gliding joints, the three middle metacarpal bones, and, by saddle-shaped joints, the metacarpal bones of the little finger and thumb. Its non-articular inner border, projecting even beyond the ulna, is deeper from above downwards, and more prominent than the outer border, which is also non-articular, but shorter and more recessed beneath the styloid process of the radius. Its dorsal surface is nearly even and convex, all of the bones which enter into it, except the semi-lunar, being wider behind than in front, or more or less wedge-shaped from behind forwards; the palmar surface, on the other hand, is concave, and hence the lower border of the carpus forms a portion of an *arch,* from side to side. The trapezium, in particular, advances forwards on the radial side; but the carpus appears still further hollowed on its palmar aspect, on account of the presence of four bony processes, two at each side of the wrist, namely, the pisiform bone and the unciform process, near the ulnar border, and the tuberosity of the scaphoid and the oblique ridge of the trapezium, near the radial border. It is between these, that the strong anterior annular ligament crosses, so as to form a completely enclosed channel, for the passage of the tendons of the long flexor muscles of the fingers and thumb; the tendon of the flexor carpi radialis passes through the ligament itself.

The two rows of carpal bones, form each, a transverse compound segment of the entire carpus. The complicated articulation between them, the *transverse articulation of the wrist,* is composed, above, of a concavo-convex surface, consisting, on its ulnar side, of the deep concavity formed by the cuneiform and semi-lunar bones, and, on the radial side, of the shallow convexity formed by the scaphoid bone; whilst, below, it is composed of a convexo-concave surface, consisting, on the ulnar side, of the prominent convexity formed by the unciform bone and os magnum, and, on the radial side, of a shallow concavity formed by the trapezoid bone and the trapezium. This joint is a gliding joint, having some of the characters of a hinge-joint.

The Metacarpus.—The five *metacarpal* bones of the hand, the representatives of the five metatarsals in the foot, differ from these, in being shorter, bone for bone, and in having only the four inner ones arranged nearly parallel with each other, the first metacarpal for the thumb, standing off from the rest.

They are long bones, with prismatic *shafts* and expanded ends. The *shafts* are somewhat curved in the longitudinal direction, being convex on the back, and concave towards the palm; they are thinnest in the middle, so that the interosseous spaces between them, are there widest. The concavity of their palmar surfaces contributes to form the *longitudinal palmar arch*, figs. 58, 60. Their dorsal surface, fig. 59, is broad and rough towards the base, but lower down, is marked by a median ridge, which, at about the upper third of the bone, bifurcates, the two branches diverging and descending to two small tubercles on the sides of the lower end of the bone; the two diverging lines enclose a smooth, flattened, triangular, and almost subcutaneous surface, which is covered by the corresponding flat extensor tendon. On each side of these lines, are excavated surfaces, for the partial origin of the dorsal interosseous muscles. The fifth metacarpal bone, however, has only one oblique line, on its dorsal aspect, passing downwards from its ulnar to its radial border; whilst the dorsum of the metacarpal bone of the thumb has no line. The excavated surfaces on each side of these lines, are continuous with the lateral portions of the shafts, which limit the interosseous spaces; they meet on the palmar aspect, in a narrow ridge, which spreads out, upwards and downwards, towards each end of the bone; they give origin to the palmar, as well as to portions of the dorsal interosseous muscles. The *upper ends*, or *bases*, of the metacarpal bones are four-sided, but are broader at the back than in front, and are compressed laterally, where they touch each other; they articulate, by their smooth upper surface, with the carpus, forming gliding joints, and, by one, or even two small lateral facets, with each other; they are closely held together by interosseous ligaments, attached to roughened parts of their sides; they are also roughened for ligaments in front and behind. The *lower ends*, or *heads*, of these bones, much broader and larger than the corresponding bones in the foot, with the exception of the first, are flattened at the sides, where they present depressions, surmounted, posteriorly, by little tubercles, for the attachment of the lateral ligaments. They terminate in large articular surfaces, broader in front than behind, and convex in all directions, but especially so in the antero-posterior direction, and prolonged further on the palmar than on the dorsal aspect of the bones; they are adapted to deep concavities on the hinder ends of the first phalanges of the fingers, with which they form oblong ball-and-socket joints; on the palmar aspect, fig. 58, they present two slight lateral backward prolongations, between which the flexor tendons lie. To the prominent borders of these, are attached the strong ligaments which connect the four inner metacarpal bones, and also bind down the flexor tendons; these lateral prominences are most developed on the free borders of the hand, namely on the radial side of the second metacarpal, and on the ulnar side of the fifth metacarpal bone.

The metacarpal bones present numerous individual *peculiarities*, especially the first metacarpal. They differ in length, breadth, and form; they are also differently connected with the carpus, and with each other, and they give origin or insertion to different muscles or tendons. The largest, but not the thickest, is the second metacarpal, which supports the index-finger; next to that, in length, but somewhat thicker, as it has to bear the middle finger, is the third or middle one; then the fourth, and, next to that, the fifth for the little finger, the thickness of the two latter diminishing in the same order; lastly, the metacarpal bone for the thumb, is the widest, thickest, and shortest of all, reaching only as low as the middle of the second.

The *fifth* metacarpal, which supports the little finger, is articulated, at its base, by means of an oblique concavo-convex facet with the inner portion of the inferior articular surface of the unciform bone, so as to form a somewhat saddle-shaped joint; moreover, it has only a single lateral facet, namely, on the radial side of its base, for articulation with the fourth metacarpal. The tendon of the extensor carpi ulnaris muscle is inserted into a small tubercle seen on the inner and hinder part of its base; a prolongation from the tendon of the flexor carpi ulnaris, is attached to the fore part of its base; and the opponens minimi digiti is inserted along its ulnar border. The *fourth* metacarpal bone, which supports the ring finger, has, on its base, a quadrangular facet, for articulation with the outer portion of the lower surface of the unciform bone; it also has a small, flat, articular facet on its hinder and outer angle, which touches the os magnum; besides this, it has a single lateral facet for articulation with the base of the fifth, and two others, with an intermediate rough groove, for articulation with similar facets on the base of the third metacarpal. The *third* metacarpal, which carries the middle finger, is wedged deeply in between the bases of the fourth and second, both of which it touches by one, or by two, small lateral facets, whilst its upper end articulates with the large middle portion of the under surface of the os magnum. From its radial corner, on the back of the hand, a pointed *eminence* overlaps the os magnum, serves to steady the bone, and provides a place of insertion for the tendon of the extensor carpi radialis brevior muscle. The adductor pollicis muscle arises from the longitudinal median ridge, on its palmar surface. The *second* metacarpal bone, on which the fore-finger is supported, is, as already stated, the longest of the series; on the dorsal aspect, its large upper end presents a deeply indented outline, owing to its articulation, by its widely notched base, with three of the carpal bones, and also to its having two angular prominences between them. Thus, it articulates, by a narrow edge, with the os magnum; by a broad concavo-convex surface, with the trapezoid; and by a third oblique facet directed towards the root of the thumb, with a corresponding facet on the trapezium. On the inner side of its base, it has a single, or double facet, for articulation with the third metacarpal bone. The outer prominence on its dorsum, the one nearer to the thumb, affords insertion to the tendon of the extensor carpi radialis longior; on its palmar aspect, is a broad, rough surface for the attachment of the tendon of the flexor carpi radialis. The *first* metacarpal bone, figs. 58, 59, 60, belonging to the thumb, is distinguished from the rest, not only by its being the shortest, broadest, and flattest, and by its being divergent in direction, but by the peculiarity of the joint at its base, and by certain specialities of form. Its wide, slightly convex, *dorsal* surface, fig. 60, is smooth, of nearly equal width throughout, has no bifurcating or oblique line, and is covered only by tendons and by the skin; its *palmar* surface, concave from above downwards, has no prominent median ridge, but is smooth for the attachment of the opponens pollicis muscle; its inner border gives partial origin to the first and largest dorsal interosseous muscles; its outer border is free. The *base* of the bone, widened from side to side, presents a deep and perfect saddle-shaped surface, for articulation with the trapezium; it has its convexity from side to side, and its concavity from behind forwards, the opposite arrangement to that on the trapezium; moreover, the base of the bone presents, both in front and behind, an angular prominence, which helps to render the joint more secure. There is no lateral facet on the base, for articulation with the second metacarpal bone, which it does not even touch. On the outer and hinder part of the base, is a tubercle for the insertion of the extensor ossis metacarpi pollicis. Owing to the relatively advanced position of the trapezium, and to the oblique direction inwards of the articulation between it and the first metacarpal bone, the latter is not only placed more forward than the other metacarpals, but has its palmar surface turned inwards, in a direction across the palm. The singularly useful opposability of the thumb depends mainly on these conditions. The *head* of the first metacarpal, like the rest of the bone, much wider from side to side than it is thick, has its terminal articular surface, unlike that of the other metacarpals, transversely oblong, and much less convex from side to side; it is, however, as in these, continued on to the palmar aspect, where it is prolonged, by two little continuous grooves, on which the two *sesamoid* bones, fig. 58, contained in the double tendon of the short flexor muscle of the thumb, are articulated and glide. On each side of the head of the bone, is a small tubercle, for the attachment of the lateral ligaments of the joint.

The head of the metacarpal bone of the thumb being so widely separated from that of the second, the two have no transverse ligament between them, as is the case between the other four, and between all the metatarsal bones in the foot, including even that of the great toe. The first interosseous space in the hand, is, also, very wide, triangular, and quite open below, instead of forming a narrow elliptical space, as between the other metacarpal and between all the metatarsal bones. The remaining four metacarpal bones, however, are not exactly parallel with each other, but, owing to the slight convexity of the lower border of the carpus, they radiate out, like the sticks of a fan, so as to diverge at their distal ends. This is especially the case, with the second in an outward, and with the fifth in an inward direction; hence the second and fourth interosseous spaces are comparatively wider below, than the third. The heads of the metacarpal bones of the fingers, describe together a slightly curved line; and, owing to the arched form of the carpus, with which they are connected, they also form a laterally arched framework. This is the *transverse arch of the palm*; it is increased, especially at the anterior part of the metacarpus, to which the fingers are attached, by the forward movements possible at the bases of the bones. The arched form of the anterior part of the metacarpus, enables the points of the fingers to be brought more easily together.

The Phalanges.—The *phalanges of the fingers and the thumb*, figs. 58, 59, 60, in comparison with those in the foot, if we set aside the bones of the thumb and the great toe, are so large, that it is easier to distinguish the proper phalangeal characters in them; and they are so long, that they are much better adapted for prehensile purposes. Miniature long bones, having slender shafts tapering downwards, and two enlarged extremities, they are, in all cases, wider from side to side, and thinner from before backwards. The first or proximal phalanges are the longest and largest, and the last or terminal phalanges, the shortest and smallest. The shafts of all the digital phalanges are convex on the dorsal surface, both longitudinally and transversely; but, on the palmar surface, they are slightly concave from above downwards, though flattened transversely. Their dorsal surfaces, fig. 59, moreover, are smooth for adaptation to the extensor tendons, by which they are covered, besides the skin; their palmar surfaces, fig. 58, have the flexor tendons lying against their median flattened part, but at each side of the first and second phalanges, a slightly elevated ridge exists, for the attachment of the sheaths which bind down those tendons. On the first phalanx of the thumb, these lateral ridges are rounded off.

The *first phalanges* of both the fingers and the thumb are distinguished by having, at their *upper ends*, or *bases*, simple, transversely oblong, cup-like cavities, by which they are articulated by so many little ball-and-socket joints, with the rounded heads of the corresponding metacarpal bones. Whilst, however, the convex articular surfaces of these latter bones are longer from behind forwards than from side to side, the articular cavities of the first phalanges are longer from side to side than they are deep from before backwards. The latter, moreover, are not so large as the former; but, in the recent state, the articular cavity is extended upwards on the palmar aspect by the so-called glenoid ligament. The joints thus formed are limited in their movements, as compared with the spheroidal ball-and-socket joints ; but it is at these joints, that the free movements of the entire fingers, at their bases, are performed. The cup-like cavity of the first phalanx of the fore-finger appears to be the deepest ; whilst that of the first phalanx of the thumb is much shallower, and wider from side to side, than the rest, in accordance with the greater breadth of its corresponding bone. On each side of the bases of the first phalanges, are small tubercles for the attachment of the lateral ligaments, and of the tendons of the interosseous muscles ; but on the inner side of the base of the first phalanx of the little finger, instead of an interosseous muscle, there is the abductor muscle, and also the short flexor muscle of that finger. Into the inner and outer sides of the base of the first phalanx of the thumb, are inserted the adductor and the abductor pollicis, and, with these, the two corresponding heads of the flexor brevis pollicis. At the back of this phalanx in the thumb, there is also inserted the tendon of the extensor primi internodii pollicis ; and, in the fingers, occasional little divergent slips of the extensor communis digitorum. The *lower ends* or *heads* of the first phalanges, are flattened behind and before, and have articular surfaces altogether different from those of the metacarpal bones, being of a distinctly condyloid and trochlear shape, having two small condyles, with a comparatively wide, shallow, longitudinal groove between them ; they are broader and prolonged very much further on the palmar than on the dorsal aspect ; in the latter situation, the groove only exists ; in the former, the lateral condyloid surfaces are most evident. On each side, are rough depressions, in which there are prominences, situated anteriorly, for the attachment of the lateral ligaments, which are, therefore, fixed in front of the axis of motion of these little hinge-joints, so as not to interfere with their flexion, which is here greater than in the other joints of the fingers. The depressions on the sides of the heads of these phalanges, are more marked towards the dorsal surface, fig. 59, where the bone is, as it were, bevelled off, so as to permit the lateral slips of the extensor tendon, which divides as it passes these joints, to slide easily asunder when the joints are flexed.

The *second* phalanges, in all cases shorter and more slender than the first, differ from them essentially, in the form of their proximal ends, which, instead of being oval cups, have two shallow depressions, one on each side, and a median longitudinal ridge, by means of which they are adapted accurately to the condyloid and trochlear articulating surfaces on the lower ends of the first phalanges. The joints thus constructed resemble miniature knee-joints, and form very complete hinges, having, as just stated, an extremely free movement of flexion. Besides lateral prominences for the ligaments, these bones have each, at the upper end of their dorsal surfaces, a little tubercle, for the insertion of the median slip of the corresponding common extensor tendon. Their distal ends display small trochlear and condyloid surfaces, like those on the distal ends of the first phalanges, but on a smaller scale, with the groove and prominences less pronounced, and not prolonged so far on the palmar aspect. The sides of the lower ends of the phalanges are not so markedly bevelled, nor are the lateral prominences for the ligaments so large. On the inner borders of the lateral ridges on the palmar aspect of the shafts of the second phalanges, intended for the attachment of the sheaths of the flexor tendons, are two rough longitudinal lines, for the insertion of the slips of the bifurcated tendon of the flexor sublimis digitorum muscle.

The *last*, or *ungual* phalanges, the third in the fingers, but the second, numerically, in the thumb, which, however, has no proper second phalanx, are, again, shorter and more slender than the second, and have very tapering shafts. Their upper ends articulate, by means of a surface having two very shallow depressions and an intervening ridge, with the condyloid and trochlear surfaces on the lower ends of the bones of the previous row, forming hinge-joints, with, however, much less range of motion in the palmar direction. The introduction of hinge-joints at the two interphalangeal articulations, renders the action of the entire finger very determinate, whilst the ball-and-socket joints at the bases of the first phalanges, permit of a great range of motion at the tip of each. Near the distal end, the dorsal surface of the last phalanges becomes elevated and convex, for the support of the matrix of the nail; and quite at their extremities, on their somewhat flattened palmar aspect, they each present a semi-lunar or horse-shoe-shaped rough eminence, fig. 58, reaching backwards, in the form of two little horns, for the support of the fibrous and other structures, which form the pulp of the finger. On the dorsal aspect of the upper end of these phalanges, is a small tubercle, for the insertion of the final slip of the extensor tendon; and on their palmar aspect, a transverse roughened surface, for the insertion of the deep flexor tendon. The ungual phalanx of the thumb, is both the longest and broadest of the series; it resembles the others in its form and uses, but it has the tendon of the extensor secundi internodii pollicis inserted into its dorsal surface, and that of the flexor longus pollicis into its broad, palmar surface. In the fore-finger and little finger, tendinous slips from their proper extensor muscles, are attached, with the common extensor tendons, to the second and third phalanges.

The first phalanx of the middle finger is the longest, next that of the fore-finger, then that of the ring-finger, and, lastly, that of the little finger. In the case of the second and last phalanges, the order of diminution is so far changed, that these bones are rather longer in the ring-finger than in the index-finger; but the middle and little fingers still show the longest and shortest bones. The entire ring-finger, however, is as long as, and usually longer than, the entire fore-finger. As to the apparent length of the fingers, as indicated by the position of their tips when the hand is fully extended, this depends on a double condition, namely, on the length of the finger itself, and on that of the corresponding metacarpal bone, a point which has been generally overlooked in discussions of the question. In this way, although the middle finger is always not only the largest but the longest, and the little finger is the shortest, and, as a rule, the tip of the ring-finger reaches lower down than that of the index-finger, yet, in many cases, the latter projects beyond the former, owing, mainly, to the second metacarpal bone being of unusual length. The apparent lengths of these two fingers may vary in the two hands. The first phalanx of the thumb is longer than that of the little finger; the last phalanx is longer than that even of the middle finger; the great width of both is their special characteristic.

The Hand as a Whole.—The bones of the hand are constructed and put together, so as to secure a combination of lightness, strength, elasticity, and grasping and holding power, with great mobility. The uses of the hand are singularly augmented by the pronation and supination movements of the radius, by the extreme movement of flexion at the elbow, and by the remarkable freedom of the shoulder-joint.

The lightness, the tapering form forwards, and the relatively smaller total size of the hand, as compared with the weight, increasing width forward, and great mass of the foot, are very striking. The slightness of the longitudinal and transverse *palmar arches*, compared with the arches of the foot, is also obvious. The hand measures only about one-tenth, and the foot about a sixth part of the length of the entire skeleton. This diminution in size affects, however, only the hinder portion of the hand, that is, the carpus, the bones of which are all much smaller than those of the tarsus; and, moreover, it is in the proximal part of the carpus, namely, in the semi-lunar and cuneiform bones, which represent the very large astragalus and the still larger os calcis, that the most marked relative diminution occurs; the part of the hand, indeed, which corresponds with the heel, is almost suppressed. The small size of the carpus, as compared with the tarsus, is noticeable, not only in its comparative narrowness and thinness, but in its reduced length; for it occupies only about one-sixth part of the entire hand, whilst the tarsus comprises nearly one-half the length of the foot. This leaves, as it were, more material to be disposed of in the construction of the middle and anterior parts of the hand. Of this, the metacarpus takes about two-fifths, and the phalanges, as measured on the middle or longest finger, about the remaining three-fifths; whereas in the foot, the lengths of the middle and anterior parts, or metatarsal and phalangeal portions, are in the reverse ratio of three to two. Whilst, therefore, the middle point of the foot corresponds with the anterior border of the tarsus, the middle of the hand is very nearly as far forwards as the lower end of the metacarpus.

Surface-forms dependent on the Bones of the Hand.

The outer border of the carpus is short, and sunk in between the styloid process of the radius and the base of the first metacarpal bone, at the root of the thumb, and is bridged over by the straightened tendons of the extensors of the thumb. The inner border is somewhat prominent, and more nearly subcutaneous, the projecting unciform bone being especially so. The back of the carpus is covered by the numerous extensor tendons, but its slight general convexity determines that of the entire wrist. Traced from side to side, the most prominent part of the wrist is not along the middle line, but nearer to the radial border, in a line with the prominences produced by the scaphoid, trapezoid, and second metacarpal bones, so that the curve of the convexity falls suddenly towards the root of the thumb, but gently towards the root of the little finger. Followed from above downwards, the posterior bend of the wrist is rounded off, by the intervention of the transverse carpal articulation between the first and second rows of the carpal bones. In front, the wrist presents two subcutaneous eminences, one larger and flatter, due to the scaphoid tuberosity and the prominent oblique ridge of the trapezium, just above the root of the thumb, and, the other smaller but more prominent, caused by the pisiform bone, which may be named the *pisiform eminence.* The other bones, including even the trapezoid, the os magnum, and the large unciform process, are covered and thoroughly concealed, by the annular ligament, beneath which the flexor tendons pass, and also by the origins of the short muscles of the thumb and little finger. If the hand be placed downwards, and flat on a table, with the fore-arm nearly vertical, the resemblance of the several parts to the corresponding ones of the foot, will become evident. On then looking at the radial border of the wrist, owing to the small size of its component bones, to the overlapping of the radius on the one hand, and of the ball of the thumb on the other, as well as to the shortness of the thumb, as compared with the great toe, the likeness is obscured; but on looking at the ulnar border, it will be at once perceived that the form produced by the pisiform eminence, situated close to the root of the little finger, may be regarded as the *heel of the hand.* It constitutes a remarkably fixed point, in spite of all possible changes in the position of the hand itself; it is, of course, smaller and more pointed behind, than is the heel in the foot, but the palm of the hand spreads out from it, just as the sole does from the heel, the forms due to the thumb being quite independent. Moreover, let the hand be moved in any direction, the pisiform eminence remains always a determinate and easily recognisable guide-point, to which all the more changeable forms of the palm may be referred.

The *back* of the hand, like the bony metacarpus itself, is convex from side to side. The dorsal surface of the fifth metacarpal bone is almost entirely subcutaneous, but the others are covered on this aspect by tendons, even near their lower ends, and are scarcely visible, except in thin hands; they may even correspond with depressions, in fleshy and fat hands. The *eminence* on the base of the third metacarpal bone, is, frequently, very perceptible under the skin; but this, like other prominent forms dependent on bony processes, if too strongly marked, constitutes a departure from beauty, though it may confer a character of strength upon the hand. The heads of the metacarpal bones, which support the fingers, form the first row of knuckles, of which that belonging to the middle finger is usually the most prominent, that of the index-finger the next, then those of the fourth and fifth, the last being the least marked. The prominences of these knuckles, as well as those of the subsequent rows, are invariably formed by the distal ends of the proximal bones at each joint, and not by the proximal ends of the distal bones. Hence, when the fingers are bent, the first row of knuckles, like the heads of the metacarpal bones which form them, are always more or less rounded in their contour; the second row of knuckles, formed by the condyloid and trochlear distal ends of the first phalanges, have a nearly flat or square transverse outline, when the fingers are slightly flexed, but are even hollowed or concave, when the fingers are much bent, a form which is in strict accordance with the grooved shape of the trochleæ of these little joints, and with the extreme amount of flexion possible at them; lastly, at the third or last row of knuckles, the transverse contour, when the joints are flexed, is flat, or very slightly hollowed, the trochlear grooves here being feebly marked. When the fingers are extended, all these joints are marked by depressions; those over the heads of the metacarpal bones are oval, and form elongated dimples in well-nourished hands; those over the interphalangeal articulations, are marked by transverse crescentic folds of the skin.

The digital phalanges being, like the femur and the humerus, single long bones and free all round, more or less govern the general form of the fingers, giving to the first and second segments of the several digits, their slightly curved form from their base forwards, and, to the last segments, their peculiar shape as far down as the nails. The influence of the form of these bones, is especially apparent along the back of the fingers, over the dorsum of each phalanx, and, more particularly, at the back of the second phalanges, the little tubercles near the bases of which, also very frequently show as slight but special eminences, not to be detected on the first or third phalanges.

In the hollowed palm of the hand, the four inner metacarpal bones are completely concealed by muscles, tendons, and fascia; but, nevertheless, the exact position of the heads of those bones, can be detected by the presence of corresponding eminences, of which, the second, third, and fifth are more obvious than the fourth, which corresponds with the ring-finger. In fleshy hands, however, these eminences are converted into depressions, especially when the fingers are approximated; they are necessarily plainer when the palm is spread out flat, and disappear when it is curved or hollowed. On the palmar aspect of the fingers, the bony forms are entirely obscured.

As to the thumb, the base of the metacarpal bone projects considerably beyond the trapezium, and forms a well-marked prominence, a short distance below the styloid process of the radius; from this point, the broad back of this metacarpal bone is covered only by tendons, and its lower end, with its lateral tubercles, gives rise, at the first knuckle of the thumb, not to a rounded contour, like the heads of the other metacarpals, but to a flattened one, with two projecting little knobs at each side. On the palmar aspect, the bone is completely concealed, but the outer sesamoid bone forms a prominent point. The phalanges determine the general forms of the free portion of the thumb; the second or last knuckle of the thumb, has, when bent, a deeply excavated contour, in conformity with the strongly marked condyloid and trochlear form of the head of the first phalanx, which constitutes the prominent part of this joint.

The Bones of the Cranium.

The cranium consists of the occipital, the two parietal, the frontal, the two temporal, the sphenoid, and the ethmoid bones. Of these bones, the occipital, parietals, temporals, and frontal, are relatively large in man.

The Occipital Bone.—The *occipital bone* or *occiput*, figs. 61, 62, O, may be first described, as it is the lowest bone of the cranium, by which the head is joined to the neck. As its name implies, it is not only the lowest, but the *hindmost* bone of the cranium; yet it forms a very large portion of the under surface or base, and only a small part of the back of the skull. It is shaped somewhat like an ovate leaf, bent on itself, and having its narrow or stalk end turned forwards almost horizontally into the base of the cranium, and its broader, expanded part, directed nearly vertically upwards, and a little backwards, in the occipital region. Its concavity is, of course, turned towards the interior, and its convexity towards the exterior of the skull. It is the outer surface of this, and of the other cranial and facial bones, that will almost exclusively occupy attention here. The numerous foramina in the base of the skull, for blood-vessels and nerves, need not be described. Along the line where the horizontal and vertical portions of the occipital bone meet, is a strongly marked, curved ridge, the *superior curved line*, figs. 61, 62, *l*, which extends right and left, and presents, in the middle line, the prominent *occipital protuberance*, figs. 61 *e*, 62, O.

The *horizontal* portion of the bone, below and in front of the curved line and the occipital protuberance, is concealed by the muscles of the neck, and does not influence the surface forms; but, nevertheless, it must be described as forming the part of the cranium which articulates with the first cervical vertebra. In it, is the *foramen magnum*, *f*, a large, oval aperture, with sloping margins, having its long axis directed from before backwards, and its plane nearly horizontal, which leads upwards into the cranial cavity, corresponds with the vertebral canal, below, and gives passage to the spinal cord, as this passes down from the brain. On the sides of the foramen magnum, are

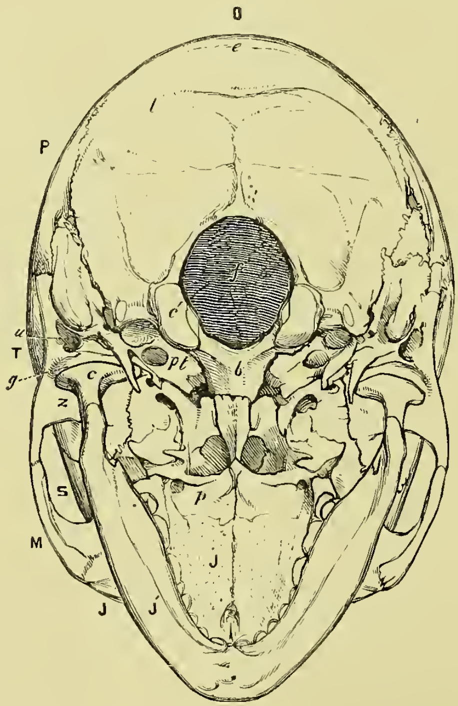


Fig. 61.—The Base of the Skull. O, occipital bone; *b*, basilar process; *c'*, left occipital condyle; *c*, occipital protuberance; *f*, foramen magnum; *l*, superior curved line. P, left parietal bone. T, left temporal bone; *g*, glenoid cavity; *pt*, petrous portion; *u*, auditory foramen; *z*, zygomatic process. S, part of left wing of sphenoid bone. M, left malar bone. J J, left superior maxillary bone. *p*, left palate bone. J', lower jaw bone; *c*, left condyle.

the right and left *occipital condyles*, *c'*, articular processes, which are received into, and rest upon, the two cup-shaped upper articular surfaces of the atlas. Like these surfaces, the occipital condyles are ear-shaped, being slightly incurved on their inner, and rounded on their outer, border; they are situated nearer to the front of the foramen magnum, and converge slightly forwards. Their under surfaces, smooth and convex from before backwards, are not horizontal from side to side, but slope downwards and inwards, the outer border being less prominent than the inner one, so that the plane of the surfaces is turned downwards and outwards. They are longer from before backwards than the cup-shaped cavities of the atlas, so as to ensure great play with security of movement, in the nodding motions of the head ; behind each condyle, is a depression in the occipital bone, into which the hinder border of the corresponding articular process of the atlas is received, in the backward movement of the head. Close to the inner border of the condyles, there are rough surfaces, for the attachment of the cheek ligaments, which pass up from the odontoid process of the axis.

To the outer side of each condyle, the occipital bone is extended, like the transverse process of a vertebra, to form the *jugular eminence,* the under rough surface of which, gives attachment to the rectus capitis lateralis muscle. In front of the foramen magnum, the occipital bone is prolonged into a narrow stalk-like process, which may be compared with the body of a vertebra, and ascends a little, as it passes forwards. This is the *basilar process, b,* which, in the adult cranium, joins the sphenoid bone in front, by complete bony union, and gives attachment, on each side of the median line, to the two anterior recti capitis muscles, as well as to the pharynx.

Behind the foramen magnum, in the middle line, is the *occipital crest or spine,* which resembles the spinous process of a vertebra, and extends backwards, as far as the occipital protuberance, at the middle of the superior curved line already mentioned. Between this line, *l,* and the foramen magnum, on each side, is another nearly parallel curved line, the *inferior curved line.* Besides these lines, which represent thickened parts of the occipital bone, there are two short ridges passing from the condyles to the jugular eminences, and two others, on each side, extending from the same parts to the front and back of the foramen magnum. All these ridges serve to strengthen the bone, where it has to bear weight and shock. Some of them, together with roughened surfaces between them, also give insertion to numerous muscles, which are symmetrical on the two sides. Thus, to the inferior curved line, and to a small portion of the bone in front of it, are attached the recti capitis postici, major and minor ; above and to the outer side of these, between the curved lines, is fixed, on each side, the obliquus capitis superior ; between the two curved lines, also on each side, are attached next to the median line, the complexus, and, further outwards, a portion of the splenius capitis ; above that, to the superior curved line, the sterno-cleido-mastoid muscle. The occipital protuberance affords attachment, in the middle line, to the slight ligamentum nuchæ, and on each side, as well as on the inner third of the superior curved line, to the trapezius muscle ; the outer half or two-thirds of that line gives origin to the occipital portion of the corresponding occipito-frontalis muscle, the middle part of its tendon, or epicranial aponeurosis, being attached to the occipital protuberance and the superior curved line between the muscles.

The nearly *vertical* portion of the occipital bone, fig. 62, above the superior curved line, is smoother and nearly subcutaneous, being only covered by the thin occipito-frontalis muscle, and the rest of the scalp. It inclines upwards and somewhat backwards, and forms only a small part of the back of the cranial vault. The occipital protuberance, which bounds it below, is the thickest part of the bone, and, indeed, of the whole skull. It is the part which strikes the ground, on falling backwards. It has no direct relation with either the cerebellum or the cerebrum; for the former corresponds with the concealed horizontal part of the bone, below the protuberance and the superior curved line, whilst the cerebrum is placed above these parts. The protuberance, therefore, is situated between them, and does not indicate any special local development of either.

As already stated, the occipital bone is articulated with the atlas, below, and united solidly by bone, in front, with the sphenoid bone; its sides are connected by rough edges with the petrous and mastoid portions of the temporal bones, and its sinuous upper border by a thick indented edge with the two parietals. Like the broad portions of the other cranial bones, it is composed of an outer and an inner layer of compact tissue, named *tables*, connected by intermediate, cancellated tissue, known as the *diploë*; the inner table, from its appearance, hardness, and brittleness, is called the *vitreous table*. At the occipital protuberance, and in the thickest parts of all the flat cranial bones, the two tables are thick, wide apart, and have much cancellated tissue between them. In the thinner parts of these bones, as, for example, in the so-called fossæ, the diploë is scanty, and the two tables nearly touch each other.

The Parietal Bones.—Situated upon the two *sides* and the summit or *vertex* of the cranium, are the two broad *parietal* bones, figs. 61, 62, 63, P. Each of these is quadrangular in shape, convex on the outer, concave on the inner surface, and bent along its antero-posterior diameter, so that it consists of an almost vertical part, which forms a large portion of the side of the cranium, and of a more horizontal part, which forms a large portion of the cranial vault or roof.

Like the occipital bone, each parietal has one portion more thickly, and another less thickly covered by soft structures, and these are also separated from each other by a *curved line*, figs. 62, 63, *l*; moreover, it has a special *eminence* upon it. This *parietal eminence*, •, is situated a little below, and in front of the centre of the bone; it is not indicative of the existence of any special organ in the brain, although extreme width of the cranium opposite to those eminences, must be associated with a corresponding shape of the cerebrum. It is the seat of the primitive ossifying centre, from which each parietal bone has grown in all directions, and which always, more or less, retains its prominence with regard to the rest of the bone; it is the thickest, and strongest part of the bone. A short distance below this eminence, the curved line just mentioned, forming part of the *temporal ridge*, arches from before backwards across the bone; below it the parietal bone forms a part of the temporal fossa, and is covered first by the temporal muscle, to which it gives partial origin, and, over that, by the temporal fascia, which is itself attached along the curved line; above and behind the line, the bone is covered only by the expanded tendon or aponeurosis of the occipito-frontalis muscle.

The posterior borders of the two parietal bones, somewhat sinuous, are connected by thick and deeply indented edges with the occipital bone; the superior borders, straight, are joined to each other by serrated edges, along the middle line at the vertex of the skull; the anterior borders, which are slightly incurved, are united, by a finely serrated edge, with the frontal bone; and the lower border of each, by thin and bevelled edges, with the sphenoid bone and with the flat part of the temporal bone, and, further back, by thick rough edges, with the mastoid part of the latter bone.

The outer and inner tables of the parietal bones are nearly equidistant all over, but are somewhat more separated opposite the parietal eminences, where the tables are thicker, and the diploë is more abundant.

The Frontal Bone.—The *frontal* bone, figs. 62, 63, F, like the occipital, is, in the adult, a single median bone. It completes the fore-part of the skull, constitutes, as its name implies, the portion of the cranium corresponding with the *forehead*, forms the root of the nose and the upper border of the orbits or eye sockets, and, lastly, sends backwards two bony plates, which form the roofs of those cavities, and part of the base of the cranium.

The *orbital plates*, fig. 63, entirely removed from the surface, are thin, concave on the under surface, and arch over the orbits; between them, and seen only inside the cranium, is an interval into which the ethmoid bone is fitted. In front of this, a process, named the *nasal spine*, projects deeply, downwards and forwards, from the median portion of the bone towards the nose.

The frontal portion of the bone, or *frontal plate*, is convex and quite smooth in its upper part, and exhibits, on each half of the bone, like the separate parietal bones, a curved line, which marks off a more covered from a less covered portion, and also a special bony eminence. It likewise possesses other eminences, ridges, and processes; its fore-part is sometimes named the *sinciput* (*semi*, half; *caput*, the head).

The *curved lines* of the frontal bone, figs. 62, 63, *l*, are seen one on each side, above the temples; they form the anterior portion of the *temporal ridges*, fig. 62, *l*, *l*, limit the temporal fossæ in front, and became continuous backwards, with the portions of those ridges situated on the parietal bones;

they serve, on each side, for the attachment of a part of the temporal fascia, the concealed part of the bone below them giving partial origin to the corresponding temporal muscle. In front, fig. 63, the temporal ridges terminate at the two very pronounced *external angular processes*, which pass downwards and outwards on the outer side of the orbits, and join, by a thick indented edge, the corresponding malar bones, or cheek bones, M, and so form bonds of connexion between the cranium and the face. Commencing at the external angular processes, and curving inwards, over the orbits, towards the root of the nose, are the two strongly marked *supra-orbital ridges or arches*, which form the upper margins of those sockets; the outer end of each arch, is very pro-

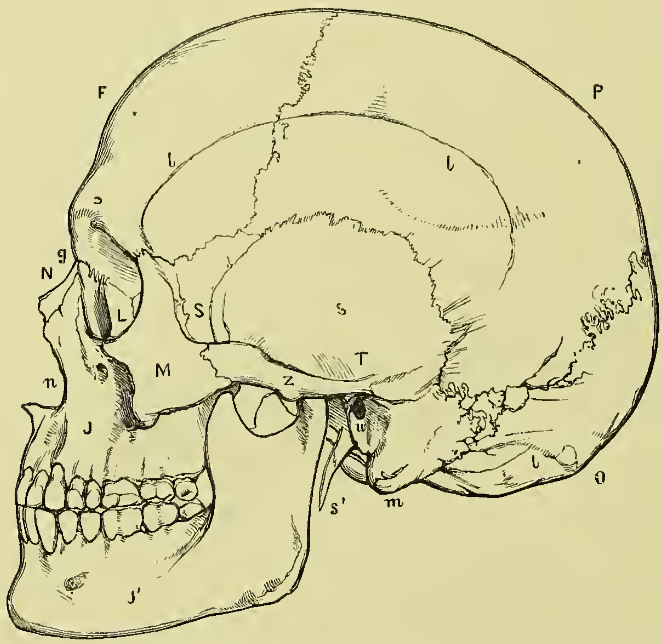


Fig. 62.—Left side of the Skull. O, occipital bone; *l*, superior curved line. P, parietal; *l*, temporal ridge; •, parietal eminence. F, frontal; *c* for *c*, superciliary eminence; *g*, glabella; *l*, temporal ridge; •, frontal eminence. T, temporal; *m*, mastoid process; S, squamous portion; S′, styloid process; *u*, auditory foramen; *z*, zygoma. S, great wing of sphenoid. L, lacrymal bone. M, malar bone. N, nasal bone. J, upper jaw bone. *n*, nasal notch. J′, lower jaw bone.

minent and sharp, but the inner end gradually subsides into a broad and smooth border; a small notch or foramen at the upper part of each, transmits a nerve. The inner ends of these arches, on the sides of the root of the nose, form the *internal angular processes*, which are much less prominent than the external processes. Between them, is the broad surface which assists in forming the root of the nose, and which, inclining backwards, produces here an indentation, of greater or less depth in different skulls, best seen in profile. Above this indentation, in the middle line, is the broad, somewhat triangular smooth surface, named the *glabella*, *g*. The lower edges of the internal angular processes are connected with the lacrymal bones, fig. 62, L, and with the upper jaw-bones, J. The intermediate indented part below the glabella, sometimes named the *nasal notch*, supports the two small nasal bones N, the deep-seated nasal spine also serving to sustain them. On each side of the glabella, is the *nasal eminence*, passing from which, upwards and outwards, a little above the inner half of the supra-orbital arch, and separated from it by a slight flattening of the bone, is an oblique, slightly curved, smooth ridge,

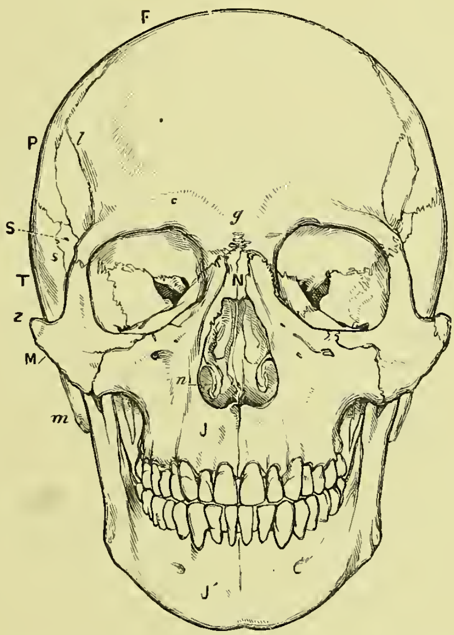


Fig. 63.—The front view of the Skull. References the same as in Fig. 62.

larger and more prominent internally, and subsiding gradually as it passes outwards, known as the *superciliary eminence*, figs. 62, 63, *c*.

These nasal and superciliary eminences of the two sides, correspond with large subjacent cavities situated in the substance of the bone, named the *frontal cells or sinuses*. These sinuses, one in each half of the bone, are of considerable interest; they are formed by the separation of the outer and inner tables of the frontal bone, and by the substitution of spaces containing air, in place of the diploë, the cavities thus formed communicating with corresponding sinuses in the ethmoid bone, and these again with the interior of the nose, so that air can pass, from without, into the whole series of sinuses. They are lined by a mucous membrane, which is continuous with that of the nasal cavities. One use of these sinuses, is to perfect the resonance of the voice; for, when they are obstructed, that resonance is diminished, and the vocal sounds are 'damped' in the head, the sensation being felt by the individual concerned, as well as being noticeable by others. There are similar air-cavities in the cranial or other bones of animals, which lighten the portion of the skeleton, in which they occur, as is most obvious in the case of the long bones of birds of powerful flight. But, in the cranium, they accompany modifications of the bony framework for mechanical purposes, and this is the true explanation of their existence. Extreme examples are met with in the elephant, and the toucan, in which the enormously expanded frontal and other sinuses, enable the cranium to support sufficiently large facial bones, whereon may be carried the heavy tusks of the one, and the huge bills of the other. In man, likewise, these expansions of the frontal bone, undoubtedly serve the mechanical purpose of increasing the anterior projection of the base of the cranium, for the attachment of the subjacent facial framework, and especially of that part of it which belongs to the nose, and to the inner border of the orbit, so as to form a broader base of support to the ascending part of the upper jaw-bone, through which pressure is exercised in mastication. Their cons ant relation to the size of the face, is shown by many facts. Thus, they are absent in early life, when the face is relatively small, the jaws are feeble and without teeth, and the nose is less prominent; they begin to be developed first, when the features commence to expand; they are smaller in women than in men, in whom, the features are larger and more prominent, every part of the bony framework of the face, including the upper and lower jaws, being of greater size; they diminish in old age, when the face and jaws also waste; and, lastly, they are small, or, in some instances, absent, even though there be slight external eminences, in certain races, in which, as in the Australians, the face and nose are very diminutive. They can have no special relation to any local development of the cerebrum, but they vary exceedingly in size and prominence in different individuals, being, as a rule, larger, and more marked, in powerfully built men. In advanced life, the glabella sometimes becomes relatively prominent, probably owing to the subsidence of the nasal and superciliary eminences. Without much external prominence, the cavities of the frontal sinuses may be large, in old age, in consequence of the inner table of the skull receding as the brain wastes.

Somewhat below the middle of each half of the *exposed* portion of the frontal bone, above the *superciliary* eminences, and separated from them by a slight furrow, are the proper *frontal eminences*, . . These correspond with the two centres of ossification of the bone, which remain more or less prominent, even when the bone has grown to its full size. They are therefore quite similar in nature to the parietal eminences already described, and have no direct cerebral signification. As a rule, the development of the entire frontal bone coincides, generally, with that of the anterior lobe of the cerebrum; yet it may occur, that, owing to an unusual development of the superciliary eminences and supra-orbital arches, a visibly slanting forehead may conceal a large frontal cerebral lobe; or this may even, in some cases, be, as it were, pushed back, though not reduced in size. The frontal eminences not only vary very much in different individuals, but, in opposition to the law of symmetry, are often unequally developed on the two sides. This is also true of the parietal and occipital bones.

In early life, the two halves of the frontal bone are distinct, each having its own ossific centre; but, in the process of growth, these meet along the middle line, and there form a vertical serrated junction, which commonly becomes completely obliterated, its seat being sometimes indicated by a slight median ridge. In a certain number of cases, traces of it remain throughout life.

The posterior convex border of the frontal bone joins the two parietal bones; it is also connected in the temporal fossa, on each side, with a small portion of the sphenoid bone.

Besides the two temporal muscles, which partly cover the sides of the frontal bones, the orbicular muscles of the eyelids, and the corrugators of the eyebrows, are attached near the margins of the orbits. The fore-part of the bone is covered by the frontal portion of the right and left occipito-frontales muscles, the expanded aponeurosis of which overlies the upper part of the bone.

The Temporal Bones.—These bones, figs. 61, 62, 63, T, two in number, and symmetrical, are situated on the sides of the cranium, at and behind the temples, where they fill up a semi-circular space left between the occipital, parietal, and sphenoid bones; they, also, project obliquely inwards and forwards, into the base of the cranium; moreover, they give off one process, which descends behind the ear, and another, which passes forwards towards the cheek.

The shape of each temporal bone is, therefore, very complicated. It consists of four parts, named the *petrous*, *squamous*, *mastoid*, and *zygomatic* portions, which meet, around an oval aperture, the *external auditory foramen*, figs. 61, 62, *u*, leading into a canal named the *external auditory meatus*, or *ear passage*. This canal penetrates deeply into the *petrous portion* of the temporal bone, so named, from its hardness (πέτρα, a rock), which passes, in the form of a long narrow wedge, into the base of the skull, fig. 61, *pt*, where it fits closely in, between the occipital and sphenoid bones, and contains the essential parts of the organ of hearing, to which the meatus leads. The opening of the meatus is surrounded by a bony lip, the lower end of which is named the *auditory process*; to this, the cartilage of the external ear is firmly attached. Beneath and to the inner side of the auditory process, the long slender pointed *styloid process*, fig. 62, *s'*, projects, obliquely downwards, forwards, and inwards, into the neck; it gives origin to three suspensory muscles, the stylo-pharyngeus, stylo-glossus, and stylo-hyoid muscles, which descend to the pharynx, the tongue, and the hyoid bone; from it also, two ligaments, the stylo-hyoid and stylo-maxillary, pass down to the hyoid bone and to the lower jaw. The *squamous portion*, *s*, of the temporal bone, placed above the auditory meatus, is continuous, below, with the narrow petrous portion, but expands, above, into a thin, flattened, semicircular, scale-like piece of bone (*squama*, a scale), which is adapted above, by means of a thin overlapping edge, to the bevelled and thin lower border of the parietal bone, P, and in front, by a thicker bevelled edge to the sphenoid bone, S; behind and below, it becomes continuous with the mastoid portion of the bone. The squamous portion is smooth, slightly convex, and forms the chief portion of the floor of the temporal fossa, from which the temporal muscle arises. A strong curved ridge passes obliquely backwards upon the lower part of the squamous bone, which is continuous with the curved temporal ridge, *l*, on the parietal bone, and here marks the boundary of the temporal fossa. Below the curved ridge on the temporal bone, a small part of the squamous portion is subcutaneous.

Immediately behind the auditory foramen, and continuous, above, with the squamous portion, is a conspicuous, nipple-shaped mass of bone projecting downwards, the *mastoid* process, *m*, (*μαστός*, breast). This is convex and somewhat pointed at its apex, but widens out, upwards and backwards, at its base, to form the *mastoid portion* of the temporal bone, which fits in between the occipital and parietal bones, being joined to them by rugged surfaces and serrated edges. The mastoid process contains a number of open spaces, the *mastoid cells*, which communicate with the cavity of the drum of the ear, and act as reinforcing chambers for sound. Like the frontal sinuses, the mastoid cells necessarily lighten the bony skull; and their chief mechanical use is to increase the size, without adding to the weight of this part of the temporal bone. To this process, are attached certain muscles concerned in moving the head upon the neck, namely, the trachelo-mastoid, and portions of the splenius capitis and of the well-known and large sterno-cleido-mastoid muscle. The surfaces of attachment, and the points of leverage of these muscles, are hereby much increased. Accordingly, the mastoid processes reach their utmost development in the adult; they are larger in men than in women, larger in finely developed races and individuals than in those of slender form and stature, very small in childhood, and scarcely recognisable in the infant. The cells in their interior do not appear until the approach of puberty. On the deep surface of the process, fig. 61, is a groove, named the *digastric fossa*, for the origin of the digastric muscle; a small slip of the occipito-frontalis muscle arises from it behind; where it joins the squamous portion, it gives rise to the retrahens aurem muscle. The most prominent outer part of the mastoid process is subcutaneous.

In front of the auditory foramen, and jutting, at first outwards and then forwards, from below the curved oblique line on the squamous portion of the bone, is a flattened process, named the *zygoma* (ζύγωμα, a band) or *zygomatic process*, *z*, which, becoming more slender, passes nearly horizontally forwards, to join, by an overlapping sinuous and slightly jagged edge, the hinder portion of the corresponding malar bone, M. In this way, it forms a sort of flying buttress or free arch, called the *zygomatic arch*, which serves here to connect the bones of the cranium and face. The temporal muscle passes down on the inner side of this arch, to reach the lower jaw bone, the muscle moving freely under it, and playing posteriorly, in a deep channel formed on the upper surface of the broad base of the zygoma. The upper thin free border of the zygoma forms part of the margin of the temporal fossa, which, in front of this, is limited by the hinder border of the malar bone; and, as already stated, in the rest of its extent, in front, above, and behind, by the curved temporal ridges, traceable continuously on the frontal, parietal, and temporal bones back to the root of the zygoma again, fig. 61. The strong temporal fascia is attached to this border of the zygoma, as well as to the other parts of the margin of the fossa. The outer and convex surface of the zygoma is subcutaneous, the lower border and the inner surface give attachment to the masseter muscle.

The base of the zygoma, spreading out widely and horizontally from the squamous portion of the bone, is attached to it by three ridges, called *roots*; one of these is continuous backwards with the temporal ridge already described; the two others pass directly inwards, and being connected by a concave plate of bone, form the roof and anterior and posterior borders of the outer part of a shallow fossa, named the *glenoid cavity*, fig. 61, *g*, the inner part of which, extends beneath the squamous portion of the bone. It is oval, with its longest diameter directed inwards and backwards, so that a line continuous with it, would, if prolonged, impinge on the anterior margin of the foramen magnum. This is the socket for the corresponding condyle of the lower jaw, the long axis of which condyle has a similar direction; in the joint between them, is an inter-articular fibro-cartilage. The anterior part alone of the glenoid cavity is articular; it presents a thick and rounded border in front, named the *eminentia articularis*. The hinder non-articular part of the cavity is marked off from the fore-part by a transverse fissure, the *Glaserian fissure*, which indicates a primitive separation between the squamous and petrous portions of the temporal bone. This part of the cavity, is filled by a small piece of the parotid gland; its inner and posterior wall is formed by the *vaginal* process, a plate of bone so called, because it ensheaths the styloid process already mentioned. A small tubercle beneath the root of the zygoma in front of the glenoid cavity, gives attachment to the external lateral ligament of the articulation of the lower jaw.

The Sphenoid Bone.—The *sphenoid* bone, figs. 61, 62, 63, S, is a single bone, *wedged* in between the other cranial bones, across the base of the skull; it also enters into the formation of the nasal and orbital cavities; and it is seen on the sides of the skull, fig. 62, S, at the deepest part of both temporal fossæ. It is everywhere completely removed from the surface. This bone is shaped something like a bat, with the wings opened out; but besides a body, it has two wing-like expansions, on each side, and two processes projecting downwards from it, like legs. It is a most complicated bone, connected with all the other bones of the cranium, and also with five of the bones of the face. Anatomically, it is of great interest; but, for the artist, a very brief description of it will suffice.

Its thick and strong *body*, fig. 61, is, in the adult, solidly continuous behind, with the basilar portion of the occipital bone, fig. 61, *b*. In front, the bone is hollowed out, so as to increase its surfaces, without adding to its weight, by the formation of air cavities. It here joins the ethmoid bone, completes the base of the skull, and serves to support the septum of the nose. Its two wings enter into the orbits, where they join the frontal and malar bones, and give origin to the levator palpebræ, and five muscles of the eye-ball. The outer ends of the greater wings appear in the temporal fossæ, fig. 62, S, where they are interposed between, and joined with the frontal, parietal, and the squamous and petrous portions of the temporal bone. A horizontal ridge here divides a surface of origin above, for the temporal muscle, from one below, for the external pterygoid muscle.

Sometimes, the greater wing of the sphenoid bone, on one or both sides of the skull, does not extend far enough backwards to reach the parietal bone; in this exceptional condition, the frontal bone and the squamous portion of the temporal bone touch each other. In the base of the skull, the greater wing of the sphenoid is closely fitted in, between the squamous and petrous portions of the temporal bone, and gives attachment to the internal lateral ligament of the lower jaw. The two descending processes of the sphenoid bone, named the *pterygoid processes*, pass down on the outer side of the *posterior nasal openings*, serve to support the two palate bones, and give origin to the external and internal pterygoid muscles, which act upon the lower jaw.

The Ethmoid Bone.—The *ethmoid* bone, is a single, thin, complex bone, which contains the olfactory apparatus, and fills in the base of the cranium, between the sphenoid and frontal bones, above the nose and between the orbits, on the inner walls of which only, is it visible in the dried skull. It assists in forming the bony septum or median partition of the nose, and is connected with the nasal bones, and the vomer or proper median bone of the nose, and also with the lacrymal, superior maxillary, and palate bones. Certain parts of it are very largely developed, in some mammalia.

The Bones of the Face.

Of the bones of the face, the *vomer* or proper bony septum of the nose, and the two *turbinated* bones, are situated in the nasal cavities, within which the edges of both are just visible, fig. 63; the *palate* bones complete the back part of the hard palate, fig. 61, *p*, and also reach the sides of the nasal cavities and the orbits, in which latter, the *lacrymal* bones, fig. 62, L, sometimes named, from their thinness, the *ossa unguis* (*unguis*, the nail), are also seen; to the lacrymal bones, the tendon of the little tensor tarsi muscle of the eyelids is attached. There remain the *malar* bones, the *superior maxillaries*, the *nasal* bones, and the *lower jaw bone*, which actually appear on the outer surface of the bony framework of the face.

The Malar Bones.—The *malar* bones or *cheek* bones, figs. 61, 62, 63, M, are the two thick, irregularly quadrangular bones, which underlie the prominent portion of the cheeks, and which become so plainly discernible in emaciated persons; they also pass backwards, to assist in forming the zygomatic arches, and likewise complete the floor, the outer wall, and the outer border of the orbit.

Each malar bone consists of a central part or *body*, of an *orbital plate*, and of *three processes*, one running upwards, one backwards, and one forwards. The *body* of the bone is prominent on its outer side, where it forms the *malar eminence*, which is broad, unevenly convex and partly subcutaneous; it is crossed by a nearly horizontal ridge, which divides it into a narrower lower surface, giving origin to the two zygomatic muscles and, in front of these, to the levator labii superioris, and a broader upper surface, somewhat depressed, which becomes continuous with the superior process of the bone. This *superior* or *frontal process*, figs. 62, 63, is the broadest and longest of the three; it ascends to join, by a jagged surface, the external angular process of the frontal bone, to complete the outer border of the orbit, and to unite the cranium and the face. This part of the orbital border is incurved, so as, with the depression in the adjacent part of the body of the bone, to increase the range of vision in the outward and downward direction; upon this portion of the malar bone, the orbicularis palpebrarum muscle rests. The *posterior* or *zygomatic process*, fig. 62, is the shortest of the three; it passes backwards, and is bevelled off obliquely, beneath the anterior extremity of the zygomatic process of the temporal bone, which there rests upon it, the junction of the two by a firm jagged suture, completing the malar and zygomatic arch, which here unites the cranium and the face. The *anterior* or *maxillary process*, fig. 63, is the most slender; it consists of a narrow, pointed spike, which passes inwards and forwards, beneath the orbit, of which it helps to form the lower margin, and rests below on the superior maxillary bone, to which it is very strongly joined by a rough surface and a slightly indented edge. The malar bone presents three free borders; a *posterior* border curved like an italic *f*, which forms part of the boundary of the temporal fossa, and has the temporal muscle and fascia connected with it; a very evenly curved *anterior* border, which constitutes about one-third of the orbital margin; and, lastly, an *inferior* border, which forms part of the lower edge of the zygomatic arch, and furnishes attachment to the anterior portion of the masseter muscle. The deeper parts of the malar bone appear in the outer wall of the orbit, and in the fossa beneath the zygoma, where they join the superior maxillary, sphenoidal, and frontal bones.

The Superior Maxillary Bones.—These two large bones, right and left, figs. 61, 62, 63, J, are united in the middle line to form, as their name implies, the *upper jaw*. They are placed almost vertically beneath the frontal bone, except in the Black races. As compared with animals, this position of the maxillary bones is characteristic of man; and so, likewise, is their relatively small size. They support the malar bones on each side, form part of the floor, lower border and inner side of the orbits, have the nasal bones attached to them in front, bound the anterior nasal openings on the sides and below, and support the upper teeth. Behind and within the dental arch, their deeper parts form the fore-part of the hard palate.

The broad central part of each superior maxillary bone, or *body*, is composed of comparatively thin, bony walls, enclosing the *antrum*, (*antrum*, a cave), the largest air-cavity in either the cranium or the face, which communicates, like the other sinuses, with the nasal cavities. The *anterior surface* of the bone, fig. 63, pierced by a foramen for a nerve, is considerably depressed between the prominence of the cheek and the nose, the falling in of the bony surface being concealed by the soft parts in health, but shown in the hollow or sunken cheek of the emaciated face. The deepest part of this depression, the *canine fossa*, is bounded in front by the *canine eminence*, an oblique ridge corresponding with the socket of the canine tooth. At the inner side of this ridge, is the smaller *myrtiform*, or *incisive fossa*, situated above the incisor teeth.

From the body of the superior maxillary bone, four processes extend in different directions, named, the malar, alveolar, palatine and nasal processes. The *malar process*, fig. 63, thick and triangular, juts upwards and outwards beneath the malar bone, to which it is joined by a broad rough surface and sinuous edge, running first outwards, and then downwards; it projects so far outwards, as to reach the lower border of the malar and zygomatic arch. The *alveolar process* is the thickest part of the bone, and is broader behind than in front. Its lower or *dental border* is evenly curved, and the two together, being connected firmly by broad edges along the middle line, form an elongated horse-shoe shaped rim, named the *superior dental arch*, in which the *alveoli* or *sockets* for the upper teeth, are situated. These teeth are, in the adult jaw, eight in number on each side, namely, two *incisors*, one *canine*, two *bicuspids* or *small molars*, and three *large molars*. The situation of the alveoli is indicated by slight ridges and depressions on the surface of the bone, the ridge for the canine tooth, already mentioned, being particularly prominent. The sockets themselves vary in size, depth, and shape, according to the teeth which are fitted into them, being single for the incisor, canine and bicuspid, but subdivided for the triple-fanged molar teeth. In advanced age, the alveolar border undergoes absorption, as the teeth fall out; the alveoli are then obliterated, and the border of the bone becomes thin and solid. The *palatine process* of this bone, fig. 61, J, passes horizontally inwards from the dental border, between the mouth and the nose, and joins with the palatine process of the opposite superior maxillary bone, to form the anterior two-thirds of the hard palate, the hinder third being formed by the palate bones, *p*. In this way, the bony roof of the mouth and the floor of the nose, are completed. The upper concave surface of the palatine process, presents a median longitudinal crest, which, with that on the opposite bone, supports the vomer, or bony septum of the nose. The outer surface of the alveolar border, is covered by the gums, and concealed by the cheeks and upper lips; behind, it ends in the rounded *maxillary tuberosity*, which joins the palate bone; in front, just above the incisive fossa, it is continued beneath the anterior openings of the nose, and completes, by its upper curved border, the lower margin of those apertures. In the middle line, is a little, sharp, curved process, named the *anterior nasal spine*, fig. 62, which, directed forwards, or forwards and a little upwards, and united with a similar process on the opposite bone, assists in supporting the cartilaginous septum of the nose.

The *nasal process*, frequently called the *ascending* or *mounting process*, of the superior maxillary bone, ascends inwards, and a little backwards, between the cavities of the orbit and the nose, and becoming narrower, reaches as high as the internal angular process of the frontal bone, to which its oblique upper border is united by a finely indented edge. Its external surface, directed outwards and a little forwards, and somewhat undulating, is nearly subcutaneous, being covered only by the skin and by the thin orbicularis palpebrarum muscle; it forms the sloping side of the nose, its inner surface entering into that cavity, and coming into contact with the ethmoid and the inferior turbinated bones. The posterior border of this ascending process, curved and sharp below, forms part of the lower and inner borders and walls of the orbit, within which, it joins the lacrymal, ethmoid and palate bones. The anterior border of this process, strongly curved and sharp, bounds a deep *notch*, *n*, having its concavity turned towards the middle line, and constituting the margin of the anterior opening of the nose, to which the lateral nasal cartilage is attached. Lastly, above this notch, the bone is connected by a straight ragged edge with the outer border of the corresponding nasal bone ; hence, the ascending process of the superior maxillary bone, supports and throws forwards the bridge of the nose.

Numerous muscles are connected with the superior maxillary bones. Thus, on each side, from the under border of the malar process, arises a small part of the masseter muscle; from the lateral surface of the alveolar border, one portion of the buccinator; from the myrtiform fossa, in front, the depressor of the ala of the nose; from the anterior nasal spine, some fibres of the orbicularis oris; from the bottom of the canine fossa, the levator anguli oris; above this, the levator labii superioris; and, in front of that, the compressor narium. From the ascending process, arises the levator labii superioris et alæ nasi; from the orbital margin, the tendo oculi, and the orbicularis palpebrarum ; and within the orbit, the inferior oblique muscle of the eye-ball.

The Nasal Bones.—The *nasal bones*, figs. 62, 63, N, two in number, right and left, surmount and complete the anterior openings of the nose above ; they assist in forming the bony framework of the *bridge of the nose*. They are elongated, quadrilateral bones, narrower and thicker above, wider and thinner below, but varying both in width and length in different skulls. They are united, at their upper thicker jagged ends, by a large surface for such small bones, to the frontal bone, just below the glabella. Their outer borders are bevelled, and supported by, and attached to, the ascending processes of the superior maxillary bones. Along the middle line, the inner borders of the two bones are flat, and joined firmly together ; these borders project into the interior of the nose, forming a longitudinal *crest*, which strengthens the bones, and serves to connect them with the nasal spine of the frontal bone, and with the ethmoidal portion of the septum of the nose. Their lower borders are free, thin, and notched, and form the continuous, curved upper margin of the *anterior nasal openings*, the highest part of which is named the *nasal angle* ; in the recent state this margin gives attachment to the lateral cartilages of the nose.

The anterior surfaces of the nasal bones, slightly hollowed above, but convex lower down, are nearly subcutaneous, being covered only by very thin muscles ; they are inclined backwards and outwards from each other, and give shape and character to the corresponding part of the nose. In the lower races of men, the nasal bones are small and flattened, and in the anthropoid apes, they are placed nearly, or actually, in the same plane. The arch which they form, resting on the frontal, ethmoid, and superior maxillary bones, is so strong, that it can bear great weights, and resist most powerful blows.

The Inferior Maxillary Bone.—This bone, the *lower jaw bone*, or *mandible*, figs. 61, 62, 63, J′, is the largest and strongest in the face. Originally composed of two symmetrical halves, it very early becomes a single bone, by the union of these vertically along the middle line, forming the *symphysis*. It is shaped somewhat like a horse-shoe, with the open ends directed backwards and turned sharply up. In regard to length, it is adapted to meet the upper jaw bone; being used only for purposes of mastication and speech, and not for seizing food or prey, both jaws are comparatively short. The thick, solid, horizontal part, which supports the *inferior dental arch*, containing the lower teeth, is named the *body*, and the upturned, flattened ends, the *rami* or *branches*. The under border of the body meets the hinder border of the ramus, on each side, at the rounded *angle*, a very important point in relation to the width and form of the cheek.

The posterior border of each ramus, expands above, chiefly on its inner aspect, into an obliquely placed oblong eminence, named the *condyle*, fig. 61, *c*, (*κόνδυλος*, a knuckle).

The *two condyles*, convex from before backwards, and also from side to side, are received into the glenoid cavities of the two temporal bones, and, with an inter-articular fibro-cartilage, form the temporo-maxillary articulations. The inner end of each condyle, reaches somewhat further back than the outer end, and, as in the case of the glenoid cavities, lines drawn through their long axes, would, if prolonged inwards, meet at an obtuse angle, in front of the foramen magnum. The outer part of each condyle is a little higher than the inner part, and the roof of the glenoid cavity exhibits a corresponding obliquity from without inwards. These two conditions obviously increase the security of the joints; for the oblique position of the condyles, and the inclination of their upper surfaces, must both tend to prevent their lateral displacement. The inter-articular fibro-cartilages greatly facilitate the movements of the joints.

Below each condyle, is a narrow part, named the *neck* of the bone, which is convex behind, but somewhat widened laterally, and presents in front, a small depression for the insertion of the external pterygoid muscle. The neck descends to the ramus, and is placed beneath the outer part of the condyle, which, therefore, projects inwards beyond the ramus. In front of the neck, the upper, sharp concave margin of the ramus, forms the *sigmoid notch*, in front of which, is the laterally flattened, bill-shaped projection, named the *coronoid process*, fig. 62. When the lower jaw is in position, with the condyles in the glenoid cavities, the coronoid processes reach up, under cover of the zygomatic arches, into the zygomatic and temporal fossæ, where the two temporal muscles are attached to them. The leverage which they afford to those muscles, is very advantageous; the coronoid processes, moreover, are nearly vertical in direction, that is, in a direct line with the muscles, whilst the ramus and neck, which support the respective condyles, slant upwards and outwards, towards the glenoid cavities.

The broad, quadrangular outer surface of each ramus, is flattened, and, together with a part of the coronoid process, has the masseter muscle attached to it; the muscle extends to its lower border, and even to the angle of the bone, which is more or less everted and roughened at its margin, thus giving further space for the insertion of that muscle, and increased leverage for its action. On the inner surface of the ramus, the posterior thick border gives attachment to the internal pterygoid muscle; in front of that, is a flat process, for the internal lateral ligament of the jaw, which conceals a foramen for a nerve. Besides certain rough surfaces and strengthening ridges of bone, an *internal oblique line* is seen passing forwards, on the inner surface of the *body* of the jaw, beneath the molar teeth, ending still further forward in the *mylo-hyoid ridge*, fig. 61, which affords attachment to the mylo-hyoid muscle, placed across the floor of the mouth. At the fore-part of this ridge, on the inner surface of the jaw, just behind the chin, are four small tubercles, the *genial tubercles*, (*γένειον*, the chin), two on each side of the symphysis, fig. 61, for the insertion of the genio-hyo-glossus and genio-hyoideus muscles; below these, are two small rough depressions, likewise one on each side of the middle line, for the attachment of the anterior portion of the right and left digastric muscles.

On the outer surface of the lower jaw, continuous with the anterior border of the ramus, is the *external oblique line*, fig. 62, which, commencing as a sharp curved ridge at the base of the coronoid process, quickly subsides as it passes forwards, below the alveolar portion of the bone, towards the chin. Along the middle of this line, the depressor anguli oris muscle is attached; a little above, and in front of it, the depressor labii inferioris; whilst, below the line, near the lower border of the bone, is the surface to which some fibres of the platysma myoides muscle are fixed. The lower border of the body of the jaw, is thick, rounded and very strong; but it becomes thinner near the angle of the bone; it is partly subcutaneous, between the angle and the symphysis. Opposite the symphysis, this border, as seen best in front, is slightly indented, fig. 63, and usually presents a sharp edge, which is continuous, on each side, with the faintly marked end of the external oblique line. Above this edge, is a small, prominent triangular eminence, bounded above by two curved lines, named the *mental eminence*, *mentum*, or *chin*, figs. 62, 63, which is subcutaneous, and forms the projecting part of the chin. Its upper boundary lines meet at a median longitudinal crest, which indicates the position of the *symphysis*, or line of union of the two primitive halves of the bone. In man, the symphysis menti is characteristically vertical; the mental eminence itself may even project beyond it, in well-marked bones. On either side of the symphysis, is a slight depression, named the *mental fossa*, from which the levator menti muscle arises. A short distance outside this, is a foramen for a nerve.

The alveolar portion of the lower jaw, placed above the external and internal oblique lines, is widened, more so behind than in front, to contain, along its horse-shoe shaped border, the nearly vertical sockets or *alveoli*, into which the fangs of the lower teeth are inserted. These alveoli have thicker sides than those of the upper jaw, and, like them, produce slight elevations and depressions on the outer surface of the bone. The lower part of the buccinator muscle is inserted just outside the sockets of the hinder teeth. The teeth, eight in number in each half of the adult jaw, are, as in the upper jaw, two incisors in front, then one canine, followed by two bicuspids or small molars, and completed by the three large molars. The wisdom teeth are the last molars in each jaw. In advanced life, as happens to the upper jaw, the alveoli of the lower jaw become absorbed, the teeth dropping out, so that only the dense lower portion of the bone, above the two oblique lines, remains.

The complete alveolar borders of the upper and lower jaws, form, with the teeth, two parabolic or hyperbolic arches, named the *dental arches*. On comparing them, it is seen that the upper one, being rather deeper, a little more spread out, and less vertical, forms a rather broader and more projecting horse-shoe than the lower one; so that the upper teeth, which, on the whole, are also larger than the lower, project a little beyond them on each side, and decidedly overlap them in front; hence, the lower teeth shut in behind the upper ones. If the edges of the incisor teeth of the two jaws constantly met, they would more rapidly suffer from the effects of attrition. The teeth in man, as distinguished from those of animals, form perfectly continuous rows in both jaws, being of nearly equal height, and without any gaps, or so-called *diastemmata*, between them. Their nearly perpendicular setting is also characteristic, as compared with the oblique direction of the teeth of most animals.

The relative size, position, and individual forms and characters of the front teeth, demand attention, for they are frequently exposed to view, especially during certain emotions. These variations in the size and shape of the teeth, afford a good example of the mode in which organic forms, though repeated, are so differently modelled as to cease to be identical. In art, the repetition of the same form, for all the teeth exposed to view in the laughing mouth, gives this not only a formal, but an inhuman aspect. The four upper incisors are much larger than the four lower ones, and are somewhat less vertical, being inclined more forwards than the lower ones; they are so broad, as to pass nearly as far as the outer margin of the lower canine teeth.

In the upper jaw, the two middle incisors, right and left, by far the largest of the entire incisor group, are larger than the two lateral incisors ; in the lower jaw, on the contrary, the two middle or central incisors are smaller than the two lateral ones. The incisors are wedge-shaped, slightly convex in front, and have nearly straight or flat edges, but this is more marked in regard to the middle incisors. The canine teeth are the longest, and have a pyramidal or pointed shape. The upper canines, one on each side, are larger and more pointed than the lower ones, so that the former shut down beyond, or outside of, the latter, and, indeed, become opposed to the first small molars or bicuspids of the lower jaw. Moreover, as the horse-shoe shaped alveolar border of each jaw, curves a little more suddenly opposite to the canine teeth, the arch itself is wider across at this point in the upper than in the lower jaw, as already indicated. Behind the canines, the teeth, except on rare occasions, are lost to view ; but it may be remembered that each tooth in the upper jaw, whether bicuspid or molar, is placed a little further back than the corresponding tooth in the lower jaw, so that the latter shuts a little in front of the former. Moreover, the upper molars slant a little outwards, and the lower ones a little inwards to meet them. The edges of the entire upper row of teeth, seen sideways, form a slightly convex line, more marked in the lower races of mankind; whilst the margin formed by the lower teeth, is correspondingly concave; but the general direction of their line of contact, is horizontal. The alveolar portion of both jaws is covered only by the gums, which are themselves continuous with the cheeks and lips.

The Skull considered as a whole.

The *cranial portion* of the skull presents a *base, sides,* and *vault.* In the uneven *base,* fig. 61, are found, commencing from behind, the greater part of the occipital bone; part of the mastoid and squamous, and all of the petrous portions of the temporal bones; the under surface of the sphenoid bone, except a portion of its greater wings ; the orbital plates of the frontal bone, and the horizontal plate of the ethmoid; the two last-named parts are concealed from view by the vomer, palate, and superior maxillary bones. The smoother *sides,* fig. 62, are formed, successively, by portions of the occipital, parietal, and frontal bones, with a part of the great wings of the sphenoid, and the squamous and mastoid portions of the temporal bones. The smooth and convex *vault,* figs. 62, 63, comprises the part of the occipital bone above its protuberance, the parts of the parietal bones above the curved lines, the upper part of the frontal bone between its temporal ridges, and down to the orbital margin, the external and internal angles, and the nasal eminence. Of these bones, the occipital and sphenoid coalesce solidly in the adult, at the basilar process, in front of the foramen magnum, the weight of the head being mainly transmitted through those bones to the occipital condyles, and thence to the first cervical vertebra; so likewise, all shocks from below, are first received by these two firmly conjoined bones.

The lines of connexion between the other cranial bones, between the facial bones, and between the bones of the cranium and the face, the so-called *sutures,* are only distinctly traceable on the dried skull, and are named after the bones, or parts of bones, which meet at them. Those in the *base* of the skull, fig. 61, are, for the most part, formed by broad rugged edges, plane, or scarcely indented; but a few, in the fore-part of the base, present comparatively thin and finely indented edges; the greatest weight, and the most powerful shocks, pass through the former set. Of the sutures visible on the *sides* and *vault* of the cranium, fig. 62, the *occipito-parietal,* situated between the upper convex border of the occipital bone, and the posterior concave borders of the two parietals, also named the *lambdoidal suture,* (Λ, the Greek letter L, *lambda*), has broad and deeply indented edges, with elevated borders. The separate islets of bone, called *ossa triquetra* (three-sided) or *Wormian* bones (after an anatomist), fig. 62, are chiefly found in this suture, though they occur also in neighbouring sutures. In the middle line along the vertex, is the well-marked, deeply serrated *parietal* or *inter-parietal suture,* otherwise named the *sagittal suture,* from its straight, median, arrow-like course (*sagitta,* an arrow), between the lambdoidal and the fronto-parietal sutures. In the infant, the cranial bones are incomplete, opposite both ends of this suture, the membranous intervals being named, from their rising and falling, the posterior and anterior *fontanelles* (*fons,* a fount); the part which corresponds with the latter, in the closed skull, is named the *bregma,* (βρέγμα, a fount). A continuation of this median suture between the two halves of the frontal bone, down to the root of the nose, constitutes the *frontal suture,* present in early life, sometimes persistent, but usually obliterated, in the adult. The *fronto-parietal suture,* fig. 62, between the anterior concave borders of the two parietal bones and the posterior convex border of the frontal bone, named, from its position, the *coronal suture* (*corona,* a fillet), passes across the cranium, from the point of one great wing of the sphenoid bone to the other, being a little curved backwards at the top of the skull, and very distinctly serrated. In the middle of this suture, the frontal bone overlaps the parietals, but, at the sides, the parietals overlap the frontal. The lower concave border of each parietal bone is joined to the squamous portion of the corresponding temporal bone, by the *squamous suture,* fig. 63, the edges of both bones being much bevelled off, so that the temporal widely overlaps the parietal bone; behind this, the *masto-parietal* and *masto-occipital sutures,* are thick-edged and deeply indented; in front, is the short and finely denticulated *spheno-parietal suture,* seen in the temporal fossa. From the two ends of this suture, the *squamo-* and *fronto-*

sphenoidal sutures, pass down, behind and in front of the great wing of the sphenoid, into the base of the skull. Here, the temporal bone overlaps the sphenoid, whilst the latter overlaps the frontal and the adjacent angle of the parietal. As life advances, some of the cranial sutures show a tendency to close by bony union, which usually begins in the sagittal suture, extends to the lambdoidal, and may afterwards affect the coronal and other superficial sutures.

The *facial sutures*, named from their smoother borders *harmonia*, have either very thick edges, as in the *malo-maxillary* and *inter-maxillary sutures*, or thinner ones, as in the *nasi-maxillary* and *inter-nasal sutures*.

Of the *cranio-facial sutures*, the superficial ones, such as the *zygomatic*, *fronto-malar*, *fronto-maxillary* and *fronto-nasal sutures*, have rather thick edges and fine serratures, are very strong, and form important ties between the bones of the face and cranium; but the deeper ones, in the orbits and nose, have usually smoother lines of contact and connexion.

Surface-forms dependent on the Bones of the Cranium and the Face.

The general and particular forms of the living head and face, depend very much on those of the cranial and facial bones. Hence, the variations which occur in the dimensions and shape of these parts of the skeleton, are of great interest to the artist.

The most obvious character in the human head, as distinguished from that of animals, is the great proportionate size of the *cranium proper*, as compared with that of the *face*, corresponding, as it does, with the remarkable development, in man, of the two cerebral hemispheres, which are concerned in the manifestation of the higher intellectual processes. The cranium not only protects, but undoubtedly corresponds in general size and form with the entire brain, of which the *cerebrum* occupies about seven-ninths and the *cerebellum* about one-ninth of the cranial cavity, the rest being taken up by the medulla oblongata or commencement of the spinal cord, and by membranes, blood-vessels, blood and cerebro-spinal fluid. The cerebellum is placed in the inferior occipital region, below the occipital protuberance and the superior curved line; the cerebrum, with its large hemispheres, is situated in the superior occipital, and in the temporal, parietal and frontal regions.

The *general form* of the *cranium* is more or less ovoid; but it is somewhat flattened on its base, and at the sides. Seen from *below*, fig. 61, where its base is so uneven, its ovoid shape is recognisable; but this is more evident, when it is looked at from *above*. Its long diameter is placed in the middle line, from before backwards, from the glabella to the occipital protuberance; whilst its greatest transverse diameter, most commonly passes through the parietal eminences, but sometimes through some other prominent part of the parietal region; it is always behind the middle of the entire mass, the outline of which, accordingly, as viewed either from above or below, curves suddenly backwards, but only gradually forwards. The lateral and upper surfaces of the ovoid cranium are characteristically smooth, as if it were well distended above and at the sides, as though filled out by its contents; but it is uneven, and pierced by many openings below. This smoothness, however, is mainly due to the absence, from the two former situations, of any very prominent ridges or crests for the attachment of muscles, such as are found in the skulls of most mammalia. Seen from *behind*, the cranium presents the appearance of a vault or dome, springing from a flattened base, formed between the two mastoid processes of the temporal bones, and culminating in the parietal bones. In *front*, fig. 63, a similar, but much lower and narrower, dome is formed above the orbits, reaching as high as the coronal suture. At the *sides*, fig. 62, the curved profile commences at the plane of the foramen magnum, runs backwards beneath the inferior, and then behind the superior occipital regions, passing over the occipital protuberance; it continues over the posterior flattened portion of the parietals, next along the curved vertex formed by the upper surfaces of the parietals, and then finishes by the profile line of the frontal bone, which, at first convex, becomes usually a little hollowed and slanting as it descends, again becomes convex opposite the frontal sinuses, and then sinks over the glabella, into the depression or indentation found above and at the root of the nose. From that point, the base line of the cranium proper slants obliquely backwards and downwards, at first gently and then more abruptly, passing a little below the external auditory opening, to the plane of the foramen magnum, from which the profile was traced.

The *base* of the cranium, which is bounded behind, and, for a short distance, at each side, by the superior curved line of the occipital bone, by the borders of the mastoid process of the temporal bone and by the under margin of the external auditory meatus, and which is then concealed by the lower jaw and other bones of the face, is so completely covered by the muscles of the back and sides of the neck and by other soft parts, as well as by the upper part of the spine, that it nowhere directly influences the external form. But, above the boundary line of the base, that is, behind, at the sides, on the vertex, and in front, the cranial forms are more or less plainly revealed upon the surface of the living head. An easily recognisable central point on the side of the cranium, is the external auditory meatus; it indicates the position of the cartilage of the ear, the little projecting lid on the fore-part of which, named the tragus, precisely covers the external meatus. Below and behind this meatus, is the broad, outer, subcutaneous surface of the mastoid process, which may always be felt, and is frequently apparent behind the ear.

Immediately in front of, but a little higher than, the auditory meatus, the zygomatic process may be felt beneath the skin, becoming more and more prominent, as it springs outwards, to form, with the malar bone, the zygomatic arch, which is completely subcutaneous. Above this, is the temporal fossa, which, formed by portions of the temporal, parietal, frontal, and sphenoid bones, and limited by the temporal ridges or curved lines on those bones, is filled in by the thick temporal muscle and temporal fascia, and is bounded in front, by the conjoined ascending process of the malar bone and external angular process of the frontal bone. The upper and fore-parts of the temporal ridge are subcutaneous, and, in thin persons, form a curved edge, but, in muscular individuals, a slightly marked groove. The external frontal angle is also plainly evident, being covered only by a part of the thin orbicular muscle of the eyelids, and by skin.

In the middle line behind, and just at the junction of the inner ends of the right and left superior curved lines of the occiput, the occipital protuberance determines the projection of the back of the head. Above this, the hinder part of the head, the whole of the vertex and the forehead, are covered only by the scalp, including the occipito-frontales muscles and their aponeurosis; so that, allowance being made for the smoothness produced by the covering of the scalp, the shape of the head has nearly exactly the same general and local forms, as the occipital, parietal, and frontal bones themselves. In bald persons this is very obvious; even the thickened borders of the lambdoidal and sagittal sutures are plainly traceable. Sometimes, the vertex is somewhat flattened, and, at other times, it is raised, like the roof of a house. Always there are seen, at a certain distance on each side of the middle line, above the curved border of the temporal fossæ on the parietal bones, the two parietal eminences, which, as a rule, determine the place of greatest breadth of the head. Passing forward, is the smooth, convex upper part of the frontal bone, with its two frontal eminences; between and below these eminences, the bone is more or less depressed, in proportion to the size of the eminences themselves, and so is the forehead. Lower down, the superciliary eminences over the frontal sinuses, influence the surface forms, in a more or less marked manner in different persons, producing oblong elevations, oblique from within upwards and outwards, commencing on either side of the smooth glabella, with an inner and lower rounded form, and gradually becoming more pointed, and subsiding at their outer and upper ends. All these parts are recognisable on the living head, the surface modelling of which, when the subjacent frontal muscles are not in action, is strictly dependent upon them. On each side, the forehead is bounded by the external angular process, and adjacent curved line or temporal ridge of the frontal bone, which, as already stated, are nearly subcutaneous, the former being covered only by the orbicularis muscle. The sharp supra-orbital ridge, or upper border of the orbit, is, along its inner and upper parts, obscured by the thick eyebrow and its muscles; but towards the outer part, where it corresponds with the anterior edge of the external angular process of the frontal bone, it becomes much more prominent, and is covered only by the thin orbicular muscle of the eyelids and the skin, so that it very precisely determines the external form, which, indeed, is very pronounced in this situation, immediately in front of the temple. The temple itself is either slightly convex from the action of a large temporal muscle, or sunk in when this muscle is very thin.

The bony framework of the *face* is in complete contrast with that of the cranium, being irregularly angular in its general contour, and very uneven on its surface. Seen from *below*, the outline is bluntly triangular, the base of the triangle being turned backwards, and formed by a transverse line drawn through the condyles of the lower jaw, behind the angles of that bone, the blunted apex being directed forwards, and corresponding with the under surface of the symphysis menti. Viewed on its lateral aspect, the *profile* of the face also forms a triangle, having its hinder angle truncated along a line corresponding with the posterior border of the ramus of the lower jaw; its upper defective side, extending from the root of the nose to the condyle of the lower jaw, is attached beneath the slanting base of the cranium; its under defective side reaches from the angle of the jaw to the chin; its remaining anterior side is determined by a line drawn from the chin to the root of the nose. Regarded *in front*, the outline of the face is included in a hexagonal figure, having unequal sides; a long horizontal upper side, corresponding with the cranio-facial junction, is formed by a line drawn transversely through the root of the nose, and the lower edges of the external and internal angular processes of the frontal bone; two very short sides descend, each obliquely outwards and downwards, from the external angular process of the frontal bone to the most prominent part of the zygoma, just behind and below the malar eminence; two much longer sides are bounded by lines running downwards and inwards, from the zygomatic arches to the two angles of the lower jaw; lastly, a horizontal under side is formed by a line, longer than the two last, but shorter than the upper horizontal line, beneath the lower jaw. This under side is somewhat indented in the middle, and truncated at its two ends. The greatest breadth of the facial hexagon, is opposite a horizontal line passing through the hinder part of the face, at the most prominent points of the zygomatic arches, just behind and below the malar eminences, which line, accordingly, corresponds with the longest transverse diameter, or greatest width of the face; this is, invariably, in excess of the vertical diameter, drawn in the median plane, from the root of the nose to the point of the chin. In the profile view of the cranial and facial bones together, it will be noticed that the plane of the foramen magnum, corresponds, more or less closely, with a line passing along the floor of the nasal fossæ, but, according to the position of the head, this will necessarily vary. The parts on which the head is actually balanced, are the occipital condyles, and the position of these may be determined, almost exactly, by remembering that they are placed, when the head is in a state of equilibrium, a little in front of the anterior borders of the mastoid processes, on a level with the middle of those bony prominences ; they of course project below the plane of the foramen magnum. It has been lately assumed by craniologists, treating of the dried skull, that this plane always corresponds with the horizontal axis of the orbits, but this conclusion is erroneous.

The startling death's head appearance of the facial osseous framework, is almost entirely concealed by soft structures, a few of its more prominent parts only being subcutaneous. In front, in the middle line above, are certain portions of the nasal and superior maxillary bones, which form the bridge and sides of the nose ; below, is the triangular mental eminence, with its indented lower outline at the point of the chin, which gives prominence and breadth to that region. At each side, is the outer, partly subcutaneous surface of the malar eminence, running back into the zygomatic arch, and passing upwards and forwards into the adjacent portion of the orbital rim, which here recedes, and is covered only by the thin orbicularis palpebrarum; immediately beneath the hinder, receding part of the zygoma, and just in front of the external auditory meatus, is always to be felt, and sometimes to be seen, an elevation produced by the outer end of the condyle of the lower jaw ; the posterior border of the ramus of the jaw is obscured by the parotid salivary gland, but, lower down, the small, prominent, everted portion of the lower border of the jaw, just in front of its angle, causes a very remarkable and evident point upon the surface form ; lastly, all round the under border of the face, the long, subcutaneous part of the margin of the jaw, from the angles to the symphysis, thin posteriorly, but much thicker and more rounded at the sides and in front, determines, under all positions of the neck or head, in a very definite manner, the general contour in this situation ; at the same time, the actual line depends upon soft tissues, glandular, muscular, and fatty.

The remaining bones of the face, are concealed, more or less completely, by muscles, as well as by fatty tissue and skin ; the broad rami of the lower jaw are covered by the large masseter muscles ; the rest of the surface of that bone, and also the upper jaw bones, up to the side of the nose and the inner and lower margins of the orbit, are concealed by fat, by the buccinator muscles, and by the numerous muscles of the upper lip; the hollow eye-sockets are filled up by the eye-balls and other parts, covered in by the delicately formed eyelids; and the large repulsive opening of the anterior bony nares is quite obliterated by the projecting, softly modelled, cartilages of the nose, and its cutaneous covering.

Variations in the Forms of the Head and Face.—No description can communicate an adequate notion of the numerous modifications of the surface-forms of the head and face, which are due to *variations* in the size and shape of the cranial and facial bones. These parts, indeed, are the most variable of the human skeleton, or, at all events, the parts in which the effects of variation, and, it may be added, of a want of symmetry between the two sides, are most apparent.

Setting aside such acquired or accidental cranial and facial peculiarities, as depend upon disorders of development, on disease, artificial treatment, or injury, such, for example, as are seen in idiots, in hydrocephalic or otherwise deformed heads, in cases of premature *synostosis,* or junction of the sutures, and in heads which have been subjected to various kinds of pressure during the period of growth, there still remains an extraordinary *individual tendency* to variation in both size and form, in the cranium and the face. No two crania, indeed, are exactly alike. The capacity may be large, moderate, or small; the general form may be long, broad, or high; the forehead may be low or lofty, upright or retiring, wide or narrow, square or tapering upwards, smooth or modelled with massive forms above the brows; the vertex may be high or depressed, flat, or thrown up into a median ridge; the occipital region and protuberance may be pointed and narrow, or flat, broad and depressed; the mastoid processes may be large and prominent, or the reverse; the temporal region may be full, flat or sunken; the zygomata, boldly arched, or shallow and receding; the malar eminences, broad or narrow, and the cheeks, accordingly, high or flat; the nasal bridge may be short or long, elevated or sunk; the transverse diameters of the orbits, usually inclined downwards and outwards, may be horizontal, or perhaps even inclined upwards, at their outer ends; the angles of the lower jaw may be obtuse, or nearly rectangular, smooth at the side, or strongly everted, and roughened at their lower edge; the whole face may retire towards the cranium, or it may project slightly, or in a very marked degree, from it; the lower jaw may be slender and short, or deep and long, the chin may be prominent or retiring, square or pointed, and the front teeth, implanted, either vertically or more or less obliquely, in the alveolar borders; lastly, even the size of the teeth may greatly vary.

These and other innumerable modifications necessarily produce great effect on the physiognomy of individuals. Certain peculiarities belong to families, and are transmitted to perhaps remote generations, after a temporary disappearance in one or more. If some of them occur, constantly and characteristically, amongst a number of families, they furnish signs or marks of typical importance, in reference to tribe and race. Their intimate study is the task of the cranioscopist, ethnologist, and anthropologist, rather than that of the anatomist. Their consideration, as well as the various results of craniometrical measurements, and triangulation of the face, must be reserved, with the subject of Proportion, for a future occasion.

The influence of *growth* on the forms of the cranium and face is too remarkable to be here left unnoticed; although a fuller treatment of this question, would be more appropriate in a treatise on Evolution. Both the cranium and the face continue to grow, up to the period of adult life; but the cranium especially, is, in proportion to the stature and mass of the body, much larger in infancy than in childhood, and larger in the child than in the adult. The face, however, is, relatively to the cranium, smaller in early life than afterwards. These facts are rendered evident in the proportionally larger size of the head in infants and children, as compared with adults, and in the smaller size of their features. In the very young infant, the cranium is often much elongated from before backwards, being especially large in the occipital region, compressed from side to side, and, at the same time, deficient in height; but it speedily fills out, as it were, and acquires, what may be termed its juvenile characteristics. These are a general roundness and smoothness, owing to a relatively fuller form over the occipital, frontal, and especially over the parietal eminences, and to the absence of the superciliary eminences, due to the non-existence or rudimentary condition of the frontal sinuses. The vertex and the forehead are, in particular, very smooth and rounded, and the latter very prominent in profile, owing partly to the non-development of the superciliary eminences and supra-orbital ridges, but also to the relatively small size of the face, which the cranium now seems, as it were, to overhang. The external frontal angles, the malar eminences, and the zygomata as well as all the processes and ridges of the cranium and face, are feebly pronounced; the temporal fossæ are shallow, and the mastoid processes are small, their cells or sinuses being in a rudimentary state of evolution. The occipital condyles are small, and placed further forwards, in relation to the mass of the head. Owing to the fulness of the temporal, parietal, and lateral frontal regions of the cranium, and to the slight development of the zygomatic arches, these latter are not so prominent as in the adult, and, therefore, the bony framework of the face, seen from the front, has a nearly triangular form, coming to a point below. In the face itself, the nasal bones are very small and short, and are as yet but little relieved from the superior maxillary bones; whilst these also are small, owing to the undeveloped condition of the great maxillary sinuses or antra. The orbital margins, especially the upper portions, are less prominent; and, the orbital cavities, though large, in proportion to the head and face, are shallow, in relation to the size of the eyeballs, so that these, as well as the eyelids, are remarkably prominent. The alveolar arches of both jaws, are short from before backwards, and not yet fully developed; both the alveolar borders, at first bare of teeth, are comparatively slender and shallow, meet together, and thus reduce the vertical measurement of the face; even when the milk teeth have appeared, twenty in number, ten in each jaw, and comparatively small, the lower portion of the face is still but little developed. The mental eminence, moreover, is not yet well pronounced; the under part of the body of the lower jaw is very shallow, and on but a slightly lower level than the plane of the foramen magnum; the alveolar portion is larger than the part which supports it. At first, the angle is very obtuse, the ramus slanting upwards and backwards, and only gradually acquiring a more rectangular outline. As growth advances, it is chiefly the portion of the jaws in which the molar teeth are implanted, that increases in length, to accommodate those teeth, which, in the second dentition, are so much larger than those of the first, and occupy a position in the jaw behind them.

The Skeleton considered generally.

The bony framework not only regulates the height, breadth, and depth of the vertebrate form, but it so obviously determines its general and local characters, proportions, and shape, that it is easy to distinguish the skeleton of any well-known animal. The human skeleton is instantly recognised amongst a host of others, even amongst those of the highest apes.

From the feet to the head, the complex skeleton of man, figs. 64, 65, is constructed with special reference to its fitness for the erect position in standing, and in locomotion; even the shoulder-girdles and upper limbs, set apart for purposes of tact and prehension, are specially modified, so as to be in accord with the upright position of the trunk, to or from which they are attached or suspended.

In both the lower and upper *limbs*, the segments into which they are divided, namely, the thigh, leg, and foot, and the arm, fore-arm, and hand, diminish, in man, regularly in length; this is true even of the phalanges of the toes and fingers; but, in the mammalia generally, the segments of the limbs usually increase in length, from the trunk to the distal end of the limb. The *lower limbs* are characteristically large in man. The *feet* are not only in themselves very broad and strong, but they are very large in proportion to the body; they are also peculiar, in being placed completely at right angles to the leg, and in the perfect manner in which the entire weight-bearing parts, from heel to toes, can be planted on the ground; the double arch of the foot, longitudinal and transverse, and, necessarily, the arched instep, are exceptionally well developed, so as to receive and transmit the weight from the leg; the great toe is especially large and strong, and, moreover, characteristically parallel to the others, not opposable as it is even in the most anthropoid apes; hence, it bears weight on its ball in front, in conjunction with the balls of the other toes, and can act as a strong lever for the forward propulsion of the body, in walking; the short and slender phalanges of the other toes are also noticeable, their use being not prehensile, but to contribute to the elasticity of this part of the foot; lastly, the great projection of the heel-bone backwards, not absolutely, but in proportion to the length of the foot, gives remarkable leverage to the muscles of the calf,

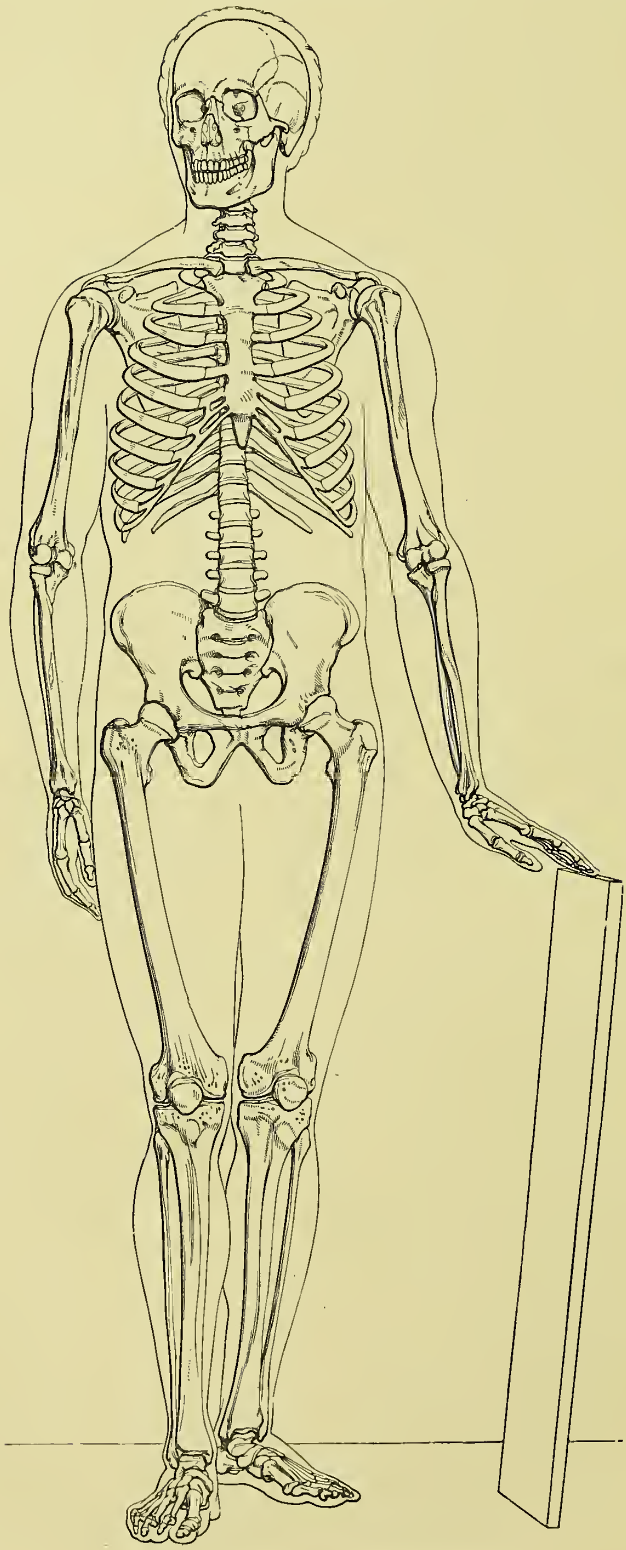


Fig. 64. - Front view of the Male Skeleton.

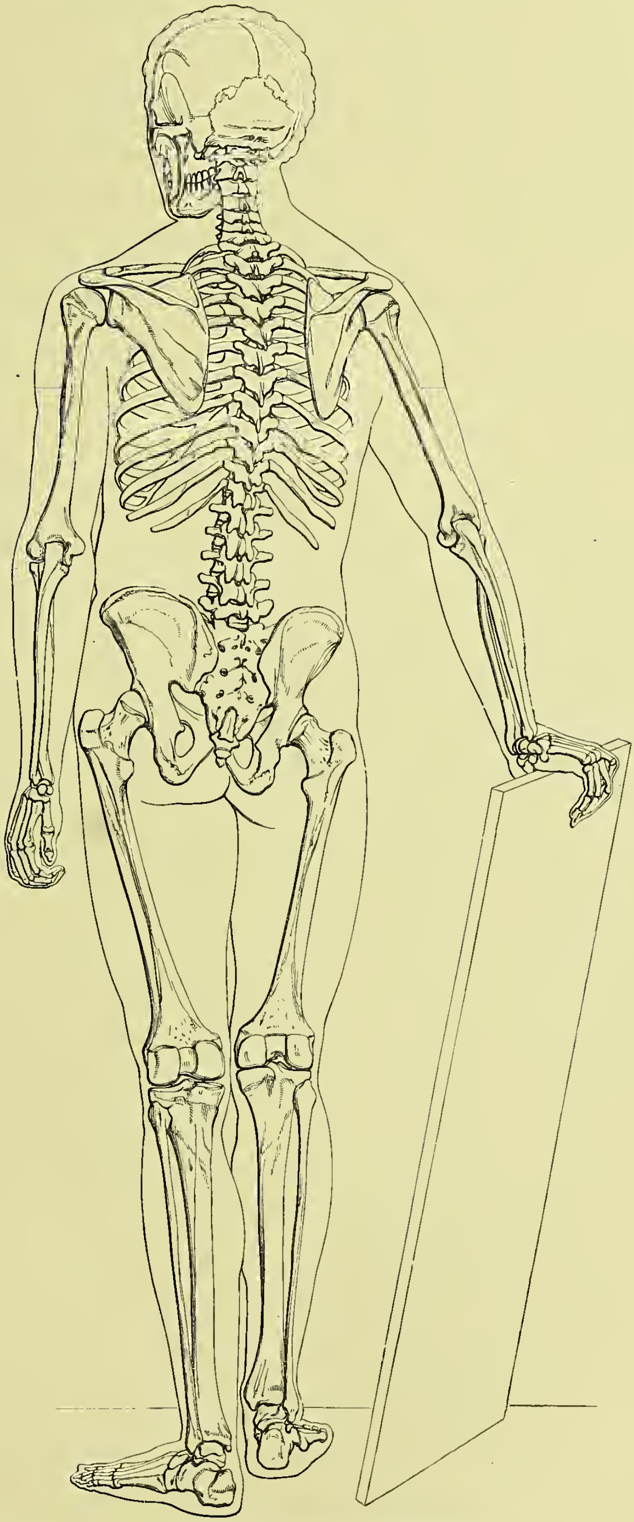


Fig. 65.—Back view of the Male Skeleton

which can sustain the tibia and fibula upright, on the summit of the arch of the foot, and can raise the heel from the ground, even with the full weight of the body supported on one leg.

The *legs* and *thighs*, which, in man, are exceptionally placed in a line with, and not at right angles to, the trunk, are also unusually long, in proportion to the body, very strong, and furnished with remarkably broad and horizontal surfaces at the ankle and knee-joints, all these provisions being adapted to easy, swift, and safe biped locomotion. The complete independence of the fibula, and its firm articulation with the tibia, give strength to this part of the limb, and width for the attachment of its muscles, with increased leverage for their action. The tibia can be rotated slightly, on the femur, when the knee is bent, but, in the straight position, the tibia and femur are closely locked together, so that the former, and, therefore, the entire leg, becomes vertical under the lower end of the femur, the direction of which, downwards and inwards, due to the length of its neck and the width of the pelvis, is compensated for, by the special elongation of its internal condyle. The great proportional length of the neck of the femur, also gives unusual width to the skeleton on a level with the greater trochanters, and advantageous leverage to the muscles attached to them, and to the pelvis. Lastly, the joints of the lower limb are so arranged, as to bend in opposite directions alternately, the foot forwards, the knee backwards, and the hip-joint forwards again, so that the whole limb can be folded up and re-stretched, as is constantly required in many modes of progression.

The human *pelvis* is relatively broad, capacious, short, and strong, as contrasted with the narrow, elongated, and compressed pelvis of quadrupeds generally; moreover, it is fixed at a certain angle to the vertebral column, instead of being almost in a line with it. It forms a singularly firm, solid ring, which acts as a basis for the whole trunk, whence the weight is transmitted to the lower limbs; it likewise furnishes a means of support to the viscera, which have now to be carried in an upright position, and also affords advantageous points of leverage for the muscles which, on the one hand, balance the pelvis on the heads of the two thigh-bones, and, on the other, sustain the entire upper part of the body, both in the antero-posterior and the lateral direction, upon the sacrum. For these purposes, the sacrum is proportionally very broad, especially at its base, and the two acetabula are unusually widely separated from each other, being, moreover, comparatively deep, and having their upper borders the most prominently developed. The peculiar inclination of the human pelvis, and the lines of greatest strength of its bones, are also in accordance with the direction, in which weight is transmitted through it.

The moveable part of the *vertebral column*, in man, more nearly vertical than in any animal, is, speaking generally, largest below, and becomes smaller and lighter in passing upwards, notwithstanding its secondary pyramidal construction, already described; whereas, in quadrupeds, the dorsal and lumbar vertebræ are not so different in size, and the cervical vertebræ exhibit much variation, according to the length or shortness, the slenderness or thickness, of the neck. In place of a single, long, and slight curve in the loins and back, the human spine exhibits a triple curve, which combines strength, elasticity, and security, with great facility of movement in the erect position, upon so comparatively small a base as the top of the sacrum. The proportionally large lumbar spines, and small upper dorsal and lower cervical spines, are associated with the presence of very powerful muscles in the loins, and less powerful ones in the neck, the head being carried in an upright position, instead of in a more or less horizontal position, as in animals; these, indeed, require not only stronger cervical muscles, but also the assistance of the elastic ligamentum nuchæ to support the head, yet there is less necessity, in them, for specially powerful erector spinæ muscles in the loins.

The *thorax,* in man, as it is in apes, is wider transversely, and not deeper from its vertebral to its sternal aspect, as in quadrupeds. In these latter, the flattening of the chest at the sides, enables the weight of the trunk and its contents, to be more easily suspended beneath the horizontally-carried vertebral column, and also permits the fore-limbs to be brought more immediately under the trunk itself. On the contrary, the lateral development of the thorax, in man, diffuses the weight of the upper part of the body better over the two lower limbs, and renders the lateral balancing of the trunk, more easy in the erect attitude; it also throws apart the upper limbs, thus considerably increasing their fitness for wide excursive movements.

The *upper limbs,* themselves, are neither of about equal length with the lower ones, as in quadrupeds, nor much longer than the lower ones, as in apes, but shorter, smaller, and lighter than those limbs, so as to be easily and freely mobile. The openness of the shoulder-girdle behind, and the presence of the long, but light, suspensory bars or collar-bones, forming such slender means of connexion between the scapulæ and the rest of the trunk, and yet thrusting the upper limbs far outwards, are specially adapted to the purposes of a prehensile limb, and altogether contra-indicate a locomotive function. The looseness of the shoulder-joint at the shallow glenoid cavity, and the complete universality of its movements, give the arm a range of motion in all directions elsewhere unequalled; whilst the length of the whole limb, down to the points of the fingers, enables it to reach every part of the body and lower limbs, when, at least, these also concur in the attempt; no such result is attainable by the feet, except in the trained acrobat. The joints of the upper limb, all bend in the same direction, not alternately in opposite ways, as in the leg; they double up and open freely; more especially, they fold easily over the front of the trunk. The carpus is articulated in a line with the fore-arm, instead of at right angles, as is the case with the tarsus upon the leg; the fingers, with their long yet strong phalanges, are evidently destined for both firmly grasping objects, and for the more delicate purposes of tact; in length, strength, and complete opposability to the fingers, the thumb surpasses that of even the highest anthropoid apes; and, lastly, the complete independence of the radius, and the perfection of its movements of rotation with the hand, multiply the power of this wonderful instrument of touch, prehension and expression.

Finally, the *head*, situated, not at the extremity of a longitudinal, but on the summit of a vertical column, has the face, not protruding forward, but much reduced in its relative size, as compared with the cranium, and brought well beneath the anterior part of the latter. The condyles of the occipital bone are placed horizontally and nearly beneath the centre of the skull, so that the entire weight of the head is more easily balanced on the first cervical vertebra. Moderately sized, dorsally placed muscles, are sufficient to maintain it in equilibrium, and to prevent it falling forward; no strong ligamentum nuchæ is needed, and, as already stated, the lower cervical and upper dorsal spines are comparatively small.

The Female Skeleton.

As the human skeleton may be immediately recognised amongst others most nearly resembling it, so there are also such evident general and particular differences between a well-marked male and a well-formed female skeleton, that even a cursory view, by a slightly practised eye, will almost instantly detect them. Nevertheless, the determination of the sexual characters of separate or disarticulated bones, is often exceedingly difficult; especially in regard to certain less differentiated parts of the skeleton, and in the case of bones which may have belonged to small men or to large women.

It is evident that the chief differences between the male and female form, are intimately associated with the differences between their osseous frames. These relate to the height, breadth, and depth of the skeleton considered as a whole; to the size, shape, proportion, and direction of its component bones; or to the relative development of their various parts. The entire skeleton of the female, fig. 66, is, of course, of less height than that of the male. Supposing the mean height of the male skeleton, to be 64 inches, that is to say, about 2 inches less than the mean stature of the living person, then the average height of the female skeleton, would be, according to Quételet, about one-sixteenth less, that is 60 inches. On comparing the length of the trunk, with that of the lower limbs, in the two sexes, it will be found that, relatively speaking, those limbs are shorter, as well as smaller, in the female than in the male skeleton; in other words, there is less difference in the

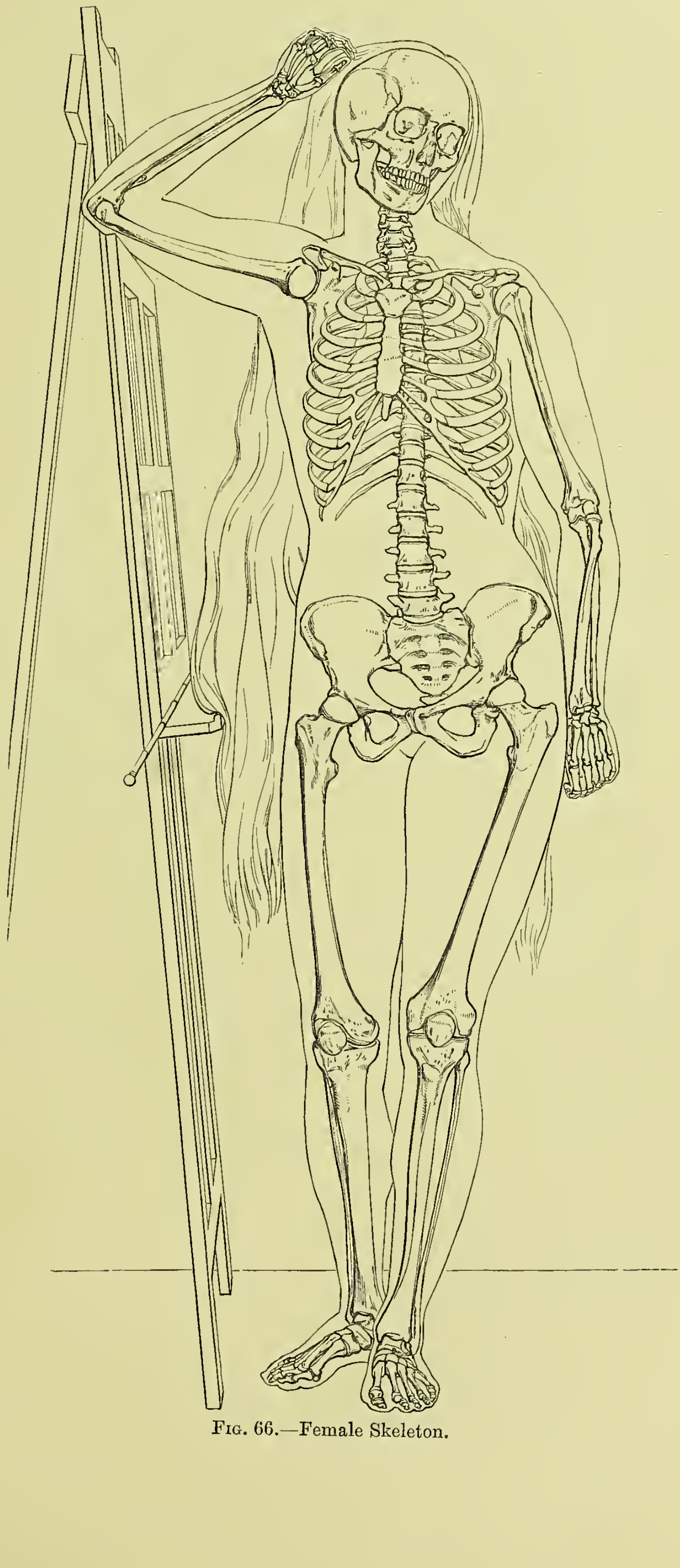


Fig. 66.—Female Skeleton.

length of the trunk in the two sexes, than there is in that of the lower limbs. Hence men and women appear of more equal height when sitting together, than when standing side by side. The proportion between the upper and lower limbs, is said to be more agreeable or perfect, in the female, than in the male. As to the breadth of the skeleton from side to side, that of the female skeleton is, speaking generally, less than that of the male ; but this inferiority in width is most marked across the shoulders, and least so across the region of the hips. This is dependent on the fact that the male skeleton is broader across the shoulders, than opposite the hips ; whilst the female skeleton, is of almost equal or of equal width, in those two regions. Sometimes, the measurement across the hips, in the female, actually exceeds that in the male, as in a comparison between male and female skeletons of similar, or nearly similar, height. The dimensions of the pelvis in the female, are more independent of the stature than in the male. The depth of the female skeleton, from before backwards, is less, at all points, than that of the male skeleton ; but the difference is least marked in the pelvic region.

Speaking generally, every bone in the female skeleton, in harmony with the slighter frame of the woman, is shorter, more slender, lighter, and weaker, than the corresponding bone in the male ; at the same time, all the various notches, foramina, canals, and cavities, such, for example, as the obturator foramen of the innominate bone, the spinal canal, the thorax, the sternal notch, the foramen magnum in the occipital bone, the cranium, the orbits, the nasal fossæ and the mouth, are, likewise, smaller, the parts which these transmit or contain, being themselves of less bulk. Again, the articular surfaces of the joints, of whatever kind, as, for instance, those of the vertebræ, those of the tarsus, the sigmoid cavity of the ulna, or the head of the femur and the acetabulum, are also smaller in the female, in whom the joints are of less size. The curvatures and twists which characterise certain long bones, are much less pronounced in the female. The eminences, lines, ridges, tuberosities, tubercles, and processes, are less marked and prominent, roughened surfaces are less rugged, and depressions and grooves are shallower, in accordance with the smaller size and relative weakness of the ligaments, tendons, and muscles attached to, or associated with, them; such are the hinder prominence of the os calcis, the anterior tuberosity of the tibia, the trochanters of the femur, the spinous processes, the crest and the curved lines of the ilium, the spinous and other processes of the vertebræ, the spinous process, acromion and coracoid process of the scapula, the tuberosities of the humerus, the bicipital tuberosity of the radius, the styloid processes of that bone and the ulna, the pisiform bone of the carpus, and the various grooves about the tarsus and wrist, the curved lines on the occipital, parietal, and temporal bones, and, the mastoid processes of the last. To express the facts in an opposite way, the male skeleton is not only larger and stronger, but much more rugged in its forms, than that of the female, which is not merely smaller, lighter, and more fragile, but is smoother, and, as it were, softer and more graceful in its contours and surfaces.

The local differences of form, proportion, and direction, in the various parts of the female skeleton, as compared with the male, are very numerous.

Thus, in regard to the *foot*, figs. 67, 68, not only is the bony framework smaller in the female than in the male, bone for bone, and, therefore, as a whole, and, not only have the bones, severally, gentler contours and

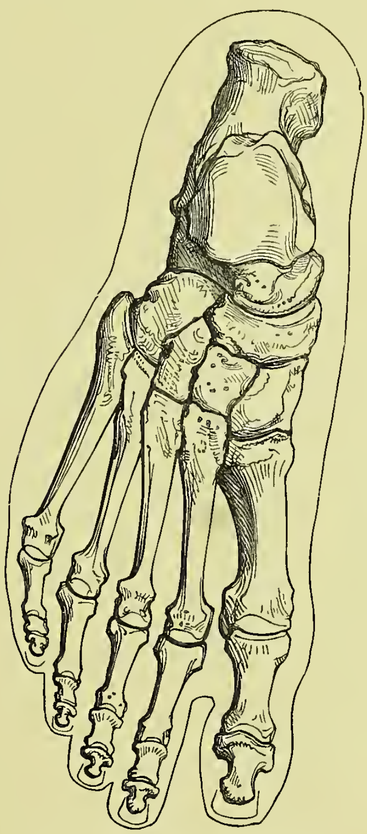


Fig. 67.—Male Foot in outline.

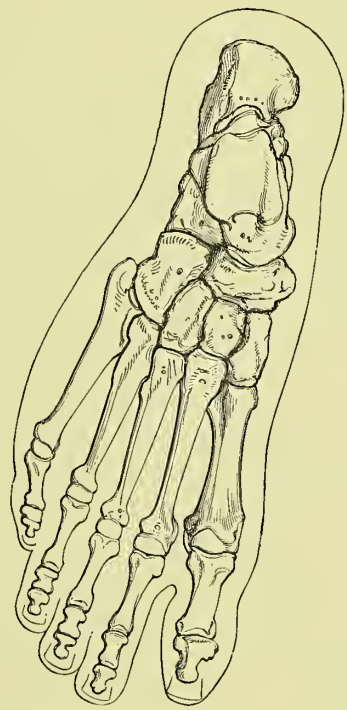


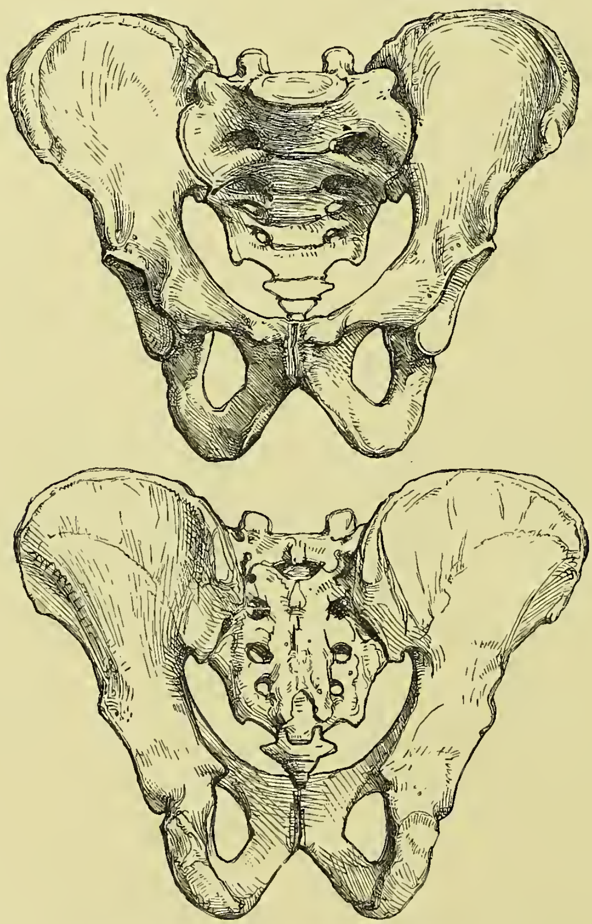
Fig. 68.—Female Foot in outline.

smoother surfaces; but the entire foot of the female is narrower, in proportion to its length, than that of the male, which, on the other hand, is characterised by a greater relative breadth than length. This difference is, moreover, recognisable in each section of the foot, tarsal, metatarsal, and phalangeal. But the elongation of the female foot, is especially noticeable in the middle and anterior regions, or metatarsal and phalangeal regions taken together; for they are decidedly longer, in proportion to the tarsus, than in the male foot. Hence, whilst the tarsus is relatively shorter and broader and, therefore, stronger, and better adapted for bearing weight, in the male, than in the female, the anterior part of the foot is especially elongated, in the latter. In other words, the foot is more foot-like, in the male; whereas, it inclines towards the characters of the hand, in the female. Even the upper articular surface of the astragalus is longer, in proportion to its width, in the female than it is in the male, in whom it is relatively broader, and thus affords a wider bearing-surface, whilst the extent of backward and forward movement of the foot at the ankle-joint, is, greater in the female than in the male. Moreover, if a line be drawn, from behind forwards, through the long diameter of this articular surface, it will, in the male, pass through the middle of the metatarsal bone of the great toe, and close to the inner side of the last phalanx of that toe; whereas, in the female foot, it speedily gains the inner border of the foot, passing only through the base of the metatarsal bone of the great toe; in other words, the astragalus is placed much more obliquely in the female, than in the male foot, its head, and the inner side of the scaphoid bone in front of it, projecting further inwards, owing, apparently, to a slight lateral, or inward, yielding, across the line of the transverse joint of the foot. This yielding of the inner border of the foot, added to the oblique direction of the articular surface of the astragalus, may help to explain the greater disposition, in the female, to point the entire foot outwards; whilst the narrowness of that surface, and the freedom of the transverse articulation will explain the greater mobility, pliability, and grace of movement of the foot, in women, as compared with men. A slight yielding of this part of the arch of the female foot, on the under side, also gives the scaphoid bone, a more horizontal position in the tarsus, and, accordingly, more of its internal tuberosity becomes visible from above; whereas, in the male foot, this bone is placed more obliquely from side to side, its tuberosity being turned downwards. All these arrangements indicate comparatively greater elegance in the female foot, and greater strength in the male. Lastly, the tarsal bones, except the astragalus, are more in a straight line with those of the metatarsus and phalanges in the female foot, a disposition less favourable for the dissipation of shock than the more undulating arrangement of the parts seen in the male foot.

The *leg bones* and the *femur*, compare figs. 64, 66, in accordance with the relative shortness of the lower limb, are also proportionally shorter in women than in men. The tibia, and with it, of course, the fibula, inclines upwards and slightly inwards, from the foot to the knee, in the female; whereas, it is placed vertically on the foot, in the standing position, in the male. This obliquity of the leg-bones compensates for the greater inclination outwards of the femur, at its upper end, in the female, dependent on the shortness of that bone, and the greater distance between the two acetabula at the hip-joints. Hence, the lower limbs are more in-kneed, or bent inwards at the knee, in the female than in the male; moreover, there is, in the former, a tendency to an external rotatory displacement of the leg upon the thigh, and to a separation of the ankles, as well as to a pointing outwards of the whole foot, to which attention has already been drawn. The articular surfaces at each end of the tibia, are slightly modified in the female, to suit the peculiar direction it has to take, and the internal condyle of the femur is, relatively, a little longer in that sex. The shortness of the leg-bones, and still more markedly of the thigh-bones, in the female, the greater separation of the heads of the latter at the hip-joints, the less obtuse angle between the necks and the shafts of these bones, the greater inclination of these shafts downwards to the knees, and the subsequent slight inclination outwards of the tibiæ at the ankles, make the lower limb, in the female, a less perfect columnar structure for bearing weight, and a less powerful locomotive apparatus, than the lower limb of the man; but the alternately opposite inclination of its two segments, and the corresponding obliquity of the articular planes of the knee and ankle-joints, impart to it, in the female, as we have seen to be the case in the foot, a greater degree of play in its outlines, and more variety in its pose. In the female, besides a diminution in size, in all directions, of the bones about the knee-joint, the head of the fibula and the anterior tuberosity of the tibia, are, in particular, smaller and less prominent, whilst the patella is longer and narrower, than in the male, conditions which materially influence the forms, in front of and around the knee, in the former sex.

The most numerous and remarkable differences between the skeleton of the male and female, however, are to be found in the *pelvis*, figs. 69, 70, 71, 72. Of the actual measurements of the male and female pelvis, as recorded by anatomists, but few are of interest to the Artist, for they relate chiefly to the dimensions of its internal cavity. The relative proportions of these, however, convey some idea of the differences in this part of the skeleton, as to its width and its depth from behind forwards. Taking average measurements, the transverse diameter of the inlet at the brim, is, in the male, 4·5 inches, and, in the female, 5·25 inches; whereas, the antero-posterior diameter is, in the male, 4 inches, and, in the female, 4·5 inches. As to the lower aperture of the pelvis, or the outlet, its transverse measurement, between the tuberosities of the ischia, in the male, is 3·5 inches, and, in the female, 4·75 inches; whilst the antero-posterior measurement from the sub-pubic arch to the coccyx, is, in the male, 3·25 inches, and, in the female, 4·5.

Regarded from the front or behind, the female pelvis, figs. 71, 72, is wider, but vertically shorter or more shallow than the male, figs. 69, 70, which is narrow, and long or deep. All its parts are smoother, lighter, and necessarily weaker, in the female; the alæ of the iliac bones are thinner, broader, flatter, and more expanded, the crests of the ilia are longer but shallower, not rising up so high; they are also further apart, so that the average extreme width from one crest to another, is greater, though their height is less; the anterior superior spinous processes of the iliac bones, are also further apart; the tuberosities of the ischia are not only shorter, more slender, and more widely separated from each other, but, instead of being nearly vertical, are directed somewhat obliquely outwards and downwards, contributing thus to the width and the shallowness of the pelvis; the pubic bones are longer and more slender; the pubic symphysis is shallower and less firmly joined; the pubic arch forms, on its under side, an obtuse angle of 90° to 100°, instead of an acute angle of 80° to 90°, as in the male; whilst the edges are also smoother and more

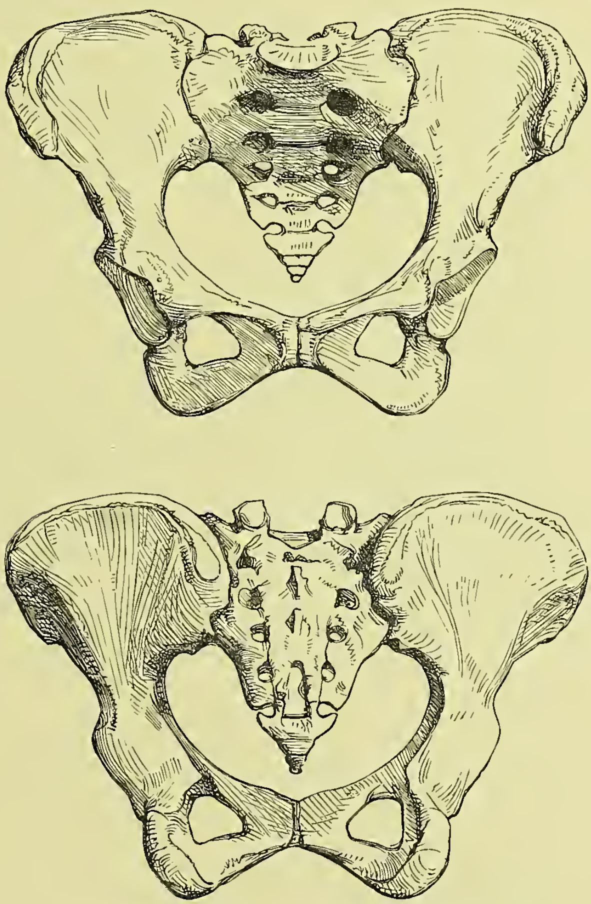


Figs. 69 and 70.— Male Pelvis, back and front.

everted in the latter. In the male, the obturator foramen is longest from above downwards, and somewhat oval; but in the female, it is not only smaller, but triangular, with the corners rounded off, and widest in the transverse direction. Posteriorly, the sacro-sciatic notches are much wider in the female than in the male pelvis. The acetabula are not merely much wider apart, but smaller in the female.

The female sacrum is proportionally wider, and at its base absolutely so;

this is due to an increased width of its lateral masses, the bodies of the sacral vertebræ being actually narrower and smaller than in the male, so that the sacral promontory intrudes less into the pelvic cavity. The female sacrum is less overlapped behind by the two innominate bones, so that the posterior superior spinous processes of the ilia, are further apart, the difference being even more marked than in the case of the anterior superior spinous processes. Although the upper part of the female sacrum is proportionally very wide, the



Figs. 71 and 72.—Female Pelvis, back and front.

lower part is narrow and tapering, and the coccyx is slender and moveable. The sacrum and the coccyx together, are proportionally long and flat, so that they form part of a larger curve than in the male. As is best seen in a side view, the sacrum projects more backwards, or is placed more obliquely, so that its dorsal surface is less vertical in the female. Most of these differences produce some effect on the surface forms. The *iliac furrow*, corresponding, on each side, with the iliac crest, is not only longer, but less elevated above the hip-joint; the *sacral plane* is larger, and more inclined from the perpendicular, especially in the standing position; for as the sacral promontory does not advance so far forwards into the pelvic cavity, the upper portion of the pelvis has to roll forwards so much the more, in order to bring the centre of gravity of the whole body, over the heads of the thigh-bones at the acetabula. Hence, in the female, the greater deviation from the perpendicular of the gluteal region, and the more marked incurvation of the loins in the female figure. The points or depressions at the corners of the *ilio-sacral triangle*, formed by the tuberosity of the sacrum, and the two posterior superior spinous processes of the ilia, are all further asunder, and the intermediate surface is larger and flatter, and its inferior angle more obtuse.

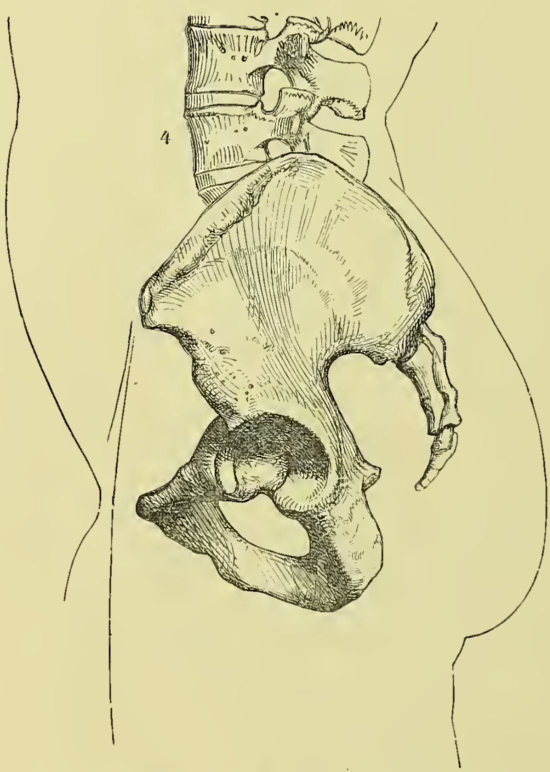


Fig. 73.—Male Pelvis. 4, fourth Lumbar Vertebra.

The deficient height of the female pelvis, as compared with that of the male, and its less massive form, are well seen, also, in a *side* view, figs. 73, 74. The great expansion of the ilium, from front to back, and especially backwards, behind the acetabulum, is at once evident; or, it may be said to be prolonged very much in advance of the sacrum. This, in part, explains the great size of the sacro-sciatic notch, in the female pelvis; but the greater length, obliquity backwards, and flatness or deficiency of curvature, of the sacrum itself, contribute to enlarge that notch. Not only is the lower part of the pelvis more slender in the female, but, in accordance with the smaller size of the heads of the thigh-bones, the acetabula are also smaller; these sockets are directed more downwards, and less outwards, than in the male, so that less of their interior is seen on the lateral aspect of the dried pelvis. Lastly, the upper part of the pelvis is inclined so much more forwards in the female, that the pubic portion is brought more nearly beneath the acetabula, and the prominence of the pubes recedes, so as to fall behind the anterior superior spinous processes of the ilia, instead of projecting forwards, beyond them. Moreover, the anterior and posterior surfaces of the pubes become almost inferior and superior; the apex of the coccyx, instead of being on a level with the lower border of the pubic arch, as in the male, is situated a little above that border; whilst the base of the sacrum is placed higher above the level of the pubic bones.

Though the sacral promontory does not enter so far into the pelvic cavity of the female, as it does in the male, nevertheless, owing to the greater inclination of the *sacrum* itself, backwards, the sacro-vertebral angle is more sudden. Besides being, like the rest of the skeleton, more slender in every respect, both as to mass and form, the *moveable part of the spinal column*, in the female, has its dorsal region relatively shorter, but, its lumbar and cervical regions relatively longer than in the male, figs. 64, 66. The lumbar region, moreover, appears still longer, from its being more free between the pelvis and the thorax, on account of the iliac crests not rising so high, and the ribs not descending so low, in the female skeleton; in the male skeleton, on the other hand, the loins are shorter, stronger, and more closely filled up by the higher iliac crests, and the more descending ribs, figs. 64, 66. As already mentioned, the lumbar region, in the female, becomes much incurved in the standing position, and it altogether possesses greater length, slenderness, freedom and mobility, and may be more narrowly compressed above the pelvis, at the waist; too frequently, however, this is done at the expense of the natural beauty of the figure, and at the cost of injury to the health. Higher up, in accordance with the smaller size of the head, the spinous process of the vertebra prominens is relatively small in the female skeleton; whilst the proportionate elongation and slenderness of the rest of the cervical vertebræ, are in harmony with the longer, narrower, and more rounded *neck* of women,

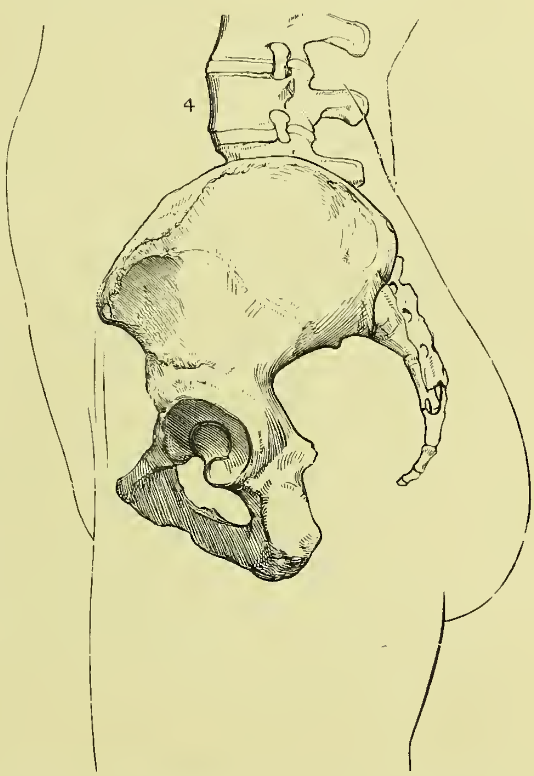


Fig. 74.—Female Pelvis. 4, fourth Lumbar Vertebra.

as compared with that of men. The length of the neck, in women, especially at its lower part, is, however, greatly dependent on the lowering of the sternum and of the shoulder-girdles, owing to the very marked *obliquity* of the upper ribs, fig. 191.

The *thorax*, figs. 64, 66, is not only slighter in its construction, smaller in all directions, and of less capacity, but it is proportionally shorter; it is, comparatively speaking, somewhat larger in its upper half, owing, perhaps, to its being habitually more or less compressed in its lower third, by tight costume. The ribs themselves, being shorter, necessarily form parts of smaller curves, and thus the thorax is more barrel-shaped. The upper ribs, as just stated, are much more *oblique*, and so are the lower ones, partly, perhaps, from the effects of compression. The abdomino-thoracic arch, or angle, formed by the lower borders of the costal cartilages, from the tenth to the seventh, meeting at the xiphoid cartilage, is much more pointed, or acute, than in the male. As the relative widths of the upper border of the pelvis, or abdomino-pelvic arch, in the two sexes, are reversed, it is evident that the external form of the abdominal area must be narrower below than above, in the male, whereas it is wider below, in the female figure. Poupart's ligament, the tendinous cord which passes from the anterior superior spinous process of the ilium to the spine of the os pubis, is more slanting in the male, but nearer to the horizontal line in the female.

The *sternum*, figs. 64, 66, in the female, is not only smaller, but is relatively shorter, and, as just stated, owing to the greater obliquity of the upper ribs, it is placed lower down, in relation to the vertebral column, figs. 190, 191. The manubrium is narrower, and the supra-sternal notch, or furcula, both smaller and more shallow, so that it becomes only slightly perceptible on the surface; but the change of direction between the manubrium and the second piece of the sternum, is more gentle, and this, added to the shortness of the bone, makes the front of the thorax smoother and more prominent, though narrower than in man.

The *clavicles*, figs. 64, 66, are not only weaker, but straighter or less curved in the female than in the male, and although they are attached to a less elevated sternum, at their inner ends, they are more nearly horizontal, or less upwardly inclined at the shoulders, in consequence of these falling lower and more forwards, owing to the very oblique direction of the upper ribs. The scapulæ are thinner, and their processes less developed; the alæ are narrower, and more pointed below; the ridges on the sub-scapular fossa are less marked; the projecting plate of the spine is shorter, and runs more obliquely downwards on the back of the bone; their posterior border is often concave in outline, instead of presenting a convex or obtuse-angled margin; this border also deviates more from the spine below. Unlike what is observed in regard to the pelvic girdle, the shoulder girdle, figs. 64, 66, is relatively smaller and less developed in the female skeleton, and to these conditions, as well as to the obliquity of the upper ribs, and the consequent lowering of the sternum and of its attached shoulder girdle, the narrowness of the female figure across the shoulders is due; whilst the falling, or sloping, of the shoulders, and the elongated neck, as compared with the more squarely-built male form, and the shorter neck, are due to a combination of the same conditions, as well as to slight differences in the female neck itself, figs. 190, 191.

In the female, the *upper* and *lower limbs* are duly proportioned, figs. 64, 66, in relation to each other; but as already stated, both limbs are shorter, in comparison with the trunk. The proportions of the upper limb to the lower limb, are said to be more agreeable. When the arm is suspended by the side, the elbow-joint, in the female, reaches only to about the level of the second lumbar vertebra, instead of to about that of the third, or midway between the last rib and the crest of the ilium, as in the male; and, owing further to the deficiency in height of the iliac crests, there is a still more marked discrepancy between the two sexes, in the distance between the elbow and the innominate bone, in the standing position, this being much less in the male than in the female. In the male skeleton, again, the wrist-joint of the dependent arm, descends to the level of the bottom of the tuberosity of the ischium, a little below the great trochanter of the femur, whilst, in the female, it reaches to that of the pubic symphysis; moreover, when the hand is open, the tips of the middle fingers, in the male, are opposite to the middle of the thigh, that is, lower down than in the female. The greater development of both limbs, upper as well as lower, as compared with the trunk, in man, figs. 64, 66, confers upon him greater mechanical advantages, as regards physical strength, both in reference to locomotive and prehensile acts; and it is only exceptionally, as in the case of a Diana, or an Atalanta, that the female limbs may be assumed to surpass their ordinary proportions as to length. The differences in the skeleton of the male and the female, thus pointed out, show that the evolutional changes in the animal system, which manifest themselves in the development of the limbs, reach their furthest point in the male form, whilst the vegetative system concentred in the trunk, is equally developed in the two sexes, or even more so in the female.

In the *arm* and *fore-arm*, the bones are smaller and less marked, and the radius is straighter. The *hand*, figs. 75, 76, is not less differently characterised, in the female, than the foot. The carpus is proportionally long and narrow, the os magnum especially being narrowed, so that the bones on either side of it, are brought nearer together. The trapezium, in particular, is not placed so far outwards, but is more in a line with the scaphoid, and more parallel with the trapezoid. Hence, the characteristics of the female hand, are a somewhat nearer approach to parallelism of the thumb with the fore-finger, less breadth of the hand at its base, and a smaller size of the ball of the thumb; whilst, in the male hand, the thumb projects out more from the side of the hand, and its root or ball is much wider. The part of the metacarpus corresponding with the four inner metacarpal bones, is also longer and narrower, in the woman's hand; the phalanges of the fingers, are likewise longer in proportion to their width, so that the entire hand, when

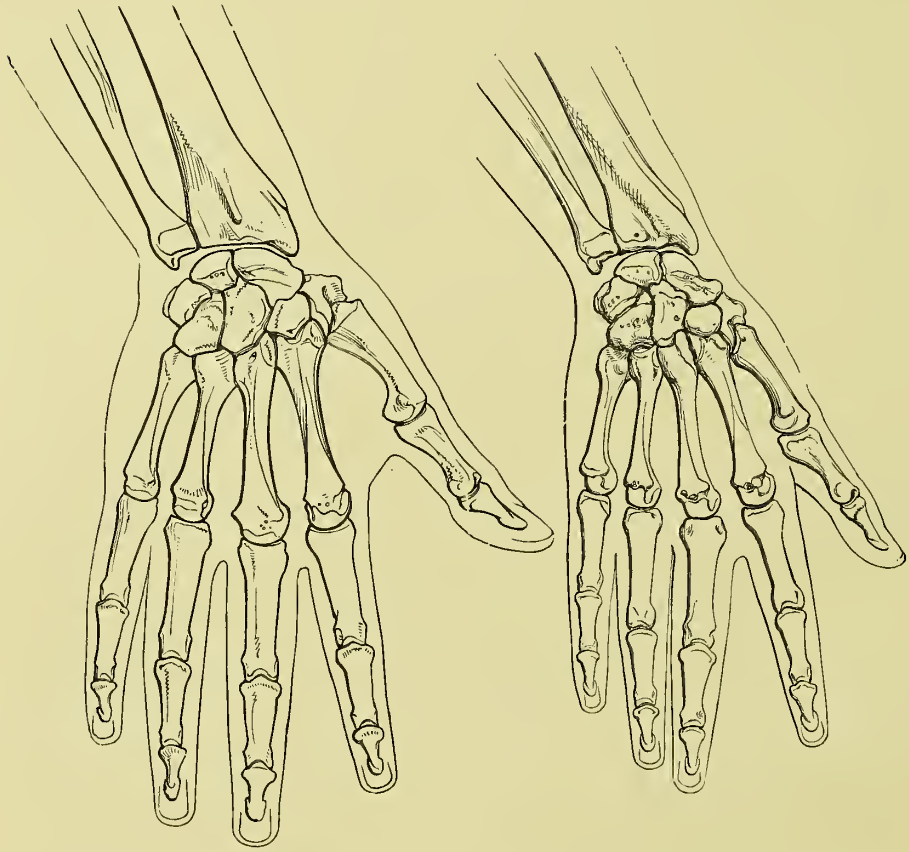


Fig. 75.—The Bones of the Male Hand. Fig. 76.—The Bones of the Female Hand.

the fingers are straight and closely approximated, is, accordingly, not only smaller, but, comparatively, more tapering than the hand of the male.

The peculiarities of form, in the female *cranium* and *face*, figs. 66, 191, depend, not only on the greater smoothness of its surfaces, and the partial suppression of the various ridges, eminences, and processes, but also on the relative proportion of its several parts. Taking, as a standard, the cranial and facial forms in the male, the differences observable in the female head, may be said generally to indicate a less amount of departure from the infantile or juvenile characters. In fact, up to a certain period of life, except a difference in size, in favour of the male cranium and face, which, indeed, exists from the moment of birth, and is permanently retained, no distinctly marked sexual differences can be noticed; but these are subsequently established by the evolution of masculine characters in the male, the female head and face retaining a nearer resemblance to the child's. Thus the female *cranium*, as compared with the male, is absolutely smaller, though relatively to the rest of the skeleton, it is often larger. In shape, it is more regularly ovoid; it has more gentle contours, and smoother surfaces; its various ridges and eminences are softened down, and its substance is thinner and lighter. In particular, the occipital protuberance is less prominent, and the adjacent superior curved lines are less marked; the curved temporal ridge, on each side, for the attachment of the temporal fascia, is less pronounced; the vertex, along the sagittal suture, is lower and more rounded; the supra-orbital margins are smoothly and finely arched, especially towards their outer ends; the forehead is rounded and full, opposite the frontal eminences, but, suddenly changing its profile on a level with them, becomes nearly vertical, down to the glabella, which is comparatively flat; more especially the superciliary eminences and the frontal sinuses within them, are very slightly developed. In the *face*, the malar eminences are subdued, the zygomatic arches are slender, and but little projecting, and the nasal bones smaller and especially narrower, so that the bridge of the nose is not so wide, though it may be nearly as prominent. The alveolar and dental arches are not only more delicately formed, but are narrower from side to side, more elliptical, and more regular in outline and curve. The teeth are smaller and less prominent, and the dental line along which they meet, is curved obliquely upwards behind. The angle of the lower jaw is more obtuse, the ramus being more oblique, and the body of the bone less horizontal. The chin is smaller, and more pointed than in the male. In the base of the cranium, the concealed part of the occipital bone is not only less convex, but it inclines more obliquely upwards and backwards; the foramen magnum, is smaller, and the occipital condyles on each side, are not only smaller, but less prominent. Considered as a whole, the cranium is, proportionally, somewhat elongated from before backwards, and moderately wide; but, relatively, it is not so high as in the male; its occipital region is most developed, next, the frontal, and, least of all, the parietal and temporal regions. The face, as a whole, is, proportionally to the cranium, smaller in the female, less prominent at the cheeks, and more slanting forwards towards the chin. The front view of the cranium and the face together, presents a longer and more elegant ovoid figure.

The special characters of every part of the skeleton, which are distinctive of sex, appear only as development advances; so likewise, as old *age* comes on, the male and female skeletons once more approach in character. The more rugged male skeleton, in accordance with the decreasing activity of the muscular system, becomes somewhat softer; whilst the smoother female skeleton is said to lose some of its delicacy of form, and to become more masculine. In both sexes, all the bones progressively waste; the necks of the thigh-bones become shorter and more nearly at a right angle with the shafts; the heads of those bones become smaller; the lower limbs are bent at the ankle, knee, and hip, and the pelvis becomes tilted forwards, by the now feebly supported super-incumbent weight; whilst the several components of the vertebral column, the ribs and the sternum, the clavicles and the scapulæ, become adapted to the stooping position of the back and shoulders. In all these changes, the individual bones participate, especially their articular extremities and surfaces. The neck becomes inclined forwards, and the cranium and face drop upon the neck. The teeth falling out, the alveolar borders of the jaws are absorbed, the alveoli disappear, and a thin firm margin of bone alone remains. The tuberosity of the upper jaw wastes, and the ramus of the lower jaw becomes oblique, and its angle very obtuse; the convex profile line of the front of the superior maxillary bone, and the vertical contour of the front of the lower jaw, now each incline backwards to the other, so that the mouth recedes, whilst the chin becomes slanting, and approaches more closely to the nose. The depth of the lower part of the face is thus diminished, as in the infantile face. All the osseous forms, however, instead of being concealed and rounded, become angular and more plainly revealed beneath the surface, in the aged and decrepit frame.

THE JOINTS.

THE JOINTS CONSIDERED GENERALLY.

The places where the separate bones meet, and the parts which connect them, are called the *joints* or *articulations* (*articulus*, a joint). That part of the science of anatomy, which relates to the joints, is named *Arthrology* (ἄρθρον, a joint; λόγος, a discourse). The joints permit the various movements of the body. The shape of the bony surfaces, which enter into their formation, determines the character, whilst the position, length, and strength of the soft parts, which hold the bones together, regulate the extent of those movements. The muscles are the active agents; whilst the bones furnish fulcra and levers, to give effect to their action.

The joints are divided into three classes, named, according to the degree of motion permitted at them, the *Immoveable*, the *Mixed*, and the *Moveable Joints.*

The Immoveable Joints.

The *Immoveable Joints*, or *Synarthroses* (σύν, together; ἄρθρον, a joint), include the several kinds of *Suture* met with in the cranium and the face. Some of these sutures, such as the lambdoidal, sagittal, and coronal sutures, are named *dentate* or *serrated*, because the edges of the bones are jagged (*dens*, a tooth; *serra*, a saw). These edges fit into each other, a thin layer of fibrous membrane, continuous with the periosteum, intervening between them. When, as in the lambdoidal suture, the borders of the adjacent bones are elevated, the suture is said to be *limbous* (*limbus*, a selvage). The *squamous* suture, has thin, bevelled, and overlapping margins. When the opposed edges are linear and smooth, as in some of the articulations of the face, this more simple suture is termed *harmonia* (ἁρμονία; ἄρειν, to fit). In a few cases, a ridge in one bone is received into a groove in another, and the union is called *schindylesis* (σχινδύλησις, a fissure); whilst the mode of fastening of a tooth into its socket, is termed *gomphosis* (γόμφος, a nail).

As implied by their name, *no movements* occur at the true synarthroses or immoveable joints; but they permit of the continuous growth of the adjoining bones, and they serve to deaden shock. In advanced life, some of these sutures are obliterated by osseous union. The junction of the first costal cartilage with the upper piece of the sternum, and those of all the ribs with their cartilages, are not true articulations, but merely places of continuity between bone and cartilage; they might be regarded as special synarthroses.

The Mixed Joints.

The *mixed* joints, or *Amphiarthroses* (ἀμφί, around; ἄρθρον, a joint), include those, in which the opposed surfaces of the bones are everywhere connected together by an intermediate soft substance, *fibrous* externally, and more or less *fibro-cartilaginous* towards its central part. In most of these mixed joints, there is no intermediate cavity in the fibro-cartilage between the bones, but, in a few, such a cavity exists, lined by an imperfect *synovial membrane*; and, in this way, they approach in character the moveable joints.

The fibro-cartilage which forms the central part of the uniting medium, is composed of fibrous, mixed with cartilaginous tissue. It differs, as to firmness or softness, in different articulations, sometimes containing coarse fibres, sometimes a delicate fibrous matrix. Externally, the bones are connected together by special *ligaments* (*ligare*, to tie), which are dense, tough, and almost inextensible structures, composed of parallel or closely interlaced bundles of fibrous tissue, which form white, shining, non-elastic cords or bands. In certain of these joints, however, the ligaments are of a yellowish colour, owing to the presence in them of bundles of so-called *yellow elastic tissue*, which imparts to them more or less elasticity.

The mixed joints having no central cavity, are exemplified by the articulations between the bodies of the vertebræ, and, until bony union occurs between them, by the junctions of the three pieces of the sternum. The mixed joints having a central cavity and an imperfect synovial membrane, are the articulations of the sacrum with the ilia, and that of the pubic bones together. The former is the *sacro-iliac junction* or *synchondrosis* (σύν, together, χόνδρος, gristle). The latter is named the pubic *symphysis* (σύν, together; φύειν, to grow), although the bones do not here grow together, as at the symphysis of the lower jaw, which is properly so named.

The mixed joints have great strength, but the *movements* permitted at them are slight; no distinct gliding motion even is possible, but only an exceedingly limited change of relative position of the adjacent bones, in every direction. They confer elasticity and resiliency on certain parts of the body, and deaden the effects of shock or strain. In reference to the *external form*, they, for the most part, do not permit any perceptible changes at individual joints; but when the effect is multiplied, as in the series of articulations between the bodies of the moveable vertebræ, it gives rise to considerable changes of the outward form, by producing gentle curves over longer ranges of the bony framework.

The Moveable Joints.

The *Moveable Joints* or *Diarthroses*, are the most perfect, and the most moveable of all the articulations in the body. In them, as the prefix '*dia*' implies (*διά*, through), the severance of the surfaces of the bones, which enter into their formation, is complete, so that these are not joined, but are brought into relation with each other, by the close adaptation of their specially-shaped, smooth *articular ends*. These ends are covered with *cartilage* or gristle, whilst the bones themselves are held together by a membranous *capsule*, which is smooth and moist on its internal surface, and is strengthened externally by proper *ligaments*. Atmospheric pressure also aids in keeping the articular surfaces closely applied to each other; so also does the muscular force.

The *articular* layer of a *bone*, forming its articular surface, is hard, smooth and destitute of pores; it is primitive bone, or ossified cartilage, very different from other parts of the surfaces of bones, which, though compact, are porous for the transmission of blood-vessels. On this, rests the plate of *articular cartilage*, which differs from fibro-cartilage, in being a uniformly firm, elastic, highly flexible substance, of a bluish-white or pearly hue. It is closely adherent to the bone, and is usually thickest, where the greatest weight or pressure has to be borne, so that, on the rounded heads of the bones, it is thicker in its centre and thinner at the margins, whereas, in hollow sockets, it is often the reverse. Its free surface is very smooth and highly polished. It not only forms an elastic pad, by which shock is deadened, but it enables the movements of the joints to be performed easily and smoothly.

In certain moveable joints, for the better and safer performance of their respective motions, distinct *inter-articular fibro-cartilages* exist between the articular surfaces of the joint, as in the knee and wrist, in the articulation at the inner end of the collar-bone, and in that of the lower jaw.

The *capsule* of a moveable joint is a thin, membranous tube, closed at each end, by being attached to the opposed bones, just beyond the borders of their articular surfaces; it limits the joint, which, therefore, has a definite cavity, sometimes double, as when a perfect inter-articular cartilage exists. The cavities of all the moveable joints are lined, except over the articular cartilage at the ends of the bones, by a delicate membrane which secretes a viscid fluid, vulgarly known as joint-oil, though it is not of an oily or greasy nature; it is, in fact, albuminous, and, from its resemblance to unboiled white of egg, is named *synovia* (*σύν, like*; *ωόν*, an egg), the membrane which secretes it, being called the *synovial membrane*. The use of the synovia is to diminish friction, and facilitate noiseless motion, at the joints. External to the capsule, is situated, usually, more or less fatty tissue, which often projects into folds of the synovial membrane, and so fills up intervals between the bones. In the most moveable joints, this surrounding fatty tissue is very abundant. Upon the capsule, and commonly blended with it, are placed the *proper ligaments*, fibrous bands, which consist of a strong, *non-extensile, white fibrous tissue*; in some joints, these spread out and merely strengthen the capsule, whilst in others, they form more or less distinct, dense, flattened, shining, silvery bands, or rounded cords. They not merely hold the bones together, but serve the special purpose of controlling and checking the movements of the joints. In some situations, as in one of the ligaments in the sole of the foot, in another at the back of the ankle, and elsewhere, yellow elastic fibres are blended with the white, non-extensile fibres. Between the arches of the moveable vertebræ, as high up as the axis, *yellow* ligaments exist, of pure yellow elastic tissue, which act like springs after they have been stretched, drawing the bones together again, independently of muscular action. Frequently, the ligaments of the moveable joints are reinforced, as it were, by the tendons of muscles, which are connected with, or pass over, them, and, in a few instances, muscular fibres are attached to the capsule, and to the inter-articular cartilages, if these exist, so as simultaneously to draw these parts out of the way, during the action of the joint. In some places, as between the sides of the tarsal and carpal bones, and between the ribs and the transverse processes of the vertebræ, fibrous bands, called *interosseous ligaments*, pass directly between two adjacent bones, more or less close to a joint; their presence gives additional strength and elasticity to the parts in which they occur. The tibia and fibula, and the radius and ulna, are tied together, through nearly their whole length, by broad *interosseous membranes*, which serve, likewise, to give partial origin to neighbouring muscles. Sometimes, as between the ischium and sacrum, and between the ilium and the last lumbar vertebra, very strong ligaments pass from bone to bone, at a considerable distance from a joint; and, again, a ligament may extend from one point to another on the same bone, as occurs on the scapula; or a fibrous membrane may serve to close an opening in a bone, like the obturator membrane in the innominate bone.

The several *varieties* of the moveable articulations, or diarthroses, are named after the form of their articular surfaces, and the nature of the movements permitted at them. They are, the simple *planiform*, or *gliding joints*; the *trochlear, pulley-like*, or *hinge-like* joints; the *ball-and-socket*, or *universal* joints; and lastly, the *pivot* or *rolling* joints.

The simple Planiform or Gliding Joints or Arthrodia (*ἄρθρον*, a joint).—These are the most common in the body. They vary in the degree of simplicity of their surfaces. None of them are actually flat or plane, as there is no true plane surface in the body; some have slightly convex, or concave surfaces; others are undulating or concavo-convex; whilst some manifest a transition to trochlear, or even to pivot joints. The ligaments of these gliding joints are placed in such positions, as to resist the forces which act most strongly on the joint. In the limbs, strong tendons often support the ligaments.

Gliding joints occur in most of the articulations of the metatarsus and tarsus, that is, with the exception of the joint between the scaphoid and the astragalus; in the articulations between the bones of the leg; in those between the articular processes of the spine, including those between the atlas and the occiput, which latter are so concave and convex, as to resemble ball-and-socket joints; in all the articulations of the thorax; in those at both ends of the collar-bone; in that between the lower ends of the radius and ulna; in those of the carpus and metacarpus, except that of the os magnum with the scaphoid and semilunar bone, and that between the trapezium and the first metacarpal bone. Finally, the articulations of the lower jaw with the temporal bones, may here be mentioned; but, from the marked convexity of the condyles of the jaw, and the depth of the glenoid cavities of the temporal bones, these joints somewhat resemble both the hinge and the ball-and-socket joints.

The *movements* in these gliding joints, though simple, confer elasticity on certain parts, and permit of slight, though more or less important changes of position and form in others, giving rise to movements simulating those of the more moveable articulations.

The Pulley-like or Trochlear Joints (*trochlea*, a pulley; *τροχός*, a wheel), **Hinge Joints or Ginglymoid Articulations** (*γιγγλυμός*, a hinge).—These are not so numerous as the planiform joints. In them, the end of one bone is fashioned into a median groove or pulley, with two lateral prominent borders, or condyles, whilst that of the other has a median ridge, and two lateral concavities; but the surfaces are sometimes otherwise adapted by complex opposing curves. They admit of free *movements* in one plane only, but, of course, in two directions, namely, forwards and backwards, usually named *flexion* and *extension*. Always, some degree of lateral motion is permitted, in certain positions of the joint. The essential to and fro motion in these joints is, however, limited and characteristic. Their strongest ligaments are placed at the sides of the joints, but behind the axis of motion, or else on the aspect of flexion, or that towards which the joint may be bent. It is at these joints, that muscular fibres are often connected with the capsules, which are thus drawn away from between the bones, in certain movements.

The pulley-like joints are confined to the limbs. They occur between the phalanges of the toes and fingers, and at the ankle, knee, and elbow. The ankle, however, allows side movements, and the knee a limited rotatory motion, when these joints are bent; whilst the elbow joint, which is the most perfect hinge joint in the body, exhibits a slight, lateral looseness, when more or less flexed.

The Ball-and-Socket Joints, Universal Joints, or Enarthrodia (ἐν, in; ἄρθρον, a joint).—These are formed by the reception of the rounded extremity or *head* of one bone, which represents a greater or a less part of a spheroid, into a cup-like cavity or *socket*, sometimes shallow, sometimes deep, of another bone. These joints, therefore, exhibit *movements* in all directions; that is to say, besides *flexion* and *extension*, they permit of movements from side to side, known as *adduction* and *abduction*, according as they occur towards, or from, the median plane of the body or of a limb; of a combination of all four of these movements, which is named *circumduction*, and, in certain joints, of a movement of *rotation* of the distant bone upon its axis, likewise. Nor are these movements confined to a few directions, but they take place in all intermediate paths. The capsules and ligaments of the ball-and-socket joints are, for the most part, weak and loose, except on some special aspect where unusual strength is needed. These articulations are, moreover, immediately surrounded and protected by the tendons of the so-called *capsular* muscles, which are more numerous than those around other joints.

The ball-and-socket joints are also restricted to the limbs. They include, in the lower limb, the joints between the first phalanges and the metatarsal bones; that between the scaphoid and the head of the astragalus; and the hip joint, which is the most perfect ball-and-socket joint in the body. In the upper limb, are the shoulder joint; the wrist joint, which, though resembling somewhat a hinge joint, is more than that, having very varied motions; the articulation between the scaphoid and semi-lunar bones, and the head of the os magnum; the joint between the trapezium and the metacarpal bone of the thumb, which, from the mutual adaptation of its alternating concavo-convex saddle-shaped surfaces, has been designated a *reciprocal* enarthrodial articulation; and, lastly, the joints between the metacarpal bones and first phalanges of the fingers and thumb.

The Pivot or Rolling Joints, or Diarthrodia Rotatoria (*rota*, a wheel).—These, which have also been designated *lateral ginglymoid* articulations, consist of a sort of pivot belonging to one bone, received into a ring, formed, partly by another bone, and partly by ligament. The movements are peculiar and limited; either the composite ring rotates around the pivot, or the pivot turns round within the ring.

There are only two of these rotatory joints in the body, viz.: the articulation between the anterior arch of the atlas and the odontoid process of the axis, and the joint between the side of the head of the radius and the side of the upper end of the ulna. In the joint between the axis and the atlas, the bony and ligamentous ring rotates around the osseous pivot; in the joint between the radius and ulna, the osseous pivot moves within the bony and ligamentous ring.

Surface-forms, dependent on, or modified by, the Joints.

The ligaments, being for the most part deeply seated, scarcely ever individually influence the outward form. The few instances in which they do so, will be mentioned in their proper place; but they everywhere round off or smooth the bony prominences which do determine the forms in the immediate neighbourhood of the joints, constituting, outside the periosteum, the first clothing of the skeleton in those situations.

The effect of the action of the different moveable joints, in producing changes in the position of parts, is widely different. Thus, in the planiform joints, it is usually comparatively slight, though still very important, as in the tarsus and the carpus; but, sometimes, it is more considerable, as in the case of the ribs; or it may be still greater as at the joints between the clavicles and the sternum. In the hinge joints, the effect is very remarkable, allowing, for example, complete folding and straightening of the knee and elbow. In the ball-and-socket joints, however, it is the greatest, as noticeable at the hip, but especially at the shoulder, permitting, there, of a circular sweep of the entire upper limb. In the rolling joints, on the other hand, the results are very peculiar and precise, as in the turning of the head upon the neck, and in the singular movements of pronation and supination of the radius, and, with it, of the hand, by which the utility of the latter is so much increased.

The limitation of these movements, supposing sufficient force to be exercised in their production, is, obviously, ultimately due to the ligaments; and it is equally evident that the ligaments on one aspect, or one side of the axis of motion of a joint, must arrest the movement in the opposite direction. But, in hinge joints especially, the movement of extension is checked by the flexor muscles and their tendons, and the movement of flexion by the extensor muscles and their tendons. Sometimes the movement of flexion is ordinarily limited by the approximation of the soft parts, supported, of course, by the bones, as occurs in the case of the knee and hip joint, the shoulder joint and elbow, and of those of the fingers and thumb. It is usually stated that, as regards the ankle and hip joints, the shoulder, and especially the elbow, certain movements are ultimately stopped by the locking together of the bones, as, for example, by the great tuberosity of the head of the humerus striking against the acromion process, and by the olecranon and coronoid processes of the ulna, as well as the head of the radius, coming into contact with their respective fossæ on the humerus. But, in these cases even, there is no perceptible collision experienced in the joint, and there is no pain, as if from nipping of the capsule, synovial membrane, or periosteum; and it is far more probable, that, unless under circumstances of extreme violence, the ligaments control the movements, just before actual contact of the bony prominences can take place. The fitting of the bones one into the other, has reference to the steadiness of the joint, and is a good example of the mutual adaptation of the forms of neighbouring parts due to organic modelling and growth.

The changes in the relative positions of the different parts of the body, or limbs, which take place in consequence of movement at the joints, are not merely mechanically useful and interesting, but they give rise to great varieties in the general *attitude* and *form*. These, and the numerous alterations of *local form* which occur chiefly in the neighbourhood of the joints of the limbs, require to be specially studied by the artist upon the living model. Space does not permit of their separate consideration here. Most of such local changes depend on the shifting of the position of the bones, but some, on the tightening or relaxation of tendons over or near the joints. Many, however, are due to the drawing in by means of deep connexions, or to the pressing in by the atmosphere acting everywhere on the body, of loose synovial folds or fringes, and outlying fatty masses, into the recesses of a joint in certain positions of a limb, these being forced out again from their retirement in other positions, by the altered direction of the bones and by the tension of the surrounding ligaments, tendons or muscles. This is particularly the case behind and in front of the two malleoli, about the front and sides of the knee, and at the back of the elbow. It may even be said that the fatty tissue herein fulfils an important office; for as, owing to the shapes of the bones, some tissue must be drawn or pressed in or out, during the action of most of the joints, fat is the most suitable tissue to be so displaced.

Other remarkable changes are due to the *obliquity* of most articular surfaces, and to accompanying slight yieldings of the ligaments, in consequence of which, the successive segments of the limbs do not move upon each other entirely in one plane, but in continually changing planes; and, thus, new combinations of lines are ever presenting themselves in the living figure. Just as the slight curvatures and twistings in the long bones, are a source of variety and elegance, in the stationary condition of the body and the limbs, so the oblique movements and positions accomplished and assumed, owing to the shape of the surfaces in the joints, are the causes of many graces of outline and form, in pose and action. Moreover by an *association* of different movements occurring in the same joint, as, for example, in the knee or ankle, the elbow or the wrist, its movements are relieved from an otherwise unavoidable stiffness or formality; and, in consequence of the participation of many joints, in the assumption of a given attitude, or in the execution of a particular movement, additional causes of beauty arise; take, as an example, the combined movements of the knee, ankle, and foot.

It is important to note that the movements of all joints may be regarded as being of three different kinds, namely, first, those which are *free*, or are produced simply by muscular action; secondly, those which are *forced*, or are brought about by the sole influence of weight, pressure, or other external force or internal resistance; and thirdly, *mixed* actions, in which, muscular force, gravity, and external or internal resistance all take part. In free actions, the articular surfaces determine precisely the resulting movements; as a rule, these free actions follow the paths dictated by the forms of the articular surfaces, and are absolutely agreeable. If in perfect obedience to these forms, they appear natural and pleasing; but when contrary to them, they become certainly less agreeable, and probably are offensive. Nevertheless, these last movements, if obviously forced, that is when due to some evident constraint, are at once accepted as possible and proper.

That the *muscles* are always arranged *in harmony with the articular surfaces*, is quite certain; for the forms of those surfaces are necessarily developed in concert with, and under the direct modelling influence of, the muscles which move the bones concerned. The strict relationship between the number, position, and line of action of the muscles around a joint, considered in relation to the character of its movements, points to such a conclusion. Given the kind of joint, the general arrangement of its muscles may be predicated; and given the facts concerning the muscles, the general character of the joint may be defined. Even when a single joint is capable of performing associated movements, or when several joints concur in such results, suitable muscles necessarily exist. As the grooves and prominences on the surface of a bone, are formed more or less under the control of the tendons and muscles which play upon or pull upon them, from infancy onwards, so the pulleys and condyles of a joint must be acted on, by the constant exertion of muscular force upon them. But, here also, gravity and resistance, in the shape of the weight of the body, of pressure from without, and of the mutual reaction of the fulcra of support, and of the internal levers of the body, play a most important part. The flattened and simple form of the planiform joints, as for example, of those of the tarsus, are probably chiefly determined by weight and resistance; whereas, in the perfection of the more variably formed hinge joints, ball-and-socket joints, and pivot joints, muscular force probably has more direct influence. In the lower limbs, however, and in the vertebral column, weight has necessarily the greater effect; in the upper limb, which is suspended from the trunk, the influence of muscular action must relatively preponderate. The more simple form of the articular surfaces, in the joint at the base of the metatarsal bone of the great toe, in the ankle and in the knee, illustrates the former condition; the more complex surfaces, in the joint at the root of the thumb, in the wrist and in the elbow, exemplify the latter. The movements of the lower limb are alternately free and forced, those of the upper limb are more habitually free.

Table of the Joints, their Names and Classification.

The names of the particular joints, as is shown in this table, are usually derived from those of the bones which enter into their formation.

Immoveable Joints, or Synarthroses.

Sutures, cranial and facial.
Costo-chondral.
Chondro-sternal, of first rib.

Mixed Joints, or Amphiarthroses.

a. *Without a synovial cavity.*
- Intervertebral, of bodies.
- Sacro-lumbar ,,
- Sacral and coccygeal ,,
- Sternal.

b. *With an imperfect synovial cavity.*
- Sacro-iliac synchondrosis.
- Pubic symphysis.

Moveable Joints, or Diarthroses.

a. *Planiform Joints, or Arthrodia.*
- Temporo-maxillary.
- Occipito-atlantal.
- Intervertebral, of articular processes.
- Sacro-lumbar ,, ,,
- Costo-vertebral, costo-central.
- ,, ,, costo-transverse.
- Interchondral, of 6th to 9th rib cartilages.
- Chondro-sternal, of 2nd to 7th ribs.
- Sterno-clavicular.
- Acromio-clavicular.
- Radio-ulnar, inferior.

Moveable Joints.—continued.

- Carpal, except that of os magnum, with scaphoid and semi-lunar.
- Carpo-metacarpal.
- Tibio-fibular, superior and inferior.
- Tarsal, except astragalo-scaphoid.
- Tarso-metatarsal.
- Metatarsal.

b. *Hinge Joints or Ginglymoid Joints.*
- Elbow joint, humero-cubital.
- Phalangeal, of fingers and thumb.
- Knee joint, femoro-tibial.
- Ankle joint, tibia and fibula with astragalus.
- Phalangeal of fingers and toes.

c. *Ball-and-Socket Joints, or Enarthrodia.*
- Shoulder joint, scapulo-humeral.
- Wrist joint, radio-carpal.
- Carpal; os magnum with the scaphoid and semi-lunar.
- Carpo-metacarpal, of thumb.
- Metacarpo-phalangeal.
- Hip joint, coxo-femoral.
- Tarsal; astragalo-scaphoid.
- Metatarso-phalangeal.

d. *Pivot Joints, or Diarthrodia rotatoria.*
- Atlanto-axial.
- Radio-ulnar, superior.

THE PARTICULAR JOINTS.

After the explanations given in the preceding general account of the articulations, the movements proper to each joint, which, indeed, are sufficiently evident, do not require to be always specifically mentioned. The forms of the various articular surfaces, as well as the position and character of the roughened depressions or eminences, to which the several ligaments are attached, have been fully described with the bones. Attention has now to be directed specially to the *ligaments*; but the shape and connexions of the inter-articular fibro-cartilages, where these exist, and also any peculiarities presented by the capsule and synovial membrane, invite examination. The names of the several ligaments are derived, commonly, from those of the bones or parts of bones, with which they are connected, but, not unfrequently, from the side or aspect of the joint or limb, on which they are placed, and, occasionally, from their special use or office. A consideration of the position and points of attachment of the special ligaments of any joint, will usually lead to just conclusions, as to the mode in which they restrain or check its movements. The extent or relative freedom of those movements can easily be studied on one's own body.

The Joints of the Lower Limb.

The Phalangeal Joints.—These small ginglymoid articulations, two in all four outer toes, and one in the great toe, figs. 77 to 80, have *no proper dorsal* ligament, the thin capsule being here merely strengthened by an expansion of the corresponding extensor tendon of the toes. Two strong *lateral ligaments* are attached to the sides of the phalanges; these are blended with the *plantar* ligament, a dense fibro-cartilaginous structure, intimately united with the sheath of the flexor tendons on the under side of the toes. This strong plantar structure is fixed especially to the more remote phalanx, so as to deepen the socket for the head of the nearer one, on which the distant one freely plays. It has been likened to the sesamoid bones.

Movements.—Flexion is here more free than extension; and, as in the fingers, it is very free in the first joints, so that the toes are brought well down upon the ground. Forced extension in the last joints, is more free than in the fingers.

The Metatarso-phalangeal Joints.—In these little ball-and-socket joints, figs. 77 to 80, as in the phalangeal joints, the place of a *dorsal ligament* is supplied by the capsule, strengthened by an expansion of the corresponding extensor tendon, which covers in the joint. The *plantar ligament* is here also a thick, fibro-cartilaginous structure, attached to the sheath of the flexor tendons, to the lateral ligaments, and to the transverse metatarsal ligament. It is fixed firmly to the first phalanx, but only loosely to the metatarsal bone, and helps to deepen the articular cavity of the former, for the reception of the head of the latter. In the large joint of the great toe, the plantar ligament is thicker, and contains two sesamoid bones, which are themselves strongly bound together, and glide beneath the grooved head of the first metatarsal bone, figs. 79, 80. The *lateral ligaments* are strong triangular bands, attached by their narrow ends, above, to the sides of the metatarsal bones, and, below, to the sides of the phalanges and the plantar ligament. In the great toe, the lateral ligaments are fixed chiefly to the sesamoid bones.

Movements.—Extension in these joints, especially when forced, is more free than flexion, much more so than in the fingers, the toes being brought well towards the metatarsus. In free extension, the toes are carried outwards as well as upwards, but inwards and downwards in flexion, so that they change their direction in reference to the metatarsal bones. Circumduction is limited. Owing to the opposite direction of the long diameters of the ball and the socket, free rotation is impossible; but forced rotation occurs, when the toes are on the ground, and the foot is turned sideways. The joint of the great toe is the freest. The effect of the sandal-strap, or of the barred stirrup-iron, in widening the interval between the great toe and the second toe, is well known.

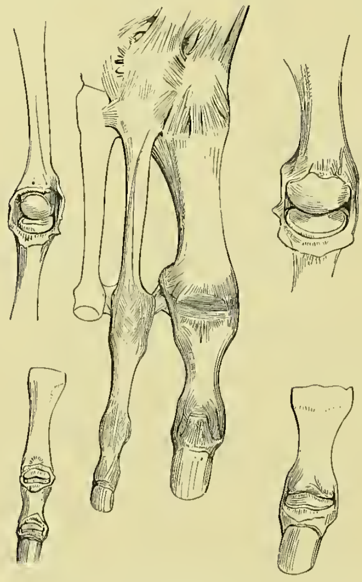


FIG. 77.—The Ligaments of the Toes and the Metatarsus; the Joints of the Toes laid open.

The Metatarsal Joints.—The heads of the five metatarsal bones, though somewhat separated, are strongly held together by the *transverse metatarsal ligament*, fig. 77, a narrow band, which passes across beneath them, and is connected with the fibro-cartilaginous plantar ligaments of the metatarso-phalangeal articulations. This ligament prevents the too great spreading out of the fore part of the metatarsus, when weight is borne upon the foot. The *bases* of the four outer metatarsal bones are connected together, at their lateral planiform joints, by transverse *dorsal ligaments*, figs. 77, 78, by similarly disposed, but stronger, *plantar ligaments*, and by short, firm, *interosseous ligaments*. The base of the metatarsal bone of the great toe, has no lateral joint between it and that of the second toe, a fact which illustrates its relationship to the thumb; but, nevertheless, the two bones are strongly bound together by an interosseous ligament. These interosseous ligaments support the transverse arch of the foot.

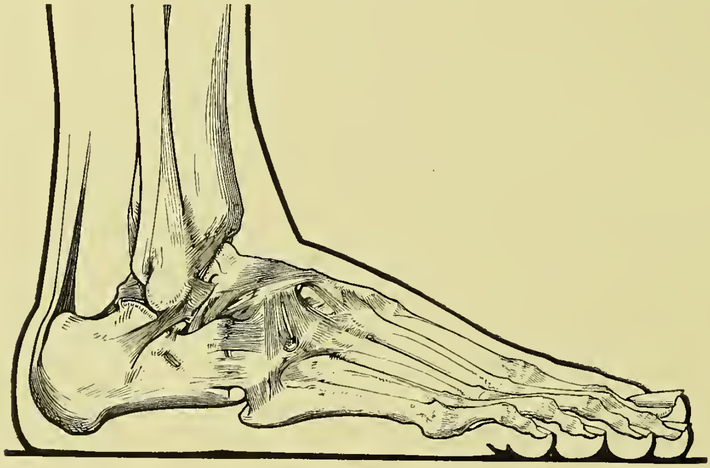
Movements.—The heads of the metatarsal bones move past each other freely; but their bases are closely fixed together.

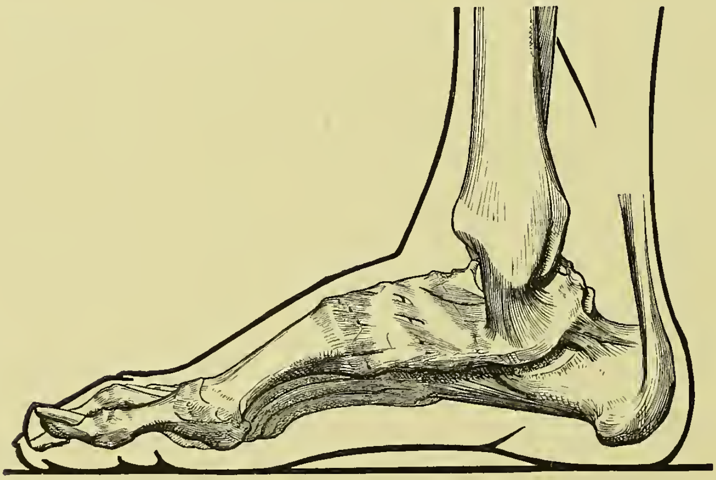
The Tarso-metatarsal Joints.—Of these gliding joints, figs. 77 to 80, the *first* and largest, belonging to the great toe, figs. 79, 80, is a separate joint, held together by its capsule, by a broad, thin *dorsal ligament*, and by a stronger *plantar ligament*. The *second* tarso-metatarsal articulation, very complicated, has three *dorsal ligaments*, one from the second metatarsal to each cuneiform bone, that to the middle one being double; a very strong longitudinal *plantar ligament*, fixed to the middle cuneiform bone; and two lateral *interosseous ligaments*, attached to the internal and external cuneiform bones. The *third* tarso-metatarsal joint, continuous with the second, also has a thin *dorsal ligament*, a thick *plantar ligament*, and an *interosseous ligament* connecting it with the external cuneiform bone. The *fourth* and *fifth* of these articulations, fig. 78, constitute a common joint, the *dorsal ligaments* of which are relatively stronger than the *plantar*.

Movements.—The movements at the bases of the second and third metatarsal bones, are very slight; at the base of the fourth, the gliding is such as to permit an upward and downward, and a slight spreading movement; in the case of the fifth, it amounts to an imperfect flexion, accompanied by an oblique movement of adduction, whilst the opposite movement of extension, with abduction, is also possible. The metatarsal bone of the great toe glides slightly sideways, but scarcely at all upwards and downwards; so that, whilst it serves to widen the foot by spreading this a little, it is well adapted to bear vertical strains. A sort of forced rotation also takes place in this and in the fifth tarso-metatarsal joint.

The Tarsal Joints.—The gliding joints formed between the five tarsal bones situated in front of the transverse joint of the tarsus, namely, those between the cuboid and the three cuneiform bones, and between these latter and the scaphoid bone, the last sometimes also articulating with the cuboid, are held together by strong *dorsal*, *plantar*, and *interosseous ligaments*, figs. 78, 79, which help to maintain the transverse arch of the foot. The plantar ligaments between the scaphoid and the three cuneiform bones, are chiefly composed of offsets from the tendon of the tibialis posticus muscle. The five bones just mentioned, being separated by the transverse joint from the two remaining bones of the tarsus, namely, the os calcis and the astragalus, constitute an anterior tarsal segment, which may be conveniently designated the *pro-tarsus*; whilst the two bones constituting the hinder tarsal segment, might be termed the *epi-tarsus*.

The slightly undulating, planiform *calcaneo-cuboid* articulation, which forms the *outer part* of the *transverse joint* of the tarsus, has one *dorsal ligament* on the outer side of the joint, fig. 78, and another *dorsal* or *interosseous ligament* passing backwards to the deep groove in the os calcis. It also has two very strong *plantar* ligaments, viz.: the *short calcaneo-cuboid ligament*, fig. 80, placed close beneath the bones, and the *long calcaneo-cuboid ligament*, fig. 79, the longest of the tarsal ligaments (ligamentum longum plantæ), placed nearer the skin, though still very deep, and extending from close to the tuberosities of the os calcis, to the oblique ridge on the cuboid bone, some of





Figs. 78, 79.—The Ligaments of the Toes, Metatarsus, Tarsus, and Ankle Joint, seen on the outer, inner, and under sides of the Foot.

its fibres passing beyond the groove for the tendon of the peroneus longus, to the bases of the central three metatarsal bones.

The *astragalo-scaphoid* articulation, which forms the *inner part* of the *transverse tarsal joint*, the only ball-and-socket joint in the tarsus, has a broad *dorsal ligament*, fig. 79 ; but the places of *lateral* and *plantar ligaments*, are supplied by a strong and peculiar ligament, which extends between the os calcis and the scaphoid bone. These two last-named bones, indeed, do not directly articulate, but they are tied together by a *dorsal ligament*, fig.

78, extending from the fore part of the deep groove on the os calcis, to the outer side of the scaphoid bone, and by a much stronger *plantar ligament* of very special structure, the *inferior calcaneo-scaphoid ligament,* fig. 80 †; this is a broad, thick band, which passes from the fore part of the sustentaculum tali of the os calcis, beneath the head of the astragalus, which rests upon it, to the under surface of the scaphoid bone, as far forwards as the tuberosity, and also upwards on the inner side of the bone, fig. 79. The upper surface of this ligament, covered by synovial membrane, enters into the astragalo-scaphoid joint, and partly supports the head of the astragalus ; in its substance, is found some fibro-cartilage, and its yellowish hue and marked elasticity, indicate the existence in it, of an admixture of yellow elastic tissue.

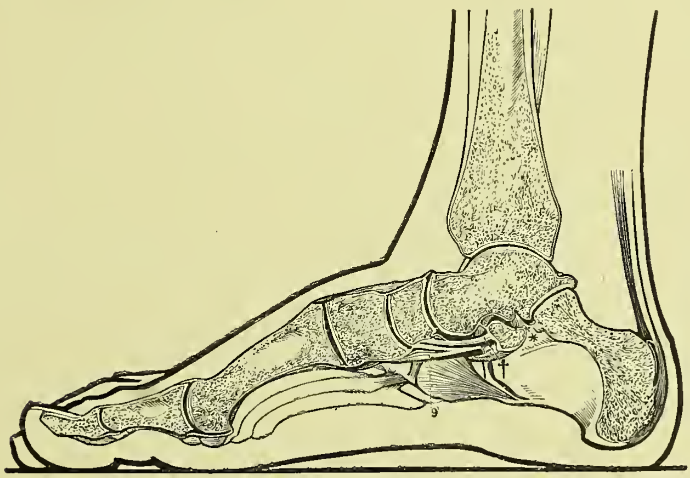


Fig. 80.—Longitudinal section through all the joints along the inner border of the Foot, and through the middle of the Ankle Joint. †, Inferior calcaneo-scaphoid ligament. *, Interosseous astragalo-calcaneal ligament. 9′, Tendon of tibialis posticus muscle.

The *astragalo-calcaneal* articulation, the peculiar double gliding joint, formed between the upper surface of the os calcis and the under surface of the astragalus, is chiefly held together by a very strong transverse *interosseous* ligament, figs. 80, 81, 82, *, which occupies the sinus pedis, formed by the grooves on the two bones, between their articular facets, fig. 11. There are also slight *internal, posterior,* and *external ligaments* ; but the interosseous one is thick, more than an inch wide from side to side, and composed of fibres, which spread upwards in three directions, so as better to resist strains. The part of the joint in front of the ligament, is continuous with the astragalo-scaphoid joint.

Movements.—Whilst the tarsal articulations, generally, impart elasticity and resisting power to the foot, especially to its transverse and longitudinal arches, they also endow it with flexibility, so that its curvatures may be more or less continually changed. Thus, under pressure, the tarsal arches become flattened, owing to the slight separation of the contiguous surfaces of the bones below, and they regain their form, when the super-incumbent weight is removed. On the inner border of the foot, the strong and somewhat elastic calcaneo-scaphoid ligament yields and recoils. The calcaneo-cuboid and the other ligaments, as well as the plantar fascia, offer a firmer resistance, in which action, the flexor muscles also assist; when the heel is raised, those muscles, acting on the pro-tarsus and the toes, contribute to relieve the joints from the extra strain. In free movements of the foot across its transverse articulation, the bending down of the anterior part of the tarsus, or pro-tarsus, is accompanied by an inward movement, and its re-elevation by an outward movement, both being permitted by the prolongation of the convex and concave astragalo-scaphoid articular surfaces, in an oblique direction, downwards and inwards, and by the comparatively plane calcaneo-cuboid joint; these movements involve also a slight rotation of the socket of the scaphoid on the head of the astragalus, by which, the anterior portion of the foot has its inner border either raised or lowered, and the sole inverted or everted. Simple outward and inward movements are here resisted by the great width of this transverse articulation.

Supposing the foot to be *free*, the movements at the astragalo-calcaneal articulation consist of a backward and forward motion, of a horizontal rotatory motion, and of a lateral motion of the os calcis, with the rest of the foot, beneath the astragalus. These motions are so associated, that the part of the foot below and beyond the astragalus, may be carried forwards, outwards and upwards, or backwards, inwards and downwards, the sole being everted in the former and inverted in the latter movements, both being always associated and harmonised with the movements occurring in the transverse tarsal joint. When the foot is *fixed*, movements, reciprocal with those just described, take place, namely, movements of the astragalus and the os calcis upon the scaphoid and cuboid, and of the astragalus upon the os calcis. It is by these, that the foot is adapted to uneven surfaces of the ground, whilst the leg, with the astragalus locked between the malleoli, is enabled to be inclined sideways at various angles.

The Ankle Joint.—The strong hinge joint, formed at the *ankle*, figs. 78 to 82, has its capsule strengthened, in front, by a broad and thin *anterior ligament*, which passes from the astragalus to the tibia, and blends with the lateral ligaments. A somewhat thinner *posterior ligament* connects these bones behind; but a stronger portion ties the astragalus to the fibula, being attached to the deep depression, seen, from behind, on the external malleolus. As always occurs with hinge joints, the lateral ligaments are very strong. The *internal lateral*, figs. 79, 81, 82, named from its shape the *deltoid ligament*, (Δ, the Greek letter, delta), has its apex fixed around the summit and borders of the internal malleolus, whence its fibres radiate to their insertions, some passing forwards, beyond the astragalus, to the scaphoid bone, and to the inferior calcaneo-scaphoid ligament, others downwards, partly to the astragalus, but chiefly to the sustentaculum tali of the os calcis, and others backwards to the astragalus. The *external lateral ligament*, figs. 78, 81, 82, consists of three distinct bands, which descend from the front, tip, and back of the external malleolus; they are attached, respectively, the *anterior* band, the shortest, to the astragalus in front of its external articular surface; the *middle* band, the longest, which passes beyond the astragalus, to a tubercle about the centre of the outer surface of the os calcis; and the *posterior* band, the strongest and most deeply seated, to the back of the astragalus, behind its external articular surface.

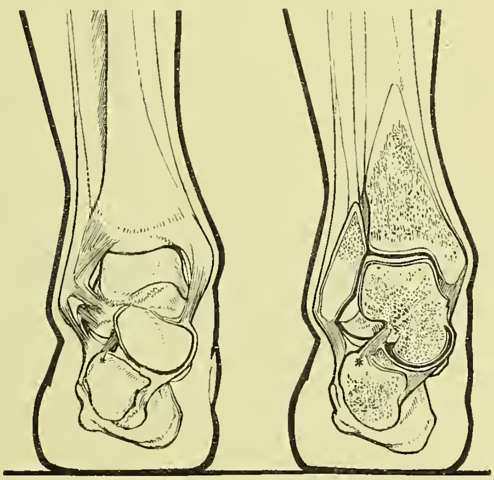


FIG. 81.—Articular surfaces of the Os Calcis and Astragalus belonging to the Transverse Joint of the Tarsus; the Ankle Joint laid open in front.
FIG. 82.—Vertical transverse section through the Astragalo-calcaneal Joint, and the Ankle Joint. *, the Interosseous Astragalo-calcaneal ligament.

As is usual, in joints possessing considerable freedom of motion, some fatty tissue outside the looser parts of the capsule, serves to fill up any slight interspaces between the bones, ligaments and tendons, in front of and behind the joint.

Movements. — Extension is more free than flexion. Owing to the relative width of the trochlear surface of the astragalus in front, this bone is closely fitted into the tibio-fibular socket in the rectangular or flexed position, that is, in the position in which the foot ordinarily bears most weight; but when the foot is extended, the narrower part of the astragalus lies in the socket, and then the slight lateral movements noticeable at this joint, become more evident. Nevertheless, these movements are arrested, at the limit of forced extension, by the tightening of the ligaments, as occurs in standing on tiptoe. Owing to certain obliquities of the articular surfaces at this joint, the foot is slightly adducted towards the middle line of the body, when it is straightened; but it is abducted or turned outwards, when it is brought up towards the leg. When the foot is fixed, reciprocal opposite movements occur, so that, in standing with the foot flat on the ground, the leg is inclined inwards at the ankle, whereas, in standing on tiptoe, the leg falls more directly over the foot. The lateral movements occurring at the astragalo-calcaneal articulation, obviously save the ankle joint from lateral strains; and as the ligaments of the ankle proper descend, beyond the astragalus, to the os calcis, they serve to support the joint between those bones, as well as the ankle joint itself, and guard both against the effects of lateral twisting.

The broad deltoid ligament, filling in the interval between the internal malleolus and the tarsal bones, assists in smoothing the surface forms in that region; whilst the middle and especially the anterior band of the external lateral ligament, are sometimes recognisable on the surface below the external malleolus.

The Tibio-fibular Joints.—The *inferior tibio-fibular*, planiform articulation has a flat *anterior ligament*, figs. 78, 81, passing from the tibia to the fibula, and widening out at its attachment to the latter; a similar *posterior ligament*, fig. 78; a narrow *transverse ligament*, consisting of mixed yellow and white fibres, extending across the back of the joint from the external malleolus to the tibia, chiefly along the hinder border of the articular surface of the latter; and, lastly, an *inferior interosseous ligament*, fig. 82, consisting of short, intersecting fibres, which pass from bone to bone, just above their narrow lateral articular facets. Of these ligaments, the last-named is the strongest; but the transverse ligament is the most remarkable, as it serves to deepen the socket of the ankle joint behind, and is decidedly elastic. The articular cavity communicates with that of the ankle joint.

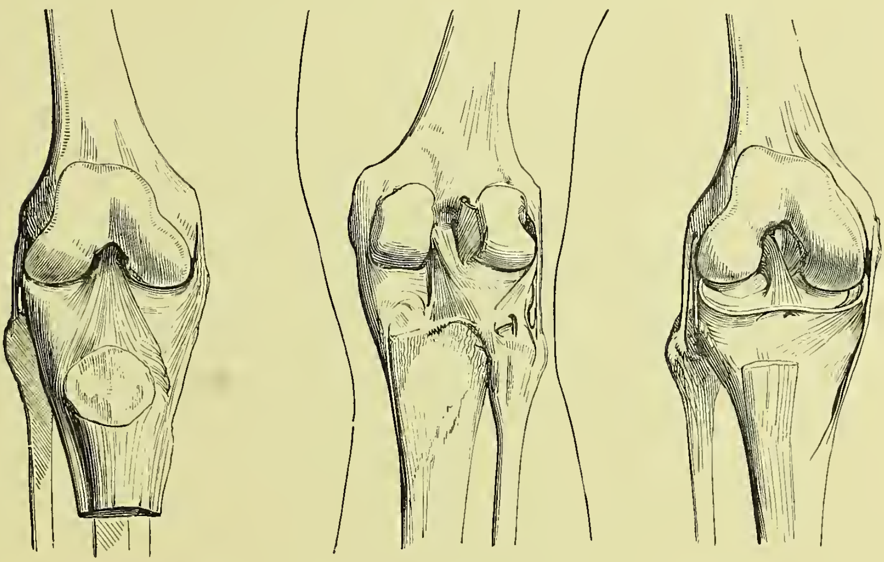
A firm, *interosseous membrane* stretches from the interosseous ridge of one bone to that of the other, its fibres, for the most part, passing downwards and outwards, from the tibia to the fibula; it gives attachment to muscles, and leaves small spaces above and below it.

The *superior tibio-fibular* articulation, fig. 85, also planiform, is completed by a strong *anterior*, and a somewhat weaker *posterior ligament*, fig. 84, the fibres of both of which pass obliquely from bone to bone. This little joint sometimes communicates with the knee joint.

Movements.—The fibula is here the moveable bone, but its movement on the tibia is very slight. The lower end may be somewhat separated from the tibia, by weight or strain, and then spring back, the elastic transverse ligament being brought into play; the strong inferior interosseous ligament acts not only as a tie, but as a pad between the bones. The interosseous membrane, as it were, suspends the fibula from the tibia; it also diffuses the effects of longitudinal shocks or pressure from below, from the tibia to the fibula. The slight gliding movements at the superior tibio-fibular articulation, save the slender bone of the leg from the effects of shock or pressure acting from below.

The Knee Joint.—The *knee*, the largest joint in the body, figs. 83 to 87, has the loosest *capsule*, a thin but strong fibrous membrane, which encloses the joint, and fills in the intervals between the special ligaments. It is attached above to the femur, in front and at the sides to the patella and to the inter-articular cartilages, and below to the tibia; it is strengthened, generally, by the fascia which invests the lower limb, and also by tendinous expansions from the surrounding muscles, figs. 140, 142, 145. In front of the joint, below the patella, and reaching from that bone to the anterior tuberosity of the tibia, is the broad, thick prolongation of the tendon of the great extensor muscles, the *ligamentum patellæ*, sometimes named the *anterior ligament* of the knee, figs. 86, 140, *l p*.

Of the proper ligaments, the *posterior* is a strong wide band, figs. 86, 144, formed partly by the capsule of the joint, and partly by fibres reflected from



The Knee Joint laid open.

Fig. 83.—Front view, with the patella turned down, showing its articular surface, a part of the extensor tendon, and the ligamentum mucosum.

Fig. 84.—Back view, showing the crucial ligaments, and posterior margins of the semilunar fibro-cartilages.

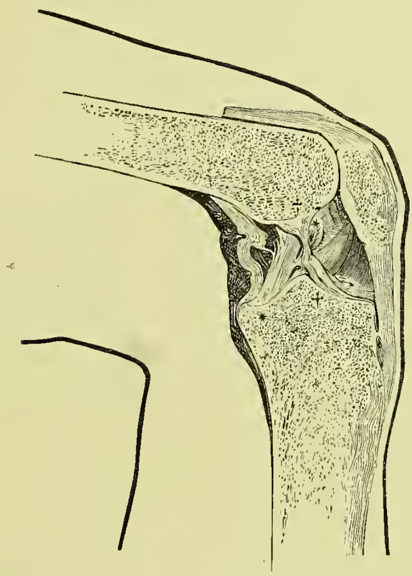
Fig. 85.—Front view, the femur thrown a little back, the patella, with the greater part of its ligament, having been removed; it shows the crucial ligaments and anterior margins of the semilunar fibro-cartilages.

the tendon of the semi-membranosus muscle; it also receives fibres from the tendons of the popliteus and gastrocnemius. It passes obliquely from the back of the internal tibial tuberosity, to the outer condyle of the femur. The *lateral ligaments*, as in hinge joints generally, are of great strength, and are fixed further back than the centre of motion in the joint. The *internal lateral* ligament, figs. 83 to 85, a broad flat band, passes from the tubercle on the inner condyle of the femur, to the internal tuberosity and side of the tibia; it blends with the capsule of the joint; its deep surface, partly free and lined by the synovial membrane, moves over the side of the condyle of the femur, or the bone moves beneath the ligament; it is, however, attached to the margin of the internal semilunar cartilage, which is thus fixed to the head of the tibia. The *external lateral ligament*, figs. 83 to 85, a strong rounded cord, passes downwards, from the tubercle on the outer condyle of the femur, to the head of the fibula; it is shorter than the internal lateral ligament, is placed a little further back, and is not connected with the external semilunar cartilage. Behind it, a second, or *short external lateral* ligament, usually passes from the outer condyle of the femur, to the styloid process of the fibula, being connected with the capsule and with the tendon of the popliteus muscle; its points of attachment, both above and below, are so prominent that, contrary to the general rule as to ligaments, it may often be recognised on the surface, more especially when the knee is forcibly straightened or over-extended, or when it is bent and the leg rotated inwards.

Placed deeply at the back of the joint, and projecting into it, but still outside the synovial membrane, are two very strong fibrous bands, named the *crucial ligaments*, figs. 84 to 87, because they decussate or cross each other after the manner of the lines of the letter X. The *anterior*, or *external, crucial ligament*, figs. 85, 87, ††, extends from the depression in front of the spine of the tibia, close to the internal articular facet, upwards, backwards, and outwards, to the upper and back part of the inter-condyloid fossa, and to the inner or deep surface of the external condyle of the femur; it is connected, below, with the fore part of the external semilunar cartilage. The *posterior*, or *internal, crucial ligament*, figs. 84, 86, and 87, **, extends from the depression behind the spine of the tibia, in front of the posterior ends of both semilunar cartilages, upwards, forwards, and inwards, in a radiating manner, to the outer or deep surface of the inner condyle of the femur, as far as to the fore part of the inter-condyloid fossa. These crucial ligaments not only tie the bones together, but specially resist the displacement of either bone on the other, in a backward or forward direction.

The *inter-articular* or *semilunar cartilages*, figs. 85, 86, are two crescentic fibro-cartilaginous plates, which cover the borders only of the two articular facets of the tibia; their extremities, fixed in front of and behind the spine of that bone, are fibrous, but the parts between the articular ends of the tibia and femur, are cartilaginous. Their convex borders are thick, and connected with the capsule; their concave borders are thin, and free in the joint. Their upper surfaces are hollowed, thus increasing the depth of the concavities, on which the condyles of the femur rest; their under surfaces, in contact with the tibia, are flattened. The *internal cartilage* is almost semicircular, but is somewhat elongated from before backwards; its convex border is attached to the internal lateral ligament, to some tendinous fibres belonging to the semi-membranosus muscle, and also, by short, so-called *coronary* fibres, to the head of the tibia. The *external cartilage* forms nearly the whole of a circle, smaller than that of the internal cartilage, its attached ends being interposed between those of the latter, and separating them from the spine of the tibia. It is connected, in front and behind, with both crucial ligaments, and also with the external cartilage, by a special *transverse ligament*; but it is not so closely connected with the tibia, or with the capsule, its anterior end being entirely within the joint, and its posterior end separated from the capsule by the tendon of the popliteus muscle, which furnishes some fibres to it.

The *synovial membrane* of the knee, which lines the capsule and the articular surfaces of its numerous ligaments, is the largest in the body, and facilitates the extensive movements of this great hinge joint. It forms a



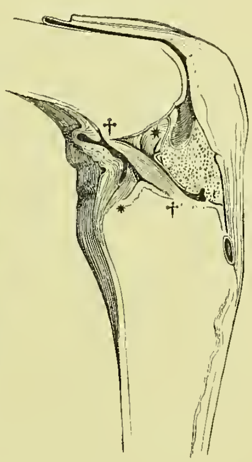


Fig. 86.—Vertical median section through the Knee Joint, showing the bones covered with articular cartilage, the posterior ligament, the posterior crucial ligament, *, a part of the anterior crucial ligament, †, and the ligamentum patellæ, with the bursa between it and the Tibia.

Fig. 87.—Vertical section made to the outer side of the middle line. Anterior crucial ligament, ††. Posterior crucial ligament, **. In front of these, is the fatty tissue of the ligamentum mucosum, behind the ligamentum patellæ.

pouch in front of the lower part of the femur, beneath the broad tendon of the great extensor muscles, a few deeply seated fleshy fibres being connected with the capsule, and serving to withdraw it out of the way of the patella, during extension of the leg. Folds and processes of the synovial membrane, containing fat and vessels, constitute the *alar ligaments*, and the *ligamentum mucosum*, figs. 83, 87, seen, in the opened joint, behind and at the sides of the ligamentum patellæ. In this situation, also, there are large cushions of fat connected with the alar and mucous ligaments, fig. 87, which project or retire from observation, according as the extensor muscles, which are connected with the patella, are in action or at rest.

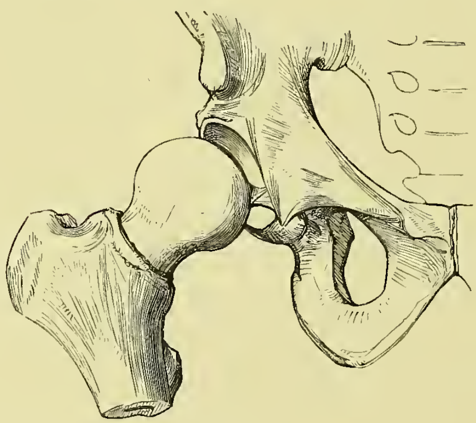
Movements.—The range of movement at the knee joint is greater than that at any other joint in the body; but, notwithstanding this, and the fact that its component bones are the longest in the body, the great breadth of its articular surfaces, the existence of the peculiarly shaped inter-articular cartilages, and the strength of its ligaments, render it very secure. The inter-articular cartilages move always with the tibia, on the condyles of the femur; or the condyles of the femur move on the tibia and the cartilages. Flexion is by far the freest movement, and may be said to be complete, being arrested only, or chiefly, by contact of the leg with the thigh. Extension may be carried a little beyond the straight line, as when the knee is thrown back in standing at ease, in which position the weight of the body is supported, without muscular effort, by the tightening of the ligaments at the sides, and back of the joint. Owing to the unequal length of the two condyles, oblique movements occur at this joint, by which, in extension, the tibia, with the external semilunar cartilage, is abducted, or moved towards the outer condyle, and the leg is directed outwards; whilst, in flexion, the tibia and the internal cartilage are adducted on the inner condyle, and the leg is again turned inwards, or in the same plane as the thigh; the leg and foot are thus thrown outwards in extension of the knee, and drawn inwards again during flexion. These oblique movements give variety and grace to the relative positions of the long segments of the lower limb. In extension of the knee, nearly all the ligaments are tightened, even the lateral ligaments, which are fixed behind the axis of motion at the joint, the exceptions being the ligamentum patellæ and the posterior crucial ligament; in this position, the two long bony segments of the lower limb are locked together, so as to form a single firm column, in which no rotation is possible of one part upon the other, a provision admirably adapted to the necessities of the erect posture. But as the knee is gradually bent, a proper rotatory movement of the leg upon the thigh is permitted, this being most marked in semi-flexion; it is in this position, that the strong posterior, lateral, and anterior crucial ligaments are all relaxed. This rotatory movement of the tibia takes place beneath the internal condyle of the femur, the most evident movement of displacement of the tibia being at its external tuberosity, the fibula of course moving with it.

The oblique movements of the *patella* upwards and downwards, during flexion and extension of the knee, upon the end of the femur, have been already explained, p. 61. In the straight position of the knee, the anterior surface of the patella is directed forwards, but, in flexion, it is turned a little outwards; in extension, the ligamentum patellæ descends somewhat obliquely outwards to the anterior tuberosity of the tibia, whilst, in flexion, it is almost vertical. The position of the lower end of the ligamentum patellæ, is necessarily changed in rotation of the leg upon the thigh, in different degrees of flexion of the joint, and the direction of the ligament varies accordingly. In standing completely at ease, with all the muscles of the thigh at rest, the patella is usually allowed to fall loosely in front of the joint, but it may also be then drawn up by the voluntary action of the extensor muscles attached to it; in the former case, the fatty cushions on either side of and behind the ligamentum patellæ, are not compressed, but retire behind that ligament; when, however, the patella is drawn up, they are pushed out on each side of it.

It will be understood, that every movement of the tibia upon the femur may be reciprocated by an opposite movement of the femur on the tibia; for example, if during the sitting posture with the leg vertical, the limb be simply straightened at the knee joint, the head of the tibia moves forwards beneath the condyles of the femur; but, if, from the same position, the erect attitude is assumed, the condyles of the femur move backwards on the head of the tibia, the cartilages, in the one case, following, and, in the other, remaining with the tibia, and doubtless serving as guides to the necessary sliding movements.

The Hip Joint.—The articular cartilage, which covers the ball, and that which lines the socket, of the hip joint, fig. 90, are thickest at the upper part of each. The socket itself is surrounded by a peculiar structure attached firmly to its rim, named the *cotyloid ligament*, figs. 88, 90. This is shaped like a ring, having a prismoidal section; its broader side, fibro-cartilaginous, is fixed to the bony rim and also to the cartilaginous lining of the acetabulum; whilst its thinner side, or edge, containing yellow elastic fibres, is free and contracted, so as to overhang the cavity of the acetabulum; it thus not only deepens the socket, but narrows the outlet; it also embraces the head of the femur, in contact with which it is maintained by the capsule and accessory ligaments; it is much thicker above and behind the joint, than elsewhere. Some superficial fibres of this cotyloid ligament, strengthened by proper fibres, constitute the *transverse ligament*, which passes across the notch of the acetabulum, thus completing the rim, and giving a uniform edge to the socket, at the same time permitting vessels and nerves to enter the joint. The head of the femur is connected directly with the bottom of the socket, by the *ligamentum teres*, or *round ligament*, fig. 88, which is unique, in the fact that it passes across the interior of the joint. It is not cord-like in shape, however, but triangular; its narrower end is fixed to the double pit on the inner aspect of the head of the femur; becoming flattened, it passes down, along a slight depression on the inner side of the head of the bone, fig. 90, and is attached by its base, which is divided into two parts, to the ischial and pubic margins of the notch of the acetabulum, blending with the ends of the transverse ligament. It is completely invested by a tubular prolongation of the synovial membrane. It is usually strong, but it differs much in thickness, in different individuals.

The *capsule* of the hip joint, for the most part dense and firm, is attached to the neck of the femur, in front, fig. 88, as far down as the anterior trochanteric line, and, elsewhere, nearly to the root of the greater trochanter; above, it is fixed to the cotyloid ligament and the rim of the acetabulum. Its lower part is thin and loose, fig. 90, but it is thicker above, and, especially, in front; its upper part is supported by fibres from the reflected portion of the tendon of the rectus femoris muscle. This capsule is fortified by four strong *accessory ligaments*; first, the *ilio-femoral ligament*, fig. 89, a very strong band, often half-an-inch thick, narrow above, but spreading out below, which extends from the anterior inferior spinous process of the ilium, over the front of the capsule, to the anterior inter-trochanteric line of the femur; secondly, the *ilio-trochanteric ligament*, fig. 89, reaching from near the anterior inferior spinous process of the ilium to the front of the root of the greater trochanter, and adjacent part of the neck of the femur; thirdly, the *pubo-femoral ligament*, proceeding from the pubic bone, near the acetabulum, to the front of the smaller trochanter and neighbouring part of the neck of the femur; and, lastly, the *orbicular ligament*, situated on the back of the capsule, which, extending between the ilio-trochanteric and pubo-femoral ligaments, closely embraces the hind part of the neck of the femur, and receives certain longitudinal fibres descending from the hip-bone, which, therefore, do not reach the femur itself.



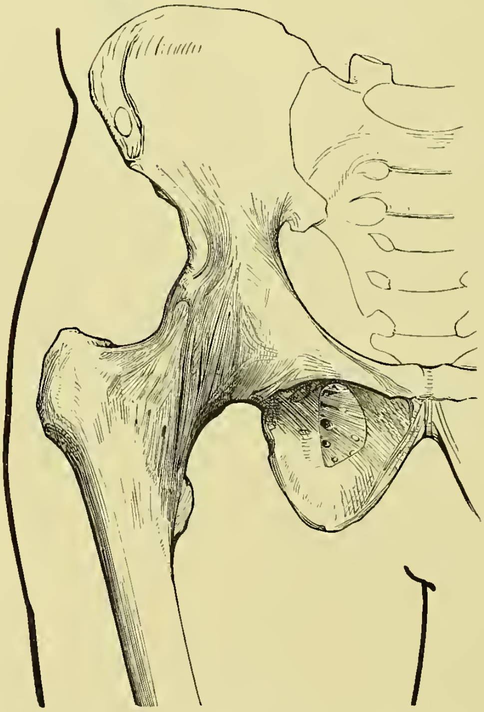


Fig. 88.—The Hip Joint seen from the front, and laid open, showing the acetabulum, the cotyloid ligament, and the ligamentum teres.

Fig. 89.—The joint seen from the front and closed, showing the capsule, and the accessory ligaments; also the symphysis pubis, and the obturator membrane.

Movements.—Flexion is here the freest movement; next in point of freedom, is abduction, then adduction, and, lastly, extension, which is the most limited, and is soon restrained by the tightening of the thick capsule and the accessory ligaments, in front of the joint, as occurs in standing at ease. In this posture, as just stated, the knee likewise is held tight by its ligaments, but the ankle joint is not so supported, for it is the seat of free balancing movements. Circumduction at the hip joint, is not so free as in the shoulder; but rotation is more free, external rotation being more extensive than rotation inwards. The influence of atmospheric pressure in retaining the articular surfaces of joints in contact, has been especially demonstrated by experiments on the hip joint; and it appears that the forward movement of the freely-swayed lower limb in locomotion, is, in a great measure, pendulum-like, and independent of muscular effort, except in so far as it is guided or checked by the muscles.

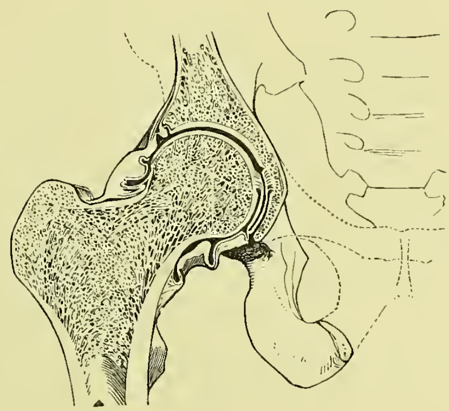


FIG. 90.—Vertical section through the Hip Joint, showing the structure of the bones, the encrusting cartilage, the ligamentum teres, and the loose, folded capsule.

Every movement of the head of the femur in the acetabulum, is reciprocated by an opposite movement of the innominate bone, and, therefore, of the entire pelvic girdle, on the head of the thigh-bone. Thus, the backward movement of the pelvis, performed in standing upright, is equivalent to extension, and the forward movement in stooping, to flexion of the thigh; the inclination of the pelvis, outwards or inwards, corresponds to abduction or adduction, of the thigh; whilst the swinging of the pelvis horizontally forwards or backwards, is equivalent to rotation of the thigh inwards or outwards. The ligamentum teres checks adduction of the thigh, or a sinking down of the pelvis upon the opposite side, and, possibly, also limits the reciprocal, horizontal rotatory movements of the femur and the pelvis on each other.

THE JOINTS OF THE PELVIS.

At the *symphysis pubis*, the ovoid *inter-articular fibro-cartilage*, thicker in front than behind, closely attached by ridges and furrows to the bones on either side, and often including an imperfect synovial cavity, fig. 88, is connected, by its edges, to the ligaments which surround the joint. The *anterior ligament*, fig. 89, partly fibro-cartilaginous, consists superficially of decussating fibres. The *inferior* or *sub-pubic ligament*, or *ligamentum arcuatum*, fig. 89, is the most remarkable, being strong, yellowish, and elastic; it completes the pubic arch below. The *posterior* and *superior ligaments* are thin.

The *sacro-iliac junctions*, or *synchondroses*, are similar, but still stronger joints. The large ear-shaped *fibro-cartilages*, encrusting the bones, contain a soft central part, or a cavity. There is a thin *anterior ligament*; but, the bones are especially held together by remarkably thick *posterior ligaments*, extending from the broad rough surfaces of the ilia, behind the joints, to the prominent tubercles on the back of the sacrum.

The hip-bones are also fastened to the sacrum, by the two firm *sacro-sciatic ligaments*, *anterior* and *posterior*, fig. 142, *s*, *s′*, which pass on each side, from the tuberosity and spine of the ischium, to the side of the sacrum and the coccyx. Both these ligaments give origin to muscular fibres; between them and the bones, are intervals, through which the pyriformis muscle and the compound tendon of the internal obturator muscle, pass out of the pelvis to the femur. The *obturator ligament*, fig. 89, which almost completely closes the thyroid foramen, gives partial origin to the two obturator muscles. The tendinous cord, named *Poupart's ligament*, figs. 153, 154, *p*, reaching from the anterior superior spinous process of the ilium, to the spine and crest of the pubes, is really the thickened lower border of the tendon of the external oblique muscle of the abdomen, fig. 155.

Movements.—The articulations of the pelvis hold its component bones together, give it elasticity, and prevent shock. The strong posterior ligaments serve to suspend the sacrum and the vertebral column above it, between the ilia, the sacrum appearing as if it would drop between those bones; but its anterior part is slightly narrowed, across the front of the alæ, so that its edges are underlapped by the ilia, provided that the three bones are firmly held together by the intervening fibro-cartilages, and by the very strong ligaments.

The mixed pelvic articulations permit no intrinsic movements capable of disturbing the local forms. Poupart's ligament, however, establishes an outward surface *furrow*, which defines the limit between the thigh and the abdomen.

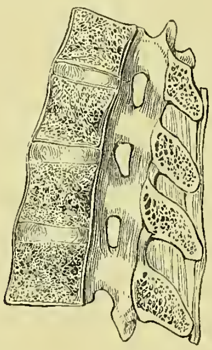
The Joints of the Vertebral Column.

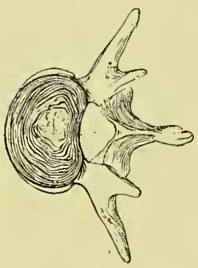
The Sacro-coccygeal, and Coccygeal Joints.—These mixed joints, until they become ossified after middle life, earlier in men, however, than in women, consist of interposed *fibro-cartilages* or *inter-vertebral substances*, and of weak *anterior*, and stronger *posterior* ligaments.

The Sacro-vertebral Articulation, and Ilio-lumbar Ligaments.—An *intervertebral* substance, with ligaments similar to those which unite the bodies and the articular and other processes of the moveable vertebræ, is present between the sacrum and the lowest lumbar vertebra. But two special ligaments exist on each side, namely, the *sacro-vertebral ligament*, a triangular band, extending from the upper surface of the sacrum to the under surface of the last lumbar transverse process, and the *ilio-lumbar* ligament, also triangular, which converges from the broad hinder part of the crest of the ilium, to the summit of the same transverse process. These two strong ligaments afford powerful support to the junction of the moveable with the immoveable portion of the vertebral column, at which great strains are continually borne.

The Joints of the Moveable Vertebræ.—The moveable vertebræ are so far peculiar, that they articulate with each other by both *mixed* and *moveable* joints, by the former at their bodies, by the latter at their articular processes. The laminæ, the spinous processes, and the transverse processes, are also connected by special ligaments.

The *intervertebral fibro-cartilages, substances*, or *discs*, figs. 91 to 93, which connect the *bodies* of the vertebræ, from the sacrum to the axis, differ in consistency and structure at their circumference and at their centres, but they adhere everywhere to the bodies of the vertebræ between which they are placed; they are also attached by their edges to the adjacent ligaments. In outline and size, they correspond with the bodies of the vertebræ in the different regions; and they are not flat above and below, but lenticular. They are absolutely, and proportionally, thickest in the lumbar region; and proportionally thicker in the cervical than in the dorsal region. In the lumbar and cervical regions, where the spine is convex anteriorly, the discs are thicker in front; in the dorsal region, where the spine is concave anteriorly, they are slightly thicker behind. The curve of the lumbar and cervical regions, depends mainly on the wedge-shape of the intervertebral discs; whereas that of the dorsal region is principally dependent on the shape of the bodies of the vertebræ. The intervertebral substances form nearly one-fourth of the whole length of the moveable portion of the spine; they are said to undergo, from pressure in the upright posture, a slight diminution in thickness, by which the stature is reduced during the day, nearly half an inch, which is recovered in the night. The outer portion of each intervertebral disc is laminated, fig. 91, being composed of alternate layers of fibrous membrane and fibro-cartilage, concentrically arranged, those next to the circumference of the disc being more closely, and those nearer to the centre less closely packed together. As seen on a transverse section, fig. 92, these layers resemble the divided scales of an onion. The component fibres of the membranous laminæ, pass obliquely between the bodies of the vertebræ, the fibres of each successive layer having an opposite direction, so that they cross each other and resist strains in all directions; some of the fibres, however, pursue a less regular course. The central portion of each intervertebral substance, figs. 91, 92, forming less than half of its area, and placed nearer to the back of the disc, is composed of a pulpy, elastic, semi-translucent, pale yellowish substance, which, on a transverse section of the disc, rises up and assumes a conical or swollen form. This is more abundant in the lumbar and cervical,





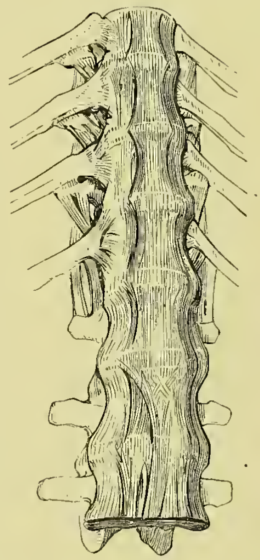


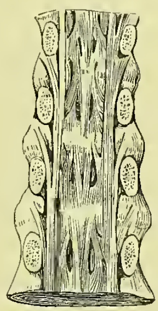
FIG. 91.—Vertical median section through the dorsi-lumbar region of the Spine, showing the intervertebral discs, the capsular ligaments, and the inter- and supra-spinous ligaments; also a part of the spinal canal.
FIG. 92.—Upper view of a Lumbar Vertebra, with transverse section of its intervertebral disc.
FIG. 93.—Front view of four dorsal, and three lumbar vertebræ, showing the anterior common ligament, and the edges of the intervertebral discs; it also shows the costo-vertebral ligaments.

than in the dorsal region. It consists of a very soft, delicate fibro-cartilage; near the bones, it merges into true cartilage.

The bodies of the moveable vertebræ are further connected together by an *anterior common ligament*, fig. 93, which extends from the sacrum to the axis, whence it is prolonged upwards to the base of the skull; it gradually diminishes in breadth from below upwards, and is composed of deeper fibres attached to the intervertebral discs and the adjacent vertebræ, and of superficial fibres reaching over three or four vertebræ; a few lateral fibres also pass from bone to bone. Within the spinal canal, is a strong *posterior common ligament*, fig. 94, situated upon, and attached to the back of the bodies of the vertebræ, from the sacrum to the axis, whence it is prolonged to the occipital bone. Some loose tissue intervenes between it and the sheath of the spinal cord, which is, therefore, undisturbed by the movements of the spine.

The *laminæ* of the moveable vertebræ are connected by the *ligamenta subflava*, fig. 95, which extend between them, from the sacrum to the axis. They consist each of two yellow, flattened, lateral bands, separated by a narrow interval opposite the spinous process, and composed of fibres of yellow elastic tissue, which pass almost vertically from vertebra to vertebra. They are thickest in the lumbar region, thinner and longer in the dorsal region, broad, yet weaker between the cervical vertebræ.

The *spinous processes* of the vertebræ are connected by thin membranous *interspinous* ligaments, fig. 91, extending between them, from their roots to their tips. A strong longitudinal cord, named the *supra-spinous* ligament, fig. 91, also reaches over the spinous processes, as high as the seventh cervical vertebra; it is thicker and broader in the loins than in the back; some of its fibres pass from the tip of one spine to that of another, others pass over three or four spines. From the spine of the seventh cervical vertebra, or vertebra prominens, the supra-spinous ligament is continuous with the *ligamentum nuchæ*, a thin, elastic, fibrous membrane, which extends along the median line, as high as the occipital protuberance, and gives off processes from its anterior surface to the spines of the other cervical vertebræ, fig. 190, *n*.



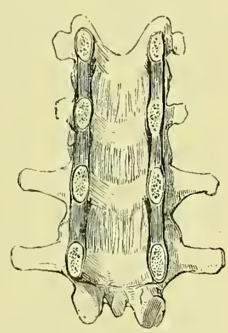


Fig. 94.—Posterior view of the bodies of four vertebræ, one dorsal and three lumbar, to show posterior common ligament.

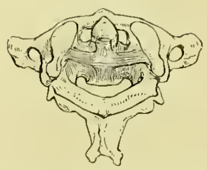
Fig. 95.—Anterior view of the arches of the same vertebræ, to show the ligamenta subflava between the laminæ.

Inter-transverse ligaments connect the *transverse* processes of the vertebræ, being largest in the lumbar region, smaller in the back, and either very slightly developed in, or absent from the neck.

Lastly, the gliding joints formed between the surfaces of the *articular processes* of the moveable vertebræ, concave and convex in the loins, but planiform in the back and neck, are held together by proper *capsules*, fig. 91, which, in all cases loose, are most so in the cervical region.

Movements.—Commencing from the upright posture, forward bending of the moveable part of the vertebral column is most free in the back, *i.e.* in the middle and lower part of the dorsum; it is less free in the loins, and least so in the neck. Bending backwards is most free in the neck, nearly as much so in the loins, but only slight in the back. Hence in stooping forwards, the neck and loins become merely flattened, whilst the back is strongly arched; whereas in bending backwards, the neck and loins become deeply incurved, whilst the back, except in its lower region, is only straightened. Lateral inclination of the spine is most free in the loins, rather less in the neck, and least in the back. Twisting around the vertical axis, or pure rotation, would be free in the back, were it not limited by the ribs; it is less in the neck generally; and it scarcely exists in the loins. The use of the intervertebral discs is obvious, preventing shock, and permitting limited movement in all directions, after the manner of a closed ball-and-socket joint, above and below each disc. The ligamenta subflava not only connect the vertebral arches and complete the canal, but permit of forward bending, especially in the back, and then assist the muscles, by their elasticity, in straightening the spine, thus saving the expenditure of muscular force.

The Atlanto-axial Joints.—The gliding joints formed, one on each side, between the *articular processes* of the axis and atlas, have thin and loose connecting capsules, stronger in front than behind. Within the ring of the atlas, there is a distinct little joint, with capsule and synovial membrane, between the front of the odontoid process of the axis and the arch of the atlas. Behind the odontoid process, is a strong, flat, curved band, the *transverse atlanto-axial ligament*, fig. 96, passing across, close to the neck of that process, a separate little articular cavity existing between them; from its central thickest part, a small slip ascends to the basilar process of the occipital bone, and another passes downwards to the root of the odontoid process; hence it is named the *cruciform ligament*, fig. 96. These two vertebræ are also connected, in front, by an *anterior atlanto-axial ligament*, a thin, loose membrane, strengthened in the middle line, and reaching from the base of the odontoid process to the anterior tubercle of the atlas; and, behind, by an equally thin, loose *posterior atlanto-axial ligament*, which extends between the arches of the bones.



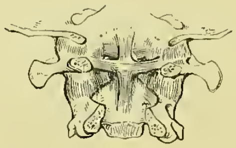


Fig. 96.—Posterior view of the transverse atlanto-axial ligament, and its upward and downward slips, constituting the cruciform ligament.
Fig. 97.—Posterior view of the occipito-axial or odontoid ligaments, namely, the central ligament, and the two alar, or check ligaments.

The Occipito-axial Ligaments.—The odontoid process of the axis does not touch, nor articulate directly with, the occipital bone; but the two bones are connected by a remarkable ligamentous apparatus, constituting the *odontoid ligaments*, fig. 97. Thus, a strong *central odontoid ligament* (ligamentum suspensorium dentis) passes upwards, from the apex of the odontoid process to the anterior margin of the foramen magnum. On the sides of this, are the *lateral* or *alar odontoid ligaments*, or *check ligaments*, two thick rounded cords, connected at their lower ends, which partially cross each other, with the apex of the odontoid process, and attached, above, close to the condyles of the occipital bone. These odontoid ligaments, and also the transverse atlanto-axial ligament, are covered behind, within the spinal canal, by a continuation of the posterior common ligament, which passes up from the axis to the margin of the foramen magnum.

The Occipito-atlantal Joints.—The concavo-convex gliding joints, between the articular processes of the atlas and the occiput, are connected by thin loose capsules. An *anterior occipito-atlantal ligament*, consisting of a broad membrane, strengthened in the middle, extends from the anterior arch of the atlas, to the basilar process of the occipital bone, in front of the foramen magnum. An equally wide, *posterior occipito-atlantal ligament* is attached below to the posterior arch of the atlas, and above to the occipital bone, just behind the foramen magnum. Two short strong *lateral inter-transverse ligaments*, one on each side, complete the means of connexion between the atlas and the skull.

Movements.—The rotatory movements and the nodding movements of the head, depend on the mechanism of the atlanto-axial and occipito-atlantal joints, the rotatory movements occurring at the former, and the nodding movements at the latter. The rotatory movements are obviously checked by the ligaments named after their use; but those ligaments aid the others situated behind the odontoid process, in restraining the forward nodding motion as well. The strong transverse atlanto-axial ligament keeps the odontoid process in its place, and prevents pressure on the spinal cord. Many combinations of the movements proper to the joints between the head and the two upper cervical vertebræ, with movements belonging to the neck itself lower down, constantly occur, as in listening, looking in different directions, or in meditation. Direct lateral movements of inclination of the head, are of this kind. Rotation, again, is hardly ever truly horizontal, unless with the co-operation of the cervical vertebræ generally; for the atlanto-axial rotation is accompanied by a descent of the head on the side towards which the face is turned, whereas the habitual movement is one of an upward kind towards that side. In consequence of the obliquity and peculiar relations of the articular surfaces on the two sides of the vertebro-cranial axis, all the free movements in this region are more or less graceful.

The Joints of the Thorax.

The Costo-Vertebral Joints.—The gliding *costo-central* articulations, between the heads of the ribs and the bodies of the vertebræ, possess a short *inter-articular ligament* or *fibro-cartilage*, which extends from the ridge between the two costal articular facets, to the corresponding inter-vertebral disc, thus forming double planiform, or angular hinge joints. Each costo-central joint, single or double, is completed by an anterior, *stellate ligament,* fig. 93, which radiates from the rib, to the vertebra above, to the vertebra below, and to the inter-vertebral disc between them. In the case of the twelfth, eleventh and first ribs, which join one vertebra only, no inter-articular ligament exists, and the stellate ligament is attached to the vertebra with which the rib articulates, and to that immediately above it.

The small gliding *costo-transverse* articulations, between the tubercles of the ribs and the tips of the corresponding transverse processes, are supported by a strong *interosseous costo-transverse* ligament, passing from the neck of the rib to the transverse process; by a *posterior costo-transverse* ligament, fig. 93, extending from the tubercle of the rib to the summit of the transverse process of the vertebra below; and by an *anterior costo-transverse ligament,* fig. 93, reaching from the neck of the rib to the transverse process of the vertebra above. These ligaments are modified, or absent, in the case of the first, eleventh, and last ribs.

The Costo-Chondral and Inter-Chondral Junctions.—The anterior end of each rib, is closely fitted to the outer end of its cartilage, and these two are held together by the periosteum and perichondrium, which invest them. There is no decided movement here, excepting, it is said, in the case of the second rib. The little gliding joints formed between the borders of the costal cartilages, from the ninth up to the sixth, possess capsules, and overlying *transverse ligaments.*

The Chondro-sternal Joints.—These planiform articulations are held together by small *inter-articular ligaments,* which connect the ends of the cartilages with the bottom of the sternal notches, and so form little double joints. *Anterior chondro-sternal ligaments,* fig. 98, radiate from these cartilages on to the front of the sternum, interlacing with those of the opposite side, with those above and below them, and with the aponeuroses of the greater pectoral muscles. There are also similar, but weaker, *posterior chondro-sternal ligaments.* The cartilage of the seventh rib has a single joint, and a *chondro-xiphoid* ligament passes from it to the xiphoid appendix of the sternum.

The Sternal Junctions.—The synchondrosis between the manubrium and the body of the sternum, fig. 98, contains an intervening *cartilage,* and is strengthened by *anterior* and *posterior* longitudinal *ligaments.* The body of the sternum is similarly connected with the xiphoid cartilage. These junctions, late in life, become osseous. Mobility can scarcely be said to exist in either ; but the xiphoid cartilage itself is elastic, until it becomes ossified.

Movements.—The slight gliding movements at the vertebral ends of the ribs and the sternal ends of their cartilages, permit movements of elevation and depression of each rib, around the chord of what may be called the costo-chondral arc. In these movements, the ribs ascend and descend, and likewise rotate on their two extremities; the inter-costal spaces widen and contract; the entire chest is, alternately, elongated, widened, and increased in depth from before backwards, or shortened and contracted both in width and depth. The sternum is, at the same time, either lifted upwards and forwards, especially its lower part, or it retires downwards and backwards. These are the respiratory movements of the thoracic walls, the expanding movements being those of inspiration, and the contracting movements those of expiration. They are supplemented, in their effects upon the general capacity of the thorax, by the associated movements of the diaphragm, which powerful muscle contracts and descends in inspiration, so as to elongate the chest, and then relaxes so as to ascend, and thus help in shortening that cavity. But the thorax is also subject to a variety of movements, as a part of the trunk. Thus the ribs, especially the lower ones, approximate in front, as the spine bends forwards, and separate from each other, when the lumbar and lower dorsal regions are curved backwards; in lateral inclination of the spine, the ribs approximate on the side of the movement, and separate on the opposite side; they must necessarily be opposed to rotatory movement of the spine; and this, as we have seen, is very slight in the dorsal region, to which the ribs are confined.

The Joints of the Shoulder-Girdle.

The Sterno-clavicular Joint.—In the interior of this gliding joint, fig. 98, is a circular *inter-articular fibro-cartilage*, thicker at its circumference than at its centre, and firmly fixed, by its lower edge, to the lower border of the sternal articular facet, and to the cartilage of the first rib, and by its upper edge, which is its thickest portion, to the upper and back part of the inner end of the clavicle. The joint is, therefore, usually double, the sternal part being the looser; but sometimes the cartilage is perforated, and then the two parts communicate. The general capsule, which is thicker behind, and everywhere attached to the edges of the fibro-cartilage, is strengthened by a broad *anterior ligament*, fig. 98, passing obliquely from bone to bone; by a narrower *posterior ligament*; and by a flat band, of variable size, named the *inter-clavicular ligament*, fig. 98, which ties together the inner ends of the two collar bones, passing across, adhering to, and partly filling up the supra-sternal notch, the surface-forms of which it modifies. At a short distance from the outer side of the sterno-clavicular joint, is the *costo-clavicular*, or *rhomboid ligament*, fig. 98, a short, flat band, which connects the cartilage of the first rib, with the under surface of the inner end of the clavicle; although this ligament does not enter directly into the formation of the sterno-clavicular joint, it materially strengthens the connection between the two bones.

Movements.—The sterno-clavicular articulation is very strong. The effects of blows on the outer end of the collar-bone, are admirably resisted by the peculiar attachments of the inter-articular cartilage, namely, to the sternum at its lower edge, and to the collar-bone at its upper edge. If its points of attachment were reversed, its means of resistance against such blows, would be seriously impaired. The cartilage also acts as a cushion, or pad, to deaden shock, and it likewise serves to better adapt the bony surfaces, which, from their difference in size and form, are inadequate to fit

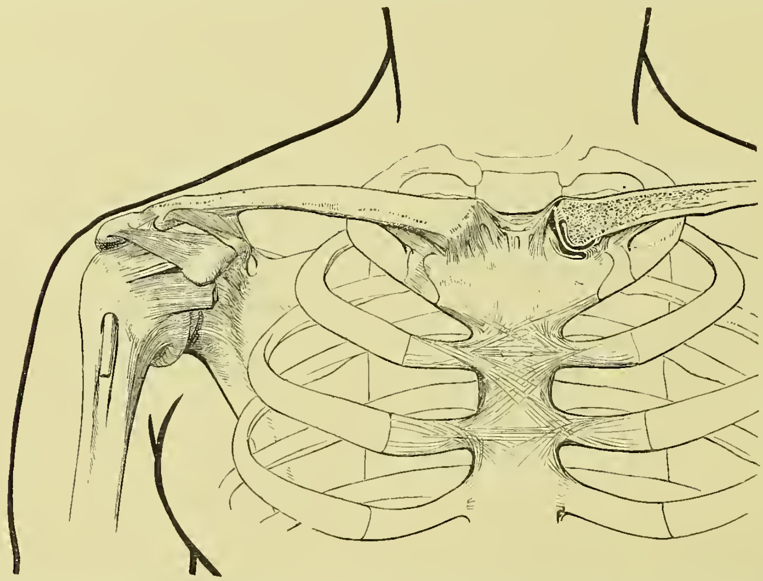


FIG. 98.—The Ligaments of the sternal, sterno-clavicular, and scapulo-clavicular articulations, and those of the shoulder joint. The left sterno-clavicular joint is opened to show the inter-articular fibro-cartilage. Tendons of capsular muscles are seen on the shoulder joint.

each other. The movements at this joint are as varied as those of a ball-and-socket joint; namely, elevation and depression, backward and forward movements, a circumductory movement on the inner end of the collar bone, and also a slight movement of rotation on its axis. These are all especially restrained by the strong costo-clavicular ligament.

The Acromio-Clavicular Joint, and Coraco-Clavicular Ligaments.—The above-named gliding joint is completed by a small wedge-shaped *inter-articular fibro-cartilage*, a capsule, and *superior* and *inferior* ligaments, fig. 98. This joint is mechanically weak, but the connection of the collar-bone with the scapula, is further secured by the two powerful *coraco-clavicular ligaments*. Of these, the *trapezoid ligament*, fig. 98, descends from the oblique line on the under surface of the clavicle, to the inner border of the coracoid process of the scapula, whilst the *conoid ligament*, fig. 98, placed behind the trapezoid, passes from the conoid tubercle and the neighbouring surface of the clavicle, to the hinder part of the coracoid process.

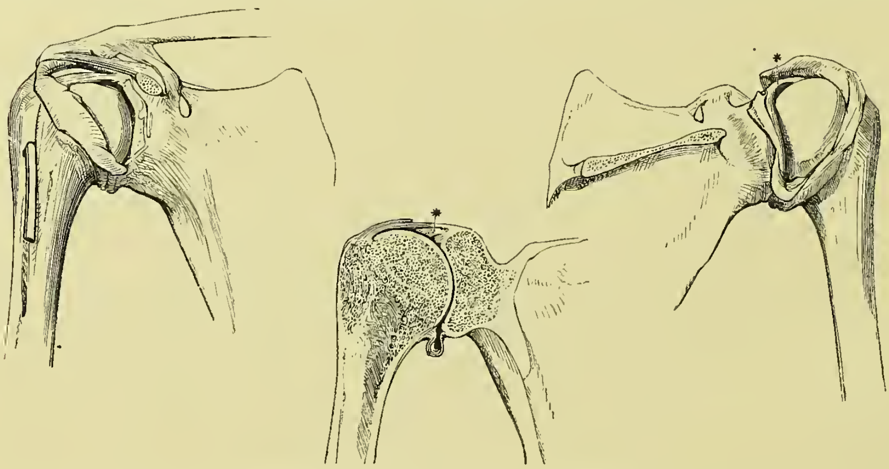
Movements.—The gliding movements at the acromio-clavicular articulation serve, amongst other purposes, to enable the scapula, and, therefore, its glenoid cavity, to be adjusted to varying directions of the shaft of the humerus, when that bone is fixed and the shoulder-girdle moves upon its head. The very strong trapezoid and conoid coraco-clavicular ligaments support the scapula against direct inward pull or thrust, such as frequently occurs in the use of the upper limb. Moreover, they assist in so connecting it with the clavicle, that it is carried upwards, downwards, forwards, and backwards, with that bone, and likewise participates in the proper clavicular movements of circumduction and rotation. In moving up and down, the scapular motion is nearly vertical, but in moving forwards and backwards, it follows a curved path, upon the thorax. When the arm is raised above the horizontal line of the shoulder towards the head, the scapula, with the clavicle, rotates in a peculiar manner, on an imaginary and moveable axis, passing, from before backwards, through the upper part of the infra-spinous fossa.

The Coracoid and Coraco-Acromial Ligaments.—These two ligaments are proper to the scapula itself. The *coracoid ligament*, fig. 98, is a small slip, which crosses the supra-scapular notch, and converts it into a foramen. The *coraco-acromial ligament*, fig. 98, is a strong, flat, triangular band, attached, by its base, to the outer border of the coracoid process, and, by its apex, to the tip of the acromion. It crosses over the top of the shoulder joint, forming a portion of the deep vault above it; it protects the head of the humerus, and, in certain circumstances, may arrest its undue ascent, under the influence of external pressure; but, it is separated from the joint, by the tendon of the supra-spinatus muscle, a synovial bursa intervening.

The Joints of the Upper Limb.

The Shoulder Joint.—The *shoulder joint*, figs. 98 to 101, is the loosest ball-and-socket joint in the body, the socket being only half as wide, and about two-thirds as deep, as the ball which moves in it. The capsular ligament, figs. 98 to 101, is very lax. The cartilage, which lines the glenoid cavity, fig. 101, and that which covers the head of the humerus, are nearly of equal thickness throughout, excepting just near their margins. This joint is constructed for purposes of free motion chiefly, whilst the stronger hip joint is suited for those of support.

The *glenoid ligament*, situated within the joint, is a narrow, firm, yellowish, fibrous ring, attached, like the cotyloid ligament around the acetabulum, to the margin of the shallow, glenoid cavity, which it serves somewhat to deepen ; its free edge is thin, but the side fixed to the bone is thicker; at its upper part, it is blended with the long head of the biceps, figs. 99, 100, 101, and with some fibres of the capsule of the joint. The *capsule*, figs. 99 to 101, attached above, around the margin of the glenoid cavity, and below, to the neck of the humerus, reaches furthest down on the inner side of the bone. Its principal accessory ligament, the *coraco-humeral ligament*, fig. 98, is a broad band, which passes over the upper and outer part of the joint, from the base of the coracoid process to both tuberosities of the humerus, and to the margins of the bicipital groove. A deeper set of fibres, proceeding from near the slight depression in the anterior glenoid margin, to the anterior



Three views of the Shoulder Joint opened.

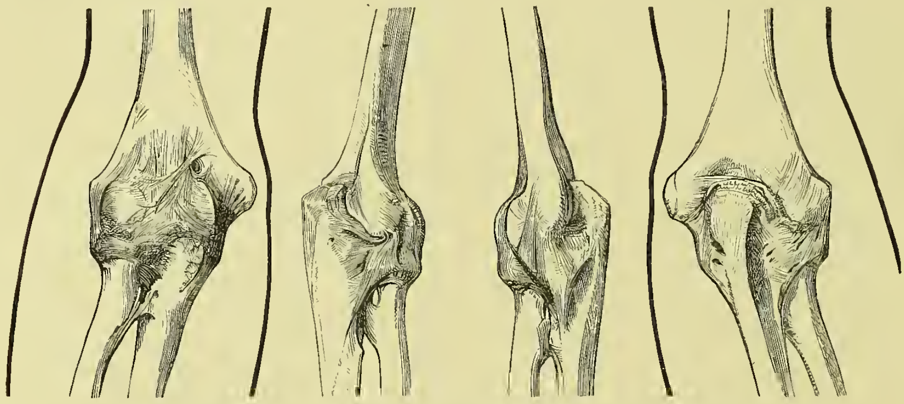
FIG. 99.—Front view, showing the tendon of the long head of the biceps muscle, crossing the articular cavity ; also the coraco-clavicular and the acromio-clavicular ligaments.
FIG. 100.—Back view, showing the loose capsule, and the proportionally larger part of the head of the humerus ; also a small piece of the biceps tendon, *.
FIG. 101.—Vertical section through the joint, showing the bones, the encrusting cartilage, the biceps tendon, *, and the loose capsule.

border of the bicipital groove, has been compared with the ligamentum teres of the hip-joint. The capsule is so loose, that, on cutting through the tendons of the surrounding capsular muscles, the head of the humerus drops at least an inch from the socket. These tendons are connected with the capsule itself; above and behind, are those of the supra-spinatus, fig. 98, infra-spinatus, and teres minor muscles; and, in front, the sub-scapular tendon, fig. 98. Below the joint, is the tendon of the long head of the triceps muscle ; whilst the long tendon of the biceps muscle, pursuing the unusual course of crossing the interior of the joint, passes from the upper border of the glenoid cavity, over the head of the humerus, which it slightly marks, to reach the bicipital groove, figs. 98 to 101; this tendon is surrounded by a tube of the synovial membrane, which also lines the groove.

Movements.—These are universal and very free, most of them being more free than those of the hip; but rotation is not so free, as the neck of the humerus is much shorter than that of the femur. The numerous capsular muscles, with atmospheric pressure, maintain the bones in contact; and the upper limb executes a free pendulum movement, which helps to adjust the centre of gravity, and so balances the body, in walking. As compared with the lower limb, the motions of the upper one are more frequently free, whilst those of the lower limb are forced by weight or pressure. The habitual action of the lower limb is towards rotation outwards, whilst that of the upper one is towards rotation inwards, or over the body; this is true of the elbow and wrist also. When the arm is raised from the side, or abducted, it stops at a right angle with the trunk, provided that the scapula be fixed. The head of the humerus rolls in beneath the acromion, and its greater tuberosity approximates closely to that process; there is no actual collision of the bones, nor are the intermediate soft tissues pressed or nipped, which would be painful; but the movement is arrested, especially by the anterior accessory ligament, and by the muscles, just before any such contact can occur.

The Elbow Joint.—The *elbow*, the most perfect hinge joint in the body, figs. 102 to 108, is completed by a *loose capsule*, by anterior and posterior ligaments, and, like other hinge joints, by two strong lateral ligaments. Its cavity is continuous with that between the lesser sigmoid cavity of the ulna and the head of the radius, and with that between the head of the radius and the radio-ulnar orbicular ligament. The *anterior ligament*, figs. 102, 106, strongest opposite the middle of the joint, descends from the margin of the coronoid fossa of the humerus to the front of the coronoid process of the ulna, and to the orbicular ligament around the head of the radius; on either side, it joins the lateral ligaments. The *posterior ligament*, fig. 105, thinner and looser than the anterior, is attached, above, along the upper border of the trochlea, and, below, to the margin of the olecranon process, some of its fibres passing transversely, and others reaching the orbicular ligament of the radius. The *internal lateral ligament*, fig. 104, triangular in shape, is attached, by its apex, to the inner condyle of the humerus, just beneath the epi-trochlea. Its fibres diverge as they descend, to be attached to the side of the olecranon, to the margin of the coronoid process, and to a transverse band which passes between these two processes. The *external lateral ligament*, figs. 103, 107, consists chiefly of a short, narrow, rounded band, attached above to the outer condyle or epi-condyle of the humerus, and, below, to the orbicular ligament of the radius, fig. 107, a few of its hinder fibres passing over this ligament, to reach the margin of the greater sigmoid cavity of the ulna.

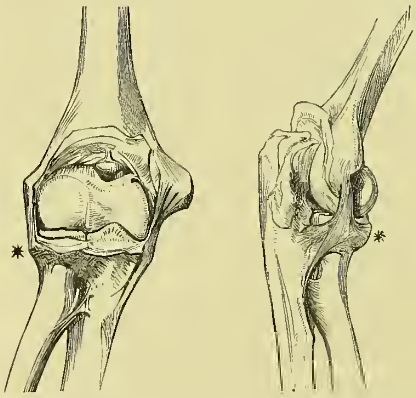
Movements.—Flexion, here much more free than extension, is nearly as free as at the knee joint. Extension, limited to a little beyond the straight position, is checked, as elsewhere, not by bony contact, of which we should at least be conscious, even if it were not painful, but by the tension of the an-



The Ligaments of the Elbow, and Superior Radio-ulnar Joints.

FIG. 102.—Front view, showing the anterior and lateral ligaments. FIG. 103.—Outer view, showing the lateral ligament, attached to the orbicular ligament of the radius. FIG. 104.—Inner view, showing the internal lateral ligament, attached to ulna. FIG. 105.—Back view, showing the posterior ligament, and back of the lateral and orbicular ligaments.

terior portions of the lateral ligaments, by the anterior ligament, and by the action of the brachialis anticus muscle. In very violent extension, such as occurs in accidents, a collision doubtless occurs. In extension, the elbow



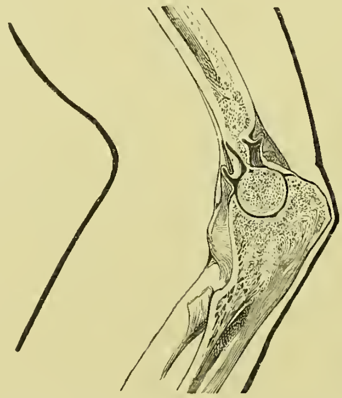


FIG. 106.—Front view of the Elbow, and Radio-ulnar joints laid open, showing edge of orbicular ligament of the radius, *.
FIG. 107.—Outer side of the same, showing attachment of external lateral ligament to the orbicular ligament, *.

FIG. 108.—Vertical median section through the right elbow joint, showing the structure of the bones, the thin part of the humerus opposite its fossæ, the line of the joint, and the folds of the capsule ; also the insertion of the biceps tendon.

is stiff and firm ; in flexion, the joint exhibits a slight lateral play, the inner portions only of the trochlea of the humerus and of the sigmoid notch of the ulna, being then in perfect adaptation. The obliquity of these surfaces, in certain directions, causes an oblique or cross action of the ulna upon the humerus, and, therefore, of the fore-arm, as the joint is alternately flexed or extended; thus, in extension, the fore-arm is directed downwards and outwards, and forms, with the arm, a very obtuse angle, projecting on the inner side of the elbow; whereas, in flexion, the fore-arm gradually passes into the same plane as the arm itself, and may even fold across it to its inner side. Here, also, the effect of obliquity of line and action, in imparting grace, is very apparent. The attachment of the lower end of the external lateral ligament to the orbicular ligament of the radius, and not to that bone itself, permits the rolling movement of the latter, whilst it does not lessen the security of the elbow-hinge. An arrangement somewhat similar, but not so perfect, takes place with the posterior longitudinal ligamentous fibres of the hip joint, where these end on the orbicular ligament.

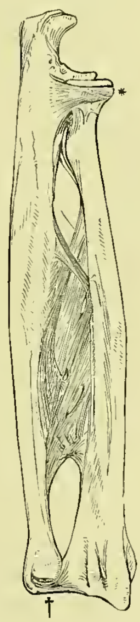


FIG. 109.—The Radio - ulnar Joints, showing the orbicular ligament, *, the oblique and the interosseous ligaments, and the inter-articular cartilage, †, below

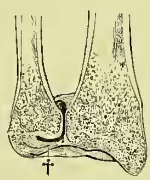
The Radio-ulnar Joints.—The *superior radio-ulnar joint*, the pivot or rolling joint formed between the upper ends of the radius and ulna, figs. 102 to 109, is enclosed by the capsule of the elbow joint, with which it is continuous. The chief ligament is the strong *orbicular* or *annular ligament*, figs. 106, 107, 109, *, a flat band, forming nearly four-fifths of a ring, the ends of which are fixed, in front and behind, to the edges of the lesser sigmoid cavity of the ulna, and to two slight ridges below them. Its upper and lower borders are connected with the capsule; its outer surface receives the lower end of the external lateral ligament; its inner surface, smooth, and lined by the synovial membrane, embraces the side of the head of the radius; it is thickest behind. It assists in tying the radius to the ulna, so that the two bones move together, in using the elbow joint; but it provides for the safe rotation of the head of the radius upon the capitellum of the humerus, within the fibrous and bony ring formed by it, and by the lesser sigmoid cavity of the ulna; it also resists the traction of the powerful biceps muscle, which pulls forcibly on the radius, in bending or supinating the fore-arm, whenever any resistance is offered to these movements, as, for example, in carrying a heavy basket on the fore-arm.

The *shafts* of the ulna and radius are connected, first, by the *round*, or *oblique ligament*, fig. 109, which passes, downwards and outwards, from the front of the coronoid process of the ulna, to just below the bicipital tuberosity of the radius; and, secondly, by the *interosseous membrane*, most of the fibres of which run in the opposite direction to those of the round ligament, that is downwards and inwards, from the interosseous ridge of the radius to that of the ulna. This membrane is broadest in the middle of the fore-arm, where the radius is curved outwards ; it leaves rather large spaces, above and below it. It helps to tie the bones together, resist strains or shocks passing up through the radius, and furnishes surfaces of origin for neighbouring muscles. It is interesting to note that the fibres of the interosseous membranes in the leg and the fore-arm, anatomically considered, have a homologous direction, namely, from tibia to fibula, and from radius to ulna; and, this, though the office of the two limbs is different in man, the one being for support, the other for free motion. But, in the fore-arm, the ligament is chiefly called into use, in resisting thrusts towards the trunk, just as it is in the leg.

The *inferior radio-ulnar* gliding articulation, figs. 109, 110, sometimes regarded as a lateral hinge joint, or a sort of rolling joint, is provided with *anterior* and *posterior ligaments*, passing across from bone to bone, a proper *capsule*, lined by a synovial membrane, named from its looseness, the *membrana sacciformis*, fig. 110, and a strong *inter-articular fibro-cartilage*. This latter is a thick triangular plate, figs. 109, 110, †, connecting the radius with the ulna, and placed transversely beneath the head of the latter, so as to be interposed between it and the wrist joint. Its base is fixed to the sharp margin of the radius, between its ulnar and carpal articular facets, and its apex, to the root of the styloid process of the ulna; its anterior and posterior margins are attached to the corresponding ligaments of the wrist joint. It is bi-concave, its upper surface being in contact with the head of the ulna, and belonging, therefore, to the joint now being described; whilst its under surface is in contact with the cuneiform bone, and enters into the formation of the wrist joint. It is sometimes perforated, when the two joints communicate.

Movements.—The mechanism of the rolling movements, pronation and supination, of the radius upon the ulna, has been described, partly with the bones, and partly, just now, with the ligaments concerned. The longitudinal axis of rotation passes through the neck and head of the radius and the capitellum of the humerus, on the one hand, and through the lower end of the radius and the head of the ulna, down through the ring-finger, on the other. The radius rolls within a fibro-osseous ring above, and upon a rounded surface below. The extent of rotation is about half a circle. Supination and pronation are both checked by the interosseous and oblique ligaments; pronation is arrested, just before actual contact, or collision of bone with bone, although they then cross each other.

The Wrist Joint.—The *wrist joint* or *radio-carpal* articulation, figs. 111, 112, is a modified, broad, ball-and-socket joint, formed, above, by the lower end of the radius and the under surface of the radio-ulnar inter-articular fibro-cartilage, which excludes the head of the ulna, and, below, by the scaphoid, semilunar, and cuneiform bones; it has a broad *anterior ligament*, spreading out from the radius and the edge of the inter-articular fibro-cartilage, to the first row of carpal bones, and even to the os magnum, many of its fibres passing obliquely, or almost transversely, inwards to the carpal bones; a thinner *posterior ligament*, fig. 111, is also directed downwards and inwards, from the radius and the inter-articular fibro-cartilage, to the adjacent carpal bones, the cuneiform bone receiving a special band, whilst some fibres reach the back of the wrist, lower down. These two ligaments tie the carpus to the radius, so that the hand is carried securely, with that bone, in pronation and supination, the oblique direction of their strongest fibres adapting them to this office. *External* and *internal lateral ligaments*, fig. 111, extend from



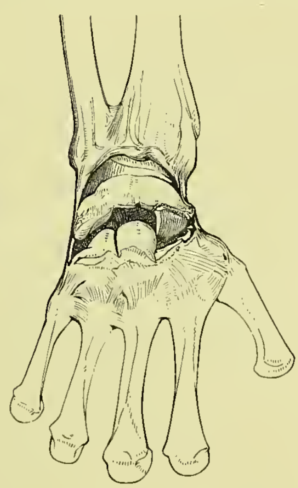


Fig. 110.—Transverse vertical section, through the inferior Radio-ulnar Joint, showing the structure of the bones, the inter-articular fibro-cartilage, †, and the membrana sacciformis above it.

Fig. 111.—Back view of the ligaments of the Wrist Joint, and of the inferior radio-ulnar, carpal, and metacarpal ligaments.

Fig. 112.—The same, with the Wrist Joint, and the Transverse Carpal Joint, both laid open.

the styloid processes of the radius and ulna, above, to the scaphoid and trapezium, and to the cuneiform and pisiform bones, below, both joining the anterior annular ligament of the wrist, which is derived from the fascia.

Movements.—The wrist, although a ball-and-socket joint, permits only slight circumduction of the entire hand, and no rotation; this is owing to the lateral breadth of both the ball and the socket. Extension is more free than flexion, and adduction exceeds abduction. In the free action of the hand extension is associated with abduction, and flexion with adduction; the oblique movements thus produced, are at once recognised, as easy and graceful; whilst the opposite combinations, namely, of extension with adduction, and flexion with abduction, are most disagreeable; even perfectly straight extension and flexion appear stiff and awkward. In forced actions, or mixed free and forced actions, the deviations from the lines of graceful movement are accepted, if explained by circumstances ; as, for example, when they are due to leaning or pressing against any external support or object, or to carrying a weight, or offering resistance to external force.

The Carpal Joints.—The planiform joints of the *first row* of carpal bones, or *epi-carpus*, as it might be termed, are held together by thin *palmar*, and thick *dorsal ligaments*, fig. 111, and also by strong *interosseous ligaments*, fig. 112, placed near the upper part of the contiguous surfaces of the component bones, so as to render the general articular surface almost even. The little joint between the pisiform and the cuneiform bones, is quite distinct, having its own capsule and ligaments, the latter being connected with the unciform bone, and even with the fifth metacarpal bone.

The articulations of the *second row* of the carpus, which constitutes what may be named the *pro-carpus*, are likewise of the planiform kind, and are completed by *palmar*, *dorsal* and *interosseous ligaments*, that between the os magnum and unciform being very strong.

The complex *transverse joint* of the carpus, fig. 112, planiform on each side, but ball-and-socket-like, opposite the head of the os magnum, is practically a hinge-joint; it is completed by *palmar*, *dorsal* and *lateral ligaments*, but, excepting an occasional small band between the os magnum and the scaphoid bone, there is *no interosseous* ligament here, which would have impeded the movements between the two rows of bones. The palmar ligaments chiefly converge to the os magnum ; of the dorsal bands, one passes across the head of that bone.

Movements.—The pro-carpal ball of the transverse articulation of the carpus, is so locked into its deep socket, that the actual movement here is hinge-like only. Flexion of the pro-carpus is more free than extension, the reverse of what occurs at the wrist joint itself; but, in the combined movements of both lines of articulation, the total flexion is more free than the total extension, except where the latter is forced. The gliding movements at the other carpal joints, are not so free as those at the tarsal articulations generally.

The Carpo-Metacarpal Joints.—The planiform joints of the four outer metacarpal bones, have each one *palmar* and two *dorsal ligaments*, figs. 111, 112, one from each adjacent carpal bone. The *fifth* metacarpal, which supports the little finger, has only one dorsal band attached to the unciform bone; the *third*, supporting the middle finger, has interosseous ligaments connecting it with the os magnum and the unciform bone. The saddle-shaped joint at the root of the *thumb*, figs. 111, 114, 115, is held together by a rather loose *capsule*, strengthened by *dorsal* and *palmar* fibres, and by special *external* and *internal lateral ligaments*.

Movements.—In the carpo-metacarpal joint at the root of the thumb, all movements are possible, except that of rotation, which is prevented by the opposed saddle-shaped articular surfaces. Circumduction is very free; and so, especially, is a combination of flexion with adduction, to which the term *opposition* is given, and in which the entire thumb is brought over the front of the palm, so that its tip can be put in contact with one or all of the finger-tips. At the fifth carpo-metacarpal articulation, the movements are similar, but much less free; even a certain amount of opposition is possible, by which the inner border of the palm is elevated, and the ball of the little finger is made to approach the ball of the thumb.

The Metacarpal Joints.—The small gliding joints between the bases of the four inner metacarpal bones, fig. 111, are connected by transverse *dorsal* and *palmar ligaments*, and by strong *interosseous ligaments*. There is no joint between the bases of the first and second metacarpal bones, that of the thumb being, in this respect, free; but the two bones are tied together by a strong *interosseous* ligament. Its head is, of course, quite free; even the heads of the four inner metacarpal bones do not articulate with each other, but are loosely connected together by a narrow *transverse metacarpal ligament*, fig. 182, which passes across their palmar aspect, beneath the flexor tendons, with the sheaths of which, as well as with the metacarpo-phalangeal ligaments, it is blended.

Movements.—The gliding *movements* possible at the bases of the metacarpal bones, are most free between the fifth and fourth metacarpals. Free lateral, and backward and forward motions can be produced between the heads of the four inner metacarpals; these give great suppleness to the hand, and a power of hollowing the palm and increasing the transverse curve on which the fingers rest, so that they more easily meet in front of the palm.

The remaining joints in the hand, namely the metacarpo-phalangeal and the phalangeal, precisely similar to the corresponding metatarso-phalangeal and phalangeal joints in the foot, are, with the exception of those of the thumb, larger, and have their characters more pronounced, than those in the lower limb.

The Metacarpo-Phalangeal Joints.—In these shallow and modified ball-and-socket joints, fig. 113, there is *no* proper *dorsal ligament*, its place being supplied by the corresponding tendon of the extensor muscle, and by expansions from that tendon. An *anterior ligament*, a dense, longitudinal, fibro-cartilaginous, and, sometimes, bony structure, has been compared with the sesamoid bones of the corresponding joint of the thumb. It is blended with the lateral ligaments, the sheath of the flexor tendons, and the transverse metacarpal ligament, with which latter, it forms a groove for those tendons. It is fixed firmly to the phalanx, but only loosely to the metacarpal bone, so as to deepen the cavity of the former, for the reception of the head of the latter; it is sometimes named the *glenoid ligament.* In the metacarpo-phalangeal articulation of the *thumb*, figs. 114, 115, this anterior ligament is very strong, and includes the two sesamoid bones, which are held together by transverse fibres, and glide upon the small trochlear grooves in front of the rounded head of the first metacarpal bone. *Lateral ligaments, internal* and *external,* also exist, flattened triangular bands, attached, by their narrow ends, to the sides of the heads of the metacarpal bones, and, by their wider ends, to the sides of the phalanges and to the

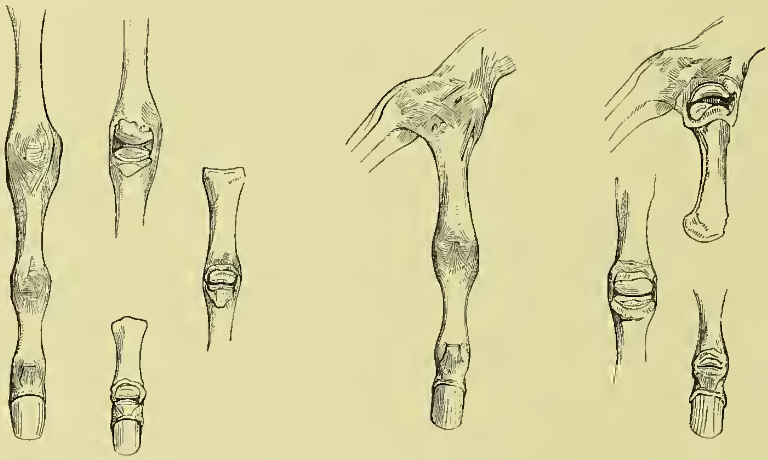


Fig. 113.—The Ligaments and Joints of a Finger.
Fig. 114.—The Ligaments of the Thumb, including its Carpo-Metacarpal Joint.
Fig. 115.—The Joints of the Thumb laid open.

thick anterior ligaments. In the thumb, most of the fibres of the lateral ligaments are inserted into the sesamoid bones.

Movements.—At these joints, all movements are possible, excepting free rotation; but this may be forced, as from external causes. The spreading out of the fingers from each other, at their bases, is permitted at these joints; all the fingers are thus capable of lateral separation, or any single finger from its neighbour, or any one from the rest, or the two inner from the two outer ones. Flexion is more free than extension, reaching to about a right angle; extension, unless forced, goes only a little beyond a straight line. Extension, when quite free, and unchecked by special intention or effort, is essentially associated with abduction; whilst flexion is similarly combined with adduction. The reverse combinations are forced, and require explanation, to be acceptable to the eye. Of the several fingers, the forefinger enjoys the most freedom of circumduction at its base, and the little finger comes next. At the corresponding metacarpo-phalangeal articulation of the thumb, flexion to a right angle is quite impossible, and there is little or no circumduction, the surfaces of the joint being unusually broad; but this movement is much more extensive at the base of its metacarpal bone, than it is at the root of the forefinger.

The Phalangeal Joints.—These miniature hinge joints, two in each finger, fig. 113, but only one in the thumb, figs. 114, 115, have similar ligaments to those of the metacarpo-phalangeal joints; but the *lateral ligaments*, attached to the well-marked tubercles on the sides of the bones, are relatively stronger, and more closely fitted to the bones. The *glenoid ligaments*, fixed more firmly to the distal or moving phalanx than to the proximal one, on which the other moves, deepen the shallow socket on the distal phalanx; but they are less developed than at the metacarpo-phalangeal joints. The expanded extensor tendon supplies the place of a proper *dorsal* ligament. All the ligaments are smaller in the last phalangeal articulations.

Movements.—The free movements at the phalangeal joints, are those of flexion and extension only; hence the movements of the segments of the fingers and thumb are very precise; whilst the spreading out and lateral play of the fingers are provided for at their base. The extreme amount of flexion at the first inter-phalangeal joints, which bend to an acute angle, renders the holding power of the hand much more secure; at the last joints, in both the fingers and thumb, flexion is limited to a right angle. Over-extension is possible at the last joints, if these are forced. A certain lateral obliquity of the articular surfaces, in the case of the fore and little fingers, causes them to lean or curve slightly towards the middle of the hand, which thus acquires a more tapering form.

The Joints of the Head and Face.

The Sutures.—The different *sutures* found in the cranium and face, have been described with the bones, p. 171.

The Joints of the Lower Jaw.—The *temporo-maxillary articulations*, right and left, are of peculiar and complex form, each combining the characters of gliding, modified ball-and-socket, and hinge joints.

The *capsule* of each joint, attached, above, around the articular portion of the glenoid cavity of the temporal bone, and, below, around the condyle of the lower jaw, is thin, loose, wider above than below, and thickest at the back of the joint. A short, thin, narrow band, the *external lateral ligament*, passes from the zygoma and the tubercle at its root, downwards and backwards, to the outer side and back of the neck of the lower jaw. A long, thin, triangular band, the *internal lateral ligament,* extends downwards and forwards, from the spinous process of the sphenoid bone, and, passing by the neck of the lower jaw, is attached to a flat process and elevated ridge, found on the inner surface of its ramus. Lastly, an accessory fibrous band, derived from the fascia of the neck, named the *stylo-maxillary ligament,* reaches from the styloid process of the temporal bone, to the posterior border of the ramus of the jaw, and aids in supporting the bone, in its peculiar suspended position. The powerful muscles of mastication, connected with this bone, serve to maintain its condyles in due apposition with the inter-articular cartilage of each joint, and these, again, with the glenoid cavities of the temporal bones. Each of these fibro-cartilages, which divides the cavity of the corresponding joint into two parts, is a transversely oval strong plate,

FIG. 116.—The Ligaments of the left side of the Lower Jaw.
FIG. 117.—The Articulation of the Lower Jaw laid open, to show the inter-articular cartilage. The coronoid process is removed, to show the external pterygoid muscle *p*, with some of its fibres attached to the cartilage.

thickest behind and thinnest at its centre, where it is sometimes perforated, so that the two articular cavities communicate. Its upper surface, concavo-convex from before backwards, but slightly convex from side to side, is adapted to the form of the corresponding glenoid cavity; its under surface, which rests on the condyle of the lower jaw-bone, is concave, more deeply so from before backwards. Its borders are attached to the capsular ligament, and, externally, to the external lateral ligament; whilst, in front, it has, inserted into it, a few fibres from the external pterygoid muscle. The part of the capsule above the fibro-cartilage, is looser than the part below it, so that, as a rule, the cartilage follows the movements of the jaw-bone on the temporal bone.

Movements.—The two joints of the lower jaw represent a double hinge, which acts with great security up and down; it also permits direct backward and forward movements, and lateral horizontal ones of the whole bone, the latter being dependent on alternate oblique forward and backward movements of one or other condyle. All these movements are employed during mastication, providing not merely for the closure of the jaws, but also for the rotation of the lower teeth beneath the upper ones. It is important to note that, in opening the mouth, which occurs not only in eating, but in oratory, in singing, in yawning, and in the expression of certain strong or startling emotions, the condyles, and with them the whole lower jaw, move a little forwards, and yet the chin and the angle are carried backwards; at the same time, both the body and rami change their direction in regard to neighbouring parts, though not to each other. In closing the mouth, the condyles again move backwards, but the angle and the chin are carried forwards, the rami and body recovering their respective positions in reference to adjacent parts. The backward and forward movements of the jaw are employed in grimacing, and so, in fact, are the side to side motions of the chin, in making 'wry' faces.

THE MUSCLES.

THE MUSCULAR SYSTEM.

The *muscles* (μῦς, a muscle, a mouse), the contractile organs placed between the bones and the skin, constitute the *flesh* of animals. This flesh, usually of a characteristic reddish colour, varies from a deep red to a pale pink, or is even almost white, as in the lower vertebrate animals, or in particular muscles, in the higher vertebrata. In man, the flesh is red; but its colour is paler in early life, and in debilitated persons; it is darker in the dark races. This contractile substance, or flesh, does not form a homogeneous environment of the bones, but is disposed in separate masses of different size, form, and connexions, named *Muscles*, fig. 119. These are, moreover, called *Voluntary muscles*, because they are under the government of the *will.* In the interior of the body, as in the walls of the heart and alimentary canal other and peculiar muscular structures exist, which, being emancipated from volitional control, are termed *Involuntary.*

A few of the voluntary muscles, such as those of the lips, consist of fleshy substance only; but, nearly always, this material is combined, in various ways, with a dense white fibrous tissue, arranged in cords, bands, or membranes, constituting the so-called *tendons*, or *aponeuroses.* The two structures together form an individual muscle, so that, in defining a muscle, both its tendinous and its fleshy part or parts, are always included. The voluntary muscles and their tendons make up the *Muscular System*, the study of which is termed *Myology.*

The Structure and Action of the Muscles.

Every *voluntary* muscle is composed of few or many parallel *bundles* of a soft reddish tissue, arranged in different directions in different muscles, sometimes longitudinally, sometimes obliquely to the axis of the muscle, and sometimes in curved lines, fig. 119. These bundles are named *fasciculi*, the larger ones being composed of smaller ones, and these again, when fully unravelled, of the *smallest* or *ultimate fasciculi*, fig. 118, *a*. All the fasciculi, small and large, are held together by a web of fine areolar connective tissue, known as the *perimysium*, in which the vessels and nerves of the muscle are supported. Each ultimate fasciculus (of which a small portion is shown at *b*), when examined under a magnifying lens, is seen to consist of a number of laterally compressed prismatic fibres, embedded in a finer perimysium, and measuring about $\frac{1}{400}$th of an inch in diameter, and from 1 inch to $1\frac{1}{2}$ inch in length ; these are the *muscular fibres*. Each fibre, again, *g*, is composed of a soft substance, named *sarcode*, (*sarx*, flesh), capable of almost unlimited longitudinal subdivision into numerous delicate threads, named the muscular *fibrillæ*,

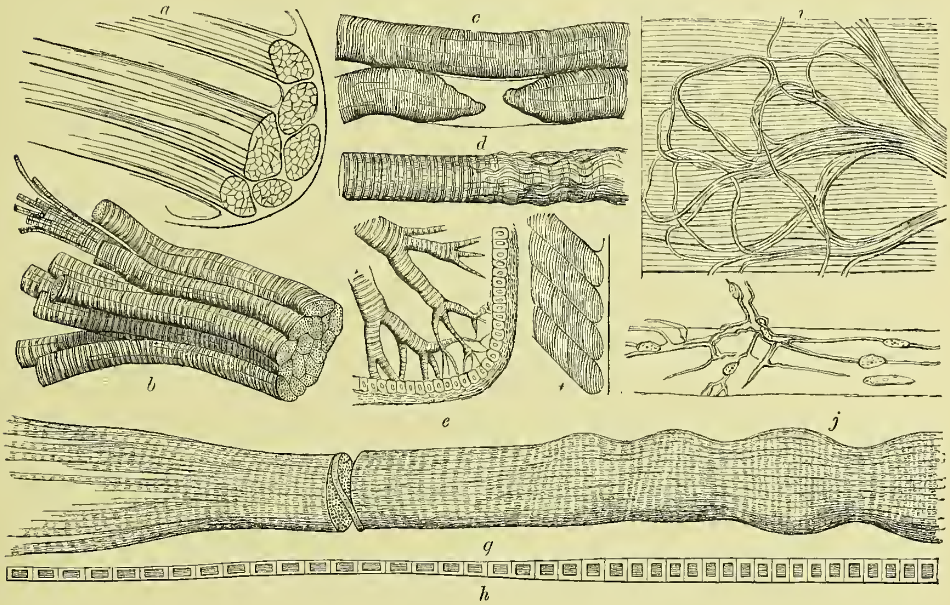


FIG. 118.—Microscopic structure of Muscle ; *a*, portion of a small fasciculus, with six of its component ultimate fasciculi and the perimysium ; *b*, part of an ultimate fasciculus containing fifteen striped muscular fibres, cut across at one end, and free at the other, one being partially unravelled ; *c*, parts of two muscular fibres, one ruptured, so as to show it ; tubular sarcolemma ; *d*, a single fibre passing into a bundle of fibrous connective tissues ; *e*, ramified fibres ending in the mucous membrane of the tongue ; *f*, fibres terminating obliquely on the white fibrous tissue of a tendon ; *g*, part of a single fibre, more highly magnified and diagrammatic, showing its longitudinal subdivision into fibrillæ, and its transverse splitting into a disc, also the longitudinal lines and transverse striæ, and lastly, the change of form and appearance due to contraction ; *h*, a single fibrilla, still more highly magnified, showing its component sarcous cylinders, with their dark centres, and clear surrounding material separated by a fine cross line. The dark centres correspond with the transverse striæ, and contain the bundles of longitudinal rods ; *i*, bundles of nerve fibres running, in loops, across five ultimate fasciculi of a flat muscle ; *j*, ultimate ending of a single nerve fibre, upon and within the sarcolemma of a muscular fibre.

which are enclosed in a transparent, homogeneous, tubular sheath, named the *sarcolemma*, best seen when the soft contractile contents are broken across *c*. Each fibrilla, *h*, appears to be built up of a row of short cylindrical particles of uniform size, dark in the centre and lighter around, named the *sarcous elements*, which cohere together end to end, to form a fibrilla. But the sarcode of every fibre is also capable of splitting crosswise into transverse *discs*, *g*, consisting each of a single stratum of the sarcous cylinders, cohering by their sides, like pieces of a layer of mosaic work, and compiled so evenly across the fibre, that this latter is marked, not only by faint longitudinal lines corresponding with fibrillæ, but by more distinct, dark, transverse stripes or *striæ*, agreeing in width with the dark centres of the cylindrical elements, and very nearly with the thickness of the discs.

Still further, exquisitely delicate systems of fine dark rods with enlarged ends, surrounded by a lighter material, have been detected in the substance of the cylindrical elements; these rods produce the central dark spot in each cylinder, *h*, and are concerned in the physical changes which the cylinders undergo during the contraction and relaxation of the entire fibre. The transverse striæ, indicating the existence of the discs, are characteristic of all voluntary muscular fibres, which are, therefore, also known as *striated* or *striped* muscular fibres. The involuntary muscular fibres generally, are *plain* or *unstriped*, having no cross striæ; they are also shorter, flattened, and fusiform, or tapering at each end; the muscular fibres of the heart, however, are indistinctly striated, and likewise branched; the ultimate voluntary fibres beneath the mucous coat of the tongue, are also ramified, *e*.

An aggregation of striated muscular fibres, thus elaborately constructed, arranged parallel with each other, and embedded in the perimysium, constitutes an ultimate fasciculus; few or many of these, united by a coarser perimysium, form the larger fasciculi; these, again, are gathered together into still larger ones, which combined in various numbers and ways into one separate mass, held together and enclosed by areolar connective tissue, contribute to build up an *individual muscle*. In attaching themselves to their tendons, the muscular fibres end, either by a direct transition into a bundle of wavy connective tissue filaments, *d*, or by the oblique fastening of the rounded ends of the fibres into little depressions on the side of the tendinous structure, *f*. It is always through the intervention of some sort of membrane, that muscular fibres are fixed to bone or cartilage.

The red substance of voluntary muscle contains as much as three-fourths of its weight of water; the remaining 25 per cent. is composed of solids, about 15 parts of which consist of a peculiar albuminoid material, named *myosin*, from which another compound is obtainable, named *syntonin*, (*συντείνειν*, to draw together, or contract); from 3 to 4 parts are fatty matters, and the rest is albumen, gelatin, colouring matter, extractives, organic acids, and alkaline and earthy salts. Muscular substance also contains uncombined oxygen and carbonic acid. It has an acid juice, and a characteristic odour, formerly said to depend on a particular constituent named *osmazome*; but this is a very complex substance.

Living muscular tissue is not only soft but *strong*, *flexible*, and very *extensible* and *elastic*, qualities which are of essential service in the economy. Its living elasticity is more or less dependent on a form of slight vital contractility, known as *tonicity*; but its characteristic property, also vital or vito-physical, not merely physical, is that of *contractility*. This property is possessed by all muscular fibres, whether voluntary or involuntary, by certain simple microscopical tissue elements and organisms, such as the microscopic cilia, the colourless blood corpuscles, the amœboid animalcules, and, indeed, by all active protoplasm, whether animal or vegetable. It is the cause or source of all automatic movements in animals and plants. It consists, essentially, in a peculiar intrinsic re-arrangement of the molecules of the contractile mass. In the simplest cases, this change occurs slowly and irregularly; in others, slowly and more regularly; and, again, in others, rapidly and very regularly. In a voluntary muscular fibre, with its highly complicated organisation of discs or rows of sarcous elements, containing internal systems of rods, the change of form, due to the re-arrangement of their molecules, is definite in direction, and very rapid in its operation. It results, invariably, in an alteration in the shape and proximity of the rods, in a widening out of the sarcous cylinders or discs of cylinders, and an approximation of their ends, *h*. Concurring in all the sarcous cylinders of a disc, and in those of the adjacent discs, it produces a *shortening* of the corresponding fibre from end to end, accompanied by a *thickening* in its diameter. In a contracting fibre, fig. 118, *g*, just below *j*, the ends of the sarcous cylinders and discs approach each other, whilst their sides become more remote; hence, the transverse striæ become finer, and closer together, than in the quiescent fibre. In these changes, the tubular sheath or sarcolemma, *e*, appears to take no part, though its elasticity may help to restore the fibre to its original shape, as it again relaxes. The contraction of a given fibre may commence at one end, or at one or more intermediate points. As seen under a microscope, in the fibres of a cold-blooded animal, and when the fibre is losing its rapidity of action, such a point becomes darker than the rest; the change spreads across the fibre, and is then seen to be propagated, in a wavelike manner, along the magnified fibre, parts of which may be observed in action, and parts in a condition of relaxation.

Under the galvanic stimulus, a single act of contraction, including the return to a state of relaxation, occupies about $\frac{1}{10}$th of a second; and, probably, ten waves in a second, blended together, by the effects of tension and elastic recoil, would be enough to produce a continuous effect, and give rise to a definite gentle contraction; but, in active exertion, as indicated by experiment, at least twenty such waves may occur in each second.

The rate at which the waves move along the fibre, appears to vary from

3 to 12 feet per second. In actual operation during life, the contraction must therefore practically affect every portion of a single fibre, which measures at most $1\frac{1}{2}$ inch in length, simultaneously, and, very quickly, all the fibres of one fasciculus, and all the fasciculi of one muscle, so accomplishing a combined and regular movement in the whole muscle; but probably the component fibres, and even the several fasciculi, really support each other by acting and resting, in very rapid succession, in such aggregates and in such small intervals of time, as enable the muscle to maintain the necessary continuous effort. Out of the body, and quite free, a muscular fibre may shorten itself by three-fifths of its length; but, in a living muscle, the practical effect is a *shortening* of from about one-third to nearly one-half, the amount varying on different occasions, and under different circumstances. This is always accompanied by a corresponding *thickening* of the muscle. The substance of a muscle becomes firmer, and even *hard*, during contraction, when its ends are fixed, owing to the tension of its fibres. Nevertheless, the shortening and increase of thickness, which then occur, are not accompanied by any important condensation of its fleshy substance; this, indeed, like water, of which it contains so much, is almost incompressible. Accordingly, unlike what occurs in the contraction of a cooling substance, such as a ball of hot iron, there is but little *change in the bulk* of a muscle, when it contracts; this is said to amount to only $\frac{1}{1300}$th of its mass, when in a state of rest. Since long fasciculi will practically contract in the same time as short ones, it is evident that a combination of these in a muscle, will contract through more space, in a given time, in proportion to their length, and thus produce more motion; but they will act more strongly, in proportion to their number; hence the velocity of action of a muscle may be estimated from its length, and the power, from its sectional area across its component fasciculi.

It can be shown, experimentally, that the contraction of a muscular fibre, though called spontaneous or *automatic*, is the result of the application of some stimulant to the fibre. The *stimulus* may be external or internal, and either mechanical, thermal, electrical, or chemical, vito-chemical or vital. It is observable in all cases, that, within the limits of its absolute power, the muscular tissue contracts more powerfully, as the stimulus itself, whatever its nature, is stronger. During life, the muscles are naturally excited to act, by a stimulus operating through, or originating in the nervous system, and conveyed to them by the motor nerves. Such a *stimulus* is *vital*, and leads to the excitation of the movements due to reflex, emotional, or volitional changes occurring in the nerve centres. It reaches the muscles along the nerves distributed upon the muscular fibres, fig. 118, *i*, *j*. As the amount of force exercised by a muscle, is in a direct ratio with the intensity of the exciting stimulus, so the swiftness and duration of its action depend, within certain limits, on the rapid incidence, and the continuance of the stimulus. Overstimulation exhausts it entirely, and rest is then needed for the restoration of its power, by re-nutrition. It is a subject of profound interest, that the will not only stimulates a muscle, but that, guided by sensations and experience, it can regulate the *force* and *speed* with which it shall act, and so govern the intensity, the duration, and, therefore, the cessation of its action.

The ultimate result or effect of muscular contraction in the living body, is the manifestation of the so-called *muscular force*, which produces movements or displacements of the parts with which the muscular tissue is connected, the tendency, of course, being to approximate such parts. The intrinsic value of the muscular force, as estimated by direct experiments on muscle, and measured by work accomplished, is enormous; but there is considerable loss in its actual employment in the body; nevertheless, every square inch of section, of the human arm muscles, can resist a weight of 85 lbs. avoirdupois, and of the muscles of the calf of the leg one of 115 lbs. avoirdupois. It has been shown that the force capable of being exerted by muscles employed in the animal economy, as compared with the necessary combustion of material, is double that developed in the best steam engines, being in the proportion of one-fifth instead of one-tenth of the total heat evolved. The total muscular force of a man, is equal to one-tenth of a horse power.

The various adaptations of the muscular force to the wants of the animal frame and its several parts, are a just cause of admiration. The entire muscular system of man weighs about three-sevenths of the total weight of the living body. There are about 480 individual muscles, arranged in pairs, 240 upon each side. They vary exceedingly in size, some measuring only a few lines in length, and still less in thickness; whilst others are two feet long, several inches thick, and many wide; the muscles of the tympanum of the ear altogether weigh only a few grains, the large vasti muscles of the thigh contain as many pounds.

The human muscles, fig. 119, are arranged in two or more layers, some being *deep-seated* upon the bones, others *superficial*, and some so near the skin as to be called *subcutaneous*; whilst a few end in the skin, and are named *cutaneous*. Most muscles, including all the deep ones, are attached, by both ends, to the bony or cartilaginous framework of the body; but some are fixed to the skeleton, or to cartilage, by one end only, the other being connected with soft parts; a few have no connexion with bones or cartilages at all, but are attached merely to soft parts. It is obvious that, in the first case, the muscular force, if permitted to act, will affect one or other, or both, of the bones to which the muscles are attached, according as these are more or less moveable at the time; in the other two cases, the bone will remain stationary, and the soft parts only be moved. The more fixed end of a muscle which is attached by each end to a bone, or the fixed end of a muscle which is attached to bone by one end only, is called its *origin*, the other or more moveable end being known as its *insertion*. The origin is, most frequently, nearer to the centre of the body, and the insertion more remote from it. All muscles which are attached to bone, are provided with either *tendons* or *aponeuroses*. These white fibrous structures are inextensible and inelastic, or the muscular force would be partly lost in stretching them. The form and size, the breadth and length, of the aponeuroses and tendons vary much, according to their position and use, as well as the size, form, and structure of the fleshy parts themselves. On the trunk, the superficial muscles and their aponeuroses, fig. 119, are usually broad, flat, and thin, but the deeper ones are much subdivided; on the limbs, the muscles are more frequently long and rounded, fusiform or flat, whilst the tendons are flat, cord-like, tapering, and often split so as to reach many bones. Muscles sometimes arise directly and broadly from the surfaces of bones, or rather from the periosteum which covers the bones; but, more frequently, they arise by tendons.

Such tendons of origin are usually broad or conical; but tendons of insertion, on the contrary, are generally long, and roundish or flattened, and often subdivided. The former arrangement enables a large number of muscular fibres to act from a single given part of the skeleton; whereas the latter transmits a large amount of muscular force to distant and precise points of bone, sometimes even over one or more joints. In all cases, tendons not only do not waste the muscular force which is applied to them, as they do not stretch, but they also serve to economise muscular substance. Tendons are also employed, where one muscle has to move over another, or has to emerge from, or dip in, amongst others, so that, although friction must take place between them, they glide over each other without pain, synovial bursæ frequently intervening. Pain would be experienced, if muscle moved on muscle, or muscle on tendon, or the reverse.

In the action of the muscles on the solid framework of the body, the force employed operates on the bones after the manner of levers in mechanics, the fulcra being usually situated in the joints. Examples of all three kinds of levers are met with in different situations in the body, but the first and third are much more frequently employed than the second. The first, in which the fulcrum is the middle factor, is chiefly used where strength is required, as at the back of the hip joint, and of the neck; the third, in which the power is in the middle, is employed where swiftness of movement is needed, as in front of the elbow, and at the back of the knee; the second, properly considered, is used very sparingly, as beneath the lower jaw, but not at the heel, as is usually taught. The relative lengths of the lever arms, that is of the power arm and weight arm, differ also according to need; but this subject cannot be fully discussed here. The first action of the muscles is to press the articular surfaces of the joints together; afterwards, they move the bones. Usually, the efficient action of a muscle is exerted in the line of

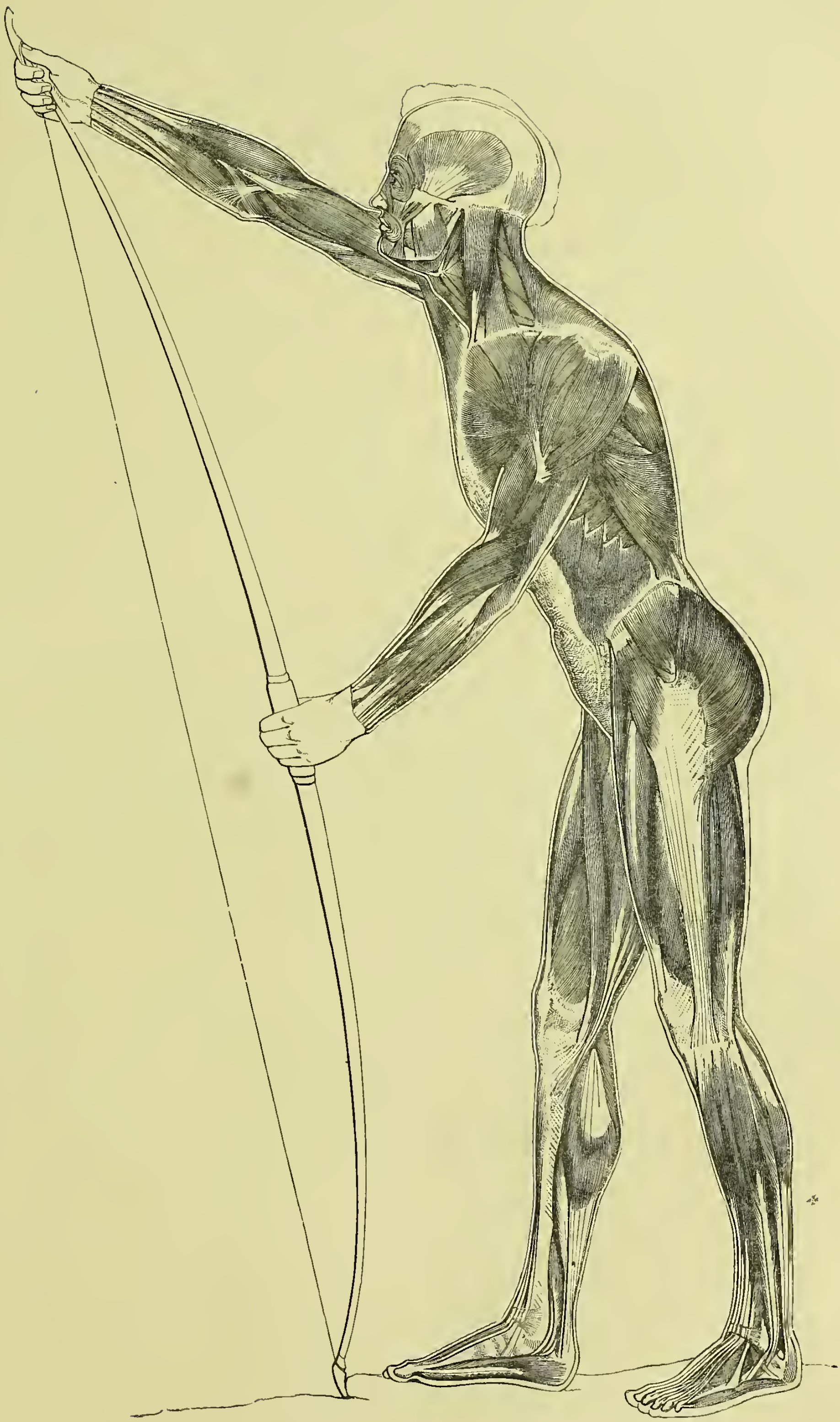


Fig. 119.—The Muscular System as in action (*see* fig. 6).

direction of its axis, or in that of the tendon on which its fasciculi end. For the most part, but not invariably, these tendons are, of necessity, inserted at a more or less acute angle to the axis of the bones on which the muscles draw; if so, the prominences of the bones increase their leverage; occasionally, however, a tendon turns down nearly perpendicularly upon a bone, or spreads out or twists, in some peculiar way, to gain a special hold and action on it. Sometimes the movement of a bone is commenced by the action of one set of fasciculi of a muscle, or by one muscle, and then it is prolonged or continued by others. When a bone is to be held firmly in a given position, opposing or antagonist muscles also act, and fix or stiffen the joint at which the bone usually moves, holding the articular surfaces tightly together. Any actual movements which take place, are determined by the surfaces and ligaments of the joints. The reversal of a given movement always involves a loss of force; this cannot be avoided, for no continuous circular motion is possible, such as is employed in wheeled engines. Frequently, a tendon is *deflected* over some point or surface of a bone, and then the efficient force of the muscle, reduced even as much as 30 per cent. owing to friction, operates in a new direction from the point of deflection, and at an angle with the axis of the muscle itself. The perfect flexibility of a tendon which has thus to turn and bend, is of immense advantage, especially as it is accompanied by great strength, and practical inextensibility. Sometimes, at the place of deflection of a tendon, a small nodule of fibro-cartilage or cartilage, or a sesamoid bone, is formed in its substance; on the bone, over which it turns, there always exists a smooth groove, covered with a film of cartilage, and often converted by a fibrous band into a canal; this is lined by a synovial membrane, as especially seen in the foot and hand, where long tendons travel through channels, half osseous and half fibrous.

As a rule, deep-seated muscles and their tendons, whether broad or narrow, are very short, and pass from one bone to the next, that is over one joint only, on which alone they can act; whereas, the more superficial, or actually superficial, muscles frequently extend from one bone to a distant one, over two or even more joints, on which they have an immediate, intermediate, or remote action. The reverse arrangement would be obviously impossible, without some special contrivance. Such cases do, however, occur in the distal portions of the limbs, as when the tendons of a deep muscle pass through splits in those of a superficial one, as seen in the two flexors of the fingers; the deep muscle may even be longer than the superficial one, as in the two flexors of the toes. The contraction of a single muscle is sometimes, though rarely, sufficient for the performance of a given action; but, much more commonly, several or many muscles concur in the production of a single definite and, so-called, *co-ordinated* movement; some muscles, for example, fix certain bones, whilst others act upon more distant bones. Certain muscles, acting over the back of a joint, *extend* it, others on the opposite side, *flex* it; some *abduct*, and others *adduct*, the bone into which they are inserted; others *rotate* it, and, lastly, all these co-operate in *circumducting* it. As the articular surfaces of a joint are shaped in harmony with the muscles which act upon it, so, as already stated (p. 207), the muscles are developed, constructed, disposed, and attached, in strict conformity with the character and possible movements of the joint on which they act, the agreement being one of simultaneous and harmonised organic evolution and growth. Gliding joints and hinge joints have fewer muscles than ball-and-socket joints; gliding joints usually have short muscles, hinge and ball-and-socket joints, longer ones; hinge joints have their muscles on two sides of the joint, ball-and-socket joints, on all sides; rolling joints have rotating muscles, but no hinge joint has a rotating or a circumductory system of muscles; lastly, special joints, such as those concerned in the pronation and supination of the fore-arm and hand, have their special muscles, pronators and supinators. Muscles are often obviously arranged in *groups*, having a common function; other groups have opposing functions; some assist or supplement, and others check or restrain, the operation of adjacent muscles, or groups of muscles, so that there are *associated, accessory, supplementary*, and also *opposing* or *antagonistic*, muscles, or groups of muscles.

As the movements at a given joint are sometimes free and sometimes *forced*, p. 207, so a muscle, or a set of muscles, may act either *freely*, that is from the centre of the body to the limbs, or from the root of a limb to its extremity, or *forcedly*, that is, from the fixed part of a limb, inwards towards its root, or towards the trunk. The former may also be called *direct*, and the latter *reversed*, actions of the same muscle or muscles. Usually the muscles of the upper limbs act freely or directly, but, when these limbs hold on to a fixed object, or support the body, their action is forced or reversed; on the contrary, the muscles of the lower limbs act forcedly or reversedly, when they are engaged in sustaining the weight of the body, or in propelling it forwards and upwards in locomotion, but freely or directly, when the limb is projected forwards, sideways, or backwards, in space. The muscles of the neck always act freely, even when a weight is carried on the head, but, forcedly, in the case of a clown standing, as it is called, on that part. The muscles of the lower limb, especially, have always to be studied as if acting from below, with the foot fixed on the ground, as well as from above, with the limb moving in the air. The muscles erect and move the body and enable it to carry weights.

Speaking generally, when muscles cease to act, the weight of the part acted on, serves to restore the balance on one side or the other of a joint; but, where gravity does not especially operate, as in the case of the muscles of the eyeballs or of the face generally, the tonic condition of all the surrounding muscles conjointly, produces a state of equilibrium in the parts concerned.

The Influence of the Muscular System on the General and Local Forms.

The manifest influence of the muscles on the *surface-forms* of the body, figs. 119, 198, 199, justifies the minutest examination of every detail concerning their form, structure, and connexions. The deeper-seated muscles, in this respect, are of less importance than the superficial ones; they are hidden from view, but they serve to fill up the hollows, vacuities, and angular intervals existing in the hard framework of the body; they form the first fleshy clothing of the bones. But the superficial muscles cover nearly every part of the skeleton, save only those subcutaneous parts, which have been fully described with the bones themselves; moreover, in man, in whom the erect position demands a more uniform distribution of the muscular organs around the osseous columns of support, they nearly everywhere determine, by their position and mass, the outward general and local form of the body and limbs; they give breadth and smoothness to the trunk, and special roundness and richness to the limbs; whereas, in quadrupeds, the body is more flattened on the sides, and the movements of the limbs are more simply hinge-like, to and fro, so that the muscles and tendons are placed chiefly in front of and behind the bones, and the general form of the limbs is also flattened laterally. The introduction of long tendons in the limbs, especially in the leg and fore-arm, and on the toes and fingers, not only, as already stated, economises the more highly organised contractile tissue, and conveys the action of the muscles conveniently to great distances, but it also aids in lightening the weight, and in tapering the general forms of the limbs in their distal segments, and thus adds greatly to their elegance and beauty. Unlike the straps and bands used in certain machinery, tendons, whether rounded or flat, never present quite straight borders or squared ends; their width continually varies, their edges are oblique or gently curved, and their attachments spread out, so as not only to take good hold of the bones to which they are fixed, but, if superficial enough, to blend finely and imperceptibly with the harder contours of these.

The forms of the deeper-seated muscles, including both their fleshy and their tendinous portions, are, for the most part, simple, their outlines being often geometrical, linear, triangular, or quadrangular, and their surfaces flat; but those of the superficial muscles, which are so far exposed that they actually determine the surface-forms, are, as regards their tendons or aponeuroses, as well as their muscular portions, singularly complex both in outline and mass, presenting graceful contours and richly modelled surfaces of the most varied character, flowing agreeably into each other. The local details of the surface-forms depend so largely on the particular shapes of the individual muscles, their bulgings, flattenings, hollows, projections, ridges and curves, their fleshy and their tendinous or aponeurotic portions being, in this respect, of equal importance, that it is difficult to set limits to their study, which is replete with interest and utility. Many of the muscles, indeed, as shown in fig. 120, possess such specialities of form and structure, that they may well lay claim to the character of individuality; they manifest the qualities of *specialised* organs, and, one is tempted to say, simulate some of those of individual organisms.

The few muscles which are connected with soft parts only, are the simplest in both form and structure; they consist of flat, or curved planes, attached only to the mucous membranes, the skin, or the subcutaneous fascia; they merely move, and render tense, or throw into folds or close up, the parts with which they are connected. The platysma myoides, fig. 120, P, is an example of these.

The more numerous instances of muscles, which are attached to bone at one end, and to some soft tissue or organ at the other, have also simple forms. Such, for example, are the flat *curvilinear planes* of fleshy fibres, named orbicular muscles, which surround the mouth O, and eyelids O′, both of which serve to close the apertures which they embrace. Others, however, forming linear, triangular, quadrilateral sheets of fleshy fasciculi, represented by the great zygomatic muscle of the mouth Z, draw upon the soft parts to which they are attached, and move them out of one position into another, in the direction of the muscle itself. In this category, all the other muscles which descend or ascend to reach the lips, may be classed; also those of the eyebrows and the various muscles in the orbit, which move the upper eyelid and the eyeballs; likewise certain muscular slips, which are attached to the capsules of joints; and lastly, the important tensor muscle of the fascia of the thigh, fig. 145, ^{32}.

But it is the numerous muscles attached at both ends to the skeleton, and moving the bones on each other, which present the greatest variety of shape, structure, and connexions. Most of them are larger in the centre, and smaller at each end. Some of them, as illustrated by the sartorius muscle of the thigh, S, are *long, strap-shaped* or *ribbon-shaped*, and are composed of longitudinal fasciculi reaching from one end of the muscle to the other; they may be twisted in their course, as the sartorius especially is; they are all necessarily swift in action, and so move the bones, on which they pull, through a relatively great space, in a given time. Other muscles are *short, round, conical, tapering,* or *spindle-shaped*, like the pronator teres of the forearm, P′, in which case, the fasciculi arise from a broader origin, and are gathered gradually upon the sides of a tapering tendon of insertion, narrower than the muscle itself. Many muscles are *triangular* in shape, as seen in the adductor longus of the thigh A, the muscular fasciculi radiating from a thick and narrow, to a thin and wide tendon. Numerous muscles have tendons of insertion as long as, or longer than, their fleshy portions, such as some of the muscles of the leg and of the forearm, which proceed to the toes or fingers, figs. 134, 173. The biceps muscle of the arm, B, has one very long and slender tendon of origin; but it also possesses another tendon of origin, and so is named *bicipital* or *two-headed*. The length of these two tendons of origin is determined by the fact, that there are overlying muscles, the tendons of which have to play over the biceps, whilst the biceps has to work beneath them; the fleshy part of this muscle is relatively short and fusiform, and consists of delicate and regular fasciculi, springing from the surface of the two tendons of origin, and ending, by an oblique border, on the surface of the tendon of insertion, which, at first rounded, soon becomes flat, and undergoes a half twist, as it penetrates between the radius and the ulna, to reach its point of insertion on the former bone. Again, a muscle may be *tricipital* or possessed of *three heads*, like the triceps of the arm T, the separate portions of which, being too large to end on a round and tapering tendon, are gathered on to the under surface and borders of a broad flat tendon of insertion; the lines of junction of the fleshy with the tendinous portions of this and of other superficial muscles, are more or less curved, and not straight and square, or even linearly oblique, as is usually the case in deep-seated muscles. Again, muscles may have still more multiple origins, as the *quadriceps* of the thigh, the *complexus* at the back of the neck, C, the *multifidus* spinæ, M, and certain other muscles, which arise from a series of bones, like the vertebræ or ribs. Parts of the complexus muscle furnish an example of the presence of a transverse, tendinous *inscription* or *intersection*, and also of a complete *intermediate tendon*, such as is seen on the inner portion of that muscle, known as the biventer cervicis, or *two-bellied* muscle; two other instances occur in the neck, namely, the omo-hyoid and the digastric muscle. The rectus muscle of the abdomen R, furnishes the most striking instance of the existence of tendinous inscriptions along the course of a muscle; they are indications of a segmentation of the soft parts, similar to those met with in the vertebral column and its appendages, the ribs. Under certain circumstances, multiplicity of origin from a series of similar bones such as the ribs, gives rise to a peculiarly complicated arrangement of the muscle itself, and to a *serrated* form at its edge, as seen in the great serratus muscle situated on the side of the thorax, S′. A flat *quadrangular* form, met with in the pronator quadratus of the forearm Q, affords an example of extreme simplicity of shape, in a deep-seated muscle. A *compound triangular* form, with two of the angles rounded off, occurs in the great pectoral muscle P″, which also furnishes an illustration of the twisting of a muscle, as it reaches its flat tendon of insertion. Another modified *triangular* form is seen in the well-known *deltoid* or delta-shaped muscle of the shoulder, D; this, moreover, exhibits a remarkable internal structure, which serves

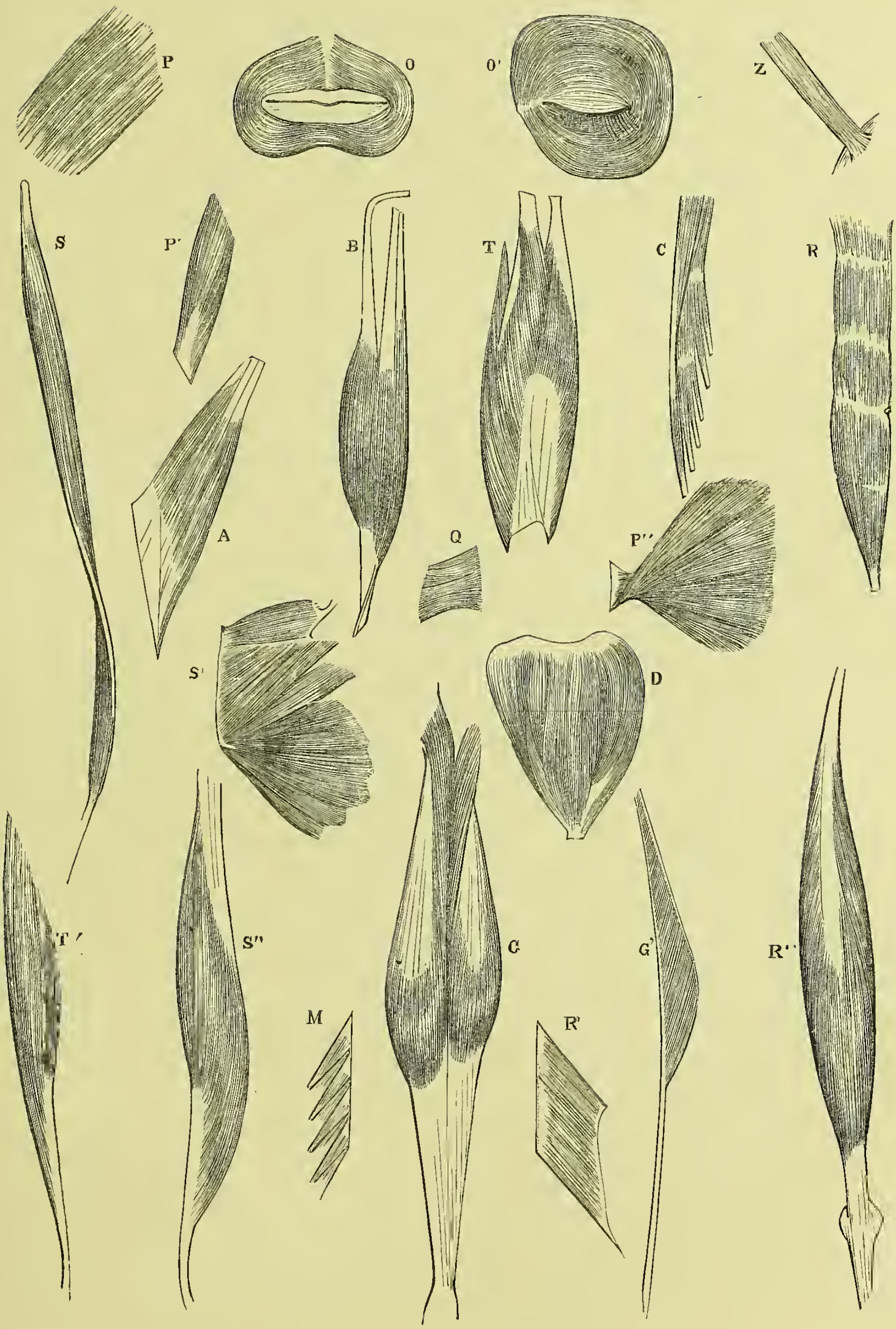


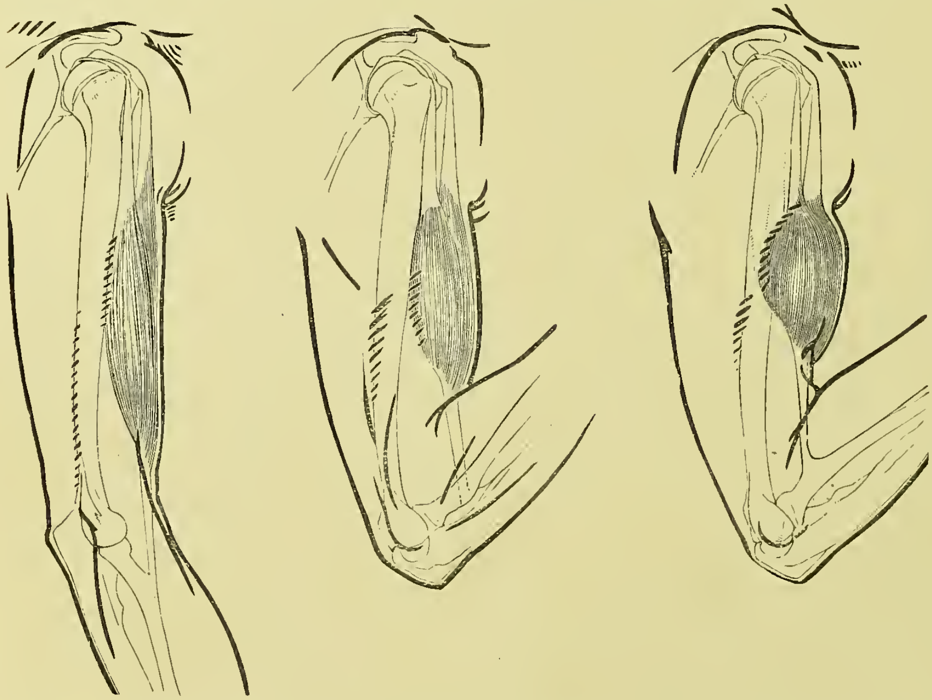
FIG. 120.--The Forms of Muscles and Tendons. The names are sufficiently indicated in the text.

to accumulate a vast number of short muscular fasciculi in a given space, and enables these, proceeding from a broad base, to be gathered finally on one moderate-sized, though strong, tendon. This is accomplished by means of one series of tapering tendons passing down into the muscle from its extensive line of origin; by another set of tendons coming from the strong and folded tendon of insertion, also tapering, and reaching up between the first set; and lastly, by an immense number of short fasciculi, passing obliquely from the sides of one set of tendons to the sides of the other. The provision for securing great strength is here complete, for the fasciculi, though short, are extremely numerous, and the force of the deltoid is not to be measured by a cross section through the widest part of the muscle, but by a series of vertical sections made through its numerous planes of oblique fasciculi, figs. 163–5. A *fusiform* muscle, with a fleshy origin, like the tibialis anticus, T′, generally ends by its fasciculi fastening themselves obliquely to one edge of a long tendon, which therefore appears as if gradually emerging from one side of the muscle, like the quill of a feather stripped of its barbs on one side; hence the muscle is said to be *semi-penniform*; in such a case, the tendon is usually superficial, and frequently flattened, presenting one edge towards the skin, the muscular part reaching its under edge from the bone. A muscle may have a tapering tendon at both ends, with intermediate oblique fleshy fasciculi, as in the instance of the semi-membranosus, S″; the force of such muscles is obviously greater than if their fasciculi were arranged longitudinally, for the cross section at right angles to the fasciculi, would then be much less than it is, in the muscle as actually constructed. An instance of a completely *penniform* muscle, sometimes named *bi-penniform*, that is, one in which the fasciculi are attached to both sides, as well as to the under surface, of a central tendon, like the barbs of a perfect quill, is seen in the rectus muscle of the thigh R″, a very fine fusiform muscle, the fasciculi of which end on a strong tendon below, as usual, along an obliquely curved border; on passing over the end of the femur, this tendon includes the patella, a large sesamoid bone, in its substance. Two very simple muscles have a *rhomboidal* shape, the so-called rhomboid muscles, lesser and greater, of the scapula, R′; they are deep-seated and consist merely of parallel fasciculi, and narrow flat tendons. Extreme simplicity of form, with its frequent concomitant *repetition*, is seen in the multifidus muscle of the spine M, which is composed of numerous little short slips of mixed fleshy and tendinous bundles. In very marked contrast with this, is the complicated form and structure of the gastrocnemius, or *bellied muscle of the calf of the leg*, G. This consists, first, of two tendinous heads giving off fleshy fasciculi, which pass down obliquely towards each other and end on a deep-seated median tendon; and, secondly, of two foliated tendons spreading out superficially on the back of the muscle, and giving origin, by their deep surfaces and rounded edges, to fasciculi, which pass downwards and forwards, as shown in the sectional view G′, to a strong broad tendon; this is continuous with the median tendon above described, and ends below, by tapering, and joining the equally tapering tendon of the soleus muscle situated beneath it. The muscular fasciculi of the gastrocnemius form two fleshy bellies, united along the middle of the muscle, of unequal length, breadth and thickness, both ending on the tendon in curved borders; whilst the tendon itself has unequally curved sides. This is the most complex single muscle in the body; it serves well to illustrate the general proposition already laid down, that the superficial muscles display more highly finished forms, as compared with the more simply shaped, deep-seated muscles. In reference to this point, also, it will be observed that, of the series of muscles shown in fig. 120, those marked A, Q, M, and R′, are deep-seated muscles, whilst those marked B, T, P″, D, R″, and G, are superficial. In fig. 147, are shown the deepest vertebral muscles, which may be contrasted with fig. 167, representing the superficial muscles of the back. Doubtless, every line and surface of a muscle, whether simple or complicated, is dependent on a form and structure, necessitated by and adapted to certain mechanical uses, according as these are themselves, simple or complex. Quantities of contractile tissue indicate seats and lines of force and work. But it is obvious that the resulting forms have also an æsthetic import, inasmuch as in superficial muscles, which produce so many of the recognisable surface-forms of the body, they are more beautifully modelled than in the deeper ones, which do not directly affect those forms. It has to be remarked, in conclusion, that no individual muscle is symmetrical in itself; for its ends, sides, and surfaces are always unequal in form. Hence each limb is also unsymmetrical, as regards its different aspects.

The influence of the muscles on the surface-forms becomes still more striking, when such swiftly contracting and as swiftly relaxing organs are put *in action*; for this heightens their effect, and so multiplies the changes of form which they undergo, that these become almost endless. They are, indeed, capable of being observed better than they can be described, and they require the lifetime of the artist practically to master. If the bones furnish examples of 'still life,' the muscles illustrate 'life in motion;' the bones are inanimate, though not dead, the muscles are truly 'quick.'

Every living muscle may be in a state of perfect *rest*, as when the body is reclining and the limbs are in attitudes of repose, or in the recumbent posture, or during *sleep*, though, even then, the living muscular substance is in a condition of *tonic contraction*, a gentle form of incessant action, wrongly attributed to a separate quality, designated *muscular tonicity*, but which is a part of their healthy contractility. During the waking state, a muscle may be in various degrees of *tension*, owing to the resistance of other muscles, or to weight; or again, it may be *relaxed* beyond its ordinary condition during rest, as when it yields or is mechanically stretched, to permit the employment of antagonist muscles; or, lastly, it may be in different stages of active *contraction*, from the most moderate to the most vigorous exercise of its power, and that, in different conditions of its fasciculi as to length.

The most important changes of state in a muscle attached by both ends to bone, and their different effects on the surface-forms, are illustrated in the annexed representations of different conditions of the well-known and easily observed *biceps muscle of the arm*, perhaps the most independent and freely moving muscle in the whole body. In fig. 121, the entire arm being dependent, the elbow-joint extended, and the forearm supinated, this muscle is perfectly tranquil or relaxed, elongated to nearly its full extent, but, of course, in a state



Figs. 121, 122, 123.—Three different conditions of the biceps muscle of the arm, to show their effects on the outward or surface forms.—Fig. 121. The muscle relaxed, and stretched by gravity, the forearm supinated.—Fig. 122. the muscle moderately contracted, the forearm being flexed, and the radius pronated.—Fig. 123. The muscle contracted to its utmost, the forearm flexed, and the radius supinated.

of tonic contraction. It is, accordingly, narrow, or slender, and its surfaces present gently and elegantly curved forms, altogether peculiar to this individual muscle, of course, dependent, first, on the number, length and arrangement of its component fasciculi, and their mode of attachment to its two tendons of origin and to its single tendon of insertion, and, secondly, on the length, breadth, special form, and course of those tendons themselves. In this condition, the fleshy portion of the muscle obviously determines the delicate and complex undulating contour of the front of the arm, tapering gradually, both upwards and downwards, into the tendon-forms; it is slightly indented or flattened along the middle, where the fasciculi are nearly parallel, but it is gently, though unequally, convex at both ends, where these spring from, or bend down upon the tendons, more markedly so at its lower end. The posterior border of the muscle determines the agreeable curves of an *intermuscular marking*, seen on the surface of the arm behind it, indicated in the sketch, by the series of cross lines over the anterior border of the humerus. The long axis of the muscle and its tendons, forms with that of the shaft of the humerus, a very small angle. Lastly, the two upper tendons are concealed beneath the deltoid and the pectoral muscles; whilst the lower tendon sinks into the fold of the elbow, being drawn down with the radius, to which it is fixed, and is thus acted upon and straightened by gravity. In fig. 122, the forearm being fully flexed, but now pronated, the biceps is in a state of strong, but not of complete contraction. Its fleshy portion is much shortened and widened; its anterior contour, and with this, that of the arm, is, accordingly, also shorter and more convex, but it still retains traces of flatness opposite its middle, and shows an increasingly convex outline above, but especially below. Its posterior contour, with its coincident intermuscular surface marking, has also become more convex, and, as shown by the cross lines, has descended in the arm, and no longer follows the anterior border of the humerus. The two upper tendons, unchanged in length, are still concealed by the deltoid and pectoral muscles; the lower one, also, not lengthened, although it is partly held down, owing to the pronation of the forearm, is drawn up by the muscle, which thus flexes the elbow joint. Lastly, the common axis of the muscle and its tendons, is now changed with the shifting forwards of the position of its point of attachment to the radius, so that it forms a more open angle with that of the shaft of the humerus. In fig. 123, the forearm being now not only fully flexed, but supinated, the muscle is completely contracted, so far, at least, as the bones will practically permit. Its length is now extraordinarily diminished, that is to about one-half of what it was in the relaxed condition; whilst it is proportionately widened in the middle to about double its original width. Its anterior contour, now markedly convex, and protuberant, still enables the eye to trace the peculiarities of its middle and terminal portions, due to the structural arrangements of its fasciculi, the abruptness of its upper and lower convexities being remarkable and characteristic. Its posterior contour is likewise much more convex, and determines a more strongly curved intermuscular marking on the surface, now drawn higher up, and overlapping the shaft of the humerus. The line of greatest transverse width of the contracted muscle, corresponds with the part in which the greatest number of fasciculi is present. The two upper tendons, inextensible and not stretched, are still concealed by the pectoral and deltoid muscles; but the tendon of insertion, equally unstretched, is now, owing to the radius being in the position of supination, withdrawn from the depression in front of the elbow, and forms a ridge, here partly concealed from view by a fold, caused by the long supinator muscle. Lastly, the direction of the axis of the entire biceps is now again altered, owing to the extreme flexion and rotation of the radius, and the shifting backwards of the lower attachment of the muscle, so that it is now almost parallel with that of the shaft of the humerus. The several conditions above described, are accompanied by simultaneous alterations in the shape of the muscle on all sides; for, as it has a solid form, it must undergo change in every direction, and thus must influence the surface-forms on the inner as well as the outer aspect of the forearm. Moreover, the muscle may be in a simple state of tonic contraction, or in a condition of active contraction at all stages as to length. Lastly, the order of the changes may be reversed.

These changes in the form and position of a muscle, and in the position of its tendon or tendons, are *primary* or *intrinsic*, due to the action of the muscle itself; but they frequently produce *secondary* or *incidental* changes in surrounding parts, and are furthermore accompanied by *complementary* changes in neighbouring or opposed muscles, which must not be lost sight of, as regards their effect on the local forms. For example, the two tendons of origin of the biceps undergo very slight change of position, the shoulder-joint, in the cases shown in the figures, being supposed to remain stationary; but the fleshy mass and the tendon of insertion are much more displaced, both longitudinally and from before backwards. Hence, the antero-posterior diameter of the arm is increased in the second position of the biceps, fig. 122, not entirely as a consequence of the altered shape of the muscle, but also of its slight forward displacement. At the same time, the brachialis anticus, which also contracts, moves forwards beneath it. Again, the pectoral and the deltoid muscles have their borders pressed forwards and their shape slightly altered by the displaced tendons which pass beneath them. Furthermore, when the biceps is in action, its antagonist muscle, the *triceps* at the back of the arm, figs. 166, 167, [59], undergoes various *complementary* changes, which, indeed, as most frequently happens, are very complicated. Thus, in fig. 121, the triceps is relaxed, quiescent, and only tonically contracted, yielding in such a way, as not to oppose the contemplated movement; its outline and that of the arm itself, are slightly concave above, because of the tendons in that situation; it is gently convex lower down, opposite the thickest part of its middle fleshy portion; and, lastly, it is depressed or concave below, over its broad flat tendon of insertion, the form of which is broken by a slight cutaneous fold. In fig. 122, the muscle is more relaxed, being to a certain extent actually stretched, and yet its posterior forms become more clearly pronounced through the skin, because, by the downward and forward movement of the olecranon process, the lower part of the entire muscle is brought nearer to the back of the humerus. In fig. 123, the muscle is still further stretched; nevertheless, the general convexity of its hinder outline is again more marked, probably owing to some slight counter-effort, required to steady the ulna, for the supination movement of the radius upon it. This condition furnishes an example of a muscle contracting in an elongated state, owing to the shortened condition of its fully contracted antagonist, the biceps, preventing any opposite movement of the bones. In the two former positions of the triceps, figs. 121, 122, the outlines of its fleshy and tendinous portions pass gently into each other, a condition characteristic of the relaxed, or simply tonic condition, with or without actual stretching, of a muscle. Even in the contracted state, provided the muscle is stretched, as in fig. 123, the contours remain somewhat soft; it is only when the muscle is more, or completely shortened, as well as contracted, that the differences in outline between the tendinous and the fleshy portions are prominently marked.

Every muscle in the body undergoes the changes just described, and the primary or *essential*, and secondary, *incidental*, or complementary changes, whether due to action, or to rest, should be carefully studied in all the superficial or subcutaneous muscles. Each may contract in different degrees of intensity, and also in any of its conditions or stages as to length, accordingly as it is free or opposed; each may be, complementarily relaxed, mechanically stretched, and, together with its tendons, secondarily displaced in relation to the surrounding parts, which may thus have their forms also affected.

In regard to these changes, certain general rules are useful to remember. Thus the thickest part of any given muscle, whatever its primitive shape, becomes the most convex, when it is contracted; even broad muscles and straplike muscles become more elevated, in places where they are thickest; compound muscles, composed of many slips, have their separate subdivisions made more distinct, and when they have oblique fasciculi, widen themselves, out of all proportion to the amount of shortening which they undergo. Tendons and aponeuroses suffer no alteration of their actual length or width; but wide tendons and expanded aponeuroses become flattened or even depressed, and tapering or rounded ones usually start up, and become more prominent; transverse tendinous intersections become depressions between the elevated fleshy parts of a transversely segmented muscle; whilst longitudinal tendinous intervals, and the borders of intermuscular septa, appear as superficial grooves or markings. In figs. 166, 167, are to be found some illustrations of these points. In fig. 166, the greater pectoral muscle, [55], and the latissimus dorsi muscle, [50], are both not merely relaxed, but mechanically stretched, and so is the coraco-brachialis, [56]; whilst the triceps of the arm, [59], and the biceps, [58], are both in moderate action, opposing and balancing each other. In fig. 167, the latissimus dorsi, [50], of the right side, is relaxed and mechanically stretched, whilst on the left side, it is quiescent; the right trapezius, [51], is in powerful action, its upper and middle portion being accordingly shortened and thickened, but its lower portion, though contracted, not so shortened, because the scapula is carried forwards from the spine; the right deltoid muscle, [52], is also strongly contracted, but its hinder border has to sweep round the back of the head of the humerus, and, accordingly, is somewhat extended, though in action; on the left side, both the two last-named muscles are absolutely quiet, or only tonically contracted.

The softness and flexibility of the living muscular tissue, and also its remarkable elasticity or power of extension and recoil, which seems allied to its tonicity, but is independent of, and, indeed, is partially diminished during its active contraction, enable the muscles to adapt themselves quickly to the varying positions of the neighbouring parts, especially of those of the bones moving at the joints, as well as to the constant changes of length, which they themselves undergo, when they are relaxed or contracted in different degress, or when they are elongated by being mechanically stretched, by the gravity of parts of the body, or by antagonist muscles. The fact that the muscular substance practically undergoes no diminution in bulk as it contracts, has this obvious general application, namely, that the total mass of the corresponding part of a limb remains unaltered, whatever the condition of its muscles may be. The arm is thicker around in fig. 123, than in fig. 121, but its anterior part is shorter, and the parts about the tendon of the biceps are drawn in, so that the increase in one part is compensated by a diminution in other respects and situations.

There is yet another condition of the muscles, which it is important for the artist to consider, namely that which occurs after death. At the moment of death, and the cessation of control on the part of the nervous system, voluntary and involuntary, the muscles become absolutely relaxed, and the whole body flaccid; so that, in obedience to gravity, the head falls backwards, forwards, or to one side, the lower jaw drops, the mouth and eyelids open by their mere elasticity, and the limbs lie helplessly, the upper ones either slightly flexed, or as accident has placed them, and the lower ones usually with the feet extended and everted, owing to their weight. Sooner or later, however, according to circumstances, the muscles pass into the condition known as *post-mortem rigidity*, or *rigor mortis*, in which they become so firmly contracted, that the body and limbs are quite stiff—'stiffened in death.' The force required to overcome this rigor mortis is very great. The form assumed by each muscle in this condition, is the one which is possible to it, in the actual position of the body and limbs, at the moment of death, or that which the relative length and elasticity of the antagonist muscles permit, or the balance of forces then brings about, unless some insuperable weight or resistance interferes with the action of those causes. Hence, the upper eyelid continues to be partly drawn up, but the lower jaw again rises, the teeth are set together, and the mouth is ultimately closed; whilst the facial muscles, often painfully distorted by violent emotion or suffering, usually, but not always, lapse into a condition of equilibrium, in harmony with their normal forces, and thus restore the placid forms of expression habitual to the face in sleep, now assumed and fixed, in the final repose of death. The head, however, if unsupported, remains fallen backwards, or forwards, or to one side, the muscles of the neck having no power, even when they become rigid, to overcome its weight, so that they stiffen as they lie. The trunk may be straight or coiled up; the limbs extended, or folded, the upper ones sometimes retaining an attitude of grasping, assumed in the last moments of life, and the lower ones remaining straight and rotated outwards, or bent up, according to the conditions of the surface on which they may have fallen and rested at the moment of death. The toes and fingers become flexed, because the flexors are stronger, or perhaps because they are shorter than the extensors, and the thumb especially is strongly bent and drawn across the palm, within the closed fingers.

It is said that the rigor mortis may commence as early as, but not earlier than, about ten minutes after death, and not later than seven hours after that event, the former fact being frequently ignored by actors, who are carried off rigid from the stage, immediately after having mimicked death 'to make a' modern 'holiday.' The rigidity may last only half an hour, or may continue for a week. It comes on earlier and departs sooner, when the system has been exhausted during life by disease; but it appears later and lasts longer, when death occurs suddenly, in a previously healthy person. The stiffening begins in the neck and face, extends to the upper and then to the lower limbs, and it passes off in the same order.

This condition of rigidity is not a vital act, but depends on post-mortem chemical changes in the muscle, one effect of which is the coagulation of the myosin into syntonin. Still later, further chemical decompositions occur, and the muscular substance again becomes soft, and the muscles quite flaccid. It is either in the later stages of this rigid condition, or in the earlier stages of final softening, that the anatomist explores the muscles; and in order to translate the appearances displayed by the scalpel, the artist must restore, by more or less modification of the forms actually observed, the configuration of the parts as they would exist in life. The dissected view of the muscles of the head and neck represented in fig. 186, serves to show, by comparison with fig. 187, on the opposite page, the differences here alluded to.

The Coverings of the Muscles. The Fasciæ, deep and superficial, the Skin, and the Subcutaneous Veins.

The muscles are covered, immediately, by a firm membranous investment named the fascia, or *proper fascia*; over this, is a loose single or double layer of areolar or connective tissue, called the *superficial fascia*, in which the cutaneous muscles, and subcutaneous veins are situated; over this again, is the *common integument* or *skin*.

The Proper Fascia.—This firm and somewhat tense membrane, composed of white fibrous tissue, arranged, in its stronger parts, in intersecting layers, or in very dense and close shining bands, forms an almost continuous covering over the whole body. It is thicker on the back than on the front of the trunk, and much thicker on the outer than on the inner side of the limbs; it is thickest in the soles of the feet and palms of the hands, where it forms the plantar and palmar fasciæ. This fascia not only holds the muscles together, but, also; gives off firm partitions between the several layers of the muscles, and others between the muscles themselves; these latter constitute the *intermuscular septa*, and, in the limbs especially, the *sheaths of the muscles.*

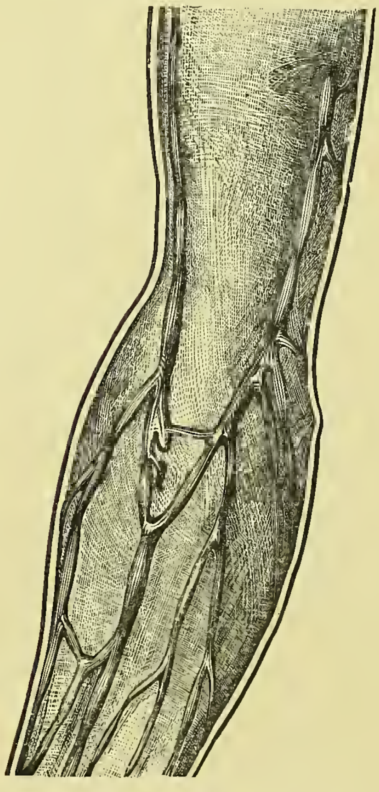


Fig. 124, showing the Proper Fascia of a part of the arm and forearm, with the Subcutaneous Veins resting upon it, the superficial fascia and the skin having been removed. The oblique offset from the tendon of the biceps is also shown.

The former not only separate, but give partial attachment to adjacent muscles; the latter prevent displacements of the muscles, and confine them to certain planes or channels, as, for example, is seen in the case of the sartorius, fig. 141, [33], the rectus abdominis, fig. 166, [35], and the erector spinæ, fig. 152, [27]. Both kinds would appear to brace the muscles together, and so support them in action. Those parts of the fascia, which merely cover in the muscles, are named *aponeuroses of investment*, such, for example, as the fascia in front of the arm and forearm, fig. 124; but those which give attachment to muscles also, are called *aponeuroses of origin*, such as the temporal aponeurosis, fig. 186, the vertical aponeurosis, fig. 152, or *aponeuroses of insertion*, such as the fascia lata of the thigh, fig. 145, and the aponeurotic slip of the biceps muscle of the arm, figs. 124, 166, [68]. Some aponeuroses or fasciæ serve both for investment and attachment, as that of the latissimus dorsi, fig. 167, [50], which covers the erector spinæ, and that of the extensor muscles in the leg and forearm. Beneath the fascia, the interspaces between the muscles are occupied by the larger blood-vessels and nerves, or by a little fat. About the wrist and ankle, the deep fascia is strengthened, and forms the *annular ligaments*, figs. 131, 132, 182, 185, and the so-called *retinacula*, which are fastened to the bones, and keep the tendons in their proper grooves.

The Superficial Fascia.—This is a loose moist web of areolar tissue, which nearly everywhere connects the deep fascia with the skin, in such a way that the latter can move more or less freely over the former. It contains the subcutaneous fatty tissue of the body, and hence has been termed the *panniculus adiposus*. On the front and inner aspect of the limbs, and on the front and sides of the neck, it consists of two easily separable layers, between which the subcutaneous veins, fig. 124, are situated. On the head, face, and neck, the cutaneous muscles are placed in the deeper of the two layers, which contains little or no fat, and is named the *panniculus carnosus*. On the abdomen, on the contrary, this superficial fascia contains much soft fat, and, on the back, a more granular fat. It is also thick and loaded with fat, over and below the gluteal region. The superficial fascia as well as the skin, is particularly loose over the prominences of the joints, where it presents closed spaces or cavities named *bursæ* (bursa, a purse), which facilitate the movement of the skin over those parts. It may be said almost to give place to fat, in the palms and soles, and on the face, to yield to the muscles which penetrate it to reach the under side of the skin.

The Skin.—The *skin* or *common integument* of the body, consists of two super-imposed and closely adherent membranous structures. The deeper and thicker membrane is the *cutis, derma, corion,* or *true skin*; this is a dense, pinkish or yellowish white, translucent structure, varying in thickness from about $\frac{1}{8}$th of an inch in the soles of the feet, to about $\frac{1}{50}$th of an inch in the eyelids; it is composed chiefly of areolar tissue, but contains also yellow elastic fibres, and a certain number of scattered, pale, involuntary muscular fibres, besides blood-vessels and nerves; it is therefore strong, flexible, elastic, slightly contractile, as seen under the influence of cold and fear, and liable to changes of colour from variations in the quantity of blood circulating through its vessels, as observed especially in the face, and in the palms of the hands. Its under surface is connected with the superficial fascia and subcutaneous fat; in its substance are found the hair bulbs and sacs, the sebaceous follicles, and the sudoriferous glands. Its surface is smooth, but marked with a network of fine lines, or parallel ridges, and presents in parts many little sensitive eminences, named papillæ. Upon it, is closely attached the thinner superficial membrane of the skin, named the *cuticle, epidermis,* or *scarf skin*. The innermost strata of the *cuticle*, soft, moist, and translucent, form the *rete mucosum of Malpighi*, which, though colourless in a fair white skin, is coloured in darker complexions, and contains much pigment in the yellow, brown, and black races; the outermost stratum of the cuticle, is dry, colourless and transparent, and consists of microscopic scales. The total thickness of the cuticle varies from $\frac{1}{12}$th of an inch in the soles, to $\frac{1}{200}$th of an inch in the body generally; it is marked by the same network of lines or ridges, as the cutis on which it is moulded, but it conceals the papillæ; it is, of course, perforated by the hairs, whilst the ducts of the sudoriferous glands open in the form of little pores on its surface. The hairs and nails belong structurally to the cuticle, and like it, are destitute of blood-vessels and nerves, and are therefore non-vascular and not sensitive.

The *skin*, thus formed, thinner and finer in women than in men, owes its thickness chiefly to the cutis, excepting in the palms and soles, where the cuticle also is very thick. Speaking generally, the skin is thicker on the back than on the fore part of the trunk, and thicker on the outer than on the inner aspect of the limbs; it is, for the most part, thin at the foldings of the joints, but it is still thinner on the eyelids, in the auditory meatus, and especially on the red border of the lips, where it becomes continuous with the mucous membrane of the mouth. The fine intersecting lines of the cutis with the corresponding furrows of the cuticle, cut up the surface of the skin into minute, lozenge-shaped or angular spaces, which are exceedingly small on the thinner parts of the skin, sometimes larger and well-marked as on the back of the hand, and pass gradually into the still larger creases opposite the foldings of the joints. The parallel ridges belonging to the cutis, are peculiar to the palms and soles, where they form curvilinear lines very characteristically arranged. Fine hairs grow everywhere, except on the palms and soles, and on the eyelids; these, and also the larger hairs, have usually each a small pale muscular fibre so connected with their bulbs or sacs, that when it contracts, as under the influence of cold, or of fear, which, interrupting the flow of blood to the skin, produces a sense of coldness on the surface, the hair is temporarily erected, and the skin roughened, so as to produce the condition known as 'goose-skin.'

In the face, many of the fibres of the muscles, especially of the eyebrows, lips, and chin, are inserted into the under surface of the cutis; this is also true of the fibres of the palmaris brevis muscle in the hand. Over the palms and soles, especially on the heel, toes, and tips of the fingers, the skin is firmly adherent to the fibrous and fatty tissue beneath it, and, through the former, to the periosteum of the bones. Along the various *furrows* corresponding with the subcutaneous portions of the skeleton, where the superficial fascia is very scantily developed, the skin is also fixed a little more closely than over the proper fascia around, and this is likewise the case along the linea alba, and the tendinous intersections of the recti muscles of the abdomen. On the contrary, over the prominences of the bones on the aspect of extension of the joints, where bursæ exist in the superficial fascia, the skin is very loosely attached, and is thrown into folds of special shape, when the joints are straightened.

The natural coverings of the muscles, thus described, soften down the external forms both of the fleshy and tendinous portions of these contractile organs, even in the most energetic actions; and when the muscles are at rest, the coverings almost entirely obliterate their specific forms, leaving only the general masses revealed. In some parts, too, as over the front of the knee, in the groin, above the iliac crest, and at the back of the elbow, the foldings or creasings of the skin even traverse the muscular forms. In the face, all the muscular forms are hid, the skin folds and wrinkles, entirely determining the actual surface-forms.

The precise influence of the general integument in concealing the subjacent forms of the bones, muscles and tendons, which are still recognisable through it, depends not merely on the thickness of the skin proper, but also on that of the fatty covering or panniculus adiposus belonging to the superficial fascia. These two parts by no means correspond in thickness. The following measurements, taken on a well-nourished subject, indicate the amount of concealment of the subjacent parts in different regions of the body, or, as it may otherwise be expressed, the degree in which those parts are more or less clearly revealed upon the surface. Commencing with the sole of the foot, the thickness of the skin and subjacent fat under the os calcis was found to be $\frac{7}{8}$ths of an inch, and under the ball of the great toe $\frac{1}{2}$ an inch. Behind the inner malleolus and on the leg generally, it was $\frac{3}{16}$ths of an inch, and over the middle of the calf $\frac{1}{4}$ of an inch; but over the tendo Achillis it was only $\frac{1}{8}$th of an inch, so that the form of that tendon is very conspicuously revealed. On each side of the patella, it was $\frac{1}{4}$ of an inch; in the upper part of the popliteal space, $\frac{5}{16}$ths of an inch; over the rest of the thigh generally, $\frac{7}{16}$ths; but on the inside it was rather less, and on the outer side and back, it was from $\frac{9}{16}$ths to $\frac{5}{8}$ths, over the gluteus maximus, and even 1 inch on the outer and upper part of the back of the thigh. Over the abdomen, it varied from $\frac{3}{8}$ths, above Poupart's ligament, to $\frac{1}{2}$ an inch, at the side of the umbilicus; over the great pectoral muscle, and in the axilla, it was only $\frac{1}{4}$ of an inch; on the back, $\frac{5}{16}$ths of an inch in the lumbar region, $\frac{1}{4}$ of an inch in the dorsal region, but as much as $\frac{1}{2}$ an inch over the spine between the scapulæ, and again only $\frac{5}{16}$ths, at the posterior border of the scapula, and over the ligamentum nuchæ. At the top of the deltoid it was $\frac{1}{4}$ of an inch, but over the swell of that muscle, $\frac{3}{8}$ths; in the middle of the arm, $\frac{1}{8}$ of an inch; in the forearm, it also averaged about $\frac{1}{8}$th, but was greater on the outer side; lastly, over the ball of the thumb, and the palm generally, it was between $\frac{1}{8}$th and $\frac{3}{16}$ths.

The Subcutaneous Veins.—In certain regions of the trunk and limbs, where the skin is thin, and loosely attached to the proper fascia, as on the back of the foot, the inner side and back of the leg, the inner side and front of the thigh, the front of the abdomen and chest, the front and sides of the neck, the forehead and temples, the front of the arm and forearm, and the back of the hand, the subcutaneous veins are sufficiently large to appear through the skin. The smaller branches in which they commence, emerge gradually into view, as meandering blue lines, but soon they form very definite, but soft and easily obliterated, straight or tortuous elevations, which unite into fewer and larger ones, as the veins which produce them proceed towards the heart, until they end in a few still larger and straighter venous trunks, which dip into, and disappear beneath the proper fascia, fig. 124, to join the deep veins. Owing to the presence of valves in the interior of the veins, situated opposite little pouches in their sides, the veins themselves are not uniform in outline, but have a slightly knotted appearance; this is more evident in the larger and straighter trunks, than in the small tortuous branches. The course of the smaller subcutaneous veins is so various, in different subjects, that, even for the anatomist, only a general description of them is possible; that of the larger trunks is more constant. A few words concerning each, will be found in the account of the surface-forms of each region in which they occur. They become fuller under the influence of gravity, or a dependent position of any part; also when the muscles of a limb are acting powerfully, whether under emotion or voluntary control; likewise, when the body is heated and the integuments relaxed, and when the breath is strongly held, an act which checks the return of blood to the heart. On the other hand, cold, repose, sleep, and a horizontal or elevated position of the body, or of any part, diminish the calibre of the superficial veins.

THE INDIVIDUAL MUSCLES.

The *individual muscles*, sometimes arbitrarily or insufficiently defined, are named, on very different principles. Some, for example, from their shape, as the orbicularis, triangularis, quadratus, rhomboideus, serratus, trapezius, and deltoid; others, from the number of their origins or longitudinal divisions, as the biceps, triceps, quadriceps and multifidus, or of their transverse divisions, as the digastric, or of both, as the complexus; from their direction, as the recti, the transversalis and the oblique; from their relation to certain bones or other parts, as the tibialis and peronei, the obturators and intercostals; from their attachments, both of origin and insertion, as the sterno-cleido-mastoid, sterno-hyoid, sterno-thyroid and occipito-frontalis; from their regional position, as the popliteus, glutei, palmaris, and temporal muscles; and, lastly, from their action or use, such as the extensors, flexors, abductors, adductors, pronators, supinators, rotators, elevators, depressors, compressors, and dilators, the meanings of which terms need no explanation.

Many of the muscles present *varieties* in their form and attachments. Occasionally, they are unusually divided into two or more parts; sometimes a portion of a muscle is absent, or the entire muscle may be wanting; a muscle may have an additional origin, or insertion, or be closely united with a neighbouring muscle; occasionally, a muscle is doubled, that is to say, two muscles resembling each other in form and points of attachment, are found side by side, in the place of one. Such variations are chiefly met with in the limbs, especially in the upper or most elaborately developed limb. It is by no means uncommon to find the number of tendons into which a flexor or extensor muscles divides, either increased or diminished; and not unfrequently, unusual junctions of tendons are discovered. In figs. 132 and 184 drawn from the same subject, but not the one employed for the illustrations of the muscles generally, there are shown, examples of additional tendinous slips in the foot, extending from the peroneus tertius to the base of the first phalanx of the little toe, and in the hand, from the extensor carpi ulnaris to the corresponding phalanx of the little finger. These accessory or supernumerary muscular or tendinous slips are not the result of mere over-use; they have a deeper significance, being expressions of the tendency to vary exhibited in living organisms, in internal structure, as well as in outward form. There is a mystery as to the particular cause of the variations, in any given case, or series of cases; and they often display a waywardness, justifying the appellation of 'sports;' considering the multitude of beings evolved, generation after generation, and the complex nature of the developmental process, it would be even more wonderful, if there were no play of the evolutional force which is so incessantly at work. Many of the varieties found in man, are homologous with structural arrangements proper to other animal forms; and it would seem that this tendency to vary, furnishes the most probable explanation of the occurrence, in long periods of time, of such differences as, being taken advantage of, end in the permanent appearance of superadded, or more highly evolved parts, in the ascending scale of animals. The progressive development of the numerous muscles of the thumb, and of the thumb itself, in the animal series, or of the muscles which pronate and supinate the hand, the radius becoming at the same time so freed from the ulna, as to be able to execute its peculiar rolling movements upon that bone, may be taken as probable examples of this mode of gradual evolution.

The illustrations of the muscles, in the following pages, have been drawn on the wood from dissections, an outline of the part or region concerned, having been first designed from the life, the forms of the dead muscles being then accommodated to those of the living figure. The bones, also drawn from nature, are represented with due care as regards their relations both to the muscles, and to the surface-forms. The subject on which the dissections for the muscles were prepared, excepting those of the side views of the foot and hand just mentioned, those of the side and front view of the face, figs. 187, 192, and those of the eyeball and lips, was that of a powerful man, in whom, owing to his peculiar occupation, the muscles of the shoulder, arm, and fore-arm were very largely developed.

The Tables prefixed to each principal region, contain a list of the muscles of that region, designated by their Latin names, and arranged in due order from the deeper to the superficial sets. The numerals appended to each muscle, indicate the reference number of that muscle, in every illustration in which it appears. The tendons of insertion are marked, in the drawings, with corresponding numerals, *accented*.

The chief anatomical points of interest, in regard to any given muscle, are its *position*, whether *deep* or *superficial*; its *shape*; its *direction*; its *origin*, and its *insertion*. In the ensuing descriptions, the first three points are given, in the above-named order, in the first sentence after the name. In a second sentence, the origin and insertion are stated, the two being separated merely by a dash ——. In certain instances, where this formal method cannot be adopted, a more lengthened description is given, or special details are superadded. Lastly, the *action* of the muscle is described, except where this is plainly indicated by the name. The relations of the muscles to surrounding parts, always mentioned in anatomical works, are omitted, but may be safely studied in the illustrations, to which also, as already recommended, the student should refer, whilst learning the places of attachment of the Muscles, given in the description of the Bones. The deep-seated muscles are briefly noticed; but special attention is paid to all the peculiarities of the superficial muscles, which directly influence the surface-forms. This renders it unnecessary to do more, at the end of the description of the muscles of each principal region, than shortly to review the surface-forms dependent on the muscles and tendons of each part. To this is added some notice of the influence on the forms of the fasciæ, skin, and veins.

Table of the Muscles of the Lower Limb.

THE FOOT.	THE LEG.
Interossei, dorsales pedis (four), 1.	Tibialis anticus, 14.
,, plantares pedis (three), 2.	Extensor proprius pollicis pedis, 12.
Abductor minimi digiti pedis, 1*a*.	,, longus digitorum pedis, 11.
,, pollicis pedis, 1*b*.	Peroneus tertius vel anticus, 15.
Adductor pollicis pedis, 2*b*.	,, brevis, 16.
Transversus pedis, 3.	,, longus, 17.
Flexor brevis minimi digiti pedis, 4.	Tibialis posticus, 9
,, ,, pollicis pedis, 5.	Flexor longus pollicis pedis, 8.
,, Accessorius, 7*a*.	,, longus digitorum pedis, 7.
Lumbricales pedis (four), 7*b*.	Soleus, 18.
Flexor brevis digitorum pedis, 6.	Popliteus, 19.
Extensor brevis digitorum pedis, 10.	Plantaris, 20.
(*Annular ligaments*), *a*, *a*.	Gastrocnemius, 21.
	(*Tendo Achillis*),

THE THIGH.

Vastus externus, 23.	Sartorius, 33.
,, internus, 24.	Gracilis, 34.
Crureus, 24*a*.	Semi-membranosus, 35.
Subcrureus.	Semi-tendinosus, 36.
Rectus femoris, 25	Biceps cruris, 37*a*, 37*b*.
Adductor magnus, 26.	Quadratus femoris, 38.
,, longus, 27.	Obturator externus, 39.
,, brevis, 28.	Gemellus inferior, 40.
Pectineus, 29.	Obturator internus, 41.
Psoas magnus, 30.	Gemellus superior, 42.
,, parvus.	Pyriformis, 43.
Iliacus, 31.	Gluteus minimus, 44.
Tensor vaginæ femoris, 32.	,, medius, 45.
(*Fascia lata*), 32′.	,, maximus, 46.

The Muscles of the Foot.

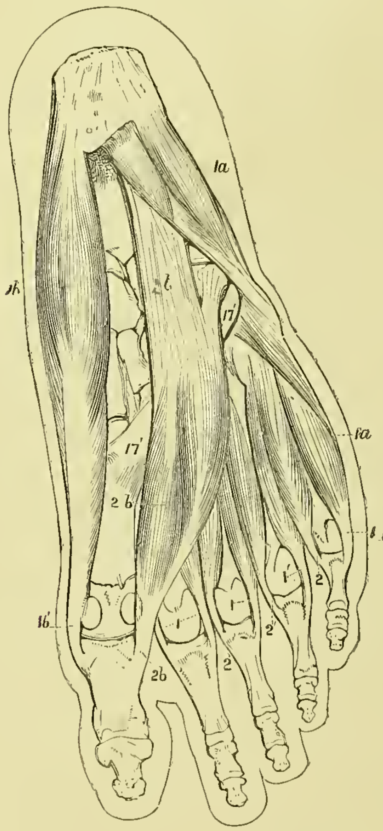
The muscles of the foot are partly situated in the sole, and partly on the dorsal surface; in the former situation, they are numerous and arranged in layers, but in the latter, there is only one muscle, although parts of others are seen between the metatarsal bones, and on the borders of the foot. All the muscles of the foot act upon the toes, but in such different ways, that they may be *grouped*, according as they *abduct* or spread the toes, *adduct* or draw them together, *flex*, or *extend* them. The foot is also traversed by many long tendons, belonging to muscles situated in the leg; some of these are placed in the sole, some on the sides and dorsum of the foot, whilst one descends only as far as the back of the heel.

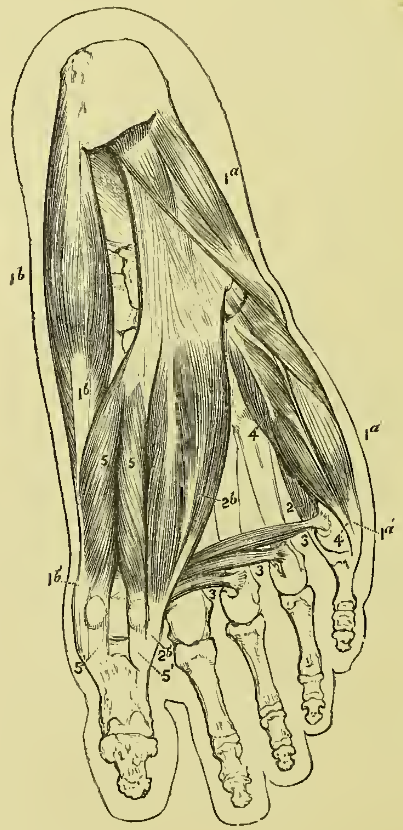
The Abductor and Adductor Group, fig. 125.—This includes, as abductors, the dorsal interosseous muscles, and the proper abductors of the little and great toes. The adductors consist of the plantar interossei, the adductor of the great toe, and the transverse muscle of the foot.

Interossei dorsales pedis, figs. 125, 130, ^{1} $^{1'}$. Deep; four in number, penniform; along the interosseous spaces. Sides of the metatarsal bones, by two heads——bases of the first phalanges, and expanded tendons of the long extensor of the toes. The first of the dorsal interosseous muscles, is inserted into the inner side of the first phalanx of the second toe; the second, third, and fourth, into the outer sides of the phalanges of the corresponding toes. They are abductors from an imaginary line passing through the axis of the second, usually the longest toe; the first muscle draws that toe from such a line, inwards or towards the great toe; the second draws it outwards from that line, and the third and fourth abduct the corresponding toes.

Interossei plantares pedis, figs. 125, 130, ^{2} $^{2'}$. Deep; three in number, fusiform, and semi-penniform; along the interosseous spaces. Under and inner surfaces of the third, fourth, and fifth metatarsal bones——inner sides of the bases of the first phalanges of the corresponding toes, and expanded tendons of the long extensor of the toes. The plantar interosseous muscles, adduct the third, fourth, and fifth toes, towards the imaginary line passing through the second toe.

The two sets of interosseous muscles furnish abductor and adductor muscles to the second, third, and fourth toes, and an adductor only to the fifth toe. But this last-named toe has a special abductor, and the great toe has a





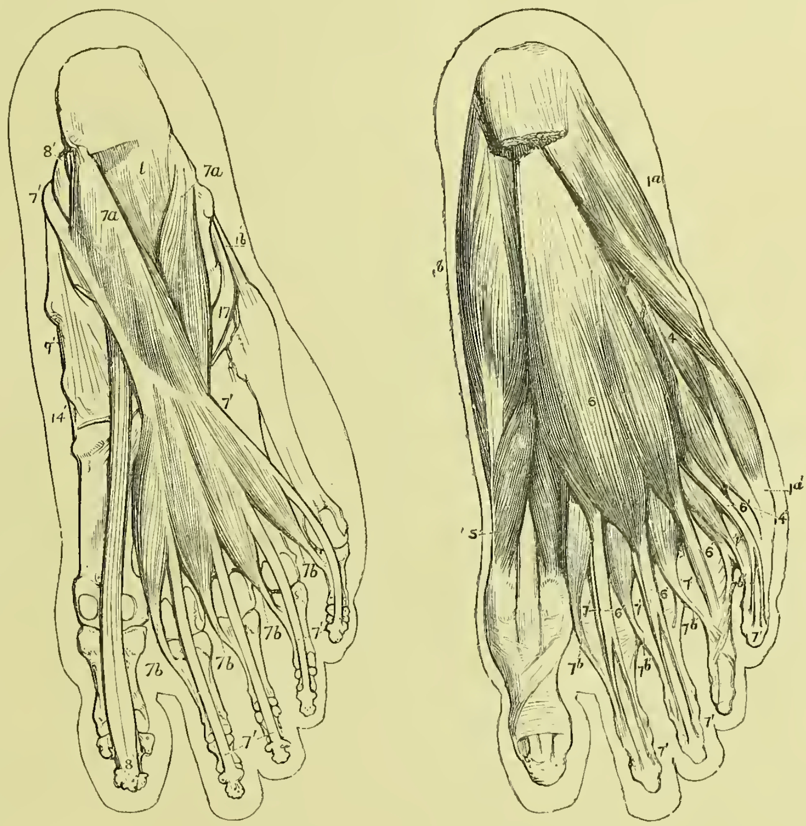
Muscles in the Sole of the Foot.

FIG. 125.—Abductor and Adductor Group.
FIG. 126.—Deep Flexor Group, with two Abductors, and an Adductor.

special abductor and adductor; so that all five toes, in accordance with the character of the joint at their base, have an abductor and adductor muscle, which act on its first phalanx, besides flexor and extensor muscles.

Abductor pollicis pedis, figs. 125, 126, 128, 130, 131, $^{1b\ 1b'}$. Superficial; thick, broad behind, with a strong tendon on the plantar surface, tapering in front; along the inner border of the foot. Inner side of the larger tuberosity of the os calcis, internal annular ligament of the ankle, plantar fascia, and adjacent intermuscular septum——internal sesamoid bone and inner side of the base of the first phalanx of the great toe, together with the inner half of the short flexor of that toe. This muscle is an abductor, but a still more effectual flexor of the great toe.

Adductor pollicis pedis, fig. 125, 126, $_2b$. Deep; the largest muscle in the sole; prismatic, and tapering forwards to a narrow tendon; oblique, through the middle of the foot. Bases of the second, third and fourth metatarsal bones, and sheath of the tendon of the peroneus longus muscle——



Muscles in the Sole of the Foot.

FIG. 127.—Accessory Flexor, Lumbricales and long Tendons.
FIG. 128.—Superficial view of the Short Flexor, with the other muscles complete.

outer side of the base of the first phalanx of the great toe, together with the outer half of the short flexor of that toe. It adducts the great toe towards the second one, and then assists in flexing it.

Transversalis or *transversus pedis*, fig. 126, $^{3-3}$.— Deep; consists of several bundles; transverse beneath the fore part of the metatarsus. Under side of dense capsules of the second, third, fourth, and sometimes of the fifth metatarso-phalangeal joints, transverse ligament of the metatarsus, and, occasionally, the head of the fifth metatarsal bone——outer side of the first phalanx of the great toe, in union with the tendon of the adductor of that toe. This muscle, unrepresented in the hand, adducts or approximates all the toes, and increases the curve of the transverse arch of the metatarsus.

Abductor minimi digiti pedis, figs. 125, 126–128, 130–132, [1a 1a′]. Superficial; elongated, rounded, conical; along the outer border of the foot. Outer tuberosity and under surface of the os calcis, plantar fascia, and adjacent intermuscular septum——outer side of the base of the first phalanx of the little toe. It is slightly attached, in its course, to the base of the fifth metatarsal bone. It acts as a flexor, as well as an abductor of the little toe.

The Flexor Group, figs. 126–128.—This includes the short flexor of the little toe, the short flexor of the great toe, the accessory flexor, the lumbricales, and the short flexor of the four outer toes.

Flexor brevis pollicis pedis, figs. 126–128, [5 5]. Covered behind, superficial in front; bifid, each half being fusiform and semi-penniform; along the under surface of the first metatarsal bone, its two halves being separated in front, by the tendon of the long flexor of the same toe. Inner border of the cuboid bone, part of external cuneiform bone, and prolonged tendon of tibialis posticus——the two sesamoid bones and corresponding borders of the base of the first phalanx of the great toe, the inner half joining the abductor, and the outer half the adductor of that toe. It is a powerful flexor of the first phalanx of the great toe.

Flexor brevis minimi digiti pedis, figs. 126–128, [4 4]. Slightly overlapped behind, otherwise superficial; fusiform and penniform; along the under surface of the fifth metatarsal bone. Base of that metatarsal bone, and sheath of the peroneus longus muscle——outer side of the base of the first phalanx of the little toe. Besides flexing the little toe, it draws its metatarsal bone downwards and inwards.

The position and course of the tendons which enter the foot from the leg, fig. 127, may now be followed. These are, commencing on the inner border of the foot, the *tendon of the tibialis posticus*, [9′], passing forwards to the tuberosity of the scaphoid bone, and sending fibrous prolongations into the sole of the foot; the *tendon of the long flexor muscle of the great toe*, [8′ 8′], passing forwards beneath that toe, to its last phalanx; the tendon of the *long flexor muscle of the four outer toes*, [7′ 7′], running obliquely forwards and outwards, and dividing into four slips, which pass beneath those toes, to their last phalanges; the *tendon of the peroneus longus*, figs. 125–127, [17′], running obliquely forwards and inwards, in a groove on the under side of the cuboid bone, and onwards to the base of the metatarsal bone of the great toe; and lastly, the *tendon of the peroneus brevis*, fig. 127, [16′], inserted into the tuberosity at the base of the fifth metatarsal bone.

Flexor accessorius, fig. 127, [7a 7a]. Deep; flat, four-sided, with two heads of origin, the inner being the larger; convergent towards the middle of the sole. *Inner* head, from concave inner surface of os calcis, and calcaneo-scaphoid ligament, *outer* head, from under and outer surface of os calcis, and calcaneo-cuboid ligament——along the outer margin, and the upper and under surfaces of the common tendon of the long flexor of the toes, by tendinous bands, fine slips also passing to the subdivisions of that tendon for the second, third, and fourth toes, and to the tendon of the long flexor of the great toe. It not only assists the long flexor of the toes, but combines with it, so as to convert the oblique pull of the tendons of that muscle into a directly backward traction upon the toes.

Lumbricales pedis, figs. 127, 128, ^{7b} $^{7b'}$. Deep, excepting their slender tendons between the toes; four in number, small, tapering, *wormlike*, the inner one semi-penniform, the others penniform; along the inner margin of each subdivision of the long flexor tendon. Margins of those subdivisions, the inner muscle from one, the others from two adjacent subdivisions——inner margins of the expanded tendons of the long extensor of the toes. These small muscles, if the tendons of the long flexor are fixed, flex the first phalanges of the four inner toes, and bend them to their own side.

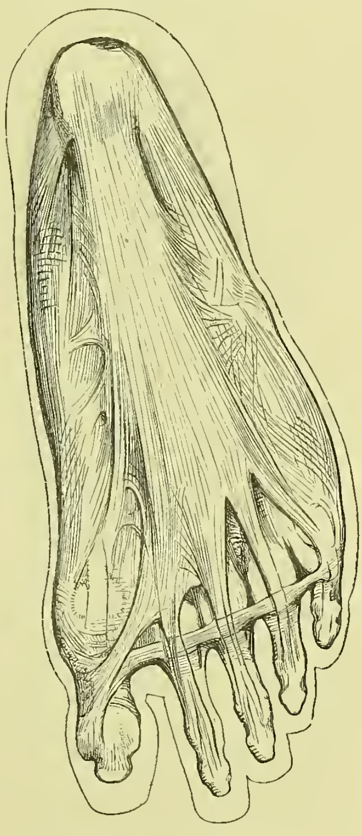


Fig 129.—The Plantar Fascia.

Flexor brevis digitorum pedis, fig. 128, ^{6} $^{6'}$. Superficial, but covered by the dense central portion of the plantar fascia; pointed behind, wide and thick in front, and ending in four tendons; longitudinal, along the middle of the sole, between the abductors of the great and little toes. Inner part of the larger tuberosity of the os calcis, central portion of the plantar fascia, and adjacent intermuscular septa——by its four tendons, into both margins of the under surfaces of the second phalanges of the four outer toes. The four tendons, enclosed in a strong fibrous sheath, common to both the short and the long flexor, split opposite the first phalanges, and permit the corresponding tendons of the long flexor to pass from under them, through a sort of grooved channel, the split portions again uniting beneath the long tendons; then they once more divide into two slips, to be inserted into the margins of the second phalanges. Having flexed the second phalanges upon the first, this muscle flexes the first phalanges also, and brings the toes together. As this muscle, and also the flexor accessorius and the abductors of the great and little toes, arise from the os calcis, behind the transverse joint of the foot, they all ultimately act on the metatarsus and protarsus, especially curving them downwards, and resisting strains upon the longitudinal plantar arch.

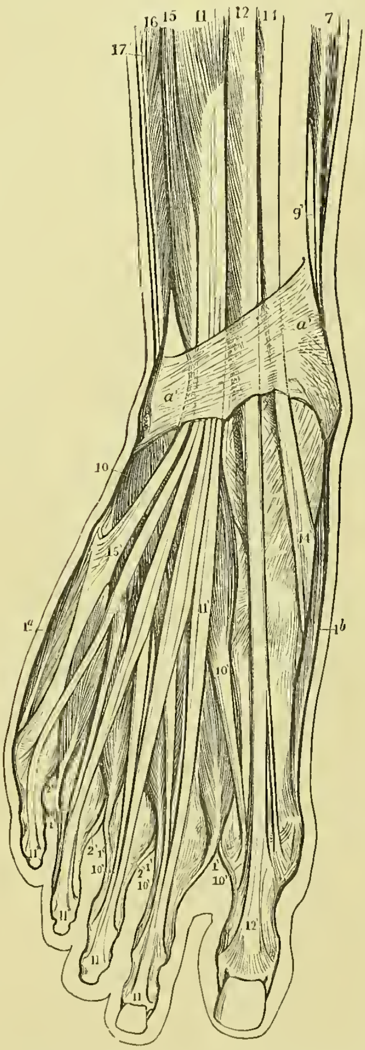


Fig. 130.—Muscles and Tendons on the Dorsum of the Foot, with the Annular Ligament, *a*, *a'*.

The plantar fascia, fig. 129. The *central portion* of this fascia, very dense, flattened, and narrow behind, where it is fixed to the os calcis, but fuller, wider, and thinner in front, divides beyond the middle of the metatarsus into five bands, which are connected by transverse fibres forming the *superficial transverse ligament*. Each band gives off lateral slips to the sides of the heads of the metatarsal bones, and to the deep transverse ligament, and is continued onwards, to blend with the strong fibrous sheaths of the flexor tendons of the toes. The tendons of the lumbricales and interossei pass forwards between these bands. The *outer* and *inner* portions of the plantar fascia, much thinner than the central part with which they are continuous, are prolonged over the borders of the foot, where they join with the fascia on the dorsum. The outer portion is thicker behind, and is attached to the os calcis, and also to the tuberosity of the fifth metatarsal bone; the inner portion is the thinnest part of the fascia, and joins the internal annular ligament of the ankle behind. Where the central and lateral portions of the plantar fascia unite, two strong intermuscular septa pass up between the short flexor of the toes and the abductors of the great and little toes, and give off finer partitions between the other muscles, which ultimately reach the bones. The plantar fascia protects the muscles, nerves, and blood-vessels of the sole, and assists in supporting the arch of the foot; as the three superficial plantar muscles arise partly from its deep or upper surface, the hollow of the foot is increased, and the arch is additionally supported when they are in action.

The Extensor Group.—There is but one extensor muscle, which is placed on the dorsum of the foot; portions of the dorsal interosseous muscles, however, appear between the metatarsal bones, and parts of the abductor muscles of the great and little toes are seen on the borders of the foot.

Extensor brevis digitorum, figs. 130, 132, [10] [10′]. Superficial, but crossed by the tendons of the long extensor of the toes, and of the peroneus tertius; broad, somewhat pointed behind, dividing in front into four slips, each giving off a tendon; passing obliquely inwards along the outer part of the back of the foot, just beyond the bases of the four outer metatarsal bones. Outer side of the os calcis, astragalo-calcaneal ligament, and lower band of anterior annular ligament——by its inner tendon, into the base of the first phalanx of the great toe, and by its other three tendons, into the outer margins of the tendons of the long extensor belonging to the second, third, and fourth toes, so contributing to form the common tendinous expansion on the backs of their phalanges. This muscle sends no tendon to the little toe. It acts on the first phalanx of the great toe, but it also co-operates with the long extensor in acting on all the phalanges of the second, third, and fourth toes. It gives to the four inner toes an outward direction when they are extended, especially acting thus on the great toe. It may also aid slightly in straightening the metatarsus and protarsus.

The *tendons* which descend from the muscles of the leg, on to the *dorsum of the foot*, figs. 130–132, may now be traced, as they escape beneath the anterior annular ligament. Commencing on the inner border of the instep, they are, the *tendon of the tibialis anticus*, [14′], passing obliquely over the inner border of the tarsus to the internal cuneiform bone, and the base of the first metatarsal bone; the *tendon* of the *proper extensor of the great toe*, [12′], descending along the tarsus, the first metatarsal bone, and the back of the great toe, to the last phalanx of that toe; the *tendon of the long extensor of the toes*, [11′], dividing into four slips, which diverge, as they pass forwards on the tarsus, metatarsus and toes, to be inserted into the second and third phalanges of the four outer toes; and lastly, the tendon of the *peroneus tertius*, [15′], passing obliquely over the outer border of the tarsus, to the base of the fifth metatarsal bone. At the back of the heel, is found the very large tendo Achillis, figs. 131, 132, [22], descending from the muscles of the calf to the os calcis.

The *fascia on the dorsum of the foot*, and the *annular ligaments of the ankle*. The back of the foot and its numerous tendons, with the short extensor muscle lying beneath them and close to the bones, is covered in by a thin *dorsal* fascia, which is gradually lost on and between the toes in front, is continuous with the lateral portions of the plantar fascia on either border of the foot, and is united behind, with the *annular ligaments of the ankle*. These latter are merely thicker portions of the fascia of the leg, strengthened by transverse and oblique fibres, fastened to the tibia, fibula, and os calcis, and embracing the limb, above and below the ankle joint; they serve the important purpose of binding down the long tendons, which pass from the muscles of the leg into the foot, so that these cannot start far away from the bones during the action of the muscles, the direction of which action is here necessarily changed.

The *anterior annular ligament*, figs. 130–132, *a a'*, consists of two bands united by a thinner fascia. The *upper*, stronger band is placed vertically in the leg, above the level of the ankle-joint; it contains two sheaths, an inner one for the tendon of the tibialis anticus, 14′, and an outer one for the tendons of the long extensor of the toes, 11′, and of the peroneus

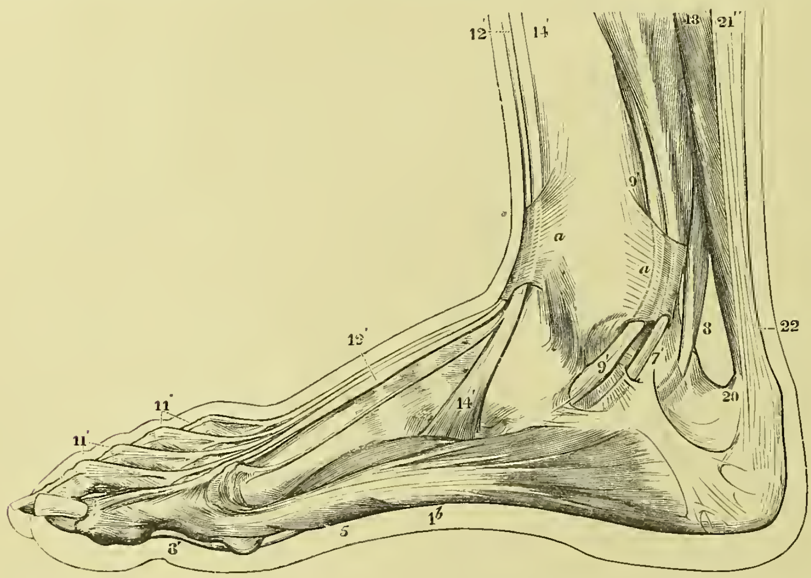


Fig. 131.—Muscles and Tendons on the inner border of the Foot, with the Anterior and Internal Annular Ligaments, *a*, *a*.

tertius, 15′; the tendon of the extensor of the great toe, 12′, passes altogether beneath it. The *lower* band is placed obliquely across the highest part of the tarsus; it contains three sheaths, lined by separate synovial membranes; an inner one for the tendon of the tibialis anticus, 14′; a middle one for that of the extensor of the great toe, 12′; and an outer one for the tendons of the long extensor of the toes, 11′, and of the peroneus tertius, 15′.

The *internal annular ligament*, fig. 131, *a*, is a strong fibrous band, attached, above, to the internal malleolus, and below, to the inner margin of the os calcis; it is continuous, on the one hand, with the fascia of the leg, and, on the other, with the origin of the abductor of the great toe, and with the plantar fascia. It forms, with the bony grooves on the inner side of the os calcis, three canals lined by synovial membranes, for the transmission, from the back of the leg to the sole of the foot, of the tendon of the tibialis posticus, 9′, of that of the long flexor of the toes, 7′, and, behind these, and resting partly on the astragalus, of that of the long flexor of the great toe, 8′.

The *external annular ligament*, fig. 132, passes from the external malleolus to the outer surface of the os calcis, and encloses in a single synovial sheath the tendons of the peroneus brevis, 16′, and peroneus longus, 17′, muscles.

The passage of the tendons of the deep flexor muscles of the leg and of the peronei, behind the malleoli into the foot, furnishes good examples of the deflection of muscular force around a bony prominence, so that it no longer acts in the line of the fleshy masses; for, when these muscles act from below upwards, they draw *upon* the malleoli, and when from above downwards, they pull *from* them.

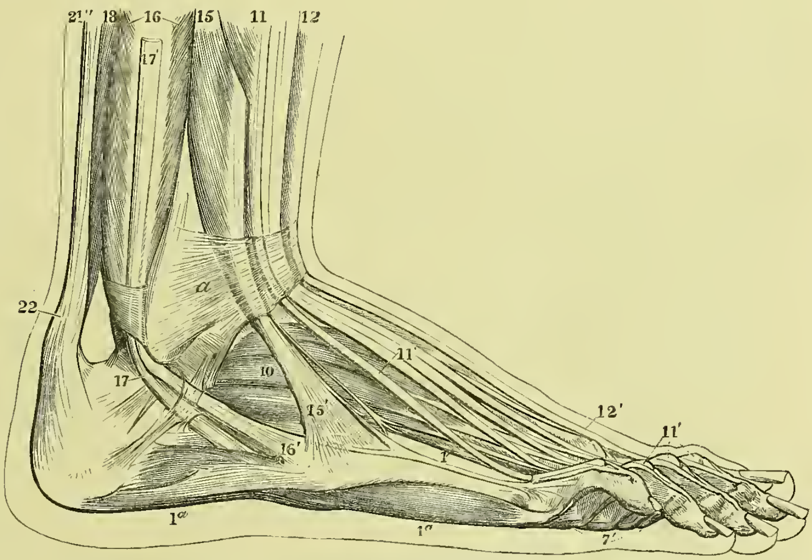


FIG. 132.—Muscles and Tendons on the outer border and Dorsum of the Foot, with the Anterior Annular, *a*, and External Annular Ligament.

THE MUSCLES OF THE LEG.

N.B. Figs. 127 to 132 should be referred to, whilst studying the Muscles of the Leg.

The muscles of the leg may be arranged into an *anterior* or *extensor group*, which serves to extend the toes and the protarsus, but bends the foot upwards at the ankle joint, or raises it towards the leg; an *outer* or *peroneal group*, which flexes the protarsus, but straightens the foot at the ankle; a deep *posterior* or *flexor group*, which flexes the toes and the protarsus, but straightens the foot; and lastly a *superficial posterior group*, forming the muscles of the calf, which straighten the foot, at the astragalo-calcaneal and ankle joints.

The Anterior Group, figs. 133, 134.—This includes the anterior tibial muscle, the proper extensor of the great toe, the long extensor of the four outer toes, and the third or anterior peroneal muscle. The tendons of these muscles have already been traced in the foot; those of the first and last-named muscles, extending only to the protarsus, those of the second and third, reaching to the toes.

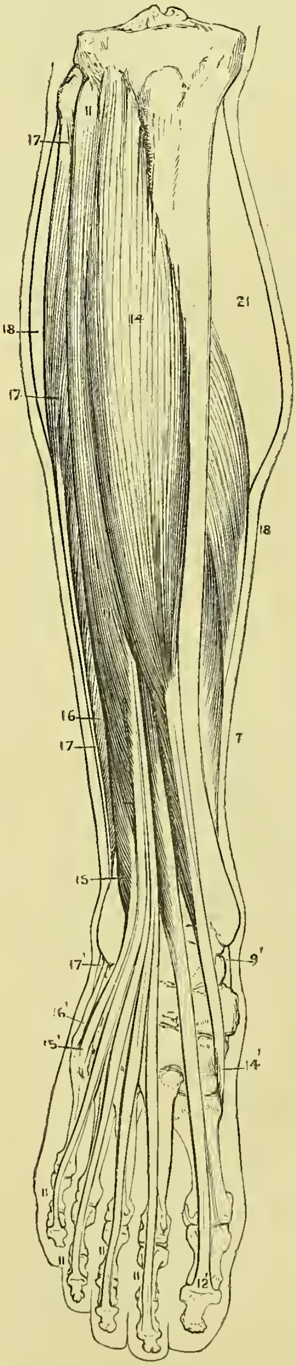


Fig. 133.—Muscles of the Leg; Anterior Group.

Tibialis anticus, figs. 133, 134, 138, [14, 14′]. Superficial; thick and fleshy above, tapering downwards, and ending below the middle of the leg, obliquely, on a strong flat tendon, which appears on the front and inner side of the muscle; vertical in the leg, at first between the tibia and the long extensor of the toes, then in front of the tibia, afterwards obliquely, downwards forwards and inwards beneath the anterior annular ligament, over the astragalus and scaphoid, to the inner border of the protarsus. Outer tuberosity and upper half or more of the external surface of the shaft of the tibia, adjacent part of the interosseous membrane, intermuscular septum between it and the long extensor of the toes, and, near its upper end, the strong fascia of the leg—— inner and under edge of the internal cuneiform bone, and inner side of the base of the first metatarsal bone. Acting from above, in free movements, this muscle assists in extending the protarsus, but it flexes the whole foot upon the leg; it also adducts the protarsus and the entire foot, so as to point the toes inwards; alone, but especially with the tibiàlis posticus, it elevates the inner border of the foot and so inverts or turns the sole inwards, the movements produced occurring not only at the transverse joint of the foot, but between the astragalus and os calcis, and, also, though slightly, at the ankle joint. In stepping forward, this muscle helps to raise the foot from the ground. Acting from below, in forced movements, as in standing, it co-operates with the two extensors of the toes, and the peroneus tertius, in drawing the leg bones forwards, and in maintaining them in a vertical position, steadying the tibia on the astragalus.

Extensor proprius pollicis, figs. 133, 134, 12′. Deep above, superficial in its lower half; thin and flattened, ending obliquely from behind, on a long and strong tendon; vertical in the leg, appearing in the lower third, between the tibialis anticus and the long extensor of the toes, then oblique, through and beneath the annular ligament, along the upper surface of the tarsus, the first metatarsal bone, and the first phalanx of the great toe. Middle three-fifths of the anterior portion of the inner surface of the fibula, and adjacent part of the interosseous membrane——back of the base of the last phalanx of the great toe. Besides extending the great toe, this muscle aids in extending the protarsus, in flexing the foot at the ankle, in raising the foot from the ground in walking, and, when it acts from below, in drawing forwards and sustaining the leg upright, in standing.

Extensor longus digitorum, figs. 133, 134, 11 11′. Superficial; long, flat, semi-penniform, ending obliquely, in the lower third of the leg, on the under and outer side of a broad flat tendon, which first becomes fissured, and then divided into four flat tendons, for the four outer toes; vertical in the leg, between the anterior tibial and the peroneal muscles, then oblique, beneath the annular ligament, and along the back of the tarsus, metatarsus and toes. External tuberosity of the tibia, head and upper three-fourths of the fore part of the inner

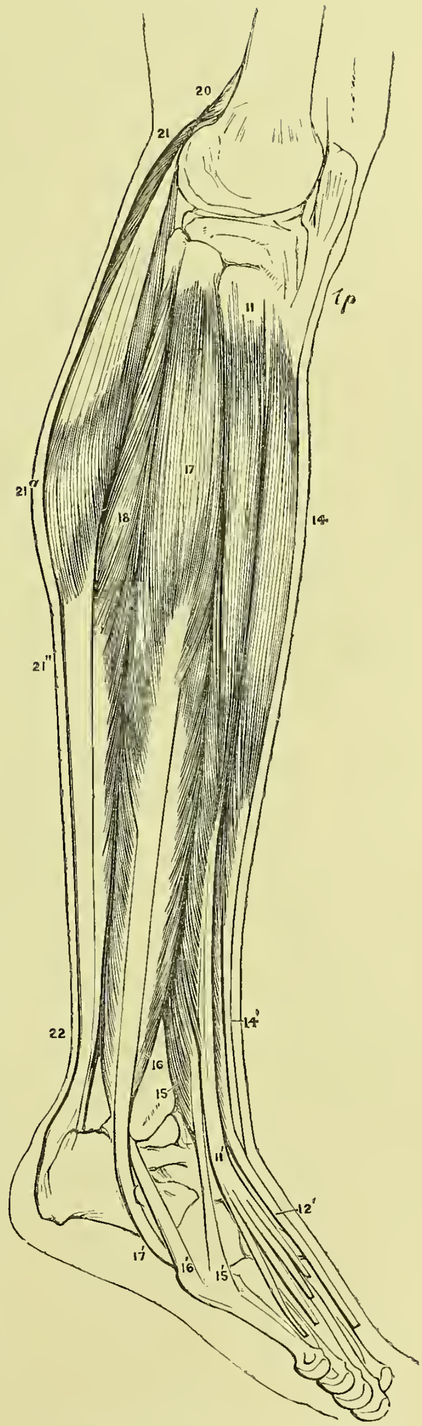


Fig. 134.—Muscles of the Leg; Outer or Peroneal Group.

surface of the fibula, adjacent part of the interosseous membrane, intermuscular septa on each side, and fascia of the leg——the muscle forms, on the first phalanx of each of the four outer toes, a broad tendinous expansion, which divides, opposite to the first interphalangeal joint, into three slips, a central one, inserted into the base of the second phalanx, and two lateral slips, which pass over the bevelled sides of the head of the first phalanx, again unite on the back of the second, and run on to be fixed to the base of the third phalanx. The broad expansion belonging to the second, third and fourth toes, is joined, on the first phalanx, by the tendons of the short extensor muscle, and by those of the lumbricales and interosseous muscles. The splitting of the tendon over the first phalangeal articulation, favours the extreme flexion of that joint. This muscle, with the short extensor, extends all the joints of the toes, that at the base included, thus liberating the toes from holding on to any surface of support. It also extends the protarsus, flexes the foot on the leg, raises the point of the foot from the ground in walking, and assists in steadying the leg upon the foot, in standing.

Peroneus tertius, or *anticus*, figs. 133, 134, [15] [15′]. Superficial; short, small, flattened, semi-penniform, ending obliquely in a slender anterior tendon, which widens out again below; vertical in the leg, closely associated with the outer border of the long extensor, of which some regard it as a part, then, oblique downwards and forwards beneath the anterior annular ligament, and along the outer side of the tarsus. Lower fourth of the anterior portion of the inner surface of the fibula, lower part of the interosseous membrane, and intermuscular septum between it and the peroneus brevis——dorsal aspect of the base of the fifth metatarsal bone. This muscle, which is sometimes wanting, and sometimes gives off adventitious tendinous slips, helps, in walking, to extend the protarsus, to flex the foot on the leg, and, in standing, to steady the leg upon the foot; it also, in conjunction with the two other peronei muscles, elevates the outer border of the foot, chiefly at the transverse joint of the tarsus, but also at the astragalo-calcaneal and ankle joints, and so everts the sole.

The Outer Group, fig. 134, &c.—This consists of the short and long peroneal muscles, so named because they are placed upon the *perone* or fibula (περόνη, fibula, a clasp). Unlike the peroneus tertius or anticus, just described, their tendons pass *behind* the external malleolus to reach the foot.

Peroneus brevis, figs. 133, 134, 137, [16] [16′]. Partly covered, but superficial both in front of and behind the tendon of the peroneus longus, which lies upon it; elongated, flat and penniform, its fibres ending obliquely on the borders of a rather broad, flat, median tendon; vertical in the lower two-thirds of the leg, covering the fibula, between the extensor longus, the peroneus tertius and the back of the external malleolus in front, and the soleus muscle behind, it enters a groove behind the malleolus with the tendon of the peroneus longus, and is then deflected and turns in the same compartment of the external annular ligament, obliquely downwards and forwards, through a separate sheath on the outer side of the os calcis, and thence along the side of the cuboid bone. Lower two-thirds of the outer surface of the shaft of the fibula, adjacent intermuscular septa, and fascia of the leg ——prominent tuberosity at the base of the fifth metatarsal bone. This muscle helps to flex the protarsus, to extend the foot on the leg, to abduct the foot, and slightly to evert the sole; when the fore part of the metatarsus rests on the ground, it aids in raising the heel. Acting from below, it assists in drawing the leg back upon the astragalus, and steadying it in the vertical position, in standing.

Peroneus longus, figs. 133, 134, 137, [17] [17′]. Superficial in the leg, but placed deeply, and close to the bones, in the sole of the foot; elongated and penniform, much longer, both in the leg and in the foot, than the last named muscle, its fibres ending obliquely about the middle of the leg, much sooner in front than behind, on a very long tendon, which is thickened and even fibro-cartilaginous, behind the external malleolus; in the leg, vertical, as low as the groove behind the external malleolus, covering the fibula above, and the short peroneus lower down, and placed between the long extensor and the soleus muscles, but below the malleolus, its tendon is deflected, and turns obliquely, downwards and forwards, passing beneath the external annular ligament, below the peroneal tubercle on the outer side of the os calcis, and under cover of the abductor of the little toe, reaches the under surface of the cuboid bone, and is, finally, directed obliquely across the sole of the foot, supported against the bones, in a strong sheath, formed partly by the long calcaneo-cuboid ligament. Head and upper two-thirds of the outer surface of the fibula, adjacent intermuscular septa, and superjacent fascia of the leg——under surface of the internal cuneiform, but chiefly the base of the metatarsal bone of the great toe, a slip occasionally going to the second metatarsal bone. When the foot is free and extended, this muscle first flexes the protarsus, and then extends the foot upon the leg; it also depresses the inner, and raises the outer border of the foot, and so everts the sole. Like the peroneus brevis, operating from behind the external malleolus, it assists in steadying the leg upon the foot, in standing. Moreover, acting round the outer border of the foot, upon the fibula, it prevents the leg being inclined too much inwards; lastly, in the propulsion of the body forwards, in walking, it presses the ball of the great toe firmly against the ground.

The Deep Posterior Group, fig. 135; &c.—This includes the posterior tibial muscle, the long flexor of the great toe, and the long flexor of the four outer toes.

Tibialis posticus, figs. 135, 137, 138, [9], [9′]. Deep, except a portion of its tendon, which is subcutaneous behind and below the internal malleolus; bifid and penniform, the fibres converging quickly to a strong median tendon; vertical in the leg, resting on the tibia and interosseous membrane, the tendon being deflected at the groove on the back of the malleolus, beneath the internal annular ligament, and then curving forwards on the internal lateral ligament, and beneath the astragalo-scaphoid articulation, where it is often fibro-cartilaginous, and so enters the sole. Back of the tibia, from its oblique line down to near its lower end, almost the whole length of the interosseous membrane, inner side of the fibula, excepting its lower fifth, adjacent intermuscular septa, and deep fascia——tuberosity of the scaphoid bone, sending numerous and strong prolongations, to the neighbouring tarsal, and middle three metatarsal bones. This muscle flexes the protarsus, extends the foot on the leg, and likewise assists the tibialis anticus in adducting these parts successively, and in inverting the sole. Taking its fixed point below, and co-operating with the other posterior muscles, it helps to maintain the upright posture, steadying the tibia on the astragalus, also to raise the leg from its forwardly inclined position in the stooping attitude, and, lastly, to press the foot on the ground, and straighten the leg upon the foot, so as to impart a forward propulsive movement to the body, in walking.

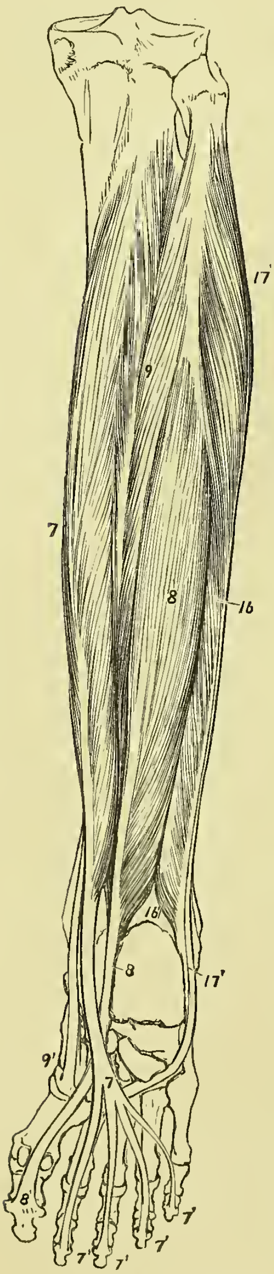


Fig. 135.—Muscles of the Leg; Deep Posterior Group.

Flexor longus pollicis, figs. 135, 137, 138, [8] [8′]. Deep and covered, except behind the astragalus, in front of the tendo Achillis; elongated, its fibres ending on a tendon, which appears on the back of the muscle; nearly vertical in the leg, behind the fibula and interosseous membrane, its tendon being deflected along a deeply seated groove on the back of the lower end of the tibia, next through a groove on the astragalus, and then beneath the sustentaculum tali of the os calcis, into the sole of the foot, where it passes obliquely downwards and forwards, between the two parts of the short flexor of the great toe. Lower half or more of the back of the fibula, intermuscular septum between it and the peronei muscles, and fascia covering the tibialis posticus——under side of the base of the last phalanx of the great toe. It first bends the last phalanx, and then the first phalanx of that toe. It is connected by a strong slip, joined by some fibres of the accessorius muscle, with the long flexor tendons of the second and third toes, which are thus associated with the great toe by their muscular arrangements, as well as by the connexions of their tarsal bones; it, accordingly, acts on all the three toes, on which the weight of the body is essentially borne, when the heel is raised from the ground. It assists the other posterior muscles in their free action, as in flexing the protarsus and extending the foot; also in steadying and straightening the leg, in resting on the flat foot, in raising the heel, in standing on tip-toe, and in the forward propulsion of the body, during the fixed or forced positions of the lower limb.

Flexor longus digitorum, figs. 135, 137, 138, [7] [7′]. Deep and covered above, but superficial, in the lower third of the inner side of the leg, between the tibia and the soleus muscle, and also behind and below the internal malleolus; elongated, pointed above, its fibres ending on a strong tendon occupying nearly the whole length of the back of the muscle; vertical behind the tibia in the leg, its tendon being there deflected at the groove behind the malleolus beneath the internal annular ligament, and then passing obliquely outwards and forwards, over the inner border of the tarsus, into the sole, superficially to the tendon of the long flexor of the great toe, but covered by the short flexor of the toes, and, lastly, being joined behind by the flexor accessorius, divides into four tendons for the four outer toes. Back of the tibia, from below its oblique line to about three inches from its lower end, and the intermuscular septum between it and the tibialis posticus——last phalanges of the four outer toes. The four terminal tendons of the long flexor, that for the second toe being nearly straight and the others more and more oblique, give origin to the lumbricales muscles along their inner border; each tendon, covered superficially by a tendon of the short flexor, enters a common sheath with that tendon, and opposite the first phalanx, passes through the split in the latter, to reach its destination. Owing to this arrangement, the flexor longus is named '*perforans*,' and the flexor brevis, '*perforatus*.' The sheaths of these tendons, which confine them against the first and second phalanges, are attached, on each side, to the margins of the under surfaces of those bones; they are thin opposite to the joints, where otherwise, they would interfere with flexion, but much thickened opposite the phalanges by cross bands named *ligamenta vaginalia*; they are lined by synovial membrane, and are traversed by slender cords, *ligamenta brevia*, connecting the tendons with the dense fibro-cartilaginous structure of the plantar ligaments (see p. 209), which are thus drawn up by the flexor muscles, simultaneously with the phalanx in front of them. Certain median folds passing from the long flexor tendons to the last phalanges, containing two thin streaks of yellow elastic tissue, have been described by myself and

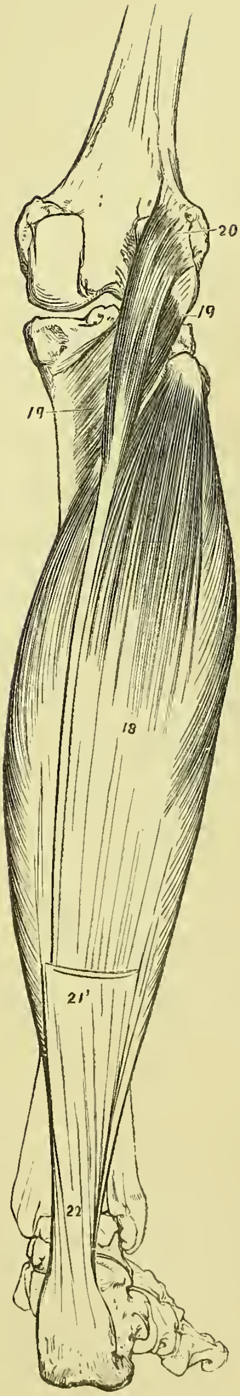


FIG. 136.—Muscles of the Leg; part of Superficial Group, with the Popliteus.

named *vincula subflava*; they are very large in some mammals and in birds. The long flexor of the toes, bends first the last phalanges, then the second and first, and afterwards the protarsus; lastly, it must assist in extending the foot. The oblique direction of its pull upon the toes is modified by the flexor accessorius, and the two inner tendons are acted on by the long flexor of the great toe. It aids in *all* the movements of the foot, just mentioned in describing these last-named muscles, except that it does not act on the great toe itself. Together with the short flexors, and the abductors and adductors, it enables the naked foot to grip firmly on to any surface of support.

The Superficial Posterior Group, figs. 136, &c. This consists of the soleus, plantaris, and gastrocnemius muscles. With these may be described, the comparatively small but interesting popliteus muscle, situated just above the soleus.

Popliteus, fig. 136, [19]. Deep and completely covered in the ham (poples); thin, flat, triangular; oblique downwards and inwards across the back of the knee-joint and upper part of the tibia, its narrow tendon of origin being situated within the joint. Fore part of a depression on the side of the outer condyle of the femur, covered by the external lateral ligament, a few fibres coming from the posterior ligament——triangular surface on the back of the tibia above its oblique line. This muscle so far co-operates with the gastrocnemius, that it aids in flexing the leg upon the thigh; but its special use is to rotate the tibia inwards, as the leg is being flexed, a movement which occurs in bringing the hinder limb forward in walking or running, in order to correct the abducted position of the foot, assumed as the body is carried forwards over it. By its connexion with the posterior ligament, and, indirectly, with the internal semilunar cartilage, it probably assists in accommodating the position of the latter to the oblique gliding movement of the condyles of the femur, in flexion of the joint.

Soleus, figs. 134, 136, 137, 138, [18]. Covered by the gastrocnemius, except its two borders, of which the outer one is superficial throughout, and the inner one in its lower two thirds; broad, flat, pointed above, and shaped like a sole fish (solea); vertical behind both bones of the leg, its numerous fasciculi ending in a broad, strong, flat aponeurosis, situated on the back of the muscle, and narrowing and thickening downwards, [18′], until it joins with the tendon of the gastrocnemius which covers it, to form the tendo Achillis, [22]. Hinder part of the head, and upper half, nearly, of the back of the fibula, oblique line of the tibia and middle third of its inner border, and a strong fibrous arch crossing from bone to bone——the lower part of the back of the os calcis. The action of the soleus will be more usefully studied together with that of the gastrocnemius.

Plantaris, figs. 136, 138, [20] [20′]. Deep and covered, except at its lower end; its fleshy portion diminutive, fusiform, only two or three inches in length, ending in a very long slender tendon, the longest in the body; oblique downwards and inwards, between the soleus and gastrocnemius, appearing, at its upper end, in the ham, in contact with the inner head of the latter, but below the middle of the leg, along the inner border of the tendo Achillis. A rough line above the external condyle of the femur and posterior ligament of the knee joint —back of the os calcis, with or close to the tendo Achillis, sometimes only to the internal annular ligament of the ankle, or to the adjacent fascia or subcutaneous fat at the back of that joint. This muscle may be double or wanting; it represents the palmaris longus in the fore-arm and palm, but its tendon does not reach the sole of the foot (planta), as its name

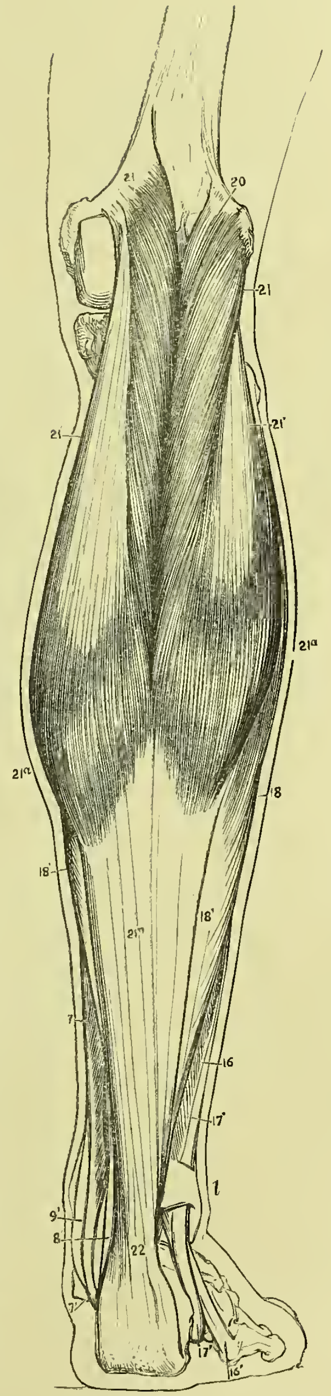


Fig. 137.—Muscles of the Leg; Superficial view of the Calf.

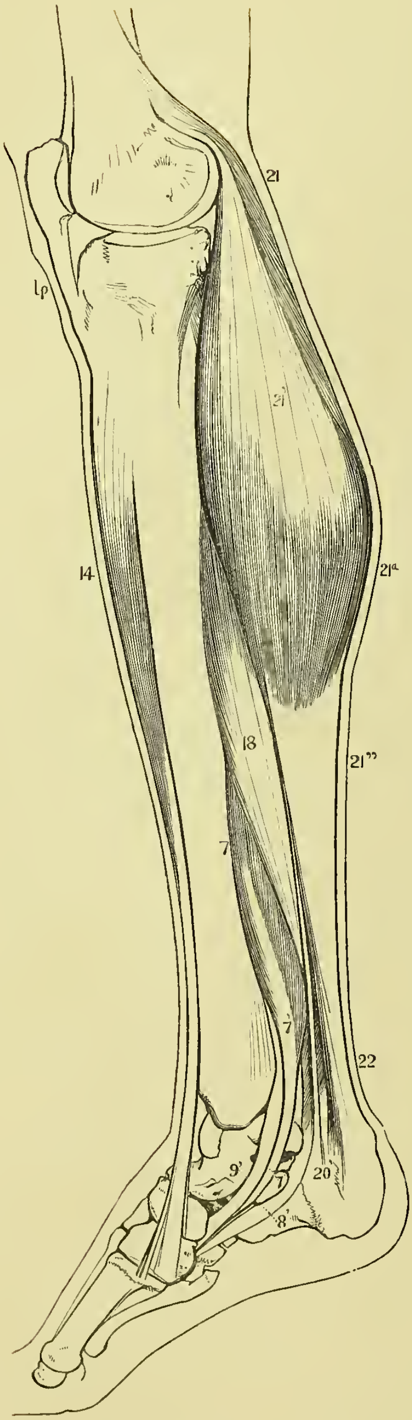


Fig. 138.—Muscles of the Leg, seen from the inner side.

implies. Its action on the bones of the leg and foot, though feeble, must coincide with that of the gastrocnemius; but its connexion above with the posterior ligament of the knee, and below with the fatty tissue at the back of the ankle, may enable it to draw out of the way the capsules of those joints, and the external semilunar cartilage of the former joint, in the rapid flexion and extension of the leg and foot caused by the gastrocnemius and soleus, of which the plantaris is a satellite.

Gastrocnemius, figs. 134, 137, 138, ^{21}, ^{21a}, $^{21'}$. Superficial, except small portions of its two heads, above, in the popliteal space; a double-headed and double-bellied muscle, one of the most beautifully shaped in the body, commencing by two heads emerging at the popliteal space or ham, from between the hamstring muscles, and ending, below, on a broad tendon, which tapers downwards to join that of the soleus, to form the tendo Achillis; vertical at the back of the leg, forming the swelling of the calf (γαστήρ, belly, κνήμη, the leg). Back of the two condyles of the femur, the *outer* head from a pit on the outer surface of the condyle, above the origin of the popliteus, and from the upper and posterior surface of the condyle, the *inner* head from an impression on the back of the internal condyle, and a rough line above it, ——lower half of the back of the os calcis, by the tendo Achillis. The tendons of origin of this large complex muscle are short, narrow and flat; the outer one occasionally contains a fibro-cartilaginous or bony nodule, whilst a bursa is often found between the inner head and the internal condyle. Each tendon gives off an elegantly shaped aponeurosis [21′], slender above, but spreading out below, which covers the hinder surface of the corresponding portion or belly of the muscle, and, as it lies upon the fleshy fibres, somewhat resembles the central spot of a shamrock leaf. The muscular fasciculi from the two short tendons of origin pass obliquely downwards towards each other, and unite upon a tendinous raphé in the middle of the muscle, forming two long rolls of fleshy substance; the fasciculi from the leaf-like aponeurosis pass from the deep surfaces and edges of these, to the hinder aspect of another aponeurosis situated upon the deep or anterior surface of the muscle, and which, emerging from beneath the muscular fibres [21″], and gradually thickening and narrowing downwards, unites at a short distance above the heel, with that of the soleus, to constitute the tendo Achillis [22]. The inner head of the gastrocnemius arises higher up, and projects further back, than the outer head; the inner belly is larger and longer, and its lower end is more pointed, and reaches further down in the calf, than the outer one; the central leaf-like aponeurotic expansion of the inner head, is also wider and thicker than that of the outer one, and the lower obliquely curved border of its muscular belly has a more abrupt profile outline than the corresponding part of the outer head: in these ways, the general symmetry of this richly modelled muscle is varied, and the formality of mere repetition is avoided.

The *tendo Achillis*, figs. 134, 136, 137, 138, [22], named, as is well known, from its occupying the vulnerable part, by which Thetis is said to have held her famous son, when she dipped him in the river Styx, the common tendon of the soleus and gastrocnemius, formed by their super-imposed and blended tendons of insertion, is the thickest and strongest tendon in the body, being more than six inches in length, and nearly three in width at its upper part, though less than an inch wide below. It becomes free from the muscular portion of the gastrocnemius behind, about the middle of the leg, but it receives fleshy bundles from the soleus in front, almost throughout its whole length; gradually narrowing towards its lower end, it then widens a little as it passes over the upper half of the back of the os calcis, a bursa intervening, and is finally attached to the lower half of that surface of the bone, chiefly above the inner tuberosity, that is, rather towards the inner than towards the outer border of the heel. As indicated by oblique markings on the surface, the component parts of this large tendon decussate, the deeper or soleus portion passing to the inner border, and the superficial or gastrocnemius portion to the outer border, of the back of the os calcis.

The soleus and gastrocnemius, in their free action, extend the entire foot at the ankle joint, and also produce a gliding motion at the astragalo-calcaneal joint, but they have no direct action on the protarsus, like the other muscles at the back and outer side of the leg, which, however, do assist in extending the foot, as well as flexing the protarsus and toes. The gastrocnemius is more powerful than the soleus. When the fore part of the foot is fixed on the ground, both muscles, in their forced action, raise the heel and lift the rest of the leg with the superincumbent weight of the whole body in space; in this movement, and also in the propulsion forward of the body, although they are aided by the deep posterior and the outer group, they are the important agents, the gastrocnemius being especially called into play. As the last-named muscle arises from the femur, it acts most effectually when the knee is straightened by the triceps extensor muscle connected with the patella in front. When the foot is resting flat, or on tip-toe, both muscles of the calf, acting from below, steady the tibia upon the astragalus, and prevent the leg and body from falling forwards; here also, they are assisted by the deep posterior and outer group, the soleus drawing upon the bones of the leg directly, but the gastrocnemius only indirectly, through the thigh bone, which becomes fixed at the knee joint. The double origin of these two muscles, absolutely united at their insertion by the tendo Achillis, is an instance of a provision, elsewhere met with in the limbs, for the performance of a given movement by one or the other muscle in different positions of flexion or extension of its component segments. Thus, for example, when the knee is bent, the gastrocnemius may lose some of its power of extending the foot, raising the heel, or supporting the leg, according as it acts from above or below, but the soleus, being attached to the leg bones below the knee, still remains equally competent to accomplish those actions. Moreover, in squatting with the knees bent and the heels raised, the gastrocnemius is *relaxed*, and so the leg, with this muscle softened, can be closely flexed upon the thigh, whilst, yet, the soleus remains contracted or capable of complete action, and can not only sustain the foot and leg in the required positions, but can begin drawing back the leg from its forwardly inclined direction, and gradually raise it on the foot, as required for the erect attitude. In this progressive movement, the gastrocnemius cannot effectually assist, until the knee is more or less straightened, and held firm by its extensor muscles in front. Lastly, the gastrocnemius is a flexor of the leg upon the thigh, and of the thigh upon the leg.

The fascia of the leg. This is continuous, below, with the annular ligaments of the ankle, and, above, with the strong fascia of the thigh which surrounds the knee. It embraces all the muscles of the leg, and is fixed to the periosteum on the anterior and posterior borders of the subcutaneous surface of the tibia, and also to the subcutaneous parts of the heads of the tibia and fibula; it is thicker just above the ankle, and on the outer side of the leg, but thinner on the inner side, and over the gastrocnemius; it sends intermuscular septa between the groups of muscles, and between the individual muscles of the leg.

The Muscles of the Thigh.

The numerous large muscles which surround the femur, may be conveniently arranged in groups, according to their obvious uses, when they are in *free* action from above downwards. These are an *extensor group*, which serves to extend the leg at the knee joint; an *adductor group*, one marked action of which, is to adduct the thigh or draw it inwards towards or over the opposite limb; an *adducent-flexor group*, which both adducts the thigh, and flexes the leg at the knee joint; a *flexor group*, which essentially flexes the leg; a *rotator group*, which rotates the thigh bone outwards; a *gluteal group*, which extends, abducts and rotates the thigh; and, lastly, a muscle, associated with the gluteal group, and specially connected with the *fascia* of the thigh. But all these groups contain muscles, which have additional and different actions. Thus, one of the extensors and all the adductors and adducent-flexors of the leg, co-operate in flexing the thigh upon the trunk. Moreover, all the muscles, without exception, when operating from their lower attachments as fixed points, in more or less forced actions, have their special uses. Thus, the extensors of the leg serve to erect and steady the thigh bone upon the head of the tibia; the adductors of the thigh prevent the pelvis from falling outwards over the head of the femur; the adducent-flexors of the leg with one of the extensors, prevent it falling backwards; the flexors of the leg, from tilting forwards; the rotators of the femur, roll or swing the pelvis inwards; the gluteal muscles support it behind and at the outer side, and roll it inwards or outwards; whilst the associated gluteal muscle of the fascia, also steadies the pelvis in front and on the outer side, and rolls it outwards.

The Extensor Group, figs. 139, 140. This group, which covers the front and sides of the whole shaft of the femur, consists, on the outer side, of the vastus externus, on the inner and anterior aspect, of the united vastus internus and the crureus, and, in front, of the rectus femoris. These muscles, ending below in a common tendon of insertion on the patella, are named the *triceps extensor of the leg*, sometimes the *quadriceps* extensor, the vastus internus and the crureus being then regarded as separate muscles.

Vastus externus, the *outer* and *largest portion* of the *triceps extensor*, figs. 139, 140, 144, 146, [23]. Concealed for a short distance above, but superficial in the rest of its extent; pointed at its upper end, but soon becoming broad and thick, it finally appears flatter and thinner, its fleshy part not reaching so low as the vastus internus; nearly vertical on the outer surface of the thigh. By a broad superficial aponeurosis, covering three-fourths of the muscle, from the root of the neck of the femur, the front and outer side of the base of the greater trochanter, the line leading thence to the linea aspera,

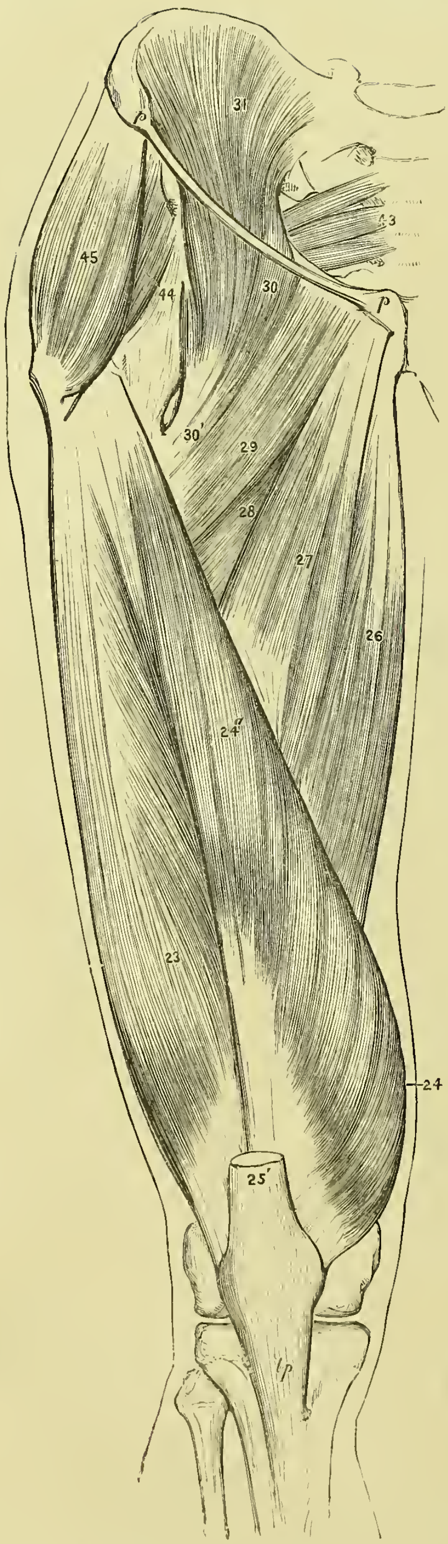


Fig. 139. The Extensor and Adductor Groups.

nearly the whole length of the outer lip of that line, and the external intermuscular septum——by a deep aponeurosis commencing beneath the lower part of the muscle, ending in a flat tendon, which blends with the tendons of the crureus, vastus internus and rectus, and gives off an expansion to the outer margin of the patella.

Vastus internus and crureus, the *anterior, inner*, and *smaller portion of the triceps*, figs. 139, 140, 142, 144, ^{24}, $^{24''}$. The crureus, $^{24''}$, concealed above, but the vastus internus, ^{24}, superficial below, appearing between the rectus and the sartorius; very pointed and flattened above, but full and broad below; nearly vertical on the front and inner side of the femur, the fleshy part reaching lower down, and projecting more than the vastus externus. From almost the whole length of the front and inner side of the shaft of the femur, from the anterior intertrochanteric line, the spiral line, and the inner lip of the linea aspera, down to about two inches from the lower end of the bone ——with the tendons of the vastus externus and rectus, to the patella, reaching along its inner border. The fleshy fasciculi of the crureus are nearly vertical, but those of the vastus internus are first oblique, and then curved, and finally nearly horizontal just above the internal condyle; the tendon of insertion commences upon the surface of the crureus, but beneath the vastus internus.

Subcrureus. Deep and completely concealed by the crureus; a few bundles only; vertical. Lower part of the front of the femur, three inches from its lower end——upper part of the capsule of the knee joint.

Rectus femoris, 140, 142, 146, 25, or *middle portion of the triceps*. Concealed at its origin only, by the sartorius and tensor vaginæ femoris, superficial in the rest of its extent; very regularly fusiform, broad in the middle, tapering at either end, and widely penniform; nearly vertical, but slightly inclined inwards, down the middle of the front of the thigh. From the ilium, by two tendons, *one*, straight and rounded, from the anterior inferior spinous process, *the other*, flattened and reflected from along a groove over the acetabulum, giving fibres which strengthen the capsule of the hip joint——together with the tendons of the two vasti and the crureus into the upper border of the patella. The two tendons of origin soon join at an acute angle, and spread out into a superficial median aponeurosis; from this, the fleshy fasciculi pass sideways and backwards, to end higher up than those of the vasti muscles, upon a deep aponeurosis, which is continuous with the tendon of insertion into the patella, some of the fibres of which tendon pass over the patella to join those of the ligamentum patellæ.

The *common tendon* of insertion of the triceps extensor, figs. 139, 140, 25′, passes over the capsule of the knee joint to reach the top and sides of the patella; it is narrower above than below; its outer border ascends higher up than, but does not reach so low down as the inner one, and, thus, it is shorter, as well as less curved; its upper

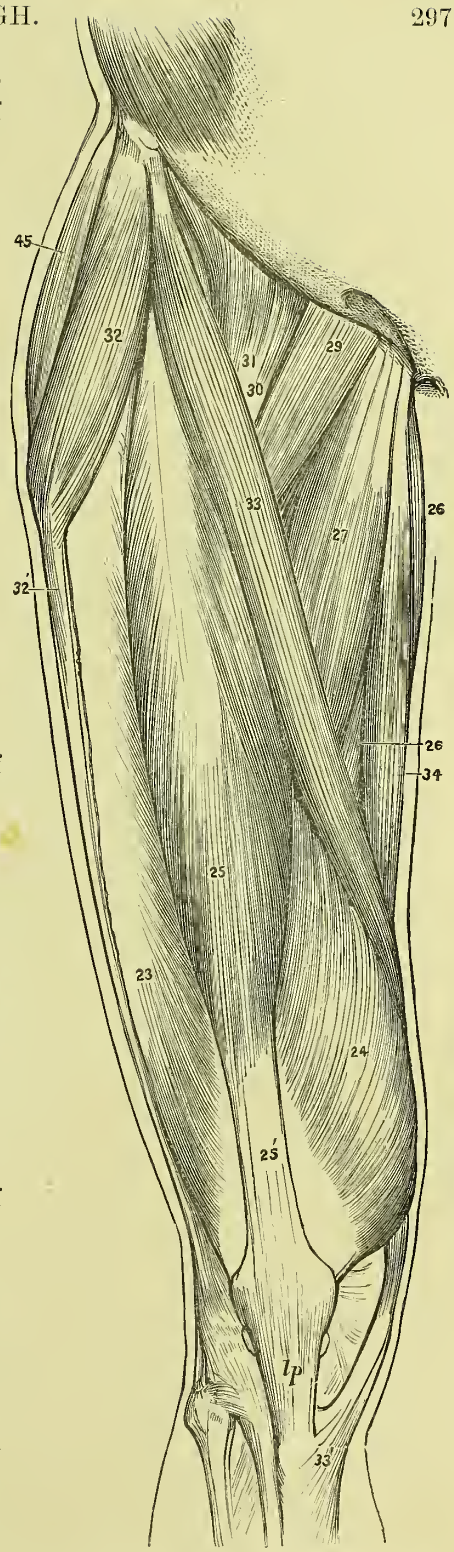


Fig. 140.—Muscles of the Thigh; front view.

border is obliquely notched, owing to the mode in which the rectus terminates upon it, the outer fork of the tendon reaching higher than the inner one; below the patella, it constitutes the *ligamentum patellæ*, figs. 139, 140, 142, 144, *lp*, which descends over the upper half of the anterior tuberosity of the tibia, a bursa intervening, and is inserted obliquely into the lower half of that process, and into the ridge a little beyond it, reaching lower down on the outer side. The common tendon gives off lateral fibrous expansions, the inner one being the stronger, which pass over the sides of the knee joint, and, with the fascia, become attached below to the heads of the tibia and fibula.

The vastus internus and crureus, the vastus externus, and the rectus, acting in free motion, are extensors of the leg upon the thigh, as, for example, in throwing forward the leg, and straightening the lower limb, in walking or kicking. In assuming the standing posture, the triceps, acting from the tibia below, raises and supports the femur upon the head of the tibia. The vasti and crureus are attached to the femur only; but the rectus, being fixed to the pelvis, either flexes the thigh, or draws the pelvis forwards; it also aids in maintaining the erect position, by helping to poise the pelvic girdle upon the thigh bone, and preventing it from falling backwards. The subcrureus muscle during extension of the knee, pulls up the capsule of the joint out of the way of the patella.

The Adductor Group, figs. 139, 141, 144. This group, situated on the inner side of the thigh, includes from below upwards the adductor magnus, adductor longus, adductor brevis, and pectineus; with these, but situated in the pelvis, may be associated the psoas magnus, the iliacus, and, where it exists, the psoas parvus.

Adductor magnus, figs. 141, 144, [26]. Almost entirely concealed; large, flat, thick and triangular, having its obtuse angle at the pelvis, its short side upwards, its long side turned to the inner aspect of the limb, and its base along the femur; radiating, its upper and shortest fasciculi passing horizontally outwards, its middle ones more and more obliquely downwards and outwards, the lowest and longest, nearly vertically downwards. Pubic arch, from near the symphysis to the under surface and outer border of the tuberosity of the ischium,——lower part of the linea quadrati, oblique line leading from the greater trochanter to the linea aspera, whole length of the linea aspera itself, and the tuberosity on the inner condyle of the femur. The chief part of the muscle is inserted by a broad, thin, but strong aponeurosis perforated for blood-vessels, and connected below with the lower part of the origin of the vastus internus; but the lower part of the tendon, [26′], forms a well-marked rounded edge or cord, fixed to the tuberosity above the inner condyle. This muscle is the most powerful adductor of the thigh, drawing it inwards, even across the opposite limb; it also assists in rotating the thigh outwards. In walking, it draws the hinder limb forwards, and then projects it in advance of the pelvis. Acting from below, it supports the pelvis on the inner side of, and, likewise, behind the hip joint; it may also depress the pelvis in either of these directions. This is the great equestrian muscle, accomplishing the grip of the knees upon the animal or saddle.

Adductor longus, figs. 139, 141, [27]. Superficial, except below, where it is covered by the sartorius and gracilis; flat, triangular, elongated and elegant, with its apex at the pubes; oblique downwards and outwards. Front of the os pubis, close below the junction of the crest with the symphysis, by a narrow flat tendon,——middle third of the inner lip of the linea aspera, by an aponeurosis, connected with the adductor magnus and vastus internus. Its actions resemble those of the adductor magnus; but it is a more direct flexor of the thigh upon the pelvis, and of the pelvis upon the thigh.

Adductor brevis, figs. 139, 141, [28]. Deep seated, concealed by the long adductor, pectineus, and sartorius; flat, elongated, nearly quadrangular; oblique downwards, outwards, and somewhat backwards. Outer surface of the descending ramus of the os pubis——the line leading from the lesser trochanter to the linea aspera of the femur, and a small part of that line itself. Its action is the same as that of the adductor longus.

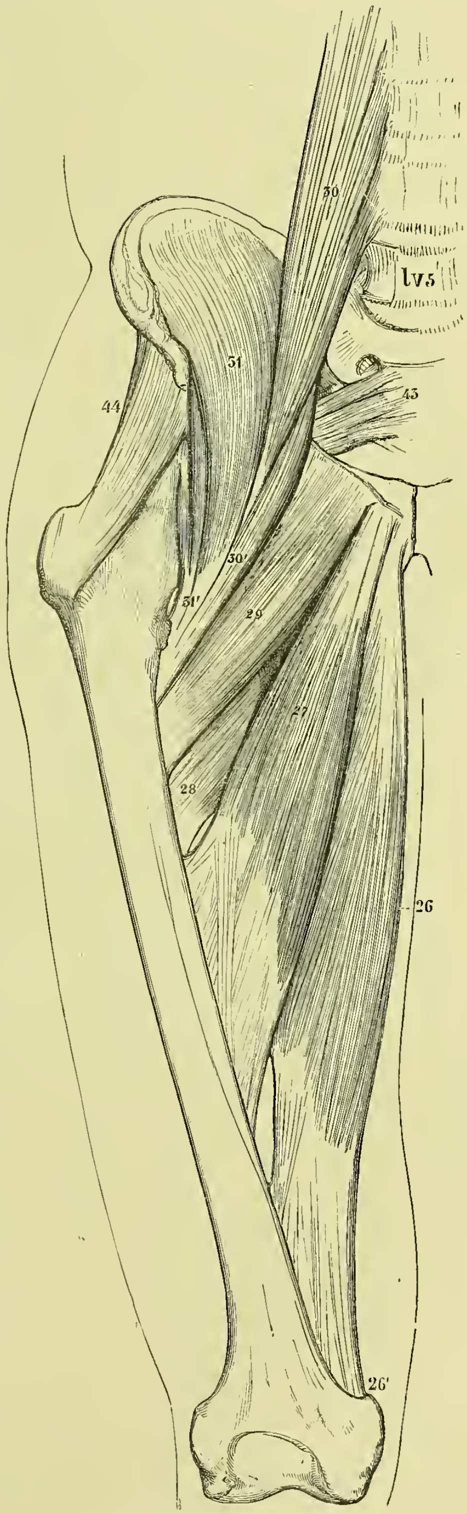


Fig. 141.—The Adductor Group.

Pectineus, figs. 139, 141, [29]. Superficial, except below, where it is crossed by the sartorius ; flat and quadrangular; directed downwards, backwards, and outwards, but slightly twisted, so that its anterior and posterior surfaces are turned outwards and inwards. Pubic portion of the ilio-pectineal line, or *pecten*, and the smooth triangular surface of bone below that line——back of the lesser trochanter, and upper part of the line leading thence to the linea aspera. It co-operates with the short and long adductors, especially in rotating the femur outwards.

Psoas magnus, figs. 139, 142, [30]. Deep seated at its origin and insertion, superficial between Poupart's ligament and the sartorius, but here covered by vessels, glands and fat, besides the strong fascia ; long and fusiform ; descends through the loins (ψόαι, the loins) and the pelvis, below Poupart's ligament, fig. 138, *p*, *p*, over the front of the hip joint, accompanied by the iliacus muscle, and passing backwards as well as outwards. Bodies of the twelfth dorsal, and five lumbar vertebræ, edges of the intervertebral substances, and front of the transverse processes——lesser trochanter of the femur, by a thick tendon, which also receives most of the fasciculi of the iliacus. This muscle is a flexor and external rotator of the thigh upon the pelvis. Acting from below, it bends the lumbar portion of the spine forwards, and flexes the pelvis ; the muscle of one side inclines the spine somewhat sideways, and assists in the lateral balance of the body ; the two muscles prevent the trunk from falling backwards, and are also engaged in raising it from the recumbent posture.

Iliacus, figs. 139, 142, [31]. Deep seated, above, within the pelvis, and below, near its insertion, but superficial for a small space below Poupart's ligament, between the sartorius and the rectus ; flat, triangular, radiating ; its fasciculi converge downwards, forwards and inwards, beneath Poupart's ligament, and then pass over the brim of the pelvis and front of the hip joint, backwards and downwards. Iliac fossa, ilio-lumbar ligament, upper part of the sacrum, and capsule of the hip joint——outer border of the tendon of the psoas magnus, and a triangular surface between the lesser trochanter and the linea aspera. Like the psoas magnus, with which it is inserted, it is a flexor and external rotator of the thigh. Acting from below, it resists the falling backwards of the pelvis in the standing posture, and supports the hip joint in front ; it also, with the psoas, rotates the pelvis inwards and forwards upon the head of the femur.

Psoas parvus. Deep seated throughout ; long, slender, fusiform ; descends along the brim of the pelvis. Bodies of twelfth dorsal and first lumbar vertebræ, and intervening intervertebral disc——ilio-pectineal line, by a long thin tendon blended with the iliac fascia, which it serves to tighten. Constant in Mammalia, it is usually wanting in Man. Acting from below, it may feebly assist the psoas magnus.

The Adducent-Flexor Group, figs. 140, 142. This comprises two long narrow muscles, the sartorius and the gracilis, the one crossing the front of the thigh obliquely, the other descending along its inner side.

Sartorius, figs. 140, 142, 143, [33]. Superficial throughout, but enclosed in a strong sheath formed by the fascia; very long, containing the longest fleshy fasciculi in the body, narrow and fusiform above, prismatic where it fits in between the rectus and vastus internus, and the adductors, then flat and ribbon-shaped, a form wrongly attributed to it throughout its whole length; descends obliquely downwards and inwards over the rectus, iliacus, psoas, pectineus and adductor longus, then vertically between the gracilis and the vastus internus, next over the tendon of the adductor magnus, then down in front of the gracilis, by the hinder part of the side of the inner condyle of the femur and the internal lateral ligament of the knee joint, and lastly, curves gently forwards, ceasing gradually to be fleshy, to gain the inner side of the upper end of the tibia. Anterior superior spinous process of the ilium, and upper half of the notch below it——upper part of the inner surface of the shaft of the tibia, as far forwards as the crest of the bone, by a flat triangular aponeurosis. This is a most important muscle as regards the surface; it is named the sartorius or *tailor's* muscle (sartor, a tailor), because it assists in crossing the legs, in the squatting position. Its anterior surface above, soon turns forwards and inwards, and, in the lower third of the muscle, looks directly inwards; its fleshy fasciculi descend further down on the hinder edge of its tendon of insertion, reaching below the knee joint; the triangular expansion of that tendon covers the tendons of the gracilis and the semi-tendinosus, a bursa intervening; it also blends with the fascia, and with the capsule of the knee. The sartorius, in free movements, first bends the leg upon the thigh, then flexes the thigh upon the pelvis, next rotates the thigh, and, lastly, may also adduct it, so as to bring the limb over the opposite one; when the knee is bent, it rotates the tibia inwards, thus assisting the semi-tendinosus and the popliteus. Acting from below in forced movements, it supports the knee on the inner side, flexes the pelvis on the thigh, and rotates it inwards over the head of the femur; both muscles acting, prevent the pelvis falling backwards, in the standing posture.

Gracilis, 140, 142, 144, [34]. Superficial; thin, slender (whence its name), flattened or ribbon-shaped in its upper half, tapering to a long delicate tendon, which occupies its lower third; vertical, along the inner side of the adductors, and then between the sartorius and the tendon of the semi-membranosus, somewhat behind the knee, finally curving forwards upon the lateral ligament of that joint, to the upper end of the tibia. Lower border of the descending ramus of the os pubis——upper part of the inner side of the tibia, just beneath the internal tuberosity. Its tendon lies behind the sartorius, but in front of and above the tendon of the semi-tendinosus; its insertion is covered by the expanded tendon of the sartorius, and is connected with the fascia. The

Fig. 142.—Muscles of the Thigh ; inner view complete.

gracilis assists in flexing the leg, and in adducting the thigh; it also rotates the tibia inwards, when the knee is bent. Acting from below, it flexes the pelvis, and supports it upon the head of the femur, on the inner side.

The Flexor Group, figs. 142, 143, 146. This group, situated entirely at the back of the thigh, consists of the semi-membranosus, and semi-tendinosus on the inner, and of the biceps on the outer side.

Semi-membranosus, figs. 142, 143, [35]. Overlaid by the semi-tendinosus and the biceps, but partially superficial below, and also along its inner border, except for a short distance above, where it is covered by the gluteus maximus; long, and flat, though thick, its middle part fleshy, but composed above of a flattened, membrane-like, deep tendon, and below of a similar and narrower tendon appearing on its inner border; vertical, behind the adductor magnus and the gracilis, its lower part forming the upper and inner boundary of the popliteal space or ham, its tendon constituting the principal inner hamstring. Back of the tuberosity of the ischium, under cover of the semi-tendinosus and biceps——back of the internal tuberosity of the tibia. The tendon of insertion passes beneath the internal lateral ligament of the knee joint, is connected, through that ligament, with the internal semilunar cartilage, and gives off a strong reflected band, which forms a chief part of the posterior ligament of the joint. This muscle flexes the leg upon the thigh, and then extends the thigh backwards on the pelvis; when the knee is bent, it rotates the tibia inwards. Acting from below, it supports the knee behind, and also draws the pelvis backwards, and helps to sustain it in the standing posture.

Semi-tendinosus, figs. 142, 143, [36]. Superficial, except above, where it is covered by the gluteus maximus; flattened above, tapering below, its fibres ending gradually and obliquely, from about the middle of the thigh, upon a very long tendon, which first appears on the hinder and inner part of the muscle, of which it forms, as the name implies, about one half; nearly vertical upon the semi-membranosus, at first connected with, and then in contact with the biceps, afterwards separated from it, to assist in forming the inner hamstring. Back of the tuberosity of the ischium, together with the long head of the biceps——inner surface of the upper part of the tibia, below its internal tuberosity. Its tendon of insertion curves gently forwards, behind that of the gracilis, rests on the internal lateral ligament of the knee, and is connected with the fascia of the leg. Its actions are similar to those of the semi-membranosus, but it rotates the leg inwards more effectually. Both muscles co-operate, in this respect, with the popliteus, gracilis, and sartorius.

Biceps cruris, figs. 143, 146, [37a], [37b]. Superficial, except above, where it is covered by the gluteus maximus; double headed, its long head, [37a], of an elegant fusiform shape, its short head, [37b], broad above, tapering, and penniform below, its strong straight common tendon of insertion, appearing

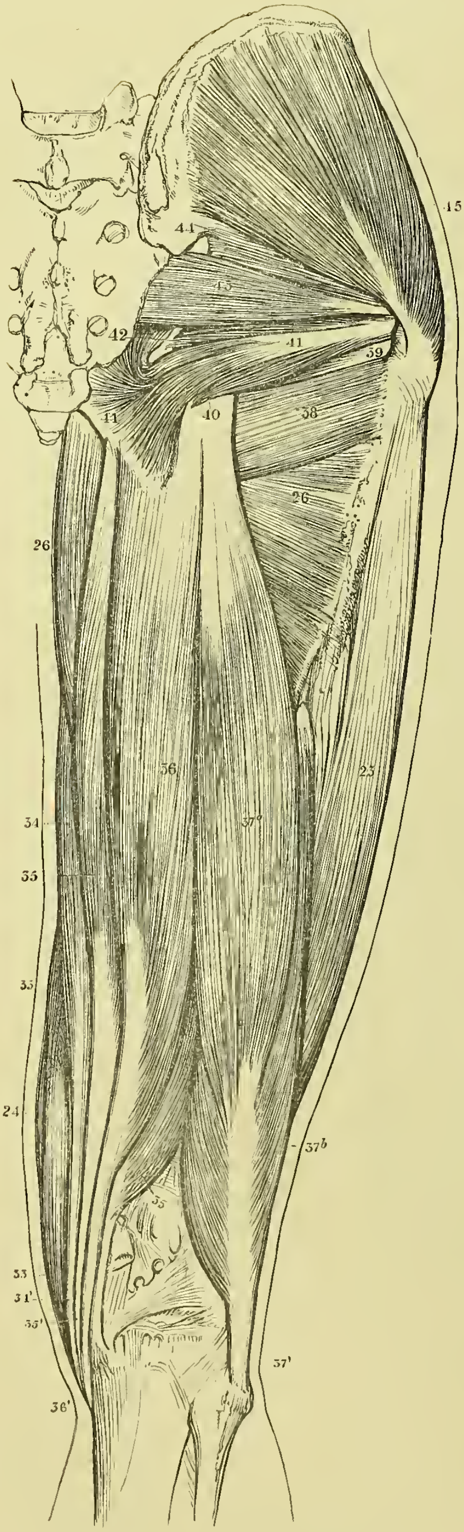


FIG. 143.—The Flexor and Rotator Groups.

first on the back of the muscle; obliquely downwards and outwards, its long head behind the adductor magnus, its short head parallel with the hinder border of the vastus internus, at first in connexion with, then in contact with the semi-tendinosus, finally separating from that and the semi-membranosus, its fleshy fibres descending lower down than the latter, and its tendon forming by itself the outer hamstring. The *long* head, from the back of the ischial tuberosity, by a conjoined tendon with the semi-tendinosus, the *short* head, from the middle part of the lower two thirds of the linea aspera of the femur, the oblique line leading to the back of the outer condyle, and the external intermuscular septum——head of the fibula, by two distinct tendinous bands, which embrace the external lateral ligament of the knee joint, and send forwards an expansion on to the tibia. It is a powerful flexor of the leg and extensor of the thigh, being thus associated, both anatomically and in its action, with the semi-tendinosus; but it rotates the fibula and tibia outwards, when the knee is bent. Acting from below, it supports the knee joint, draws the pelvis backwards, and sustains it, from behind, in the upright posture.

The Rotator Group, figs. 142, 146. These muscles, all of which are small, and placed transversely between the pelvis and the upper part of the femur, lie entirely concealed by the gluteus maximus. They consist, beginning from below, of the quadratus femoris, the obturator externus, the obturator internus with the two gemelli, and the pyriformis.

Quadratus femoris, figs. 143, 144, [38]. Deep; short, square; nearly horizontal, forming a flat vertical plane, situated above the adductor magnus. Outer border of ischial tuberosity, close to the origin of the great adductor——tubercle on the posterior intertrochanteric line, and upper part of the linea quadrati of the femur.

Obturator externus, figs. 143, 144, [39]. Deep, outside the pelvis; flat, triangular, converging to a narrow tendon; nearly horizontal, but oblique backwards and outwards, from the outer surface of the pelvis, beneath and behind the hip-joint. Inner two-thirds of the outer surface of the margin of the obturator foramen, and anterior half of the obturator membrane——digital fossa of the greater trochanter. Its cord-like tendon of insertion lies between the quadratus and the inferior gemellus.

Obturator internus, figs. 142, 143, 144, [41]. Deep, partly within, and partly outside the pelvis; large, thick, triangular, its fasciculi converging to a series of from three to five tendinous slips, which unite into one tendon of insertion; within the pelvis, obliquely backwards to the inner border of the

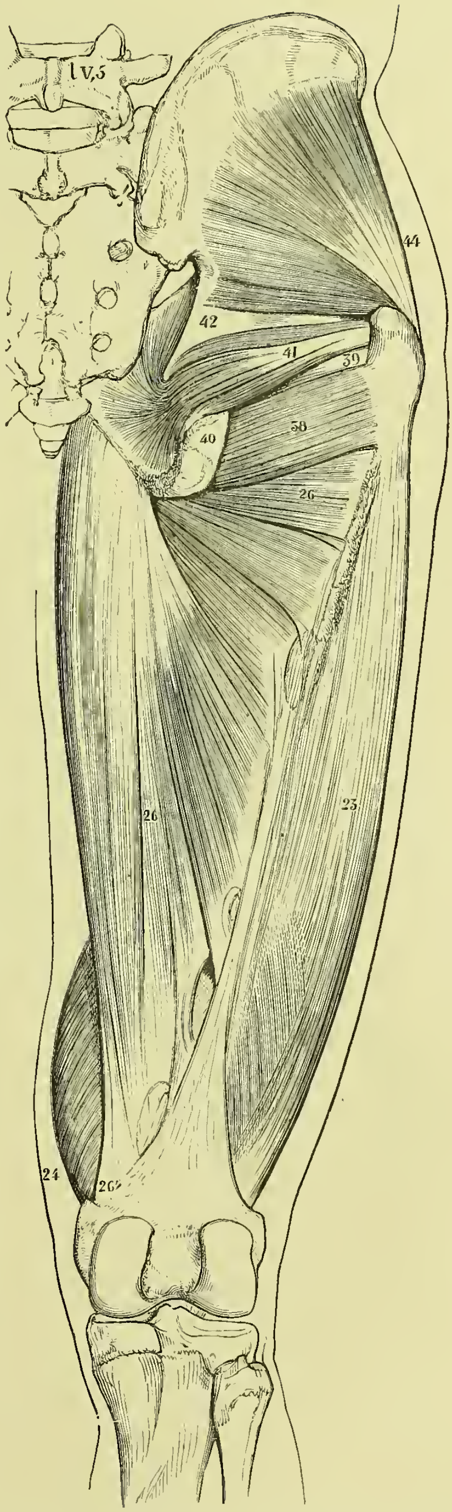


Fig. 144.—The Rotators, Vasti, and Great Adductor.

ischial tuberosity, opposite the small sacro-sciatic notch, then deflected over slight grooves in the bone covered with cartilage and provided with a synovial membrane, and thence passing outwards and somewhat upwards, behind the hip joint. Inner surface of the borders of the obturator foramen, obturator membrane, and surface of the ischium behind the foramen——upper border of the greater trochanter, and contiguous part of the neck of the femur, in conjunction with the two gemelli.

Gemelli, or *twin* muscles, *inferior* and *superior*, figs. 143, 144, [40], [42]. Deep; small and slender; nearly horizontal outwards, at the back of the hip joint, one below, the other above the obturator internus, with which they are conjoined in their insertion. The *inferior*, the larger, [40], from the upper and back part of the ischial tuberosity, the *superior*, [42], sometimes wanting, from the outer and lower part of the ischial spine——lower and upper borders of the tendon of the obturator internus, and thus to the greater trochanter of the femur. They are extra-pelvic portions of the obturator internus.

Pyriformis, figs. 139, 142, 143, [43]. Deep, and partly within the pelvis; long pyramidal, commencing by three digitations, tapering gradually to a single, cord-like tendon; oblique, downwards and outwards, passing out of the pelvis, through the great sacro-sciatic notch, and thence to the back of the femur. Front of the sacrum, and slightly from the margin of that notch, and adjacent ligament——back of the upper part of the greater trochanter, between the tendons of the obturator internus and gluteus minimus, its own tendon being more or less connected with them.

The six muscles just described, all rotate the femur outwards, an habitual position of the lower limb; but when the thigh is flexed, as, for example, in the sitting posture, they, with the exception of the obturator externus, abduct the femur, the last-named muscle, owing to its tendon being placed below the hip joint, still acting as an external rotator. When the lower limb is fixed, they slightly rotate the pelvis on the head of the femur, so as to turn the pubes towards the opposite side; reciprocal rotatory movements of this kind occur in walking. In standing, these muscles steady the hip joint behind. The obturator externus may assist in drooping the pelvis forwards.

The Gluteal Group, figs. 139–146. This very distinct group, which covers the outer surface of the ilium, the hip joint, the head and neck of the femur, the rotator group, and the upper portion of the flexor muscles, consists of the gluteus minimus, gluteus medius, and gluteus maximus.

Gluteus minimus, figs. 139, 143, 144, [44]. Deep and entirely concealed; fan-shaped, its fibres converging below to the under side of a triangular tendon; obliquely downwards and outwards. Outer surface of the ilium, between the inferior and superior curved lines, and margin of the great sacro-sciatic notch——an impression on the front of the greater trochanter, close to, and often conjoined with, the pyriformis. A few fibres are fixed to the capsule of the hip joint.

Gluteus medius, figs. 139, 140, 143, 145, 146, [45]. Deep in its hinder portion, superficial in its fore part; broad, thick and triangular, its fibres converging to a strong narrow tendon appearing on the hinder part of the muscle; obliquely downwards and outwards. Outer surface of the ilium, between the superior curved line and the crest, as far back as the vertical line, and as far forwards as the tensor vaginæ femoris muscle, also from the strong fascia which covers its anterior portion——an impression on the outer surface of the greater trochanter, in front of an oblique line running downwards and forwards on that process.

Gluteus maximus, figs. 142, 145, 146, [46], [46′]. Superficial throughout, but covered by a strong fascia, a large quantity of adipose tissue, and a thick integument; one of the largest muscles in the body, quadrilateral, broad and thick, composed of exceedingly coarse fasciculi; oblique downwards, outwards and forwards, bound down closely to the gluteus medius along its thinner upper margin, but loose or free, and very thick along its lower border, which is covered by a large fold of skin and much subcutaneous granular fat. Posterior fourth of the crest of the ilium, surface of that bone behind the vertical line, back of the lower part of the sacrum and of the coccyx, great sacro-sciatic ligament, and aponeurosis of the erector spinæ muscle——the *upper two-thirds* of the muscle on a thin but strong tendinous lamina, which passes over the greater trochanter, a bursa intervening, and joins the fascia of the thigh, the *lower third*, on a thick short tendon, which is fixed to the lower part of the rough line leading from the greater trochanter to the linea aspera, between the adductor magnus and vastus externus, with which latter muscle it is slightly connected. The

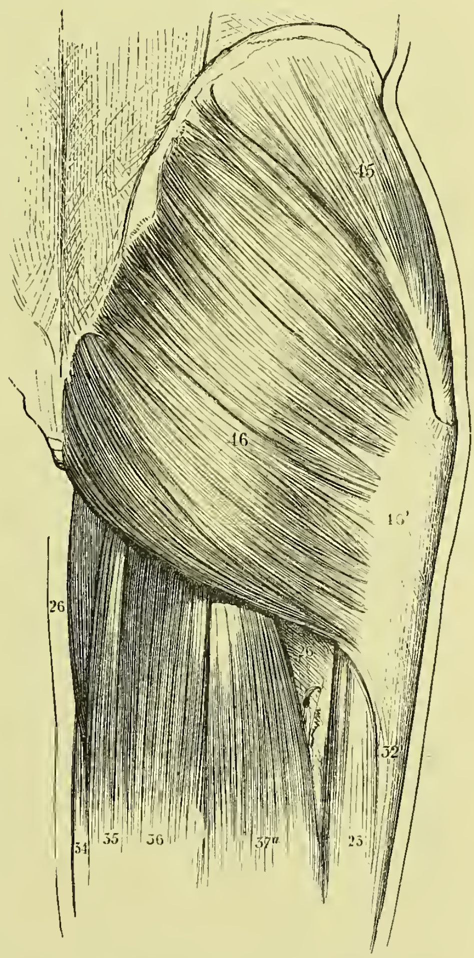


Fig. 145.—Muscles of the Thigh; the Gluteal Group.

gluteus maximus covers the ischial tuberosity behind, in the standing posture; but that process is left uncovered by the muscle, in the sitting position.

All three glutei muscles abduct the femur; the gluteus maximus, and the posterior fasciculi of the gluteus medius and minimus, also extend and rotate that bone outwards; but the anterior fibres of the two last-named muscles will, if they can act separately, flex and rotate it inwards. The gluteus maximus also tightens the fascia of the thigh. Acting from below, all three muscles support the pelvis upon the head of the femur, on the outer side of and behind the hip joint, especially when, as in every step, the body is balanced on one lower limb, in which case, they prevent the pelvis and trunk from dropping forwards, or to the opposite side. The anterior portions of the gluteus minimus and medius, flex and rotate the fore part of the pelvis on the thigh, towards their own side; their posterior portions and the gluteus maximus rotate it in the opposite direction. Such reciprocal rotatory movements between the pelvis and thigh, and between the thigh and pelvis, occur at every step. When the glutei of both sides act, they prevent the pelvis and trunk from falling forwards, and serve to erect them from the stooping position, especially the glutei maximi, which, accordingly, are characteristically large in Man.

The *fascia lata* and its *tensor muscle*, figs. 140, 146. This fascia, the proper fascia of the thigh, which is continuous with that of the leg, is fixed, below, to the tuberosities of the tibia, the head of the fibula, and the condyles of the femur; whilst, above, it is strongly attached to Poupart's ligament, the front of the pubes, the pubic arch, the tuberosity of the ischium, the sacro-sciatic ligaments, the side of the coccyx and sacrum, and the whole length of the outer lip of the crest of the ilium, to Poupart's ligament again. It thus forms a continuous and firm investment around the thigh; but, besides this, it sends inwards, deep processes and intermuscular septa. About the knee, it is strengthened by expansions from the adjacent tendons, and presents transverse bands named *retinacula*, which are fixed to the borders of the patella; but it is separated from the front of that bone by an intervening synovial bursa. It passes across, and so encloses the popliteal space, or ham, and holds together the muscles and the hamstring tendons, which bound that space. Its two principal intermuscular septa are attached along the two lips of the linea aspera, and the two lower and upper lines diverging from it; the outer septum passes between the vastus externus and the short head of the biceps; the inner one, thinner, separates the vastus internus from the adductor group; other finer intermuscular partitions also exist, and the sartorius especially, as is needed from its oblique direction, has a long and very perfect sheath. Above, the fascia is connected deeply with the capsule of the hip joint, which is strengthened and supported by it in front. It is thickest and strongest down the outer side of the thigh, where, extending

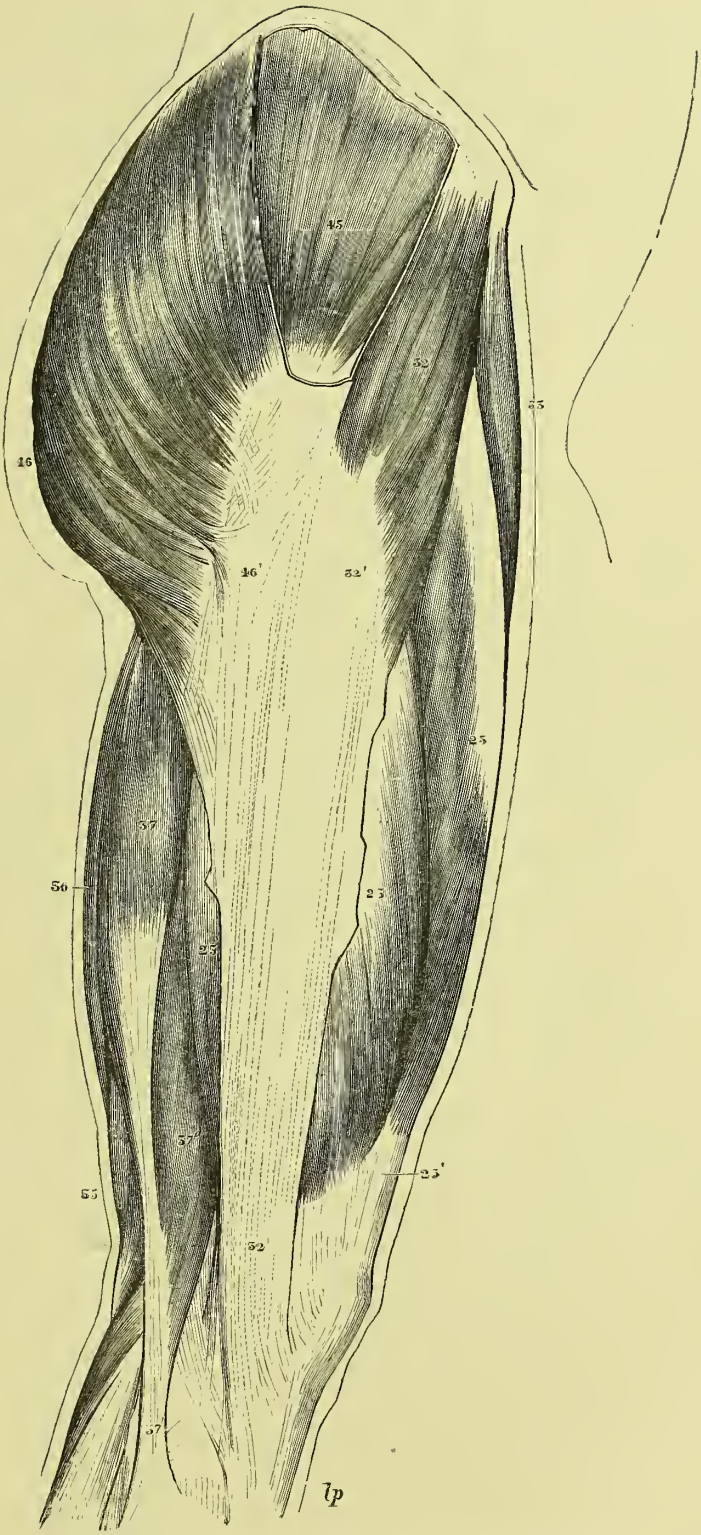


Fig. 146.—Muscles of the Thigh; Outer View complete

from the ilium, above, to the outer side of the tibia and to the fibula, below, it forms the so-named *ilio-tibial band*, fig. 146, 32′, 32″, which is so firm as to flatten the vastus externus, and descends, almost like a tendon, on the outer side of the knee, in front of the tendon of the biceps muscle. It is into this part, that the upper portion of the gluteus maximus, and the proper tensor muscle of the fascia, are inserted above.

Tensor vaginæ femoris, figs. 140–146, 32. Superficial; short, flat but thick, narrow above, widening below, and ending along an oblique line, its anterior border being much longer than the posterior one; obliquely downwards, outwards and backwards, in the upper and outer part of the thigh, behind and outside the upper ends of the sartorius, rectus femoris, and vastus externus, and in front of the gluteus medius, being, in fact, an offshoot or associate of the gluteal group. A small surface on the outer lip of the crest of the ilium, anterior superior spinous process, close to the origin of the sartorius, and upper part of the notch below that process——fascia lata, by a thin sheet of tendinous fibres interposed between two layers of that fascia, in front of and, for a short distance, below the greater trochanter, opposite the attachment of the gluteus maximus to that fascia. Acting on and through the fascia lata, it tightens that membrane, as its name implies, and thus braces and supports the subjacent muscles; it then abducts, even flexes, and rotates the thigh inwards. In standing, it helps to stiffen the knee joint; and, acting from below, it steadies the pelvis on the femur, flexes it, and rotates it towards its own side. The great number and extensive distribution of the muscles which surround the ball-and-socket joint of the hip, cannot fail to attract notice.

Surface-forms dependent on the Muscles of the Foot, Leg and Thigh.

The Foot.—The deep muscles in the *sole of the foot*, as elsewhere, clothe the bones, and fill up the intervals between them. Of the superficial muscles, the abductor with the flexor of the little toe produce the most marked effects on the surface, giving rise to a corresponding, narrow, rounded elevation along the outer border of the sole, filling up the comparatively flat bony arch, on that side, and bringing down its actual contour to a level with the ground, in the standing posture. The abductor of the great toe, in like manner, covers the inner deeply arched border of the sole; but the muscle is braced up closely against the bones, and its particular form is not quite so apparent. The remaining superficial muscle, the short flexor of the toes, is so bound over by the dense central portion of the plantar fascia, that its individual form is subdued the fascia itself here determining a somewhat flattened or sunken median surface, bounded behind, on the outer side, and in front, by the thickened padded parts of the integument of the sole, and passing gently upwards into the hollow on the inner border of the foot. Over the pads of the sole, corresponding with the seats of pressure, including the long oval pad beneath the os calcis, and the anterior curved padded elevation commencing at the ball of the little toe, and enlarging inwards to beneath the ball of the great toe, the integument is thick, and dull on the surface; but in the centre, and on the inner hollow part of the sole, it is thinner and brighter, and is crossed, everywhere, by numerous creases, which undulate from the front and sides of the large calcaneal pad, towards and over the inner border of the foot, but which change their direction, in accordance with the movements of the parts.

The surface-forms of the *borders* of the foot, are obviously and mainly due to the corresponding abductor muscles, that of the little toe obscuring the prominence of the fifth metatarsal bone, and producing gently convex contours before and behind it, that of the great toe concealing the bony forms, smoothing the general outline, and producing a local fulness or convexity, in front of and below the inner ankle. The integument changes its character much more suddenly along the outer than upon the inner border of the foot; the creases which pass obliquely forwards over both borders, are short on the outer, and much longer on the inner side; here also the skin is much thinner, and, already, wandering veins are visible through it. On this border of the foot, the tendon of the tibialis anticus may be readily traced, when that muscle is in action; but the tendons behind the internal malleolus, except a short piece of that of the tibialis posticus, are lost, as they descend into the foot. On the outer side of the foot, below and in front of the external malleolus, the tendon of the peroneus brevis is easily traceable, when the muscle is in action; but that of the peroneus longus is concealed by it, and soon disappears, as it passes deeply into the sole.

On the back of the foot, the dorsal interossei not only fill in the spaces between the bones, but, when well developed, or in action, bulge upwards into view. The course of the different tendons may be distinctly recognised through the skin, forming more or less marked elevated ridges, according as their muscles are in action or at rest. The lines which they follow are so plain, that it is hardly necessary to refer to their actual anatomical relations. The mode in which they are disposed or grouped on the back of the foot, is such as completely to avoid the formality which the presence of so many nearly straight radiating cords would otherwise have produced. Thus, they are not symmetrical in themselves, either in length or thickness; they do not spread out from one common point; there is, first, a short thick tendon, the tibialis anticus, then a long strong tendon, the extensor proprius pollicis, then a cluster of long flat tendons, those of the extensor longus, and, lastly, a very short and slender one, the peroneus tertius; even the point of divergence of the clustered tendons is not central as regards the instep, but lies towards its outer part, and the separate tendons radiate forwards at different angles. In short, all these tendon-lines and their intervening spaces are of unequal length, width and angular measurement; the resulting modelling is singularly complex and interesting, not less so, because, when the foot is at rest, many of the forms are but very obscurely indicated. Occasionally, too, these forms are further chequered and heightened by the appearance of fainter ridges, dependent on portions of the extensor brevis tendons coming near the surface, especially the one intersecting the wider interspace between the long tendons proceeding to the great and the second toes. The fleshy portion of the extensor brevis, though crossed by the tendons of the extensor longus digitorum and the peroneus tertius, determines a remarkable fulness over the outer half of the back of the tarsus, which completely redeems the poverty of that comparatively flattened region of the osseous framework of the foot. Its rich form, terminating, in front, along a curved oblique line, corresponding with the ends of its several fleshy subdivisions, constitutes a chief beauty of the human instep, elevating and enriching the form of its outer side, as may be well seen in the antique, and, as is especially well exemplified in the restored foot of the Venus de Medici, in comparison with which, the attenuated mass of the extensor brevis muscle, in a modern boot-oppressed foot, is very disappointing. This muscular form is much developed in all those actions, in which the toes are raised, even if the foot itself be simultaneously straightened.

On the outer border of the foot, tending to the back of the external malleolus are seen the rootlets of the external saphenous vein; on the dorsum of the foot are venous branches and arches, which form the commencement of the internal saphenous vein, running towards the front of the internal malleolus. The smaller and straighter venules which run back from the toes, to join the arches on the dorsum of the foot, emerge from between the toes.

The Leg.—The forms of the leg are very largely dependent on its muscles, and, of these, all but one, the popliteus, appear somewhere on the surface, most of them partially, namely, the extensor proprius pollicis, peroneus brevis, tibialis posticus, flexor longus pollicis, flexor longus digitorum, soleus and plantaris; but the others, namely, the tibialis anticus, extensor longus digitorum, peroneus tertius, peroneus longus and gastrocnemius, are entirely superficial.

Between the adjacent superficial or partly superficial muscles, are seen various linear depressions, or *intermuscular markings*, corresponding with intermuscular spaces or septa. They appear and disappear, according as the muscles on each side of them are in action or at rest. A long and gently curved intermuscular marking, brought into view when the foot is bent up on the leg, exists between the tibialis anticus and the extensor longus digitorum; it is convex outwardly, most evident opposite the prominent parts of the muscles, and widens out below into a sort of plane, issuing from which the tendon of the extensor proprius pollicis makes its presence felt. Between the extensor longus digitorum and the peroneus tertius in front, and the two larger peronei muscles behind, is another marking, narrow and deep above, as it descends from the depression over the head of the fibula, but soon widening and flattening, as it reaches down, along the *peroneal furrow*, to the triangular surface-form above the external malleolus. Between those peronei and the outer border of the soleus, is another and still plainer and longer intermuscular marking, brought into view by standing on tip-toe, slightly convex anteriorly, and extending from below the head of the fibula, down to the longitudinal hollow between the back of the external malleolus and the tendo Achillis, which is itself lost on the plane surface corresponding with the outer side of the os calcis. Lastly, on the inner side of the leg, between the inner border of the soleus, and the lower exposed portion of the flexor longus digitorum, is another short curved intermuscular marking, running obliquely backwards, and slightly convex anteriorly.

The muscular and tendinous forms between these several markings, have been carefully described, and if the descriptions be read, with the living model to refer to, every surface point will be easily recognised. Commencing at the anterior border of the subcutaneous surface of the tibia, or *tibial furrow*, the fusiform tibialis anticus is seen to be partly let in to the excavated border of that bone and also to project forwards beyond it, so as to fill up its meagre anterior outline, and really to determine the gently convex anterior profile line of the upper portion of the leg; lower down, the tendon of this muscle also partly conceals the bone, and obliterates the nearly right angle between the tibia and the astragalus, thus determining the slanting line by which the form of the foot is set so firmly on to that of the leg. The precise places and modes of termination of the fleshy or the tendinous parts of the tibialis anticus, and also of the adjacent extensors and of the two peronei, are plainly visible on the surface, when these muscles are brought respectively into action. The bold swelling, and the high position and abrupt termination, in the leg, of the fleshy portion of the peroneus longus, and the flatness produced lower down by its very long tendon overlying the tendon of the peroneus brevis, are often recognisable, especially in standing on tip-toe. The origins of the extensor longus digitorum, peroneus longus, and soleus, surround the head of the fibula, and when in a state of contraction, cause it to appear as a depression. When the soleus is acting, its borders become very plain, as narrow curved prominences, of which the outer one is much the longer, reaching both higher up and lower down, and being, moreover, straighter and narrower, in comparison with the shorter, more oblique and thicker inner border, in front of which, is an elongated and slightly convex surface, due to the edges of the deep posterior group of muscles, lying close to the posterior border of the tibial surface-furrow. Upon the back of the soleus, are seen, when the gastrocnemius is in action, two curved lines or markings, or rather changes of form, convex towards either border of the leg, which indicate the free borders of the two fleshy bellies of the gastrocnemius. The greater length, breadth and prominence of the inner, as compared with the outer of these fleshy masses, the lower position and more abrupt form of the termination of the inner one on the common tendon of insertion, the position of the two foliated tendons higher up, the differences between them, and the characteristic longitudinal roll dependent on the medium fleshy fasciculi issuing from between the hamstrings, are all plainly responsible for like forms on the surface. The projection of the calf is seen to be situated higher up, and to be more gently curved, as viewed from the outer than from the inner side of the leg, where it is not only lower down and more angular in form, but also stands out further backwards. In action, the lower edge of the inner belly especially, does not simply become more convex, but its foliated tendon becomes flatter, and the fleshy part more angular. The broad, but downward tapering tendon of the two muscles of the calf, and its continuation as the tendo Achillis, are well-known characteristics of the surface of the back of the leg, as this joins on to the heel. The inner margin of the tendo Achillis may be traced from above the os calcis, descending in a nearly straight line, coincident with the inner border of that bone; whilst the outer margin of the tendon, on the contrary, curves outwards, as it spreads to gain the bone, the border of which it meets, therefore, at an angle. The presence of the slender tendon of the plantaris, which usually appears close to the inner margin of the tendo Achillis, may assist in determining the form along that margin. Lastly, the tendo Achillis, though not included beneath the annular ligament itself, is, nevertheless, so bound down by the fascia, that when the foot is straightened on the leg, it follows the tibia and fibula, whilst the heel itself projects prominently backwards. On either side of the lower part of the tendon, where it passes over, but is not fixed to the bone, are slight prominences due to the bone itself, covered with fat.

In front and on each side of the tendon, at the back of the ankle joint, is also much fatty tissue, which becomes pressed out by the astragalus, and projects on each margin of the tendon, when the foot is bent up against the leg. Fat also fills the depression in the bony framework, seen opposite the so-called sinus pedis. Strong transverse folds or creases appear in the skin in front of the ankle, when the foot is bent up. Elsewhere on the leg, the skin and the subcutaneous fat present nothing peculiar to note, except about the knee, as will be presently noticed.

Ascending from behind the internal malleolus, is the lower end of the *external saphenous vein*, which turns to the back of the leg, and passes up, over the middle of the gastrocnemius, to reach and enter the popliteal space, into which it disappears. On the front of the internal malleolus, is the commencing trunk of the *internal saphenous vein*, which passes up the leg behind the tibial furrow, receiving branches as it ascends, and being more or less pouched or knotted in its forms ; it reaches the back of the inner side of the knee, resting on the soft bed formed by the fat, just behind the inner hamstring, where it enters the region of the thigh.

The Thigh.—The muscles of the thigh have even a more general influence on the surface-forms than those of the leg, for, with the exception of small portions of the condyles, and of the greater trochanter, the whole femur is enclasped by large muscular masses. Of these, the crureus and the subcrureus, the rotators and the gluteus minimus, are completely hidden by other muscles; the gluteus medius is more than half concealed; the adductors are not quite so much covered; the extensor and the flexor groups are but slightly so at their upper ends; whilst, lastly, the sartorius, gracilis, gluteus maximus and tensor vaginæ femoris, are entirely superficial.

The most noticeable *intermuscular marking* on the surface of the thigh, is the one which falls opposite the external intermuscular septum between the vastus externus and the biceps. The internal intermuscular septum produces a marking both above and below the sartorius, but it is interrupted, in the lower part of the thigh, by the sartorius muscle and its sheath. The line of separation between the semi-tendinosus and the biceps, seen down the back of the thigh, is the only remaining distinct intermuscular marking. Elsewhere, the borders of the muscles are indicated by prominences, rather than by linear depressions.

The general form of the extensor group of muscles follows the direction of the femur, which lies in its midst; the great length, breadth, and flatness of the outer surface of the thigh correspond with the large undivided mass of the vastus externus, and the broad and tense overlying portion of the fascia lata. The beautiful fusiform rectus, emerges from the triangular depression formed between the sartorius and the tensor vaginæ femoris, which descend from a common point, the neighbourhood of the anterior superior spine of the ilium ; it passes obliquely downwards, and determines the elegant convex outline of the front of the thigh, supported, of course, by the slightly convex femur itself; the borders of the rectus are more or less plainly discernible, according as it is in action or at rest. The short, but bold and richly prominent vastus internus, just above the level of the knee, forms a striking contrast with the long, but nearly flat plane of the external vastus, which fades away down to the depression or inbending, opposite the outer side of the joint. The mode of ending of the fleshy fasciculi of the extensor muscles upon their common tendon of insertion, and the form of that tendon have already been described; they are revealed clearly upon the surface, when the muscles are in action; but when these are at rest, as in standing at ease, they are obscured and modified by foldings of the skin. The adductor group fills in the large triangular space between the slanting femur and the inner border of the thigh, the contour line of the upper portion of which, is chiefly dependent on these muscles; they scarcely offer any marks or signs of subdivision into separate forms, but the tendon and inner edge of the adductor longus stand out in certain actions, as a well-marked narrow ridge, proceeding downwards and outwards from the pubes, and forming the inner side of a flattened and clearly defined triangular surface seen on the front of the upper part of the thigh, below the fold of the groin, and having its outer side bounded by the narrow oblique plane of the sartorius muscle; in front of the lower part of the sartorius, and behind the lower part of the vastus internus, the tendinous cord of the great adductor makes itself felt, and sometimes momentarily seen, as a short ridge, running down towards the small tubercle on the face of the inner condyle. The thin gracilis muscle covers over and combines the forms of the inner edges of the adductor muscles, that of the great adductor being very thick, and thus, smooths the inner surface of the thigh above. The sartorius, lying in its sheath, in the oblique gutter-like bed, formed between the adductor and extensor groups, may be brought well into view, in the standing position, by flexing the thigh and leg, rotating the whole limb outwards, and carrying the foot towards the opposite leg; it then produces, at its upper end, a prominent conical ridge, widening downwards into a rounded elevation, which only gradually changes into a flattened plane, this being itself finally lost upon the general full and softly curved eminence, seen behind and below the inner side of the knee. At the back of the thigh, the flexor mass escapes from beneath the gluteal fold; at first narrow and depressed, but lower down, wider and more prominent, it finally flattens out, and separates at an unequal angle, to form the two borders of the sunken lozenge-shaped popliteal space, and to constitute, below, the so-called hamstrings. The inner hamstring, descending obliquely inwards, contains the tendons of the semi-membranosus, semi-tendinosus, and gracilis, as well as the lower part of the still fleshy sartorius; it is thicker, more rounded, more prominent backwards, more oblique and more curved, and reaches lower down than the biceps or outer hamstring; but, nevertheless, one of its cords, namely the tendon of the semi-tendinosus, sometimes starts up as a sharper ridge than that produced on the outer side by the tendon of the biceps, which, moreover, is thicker, and pursues a more direct and vertical course down to the head of the fibula. The gluteal region, with its copious form, is redeemed from commonness, by the variety of its local modelling; compressed towards the fore part of the hip, where it inclines gently downwards and outwards from the pelvis and is supported by the denser part of the fascia lata, it is more prominent laterally behind, where the thickest portion of the gluteus maximus exists, and where, especially during the contracted state, a very broad convex form is produced, above and behind the depressed area, within which the tendinous portion of the muscle and the greater trochanter are situated; the trochanter is, however, sometimes prominent, as when the thigh is thrown over the opposite limb. Anteriorly, the trochanteric depression is bounded by the elevation due to the tensor vaginæ femoris; this muscle, which, seen from the front, balances the sartorius, yet descends from their common-starting point at a different inclination, and forms, not a prominent ridge, but a broad elevation, which is directed downwards and backwards towards the front of the greater trochanter, where it ends by an oblique or nearly vertical border. Acting on or from the ilio-tibial band of the fascia, it tightens that band, which then flattens the vastus externus, and produces the narrow tendon-like plane, on the outer side of the knee, in front of the more rounded ridge caused by the tendon of the biceps; the former leads to the outer tuberosity of the tibia, the latter to the head of the fibula, and there is a distinct sulcus between them.

The *integument* in front of the knee joint is very loose. When the knee is bent, as the skin is tightened over the subjacent parts, its folds disappear, and the forms of the two vasti muscles, passing over the condyles of the femur, with the strong median tendon descending from the rectus and slightly spreading out as it reaches the patella, as well as the bony forms themselves, can be easily traced. When the knee is straight, and the patella is drawn up by the rectus, the tendon and this bone also become visible, the former as a broad ridge, the latter as a depression between the soft parts pressed out around it; but when, as in standing at ease, the knee is straight, and the patella is let down or dropped, a soft cutaneous fold passes obliquely downwards and inwards over the inner condyle, completely obscuring the oppositely inclined form of the vastus internus. This fold corresponds with the line along which the skin, looser in front of the knee, becomes more firmly attached to the fascia above the joint, as may be shown by tucking the fingers under the fold, which can easily be done; the same thing can also be accomplished, on a smaller scale, over the first phalangeal joint in the fingers. The large transverse gluteal fold, below the gluteal region, is also a tegumentary form; it does not follow strictly the lower border of the gluteus maximus muscle, but is due to the presence of a special accumulation of adipose tissue towards the inner portion of that fold. This not only furnishes a cushion of support to the body in the sitting posture, when it is drawn partly beneath the ischial tuberosity, and likewise serves the purpose of concealing the lower part of the trunk, but it changes the oblique line of the lower border of the gluteus maximus into a more nearly horizontal line. It thus affords an illustration of the use of fat in modifying the subjacent anatomical forms; for, whereas the slanting lines of the lower borders of the two glutei muscles, plainly recognisable in the emaciated figure, furnish a very feeble termination to the broad surfaces of the trunk above them, the square lines of the actual form, combining with the vertical spinal furrow, like rectangular lines generally, give an appearance of solid and efficient support to the masses higher up.

The chief venous trunk to be noticed in the thigh, is that of the internal saphenous vein, which, however, is much obscured by the fat in which it is imbedded until near its upper end, which terminates about two inches below Poupart's ligament, to enter the saphenous opening in the fascia lata.

Table of the Muscles of the Trunk.

The Deep Vertebral Group.

Multifidus spinæ, 1.
Rotatores spinæ, 1.
Inter-transversales, 2.
Inter-spinales, 3.
Semi-spinalis dorsi, 4.
,, colli, 5.
Rectus capitis posticus major, 6.
,, ,, ,, minor, 7.
Obliquus capitis inferior, 8.
,, ,, superior, 9.

The Præ-Vertebral Group.

Longus colli, 15.
Rectus capitis lateralis, 16.
,, ,, anticus minor, 17.
,, ,, ,, major, 18.

The Deep Thoracic Group.

Quadratus lumborum, 10.
Diaphragm, 14.
Triangularis sterni, 31.
Intercostales interni, 11.
,, externi, 12.
Levatores costarum, 13.
Scalenus posticus, 19.
,, medius, 20.
,, anticus, 21.

The Longitudinal Dorsal Group.

Erector spinæ, 22.
Sacro-lumbalis, 23.
Musculus accessorius, 23*a*.
Cervicalis ascendens, 23*b*.
Longissimus dorsi, 24.
Transversalis colli, 24*a*.
Trachelo-mastoid, 24*b*.
Complexus, 25.
Biventer cervicis, 25*a*.
Spinalis dorsi, 26.
,, colli, 26*a*.
(*Lumbar fascia*), 27.
(*Vertebral aponeurosis*), 27*a*.

The Divergent Dorsal Group.

Serratus posticus inferior, 28.
,, ,, superior, 29.
Splenius colli, 30.
,, capitis, 30*a*.

The Abdominal Group.

Transversalis abdominis, 32.
Obliquus internus abdominis, 33.
,, externus abdominis, 34
Rectus abdominis, 35.
Pyramidalis, 36.
Sheath of the rectus, 37.
Linea alba, 38.
Lineæ transversæ, 39.
,, semilunares, 40.

The Shoulder-girdle Group.

Levator anguli scapulæ, 41.
Rhomboideus minor, 42.
,, major, 43.
Serratus magnus, 44.

The Scapular Group.

Subscapularis, 45.
Supra-spinatus, 46.
Infra-spinatus, 47.
Teres minor, 48.
,, major, 49.

The Superficial Dorsal Group

Latissimus dorsi, 50.
Trapezius, 51.

The Pectoral Group.

Subclavius, 53.
Pectoralis minor, 54.
,, major, 55.

The Shoulder-cap Muscle.

Deltoid, 52.

The muscles of the *Trunk* include those of the Back and Neck, the Thorax, the Abdomen, and the Shoulder. Each of these sets consists of more than one layer, those of the Back, especially, being so numerous, as to be usually arranged in five distinct layers. Moreover, many of the muscles of one region pass also into another, so that no precisely regional classification of them is possible. For the present purpose, it is better, whilst paying due regard to their connexions and uses, to arrange them in topographical groups; for, in this way, their relations to the forms of the torso, will be better understood. The annexed Table indicates all these muscles, arranged in order from the deepest to the most superficial, in each group; the numbers, as before, are those by which they are referred to, in the several figures in which they occur. In the succeeding descriptions, the same order is observed.

The Deep Vertebral Group, figs. 147, 148.—This contains the following small, short muscles, connected with the vertebræ, or with the occiput, which is a modified vertebra.

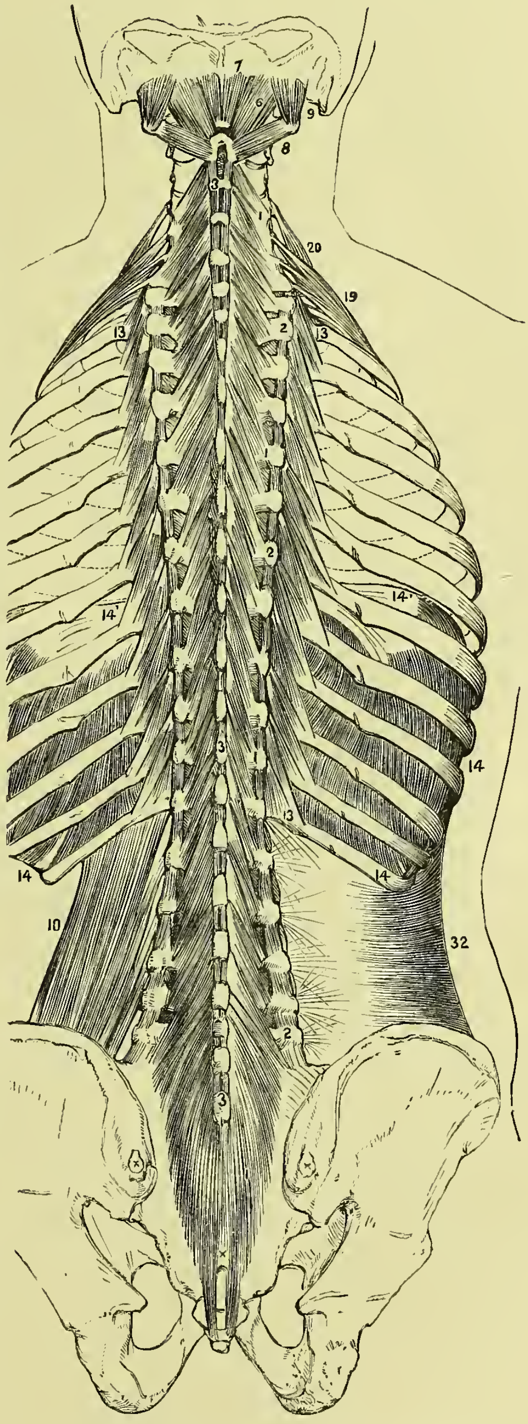


FIG. 147.– The Deep Vertebral and Deep Thoracic Groups.

Multifidus spinæ. fig. 147, [1], [1]. Deep; a series of fleshy and tendinous bundles, largest towards the lower part of the loins; oblique upwards and inwards, through the whole length of the spine. Back of the sacrum, posterior superior spinous process of the ilium, sacro-iliac ligaments, aponeurosis of the erector spinæ muscle, articular and accessory tubercles of the lumbar, transverse processes of the dorsal, and articular processes of the lower four cervical, vertebræ——laminæ and spinous processes of the vertebræ abcve, the deeper fasciculi passing from one vertebra to the next, and the more superficial fasciculi, to the second, third, or fourth vertebra higher up. *Rotatores spinæ.* Deep; eleven small slips, found in the dorsal region only; less oblique than the multifid fasciculi which cover them. Transverse processes of the vertebræ——laminæ of next vertebra above. *Inter-transversales*, fig. 147, [2], [2]. Deep; short slips, thick and double in the loins, smaller and single in the back, more distinct and again double in the neck; vertical between the transverse processes, which are themselves bifid in the cervical vertebræ. *Inter-spinales*, fig. 147, [3], [3]. Deep, their edges covered only by the supra-spinous ligament; short slips, arranged on each side of the middle line, thin and flat in the loins, few and small in the back, larger and rounded in the neck, vertical between the spinous processes, absent between the axis and atlas. A few *supra-spinal* muscular slips are also described. *Extensor coccygis*, fig. 147, *. Deep; a slender prolongation from the deep vertebral set; vertical from the sacrum to the coccyx, a rudiment of the extensor of the caudal vertebræ in animals; not always present. *Semi-spinales dorsi*, and *colli*, fig. 148. Deep, resting on the multifidus spinæ; tendinous and fleshy slips; oblique from the transverse to the spinous processes. The *dorsal part*, [4], [4], from the six dorsal transverse processes, namely, from the tenth to the fifth——the upper four dorsal and lower two cervical spines; the *cervical* part, [5], [5], thicker, especially above, from the four upper dorsal transverse processes ——four cervical spines, namely, from the fifth to the second.

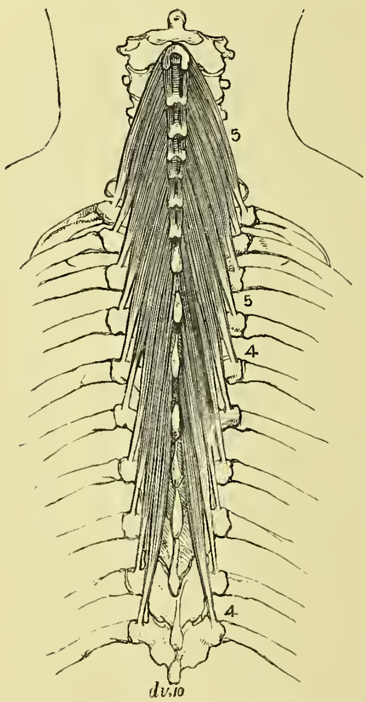


Fig. 148.—Deep Vertebral Muscles; the Semi-spinales.

Of this deep vertebral group, the vertical inter-transverse and interspinous muscles, approximate the processes to which they are attached, and help to bend the spine sideways or backwards. The oblique rotatores, multifidi spinæ, and semi-spinales, rotate the spine, so that the trunk and neck are turned over to the opposite side; they may also incline the spine sideways. If the muscles of the two sides co-operate, they extend the vertebral column, and so assist, though feebly, in maintaining the erect posture. The movements between any two adjacent vertebræ, produced by these muscles, are slight, but in the aggregate they are evident enough. The muscles act, in the upright posture, as supports to the ligaments, serving as contractile braces, to guard the spine from undue curvature.

Recti postici and obliqui capitis. At the upper part of the neck, the deep vertebral muscles are replaced by, or rather developed into, special *straight* and *oblique* muscles, adapted to execute slight movements between the atlas and axis, and between the occiput and the atlas, such as occur, for example, in listening, and in the attentive exercise of the sense of sight. *Rectus capitis posticus major*, fig. 147, [6]. Deep; flat, triangular; upwards and outwards. Spinous process of the axis——inferior curved line of the occiput. *Rectus capitis posticus minor*, [7]. Deep; triangular; nearly vertical. Back of the atlas, near the tubercle——inferior curved line of the occipital bone, and between that and the foramen magnum. *Obliquus capitis inferior*, [8]. Deep; flat; upwards and outwards. Spinous process of the axis——point of the transverse process of the atlas. *Obliquus capitis superior*, [9]. Deep; triangular, flat; upwards and inwards. Transverse process of the atlas——between the curved lines of the occiput, above the rectus posticus major. The rectus minor and the obliquus superior, draw the head down behind; so, likewise, will the recti majores of the two sides, acting together. The rectus major and the obliquus inferior of one side, rotate the atlas, with the head, around the odontoid process, turning the face to their own side; the two inferior obliqui and the two larger recti, when acting together, keep the head straight.

The Præ-Vertebral Group, fig. 149.—This is limited to the upper dorsal and the cervical regions, and consists of the longus colli, rectus capitis anticus major and minor, and the rectus capitis lateralis.

Longus colli, fig. 149, [15]. Deep; divided into three portions, each composed of separate slips; one vertical, and two oblique portions. *Inferior* portion, bodies of two or three dorsal vertebræ——fifth and sixth cervical transverse processes; *superior* portion, third, fourth and fifth cervical transverse processes——tubercle on anterior arch of the atlas; *middle* portion, bodies of three upper dorsal, and three lower cervical vertebræ——bodies of fourth, third and second cervical vertebræ. This muscle aids in rotating the neck, but chiefly acts in bringing it forwards. *Rectus capitis anticus major*, [18]. Deep; long and thick; converging towards the middle line. Anterior tubercles of the transverse processes of four cervical vertebræ——basilar process of the occipital bone. *Rectus capitis anticus minor*,[17]. Deep; flat, quadrangular; upwards and inwards. Anterior arch of the atlas——basilar process of the occiput, behind the last-named muscle. *Rectus capitis lateralis*, [16]. Deep; short, flat; vertical, like an inter-transverse muscle. Transverse process of the atlas——jugular process of the occipital bone. The rectus major flexes the upper part of the neck, as well as the head; both recti may rotate the head slightly; the lateral rectus inclines the head a little to its own side.

The Deep Thoracic Group, figs. 147, 150, 152–155. This includes the quadratus lumborum, situated in the loins, but acting on the last rib; the thoracic muscles proper, or muscles of ordinary respiration, namely, the internal and external intercostals, the levatores costarum, the diaphragm, and the triangularis sterni; and, lastly, the scaleni muscles, placed in the neck, but acting on the upper two ribs.

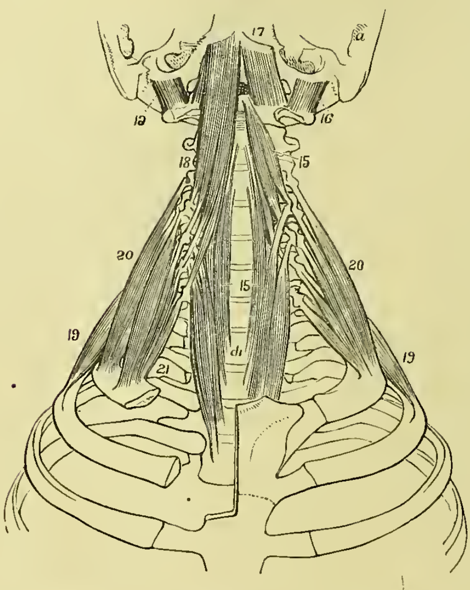


Fig. 149.—The Præ-Vertebral Group; with the Scaleni.

Quadratus lumborum, fig. 147, [10]. Deep; thick, nearly square, being broader below; vertical, in a strong sheath formed by the lumbar fascia. Inner lip of hinder part of the iliac crest, ilio-lumbar ligament, and transverse processes of the middle three lumbar vertebræ——lower border of the last rib, for about half its length, and transverse processes of the upper four lumbar vertebræ. It depresses the last rib, and inclines the lumbar portion of the spine to its own side; acting from the spine, it suspends or even raises the pelvis on its own side. Both muscles straighten and support the loins.

Intercostales interni, figs. 150, 154, [11], [11]. Deep; eleven in number, on each side, composed of short mixed fleshy and tendinous fasciculi; obliquely upwards and inwards, between the ribs, from near the angles behind, to the sternum in front, the lowest two joining the internal oblique muscle of the abdomen. Upper border of the rib below——inner lip of the groove on the under border of the rib above, and its costal cartilage. *Infracostales* are described, consisting of small bundles, occupying the inner aspect of the ribs, where the internal intercostals cease behind; they are not present in every space. *Intercostales externi*, figs. 152, 155, [12], [12]. Deep; eleven in number, on each side, composed of short, mixed fleshy and tendinous, slips; obliquely downwards and inwards, between the ribs, from the tubercles behind, to near the commencement of the costal cartilages, in front, whence they are continued by a thin fascia to the sternum, the lower muscles, however, extending forwards between the cartilages, and the two lowest reaching to the ends of the ribs. Outer lip of the groove on the under border of the rib above——upper border of the rib below. The external intercostals are thicker than the internal ones ; the fasciculi of the two muscles cross each other; the former are deficient in the fore part, and the latter in the hinder part of the intercostal spaces. *Levatores costarum*, fig. 147, [13], [13]. Deep; twelve in number, small, fan-shaped, tendinous and fleshy ; downwards and outwards, from the spine to the ribs. Transverse processes of the seventh cervical, and of all the dorsal vertebræ except the lowest——upper borders of the ribs below, between their tubercles and angles. These muscles increase in size from above downwards; and some of the lower muscles send down slips to the second rib below, named *levatores costarum longiores*. The anterior portions of the five or six upper internal intercostals, near the sternum, elevate the ribs, and so assist in inspiration ; but, elsewhere, they depress the ribs, invert their lower borders, narrow the intercostal spaces, and so diminish the capacity of the thorax, both in width, and in depth from before backwards, thus acting as expiratory muscles. All the external intercostals, on the contrary, are inspiratory muscles, elevating the ribs, especially in front, everting their lower borders, and thus increasing the lateral and antero-posterior dimensions of the thorax. The levatores costarum assist the hindmost parts of the external intercostals in raising the ribs, and are inspiratory muscles.

Diaphragma, figs. 147, 153, [14], [14′]. Deep; a partly muscular, partly tendinous septum, arched or vaulted upwards ; placed obliquely between the abdomen and the thorax, hence named the *midriff*, separating the two cavities, and forming a concave roof to the one, and a convex floor to the other. Bodies of the upper three lumbar vertebræ, fascia in front of the quadratus lumborum, lower six costal cartilages, portions of the corresponding ribs, and back of the xiphoid appendix——posterior, lateral, and anterior borders of a large, central, heart-shaped or trefoil sheet of tendon. The diaphragm is placed about opposite the junction of the lower two-thirds with the upper third of the trunk; its convexity reaches, on the right side, as high as the level of the fore part of the fifth rib, on the left side, to the level of that of the sixth rib. The heart rests on its central tendon, the apex of that organ pointing to the left of the sternum, below and internal to the centre of the mammary gland; the lungs are, of course, in contact with the diaphragm on both sides, above; the liver touches its under concave surface, chiefly on the right side, but also, to a slight extent on the left; the stomach and spleen reach it still further on the left; the kidneys touch its hinder portions, on both sides. The circumferential parts of the diaphragm being muscular, and the central part tendinous, the former, when they contract, become less arched or nearly straight, and are drawn inwards, away from the spine and the lower border of the thorax, and, at the same time, cause the central tendon to become flattened, and to descend; in this way, the cavity of the thorax is temporarily elongated. The diaphragm is, therefore, an inspiratory muscle; for the enlargement of the thorax, caused by its descent, and by the elevation and outward rotation of the ribs, through the action of the other muscles of inspiration, is followed by the entrance of air along the windpipe and its branches, into the lungs. This air is again expelled during expiration, when the chest walls fall in, and the diaphragm ascends. After a full inspiration, the air is sometimes held in the chest by the closure of the glottis, in the larynx, and then the thoracic walls are rendered firmer, as a preparation for efforts to be made with the upper limbs. When the diaphragm descends, the contents of the abdomen are pushed downwards and forwards, and the abdominal walls become more prominent in front; in expiration, the viscera of the abdomen again ascend, and the walls of that cavity fall back.

Triangularis sterni, fig. 161, [31], [31]. Deep; separate, small bundles forming an open triangular sheet; divergent, from below upwards, behind the sternum and costal cartilages. Back of the xiphoid appendix and lower part of the body of the sternum —— lower borders and deep surfaces of most of the costal cartilages of the true ribs. It is subject to great variety in different subjects; its lowest bundles are nearly horizontal, and appear as if continuous with the transverse muscle of the abdomen. By some, they are said to be expiratory in their action, but others maintain a contrary view.

Scaleni, posticus, medius, and *anticus*, figs. 147, 149. Deep seated; named from their resemblance in form to a *scalene triangle*; oblique, downwards, outwards and forwards, from the cervical region of the spine to the first and second ribs. *Scalenus posticus*, [19], the smallest, transverse processes of the two or three lower cervical vertebræ——second rib, between the tubercle and angle, in front of the levator muscle. *Scalenus medius*, [20], the largest, posterior tubercles of the six lower cervical transverse processes—— rough elevation on the first rib, in front of the tubercle. *Scalenus anticus*, fig. 149, [21], anterior tubercles of the third to the sixth cervical transverse processes——scalene tubercle and ridge, on the upper surface of the first rib. The scaleni, acting from the neck, elevate, or, at all events, fix the upper ribs, and are, therefore, adjuvant inspiratory muscles. Acting from the ribs, of which the first one is the most fixed, they incline the neck forwards and to one side; and when the muscles of both sides contract, they balance the neck, and maintain it in lateral equipose.

The Longitudinal Dorsal Group,—figs. 150–152.—This includes the erector spinæ, situated in the loins and back, and its prolongations into the neck, together with the complexus, and spinales muscles. They are very complicated in structure, and are held in position by the lumbar and vertebral fasciæ, which will be described immediately after them. They are very large and powerful muscles, which erect the trunk, and help to support the head upon the neck.

Erector spinæ, fig. 150, [22]. Deep, being covered by a sheath formed by the lumbar fascia and vertebral aponeurosis, as well as by parts of other muscles of the back; narrow and pointed below, over the sacrum, very large and prominent in the lumbar region, smaller and flattened in the back; vertical or longitudinal, along the vertebro-costal grooves, between the spinous processes and the angles of the ribs, where these exist, elsewhere between the spinous and transverse processes. Before this muscle reaches the level of the lowest rib, it divides into two parts, an outer, smaller and shorter part, named the *sacro-lumbalis*, [23], and an inner, larger and longer part, named the *longissimus dorsi*, [24]. Both parts are

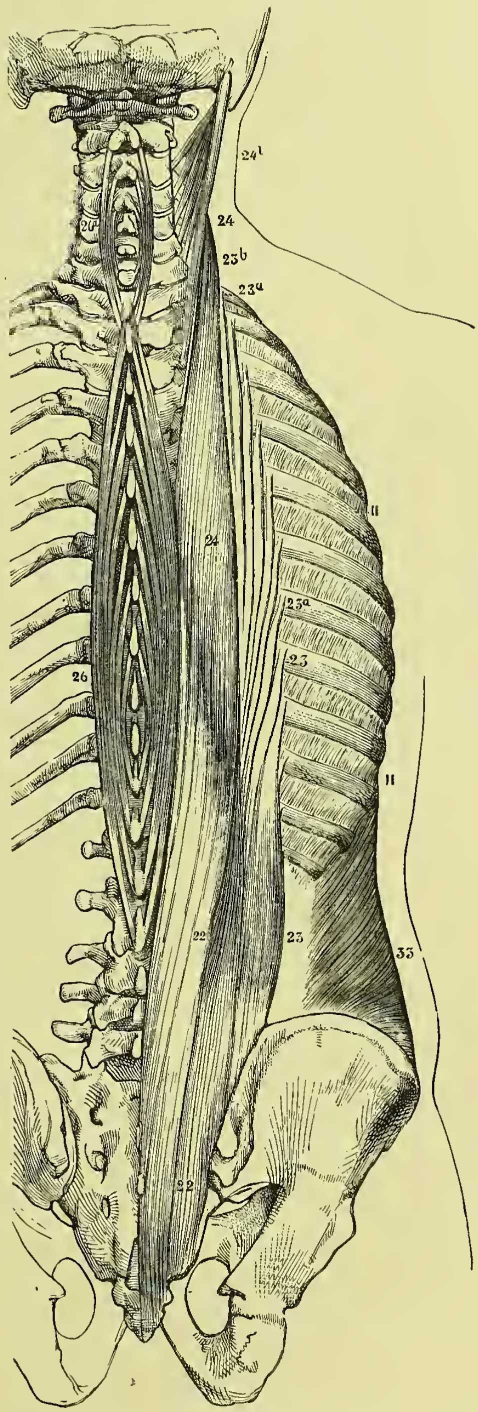


Fig. 150.—The Longitudinal Dorsal Group, in the Back and Neck.

tendinous on the surface below, but the tendon of the sacro-lumbalis terminates much sooner than that of the longissimus dorsi; both end by oblique borders running upwards and inwards. Common origin: inner lip of the hinder fourth of the crest of the ilium, hinder border of the ilium and part of the back of the sacrum, the sacral, lumbar, and lower two or three dorsal spinous processes, and lumbar fascia, with which it is at first inseparably connected——the *sacro-lumbalis*, angles of the lower six or seven ribs, by separate flat tendons, connected at their edges——the *longissimus dorsi*, lower nine or ten ribs between their angles and tubercles, and all the dorsal transverse processes, by tendinous and fleshy slips. Both parts of the erector spinæ are continued upwards by numerous processes through the back, and are also prolonged into the neck. The sacro-lumbalis is continued in the back by the *musculus accessorius*, [23a], which proceeds from the angles of the lower six ribs, to the angles of the upper six ribs; it is prolonged, into the neck, by the *cervicalis ascendens*, [23b], which proceeds from the angles of the upper four or five ribs, to the fourth, fifth and sixth cervical transverse processes. The longissimus dorsi is continued in the back, and prolonged into the neck, by the *transversalis colli*, [24a], which proceeds from the upper five or six dorsal transverse processes, to the posterior tubercles of the cervical transverse processes, from the sixth to the second; and it is further prolonged up to the skull, by the *trachelo-mastoid*, figs. 150, 151, [24] (τράχηλος, the neck), which proceeds from the same dorsal transverse processes, and from the lower three or four cervical articular processes, to the back of the mastoid process of the temporal bone, under cover of the splenius and the sterno-mastoid muscles.

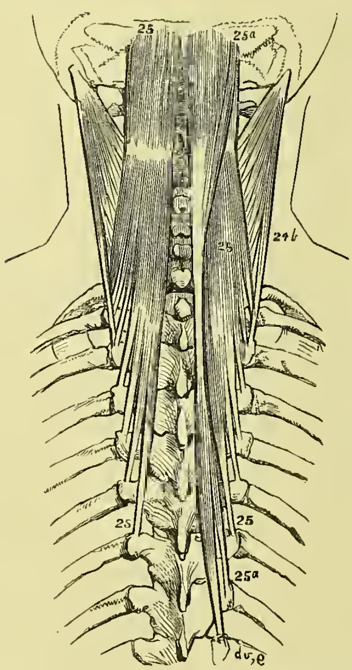


Fig. 151.—The Longitudinal Dorsal Group in the Neck.

Complexus, fig. 151, [25], [25]. Deep; broad below, narrower above, marked by a transverse tendinous intersection, its inner portion being distinct, and named *biventer cervicis*, [25a], from its having two fleshy bellies and an intermediate tendon; an associate of the erector spinæ, upwards and inwards, in the vertebral groove of the back and neck. Upper six dorsal and seventh cervical transverse processes, and three cervical articular processes higher up——inner part of the under surface of the occipital bone, between the two curved lines.

Spinales dorsi et colli, fig. 150, [26], [26a]. Deep; variable longitudinal slips, situated on the inner border of, and associated with, the erector spinæ, remarkable for both arising from and being inserted into the spinous processes. *Spinalis dorsi*, upper two lumbar, and lower two dorsal spines——upper eight dorsal spines; *spinalis colli*, upper two dorsal, and lower two or three cervical spines——second and third cervical spines.

The action of the two erectores spinæ in straightening the back, as in rising from the stooping posture, is indicated by their name. Continuing to act, they bend the trunk backwards, this movement, however, as has been explained, occurring chiefly at the loins. The two musculi accessorii and spinales dorsi co-operate with the erectors. The cervicalis ascendens, transversalis colli and trachelo-mastoid, and also the complexus and spinalis colli, of the two sides, straighten and bend back the neck, the trachelo-mastoid likewise acting thus on the head. In each case, the muscles of one side incline the loins, back, neck or head, to their own side, slightly rotating them to that side, except in the case of the complexus, which rotates the face to the opposite side. The lower portions of the erector spinæ may aid the expiratory movements; but if the neck be fixed, the upper portions of these and of the cervicalis ascendens, would be inspiratory. The trachelo-mastoid and the complexus, approximate the side of the head to the shoulder.

The fascia lumborum and the vertebral fascia or aponeurosis, fig. 152. The *fascia of the loins*, [27], is formed by the splitting of the broad tendon of the deepest of the three muscles which form the sides of the

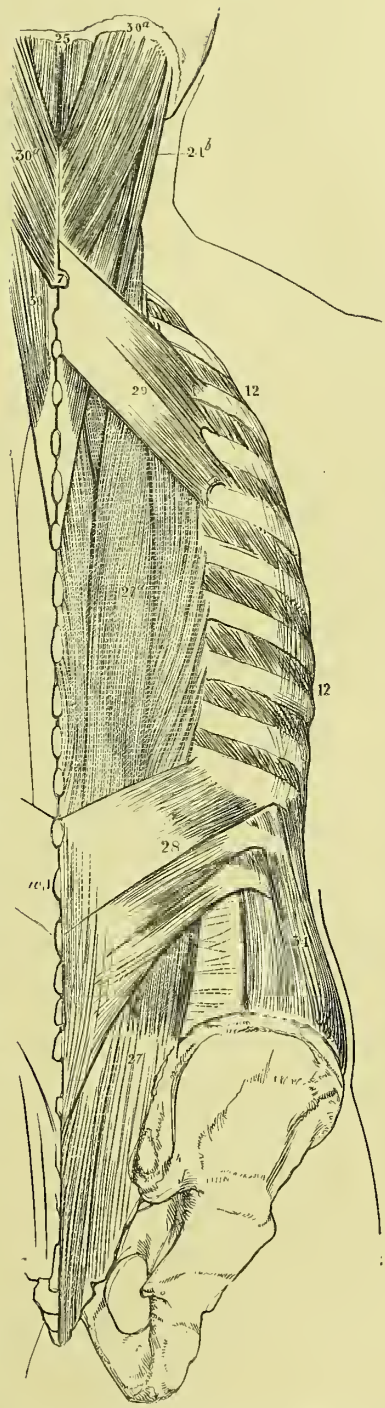


Fig. 152.—The Divergent Dorsal Group, in the Back and Neck, with the Lumbar and Vertebral Fasciæ.

abdominal walls, namely the transversalis abdominis. Along the outer edge of the quadratus lumborum muscle, this tendon splits into three layers, between which are enclosed the quadratus muscle itself, and the erector spinæ; a thin layer passing in front of the quadratus is attached to the transverse processes of the lumbar vertebræ, to the crest of the ilium and to the lower border of the last rib; another layer, much stronger, passing behind that muscle and in front of the erector spinæ, is also fixed to the lumbar transverse processes; lastly, a third, very strong aponeurotic layer, passing behind the erector spinæ, reaches the crest of the ilium and the spinous processes of the sacral, lumbar and lower dorsal vertebræ. This last layer is blended with the tendinous origin of the erector spinæ, and also, in itself, constitutes the broad origin of the latissimus dorsi muscle, to be hereafter described; it likewise furnishes an origin to the serratus posticus inferior muscle, 152, [28]. Above this, it becomes thinner and is named the *vertebral fascia* or *aponeurosis*, [27a], which, attached, on the one hand, to the spinous processes, and, on the other, to the angles of the ribs, binds down the sacrolumbalis and longissimus dorsi, the continuations of these muscles and also the spinalis dorsi, furnishes coverings to the serratus posticus superior, the complexus, and the two splenii muscles in the back and neck, and then becomes continuous with the cervical fascia.

The Divergent Dorsal Group, fig. 152.—This includes the two posterior serrati and the two splenii muscles, which agree in arising from the spinous processes, and diverging from them; but, otherwise, their association, here, is artificial, the former set proceeding to the thorax, the latter to the neck and head. Over them, are situated the shoulder-girdle muscles, and the two broad superficial muscles of the back.

Serratus posticus inferior, fig. 152, [28]. Deep; flat, thin, irregularly quadrilateral, single and tendinous at its origin, ending in three or four fleshy digitations; oblique, upwards and outwards. Upper two or three lumbar, and lower two dorsal spines, interspinous ligaments, and posterior layer of the fascia lumborum, which is blended with the tendon of origin of the latissimus dorsi——inferior borders of lower three or four ribs, beyond their angles. *Serratus posticus superior*, [29]. Deep; like the inferior muscle, digitate, but narrower; oblique, downwards and outwards. Upper two or three dorsal and lowest cervical spines, and ligamentum nuchæ——upper borders of the second, third and fourth ribs, beyond their angles. The two posterior serrati are so connected with the vertebral aponeurosis, that they tighten it, and thus brace the erector spinæ. The superior one is evidently an inspiratory muscle, elevating the ribs. The inferior one may also be inspiratory, by fixing the lower ribs, and so aiding the downward action of the diaphragm, as well as elongating the thorax; it has, however, been regarded as an expiratory muscle.

Splenius colli and splenius capitis, fig. 152, [30], [30a]. Deep; shaped like the leaves of the spleen-wort or hart's-tongue (σπλήν), the tendinous points being downwards, and the broader fleshy parts upwards; ascend obliquely outwards, from the upper part of the back to the neck and head. Common origin, upper six dorsal and lowest cervical spines, and ligamentum nuchæ——the *splenius colli*, upper three cervical transverse processes——the *splenius capitis*, occipital bone beneath the superior curved line, and back of the mastoid process of the temporal bone. The two splenii capitis, as they diverge upwards, expose the two complexi muscles between them. Acting together, the splenii of the two sides draw the neck and head backwards; acting independently, they incline and rotate the head and neck to their own side.

The Abdominal Group, figs. 147, 150, 152–155.—This includes, first, the three broad muscles, which, from the direction of their fleshy fasciculi, are named, the transverse and the internal and external oblique muscles; they enclose the abdominal cavity, at the sides and in front, by a threefold musculo-tendinous wall. It also includes the large vertical rectus abdominis, which is situated on the front of the abdomen, in a sheath formed by the aponeuroses of the broad muscles, and, lastly, the small pyramidalis muscle, which is associated with the lower end of the rectus.

Transversalis abdominis, figs. 147, 153, [32]. Deep; a very broad, irregularly quadrilateral, curved muscle, partly tendinous but chiefly fleshy behind and at the sides, tendinous in front; more or less transverse, its lower fasciculi long and arched downwards and forwards, the middle and upper ones horizontal, the latter being very short. Outer half of Poupart's ligament, *p*, anterior two thirds of the inner lip of the crest of the ilium, lumbar fascia connecting it with the lumbar vertebræ, and inner surface of the lower six costal cartilages, by tendinous fibres from the twelfth and eleventh, but otherwise by fleshy bundles, which interdigitate with the diaphragm, and are continuous with the lower part of the triangularis sterni——broad anterior aponeurosis commencing a short distance from the outer border of the rectus muscle and its sheath, [37], and passing inwards, to be blended with the aponeuroses of the two oblique muscles, and with those of the three muscles of the opposite side, in the *linea alba*, [38], a strong, vertical, fibrous structure which occupies the middle line of the abdomen. In its lower fourth, fig. 153, [37′], the aponeurosis of the transversalis muscle passes altogether in front of the rectus muscle, leaving that muscle comparatively free behind; but in its upper three fourths, [37], it passes behind that muscle, and so assists in forming a sheath for it, in that situation. The transversalis muscle is supported on its inner surface by a layer of fascia, and this again is lined by the peritoneum, a smooth serous membrane which covers the interior of the abdomen, and is reflected over the viscera generally.

Obliquus internus abdominis, figs. 150, 154, [33]. Deep, so named, because it is placed deeper than the external oblique, by which it is covered, except at a very minute triangular space, between the margins of the external oblique and the latissimus dorsi muscles, just above the crest of the ilium, fig. 167; fleshy behind, at the side, and in front, as far as the outer margin of the rectus muscle, thence tendinous or aponeurotic to the linea alba; the fleshy fasciculi, for the most part oblique, forwards, upwards and inwards, but the lower ones horizontal, and the lowest descending obliquely forwards and inwards. Outer half of Poupart's ligament, *p*, intermediate surface between the two lips of the anterior two-thirds of the crest of the ilium, and lumbar fascia——inner end of the pecten, and crest of the pubes, broad anterior aponeurosis of the muscle, from the pelvis to the thorax, and inferior borders of the lower three or four costal cartilages, uniting with the corresponding internal intercostal muscles. Near the outer margin of the rectus, fig. 154, [35], the aponeurosis, in its upper three-fourths, splits into two layers, of which the posterior one, unites with the aponeurosis of the transversalis, fig. 153, [37], to pass behind the rectus, fig. 154, [35], whilst the anterior one unites with the aponeurosis of the external oblique, and passes in front of the rectus, both uniting beyond it, and ultimately reaching the linea alba, [38]; in the lower fourth, the aponeurosis remains undivided, and, with that of the transversalis, passes altogether in front of the rectus, to the linea alba. At its upper end, the split aponeurosis is connected, deeply, with the xiphoid cartilage and the eighth and seventh costal cartilages, and, super-

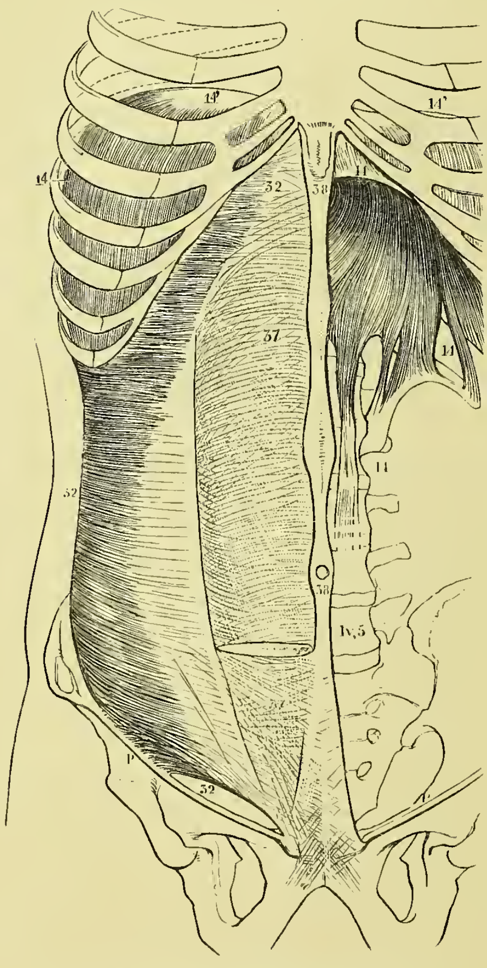


FIG. 153.—Deep Abdominal Layer; with parts of the Diaphragm.

ficially, with the ninth rib and the external oblique muscle; at its lower end, it unites with the aponeurosis of the transversalis, to form the *conjoined tendon*, by which both are attached to the inner end of the pecten and crest of the pubes. From the free arched lower border of the internal oblique muscle, a few fleshy fasciculi, constituting the *cremaster* muscle, are detached, to proceed along the cord, which here passes out of the abdominal cavity.

Obliquus externus abdominis, figs. 152, 155, [34]. Superficial throughout, except for a very small space behind, where it is overlapped by the latissimus dorsi; very broad and irregularly quadrilateral, consisting above, behind and at the side, of numerous fleshy digitations, and, in front and below, of a wide aponeurosis; its muscular fasciculi, thicker and larger than those of the internal oblique, are, with the exception of the hindmost which are nearly vertical, directed downwards, forwards and inwards, and, accordingly, in the reverse direction to those of the internal oblique. Outer surface and lower borders of the lower eight ribs, by as many distinct processes or digitations——anterior half, or more, of the outer lip of the crest of the ilium, and the broad aponeurosis which covers the front of the abdomen, reaching from Poupart's ligament and the pubes to the sternum and certain costal cartilages, and uniting with the aponeuroses of all the broad muscles of both sides of the abdomen, in the linea alba. The digitations of this muscle commence by oblique lines on the several ribs; the upper five increase in size from above downwards, and are received between corresponding digitations of the serratus magnus muscle, to be presently described; the lower three diminish in size from above downwards, and are received between the digitations of the latissimus dorsi, which here slightly overlaps the external oblique. The line of attachment of the series of digitations is crescentic, fig. 166, being slightly convex forwards and downwards, the upper and lower digitations approaching the costal cartilages, the middle ones being at some distance from them. The lower digitations are somewhat variable in number and in form; and sometimes a fleshy bundle connects this muscle with the great serratus.

The combined superficial *aponeurosis* of the three broad *abdominal muscles*, fig. 155, constitutes the largest and most remarkable aponeurotic structure in the whole body; it is widest below, and somewhat narrower across the middle than it is above; its upper fibres are connected with the pectoralis major muscle; including the aponeurosis of the internal oblique, it forms the anterior wall of the sheath of the rectus; its lower border, very strong and distinct, forms *Poupart's ligament*, which extends obliquely downwards and inwards, from the anterior superior spinous process of the ilium to the spine of the pubes, and which, being attached to the fascia lata of the thigh, is fixed, so as to be convex downwards, in its middle portion, where it forms the anatomical delimitation of the trunk from the lower limb. The inner end of Poupart's ligament, somewhat rounded, forms the *outer* border or *pillar* of the *external abdominal ring*, [34a], an opening in the aponeurosis, through which the cord passes; the *inner pillar*, thinner, flattened, and also formed by the aponeurosis, is fixed to the front of the symphysis pubis, its fibres interlacing with those of the opposite side, whilst other strengthening fibres, named *intercolumnar*, cross over and above the ring. From the symphysis pubis, upwards along the middle line of the abdomen, to the xiphoid cartilage, is the *linea alba*, [38], already mentioned as formed by the blending of all the aponeurotic structures in this situation. It is a *white band*, wider above than below, and presents, at the junction of its lower two-fifths with its upper three-fifths, a lozenge-shaped depression, in the middle of which is the scar, named the *umbilicus*. The linea alba separates the inner borders of the two recti muscles, right and left, forming an intermuscular marking between them. On the outer border of each muscle, is a vertical curved white line, convex outwardly, reaching from the pubes to the eighth rib, and named the *linea semilunaris*, [40]; this corresponds with the line along which the aponeurosis of the internal oblique splits, to form the sheath of the rectus muscle. Some distance outside each linea semilunaris, but curved in the opposite direction, is the undulating border of the fleshy portion of the external oblique itself. Crossing between the linea alba and the lineæ semilunares are the *lineæ transversæ*, [39], horizontal but slightly depressed markings, situated in pairs, opposite to certain tendinous intersections or inscriptions belonging to the recti muscles, which are here attached to the under side of the aponeurosis; one pair of these lines always diverges from a little above the umbilicus; they are homologous with the abdominal ribs of the crocodile, which, indeed, are supported on a longitudinal, cartilaginous, linea alba.

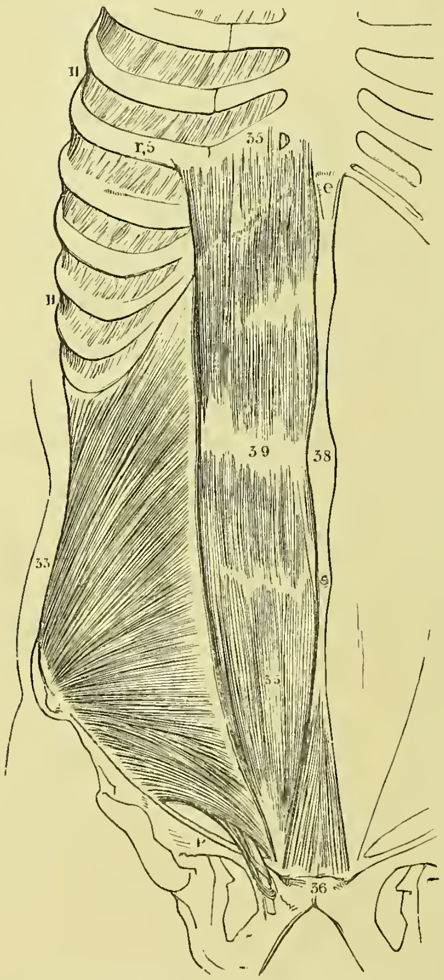


Fig. 154.—Middle Abdominal Layer, with the Rectus and Pyramidalis.

Rectus abdominis, figs. 154, 166, [35]. Enclosed, in its upper three-fourths, in a sheath formed by the splitting of the aponeurosis of the internal oblique muscle, covered also by the aponeurosis of the external oblique, but, in its lower fourth, covered by the united aponeuroses of all three of the broad muscles; long, flat, pointed below, but widening and, finally, becoming very thin above, exhibiting in its course three or four transverse tendinous inscriptions or intersections, [39], which, more or less completely, divide the muscle into segments, one intersection always curving upwards from near the umbilicus, two being above that, and sometimes a fourth, imperfect one, existing below; vertical from the pelvis to the chest, on one side of the middle line, between the linea alba, and the corresponding linea transversalis. Crest and symphysis of the pubes, by a larger and smaller tendinous process——fifth rib, fifth, sixth and seventh costal cartilages, and xiphoid cartilage, by three, thin, fleshy portions.

Pyramidalis abdominis, fig. 154, [36]. Covered by the aponeurosis of the external oblique; triangular, pointed above, small in man, sometimes absent, the rectus then being larger, sometimes double; vertical, close to the middle line. Front of the pubes and anterior pubic ligament——linea alba, half way between the pubes and the umbilicus.

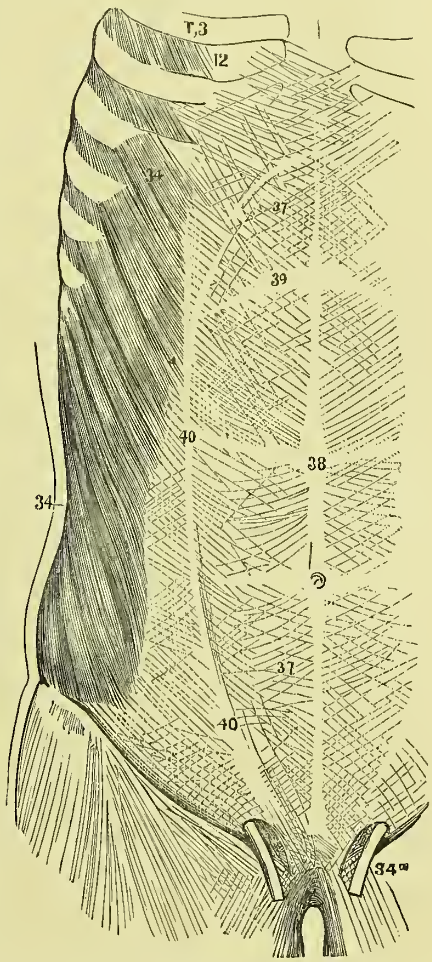


FIG. 155.—Superficial Abdominal Layer.

The three broad muscles of the abdomen have similar but not, in all respects, identical actions. Crossing each other in three different directions, they support and compress the viscera evenly, in all positions of the body. By this general compression of the contents of the abdomen, they assist in carrying the viscera upwards and backwards, as the diaphragm relaxes and ascends in expiration. They are themselves somewhat relaxed during inspiration. They may, however, when the spine is fixed, draw the lower ribs downwards and inwards, and so aid in expiration. When the pelvis is fixed and the spine is free, the muscles of both sides acting together, the thorax is inclined forwards, the dorsal region especially being flexed. If they all act on one side, lateral inclination of the trunk to that side will ensue. The oblique muscles will also cause some rotation of the trunk, in which the face is turned to the opposite side, if the external oblique be in action, but to the same side, if the internal oblique be brought into play. If the thorax be fixed, these muscles, co-operating on the two sides, pull upon the pelvis, and raise it forwards, as in climbing; or, acting independently, the pelvis is drawn up to one side or the other, with or without a movement of rotation. The two recti muscles, acting from below, draw the thorax downwards and forwards, or, if one acts, it may incline the trunk slightly. Acting from above, the thorax being fixed, they draw the pelvis upwards and forwards, as in climbing. The segmentation of this muscle, and its enclosure in so firm a sheath, enable it to maintain its action in all possible bendings and twistings of the body; the segments are very numerous in very long-bodied animals, such as the weasel. The pyramidalis tightens the linea alba and assists the lower part of the rectus.

The Shoulder-girdle Group, figs. 156, 157.—This consists of the four *suspensory muscles* of the scapula, which proceed from the vertebral column or the chest, to the base of that bone, and move it upon the thorax; it includes the levator of the angle of the scapula, the lesser and greater rhomboids, and the great serratus muscle.

Levator anguli scapulæ, figs. 156, 161, [41]. Deep, excepting a small portion, left uncovered at the side of the neck between the trapezius and the sterno-mastoid muscles, fig. 187; long, tendinous and subdivided above, thick and flattened below; downwards, outwards, and a little backwards from the neck to the scapula. Posterior tubercles of upper four cervical transverse processes——base of the scapula, from the superior angle to the spinous process. This muscle is subject to considerable variety; it may arise from three or five vertebræ, from the occipital bone, or the mastoid process; sometimes it is divided into bundles throughout; it may be connected with the second rib, or with the scaleni muscles, or with the great serratus. It lifts upwards the angle of the scapula, aiding the trapezius in bearing weights, or in shrugging the shoulders. When the scapula is fixed, it inclines the neck to its own side and rotates it backwards.

Rhomboidei minor and major, 156. The *rhomboideus minor*, [42]; deep, covered by the trapezius; rhomboidal, narrow and flat; oblique downwards and outwards, in the upper part of the back. Lower two or three cervical and first dorsal spines, and ligamentum nuchæ——base of the scapula, opposite the smooth triangular surface at the root of the spinous process. The *rhomboideus major*, [43], deep, covered by the trapezius only, excepting a small triangular portion below, whilst another very small piece is crossed by the latissimus dorsi, fig. 167 ; rhomboidal, flat but broader than the last muscle ; oblique downwards and outwards, from the spine to the scapula. Upper four or five dorsal spines and supra-spinous ligament——base of the scapula, from the root of the spinous process to the inferior angle. Many of its fasciculi are attached to a strong tendinous band, which is fixed to the scapula near its lower angle, and is elsewhere bound to the base of the bone by connective tissue. The rhomboid muscles draw the scapula upwards, backwards and inwards ; the greater muscle, acting through its tendinous band on the lower angle especially, depresses the acromion process, and thus rotates the whole bone on the chest. The rhomboids co-operate, as will be presently explained, with the great serratus and the trapezius muscles.

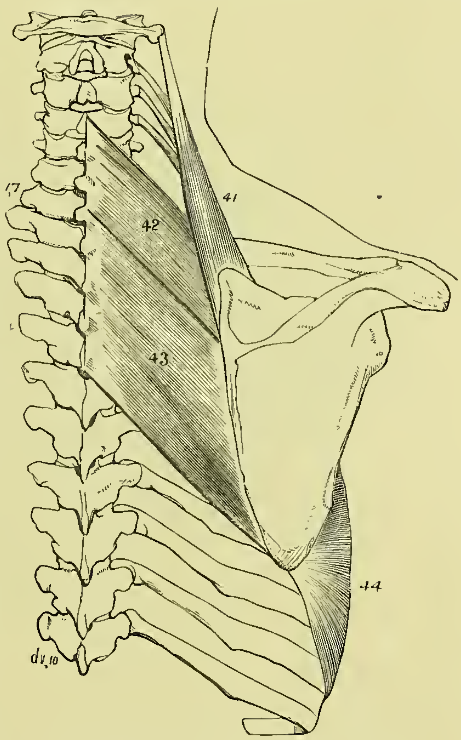


Fig. 156.—The Shoulder-girdle Group.

Serratus magnus, figs. 156, 157, 161, 166, [44]. Superficial, on the side of the thorax just below the axilla, but elsewhere deep-seated, beneath the scapula and its muscles, and also beneath the latissimus dorsi and the pectorales major and minor ; thick, broad, irregularly quadrilateral, with a curved and boldly serrated anterior crescentic border, disposed in a series of pointed, fleshy digitations ; embracing a large portion of the side of the thorax, its numerous bundles passing backwards beneath the scapula, and converging, somewhat, to reach the base of that bone. Outer surfaces and upper borders of the upper eight ribs, and intervening intercostal fascia——whole length of the under surface of the base of the scapula. The digitations from the upper two ribs and the intervening fascia, fig. 157, form a narrow thick mass, which proceeds backwards and somewhat upwards, to be fixed to a triangular impression on the deep surface of the superior angle of the scapula ; those from the third and fourth ribs, form a broader and thinner portion, which passes directly backwards to the deep margin, or lip, of the base of the scapula, between its two angles ; the digitations from the fifth to the eighth ribs, commence along oblique lines upon the ribs and their intervening fascia, vary in length and width, diminishing, in both respects, from above downwards, and ascend obliquely backwards in a fan-shaped form, to be attached in a thick mass, to an impression on the deep surface of the inferior angle of the scapula. These lower digitations, interlock or interdigitate, at their origin, with the alternately disposed digitations of the external oblique muscle of the abdomen, fig. 166. The scapular attachment of the middle portion of the great serratus, is separated from that of the rhomboideus major, along the base of the scapula, by a narrow margin of bone and tendon only, as may be shown by lifting the scapula away from the side of the thorax, fig. 157. This muscle, like others belonging to the shoulder-girdle, is subject to varieties of size, form, and connexions; thus, it may have additional origins from the ninth and tenth ribs; or some of its lower digitations, or, especially, its uppermost one, may be wanting; it may be divided into two or three distinct parts; it is, not unfrequently, connected by fleshy slips, with the external oblique muscle, the external intercostals, or the levator anguli scapulæ. Acting from the thorax, the great serratus draws the scapula downwards, outwards, and forwards; if its action be controlled by the rhomboids, it carries the scapula horizontally outwards and forwards; so, inversely, if the serratus controls the rhomboids, these latter draw that bone directly inwards and backwards. Conjointly these two muscles maintain the scapula in close application to the walls of the thorax, and so impart to it a firmness as a fulcrum of support to the humerus, whatever may be its change of position. The lower part of the muscle co-operates, also, with the trapezius, in rotating the scapula, and elevating the point of the shoulder. Acting from the thorax, the serratus is called into play in fencing, when the raised arm requires to be outstretched; and in pushing, in which it exerts considerable force. Acting from the scapula, it assists, like all the muscles which connect the trunk with the upper limb, in drawing the body upwards, or forwards, as in climbing, and in swimming; it likewise helps to suspend the body, during the use of crutches. In quadrupeds, the

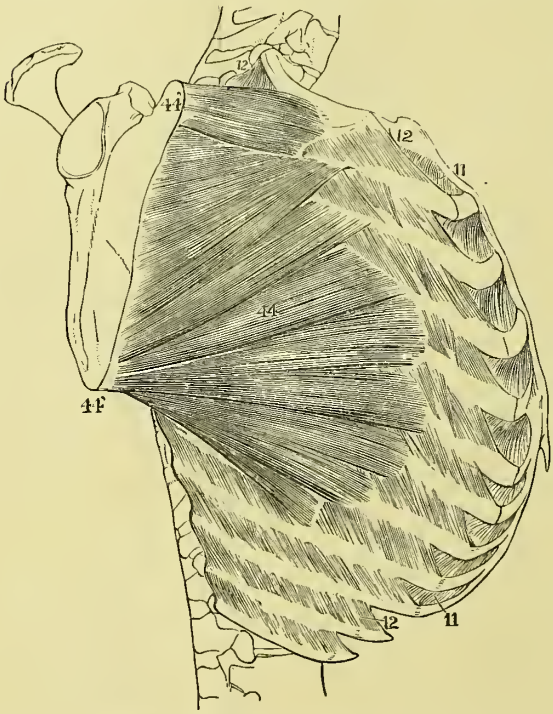


FIG. 157.—The Great Serratus Muscle, with the Scapula lifted from the chest.

two great serrati are very powerful muscles, and serve to sling the anterior part of the trunk between the nearly upright scapulæ. Lastly, when the human scapulæ are fixed from above, the great serrati elevate and expand the ribs, and so help to dilate the chest, acting, in laboured breathing, as most influential auxiliary muscles of inspiration.

The Scapular Group, figs. 158, 167.—This consists of five muscles, which pass from the scapula to the humerus, and act, generally, as rotators of that bone; they are the subscapular, the supra- and infra-spinati, and the two teres muscles.

Subscapularis, figs. 161, 168, 169, [45]. Deep; triangular, intersected by tendinous laminæ, proceeding from ridges on the bone; placed beneath the scapula, occupying its sub-scapular fossa, and converging to the front of the shoulder joint, a bursa intervening. Anterior surface of the scapula, excepting near the angles where the serratus is fixed, and also excepting a space near the back of the bone——lesser tuberosity of the humerus, by a flat tendon connected with the capsule of the shoulder joint, and, by a few fleshy fasciculi, below the tendon. It draws the raised arm downwards and inwards to the side, and rotates the humerus inwards, when that bone is dependent by the body.

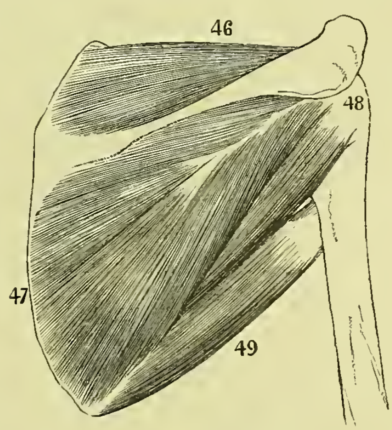


Fig. 158.—The Scapular Group.

Supra-spinatus, fig. 158, [46]. Deep, but covered only by the trapezius; thick, triangular; occupying the supra-spinous fossa, proceeding horizontally along it, and converging beneath the acromion process and the coraco-acromial ligament. Supra-spinous fossa of the scapula, excepting near the neck of the bone, and the strong fascia which covers the muscle——uppermost of the three impressions on the greater tuberosity of the humerus, by a narrow tendon which adheres to the capsule of the joint. It elevates the humerus, and aids other muscles in rotating it either way.

Infra-spinatus, figs. 158, 167, [47]. Deep, and covered over its upper and outer third by the deltoid, at its upper and inner corner by the trapezius, and at its lower angle, slightly, by the latissimus dorsi, but, elsewhere, superficial in a remarkable triangular space left between those muscles, fig. 167; triangular, thick, much larger than the supra-spinatus; occupying the greater part of the infra-spinous fossa, its fasciculi converging obliquely upwards and outwards to the back of the shoulder joint. Inner two-thirds of the infra-spinous fossa, and the strong fascia which covers the muscle——middle impression on the greater tuberosity of the humerus, by a tendon, which appears on the surface of the muscle, adheres to the capsule of the joint, and unites with the tendons of the supra-spinatus and teres minor muscles. This muscle rotates the humerus outwards, when the bone is vertical; but carries it backwards, when it is raised.

Teres minor, figs. 158, 167, [48]. Superficial, in its middle part, between the deltoid, infra-spinatus and teres major, but deep at both ends; narrow, and fusiform; oblique upwards and outwards, from the lower part of the scapula to the back of the shoulder. Upper two-thirds of the hinder part of the anterior border of the scapula, and intermuscular septa between it and the infra-spinatus and teres major ——lowermost of the three impressions on the greater tuberosity of the humerus, by a thick tendon, adherent to the capsule of the joint, and, by a few fleshy fasciculi, below the tendon. It rotates the humerus outwards, when that bone is in a dependent position; when the arm is raised, it assists in maintaining the limb in that direction, and in drawing it backwards. The four rotator muscles just described, obviously perform all those shorter and minor adjusting movements of the humerus in the glenoid cavity, which are incessantly required in the manifold uses of the upper limb; they are the capsular muscles, already alluded to (p. 234), which protect, strengthen and support the shoulder joint, and serve to maintain the head of the bone in due contact with the shallow glenoid cup; they also draw the capsule in various directions out of harm's way, in the action of the joint.

Teres major, figs. 158, 167, [49]. Superficial in the greater part of its extent, but partly embraced by the latissimus dorsi below, and crossed, above, by the long head of the triceps muscle of the arm; narrow, thick, and somewhat flattened, composed of longitudinal fasciculi ending on a flat tendon; oblique upwards and outwards, from the lower angle of the scapula, along the hinder border of the axilla, which is principally formed by it, and then in front of the long head of the triceps, to reach the shaft of the humerus. Rough quadrangular surface on the back of the inferior angle of the scapula, axillary margin of the bone, and adjacent intermuscular septa——inner lip of the bicipital groove of the humerus, by its flat tendon. The teres major draws the raised arm down to the side, and also carries it backwards, and rotates the humerus inwards.

The Superficial Dorsal Group, figs. 159, 160, 167.—This includes the two remarkably broad and almost entirely superficial muscles of the back and neck, which cover the dorsal aspect of the trunk in nearly its whole extent, from the pelvic girdle to the shoulder-girdle, and, beyond that, to the head. By their insertions and actions, however, one is a muscle of the shoulder-girdle, and the other of the upper limb. They are the latissimus dorsi and the trapezius.

Latissimus dorsi, figs. 159, 167, [50 50′]. Superficial, except a small triangular part at its upper and inner corner, which is overlapped by the trapezius; very broad, flat and triangular, for the most part thin, but thicker along its anterior border; its lower fleshy fasciculi nearly vertical, its middle ones oblique upwards and outwards, its upper ones horizontal, all converging to the hinder border of the axilla, whence the muscle ascends to the shaft of the humerus. Lower five or six dorsal spines, all the lumbar, and upper two or three sacral spines, supraspinous ligament, outer lip of nearly the posterior half of the iliac crest, and lower three or four ribs——bottom of the bicipital groove of the humerus, by a short, flat, quadrilateral tendon, blended with that of the teres major. The spinal and pelvic origins of this muscle form a broad, thin, but strong aponeurosis, which, wider below than above, is inseparably joined with the aponeurosis of the erector spinæ, and gives attachment to the fleshy fasciculi, along an oblique curved line passing downwards and outwards through the lumbar region. The three or four fleshy fasciculi from the ribs, fig. 162, interdigitate with as many of the processes of the external oblique, and, ascending together with the fasciculi from the crest of the ilium, form the comparatively thick anterior border of the muscle. The upper horizontal border, which crosses over the lower angle of the scapula, and is sometimes attached to it by a thin slip, is very thin. The narrow terminal portion of

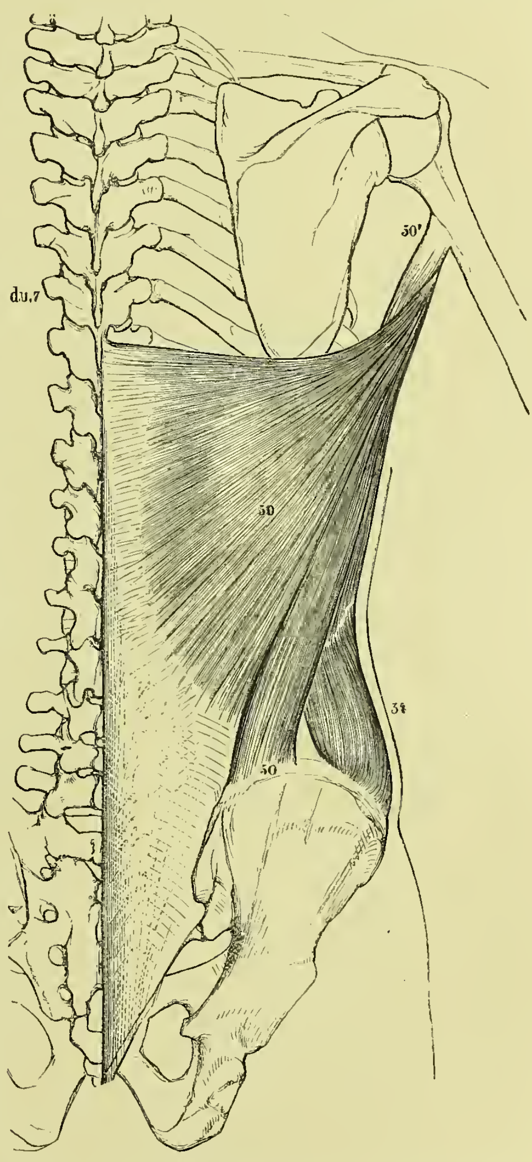


FIG. 159.—The Latissimus Dorsi, of the Superficial Dorsal Group.

the latissimus dorsi wraps round, and embraces, the lower border of the teres major, fig. 166, the two constituting the posterior border of the axilla; the latissimus here twists on itself, so as to form a sort of groove or channel for the reception of the teres, in doing which, its posterior surface becomes anterior, fig. 159. Moreover, its tendon of insertion passes in front of that of the teres major, and is so changed in its direction, that the edge connected with the lower fibres of the muscle, reaches higher up on the humerus, than that with which the upper fibres are continuous. When the arm is raised, the powerful latissimus dorsi will draw it downwards and backwards, and, at the same time, may rotate it inwards, thus assisting the teres major; but, in these actions, it moves the whole shoulder-girdle as well, which the teres cannot accomplish, and thus, it co-operates with the rhomboids, and counteracts the effect of the great serratus and the trapezius. Acting alone, the latissimus carries the upper limb behind the trunk, but if with the pectoralis major, it draws the humerus directly to the side. It is the great muscle employed in striking a blow downwards with a sabre, or in felling a tree with an axe,—the unusual length of its fasciculi, the longest next to those of the sartorius, giving rapidity to such blows. When both upper limbs are fixed, the latissimi of the two sides aid the pectoral muscles and the great serrati, in suspending the body, as in climbing, or in swinging it on crutches; they, then also, through their pelvic attachments, assist the abdominal muscles, in supporting and elevating the pelvic girdle. Their costal digitations become, when the arms are fixed, auxiliary inspiratory muscles. It is said that the upper portion of the latissimus helps to maintain the scapula in its place against the thorax; but this part of the muscle is very thin, and probably such an exercise of its powers would be painful; the rhomboids and the great serratus really perform this necessary office.

Trapezius, figs. 160, 161, 167, [51]. Superficial in every part; large, flat, triangular, the two muscles together, fig. 167, forming the *trapezoid* figure, and sometimes jointly named the *cucullaris*, from their likeness to the dependent cowl of a monk's hood; converging from the back, the neck, and the occiput, to the scapula and collar bone, the lower fasciculi passing upwards and outwards, the middle ones more or less horizontally, and the upper ones downwards, outwards and forwards. Spinous processes of all the dorsal vertebræ, and the seventh cervical vertebra, supra-spinous ligament, ligamentum nuchæ, fig. 190, *ln*, occipital protuberance and inner third of superior curved line of occiput——rough impression just above the root of the spinous process of the scapula, upper margin of that process, inner border of the acromion process, and outer third of the hinder border of the clavicle. At its lower end, the extensive aponeurosis of origin of the trapezius, fig. 160, [51] to [51], is thin, and triangular in shape; in its middle part, it consists merely of short tendinous fibres; from the second dorsal spine upwards to the cranium, it widens out, [N], and presents a semi-elliptical border, so that the aponeuroses of the two sides form an ellipse, fig. 167, N, prolonged upwards, and having the spinous process of the vertebra prominens about opposite to its line of greatest width. The lower part of the fleshy portion of the muscle is thin; the middle and upper parts are thicker, especially the part which passes across to the point of the shoulder. The lower part of the muscle ends on a flat triangular tendon of insertion, which glides over the smooth triangular surface at the root of the spinous process of the scapula, a bursa intervening, and so reaches the upper border of that process, just beyond; the rest of the insertion consists of short tendinous fibres, mixed with fleshy fasciculi; these trespass on the portions of the scapula and clavicle, to which they are attached, and which, it will be seen, correspond exactly in extent, with the line of origin of the deltoid muscle below. The trapezius may vary, even on the two sides of the body; its occipital origin may be wanting; its cervical and dorsal parts are sometimes distinct; its dorsal origin may be limited to five or six vertebræ; sometimes its clavicular attachment, fig. 161, reaches as far forwards as the posterior border of the sterno-mastoid muscle. Usually, however, there is, here, an interval between the two muscles, figs. 160, 166, 187, in which, small parts of the scaleni, *ScA*, *ScP*, the levator anguli scapulæ, [41], *Lc*, and splenius capitis, [30a], *Sp*, become superficial. In the back, fig. 167, a little triangular space, [27′], exists between the greater rhomboid, the trapezius, and the latissimus dorsi muscles, in which, small parts of the seventh rib and of the subjacent external intercostal muscle, become subcutaneous. Acting as a whole, and by itself, the trapezius carries the scapula, and, with it, the clavicle, upwards and backwards. If the scapula be free, the upper or cranial part of the muscle, contracting by itself, would assist the levator and the lesser rhomboid in raising

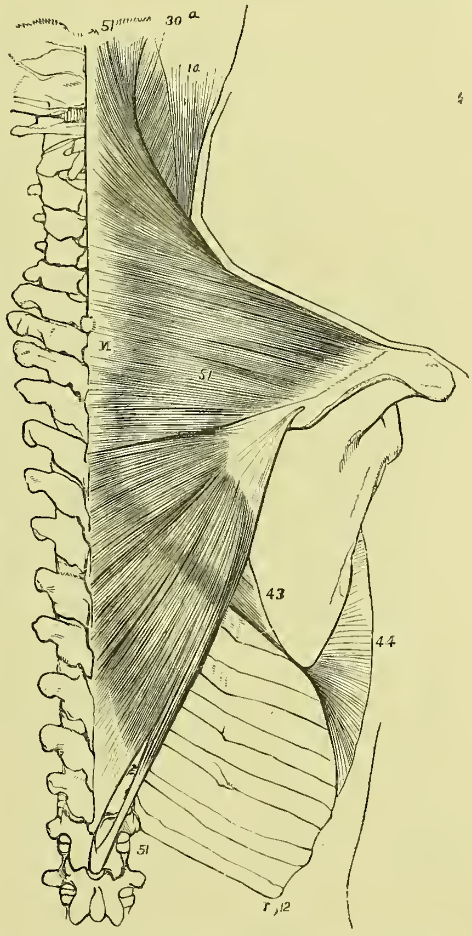


Fig. 160.—The Trapezius, of the Superficial Dorsal Group.

the scapula, as in shrugging the shoulder, or in carrying a weight upon it; the middle, or cervical and upper dorsal part, alone, or aided by the rhomboid, will draw the scapula directly inwards, towards the vertebral column; the lower part of the trapezius, acting alone, will draw the shoulder downwards and inwards, but, co-operating with the subclavius and pectoralis minor, will simply depress it. When, however, the scapula is so held, that it cannot move, as a whole, in any and every direction, as, for example, directly backwards or upwards, but is maintained more or less *in situ* by the combined action of the rhomboid and the great serratus, then, the entire trapezius has a peculiar combined action, essential to the characteristically free elevation of the upper limb, see fig. 167; thus, the upper fasciculi of the muscle raise the outer end of the clavicle and the scapula and lift them inwards; the middle fasciculi also draw the scapular spinous process inwards and upwards; whilst the lower fasciculi, gliding over the triangular smooth surface at the root of the spinous process, so as likewise to act upon its upper margin, draw this part of the bone downwards and inwards. The result is, fig. 167, that the superior angle of the base of the scapula is depressed, and moved slightly inwards; the inferior angle is carried outwards and forwards into the axilla, and is slightly raised; the posterior border becomes inclined outwards, instead of being vertical; the axillary border is rendered prominent; and, lastly, the outer angle, which supports the glenoid cavity, is pointed upwards, outwards and forwards. The whole bone is, in fact, rotated on a continually shifting axis, which passes perpendicularly to the surface of the bone, through the upper part of the infra-spinous fossa; the spinous and the acromion processes change from a horizontal to an oblique direction, the surface of the latter being now especially turned upwards and backwards. It is this movement, which enables the entire upper limb to be raised beyond the horizontal line. The precise position of the scapula, during this rotatory movement, is made to vary, by the mutual action of the two rhomboids and the great serratus. When the shoulder-girdle is quite fixed, the upper part of the trapezius will incline the head to its own side, and rotate it, so as to turn the face to the opposite side; both trapezii will, under the same conditions, draw the head backwards, and raise the face.

The Pectoral Group, figs. 161, 162, 166.—This includes the subclavius muscle, and the lesser and greater pectoral muscles. They pass from the front of the thorax to the clavicle, the scapula, and the humerus, respectively, the two former being shoulder-girdle muscles, the last, a muscle of the upper limb.

Subclavius, figs. 161, 162, [53]. Deep; conical, tapering at its inner tendinous end, wider and fleshy at its outer end; oblique, outwards and upwards, under the collar bone, bound down by a strong fascia. Junction of the cartilaginous and bony portions of the first rib —— deep groove on the under surface of the clavicle. Sometimes, the subclavius is partially, or even wholly, inserted into the coracoid process of the scapula. It depresses the shoulder; it draws the clavicle downwards and forwards, and, when the whole arm is raised, helps to roll the clavicle on its long axis, and rotate its upper surface backwards. It may become an auxiliary muscle of inspiration, by lifting or fixing the first rib, when the arms are raised and fixed.

Pectoralis minor, figs. 161, 162, 166, [54]. Deep, except if the arm be raised above the head, when its lower border is partially superficial in the axilla; flat, triangular, consisting below, of three fleshy portions, united to a narrow tendon above; passes obliquely upwards and outwards, across the upper part of the axillary space. Outer surfaces of the third, fourth and fifth ribs, external to their cartilages, and intervening intercostal fascia—— front of the coracoid process of the scapula, its tendon being united to the conjoined tendon of origin of the coraco-brachialis and biceps muscles of the arm. It draws the scapula, and, therefore, the shoulder, downwards and forwards, moving that bone away from the vertebral column behind. It behaves as an antagonist to the rhomboids and the trapezius, not only in this respect, but also in reference to the peculiar rotatory movement of the scapula, in which it helps to depress, instead of elevating, the point of the shoulder. If the scapula be fixed, the pectoralis minor will assist in laboured respiration.

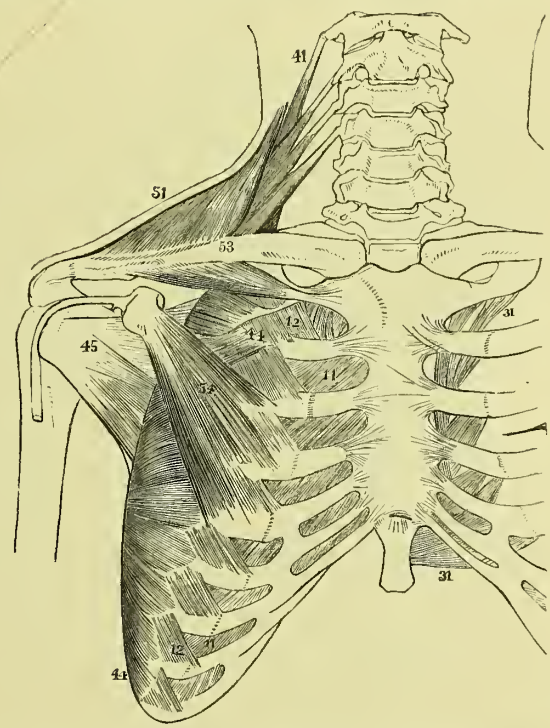


FIG. 161.—Deep portion of the Pectoral Group, with parts of the Shoulder-Girdle Group, and of the Trapezius.

Pectoralis major, figs. 162, 166, [55]. Superficial, except quite at its insertion, but overlaid by the mamma or mammary gland, and by some fatty tissue, near its lower border, and covered by the thin cutaneous platysma muscle above; a thick, broad, triangular muscle, its base turned towards the middle line of the chest, its upper and lower corners rounded off, and consisting of three distinct parts, namely, a clavicular and two sterno-costal or thoracic parts ; its numerous fasciculi converge towards the front of the axilla, of which it forms the thick anterior border, the clavicular fasciculi passing obliquely downwards and outwards, the upper sternal and costal fasciculi gradually less obliquely, and the lower sternal and costal fasciculi horizontally outwards, or obliquely upwards and outwards. Aponeurosis of the external oblique muscle of the abdomen, front of the body and manubrium of the sternum, the tendinous fibres of origin sometimes decussating with those of the opposite muscle, front of six costal cartilages, namely, from the sixth to the second, and under border of the inner half of the clavicle ——anterior lip of the bicipital groove of the humerus, by a flat tendon, which is twisted on itself. To reach this tendon, the fleshy part of the muscle also twists, fig. 162, its lower fasciculi turning up beneath the middle and upper ones, and becoming continuous with the highest part of the tendon, the middle fasciculi, but, especially, the upper or clavicular ones, passing in front of or overlapping the lower ones, and ending on the lowest part of the tendon. The anterior border of the deltoid is partly received into the shallow groove or channel, formed by the twisting of the narrow outer part of the greater pectoral muscle and its tendon, fig. 165 ; the arrangement resembles that, by which its associate muscle, the latissimus dorsi, embraces the teres major. The tendons of the deltoid and the greater pectoral are connected together by fibrous tissue, and the latter is also blended with the fascia of the arm. It is by this fascia, that the axilla is closed beneath, by a sort of floor, and that the borders of the axilla are held in their position. The axillary space itself reaches up as high as the first rib, from above which the great nerves and blood-vessels descend through the space, to reach the inner side of the arm, forming a soft, longitudinal eminence, seen emerging from the arm-pit, when the limb is

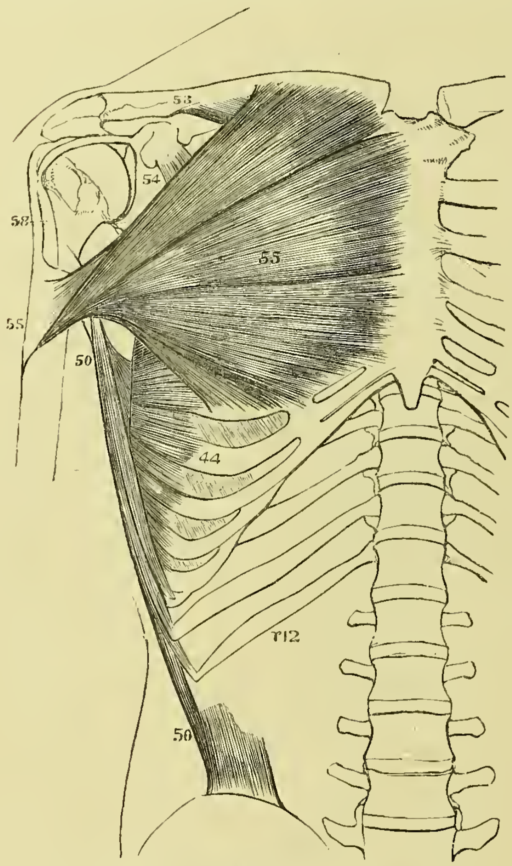


FIG. 162.—The Pectoral Group, with part of the Latissimus Dorsi.

raised. The great pectoral muscle draws the humerus forwards across the front of the chest, and rotates it inwards, in the latter action co-operating with the latissimus dorsi. Conjointly with this muscle, and with the teres major, the middle and lower portions of the pectoral bring the arm suddenly downwards from the elevated position, as in cutting, or chopping, with sword or axe; but the upper or clavicular part distinctly helps in raising the arm, or in fixing it in a forward elevated position. In rowing and swimming, the two great pectorals bring the upper limbs forwards, whilst the latissimi dorsi muscles carry them backwards; all four muscles support the body on crutches, and sustain its weight in the act of climbing. In forced inspiration, the shoulders being raised, the pectorals are called into play.

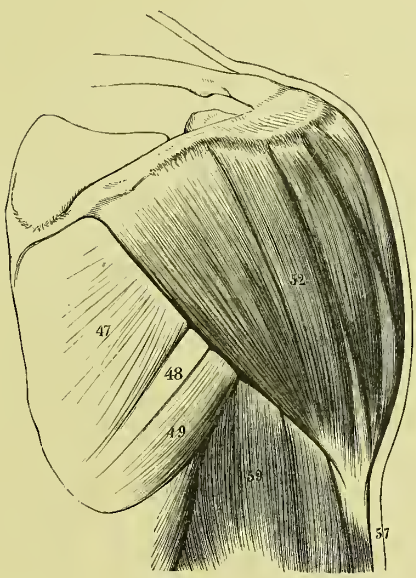


Fig. 163.—The Deltoid Muscle, from the Back.

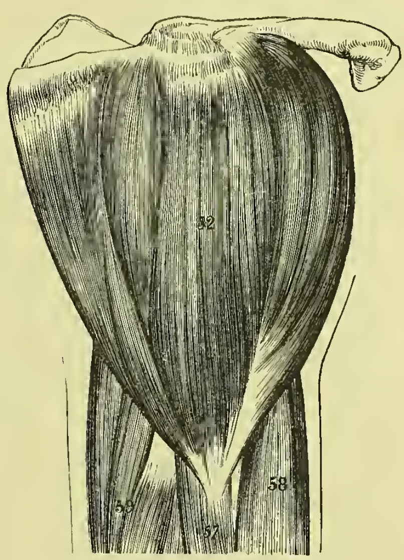


Fig. 164.—The same, from the outer side.

The Shoulder-cap Muscle, figs. 163 to 167.—This is the well-known deltoid muscle, which passes from the clavicle and scapula to the humerus, and joins on the arm to the trunk.

Deltoideus, figs. 163, 164, 165, [52]. Superficial throughout, forming the prominent cap of the shoulder, and covering the deep-seated articular muscles, as well as the head and upper end of the humerus; thick, triangular, like an inverted Greek letter, delta, Δ, broad above, bent on itself horizontally, so as to cover the shoulder behind, on its outer aspect, and in front, and composed of numerous large fusiform, or conical, and more or less distinctly penniform, fleshy processes, arising from short tendinous bands, and ending on central tendons, all of which converge to one strong, pointed and folded tendon below; the hinder processes of the muscle, somewhat thin and flat, pass obliquely outwards, forwards and downwards, the middle processes, fuller, descend vertically, the anterior processes, thicker and more prominent, pass obliquely outwards, backwards and downwards, to the chief subdivisions of the common tendon. Lower lip of the spinous process of the scapula, along nearly its whole length, outer and anterior border of the acromion process, and lower border and anterior surface of the outer third of the clavicle——triangular rough V-shaped surface, or deltoid impression, just above the middle of the outer side of the shaft of the humerus. The extensive origin, the vast number of ultimate fasciculi and fibres, and the mode in which the outer processes of the muscle especially, turn down, so as to be almost perpendicular to the surface of their attachment, are conditions, which compensate, as it were, for the disadvantageous direction of the muscle, in reference to the axis of motion of the humerus at the shoulder joint. The anterior portion of the deltoid is rendered more prominent than the posterior, by the immediately subjacent and large head of the humerus, which, owing to the position and direction of the glenoid cavity, is placed in advance of the point of the acromion process. The posterior border of the deltoid, fig. 163, thin and straight, is bound down to the fascia covering the infra-spinatus, which muscle, as well as the teres minor and major, it crosses over; its anterior border, fig. 165, thicker and somewhat convex, is placed along the upper and outer margin of the greater pectoral muscle, an intermuscular marking existing between them, which opens upwards beneath the clavicle into the small triangular depression or coracoid furrow, elsewhere described. The long, scapular and clavicular line of origin of the deltoid, corresponds, as already stated, precisely with the equally long line of insertion of the trapezius; these are, indeed, associated or congener muscles, separated only by a narrow osseous zone, formed by the intermediate parts of the spinous and acromion processes of the scapula and of the outer third of the clavicle. The deltoid muscle raises the arm directly from the side, and brings it into a nearly horizontal position, or at almost a right angle with the trunk; any further elevation of the upper limb is accomplished by a lifting upwards of the clavicle and

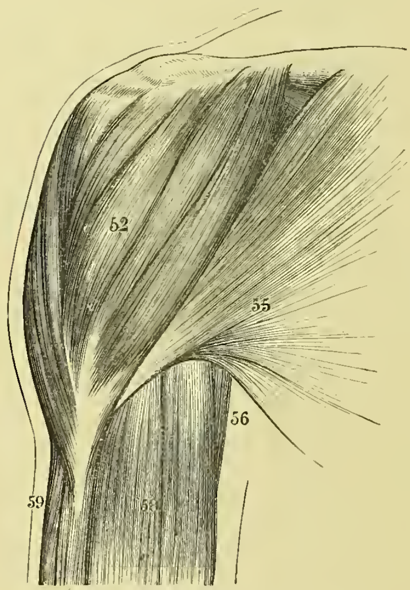


FIG. 165.—Deltoid Muscle from the front.

scapula, at the shoulder, the last-named bone rotating upwards, under the influence of the trapezius muscle, as already explained. Thus, an action, which is begun by the deltoid, is completed by the trapezius. The anterior part of the deltoid assists the pectoralis major, in drawing the humerus forwards; the posterior part aids the teres major and the latissimus dorsi, in moving it backwards. The entire muscle protects the shoulder joint, and, co-operating with the deep rotators, is employed in fixing the head of the humerus against the glenoid cavity, in the raised position, as required during fencing, in thrusting, or in parrying blows.

Surface-forms dependent on the Muscles of the Trunk.

The *deep vertebral* muscles, from the multifidus spinæ to the small muscles beneath the occiput, form the first clothing of the vertebral column behind, and help to fill in the vertebral grooves; the *præ-vertebral* group covers the cervical vertebræ in front; the *deep thoracic* muscles, the levators and intercostals, close the narrow intervals between the ribs; whilst the quadratus lumborum and the scaleni, on each side, partly obliterate the larger gaps in the skeleton, between the thorax and the pelvis below, and between the thorax and the head above. But none of these muscles directly affect the surface-forms

The *longitudinal dorsal* group, including so many and such complicated muscles, though covered completely by the more superficial layers, has a very marked influence on the surface-forms, both in the back and in the neck. The erector spinæ, bound down by the lumbar and vertebral aponeuroses, and further overlaid by the adherent, but thin tendon of origin of the latissimus, fig. 167, produces a pointed form tapering downwards on the back of the sacrum, a large, convex, vertical prominence in the loins, and a flattened and narrowed plane, which gradually subsides above the middle of the back. In each region, the muscles of the two sides determine the depth of the median spinal furrow, which is narrow and shallow below, deepest in the loins, and again becomes more shallow, or even obliterated, in the back. Two local elevations in the surface-forms of the erector spinæ, indicate the places where the fleshy fibres free themselves above, from the aponeurotic portions lower down, fig. 150; these local elevations, the one belonging to the longissimus dorsi being higher up than that of the sacro-lumbalis, are bounded below, by borders curving obliquely downwards and outwards, and have their effect increased by their coincidence with those of the slanting lower border of the fleshy part of the latissimus dorsi, especially noticeable when that muscle is in action. The extensions of the erector spinæ into the neck, and up to the skull, fig. 151, widen the cervical region upwards. The *divergent* splenii muscles, fig. 152, also contribute importantly to this result. The divergent serratus posticus superior is hidden by the scapula; but the serratus inferior may determine, upon the back of the thorax, on the outer side of the sacro-lumbalis, a short vertical elevation, due to the combination of its three strongly contracted fleshy processes, that is, under conditions, in which the lower ribs require to be fixed during great efforts.

The broad and straight muscles, which enclose the *abdomen* at the sides and in front, fig. 155, complete the filling up of the interval between the osseous parts of the pelvis and the thorax, and correspond with the waist, the narrowest part of which, or *waist proper*, is on a level with the tips of the floating ribs, opposite to the upper part of the second lumbar vertebra; above this the trunk gradually expands, in correspondence with the ribs; below it, the sides of the abdomen present an undulatory outline. The umbilicus is placed below the line of the waist, level with the upper border of the fourth lumbar vertebra; the greatest prominence of the abdomen, both in front and at the sides, is still lower down, opposite the upper border of the fifth lumbar vertebra, just above the level of the iliac crests in the female, but at about that level in the male. The superficial external oblique muscles, right and left, partly fleshy and partly tendinous, and the two intercalated and intersected recti muscles, are alone responsible for the surface-forms of the abdominal region. The linea alba, the lineæ semilunares, and the lineæ transversæ, of which one set passes off just above the umbilicus, most agreeably subdivide the anterior surface, fig. 155; whilst the undulating border of the fleshy portion of each external oblique muscle, projects a little beyond the flatter tendinous portion. The thick origins of this muscle and of the internal oblique from the iliac crest, combine to form the soft well-marked roll, above that line of bone, determining the shape of the iliac furrow. On the sides of the lower part of the thorax, the inferior digitations of the external oblique muscle are overlapped by the thick border of the latissimus, fig. 159, but the higher ones conspicuously intermix with those of the *serratus* magnus, fig. 166.

This last-named muscle, amongst those belonging to the *shoulder-girdle*, has very great influence on the surface-forms, decorating, in the most remarkable manner, the side of the torso. At least six of its pointed processes become recognisable, when the arm is uplifted from the side, fig. 166, but, otherwise, only three or four, all, of course, most plainly when the muscle is in action. It is interesting to note how the anatomical details, here tend to diminish the formal effect of a zigzag line running between prominent, toothed or serrated borders, on so exposed and broad a part of the human frame. The forms themselves furnish a typical example of the effect of *repetition* of masses, but their detailed construction, fig. 166, illustrates the influence and value of *variation*. The inequality of the several digitations of the serratus, in length and width, the different obliquity of their lines of attachment to the ribs, and the unequal angles of their several points, cause each separate form dependent on them, to be unlike the one above it and below it, in position, direction, size and shape. Their apices lie along a crescentic line, and so the zigzag marking is itself curved; the digitations themselves become smaller from above downwards and their angles more acute. The course of the several fleshy processes over the sides of the chest, is also curved, and the curvature varies in each case; so that the faint, interfascicular markings between them likewise vary in direction. Furthermore, they are cut off obliquely, by the simple and well-contrasted sweeping line of the border of the latissimus behind; whilst the crescentic arrangement of their anterior ends or points, has its greatest prominence above its centre. Lastly, the processes of the serratus are thicker and somewhat more prominent, than the flattened portions of the external oblique, with which they interdigitate. The part of the lower border of the serratus, which is covered by the latissimus, raises up that muscle along an oblique line, traceable from the lower angle of the scapula, when that bone is drawn forwards, and has its lower angle lifted from the side of the chest.

The *levator anguli scapulæ* and the *rhomboids*, though covered by the trapezius, influence the surface-forms in a decided manner. The outline of the upper part of the neck, traced from below the head, is determined by a short convergent line, due to the trachelo-mastoid, fig. 152, [24b], and the divergent splenius capitis, [30a], overlapped, above, by the sterno-mastoid, fig. 167, [1a]; below this, is a longer divergent line, regulated by the subjacent levator of the angle of the scapula, fig. 156, [41]; and below this, a full convex form reaches downwards and outwards, to the acromion process. These three lines, however, are clothed by the cranial, cervical and upper dorsal fleshy portions of the *trapezius*, fig. 160, which muscle thus combines and modulates them into the exceedingly beautiful contour of this part of the body, fig. 167. The rhomboid muscles, minor and major, give rise to a special, slightly elevated plane, between the spinal furrow and the proper scapular eminence, which ends below in an oblique edge, figs. 160, 167, sometimes visible, sometimes obscure or hidden, which is, for a short distance near the lower angle of the scapula, still more defined, being uncovered by the trapezius. When the scapula is moved forwards and raised, fig. 167 (right side), the rhomboids are relaxed, and their special form disappears, whilst those of the serratus are rendered more obvious, even through the thin latissimus, as already mentioned; but, when that bone is carried backwards towards the spine (left side), the rhomboids are contracted, so as to form a vertical eminence, which is subdued or increased by the trapezius, according as the dorsal portion of this muscle is relaxed or contracted. When the scapula is held firmly in any given position between the rhomboids and the great serratus, the raised lower borders of the greater rhomboid and the serratus form a common oblique line or ridge, interrupted only at the lower

Fig. 166.—The Surface Muscles of the Trunk and Upper Limb.

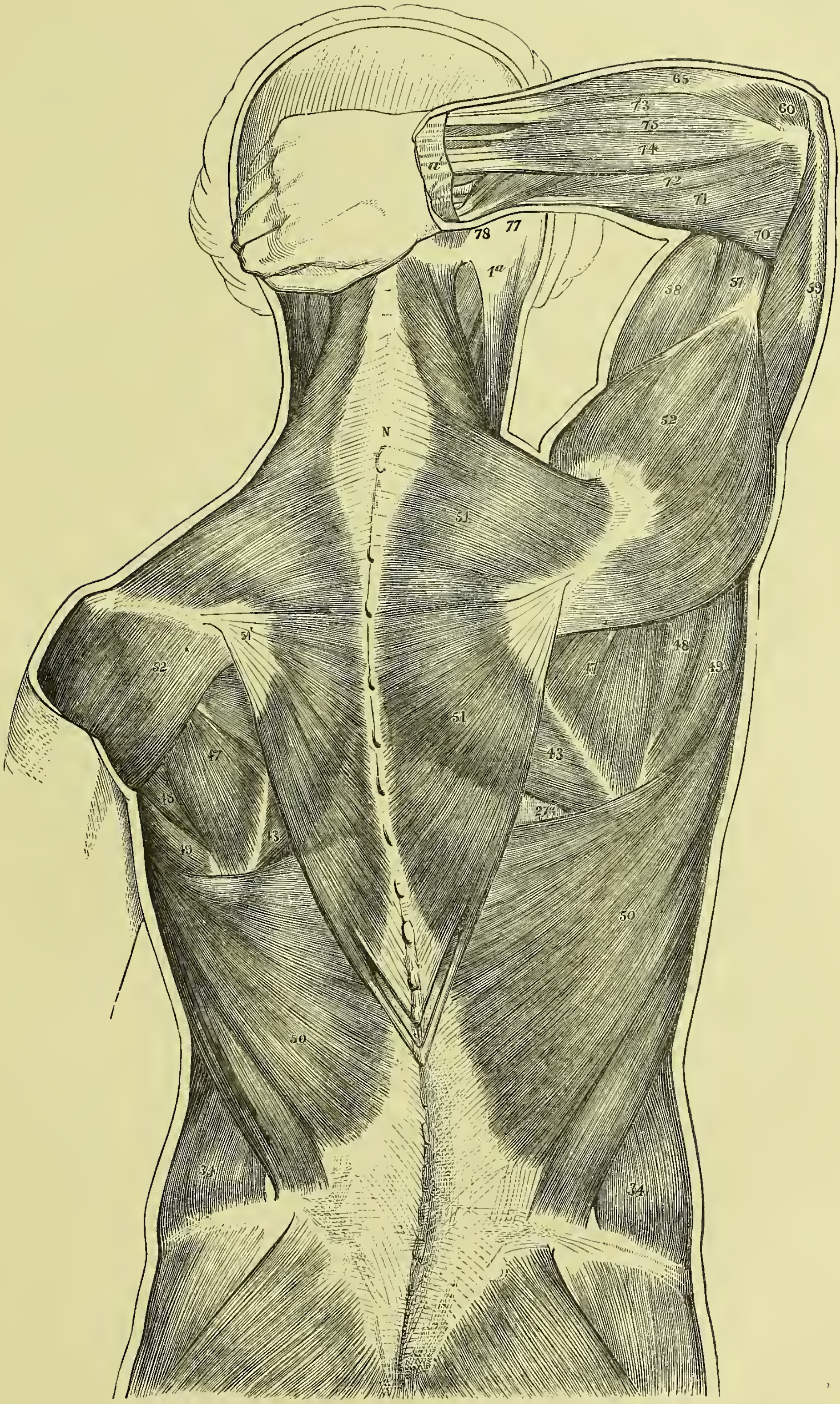


Fig. 167.—The Surface Muscles of the Trunk and Upper Limb.

angle of the scapula. The elongated elliptical tendinous plane, [N], formed at the back of the neck by the two trapezii, is always observable as an oval depression on the surface, especially, however, when the lateral fleshy portions of those muscles are in action, as when the head is thrown back, or both arms are raised above the head. The small, flat, triangular tendon of the trapezius, [51′], which passes over the root of the spinous process of the scapula, produces a similarly shaped depression amongst the adjacent fleshy masses, which readily informs the eye of the position of that part of the scapula, however much that very moveable bone may be shifted in position; from this point downwards, to the inferior tendon at the apex of the muscle, the outer and lower edge of the trapezius may be traced, when it is in play, either as a waving, or as a straight border, according to the vigour of its action. It may be added, that the plane of the entire trapezius itself, when its muscular fasciculi are quiescent, undulates in accordance with the forms of the subjacent masses, but when these fasciculi are in action, the muscle asserts its own forms, both fleshy and tendinous.

The superficial triangular portion of the *infra-spinatus*, fig. 167, [47], is often seen as a full prominent form, marked by several oblique linear depressions, due to tendinous bands between the muscular bundles; an evident intermuscular marking exists between the infra-spinatus and the teres minor, and another between that and the teres major. The entire scapular prominence changes its position with the bone itself, and its contained or subordinate forms are carried to and fro with it, fig. 167. As the scapula itself rotates upwards and forwards, the vertical scapular furrow, situated along the base of that bone, between the insertion of the greater rhomboid and the origin of the infra-spinatus, assumes an oblique direction downwards and outwards; whereas the oblique scapula furrow and the acromion depression, situated between the insertion of the trapezius and the origin of the deltoid, become much more oblique, and their surfaces are turned backwards and upwards, instead of nearly directly upwards. The teres major obscures the lower angle and the axillary border of the bone, but both may yet be traced, carried forwards towards the armpit, of which that muscle itself essentially forms the very thick posterior border.

The *latissimus dorsi*, the largest stratum of muscular substance in the body, sweeps over the lumbar and lower thoracic regions, fig. 167, [50], revealing through its thinner parts the mass of the erector spinæ, and, sometimes, that of the serratus posticus inferior, and then, higher up, the curved and convex forms of the ribs, and the slightly depressed intercostal muscular planes between them. Its anterior thicker border, traceable from the hinder part of the iliac crest and from the lower ribs, forms either a soft rim or a more prominent rounded edge, crossing obliquely upwards and forwards over the external oblique and the great serratus, to the hinder border of the axilla, where it holds the teres major in its embrace, fig. 166, supports and strengthens the local form, and contributes to the greater relative length and obliquity of the posterior border of the axilla.

The preceding account of the muscular forms seen on the back, suffices, without recapitulation, to show how numerous they are, and how difficult to analyse, without a knowledge of the anatomical structures on which they depend. The order in which they have just been described, is that in which the student will do well to study them on the living figure, or on an antique statue, and to endeavour to block them out in his own models or drawings. Whatever the position and action of the trunk and of the moveable shoulder-girdle and upper limbs, the relations of the skeleton-forms of the pelvis, vertebral column, ribs and scapulæ to the surface-forms, should first be determined. Then, the influence of the longitudinal group of muscles should be considered. Next, that of the divergent muscles, especially in the neck, should be studied. These being defined, the effect of the shoulder-girdle muscles and of the proper scapular muscles, may be examined and ascertained, constant regard being had to the important results of changes of position on them. Lastly, the forms of the trapezius and the latissimus dorsi, overlying all, may be investigated. The alterations produced in each muscle, by rest and by contraction, in every stage of elongation from stretching, or of recoil through elasticity, must be incessantly watched and constantly allowed for, not only in reference to the forms of the fleshy masses themselves, but also to those of the tendinous parts in connexion with them. In this way alone, can the otherwise puzzling and, indeed, incomprehensible forms of the back be safely subordinated to the artistic eye and hand. It has been said, perhaps irreverently, that, in the powerful drawings of Michael Angelo, the back is sometimes represented full of unmeaning forms.

The *greater pectoral* muscle, figs. 162, 166, [55], constitutes the basis of the shorter, thinner and less oblique, anterior border of the axilla; but it also forms the large pectoral plane, which slants downwards, outwards and backwards, from the front of the chest, and from beneath the inner half of the collar bone, to the upper part of the arm, below the rounded prominence of the shoulder. The subclavius muscle and the pectoralis minor, both, indirectly affect the character of the pectoral plane, the latter muscle, especially, bridging over the deep upper part of the axillary space, tilting the corresponding part of the pectoralis major forwards, fig. 162, and so relieving that plane from having a sunken and impoverished appearance there; its lowest process also appears, when the arm is raised, fig. 166, as a slight independent form at the lower part of the anterior border of the axilla. The festooned origins of the sternal bundles of the great pectoral muscles, determine the width and form of the surface sternal furrow; the clavicular origin of the muscle, somewhat less prominent than the collar bone itself, is often marked off from the rest of the muscle, by an interfascicular depression, and it is always distinguished from the deltoid by a more strongly pronounced intermuscular marking, running downwards and outwards from the small, triangular, sub-clavicular or coracoid depression. Its lower border is the chief, but not the sole, determining cause of the transverse *subpectoral fold.*

The *deltoid* surface-form, figs. 163–165, [52], might seem to require no special description, its anatomical details being very familiar, and so completely revealed through the integument. It rounds off the shoulder, and, as it were, cements the upper limb to the trunk. Its thin, nearly straight, and tightly bound down, posterior border, forms, at first, only a slightly elevated ridge, but becomes much thicker and more prominent, where it crosses behind the posterior axillary muscles and passes onwards to the arm; its anterior border, situated next to the greater pectoral, is thicker, and gently curved. The peculiarities of the deltoid prominence are determined not merely by the relative thickness of that muscle at different parts, but by the presence of the head of the humerus beneath it; for, since the position of that bone is somewhat in advance of the point of the acromion, the deltoid form is comparatively flat behind, but much fuller and more convex in front of the shoulder, the extreme lateral projection of which is due to the middle portion of the muscle being pushed outwards by the greater tuberosity of the humerus. The highly characteristic difference between the front and back of the shoulder, just noticed, must not be overlooked. The numerous processes of the deltoid produce precisely corresponding forms, radiating from the tip of the acromions the borders of the spinous process of the scapula, and the outer third of the collar bone; they widen out, as they approach the middle of the muscle, and then, again, become narrow and pointed, as they gather down upon the ridge formed by its tendon of insertion, which tapers so finely down, that it reaches lower on the arm than is often represented. The undulating curved surface-form of the deltoid prominence is most pronounced opposite the central bundles, which descend from the acromion, their outline, fig. 164, turning down upon the tendon more abruptly than that of the posterior, or even of the anterior, bundles. The festooned borders of the origin of the muscle, together with the more even lines of insertion of the trapezius, determine the actual surface-forms of the oblique scapular, the acromial, and the clavicular furrows, which are found above the shoulder.

The *integument* of the trunk, rather thicker on the back than in front of the torso, and also more loaded with subjacent fat, except perhaps between the umbilicus and the pubes, everywhere softens the forms of the numerous subjacent muscles, the several boundaries of which are, as a rule, indicated by elevated borders, and not by intermuscular markings, as in the limbs. The skin and the superficial fascia, being here, as elsewhere, fastened somewhat more closely to the subcutaneous bony eminences, than to the surrounding proper fascia, the spinal furrow presents little longitudinal dimples, with transverse creases, traceable from the lumbar and lower dorsal spines, and crossing over the surface-forms of the erectores spinæ muscles, on each side of that furrow; these are not due to muscular intersections or inscriptions, such as sub-divide the recti muscles, to which, however, the fascia and skin are also comparatively speaking very closely adherent, so that they show on the surface. Across the lower part of the abdomen, above the pubic prominence, is a crescentic depression, which is gradually lost above the furrow formed by Poupart's ligament; the inner end of this furrow itself, disappears towards the pubes, and there is seen below it, a second oblique folding of the skin, which subsides outwards upon the thigh. Long and deep foldings of the integument appear, and disappear, across the loins and around the waist, according as the trunk is bent backwards or sideways, or is rotated, or brought straight or upright again. The axilla, closed in by a sort of floor, formed by the proper fascia, which keeps its borders in position, appears as a long triangular depression, between the chest and the arm, when the upper limb is raised, fig. 166, but merely as a narrow and shallow sulcus, when this is more or less dependent; the contrast between its shorter anterior and its longer posterior borders, has already been alluded to.

Chiefly resting upon, but partially overlapping the lower border of the pectoral plane on either side, is the mamma or mammary gland, rounded, conical, shorter and somewhat flatter above, but longer and more convex below, in the female bust, and projecting outwards and forwards, because the pectoral plane itself, on which it rests, slants backwards from the front of the chest towards the shoulder. These characters are scarcely recognisable in the male breast; but, to the outer side of and below it, there exists an accumulation of adipose tissue, which completely changes the form and direction of the neighbouring transverse subpectoral fold. The lower margin of the great pectoral muscle trends upwards obliquely to the armpit, whilst its inner end is rounded off, the result being a form in itself as meagre, and bounded by a line which in composition would be as weak, as that which would be produced by the slanting lower border of the gluteus maximus, above the back of the thigh; but the intervention of the rudimentary mammary gland and some accompanying subcutaneous fat, produces a bolder and a firmer form, more square in its outline below, and bounded by a pronounced fold, rectangular in relation to the vertical lines of the sternal furrow and the median depression of the linea alba. This rectangular subpectoral depression, as well as the horizontal lineæ transversæ, and the vertically disposed linea alba and lineæ semilunares, imparting a certain breadth and grandeur to the male figure, were never lost sight of by the Greek and Græco-Roman sculptors; they are forms which would doubtless be developed in their models, in whom, youth, the exercises of the gymnasium, and a costume which never fettered the growth of the body, combined to realise the richest development of such local forms.

Finally, it must be remarked, that the undulating surfaces and sweeping lines, traceable on the anterior aspect of the human torso, have their characters intensified by the presence of the three fixed points, dependent on the umbilicus, and the right and left mammillæ; for, as will at once be granted, if these be omitted from a model, or a drawing of this part of the body, the life and spirit of the form are even more completely extinguished, than the full meaning of that of a shield is destroyed, when it is destitute of a central boss. The subcutaneous veins of the upper part of the chest, marble, by their bluish traces, the surface of that region of the trunk, more especially on the female bust; but on the abdomen generally, and, in particular, on the back, these vessels are concealed by fat or are too small to be defined.

The effects of inspiration and expiration, and of holding the breath on the forms of the thorax and abdomen, must be strictly regarded. The widening of the costal curves at the sides, and the lifting upwards and forwards of the sternal furrow and pectoral planes, are very obvious, externally; but the elongation of the chest, being chiefly diaphragmatic, is less noticeable. In unimpeded inspiration, the lower border of the thorax also expands, and the abdomen becomes somewhat more prominent. This latter change is more marked in the male; whilst, in the female, the thorax is more concerned in the inspiratory expansion. In holding the breath, preparatory to making efforts, the thorax is generally, but not necessarily, fully expanded, and the abdomen prominent. In very laboured and emotional breathing, the auxiliary inspiratory muscles, at least, are at play, and the shoulders rise and fall, or are even fixed by holding on to external objects, so as to enable such muscles as the scaleni, the levator anguli scapulæ, the rhomboids and the great serratus, to co-operate in lifting the ribs in inspiration. In the severest forms of laboured breathing, every muscle in the body is directly or indirectly concerned.

Table of the Muscles of the Upper Limb.

TRUNK AND UPPER LIMB.	THE ARM.
Levator anguli scapulæ, 41.	Coraco-brachialis, 56.
Rhomboideus minor, 42.	Brachialis anticus, 57.
,, major, 43.	Biceps, 58.
Serratus magnus, 44.	Triceps, 59.
Subscapularis, 45.	Sub-anconeus.
Supra-spinatus, 46.	Anconeus, 60.
Infra-spinatus, 47.	
Teres minor, 48.	THE FORE-ARM.
,, major, 49.	Pronator quadratus, 61.
Latissimus dorsi, 50.	,, teres, 62.
Trapezius, 51.	Flexor carpi radialis, 63.
Deltoid, 52.	Palmaris longus, 64.
Subclavius, 53.	Flexor carpi ulnaris, 65.
Pectoralis minor, 54.	,, digitorum sublimis, 66.
,, major, 55.	,, digitorum profundus, 67.

Table of Muscles of the Upper Limb—*continued.*

THE FORE-ARM—*continued.*	THE HAND.
Flexor longus pollicis, 68.	Interossei dorsales, 80.
Supinator brevis, 69.	Abductor minimi digiti, 80*a*.
,, longus, 70.	,, pollicis, 80*b*.
Extensor carpi radialis longior, 71.	Interossei palmares, 81.
,, ,, ,, brevior, 72.	Abductor pollicis, 81*a*.
,, ,, ulnaris, 73.	Opponens pollicis, 82.
,, communis digitorum, 74.	,, minimi digiti, 82*a*.
,, minimi digiti, 75.	Lumbricales, 67*a*.
,, indicis, 76.	Flexor brevis minimi digiti, 83.
,, ossis metacarpi pollicis, 77.	,, brevis pollicis, 84.
,, primi internodii pollicis, 78.	Palmaris brevis, 85.
,, secundi internodii pollicis, 79.	(*Palmar fascia*, 64.)

The muscles of the shoulder-girdle, the scapular or, as they have been termed, the scapulo-humeral muscles, and the superficial shoulder muscle, all of which are really connected with the *Upper Limb*, have been already noticed with the other muscles of the *Trunk*, in which part they are chiefly placed. It remains here to describe the muscles situated in the Arm, the Fore-arm, and the Hand.

The Muscles of the Arm.

These, few in number, include an *adductor* muscle of the arm, the coraco-brachialis, which is really a scapulo-humeral muscle, a *flexor* group, which bends the fore-arm, and an *extensor* group, which straightens the fore-arm.

The Adductor Muscle.—*Coraco-brachialis*, fig. 168, [56]. Deep, except for a short distance on the inner side of the arm, especially seen when this is raised; elongated, conical, narrow and tendinous above, flat and tendinous below; downwards and outwards, through the outer side of the axilla. Apex of the coracoid process of the scapula, in close connexion with the short head of the biceps——ridge along the middle of the inner side of the humerus. This muscle adducts the humerus, and draws it not only inwards, but forwards and upwards. If the upper limb be fixed, it aids in drawing the scapula, or the trunk, towards the arm.

The Flexor Group, figs. 168, 169.—This consists of the brachialis anticus, and the biceps muscle of the arm.

Brachialis anticus, figs. 168, 169, [57]. Covered in front, by the biceps and its tendon, but superficial on either side, showing more on the outer than the inner border of the arm; broad, fusiform, pointed at each end, and somewhat flattened; embraces, by a forklike origin, the V-shaped tendon of the deltoid, descends a little inwards in front of the humerus, and sinks deeply into the space in front of the elbow. Lower half of the anterior surface of the humerus below the deltoid impression, and parts of the adjacent intermuscular septa——rough triangular depression, in front of and below the coronoid process of the ulna. This muscle is sometimes double or divided into two or more portions below. It is the most essential of the two powerful flexors of the elbow joint.

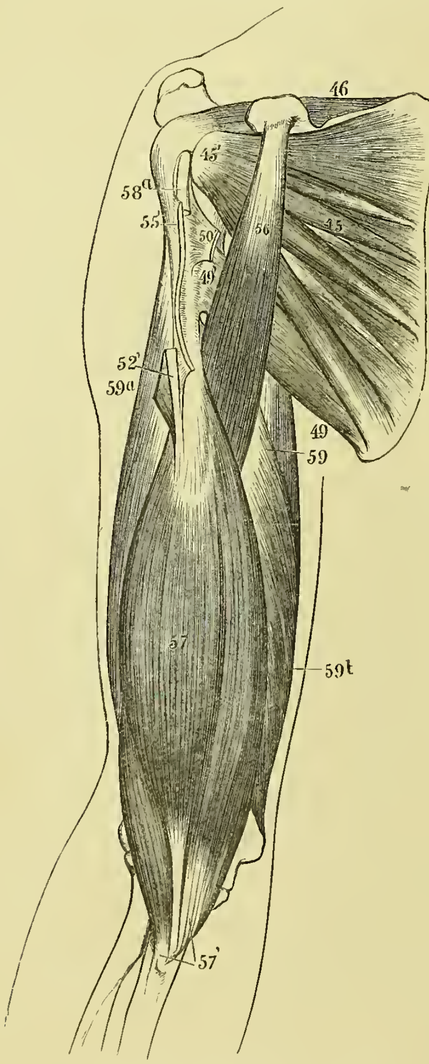


Fig. 168.—Deep Anterior and other Muscles of the Arm.

Biceps cubiti, fig. 169, [58]. Superficial, except above, where it is concealed by the pectoralis major and the deltoid, and below, where its tendon of insertion dips into the hollow in front of the elbow; asymmetrically fusiform, being bicipital or two-headed, the fasciculi belonging to its outer or longer head, being smaller and shorter than those of the inner or shorter head, which reach both higher up and lower down in the muscle; from the front of the shoulder and upper part of the axilla, downwards and a little outwards, in front of the humerus. *Inner* or *short* head, [58], by a flat tendon, in connexion with the coraco-brachialis, from the apex of the coracoid process; *outer* or *long* head, [58a], by a long rounded tendon, from the upper part of the glenoid cavity and glenoid ligament, within the shoulder joint——back part of the bicipital tuberosity of the radius, by a long tapering tendon, [58′], which becomes flattened, and twists on itself, as it passes downwards and backwards between the radius and ulna, a bursa intervening between it and the smooth part of the tuberosity. As already frequently alluded to, the long tendon passes like a strap over the head of the humerus, and then, leaving the joint, descends along the bicipital groove. The two tendons of origin cease, and the fleshy fasciculi begin, those of the outer head abruptly, but those of the inner head more gradually, just where the friction from the overlapping deltoid and pectoral muscles discontinues; the two fleshy parts of the muscle unite above the middle of the arm, to form a full, fusiform, but slightly flattened mass, which terminates, sooner and somewhat abruptly on the tendon of insertion, on the outer border, but, later and more gradually, on the inner border of the tendon. The exceedingly beautiful and complicated forms of this muscle have been selected for special explanation, p. 262. As it is about to dip into the hollow at the bend of the elbow, its tendon gives off a strong fibrous expansion, the *bicipital fascia*, figs. 124, 166, [68], which spreads out, obliquely downwards and inwards, over the fascia of the fore-arm below the elbow. As the biceps muscle passes over three joints, it can produce motion in all. First, acting on the shoulder-joint, it raises, or abducts the humerus by its long head, and draws it forwards by its short head, which therefore aids in bringing the arm towards and in front of the trunk. Its long tendon supplements the ligaments of the shoulder, and enables the muscle to press the head of the humerus against the glenoid cavity, and so retain it *in situ*, especially in the dependent position; the biceps, also, thus resists the escape of the humerus from the glenoid cavity, as, for example, when the deltoid muscle tends to draw that bone upwards; in these respects, this long tendon acts even more effectually than a ligament, as, by means of the muscular fasciculi connected with it, it can be adapted both to any change of position of the bone, and to every varying degree of force.

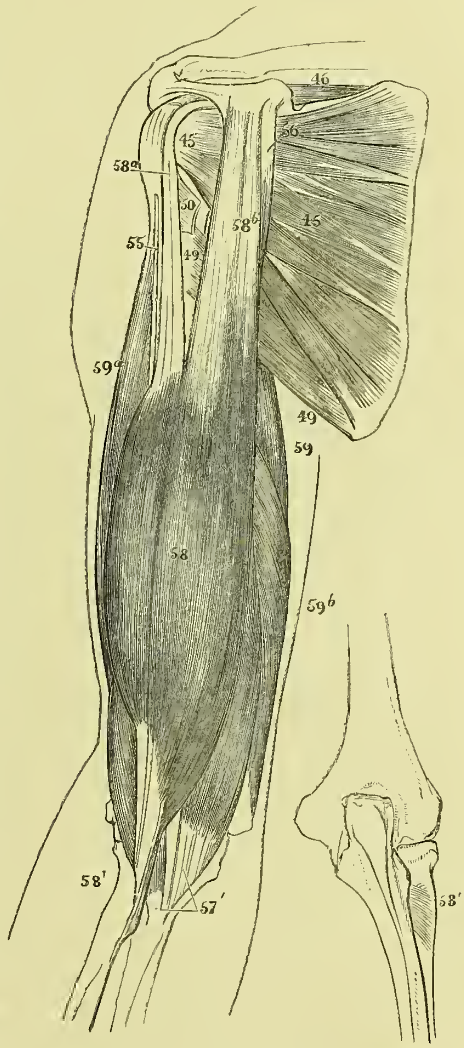


Fig. 169.—Superficial Anterior and other Muscles of the Arm.

Secondly, the biceps, acting on the elbow joint, is a powerful flexor of the fore-arm, balancing by its hold on the radius, the action of the brachialis anticus on the ulna; it also draws upon the ulnar side of the fore-arm, through its bicipital fibrous expansion. Thirdly, the biceps passes beyond the superior radio-ulnar articulation; hence, as soon as the fore-arm is ever so slightly flexed, it begins to act as a supinator, rolling the radius, and, with it, the hand, outwards and backwards, so as to turn the palm of the hand upwards. The most complete action of the biceps takes place, when the arm is raised and brought forwards, the fore-arm is flexed, and the hand supinated; but it may be brought into use, in many combinations of these movements. In striking downwards with a dagger, held in the prone hand, the muscle is in less powerful action, than in performing the outward guard with a sword, in which movement, the hand is supine, although the amount of flexion of the fore-arm may be the same in the two attitudes. In order that this muscle should act effectively on the shoulder joint, the radius must be supinated, or, if pronated, it must be fixed.

The Extensor Group, fig. 170.—This is represented by the triceps muscle of the arm, but, with it, may be associated the anconeus.

Triceps cubiti, figs. 168, 169, 170, [59], [59a], [59b]. Superficial, except for a short distance above, where it is concealed by the deltoid and teres muscles; a peculiarly shaped, three-headed muscle, its fasciculi ending below, on the deep surface, upper end, and outer and inner borders of a long, flat, quadrilateral tendon; longitudinally down the back of the humerus, from below the shoulder joint to the elbow joint. *Middle or long head*, from a tubercle and surrounding depression beneath the neck of the scapula, *outer head*, from the back of the humerus, between the insertion of the teres minor and the musculo-spiral groove, and from the external intermuscular septum, *inner* or short *head*, from the back of the humerus, below the musculo-spiral groove, also from just beneath the insertion of the teres major, and from the internal intermuscular septum——upper border and sides of the olecranon process. The middle tendon of origin is flat, and connected slightly with the glenoid ligament and the capsule of the shoulder joint; the other two tendons of origin are pointed. The fleshy part of the middle head is narrow; that of the outer head, larger than the others, is fusiform; that of the inner head is also fusiform, but both the latter become flattened below; the outer one descends lower, and is almost continuous with the upper border of the anconeus. The broad tendon of insertion commences somewhat above the middle of the back of the arm, and appears depressed amongst the fleshy fasciculi above it, and at its sides; its upper border is oblique, the outer fleshy fasciculi terminating upon it, and upon the outer border; its lower end is separated from the highest part of the olecranon by a bursa; some of its fibres pass over that process on to the triangular subcutaneous surface of the bone beyond. The triceps is the only muscle situated at the back of the arm; it is the proper extensor of the fore-arm, being the essential striking muscle, in hitting forwards with the closed hand, a movement only prepared for by the biceps, which often has the reputation of being the pugilistic muscle.

In pulling an oar, the biceps is the active muscle; but in throwing or striking a ball, the triceps, as well as the great serratus, are energetically employed, the former to straighten the fore-arm, the latter to swing the shoulder-girdle forwards. The long head of the triceps, being fixed to the scapula, may depress, adduct, and draw the humerus backwards, towards or upon the trunk.

Anconeus, fig. 170, [60]. Superficial; triangular, flat, narrow above; diverging obliquely downwards and inwards, over the outer side and back of the elbow joint. Back of the external condyle of the humerus ——outer side of the olecranon, and triangular surface of the ulna, below it. This muscle seems like a continuation of the outer part of the triceps, which it assists, in extending the fore-arm; during that movement, it probably guides the ulna on to the outer part of the back of the trochlea. It, perhaps also, accomplishes that slight abduction of the ulna, which always accompanies, and aids, pronation of the radius.

Placed deeply beneath the lower part of the triceps, but not beneath the anconeus, are two or three fleshy fasciculi, which arise from the back of the humerus, above the olecranon fossa, and are attached to the loose capsule of the elbow joint, below. They are analogous to the subcrureus in the thigh, and have, therefore, been named, though inexactly, the *sub-anconeus*; they draw the capsule and synovial membrane out of the way, in extension of the joint.

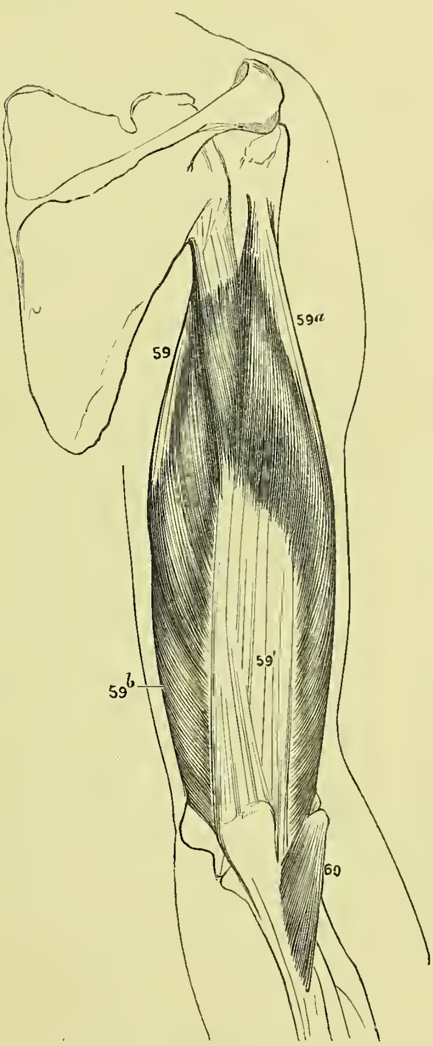


Fig. 170.—Posterior Muscle of the Arm, and Anconeus.

The Muscles of the Fore-arm.

The muscles of the fore-arm are easily arranged into an *anterior* and a *posterior* group, the former arising partly from the inner condyle of the humerus, and partly from the front of the ulna and radius, and the latter proceeding partly from the external condyle and condyloid ridge of the humerus, and partly from the back of the ulna and radius. The anterior group descends on the front of the fore-arm, wrist, and hand, and is essentially a *flexor group*, but, with it, are associated two *pronator* muscles of the radius ; the posterior group descends on the back of the fore-arm, wrist, and hand, and is essentially an *extensor group*, but with it, are associated two *supinator* muscles of the radius. These two double groups may be separately examined.

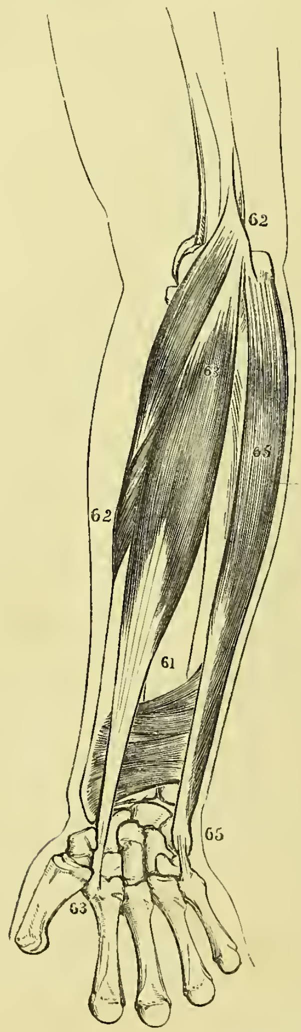


Fig. 171.—The Pronators, and the Flexors of the Wrist.

The Pronator and Flexor Group, figs. 171 to 174.—This includes two pronators, one deep, the other superficial, namely, the pronator quadratus, and the pronator teres ; three flexors of the wrist, which are all superficial, namely, the radial flexor, the palmaris longus, and the ulnar flexor of the wrist ; and, lastly, three long flexors of the fingers and thumb, which are more deeply seated, namely, the sublime flexor and the deep flexor of the fingers, and the long flexor of the thumb.

Pronator quadratus, fig. 171, [61]. Deep ; small, flat, quadrilateral ; transversely, or somewhat obliquely, from ulna to radius, in contact with those bones and the interosseous membrane. Front and inner border of the lower part of the shaft of the ulna——broad anterior surface of the lower fourth of the radius. It rotates the radius inwards upon the ulna, pronating the hand with the former bone.

Pronator radii teres, figs. 171, 174,[62]. Superficial, except at its deep origin, and its insertion ; spindle-shaped, as its name implies, and having a larger superficial, and a smaller deep origin ; obliquely downwards and outwards, across the front of the fore-arm, being the highest of the muscles arising from the inner condyle of the humerus, and forming the inner border of the hollow at the bend of the elbow. Larger *superficial* part, inner condyle of the humerus, by a tendon common to it and the flexors of the wrist, epi-trochlear ridge by fleshy fibres, fascia of the fore-arm and adjacent intermuscular septum, smaller *deep* part, inner side of coronoid process of the ulna, by a thin tendinous slip——rough ridge on the middle of the outer side of the radius, by a short broad flat tendon, which wraps round that bone. This muscle pronates the hand, but it also assists in flexing the elbow.

Flexor carpi radialis, figs. 171, 174, [63]. Superficial, except at its insertion ; its fleshy portion, broad and fusiform above, penniform below, its fasciculi ending at the middle of the fore-arm, on the sides of a strong, flat tendon, which tapers and then becomes rounded ; obliquely downwards and outwards, the tendon of insertion passing through the anterior annular ligament of the wrist, and along a groove in the trapezium, converted by fibrous bands into a channel. Inner condyle of the humerus, by the common tendon, fascia of the fore-arm, and adjacent intermuscular septa——front of the base of the metacarpal bone of the forefinger. This muscle not only flexes the wrist joint, but, from its oblique direction, it also assists somewhat in pronating the hand ; it likewise aids in bending the elbow joint.

Palmaris longus, figs. 174, 181, 182, [64]. Superficial throughout ; small, slender, fusiform, quickly ending at the middle of the fore-arm, in a long, thin, flat, delicate tendon; obliquely downwards, from the inner side of the fore-arm to the front of the palm, passing over the annular ligament of the wrist. Inner condyle of the humerus, by the common tendon, fascia of the fore-arm, and adjacent intermuscular septa——palmar fascia, opposite the middle of the wrist, fig. 182. This small muscle is the homologue of the plantaris in the leg. It is subject to much variation ; its fleshy part may be very long, or central between two tendons, or confined to the lower part of the muscle ; it may be double; it frequently sends tendinous slips to the muscles of the ball of the thumb, and sometimes also to the ball of the little finger. It tightens the palmar fascia, and assists in flexing the wrist, and even the elbow.

Flexor carpi ulnaris, figs. 171, 174, 177, 185, [65]. Superficial throughout; the fleshy part is long, thick, and somewhat flattened, the tendon of insertion appears on the anterior edge of the lower half of the muscle, and receives fleshy fasciculi as low down as the wrist; longitudinal, along the inner border of the fore-arm, being the innermost of the superficial flexor group, and bounding the ulnar furrow, situated along the posterior border of that bone, fig. 177. Inner condyle of the humerus, by the common tendon, inner side of the olecranon, and upper two-thirds of the posterior border of the ulna, and an aponeurosis common to it and to the flexor digitorum profundus ——the pisiform bone, beyond which, tendinous slips pass to the annular ligament, the palmar fascia, the muscles of the ball of the little finger, and the front of the base of the fifth metacarpal bone. This muscle, besides flexing the wrist, adducts or draws the hand inwards ; it may also aid in flexing the elbow.

Flexor digitorum sublimis, figs. 172, 174, 181, [66 66′]. Deep, concealed in the fore-arm, except between the tendons of the two flexors of the wrist and of the palmaris longus, also covered in the palm and on the fingers, by the fascia and the sheaths of the tendons; the broadest and thickest of the flexor group, arising, most extensively, from the humerus, ulna, and radius, its fasciculi terminating obliquely, somewhat below the middle of the fore-arm, upon four strong tendons; longitudinally down the front of the fore-arm, beneath the anterior annular ligament of the wrist, through the palm, and along the front of the fingers, as far as the second phalanges. Inner condyle of the humerus, internal lateral ligament of the elbow joint, inner side of coronoid process of the ulna, and oblique line of the radius, down to the insertion of the pronator teres——by four tendons, that for the little finger being the smallest, which pass through the palm onwards to the fingers, superficial to the tendons of the flexor profundus, but which split, opposite the first phalanges, to give passage to those tendons, then unite beneath them, and, again dividing, are inserted into the lateral ridges on the anterior surface of the second phalanges. This is the flexor *perforatus* muscle. It first flexes the second phalanges of the fingers, then the first phalanges also, unless these are fixed by the action of the extensor muscle, and, lastly, it aids powerfully in bending the wrist. Its action in flexing the elbow, is very slight.

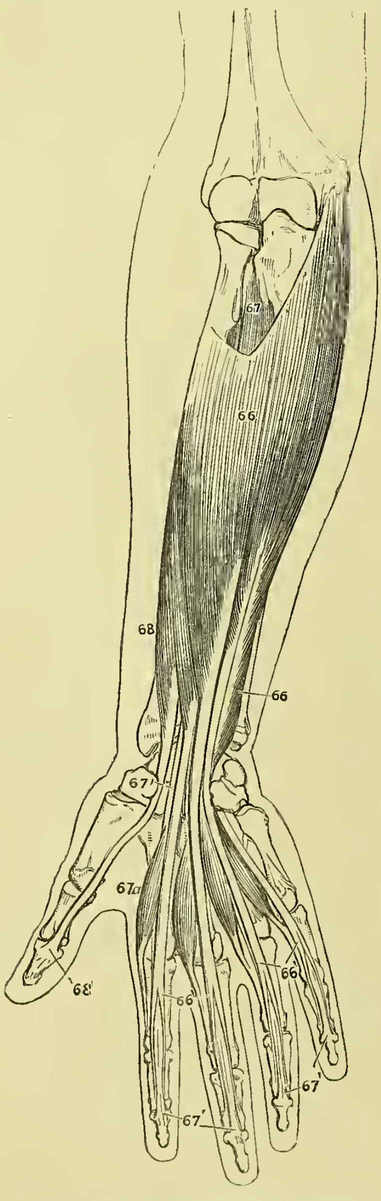


Fig. 172. The Superficial and Deep Flexors of the Fingers and Thumb.

Flexor digitorum profundus, figs. 172, 173, 174, 181, 67 67'. Deep, except near its insertions; a thick muscle, the fasciculi of which are gathered on the edges and under surfaces of four strong tendons, that for the forefinger being separate from the others; longitudinal in the fore-arm, passing beneath the anterior annular ligament and the palmar fascia, into the hand, and then along the fingers, in the digital sheaths, to the last phalanges. Front and inner surface of the upper two-thirds of the ulna, ulnar half of the adjacent part of the interosseous membrane, and the aponeurosis common to it and the flexor carpi ulnaris——by four tendons, which descend through the palm, and along the fingers, under cover of the tendons of the flexor sublimis, but, opposite the first phalanges, pass through the splits in those tendons, and then continue to the bases of the last phalanges. This is the flexor *perforans* muscle. In the palm, its four tendons give origin to the four *lumbricales* muscles, to be presently described. It not only flexes the last phalanges of the fingers, after the second have been bent by the flexor sublimis, but it also helps to flex the entire fingers and the wrist, and, to a slight extent, the elbow.

Flexor longus pollicis, figs. 172, 173, 174, 181, [68 68′]. Deep, except for a short distance above the wrist, between the tendons of the flexor carpi radialis and supinator longus; semi-penniform, its fasciculi reaching as low down as the wrist, to the under side of a flat tendon; longitudinal, in front of the radius, its tendon passing beneath the annular ligament, and then along the palmar aspect of the thumb. Upper two-thirds of the front of the radius, below its oblique line, neighbouring portion of the interosseous membrane, and, often, the base of the coronoid process of the ulna——front of the base of the last phalanx of the thumb. An accessory tendon sometimes exists, proceeding, in different cases, from the flexor sublimis, from the coronoid process of the ulna, from the internal condyle of the humerus, from the flexor profundus, or from the pronator teres. It flexes, in succession, the last phalanx, the first phalanx, and the metacarpal bone of the thumb, and then the wrist.

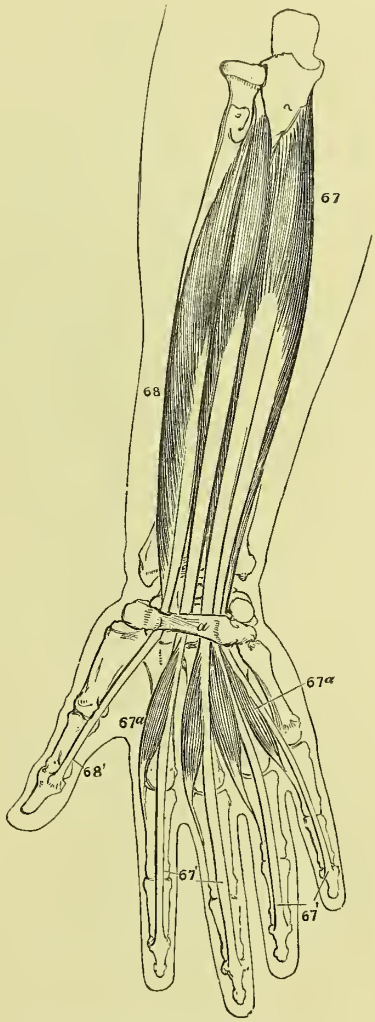


FIG. 173.—The Deep Flexors of the Fingers and Thumb.

The Extensor and Supinator Group, figs. 174 to 177, and 183 to 185.—This includes two supinators, one deep and the other superficial, just as there is a deep and a superficial pronator; also, three extensors of the wrist, namely the long and short radial extensors, and the ulnar extensor of the wrist; three extensors of the fingers, namely the common extensor, the extensor of the little finger, and that of the forefinger; and, lastly, three extensors of the thumb, destined, respectively, for its metacarpal bone, its first phalanx, and its second phalanx.

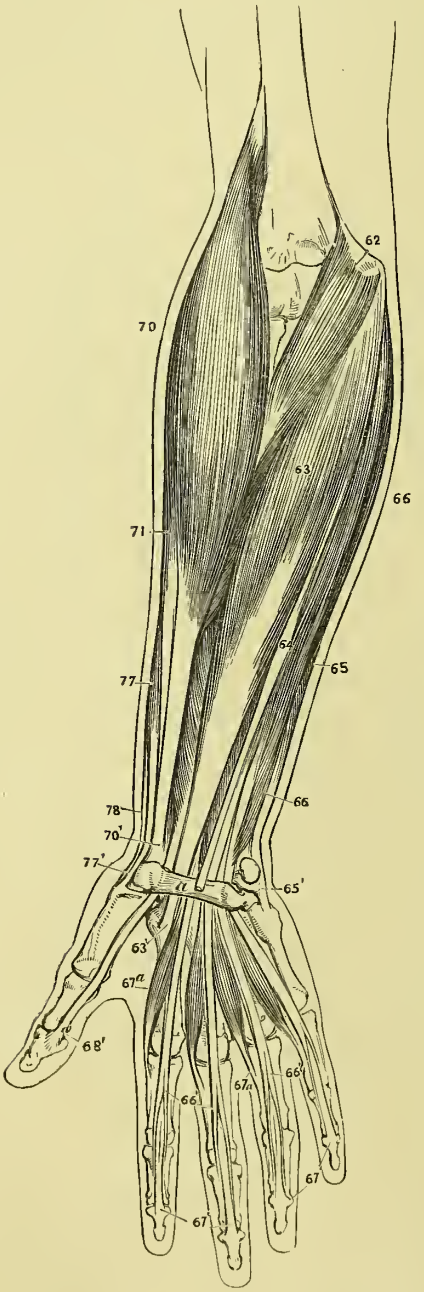


Fig. 174.—Muscles in front of the Fore-arm, complete.

Supinator radii brevis, fig. 175, [69]. Deep-seated throughout; short and broad; oblique round the upper part of the radius, almost surrounding it in a sort of muscular cylinder. External lateral ligament of the elbow joint, orbicular ligament of the radius, rough spot below the lesser sigmoid cavity of the ulna, and adjacent two inches of the outer border of that bone ——upper part of the radius, as low down as the insertion of the pronator teres, except the bicipital tuberosity and a narrow surface below it. It is a direct supinator of the radius and hand, and is more powerful, in this respect, than the supinator longus; but, as already mentioned, when the fore-arm is flexed, the biceps is the most powerful supinator muscle.

Supinator radii longus, figs. 174, 176, 177, 185, [70 70′]. Superficial throughout, except that its tendon is crossed by two of the extensors of the thumb; long, thin, ribbon-shaped, ending obliquely, about the middle of the fore-arm, in a flat tendon; longitudinal, in the lower part of the outer side of the arm, and along the outer border of the fore-arm. Upper two-thirds of the epi-condyloid ridge of the humerus, and external intermuscular septum ——base of the styloid process of the radius. Above the elbow, the edges of this thin muscle are directed towards the bone and towards the skin, but, in the fore-arm, it turns, so as to become widened out, and flattened upon the subjacent muscles; its fasciculi terminate obliquely on its tendon, about the middle of the fore-arm. It forms the outer margin of the triangular hollow, in front of the bend of the elbow. This muscle acts slightly as a supinator, most so, when the fore-arm is flexed at the elbow; but it is, evidently, a powerful adjuvant flexor of the elbow joint, acting, however, after the other flexors have commenced to bend the elbow. It is used in carrying weights, when the fore-arm is semi-flexed; it also serves, then, to maintain the fore-arm in the mid-position between supination and pronation, that is, with the thumb uppermost.

Extensor carpi radialis longior, figs. 176, 177, 183, 184, 71 71′. Superficial, except where partly overlapped, above, by the long supinator, and lower down, where it is crossed by the extensors of the thumb; fusiform, ending suddenly at the upper third of the fore-arm, in a flat tendon; longitudinal along the outer side of the fore-arm, to the back of the carpus and metacarpus, its tendon passing beneath the posterior annular ligament, in a grove on the back of the radius. Lower third of the epi-condyloid ridge of the humerus, and external intermuscular septum——base of the metacarpal bone of the index finger. This muscle not only extends the wrist, but abducts the hand. It may help to flex, and to steady, or fix the elbow joint.

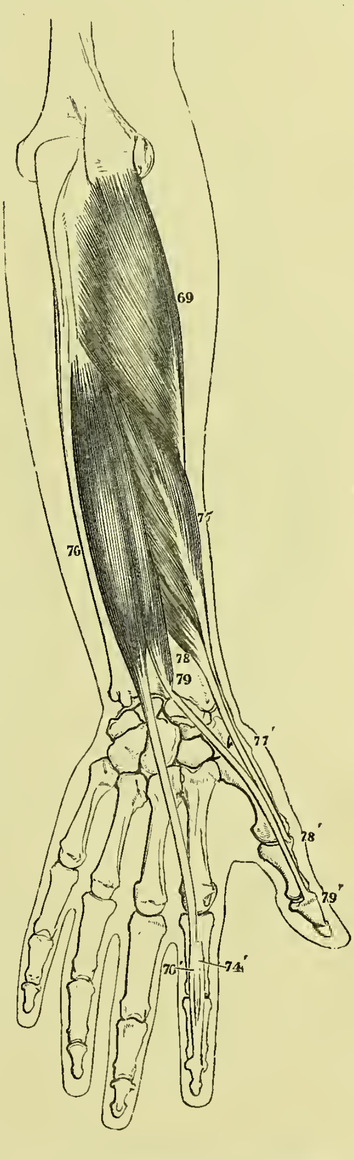


Fig. 175.—Short Supinator, and Extensors of the Thumb and Index Finger.

Extensor carpi radialis brevior, figs. 176, 177, 183, 184, 72 72′. Partly superficial, between the last-named muscle and the common extensor of the fingers, but crossed, lower down, by the extensors of the thumb; shorter, as its name implies, but also wider and thicker than the extensor longior, its fasciculi ending gradually on the tendon of insertion, which passes down, together with that of the extensor longior, in the same groove on the radius, and through the same compartment in the posterior annular ligament. External condyle of the humerus, by a tendon common to it and the adjacent muscles, and capsule of the elbow joint——base of the metacarpal bone of the middle finger. This muscle extends the wrist and elbow, and also abducts the hand.

Extensor carpi ulnaris, figs. 176, 177, 183, 185, [73], [73′]. Superficial throughout; fusiform, the fleshy fasciculi reaching lower down than those of the radial extensors; longitudinal, but directed somewhat inwards, along the ulnar furrow, of which it forms the posterior boundary, figs. 176, 177, and by which it is separated from the ulnar flexor of the carpus, its tendon passing on to the wrist, in a groove behind the styloid process of the ulna, in a separate compartment in the posterior annular ligament. External condyle of the humerus, by the common tendon, middle third of the posterior border of the ulna, just below the insertion of the anconeus and fascia of the fore-arm——back of the base of the fifth metacarpal bone. It extends the wrist, and adducts the hand; it may also aid in extending the elbow. The habitual combination of abduction of the hand with extension of the wrist joint, and of adduction with flexion of that part, are chiefly noticeable as associated movements, in the free motions of the limb; they are in harmony with the surfaces of the joints; the general oblique direction and laterally placed insertions of the radial and ulnar muscles, enable them to accomplish the requisite combinations.

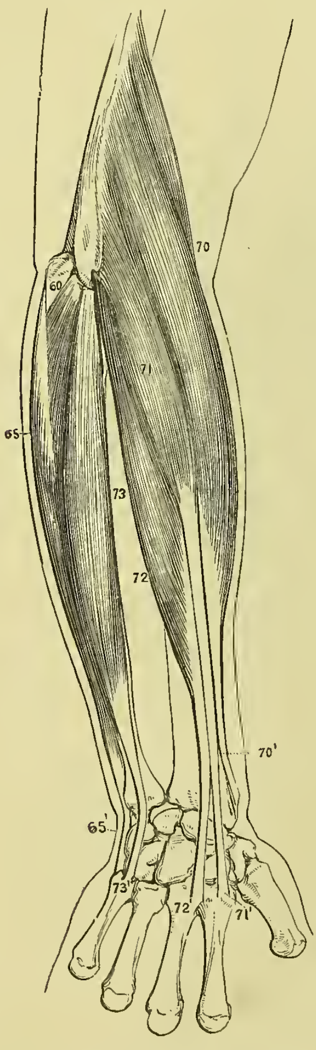


Fig. 176.—Long Supinator, and Extensors of the Wrist.

Extensor communis digitorum, figs. 177, 183, [74] [74′]. Superficial throughout; fusiform above, its fasciculi ending obliquely below the middle of the fore-arm, on a flat tendon, which divides into a narrow slip for the index finger, a broader one for the middle finger, and a third, also broad, which again subdivides into two for the fourth and fifth fingers; longitudinal, down the back of the fore-arm, its four ultimate tendinous slips, passing in a groove on the back of the radius, and through a single compartment beneath the posterior annular ligament, to the back of the hand, and along the dorsal aspect of the fingers. External condyle of the humerus, by the common tendon, fascia of the fore-arm, and adjacent intermuscular septa——by its four tendons, into the dorsal surface of the bases of the second and third phalanges of the fingers.

It extends all the phalanges of the fingers, then the wrist, and even the elbow; it also has a tendency to separate the fingers, as it extends them, whilst the flexor muscles, on the contrary, bring the fingers together.

Extensor minimi digiti, figs. 177, 183, 185, [75] [75′]. Superficial; long and slender, with a delicate tendon; descends on the inner side of the common extensor, but passes, between the radius and ulna, through a separate compartment of the posterior annular ligament, on to the back of the carpus, the fifth metacarpal bone, and the little finger. Common tendon of origin of the digital extensors——dorsal aspect of the last two phalanges of the little finger. As an accessory of the common extensor, it assists in extending the little finger, and then, also, the wrist, and even the elbow; acting alone, it extends the little finger independently of the others, an habitual action by no means uncommon, and frequently inherited in families. The little finger has been named the *auricular* finger, from its adaptation to the office of rubbing or cleansing the meatus or opening of the ear; hence this muscle is also named *auricularis*.

Extensor indicis, figs. 175, 177, 183, [76] [76′]. Covered by the common extensor; elongated and rounded, ending, just above the back of the wrist, in a flat tendon; this descends in the same compartment as the common extensor tendon, but covered by it, and then accompanies the slip of that tendon to the back of the carpus, metacarpus, and fore-finger, placed somewhat to its inner, or ulnar side. Lower half of the back of the ulna, below the extensors of the thumb, and adjacent interosseous membrane——dorsal aspect of the last two phalanges of the forefinger. This

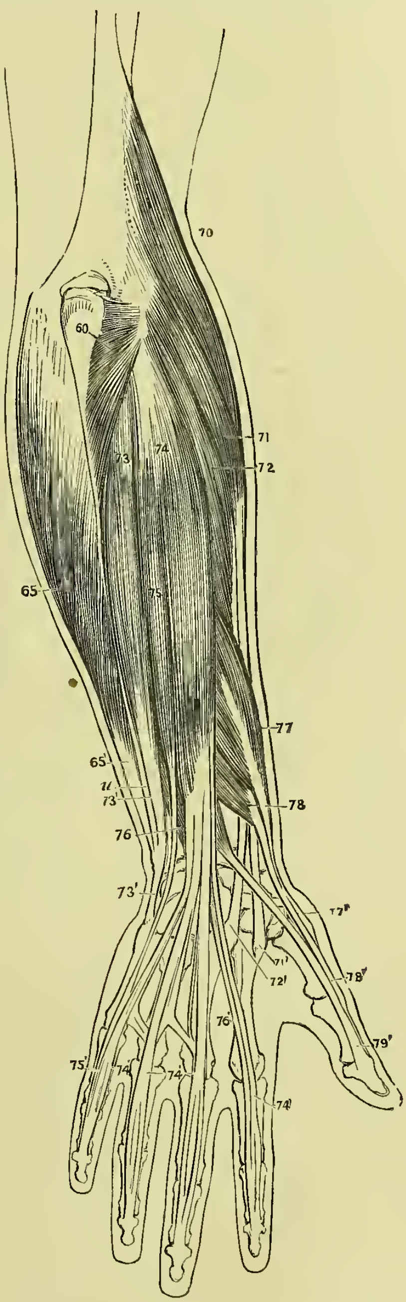


Fig. 177.—The Muscles on the back of the Fore-arm, complete.

muscle is larger than the extensor of the little finger, and, unlike it, is quite independent of the common extensor. It either assists that muscle, or *acts entirely by itself,* in straightening the forefinger, which has the most independent action of all the fingers, and is used specially in *pointing*; hence this finger is named the *index finger,* and the muscle the *indicator* muscle. When the other three fingers are flexed, the index finger can be very easily and completely extended alone, being in that case, however, adducted rather than abducted. The little finger is the next freest, and then the middle finger, whilst the ring finger is the most tied down, as will be again alluded to.

Extensor ossis metacarpi pollicis, sometimes named *abductor pollicis longus,* figs. 175, 177, 183, 184, 77 77′. Deep-seated above, but emerges, just below the middle of the fore-arm, from beneath the common extensor, and is then superficial; broad and penniform, its fasciculi ending on a central tendon of insertion; obliquely downwards and outwards, from the back of the fore-arm, to the outer border of the wrist, the tendon passing through a groove on the outer side of the styloid process of the radius, through the outermost compartment of the posterior annular ligament. Back of the ulna, just below the supinator brevis, back of the radius, below the same muscle, and intervening interosseous membrane ——dorsal aspect of the metacarpal bone of the thumb.

Extensor primi internodii pollicis, figs. 175, 177, 183, 184, 78 78′. Covered for a short distance above, elsewhere superficial; much smaller than the last muscle; emerges from beneath the common extensor, lower down than that muscle, the two tendons passing through the same compartment of the annular ligament. Back of the radius and interosseous membrane, below the middle of the fore-arm——dorsal aspect of the base of the first phalanx of the thumb.

Extensor secundi internodii pollicis, figs. 175, 177, 183, 184, 79 79′. The fleshy portion nearly entirely covered, the tendinous part superficial; elongated, fusiform, but larger than the last-described muscle; its long, slender tendon enters the oblique groove on the back of the lower end of the radius, passes obliquely through a separate compartment of the annular ligament, and crosses over the tendons of both radial extensors of the wrist, to reach and run along the back of the thumb. Back of the ulna, below the supinator brevis, and interosseous membrane——dorsal aspect of the base of the last phalanx of the thumb.

The three extensors of the thumb first straighten its three component bones, respectively; the second and third muscles, after fulfilling this office, obviously assist in extending the bone or bones behind their points of insertion. The three muscles then aid in extending the wrist, and in abducting the entire hand, or drawing it towards the radial border of the fore-arm. The extensor of the metacarpal bone, is also a special abductor of the thumb itself, and hence has been named, the *long abductor of the thumb.*

The Muscles of the Hand.

There is no muscle on the back of the hand corresponding with the short extensor of the toes in the foot; but the dorsal interosseous muscles are here visible between the metacarpal bones, and the long extensor tendons also pass down the back of the hand. All the muscles of the hand, are accessible from the palm, arranged in superimposed layers; and, as in the foot, the long flexor tendons descend into it, from the part of the limb above it. The groups into which the muscles of the palm, which act upon the digits, may be arranged, are an *abductor and adductor* group, an *opponent* group, and

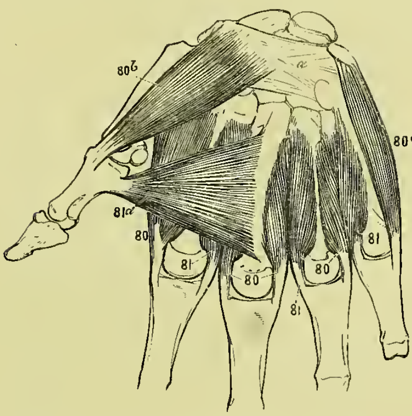


Fig. 178.—Abductor and Adductor Group.

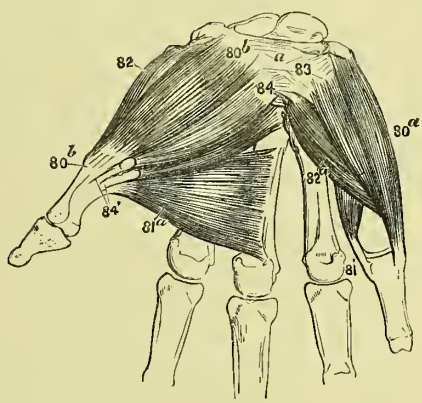


Fig 179.—Short Flexors, Abductors, Adductors and Opponent Muscles.

a *short flexor* group. The *long tendons* either act on the carpus and procarpus, at the wrist joint and transverse carpal articulation, or they pass down to the fingers and thumb, which they serve to bend or straighten. To one set of these, the *lumbricales* muscles are attached. There is also a special cutaneous *palmar muscle,* connected with the *palmar fascia,* which, as well as the *dorsal fascia* and the *annular ligaments* of the wrist, must here receive attention.

The Abductor and Adductor Group, figs. 178 to 185.—The *abductors* include, as in the foot, the dorsal interossei, and the abductors of the little finger and the thumb; the *adductors* comprise the palmar interossei, and the adductor of the thumb.

Interossei dorsales, figs. 178, 183, 184, ^{80} $^{80'}$. Superficial on the dorsal aspect, but deep-seated in the palm; four in number, small, penniform;

longitudinal, between the metacarpal bones. Adjacent sides of all the metacarpal bones——tubercles on the sides of the bases of the first phalanges of the fingers, and the aponeurotic expansions of the common extensor tendons. The first dorsal interosseous, between the first and second metacarpal bones, is the largest, and is triangular in shape; it is sometimes named the *abductor indicis.* The short tendons of the first and the second dorsal interossei, are inserted into the radial side of the index and the middle fingers; those of the third and fourth, into the ulnar side of the middle and ring fingers. The second and third muscles, therefore, abduct the middle finger from an imaginary line passing through its longitudinal axis; the first and fourth abduct the index and the ring fingers from the middle finger, or from the same line passing through it. In the foot, it will be remembered that the line, from and to which, abduction and adduction of the toes take place, passes, down the second toe, which is usually the longest, and not down the middle digit, as in the hand, which finger is also the longest.

Abductor minimi digiti, figs. 178, 179, 181, 183, 185, ^{80a}. Superficial; fusiform; the innermost of the muscles in the palm, being placed along its inner border. Pisiform bone and tendon of the flexor carpi ulnaris——ulnar side of the base of the first phalanx of the little finger, and the expansion of the extensor tendon. It abducts the little finger, and aids in flexing it.

Abductor pollicis, or *abductor brevis pollicis,* figs. 178, 179, 181, 183, 184, ^{80b}. Superficial; narrow, flat; obliquely downwards, and outwards, on the ball of the thumb. Oblique ridge on the trapezium, and anterior annular ligament——outer side of the base of the first phalanx of the thumb. It is sometimes connected with the extensor ossis metacarpi pollicis. It abducts the thumb on its metacarpal bone, and draws the whole thumb forwards.

Interossei palmares, figs. 178, 181, ^{81} $^{81'}$. Deep; three in number, smaller than the dorsal interossei, semi-penniform; longitudinal upon, not between, the metacarpal bones. The *first,* ulnar side of the second metacarpal bone——ulnar side of the first phalanx of the index finger; the *second* and *third,* radial sides of the fourth and fifth metacarpal bones——radial sides of the first phalanges of the ring and little fingers. Like the dorsal interossei, their tendons also join the expansion of the common extensor tendon on the back of each finger. They adduct the index, ring and little fingers, towards the middle finger.

Adductor pollicis, figs. 178, 179, 181, 183, 184, ^{81a}. Deep, except in the fold between the forefinger and the thumb; triangular, the broadest muscle of the thumb; converges transversely from the deepest part of the centre of the palm, across the web of the thumb, seeming to belong to the palmar interosseous series. Palmar surface of the metacarpal bone of the middle finger——inner side of the base of the first phalanx of the thumb, together with the inner portion of the flexor brevis pollicis. It adducts the thumb, and then assists in drawing it forwards, and opposing it to the fingers. This muscle completes the adductor group. The seven interossei, together with the abductor of the little finger, and the abductor and the adductor of the thumb, furnish ten muscles, five of which abduct, and five adduct the fingers and thumb respectively, at their bases, or metacarpo-phalangeal joints. These are ball-and-socket joints, and, therefore, capable of the movement of circumduction, which is performed by the consecutive action of the abductor, extensor, adductor, and flexor muscles, in each case.

The Opponent Group, fig. 180.—This group consists of the opponens muscle of the little finger, and the opponens of the thumb; they are not peculiar to the hand, there being, sometimes, small equivalent muscles in the foot. Their full development is associated with the existence of the unusually moveable articulations at the bases of the fifth and first metacarpal bones, into which they are inserted; they afford good examples of special anatomical correlation between muscles and joints.

Opponens pollicis, figs. 179 to 181, 184, [82]. —Deep, but projecting superficially along the outer border of the abductor pollicis; broad, quadrangular, powerful; oblique downwards and outwards, being the outermost of the muscles of the ball of the thumb. Oblique ridge and surface of the trapezium, and anterior annular ligament——whole length of the front and outer border of the metacarpal bone of the thumb. It flexes the metacarpal bone of the thumb, and, hence, has been named the *flexor ossis metacarpi pollicis*; it not only draws that bone inwards and forwards across the palm, but rotates it, at its saddle-shaped joint on the trapezium, so as to enable the thumb to be *opposed* to any or all of the fingers, and its point to meet any or all of their tips.

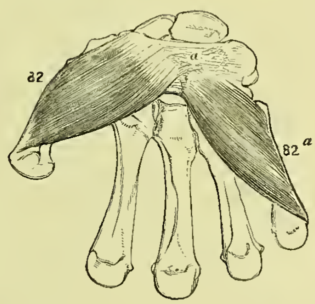


Fig. 180.—Opponent Muscles of the Thumb and Little Finger.

Opponens minimi digiti, figs. 179 to 181, 185, [82a]. Deep; broad, quadrangular; oblique, downwards and inwards. Hook-like process of the unciform bone, and anterior annular ligament——whole length of the ulnar border of the metacarpal bone of the little finger. Acting on the imperfectly saddle-shaped joint at the base of the fifth metacarpal bone, it flexes that bone, and draws it in front of, or opposes it to the ball of the thumb, in this way, raising up the inner border of the palm, and increasing the depth of the hollow of the hand.

The Short Flexor Group, figs. 179, 181.—This includes the short flexor of the little finger, and that of the thumb, which complete the muscles forming the balls or eminences of those digits, the ball of the thumb being known as the *thenar* eminence, and that of the little finger, as the *hypo-thenar* eminence (*ὑπό, under, θέναρ, the palm*).

Flexor brevis minimi digiti, figs. 179, 181, [83]. Superficial, but crossed by the palmaris brevis muscle; fusiform; oblique, downwards and inwards. Tip of the unciform process, and anterior annular ligament——base of the first phalanx of the little finger, together with the tendon of the abductor. This muscle is often incorporated with the abductor, or it may be absent. It flexes the first phalanx of the little finger, being assisted by the abductor and the long flexors; it also co-operates with the opponens muscle.

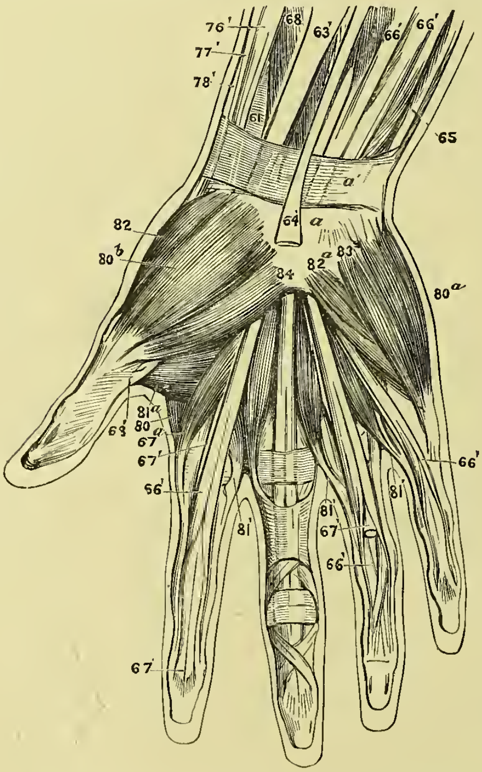


Fig. 181.—Muscles and Tendons, in the Palm, complete.

Flexor brevis pollicis, figs. 179, 181, [81]. One portion deep, the other superficial; a large, double muscle, each part fusiform; oblique, downwards and outwards, from the middle part of the carpus, through the ball of the thumb, the two parts separated by the tendon of the long flexor of the thumb. Deep or *inner* part, os magnum, trapezoid bone, bases of the second and third metacarpal bones, and sheath of the tendon of the flexor carpi radialis——outer side of the base of the first phalanx of the thumb; superficial or *outer* part, trapezium and anterior annular ligament——inner side of the base of the first phalanx of the thumb. The tendon of each part encloses one of the sesamoid bones of the thumb; the deep or inner tendon joins that of the adductor, and the superficial or outer tendon, that of the abductor pollicis. This strong muscle flexes the thumb, and aids in drawing its metacarpal bone forwards and inwards.

The long flexor tendons in the palm, figs. 172, 173, 181. These include the tendon of the long flexor of the thumb, and the four tendons of the deep and of the superficial flexors of the fingers. The *tendon of the long flexor* of the thumb, figs. 172 to 174, 181, [68′], passes beneath the annular ligament, outside those of the flexor profundus, then between the two parts of the flexor brevis pollicis, and, lastly, in a fibrous sheath, which retains it in position, upon the first phalanx of the thumb; this sheath becomes thinner opposite to the joint between the two phalanges, so as not to interfere with flexion of that intermediate joint. The *tendons* of the *flexor digitorum sublimis*, figs. 172, 181, [66′], and *profundus*, figs. 172, 173, 181, [67′], pass together beneath the annular ligament, and emerge from between the balls of the thumb and little finger, into the flat part of the palm, whence they enter the digital sheaths on the several fingers, retaining, throughout, their mutual relations, one covering the other. The digital sheaths consist of very strong transverse bands, *ligamenta vaginalia*, opposite to the first and second phalanges, but are much thinner opposite to the inter-phalangeal joints, so as to permit of the movement of flexion there. As in the foot, the superficial tendons, here those of the flexor sublimis, divide into two slips, which form a grooved channel for the reception of the corresponding deep tendons, join beneath those tendons, and again subdivide, to be attached to the lateral ridges on the second phalanges, whilst the deep tendons proceed onwards to the base of the last phalanges. The digital sheaths are lined by synovial membranes; delicate vascular folds, *vincula vasculosa*, pass from the front of the phalanges to the deep surface of both tendons; fibrous bands, *ligamenta brevia*, connect the tendons with the dense plantar ligaments of the inter-phalangeal joints, and so pull up the capsules during flexion of the fingers; the ultimate ligamenta brevia of the deep tendons, contain, each, two small slips of elastic tissue, described and named by me, *vincula subflava*, which are larger than those in the foot, and probably help to slide the deep tendons forwards in the channel formed by the superficial tendons, during some of the movements of the fingers.

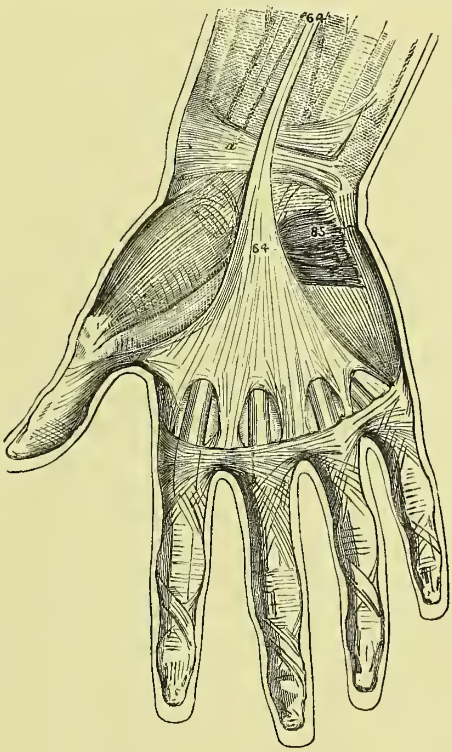


Fig. 182.—The Palmar Fascia, and Palmaris Brevis Muscle.

Lumbricales, figs. 172 to 174, 181, 184, [67a]. Deep, except at their insertions; four in number, small, fusiform, or *wormlike*, the two inner ones penniform; longitudinal on the radial borders of the flexor tendons, downwards to the same side of the fingers. Radial or outer sides of the deep flexor tendons, close to the annular ligament, the two inner ones, also from the ulnar sides of the tendons for the middle and ring fingers——radial margins of the aponeurotic expansions of the extensor tendons on the backs of the first phalanges of the fingers. These small muscles feebly flex the fingers at their base, making them also turn, and rotate slightly, towards their radial borders, that is, towards the thumb, as they become bent. It is said that, when the deep flexor is fixed, they may aid in extending the second and last phalanges. It may further be suggested, that these little muscles, acting from their insertions, may help to slide the deep flexor tendons in the channels formed for them by the superficial tendons, when the fingers are rapidly extended; it is to be noted, that, both in the hand and foot, they are confined to the digits in which the deep tendon perforates a channelled passage in the superficial tendon; for they are absent in the thumb and great toe, the long tendons of which are free from that condition of restraint.

The palmar fascia, and palmaris brevis muscle, fig. 182, [85]. The palmar fascia, like the plantar fascia, consists of a very dense *central* portion, and of *two lateral*, thinner portions. The central portion, fig. 182, [64], is thick, white, and triangular or fanshaped; it is narrow, above, where it is blended with the anterior annular ligament, and is continuous with the expanded end of the slender tendon of the palmaris longus, [64′]; it is broad below, and divided into four processes, which are prolonged on the digital sheaths for the flexor tendons, and are connected together by transverse fibres, which form arches over those tendons and the tendons of the lumbricales and interossei muscles. Other interdigital bands are connected with the deep transverse metacarpal ligament; whilst others, again, form a superficial transverse ligament, which extends into, and supports, the webs between the fingers. The thinner lateral portions of the palmar fascia, cover the muscles of the ball of the thumb and of the little finger, and are continuous, at the borders of the hand, with the dorsal fascia. Intermuscular septa pass from the palmar fascia, between the several muscles of the palm.

Palmaris brevis, figs. 182, 185, [85]. Superficial and *cutaneous*; a thin, flat, quadrilateral muscle, composed of several bundles; transverse over the inner part of the palm. Annular ligament and central part of the palmar fascia——under surface of the skin, along the inner border of the palm. This muscle has no connection with the skeleton; it is sometimes very thin and scattered. It wrinkles the skin on the inner border of the hand, thus increasing the depth of the hollow of the palm.

The annular ligaments of the wrist, figs. 173, 174, 178–185. The *anterior annular ligament*, figs. 173, 174, 178 to 181, [a], is a strong fibrous band, continuous above with the fascia of the fore-arm, below with the palmar fascia, and attached externally to the tuberosity of the scaphoid and the ridge on the trapezium, and internally to the pisiform bone and to the hook-like process of the unciform bone. It converts the transverse arch of the carpus into a canal for the passage of the long flexor tendons of the fingers, figs. 173, 174, [a]. It blends with the ligaments of the carpus, and contributes greatly to the strength of the wrist, and to the maintenance of its arch. The tendon of the palmaris longus passes over it, fig. 181, that of the flexor carpi ulnaris is partially inserted into it, that of the flexor carpi radialis passes through it; most of the short muscles of the thumb and little finger are connected with it. Just above the hand, across the front of the lower part of the fore-arm, the fascia is strengthened by transverse fibres, which form a sort of *superficial anterior annular ligament*, figs. 181, 182, [a′].

The *posterior annular ligament*, figs. 183, 184, 185, [a′], also derived from the proper fascia, and continuous, above, with the fascia of the fore-arm and, below, with the dorsal fascia of the hand, is attached, externally to the outer border of the radius, and internally to the pisiform and cuneiform bones; between these points, it is fixed by the *retinaecula* to the ridges on the back of the radius and ulna, to form, with the grooves on those bones, p. 133, the several compartments for the passage of the extensor tendons. By this means, the tendons are bound down in their places against the bones, when the hand is extended, whilst synovial lining membranes facilitate the free movement of the tendons in their respective channels. This ligament also strengthens the wrist behind, and helps especially to connect the hand with the radius, during pronation and supination.

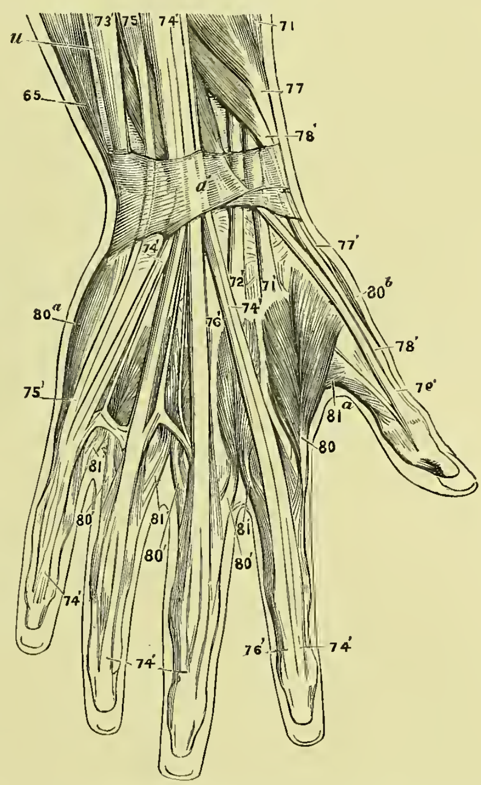


Fig. 183.—Muscles and Tendons on the back of the Hand, with the Posterior Annular Ligament, *a′*.

The *extensor tendons on the back of the hand*, figs. 175 to 177, 183 to 185. The *tendon of the extensor carpi ulnaris*, [73′], on the inner border of the hand, emerging from the innermost compartment of the posterior annular ligament, quickly reaches the base of the fifth metacarpal bone. The slender *tendon of the extensor minimi digiti*, 75′, passes forwards from the next compartment, on the back of the fifth metacarpal bone, to meet and join, on the back of the little finger, the outermost of the *four tendons of the common extensor of the fingers*. These tendons, 74′, emerging from a common compartment, diverge as they pass forwards, to the back of the knuckles at the base of each finger; here, each tendon expands so as to cover the dorsum of the first phalanx with a broad aponeurosis, which receives on its radial margin the delicate tendons of the lumbricales, and on both margins, offsets from the tendons of the interossei muscles. At the middle of the first phalanx, each common extensor tendon divides into three slips, of which the central and thinner one is inserted into the base of the second phalanx, whilst the lateral slips pass over the bevelled sides of the head of the first phalanx, and over the lateral ligaments of the neighbouring joint, unite together on the back of the second phalanx, and are finally inserted into the base of the last phalanx. The tendons of the common extensor intended for the middle, ring,

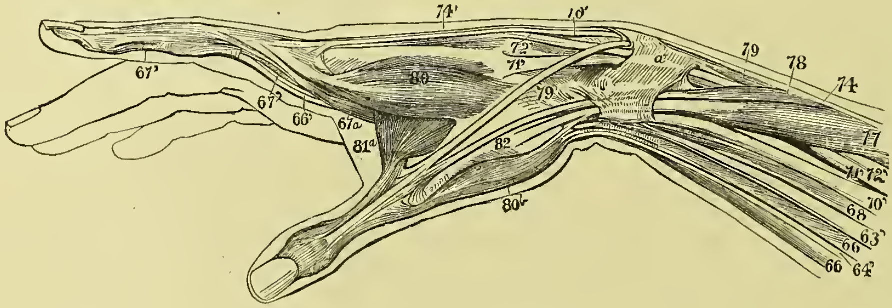


Fig. 184.—Outer Border of Wrist and Hand.

and little fingers, are variously connected together by short oblique tendinous slips, the strongest of which usually diverge from the ring finger tendon to the other two; hence, that finger cannot be fully or readily extended, when the two neighbouring fingers are flexed; for, it is then, as if it were tied down, because the action of the common extensor muscle cannot be communicated separately to it. The three inner fingers are, therefore, usually associated in the movement of extension; but the little finger is comparatively independent, owing to its possessing a special extensor, besides a division of the common extensor tendon. The *tendon of the extensor indicis*, 76′, descending from the same compartment as those of the common extensor, but concealed by the outermost tendon, runs along the ulnar border of that tendon, and joins it at last, in its expansion on the back of the first phalanx of the index finger; it endows that finger with its characteristic independence as to extension. Next to this, the *tendons of the extensores carpi radiales, longior*, 71′ and *brevior*, 72′, pass from their common compartment vertically down to the bases of the third and second metacarpal bones. Crossing over these very obliquely, in a separate narrow compartment of the annular ligament, is the *tendon of the extensor of the last phalanx of the thumb*, 79′, and, after a decided interval, the shorter *tendon of the extensor of the first phalanx of the thumb*, 78′, and, with it, the still shorter tendon of the *extensor of the metacarpal bone of the thumb*, 77′, which, accordingly, is endowed with a remarkable facility of extension and abduction. The arrangements of the extensor tendons, determine to a great degree, the natural and easy grouping of the fingers, especially in the various attitudes of extension, assumed in free motions of the hand. The five digits fall into *three* groups, one, composed of the three inner associated fingers, a second, including only the index finger, and a third, formed by the thumb. In extending the fingers, they naturally open away from each other, and usually in the above-named groups; if it be intended to point the way, to indicate an object, or to impress a statement, the index finger is alone extended, and somewhat *adducted*, whilst the three associated fingers are flexed,

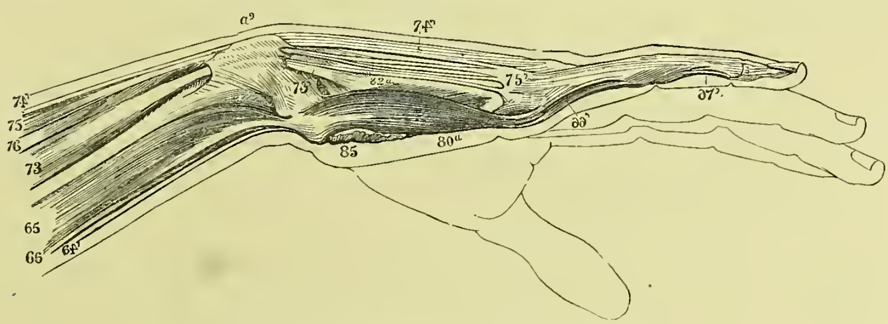


Fig. 185.—Inner Border of Wrist and Hand.

with or without the thumb. If special signs or gestures are to be made, the fingers may be opened or divided, and pointed arbitrarily, as was done by the patriots of the Four Cantons, and, as is now resorted to, in the finger-language of the Italians.

The fascia of the upper limb.—Continuous with the fascia covering the deltoid muscle, and with that which closes in the axilla, the fascia of the arm is somewhat thicker on the outer than on the inner side; it gives off the two strong intermuscular septa, by which it is attached to the condyles and epi-condyloid ridges of the humerus; and also a finer membranous layer between the brachialis anticus and the biceps. It passes over the hollow in front of the elbow, uniting its borders, and keeping the tendon of the biceps in its place. In the fore-arm, the fascia is very strong and aponeurotic below the condyles of the humerus, and furnishes important surfaces of attachment to the superficial flexor and pronator group of muscles in front, and to the common extensor group behind; it also gives off numerous intermuscular septa, and a layer of membrane passing across between the superficial and the deep flexor muscles ; below the elbow, on the inner side, it is strengthened by the *bicipital fascia*, figs. 124, 166, [68], already noticed with the biceps muscle ; lastly, it is attached to the olecranon process, and along the posterior border of the ulna, in the ulnar furrow. At the wrist, it is continuous with the annular ligaments and, thence, with the fasciæ of the hand, just described.

Surface-Forms dependent on the Muscles of the Upper Limb.

The effects produced by the biceps muscle, when at rest and in action, on the surface-forms of the arm, have been fully examined, p. 262. On either side of it, the plane of the brachialis anticus becomes evident, long and narrow on the outer side, shorter and somewhat triangular, just above the elbow on the inner side. The coraco-brachialis is recognisable, only when the arm is lifted from the body. On the back of the arm, a somewhat strongly marked, longitudinal elevation, emerging from beneath the deltoid, narrow above, but swelling out downwards as low as the middle of the arm, indicates the position of the long head of the triceps, whilst on either side, the asymmetrical forms of its two other heads are plainly seen, the outer one, longer and less prominent, the inner one shorter but more prominent ; between them, is the elongated quadrangular plane, dependent on the tendon of this compound muscle, flatter than the fleshy portions, but slightly convex from side to side, its upper end cut off obliquely, from within outwards, its inner border longer than the outer one, which is, however, somewhat more evident ; moreover, it becomes wider and flatter below, between the condyles of the humerus.

In front of the elbow, is the well-known asymmetrical, triangular space or hollow, with its unequal sides, and its unequally divided surface. The inner border, commencing at the inner condyle of the humerus, and corresponding with the pronator teres, is shorter, more oblique, and less prominent, being held down by the strong fascia ; the outer border, commencing higher up above the outer condyle, and corresponding with the supinator longus, is longer, nearly vertical, and more prominent, being covered by a thinner part of the fascia ; the base of the triangle, obscurely marked, corresponds with the lower part of the fleshy portion of the brachialis anticus, and is traversed somewhat obliquely from within outwards, by the prominence due to the tendon of the biceps muscle, which enters the space from above, and divides it into two unequal parts. The popliteal space, on the other hand, the homologous space on the lower limb, is lozenge shaped, not triangular, has its most prominent sides above it, not below, and is traversed by a median prominence, which enters it from below, not from above.

The hollow of the elbow is continued down the front of the fore-arm, by the principal intermuscular marking, which separates the flexor and pronator group from the supinator and extensor group of muscles. The general mass of the former group, occupies the greater part of the anterior surface of the fore-arm, and also its inner border, with a small part of the hinder surface; that of the latter group occupies a small part of the anterior surface, as well as the outer border, with the greater part of the hinder surface; they meet at, or are separated behind by, the undulating or sinuous ulnar furrow. The intermuscular marking, just mentioned as placed between them in front, opens out below, opposite the tendinous parts of the muscles, into a wide and shallow longitudinal plane, which reaches down nearly to the wrist, but is obliterated towards its lower end by the prominence of the lower part of the radius; it is occupied by the flexor longus pollicis. The general mass of the flexor and pronator group is pointed above, at the inner condyle of the humerus, and is somewhat compressed below that condyle, where it is crossed by the oblique bands of the bicipital fascia; it then quickly enlarges to its fullest breadth, after which it gradually tapers down to the wrist. The supinator and extensor mass, on the other hand, commences, above the elbow, in the arm, emerging as a very characteristic oblique elevation from between the brachialis and the triceps, acquires its greatest breadth on a level with the external condyle of the humerus, higher up than the pronator and flexor mass, tapers downwards more suddenly, and ends in a longer and straighter line, reaching nearly down to the wrist. Hence, the different contours of the outer and inner borders of the fore-arm. Each of the two chief masses formed by the muscles of the fore-arm, presents intrinsic muscular and tendinous surface-forms, separated by subordinate intermuscular markings and intertendinous planes or depressions.

In the position of supination, the surface-forms of the pronator and flexor group have an oblique direction, downwards and outwards, on the front of the fore-arm, and those of the supinator and extensor group, downwards and inwards, on the back of the fore-arm; but when the fore-arm is in the position of pronation, the aspects of the wrist are so changed in relation to the inner and outer condyles of the humerus, that the musculo-tendinous forms and intermediate markings, of both groups, pursue a more nearly longitudinal direction on the two flattened surfaces of the fore-arm.

The outermost elevation on the *pronator and flexor mass*, next below that of the pronator teres, is produced by the fleshy and tendinous parts of the flexor carpi radialis; it is rounded and full above, but ends in a narrower, nearly longitudinal ridge below, which runs down towards the inner part of the ball of the thumb, opposite to the junction of the outer with the middle third of the front of the wrist; if prolonged, the line of this tendon would pass through the base of the second metacarpal bone, and then out of the palm between the second and third fingers, when the hand is simply extended. On the inner side of this ridge, and separated from it by a narrow intertendinous depression, ending above in a slightly pronounced intermuscular marking, is a more slender ridge, caused by the delicate tendon of the palmaris longus, which runs quite superficially, especially below, where it spreads out a little, and is lost in the central part of the palm. Next, on the inner side of this, is an elongated triangular plane, widening out below, corresponding with the interval between the palmaris longus and the flexor carpi ulnaris, and occupied by the inner set of the tendons of the flexor sublimis digitorum; the thin ridge formed by the tendon of the flexor carpi ulnaris, the innermost of the flexor group, is sharper but much less prominent, and placed on a lower level than those of the flexor carpi radialis and palmaris longus, which are much more conspicuous. The actual prominence of each of the flexor forms, is, however, dependent on the condition of the muscles which produce them. Thus, when the wrist only is flexed, the fingers and thumb being kept extended, the tendons of the flexor carpi radialis and palmaris longus are prominent, and nearly equally so; when the fingers and thumb are in a state of easy semi-flexion, the tendon of the palmaris often sinks out of sight, whilst that of the radial flexor remains visible; when the fingers and thumb, as well as the wrist, are firmly flexed, then the palmaris longus becomes more prominent than the radial flexor; in order to bring the tendon of the flexor carpi ulnaris into full prominence, it is necessary to adduct, as well as to flex, the hand at the wrist joint. Again, when the fingers and thumb are extended, or in a state of semi-flexion and quiet, their long flexor muscles and tendons fill up smoothly the intervals which they occupy between the flexors of the wrist and palm; but when the hand is firmly clenched, the muscular portions of those long flexors are retracted up into the fore-arm, and, then, the tendon of the long flexor of the thumb is drawn in, so as to increase the hollow between the flexor carpi radialis and the supinator, whilst the tendons of the flexor sublimis project in the interval between the palmaris longus and the flexor carpi ulnaris. If, now, the little finger be very firmly closed, its short muscles are sufficiently strong to draw the somewhat moveable pisiform bone downwards and a little outwards, by which movement the tendon of the flexor carpi ulnaris is tightened and made more prominent, the front of the wrist is slightly widened, and numerous vertical wrinkles are produced in the skin above the pisiform bone itself, to which the integument is more or less attached.

Beyond the full, fleshy form produced on the outer border of the upper part of the fore-arm by the long *supinator* muscle, overlying the two radial extensors of the wrist, subordinate intermuscular markings are recognisable between those muscles, between the radial extensors and the common extensor of the fingers, and between the extensor minimi digiti and the ulnar extensor of the wrist, which is the innermost muscle and tendon of this group. The largest intermuscular interval, here, is that between the two radial extensors and the common extensor of the fingers, which widens out below, as the muscles become tendinous, and from which emerges on the outer border of the lower part of the fore-arm, a remarkable, oblique, elongated eminence, partially subdivided, and passing downwards and outwards over the back and outer border of the radius, towards the root of the thumb, ending upon it in the form of a slight ridge. This eminence and ridge are produced by the extensor of the metacarpal bone and by that of the first phalanx of the thumb; they interrupt, especially when the thumb is extended, in a very noticeable manner, the otherwise simple, and almost straight contour line of the lower part of the outer border of the fore-arm. The general mass of the supinator and extensor group, is subdivided into three subordinate forms; first, an outer, longitudinal, full form, descending from the arm, dependent on the long supinator and the two radial extensors, lifted up, as it were, by the subjacent external condyle of the humerus, the radius and the short supinator muscle; secondly, an intermediate emergent form, due to the extensor muscles of the thumb; and, thirdly, an inner longitudinal pointed form, produced by the common and special extensors of the fingers, and the ulnar extensor of the wrist. This last-named form tapers upwards, towards the external condyle, a short space in front of the subcutaneous part of the ulna, its posterior or inner border, describing a long sweeping curve, formed above by the intermuscular marking between it and the anconeus, and lower down by the ulnar furrow. The anconeus muscle itself produces a well-marked triangular, and slightly elevated plane, situated behind the upper part of this extensor mass, between it and the subcutaneous portion of the ulna, terminating above, at the back of the outer condyle of the humerus, which here sinks into the well-known dimple amongst the surrounding muscular forms. A slight intermuscular marking separates the ulnar extensor of the wrist from the extensors of the fingers.

On the *back of the hand*, the four tendons of the common extensor are so arranged, as to obviate any appearance of formality. They radiate from a point, not in the centre of the wrist, but nearer to its ulnar border; their lengths, their sizes, the angles at which they diverge, and the spaces between them, are all unequal. The strongest and straightest, but only the second as to length, is the tendon for the middle finger; the single tendon on its radial side, that for the index finger, is the longest, but not quite so thick; it is, however, thicker, and more divergent than the one for the ring finger; the tendon for the little finger is the thinnest, shortest and most divergent. The tendon of the special extensor of the little finger, can be traced coming down, separately, from near the lower end of the ulna; whilst that of the indicator muscle is in closer contact with, though really more independent of, the tendon of the common extensor which proceeds to the same finger. These two special extensors are more plainly distinguishable, when the other fingers are flexed, and the little and index fingers are separately extended. The tendons of the two radial and the ulnar extensors of the carpus, though very short beyond the wrist, are seen, in violent actions of the hand, as prominent ridges, the latter filling up the interval between the back of the styloid process of the ulna and the base of the fifth metacarpal bone, and the two former descending in the wider space left between the extensor tendons belonging to the index finger, and that proceeding to the last phalanx of the thumb. This last-named tendon gives rise to a well-marked and very oblique ridge, crossing outwards to its destination on the back of the thumb; between it and the less oblique tendon of the extensor of the first phalanx of the thumb, is a deep triangular depression or fossa, best seen when the thumb is extended, and whimsically named the anatomical snuff-box, '*la tabatière anatomique*,' as it forms a convenient measure of a dose of snuff, which may be given and received, without soiling the finger-tips of either donor or recipient. The tendon outside this fossa, together with the shorter one of the extensor of the metacarpal bone of the thumb, bridge over the interval between the styloid process of the radius and the root of the thumb, and here impart width to the expanding line of the wrist, as it joins on to the hand. The abductor pollicis gives fulness to the outline of the thumb beyond. The first dorsal interosseous muscle, larger than the rest, produces the longitudinal, prominent, soft form, seen behind the web of the thumb, partly filling up the void between the first and second metacarpal bones and increasing the breadth of the hand, by an undulating contour line proceeding from just above the head of the metacarpal bone of the thumb to the outer side of the root of the index finger. When the thumb is adducted, this soft prominence is still more marked. The other dorsal interosseous muscles produce, each, on the back of the hand, a fulness between the several diverging extensor tendons. The abductor of the little finger is responsible for the rich, sinuous contour-line of the inner border of the hand. The forms of the different knuckles have already been explained as dependent on those of the bones of the fingers and the thumb (p. 150); the expanded extensor tendons round off, or soften, those of the first knuckles of the fingers; the splitting of these tendons, to pass by the sides of the second knuckles, not only permits those joints to bend most freely, but reveals their trochlear form; whilst the terminal slips of the tendons fill up and obscure the slighter concavities of the last knuckles, or give them a flattened or somewhat convex transverse outline.

In the *palm of the hand*, it is evident that the central depressed part, or hollow, corresponds with the central, fan-shaped portion of the palmar fascia; whilst the characteristic thenar and hypothenar eminences, or balls of the thumb and little finger, differing widely from each other, represent very accurately the fleshy masses, formed by their short muscles respectively. The ball of the thumb is not only larger and rounder than that of the little finger, but it is less abruptly defined at the wrist; it seems, moreover, as if the thumb were set on to the rest of the hand. The ball of the little finger, smaller and narrower, appears to form rather a part of the hand itself; but, besides this, it is sharply defined from the wrist, by the somewhat pointed eminence, which has been already indicated, as constituting the *heel of the hand*; this is placed just below the pisiform bone, to which the tendon of the flexor carpi ulnaris descends, like the tendo Achillis to the os calcis in the foot. Thus characterised, the ball of the little finger resembles a narrow heel; but this is, on the whole, an animal character, reminding one of the form of a monkey's paw, and, accordingly, it is a peculiarity, to be concealed rather than exaggerated, in the human hand. The wide adductor of the thumb imparts great breadth to the corresponding part of the palm, and gives rise to a ridge which passes across the front of the web of skin, which is placed between this ridge and the prominence produced by the first dorsal interosseous muscle, already described. The webs between the fingers, generally, reach down further on the palmar than on the dorsal aspect, presenting well-defined margins, whereas, on the back of the hand, they form interdigital slanting furrows. Across the ball of the little finger, the palmaris brevis passes, and when in action, puckers in the skin along its inner side, and raises the inner border of the palm, so as to deepen its hollow, and thus help to form 'the drinking-cup of Diogenes,' produced mainly, however, by the action of the opponens muscles of the little finger and the thumb. The inner part of the palm of the hand, smooth in its quiescent state, is made, as it were, to *frown*, in anger or fear, but especially during fright and anguish, by the palmaris brevis, which might be called the *corrugator palmæ*. This muscle has been jocosely named 'the *guinea muscle*,' being presumed to be employed in the dexterous capture of the fee, as this is deftly transferred from the hand of the retiring patient, to the palm of the consultee.

The integuments are thicker behind and on the outer side, and much more delicate on the inner side and in front of the upper limb, excepting in the hand, where the reverse is the case. At the back of the elbow, the skin presents the redundancy and looseness common on the aspect of extension of hinge-joints, so that, when the limb is straightened, it is thrown into folds, one of which, passing softly and obliquely from the inner to the outer side, just above the elbow, reminds one of the similar oblique fold above the knee, and must not be taken for a muscular form. In the front of the elbow, the skin is very thin, to admit of being closely folded. At the back of the wrists, it presents slight transverse wrinkles, but in front, it shows two very distinct oblique lines, just above the well-marked indented border, which limits the commencement of the palm of the hand. The *palm* itself is traversed by numerous creases, some of which are more important than the rest, and amongst these are the so-called 'lines of Fate,' the subjects of many of the fancies of cheiromancy, and the basis of the tricks of palmistry. There are *four* principal *palmar lines*, two *transverse* and two *longitudinal*, so arranged as to form a figure like an Italic capital letter *M*. These can be completely reconciled with, and explained by, the anatomical construction of the hand. As already shown, the three inner fingers are structurally associated, in consequence of their extensor tendons being connected by oblique slips; and, as a consequence of this, they are also physiologically associated in their actions. If, now, these three fingers be flexed together, a transverse curved crease appears, commencing opposite the interdigital fold between the middle and index fingers, and passing inwards, with its convexity turned towards the centre of the palm, on to the inner border of the hand above the root of the little finger. If, then, the index finger be flexed, a second transverse curved crease is formed, passing from the outer border of the hand above the root of that finger, across the middle of the palm, on to the ball of the little finger, having its convexity turned towards the first crease. Next, if the little finger be adducted, towards the middle of the palm, a nearly straight longitudinal crease is produced, commencing in the interval between the balls of the little finger and the thumb, and passing through the middle of the palm, intersecting the second transverse crease, and meeting the first, opposite the root of the middle finger. Lastly, if the thumb be now adducted, a second, but strongly curved, longitudinal crease is formed, coursing round the inner border of the ball of the thumb, with its convexity directed inwards, towards the centre of the palm. As seen on the right palm, the two transverse creases form the two up-strokes, and the two longitudinal creases, the two down-strokes of the Italic *M*; on the left palm, the strokes of the letter are formed in the reverse way. This is a plain scientific explanation of the chief lines of the palm to which all its subordinate lines more or less conform. They are ruled by actual movements, as these are by the relative mobility of the fingers and the thumb, already explained, p. 379. The transverse lines are due to creases of flexion, the longitudinal ones, to creases of adduction. The creases themselves, it is well to add, are not caused, in the individual, by the use of the parts, but are previously developed, as the hand itself is being formed. The short double creases seen at the flexures of the joints of the fingers, less perfectly formed at the root of the index finger, and only single at the root of the little finger, are placed, the first row, about opposite the middle of the first phalanges, the second and third rows, a little behind the corresponding joints. The skin is thinner and smoother at these creases, and often coloured bluish by veins; but, elsewhere, the integument is thicker, and roughened by the ridges peculiar to the palm and to the sole. The pulpy enlargements seen in front of the last phalanges, traversed by curvilinear ridges, if well developed and marked by their characteristic central eminence, constitute unmistakeable evidence of a sensitive hand. The nails, which support these pulps at the back, should be broad, gently arched from side to side, and bounded by a closely fitting rim or matrix, crescentic behind and slightly divergent forwards at the sides; they are figured by a delicately marked *lunula* at the root, especially visible in the thumb-nails. The nails, in fact, should neither be narrow, nor long, nor strongly curved, nor markedly almond-shaped, as it is termed; but they should maintain the breadth so characteristic of the human form, even to its finger-ends, as opposed to, and distinguished from, the poor and narrow shape of the laterally compressed nails or claws, of many of the lower animals.

The *subcutaneous veins* of the upper limb commence by short, straight branches, seen on the dorsum of the hand, running from the backs of the fingers, and then between the knuckles, not over them, to gain the *dorsal venous arch,* which crosses the back of the broad part of the hand. This arch, always festooned, and often interrupted, is placed nearer to the fingers than to the wrist, but it varies much in form and completeness, in different persons, and even on the right and left hands. From it, are given off longitudinal trunks, which unite into fewer and longer ones. Of these, some find their way, over the outer border of the fore-arm, especially one large one from the back of the thumb, to form the so-called *radial* veins; some turn round the inner border of the fore-arm, and form the *ulnar* veins; and others ascend from the ball of the thumb and middle of the palm, to form the *median* veins. Having reached the front of the elbow, fig. 124, the three sets of veins coalesce, in a tolerably constant manner, so as, ultimately, to form two chief venous trunks; one of these, on the outer side of the arm, named the *cephalic vein,* ascends near the outer border of the biceps muscle, and then along the intermuscular space between the pectoral and deltoid muscles to disappear in the coracoid furrow, where it dips through the fascia to join the deep veins; the other trunk, on the inner side of the arm, named the *basilic vein,* passes up near the inner border of the biceps, and peirces the fascia sooner, that is, about the middle of the arm, and so disappears from view.

Table of the Muscles of the Neck, Head, and Face.

THE NECK.	THE HEAD AND FACE.
Sterno-cleido-mastoideus, 1, 1*a*.	*Masticatory Group.*
Sterno-thyroideus, 2.	Temporalis, 10.
Thyro-hyoideus, 3.	Masseter, 11.
Sterno-hyoideus, 4.	Buccinator, 12.
Omo-hyoideus, 5, 5.	
Mylo-hyoideus, 6.	*Epicranial Group.*
Digastricus, 7, 7′.	
Stylo-hyoideus, 8.	Occipito-frontalis, 13, 13′.
Platysma myoides, 9.	Corrugator supercilii, 17.

Table of the Muscles of the Neck, &c.—*continued*

THE HEAD AND FACE—*continued.*

Auricular Group.

Attrahens aurem, 14.
Attollens aurem, 15, 15′.
Retrahens aurem, 16.

Ocular Group.

Rectus superior, 21.
,, inferior, 22.
,, externus, 23.
,, internus, 24.
Obliquus superior, 25.
,, inferior, 26.

Palpebral Group.

Levator palpebræ superioris, 19.
Tensor tarsi, 20.
Orbicularis palpebrarum, 18.
(*Tendo palpebrarum*, T O.)

Nasal Group.

Pyramidalis nasi, 27.
Compressor alæ nasi, 28.
Dilatatores naris.
Depressor alæ nasi, 30.
Levator labii superioris alæque nasi, 31.

Labial Group.

Levator labii superioris, 32.
,, anguli oris, 33.
Zygomaticus major, 34.
,, minor, 35.
Depressor anguli oris, or Triangularis oris, 36.
Depressor labii inferioris, or Quadratus menti, 37.
Levator labii inferioris, or Levator menti, 38.
Orbicularis, 39.
Risorius, 40.

The Muscles of the Neck.

Many of the muscles situated in the neck, for example, the deep vertebral muscles and the longitudinal and divergent muscles at the back of the neck, as well as the scaleni, the levator anguli scapulæ and the prævertebral group in front, have already been described, with the muscles of the Trunk and Upper Limb. In front of the prævertebral muscles, is placed the *pharynx*, a membranous sac, covered outside by muscles, depending from the base of the skull, and reaching down to about the middle of the throat, where it is continuous with the *œsophagus* or *gullet*. In front of the upper part of the pharynx, and communicating with it, are the cavities of the nose and mouth; lower down, is the root of the tongue, with its proper muscles, supported by the *hyoid bone*, fig. 190, *h*; beneath that, is the *larynx*, or organ of voice, *t*, which also opens into the pharynx; and, below this, is the *trachea* or *windpipe*, *w*, into which the larynx leads, and which lies in front of the œsophagus, in the remainder of the neck, whence both tubes pass into the thorax. Suspended from the larynx, on each side of the windpipe, is the *thyroid body*, T. All these parts, from the sternum up to the lower jaw, are covered by muscles, some being placed below the hyoid bone, forming a *depressor group*, and others above it, constituting an *elevator group* of that bone; all are enclosed in a V-shaped space, as seen from the front of the neck, fig. 193, bounded, on the sides, by the sterno-cleido-mastoid muscles, [1] [1a], below by the sternal notch, and above by the mastoid processes of the temporal bones, and the lower jaw. The right and left halves of this V-shaped interval, constitute the *anterior triangles* of the neck. Behind each sterno-cleido-mastoid muscle, figs. 186, 187, [1] [1a], between it and the corresponding trapezius muscle, [51], which forms the extreme border of the neck, is another triangular interval, named the *posterior triangle* of the neck, which has its base at the collar bone, and in which, are placed, from above downwards, parts of the splenius capitis, *Sp*, levator anguli scapulæ, *Le*, scalenus posticus, *Sc p*, and scalenus anticus, *Sc a*, muscles. A small portion of one of the depressors of the hyoid bone, the omo-hyoid, [5], appears in this triangle. Finally, the platysma myoides, fig. 193, [9], the largest cutaneous muscle in the human body, covers nearly the whole side of the neck.

Sterno-Cleido-Mastoideus, figs. 186, 187, 193, [1] [1a].—Superficial, but chiefly covered by the thin platysma myoides; consists below, of two portions or heads, an *inner* narrow and fusiform, [1], and an *outer* wide and flattened head, [1a], the two joining about the middle of the neck, to form a thick prominent mass, which again widens out above; the *inner* portion upwards and backwards, the *outer* portion nearly vertically upwards, passing beneath the other. The *inner* or *sternal* head, [1], tendinous in front and fleshy behind, from the front of the manubrium of the sternum, the *outer* or *clavicular* head, [1a], entirely fleshy, from the upper border of the inner third of the clavicle——by a broad tendon, into the anterior border and outer surface of the mastoid process of the temporal bone, a ridge behind that process, and a small part of the superior curved line of the occipital bone. Between the two heads, below, is a small, but well-marked, triangular depression or fossa, just above the enlarged inner end of the collar bone, in which there is no muscular substance, but which is covered in by the fascia of the neck. The entire muscle is narrower in the middle than at either end; and it turns or twists slightly, so that its anterior surface is directed outwards, as it ascends. Sometimes its outer head, and the trapezius also, are so wide, that the two muscles meet over the posterior triangle of the neck. From having a clavicular as well as a sternal origin, this muscle is named, in full, the *sterno-cleido-mastoid* (*κλεὶς*, cleis, *clavis*, a key); but, for brevity sake, it is usually called the *sterno-mastoid.* The muscle of one side flexes the head slightly, and rotates it, so as to turn the face and chin to the other side; in this action, it is assisted by the opposite splenius capitis and obliquus capitis inferior muscles. If it co-operates with the splenius and the trapezius of its own side, it inclines the head towards the corresponding shoulder. The two sterno-mastoids acting together, bow the head forwards on the neck, and then flex the neck upon the chest; in raising the head from the supine recumbent position, both muscles are also called into use, their leverage being much more advantageous than that of the prævertebral

Fig. 186.—Dissection of the Muscles of the Neck, Head, and Face.

muscles, which are so close to the spine. In these last two actions, the sternal portion of the muscle is chiefly concerned. The clavicular portion, if acting from the head, assists in raising the shoulder; and both parts may act as inspiratory muscles, in laboured breathing.

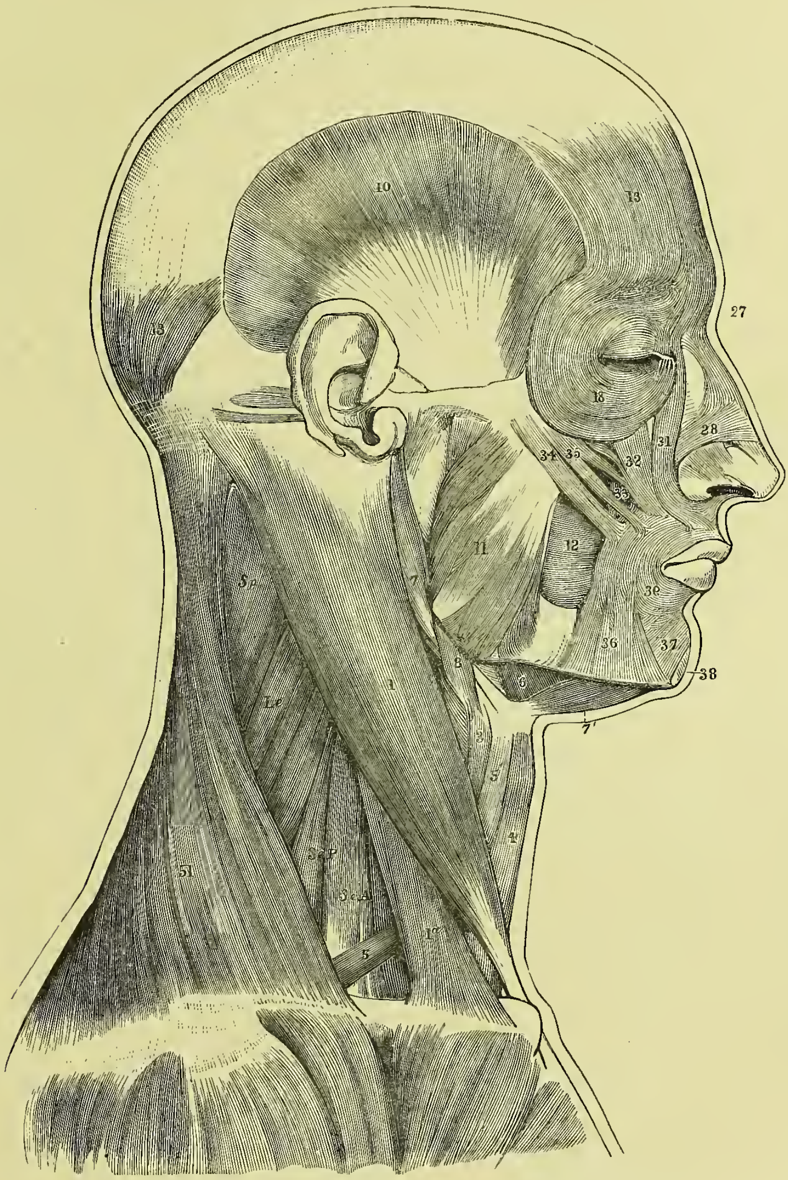


Fig. 187.—Muscles of the side of the Neck, Head, and Face.

The Hyoid or Lingual Bone, figs. 1, 188, 189, 190, *h*. This single, small bone, named from its resemblance to the Greek letter *υ* (upsilon), and from its supporting the tongue (lingua), is suspended, by ligaments and muscles, from the styloid and mastoid processes of the temporal bone, and from the inner surface of the lower jaw, a little below the level of the arch of which, it is placed, horizontally, across the middle line, with its open ends turned backwards, and so held in position, that it determines the peculiar re-entering angle of the neck, beneath the lower jaw, fig. 190. It not only supports the tongue above, but most of the lingual muscles are attached to it; from it, hangs the larynx below; and in this direction, the bone itself is connected by muscles with the first rib, the sternum, the clavicle and the scapula. The anterior surface of the thicker central part, or *body*, of the hyoid bone, is marked by impressions for the attachment of muscles, but its lower border is subcutaneous. Its open ends, named the *greater cornua*, and two smaller nearly upright processes, named the *lesser cornua*, are for the attachment of its suspensory ligaments and its *elevator muscles*. The prongs of this horse-shoe shaped bone, serve to protect, and keep open the superior aperture of the larynx, which they partly embrace, and so secure the constant freedom of this passage to air, a condition necessary to life.

The larynx or organ of voice, figs. 188, 189, 190. This part of the common air passage leading to the lungs, forms a three-sided and inverted pyramid, having its base suspended from the hyoid bone, its truncated apex connected with the trachea, one side turned backwards to the throat, and its other two sides meeting at a projecting vertical ridge in the median line of the neck, a short distance below the re-entering angle corresponding with the hyoid bone. Its framework consists of four principal cartilages. First, the *cricoid cartilage*, fig. 190, *c*, named from its resemblance to a *signet ring* (*κρίκος*, a ring), forms a short, hollow cylinder or ring, placed at the top of the trachea, with its narrow or shallow part turned forwards and recognisable in front, and its broader, deeper, or signet-like part, turned backwards. Resting upon the sides of the cricoid, and overlapping it, is the largest cartilage of the larynx, named, from its shape and office, the *thyroid cartilage*, figs. 188, 189, 190, *t*, (*θυρεός*, a shield); this consists of a transversely oblong, cartilaginous plate, notched in the middle of its upper border, and bent backwards on itself in the middle line, so as to form the ridge above mentioned; its two halves or *alæ*, spread apart backwards, embrace and conceal the sides of the cricoid cartilage, and terminate in two free hinder borders. These borders end, above and below, in little processes, called *cornua*, the lower ones, short and turned forwards, articulating by small facets with the sides of the cricoid cartilage, the upper ones, longer and curved backwards, being connected by ligaments with the greater cornua of the hyoid bone. The upper notched border of the thyroid cartilage, much longer than the lower border, is attached to the hyoid bone by the thyro-hyoid membrane, which, however, is not fixed to the lower margin of that bone, but passes behind its inner curved surface, to gain its upper margin; and, as the upper notched portion of the front of the thyroid cartilage, is bevelled off obliquely downwards and forwards, this cartilage, carrying the rest of the larynx and the windpipe, can ascend behind and within the arch of the hyoid bone. The bevelled portion of the thyroid cartilage forms an obtuse angle with its median ridge, which inclines gently backwards and downwards; the angular projection itself constitutes the *pomum Adami* or *Adam's apple*, so named because of its prominence in Man, as compared with Woman. The lower, shorter border of the thyroid cartilage is concave, and is connected with the front and sides of the cricoid, by the thick elastic *crico-thyroid membrane.* Inside the back of the larynx, supported on, and moveably articulated with, the deeper part of the cricoid cartilage, are the two other principal laryngeal cartilages, namely the right and left *arytenoid cartilages,* so-called from their peculiar shape (*ἀρύταινα*, a pitcher); to these, the hinder ends of the right and left true *vocal cords* are attached, the anterior ends being fixed to the back of the median folded part of the thyroid cartilage, just below its prominent angle. Between these cords, is the opening called the *glottis,* through which the air is inspired and expired, in breathing. By the vibration of the vocal cords on either side of it, the voice is produced. The glottis is, moreover, guarded by a leaf-shaped, soft, fibro-cartilaginous valve, named the *epiglottis,* which is situated deeply out of sight, at the root of the tongue, falling back over the opening, in the act of swallowing.

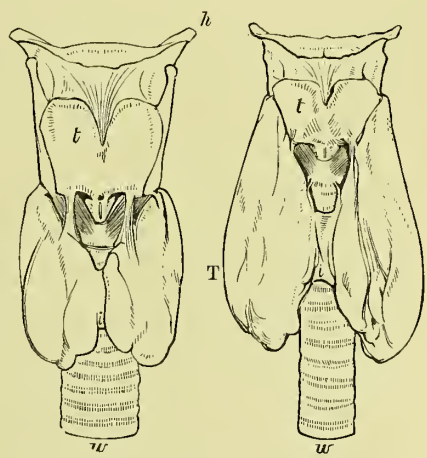


Fig. 188.—Hyoid Bone, Larynx, and Thyroid Body, in the Male.
Fig. 189.—The same parts in the Female.

Attached by membrane to the lower border of the cricoid cartilage, is the *trachea* or *windpipe,* figs. 188, 189, 190, *w*, composed of a series of C-shaped flattened cartilages, connected together by intermediate membranes, and completed behind by a flat membranous wall, so as to form a continuous tube, which descends through the lower part of the neck into the thorax, where, by means of its branches, it communicates with the lungs.

Suspended from the sides and front of the thyroid cartilage, and overlapping the upper part of the trachea, is the *thyroid body,* T, a glandular organ of peculiar construction, consisting of two lateral *lobes,* united by a narrow median part, named the *isthmus.* This gland is much larger in the female, fig. 189, than in the male, fig. 188, whilst, on the contrary, the hyoid apparatus, the larynx and the trachea are smaller in women.

The larynx, as well as the tongue, palate, and pharynx, have many deep-seated intrinsic muscles, by which their several movements and actions are performed; one pair of small laryngeal muscles, the *crico-thyroid*, is seen lying on the cricoid cartilage in figs. 188, 189, and also in fig. 190, *c t*; one of the constrictor muscles, of the pharynx, *c o*, is also shown in fig. 190. But it is necessary to limit one's attention to those muscles only, which affect the surface-forms, namely, the *depressor* and *elevator* groups, which act upon the moveable hyoid and laryngeal apparatus, either lowering or raising them in the neck.

The Depressor Group, figs. 186, 187, 193.—This includes the sterno-thyroid, thyro-hyoid, sterno-hyoid, and omo-hyoid muscles.

Sterno-thyroideus, 190, [2]. Deep-seated, and nearly covered; flat, band-like, having a tendinous intersection across its lower part; nearly vertical. Back of the upper piece of the sternum, and first, or first and second costal cartilages——an oblique line on the ala of the thyroid cartilage. It depresses not only the larynx, but, through it, the hyoid apparatus generally, and the tongue with it.

Thyro-hyoideus, figs. 186, 187, 190, 193, [3]. Partly superficial, above; short, flat, quadrilateral; vertical, continuous upwards from the last muscle. Oblique line on the ala of the thyroid cartilage——body and greater cornu of hyoid bone. If the larynx be held down by the sterno-thyroid, then the thyro-hyoid depresses the hyoid bone; but if the hyoid bone be held up, then this muscle elevates the larynx behind and within the hyoid arch, as always occurs in swallowing, during which act, the larynx may be seen to ascend suddenly. By this movement, the epiglottis is lifted against the root of the tongue, and so is pressed back over the glottis, as the food descends.

Sterno-hyoideus, figs. 186, 187, 193, [4]. Superficial, except below, where it is placed behind the sternum, clavicle, and sterno-mastoid muscle; flat, narrow, ribbon-shaped, presenting usually a small tendinous intersection; upwards and a little inwards. Back of the upper piece of the sternum, higher up than the sterno-thyroid, cartilage of the first rib, and, sometimes, the clavicle——lower border of the body of the hyoid bone. This muscle touches its fellow muscle along the middle line; but they diverge slightly opposite to the Pomum Adami, and still more widely near the sternum. It depresses the hyoid bone.

Omo-hyoideus, figs. 186, 187, 193, [5] [5′]. Successively concealed, superficial, and concealed; consists of two fleshy portions, inferior and superior, joined by a small round tendon of variable length and size; the *inferior* portion, [5], inclined forwards, inwards and slightly upwards, across the lower part of the neck, the *superior* portion, [5′], almost vertical, but inclined slightly forwards and inwards, the two portions forming an obtuse angle, at the intermediate tendon. Behind the notch in the upper border of the scapula (ὦμος, the top of the shoulder), and the neighbouring ligament——body of the hyoid bone. This peculiar muscle presents many varieties, especially in its inferior portion. Usually, this portion is partially seen, crossing the posterior triangle of the neck, a little above the collar-bone; the intermediate tendon is covered by the sterno-mastoid muscle, and is held in its angular position by a special fold of the cervical fascia; the superior fleshy portion is superficial in the anterior triangle of the neck. The omo-hyoid muscle depresses the hyoid bone, and also draws it backwards; it is concerned in swallowing, and especially in the act of suckling, as may be seen in infants. It also acts in the spasmodic choking and swallowing efforts, which acccompany certain painful emotions, during which, the larynx itself ascends, whilst the hyoid bone is fixed, or even drawn downwards.

The Elevator Group, figs. 186, 187, 190.—This consists essentially of the mylo-hyoid, the digastric, and the stylo-hyoid muscles.

Mylo-hyoideus, figs. 186, 187, [6]. Partly superficial, partly crossed by the digastric muscle; broad, triangular, its base being attached to the lower jaw, and its apex to the hyoid bone; stretched beneath the tongue and the cavity of the mouth, to which it forms a sort of floor. Mylo-hyoid ridge on the inner surface of the jaw, from the symphysis backwards, to opposite the last molar tooth——the *anterior* and *middle* fasciculi end along a median fibrous raphé, and join the fibres of the opposite muscle at an acute angle; the *posterior* fibres only are attached to the hyoid bone. It draws the hyoid bone and its appendages upwards and forwards; but if that bone be fixed, it aids in depressing the lower jaw, and in opening the mouth, as in yawning. The proper muscles of the tongue, of which one only, the *hyo-glossus*, is partially exposed behind the mylo-hyoid, are placed above the mylo-hyoid muscle.

Digastricus, figs. 186, 187, 190, [7] [7′]. Superficial, except where it is covered by the sterno-mastoid; consists, as implied by its name, of two fleshy portions or bellies, posterior and anterior, joined by an intermediate rounded tendon; the *posterior portion*, [7], passes downwards, forwards and inwards, between the mastoid process of the temporal bone and the hyoid bone, the *anterior portion*, [7′], passes, thence, upwards, forwards and slightly inwards, to the back of the symphysis of the lower jaw, the intermediate tendon situated at the obtuse angle between them, passing through the lower end of the tendon of insertion of the stylo-hyoid muscle, by which, and by a sling of tendinous tissue lined by a synovial membrane, it is held to the body and greater cornu of the hyoid bone. The *posterior* portion, from the digastric fossa on the inner side of the mastoid process, the *anterior* portion, from a rough depression on the inner surface of the lower jaw, close to the symphysis——

side and greater cornu of the hyoid bone, by the intermediate tendon and its sling. The anterior portion of the muscle is shorter than the posterior one. The posterior portion is very deeply seated, beneath the parotid salivary gland; the submaxillary salivary gland is placed, beneath the jaw, in the angle above its tendon, resting partly on the mylo-hyoid muscle. When the hyoid bone is held down, the digastric muscle, both portions acting, depresses the jaw, and thus opens the mouth wide; but if the jaw be held up and fixed, then this muscle lifts up the hyoid bone and its appendages. If the posterior portion could act alone, it would draw the hyoid bone upwards and backwards; which the anterior portion alone would, as in the first stage of swallowing, lift it upwards and forwards.

Stylo-hyoideus, figs. 186, 187, 190, [8]. Deep-seated, except quite at its insertion; small, slender, divided into two bundles near its insertion, for the passage of the tendon of the digastric muscle; oblique downwards and forwards. Outer surface of the styloid process of the temporal bone——junction of the greater cornu with the body of the hyoid bone. This little muscle is sometimes absent. It suspends, and draws the hyoid bone upwards and backwards. Near it, but equally concealed, are two other suspensory muscles, which descend from the styloid process, one to the pharynx and the other to the tongue; behind and beneath it, is a part of the pharynx itself.

The *fascia of the neck*. This is a very strong membrane, which passes from the border of one trapezius to that of the other, embracing all the soft parts of the neck, and splitting and uniting again, to form, amongst others, a very firm sheath for the sterno-mastoid muscle, which, like the sartorius, has an oblique direction, and requires such a restraint, to keep it in its place during action. The cervical fascia also furnishes a sort of sling for the tendon of the omo-hyoid muscle.

Platysma myoides, fig. 193,-[9]. This, the largest *cutaneous muscle* in the human body, is the sole representative of the great investing cutaneous muscle of the trunk, the *panniculus carnosus* of the Mammalia generally, which, in the hedgehog, serves to roll up that animal into a ball, erects the quills upon the excited porcupine, raises the crest of the dog or cat, and the mane of the lion, and enables the horse to shake the skin upon its flanks, so as to rattle its harness or dislodge a fly. Superficial; a thin, broad (πλατύς, broad), irregularly quadrangular sheet of pale muscular bundles, lying in the superficial fascia upon the proper fascia of the neck; oblique upwards, forwards and inwards, from the upper part of the shoulder and chest, across the side of the neck, on to the front of the neck and the lower part of the face. Fascia covering portions of the pectoral, deltoid and trapezius muscles, and subcutaneous periosteum of the acromion process and the collar bone——the *inner* or *anterior* fasciculi meet and interlace with those of the muscle of the opposite side, a short distance below the chin; the *middle* and larger part of the muscle reaches the lower jaw, becoming chiefly attached to its subcutaneous periosteum, from the symphysis backwards; the *outer* or *hinder* bundles pass forwards over the lower part of the side of the face, fig. 186, [9], and blend with the muscles at the corner of the mouth. A few of the very highest fibres were described by Santorini, as the *risorius* or *laughing muscle*, [40]. The fasciculi of the platysma are more intimately connected with the skin in the lower part of the muscle, than in its upper part. The entire muscle forms a general additional covering to parts of the pectoralis major, deltoid, trapezius, scaleni, omo-hyoid, sterno-mastoid, sterno-hyoid, digastric and mylo-hyoid muscles; but it is so thin, that it softens, yet does not hide their forms. In its action, which sometimes occurs suddenly, as a sort of 'nervous' twitching, it throws the skin into oblique, linear ridges, parallel with its fasciculi. The anterior and middle portions of the platysma may aid in depressing the jaw; the hinder or facial portion draws the lower lip and the angle of the mouth downwards and backwards, and so assists in the expression of fear and grief.

The male and female neck and throat, figs. 190, 191. It has been previously shown, p. 194, that the relative length of the neck, in the two sexes, depends more on the degree of obliquity of the ribs, and the consequent position of the sternum, than on a difference of length in the cervical region of the spine. This fact is well shown in the accompanying illustrations, drawn carefully from nature, figs. 190, 191, in which it will be seen that the top of the sternum, in the male, is on a level with the lower part of the body of the second dorsal vertebra, whereas, in the female, it is on a level with the lower part of the body of the third. The greater obliquity of the concealed portion of the occipital bone, in the female, also adds to the length of the hinder part of the neck in that sex. The greater thickness of the component bones of the neck in the male, increases its apparent shortness; but the muscles behind the neck, having to support a heavier weight, are also actually, and relatively thicker in the male; and, in front of the spine, the hyoid bone and its appendages, the larynx, the trachea, and all the muscles both depressors and elevators, are of much larger dimensions, especially from before backwards, and from side to side. Owing to the differences in the length and obliquity of the lower jaw, the re-entering angle of the neck, in front, is nearly a right angle in the male, but is somewhat more acute in the female. Besides this, the profile line of the throat lower down, and its lateral surface-forms are especially modified in the two sexes. The 'Pomum Adami' is much less prominent, and also relatively somewhat higher up in the female, but lower down, and more projecting in the male. Below the larynx, the thyroid body, T, which is covered by the depressor muscles of the hyoid bone, nevertheless, chiefly determines the general surface-forms of the throat. In the shorter and thicker neck of the male, this body, the function of which is not well determined, sinks backwards, and retires even beneath the top of the sternum; whereas, in the longer and more slender 'swan-like' female neck, it is longer and relatively fuller, especially below, where it gives rise to

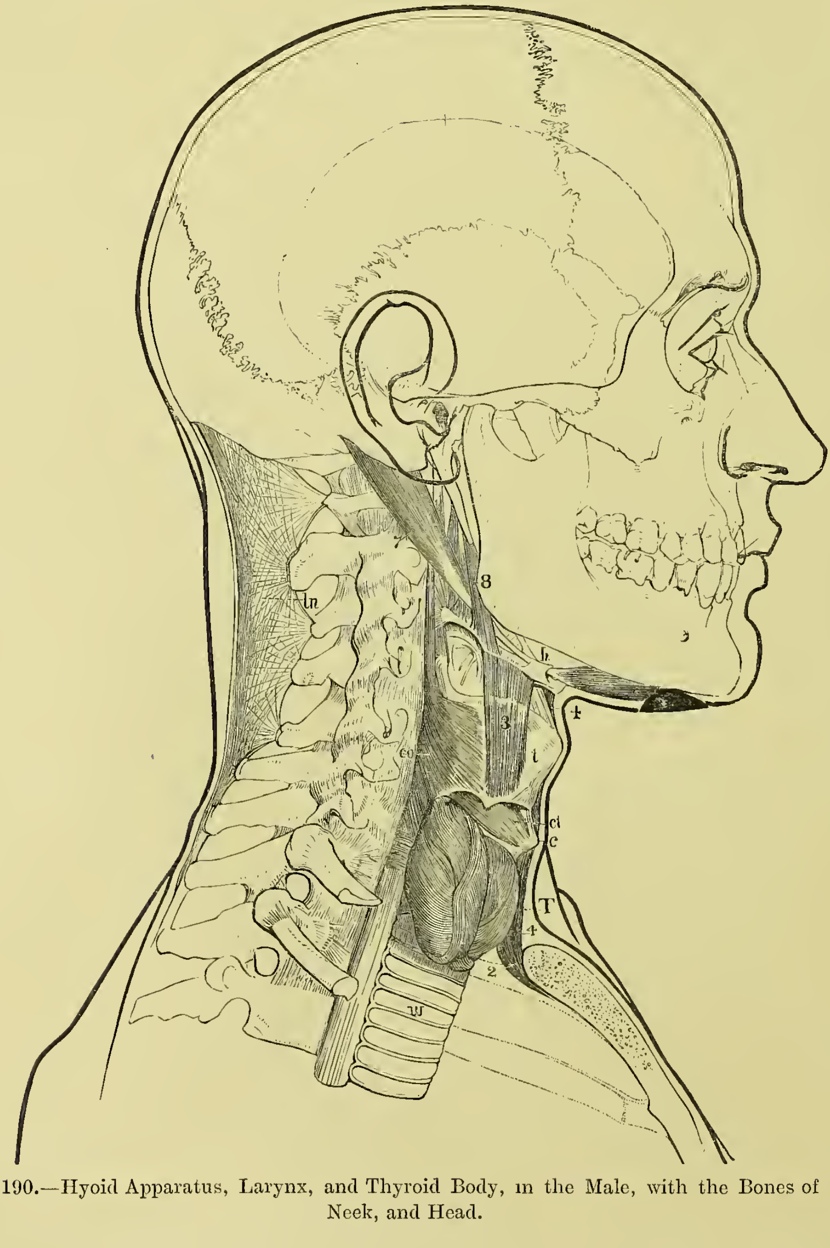


Fig. 190.—Hyoid Apparatus, Larynx, and Thyroid Body, in the Male, with the Bones of the Neck, and Head.

the peculiar smooth contour of the lower part of the female throat, and produces a rounded fulness on either side of the middle line, a beauty sufficiently appreciated by artists. Between the Pomum Adami and the supra-sternal notch, the outline of the male throat sometimes shows a second smaller eminence, due to the cricoid cartilage, *c*; but, in the female, this cartilage is not perceptible on the surface, and the profile line pursues a long, gentle and uninterrupted curve, from the thyroid eminence down to the

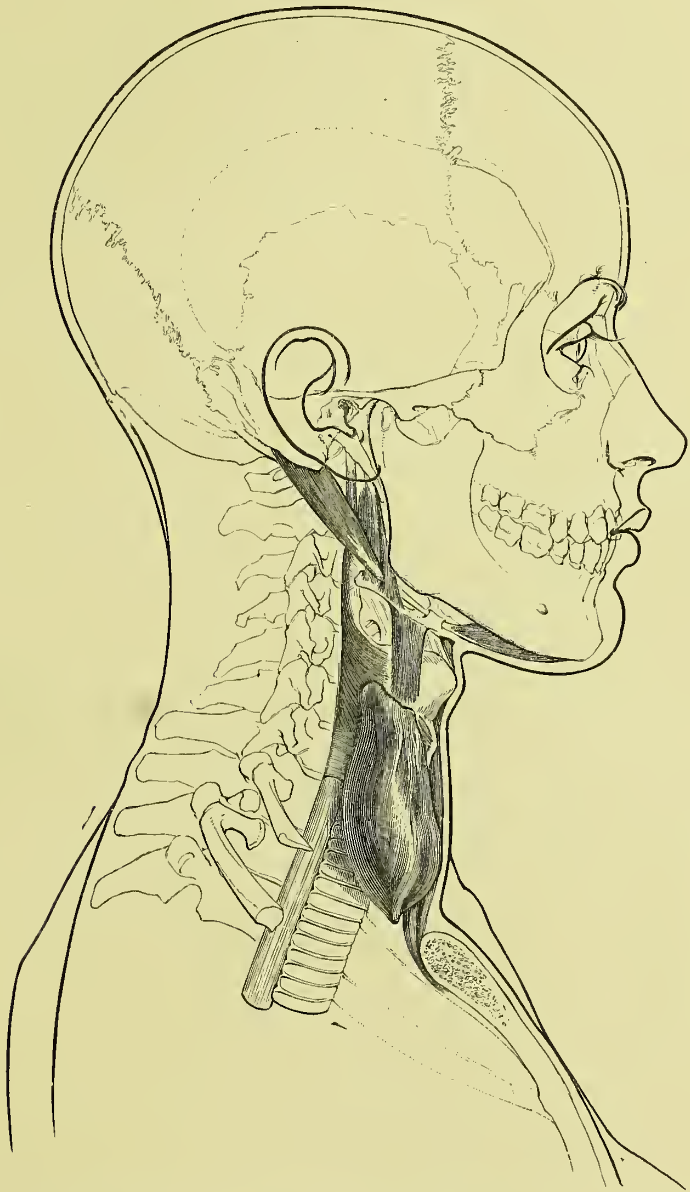


Fig. 191.—Hyoid Apparatus, Larynx, and Thyroid Body, in the Female, with the Bones of the Neck, and Head.

root of the neck. The great differences in the size, shape, and proportions of the cranium and face, in the two sexes (p. 196), are, also, illustrated in these two figures. In fig. 190, the ligamentum nuchæ, *ln*, is represented.

The Muscles of the Head and Face.

The muscles of the head and face, named *cranial* and *facial*, according to their situation upon the cranium or the face, pass, in some instances, as with the temporal muscle, and the pyramidalis nasi, from one region to another. Classified according to their action, they consist first, of the *muscles of mastication*, which move the lower jaw upon the upper one, the teeth of course, being interposed, but, in this set, may be comprised a muscle of the cheek, which helps to keep the food between the teeth ; and, secondly, of the *muscles of expression*, so named because they act specially upon the features, which are the most mobile and significant organs of expression. But most of these muscles are also concerned in some other office, such as that of drinking, the reception of food into the mouth, whistling, singing, talking, or in the exercise of the senses of sight, smell, or taste ; and, again, it must be observed, that every muscle in the body, *may* become an organ of expression. Dividing the muscles of the head and face into suitable local groups, for the purposes of description, they include a *masticatory*, an *epicranial*, an *auricular*, an *orbital* or *ocular*, a *palpebral*, a *nasal*, and a *labial* group.

The Masticatory Group, figs. 186, 187, 193.—This consists of the temporal, masseter, external and internal pterygoids, and buccinator muscles.

Temporalis, figs. 187, 192, 10 10′. Superficial above, but covered by the temporal fascia, the aponeurosis of the occipito-frontalis muscle, two of the auricular muscles, the hairy scalp, and the skin over the temple, deep-seated lower down, being covered by the zygoma, and the masseter muscle ; fan-shaped, wide and thin above, narrow and thicker below ; its hindmost fasciculi almost horizontal, those next and beyond the middle of the muscle oblique downwards and forwards, the succeeding ones nearly vertical, the anterior fasciculi downwards and a little backwards, all converging to a broad, central, superficial and fan-shaped tendon, which descends under cover of the zygoma, fig. 192. Floor of the temporal fossa, which it covers, deep surface of the temporal fascia, which closes in that fossa——inner surface and anterior border of the coronoid process of the lower jaw, from its apex down to near the last molar tooth. This muscle is connected with parts of the parietal, frontal, temporal, and sphenoid bones. It elevates the lower jaw, closes the teeth, and is the most powerful of the masticatory muscles. If the lower jaw is protruded, the hindmost part of this muscle can draw it back again.

Masseter, figs. 186, 187, 193, 11. Superficial, but overlaid by the parotid salivary gland, and crossed, in front, by the orbicularis palpebrarum, zygomaticus major, and risorius muscles ; thick, flat, and quadrangular, consisting of a smaller, *deep*, and of a larger, *superficial* portion; the *deep* portion, oblique downwards and forwards, the *superficial* portion, oblique in the opposite direction. The *deep* portion, from the hinder part of the lower border, and from the inner surface of the zygoma, the *superficial* portion, from the fore part of the lower border of the zygoma, and adjacent part of the malar process of the superior maxillary bone——the *deep* part, to the upper half of the ramus, and to the coronoid process of the lower jaw, the *superficial* part, to the lower half of the ramus, down to the angle of that bone. It is a powerful elevator of the lower jaw clenching the teeth; its superficial part assists in drawing the jaw forwards, protruding the chin, and directing it over to the opposite side.

Pterygoidei, internus and *externus*, fig. 117. Deep-seated on the inner side of the ramus of the lower jaw, not reaching the surface anywhere. The *internal pterygoid* descends from parts of the sphenoid and palate bones, to the inner surface of the ramus and angle of the inferior maxilla; it assists in closing the teeth, forming, as it were, an internal masseter muscle; it rather tends to draw the jaw backwards. The *external pterygoid*, fig. 117, *p*, passes, nearly horizontally backwards and outwards, from parts of the sphenoid bone, to the front of the neck of the lower jaw, a few fasciculi becoming attached to the capsule and inter-articular fibro-cartilage of the joint, above the condyle. It draws the condyle forwards, and so moves the entire jaw towards the opposite side, the chin, of course, included; but, if both muscles act, they simply protrude the jaw and chin. The capsular fasciculi move the fibro-cartilage simultaneously with the condyle, a condition constant, and necessary to the action of this joint.

FIG. 192.—Insertion of the Right Temporal Muscle.

The muscles which raise the lower jaw, and close the teeth, arising from the cranium or face, are very powerful; but those which depress it, acting from the hyoid bone, and only efficaciously when that bone is itself fixed, are comparatively very weak. The weight of the lower jaw, with the teeth and the soft parts connected with it, when not counteracted by the continuous gentle action of the masticatory muscles, suffices to depress it, as is seen at the moment of death.

Buccinator, figs. 186, 187, 190, [12]. Superficial forward, on the cheek (bucca), but covered behind by the masseter, the ramus of the lower jaw, and some fatty tissue, and crossed by certain muscles near the corner of the mouth; flat, thin, nearly quadrilateral; horizontal, the fasciculi converging as they pass forwards, the middle ones intersecting as they reach the angle of the lips. Outer surface of the alveolar portion of both the upper and lower jaws, opposite to the molar teeth, and a strong band of fascia, named the *pterygo-maxillary ligament,* which descends from the sphenoid bone to the lower jaw, close to the last molar tooth——the soft tissue of the two lips at the corner of the mouth, blending with the orbicular muscle. The parotid duct passes through the buccinator muscle, to enter, and convey the saliva into the mouth, the mucous membrane of which lines the inner surface of the muscle. By contracting and compressing the cheek, the buccinator retains the food between the teeth, during mastication; it widens the aperture of the mouth sideways, retracts the corner of the mouth, and wrinkles the cheek, making prominent the bucco-labial furrow. The two muscles, when the cheeks are previously distended with air, expel it from between the lips, as in blowing into a cornet or trumpet; hence, it is known as the *trumpeter's* muscle (*buccina,* a trumpet). In the representations of the face of Boreas, which, as well as the heads of 'quiring Cherubim,' be it observed, often want the inflating organs or lungs, the cheek muscles are inordinately distended, reminding one of Lear's invocation, 'Blow, winds, and crack your cheeks.'

The Epicranial Group, figs. 186, 187, 193.—This includes the two *scalp muscles,* the occipital and frontal, united by the wide epicranial aponeurosis, into one broad, digastric muscle, named occipito-frontal. Associated with the frontal portion, is the corrugator muscle of the eyebrow.

Occipito-frontalis, figs. 186, 187, 193, [13 13′]. Superficial in the frontal portion, but, elsewhere, covered by the hairy scalp; both portions broad, thin, and quadrilateral, but the frontal portion much longer, broader and paler than the occipital portion, the intervening aponeurosis being of equal breadth, but much longer than either; longitudinal over the entire smooth surface of the cranium. The *occipital portion,* [13], outer two-thirds of the superior curved line of the occipital bone, and mastoid process of the temporal bone——posterior border of the epicranial aponeurosis; the *frontal portion,* [13′], curved anterior border of that aponeurosis——external angular process of the frontal bone, nasal bone continuously with the pyramidalis nasi muscle, and, between these two points, the tissue of the eyebrow, becoming blended with the fasciculi of the orbicular and corrugator muscles. The right and left occipital portions of the muscle are separated, in the middle line, by a process of the epicranial aponeurosis, which is attached to the occipital protuberance, but the right and left frontal portions soon coalesce in the middle line. The aponeuroses of the two sides are completely united into a single, wide tendinous expansion, covering the top of the cranium; at the sides, it becomes thinner, gives origin to two of the auricular muscles, and forms a thin membranous layer over the temporal fascia, as low as the zygoma; it is everywhere closely united with the skin of the hairy scalp, which moves freely with it over the pericranium or periosteum of the cranial bones, to which it is only very loosely attached. The occipital portions of these muscles draw the scalp backwards, the frontal portions, acting from their attachments to the frontal

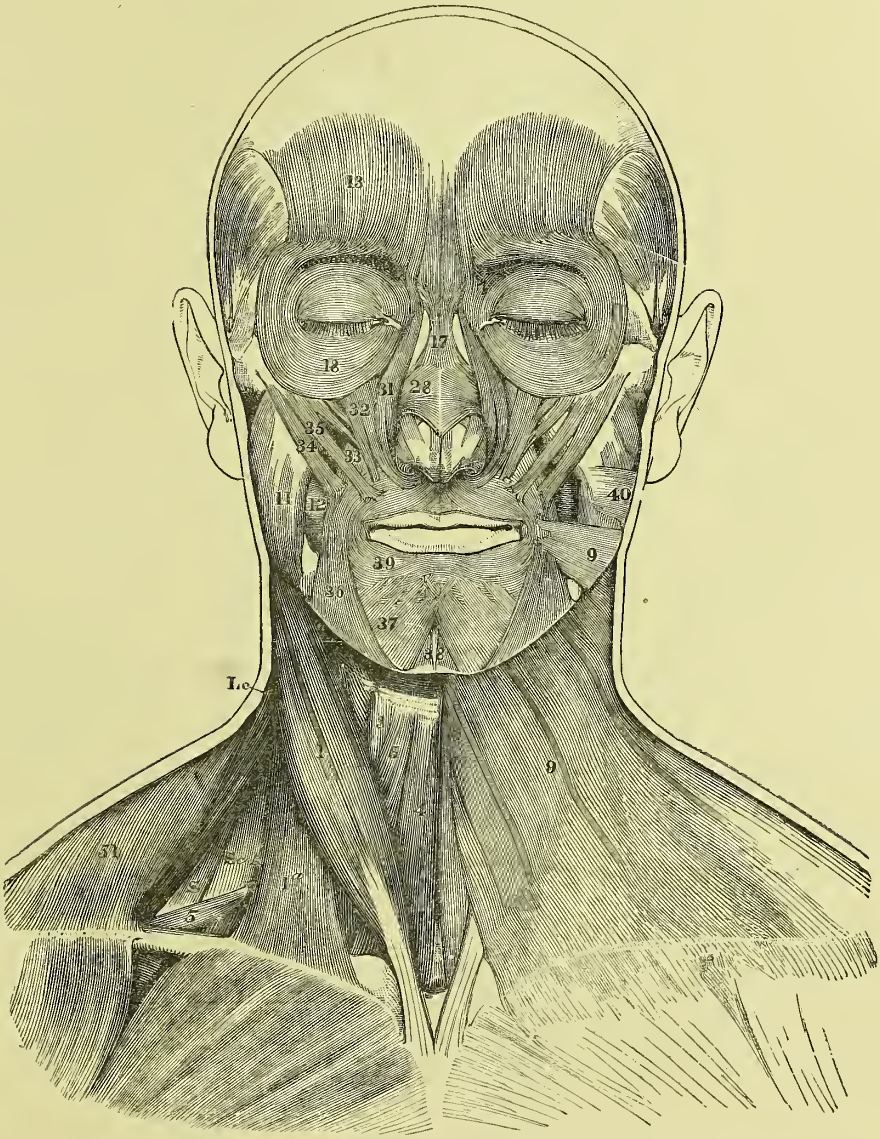


Fig. 193.—Muscles of the Neck, Head, and Face, seen from the front.

and nasal bones, draw it forwards; many persons can voluntarily execute these two movements alternately. In the ordinary action of the two muscles, the occipital portions fix the common epicranial aponeurosis, whilst the frontal portions elevate the eyebrows, as in the expression of attention or surprise, the scalp being simultaneously drawn a little backwards; when this action becomes more energetic, the eyebrows are raised higher, and the skin of the forehead is thrown into transverse, sinuous folds and wrinkles, as in fear, or fright. These wrinkles appear *across* the direction of the muscular fasciculi, a condition common to the action of all the subcutaneous muscles of the face. The occipito-frontal muscles are the only ones which can raise the eyebrows; they are more or less controlled by the pyramidales nasi, and by the corrugator muscles of the eyebrows, so that the outer end of the eyebrow can usually be elevated more than the inner end. In some persons, an asymmetrical lifting of one eyebrow is noticed, as an habitual trait in the face, usually, as will be found, on the side of the face corresponding with the stronger eye, or with the eye most used in attentive observation.

Corrugator supercilii, fig. 196, [17]. Deep, close to the frontal bone; small, narrower below than above, dark coloured; oblique outwards and a little upwards. Inner end of the superciliary eminence——deep surface of the middle of the eyebrow, blending with the frontal portion of the occipito-frontalis, and covered by the orbicularis palpebrarum. It draws the middle of the eyebrow inwards and slightly downwards, producing characteristic longitudinal furrows in the skin of the forehead, from the side of the root of the nose past the inner end of the eyebrow, *across* the direction of its fasciculi. It is the 'frowning' muscle (frons, froncer); and it expresses suffering. The eyebrow itself, or *supercilium,* is composed of a cushion of fatty tissue, containing the roots of the hairs, and intermixed with muscular fasciculi. These hairs, at the inner part of the eyebrow, are short and stand out forwards and upwards, but they become gradually longer, to beyond the middle of the brow, and then again shorter; they are here recumbent or inclined, and arranged smoothly, so as to form a more or less perfect arch.

The Auricular Group, figs. 186, 187, 193.—This includes three small muscles, the anterior, superior, and posterior auricular, otherwise named, the attrahens, attollens, and retrahens aurem.

The auricle or *external ear,* fig. 190. This part, to which the three auricular muscles are attached, surrounds the *external auditory meatus* or *ear passage,* and is also designated the *pinna* (a kind of shell). Its outer curved rim is named the *helix* (ἕλιξ, a fold or roll), at the upper and hinder part of which, is often seen a small overlapping piece, said to represent, in a rudimentary state, the upward prolongation of the ear in certain animals; internal to and parallel with the helix, is a shorter, still more curved, and bifurcated ridge, the *anti-helix*; within this, is the *concha* (a shell), which leads into the *meatus.* A small eminence in front of the concha, and partly concealing the meatus, is named the *tragus,* its inner concave surface being sometimes shaggy with hairs, like a goat's beard (τράγος, a goat); behind this, is a deep notch, and, behind that, a smaller eminence, called the *anti-tragus*. Beneath the anti-tragus depends the *lobule*, the part through which ear-rings are worn.

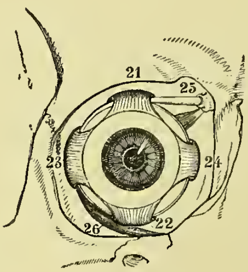
The framework of the auricle consists of a convoluted cartilage, fig. 187, the form and surfaces of which, correspond closely with those of this very variably shaped organ; but it does not extend into the dependent part or lobule, which, composed of dense areolar and fatty tissue, is soft and flexible. Certain fissures in the cartilage are occupied by fibrous tissue; the cartilage itself is prolonged, in the form of an incomplete tube, down the meatus, to become attached to the lip of the bony meatus, and it is, further, connected by ligaments with the mastoid process and the zygoma. Small, *intrinsic auricular* muscles, composed of a few fasciculi only, are found on the tragus and helix, and one larger fleshy bundle forms a *transverse* muscle behind the concha. The entire auricle is covered with a fine smooth skin. The entrance to the meatus is sometimes protected by long hairs growing from the eminence in front of that opening.

Attrahens, attollens, and *retrahens aurem,* figs. 186, 187, [14] [15] [16]. The *attrahens,* [14] and *attollens,* [15] superficial; small, thin, fan-shaped, composed of pale fasciculi; converging downwards. Aponeurosis of the occipito-frontalis, the attrahens in front of, the attollens above the ear——the *former,* to the fore part, the *latter,* by a more distinct tendon, to the back of the auricle. The *retrahens,* [16], superficial; smaller, and darker coloured; consisting of a few, rounded, horizontal bundles. Root of the mastoid process——back of the concha, by tendinous fibres. These three muscles move the external ear forwards, upwards and backwards, respectively. As a rule, they are not much under the control of the will, but may become so by practice. They may serve to steady or fix the auricle; but they are comparatively small in man.

The Ocular Group, figs. 194, 195.—This group, which is deeply seated, and entirely hidden in the orbit, includes the four recti or straight muscles, and the two oblique muscles, of the eyeball. The levator muscle of the upper eyelid, though situated within the orbit, is not an ocular muscle; it will be described with the palpebral group.

The eyeball or *globe of the eye,* figs. 194, 195. This is not a simple sphere, but is made up of a very large segment, five-sixths, of a larger sphere, and of a very small segment, one-sixth, of a smaller sphere, affixed to it in front. The former part corresponds in extent with the opaque-white, *sclerotic coat* of the eyeball (σκληρός, firm), and the latter part with that of the nearly circular, transparent and prominent *cornea* (cornu, horn). The eyeball, supported on the optic nerve as on a stalk, is lodged in the orbit, and is only partially visible between the opened eyelids, by which parts, it can be completely covered. Viewed from the front, the brilliantly clear, polished and moist cornea is seen, surrounded by the sclerotic; through the cornea, as through a watch-glass, is shown the many-coloured *iris*, a musculo-membranous diaphragm, perforated, a little to the inner side of its centre, by a round opening forming the black spot named the *pupil*, through which, light is admitted into the interior of the eyeball, and the size of which is enlarged in a feeble, and diminished in a strong light.

The globe of the eye varies somewhat in size in different individuals, and even on the two sides of the face in the same person. It is more or less prominent in the face, first, according to its relative size, as compared with the orbit, and, secondly, according to the quantity of fatty tissue on which it rests and moves, and to the amount of space occupied by the lacrymal gland in the upper and outer part of that socket. Its anterior fourth is free, and is connected with the under surface of the eyelids, by a mucous membrane,



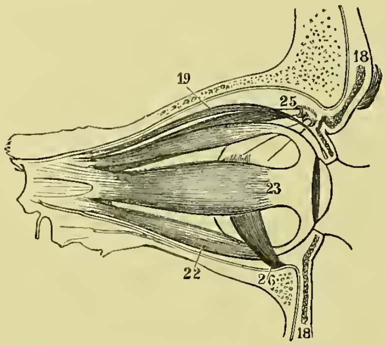


Fig. 194.—Muscles of the Right Eyeball, within the orbit, seen from the front.
Fig. 195.—The same, seen from the outer side.

named the *conjunctiva*, but so loosely, that the lids can move easily over the eyeball, and it can move easily behind them, each being provided with proper muscles for those purposes.

Recti oculi, 194, 195, *superior*, 21, *inferior*, 22, *externus*, 23, and *internus*, 24. Deep; small, elongated, flat; nearly horizontally forwards, and slightly outwards, in the axis of the orbit, and, as their names indicate, above, below, on the outer side of, and on the inner side of the eyeball. Bottom of the orbit, around the point of entrance of the optic nerve, the external rectus by two heads——globe of the eye just behind the margin of the transparent cornea, by short, thin, expanded tendons. These muscles rotate the eyeball so as to turn its front part upwards, downwards, outwards and inwards, respectively; hence they have been named, the *attollens*, the *depressor*, the *abductor*, and the *adductor*, muscles of the eyeball. Any two adjacent recti, acting together, turn the globe of the eye in an intermediate oblique direction; and it is said, that, if all co-operate, the eyeball may be drawn directly backwards in the orbit. The outward and inward movements of the eyeball, are precisely horizontal ; but, as the superior and inferior recti pass obliquely outwards and forwards, so as to reach the eyeball at an angle with its antero-posterior axis, the upward and downward movements produced by those muscles, must be accompanied by deviations of the eyeball inwards, which, however, are corrected by the two oblique muscles.

Obliqui, superior and *inferior*, figs. 194, 195, 196. Deep; the *superior*, long slender muscle, with a long deflected tendon, the *inferior*, much shorter and thicker; the *superior* or *trochlearis* muscle, [25], longitudinal, as far as a fibro-cartilaginous loop or pulley (trochlea), found at the upper and fore part of the inner wall of the orbit, through which the tendon passes, and then turns outwards, downwards and somewhat backwards, above the eyeball, the *inferior* muscle, [26], outwards, upwards and somewhat backwards, beneath the eyeball. The *superior oblique*, from the inner border of the foramen for the optic nerve, at the back of the orbit——by a flat tendon, to the sclerotic, on the outer side of the eyeball, behind its middle. The *inferior oblique*, from the inner and fore part of the floor of the orbit——by a flat tendon, to the sclerotic, on the outer side of the eyeball, behind its middle. The two oblique muscles are said to rotate the eyeball on its antero-posterior axis, though certainly not to any great extent, the superior rolling its upper half, and the inferior its lower half, slightly inwards. But the superior oblique, acting on a part of the eyeball behind its transverse diameter, directs the front of the eyeball downwards and outwards, whilst the inferior oblique, from a similar cause, directs the front of the eyeball upwards and outwards; if both muscles act, they turn the front of the eyeball directly outwards. These appear to be corrective actions, in regard to those deviations produced by the superior and inferior recti just mentioned, the inferior oblique correcting the deviation due to the superior rectus, the superior oblique that due to the inferior rectus, and the two oblique muscles concurrently, those due jointly to the two recti. By various combinations of action, the consensual, straight and oblique movements and positions, necessary for the adjustment of the two eyes towards a common point, in order to obtain single vision, are performed and assumed. The changes in position of the eyeballs, incidental to the expression of the various feelings and thoughts, are, likewise, thus accomplished, such as hope, devotion, shyness, cunning, cowering or shame.

The Palpebral Group, figs. 186, 187, 193, 196.—This includes the levator of the upper eyelid, and the tensor of the lids, both placed within the orbit, and also the orbicular muscle of the lids, situated outside it.

The *eyelids, palpebræ,* or *tarsi.* These parts contain, each, for purposes of support, a small, thin, soft, semi-lunar plate of fibro-cartilage, curved so as to fit the eyeball. One border of each cartilage corresponds with the margin of the lid, whilst the other is connected with the orbital fascia, which reaches from it, to the corresponding border of the orbit; the inner ends of the tarsal cartilages are fixed to the inner wall of the orbit by the *internal tarsal ligaments*, fibrous offsets from the short, white *tendo palpebrarum*, fig. 196, T O, which is attached to the anterior margin of the lacrymal groove; a portion of the fascia just mentioned, sometimes named the *external tarsal ligament*, fixes the outer ends of the cartilages. The upper cartilage, like the corresponding eyelid, is the larger; this eyelid also is the more moveable one, and is chiefly concerned in opening and shutting the lids. When the eyelids are closed, their relatively thick, flattened edges meet along a transverse curved line, convex downwards, and passing across below the centre of the eyeball, thus more effectually excluding light from the eyes. The eyelashes, arranged in two or more rows, reaching further towards the outer than the inner end of each eyelid, and much longer, shorter, and more numerous in the upper eyelid, curve upwards and downwards from each other, fig. 195; hence, when the lids are closed, they meet, but do not cross, so as to become entangled as they separate. The skin on the eyelids is very thin, and is always free from fat, which would interfere very much with their movements, especially with their opening. When opened, the elliptical aperture between them is what is commonly spoken of as 'the eye,' considered as a feature of the face, but through which only a small portion of the eyeball is visible. At the outer *corner*, or *canthus* (κανθός), which is situated on a plane further back than the inner corner, the eyelids meet at an acute angle, fig. 196;

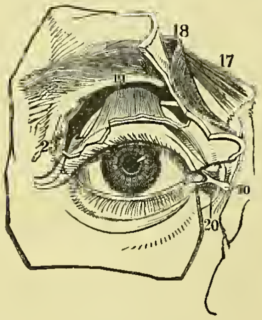


Fig. 196.—The Muscles of the Right Eyebrow and Eyelids.

but, at the inner ends, the true tarsi terminate somewhat abruptly, at the commencement of an elongated recess, the *lacrymal fossa*, which slants a little downwards and inwards, towards the nose, and really belongs to the tear apparatus, for in its upper and lower borders are concealed the lacrymal canals, which lead from two *puncta* in the eyelids, into the lacrymal sac. In this fossa, is a small, pink, moist elevation, called the *caruncle* (caro, flesh), fig. 196; and, between that and the eyeball, is a thin, semi-lunar fold of the conjunctiva, having its free concave edge turned towards the eyeball, and best seen when the eye is directed outwards; it is the representative of the *haw*, or *nictitating membrane*, existing in the horse, and of the *third eyelid* in certain birds.

Levator palpebræ superioris, figs. 195, 196, [19]. Deep, within the orbit; long, slender, flat; from behind forwards, above the superior rectus. Back part of the roof of the orbit, close to the foramen for the optic nerve—— anterior surface of the upper tarsal cartilage, by an aponeurotic expansion.

Antagonising the palpebral portion of the orbicular muscle, it raises the upper lid, and draws it back into the orbit, like the vizor of a helmet. The lower eyelid has no corresponding muscle; it moves through a much shorter distance, in closing the eye, and reverts to the open condition, by the elasticity of its connecting structures. This muscle is active in the expression of surprise and fright.

Tensor tarsi, fig. 196, [20]. Deep, behind the tendo palpebrarum and the lacrymal sac; diminutive, flat, divided externally into two slips; transverse. Hinder border of the lacrymal groove——free borders of the two tarsal cartilages, blending with the palpebral portion of the orbicular muscle, of which it seems like a deep portion. It draws the eyelids inwards, and, perhaps, by opening the lacrymal canals and sac, facilitates the passage of the tears down them; it has been called the muscle of the lacrymal sac.

Orbicularis palpebrarum, figs. 186, 187, 193, [18]. Superficial; a thin, broad, elliptical rather than circular, sheet of muscular fasciculi; disposed, in curved lines, in two portions, one thin and pale, the *palpebral* or *ciliary portion*, belonging to and covering the eyelids, the other thicker, and darker, named the *orbital portion*, *orbicularis latus*, which surrounds, rests upon, and overlaps the margins of the orbits. Anterior surface, and upper and lower borders of the *tendo palpebrarum*, fig. 196, T O, and through it, from the anterior margin of the lacrymal groove, internal angular process of the frontal bone, and nasal process of the superior maxillary bone——the *palpebral fasciculi* reach the band of fascia named the external lateral ligament, and thus become slightly attached to the adjacent part of the malar bone, the *orbital fasciculi*, unattached to bone, except at the origin of the muscle, blend, at the outer border of the muscle, on the forehead, temple and cheek, with the fibres of the occipito-frontalis, corrugator supercilii, zygomatici, and other muscles, sometimes also with the pyramidalis nasi. The palpebral portion of this muscle may simply narrow the aperture of the eyelids, as during reflection, or in the expression of joy, or, still more decidedly, in shame or grief; or it may close the eyelids, as in sleep. The fasciculi on the upper lid become much lowered and straightened, those on the lower lid are but slightly elevated. Both sets are shortened horizontally inwards, towards the tendo palpebrarum and the side of the nose; but the existence of firm cartilages in the lids, resists their movement inwards, and the effect of the contraction is, therefore, to draw the lids together. This closure takes place from the outer to the inner corner of the eyelids, the aperture, accordingly, becoming shorter, or longer, at the outer angle, as the eyelids are shut or opened; whereas, the inner angle, fixed more securely by the tendo palpebrarum, sometimes inaptly named the *tendo oculi*, T O, shifts very slightly from its place; indeed, the position of the two lacrymal fossæ, on either side of the nose, is so little changed in the various actions of the eyes and eyelids, that they form useful guide points, amongst the changeable forms around them. The orbital portion of the orbicularis muscle draws the skin of the forehead, temples, and cheek towards the orbit, and particularly towards its inner side, throwing the integument into folds or wrinkles, especially radiating from the outer corner of the eyelids, *across* the direction of the muscular fasciculi, giving rise, as age advances, to the so-called 'crows' feet.' Whilst the palpebral portion of the orbicular muscle closes the lids gently, as during sleep, or in the act of winking, the orbital portion draws them more decidedly towards each other, as in laughing or crying, or presses them in close contact, as when a foreign body is within or near the eyelids, or when one desires to shut out light, or avoid the sight of a disagreeable or dreaded object. This muscle, like all others, exhibits involuntary, emotional, and volitional movements, the palpebral portion more frequently acting involuntarily, the orbital portion, usually, under the influence of the emotions or the will.

The Nasal Group, figs. 186, 187, 193.—This consists of the pyramidal muscle, the compressor, the dilators and the depressor of the wing of the nose, and the levator of the wing of the nose and the upper lip.

The Nose.—The bony framework of the nose, already described, p. 166, is filled in, in front, by the *nasal cartilages*, figs. 186, 187, which give firmness and form to the anterior part of this exceedingly variously shaped organ. There are five principal cartilages, namely, an *upper* and a *lower lateral cartilage*, on each side, and a single median *cartilage of the septum*, between the two halves of the nose. The *cartilage* of the *septum* is triangular, irregularly flattened, and thicker at its edges than at its centre; it is fitted in, vertically, between the nasal, ethmoid, ploughshare, and superior maxillary bones, and separates the nasal fossæ and the nostrils, anteriorly; it also supports the lateral cartilages. The *upper lateral cartilage*, on each side, triangular and flattened, is attached behind, to the nasal notch of the corresponding superior maxillary bone, in front, to the cartilage of the septum and to the opposite upper lateral cartilage, and, below, to the lower lateral cartilage of its own side. This *lower lateral* cartilage, or *cartilage of the ala* or *wing* of the nose, is bent upon itself, so as to occupy the front and sides of the corresponding nostril. It is attached above, to the upper lateral cartilage, and also to the cartilage of the septum. Its outer plate, oval and pointed behind, is fixed to the nasal notch of the superior maxillary bone, by a dense membrane, which contains two or three small cartilages, the *sesamoid cartilages*; whilst below, it is embedded in the fatty tissue and thick integument which form the actual margin of the ala. The inner plate of this folded cartilage, narrower but thicker, is loosely attached to the opposite cartilage, and with it, descends below the level of the cartilage of the septum, and forms a part of the central ridge, *columna nasi*, between the nostrils, which is itself lower than the margins of the two alæ. The fore parts of the lateral cartilages of the two sides, enter into the tip of the nose, which, like the alæ, contains fatty tissue beneath a thick integument. The openings of the nostrils have a typical downward direction, in the higher races of mankind. The skin of the nose is thin, and loosely connected with the parts beneath, except upon the tip and alæ, where it is more tense, and, especially at the tip, strongly reflects light.

Pyramidalis nasi, figs. 186, 187, [27], 193, [17]. Superficial; a long triangular slip; vertical upon the frontal and nasal bones, and upper lateral nasal cartilage. Continuous with the occipito-frontalis muscle above——an aponeurosis common to it and the compressor alæ nasi below. The muscles of the two sides, in contact above, diverge as they descend; they are sometimes joined to the orbicular muscles of the eyelids. They are prolongations of the occipito-frontalis. They tighten the skin over the cartilaginous part of the nose; acting from below, they draw down the skin of the forehead, and produce transverse wrinkles over the bridge of the nose, *across* the direction of their own fasciculi. It expresses an aggressive feeling.

Compressor alæ nasi, compressor naris, vel nasi, figs. 186, 187, 193, [28]. Superficial, except at its very origin; small, triangular; inwards and forwards, on to the cartilaginous part of the nose. Canine fossa of the superior maxillary bone, by a pointed fleshy process——a thin expanded aponeurosis, uniting with that of the opposite side, and blended, above, with that of the pyramidalis muscle. It stretches or tightens the skin over the corresponding part of the nose. The two muscles, acting together, depress and compress the cartilaginous portion of the nose including the alæ. According to some, however, it may dilate the upper part of the cartilaginous nasal framework.

Dilatatores nasi, posterior and *anterior*, figs. 186, 187, 193. Superficial; diminutive, irregular, sometimes requiring the use of a lens for their detection; oblique downwards and forwards, on the side of the ala. The *posterior*, from the margin of the nasal notch and sesamoid cartilages, the *anterior*, from the cartilage of the ala——dense skin of the margin of the nostril. They raise and evert the ala of the nose, and thus enlarge the nostril; they act quietly in ordinary inspiration, especially during sleep, resisting the tendency of the nostrils to close, from atmospheric pressure; but they contract vigorously during difficult breathing, and most energetically in the expression of pride, anger, contempt or disdain.

Depressor alæ nasi, or *myrtiformis*, figs. 186, 197, [30]. Superficial, except for a short distance below, small, short, flat; radiating upwards to the nose. Incisor or myrtiform fossa of the superior maxillary bone—— septum of the nose and hinder part of the ala. It draws the ala downwards and backwards, and counteracts the movement of dilatation, by inverting the margin of the nostril. It may, also, depress the middle part of the upper lip.

Levator labii superioris, alæque nasi, figs. 186, 187, 193, [31]. Superficial, except where overlapped above, by the orbicularis palpebrarum ; long, thin, triangular ; downwards and slightly outwards, between the nose and the cheek. Nasal process of the superior maxillary bone, by a pointed end—— by two slips, an *inner*, smaller one, into the ala of the nose, an *outer* one, into the upper lip, blending with adjacent muscles. It raises the upper lip and the wing of the nose, and draws the latter outwards, so as to dilate the nostril. If the mouth be held closed, this muscle dilates the nose, without moving the lip. It is the muscle of elation, and indignation.

The Labial Group, figs. 186, 187, 193, 197.—This is a numerous group, the lips constituting the most moveable features in the face. It consists of the levator of the upper lip, the levator of the corner of the mouth or canine muscle, the greater and smaller zygomatics, the depressor of the corner of the mouth or triangular muscle of the mouth, the depressor of the lower lip or quadrate muscle of the chin, the levator of the lower lip or levator of the chin, the orbicular muscle of the mouth, and lastly, the risorius or laughing muscle.

The Lips. These very soft, flexible, and mobile parts, unlike the features already noticed, namely the ears, eyelids, and nose, have no cartilaginous framework in their interior, but are composed chiefly of interlacing muscular fasciculi, covered, on their inside, by a loose mucous membrane provided with scattered glands, and, externally, by a more closely adherent skin, which, on the red border of the lip, is very thin, and resembles a somewhat dry mucous membrane.

Levator labii superioris, figs. 186, 187, 193, [32]. Superficial, except where covered by the orbicularis palpebrarum, above; thin, flat, square; nearly vertical, beneath the orbit and the mouth. Front of the superior maxillary and malar bones, above the infra-orbital foramen—— orbicularis oris, and other adjacent muscles of the upper lip. It raises the upper lip, draws it slightly forwards, and, with the other levator muscles, increases the prominence of the cheek beneath the orbit, and helps to develop the oblique naso-labial and the bucco-labial ridge and furrow, which pass across the direction of its fasciculi, between the cheek on the one side, and the nose and upper lip on the other. The levators of the upper lip concur in producing an expression of sadness or grief.

Levator anguli oris, or *caninus*, figs. 186, 187, 193, [33]. Deep-seated; short, thick, strong; oblique, downwards and outwards. Canine fossa of the superior maxillary bone, below the infra-orbital foramen——corner of the mouth, blending with the orbicularis and other neighbouring muscles, and decussating with fasciculi of the depressor of the corner of the mouth, so as to reach the lower lip. It raises the outer part of the upper lip, and, with the last-named muscle, draws the cheek upwards, at the same time pushing the *lower eyelid* up, as occurs in crying.

Zygomaticus major, figs. 186, 187, 193, [34]. Superficial, except where overlapped, above, by a very large orbicularis palpebrarum, but always embedded in the fatty part of the cheek; a slender, fleshy band; oblique, downwards, forwards and inwards, between the cheek bone and the mouth, crossing over the masseter and buccinator muscles. Outer side of the malar bone——angle of the mouth, blending with the orbicular, the triangular, and the depressor muscles. It draws the corner of the mouth backwards, and a little upwards; it is the laughing muscle, or muscle of joy.

Zygomaticus minor, figs. 186, 187, 193, [35]. Superficial, excepting at its origin; a small elongated bundle, sometimes subdivided; oblique, downwards, forwards and inwards, a short distance above and in front of the greater zygomatic. Anterior surface of the malar bone, under cover of the orbicularis palpebrarum——outer border of the levator labii superioris, near the corner of the mouth. It assists in drawing the outer part of the upper lip, but not the corner of the mouth, upwards, outwards and backwards; it acts in producing the expression of sadness, not of joy.

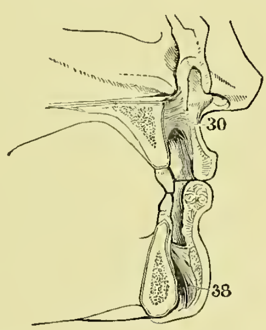


Fig. 197.—Deep Muscles of the Nose and Lips, in section.

Depressor anguli oris, or *triangularis oris*, figs. 186, 187, 193, [36]. Superficial; flat, triangular, its base below; converging upwards, and a little inwards. External oblique line of the lower jaw ——angle of the mouth, by its apex, which here blends with the risorius, the zygomaticus major, the orbicularis, and the levator anguli oris, with which latter some of its fasciculi decussate. It draws the corner of the mouth downwards, backwards, and a little outwards. It is essential to the expression of sadness or grief.

Depressor labii inferioris, or *quadratus menti*, figs. 186, 187, 193, [37]. Superficial, except at its outer and lower part, where it is covered by the triangularis oris; flat, broad, quadrilateral; oblique, upwards and inwards, meeting its fellow muscle in the middle line above, but separated from it below, by the levator menti. External oblique line of the lower jaw, from outside the mental foramen, forwards, towards the symphysis——the substance of the lower lip blending with its fellow, with the orbicular muscle, and, slightly, with the facial part of the platysma myoides. Its fasciculi are much mixed with fat. It draws the half of the lower lip downwards and a little outwards; the two muscles draw the lip directly down, and also evert it. It is said to aid in expressing irony, or to be even sufficient by itself for that purpose.

Levator labii inferioris, or *levator menti*, figs. 186, 187, 193, 197, [38]. Deep above, superficial below; small, narrow above, wider below; vertical, but inclined slightly forwards and inwards. Incisor fossa of the lower jaw ——integument of the chin. It raises the lower lip, especially its central part, the two muscles coalescing below; it also protrudes the lip, as in pouting. It produces dimples in the skin covering the chin. It expresses doubt and disdain, especially if aided by the triangularis oris.

Orbicularis oris, or *sphincter oris*, figs. 186, 187, 193, [39]. Superficial, but has certain, specially arranged, deep bundles belonging to it; median, elliptical, consisting of two portions, in this respect, repeating the arrangement of the orbicularis palpebrarum, one *labial*, occupying the red border of the lip, narrow, thick, very regular, but composed of fine pale fasciculi; the other *facial*, wider, thinner, darker, and less regular in form, surrounding the mouth. The *labial* portion has no attachments to bone, but its fasciculi pass uninterruptedly from lip to lip, around the corners of the mouth, some of them blending with fasciculi from the decussating fibres of the buccinator muscles. The *facial* portion is also, for the most part, unconnected with bone, its fasciculi intermixing with those of the numerous muscles which converge to different parts of the mouth; but certain deep-seated bundles become attached, either to the septum of the nose, or to parts of the upper or lower jaw. Thus, in the upper lip, two bundles exist on each side of the face, namely, an inner one, the *naso-labial* muscle, pointed above, but thick below, which is fixed to the nasal septum, and an outer thinner and wider one, named the *superior accessory* or *incisive muscle*, fixed to the incisive and sometimes, also, to the canine fossa of the upper jaw, outside the depressor alæ nasi. In the lower lip, there exists only one bundle, on each side of the face, namely, the *inferior accessory* or *incisive muscle*, which is fixed to the canine fossa of the lower jaw, outside the levator of that lip. The peculiar vertical median *furrow*, seen on the upper lip, beneath the nasal septum, coincides with the two naso-labial muscles, whilst the outer sides of the *ridges* on each side of that furrow, correspond with the situation of the two incisive muscles. The median furrow ends below in a prominence, named the *lobe* of the lip; all this median part of the lip, at an early period of development, is separated from the lateral parts, and the ridges represent the lines of subsequent fusion. Opposite the bottom of the furrow, on the inner surface of the lip, is a fold of the mucous membrane, named the *frænum*, running back to the surface of the upper jaw. There is no primitive median part, no median furrow, no persistent median lobe, but rather a gentle median depression, and only a very slight frænum to the lower lip. The two portions of the orbicularis oris oppose all the other muscles of the mouth, these drawing the lips in various directions, the orbicularis closing it both vertically and transversely. The labial portion, acting alone, inverts the red portion of the lips, and diminishes the width of the mouth; the facial portion, contracting alone and moderately, presses the lips against the jaws and teeth, and then protrudes them, slightly everting their free borders. Probably the labial portion, chiefly, or, only, is concerned in the habitual closure of the mouth; but the entire muscle is engaged in its more firm closure, as in sucking, drinking, or taking food. It is this muscle, also, which renders the lips tense, for the purpose of whistling. By tightening and straightening its fasciculi, the upper half of the orbicularis can draw down the upper lip, and, with it, the alæ of the nose; whilst its lower half, in the same way, raises the lower lip, and, with it, the soft parts covering the chin. The orbicular muscle of the mouth is very largely developed in the fleshy lips of the Negro, whose repulsive facility of everting the lips may be remembered. As a muscle of expression, it contracts in the more disagreeable, and relaxes in the more agreeable emotions or feelings.

Risorius, figs. 186, 193, [40]. Superficial; a thin, delicate, pale band or number of bands; apparently an offset or offsets of the platysma myoides; forwards and inwards, over the masseter and buccinator muscles. Fascia covering the masseter muscle——corner of the mouth, together with the depressor anguli oris. It retracts the corner of the mouth, and hence was named by Santorini the *risorius* or *smiling* muscle; but it has been shown that the upper part of the platysma myoides proper, draws the corner of the mouth downwards and backwards, and is concerned in the expression of sadness or grief.

Surface-forms dependent on the Muscles of the Neck, Head, and Face.

The forms of the sides and the back of the neck, and even of a small portion in front, above the outer end of the collar bone, depend, as already explained, p. 349, upon the trapezius, and certain subjacent muscles. The anterior border of the trapezius, is not indicated by an intermuscular marking, but forms a slight ridge, undulating downwards and forwards, over the neck. In front of it, is a long, slightly depressed hollow, slanting upwards and backwards, from the collar bone on to the side of the neck, due to the intermuscular space between the trapezius and the sterno-mastoid, named the posterior triangle of the neck. It is across the lower part of this hollow, that the omohyoid, when it is in action, produces a momentary ridge, running at an acute angle, upwards and inwards, from the collar bone. The part of this triangle just above the collar bone, sometimes very depressed, has been popularly named the '*salt-cellar*.' In front of it, the elevation produced by the sternomastoid muscle, is usually plainly seen. The flatter clavicular origin, the narrow prominent ridge of the sternal origin, the small triangular depression between them, the full oblique elevation of the middle portion of the muscle, its thicker anterior border, and its broader and less prominent upper end, reaching to the skull behind the ear, are all quite conspicuous, when the face is turned to the opposite side. On that side, however, the greater part of the general form of the muscle, is completely lost, its place being occupied, in the contorted neck, by a deep, oblique, sinuous doubling of the loose integument, thickened by the subjacent, relaxed and similarly folded platysma myoides ; even the upper and lower ends of the muscle, no longer in action, are much obscured. At the lower part, or apex, of the V-shaped region between the two sterno-mastoids, the boundaries of that region, formed by the sternal origins of those muscles, sharply elevated, and limiting the width of the supra-sternal or inter-clavicular notch, are strongly pronounced, and, when the neck is held symmetrically, equally so ; for, here, the intervening narrow and rounded part of the throat, corresponding with the sterno-hyoid and sterno-thyroid muscles, lying upon the trachea and the lower part of the thyroid body, is inclined downwards and backwards, so as to leave a well-marked depression between the tendons of the sterno-mastoids. Higher up, the borders of the V-shaped space become toned down, and, at the same time, the intermediate laryngeal form is broader and more prominent. The details of this form due to the thyroid body in the male and female, to the sometimes slightly recognisable cricoid cartilage, to the Pomum Adami or blunt angular eminence of the thyroid cartilage, differing in the two sexes, and, lastly, to the retiring hyoid bone, held back by its ligaments and its elevator muscles, have been fully explained with the anatomy of this region, p. 397. The inclined plane, situated above the hyoid bone, and between the two halves of the lower jaw, is slightly convex, owing to the anterior portions of the two digastric muscles projecting below the comparatively flat mylo-hyoids ; traced backwards, this plane ends, laterally, in a narrow groove, running beneath the angle of the jaw, whence a depression along the hinder border of the ramus, is traceable upwards to the ear, bounded behind by the upper part of the divergent sterno-mastoid muscle. Below the ear, and behind the ramus of the jaw, the parotid gland, lying on the posterior portion of the digastric muscle, and, below the body of the jaw, the submaxillary gland, reaching some way downwards, help to obscure the subjacent forms. Beneath the chin, an accumulation of fat accomplishes the same result. All the parts in the neck, are not only held together in their action, but softened down in their form by the strong cervical fascia, and still more by the platysma myoides and the skin, the two latter, in thin persons, causing ridges which descend obliquely on each side, from beneath the chin, over the re-entering hyoid angle and the laryngeal eminence, and, then diverging, descend over the inner end of the collar bones. In old age, when the skin loses its natural elasticity, and the subcutaneous fat disappears, these ridges become very pronounced and characteristic, being especially prominent in aged women. From a point below the angle of the jaw, the *external jugular vein* courses, in an oblique direction, backwards over the sterno-mastoid elevation, and, frequently exhibiting a distinct bulging about the middle of its course, sinks behind the outer border of that muscle, in the lower part of the posterior triangular depression of the neck ; smaller *anterior jugular veins* are sometimes seen descending in front of the throat.

The *masticatory muscles,* placed on the side of the cranium and face, decidedly influence the surface-forms. The temporal muscle, confined by its strong fascia, and, to a great extent, hidden by the hairy scalp, fills up the temporal fossa, and substitutes for it, a slightly convex surface, the anterior border of which, visible on the temple, is marked or obscure, according as the muscle is in action or at rest. The masseter muscle imparts breadth and fulness to the hinder portion of the cheek, its lower fleshy part producing a distinct form, separated from the malar eminence above, by a flattened space, corresponding with its upper tendinous portion ; this fulness is markedly increased by the extension forwards of the parotid gland. The masseter form, moreover, becomes strikingly pronounced, when the teeth are set, as in rage, its anterior border declaring itself as a strongly marked vertical ridge; whilst, with the widely opened mouth, seen in extreme horror, the muscle asserts itself by producing a long flattened plane. The buccinator muscle is concealed by fat, which abounds in this part, and which, in the chubby-cheeked school-boy, may here be pulled away from the parts beneath.

The *epicranial muscles,* like the temporal muscles, chiefly hidden by the hairy scalp, are, everywhere, so thin, in both their fleshy and their tendinous portions, that the osseous forms beneath them are revealed on the surface. The *auricular* muscles, and, most evidently, the *ocular* group, have no direct effect on the superficial forms. The *palpebral* muscles help to cover in the orbit, and to smooth over the supra-, extra-, and infra-orbital borders. The *nasal* group clothes the bones of the nose, and, moreover, the pyramidalis nasi, descending from the forehead to the bridge of the nose, plays the important part of filling in the deep notch existing in the cranium, below the glabella, and giving a more even and elegant profile here, in place of the disagreeable indentation seen in the skull. The celebrated Greek profile, though, in part, due to the form and relative position of the nasal and frontal bones, is also, in larger part, indebted to this muscle; as is evident from an inspection of Greek crania. The numerous *labial* muscles, converging from all sides, and blended around the mouth by, and with, the orbicular muscle, close up the sunken hollows of the lower part of the bony face, and, with the integuments, substitute for the grinning rows of teeth, the soft and mobile lips.

The *facial* muscles give rise to no forms directly representing their shape, so that nowhere can their size, direction, or outlines be traced upon the surface. They are all concealed by the soft mask of the skin, to which they are more or less adherent, especially at their points of insertion into its under surface. When in action, they sometimes cause depressions or dimples corresponding with the attached ends of their scattered fasciculi, as seen near the corners of the mouth, and just above the chin; or they produce folds and wrinkles, very nearly at right angles to the direction of their fasciculi, as seen across, or up and down, the forehead, over the bridge of the nose, at the outer corner of the orbit, and between the cheek and the angle of the mouth. In the limbs, where physical action is the ruling motive, the display of the mechanism of muscle and tendon, by which the work is performed, even lends emphasis to the expression of effort; but, it would seem that, in the face, whereon the feelings and emotions are enregistered, this is especially avoided. The apparatus of movement is there hidden; for the muscular fasciculi which produce the changes in the forms of the countenance, representative of those feelings and emotions, and every feeling and emotion has its concomitant movements, are effectually concealed. The changes of form alone are permitted to be seen, as though the simultaneous display of the mechanical means employed, would disturb the observation and recognition of the subtile facial mutations themselves.

In certain parts of the face, as upon the broad cheeks, and upon the central eminence above the chin, a considerable amount of fat exists, and the integument is there moved in mass; but in the parts where wrinkling is possible, the skin is thinner and more, or almost absolutely, free from subjacent fat; this is especially the case in the eyelids, where the freest movements are essential, and where the presence of fat would seriously interfere with their office. A deep crescentic fold, accompanied by the formation of a curved prominence, wider at the outer than the inner part of the orbit, and due, in some measure, to the presence of the deeply seated lacrymal gland, is formed above the upper eyelid, and another crescentic fold, below the lower eyelid, when the lids are open; but both these folds disappear, when the eyelids are closed. In the thin part of the skin near the inner corner of the eye a bluish line or two indicates the course of the so-called angular vein and its branches. Veins are also recognisable under the comparatively thin skin of the temple; and, often, a large *frontal vein* descends upon the forehead, down to one side of the root of the nose. This is the so-called *vein of wisdom*; it might rather be called the *vein of anger*, for, in that passion, it becomes very full; this is true also of the external jugular vein, on the side of the neck. A large frontal vein is an hereditary peculiarity, as is mentioned in the story of 'Redgauntlet.'

The determinate and unchangeable forms of the ear, the firmly modelled nose and the agreeable curvature and chiselled margins of the eyelids, are dependent on the existence within those parts, of cartilages of very precise shape, and, in the case of the eyelids, on the spheroidal forms of the globe of the eye itself. The lobule of the ear is a superadded part, quite characteristic of man; and whilst the auricle proper presents a certain relation, as to size and form, with the profile outline of the cranial and upper facial mass, the lobule repeats the quantity of the mass about the lower jaw (see figs. 190, 191). The curvature of the eyelids varies, according as they rest upon the larger spheroid corresponding with the sclerotic, or upon the segment of the smaller spheroid coinciding with the cornea. When the opened eyes are directed forwards, as in ordinary vision, the upper eyelid covers only a small portion of the upper part of the cornea, and its curve is not notably altered thereby; but if the sight be directed upwards, the cornea is more buried, and its curve modifies that of the upper lid; if the eyes are turned upwards and to one side, different parts of the two upper lids, that is, the outer part of one, and the inner part of the other, have their curvature thus increased. When the eyelids are closed, as in sleep or death, the greatest convexity of the upper eyelid is still over the corneal portion of the eyeball, and the direction of this is thereby revealed through the closed upper lid. Excepting in an extremely downward glance, the form of the lower eyelid is regulated entirely by that of the larger or sclerotic spheroid; for it only then covers any part of the cornea. The aperture between the two eyelids varies, both in size and direction, in different individuals, and in the different races of men. Upon its length and width, or the degree of openness of the lids, depends the character of the eyes, as regards apparent size, in different cases, quite as much as upon the dimensions of the eyeball itself. So, likewise, any inequality between the capacity of the bony orbit and its contents, may produce a like prominence of the eyes, or, on the other hand, may give rise to a peculiar sunken state of those organs. Differences in the distance between the two eyes, causing them to be wide apart, or closely set, depend upon the width, or narrowness, of the bony structures between them. The normal direction of the elliptical opening between the eyelids, is nearly horizontal; but, except when the upper lid is unusually full or tumid, the external canthus or corner is a little more elevated than the inner one, which gives peculiar animation to the expression, as may be illustrated by altering its position in a drawing or a model, so as to make it lower. In the Mongolian races, this elevation of the outer angle of the aperture, is so marked, as to constitute a national trait in the countenance. It depends on the particular point of attachment of the so-called external tarsal ligament being itself elevated, owing to the shortness of the external angular process of the frontal bone, and the greater upward projection of the ascending process of the malar bone, in those races. The singular character of the Chinese eye is further dependent on the fact, that the eyeball is not raised to the same extent as the aperture through which it is seen, so that the lower part of the coloured portion of the eye is more concealed from view, whilst the upper portion of the white part becomes more visible.

As to the human mouth, the absence of fibro-cartilage from the lips, renders it, as a feature, much more changeable than any other. It is set slightly back, between the nose and chin. The median lobe of the upper lip, its central furrow and ridges, and its two lateral arches, terminating, each, in a gentle curl, describe a form, having some resemblance to a relaxed Cupid's bow, supported by, and contrasted with the shorter, fuller, and more simply modelled lower lip, which, however, is slightly indented in the middle. Characteristic and beautiful, this part of the face is strikingly different to the protruding, but thin, meagre, and spout-like mouth of the anthropoid apes. The highly specialised muscular structures which govern its infinitely varied movements, not only adapt it to the requirements of a rapid and pure articulation of the labial sounds of speech, but explain the indescribably delicate shades of form and position, which serve to express its silent language.

The Muscular System Considered Generally.

As the mechanism of the human skeleton is obviously adapted to the erect attitude, so the fitness of the muscular system, generally, for raising the skeleton into that position, and maintaining it so, is very evident.

In the completely recumbent position of the body, all the muscles, excepting those engaged in the function of respiration, *may* be at rest; the limbs may assume any posture consistent with the forms of their joints, the influence of gravity, and the nature of the supporting surface. The masses of the muscular groups merge into each other, and the fleshy forms of individual muscles glide into those of the tendons, ceasing to be clearly indicated on the surface. When permitted to do so, they even obey the effect of weight, and show a tendency to sink or hang down at any dependent or unsupported parts of the frame, or they yield to pressure, and become more or less displaced and distorted.

In rising from a horizontal posture, the lower limbs are usually flexed, and the trunk is raised and brought forwards over them, the upper limbs assisting in this movement; the head is also thrown forward; the whole body is then moved, completely over the intended base of support, the feet; and, by a final effort, the ankle, knee, and hip joints are extended, the lower limbs are straightened above the feet, and the superincumbent weight is raised and balanced.

The tendency of the erect body to fall to the ground, if left unsupported by the muscles, is shown by what occurs in fainting or in falling asleep, in which states, the influence of gravity determines the head to drop forwards, the upper part of the spine also to fall forwards, but the whole trunk to sink, backwards or forwards, at the hips, and, both the knees and ankle joints to become doubled up. The maintenance of the erect attitude, is, therefore, entirely due to the constant exercise of the muscular force brought into use, in early life, by persevering efforts of the will, accompanied by not a few failures and mishaps, until practice makes the child perfect; and, at last, it is governed by an unconscious automatic control, exercised over many co-ordinated muscular movements. It is secured in the following manner. The muscles in the sole of the foot, besides supporting its arches, fasten the grasp of the toes on the sustaining surface, and steady the hold of the longitudinal tarso-metatarsal arch upon it; in this, the flexor muscles, which descend from the back of the leg, assist. The short and long extensors of the toes, pull back the first phalanges, and so enable the tips of the toes to be brought down upon the ground. Acting from below, the flexors at the back of the leg, with the extensors in front, and the peronei on the outer side, fix the astragalus on the scaphoid, balance it on the os calcis, and support the tibia upright upon it; the flexors are powerfully aided by the muscles of the calf, which, fixed below to the os calcis, extend or bring backwards the tibia on the astragalus, and prevent the weight of the body from doubling the one bone forward, upon the other, at the ankle. In the thigh, the triceps extensor, acting from the tibia through the ligamentum patellæ, draws the femur forwards and keeps it extended and upright upon the leg, and thus straightens the limb at the knee. Above this, the remaining muscles of the thigh, including the adductor, adducent flexor, flexor, rotator and gluteal groups, with the tensor vaginæ femoris, the iliacus and the psoas muscles, ascending on every side of the thigh, in the form of a hollow inverted cone, having the femur in its axis and the acetabulum in the centre of its base, and being attached all round to every point of the broad outer surface and prominent borders of the expanded innominate bone, act with great leverage, and thus guard and balance the pelvis and the rest of the body, upon the moveable hip joint. In this way, the pelvis is kept in equilibrio, in all directions; but, to save the expenditure of muscular force, and to diminish fatigue, the pelvis, in standing quite upright, is allowed to lunge backwards on the heads of the thigh bones until the movement is checked, in part, at least, by the strong ilio-femoral and capsular ligaments in front of the hip joint; the knee, moreover, is jerked back, so as to be over-extended, and its internal, posterior and lateral ligaments tightened; whilst, at the ankle, the muscles alone maintain the body in what, deprived of their aid, would be a condition of unstable equilibrium. Above the solid region of the pelvis, the remainder of the trunk is balanced from the front and sides, by the muscles of the abdomen and the quadrati lumborum; whilst from behind, it is extended and kept upright, by the erectores spinæ and the deeper seated vertebral muscles. The neck is sustained by the numerous cervical muscles, anterior, lateral

FIG. 198. -The Muscular System, in the Male.

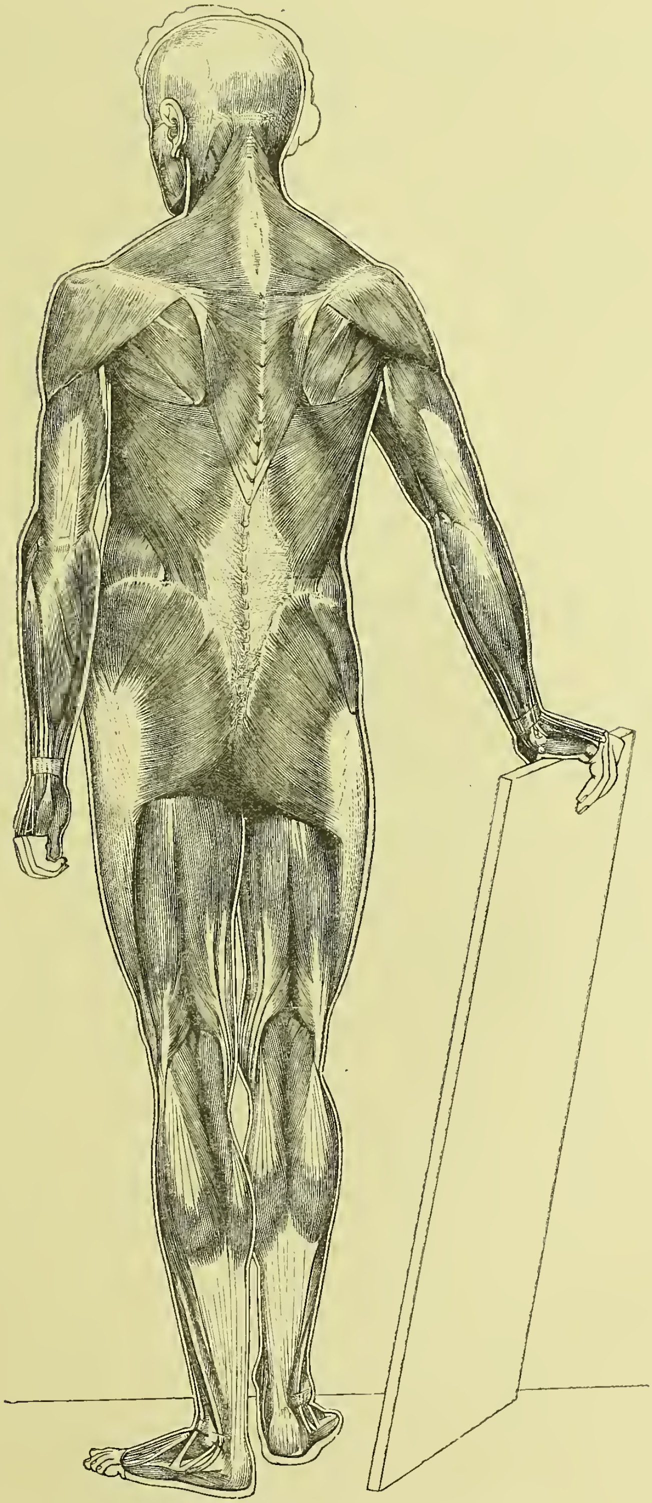


Fig. 199.—The Muscular System, in the Male.

and posterior. The head, with the lower jaw suspended in front, by its muscles and ligaments, is held in equilibrio, by the sub-occipital muscles, the complexi, the splenii capitis and the trapezii behind, and by the trachelo-mastoids and sterno-mastoids at the sides. The last-named muscles also support the sternum and collar bone in front, and with the scaleni, subclavii, and levatores costarum, sustain the weight of the thorax; whilst the levator anguli scapulæ, the rhomboids, the great serratus, the lesser pectoral, and the trapezius, serve to attach or carry the moveable shoulder girdle. Lastly, the muscles of the upper limb, from the scapular group, the deltoid, the latissimus dorsi and the greater pectoral, down to the muscles of the arm, fore-arm and hand, act upon, and command, from the trunk outwards, the lighter bony framework of this prehensile member.

In these numerous, distinct, but co-ordinated acts, does the maintenance of the upright posture really consist. The muscles of the lower limb, principally engaged in erecting the body, are placed, alternately, behind and in front, the muscles of the calf behind the ankle and leg, the triceps extensor in front of the knee and thigh, and the massive gluteal muscles behind the hip and pelvis; and, in each case, these are the most powerful muscles of the region in which they are situated. The erector muscles of the spine, and the recti of the abdomen are also very strong, and so are the numerous muscles which support the head from behind.

Besides maintaining the body in the erect posture, the muscles of the trunk and limbs, are engaged in the various acts of locomotion, in lifting and carrying weights, in striking blows in offence or defence, and in every other kind of external work; and they are also concerned in expressional movements, quite as essential as those which affect the face, as is seen in the stamping of the feet by children in a passion, by the shrugging of the shoulders, the outspread arms, the turning of the back, the wave of the hand, the uplifted, averted, or drooped head. But, as already indicated, the subjects of Animal Mechanics, Kinetics, and Expression must be postponed to another occasion.

On comparing the disposition of the muscles in the two limbs, it is seen that those of the lower limb are very definitely limited at their junction with the trunk, as for example, along the crest of the ilium, and the pubic and ischiatic margins, just as the root of the limb itself appears to be well marked on the surface; for, with the exception of the deep-seated psoas muscles, the little pyriformis, and a few fasciculi of the great gluteus, not a single muscle of this limb reaches higher up than the pelvis, no others having attachments to the vertebral column. On the contrary, there are muscles connected with the upper limb, the more highly endowed and more freely moveable extremity, which proceed from the back, and from the front and sides of the trunk, from the pelvis, the whole length of the spine, the skull, the ribs and the sternum, as, for example, the latissimus dorsi, the trapezius, the serratus magnus, and the pectoralis major. Hence the limits of the muscular apparatus of the upper limb, are not easily defined, and there is no distinct line of demarcation between them and those of the trunk, two of the broadest muscles on which, the latissimus, behind, and the great pectoral, in front, actually reach the humerus. Whilst, therefore, externally, the lower limb appears to be fastened on to the trunk, the upper one seems as if it were fused with the body. This is quite consonant with the special office and actions of each limb. As compared with the muscles which embrace the femur, those which surround the humerus are but few in number; but this is owing partly to the fact that the scapular muscles, which correspond with the adductors of the thigh, end so close to the shoulder joint. The number of muscles in the fore-arm, and in the hand, is, however, greater than that in the leg, and in the foot, owing to the existence of the pronator, supinator, and opponent muscles.

In considering, in a general manner, the form of the body, as dependent on the muscles and their tendons, it is seen that the trunk, neck and head constitute a bilaterally symmetrical mass, but that each limb, though symmetrical, as regards its fellow of the opposite side, is not so, as regards the other limb of the same side, nor yet in itself, whether it be viewed from the *front*, the *back*, or *either side*. The absence of intrinsic symmetry is equally manifested in the bones, and in the muscles. The outer and inner borders of the foot and hand, the two malleoli above the ankle, and the two styloid processes above the wrist, the upper ends of the tibia and fibula, and of the radius and ulna, the outer and inner condyles of the femur and humerus, and the trochanters and tuberosities of those bones, are all unequal in size and form. So also the outer and inner fleshy bellies of the gastrocnemius, the two hamstrings, and the two vasti muscles are of unequal length, breadth, and prominence, whilst the adductors of the thigh, and the glutei, do not balance each other, either in quantity or position. In the upper limb, the fore-part of the deltoid differs from the hinder portion, the anterior fold of the axilla is unlike the posterior one in elevation, length, thickness and inclination, the outer and inner heads of the biceps and the triceps are unlike, the muscles of the fore-arm arise above the outer condyle of the humerus much higher than those from the inner condyle, and the ball of the thumb is larger than that of the little finger. The bilateral symmetry of the central mass of the body, and of each pair of limbs, has its mechanical and developmental explanations. It, moreover, satisfies the eye as to the unity and balance of the entire form. But the absence of symmetry between the two halves of each limb, which is also associated with mechanical uses and necessities, becomes an unquestionable cause of interest from an æsthetic point of view. The formality of exact repetition, observable in the two sides of many buildings and machines, in doors and windows, in the legs of tables and chairs, in the blades of tongs and forceps, and in other articles of human workmanship, is banished from the human frame; and the opposed quantities and lines on the different aspects or sides of the separate limbs, constitute an undoubted source of variety and beauty in those parts.

A further condition of variation in the general and local muscular forms of the two sides of the body, is seen in their constant differences, as to attitude and action. Thus, the trunk and limbs, though sometimes symmetrically posed, and in an equal state as to action, are more frequently not so, the trunk being bent, inclined, or rotated, and the limbs in different, and, therefore, in asymmetrical attitudes and actions. One limb may be in one position, and the opposite limb in another; one may be in action, and the other at comparative rest. Opposite muscles in the same limb may be at work, or idle; sometimes the extensors, sometimes the flexors may be employed, their antagonists being at rest; or all the muscles of a part may be simultaneously contracted, to fix its joints, or form a basis of support for more distant movements. The performance of single or associated, simple or co-ordinate, principal or subordinate actions, necessarily introduces different local, or more or less general, changes of form as well as of position. If we stretch out a hand to welcome a friend, or raise the arm to parry a blow, or to deliver a thrust, the feet will remain stationary, or one foot will advance, or one retire; but, in each case, nearly every muscle in the body is called more or less energetically into play, and the limbs are asymmetrically disposed. There is, moreover, a fundamental opposition between the ordinary movements of the upper limbs, which are free, and those of the lower limbs, which are forced. Thus in quiet attitudes, the lower limbs are usually more or less everted, whilst the upper ones are turned in; the knee is turned forwards and outwards, the elbow backwards and outwards; the prominence of the calf is backwards and inwards, that of the front of the fore-arm forwards and inwards; the foot is turned out and at right angles, or nearly so with the leg, the hand is turned in and nearly in a line with the fore-arm; the dorsum of the foot is directed upwards, the back of the hand outwards. In all these positions, in which the balance of the muscular forces is in harmony with the character of the articular surfaces of the joints, more or less asymmetry of action and form prevails; and, indeed, the instances of perfect symmetry of action in the limbs, are quite exceptional.

But, however different may be the position, action, and form of the corresponding muscles on the two sides of the body, or in the opposite limbs, the masses on the two sides remain unchanged in quantity or bulk. Under all circumstances, the two halves of the body occupy practically the same space, and retain their equality as to their cubical contents. This is due to the non-compressibility of the muscular substance on contracting. Were it not so, every unilateral action in an aquatic animal, or in a bird of flight, would alter most inconveniently the specific gravity of the side in action, and so derange its relative buoyancy or balance. During contraction, the fleshy portions of the living body are displaced and disturbed in their forms, but not diminished in size ; if they become widened, they are simultaneously shortened ; if the tendons are straightened and rendered more prominent, the adjacent fat and skin are drawn or forced in, by their elasticity or by atmospheric pressure. The sculptor must, therefore, realise his effects by a different disposal of his material on the two sides of the body, or on opposite limbs, according as these are at rest or in action ; but his quantities must remain the same.

In the *female figure*, the *muscular system* generally, is, of course, less developed and the muscular forms are less pronounced ; but, besides this, although the skin itself is thinner and softer, the adipose layer beneath it, is proportionally thicker, so that this alone would conceal the muscular forms more completely than in the male. But there are other characteristics. Thus, the feet and hands are less muscular, along their borders ; whilst the balls of the thumb and little finger are proportionally narrower. The muscles of the leg and fore-arm have their fleshy parts relatively longer, and their tendinous parts relatively shorter, than they are in man ; moreover, the muscular fasciculi do not terminate so boldly on the tendons ; so that, for both reasons, the legs and arms are more smoothly and gradually tapered from above downwards ; the swell of the calf is especially more gentle, and descends lower down, in women than in men. All the muscles of the thigh are wider in proportion to their length, and the glutei are larger, as the greater width between the acetabula increases the necessity for larger muscles, to balance the trunk on the head of one or other femur, in walking. The lumbar, and other spinal muscles are less pronounced ; and so are the muscles lying in the back, which belong to the upper limb. In front of the torso, the abdominal muscles are full, but those of the pectoral region small, and obscured by the largely developed mammary gland. The muscles of the neck and throat are long and slender. The deltoid is oval in contour, and has no abrupt swell ; the muscles of the arm are small, so that this part of the upper limb is rounded, and not flattened, at the sides and back ; lastly, as already stated, the muscles of the fore-arm are more gradually and uniformly tapered, from above downwards to the wrist.

The female muscles approach in character to those of the infant or child, especially exhibiting this likeness in the limbs, in which parts, in children, unlike the long tendons found in the male figure, these cords are also, as in the female, proportionally short, the muscles appearing to descend very low down in the limbs.

In *old age*, the tendons become still more evident, and the fleshy masses waste, so that the 'shrunk shank' becomes associated with the bended knees, the emaciated forms of the trunk, and the stooping position of the back and head. The differences in the muscular system, due to occupation, character and race, are more striking than even those which occur in the bones, for they are more obvious to ordinary observation. The arm of the blacksmith, or the shoulder of a cricketer, the limbs of a Hercules, and the calf of the Negro, manifest well-known peculiarities referable to the greater or less amount of work performed by the muscles of those parts ; in the last-named case, the gastrocnemius is less developed, owing, it is thought, to the greater leverage afforded by the elongated heel ; or, as it may be put, the shorter os calcis of the European type, compels a larger development of the muscles of the calf.

The *integument* or *final covering* of the human body, is so soft and beautiful in woman, that its characteristic appearances may preferably be noticed in her. The colour of the skin, in all races and complexions, its tone in the dark ones, and its brilliancy in the white ones, are so remarkable, that its successful imitation in pigments is exceedingly difficult. It is translucent, and yet more or less opaque ; it transmits some light, but it reflects still more, as may be perceived at a theatre, or at an open-air assemblage of people, when it will be found that the human faces, necks and hands are strikingly discernible ; and that, in spite of the amount of colour in the skin, it is more luminous than most costumes, of similar, or even of more diluted, hues. This distinguishing quality of the skin, is probably due, in great measure, to the multitude of little reflecting surfaces, formed by the lozenge-shaped angular facets between the intersecting lines and furrows of the cutis, and to the glassy brightness of the dry film of cuticle upon them ; the latter property completely explains the dazzling character of the high lights upon the skin, where it is directly illuminated. Both conditions, not only assist in imparting brightness to the integument, under direct illumination, but also account for the remarkable amount of light and colour, reflected from it, even when it is in shadow. The complex hues of the purest coloured skin, are due to many causes, namely : to the nearly white colour of the cutis itself ; to the thin streamlets of blood in its superficial vessels, which, circulating through the skin generally in minute quantities, gives it its pale pinkish colour, but in the palms and soles, around the joints, and, especially in the face, where the capillary vessels are large, and approach very near the surface, imparts to it a delicate rosy colour, or a carmine blush ; to the transparent, yellowish adipose tissue, which contains some fluid fat ; where fat is absent or scanty, to the darker colour of the subjacent muscles, as upon the eyelids, or over the interosseous muscles on the back of the hand ; to the glistening white of tendons, as over the extensor tendons on the metacarpal bones, or over those just above the front of the wrist ; and, lastly, to the presence of subcutaneous veins, which, owing to the interception by the skin and the coats of the veins, of most of the red rays, and the freer transmission of the blue rays of the purple-coloured venous blood, appear as shadowy, bluish-tinted, wandering lines, more or less evident, in proportion to the thinness and delicacy of the skin which covers them. The influence of the hair sacs, where these are present, on the colour of the skin, is very obvious, in the grey tones which they impart to it. The bloom produced by the downy covering of the cheeks of youth, is familiar to all; the rich effect of the hair, with its varieties of tint and luminosity, as seen by direct or by transmitted light, requires no description; and the different hues of the iris, from blue or grey, to brown and almost black, need only to be mentioned. But, in the human figure especially, it is by and from the integument itself, that Light is so broken, decomposed, and reflected as Colour, as to give peculiar lustre to the Beauty dependent on its Form.

Conclusion.

It has been shown, in the preceding pages, how the forms of the Bones and Muscles, whether still or in action, influence those, both general and local, of the entire body. These hard and soft elements of the human frame have been described in detail, and their effects on the shape and ornamentation of its parts, have been, in many and various ways, illustrated and explained. Nothing, however, has been advanced, to justify a hyper-anatomical display, which constitutes the abuse of Anatomy, and has frequently brought discredit on its employment in Art. A defiance of its truths is, however, of much more frequent occurrence.

The diligent Anatomist can demonstrate the relations between Reality and Beauty; but, on the Sculptor and Painter, devolves the higher task of detecting their joint significance, and realising their combination in the creations of Art. This goal may be attained by the rough, but open, road of individual experience, or, after groping through the fog of ignorance, or escaping from the mazes of error; or it may be reached, almost unconsciously, by the possessor of Nature's *rarest* gifts. But in this, as in all other callings, to the few, as well as to the many, the path of Knowledge is the shortest and clearest avenue by which such a goal can be approached.

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