THE

ESSENTIALS OF ANATOMY

DESIGNED AS A TEXT-BOOK FOR STUDENTS

AND AS A

BOOK OF EASY REFERENCE FOR THE PRACTITIONER

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PREFACE.

It may seem to the members of the medical profession, a needless task to present another work upon Anatomy, when so many exhaustive treatises already exist; and the criticism is one in which the Authors of this volume might justly coincide were the present work intended to supercede or rival the works of such famous authors as Quain, Gray, Ellis, Sappey, Hyrtl, Holden, Wilson, Heath, Bellamy, and others who have merited enduring reputation.

It is to be hoped, however, that the public will agree with the Authors of this volume in the feeling that the more exhaustive treatises, in all their completeness of detail, often compel the student, in the beginning of his studies, to waste much valuable time in culling, from the voluminous mass of matter before him, such points as *seem to him essential*, and that, too often, these selections are not made with the judgment which the enlightenment of continued study and a higher degree of culture would afford.

The present state of advanced science and the practical bearing which minute anatomical points and microscopical discoveries in histology are assuming, all tend, possibly too often, to lead anatomical instructors to forget that the medical student must creep before he can walk, and that by a thorough comprehension of those anatomical facts which are comprised in *gross anatomy* only, can he either appreciate or properly value the higher grades of anatomical investigation.

It is, at present, too common with critics to stamp with their opprobrium all works which are not diffuse in character, and to stigmatize, as "cram books," any which show an attempt to simplify, condense, and rearrange facts hitherto well known; and to refer their readers to treatises whose exhaustiveness alone perhaps, requires the very preparatory drill which a smaller volume of well-culled facts would best afford them.

In this volume will be found, what, in the opinion of the authors at least, are some, perhaps not all, of the *essentials* of human anatomy.

It has been the endeavor of the Authors to so arrange these anatomical facts as to render their comprehension easy, even to the beginner; while they have aimed also to render it a volume of easy reference to the Surgeon and Practitioner.

Much of the matter contained has been tabulated and arranged in such a systematic form as to render the perusal of page after page of printed matter unnecessary, and, as far as possible, all points, having a *practical* bearing, have been so mentioned.

It will be observed, possibly to its detriment in the opinion of some, that this volume deals principally with anatomical facts, rather than with questionable microscopical discoveries, since, however valuable the latter may be as a step towards positive knowledge, they are constantly changing with the advance of science, and can be best acquired from the exhaustive treatises which are from time to time appearing upon these subjects.

To the casual reader, there may seem, throughout this work, a redundancy of expression, which might have been avoided; but, as this book has been partly devised to aid reference among the general practitioners of medicine, who have, too often, little time for further reading than is demanded to gain the point sought for, it has been deemed expedient to render each descriptive paragraph as little dependent upon those preceding it, as possible.

The few diagrammatic illustrations, which are contained within this volume, are presented rather as a means of impressing some particular points than as accurate representations of the parts under consideration.

Many of the valuable tables contained in the chapters upon osteology and myology, have been for years a part of the course of lectures of Professor Darling before the classes of the Medical Department of the New York University, and have appeared in print in Europe, while many new ones have been added to simplify other branches of the subject.

As this work has not been intended to supplant, but rather to accompany more exhaustive treatises, the absence of illustrations will not materially detract from its usefulness, since even beginners in medicine would hardly be well equipped for their work without some one of the standard text-books, while to the practitioner of medicine or surgery, in whose libraries are probably contained volumes replete with illustrations, this work is given to simplify anatomical review and to aid easy reference.

It seems especially important to the Authors that the explanatory matter connected with most of the tables and diagrams of this work should be perused with care, before they are used as aids to study or reference, since both will be greatly simplified by so doing.

The Authors here acknowledge their indebtedness to all of those investigators of Anatomy who have put into print the results of their researches, since it is impossible to depart, in many instances, from methods of arrangements, which have previously been given to the public, or to avoid the free use of much that, in other volumes, seems particularly valuable and worthy of perpetuation.

GENERAL INTRODUCTION.

PART I.

OSTEOLOGY.

PART II.

ARTHROLOGY.

PART III.

MYOLOGY.

PART IV.

ANGIOLOGY.

PART V.

NEUROLOGY.

PART VI.

SPLANCHNOLOGY.

1

THE ESSENTIALS OF ANATOMY.

GENERAL INTRODUCTION.

The term ANATOMY comprises that department of science, which treats of the structure of organized bodies.

Anatomy may be divided into two great classes, *Phytotomy*, or vegetable anatomy and *Zoötomy*, or animal anatomy.

The following table exhibits some of the more important divisions of Anatomy which will subsequently merit a special description.

- ANATOMY (2 great classes)
  - PHYTOTOMY or Vegetable Anatomy.
  - ZOOTOMY or Animal Anatomy.
    - *Comparative Anatomy.*
    - *Special Anatomy.*
      - Histology, or General Anatomy.
      - Morphology or Descriptive Anatomy.
      - Relative or Surgical Anatomy.

These varieties may be thus defined:

"Comparative Anatomy" is that department of science which treats of the organs in one animal as compared with those in another.

"Special Anatomy" treats of the anatomy of Species or of parts of the whole structure. It includes Histology, Morphology and Relative or Surgical Anatomy.

"Histology" treats of the intimate structure of organs or tissues.

"Morphology," or "Descriptive Anatomy," treats of the name, form, size and situation of the various structures.

"Relative," or "Surgical Anatomy," treats of portions of Special Anatomy with reference to its surgical interest and value.

Various other terms are often applied to special departments of Anatomy with reference to the *standpoint*, from which anatomical researches are considered or made. Among these special varieties may be enumerated:

(1.) "Philosophical Anatomy."—A treatise on the *mode* or or *plan* on which tissues are formed.

(2.) "Transcendental Anatomy."—The same as the Philosophical.

(3.) "Topographical Anatomy."—The anatomy of *regions* as a separate division of study.

(4.) "Microscopical Anatomy."—The study of *magnified* tissues.

(5.) "Pathological Anatomy."—The study of tissues in disease as revealed by *inspection* and *examination.*

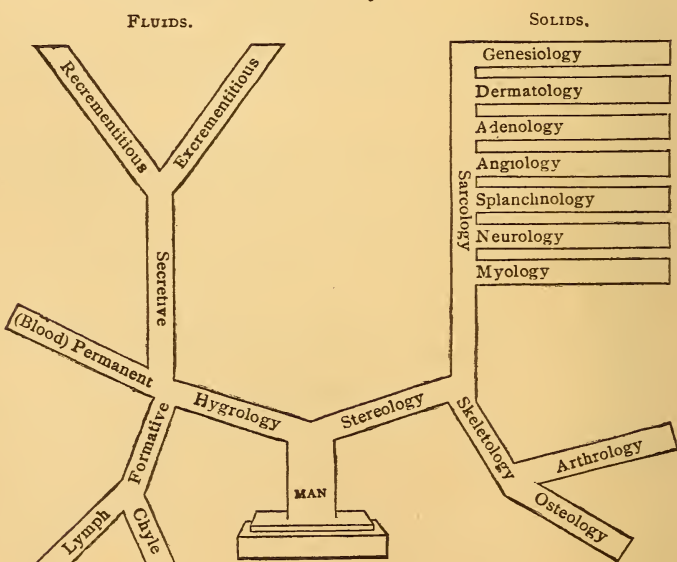
(6.) "Morbid Anatomy."—The study of the *changes* of *tissues in disease* and the explanation of the same.

(7.) "Forensic Anatomy."—The science of morbid anatomy when applied to medical jurisprudence.

(8.) "Veterinary Anatomy."—The study of the anatomical structure of the *domestic* animals.

ANATOMY OF MAN.

In the following diagrammatic illustration, are represented all the various parts of the *human frame work,* which demand the attention of the student of Anatomy.



In this diagram we see that the main anatomical elements of the body are divided into the *solid* and the *fluid* elements. The fluid elements are placed upon the left hand, while the solid elements are arranged upon the right hand side of the page.

The two main divisions given off from the central unit or man, are named respectively, *hygrology*, or the doctrine of the *fluid* elements, and *stereology*, or the doctrine of the solid elements.

STEREOLOGY is subdivided into *sarcology*, or the doctrine pertaining to the softer tissues of the body, and *skeletology*, or the doctrine of the bony framework of the body.

SARCOLOGY is shown to include, (1) *myology*, or the doctrine of the anatomy of the muscular system. (2) *neurology*, or the doctrine of the anatomy of the nervous system. (3) *splanchnology*, or the doctrine of the anatomy of the internal viscera. (4) *angiology*, or the doctrine of vessels. (5) *adenology*, or the doctrine of glandular structures. (6) *dermatology*, or the doctrine of the skin, and (7) *genesiology*, or the doctrine of the generative organs.

SKELETOLOGY is shown to include both *syndesmology*, or the doctrine of the anatomy of the joints, and *osteology*, or the doctrine of the anatomy of the special bones.

FLUIDS.

The *fluids* of the body are divided also in this diagrammatic chart into, (1) The *formative*, which include the lymph and chyle, (2) The *Blood* or *permanent* fluid, and (3) The *secretive*, which comprise the *recrementitious* fluids, which are appropriated by the body, and the *excrementitious* fluids, which are cast off as unfit for nutritive processes.

Each of these respective heads will be treated of in this volume, and the description of the various points of anatomical interest, pertaining to each, will be so tabulated and arranged, as to afford, to the student, the greatest possible help in the acquisition of accurate and practical anatomical knowledge. All points in Anatomy, which are as yet matters of doubt, will be purposely either omitted or left in question, since it is the desire and intention of the Authors to publish a volume containing only anatomical *facts* rather than to enter upon speculative ground.

OSTEOLOGY.

OSTEOLOGY.

THE SKELETON.

The bones forming the human skeleton are *two hundred* in number, and may be thus classified:

(1)	Bones of the HEAD,	22
(2)	" " TRUNK,	53
(3)	" " EXTREMITIES,	64 60
(4)	The HYOID ARCH,	1
	Total	200

The 22 bones of the HEAD consist of

Cranium	8	4 mesial. 2 pairs.
Face	14	2 mesial. 6 pairs.
Total,	22	

The 53 bones of the TRUNK consist of

Vertebræ	24	
Thorax	25	Ribs (12 Pairs.) Sternum (1 Bone)
Pelvis	4	2 mesial. 1 pair.
Total	53	

The 64 bones in both UPPER EXTREMITIES are

Shoulder	2	Scapula. Clavicle.
Arm	1	Humerus.
Forearm	2	Radius. Ulna.
Hand	8 5 14	in Carpus. " Metacarpus. Phalanges.
Total	32	(on each side.)

The 60 bones in both LOWER EXTREMITIES are

Thigh	1	Femur.
Leg	2	Patella. Fibula. Tibia.
Foot	7 5 14	in Tarsus. in Metatarsus Phalanges.
Total	30	(on each side.)

In this classification of the bones of the human body, the following structures, which by some Anatomists have been enumerated as individual bones, have been purposely excluded:

(1) Ossa Triquetra (Wormian bones.)
(2) The bones of the middle Ear.
(3) Sesamoid bones.
(4) The Teeth.

The bones of the human body may be classified in the second place, in respect to their *shape*, as follows:

BONES OF THE HUMAN BODY. (classified as to their) *shape*.	LONG bones (90)		Clavicles	2
			3 of Upper Extremity of each side	6
			Metacarpal bones	10
			3 of Lower Extremity of each side	6
			Metatarsal bones	10
			Phalanges (of hands and feet)	56
			Total,	90
	SHORT bones (30)		Carpal of both sides	16
			Tarsal " "	14
			Total,	30
	FLAT bones (40)	In Skull	Occipital. Frontal. 2 Parietal.	4
		In Face	2 Nasal. 2 Lachrymal. Vomer.	5
			Scapula	2
			Sternum	1
			Ribs	24
			Os Innominatum	2
			Patella	2
			Total,	40
	IRREGULAR bones (40)	Of the Spine	Vertebræ, 24; Sacrum, 1; Coccyx 1	26
		Of the Skull	2 Temporal, Ethmoid, Sphenoid.	4
		Of the Face	2 Superior Maxillary, 2 Malar, 2 Palate, 2 Inferior turbinated, Inferior Maxillary.	9
			Hyoid Bone	1
			Total,	40
	Total, 200			

The LONG BONES are used as means of *support* to the other portions of the skeleton, or as *levers* upon which the muscular system can act to the best advantage.

The SHORT BONES are situated where *great solidity*, a *limited amount* of *motion*, and *compactness* are required.

The FLAT BONES are important agents in the *protection* of the organs, contained within the various cavities of the body, as in the cranium, thorax, and pelvis, and from their shape they serve to give *extensive attachment* to *muscles*.

The following table will serve to show the *regions of the body* where each of these four varieties of bones predominates.

TABLE ILLUSTRATING THE POSITION OF THE BONES OF THE HUMAN SKELETON WHEN CLASSIFIED ACCORDING TO THEIR SHAPE.

	Head.		Trunk.			Extremities.		Hyoid Arch.	
Bones.	Cranium.	Face.	Vertebral column.	Thorax.	Pelvis.	Upper.	Lower.		Total.
Long.	....	..	....	...	..	46	44	....	90
Short.	....	..	....	...	..	16	14	....	30
Flat.	4	5	....	25	2	2	2	....	40
Mixed.	4	9	24	...	2	...	...	1	40
	8	14	24	25	4	64	60	1	200
	22		53			124		1	

The bones of the human skeleton may, in the *third place*, be divided for convenience of description into *single* or *mesial* bones, and into *pairs of bones*, as in following table:

BONES OF HUMAN SKELETON classified in reference to the *mesial line of the body*.)

- MESIAL OR SINGLE Bones (34.)
  - In cranium: Occipital, Sphenoid, Ethmoid, Frontal — 4
  - In face.: Vomer, Lower jaw — 2
  - Vertebræ.............. 24
  - In Pelvis.: Sacrum, Coccyx — 2
  - Sternum................ 1
  - Hyoid bone............. 1
  - Total, 34..... 34
- PAIRS of Bones (83)
  - In cranium: Parietal, Temporal — 2
  - In face: Superior maxillary, Nasal, Lachrymal, Malar, Palate. Inferior turbinated, — 6
  - In upper extremity 32
  - In lower " 30
  - In pelvis.... 1
  - In trunk (ribs) 12
  - Total, 83 × 2 = 166

Total, 200

BONY PROMINENCES AND DEPRESSIONS.

Upon almost every bone in the human skeleton are to be seen various *prominences* and *depressions*. These prominences and depressions, although they may often appear to the student but trivial and possibly accidental in their character, are nevertheless important, and each one is usually designated with some special name, which is supposed to indicate either its location, its general character, or the particular function which it is destined to perform. From such a basis of nomenclature, however, the variations in names have become almost beyond the reach of a student's memory, unless the meaning of the more common forms be pointed out and the student be assisted, by some classification, to grasp the general principles upon which these names have originally been applied. For this purpose then, the following tables are appended:

NAMES APPLIED TO PROMINENCES ON BONES.

BONY PROMINENCES.

- (I) For the purposes of *articulation.*
  - In *movable* joints.
    - Heads.
    - Condyles.
  - In *immovable* joints
    - Dentations.
    - Ridges.
    - Roots.
- (II.) For the *insertion of fibres.*
  - (1) Names given from the *general form*, viz.:
    - Tubercle (if small and uneven.)
    - Impressions.
    - Lines (if narrow and prolonged.)
    - Crests.
    - Spines (if slender and pointed.)
    - Prominences.
    - Tuberosities (if broad, rough and uneven.)
  - (2) Names given from their *resemblances*, viz.:
    - Azygos (without a fellow.)
    - Clinoid (a bed.)
    - Coracoid (a crow's beak.)
    - Coronoid (the top of a curve.)
    - Hamular (a hook.)
    - Malleolar (a little mallet.)
    - Mastoid (a nipple.)
    - Odontoid (a tooth.)
    - Pterygoid (a wing.)
    - Rostrum (a beak.)
    - Spinous (a thorn.)
    - Styloid (a pen.)
  - (3) Names given from their *use*, viz:
    - Articular.
    - Orbital.
    - Trochanteric (to turn.)
    - Zygomatic (to join.)
  - (4) Names given from their *direction*, viz.:
    - Ascending.
    - Descending.
    - Transverse.
    - Oblique.
- (III.) For the *reflection of tendons*—as Malleoli, Hamular processes, etc.

NAMES APPLIED TO CAVITIES IN BONES.

CAVITIES IN BONES.	ARTICULAR.	Cotyloid (cup shaped.) Glenoid (shallow.) Trochlea (like a pulley.) Facet (smooth.) Alveolar. Acetabulum.	
	NON ARTICULAR.	(1) For *reception* and *protection.*	Fossae. Sinuses.
		(2) For *insertion.*	Temporal. Zygomatic. Pterygoid.
		(3) For *transmission.*	Aqueducts, Foramina. Canals. Fissures. Notches.
		(4) To *increase* the *surface* of the bone.	Cells (as in Ethmoid bone.) Sinuses (as in Frontal bone.)
		(5) To *deflect tendons.*	Sciatic notches. Bicipital groove.
		(6) For the *nutrition* of the Bone.	Nutrient or Medullary. Articular. Periosteal or capillary foramina.
		(7) Depressions for *glands* or *arteries.*	

When a projection from the surface of a bone is connected to it by cartilage, it is termed an *Epiphysis;* when, by the process of ossification, the cartilage disappears and it becomes united by bone, it is called an *Apophysis.*

The shaft of a long bone is often called its *Diaphysis.*

MINUTE ANATOMY OF BONE.

If a transverse section of bone tissue be rendered sufficiently thin to allow of a microscopical examination by transmitted light, it will be found to present for inspection the following points of interest, which have been separately named and which enter prominently into its construction:

1. *Haversian Canals.*

   These canals have an average diameter of about $\frac{1}{500}$ of an inch, and are round, oval, or angular in their form. They contain arterial vessels, and, in the larger ones, veins are frequently present.

2. *Canaliculi.*

   These small canals vary in size from $\frac{1}{14000}$ to $\frac{1}{20000}$ of an inch in diameter and serve to connect the Haversian canal with spaces in the bone called lacunæ.

3. *Lacunæ.*
   These are seen as irregular dark spaces, which may be noticed to have a general circular arrangement around the Haversian canal. *They contain the bone cell.*
4. *Haversian Spaces.*
   These are larger and irregular-shaped spaces which connect the Haversian canals with the medullary spaces of cancellous bone tissue. They are found in young and in growing bones more extensively than in adult life.
5. *Concentric Lamellæ.*
   These are layers of bone tissue which are arranged *around an Haversian canal as an axis.* They enclose within their substance the lacunæ of bone.
6. *Circumferential Lamellæ.*
   These are layers of bone which serve to unite or bind together the various Haversian canals and their concentric lamellæ.
7. *Interstitial Lamellæ.*
   These are layers of bone tissue which are woven in and out between the concentric lamellæ surrounding the various Haversian canals.

Each Haversian canal, if taken in connection with its numerous investing or concentric lamellæ, is termed an *Haversian System*

The *vessels of bone* consist of arteries, veins and lymphatics, although the latter have been denied by some of the more prominent observers.

The *arteries* of bone are of three orders, as follows:

1. *Nutrient Artery*, which enters at the nutrient foramen and distributes branches along the entire length of the medullary canal of the bone.
2. *Articular Vessels*, which chiefly nourish the cancellous tissue of bone.
3. *Periosteal Vessels*, which ramify in the periosteum and which supply the compact tissue of bone with blood.

The *veins* of bone, especially the long bone, emerge also in three distinct localities as follows:

1. By a large vein which *accompanies* the *nutrient artery.*
2. By numerous large and small veins, which emerge from the *articular ends* of the bone.
3. By many small veins which escape from the compact tissue along the length of the *shaft.*

Composition of Bone.

With the exception of the teeth, bone is the hardest structure of the human body, and is composed of two distinct elements, viz., the *Organic* or *Animal* constituents, and the *Inorganic* or *Mineral* constituents. The organic elements of bone may be most clearly demonstrated by subjecting a bone to the prolonged action of a diluted solution of nitric or muriatic acid, when the mineral ingredients will be found to have been dissolved, and the bone, although still retaining its original bulk and form, will present a degree of flexibility, which will admit of its being tied into a knot without danger of fracture.

On the other hand, if a bone be subjected to extreme heat the animal ingredients will be consumed and the bone will then be found to be extremely brittle and to be greatly decreased in its weight.

The organic constituents of bone form about *one-third* of the entire bone, and the *inorganic* constituents the remaining *two-thirds.*

The various substances, revealed by a chemical analysis of the organic and inorganic constituents found in bone, are shown in the following table:

Organic matter,	Gelatin and bloodvessels and fat	33.30
Inorganic or earthy matter	Phosphate of lime	51.04
	Carbonate of lime	11.30
	Fluoride of calcium	2.00
	Phosphate of magnesia	1.16
	Soda and Chloride of Sodium	1.20
		100.00

The relative proportions between the organic and the inorganic elements of bone differ in the *various portions* of the skeleton, and also at *different periods in life.*

Thus the bones of the head and the long bones in the extremities contain more earthy matter than the bones of the trunk. The bones of the upper extremity also contain more than the corresponding bones of the lower extremity. The humerus contains a greater proportion of inorganic matter than the radius or the ulna, and the femur more than the tibia and the fibula. The metacarpal and metatarsal bones are only slightly richer in earthy matter than the bones of the trunk.

As age advances, the mineral elements of bone tend to increase. This is most especially marked in the long bones of the extremities and in the bones of the head; both of which localities in fœtal life seem to be deficient in earthy salts as compared with the proportion present during adult life. In the bones of the trunk of the adult, on the contrary, no change from the fœtal proportions between the organic and the inorganic bone ingredients occurs.

The relative proportion existing between the earthy and mineral ingredients of bone exerts a marked influence on the development of the figure and on the rapidity of repair in case of fracture. Thus the bones become bent and twisted, when an excess of organic material is present, while a marked tendency to fracture is produced by a deficiency in those elements. In rickets, the former condition is usually present from some error in nutrition, while, in old age, the latter condition is liable to be developed.

BONES OF THE HEAD.

OSTEOLOGY OF THE HEAD.

The head is composed of two great divisions, viz.:

A.	The CRANIUM.	composed of 8 bones	Total 22 bones.
B.	The FACE.	composed of 14 bones	

The 8 bones entering into the formation of the cranium may be subdivided into 4 single or mesial bones and 2 pairs of bones, as is represented in the following tabular arrangement:

BONES OF THE CRANIUM.	*Mesial* or *Single Bones*	(4)	OCCIPITAL. SPHENOID. ETHMOID. FRONTAL.
	Pairs of *Bones*	(2)	TEMPORAL. PARIETAL.
	Total	8	

The *mesial* or *single* bones are enumerated in this table in their order from behind forward and may be remembered by the initial letter of each, O. S. E. F., which bear some resemblance to the old method of spelling Joseph. As explained in the introductory pages upon osteology, these bones, like all *mesial* bones, lie in the median plane of the body and articulate upon either side with pairs of bones. It will thus be understood that when pairs of bones are spoken of, that one lies upon the right and one upon the left of the median plane of the body.

The *mesial* bones are also often called *symmetrical* bones, since they are capable of being divided into two similar parts.

In describing the bones of the cranium certain words will be encountered by the reader, the meaning of which deserve to be clearly understood before entering into the study of osteology.

In anatomy the words *external* and *internal* are used to express the relation of a bone or any separate structure, *as a whole*, to the *mesial plane* of the body.

The words *exterior* and *interior*, when applied to a bone, are used to express the relation of the *surfaces* to the *centre of the cavity* which it contributes to form. This applies particularly to the skeleton of the cranium, thorax and pelvis.

The words *anterior* and *posterior*, indicate the relation of any part to the *ventral* or *dorsal plane* of the body.

The words *superior* and *inferior*, express the relation of any part to the *central point* of the body.

The word *beneath* is applied to parts more distant from the surface.

It must be constantly borne in mind that the words superior, inferior, anterior, posterior, above and below, have reference to the position of the parts in the *erect posture of the body*, and the neglect of this caution has tended, in no small degree, to embarrass the student, and to render description otherwise full and complete, almost unintelligible.

THE OCCIPITAL BONE.

This bone is situated in the posterior and inferior part of the cranium. In form, it is classed among the *flat* bones. Its direction is both horizontal and vertical, since it enters into the formation both of the base of the skull and the posterior portion of the cranium.

The occipital bone presents for special consideration the following component parts:

An outer surface.
An inner surface.
Four borders { Superior (2.) Inferior (2.)
Four angles { Lateral (2.) Superior (1.) Inferior (1.)

OUTER SURFACE.

This portion of the occipital bone is convex in shape, and possesses several points of anatomical interest which may be thus described:

(1.) A projection called the *occipital protuberance* for the insertion of the ligamentum nuchæ.

(2.) A bony ridge running from the occipital protuberance to the foramen magnum, and called the *occipital crest*.

(3.) Two curved lines called the *superior* and *inferior curved lines* of the occipital bone. The superior affords attachment to the occipito-frontalis, sterno-mastoid and trapezius muscles. The inferior gives attachment to the rectus capitis posticus major and minor muscles.

(4.) A *space between* the two *curved lines*, from which arise the complexus, splenius capitis and the superior oblique muscles.

(5.) The *foramen magnum*, through which pass the spinal cord and its membranes, the spinal accessory nerves and the vertebral arteries.

(6.) The *condyles* of the occipital bone, which are oblong in shape, converging in front, looking downwards, forwards and outwards, and which are roughened on their inner aspect for the insertion of the check ligaments. They articulate with the cups of the atlas.

(7.) The *anterior condyloid foramina*, which are situated in front of the condyles and which transmit the hypoglossal nerves.

(8.) The *posterior condyloid foramina*, which lie behind the condyles and which transmit a vein to the lateral sinus of the skull. Occasionally no foramen is present and a *fossa* takes its place.

(9.) The *jugular processes*, which lie on the outer side of the condyle and which give attachment to the recti capitis laterales muscles and to the *lateral occipito-atloid ligaments*.

(10.) The *basilar process*, which forms the anterior projection of the occipital bone and which articulates with the body of the sphenoid bone.

(11.) The *pharyngeal spine*, which is a bony projection upon the basilar process for the attachment of the tendinous raphe and the superior constrictor muscle of the pharynx.

(12.) Two *rough depressions* upon the basilar process for the recti capitis antici majores and minores muscles.

Inner Surface.

The inner surface of the occipital bone is concave in its shape and is divided into *four fossæ* by two crucial ridges of bone, which at their point of intersection form the *internal occipital protuberance*, at the centre of which is a depression which corresponds to the *torcular Herophili.* The upper division of this crucial ridge of bone ascends to the superior angle of the occipital bone, and is deeply grooved for the superior longitudinal sinus and for the attachment of the falx cerebri.

The inferior division is termed by some anatomists the *internal occipital crest.* It descends to the foramen magnum where it bifurcates. It gives attachment to the falx cerebelli.

The lateral divisions of this crucial ridge form the inferior boundaries of the two superior or cerebral fossæ, and the superior boundary of the inferior or cerebellar fossæ of the occipital bone. They are deeply grooved for the attachment of the lateral sinuses and the tentorium cerebelli.

At the lower portion of the bone upon its inner surface, is seen again the internal margin of the *foramen magnum*, which has already been described, and, near the sides of this large opening, appear also the internal orifice of the *anterior condyloid* foramina. Upon the internal surface of the basilar process is seen the *basilar* *groove*, in which lie the pons Varolii and the medulla oblongata, and, upon each side of the basilar groove, are two smaller grooves which partly lodge the inferior petrosal sinuses.

BORDERS.

The occipital bone presents for examination two superior borders and two inferior borders.

The *superior borders* articulate with the parietal bone of each side of the cranium, and by so doing form the *lambdoidal suture*.

The *inferior borders* articulate with the *mastoid* and *petrous* portions of the temporal bone and assist in forming the jugular foramen or the foramen lacerum posterius.

ANGLES.

The occipital bone has four angles, the superior, the inferior, and two lateral angles.

The *superior angle* is formed by the approximation and union of the two superior borders of the bone. It is received between the two parietal bones of the skull and assists in forming the so-called *posterior fontanelle*, which is a triangular space bounded on either side by the parietal bones and behind by the occipital bone and which is uncovered by bone at the time of birth.

The *inferior angle* is situated at the end of the basilar process of the occipital bone and joins with the body of the sphenoid bone, to which it becomes ossified at about the eighteenth or twentieth year of age.

The *lateral angles* are received between the posterior inferior angles of the parietal bone and the mastoid portions of the temporal bones. It presents upon its inner surfaces a portion of the grooves for the attachment of the lateral sinuses.

MUSCLES ATTACHED TO THE OCCIPITAL BONE.

To the occipital bone are attached twelve pairs of muscles, all of which arise from its exterior surface.

These twelve pairs of muscles may be thus classified:

MUSCLES ATTACHED TO OCCIPITAL BONE. (12.)	To superior curved line	(3)	OCCIPITO-FRONTALIS.
			TRAPEZIUS.
			STERNO-CLEIDO-MASTOID.
	Between the curved lines	(2)	COMPLEXUS.
			SPLENIUS CAPITIS.
	Between the inferior curved line and foramen magnum	(3)	OBLIQUUS CAPITIS SUPERIOR.
			RECTUS CAPITIS POSTICUS MAJOR.
			RECTUS CAPITIS POSTICUS MINOR.
	To basilar process	(3)	SUPERIOR CONSTRICTOR OF PHARYNX.
			RECTUS CAPITIS ANTICUS MAJOR.
			RECTUS CAPITIS ANTICUS MINOR.
	To jugular process	(1)	RECTUS CAPITIS LATERALIS.
		Total 12	

The foramina in the occipital bone vary from three to five in number since three are constant and two are variable.

The two *posterior condyloid* foramina are often absent, but the two anterior condyloid foramina and the foramen magnum are constant both in their location and in the structures which they transmit.

Articulation of the Occipital Bone.

The occipital bone articulates with six bones of tne skull, which may be enumerated as follows:

Articulations of the Occipital bone.
- 2 mesial bones (2)
  - Atlas.
  - Sphenoid.
- 2 pairs of bones (4)
  - The Temporal bones.
  - The Parietal bones.

Total 6

Development of the Occipital Bone.

The occipital bone has *four centres* of development: one for the posterior or the occipital portion, one for each condyle, and one for the basilar process of the bone. At birth the bone consists of four separate parts as indicated by the location of the centres of ossification. At about the fourth year, the two condyloid portions join with the occipital portion, and two years later the basilar process becomes joined, thus completing the entire bone.

THE SPHENOID BONE.

The sphenoid bone is situated at the anterior portion of the base of the skull and is wedged in between the other bones of the cranium. In shape it resembles a bat with its wings outstretched.

It possesses 12 foramina, 12 pairs of muscles, 10 points of ossification, and it articulates with 12 bones.

The sphenoid bone enters into the formation of the following important anatomical regions.

A. Five *cavities*
- The cavity of the Cranium.
- " " " both Orbits.
- " " " both Nasal fossæ.

B. Four *fossæ*
- The temporal fossa.
- " zygomatic fossa.
- " spheno-maxillary fossa.
- " pterygoid fossa.

C. Three *fissures*
- The spheno-maxillary fissure.
- " pterygo-maxillary "
- " sphenoidal "

The sphenoid bone presents for examination the following component parts:

(1.) A Body.
(2.) Three greater processes.
(3.) Eleven lesser processes.

The 3 GREATER PROCESSES of the sphenoid bone are as follows:

(1.) The greater wings.
(2.) The lesser wings or "Processes of Ingrassias."
(3.) The pterygoid processes.

The 11 LESSER PROCESSES of the sphenoid bone may be classified as follows:

Lesser processes of the sphenoid bone.	*Single* processes	(3)	Ethmoidal spine.
			Olivary process.
			Rostrum or Azygos process.
	4 *Pairs* of processes	(8)	The two *posterior* clinoid processes.
			The two *anterior* clinoid processes.
			The two *middle* clinoid processes.
			The two spinous processes.
	Total	11	

Some of these smaller processes will be found described under the description of the body and the greater processes of the bone, since they exist either as parts of those larger projections or as prominent points upon the central body of the sphenoid.

BODY OF SPHENOID.

The body of the sphenoid bone is cuboid in its shape, but it presents only four free surfaces instead of six, since the two lateral surfaces are continuous with and afford attachment to the greater and the lesser wings and the pterygoid processes of the bone.

Upper Surface.

The upper surface of the body is situated in the interior portion of the cranium. It presents, from before backwards, the following points deserving of special mention.

(1.) The *ethmoidal spine*, which articulates with the ethmoid bone, and which consists of a horizontal projection, of a pointed shape, from the anterior edge of the body of the sphenoid.

(2.) A *smooth surface* just behind the ethmoidal spine marked by two shallow grooves for the support of the olfactory nerves.

(3.) The *optic groove*, which supports the commissure of the optic nerves and which leads, upon either side, towards the optic foramen.

(4.) The *olivary process*, just behind the optic groove, and in front of the sella turcica.

(5.) The *pituitary fossa* or *sella turcica*, so called since it lodges the pituitary body of the brain, and from its resemblance to a turkish saddle. This fossa is bounded in front by the *middle clinoid processes*, and the circular sinus of the brain is situated within it.

(6.) *Dorsum sellæ*, or the back of the saddle. This portion of the bone is grooved or notched at the sides for the passage of the 6th pair of cranial nerves, and at its superior angles it gives off the two *posterior clinoid process* for the attachment of the tentorium cerebelli.

(7.) The *cavernous groove*, which is perceived upon each side of the body and which is curved like the letter S. This groove lodges the internal carotid artery and the cavernous sinus.

Anterior Surface.

The anterior surface of the body of the sphenoid bone has a direction which is nearly vertical. It presents for examination the following points of anatomical interest and importance:

(1.) The *sphenoidal crest*.
This portion of the bone articulates with the perpendicular plate of the ethmoid bone.

(2.) The *openings* into the *sphenoidal sinuses*.
These openings extend into the body of the bone, rendering it hollow and greatly decreasing the weight of the bone, in proportion to the surface which it presents.

(3.) The *sphenoidal turbinated bones*, or "Bones of Bertin."
These bones partially close the openings of the sphenoidal sinuses and articulate with the os planum of the ethmoid; upon their sides and at their inferior portion, they articulate with the orbital processes of the palate bones.

Under Surface.

This surface of the bone enters into the formation of the nasal fossæ. It presents for examination the following points of interest:

(1.) The *rostrum* of the sphenoid.
This thin plate of bone is received into a corresponding slit-like depression in the vomer between its two alæ. It is, in reality, but a continuation downwards of the sphenoidal crest.

(2.) The *vaginal* processes.

These processes of bone are situated on each side of the rostrum. They articulate with the alæ of the vomer.

(3.) The *pterygo-palatine grooves.*

These grooves are situated externally to the vaginal processes of the sphenoid. They form, by their articulation with the sphenoidal processes of the palate bones, the so-called *pterygo-palatine* canals, which transmit the pterygo-palatine artery and the pterygo-palatine nerves.

Posterior Surface.

This surface of the body of the sphenoid bone articulates with the basilar process of the occipital bone, and becomes ossified to it at the age of eighteen or twenty. It is quadrilateral in form.

GREATER WINGS OF THE SPHENOID.

The greater wings of the sphenoid bone are large irregular shaped masses which can only be thoroughly described by division into the following parts:

(1.) A superior or cerebral surface.
(2.) An external surface.
(3.) An anterior or orbital surface.
(4.) A circumference.

The *superior* or *cerebral surface*, forms a part of the middle fossa at the base of the skull. It presents for examination four foramina, which allow of the exit of nerves from, or the entrance of vessels to the cavity of the cranium. These foramina may be thus enumerated from before backwards:

(1.) The *foramen rotundum*	which transmits	Superior maxillary nerve.
(2.) The *foramen ovale*	" "	Inferior maxillary nerve. Small petrosal nerve. Small meningeal artery.
(3.) The *foramen Vesalii*	" "	A small vein.
(4.) The *foramen spinosum*	" "	Middle meningeal artery.

The *external surface* of the greater wing of the sphenoid bone is divided by a bony ridge called the *pterygoid ridge* into a superior and an inferior portion.

The *superior* portion assists in the formation of the temporal fossa.

The *inferior* portion assists in forming the zygomatic fossa, and at its posterior portion it presents a bony prominence, called the *spine of the sphenoid*, which affords attachment for the internal lateral ligament of the jaw and also for the laxator tympani muscle.

The *anterior* or *orbital surface* of the greater wing of the sphenoid bone is quadrilateral in shape. It assists in forming the outer wall of the orbit, and it also enters into the formation of the sphenoidal, and the spheno-maxillary fissures. It articulates with the frontal and the malar bones. It presents a small bony prominence, called its *spine*, to which is attached the lower head of the external rectus muscle.

The *circumference* of the greater wing of the sphenoid bone serves the combined functions of articulation with other bones and the completion of foramina and fissures.

From the back portion of the body of the sphenoid, as you progress towards the spine of its greater wing, the circumference of the wing assists in forming the anterior margin of the *foramen lacerum medium*, and it also articulates with the petrous portion of the temporal bone.

From the *spine* of the greater wing to its *tip*, the circumference of the wing articulates with the squamous portion of the temporal bone.

This articulating surface is bevelled upon its inner aspect, in the inferior portion of its length, and upon its outer or exterior aspect, in its upper or superior portion.

From the *tip* of the greater wing to the front portion of the body, there exists a triangular surface for the articulation of that portion of the sphenoid with the frontal bone. The balance of this portion of the circumference of the wing forms the lower boundary of the sphenoidal fissure.

LESSER WINGS OF SPHENOID. (Processes of Ingrassias.)

These processes are long, thin, and of a triangular shape. They present for examination two surfaces, two borders, a base, and an apex.

The *upper surface* is smooth, and forms a part of the anterior fossa, at the base of the skull.

The *under surface* forms the back portion of the roof of the orbit and the upper boundary of the sphenoidal fissure, which transmits the 3rd, 4th, the opthalmic branch of the 5th, and the 6th nerve, the opthalmic vein, a branch of the lachrymal artery, and a process of dura mater.

The *anterior border* articulates with the frontal bone.

The *posterior borders* form, at their inner extremities, the *anterior clinoid processes*.

The base is connected to the body by two roots which by their separation enclose and form the *optic foramen* for the passage of the optic nerve and the opthalmic artery.

Pterygoid Processes of the Sphenoid.

These processes consist of two thin plates of bone, which are joined together anteriorly and which enclose between them the pterygoid fossa. These two plates, by their separation, form a triangular notch below, which articulates with the pterygoid process of the palate bone.

The pterygoid processes present for examination an anterior and a posterior surface, and an internal and external pterygoid plate. The posterior surface constitutes the pterygoid fossa which gives origin to the external pterygoid muscle.

The upper portion of the *anterior surface* forms the posterior wall of the spheno-maxillary fossa. It presents also the orifice of the *Vidian canal*, at about its point of junction with the body of the sphenoid bone.

The *external pterygoid plate* is broad, thin, and inclined outwards. It forms the inner wall of the zygomatic fossa, and the outer wall of the pterygoid fossa. It gives attachment to the internal and external pterygoid muscles.

The *internal pterygoid plate* is long and narrow. Its outer surface forms the inner boundary of the pterygoid fossa, and its inner surface forms the outer boundary of the posterior nares. It presents at its apex the *hamular process*, which reflects the tendon of the tensor palati muscle, and, at its base, it presents the *scaphoid fossa* for the origin of the same muscle.

Articulation of the Sphenoid Bone.

The sphenoid bone articulates with 12 bones which may be thus classified :

The Sphenoid bone articulates with	Four *single* or Mesial bones.		Occipital. Ethmoid. Frontal. Vomer.
	Four *pairs* of bones.	Two of Cranium	Temporal. Parietal.
		Two of the Face	Malar. Palate.

Of these twelve bones, *all the remaining bones of the cranium* comprise seven, and the remaining five are bones of the *face.*

Forâmina of the Sphenoid Bone.

The sphenoid bone presents 12 formina, which are arranged in six pairs. These formina transmit five of the twelve pairs of cranial nerves; *viz.*, 2nd, 3rd, 4th, 5th, and 6th, and other structures, as enumerated in the table of cranial foramina.

These foramina may be thus classified:

The sphenoid bone has 6 pairs of openings, *viz.*:	5 Simple foramina,	Optic foramen.
		Foramen rotundm.
		" ovale,
		" Vesalii.
		" Spinosum.
	1 Fissure,	Sphenoidal fissure.

Each of these foramina has been alluded to in the descriptions of the various parts of the sphenoid bone. They will furthermore be found considered separately and in detail in "the classified table of foramina situated at the base of the skull."

The sphenoid bone transmits two important arteries; *viz.*, the ophthalmic and the middle meningeal arteries, and contains one canal, called the Vidian canal, which transmits the Vidian nerve.

Muscles attached to the Sphenoid Bone.

The sphenoid bone affords attachment to *twelve pairs* of muscles. These muscles may be thus classified:

Muscles attached to the Sphenoid Bone.	All the muscles of the Orbit excepting the Inferior oblique muscle.	(7)	Levator palpebræ.
			Superior oblique of the eye,
			Superior rectus " "
			Inferior " " "
			External " " "
			Internal " " "
	Muscles of mastication,	(3)	Temporal.
			External pterygoid.
			Internal pterygoid.
	Muscles of deglutition,	(2)	Superior constrictor.
			Tensor palati.
	Muscle of the middle ear,	(1)	Laxator tympani.
	Total,	12	

Development of the Sphenoid.

The sphenoid is developed by ten centres of ossification. These ten centres are distributed as follows:

Centres of Ossification of the Sphenoid Bone,	For the posterior half of the Bone.	(6)	One for each *greater wing* and *external pterygoid* plate.	(2)
			One for each *internal pterygoid* plate.	(2)
			Two for the *posterior portion* of the *body* of the Sphenoid.	(2)
			Total,	6
	For the anterior half of the bone.	(4)	One for each *lesser wing* and the *anterior part* of the *body* of the Sphenoid.	(2)
			One for each of the *Sphenoidal turbinated bones.*	(2)
	Total,	10	Total,	4

The process of ossification, between and in these separate pieces, takes place in the following order:

The great wings and external pterygoid plates are first formed during the 2nd month of fœtal life.

Each internal pterygoid plate is then formed, and becomes united to the external plate at about 4½ months of fœtal life.

The two centres for the development of the body of the bone are situated underneath the sella turcica. This portion of the bone ossifies after the middle of fœtal life, and is detached from the greater processes of the bone even at the time of birth.

The lesser wings are formed by a separate centre for each. They become united at about the 8th month of fœtal life.

Ossification begins in the sphenoidal turbinated bones at the end of the 3d year.

At birth the sphenoid usually consists of the 5 following pieces:

(1.) The body joined to the lesser wings.
(2.) The 2 greater wings.
(3.) The 2 pterygoid processes.

The greater wings become united to the body during the first year, but the turbinated bones do not unite until the 10th or 12th year of age.

THE ETHMOID BONE.

This bone of the cranium is of a peculiarly light and spongy texture. It is cuboid in shape and projects downwards between the orbital plates of the frontal bone. It enters into the formation of the orbital cavities and the nasal fossæ.

This bone serves five important functions in the structure of the skull and face.

1st. It affords attachment to a strong fold of dura mater, called the *falx cerebri* or *greater falx*, which separates the two lateral halves of the brain, and which, by the separation of its two laminæ, furnishes two channels for blood, termed the superior and the inferior longitudinal sinuses of the skull.

2nd. It presents a number of small foramina for the transmission through its cribriform plate of the filaments of the olfactory nerves.

3rd. It forms a large part of the septum which separates the two nasal cavities from each other.

4th. It affords a large expanse of surface upon which the filaments of the olfactory nerves may be distributed. This portion of the bone comprises the so-called *superior* and *middle turbinated bones.*

5th. It affords a protective bony covering for the ethmoidal cells and at the same time it constitutes a large part of the inner walls of the two orbital cavities. This orbital portion of the bone is termed the "*os planum*."

The ethmoid bone may be divided, for the convenience of description into the following three portions:

(A.) The horizontal or cribriform plate.
(B.) The perpendicular plate.
(C.) The two lateral masses.

Horizontal or Cribriform Plate.

This portion of the ethmoid bone is received into the ethmoidal notch of the frontal bone. It forms the roof of the nose and a portion of the floor of the anterior fossa of the skull. It presents the following points of interest:

(1.) The *Crista galli* process.

This elevation of bone, so-called from its fancied resemblance to the comb of a cock, affords attachment to the anterior extremity of the falx cerebri, and it also articulates with the frontal bone, thus completing the *foramen cœcum.*

(2.) *Three rows of minute foramina;* situated upon either side of the crista galli process. These foramina transmit the olfactory nerves.

(3.) A *fissure* for the nasal branch of the ophthalmic nerve. This fissure is situated in the front portion of the cribriform plate.

Perpendicular Plate.

This portion of the ethmoid bone descends from the under surface of the cribriform plate and assists in forming the nasal septum.

It is more or less inclined towards one side, in the large majority of subjects, and it presents numerous grooves for the protection of the filaments of the olfactory nerves.

The perpendicular plate of the ethmoid is of an irregular pentagonal form and has five borders, viz: an upper, an antero-superior, an antero-inferior, a postero-superior, and a postero-inferior.

The *upper border* is continuous with the crista galli.

The *antero-superior border* articulates with the nasal bone.

The *antero-inferior border* joins the cartilage of the nose.

The *postero-superior border* articulates with the sphenoid.

The *postero-inferior border* articulates with the vomer.

Lateral Masses.

These portions of the ethmoid bone are cuboid in their general form and enclose a large number of irregularly shaped cavities called the *ethmoid cells*. These cells may be divided into an anterior and a posterior set.

The lateral masses of the ethmoid present for special examination the following six surfaces.

An anterior surface,
A posterior surface,
An upper surface,
An outer surface,
An inner surface,
An under surface.

The *anterior surface* presents broken cells which are rendered complete by the articulations of the lachrymal bone and the nasal process of the superior maxillary bone.

The *posterior surface*, like the preceding surface, is characterized by numerous half cells, which are rendered complete by the articulations of the sphenoidal turbinated bone and the orbital process of the palate bone.

The *upper surface* of each lateral mass presents a number of half cells which are rendered complete by the articulation of the ethmoidal notch of the frontal bone. Two *grooves* may also be here perceived which are rendered complete canals by articulation of the frontal bone, and are called the anterior and the posterior ethmoidal foramina.

The *under surface* presents the projecting mass of bone termed the *unciform process* of the ethmoid. This process articulates with the inferior turbinated bone, and also assists in forming the inner wall of the antrum of Highmore. Upon this surface of the lateral mass of the ethmoid is also perceived, the inferior surface of the *middle turbinated bone* or *process*, as it is sometimes called.

The *inner surface* of the lateral mass of the ethmoid forms part of the outer wall of the nasal fossæ. It presents from above downwards the following parts which have been specially named.

(1) The *superior turbinated process* or *bone*.

This is small in its size, and consists of a thin lamella of bone which lies in the posterior part of the nasal fossa.

(2) The *superior meatus*.

This canal opens anteriorly and communicates with the posterior ethmoidal cells.

(3) The *middle turbinated process* or *bone*.

This consists of a convoluted plate of bone which extends along the whole length of the lateral mass of the ethmoid.

(4) The *middle meatus*.

This canal within the nasal fossa, opens anteriorly and communicates with the anterior ethmoidal cells, and, by means of a wide funnel-shaped canal called the *infundibulum*, it also communicates subsequently with the frontal sinuses.

The *outer surface* of the lateral masses of the ethmoid bone presents *a smooth* thin plate of bone which helps to form the inner wall of the orbit, and which is called the *os planum*.

The *os planum* articulates with the following bones within the cavity of the orbit.

Articulation of the Os PLANUM of the Ethmoid bone.	In front—with the	Lachrymal bone,
	Above " "	Orbital plate of the Frontal bone.
	Behind " "	body of the Sphenoid.
	Below " "	Superior maxillary bone. Orbital process of the Palate bone.

ARTICULATIONS OF THE ETHMOID.

The ethmoid bone articulates with 13 bones which may be thus enumerated.

The ETHMOID BONE articulates with 13 bones, as follows:	3 *Single* or *Mesial* bones	(3)	Sphenoid. Frontal. Vomer.
	5 *pairs* of bones	(10)	Nasal. Superior Maxillary. Lachrymal. Palate. Inferior turbinated.
	Total,	13	

It will thus be perceived that the ethmoid bone articulates with all the bones of the upper jaw, with the exception of the two malar, and this number is complemented by the addition of the sphenoid and the frontal bones of the cranium.

MUSCLES.

The ethmoid bone affords attachment to no muscle.

DEVELOPMENT.

The ethmoid bone develops by *three centres* of ossification, one of which is situated in each of the lateral masses and one within the perpendicular plate of the bone.

This bone, at the time of birth, presents no attempt at ossification in either the horizontal or the perpendicular plates, but ossific granules are present in the lateral masses of the bone.

The lateral masses become joined to the cribriform plate of the ethmoid at about the end of the first year of life, and the lateral masses develop their full expanse of surface, through the formation of the ethmoidal cells, at about the sixth year of age.

THE FRONTAL BONE.

This bone is situated in the anterior portion of the cranium. Its direction is both vertical and horizontal since it consists of two portions which form nearly a right angle with each other. The vertical part is called the frontal portion of the bone, and the horizontal part is termed the orbito-nasal portion.

The *frontal* portion of this bone presents for examination, an exterior and interior surface, and two strong processes termed the *external angular* and *internal angular processes.*

The *orbito-nasal* portion of the bone, presents for special examination *two orbital plates*, and a notch between them called the *ethmoidal notch.*

Frontal or Vertical Portion.

Exterior Surface.

This surface is convex in shape, and forms the forehead. It presents in the median line either an existing suture or a median depression which indicates the point of junction of the two lateral halves of this portion of the frontal bone. Ossification becomes complete in this region, a few years after birth, except in rare cases where the suture is not obliterated.

Below this median suture is a prominent elevation of bone termed the *nasal eminence.*

On either side of the median suture, are two round elevations of bone of quite large size, which are termed the *frontal eminences.*

Above the upper margin of the orbital cavity, to which the name *supra-orbital arch* is applied, are perceived two prominent ridges of bone, which are produced by the projection forwards of that portion of the frontal bone, which covers the frontal sinuses. These ridges are called the *super-ciliary ridges.*

At about the inner third of the supra-orbital arches, are perceived two notches for the transmission of the supra-orbital vessels, and the supra-orbital nerve. These notches are called the *supra-orbital notches*, or, in case a complete foramen exists in place of the notch, the opening is called the *supra-orbital* foramen.

Interior Surface.

This surface of the vertical portion of the frontal bone is concave and presents the following points of interest.

In the median line, near the point of junction of the vertical and the horizontal portions of the frontal bone, is perceived a small foramen called the *foramen cæcum.* This foramen is usually completed by the articulation of the ethmoid bone with the frontal, but may occasionally exist independently of that bone. It transmits a small vein to the longitudinal sinus, and a prolongation of the falx cerebri.

Above this foramen lies a prominent ridge of bone, called the *frontal crest,* which is continued upwards into a *vertical groove* for the attachment of the falx cerebri, and which corresponds to the situation of the superior longitudinal sinus of the dura mater.

On the lateral portions of this surface of the frontal bone are perceived impressions which correspond to the convolutions of the brain, and which are called the *cerebral impressions*, and, running over the surface of the bone are seen numerous small grooves in which are lodged the branches of the anterior and the middle meningeal arteries.

Angular Processes.

The angular processes of the frontal bone are four in number, two of which are situated at the extreme ends of the bone, and are termed the *external angular processes*, while the remaining two are located at the centre of the face near to the inner angle of the orbital cavity, and are called the *internal angular processes* of the frontal bone.

External Angular Processes.

These processes are thick and strong, and afford articulation for the two malar bones. They also enter into the formation of the anterior part of the temporal ridge.

Internal Angular Processes.

These projections of the frontal bone are thin and afford a point of articulation for the lachrymal bones. They furthermore bound the so called *nasal notch* which affords articulation for the nasal bones, and the nasal process of the superior maxillary bone. They also, by their point of junction, form a sharp long projection to which the name *nasal spine* is applied.

Orbito-nasal or Horizontal Portion.

This portion of the frontal bone comprises two orbital plates of bone, separated by a notch into which the ethmoid bone is received, and which for that reason is called the *ethmoid notch.*

Orbital Plates.

These plates present for examination, an upper and an under surface.

The *under surface* is concave in shape, and forms the upper wall of the cavity of the orbit. It contains at its external portion a depression of quite large size called the *lachrymal fossa,* since it lodges the lachrymal gland, and at its internal portion a smaller depression called the *fovea trochlearis* into which the pulley for the superior oblique muscle of the eye is inserted.

The *upper surface* is convex in shape, and helps to form the floor of the anterior fossa of the cavity of the cranium. It presents for examination only some well marked *cerebral impressions*

Ethmoidal Notch.

This notch is filled up by the cribriform plate of the ethmoid bone. The *under surface* of the *margins* of this notch present the following points of anatomical interest and importance.

(1.) Several *half cells,* which complete and close the corresponding half cells of the ethmoid bone.

(2.) *Two grooves,* which also help to complete the anterior and posterior ethmoidal canals for the transmission of the nasal nerve and the anterior and posterior ethmoidal vessels.

(3.) The *nasal spine* which here articulates with the perpendicular plate of the ethmoid, and with the nasal bones, and which helps to form a part of the nose.

(4.) The *openings* of the *frontal sinuses,* which are situated upon either side of the nasal spine.

Articulations of the Frontal Bone.

The frontal bone articulates with 12 bones which may be thus classified:

The Frontal Bone articulates with 12 bones, *viz.:*	Two *single* or *mesial* bones.	(2)	Sphenoid. Ethmoid.	
	Five *pairs* of bones	(10)	Parietal.	One Cranial bone.
			Nasal. Superior maxillary. Lachrymal. Malar.	Four Facial bones.
	Total,	12		

Of these 12 bones with which the frontal bone articulates, it will thus be perceived that only two are single or mesial bones, and that the remainder consist of five pairs, of which one pair belongs to the cranium, and four pairs belong to the face.

Muscles attached to the Frontal Bone.

The frontal bone affords attachment to three pairs of muscles. These three pairs of muscles are all situated upon the exterior surface of the cranium, and are as follows:

Muscles attached to the FRONTAL BONE (3 pairs.)	ORBICULARIS PALPEBRARUM. CORRUGATOR SUPERCILII. TEMPORAL.

Development of the Frontal Bone.

The frontal bone is developed from *two centres* of ossification, one for each lateral half of the bone. At birth the bone consists of two pieces which afterwards become united by means of a suture running from the sagittal suture to the root of the nose.

This suture in rare cases remains open throughout life. It is called the *frontal suture.*

THE TEMPORAL BONE.

The temporal bones are situated upon either side of the base of the cranium. They are called "temporal" (*tempus*, time), because grey hairs first appear in the region of these bones.

These bones are very irregular in shape and consist of an apparent union of three distinct portions, which have been named respectively the *squamous*, the *mastoid* and the *petrous* portions of the bone from certain characteristics which are prominent in each. These portions will be described separately, and the points of anatomical interest pertaining to each will thus be more clearly set forth than if the bone be described as a whole.

A. Squamous Portion.

This portion of the temporal bone is so-called from its resemblance to a scale. It is a thin semi-circular plate of bone which lies upon the side of the skull, higher up than either of the other portions of the temporal bone. It presents for examination two surfaces and a circumferential border.

Outer Surface.

This surface of the squamous portion is convex in shape and enters into the formation of the temporal fossa. It presents for examination,

(1.) The *temporal ridge*, which forms, however, only a small portion of the *whole* of the entire bony ridge known by this name. This ridge is situated at the posterior portion of the squamous portion of the bone.

(2.) The *zygomatic process.* This process first projects outwards and subsequently curves forwards. It is broad and flattened in form and presents two borders (an upper and lower), two surfaces (outer and inner), an apex and a base.

The *upper border* is thin and affords attachment to the temporal fascia. The *lower border* is thick and shorter than the upper, and affords attachment to the masseter muscle.

The *outer surface* is convex in shape while the *inner surface* is concave. To the latter surface the masseter muscle is attached.

The *apex* is serrated and articulates with the malar bone.

The *base* is formed by three *roots* called the anterior, middle and posterior root of the zygoma. The *anterior root* is broad and directed transversely across the skull at its base. It forms a bony eminence called the *eminentia articularis*, which lies in front of the articulation of the lower jaw.

The *middle root* of the zygoma forms the posterior boundary of the glenoid fossa, while the *posterior root* of this process forms the point of origin of the temporal ridge.

(3.) The *glenoid fossa.* This is a depression of quite large size which is comprised between the anterior and the middle roots of the zygomatic process. It is divided into two parts, an anterior and a posterior, by a fissure called the *Glaserian fissure*, which affords a passage, (1) for the laxator tympani muscle, (2) for the tympanic artery, and (3) for the processus gracilis of the malleus. A canal, called the *canal of Huguier*, is present in this portion of the bone, for the transmission of the chorda tympani nerve.

The *anterior part* of the glenoid fossa is articular, and is covered with cartilage which is also prolonged over the eminentia articularis. It receives the articular head of the lower jaw.

The *posterior part* of the glenoid fossa is bounded behind by the vaginal process, and the auditory process (both of which belong to the petrous portion of the bone), and by the middle root of the zygomatic process. It lodges the *parotid gland* and is not for the purpose of articulation.

Inner Surface.

The inner surface of the squamous portion of the temporal bone is concave in its shape and presents marked cerebral impressions and grooves channelled in its substance for the protection of the middle meningeal artery and its branches.

Circumference.

The circumference of the squamous portion of the temporal bone is very thin above and posteriorly, at which portions it is bevelled internally for articulation with the parietal bone. In front, the margin is thick and is slightly bevelled upon its external surface.

It articulates, at this latter point, with the great wing of the sphenoid bone.

B. Mastoid Portion.

This portion of the temporal bone is so called from its resemblance to a *nipple.*

It is situated at the posterior part of the bone. Its outer surface is rough and perforated by numerous small foramina, one of which is of large size and is termed the *mastoid foramen.* It transmits a vein to the lateral sinus.

The tip of this portion of the temporal bone is called the *mastoid process.* It affords attachment to three muscles; *viz.*, the sterno-mastoid, the splenius capitis and the trachelo-mastoid.

Upon the inner side of this process is perceived a deep groove called the *digastric groove*, which affords attachment to the posterior belly of the digastric muscle.

Still further inwards a second groove, parallel to the digastric, is perceived, and to this the name *occipital groove* is given, since the occipital artery is lodged within it.

The *inner surface* of the mastoid portion of the temporal bone forms a part of the posterior fossa of the base of the skull, and it is deeply *grooved* for the *lateral sinus.*

The *superior border* of the mastoid portion is thick and serrated as is also the *posterior* border. The former articulates with the inferior angle of the parietal bone and the latter with the lower border of the occipital bone.

C. Petrous Portion.

The petrous portion of the temporal bone is so called from its extreme density (πετρος, rock). It is pyramidal in form and is directed forwards and inwards, being wedged in between the sphenoid bone and the basilar process of the occipital bone. It contains all the *bony cavities of the ear* within its interior and posesses therefore great anatomical importance.

It presents for examination three surfaces, three borders, a base and an apex.

Base of Petrous Portion.

This is the only *exposed* part of the petrous portion, and is situated at the side of the cranium. It presents (1) an opening in it called the *meatus auditorius externus*, which corresponds to the opening of the external cartilage of the ear, and (2) a bony ring which surrounds this opening called the *auditory process*, to which the external cartilage of the ear is attached.

Apex of Petrous Portion.

This part of the petrous portion of the temporal bone lies at the base of the skull, and is the innermost part of the entire bone. It allows of the passage of the *internal carotid canal* and forms the posterior and outer boundaries of the *foramen lacerum medium* or *foramen basis cranii.*

The petrous portion of the temporal bone is properly therefore a *truncated* pyramid, its apex not finishing in a perfect point, and it is also, as regards its direction, a pyramid laid upon its side rather than one standing upon its base, since its apex points inwards rather than upwards.

Anterior Surface.

This surface of the petrous portion of the temporal bone forms the posterior boundary of the middle fossa of the base of the skull and presents the following points of anatomical interest.

(1) The *internal opening* of the *carotid canal*, which transmits the carotid artery and the carotid plexus of the sympathetic system of nerves.

(2.) The *depression* for the *Gasserian ganglion* of the 5th pair of cranial nerves.

(3.) The *hiaius Fallopii.*
This foramen transmits the large petrosal nerve, and the petrosal branch of the middle meningeal artery.

(4.) The *foramen* for the *small petrosal nerve*, and occasionally a separate foramen for the petrosal branch of the glosso-pharyngeal nerve.

(5.) An *eminence* produced by the superior semi-circular canal of the internal ear.

(6.) A *depression* which lies above the location of the tympanum or the cavity of the middle ear.

Posterior Surface.

This surface of the petrous portion of the temporal bone forms the anterior boundary of the posterior fossa at the base of the skull. It presents two openings. as follows:

(1.) The *meatus auditorius internus.*

The internal canal leading to the cavity of the tympanum transmits the facial and auditory nerves and the auditory artery. It also transmits a prolongation of the dura mater of the brain.

(2) The *opening* of the *aquæductus vestibuli.*

This opening transmits a small artery and vein to the vestibule, and also a process of dura mater.

Inferior or Basilar Surface.

The petrous portion of the temporal bone forms a portion of the base of the skull. This surface presents the following points for special consideration.

(1.) A *diagonal line* running from before backwards and outwards.

(2) The *opening* of the *carotid canal,* through which passes the internal carotid artery and the carotid plexus of nerves.

(3) The *aquæductus cochleæ,* which transmits a vein to the cochlea.

(4.) The *jugular fossa,* which lodges the sinus of the internal jugular vein, and which assists in forming the jugular foramen or the foramen lacerum posterius.

(5.) An *opening* for *Jacobson's nerve,* which is situated in front of the jugular fossa upon a bony ridge between it and the carotid canal.

(6.) An *opening* for *Arnold's nerve,* which is situated upon the outer wall of the jugular fossa.

(7.) The *jugular surface,* which articulates with the jugular process of the occipital bone.

(8.) The *vaginal process* which embraces the root of the styloid process of the temporal bone.

(9.) The *styloid process,* which affords attachment to the following structures from above downwards.

The stylo-pharyngeus muscle.

The stylo-hyoid muscle.

The stylo-glossus muscle.
The stylo-hyoid ligament.
The stylo-maxillary ligament.

(10.) The *stylo-mastoid foramen.*
This foramen transmits the facial nerve and the stylo-mastoid artery.

(11.) A *rough surface* which affords attachment to the levator palati and the tensor tympani muscles.

(12.) The *auricular fissure* for the *exit* of the auricular branch of the pneumogastric nerve.

(13.) The *opening* of the *Aquæductus Cochleæ.*
This foramen is situated in front of and to the inner side of the jugular fossa, near to the posterior border of the petrous portion of the temporal bone.

Borders of the Petrous Portion.

The *superior* border is situated within the cavity of the skull and forms the line of separation between the *anterior* and the *middle fossæ* at the base of the skull.

It is grooved for the superior petrosal sinus and affords attachment, throughout its entire length, to the tentorium cerebelli.

The *posterior border* is grooved for the inferior petrosal sinus in front, and, behind, it assists in forming the jugular foramen.

The *anterior border* articulates, at its *inner* part, with the spinous process of the sphenoid bone, while, at its *outer* part, it is joined to the squamous portion of the temporal bone.

At the point of junction of the squamous and the petrous portions of the temporal, at the retiring angle between them, is perceived the *canal* for the *tensor tympani* muscle, and the *osseous portion* of the *Eustachian tube.*

Upon the outer side of the opening for the Eustachian tube is also perceived a small opening, called the *canal* of *Huguier*, which transmits the chorda tympani nerve.

Muscles attached to the Temporal Bone.

The 14 muscles attached to the temporal bone may be classified as follows:

The TEMPORAL BONE gives attachment to 14 muscles, *viz*,:	To squamous portion,	2	TEMPORAL. MASSETER.
	To mastoid portion,	6	OCCIPITO FRONTALIS. STERNO CLEIDO MASTOID. SPLENIUS CAPITIS. TRACHELO MASTOID. DIGASTRIC. RETRAHENS AUREM.
	To petrous portion,	3	LEVATOR PALATI. TENSOR TYMPANI. STAPEDIUS.
	To styloid process.	3	STYLO-GLOSSUS. STYLO-HYOID. STYLO-PHARYNGEUS.
	Total,	14	

ARTICULATIONS OF THE TEMPORAL BONE.

The temporal bone articulates with five bones as follows:

The TEMPORAL BONE articulates with 5 bones.	*Mesial* bones,	(3)	Occipital. Sphenoid. Inferior Maxillary.
	Lateral bones,	(2)	Parietal. Malar.
	Total,	5	

Both of the temporal bones, however, articulate with only seven bones; *viz.*, the *three mesial bones*, (occipital, sphenoid and inferior maxilla) and *two pairs* of bones (parietal and malar).

DEVELOPMENT of THE TEMPORAL BONE.

The temporal bone is developed by *four* centres, exclusive of those of the internal ear and its ossicula. These four primary centres of ossification are arranged as follows:

The four CENTRES OF DEVELOPMENT of the TEMPORAL BONE are as follows:	One for the	Squamous portion and the Zygomatic portion.
	One for the	Auditory process.
	One for the	Petrous portion and the Mastoid portion.
	One for the	Styloid process.

At birth this bone consists of three pieces, as indicated above, (excluding the styloid process). During the first year these three portions become united, the *auditory process* joining the petrous portion of the bone soon after birth.

The styloid process does not become united, however, until the 2nd or 3rd year of age.

A TABLE OF THE FORAMINA IN THE TEMPORAL BONE:

Illustrating the Location and Function of Each.

Names of Foramina.	Air.	Membranes.	Bone.	Arteries.	Veins.	Nerves.	Muscles.	Portion of Temporal bone.	Total
Fissure of Glaser.	....	....	Processus Gracilis of Malleus.	Tympanic branch of Int. Maxillary.			Laxator Tympani.	Squamous Portion.	(2)
Canal of Huguier.	....	....	....	....	....	Chorda Tympani.	....		
Mastoid foramen.	....	....	....	Small artery.	Small vein	....	....	Mastoid Portion.	(1)
Hiatus Fallopii.	....	....	....	....	....	Petrosal branch of Vidian Nerve.	....	Petrous Portion. anter. surf. (2)	(12)
Opening for lesser Petrosal nerve.	....	....	....	....	....	Lesser Petrosal nerve.	....		
Meatus Auditorius Internus.	....	....	....	Auditory artery.	....	Facial and Auditory nerve.	....	post. surf. (4)	
Angular depression.	....	....	....	....	Small vein	....	....		
Aquæductus Vestibuli.	....	Process of Dura Mater.	....	Small artery.	Small vein	....	....		
Auricular fissure.	....	do.	....	....	....	Auricular branch of Pneumogastric.	....		
Stylo-Mastoid foramen.	....	....	....	Stylo-Mastoid artery.	....	Facial nerve (exit.)	....	inferior surface. (5)	
Opening for Jacobson's Nerve.	....	....	....	....	....	Jacobson's nerve.	....		
A small foramen in Jugular fossa.	...	....	....	....	....	Arnold's nerve.	....		
Aquæductus Cochleæ.	....	....	....	....	Small vein	....	....		
Carotid canal.	....	....	....	Int. Carotid artery	....	Carotid plexus.	....		
Meatus Auditorius Externus.	Air.	....	....	....	....	....	....	base. (1)	
Canal for Tensor Tympani.	...	....	....	....	....	....	Tensor Tympani.	Angle.	(2)
Eustachian tube.	Air.	....	....	....	....	....	....		
17	2	2	1	6	4	9	2		17

The *angular depression* is not properly a foramen, being a nutrient canal only.

THE PARIETAL BONE.

This bone forms the side of the skull and is so named from (*paries*—a wall). It is quadrilateral in form and presents for examination two surfaces, four borders, and four angles.

SURFACES.

The *exterior* or *outer surface* is convex and presents three points deserving of special mention.

(1.) The *parietal foramen*, which is situated at the upper and posterior portion of the bone and which transmits a vein to the superior longitudinal sinus.

(2.) A prominent portion of bone termed the *parietal eminence*.

(3.) The *temporal ridge*, which indicates the upper boundary of the temporal fossa of the skull.

The *interior surface* of the bone is concave and presents four points of special interest, as follows:

(1.) *Cerebral eminences* and *depressions*, which correspond to the cerebral convolutions.

(2.) *Furrows* in the bone, in which are lodged the ramifications of the middle meningeal artery.

(3.) A *half-groove* near the superior border of the bone, for the superior longitudinal sinus of the skull, and for the attachment of the falx cerebri.

(4.) *Depressions* for the Pacchionian bodies, which are small, whitish bodies situated between the dura mater and the skull.

BORDERS.

The *superior border* of the bone forms, by its junction with the parietal bone of the opposite side, the sagittal suture.

The *inferior border* is bevelled on its outer surface, and is overlapped, *in front*, by the greater wing of the sphenoid bone and by the squamous portion of the temporal bone, while, *behind*, it articulates with the mastoid portion of the temporal bone.

The *anterior border* of the bone is serrated and forms the coronal suture by its articulation with the frontal bone.

The *posterior border* of the bone articulates with the occipital bone and thus forms the lambdoidal suture.

ANGLES.

The *anterior superior* and the *posterior superior* angles of the parietal bone correspond to the anterior and the posterior fontanelles.

The *anterior inferior* angle is received between the frontal bone and great wing of the sphenoid bone, one inch above and behind the superior external angle of the orbit. Internally, it is often grooved for the anterior branch of the middle meningeal artery.

The *posterior inferior* angle articulates with the mastoid portion of the temporal bone and presents, internally, a small portion of the groove for the lateral sinus.

MUSCLES.

The parietal bone affords attachment to only one muscle; *viz.*, the temporal muscle.

ARTICULATIONS OF THE PARIETAL BONE.

This bone articulates with five bones, which may be thus enumerated:

The PARIETAL BONE articulates with 5 bones, as follows:	*Mesial* bones...........	3	Occipital. Sphenoid. Frontal.
	Lateral bones	2	Temporal. Opposite Parietal.
		5	

Both parietal bones articulate also with only *five bones* as follows. The three mesial bones above mentioned and the two temporal. Since the two parietal bones meet in the median line the parietal articulation common to each one separately is wanting when both are considered together.

DEVELOPMENT.

The parietal bone is developed from only *one centre* of ossification, which corresponds with the parietal eminence.

BONES OF THE FACE.

The face is composed of 14 bones, which may be divided as follows:

BONES of the FACE. (14)	Comprised in upper jaw, (13 bones,)	Mesial bone......(1)	Vomer.
		6 pairs of bones..(12)	Nasal. Sup. Maxillary. Lachrymal. Malar, Palate. Inferior turbinated.
		Total, 13	
	Forming lower jaw, (1 mesial bone.)	Inferior maxillary.	

THE VOMER.

This bone forms the posterior and inferior part of the nasal septum. It is frequently deflected from the median line towards one side. It bears a fancied resemblance to the shape of a plough-share and presents for examination four borders and two surfaces.

It articulates, by a deep groove between two projecting *alæ* upon its *superior border*, with the rostrum of the sphenoid bone. These alæ are overlapped inferiorly by the vaginal processes of the same bone.

Its *inferior border* articulates with a ridge, formed by the palate plates of the superior maxillary and the palate bones.

Its *anterior border* is grooved above for articulation with the perpendicular plate of the ethmoid bone, and below it is joined to the cartilage of the septum between the nares.

Its *posterior border* is free. It separates the apertures of the posterior nares.

Its lateral surfaces present *small grooves* for the lodgment of small vessels and nerve filaments, and also a *larger groove* in which is lodged the naso-palatine nerve.

MUSCLES.

The vomer affords attachment to no muscle.

ARTICULATIONS.

The vomer articulates with six bones which may be thus classified:

Of the Cranium (Mesial)....	(2)	Sphenoid. Ethmoid.
Of the Face (2 pairs)........	(4)	Superior maxillary. Palate.
Total,	6	

These six bones may thus be stated to consist of two *mesial* bones and two *pairs* of bones, the former being situated in the cranium and the latter in the face.

DEVELOPMENT.

Ossification of the vomer commences, by a *single centre*, in a cartilage contained between the two laminæ, of which the bone is at first composed. This centre appears at about the same time as those of the vertebræ.

THE NASAL BONES.

These bones form the bridge of the nose. They are narrow and thick at their upper portion, and wide and thin at their lower extremity. They present for examination two surfaces and four borders.

The *outer surface* of the nasal bone is convex in shape from side to side, and concave from above downwards, especially at its upper portion where it bends to give shape to the nose. It presents several small grooves for arteries and a small foramen which transmits a vein.

The *inner surface* of the bone is inversely curved from the outer surface and presents a groove for the external branch of the nasal nerve.

The *superior border* is thick and narrow and articulates with the frontal bone.

The *inferior border* is broad and thin and is joined to the lateral cartilage of the nose. It presents a notch which transmits the nasal nerve.

The *external border* of the nasal bone articulates with the nasal process of the superior maxillary bone.

The *internal* border of the nasal bone articulates with its fellow in the mesial line of the face. It is prolonged backwards and upwards into a *crest* which articulates with the nasal spine of the frontal bone and with the perpendicular plate of the ethmoid bone.

MUSCLES ATTACHED.

No muscles are directly attached to this bone.

ARTICULATION.

The NASAL BONE articulates with four bones, as follows:	2 bones of Cranium...	Frontal. Ethmoid.
	2 bones of the Face...	Nasal. Superior maxillary.

DEVELOPMENT.

This bone is developed by *one centre* of ossification.

THE SUPERIOR MAXILLARY BONE.

This bone assists in the formation of the following parts:

3 cavities............	The *roof* of the mouth. The *floor* and *outer wall* of the nose. The *floor* of the orbit.
2 fossæ..............	The zygomatic fossa. The temporal fossa.
2 fissures............	The spheno-maxillary fissure. The pterygo-maxillary fissure.

The bone, as a whole, may be described as presenting a body and four processes, *viz.*, the malar, nasal, alveolar and palate processes, each of which will be separately described.

A. The Body.

This portion of the bone is hollow. Its cavity is termed the *antrum* of *Highmore.* The body of the superior maxillary bone may be divided into three surfaces and its central cavity.

(1.) *Outer or facial surface of body.*

This portion of the body of the bone is convex in its form. It presents, as the bone is examined from within outwards, several points which have been specially named.

The *incisive fossa*, or *myrtiform fossa*, is a depression in the outer surface of the body of the bone, near the median line, for the attachment of the depressor alæ nasi muscle.

The *canine fossa* is a large, deep depression situated immediately below the *infra-orbital foramen*, and it affords attachment for the levator anguli oris and the compressor naris muscles. The foramen immediately above it transmits the infra-orbital vessels and nerve.

The *maxillary tuberosity* is situated behind a *vertical bony ridge* upon the outer surface of the body of the bone. It affords articulation for the tuberosity of the palate bone.

(2.) *Inner surface of body.*

This portion of the bone is divided into two unequal parts by its palate process. The portion below this process forms the *anterior part* of the *roof of the mouth*, while the portion lying above the palate process forms the largest part of the *outer wall of the nasal cavity*, and presents the following points of special interest.

The *inferior turbinated crest*, a ridge of bone separating *two wide* and *deep grooves*, which run in an antero-posterior direction and which correspond to the middle and inferior meatuses of each of the nasal fossæ.

The *superior turbinated crest*, a ridge of bone surmounting the groove which corresponds to the situation of the superior meatus of the nose.

Upon the inner surface of the body, is furthermore seen a *groove*, which enters into the formation of the *nasal duct*, by its articulation with the lachrymal and the inferior turbinated bones.

The *aperture* of the *Antrum* of *Highmore* is also perceived upon this surface of the body of the bone. It is a very large opening in the disarticulated bone, but during life or in the complete skull it is of small size, being diminished by the articulations of the ethmoid, lachrymal, inferior turbinated and palate bones.

Two other points remain upon this surface which deserve notice. The first is a *vertical groove* which helps to form the posterior palatine canals, and the second is a *rough surface* which is traversed by the vertical groove previously mentioned, and which affords attachment for the articulating surface of the palate bone.

(3.) *Upper or orbital surface of body.*

This portion of the superior maxillary bone forms the greater part of the *floor* of the orbit.

Upon its inner border, it is bounded by a thin edge of bone which articulates with the lachrymal bone, the os planum of the ethmoid bone and the orbital process of the palate bone.

Upon its outer border, it is bounded by a rounded margin which forms a part of the spheno-maxillary fissure, while, in front, it forms the lower part of the circumference of the orbit.

Upon this surface of the bone is seen, at its posterior portion, the *infra-orbital groove*, which becomes the *infra-orbital canal* at the anterior portion, near to the circumference of the orbit. This canal transmits the infra-orbital nerve. A *depression* for the in-inferior oblique muscle of the eye is also perceived.

(4.) The *Antrum of Highmore.*

This cavity in the body of the superior maxillary bone is also called the *maxillary sinus.*

Its walls correspond to the three surfaces of the body of the bone. They are very thin, and contain the *infra-orbital*, the *anterior dental* and the *posterior dental* canals.

Its aperture communicates with the middle meatus of the nasal fossa and is of small size in the living subject.

The 1st and 2nd molar teeth project through its floor, and, in case of abscess of the antrum, these teeth are often drawn to establish drainage.

(B.) THE MALAR PROCESS.

This portion of the superior maxillary bone is triangular in form and presents for examination three surfaces.

Its *anterior surface* is concave in form and forms a part of the canine fossa.

Its *posterior surface* is also concave in its form and enters into the construction of the zygomatic fossa.

Its *superior surface* is roughened for articulation with the malar bone.

(C.) THE NASAL PROCESS.

This process, like the one preceding, is of a triangular form. It presents for examination two surfaces and two borders.

The *outer surface* is concave and affords attachment for the obicularis palpebrarum, and the levator labii superioris alæque nasi muscles and also for the tendo oculi.

The *inner surface* presents for examination the following points of interest:

(1.) A *roughened portion*, for articulation with the ethmoid bone.

(2.) A *superior turbinated crest*, which articulates with the middle turbinated bone of the ethmoid, which has been described in connection with the inner surface of the *body* of the bone.

(3.) An *inferior turbinated crest*, which separates the two grooves corresponding to the middle and the inferior meatuses of the nose.

The *anterior border* of the nasal process is thin and is serrated, at its *upper portion*, for articulation with the nasal bone, while, at its *lower portion*, it becomes continuous with the margin of the anterior opening of the nasal fossa.

The *posterior border* presents a groove which helps to form the nasal duct. This groove articulates, at its inner margin, with the lachrymal bone, while its outer margin forms a part of the circumference of the orbit and terminates in the *lachrymal tubercle*.

(D.) THE ALVEOLAR PROCESS.

The alveolar process of the superior maxillary bone forms, upon either side, the horse-shoe curve of the line of the teeth. It is much thicker at its posterior portion than in front, since the teeth are wider behind, and it presents, in the adult, articulations or alveoli for eight teeth, and, in the child, for five teeth only.

(E.) The Palate Process.

This portion of the bone presents for examination two surfaces and three borders.

The *upper surface* is concave, from side to side, and forms a portion of the floor of the nasal fossa. It presents, in its anterior portion, a foramen called the *incisor foramen*, or the *foramen of Stenson*. This foramen leads into a canal, called the *anterior palatine canal*, as do also two smaller foramina, which can be seen only from the under surface of the palate process and which are called the *foramina of Scarpa*.

The foramina of Stenson transmit the anterior palatine vessels and the foramina of Scarpa transmit the naso-palatine nerves.

The *under surface* of the palate process of the superior maxillary bone is concave and forms the anterior portion of the roof of the mouth. It has a rough surface and is channelled by a groove (occasionally by a complete canal) for the protection of the posterior palatine vessels and the anterior or great palatine nerve. At its posterior part, is seen the lower orifice of the *posterior palatine canal*.

The *inner border* of the palate process is raised into a ridge which, with its fellow, forms a *groove* for the vomer. At its anterior extremity, a projection, called the *anterior nasal spine*, is perceived.

The *anterior border* of the palate process forms the lower part of the anterior aperture of the nasal fossa.

The *posterior border* of the palate process articulates with the horizontal plate of the palate bone.

Muscles attached to the Superior Maxillary Bone.

The SUPERIOR MAXILLARY bone gives attachment to 11 muscles, as follows:	To nasal process		(2)	Orbicularis palpebrarum. Levator labii superioris alæqua nasi.
	To body,	Outer surface	(4)	Levator proprius labii superioris. Levator anguli oris. Compressor naris. Depressor alæ nasi.
		Facial surface	(1)	Orbicularis oris.
		Orbital surface	(1)	Inferior oblique of the Eye.
	To alveolar process		(1)	Buccinator.
	To malar process		(1)	Masseter.
	To the tuberosity		(1)	External pterygoid.
		Total,	11	

ARTICULATION.

The SUPERIOR MAXILLARY bone articulates with 9 bones, as follows:	*Mesial* bones ...	(3)	Frontal. Ethmoid. Vomer.
	Lateral bones....	(6)	Nasal. Opposite Sup. Maxillary. Lachrymal. Malar. Palate. Inferior turbinated.
	Total,	(9)	

DEVELOPMENT.

The SUPERIOR MAXILLARY bone is developed by *four centres* of ossification, as follows:	For nasal and facial portions..........	1 centre.
	" orbital and malar "	1 centre.
	" incisive portion of the bone.......	1 centre.
	" palate " " "	1 centre.
	Total,	4

THE LACHRYMAL BONES.

These bones of the face help to form the inner wall of the cavity of the orbit. Each bone presents for examination two surfaces and four borders, since it is nearly quadrilateral in shape.

The *outer surface* of the bone presents for special examination the following points.

(1.) A *marked groove*, which forms a part of the nasal duct.

(2.) A *ridge*, which affords attachment to the tensor tarsi muscle.

(3.) A *smooth surface*, which forms the inner wall of the orbit.

The *inner surface* forms a portion of the anterior part of the middle meatus of the nose, and articulates, at its posterior extremity, with the ethmoid bone. It presents a furrow which corresponds to the ridge upon the outer surface of the bone.

The *anterior border* articulates with the nasal process of the superior maxillary bone.

The *superior border* articulates with the internal angular process of the frontal bone.

The *posterior border* of the bone articulates with the os planum of the ethmoid.

The *inferior border* articulates with the orbital plate of the superior maxillary bone, and, in front, it is prolonged into a pointed process, called the *hamulus lachrymalis*, which articulates with the lachrymal process of the inferior turbinated bone, and which forms part of the nasal duct.

MUSCLES.

The lachrymal bone affords attachment to only one muscle, *viz.*, the tensor tarsi.

ARTICULATIONS.

The lachrymal bone articulates with four bones as follows:

Articulations of the Lachrymal Bone.	2 bones of *Cranium.*	Frontal. Ethmoid.
	2 bones of *Face.*	Superior maxillary. Inferior turbinated.
	Total, 4	

DEVELOPMENT.

The lachrymal bone is developed from *one centre* of ossification.

THE MALAR BONES.

These bones of the face enter into the formation of the cavities of the orbits, the temporal fossæ, and the zygomatic fossæ.

They are situated at the outer sides and upper portion of the face, and they present for examination two surfaces, three processes and four borders.

(1.) The *outer surface.*

This portion of the bone is convex in form and affords attachment to the zygomatic muscles. Upon it, is perceived a small *foramen* which transmits the *malar branch* of the temporo-malar nerve.

(2.) The *inner surface.*

This surface articulates with the superior maxillary bone, internally, and, externally, it is concave and assists in forming the temporal and zygomatic fossæ. It also presents a *foramen* which transmits the *temporal branch*, of the orbital or temporo-malar nerve.

(3.) The *orbital process.*

This portion of the malar bone projects backwards, and thus forms a portion of the outer wall and of the floor of the orbit and also a portion of the temporal fossa. It articulates, from above downwards, with the frontal, the sphenoid, and the superior maxillary bones. It *bounds* the *spheno-maxillary fissure*, anteriorly, and presents one or two small *temporo-malar foramina.*

(4.) The *frontal process.*

This process of the bone is thick and directed vertically upwards. It serves for the purpose of articulation with the external angular process of the frontal bone.

(5.) The *zygomatic process.*

This portion of the malar bone is long and is directed horizontally backwards. It articulates with the zygomatic process of the temporal bone.

(6) The *borders*, of the malar bone.

The *antero-superior border* forms the lower and outer portion of the circumference of the orbit.

The *antero-inferior border* articulates with the superior maxillary bone, upon the cheek.

The *postero-superior border* and the *postero-inferior* borders of the malar bone are continuous, respectively, with the superior and the inferior margins of the zygomatic process of the malar bone.

MUSCLES OF THE MALAR BONE.

This bone affords attachment to *five muscles* as follows:

(1.) The levator labii superioris proprius.
(2.) The zygomaticus major.
(3.) The zygomaticus minor.
(4.) The masseter.
(5.) The temporal.

ARTICULATIONS.

The malar bone articulates with four bones which may be thus enumerated:

The MALAR BONE articulates with four bones, *viz.*:	Of the *Cranium*,	(3.)	Frontal. Sphenoid. Temporal.
	Of the *Face*,	(1.)	Superior maxillary.
	Total,	4	

DEVELOPMENT.

The malar bone develops by a *single* centre of ossification, which appears at about the 8th to 10th week of fœtal life.

THE PALATE BONES.

This bone presents for examination the following component parts:

A. Horizontal plate.
B. Vertical plate.
C. Pterygoid process.
D. Orbital process.
E. Sphenoidal process.

The palate bones assist in forming the following parts: (1.) The *outer wall* and *floor* of the *nasal fossa*, (2.) the *roof* of the *mouth*, (3.) the *floor* of the *orbit*, (4.) the *pterygoid*, and *spheno-maxillary fossa*, (5.) the *inner wall* of the *antrum*.

A. The HORIZONTAL PLATE.

This portion of the bone enters into the construction of the roof of the mouth, and the floor of the nose.

Its *superior* or *nasal surface* is smooth and concave in form, and forms the posterior portion of the floor of the nose.

Its *inferior* or *buccal surface* is roughened and helps to form the roof of the mouth. It presents the following points of interest.

(1.) A *transverse ridge*, for the attachment of the aponeurosis of the tensor palati muscle.

(2.) A *deep groove*, which assists in forming the posterior palatine canal.

(3.) The *external* and *posterior small palatine foramina*, which transmit the external and the posterior palatine nerves.

Its *anterior border* is serrated for articulation with the palate process of the superior maxillary bone.

Its *posterior border* is free and affords attachment for the soft palate.

Its *inner border* is thick and is surmounted by a ridge of bone, which, by articulation with its fellow, forms a groove with which the vomer articulates. The posterior extremity of this border, when united to its fellow of the opposite side, forms the *posterior nasal spine* to which the azygos uvulæ muscle is attached.

(B.) The Vertical Plate.

This portion of the bone has two surfaces and three borders which demand description.

The *inner surface* exhibits, like the palate process and inner surface of the body of the superior maxillary bone, a *superior* and *middle turbinated crest*, and two *grooves* for the superior and middle meatuses of the nose.

The *outer surface* presents for examination the following points of special anatomical importance.

(1.) A *smooth surface*, which forms the inner wall of the spheno-maxillary fossa.

(2.) A *vertical groove*, which assists in forming the posterior palatine canal.

(3.) A *roughened surface*, with which the superior maxillary bone articulates.

(4.) A *smooth surface*, situated in front of the vertical groove, which forms part of the inner wall of the antrum.

(5.) A *roughened surface*, with which the pterygoid process of the sphenoid articulates. This surface is situated below the one for articulation with the superior maxillary bone.

The *anterior border* is thin and irregular in shape. It sends off a projection called the *maxillary process*, which helps to close the orifice of the antrum.

The *posterior border* of the palate bone articulates with the inner plate of the pterygoid process of the sphenoid bone.

The *upper border* of the same plate presents an anterior process, called the *orbital process*, and a posterior projection, termed the *sphenoidal process*. These two processes are separated by a *deep notch* which forms, by its articulation with the sphenoid bone, the greater part of the *spheno-palatine foramen*, which transmits the spheno-palatine nerves.

C. The Pterygoid Process.

This process of the palate bone fits into the notch between the two plates of the pterygoid process of the ethmoid bone, and it presents for examination a posterior surface, two lateral surfaces, and an inferior surface.

The *posterior surface* enters into the formation of the pterygoid fossa.

The two *lateral surfaces* are roughened for articulation, with the pterygoid plates of the ethmoid bone, and with the superior maxillary bone.

The *under surface* of this process forms a portion of the roof of the mouth, and presents for examination the *external* and *posterior small palatine foramina*, which transmit the external and posterior palatine nerves.

D. The Orbital Process.

This process projects upwards and outwards from the anterior portion of the upper border of the vertical plate of the palate bone. It presents three articular surfaces, and two non-articular surfaces.

The three *articular surfaces* are named, respectively, the anterior, posterior, and internal. They articulate, in this order, with the superior maxillary bone, the sphenoid bone, and the ethmoid bone.

The *non-articular surfaces* are called the *superior* or *orbital*, and the *external* or *zygomatic*. The former forms a portion of the floor of the orbit, and the latter forms a portion of the anterior wall of the spheno-maxillary fossa.

These two non-articular surfaces are separated from each other by a *rounded border*, which forms a portion of the spheno-maxillary fissure.

E. The Sphenoidal Process.

This projection from the palate bone curves upwards, backwards and inwards.

It presents for examination three surfaces, *viz.:* an upper, outer, and inner surface.

The *upper surface* articulates with the sphenoid bone, and assists in forming the pterygo-palatine canal.

The *outer surface* articulates with the pterygoid process of the sphenoid bone, and forms a small portion of the surface of the inner wall of the spheno-maxillary fossa.

The *inner surface* is concave in its form and forms a portion of the outer wall of the nasal fossæ.

Muscles attached to the Palate Bone.

The Palate Bone affords attachment to *five* muscles, as follows:	To posterior nasal spine.....	(1)	Azygos Uvulæ.
	To pterygoid process.... ...	(3)	Internal pterygoid. External pterygoid. Superior constrictor.
	To horizontal portion.	(1)	Tensor palati.
		Total, 5	

Articulations of Palate Bone.

The Palate Bone articulates with six bones, *viz.:*	*Mesial* bones............	(3)	Sphenoid. Ethmoid. Vomer.
	Lateral bones	(3)	Opposite Palate bone. Superior maxillary. Inferior turbinated.

It will thus be perceived that three of these bones are *mesial* bones, and three are situated in the face upon either side of the median line of the body.

Development of Palate Bone.

The palate bone develops by a *single* centre of ossification, which is located at the point of junction of the horizontal and the vertical plates of that bone.

THE INFERIOR TURBINATED BONES.

This is a thin curved plate of bone which extends along the outer wall of the nasal fossa.

It presents for examination two surfaces, an outer and inner, and an upper and lower border.

The *outer surface* is concave, and forms a part of the inferior meatus of the nose.

The *inner surface* is convex, and presents also vascular grooves and canals. It looks outwards and forms a portion of the outer wall of the nasal fossa.

The *upper border* of the inferior turbinated bone articulates, in front, with the inferior turbinated crest of the superior maxillary bone. It presents also for examination the following points of interest.

(1.) The *lachrymal process*, which articulates with the lachrymal and the superior maxillary bone and helps to form the nasal duct.

(2.) The *maxillary process*, which curves downwards and outwards over the lower edge of the orifice of the antrum of Highmore.

(3.) The *ethmoidal process*, which ascends to join the unciform process of the ethmoid bone.

The *lower border* of this bone is free and is about one-half inch above the floor of the nose, so that sufficient room exists to pass the tube of a stomach-pump, if circumstances should demand it.

MUSCLES.

No muscle is attached to the inferior turbinated bone.

ARTICULATION.

The INFERIOR TURBINATED bone articulates with four bones, *viz.:*	*Mesial* bone.........	(1)	Ethmoid.
	Lateral bones.	(3)	Superior maxillary. Lachrymal. Palate.

DEVELOPMENT.

The inferior turbinated bone is developed by *one centre* of ossification, which appears about the middle of fœtal life.

THE INFERIOR MAXILLARY BONE.

The lower jaw is one of the mesial or single bones of the body. It is shaped like a horse-shoe, and consists of a middle horizontal portion called the *body* of the bone, and two lateral vertical portions called the *rami* of the bone. These two portions will be examined separately.

BODY.

This portion of the inferior maxillary bone presents for examination an exterior and interior surface, and a superior and inferior border.

The *exterior* or *cutaneous surface* is convex, from side to side, and concave, from above downwards. It presents the following points of special interest:

(1.) The *symphysis* of the chin, which is a vertical ridge situated in the median line.

(2.) The *mental process* or the process of the chin, from which is given off an oblique line, called the *external oblique line* of the jaw, which becomes continuous with the anterior border of the ramus and which affords attachment to the depressor labii inferioris and the depressor anguli oris muscles.

(3.) The *incisive fossa*, which is situated above the oblique line of the jaw, and which affords attachment to the levator menti muscle.

(4.) The *mental foramen*, which lies externally to the incisive fossa and which transmits the mental vessels and nerve.

(5.) A space *above the oblique line*, which affords attachment to the buccinator muscle, and one, *below the oblique line*, for the attachment of the platysma myoides.

The *interior* or *buccal surface*, of the lower jaw is concave from side to side, and convex, from above downwards. It presents the following points for special description:

(1.) A *median depression*, corresponding to the symphysis anteriorly.

(2.) The *superior* and *inferior pairs* of *genial tubercles*, which are located upon either side of the median depression, and which afford attachment to the genio-hyo-glossus and the genio hyoid muscles.

(3.) The *mylo-hyoid-ridge*, which corresponds to the oblique line on the outer surface of the bone. It affords attachment for the mylo-hyoid muscle.

(4.) The *sublingual fossa* for the sublingual gland, which is situated on either side of the genial tubercles, near to the symphysis.

(5.) A *rough depression*, which is situated below the mylo-hyoid ridge, for the attachment of the anterior belly of the digastric muscle.

(6.) The *submaxillary fossa*, for the submaxillary gland, which is located at the external portion of the body of the bone, below the mylo-hyoid ridge.

The *superior border* of the body of the bone, is thickest where the back teeth are inserted, and presents in the adult sixteen alveoli, and in the child ten alveoli.

The *inferior border* of the bone, is thickest anteriorly, where it is slightly everted.

RAMUS.

This portion of the lower jaw is quadrilateral in form and presents the following points, which deserve special mention:

(1.) The *internal surface.*

This surface of the ramus of the jaw presents, near its middle, the aperture of the *inferior dental canal*, for the passage of the inferior dental vessels and nerve, in front of which is also perceived the *spine of the ramus*, for the attachment of the internal lateral ligament of the jaw. A prominent groove called the *mylo-hyoid groove* also exists upon this surface, in which lie the mylo-hyoid vessels and nerve, and behind this is seen a roughened surface, for the attachment of the internal pterygoid muscle.

(2.) The *external surface.*

On this surface are seen numerous oblique ridges for the attachment of the masseter muscle.

(3.) The *upper border.*

This portion of the bone presents three points of interest, *viz.:* the coronoid process, the condyloid process, and the sigmoid notch.

The *coronoid process* is triangular in form and affords attachment to the temporal muscle. At its lower and anterior part is perceived a *groove* which is continued downwards upon the alveolar process and which affords attachment to the buccinator muscle.

The *condyloid process* consists of two parts, *viz.:* the condyle and the neck.

The *condyle* is oblong in its form and convex from side to side and from before backwards. The long axis of the condyle, if prolonged inwards and slightly backwards, would meet its fellow at about the region of the anterior border of the foramen magnum in the occipital bone. It articulates with the glenoid fossa of the temporal bone.

The *neck* of the condyloid process is flattened from before backwards and is convex on its posterior surface. In front, it is hollowed out into a cavity, the pterygoid fossa, for the attachment of the external pterygoid muscle, and externally it presents a *tubercle*, for the attachment of the external lateral ligament of the jaw.

The *sigmoid notch* is a deep depression of a semilunar shape, lying between and separating the two processes. It is crossed by the masseteric vessels and nerve.

(4.) The *anterior border.*

This border of the ramus is continuous with the external oblique line upon the outer surface of the body. It is thin above, but below, where it is grooved for the buccinator muscle, it is much thicker.

(5.) The *lower* and *posterior border.*

These borders are both thick and rounded, and form by their junction the *angle of the jaw.* This point gives attachment to the masseter, and the internal pterygoid muscles, and to the stylo-maxillary ligament.

MUSCLES.

The muscles attached to the lower jaw, number fifteen pairs, and may be thus classified:

The INFERIOR MAXILLARY BONE gives attachment to 15 pairs of muscles, as follows:	To Body. (11)	To *external surface* (6)	Levator menti.
			Obicularis oris.
			Depressor labii inferioris.
			Depressor anguli oris.
			Platysma myoides.
			Buccinator.
		To *internal surface.* (5)	Genio-hyo-glossus.
			Genio-hyoid.
			Digastric.
			Mylo-hyoid.
			Superior constrictor of pharynx.
	To Ramus (4)	To *external surface.* (1)	Masseter.
		To *internal surface.* (1)	Internal pterygoid.
		To *coronoid process.* (1)	Temporal.
		To *neck of condyle.* (1)	External pterygoid.
			Total, 15 pairs.

ARTICULATION.

The lower jaw articulates with one pair of cranial bones, *viz.:* the two temporal bones.

DEVELOPMENT.

This bone is developed, before any bone in the body, except the clavicle. It probably has *two* centres of ossification, one for each lateral half of the bone. By some authorities additional centres are described as existing in the condyle, the coronoid process, the angle, and in a thin plate of bone on the inner side of the alveolar border.

Table of the Articulations and the Muscles of the Bones of the Cranium.

Name of Bone.	Articulation.	Muscles attached.
Occipital............	6 bones.	12 pairs.
Sphenoid............	12 "	12 "
Ethmoid............	13 "	
Frontal.............	12 "	3 muscles.
Temporal...........	5 "	14 "
Parietal.............	5 "	1 "

SUTURES OF THE SKULL.

In examining the exterior portion of the cranium, we are led to observe that certain well-marked lines exist, which indicate either actual or previously existing points of separation between the various bones composing it. To these lines the name of *sutures* is applied.

The number of sutures existing between the bones of the cranium may be deduced by computing the number of cranial bones with which each cranial bone articulates, and thence computing the number of sutures that may possibly be formed. We thus find that thirty-four articulations exist within the cranium, as follows:

Occipital	articulates with	5	cranial	bones.
Sphenoid	" "	7	"	'
Ethmoid	" "	2	"	"
Frontal	" "	4	"	'
Temporal	" "	6	"	"
Parietal	" "	10	"	"
	Total	34	articulations.	

Now as it requires two bones to form a suture, by dividing the total number of articulations by 2 we get 17 as the number that must necessarily exist. These 17 sutures may be arranged in two ways as follows:

Sutures at the vertex	5
" " sides	4
" " base	8
Total	17

Sutures of the CRANIUM.	In the mesial line of the Skull (5)	Inter-parietal or Sagittal.	
		Occipito-sphenoidal or Basilar	
		Spheno-ethmoidal.	
		Spheno-frontal.	
		Ethmo-frontal.	
	At the Vertex of the Skull (4)	Fronto-parietal or Coronal (one on either side)	
		Occipito-parietal or Lambdoidal (one on either side)	
	At the sides of the Skull (4)	Spheno-parietal .... (one on either side)	
		Tempero-parietal .... (one on either side)	Squamo-parietal.
			Masto-parietal.
	At the base of the Skull (4)	Occipito-temporal .... (one on either side)	Occipito-petrosal.
			Occipito-mastoidal.
		Spheno-temporal .... (one on either side)	Spheno-petrosal.
			Spheno-squamosal.

The masto-parietal suture used formerly to be called the "additamentum sutura squamosa," and the occipito-mastoid suture was termed the "additamentum sutura lambdoidalis." These two sutures, if taken together, constitute the *mastoid suture.*

The inter-parietal suture in children, and occasionally in adults, is prolonged through the frontal bone to the nose under the name of the *frontal suture.*

It thus appears that between the bones of the cranium the 17 sutures, as shown above, exist, but, by assigning special names to portions in which the constituent parts of the temporal bone enter, this number will be increased by six, making in all 23, and if the frontal suture be included the total number will be 24.

THE DIFFERENCES IN THE FORM OF THE SKULL.

The skull presents variations in form which are dependent either upon *age*, *sex*, or *national characteristics.*

In the earlier stages of fœtal life, the posterior part of the cranium is greatly in excess of the anterior portion ; but as development proceeds, the parietal region increases rapidly in its size, and subsequently the frontal region is greatly augmented.

During the first years of childhood, the upper part of the skull develops more rapidly than its base. The proportion of the face to the entire bulk of the skull gradually increases from the date of birth, at which time it forms only one-eighth of the entire bulk, till adult life is attained, when the proportion reaches nearly one-half.

The *female* skull is smoother, lighter, and generally of smaller size than that of the male, and other points of distinction exist.

The face is smaller in proportion to the cranium, the muscular prominences are less marked, the frontal sinuses are smaller, the jaws are narrower, and the frontal and occipital regions are less capacious in proportion to the parietal. The skulls of *different races* of men frequently present characteristic types as was first distinctly pointed out by Camper. The size of the skull in the various nations often exhibit marked differences; thus in the Hindoo and the ancient Peruvian, the smallest skulls are discovered, while among the Scandinavian races and the Caffre, the most massive skulls are found. Among rude tribes various characters are often found, which serve to distinguish their skulls from those of civilized nations; among these characters may be mentioned a prominence of the temporal ridges, a greater width of the zygomatic arches and of the anterior nares, a greater length and strength of the jaws and a projection forwards of the incisor teeth, so that both sets of teeth meet at a sharp angle instead of perpendicularly as in cultivated nations.

Irregularities of form, if such exist in the skull, are due either to mechanical causes or to a premature obliteration of certain of the sutures of the skull, known by the name of synostosis.

ANTERIOR REGION OF THE SKULL.

The face is bounded, above, by the nasal eminences and the upper margins of the orbit, and, below, by the prominence of the chin. On either side of the face, the malar bones and the ramus of the jaw establish its outline.

The cavity of the nose is marked, anteriorly, by a heart-shaped opening in the face which is termed the *opening of the anterior nares.*

Across the line of junction of the frontal base or the forehead and the bones of the upper jaw, can be traced a line of separation called the *transverse suture of the face.* It begins at the external angular process of the frontal bone and extends to the median line, at the root of the nose. It separates the frontal bone, successively, from the malar, the sphenoid, the ethmoid, the lachrymal, the superior maxillary and the nasal bones.

In the mesial line of the face, is also seen a suture which separates the two nasal bones, above, and the two superior maxillary bones, below, while, even in the lower jaw, the symphysis of the chin indicates the previous existence of a fœtal suture.

The various points of interest pertaining to the osteology of the face have been considered in the special descriptions of the individual bones which compose it.

The face as a whole is of oval form. It presents an irregular surface which is excavated by four large cavities, *viz.*, the orbits and nasal fossæ, in which are lodged two principal organs of special sense.

The Bony Orbit.

The orbital cavities are two in number, one on either side of the nasal fossæ. Each cavity is of the form of a quadrilateral pyramid whose axis looks outwards and forwards. Each is composed of seven bones, as follows:

Mesial bones............	(3)	Frontal. Ethmoid. Sphenoid.
Pairs of bones...........	(4)	Superior Maxillary. Lachrymal. Malar. Palate.

The three mesial bones, mentioned above, enter into the formation of *both* orbits, while one of each pair compose the remainder of each orbit. It will thus be perceived that only *eleven bones* are present in the two orbits.

Each orbit communicates with one cavity, four fossæ and one canal. The following table will illustrate the means of communication with each of these, as well as the names of the parts to which the orbit has access.

The Orbit communicates with the following parts of the skull	*One cavity*...	Through optic foramen and sphenoidal fissure.	Cranium.
	Four fossæ..	Through the spheno-maxillary fissure and nasal duct.	Nasal. Temporal. Zygomatic. Spheno-maxillary.
	One Canal..........		Nasal duct.

The orbit presents for examination the following parts: A roof, a floor, an inner wall, an outer wall, four angles, a circumference or base, and an apex.

The *roof* of the orbit is formed by the following two bones:....................	Orbital plate of Frontal. Lesser wing of Sphenoid.
The *floor* of the orbit is formed by the following three bones:..................	Orbital surface of the Superior Maxilla. Orbital process of the Malar. Orbital process of the Palate.
The *inner wall* of the orbit is formed by the following four bones in their order, from before backwards:..............	Nasal process of the Superior Maxilla. Lachrymal. Os planum of the Ethmoid. Body of the Sphenoid.
The *outer wall* of the orbit is formed by the following bones in their order, from before backwards:......................	Orbital process of Malar. Orbital surface of the great wing of the Sphenoid.

The points of interest pertaining to each of these special localities are as follows:

Roof of the orbit,

(1.) The *lachrymal fossa* for the lachrymal gland.

(2.) A *depression* for the pulley of the Superior oblique muscle of the eye.

FLOOR of the orbit.

(1.) The *infra-orbital groove*, posteriorly.
(2.) The *infra-orbital canal*, anteriorly.
(3.) A *depression*, for the inferior oblique muscle of the eye.

INNER WALL of the orbit.

(1.) A *groove* for the lachrymal sac.
(2.) The *crest of the lachrymal bone* for the tensor tarsi muscle.

OUTER WALL of the orbit.

(1.) The *orifices* of the *malar canals.*
(2.) A *small spine* for the attachment of the external rectus muscle of the eye.

SUPERIOR EXTERNAL ANGLE of the orbit.

(1.) The articulation of the frontal and malar bones.
(2.) The articulation of the frontal bone and the greater wing of the sphenoid bone.
(3.) The *sphenoidal fissure* or *foramen lacerum anterius.*

SUPERIOR INTERNAL ANGLE of the orbit.

(1.) A *suture* between the frontal bone and the lachrymal and ethmoid bones.
(2.) The *anterior ethmoidal canal.*
(3.) The *posterior ethmoidal canal.*

INFERIOR EXTERNAL ANGLE of the orbit.

(1. The *spheno-maxillary fissure.*

This transmits the infra-orbital vessels and nerves and the ascending branches of Meckel's ganglion.

INFERIOR INTERNAL ANGLE of the orbit.

(1.) A *suture*, formed by the articulation of the superior maxillary and palate bones, below, with the lachrymal and ethmoid bones, above.

CIRCUMFERENCE of the orbit.

(1.) The *supra-orbital notch* or *foramen.*

APEX of the orbit.

(1.) The *optic foramen*, which is formed by the two roots of the lesser wing of the sphenoid bone. To the upper root is attached the common tendon of the muscles of the eye.

Each of these various points of interest has already been previously described, in detail, in the accounts given of the special bones with which they are connected. It has not been deemed necessary therefore, to enter again into the *purposes* of many of the points of interest and importance which are met with in the cavity of the orbit, a simple enumeration of them being sufficient.

Muscles of the Orbit.

Within the orbital cavity arise the following eight muscles:

(1.) The External Rectus.
(2.) The Internal Rectus.
(3.) The Superior Rectus.
(4.) The Inferior Rectus.
(5.) The Superior Oblique.
(6.) The Inferior Oblique.
(7.) The Levator palpebræ.
(8.) The Tensor tarsi.

Foramina of the Orbit.

Each orbit has *nine foramina*, communicating with it, which may be thus enumerated:

The Orbit presents nine foramina, as follows:	Opening into the *cranium*	(4)	Optic foramen.
			Sphenoidal fissure.
			Anterior fronto-ethmoidal canal.
			Posterior fronto-ethmoidal canal.
	Opening into the *face*	(3)	Supra-orbital foramen.
			Infra-orbital foramen.
			Malar foramen.
	Opening into the *nose*	(1)	Nasal duct.
	Opening into the *zygomatic fossa* .	(1)	Spheno-maxillary fissure.
	Total,	9	

The supra-orbital foramen may be felt at the point of junction of the *middle* and the *inner thirds* of the supra-orbital margin, and a line drawn from that point to the interval between the bicuspid teeth of the upper and the lower jaws will cross the infra-orbital and the mental foramina. This is a valuable *guide* to these foramina, in case the division of any of the three branches of the fifth cranial nerve be demanded.

The pulley of the superior oblique muscle may be felt by pressure being applied at the internal angular process of the frontal bone, and, in operations about the orbit, this process should be carefully avoided.

The Nasal Fossæ.

The cavity of the nose is divided into two fossæ, by a vertical septum situated in the median line of the face.

Each nasal fossa is a narrow, irregularly shaped cavity, enclosed between the orbits, the superior maxillary bone, and the vertical septum, and, from below upwards, between the roof of the mouth and the anterior portion of the base of the skull.

Into the formation of *each* of the nasal fossæ, *nine* bones enter, and *fourteen* into that of *both*, as shown by the following table:

The NASAL FOSSÆ have 14 bones which enter into their formation, *viz.*:	Mesial bones..........	(4)	Ethmoid.
			Sphenoid.
			Frontal.
			Vomer.
	5 pairs of bones.......	(10)	Nasal.
			Superior maxillary,
			Lachrymal.
			Palate.
			Inferior turbinated.
		Total, 14	

Each of the nasal fossæ presents for special examination the following component parts: A roof, a floor, an inner wall, an outer wall, an anterior opening, a posterior opening.

The ROOF of each nasal fossa is narrow and forms an arch, and its longest axis lies in the antero-posterior direction. It presents the following points, which have been previously mentioned in the descriptions of the nasal, frontal, ethmoid and sphenoid bones, each of which participates in its construction.

(1,) The *anterior portion* of the *arch* of the roof, which is formed by the nasal bone and the nasal spine of the frontal bone.

(2.) The *horizontal portion* of the roof, which is formed by the under surface of the cribriform plate of the ethmoid bone.

(3.) The *posterior portion* of the *arch* of the roof, which is formed by the body of the sphenoid bone.

(4.) The *opening* into the *sphenoidal sinuses* which lies at the posterior portion of the roof.

(5.) The *olfactory foramina* and the *nasal slit*.

The FLOOR of each nasal fossa is concave, from side to side, and is formed by the *palate processes* of the superior maxillary bone and the palate bone. It possesses for examination the following points of interest:

(1.) The *suture* between the two bones forming the floor.

(2.) The *upper orifice* of the *anterior palatine canal*.

(3.) The *anterior nasal spine* of the superior maxillary bone.

(4.) The *posterior nasal spine* of the palate bone.

(5.) The *crest* upon both the bones forming the floor, which articulates with the vomer.

The INNER WALL of each of the nasal fossæ consists of the vertical septum which separates the two. It is formed principally of two bones, and, to a small extent, by five other bones, as is shown by the following enumeration:

The INNER WALL of the nasal fossæ is composed of *seven bones*, as follows:	Principally by *two* bones, *viz.*:	Above and in front.	Perpendicular plate of the ETHMOID BONE.
		Below and behind.	The VOMER.
	By *five* bones, to a small extent, *viz*:		Rostrum of SPHENOID.
			Nasal spine of FRONTAL.
			Crest of NASAL.
			Crest of PALATE.
			Crest of SUPERIOR MAXILLARY.

In front, this septum has a triangular deficiency which is filled up with the so-called *cartilage of the septum.* The inner wall of the nasal fossæ is frequently deflected from the median line towards one side, thus encroaching somewhat upon one of the cavities of the nose.

The only points of interest perceived upon the surfaces of this septum, are the *naso-palatine grooves*, and *vascular* and *nervous furrows.*

The OUTER WALL of each of the nasal fossæ is formed by six bones, as follows:

The OUTER WALL of the nasal fossa is composed of *six bones*, as follows:	In its *anterior* portion.	Middle turbinated processes of the ETHMOID BONE.
		Internal surface of SUPERIOR MAXILLARY BONE.
		INFERIOR TURBINATED BONE.
	In the *central* portion.	LACHRYMAL BONE.
		Nasal process of the SUPERIOR MAXILLARY BONE.
	In its *posterior* portion.	Vertical plate of PALATE BONE.
		Internal pterygoid plate of SPHENOID BONE.

This wall of the nasal fossa presents the following points of interest from above downwards:

(1.) The *superior turbinated bone* of the ethmoid.

(2.) The *superior meatus* of the nose, into which open the orifice of the sphenoidal sinus, the posterior ethmoidal sinuses, and the spheno-palatine foramen. This meatus consists of a short, irregular, longitudinal passage, and is situated at the *upper* and *posterior* portion of the nasal fossa.

(3.) The *middle turbinated bone* of the ethmoid.

(4.) The *middle meatus* of the nose, which is of greater length than the superior, and into which open the orifices of the antrum, the anterior ethmoidal cells and the frontal sinus.

(5.) The *inferior turbinated bone.*

(6.) The *inferior meatus* of the nose, the largest of the three passages, lies in close proximity to the floor of the nasal fossa, being situated between it and the inferior turbinated bone. It presents the interior or nasal opening of the lacrymal or nasal duct, and the upper opening of the anterior palatine canal.

Openings of the Nasal Fossæ.

Besides the anterior and the posterior openings of the nasal cavities, there are eight other openings in each fossa, which are shown in the following table:

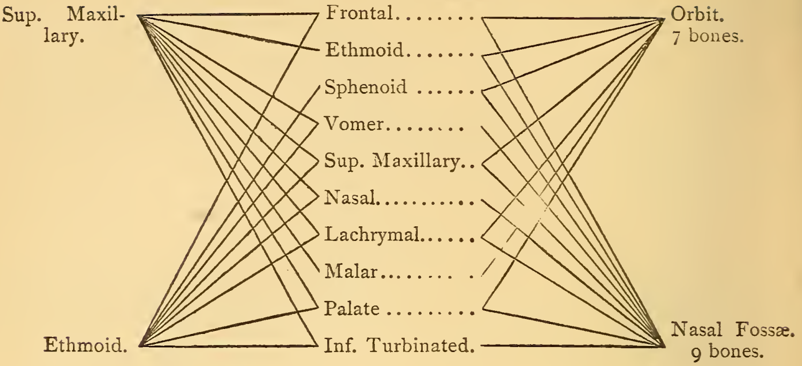
Each Nasal Fossa has eight openings, which are situated as follows:	In the superior meatus (3)	Sphenoidal sinus.
		Spheno-palatine foramen.
		Posterior ethmoidal cells.
	In the middle meatus (3)	Maxillary sinus, or antrum.
		Anterior ethmoidal cells.
		Frontal sinus, through the infundibulum.
	In the inferior meatus (2)	Lower opening of the nasal duct.
		Naso-palatine canal.
	Total, 8	

The *frontal sinuses*, which communicate with the nasal fossæ, have an important relation to the operation of trephining for wounds of the frontal region. They do not exist in children, since the tables of the skull do not begin to separate until the age of puberty. The absence of marked prominences over the region of these sinuses does not necessarily indicate their small size, since the sinuses are often formed at the expense of the inner wall of the cranium. Animalculæ and small insects have been known to obtain an entrance into the cavity of the frontal sinuses, through the nose.

The *external aperture of the nose*, in the living subject, lies on a lower plane than the floor of the nasal cavity, so that the nose must be pulled upwards, if a full view of the nasal cavity is to be obtained from in front. The inferior turbinated bone can be perceived only by dilating the ala of the nose.

Since the cavity of the nasal fossa is narrower in the transverse diameter, even in the inferior meatus, than in the perpendicular direction, any instrument introduced to remove foreign growths of extraneous bodies should be opened in the longest axis of the inferior meatus.

TABLE OF SUMMARY.



This diagram is intended to illustrate the formation of the orbital and nasal cavities, and also the various articulations of the ethmoid and the superior maxillary bones.

The lines connecting the various bones to the parts designated at the corners of the diagram show, upon the left hand of the page, the formation of the nasal cavities and the orbits, and, upon the right hand, the articulations of the ethmoid and the superior maxillary bones.

THE LATERAL REGION OF THE SKULL.

The lateral regions of the skull present for examination portions of the temporal, parietal, sphenoid, frontal, malar and inferior maxillary bones. It also presents three important regions which have received special names, and which are called, respectively, the temporal fossa, the zygomatic fossa and the spheno-maxillary fossa.

To ascertain the relative proportions of the frontal, the parietal, and the occipital regions of the skull, pass a thread from one external auditory meatus to that of the opposite side, across the frontal, the parietal, and the occipital eminences, respectively, and record their measurements.

The three principal bony points upon the lateral aspect of the skull are,

(1.) The *zygomatic arch* and the *upper portion* of the *ramus* of the jaw, the former of which arches over the temporal, zygomatic and spheno-maxillary fossæ.

(2.) The *external auditory meatus*, which is the external orifice of the bony canal leading to the drum membrane of the tympanum.

(3.) The *mastoid process* of the temporal bone which is situated at the posterior portion of this region.

Temporal Fossa.

This fossa is formed by parts of the following five bones.

(1.) The frontal bone.
(2.) The great wing of the sphenoid bone.
(3.) The temporal bone.
(4.) The anterior inferior angle of the parietal bone.
(5.) The malar bone.

It is deeply excavated in its anterior and lower portions, but is comparatively shallow in its superior and posterior portions. It is bounded as follows:

The Temporal fossa is bounded as follows:	*Above* by the	Temporal ridge.
	Below by the	Line of the zygomatic arch. Pterygoid ridge upon the greater wing of the Sphenoid bone.
	In front by the	Malar bone. Frontal bone. Great wing of the Sphenoid.
	Behind by the	Temporal ridge.

This fossa is traversed by six sutures, *viz.:*

(1.) The spheno-malar.
(2.) The spheno-frontal.
(3.) The spheno-parietal.
(4.) The squamo-sphenoidal.
(5.) The fronto-parietal, or the coronal.
(6.) The squamo-parietal.

The temporal fossa becomes continuous, at its lower border, *viz.*, at the line of the zygomatic arch and the pterygoid ridge, with the zygomatic fossa. It contains the temporal muscle and the deep temporal vessels.

Zygomatic Fossa.

The zygomatic fossa is an irregular and imperfectly closed space, the incomplete walls of which are thus formed.

The Zygomatic fossa is bounded as follows:	*In front* by the	Tuberosity of the Superior Maxillary bone.
	Internally by the	External pterygoid plate of the Sphenoid bone.
	Above by the	Under surface of the great wing of the Sphenoid bone. Squamous portion of the Temporal bone.
	Externally by the	Zygomatic arch. Ramus of lower jaw.
	Below by the	Aveolar border of the Inferior Maxillary bone.

This fossa communicates with the *temporal fossa*, beneath the zygomatic arch, and also with the *orbit* and the *spheno-maxillary fossa*. The following table illustrates the channels of communication between these three cavities.

The ZYGOMATIC FOSSA communicates......	Beneath the *zygomatic arch* with the	TEMPORAL FOSSA.
	Through the *spheno-maxillary fissure* with the....................	ORBITAL FOSSA.
	Through the *pterygo-maxillary fissure* with the..................	SPHENO-MAXILLARY FOSSA.

The *spheno-maxillary fissure* is a large sized space situated between the sphenoid and malar bones, on the outside, and the superior maxillary and palate bones, on the inside of the opening. The malar bone, however, does not always enter into its formation.

It joins at a right angle with the pterygo-maxillary fissure, which exists between the superior maxillary bone and the pterygoid process of the sphenoid bone, and thus affords an opening into the spheno-maxillary fossa.

This fissure is the means of communication between the orbit, on the one hand, and three cavities, *viz.*, the temporal, zygomatic and the spheno-maxillary fossæ, on the other.

It transmits the infra-orbital artery, the superior maxillary nerve and its orbital branches, and the ascending branches of Meckel's ganglion.

This fissure is *horizontal* in its direction, and is situated at the outer and back part of the orbit.

The *pterygo-maxillary fissure* is situated between the tuberosity of the superior maxillary bone and the pterygoid process of the sphenoid bone.

It joins the spheno-maxillary fissure, at a right angle, and transmits the terminal branches of the internal maxillary artery, in its passage from the zygomatic fossa to the spheno-maxillary fossa.

It is *vertical*, in direction, and is rather an elongated interval between the bones mentioned above, than a true fissure.

SPHENO-MAXILLARY FOSSA.

The space, called by this name, is a narrow and elongated cavity, triangular in form, comprised between the pterygoid process of the sphenoid bone and the tuberosity of the superior maxillary bone.

It is bounded as follows:

The SPHENO-MAXILLARY FOSSA is bounded as follows:............	*Above* by the.......	Under surface of the body of the Sphenoid bone.
	In front by the ...	Superior maxillary bone.
	Behind by the.....	Pterygoid process of the Sphenoid bone.
	Internally by the...	Vertical plate of the Palate bone.

This fossa has *three fissures* which terminate in it, *viz.*, the sphenoidal, the spheno-maxillary, and the pterygo-maxillary fissures.

It communicates also with *three fossæ* and *two cavities*, which may be thus enumerated:

The three fossæ are:	Orbit. Nasal cavity. Zygomatic.
The two cavities are:	Cranial. Buccal.

It has *five foramina* which open into it, *viz.:*

Foramen of the SPHENO-MAXILLARY FOSSA....	On the posterior wall. (3)	Foramen rotundum. Vidian canal. Pterygo-palatine canal.
	On the inner wall ... (1)	Spheno-palatine foramen.
	At the lower portion.. (1)	Superior orifice of the posterior palatine canal.

Of these, the foramen rotundum opens into the cranium, the vidian canal opens into the foramen basis cranii, the spheno-palatine foramen opens into the nasal fossa, the posterior palatine canal opens into the roof of the mouth, and the pterygo-palatine canal opens into the upper portion of the pharynx.

Occasionally *accessory palatine foramina* are present at the lower portion of this fossa, in addition to the opening of the posterior palatine canal.

THE UNDER SURFACE OF THE BASE OF THE SKULL.

The under surface of the skull is bounded from before backward by the following bony margins:

The BASE OF THE SKULL is bounded as follows:	*In front* by the....	Alveolar arch and the teeth of the upper jaw.
	Laterally by the....	Lower border of the Malar bone. Zygomatic arch. Imaginary line from the zygoma to the mastoid process.
	Behind by the.....	Superior curved line of the Occipital bone.

From before backwards, the base of the skull may be said to consist of five distinct regions.

A. The roof of the mouth.
B. The posterior aperture of the nasal cavity.
C. The under surface of the basilar process.
D. A quadrangular space on either side of the basilar process.
E. The under surface of the occipital bone.

Each of these regions at the base of the skull contains points deserving of enumeration and they will therefore be individually described.

A. Roof of the Mouth.

This portion of the base of the skull is formed by the palate processes of the two superior maxillary bones and by the horizontal plates of the two palate bones. It is bounded, at its circumference, by the alveolar border of the two superior maxillary bones.

It is concave in form, uneven upon its surface, and presents a *crucial suture*, which indicates the four bones which compose it.

It presents, from before backwards, the following points of interest.

(1.) The *lower openings* of the *anterior palatine canals.*
(2.) The *foramen of Stenson*, in the mesial line.
(3.) The *foramina of Scarpa* for the naso-palatine nerves.
(4.) The *posterior palatine foramina.*
(5.) The *accessory palatine foramina* for the small palatine nerves.
(6.) A *transverse ridge* of bone for the aponeurosis of the tensor palati muscles.

B. The Posterior Aperture of the Nares.

These large openings (one on either side of the mesial line) are bounded separately as follows:

The POSTERIOR NARES are bounded as follows:	*Below* by the......	Horizontal plates of the Palate bone. Posterior nasal spine of the Palate bone.
	Externally by the..	Internal pterygoid plates of the Sphenoid bone. Hamular process of Sphenoid.
	Internally by the...	Vomer.
	Above by the	Body of the Sphenoid bone.

These apertures allow of communication between the nasal cavities and the upper portion of the pharynx. Superiorly, there is perceived at the margin of these apertures, near to the body of the sphenoid bone, two points deserving of mention, *viz.:*

(1.) The *expanded alæ* of the *vomer.*
(2.) The *pterygo palatine* canals.

C. Under Surface of the Basilar Process.

The basilar process of the occipital bone lies at about the centre of the base of the skull, in the mesial line. It is situated between the foramen magnum and the posterior aperture of the nares, and is slightly less than one inch in length. It presents in the median line of the bone, the two following points of interest.

(1.) The *pharyngeal spine*, to which is attached the median raphe and the superior constrictor muscle of the pharynx.

(2.) *Two rough depressions*, upon each side of the pharyngeal spine, for the attachment of the rectus capitis anticus major and the rectus capitis anticus minor muscles of the respective sides.

D. THE QUADRANGULAR SPACES.

These spaces at the base of the skull are formed by the under surface of the occipital bone, by the *squamous* and *petrous portions* of the temporal bone, and by the *greater wing* of the sphenoid bone. They are situated upon each side of the basilar process of the occipital bone, and are each bounded as follows.

In front, by a line extending from the base of the pterygoid process to the root of the zygoma.

Externally, by a line from the root of the zygoma to the mastoid process.

Behind, by a line from the mastoid process to the anterior extremity of the condyles of the occipital bone.

Internally, by a line from the condyle to the base of the pterygoid process.

Its four *angles* correspond, therefore, to the four following points, *viz.:*

(1.) Condyle of the occipital bone.
(2.) Base of the pterygoid process.
(3.) Anterior root of the zygomatic process.
(4.) Tip of the mastoid process.

This quadrangular space is divided into two parts by an *oblique line* directed from before backwards and outwards. This line extends from the pterygoid process to the mastoid process, and, in its course, it includes the following points of interest which will here be simply enumerated, as their function has already been given in previous pages of this volume.

(1.) The *foramen lacerum medium.*

(2.) A *roughened surface* for the attachment of the levator palati and the tensor tympani muscles.

(3.) The *inferior orifice* of the *carotid canal.*

(4.) The *vaginal process* of the temporal bone.

(5.) The *styloid process* of the temporal bone.

(6.) The *stylo-mastoid* foramen.

In *front* and to the *outer side* of this diagonal line are found the following points of interest, in their order from before backwards and outwards.

(1.) The *foramen ovale.*
(2.) The *foramen Vesalii.*
(3.) The *foramen spinosum.*
(4.) The *spinous process* of the sphenoid bone.
(5.) The *opening* for the *Eustachian tube* (osseous portion.)
(6.) The *opening* for the *canal of the tensor tympani* muscle.
(7.) The *glenoid fossa* of the temporal bone.
(8.) The *Glaserian fissure*, dividing the glenoid fossa into two portions.

Behind and to the *inner side* of the diagonal line, are perceived also the following points of special interest.

(1.) The *jugular fossa.*
(2.) The *jugular foramen*, or *foramen lacerum posterius.*
(3.) The *jugular process* of the occipital bone.
(4.) The *anterior condyloid foramen.*
(5.) The *posterior condyloid foramen.*
(6.) The *foramen* for *Jacobson's nerve.*
(7.) The *foramen* for *Arnold's nerve.*
(8.) The *opening* of the *aquæductus cochleæ.*

E. The Under Surface of the Occipital Bone.

This comprises the remaining portion of the base of the skull. It exhibits the following points deserving of special enumeration.

(1.) The *condyles* of the occipital bone.
(2.) The *jugular processes* of the occipital bone.
(3.) The *anterior condyloid foramina.*
(4.) The *posterior condyloid foramina* or *fossæ.*
(5.) The *external occipital crest.*
(6.) The *superior curved line* of the occipital bone.
(7.) The *inferior curved line* of the occipital bone.
(8.) The *external occipital protuberance.*

For a detailed description of the parts mentioned in the preceding pages see the description of the individual bones of the cranium and the table of cranial foramina.

A TAIE INTERIOR OF THE CRANIUM,

NSMIT.

THROUGH THE VARIOUS FORAMINA.

SINGLE, OI	embrane of the nose to the superior longitudinal sinus, and some- lodges also a fold of the dura mater.
´	vertebral arteries, and the spinal accessory nerves.
IN ANTERIO 5 pa	lal artery. nasal branches of the ethmoidal arteries. erve.
IN MIDDLE 8 pa	the ophthalmic division of the fifth, and the sixth cranial nerves. the opthalmic vein, a branch of the lachrymal artery, and some- orbital branches of the middle meningeal artery, and a process of
	h of the trifacial or fifth cranial nerve.
	f Santorini. erve, or third branch of the fifth cranial nerve, the lesser petro- tery, a branch of the internal maxillary. al veins, and filaments of the sympathetic from the cavernous plexus. , the large petrosal nerve, and a meningeal branch from the as-
	dle meningeal artery, which anastomoses with the stylo-mastoid cular.
IN POSTERIO 6 p	ory artery, a branch of the basilar. the dura mater. spinal accessory nerves; the internal jugular vein, and meningeal geal and occipital arteries. ication between the occipital vein and lateral sinus, and occasion- cipital, called the mastoid artery, which ramifies in the dura mater. ranch from the ascending pharyngeal artery. ommunication with the vertebral vein and lateral sinus.

The ie, called the Parietal, on each side of the sagittal sature, transmits a small vein um and the foramen magnum. Of the remaining 38, 5 pairs are found in the wards.

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* Frequ

A TABLE REPRESENTING THE FORAMINA COMMUNICATING WITH THE INTERIOR OF THE CRANIUM, AND THE ORGANS WHICH THEY TRANSMIT.

	FORAMEN.	PARTS PASSING THROUGH THE VARIOUS FORAMINA.
SINGLE, OR MESIAL.	I. ANTERIOR FOSSA.	
	1. Foramen Cæcum	Transmits a small vein from the lining membrane of the nose to the superior longitudinal sinus, and sometimes one from the frontal sinus, and lodges also a fold of the dura mater.
	II. POSTERIOR FOSSA.	
	2. Foramen Magnum	Medulla oblongata and its envelopes, the vertebral arteries, and the spinal accessory nerves.
IN THE ANTERIOR FOSSA. 5 pairs.	1. Ethmoidal Fissure	The nasal nerve, and the anterior ethmoidal artery.
	2. Olfactory Foramina	Filaments of the olfactory nerve and the nasal branches of the ethmoidal arteries.
	3. Anterior Ethmoidal Canal (Fronto-Ethmoidal)	Anterior ethmoidal artery and the nasal nerve.
	4. Posterior Ethmoidal Canal (Fronto-Ethmoidal)	Posterior ethmoidal artery and vein.
	5. Optic Foramen	Optic nerve and the ophthalmic artery.
IN THE MIDDLE FOSSA. 8 pairs.	1. Foramen Lacerum Orbitale (Sphenoidal Fissure, Spheno-Frontal foramen)	The third, fourth, the three branches of the ophthalmic division of the fifth, and the sixth cranial nerves, and filaments of the sympathetic; the opthalmic vein, a branch of the lachrymal artery, and sometimes the lachrymal artery itself, the orbital branches of the middle meningeal artery, and a process of the dura mater.
	2. Foramen Rotundum	Superior maxillary nerve, or second branch of the trifacial or fifth cranial nerve.
	3. *Foramen Vesalii	A small vein, one of the emissary veins of Santorini.
	4. Foramen Ovale	The two roots of the inferior maxillary nerve, or third branch of the fifth cranial nerve, the lesser petrosal nerve, and the small meningeal artery, a branch of the internal maxillary.
	5. Foramen Spinosum	Middle meningeal artery, the two meningeal veins, and filaments of the sympathetic from the cavernous plexus.
	6. Foramen Lacerum Medium (Spheno-Petrosal, Foramen basis cranii)	Internal carotid artery, the carotid plexus, the large petrosal nerve, and a meningeal branch from the ascending pharyngeal artery.
	7. Small Foramen	Lesser petrosal nerve.
	8. Hiatus Fallopii	Large petrosal nerve, a branch of the middle meningeal artery, which anastomoses with the stylo-mastoid artery, a branch of the posterior auricular.
IN THE POSTERIOR FOSSA. 6 pairs.	1. Meatus Auditorius Internus	Facial and auditory nerves, and the auditory artery, a branch of the basilar.
	2. Aqueduct of the Vestibule	A small artery and vein, and a process of the dura mater.
	3. Foramen Lacerum Posterius (Occipito-Petrosal, Jugular) ..	Glosso-pharyngeal, pneumogastric, and spinal accessory nerves; the internal jugular vein, and meningeal branches from the ascending pharyngeal and occipital arteries.
	4. *Mastoid	A small vein which establishes a communication between the occipital vein and lateral sinus, and occasionally a small arterial twig from the occipital, called the mastoid artery, which ramifies in the dura mater.
	5. Anterior Condyloid	The hypoglossal nerve and a meningeal branch from the ascending pharyngeal artery.
	6. *Posterior Condyloid	Posterior condyloid vein, establishing a communication with the vertebral vein and lateral sinus.

The number of foramina communicating with the interior of the cranium varies from 36 to 42: 2 at vertex, rest at base. Of these, one, called the Parietal, on each side of the sagittal sature, transmits a small vein and sometimes a small artery, a branch of the occipital. Of the remaining 40, 2 are in the mesial plane: viz., the foramen cæcum and the foramen magnum. Of the remaining 38, 5 pairs are found in the anterior fossa, 8 in the middle fossa, and 6 in the posterior fossa. The foramina are arranged in regular order from before backwards.

The names printed in red indicate the Foramina through which one or more of the Cranial nerves pass; those underlined in red indicate the Foramina of exit of branches.

* Frequently absent—thus causing variations in the number of foramina present.

SKELETON OF THE TRUNK.

SKELETON OF THE TRUNK.

The skeleton of the trunk may be sub-divided into three parts, as follows:

The VERTEBRAL COLUMN.
The THORAX.
The BONY PELVIS.

THE VERTEBRAL COLUMN.

The true vertebral column is composed of twenty-four bones, placed one above the other, and extends from the occipital bone above, to the sacrum below. These bones are termed the *true vertebræ*, in contradistinction to the sacrum and the coccyx, which are termed the *false vertebræ*.

The vertebræ are named in numerical order, from above downwards, or, in other words, from the occipital bone to the sacrum, according to the *region* in which they are situated. Hence the name of any particular vertebra must be expressed by two adjectives; one indicating the region in which it is situated, and the other the place it occupies in that region.

In the cervical region, there are three vertebræ, which, in addition to the numerical, have also special names, *viz.*, the first cervical or *atlas*, the second cervical or *axis*, and the seventh cervical or the *vertebra prominens*.

Before proceeding to the description of the vertebræ, it will be well to consider the nature and function of this important portion of the skeleton, which may be thus stated:

1st. It provides a column to sustain the weight of the head and trunk.

2d. It affords a canal to lodge an important organ, the spinal cord.

3d. It affords, by means of numerous intervertebral foramina, a means of communication between the spinal cord and the various parts of the body, through the spinal nerves.

4th. It affords, by means of its spinous and transverse processes, a system of levers upon which the muscles of the trunk may act.

5th. As the column must be flexible and elastic in order to allow of the various motions of the trunk, it must consist of a number of pieces united together by means of cartilage and ligaments.

6th. In order to afford greater security to the connection between important parts than would be ensured by ligaments only, the bones are also firmly held in position by means of the articular processes.

The anatomy of the vertebræ will be considered in this volume under the following heads:

(A.) General characteristics of a Vertebra.
(B.) Regional characteristics of Vertebra.
(C.) Individual characteristics of Special Vertebræ.
(D.) The vertebral column as a whole.

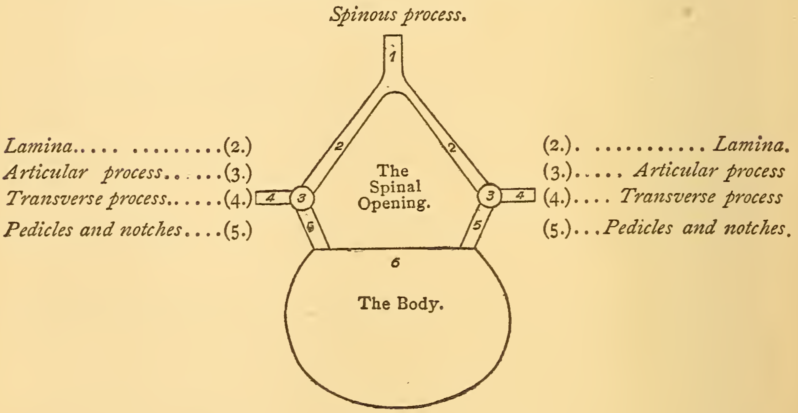
(A.)

GENERAL CHARACTERISTICS OF THE VERTEBRÆ.

A vertebra possesses the following component parts, which will each require a special description.

(1.) A BODY.
(2.) A SPINAL FORAMEN.
(3.) SEVEN PROCESSES. { A spinous process. Four articular processes. Two transverse processes.
(4.) TWO PEDICLES.
(5.) FOUR NOTCHES.
(6.) TWO LAMINÆ.

DIAGRAMMATIC PLAN OF A VERTEBRA.



(1.) THE BODY.

This portion of each vertebra presents for examination the following points:

(1.) An upper surface.
(2.) A lower surface.
(3.) An anterior surface.
(4.) A posterior surface.

The *anterior* surface..	is *convex*, from side to side. is slightly *concave*, from above downwards. has small foramina upon it for the transmission of blood-vessels
The *posterior* surface..	is *concave*, from side to side. is *flat*, from above downwards. has one or more apertures for the venæ basis vertebrarum,
The *upper* surface.....	is concave. is roughened for the intervertebral fibro-cartilage. is bordered, at its circumference, by a prominent rim of bone.
The *under* surface....	is concave. is roughened for the intervertebral fibro-cartilage. is bordered, at its circumference, by a prominent rim of bone.

(2.) THE SPINAL FORAMEN.

The spinal foramen may be rudely compared to a pentagonal arch, the base of which corresponds to the posterior surface of the body of the vertebra, the piers of which are the pedicles, and the vault of which is formed by the laminæ.

(3.) THE SPINOUS PROCESS.

This projects backwards from the point of junction of the laminæ.

(4.) THE TRANSVERSE PROCESSES.

These are two in number, one on each side. They project outwards from the sides of the arch.

(5.) THE ARTICULAR PROCESSES.

These are four in number, two on each side, and are called, from their position on the vertebra, the superior and the inferior. They are usually situated at the point of junction of the pedicles with the laminæ, but they vary. The articular processes also vary as to the *direction* towards which their surfaces are directed. The superior ones usually look backwards and the inferior ones look forwards.

(6.) THE PEDICLES.

The pedicles project backwards and slightly outwards from the point of junction between the anterior and posterior surfaces of the body. They are scooped out, on their upper and lower borders, so as to form the *notches*, which are generally deeper upon the lower than upon the upper border. These notches contribute to the formation of the intervertebral foramina.

(7.) THE NOTCHES.

These notches, when the vertebræ are superimposed upon each other, form the so-called *intervertebral foramina*, through which the spinal nerves escape, and vessels enter.

(8.) THE LAMINÆ.

These plates of bone are broad and flattened. They complete the arch and help to form the spinal foramen. They are roughened, on their upper and lower borders, for the attachment of the ligamentum subflava.

(B.)

REGIONAL CHARACTERISTICS OF THE VERTEBRÆ.

CERVICAL VERTEBRÆ.

The cervical vertebræ are the smallest and the lightest of any of the three regions of the spine. They present for examination all the points designated as common to the vertebræ in general, with the exception of the *atlas* or 1st cervical vertebra and the *axis* or 2nd cervical vertebra, which will be described under the special vertebræ. The peculiarities which are the means of determining their situation, if examined apart from other vertebræ, are as follows:

BODY.
- Small and broad from side to side.
- The *upper surface* is concave from side to side, being surmounted laterally by the projecting laminæ, and its greatest diameter is the transverse one.
- The *under surface* is convex and *prolonged downwards* in front, so as to overlap the adjoining vertebra.
- The *anterior surface* is on a *lower* level than the posterior.

PEDICLES. These arise from the *lower part* of the body.

NOTCHES. The *superior* notches are the *deepest.*

LAMINÆ. The laminæ are *long* and *narrow.*

SPINAL FORAMEN. The spinal opening is *large* and *triangular.*

SPINOUS PROCESS.
- This process projects *horizontally* backwards.
- It is *short*, *bifid*, and *grooved* on its lower surface.

TRANSVERSE PROCESS.
- This process is *short*, *bifid*, and grooved upon its upper surface.
- It is *perforated*, at its base, by the vertebral foramen.

Are situated *outside* of *the pedicle.*
Lie *in front* of the *articular process.*

ARTICULAR PROCESSES. The two *superior* look *upwards* and *backwards.*
The two *inferior* looks *downwards* and *forwards.*

The distinctive characteristic of a cervical vertebra is the presence of a *foramen* at the *base* of the *transverse process,* called the vertebral foramen, since it transmits the vertebral artery and vein and the vertebral plexus of the sympathetic system of nerves.

Each transverse process of the cervical vertebra is formed by *two roots;* the anterior root arises from the sides of the body and corresponds to the ribs which spring from the dorsal vertebra; the posterior root arises from the junction of the pedicle with the lamina and corresponds to the transverse process of the dorsal region.

The extremities of these two roots produce the *bifid* appearance of the transverse process of the cervical vertebra and form the so-called *anterior* and *posterior tubercles* of these processes, to which many of the muscles of the neck are attached.

DORSAL VERTEBRÆ.

The dorsal vertebræ are of intermediate size, being larger than those of the cervical and smaller than those of the lumbar region. Their distinguishing characteristics may be thus enumerated.

BODY. Is *heart-shaped.*
Is *thicker behind* than in front.
Has *two demi-facets* on each side, for the articulation of the head of the ribs.

PEDICLES. These arise from the *upper part* of the body.

NOTCHES. The *inferior* notches are the *broadest* and *deepest.*

LAMINÆ. The laminæ are *short* and *broad.*

SPINAL FORAMEN. The spinal opening is *small* and *round.*

SPINOUS PROCESS. This process is *long, triangular* and *oblique* in its direction.

TRANSVERSE PROCESSES. These processes are *long* and *thick.*
They are directed *obliquely outwards* and *backwards.*
They are situated *behind* the *articular processes.*
They are situated also *behind* the *pedicles.*
Their *extremity* is enlarged and

has a *facet* on its anterior surface for the attachment of the tubercle of the rib.

In a few of the *lower* dorsal vertebræ, upon the posterior surface of this process, are found three *tubercles* called the *external, inferior* and *superior.*

ARTICULAR PROCESSES. The two superior look *backwards* and slightly *outwards.*

The two inferior look *forwards* and slightly *inwards.*

LUMBAR VERTEBRÆ.

These vertebra are of very large size. Their chief characteristics may be thus enumerated:

BODY. Is very large.
Is broadest in its *transverse* diameter.
Is thicker in *front* than behind.

PEDICLES. The pedicles are *thick* and strong.
They arise from the *upper* portion of the body.

NOTCHES. The *inferior* notches are the *deepest* and *broadest.*

LAMINÆ. The laminæ are *short, thick* and very *broad.*

SPINAL FORAMEN. The spinal opening is *triangular* in shape.
Is larger than in the dorsal region but smaller than in the cervical region.

SPINOUS PROCESS. This process is *thick*, is *quadrilateral* in shape, and ends in a *rough, vertical border.*

TRANSVERSE PROCESSES. These processes are *long* and *slender.*

They are directed *horizontally outwards.*

They are situated *in front* of the *articular processes.*

They are also located *behind* the *pedicles.*

On the posterior surface of each, near its base, is a small tubercle called the *accessory tubercle*, which points downwards and inwards.

ARTICULAR PROCESSES. These processes are very thick and strong.

They are placed vertically.

The *two superior* look *backwards* and *inwards* and are *concave.*
The *two inferior* look *forwards* and *outwards* and are *convex.*

TABLE OF CONTRAST OF THE CERVICAL, DORSAL AND LUMBAR VERTEBRÆ.

	CERVICAL.	DORSAL.	LUMBAR.
BODY....	Small in size. Upper surface concave. Under surface convex. Anterior border rounded off.	Intermediate in size. Heart shaped. Thickest behind. Has 2 demi-facets on each of its sides.	Large, in point of size. Very broad. Thickest in front.
PEDICLES....	Arise from *lower* part of body.	From *upper* part of body.	From *upper* part of body.
NOTCHES....	Superior the deepest.	Inferior the deepest.	Inferior the deepest.
LAMINÆ. ...	Long and narrow.	Short and broad.	Short, broad, thick.
SPINAL OPENING......	Large and triangular.	Small and round.	Triangular and intermediate in size.
SPINOUS PROCESS	Directed horizontally backwards. Short and bifid. Grooved inferiorly.	Directed obliquely. Long and triangular. Ends in a single tubercle.	Directed backwards. Thick and quadrilateral. Rough vertical border.
TRANSVERSE PROCESSES.	Short and bifid. Grooved superiorly. Vertebral foramen at base. *Outer side* of pedicle. In *front* of artic, process.	Long, thick and oblique. Extremity enlarged. Facet on ant. surface. *Behind* the pedicle. *Behind* artic. process.	Long, slender, horizontal. "Accessory tubercle" present. *Behind* pedicle. In *front* of artic. process.
ARTICULAR PROCESSES.	*Superior* look B and U. *Inferior* look D and F. Form two small vertical columns.	*Superior* look B and O. *Inferior* look F and I. Form two columns which are nearly vertical.	*Superior* look B and I. *Inferior* look F and O. Superior are concave and widely separated. Inferior are convex and nearer together than the superior.

(C.)

CHARACTERISTICS PECULIAR TO CERTAIN VERTEBRÆ.

In the different parts of the vertebral column, there are vertebræ which, in addition to general regional characters, possess *individual characteristics*, by which they may be distinguished from all the rest. These vertebræ may be thus enumerated :

In the *cervical* region, (3), atlas, axis and vertebra prominens.

In the *dorsal* region, (5), 1st, 9th, 10th, 11th, 12th. dorsal vertebræ.

In the *lumbar* region, (1), 5th. lumbar vertebræ.

THE ATLAS.

This bone presents for examination:
- 2 arches — Anterior. / Posterior.
- 2 lateral masses.
- A spinal foramen.

It lies between the occipital bone and the axis. It corresponds to the first cervical vertebra but has received a special name from its function (supporting the globe of the head). The following points of anatomical interest pertaining to this bone are deserving of notice ;

The ANTERIOR ARCH presents:
- (1.) An *anterior* surface
  - (1) *Convex* in shape.
  - (2) A *tubercle* in its centre, for the attachments of ligaments and the longus colli muscle.
- (2.) A posterior surface
  - (1) *Concave* in shape.
  - (2) An *oval facet* in its centre, for the articulation of the odontoid process of the axis.
- (3.) An *upper* and *lower* border. To which are attached the deep occipito-atloid and the deep anterior atlo-axoid ligaments.

The POSTERIOR ARCH presents:
- (1.) Grooves for the... Superior intervertebral artery, / Inferior intervertebral artery.
- (2.) A tubercle for the rectus capitis posticus minor.

The LATERAL MASSES present:
- (1.) Four *tubercles*.. 2 Superior. / 2 Inferior. — for the transverse ligament.
- (2.) 2 *transverse processes*, which are large, and are perforated by a large foramen (vertebral.)
- (3.) 2 Sup. Articular surfaces
  - Large, oval, concave.
  - Looking upwards, inwards and backwards.
- (4.) 2 Inf. Artic. surfaces...
  - Smaller, flat and circular.
  - Looking downwards and inwards.

The *spinal foramen* is large and is divided, by the transverse ligament, into an *anterior* and *posterior space*. The anterior space lodges the odontoid process of the axis, and the posterior space lodges the upper portion of the spinal cord and its membranes.

In the atlas, the *anterior arch* forms about one-fifth only, while the *posterior* arch comprises about two-fifths of the circumference of the entire bone.

The *grooves* upon the posterior arch, for the passage of the inter-vertebral arteries, lie upon its *anterior* and *under surfaces*, and are occasionally complete foramina.

The superior articular surfaces, by their shape and direction, allow of the *nodding* motion of the head, while the inferior articular surfaces allow of a movement of *rotation* only.

ARTICULAR SURFACES..
- The *Superior set* rest upon
  - (1.) The body.
  - (2.) The pedicles.
  - (3.) The transverse processes.
- They are *large, flat* and *circular*.
- They look *upwards* and *outwards*.
- The *Inferior set* are smaller in size and look *downwards* and *forwards*.

The point of attachment of the check ligaments to the odontoid process of the axis is marked by two *rough impressions*, upon its sides, near to its apex.

The two tubercles, produced by the *bifid* condition of the spinous process of the axis, serve for the attachment of the muscles which *rotate the head* upon the spine.

THE AXIS.

The axis or the second cervical vertebra is so called from its odontoid process which allows of movement of the atlas upon it. It presents the following points of interest:

BODY. This is much *thicker* in *front* than behind.
It is *triangular* in shape.
It is prolongued downwards so as to overlap the third cervical vertebra.

The ODONTOID PROCESS (so called from its resemblance to a tooth.)

This process presents.
- (1.) An *apex*... Gives attachment to the occipito-odontoid ligament, and, laterally, to the check ligaments (lateral occipito-odontoid.)
- (2.) A *body*..... This *articulates* with the *Atlas*, in front. Behind, it lies in relation with the transverse ligament.
- (3.) A *neck*..... This is constricted into a *channel* for the *transverse ligament*.

PEDICLES. These are strong and thick and lie *beneath* the superior articular surface, on either side. They coalesce with the sides of the body and the root of the odontoid.

NOTCHES. The *superior* notches are very shallow and lie *behind* the superior articular surfaces.
The *inferior* notches are very deep and lie in *front* of the inferior articular surfaces.

LAMINÆ. These are very thick and strong in the axis.

SPINAL FORAMEN. This opening is smaller than that of the atlas, but it is still *very large*.

SPINOUS PROCESS. This process of the axis is *bifid, thick*, and *deeply grooved* upon their inferior surface.

TRANSVERSE PROCESSES. These processes of the axis are *small* and *pointed*. The foramen, at their bases, inclines obliquely *upwards* and *outwards*.

THE 7TH CERVICAL VERTEBRA OR VERTEBRA PROMINENS.

The *spinous process* of this vertebra is very *thick*, *long*, and *prominent*, from its horizontal position. It ends in a *single* tubercle for the attachment of ligamentum nuchæ.

The *transverse processes* are large, but slightly grooved, and seldom bifid.

Its *foramen* is small or it may be absent.

1ST DORSAL VERTEBRA.

This vertebra presents a *complete* facet for the head of the 1st rib, and a *demi-facet*, below, for the upper facet of the head of the 2nd rib.

Its articular process is slightly *oblique in its axis*, like the cervical vertebræ.

9TH DORSAL VERTEBRA.

This vertebra has only one *demi-facet* on the upper part of the body.

10TH DORSAL VERTEBRA.

This vertebra has but *one facet* on the *upper portion* of the body, and one on the transverse process.

11TH DORSAL VERTEBRA.

This vertebra has only *one facet*.

The *transverse processes* are short and have *no articular facet* for the rib.

12TH DORSAL VERTEBRA.

This vertebra has but one facet for the rib, which is always *complete*.

No facet for the rib exists on its *transverse process*.

The *inferior articular surfaces* are *convex* and look *forwards* and *outwards*, like the lumbar vertebræ.

5TH LUMBAR VERTEBRA.

The body is *markedly thicker in front* than behind.

The *spinous process* is small.

The *inferior articular processes* are wider apart than the superior.

The *transverse processes* are large, thick and are inclined slightly *upwards*.

STRUCTURE of THE VERTEBRÆ.

The structure of a vertebra differs in the different parts of the bone. The body is composed of light spongy cancellous tissue, having a thin coating of compact tissue on the surface, which is perforated by numerous orifices, some being of large size, for the passage of vessels. In the interior of the body are one or two large canals which converge either to one large aperture or to several smaller apertures upon its posterior surface.

These canals serve for the reception of the veins which convey the blood from the bone.

The arch of each vertebra and the processes projecting from it are covered by a thick layer of compact tissue.

DEVELOPMENT OF THE VERTEBRÆ.

A vertebra, as a rule, originally consists of *three primary cartilaginous portions*, one for each lamina and its subsequent processes, and one for the body. In the sixth week of fœtal life, ossification commences in the laminæ, and two weeks later, in the body.

At 16 *years* of age *three secondary centres* of ossification appear. One of these (occasionally two) is for the spinous process, and one for each transverse process.

At about the 21*st year* of age, *two new secondary centres* of ossification appear in the form of two plates, situated upon the upper and the lower surfaces of the bodies of the vertebræ.

Thus we have *three primary* and *five secondary centres* of ossification in each of the vertebræ, and it is not until the 30th year of life that the entire skeleton of the vertebral column is thoroughly ossified and all the component parts of each vertebra united.

Exceptions to this general rule of development, however, may be found in the axis, atlas, vertebra prominens, and in the lumbar vertebræ.

In the ATLAS, ossification commences, before birth, from *two centres*, located in the lateral masses, and progresses backwards rapidly into the posterior arch, while the anterior arch is entirely cartilaginous at the date of birth. By the 2nd or 3rd year the ossification of the posterior arch is completed, and the anterior arch is either gradually encroached upon or a special centre of ossification appears within it.

In the ATLAS *six centres* of ossification are required, before birth, for its development. Two of these are in the body of the odontoid process, one is for the body of the bone, one for each of the lateral masses, and one for the apex of the odontoid process.

The 7TH CERVICAL or VERTEBRA PROMINENS differs in its process of development from the other vertebræ, in that the *anterior root* of its transverse process is developed as a separate piece from the rest of the bone, thus requiring one additional centre of ossification. In rare instances, this portion continues to develope separately, and becoming lengthened, constitutes the so-called "cervical rib."

The LUMBAR VERTEBRÆ have *two additionl centres* of ossification (besides those peculiar to the vertebræ in general) for the tubercles which project from the back part of the *superior articular* surfaces. In rare cases, the transverse process of the lumbar vertebra may develope as a distinct and separate piece unconnected with the body, thus constituting the so-called "lumbar rib."

VERTEBRAL COLUMN AS A WHOLE.

The spinal column as a whole (including the sacrum and the coccyx), when viewed in front, resembles two pyramids united by their respective bases at a point which corresponds with the junction of the sacrum with the last lumbra vertebra.

The upper pyramid when viewed more closely may be again compared to the union of three smaller pyramids, the *first* having its apex directed upwards and including the *six lower cervical vertebræ*, the *second* including the *first four dorsal vertebræ* and diminishing in size from above downwards, while the *third* extends from the fourth dorsal vertebra to the sacrum and presents a uniform increase in size as you approach the pelvis.

If viewed laterally, the spinal column presents several curves which correspond with certain anatomical regions of the body and which are named the *cervical*, *dorsal*, *lumbar* and *pelvic* curves of the spine.

These curves have their exact boundaries, as follows:

The *cervical* curve (convex anteriorly.)	Origin. From the apex of the odontoid process of the axis. Termination. At the middle of 2d dorsal vertebra.
The *dorsal* curve (concave anteriorly.)	Origin. From the middle of the 2d dorsal vertebra. Termination. At the middle of the 12th dorsal vertebra.
The *lumbar* curve (convex anteriorly.)	Origin. From the middle of the 12th dorsal vertebra. Termination. At the sacro-vertebral angle.
The *pelvic* curve (concave anteriorly.)	Origin. From the sacro-vertebral angle. Termination. At the tip of the coccyx.

It will thus be seen that the spinal column as a whole, if viewed laterally, resembles somewhat in its shape the letter S. These curves are produced partly by the shape of the bodies of the vertebræ and partly by the inter-articular fibro-cartilages inserted between the bodies of each of the vertebræ.

In counting the vertebræ upon the living subject, friction along the spinous processes will render them prominent.

The spines of the third, fourth, and fifth cervical vertebræ cannot easily be felt, since they recede from the perpendicular line, in order to allow of free extension of the neck.

In the *cervical* region the spinal opening is *broad* and *triangular* in its shape.

In the *dorsal* region the spinal opening is *small* and *circular* in its shape.

In the *lumbar* region the spinal opening is *triangular* in shape and intermediate in its size.

Within the cavity of the *sacrum*, the spinal opening is large and triangular above, small and flattened in the middle of the bone, and, below, the posterior wall of the canal is often deficient.

The spinal column, if considered as a whole, often exhibits a slight *lateral* curvature, whose convexity is directed towards the right side of the trunk. This is probably the result, however, of excessive use of the right arm in preference to the left, since an opposite curvature has been occasionally noticed in persons who have habitually used the left hand in preference.

On a *lateral view* of the spinal column we notice, in addition to the curves previously mentioned, the following points:

(1.) The antero-posterior diameters of the *bodies* of the *true vertebræ* increase steadily, from above downwards, till the last lumbar vertebra is reached.

(2.) The *pedicles* of the cervical region are concealed.

(3.) The *intervertebral foramina* increase in size, from above downwards.

(4.) The *intervertebral foramina* change their relation to the transverse processes, since, in the cervical region, they lie *between* the transverse processes, while, in the dorsal and lumbar regions, they lie *in front* of those processes.

(5.) The *transverse processes* change in their relation to the pedicles and the articular processes, as indicated in the table below.

RELATION OF THE TRANSVERSE PROCESS OF THE VERTEBRÆ.

Transverse Process.	*Pedicle.*	*Articular Process.*
In the cervical region.	Outside of	In front of
In the dorsal region.	Behind	Behind
In the lumbar region.	Behind	In front of

(6.) The *transverse processes* of the dorsal region, on account of their inclination backwards, describe a greater curve than the *bodies* of that region.

(7.) The *spinous processes* of the dorsal region, on account of their inclination downwards, describe a lesser curve than do the bodies of the vertebræ of that region.

On viewing the spinal column *posteriorly*, we notice the following points of difference in the cervical, dorsal and lumbar regions:

(1.) The *vertebral groove* is { *Broad* and *shallow* in the cervical region. *Narrow* and *deep* in the dorsal region. *Narrow* and *shallow* in the lumbar region.

(2.) The *laminæ* are not equidistant from each other in all parts of the spinal column, being widest apart in the lumbar region and nearest together in the middle of the dorsal region.

(3.) The width between the tips of the *transverse processes* of the vertebræ also varies greatly. It increases, from above downwards, in the cervical region, diminishes in the dorsal region, and again increases in the lumbar region, till it reaches its maximum at the base of the sacrum.

The *superior articular facets* of the spinal column look *upwards* in the cervical region, *outwards* in the dorsal region, and *inwards* in the lumbar region. It will thus be seen that the cervical vertebræ can be most easily dislocated.

This important point can be easily remembered by writing the three last vowels, I, O. U., and over them the initial letters of the regions of the spine, in their order from *below* upwards, thus indicating the direction of the facet in each region.

L.	D.	C. = *Lumbar.*	*Dorsal.*	*Cervical.*
I.	O.	U. = Inwards.	Outwards.	Upwards.

The length of the *true* spinal column i. e. above the sacrum, is usually *one-third of the height* of a perfectly proportioned man.

Each vertebra has three primary centres of ossification, and five complimentary centres.

The three *primary* centres of ossification are as follows: { For the body......... 1; For the laminæ ..... 2 — 3

The five *complimentary* centres are as follows:......... { For upper surface.... 1; For lower surface..... 1; For trans. processes,.. 2; For spinous process... 1 — 5

Important Anatomical Relations of Special Vertebræ.

The 3rd Cervical Vertebra corresponds to

(1) The superior opening of the larynx.
(2) The bifurcation of the common carotid artery.
(3) The point of origin of the external and internal carotid arteries.
(4) The upper cervical ganglion of the sympathetic system of nerves.

The 5th Cervical Vertebra corresponds to

(1) The lower end of the larynx.
(2) The upper end of the trachea.
(3) The lower end of the pharynx.
(4) The origin of the œsophagus.
(5) The middle cervical ganglion of the sympathetic system of nerves.

The 2nd Lumbar Vertebra corresponds to

(1) The termination of the duodenum.
(2) The commencement of the jejunum.
(3) The lower border of the pancreas.
(4) The upper root of the mesentery.
(5) The origin of the superior mesenteric artery.
(6) The commencement of the thoracic duct.
(7) The opening of the ductus communis choledochus.
(8) The commencement of the vena portæ.
(9) The termination of the spinal cord.
(10) The commencement of the cauda equina.
(11) The crura of the diaphragm

THE THORAX.

The thorax is composed of 37 bones and 24 cartilages. Of these 37 bones 12 have already been considered as the *dorsal vertebræ*, leaving the 24 ribs and the sternum to complete the undescribed bony portion of the thorax.

THE RIBS.

The ribs, twelve in number on each side, are osseous arches, extending from the vertebral column to the sternum. Their posterior four-fifths consists of bone and constitutes the rib, properly so called, while the anterior fifth is cartilaginous, and is called the costal cartilage. The term "rib" is used as a substantive; when we have an adjective we are obliged to resort to the latin name.

The ribs are named in numerical order, from above downwards, without regard to the character of the rib. In this respect the principle of the nomenclature of the ribs differs from that of the vertebral column. The ribs arise from either side of the bodies of the dorsal vertebræ and unite, in front, with the exception of the last two ribs, with the sternum, either directly by its own cartilage or indirectly through the intervention of the common costal cartilages.

The ribs are of three kinds and are named as follows:

1st. *True* Ribs (7 in number), which articulate with the sternum by their *own* cartilages.

2nd. *False* Ribs (3 in number), which have a common cartilage which does not reach the sternum.

3rd. *Floating* Ribs (2 in number), which are movable, at their anterior extremity, in the walls of the abdomen.

The ribs increase in their *length*, from above downwards, from the first to the seventh, when the maximum length is attained. The lower four decrease in length from the eighth to the last.

The *breadth* of the ribs increases steadily from the first to the last, as does also the *width* of the intercostal spaces.

The *obliquity* of the ribs *increases* from the first to the ninth, and *decreases* from the ninth to the twelfth rib.

The ribs are both *curved* and *twisted* upon themselves, this curve being most marked in the vicinity of the posterior angle of the bone.

The *angle* of the ribs is *farther from the head* of the bone, as you descend from above downwards.

The rib is the *most vascular bone*, in proportion to its size, in the human body.

The *vessels of the rib* run near to its *lower border*, and, in tapping the chest, the trochar should be inserted as near to the upper border of the rib as possible in order to avoid hæmorrhage from injury to these vessels.

The spines of the dorsal vertebræ, on account of their obliquity, do not lie on a level with the heads of the ribs which correspond to their bodies, but nearly with the level of the rib next below. This rule, however, does not apply to the eleventh and twelfth vertebræ. This point is of value in judging of the situation of the individual ribs, on the posterior surface of the thorax.

Each rib presents for anatomical examination a shaft and two extremities. The posterior extremity presents a *head*, a *neck* and a *tubercle*.

The following points of interest pertaining to these particular localities will be found embodied in the description given below.

(1.) Posterior Extremity.

Head of Rib.

(1.) This portion of the bone presents *two oblique facets*, which are for the purpose of articulation with the bodies of two adjoining vertebræ.

(2.) A *horizontal ridge* exists between these facets, to which the interarticular ligament is attached.

Neck of Rib.

(1.) The neck is one inch in length and is flattened from before backwards.
(2.) Its anterior surface is smooth.
(3.) Its posterior surface is roughened for the costo-transverse ligments.
(4.) Its upper border has a crest, for the superior costo-transverse ligments.
(5.) Its lower border is rounded and smooth.

Tuberosity of Rib.

(1.) This prominence is most markedly developed upon the upper ribs.
(2.) Its *articular portion* is revealed by a *facet*, into which the extremity of the transverse process of the inferior vertebra, with which the rib is connected, is adapted.
(3.) Its *non-articular* portion is roughened for the attachment of the costo-transverse ligament.

(2.) THE SHAFT.

Exterior Surface.

This is convex in its form and exhibits three points of interest, the posterior and anterior angles, and a posterior rounded portion.

(1.) The *posterior angle* consists of a rough line running downwards, which gives attachment to the following muscles:
The tendons of the sacro-lumbalis.
The accessorius.
The cervicalis ascendens.
(2.) The *anterior angle*, which is similar to the posterior but less strongly marked.
(3.) A rounded portion, which lies between the tubercle and the angle of the rib, for the attachment of the fibres of the longissimus dorsi muscle.

Interior Surface.

This surface is concave in form, and from the twisted condition of the ribs, looks upwards, at the back portion of the thorax, and downwards, in the anterior portion of the chest.

It presents a *ridge*, which is most marked in the posterior two-thirds of the shaft of the rib, and which gives attachment to the internal intercostal muscles. This ridge forms the internal boundary of a *groove* along the lower border of the rib for the protection of the intercostal vessels and nerves.

Upper Border.

This portion of the shaft of the rib is smooth and gives attachment to both the external and internal intercostal muscles.

Lower Border.

This border is thin and sharp and helps to form the groove for the intercostal vessels. It gives attachment to the external intercostal muscles.

(3.) ANTERIOR EXTREMITY.

This portion of the rib is compressed and flattened from before backwards. It is studded with minute foramina for the passage of vessels, and presents for inspection a *deep oval pit* or depression, into which the corresponding costal cartilage is inserted.

PECULIAR RIBS.

The 1st, 2nd, 10th, 11th and 12th ribs present certain peculiarities which enables the accomplished anatomist to readily distinguish them, even if detached from the skeleton. These points of peculiarity will be found enumerated below in detail.

FIRST RIB.

The *upper surface* presents
- (1.) A *rough impression* for the scalenus medius muscle.
- (2.) A *tubercle* for the scalenus anticus muscle.
- (3.) *Two grooves*, the anterior one being for the subclavian vein, and the posterior one for the subclavian artery.

The *under surface* has neither a ridge nor a groove.

The *inner border* presents a part of the *tubercle* for the scalenus anticus muscle.

The *head* has only a *single facet* for articulation with the 1st dorsal vertebra.

The *tuberosity* and the *angle* are blended together.

The *anterior extremity* is unusually *large* and *thick*.

SECOND RIB.

The *outer* or *upper surface* presents
- (1.) *Rough spots* near its middle for the 1st and 2nd serrations of the serratus magnus muscle.
- (2.) A *rough* posterior impression for the scalenus posticus muscle.

The *inner* or *under surface* presents a *short* and *slight* groove.

The *tubercle* and the *angle* are close together.

TENTH RIB.

The *head* of this rib has only a *single* articular facet.

ELEVENTH RIB.

This rib has *no neck*, *no tuberosity* and but a *single* articular facet upon its head.

TWELFTH RIB.

This rib has *no neck*, *no angle*, *no tuberosity*, *no groove*.

Its head has but a *single articular* facet.

COSTAL CARTILAGES.

The *costal cartilages* (from costa—a keeper—because they are the guardians of the organs of the chest) compose about *one-fifth* of the entire circumference of the chest, the ribs, sternum and the vertebræ forming the remaining four-fifths of the circumference. They are 12 in number on each side and are arranged as follows:

The first *seven* connect the corresponding *true* ribs to the sternum.

The next *three* do not connect with the sternum but are joined to the cartilage of the rib next above.

The last *two* are not attached in front.

The costal cartilages *decrease in breadth* from the first to the last as do the spaces between the ribs.

They *increase* in *length* from the first to the seventh costal cartilage and they diminish from the eighth to the twelfth.

The *direction* of the costal cartilages also varies in the different portions of the thorax. The *first* cartilage is directed *obliquely downwards*, the *second* cartilage lies *horizontally*, the *third* is directed *slightly upwards*, the last *two* cartilages follow the *direction of the ribs* to which they are attached, while all the *remaining cartilages* follow the direction of the ribs for a *short distance* and then *ascend* more and more obliquely either to join the sternum or the costal cartilage next above it.

The costal cartilages all *taper towards their sternal end* excepting the first and the second.

The sixth, seventh, eighth and the ninth are *enlarged* at their points of articulation with each other.

The costal cartilages present the following parts of interest:

(1.) *Anterior* surfaces.

These are convex in shape, and looks upwards and forwards.

They give attachment to the following two muscles: the subclavius and the pectoralis major; and also to the *rhomboid* or *costo-clavicular* ligament.

(2.) *Posterior* surfaces.

These are concave in shape and look downwards and backwards.

They give attachment to three muscles: the triangularis sterni, the transversalis abdominis and the diaphragm.)

(3.) *Upper* borders.

These are concave and serve for the purpose of attachment of the intercostal muscles.

The 7th, 8th and 9th cartilages reveal a depression or *facet*, for articulation with the adjoining cartilage.

(4.) *Lower* borders.

These are convex and serve for the purpose of attachment of the intercostal muscles, the internal oblique muscle of the abdomen, and the rectus abdominis.

The 6th, 7th and 8th cartilages present, upon this border, articular *facets* for the other cartilages named above.

(5.) *Costal* extremities.

The costal cartilages are largest where they join the rib. This extremity is rough and rounded and is implanted into and becomes continuous with the anterior extremity, of its corresponding rib.

(6.) *Anterior* or *Sternal* extremities.

This extremity is smaller than that attached to the ribs. It is smooth and triangular in shape and fits into an *articular notch* in the sternum, in the 2nd, 3rd, 4th, 5th, 6th and 7th cartilages. In the 8th, 9th and 10th cartilages this extremity joins with other cartilages. In the 11th and 12 cartilages this extremity is free, while in the 1st costal cartilage it appears as a direct continuation of the sternum itself.

THE STERNUM.

The sternum presents for examination the following parts:

3 separate pieces called { The Manubrium. / The Gladiolus. / The Ensiform or Xiphoid Appendix.

2 Borders.

2 Surfaces.

Originally the sternum consists of six points of ossification. of which the *four middle ones* are joined together before adult life, while the upper and the lower points remain as distinct and separate portions, till age becomes somewhat advanced.

The various portions of the sternum, mentioned above, present the following points of interest.

MANUBRIUM (the handle).

This is the thickest part of the sternum. It forms the upper portion of the bone and is broadest above, and narrowest where it joins the gladiolus. It articulates with the sternal end of the clavicle and the first costal cartilage and unites, in part, with the second costal cartilage.

GLADIOLUS (the sword).

This portion of the sternum is situated in the central portion of the bone. It is long and *blade-like* in shape (from which it derives its name) and is broadest a little below its centre. It unites with the third, fourth, fifth and sixth costal cartilages, and, in part, with the second and with the seventh.

It is sometimes perforated by the *sternal foramen.*

ENSIFORM or XIPHOID APPENDIX (tip of the sword).

This terminal portion of the breast bone may be either broad, pointed, or forked in its shape. It is occasionally perforated and sometimes it is deflected towards one side. It articulates, in part only, with the seventh costal cartilage. It gives attachment to the following structures:

(1) The linea alba.
(2) The anterior abdominal aponeurosis.
(3) The inner fibres of the rectus abdominis muscle.

ANTERIOR SURFACE.

The anterior surface of the sternum varies in its configuration in the three segments forming that bone. In the *manubrium*, it is convex from side to side and concave from above downwards; in the gladiolus it is flat and traversed by three horizontal lines which indicate the location of the original four *segments*, which subsequently united. In the xiphoid appendix, it is occasionally curved.

It gives attachment to the following structures:

(1) The sternal portion of the sterno-mastoid muscle.
(2) The pectoralis major muscle.
(3) The chondro-sternal ligaments.
(4) The chondro-xiphoid ligaments.

POSTERIOR SURFACE.

This surface of the sternum is smoother than the anterior, is slightly concave, and is marked, in the region of the gladiolus, by the same three transverse lines seen upon its anterior surface, but which are much less distinct. It gives attachment to the following structures.

(1) The sterno-hyoid muscle.
(2) The sterno-thyroid muscle.
(3) The triangularis-sterni muscle.
(4) The median fasciculus of the diaphragm.
(5) The posterior chondro-sternal ligaments.

SUPERIOR BORDER.

This portion of the sternum is of extreme thickness. It presents, in its centre, a notch termed the *interclavicular notch*, and, on either side of this notch, two depressions termed the *clavicular facets*. These facets are for the articulation of the clavicle with the sternum.

LATERAL BORDERS.

The lateral borders of the sternum present seven articular notches or depressions for the articulation of the costal cartilages of the ribs. Of these seven depressions, the manubrium has two, one high up and one just at its point of junction with the gladiolus, and the gladiolus has five, the last one being at its point of junction with the ensiform appendix.

MUSCLES.

The sternum or *breast-bone* affords attachment to 9 pairs of muscles and to 1 single muscle, *viz.*, the diaphragm.

These muscles may be thus classified on a basis of the location of their point of attachment to the sterum.

To the *upper portion* of the bone 3 muscles.... ...	STERNO-CLEIDO-MASTOID. STERNO-HYOID. STERNO-THYROID.
To the *lower portion* of the bone { 4 pairs of muscles. 1 single muscle.	RECTUS ABDOMINIS. OBLIQUUS ABDOMINIS EXTERNUS OBLIQUUS ABDOMINIS INTERNUS TRANSVERSALIS ABDOMINIS. The DIAPHRAGM (single).
To the *anterior surface* of the bone 1 muscle.......	PECTORALIS MAJOR.
To the *posterior surface* of the bone 1 muscle......	TRIANGULARIS STERNI.

ARTICULATION.

The sternum articulates with the two clavicles, and with the cartilages of the seven true ribs and the common cartilage of the three false ribs.

DEVELOPMENT.

The sternum is developed by *six centres* of ossification, the situation of which is shown in the following table;

The STERNUM is developed by six centres of ossification, as follows:	For the *manubrium*	one centre.
	For the *gladiolus*	four centres.
	For the *ensiform appendix*	one centre.

Two small *additional centres*, called the episternal centres, are described by some authors as existing upon either side of the interclavicular notch.

THE THORAX IN GENERAL.

The thorax is conical in its shape, with convex walls and with an axis which is directed obliquely downwards and forwards. It is broadest below and in its transverse measurement. It is bounded by the dorsal vertebræ, the ribs, the costal cartilages and the sternum. It presents for examination,

An upper opening or apex,
A lower opening or base,
An outer surface,
An internal cavity.

Each of these portions deserve a special consideration, since a special description of the individual bones, still leaves unmentioned many points of practical interest and value.

UPPER OPENING.

The thoracic entrance is *narrow*, *heart-shaped*, and is inclined obliquely downwards and forwards.

It is bounded, behind, by the first dorsal vertebra, laterally, by the first rib and its costal cartilage, and, in front, by the first bone of the sternum. It gives passage to the following structures:

(1) The trachea.
(2) The œsophagus.
(3) The large vessels of the neck.
(4) The pneumogastric nerves.
(5) The phrenic nerves.
(6) The sympathetic nerves.
(7) The apex of the lung during inspiration.
(8) The thoracic duct.

LOWER OPENING.

This opening of the thorax is widest, in its transverse diameter, opposite the level of the ensiform appendix. Its anterior diameter is encroached upon, by the prominence of the body of the last dorsal vertebra. It is filled in below by the diaphragm, which thus separates the cavity of the thorax from the cavity of the abdomen.

It is bounded behind by the twelfth dorsal vertebra, laterally by the lower two ribs, by the anterior portions of the false ribs and by the common costal cartilage, which unites the false ribs to the sternum, and, in front, by the ensiform appendix of the sternum.

Outer Surface.

The exterior aspect of the chest measures, in front, about 8[1] inches in depth, while, in its posterior portion, the depth of the chest is about 12 inches, and, if the sides be measured along the convexity of the ribs, the lateral depth of the thorax is about 12 inches.

The posterior aspect of the thorax is depressed in the median line, and marked by the *prominences of the spines* of the vertebræ, by the two *vertebral grooves* on either side of the spines, by the *transverse processes* of the dorsal vertebræ and by the *articulations* between the *ribs* and the *transverse processes*. Away from the median line the posterior wall of the thorax becomes convex from the outward curve taken by the ribs after they leave their relations with the dorsal vertebræ.

Cavity.

The cavity of the thorax is partly divided, in the median line, by the prominence of the bodies of the dorsal vertebræ, on each side of which the cavity of the chest is prolonged backwards into two deep grooves or channels. The *transverse diameter* of the interior of the chest is greater than is its *antero-posterior* measurement. The cavity of the thorax contains the following structures:

(1) The trachea, bronchial tubes and lungs.
(2) The heart and pericardium.
(3) The arch of the aorta,
(4) The thoracic aorta and its branches.
(5) The pulmonary artery,
(6) The internal mammary artery.
(7) The superior and inferior venæ cavæ.
(8) The pulmonary veins.
(9) The innominate veins.
(10) The azygos veins.
(11) The bronchial veins.
(12) The œsophagus.
(13) The thoracic duct.

(14) The pneumogastric nerves.
(15) The phrenic nerves.
(16) The splanchnic nerves.
(17) Lymphatic vessels and glands.

These parts will be found described under the respective heads to which they properly belong.

The *thorax* of the *female* differs from that of the male in the following respects:

1. It has a smaller general capacity than the male thorax.
2. The sternum is shorter.
3. The superior opening is larger in proportion to the lower.
4. The upper ribs are more movable.

This latter peculiarity is explained as a device of nature to afford easy respiration during the period of pregnancy.

In fleshy persons, it is often difficult to count the ribs, and, as it is often necessary to *definitely locate certain points* upon the external surface of the chest, the following guides may prove of value;

1. The *nipple of the male* usually corresponds to the interval between the fourth and fifth ribs and is situated about three-quarters of an inch external to their cartilages.

2. The *scapula* extends to the space between the seventh and the eighth ribs.

3. The *lower border* of the *pectoralis major* muscle is nearly parallel with the fifth rib.

4. A line drawn around the chest on the level of the nipple intersects the *sixth rib* at the point midway between the sternum and the spinal column. As this is the seat of election in tapping the chest, this guide has a practical value.

5. As the ribs incline downwards from their point of attachment to the transverse processes of the dorsal vertebræ, it is to be remembered that the *level of a rib on the anterior aspect* of the chest does *not correspond to the level of the same dorsal vertebra*, and a guide may be afforded in estimating the approximate relation of any given point by remembering that the tip of the sternum is nearly on a level with the 10th dorsal vertebra.

6. The junction of the *first* and the *second bones* of the sternum corresponds to the anterior extremity of the 2nd rib, and this point can usually be detected by a transverse ridge upon the sternum.

THE PELVIS.

The remaining four bones, pertaining to the trunk, which have not yet been considered, are those which enter into the formation of the pelvis.

The pelvic bones may be divided in two mesial and one pair, as follows:

Mesial	(2)	Sacrum. Coccyx.
One pair..	(2)	Ossa Innominata.
Total,	4	

Each of these bones have points of great practical interest. They will be considered in the order of their enumeration.

SACRUM.

The sacrum or rump bone consists of five vertebræ blended together into one bone. In some cases the bones entering into the sacrum may be increased to six, and occasionally they may be diminished to four.

The shape of the sacrum is that of a quadrangular pyramid with a truncated apex, which looks downwards, while the base is directed upwards. It is situated within the pelvis at its posterior portion, and in the line of direct continuation of the vertebral column. In the female sex, it is broader, less curved and more obliquely situated within the pelvis. The sacrum forms by its junction with the last lumbar vertebra, a projection into the cavity of the pelvis termed the *promontory of the sacrum.*

This bone presents for examination the following portions:

An anterior surface.
A posterior surface.
Two lateral surfaces.
A base.
An apex.
A canal.

Anterior Surface.

This portion of the sacrum is concave both from above downwards and also from side to side. It is traversed by four *transverse ridges*, which indicate the union of the five different pieces of which the bone was composed, and, at the ends of these ridges, are seen the *four anterior sacral foramina*, through which escape the terminal filaments of the cauda equina, to form the sacral plexus of nerves. Four broad shallow *grooves* are also present upon each side of this surface of the sacrum, into which the fibres of the pyriformis muscle are inserted, and three prominent *ridges* divide and separate these grooves, which also give attachment to slips of the same muscle. That part of the bone, where these ridges and grooves are present, is called the *lateral mass* of the sacrum, and results from the blending together of the anterior portion of the transverse processes and the bodies of the five pieces of the sacrum.

POSTERIOR SURFACE.

This surface of the sacrum is narrow, convex and uneven. In the median line, as the surface of the bone is examined, there is perceived, (1) Three or four *tubercles*, which represent the spinous processes of the blended vertebræ. (2) A *longitudinal groove*, on each side of the tubercles, which correspond to the articular processes of the vertebræ. (3) A series of indistinct tubercles, the lower two of which are blended together and form the *sacral cornua*, or horns of the sacrum, which articulate with similar *cornua* upon the coccyx. (4) Four *posterior sacral foramina*, which are smaller than those upon the anterior surface, and which transmit the posterior branches of the sacral nerves. The posterior sacral foramina are *directly opposed to the anterior*, and hence it is possible for a pointed instrument to pass through both and wound the pelvic viscera. (5) A series of eminences, often called the *posterior transverse processes* of the sacrum, and which correspond to similar eminences upon the anterior surface.

The space contained between these latter named eminences and those tubercles in the median line is called the *sacral groove*, which is continuous, above, with the vertebral groove, and which gives origin to the erector spinæ muscle.

LATERAL SURFACES.

The lateral surface of the sacrum is broad, above, and gradually becomes narrower and narrower, as the lower extremity of the bone is approached. The upper portion is termed the *auricular surface*, from its resemblance to the auricle or pinna of the ear. This portion is covered with cartilage, and serves the purpose of articulation with the ilium.

Posterior to the auricular surface, are several *deep* and *rough depressions* for the insertion of the posterior sacro-iliac ligaments. As the lateral surface becomes narrowed, a *thin border* is perceived, which affords attachment for the sacro-sciatic ligaments and for a few fibres of the gluteus maximus muscle, and which terminates in the *inferior lateral angle* of the sacrum. Below this angle is perceived a *deep notch*, which is occasionally transformed into a foramen by the articulation of the transverse process of the coccyx with the sacrum. This foramen gives passage to the 5th sacral nerve.

Base of Sacrum.

This portion of the sacrum has the appearance of a lumbar vertebra. Thus the body, pedicles, laminæ, spinous and transverse processes, etc., belonging to the 1st sacral vertebra may be discerned. The spinal foramen is large and triangular, the articular processes are similar to those of the lumbar vertebræ, but more widely expanded, while the body is prominent and forms a part of the sacro-vertebral angle.

Apex of Sacrum.

The apex of the sacrum curves downwards and forwards, and presents a small oval surface, articulating with the first bone of the coccyx.

Sacral Canal.

The sacral canal is large and triangular in shape, at the upper portion of the bone, but it becomes small in size and flattened, at the lower portion. In this latter situation the posterior wall is incomplete, from the non development of the laminæ and the spinous processes, hence the *serious effects* of injuries to this part. Sloughs from bed-sores, in this region sometimes open into the spinal canal.

Into it open, laterally, both the anterior and posterior sacral foramina.

These foramina, as well as the sacral canal, transmit only branches of the cauda equina, since the spinal cord itself extends only to the 2nd lumbar vertebra.

Development of the Sacrum.

The sacrum is developed by 35 centres of ossification, since it consists of 5 vertebræ. These centres are arranged as follows:

The bodies of the 5 vertebræ have each 3 centres.	Total,	15
The arches of each vertebra have 2 centres.	"	10
The lateral masses of the sacrum have each 3 centres.	"	6
The lateral surfaces of the sacrum have each 2 centres.	"	4
	Total,	35

Muscles of the Sacrum.

The sacrum affords attachment to *eight* pairs of muscles, as follows:

The Sacrum affords attachment to 8 muscles, as follows:..................	To its *anterior surface* 1 muscle	Pyriformis.
	To its *base*...........1 muscle	Iliacus.
	To its *side*...........1 muscle	Coccygeus.
	To its *posterior surface* 5 muscles	Latissimus Dorsi.
		Erector Spinæ.
		Multifidus Spinæ.
		Gluteus Maximus.
		Extensor Coccygis.

Articulation.

The sacrum articulates with *two mesial* bones (the 5th lumbar vertebra and the coccyx), and with *one pair* of bones (the ossa innominata), making a total of 4 bones.

THE COCCYX.

The coccyx or huckle bone, so called from its resemblance to a cuckoo's beak, consists of four and sometimes of five bones. which are incomplete and rudimentary vertebræ. These vertebræ are *incomplete*, since they are deficient in pedicles, laminæ, and in spinous processes, as well as in a spinal canal and intervertebral foramina. They are also *rudimentary*, since the transverse and articular process are distinguishable in the first two, while the others are reduced to mere nodules of bone.

The first segment of the coccyx occasionally exists as a separate piece and is by far the largest of the five segments. Its superior articular process is sometimes prolonged into *cornua*, which articulate with the sacrum and help to form a foramen for the 5th sacral nerve.

The gradual diminution in the size of the pieces gives to the coccyx a triangular form, the base of which corresponds to the sacrum.

The borders of the coccyx are narrow and give attachment, upon either side, to the sacro-sciatic ligaments and the coccygeus muscle.

The *apex* of the coccyx is rounded and gives attachment to the tendon of the external sphincter ani muscle. Occasionally the apex of the coccyx is bifid and it may be deflected to one side.

Muscles of the Coccyx.

The coccyx affords attachment to 5 pairs of muscles, which may be thus classified:

The Coccyx affords attachment to 5 muscles, as follows:....	To the *posterior surface*,	2	Gluteus Maximus. Extensor Coccygis.
	To the *anterior surface*,	1	Levator Ani.
	To the *margin* or *side*,	1	Coccygeus.
	To the *apex* or *tip*,	1	Sphincter Ani.

Centres of Ossification.

The coccyx is developed by *four centres* of ossification, one for each piece of the bone.

Articulations.

The coccyx articulates with one bone, *viz.*, the sacrum.

OS INNOMINATUM.

The os innominatum (bone without a name) or *coxal* bone is formed by the union of three distinct bones, each of which has two names, as follows:

(1) The *Ilium* or *Haunch* bone.
(2) " *Ischium* or *Seat* bone.
(3) " *Pubes* or *Share* bone.

It is a large, irregular, flat bone, constricted towards its middle portion and expanded above and below. It is also so twisted upon itself, that its superior expanded portion is directed inwards, at its posterior part, and outwards at its anterior part, while its inferior portion is curved inwards, anteriorly, as far as the median line of the body. The three portions of which it is composed, remain distinct until about the 14th year of age, when they become united as one bone.

These three portions, the ilium, the ischium and the pubes will be considered therefore separately, after first describing two important portions of the bone which do not properly pertain to either of the three divisions alone. These two important portions are, (1) The *acetabulum* or *cotyloid cavity*, and (2) The *obturator* or *thyroid foramen*, or *foramen ovale.*

ACETABULUM OR COTYLOID CAVITY.

This cavity serves the purpose of affording an articular surface for the head of the femur. It is deep, hemispherical in shape and is composed of three parts. Of these three parts, the *ilium* forms a little less than two-fifths, including, however, the largest portion of the articular ring; the *ischium* forms a little more than two-fifths of the whole cavity, including the largest proportion of its central depressed portion; the *pubes* form the balance of the acetabulum or about one-fifth of the whole.

The *direction* of the cavity of the acetabulum is *downwards*, *forwards* and *outwards.*

It is surrounded, for the greater part of its circumference, by a ring or elevated margin of bone for the attachment of the cotyloid ligament, which deepens the cavity. This ring is deficient, however, in front and below, and is most extensively developed at its posterior portion.

The *cotyloid notch* is an opening, in margin of the acetabulum, leading into its central depressed portion, which transmits the nutrient vessels to the joint and which is continuous with the central depressed portion.

The margins of this notch give attachment to the *round* and the *transverse* ligaments of the hip joint.

The *central depression* of the acetabulum lodges a mass of fat as a bed for the round ligament of the hip joint. It is nearly circular in shape, is rough upon its surface, and is continuous with the cotyloid notch. It is formed chiefly by the *ischium.*

OBTURATOR OR THYROID FORAMEN.

This foramen is comprised between the pubes and the ischium. It is large and oval in the male sex, and *smaller* and *triangular* in the female.

It is closed by a membrane, called the obturator membrane, except at its upper part, where this membrane converts a groove, situated upon the under surface of the horizontal ramus of the pubes, into a *complete foramen* for the passage of the obturator vessels and nerves.

THE ILIUM.

The ilium is the superior expanded portion of the os innominatum. Its chief points of special anatomical interest can best be presented by a separate description of the following portions of the bone.

(1) The *outer surface*, or *dorsum.*
(2) The *inner surface.*
(3) The *upper border*, or *crest.*
(4) The *anterior border.*
(5) The *posterior border.*

Outer Surface or Dorsum.

This portion of the ilium is *convex* in front, where it looks downwards and outwards, while, behind, it is *concave* and looks downwards, outwards and backwards.

It presents for examination the following points of interest :........................	(1) Three curved lines. (2) Three surfaces for muscular attachment. (3) A section of the acetabulum. (4) A groove for the reflected tendon of the rectus femoris.

The three curved lines, mentioned above, are termed respectively the *superior*, the *middle*, and the *inferior curved lines* of the dorsum ilii. They commence at different points upon this surface of the bone and all terminate in the vicinity of the great sciatic notch.

The *superior* curved line arises about two inches in front of the posterior extremity of the crest, the *middle* curved line arises one inch and a half behind the anterior extremity of the crest, and the *inferior* curved line arises at the anterior inferior spinous process of the ilium.

The *three surfaces* for the attachment of muscles lie above and between the three curved lines of the dorsum ilii. From them arise the gluteus maxinus, the gluteus medius and the gluteus minimus muscles.

The dorsum of the ilium presents also, (1) a *triangular segment* of the acetabulum (comprising about $\frac{2}{5}$ of the whole cavity), (2) the upper portion of the rim of the acetabulum, and (3) a groove (sometimes a ridge) from which arises the reflected tendon of the rectus muscle.

Inner Surface.

This surface of the ilium presents the following parts:

(1) The *internal fossa* or *venter* of *the ilium*.

This is bounded below by the linea ileo-pectinea and presents, at its inferior part, a nutrient foramen.

(2) The *sacro-iliac surface*.

This portion of the bone is for *articulation* with the sacrum. It is covered with cartilage, and gives attachment to the posterior sacro-iliac ligaments.

(3) A portion of the *inner surface* of the *true pelvis*.

This portion of the ilium corresponds to the segment of the acetabulum previously described.

Upper Border or Crest.

This portion of the ilium is convex from before backwards, is curved into a segment of a circle, and, at its posterior portion, is concave from side to side, and, in its anterior portion, it is convex from side to side. It is thickest behind and in front, and thinnest at the sides of the ilium. It is divided into three lips, an *outer* lip, an interspace called the interstice or *middle* lip, and an *inner* lip.

To the *outer* lip are attached three muscles, *viz.*, the latissimus dorsi, the obliquus abdominis externus, the tensor vaginæ femoris, and the fascia lata of the thigh.

To the *inner* lip are attached three muscles, *viz.*, the transversalis abdominis, the quadratus lumborum, and the erector spinæ.

To the *middle* lip is attached the obliquus abdominis internus.

Anterior Border.

This portion of the ilium is long, concave in form and nearly vertical in direction. It presents, as the border is examined from above downwards, the following points:

(1) The *anterior superior spinous process.*

This portion of the ilium gives attachment to three muscles and one ligament. The muscles are the sartorius, the iliacus, and the tensor vaginæ femoris. The ligament is called *Poupart's ligament.*

(2) A *notch*, for the lower fibres of the sartorius muscle and for the external cutaneous nerve.

(3) The *anterior inferior spinous process.*

This gives attachment to the straight tendon of the rectus muscle.

(4) A *broad, shallow groove*, for the passage of the psoas magnus and the iliacus muscles, from the cavity of the pelvis.

POSTERIOR BORDER.

This portion of the ilium is shorter and more horizontal than the anterior border. It presents for examination the following points:

(1) The *posterior superior spinous process*, for the erector spinæ muscle and for the oblique sacro-iliac ligament.

(2) The *posterior inferior spinous process*, for part of the great sacro-sciatic ligament.

(3) The upper border of the *great sacro-sciatic notch.*

THE ISCHIUM.

The ischium is the lower, posterior and thickest portion of the os innominatum. It bounds the obturator foramen behind and in its lower portion, and presents for examination the following component parts:

(1) The *body* of the ischium.
(2) " *tuberosity* of the ischium.
(3) " *ascending ramus* of the ischium

BODY OF ISCHIUM.

This portion of the bone possesses three surfaces; called respectively the *exterior*, *interior* and *posterior surfaces*, and three borders called the *anterior*, the *outer* and the *inner borders.*

The *exterior surface* embraces a little more than two-fifths of the acetabulum, including the lower part of its rim, a portion of the colytoid notch, and the greater portion of its central depression. It also exhibits a deep *groove* along its length, for the passage of the tendon of the obturator externus muscle, and it assists in forming the *posterior part* of *the circumference* of the obturator foramen, from which portion arise the obturator externus and the adductor magnus muscles.

The *interior surface* forms the lower part of the lateral boundary of the true pelvis and the posterior portion of the circumference of the obturator foramen. It gives attachment to the obturator internus muscle and presents for examination two or three large *foramina* for vessels, and a *groove* for the passage of the pudic vessels and the pudic nerve.

The *posterior surface* is quadrilateral in shape, is smooth upon its surface and is broader above than below. It gives attachment to four muscles, *viz.*, the pyriformis, obturator internus and the two gemelli.

The *anterior border* of the ischium is very thin and affords attachment for the obturator membrane.

The *outer border* is thick and short.

The *inner border* is long, and exhibits the following points of interest:

(1) The lower portion of the *great sacro-sciatic notch.*

(2) The *spine* of the ischium.

(3) The *lesser sacro-sciatic notch.*

The greater and lesser sacro-sciatic notches are converted into complete foramina by the sacro-sciatic ligaments and give passage to important structures, as follows:

The *great sacro-sciatic notch* transmits	(1) The Gluteal vessels. (2) The Superior gluteal nerve. (3) The Pyriformis muscle. (4) The Pudic vessels and nerve. (5) The Sciatic vessels and nerves. (6) The nerve to the Obturator internus muscle.
The *lesser sacro-sciatic notch* transmits	(1) The Obturator internus muscle. (2) The Pudic vessels (re-entering). (3) The Pudic nerve (re-entering).

The *spine* of the ischium affords attachment to, (1) the lesser sacro-sciatic ligament, (2) to the following three muscles, *viz.*, the gemellus superior, coccygeus and the posterior fibres of the levator ani.

Tuberosity of the Ischium.

This prominent portion of bone is situated upon the lower and back part of the body of the ischium. It presents for consideration, (1) an outer lip, (2) an inner lip, and (3) four roughened spaces between the two lips.

The *outer lip* affords attachment to three muscles, *viz.*, the gemellus inferior, the quadratus femoris and the adductor magnus.

The *inner lip* affords attachment to two muscles, *viz.*, the transversus perinei and the erector penis or clitoridis, and also to the crus penis or clitoridis and to the falciform expansion of the great sacro-sciatic ligament.

The *four rough spaces*, between the two lips, give attachment to the adductor magnus, the semimembranosus, the common tendon of the semitendinosus and the biceps, and to the great sacro-sciatic ligament. They are denominated the two *superior* and the two *inferior* spaces.

Ascending Ramus of the Ischium.

This portion of the bone is thin and flattened. Its direction is upwards and it bounds the obturator foramen inferiorly. It joins with the descending ramus of the pubes and presents for examination, (1) an outer surface, (2) an inner surface, (3) an upper border, and (4) a lower border.

The *outer surface* is rough and gives attachment to three muscles, *viz.*, the gracilis, the obturator externus and the adductor magnus.

The *inner surface* is smoother than the outer and affords attachment for the obturator internus muscle.

The *upper border* is thin and sharp and serves as a point of attachment for the obturator membrane.

The *lower border* is rough and thick and gives attachment to three muscles (the gracilis, the erector penis or clitoridis and transversus perinei) and also to the crus penis or clitoridis, the deep perineal fascia and the deep layer of the superficial perineal fascia.

THE PUBES.

This bone forms the *anterior* and *inner portion* of the os innominatum. It bounds the obturator foramen above and in front and may be subdivided for convenience of description into

(1) A body.
(2) A horizontal ramus.
(3) A descending ramus.

The body of the Pubes.

This portion of the bone is quadrilateral in its shape and is flattened, from before backwards and outwards. It presents for consideration the following portions: (1) An anterior surface, (2) a posterior surface, (3) an upper border, (4) an inner border, and (5) an outer border.

The *anterior surface* is rough and slightly excavated. It gives attachment, from above downwards, to five muscles, as follows: The adductor longus, the obturator externus, the adductor brevis, the abductor magnus, and the upper portion of the gracilis.

The *posterior surface* is smooth and concave from side to side. It gives attachment to two muscles, *viz.:* the obturator internus, and the levator ani, and it also affords insertion for the pubo-prostatic ligaments, and for the anterior true ligaments of the bladder.

The *upper border* of the body of the pubes presents four points of especial interest and value. These are the *angle*, the *crest*, and the *spine* of the pubes, and the commencement of the *ilio-pectineal line.*

The *angle* of the pubes corresponds to the points of decussation of the internal pillars of the external abdominal rings.

The *crest* of the pubes affords attachment, posteriorly, to the conjoined tendon of the external oblique and transversalis muscles, and, anteriorly, to the rectus abdominis and pyramidalis muscles.

The *spine* of the pubes affords attachment to Poupart's ligament and the external pillar of the abdominal ring.

The *linea ilio-pectinea* affords attachment for the conjoined tendon, Gimbernat's ligament and triangular ligament.

The *inner border* of the body of the pubes presents a rough oval facet, which forms a part of the symphysis pubis.

The *outer border* of the body of the pubes is thin and affords attachment to the obturator membrane.

Horizontal Ramus.

The portion of the pubes designated by this name helps to form the brim of the true pelvis. It presents for examination three surfaces and one extremity.

The *upper surface* gives attachment to the pectineus muscle, and presents a continuation of the pectineal line and an eminence called the *pectineal eminence*, to which the psoas parvus is attached.

The *under surface* presents a groove for the obturator vessels and nerve and a sharp margin, which forms a portion of the circumference of the obturator foramen.

The *posterior surface* forms a part of the anterior boundary of the true pelvis. It affords attachment to some of the fibres of the obturator internus muscle.

The *outer extremity* of the horizontal ramus of the pubes forms the pubic portion of the acetabulum, or about one-fifth of the whole cavity.

Descending Ramus.

This portion of the pubic bone is thin and flattened. It is directed downwards and outwards and joins with the ascending ramus of the ischium. It presents for examination two surfaces, an anterior and posterior, and two borders, an inner and an outer.

The *anterior surface* is roughened and affords attachment to four muscles, *viz.:* the adductor brevis, the adductor magnus, the obturator externus, and the gracilis.

The *posterior surface* is smoother than the anterior and affords attachment to the obturator internus muscle.

The *inner border* is rough, thick and everted, especially in the female pelvis. It affords attachment to two muscles, the compressor urethræ and the erector penis or clitoridis, and also to the crus penis or clitoridis and to the deep perineal fascia and the deep layer of the superficial perineal fascia.

Its *outer border* is thin and sharp and affords attachment to the obturator membrane.

Muscles attached to the Os Innominatum.

The 36 muscles attached to the os innominatum may be classified into four sets, as follows:

(1) The ASCENDING set, comprising 10 muscles. Of these, 5 form the *anterior* wall of the abdomen, and 5 form the *posterior* wall of the abdomen.

(2) The DESCENDING set, comprising 15 muscles. Of these, 9 are inserted into the *femur*, and produce shortening of the thigh in case of fracture of that bone, and 6 are inserted into the *bones of the leg.*

(3) The INTERNAL set, comprising 5 muscles. These muscles all pass *towards the median line* of the body and form the *muscles of the perineum* and the *floor of the pelvis.*

(4) The EXTERNAL set, comprising 6 muscles. These muscles all pass directly *outwards* from the os innominatum.

The special muscles included under these various groups are shown in the following table:

The Ascending Set (10 muscles.)	Anterior set (5 muscles).	Rectus abdominis.
		Pyramidalis.
		Obliquus abdominis externus.
		Obliquus abdominis internus.
		Transversalis abdominis.
	Posterior set (5 muscles).	Latissimus dorsi.
		Erector spinæ.
		Quadratus lumborum.
		Multifidus Spinæ.
		Psoas parvus.

- The Descending Set. (15 muscles.)
  - Attached to the femur. (9 muscles.)
    - To *external* aspect (4)
      - Tensor vaginæ femoris.
      - Gluteus maximus.
      - Gluteus medius.
      - Gluteus minimus.
    - To *internal* aspect (5)
      - Iliacus.
      - Pectineus.
      - Adductor longus.
      - Adductor brevis.
      - Adductor magnus.
  - Attached to the bones of the leg. (6 muscles.)
    - To *anterior* aspect (3)
      - Sartorius,
      - Rectus femoris.
      - Gracilis.
    - To *posterior* aspect (ham string muscles.) (3)
      - Biceps flexor cruris.
      - Semitendinosus.
      - Semi membranosus.
- The internal set (5 muscles) ....
  - Compressor urethræ.
  - Erector penis.
  - Transversus perinei.
  - Levator ani. } forming floor of pelvis.
  - Coccygeus. } forming floor of pelvis.
- The external set (6 muscles) ....
  - Pyriformis.
  - Gemellus superior.
  - Obturator internus.
  - Gemellus inferior.
  - Obturator externus.
  - Quadratus femoris.

This arrangement of the muscles attached to the os innominatum, while it enables the student to recollect their names, serves also other purposes.

I. Thus, the *anterior group* of the *ascending set*, arising from the upper and anterior borders of the os innominatum, are the identical muscles that form the *antero-lateral wall* of the abdomen, and, with one exception, constitutes the group of muscles connected with the ensiform cartilage of the sternum.

II. The *descending set* are the muscles that produce *shortening* of the limb when the neck of the femur is fractured.

III. The *external set* are those that produce *eversion of the foot*, in the same accident.

IV. The *internal set* are not only the muscles that form the floor of the pelvis, but are also those which guide the surgeon in operations on the perineum.

V. The *descending* and *external* set, if taken together are the muscles which affect the movements of the lower extremity on the pelvis.

VI. By means of these two sets, we can deduce how many muscles must be divided in *amputation at the hip joint*. It is evident that the descending and external sets, as thus arranged, with the exception of one muscle, are the only ones that are divided; so that all we have to do is to add the descending set (15) to the external set (6), and we get 21 muscles, By adding the psoas magnus, which does not arise from the os innominatum, we obtain 22, the number divided in this amputation.

THE PELVIS IN GENERAL.

The pelvis is usually divided for convenience of description into the *false* and the *true* pelvis and includes a bony canal which is formed by the four bones previously mentioned.

The FALSE PELVIS comprises that superior *expanded* portion of the ring which corresponds to the iliac fossæ. Its walls are deficient, in front, between the anterior borders of the ilia and the horizontal rami of the pubes, and deficient also, behind, between the posterior superior iliac spines and the sacrum.

The TRUE PELVIS comprised the inferior or *constricted* portion of the ring and presents for examination,

(1) A *brim* or *inlet*.
(2) A *cavity*.
(3) A *lower opening* or *outlet*.

The BRIM or the superior circumference of the true pelvis is *heart-shaped*. It is bounded, *in front*, by the crest and the spine of the pubes, *behind*, by the anterior border of the base of the sacrum and by the sacro-vertebral angle, and, *laterally*, by the ilio-pectineal line. The plane of this opening looks upwards and forwards. Its axis is represented by a line drawn from the umbilicus to the middle bone of the coccyx, and, in an erect posture of the body, this axis forms an angle of from 60° to 65° with the horizontal plane, since the base of the sacrum lies about $3\frac{3}{4}$ inches above the upper border of the symphysis pubis. The diameters of this opening vary in the male and female pelvis, the male pelvis being the smaller by about one-half an inch in each of the diameters usually recorded.

The CAVITY of the true pelvis consists of a short curved canal which connects the superior and inferior openings. It is shallow in front, and here measures from $1\frac{1}{2}$ to 2 inches in height. At its middle portion, it is the broadest, and, at its posterior portion, it is very deep, since it runs along the concavity of the sacrum and of the coccyx, and here measures from $4\frac{1}{2}$ to $5\frac{1}{2}$ inches, in the male sex. The *antero-posterior*, *lateral* and *oblique* diameters of the cavity of the true pelvis of the male are the same, and average about $4\frac{1}{2}$ inches in length.

The lower circumference or OUTLET of the true pelvis is bounded, *above*, by the public arch, *behind*, by the tip of the coccyx, and, *laterally*, by the tuberosities of the ischia. The lateral walls of the outlet are furthermore formed by the sacro-sciatic ligaments. The plane of this outlet corresponds to an axis drawn from a point, midway between the tuberosities of the ischia, to the middle of the base of the sacrum. The coccy-pubic (antero-posterior) diameter in the male sex is usually about $3\frac{1}{4}$ inches, while the bi-ischiatic (transverse) diameter is usually about $3\frac{1}{2}$ inches.

Differences in Sexes.

The bones of the pelvis differ, in their appearance and character, in the two sexes. Thus, in the female sex, the pelvic bones are much lighter and more slender than in the male, the muscular impressions are less distinct, the ilia are more expanded, the pelvis is broader from side to side, and the iliac spines are more widely separated.

The *inlet* of the pelvis in the female is much larger than in the male and is more nearly circular, since the sacro-vertebral angle is much less prominent.

The *cavity* is more shallow and more capacious than in the male, and the spines of the ischium do not project so far into the pelvis.

The *outlet* is more expanded and more dilatable, since the coccyx is anchylosed at a much later date. The pubic arch has a wider space, its edges are more everted and the tuberosities of the ischia are more widely separated.

Points of Surgical value.

The *anterior superior spine* of the ilium is employed as a fixed point from which measurements of the lower extremity are taken, and it is also of value in determining the relative angle of the pelvis to the median line of the trunk, which is often a point of great diagnostic value. Pressure upon the two spines is often employed to detect the existence of fracture of the pelvic bone or of sacro-iliac disease.

The *spine of the pubes* is a valuable guide in the diagnosis between the *inguinal* and *femoral varieties of hernia*, and, since it lies directly over the external abdominal ring, it serves also as an anatomical guide to that opening. This bony prominence also lies on a line with the *upper border* of the *trochanter major* of the femur, in the erect attitude.

BONES OF THE UPPER EXTREMITY.

BONES OF THE UPPER EXTREMITY.

The upper extremity is a jointed appendage, which is connected to the trunk, at its upper portion, while, below that point, it is free for the rest of its extent. It is divided into four parts, *viz.*, the shoulder, the arm, the forearm, and the hand.

In the following table are enumerated the bones which assist to form each of these various portions.

The Bones of each of the Upper Extremities are *thirty-two* in number, and are situated as follows:	Forming the *shoulder*	(2)	Scapula.		
			Clavicle.		
	Forming the *arm*	(1)	Humerus.		
	Forming the *forearm*	(2)	Radius.		
			Ulna.		
	Forming the *hand*	(27)	Carpus	(8)	Scaphoid.
					Semilunar.
					Cuneiform.
					Pisiform.
					Trapezium.
					Trapezoid.
					Os Magnum.
					Unciform.
			Metacarpal bones,		(5).
			Phalanges,		(14).
	Total,	32			

THE SCAPULA.

This bone is large in its size and flat and triangular in form. It is situated at the back of the shoulder, being often called the *shoulder blade*, and extends from the 2nd to the 7th rib. It presents for special description two surfaces, three borders and three angles.

Anterior Surface.

The *anterior surface* or *venter* of the scapula looks towards the ribs, is concave and forms the so-called subscapular fossa. This fossa is deepest at its upper and outer part, where the subscapular angle exists, and presents, from within outwards, the following points:

1. A *narrow marginal surface*, which extends from the superior to the inferior angles of the bone and which affords attachment to the serratus magnus muscle.
2. *Roughened oblique ridges*, which converge at the upper and outer portion of the bone. These ridges afford attachment for the subscapularis muscle.
3. A *prominent ridge*, which is rounded and which descends from the neck of the bone, parallel to its anterior border.

4. A *deep vertical groove*, which affords attachment for the lower portion of the subscapularis muscle.

POSTERIOR SURFACE.

The *posterior surface* or *dorsum*, of the scapula is divided by a bony ridge, called the *spine* of the scapula, into two unequal portions. The upper one is called the supra-spinous fossa, and the lower one the infra-spinous fossa.

The posterior surface of the scapula is alternately concave and convex, being, from side to side, thrown into alternate ridges and depressions.

The *supra-spinous fossa* is the smaller of the two. It is smooth, broadest at its internal portion, and affords attachment to the supra-spinatus muscle.

The *infra-spinous fossa* is convex at its centre, and concave upon either side of its central portion. It presents the following points for examination, in addition to two processes, *viz.*, the spinous and the acromion.

1. *Internal oblique ridges*, for the attachment of the infra-spinatus muscle.
2. A *rough apponeurotic ridge*, running parallel with the external border of the scapula, which separates the fossa of the infra-spinatus muscle from the free edge of the bone.
3. A *marginal space*, external to the ridge above mentioned. This space affords attachment, from above downwards, to the teres minor and teres major muscles, and occasionally to a few fibres of the latissimus dorsi muscle.

The SPINOUS PROCESS of the scapula is a prominent triangular-shaped process, which crosses the dorsum of the scapula obliquely, near the line of junction of the upper and the three lower fourths, and which is continuous, at its outer extremity, with the acromion process. It presents two surfaces and three borders for examination.

The *surfaces*, are called the upper and lower surfaces of the spine. They are both concave and enter into the construction, respectively, of the supra-spinous and the infra-spinous fossæ. They afford attachment to the supra-spinatus and infra-spinatus muscles.

The *borders* are called the anterior, posterior, and external borders.

The *anterior border* is continuous with the body of the scapula.

The *posterior border* is broad and thick, and affords attachment to the trapezius muscle, by a ridge of bone termed its upper lip, and, by a similar ridge termed its lower lip, the deltoid muscle takes its origin.

The *external border* is concave in form and is lost, above, upon the acromion process, and below, upon the neck of the scapula.

The ACROMION PROCESS, of the scapula projects over the glenoid cavity of that bone, and forms the tip or prominence of the shoulder. It is flattened and somewhat triangular in shape and presents for examination two surfaces, two borders and an apex.

The *superior surface* of this process is subcutaneous and roughened for the attachment of a few fibres of the deltoid and the trapezius muscles.

The *inferior surface*, is concave, smooth, and lies in close relation to the capsule of the shoulder joint, a bursa being usually interposed.

The *outer border* affords attachment to the deltoid muscles.

The *inner border* affords attachment for the deltoid and trapezius muscles, and also present an oval facet for the articulation of the outer extremity of the clavicle.

The *apex* affords attachment for the coraco-acromial ligament.

BORDERS.

The *borders* of the scapula are three in number and are called respectively, the superior or cervical border, the external or axillary border, and the internal or vertebral border. To the latter border, the term *base* of the scapula is often applied.

The *superior border* is short and very thin. It presents the supra-scapular notch, which is converted into a foramen by a transverse ligament, beneath which ligament the supra-scapular nerve passes. It affords attachment to the omo-hyoid muscle.

The *axillary border* is very thick and affords attachment for the long head of the triceps and a part of the subscapularis muscle.

The *vertebral border* is long, thin, and prominent opposite the root of the spinous process. It affords attachment, by its anterior lip, to the serratus magnus muscle; by its posterior lip, to the supra-spinatus and infra-spinatus muscles; and by the inter space between the two, to the levator anguli scapulæ, the rhomboideus minor and the aponeurosis of the rhomboideus major muscle.

ANGLES.

The *angles* of the scapula are three in number and are called, respectively, the superior, the inferior, and the external angle.

The *superior angle* is thin and prominent and affords attachment for the two first digitations of the serratus magnus muscle, and for a few fibres of the levator anguli scapulæ and the supra-spinatus muscles.

The *inferior angle* is thick and rounded and affords attachment to the serratus magnus and the teres major muscles. It occasionally affords attachment to some of the fibres of the latissimus dorsi muscle.

The *inferior angle* of the scapula corresponds to the level of the seventh dorsal vertebra, and the seventh rib can thus be traced from behind forwards, remembering, however, that the head of the rib will be felt *above* the tip of the spine of the vertebra, which lies obliquely, and therefore not on the same level as the rib.

At the *external angle* of the scapula is situated the glenoid cavity, called the head, separated by a constricted part called the neck of that bone.

The *head* of the scapula forms the *glenoid cavity*, which is oval in shape, with its longest diameter directed vertically. It is shallow, and is deepened and enlarged by the glenoid ligament. It articulates with the head of the humerus, and affords, by its upper part or apex, attachment to the tendon of the long head of the biceps muscle.

The *neck* of the scapula presents a bony projection, called the *coracoid process*, which affords attachment to three muscles, *viz.*, the pectoralis minor, the coraco-brachialis and the short head of the biceps, and also for three ligaments, *viz.*, the conoid, the trapezoid, and the coraco-acromial ligaments.

MUSCLES ATTACHED.

The scapula affords attachment to 16 muscles, which may be classified as follows :

The SCAPULA affords attachment to 16 muscles, as follows:

- To *surfaces*. (5)
  - To dorsal surface..... (4): Supra-spinatus. Infra-spinatus. Teres minor. Teres major.
  - To costal surface. (1): Subscapularis.
- To *processes*. (5)
  - To spinous and acromion............... (2): Trapesius. Deltoid.
  - To coracoid.......... (3): Pectoralis minor. Biceps flexor cubiti. Coraco-brachialis,
- To *borders*.. (5)
  - To superior border... (1): Omo-hyoid,
  - To axillary border.... (1): Triceps extensor cubiti.
  - To vertebral border... (3): Rhomboideus minor. Rhomboideus major. Serratus magnus.
- To the *posterior superior angle*.......... (1): Levator anguli scapulæ.

Total, 16

Articulation.

The scapula articulates with two bones, *viz.*, the humerus and the clavicle.

Development.

The scapula develops by *seven centres* of ossification, as follows:

One for the *body*—which appears at the 8th week of fœtal life.
Two " " *coracoid process*—which appears during the 1st year of age.
Two " " *acromion process*— " " " " 15th and 16th year of age.
One " " *inferior angle*— " " " " 16th " "
One " " *posterior border*— " " " " 17th " "

THE CLAVICLE.

The clavicle (*clavis*, a key) or *collar bone*, is the most elastic bone in the body. It is usually classed as a long bone, although in its structure, it resembles rather a short bone. In shape it is curved like an italic (*ʃ*) and is convex, anteriorly, and rounded, in the inner two-thirds of the bone. In its outer third, it is anteriorly concave, and flattened, from above downwards.

It presents for examination, first, an inner or cylindrical portion, second, an outer or flattened portion, third, an inner or sternal end, and fourth, an outer or acromial end.

Inner or Cylindrical Portion.

This portion of the bone presents for examination the following points: an anterior, a posterior, and a superior border, and an anterior, a posterior, and an inferior surface.

The *anterior border* is continuous with the anterior border of the flattened portion of the bone, and affords attachment to the pectoralis major muscle.

The *posterior border* extends from the rhomboid impression to the conoid tubercle, and forms the posterior boundary of the subclavian groove.

The *superior border* is continuous with the posterior border of the flattened portion of the bone and affords attachment to the sterno-cleido-mastoid muscle.

The *anterior surface* is convex and is continuous with the upper surface of the flattened portion of the bone.

It is covered externally by the platysma muscle, and affords attachment, at its inner portion, to the sterno-cleido-mastoid and pectoralis major muscles.

The *posterior surface* is concave and, at its external portion, is narrowed as it becomes continuous with the posterior border of the flattened portion of the bone. It frequently gives origin, at its inner portion, to some of the fibres of the sterno-cleido-mastoid muscle, and, near its centre, it presents the orifice of the *nutrient canal* of the bone, which is directed outwards.

The *inferior surface* is narrow at its inner portion, but, externally, it is broader and becomes continuous with the under surface of the flattened portion of the bone. It presents, from within outwards, the following points:

I. An *articular facet*, which articulates with the cartilage of the first rib.

II. The *rhomboid impression*, for the rhomboid or coraco-clavicular ligament.

III. The *subclavian groove*, for the subclavius muscle.

Outer or Flattened Portion.

This portion of the clavicle presents for examination an anterior and a posterior border and a superior and an inferior surface.

The *anterior border* is thin, concave, and affords attachment to the deltoid muscle.

The *posterior border* is thick, convex, and affords attachment for the trapezius muscle.

The *superior surface* is roughened for the deltoid and trapezius muscles.

The *inferior surface* presents, at its inner portion, a prominence of bone, called the *conoid tubercle*, for the insertion of the conoid ligament, and an oblique line for the insertion of the trapezoid ligament.

Inner or Sternal End.

This end of the clavicle is larger than the shaft of the bone and is triangular in form. Its articular facet is continuous with a facet for the first rib, which is situated at the inner extremity of the inferior surface of the bone. The circumference of the end of the bone is roughened for the anterior and posterior sterno-clavicular ligaments and for the interclavicular ligament.

OUTER or ACROMIAL END.

This end of the clavicle is flattened, from above downwards. It presents a small oval facet, which looks downwards and outwards, and which articulates with the acromion process of the scapula. The circumference of this end of the bone is roughened for the insertion of the superior and inferior acromio-clavicular ligaments.

MUSCLES ATTACHED.

The muscles attached to the clavicle or collar bone are *six* in number. These muscles will be found enumerated in the following table:

The CLAVICLE affords attachment to 6 muscles, as follows:	To the *anterior surface*...	(2)	PECTORALIS MAJOR. DELTOID.
	To the *posterior surface*...	(2)	STERNO-CLEIDO-MASTOID TRAPESIUS.
	To the *lower surface*.....	(1)	SUBCLAVIUS.
	To the *external extremity*.	(1)	STERNO-HYOID.
	Total,	6	

Occasionally a few fibres of the platysma muscle arise from this bone.

DEVELOPMENT.

The clavicle begins to ossify sooner than any other bone of the body. It is formed from *two separate centres*, the one for the shaft and acromial end appearing about the sixth week of fœtal life, the other for the sternal extremity makes its appearance as an epiphysis, about the 18th or 20th year after birth. The epiphysis is united to the shaft at about the 25th year.

ARTICULATION.

The clavicle articulates with two bones, *viz.*, the sternum and the scapula, and occasionally with the cartilage of the first rib.

THE HUMERUS.

The humerus or *arm bone*, is the longest and largest bone of the upper extremity. It presents for examination an upper and a lower extremity and a shaft. Each of these portions will be separately considered.

Upper Extremity.

This portion of the humerus may be divided into the following portions: 1st, the head; 2nd, the anatomical neck; 3rd, the surgical neck; 4th, the greater tuberosity; 5th, the lesser tuberosity; and 6th, the bicipital groove.

The *head* represents nearly one-half of a sphere, and is much more extensive than the corresponding articular surface of the scapula (glenoid cavity). It looks upwards, inwards and backwards, and is bounded by a constriction in the humerus which is called the anatomical neck of that bone.

The *anatomical neck* is nearly circular in form, irregular in its outline, and affords attachment to the capsular ligament of the shoulder joint.

It separates the *head* from the *tuberosities.*

The *greater tuberosity* is a large, rounded eminence situated upon the outer side of the bicipital groove. It presents, from before backwards, *three small facets* for the attachment of the supra-spinatus, infra-spinatus and teres minor muscles.

The *lesser tuberosity* is smaller but more prominent than the greater, and is situated in front of the head of the bone and upon the inner side of the bicipital groove. It affords attachment to the subscapularis muscle.

The *bicipital* groove lies between the tuberosities and is comprised in the upper third of the bone. In it glides the tendon of the long head of the biceps, while to its bottom is attached the tendon of the latissimus dorsi muscle. It affords attachment, by its anterior or outer lip, to the pectoralis major muscle, and, by its posterior or inner lip, to the teres major muscle. It is deep and narrow above and broad and shallow below.

The *surgical neck* is that slightly constricted portion which joins the upper extremity of the bone to its shaft.

Lower Extremity.

The lower extremity is slightly curved forwards and is flattened from before backwards. It presents for examination an articular surface and an inner and outer condyle.

The ARTICULAR SURFACE is longest in the transverse direction and is sloped obliquely so as to descend lower internally than externally. It is also more prominent, anteriorly to the condyles. It may be divided into a *radial* portion (called also the *head*) and an *ulnar* portion (called also the *trochlear* portion).

The *radial portion* consists of a small rounded eminence situated on the front part of the bone. It is separated from the trochlear portion of the bone by a narrow groove for the inner border of the head of the radius, and, at its upper part, is a slight depression which receives the head of the radius when the forearm is flexed.

The *ulnar* or *trochlear portion* occupies the anterior and posterior portions of the bone. The inner border descends lower than the outer, so that the *axis* around which the ulna rotates is directed downwards and inwards. In front of the trochlea, is a depression called the *coronoid fossa* to receive the coronoid process of the ulna, during flexion of the forearm, and, behind the trochlea, a depression called the *olecranon fossa* to receive the tip of the olecranon process of the ulna, during extension of the forearm. They are lined by the synovial membrane and are separated only by a thin plate of bone. Their margins afford attachment to the anterior and the posterior ligaments of the elbow joint.

The INNER CONDYLE, of the humerus is situated a little lower than the outer and is more prominent. It affords attachment to the internal lateral ligament of the elbow joint and also to the following muscles, *viz.;* pronator radii teres, flexor carpi ulnaris, palmaris longus, flexor sublimis digitorum and flexor carpi ulnaris.

The EXTERNAL CONDYLE, of the humerus is situated higher than the inner. It affords attachment to the external lateral ligament of the elbow joint and also to the following muscles, *viz.:* extensor carpi radialis brevior, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, anconeus, and the supinator brevis.

SHAFT of HUMERUS.

This portion of the bone is cylindrical above, while, below, it is prismatic and flattened from before backwards. It presents for examination three borders and three surfaces. The borders are called respectively, the anterior, the internal and the external, while the surfaces are named the internal, the external and the posterior.

BORDERS.

The *anterior border* of the shaft of the humerus extends from the front of the great tuberosity, above, to the coronoid depression, below, and forms the anterior or outer lip of the bicipital groove.

The *internal border* of the shaft extends from the lesser tuberosity of the bone to its internal condyle. It forms, at its upper part, the inner or posterior lip of the bicipital groove, and, below, it forms the *internal condyloid ridge*.

At the middle portion of this border is perceived the *orifice* of the *nutrient canal* of the bone, which is directed downwards.

The *external border* of the shaft extends from the back portion of the greater tuberosity to the external condyle. It is less distinct than the two other borders and is crossed, above, by the musculo-spiral groove. At its lower portion, it becomes more prominent and forms the *external condyloid ridge*.

SURFACES.

The *internal surface* is narrower than the external. It presents, in its middle portion, a roughened impression for the attachment of the coraco-brachialis, and, towards its lower portion, it frequently presents a bony prominence called the *supra-condyloid* process.

The *external surface* is broader than the internal. At its middle portion, it presents a rough triangular impression for the deltoid muscle, and, below this surface, it affords attachment to the brachialis anticus muscle.

The *posterior surface* is somewhat twisted in its course. It is crossed, obliquely downwards and outwards, by the *musculo-spiral groove*, and, above and below this groove, it affords attachment to the outer and inner heads of the triceps muscle.

MUSCLES ATTACHED.

The humerus affords attachment to *twenty-five* muscles, as follows:

The HUMERUS affords attachment to 25 muscles, as follows:

- To the *upper third* of bone, (7)
  - To greater tuberosity, (3)
    - SUPRA-SPINATUS.
    - INFRA-SPINATUS.
    - TERES MINOR.
  - To lesser tuberosity, (1)
    - SUBSCAPULARIS.
  - To bicipital groove, (3)
    - PECTORALIS MAJOR.
    - LATISSIMUS DORSI.
    - TERES MAJOR.
- To the *shaft* of the bone............... (5)
  - DELTOID.
  - CORACO BRACHIALIS.
  - BRACHIALIS ANTICUS.
  - TRICEPS EXTENSOR CUBITI.
  - SUBANCONEUS.
- To the *lower third* of the bone, (13)
  - To inner condyle, (5)
    - PRONATOR RADII TERES.
    - FLEXOR CARPI RADIALIS.
    - PALMARIS LONGUS.
    - FLEXOR SUBLIMIS DIGITORUM.
    - FLEXOR CARPI ULNARIS.
  - To outer condyle, and the external condyloid ridge. (8)
    - SUPINATOR LONGUS.
    - EXTENSOR CARPI RADIALIS LONGIOR.
    - EXTENSOR CARPI RADIALIS BREVIOR.
    - EXTENSOR COMMUNIS DIGITORUM.
    - EXTENSOR MINIMI DIGITI.
    - EXTENSOR CARPI ULNARIS.
    - ANCONEUS.
    - SUPINATOR BREVIS.

Total, 25 muscles.

All the muscles which arise from the *inner condyle* of the humerus are *flexors* or *pronators*, and are situated on the anterior surface of the forearm, while those arising from the *external condyle* and the external condyloid ridge are *extensors* and *supinators*, and are situated on the posterior surface of the forearm.

DEVELOPMENT.

The humerus is developed by *seven centres* of ossification. One of these is for the shaft of the bone, one for the head, one for the greater tuberosity, one for the radial articular surface, one for the trochlear portion of the articular surface, one for the internal condyle, and one for the external condyle.

The *centre for the shaft* appears very early during fœtal life, and ossification extends rapidly towards the extremities. At birth, the extremities are cartilaginous. At about the second year of age, ossification commences in the head of the bone, and, about the third year of age, the centre for the tuberosities makes its appearance. By the fifth year, the head and tuberosities become joined together and so form a single epiphysis.

The *lower end* of the humerus exhibits ossification at the end of the second year, in the radial portion of the articular surface. The centre for the trochlear portion of the articular surface does not appear until about the twelfth year of age. At the fifth year of age, ossification commences in the internal condyle, but the external condyle does not exhibit any trace of ossification until the age of thirteen or fourteen years. At the seventeenth year of age, the outer condyle and the whole articulating surface of the bone unite with the shaft; at eighteen years of age, the inner condyle becomes united, while the upper epiphysis, although the first formed, is not joined to the shaft until about the twentieth year of age.

ARTICULATION.

The humerus articulates with *three bones*, as follows: Above with the glenoid cavity of the scapula, and, below, with the ulna and the radius.

THE ULNA.

The ulna is the most internal bone of the fore-arm. It is larger and longer than the radius, since it possesses the olecranon process and is larger in its upper than its lower portion. It may be divided into an upper extremity, a lower extremity and a shaft.

UPPER EXTREMITY.

This portion of the ulna is the largest and strongest portion of the bone. It presents two large processes, called the coronoid and the olecranon processes, and two depressions, called the greater and the lesser sigmoid cavities.

PROCESSES.

The CORONOID PROCESS of the ulna is prismatic in form and projects forwards towards the anterior surface of the forearm. It presents for examination an apex, a base, and four surfaces, an upper, under, inner and outer.

The *apex* is curved slightly upwards, and, during flexion of the forearm, is received into the coronoid fossa of the humerus.

The *base* is broad and is continuous with the shaft of the ulna.

The *upper surface* is concave, from before backwards, and serves the purpose of articulation with the humerus.

The *under surface* is concave, and is roughened for the attachment of the brachialis anticus muscle and for the oblique ligament.

The *inner surface* is roughened, and is excavated for the attachment of the flexor profundus digitorum. It presents, anteriorly and from above downwards, the following points of interest: 1. A prominent *bony margin* for the attachment of the internal lateral ligament of the elbow-joint. 2. A *tubercle*, for the attachment of the middle head of the flexor sublimis digitorum. 3. A *ridge*, for the attachment of the head of the pronator radii teres.

The *outer surface* gives origin to a few fibres of the supinator brevis, and, above, it forms the lesser sigmoid cavity of the ulna.

The OLECRANON PROCESS of the bone is large in size, and is also, like the coronoid process, slightly curved.

It presents for examination an apex, a base, an anterior, a posterior, and an upper surface, and an inner and an outer border.

The *apex* is a prominent portion of bone which, during extension of the fore-arm, is received into the olecranon fossa of the humerus.

The *base* is continuous with the shaft of the ulna.

The *anterior surface* is concave, and articulates with the lower end of the humerus.

The *posterior surface* is triangular, and forms the point of the elbow, when that joint is flexed. It is usually covered by a bursa.

The *upper surface* is roughened, at its posterior portion, for the insertion of the triceps muscle, and, in front, close to its margin, it is grooved for the insertion of the posterior ligament of the elbow-joint.

The *two borders* present for examination a continuation only of the grooves, previously mentioned, for the internal and posterior ligaments of the elbow-joint.

The GREATER SIGMOID CAVITY is embraced between the coronoid and olecranon processes of that bone. It is divided by a slightly elevated *ridge*, into two parts, the internal of which is the broadest. It articulates with the lower end of the humerus.

The LESSER SIGMOID CAVITY is situated upon the outer side of the coronoid process. It is narrow and concave from before backwards. Its extremities afford attachment to the orbicular ligament of the radius. It articulates with the head of the radius and is covered with cartilage.

LOWER EXTREMITY.

This portion of the ulna is small in size and does not participate in the wrist-joint, since it is separated by a triangular fibro- cartilage. It presents for examination a head, a styloid process, a depression, and a groove.

The *head* is flattened, at its lower portion, and rest upon the triangular fibro-cartilage, but, at its external portion, it is semi-cylindrical in form and is received into the lesser sigmoid cavity of the radius.

The *styloid process* is given off from the inner and back part of the head, and is cylindrical in its form. It affords attachment to the ulno-carpal or the internal ligament of the wrist-joint.

Between the head and the styloid process is a marked *depression* for the attachment of the triangular fibro-cartilage which separates the ulna from the wrist-joint.

Behind this depression may also be perceived a *groove*, in which plays the tendon of the extensor carpi ulnaris muscle.

SHAFT.

The shaft of the ulna is large and prismatic in form, in its upper portion, while, below, it becomes smaller and more rounded. It is slightly curved forwards, and, at its upper portion, is convex externally, but, below, the convexity is most marked at the internal portion of the bone. It presents for examination an anterior, a posterior, and an external border, and an anterior, a posterior, and an internal surface. The borders are best marked in the upper two-thirds of the shaft, and the surfaces are all three broader in the upper portion of the bone than in the lower.

The *anterior border* extends from a ridge on the inner surface of the coronoid process to the front of the styloid process. It affords attachment for the flexor profundus digitorum and the pronator quadratus muscle.

The *posterior border* extends from the lower and posterior portion of the olecranon to the back portion of the styloid process. It affords attachment, in its upper part, to the aponeurosis common to the flexor carpi ulnaris, the extensor carpi ulnaris and the flexor profundus digitorum muscles.

The *external border* divides into two branches, above, which form the boundaries of the lesser sigmoid cavity. It here embraces a *roughened surface*, for the attachment of the supinator brevis muscle. In its middle portion it is very prominent, and it here affords attachment to the interosseous ligament.

The *anterior surface* is concave in its upper three-fourths, where it affords attachment for the flexor profundus digitorum muscle, and, in its lower portion, it gives attachment to the pronator quadratus muscle. Upon this surface, at the junction of its upper and middle third, is perceived the opening of the *nutrient canal* of the ulna, which is directed upwards.

The *posterior surface* presents, at its upper portion, a triangular surface, bounded externally by an oblique ridge. This triangular space affords attachment for the anconeus muscle, while the oblique ridge, forming its outer border, affords attachment for the supinator brevis muscle. Below this point the posterior surface of the shaft is divided by a *vertical ridge*, into an inner portion, which is very narrow, and an outer portion, which is broad, and which embraces the remainder of the surface. The narrow inner portion affords attachment to the extensor carpi ulnaris muscle, although in some instances it is merely covered by it, and the outer or broader part affords attachment, from above downwards, to the four following muscles, *viz.:* the supinator brevis, the extensor ossis metacarpi pollicis, the extensor secundi internodii pollicis, and the extensor indicis.

The *internal surface* is subcutaneous in its lower fourth, and, in its upper three-fourths, it affords attachment to the flexor profundus digitorum muscle.

Muscles Attached.

The ulna affords attachment to *thirteen* muscles, which may be found classified below.

The Ulna affords attachment to 13 muscles, as follows:	To *olecranon process*	(1)	Triceps extensor cubiti.
	To *coronoid process*	(3)	Brachialis anticus. Pronator radii teres. Flexor sublimis digitorum.
	To *internal* and *anterior surface*....	(2)	Pronator quadratus. Flexor profundus digitorum.
	To *posterior surface*	(5)	Anconeus. Supinator brevis. Extensor ossis metacarpi pollicis. Extensor secundi internodii pollicis. Extensor indicis.
	To *posterior border*.	(2)	Flexor carpi ulnaris. Extensor carpi ulnaris.
	Total,	13 muscles.	

Occasionally the flexor longus pollicis is attached to the ulna.

Articulation.

The ulna articulates with two bones, namely, the humerus and the radius.

Development.

The ulna is developed by *three centres* of ossification: one for the shaft of the bone, one for the inferior extremity and one for the olecranon process. In the shaft of the bone, ossification commences, at about its centre, during the fifth week of fœtal life and rapidly extends through its greater portion. At birth, the ends of the ulna are cartilaginous. At the fourth year of age, a separate osseous nucleus makes its appearance in the centre of the head of the ulna and from this point ossification rapidly extends into the styloid process. The olecranon process does not begin to ossify until about the tenth year of age, when the shaft of the bone shows a tendency to extension into it. At about the sixteenth year of age, the upper epiphysis of the bone becomes fully joined to the shaft, but the lower one does not become united until about the twentieth year.

The Radius.

The radius is the external of the two bones of the fore-arm, and is so called from its resemblance to the spoke of a wheel. It is small above, where it forms a small part of the elbow joint, and large below where it enters largely into the structure of the wrist joint. It is prismatic in form and curved, the convexity of the bone looking outwards, in order to afford more powerful leverage to the pronator radii teres muscle and to increase the breadth of the fore-arm. It presents for examination, 1st, an upper extremity, 2nd, a lower extremity, 3rd, a shaft.

Upper Extremity.

This is smaller than the lower extremity. It presents the following points of interest, 1st, a head, 2nd a neck, 3rd, a tuberosity.

The *head* of the radius is cylindrical in form and cup-shaped above. The cup articulates with the lesser head of the humerus, and the inner and broader edge of the head corresponds to the groove between the lesser head of the humerus and the trochlea. The inner and broader part of the cylindrical surface of the head articulates with the lesser sigmoid cavity of the ulna, while the outer narrower part plays within the orbicular ligament.

The *neck* of the radius is that constricted and rounded portion of the bone which supports the head. On its posterior surface, it presents a slight ridge for the attachment of the supinator brevis.

The *tuberosity* of the radius is situated at the lower and inner part of the neck. It is rough behind for the insertion of the biceps muscle, and in front, it is smooth and is covered by a bursa.

The *tubercle* of the *radius* can be felt only on extreme pronation of the hand and on the posterior surface of the fore-arm, slightly below the head of the bone. The *head* of the *radius* can be felt to rotate at a depression in the skin, just below the bend of the elbow upon the posterior surface of the forearm, when the forearm is extended. This point is of *surgical value* in deciding upon a possible displacement of the head of that bone.

Lower Extremity.

This portion of the radius is large, thick and quadrilateral in form. It presents for consideration five surfaces, two of which are articular, *viz.*, the lower and the inner, and a styloid process.

The *inferior surface* is concave, triangular in shape, and is divided by a slight ridge, running from before backwards, into an outer, large, triangular portion for articulation with the scaphoid bone, and an inner, small portion which is quadrilateral and which articulates with the semilunar bone.

The *internal surface* or *sigmoid cavity* of the radius is narrow, concave, and articulates with the head of the ulna.

The *anterior surface* is excavated and affords attachment to the pronator quadratus. Its lower margin is prominent and affords attachment to the anterior ligament of the wrist joint.

The *external surface* is prolonged downwards into a bony prominence called the *styloid process.* This process is thick and conical in shape, and affords attachment, at its base, to the supinator longus, and, at its apex, to the radio-carpal or external lateral ligament of the wrist joint.

On the outer surface of this process, is a *shallow groove* directed obliquely downwards and forwards and divided into two grooves by a slight bony ridge. The anterior groove transmits the tendons of the extensor ossis metacarpi pollicis and the posterior groove transmits the tendon of the extensor primi internodii pollicis, both of which muscles are enclosed in one synovial sheath.

The *posterior surface* is convex and gives attachment, below, to the posterior ligament of the wrist joint. It presents, from without inwards, the following points of interest.

1. A *broad* and *shallow groove* which transmits the tendons of the extensor carpi radialis longior and the extensor carpi radialis brevior muscles, both of which are enclosed in one synovial sheath.

2. A *narrow* and *deep groove* for the extensor secundi internodii pollicis.

3. A *broad* and *shallow groove* for the extensor in-

dicis and the extensor communis digitorum, both of which are inclosed in one synovial sheath.

4. A *half groove*, which is completed by the head of the ulna and which transmits the extensor minimi digiti and its sheath.

SHAFT.

This portion of the radius is slightly concave, in front, and, in its upper portion, is small and rounded; while, lower down, it becomes larger and prismatic. It presents an anterior, a posterior, and an internal border, and an anterior, a posterior, and an external surface.

The *anterior border* extends from in front of the tuberosity to the base of the styloid process. It is prominent in its upper portion, where it forms the so-called *oblique line* of the bone, and it gives attachment to the supinator brevis, the flexor sublimis digitorum and the flexor longus pollicis muscles. In its lower portion, it affords attachment for the pronator quadratus muscle.

The *posterior border* extends from the back of the neck of the bone to the posterior portion of the styloid process. It is most distinct in its middle third.

The *internal border* extends from the back of the tuberosity to the sigmoid cavity, where it bifurcates. It is sharp and very distinct in its middle third, and affords attachment to the inter-osseous ligament.

The *anterior surface* is narrow and concave, in its upper three-fourths, and broad and concave in its lower fourth. It affords attachment to the flexor longus pollicis, in the upper portion of the bone, and to the pronator quadratus, in its lower fourth. It presents a little above its middle the orifice of the *nutrient foramen.*

The *posterior surface* is narrow and rounded in its upper portion and broad and convex in its lower portion. It affords attachment, at its upper part, to the supinator brevis muscle, and, at its middle portion, where it is rough and slightly concave, to the extensor primi internodii pollicis and a few fibres of the extensor ossis metacarpi pollicis.

The *external surface* is convex and affords attachment, in its upper portion, to the supinator brevis muscle, and, at its middle portion, it presents a rough impression for the pronator radii teres muscle.

MUSCLES ATTACHED.

The radius affords attachment to *nine muscles* which may be arranged as follows:

The RADIUS affords attachment to 9 muscles, as follows:	To its *tubercle*	(1)	BICEPS FLEXOR CUBITI.
	To its *anterior surface*	(2)	FLEXOR SUBLIMIS DIGITORUM. FLEXOR LONGUS POLLICIS.
	To its *posterior surface*	(2)	EXTENSOR OSSIS METACARPI POLLICIS. EXTENSOR PRIMI INTERNODII POLLICIS.
	To its *external border*	(4)	SUPINATOR BREVIS. PRONATOR RADII TERES. PRONATOR QUADRATUS. SUPINATOR LONGUS.
	Total,	9	

DEVELOPMENT.

The radius is developed by *three centres* of ossification: one for the shaft, one for the upper extremity, and one for the lower extremity. The centre for the *shaft* of the bone appears, near its middle, at about the eighth week of fœtal life. At birth, the ends of the bone are cartilaginous, but the shaft is almost completely ossified. About the end of the second year, the lower epiphysis appears, and about the fifth year of age, the upper epiphysis. The upper epiphysis unites with the shaft at the age of puberty, but the lower epiphysis does not become united until the twentieth year of age.

ARTICULATION.

The radius articulates with four bones, namely, the humerus, the ulna, the scaphoid, and the semilunar.

THE HAND.

The bones which compose the hand may be subdivided into three parts, *viz.*, the carpus, the metacarpus, and the digits. The following table will show the situation of the twenty-seven bones which are included in the hand:

The HAND is composed of twenty-seven bones, as follows:	Carpus (8)	In *proximal* row	(4)	Scaphoid. Semilunar. Cuneiform. Pisiform.
		In *distal* row	(4)	Trapezium. Trapezoid. Os magnum. Unciform.
	Metacarpus (5)			
	Phalanges (14)			
	Total, 27 bones.			

BONES OF THE CARPUS.

The carpal bones are *eight* in number and are divided into two rows of four bones each. The bones which enter into the formation of the *upper row* are thus named, from without inwards, transversely across the wrist. 1, the scaphoid, 2, the semilunar, 3, the cuneiform, 4, the pisiform.

The bones which comprise the *second row* of the carpus may be thus enumerated in their order from without inwards. 1, the trapezium, 2, the trapezoid, 3, the os-magnum, 4, the unciform.

The SCAPHOID BONE is named from its resemblance to the shape of a boat, being broad at one end, narrowed at the other like a prow and convex upon one side. It presents a narrow extremity which is called its *tuberosity*, and which may be felt at the *back* of the wrist, on the *inner side* of the *extensor tendons* of the thumb, a broad end, a convex and a concave surface, a convex and a concave border. It *articulates* with *five bones*, *viz.*, the semilunar bone, the trapezium, the trapezoid, the os magnum, and the radius.

The SEMILUNAR BONE is so called from a cresentic cavity and a somewhat cresentic outline. It presents four articular surfaces a concave, a convex, and two lateral, and two surfaces which are called the dorsal and the palmar. It *articulates* with *five bones*, *viz.*, the radius, the scaphoid, the os magnum, the cuneiform, and the unciform.

The CUNEIFORM is wedge-shaped, and is best distinguished from the other carpal bones by an *isolated facet* for the articulation of the pisiform bone. It presents three surfaces, a rough, a concave, and a smooth, a base, which is articular, and an apex, which is rough and pointed. It *articulates* with *three bones*, *viz.*, the semilunar, the pisiform, and the unciform.

The PISIFORM BONE may be recognized by its small size and by possessing a single articular facet. It is the smallest of the bones of the carpus, is of an ovoid form and is placed vertically in front of the cuneiform bone, where it can be felt upon the *palm* of the hand, *just below the ulna*. It possesses four sides and two extremities. One of these sides is articular, one rounded, one concave and one convex in form. It *articulates* with *one bone* only, *viz.*, the cuneiform bone.

The TRAPEZIUM is very irregular in shape, but it may be distinguished by a *deep groove* for the tendon of the flexor carpi radialis muscle. It possesses three surfaces, one articular and one oval in form, the other marked by three facets and three rough borders. It *articulates* with *four bones*, *viz.*, the scaphoid, the trapezoid, the metacarpal bone of the thumb and the second metacarpal bone.

The TRAPEZOID BONE is small, oblong and quadrilateral. It is bent upon itself near its middle portion and possesses four articular surfaces and two non-articular, one of which is large and broad and is called the *dorsal*, the other is small and rough and is called the *palmar*.

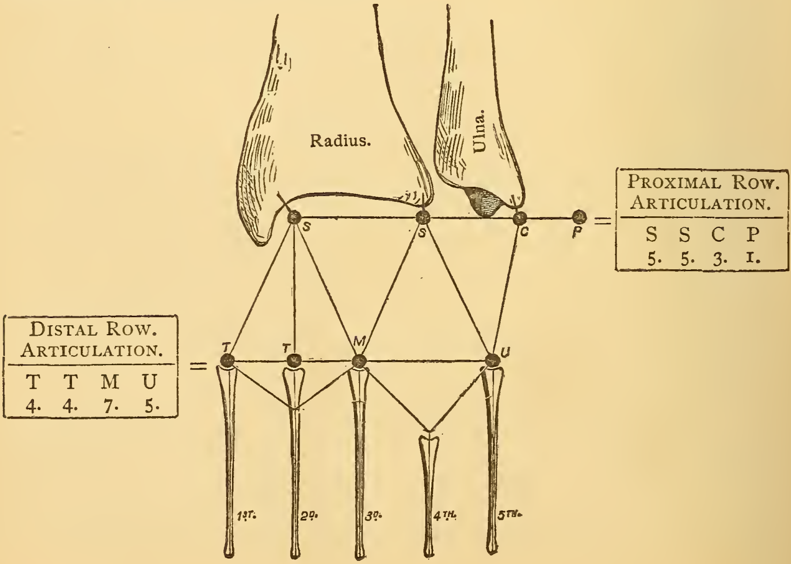
It *articulates* with *four bones*, *viz.*, the scaphoid, the trapezium, the os magnum and the second metacarpal bone.

The OS MAGNUM possesses six surfaces, *viz.*, an anterior, posterior, superior, inferior, external, and internal. It is sometimes subdivided into a head, neck, and body. It is the largest bone of the carpus and is sometimes dislocated, when it appears as a tumor on the *dorsal aspect* of the hand in the line of the *metacarpal bone* of the *middle finger*. It *articulates* with *seven bones*, viz., the scaphoid, semilunar, trapezoid, unciform, and the second, third, and fourth metacarpal bones.

The UNCIFORM BONE is triangular and is remarkable for a long and curved *process* which projects from its palmar aspect. It possesses five surfaces, three of which are articular and two free. It articulates with five bones, *viz.*, the semilunar, the cuneiform, the os magnum, and the fourth and fifth metacarpal bones.

ARTICULATION OF THE CARPUS.

The following diagram illustrates the various articulations of each of the eight carpal bones.



In this diagram the *black dots* indicate the carpal bones in their relation to each other and the bones of the forearm. The *connecting lines* indicate the points of articulation of each part in the diagram, so that by tracing all the lines from any given part the articulation of that part can easily be ascertained.

It is easy to recognize whether any bone of the carpus *belongs to the right or left side*, when it is placed in position by the following guides:

SCAPHOID.

1. The *largest articular facet* is above.
2. The *tubercle* is on its outer side.
3. The *transverse groove* is behind.

SEMILUNAR.

1. The *convex articular facet* is above.
2. The largest rough surface is in front.
3. The *semilunar facet* is on its outer side.

CUNEIFORM.

1. The *convex surface* is directed upwards.
2. The *flat surface* lies in front.
3. The *small surface* or *angle* lies on the inner side.

PISIFORM.

1. The *articular facet* lies posteriorly.
2. The *concave surface* lies on the inner side.

TRAPEZIUM.

1. The *saddle-shaped articular facet* lies below.
2. The *ridge* is directed forwards.
3. The *rough lateral surface* is directed outwards.

TRAPEZOID.

1. The *saddle-shaped articular facet* looks downwards.
2. The *large rough surface* lies posteriorly.
3. The *projecting part* lies on the inner side.

OS MAGNUM.

1. The *head* of the bone looks upward.
2. The *large rough surface* lies posteriorly.
3. The *tubercle* of the base lies on the inner side.

UNCIFORM.

1. The *unciform process* lies in front and near its lower part.
2. The *concavity* of the bone is directed outwards.

METACARPAL BONES.

The bones of the metacarpus are five in number, and are named in numerical order from the external or radial side of the hand, 1st, 2d, 3d, 4th, 5th. They are classed as long bones, and are divisible into a *head*, *shaft* and *base*. The head is directed towards the fingers while the base articulates with the carpal bones.

The *head* is rounded at the extremity, and, at each side, is flattened for the insertion of strong ligaments.

The *shaft* is prismoidal in shape and, on each side, is deeply marked for the attachment of the interossei muscles.

The *base* is quadrilateral and roughened for the insertion of tendons and ligaments. It possesses *three articular surfaces*, one at each side for the adjoining metacarpal bones, and one at the extremity for articulation with the carpus.

The *metacarpal bone* of the *thumb* is one third shorter than the rest; the articular surface of the head is less round, and the base has a *single articular surface* which joins the trapezium.

The *metacarpal bones* of the *different fingers* may be thus distinguished from each other:

In the *index finger*, the *base is very large* and has *four* articular surfaces.

In the *middle finger*, a *projecting process* exists upon the radial side of the base, and *two small facets* upon its ulnar lateral surface.

In the *ring finger*, the *base* is *small* and *square* and possesses *two small circular facets*, which correspond with those of the middle metacarpal bone.

In the *little finger*, the metacarpal bone has only *one lateral articular surface.*

Articulations of the Metacarpal Bones.

The metacarpal bones articulate, at their bases, as follows:

1st Metacarpal bone, with *one* bone,	Trapezium.
2nd Metacarpal bone, with *three* bones,	Trapezium. Trapezoid. Os magnum.
3rd Metacarpal bone, with *one* bone,	Os magnum.
4th Metacarpal bone, with *two* bones,	3d metacarpal. 5th metacarpal.
5th Metacarpal bone, with *one* bone,	Unciform.

The *head* of each metacarpal bone articulates, however, with a *phalanx.*

Muscles Attached to Metacarpal Bones.

All the *flexors* and *extensors* of the *wrist joint*, with the exception of the palmaris longus, are inserted into the *base* of a metacarpal bone.

The *metacarpal bone* of the *thumb* affords attachment to *three* muscles, *viz.*, the flexor ossis metacarpi pollicis, the extensor ossis metacarpi pollicis and the first dorsal interosseous.

The *metacarpal bone* of the *index finger* affords attachment to *five* muscles, *viz.*, the extensor carpi radialis longior, the flexor carpi radialis, the first and second dorsal interossei and the first palmar interosseous muscle.

The *metacarpal bone* of the *middle finger* affords attachment to *four* muscles, *viz.*, the extensor carpi radialis brevior, the adductor pollicis and the second and third dorsal interossei muscles.

The *metacarpal bone* of the *ring finger* affords attachment to *three* muscles, *viz.*, the third and fourth dorsal interossei and the second palmar interosseous muscle.

The *metacarpal bone* of the *little finger* affords attachment to *five* muscles, *viz.*, flexor carpi ulnaris, the extensor carpi ulnaris the opponens minimi digiti, the fourth dorsal and the third palmar interosseous muscles.

Phalanges.

The phalanges are the bones of the fingers. They are named from their arrangement in rows the first, second and third, from the metacarpal bone forwards, and are fourteen in number,—three to each finger, and two to the thumb. They are classed as long bones and are divisible into a shaft and two extremities.

The *shaft* is compressed from before backwards, convex on its posterior surface, and, in front, is flat with raised edges.

The *metacarpal extremity* of the first row of phalanges is a simple concave articular surface, but of the other two rows, it consists of a double concavity separated by a slight ridge.

The *digital extremities* of the first and second rows of phalanges present a *pulley-like surface*, which is concave in the middle and convex upon either side. The terminal extremity of the phalanx of each finger is broad, rough and expanded into a semilunar crest.

Muscles Attached to the Phalanges.

The *deep flexor* of *the fingers in common* is attached to the *third* phalanges, the *superficial flexor* of the *fingers in common* is inserted into the *second* phalanges, and the *common extensor* of the *fingers* is attached to the *second* and *third* phalanges.

In the *thumb*, the *first phalanx* affords attachment to *four* muscles, *viz.*, the adductor pollicis, the flexor brevis pollicis, the abductor pollicis and the extensor primi internodii pollicis; and the *second phalanx* to *two* muscles, *viz.*, the flexor longus pollicis and the extensor secundi internodii pollicis.

In the *second*, *third* and *fourth fingers*, the first phalanx affords attachment to one dorsal and one palmar interosseous muscle, and, in the *little finger*, the first phalanx affords attachment to the abductor minimi digiti, the flexor minimi digiti and one palmar interosseous.

In all of the fingers, save the thumb, the *second phalanges* afford attachment to the flexor sublimis digitorum and the extensor communis digitorum, while the *last phalanges* of these fingers afford attachment to the flexor profundus digitorum and the extensor communis digitorum muscles.

BONES OF THE LOWER EXTREMITY.

BONES OF THE LOWER EXTREMITY.

The skeleton of the lower extremity, as before stated, comprises thirty bones.

Each lower extremity is composed of three segments, *viz.:*

1. Thigh.
2. Leg.
3. Foot. { Tarsus. Metatarsus. Digits.

The *thigh* is constituted by one bone, *viz.*, the femur.

The *leg* is composed of three bones, *viz.*, the patella, the tibia, and the fibula.

The *foot* has three segments and twenty-six bones, *viz.*, 1. tarsus, seven bones; 2. metatarsus, five bones; 3. digits, fourteen bones, (phalanges.)

FEMUR.

The femur is a long bone, divisible, like other bones in the same class, into a shaft, a superior and an inferior extremity.

UPPER EXTREMITY.

This portion of the bone presents for examination. 1. a *head*, 2. a *neck*, 3. a *great trochanter*, 4. a *lesser trochanter*.

The *head* forms nearly two-fifths of the sphere and presents a small depression for the attachment of the ligamentum teres.

The *neck* is situated between the head and the trochanter and is longest and most inclined in youth, growing shorter and more horizontal as age advances. It is a quadrangular process of bone, directed inwards, upwards, and a little forwards. It is flattened, from before backwards, so that it is much greater in the vertical than in the antero-posterior direction. In adult life it forms an angle of 120°-125° with the shaft.

The *greater trochanter* is large, quadrilateral in shape, and is most prominent posteriorly. To its outer surface is attached the gluteus medius muscle. Its inner surface presents the so-called digital fossa for the insertion of the obturator externus muscle. Its upper border affords attachment for the obturator internus, the two gemelli and the pyriformis muscles. Its anterior border affords attachment for the gluteus minimus muscle. The so-called *intertrochanteric line* of the femur extends from the greater trochanter to the lesser, and forms the inferior boundary of the neck of the bone.

The *lesser trochanter* is small and conical in shape and affords attachment to the psoas and iliacus muscles.

LOWER EXTREMITY.

The lower extremity of the femur is broad and is expanded into two prominent processes, called the *external* and *internal condyles*, separated by a notch, behind, called the *inter-condyloid notch* which lodges the two crucial ligaments.

Of these two condyles, the *outer* is the *broadest* and *longest*, so that if the bone be placed vertically it projects full one-half inch below the inner, since the shaft of the bone is directed inwards towards the median line and therefore requires additional length upon that side.

The *outer condyle* affords attachment for the external lateral ligament of the knee-joint, the popliteus muscle, and the gastrocnemius muscle.

The *inner condyle* affords attachment for the internal lateral ligament of the knee-joint, and the inner head of the gastrocnemius muscle.

The points of bone upon either condyle of the femur, called the *tuberosities* of the condyles, give attachment to the lateral ligaments. They are situated behind and not in front of the centre of motion.

SHAFT.

The shaft of the femur is rounded in front and covered with muscles, but behind it is raised into a rough and prominent ridge called the linea aspera. Of all the bones in the body it most nearly resembles a cylinder. It is not quite straight, but is slightly curved in front. At the lower extremity of the bone, the *linea aspera* divides into two ridges, called the external and internal condyloid, which descend to the two condyles of the femur and enclose a triangular space, called the popliteal space, upon which rests the popliteal artery, while, above, two lines can be traced from the linea aspera to the trochanters. The *internal condyloid ridge* is less marked than the *external*, and presents a broad and shallow groove, for the passage of the femoral artery.

The *nutrient foramen* is situated in or near the linea aspera, at about one-third from its upper extremity, and is directed obliquely from below upwards.

Muscles Attached to the Femur.

The femur affords attachment to *twenty-three* muscles, as follows:

To its upper fifth,	10
To its shaft,	10
To its lower fifth,	3
Total,	23

Occasionally the tensor vaginæ femoris muscle takes its origin from the femur, in which case the total of muscles reaches twenty-four. The following table illustrates the points of attachment of these twenty-three muscles:

The Femur affords attachm't to 23 muscles as follows:	Attached to the *greater trochanter*			(8)	Gluteus medius. Gluteus minimus. Pyriformis. Gemellus superior. Obturator internus. Gemellus inferior. Obturator externus. Quadratus femoris.
	To the *lesser trochanter*			(2)	Psoas magnus. Iliacus.
	To the *shaft.*	*Anterior surface*		(2)	Crureus. Sub-crureus.
		Posterior surface. (8)	Linea aspera	(2)	Vastus externus. Vastus internus.
			Interstices,	(6)	Gluteus maximus. Pectineus. Biceps flexor cruris. Adductor longus. Adductor magnus. Adductor brevis.
	To *lower fifth*			(3)	Gastrocnemius. Plantaris. Popliteus.
			Total,	23	

Articulations of the Femur.

The femur articulates with three bones, namely: the os innominatum, the tibia, and the patella.

Development of the Femur.

This bone is developed by *five* centres of ossification, which are distributed as follows:

(1)	One	for the	*shaft* and *neck*,	which	appears	at the	5th month of fœtal life.			
(2)	"	"	" *lower extremity*,	"	"	"	9th	"	"	"
(3)	"	"	" *head* of the bone,	"	"	"	end of 1st year of age.			
(4)	"	"	" *greater trochanter*,	"	"	"	4th		"	"
(5)	"	"	" *lesser trochanter*,	"	"	"	14th		"	"

BONES OF THE LEG.

The bones of the leg are three in number, *viz.:*

1. The patella, or knee-pan.
2. The tibia, or shin-bone.
3. The fibula.

If the patella be recognized as a distinct bone, for it is often classed as one of the sesamoid bone, it affords attachment to four muscles, *viz.:*

Rectus femoris.
Vastus externus.
Crureus.
Vastus internus.

The patella is a triangular-shaped bone and presents two surfaces, called the anterior and the posterior surfaces, a base, which looks upwards, and an apex, which looks downwards.

The *posterior surface* has a ridge dividing it into two portions.

The *anterior surface* is convex and is perforated with numerous apertures, through which pass the nutrient vessels of the bone.

The *base* of the bone is that border which is directed upwards and which affords attachment for the muscles mentioned above.

The *apex* of the bone is that border which is directed downwards and which affords attachment to the ligamentum patellæ.

The patella articulates with one bone, *viz.*, the femur. It also enters into the formation of the knee-joint.

TIBIA.

The tibia, or shin-bone, is the large bone of the leg. It is prismoidal in form and is divisible into a shaft, an upper and a lower extremity.

Upper Extremity.

The upper extremity or *head* of the tibia is of large size and is expanded upon either side into two bony projections called the *tuberosities* of the tibia.

The *upper surface* of the head and tuberosities articulates with the condyles of the femur. The articular surface upon the inner tuberosity is *oval* in shape, and that upon the external tuberosity is broad and *nearly circular.*

On the upper surface of the tibia, between its two articular surfaces, is a projection of bone called its *spinous process*, and, behind this process, a rough depression for the attachment of the crucial ligaments of the knee-joint.

On the anterior aspect of the head of the tibia, between the two tuberosities, is a prominent elevation of bone called the *tubercle*, for the insertion of the ligamentum patellæ.

Posteriorly, the tuberosities are separated by a shallow notch, called the popliteal notch, which affords attachment for the posterior crucial ligament.

SHAFT.

The shaft of the tibia presents three surfaces: an internal, which is subcutaneous and superficial; an external, which is concave and marked by a sharp ridge for the insertion of the interosseous membrane, and a posterior, which is grooved for the insertion of muscles.

Upon the posterior surface, near the upper extremity of the bone, is an oblique ridge called the *popliteal line*, which affords attachment to the fascia of the popliteus muscle, and, below this line, the orifice of the *nutrient canal* is perceived, which is directed downwards.

LOWER EXTREMITY.

This portion of the tibia is prolonged, on its inner side, into a large process, called the *internal malleolus.* Upon the outer side, the lower extremity of the tibia is concave and triangular in form. It articulates, on its outer surface, with the other bone of the leg, *viz.*, the fibula, and, at its extremity, with the astragalus, one of the bones of the tarsus.

MUSCLES ATTACHED TO TIBIA.

The muscles attached to the tibia are *fourteen* in number. They may be thus classified:

The TIBIA affords attachment to 14 muscles, as follows:

- To the UPPER END . . . . . . (8)
  - To the *tubercle* . . . . (4)
    - Rectus femoris.
    - Vastus externus.
    - Crureus.
    - Vastus internus.
  - To the *internal surface*, (4)
    - Sartorius.
    - Gracilis.
    - Semitendinosus.
    - Semimembranosus.
- To the SHAFT, (6)
  - To the *external surface*, (2)
    - Tibialis anticus.
    - Extensor longus digitorum.
  - To the *posterior surface*, (4)
    - Popliteus.
    - Tibialis posticus.
    - Soleus.
    - Flexor longus digitorum.

Total, 14

Of these fourteen muscles, the first four are *indirectly* attached to the tibia by means of the ligamentum patellæ, and only five of the fourteen muscles arise from the bone, the rest making it their point of insertion.

The tibia has the *largest nutrient foramen* of any bone in the body.

Articulations of Tibia.

The tibia articulates with three bones, *viz.*, the femur, the fibula, and the astragalus. It enters into the formation of two joints, *viz.*, the knee and ankle joints.

Development.

The tibia develops by *three centres* of ossification, *viz.*, one for the shaft, and one for each extremity. That for the shaft appears about the 5th week of fœtal life, that for the upper extremity about the time of birth, and that for the lower extremity at about the second year.

FIBULA.

The fibula is a long and slender bone, prismoidal in shape and divisible into a shaft and two extremities.

Upper Extremity.

This portion of the bone is termed its *head.* It is thick and large, and marked by a concave surface which articulates with the external tuberosity of the tibia. At its external portion, is perceived a thick and rough prominence, to which is attached the external lateral ligaments of the knee-joint, and, behind, a process, called the *styloid process*, exists for the insertion of the tendon of the biceps muscle.

The head of the fibula is one of the prominent bony points of the knee, and lies about on the *same level* as does the *tubercle of the tibia.*

LOWER EXTREMITY.

This portion of the fibula forms the *external malleolus.* On its inner surface is a *triangular facet* for articulation with the astragalus. The posterior portion is grooved for the tendons of the peronei muscles.

SHAFT.

The shaft of the fibula presents three surfaces, an external, internal, and posterior, and three borders.

The *external surface* affords attachment to the two peronei muscles.

The *internal surface* is marked, along its middle portion, by the interosseous ridge for the attachment of the interosseous membrane.

The *posterior surface* is twisted and presents, at about its middle, the *nutrient foramen* of the bone which is directed downwards.

The shaft of the fibula arches backwards, in direct contrast with the shaft of the tibia, and affords little if any assistance in supporting the weight of the body. The difference in the curve of the shafts of the two bones of the leg has a *practical value* in performing amputations in this region, since the direction of the flap incisions is modified in accordance with it.

MUSCLES ATTACHED TO FIBULA.

The fibula affords attachment to *nine* muscles, as follows :

The FIBULA affords attachment to 9 muscles, as follows :	To the *styloid process*... (1)	Biceps flexor cruris.
	To the *anterior surface,* (3)	Extensor longus digitorum Extensor proprius pollicis. Peroneus tertius.
	To the *posterior surface,* (3)	Soleus. Tibialis posticus. Flexor longus pollicis.
	To the *external surface,* (2)	Peroneus longus. Peroneus brevis.

ARTICULATIONS OF FIBULA.

The fibula articulates with only two bones, *viz.*, the tibia and the astragalus.

DEVELOPMENT OF FIBULA.

The fibula is developed by *three centres* of ossification ; one for the shaft, and one for each extremity. In the fibula, the centre for the shaft appears rather later than in the tibia; that for the lower extremity appears in the second year; and that for the upper, not until the fourth year of age.

In this bone, the portion exhibiting the first trace of ossification is the first to unite, being situated in the lower end of the bone, or in the external malleolus. This is an exception to a *general law* of ossification, but is still an observance of that law which is governed by the direction of the nutrient canal.

General Summary.

I. Of the *twenty-three* muscles attached to the femur,
- 16 move the thigh on the trunk and vice-versa.
- 6 move the leg upon the thigh and vice-versa.
- 1 moves the foot upon the thigh and vice-versa.

II. Of the *fourteen* muscles attached to the tibia,
- 9 are attached to the upper fifth and move the leg upon the thigh and vice-versa.
- 5 are attached to the shaft and move the foot on the leg and vice-versa.

III. Of the *nine* muscles attached to the fibula,
- 1 is attached to the upper end and moves the leg upon the thigh and vice-versa.
- 8 are attached to the shaft and move the foot upon the leg and vice-versa.

BONES OF THE FOOT.

The foot is composed of twenty-six bones, and is divided into three segments, as follows:

1st. Tarsus, 7 bones.
2nd. Metatarsus, 5 bones.
3rd. Digits (5), 14 bones.

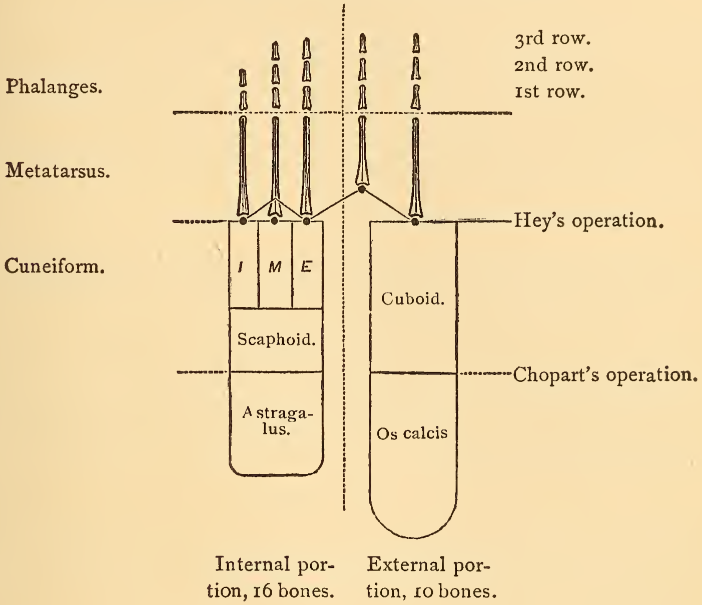
I. The *bones of the tarsus* are seven in number, and may be enumerated as follows:

Astragalus,	1.
Calcaneum,	1.
Scaphoid,	1.
Cuneiform,	3.
Cuboid,	1.
Total,	7 bones.

II. The *metatarsal bones* are five in number and are named in numerical order from within outwards, or from the tibial towards the fibular side of the foot.

III. The *digits* are also five in number, and each consists of three bones, named phalanges, with the exception of the great toe or "hallux," which has only two. The phalanges are fourteen in number and are counted from behind forwards, or from the heel towards the toes. The digits are named numerically from within outwards.

PLAN OF THE BONES OF THE FOOT.



This diagram of the bones of the foot is intended to illustrate the relative position of the bones to each other as well as the situation of the various amputations which are performed in this region.

It also illustrates some points of anatomical value, to which the attention of the student is not always directed, *viz.*:

I. The bones of the foot may be divided into two *lateral halves*, the external half comprising *ten* bones, and the internal half comprising *sixteen* bones.

II. The bones of the foot are seen, in the second place, to be capable of being divided *transversely* in the following regions: 1, between each row of the phalanges, 2, at the junction of the metatarsal bones with the tarsus, 3, in the middle of the tarsus, between the scaphoid and the cuboid bones, in front, and the astragalus and the os calcis, behind. The operations of Hey and Chopart as indicated in the diagram consist therefore of disarticulating certain bones of the foot from each other.

III. Chopart's operation consists in removing all the bones of the foot except two, *viz.*, the os calcis and the astragalus; Hey's, in removing all the bones of the foot except those of the tarsus.

IV. All of the tarsal bones articulate with *four bones* with the following exception:

Os calcis, with two bones.
External Cuneiform, with six bones.

TARSAL BONES.

The seven bones entering into the formation of the tarsus have been previously enumerated under the description of the bones of the foot. Each one, however, presents certain points of interest, and each will therefore receive a special description.

ASTRAGALUS.

This bone may be recognized by a rounded head, a broad articular facet upon its convex surface, and two articular facets, separated by a deep groove, upon its concave surface.

This bone is divisible into six surfaces, a superior, an inferior, an external, an internal, an anterior and a posterior.

It articulates with four bones, *viz.*, the tibia, the fibula, the os calcis and the scaphoid.

OS CALCIS.

This bone may be distinguished by its large size and oblong shape, also by a large and irregular portion which forms the head, and which is directed forwards, and by two articular portions upon its upper surface, which are separated by a deep groove.

The os calcis posesses *six surfaces*, *viz.*, a superior, an inferior, an external, and an internal, an anterior and a posterior.

It *articulates* with *two bones*, *viz.*, the astragalus and the cuboid.

The os calcis affords attachment to *eight muscles* as follows:

The Os Calcis affords attachment to eight muscles, as follows:	To the *upper surface*....(1)	Extensor brevis digitorum.
	To the *under surface*...(4)	Abductor pollicis. Flexor brevis digitorum. Abductor minimi digiti. Flexor accessorius.
	To the *posterior surface*.(3)	Gastrocnemius. Plantaris. Soleus.

The *plantar fascia* derives its attachment from the under surface of this bone.

SCAPHOID.

This bone is so called from its resemblance to a boat. It possesses two surfaces, *viz.*, an anterior and a posterior; two borders a superior and an inferior; and two extremities—one broad, the other pointed and thick.

The *anterior surface* is marked by *three facets* which articulate with the three cuneiform bones.

The *posterior surface* is concave to articulate with the head of the astragalus.

On the internal and lower portion of the bone is a projection, termed the *tubercle of the scaphoid*, for the insertion of the tendon of the tibialis posticus muscle.

Externally is sometimes perceived a *facet* for articulation with the cuboid.

The scaphoid bone articulates with *four bones*, *viz.*, the astragalus, and the three cuneiform bones. In rare instances, it articulates with the cuboid.

It affords attachment to only *one* muscle, *viz.*, the tibialis posticus muscle.

CUBOID.

This bone is so called from its form. It presents *three articular surfaces*, *viz.*, an anterior, a posterior and an internal; and *three non-articular snrfaces*, *viz.*, a superior, an inferior and an external.

The *superior non-articular surface* helps to form the dorsum of the foot; the *inferior* is grooved for the peroneus longus muscle.

The *posterior articular surface* joins the os-calcis; the *anterior* articulates with the fourth and fifth metatarsal bones, while the *internal* articulates with the external cuneiform bone.

It will thus be perceived that the cuboid bone articulates, like most of the tarsal bones, with *four bones*, *viz.*, the os calcis, the external cuneiform and the fourth and fifth metatarsal bones.

The cuboid affords attachment to *one muscle*, *viz.*, the flexor brevis pollicis.

CUNEIFORM BONES.

These three bones are all six-sided and wedged-shaped. They each present a dorsal surface, a plantar surface, a posterior surface, an anterior surface and two lateral surfaces.

The *posterior surfaces* articulate with the scaphoid, the *anterior surfaces* articulate with the metatarsal bones, the *lateral surfaces* articulate with each other, and, in some cases, with other bones, *viz*, the metatarsal bones and the cuboid.

The *dorsal* and *plantar surfaces* of each of the cuneiform bones have no special points of interest, save in the *internal cuneiform* bone. In this bone, the dorsal surface presents a *groove* for the tendon of the tibialis anticus muscle, and, on its plantar surface, a *tubercle* for the insertion for the tibialis posticus muscle.

The *internal* and *middle* cuneiform bones each articulate with *four bones*, but the *external* cuneiform articulates with *six*, since three metatarsal bones are in contact with it.

The *internal* cuneiform affords attachment to *two muscles, viz.*, the tibialis anticus and the tibialis posticus.

The *middle* cuneiform bone affords attachment to *one muscle*, viz., the flexor brevis pollicis.

The *external* cuneiform bone, at its inferior surface, also affords attachment to one muscle, *viz.*, the flexor brevis pollicis muscle.

METATARSAL BONES.

The metatarsal bones are five in number, are long bones, and are divisible, therefore, into a shaft and two extremities.

The *shaft* of each is prismoidal in form and is compressed from side to side.

The *tarsal extremity* or *base* of each bone is square in shape and articulates with the tarsal bones and with each other.

The *anterior extremity* forms a *rounded head*, circumscribed by a constricted portion called the *neck*, and articulates with the first row of phalanges.

Peculiarities of *the metatarsal bones.*

The *first* metatarsal bone is shorter and larger than the rest. It forms the *inner border* of the foot.

The *second* metatarsal bone is the longest and the largest of the remaining four. At its base it has *three articular facets*, since it joins with three cuneiform bones.

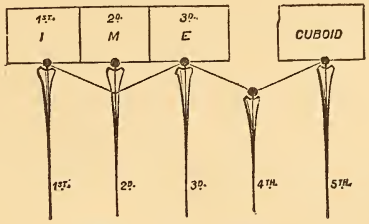
The *third* metatarsal bone has *two facets* on the *outer side* of its base and is of small size.

The *fourth* metatarsal bone is of small size and has a *single* articular facet upon *each side* of its base.

The *fifth* metatarsal bone is recognized by its broad base and by the *absence* of an *articular facet on its outer side.*

PLAN OF THE METATARSAL ARTICULATION.

CUNEIFORM.



METATARSAL BONES.

In this diagram are represented, the three cuneiform and cuboid bones and the five metatarsal bones.

The *lines* represent the points of articulation of the second and fourth metatarsal bones.

It will thus be perceived that the first metatarsal bone has only *one* point of articulation with the tarsus, that the second has *three*, that the third has *one*, that the fourth has *two*, and that the fifth has *one*.

A person, jumping and *alighting upon the toes*, has twenty-two joints and forty-four articulations to distribute the shock. These may be enumerated as follows:

METATARSAL ARTICULATIONS,	8.
TARSUS (7×4)	28.
TIBIA,	3.
FIBULA,	2.
FEMUR,	2.
OS INNOMINATUM,	1.
Total	$44. \div 2 = 22$ joints.

If concussion is received upon the *heel*, only six joints and twelve articulations distribute the shock. These six joints are as follows:

OS CALCIS,	1.
ASTRAGALUS,	3.
TIBIA,	3.
FIBULA,	2.
FEMUR,	2.
OS INNOMINATUM,	1.
Total	$12. \div 2 = 6$ joints.

It will be seen that the total number of *articulations* has been divided by two to indicate the *actual number of joints*, to which the shock is carried, since the total number of articulations of each bone has been enumerated and thus the actual number of joints has been doubled.

Points of Surgical Interest.

The following bony points, upon the *inner side* of the foot, are of surgical value, since they afford guides to the various amputations in this region.

1. The *tuberosity* of the *os calcis*, at the extremity of the heel.
2. The *inner malleolus*, in front of the heel and opposite the ankle joint.
3. The *anterior projection* of the *os calcis*, one inch below the malleolus.
4. The *tubercle* of the *scaphoid* bone, one inch in front of the malleolus.
5. The *internal cuneiform bone*, in front of the tubercle of the scaphoid.
6. The *projection* of the *first metatarsal bone*, at the base of the great toe.
7. The *extremities* of the *phalanges* of the great toe.

Upon the *outer side* of the foot, the following bony points are perceived, from behind forwards, which possess a surgical importance.

1. The *external tubercle* of the *os calcis*.
2. The *external malleolus*, which descends lower and does not extend as far forwards as the inner.
3. The *peroneal tubercle* of the *os calcis*, which lies one inch below the malleolus.
4. The *projection* of the *base* of the 5*th metatarsal bone*.

PHALANGES.

There are two phalanges in the great toe, and three in the other toes, as in the hand. They are long bones, divisible into a central portion of the shaft and two extremities.

The phalanges of the *first row* are convex, above, concave, upon the under surface, and compressed, from side to side. The posterior extremity has a single *concave* articular surface, for the head of the metatarsal bone ; and the anterior extremity, a *pulley-like surface*, for the second phalanx.

The *second phalanges* are short and diminutive, but somewhat broader than the first row.

The *third*, or *ungual phalanges*, including the second phalanx of the great toe, are flattened, from above downwards, and expanded laterally, at the base, to articulate with the second row, and, at the opposite extremity, to support the nail and the rounded extremity of the toe.

The *first row* of phalanges articulates with the metatarsal bones and the second phalanges.

The *second row*, in the great toe, articulates with the first phalanx, and, in the other toes, with the first and third phalanges.

The *third row* articulates with the second row of phalanges, in all the toes but the great toe, where the third phalanx is wanting.

MUSCLES ATTACHED TO PHALANGES.

FIRST ROW.

In the *great toe*, the abductor pollicis, the adductor pollicis, the flexor brevis pollicis, the transversus pedis and one of the tendons of the extensor brevis digitorum, are inserted.

In the *second toe*, the first and second dorsal interosseous and the first lumbricalis muscles are inserted.

In the *third toe*, the third dorsal and first palmar interosseous and the second lumbricalis muscle are inserted.

In the *fourth toe*, the fourth dorsal and second palmar interosseous and the third lumbricalis muscles are inserted.

In the *fifth toe*, the third plantar interosseus, the abductor minimi digiti, the flexor minimi digiti, and the fourth lumbricalis muscle are inserted.

SECOND ROW.

In the *great toe*, the extensor longus pollicis and the flexor longus pollicis are inserted.

In the *other four toes* the extensor longus digitorum, one slip of the extensor brevis digitorum, except in the little toe, and the flexor brevis digitorum muscles are inserted.

THIRD ROW.

Two slips of the common tendon of the extensor longus and the extensor brevis digitorum, and the flexor longus digitorum muscles are inserted into each phalanx.

ARTHROLOGY OR SYNDESMOLOGY.

ARTHROLOGY OR SYNDESMOLOGY.

The name articulation, synonymous with joint, is given, in descriptive anatomy, to the connection subsisting, in the recent skeleton, between any of the denser component parts, whether bone or cartilage.

Articulations or joints may be arranged in three classes, as follows:

- I. Synarthrosis, (immovable) 4 varieties
  - Suture.
    - Dentata.
    - Serrata.
    - Limbosa
  - Harmonia.
  - Schindylesis.
  - Gomphosis.
- II. Amphiarthrosis, synchondrosis, or symphysis, (limited motion.)
- III. Diarthrosis, (free motion) 3 varieties
  - Enarthrosis (ball and socket joint.)
  - Ginglymus (hinge joint.)
  - Arthrodia (gliding joint.)

The following structures enter into the formation, to a greater or less extent, of all the joints:

1. Bone, (articular lamella.)
2. Ligaments.
3. Cartilage, (articular, costal, or membraniform.)
4. Fibro-cartilage.
5. Synovial membrane.

The LIGAMENTS are usually composed of white fibrous tissue, although two ligaments of the body are composed purely of yellow elastic tissue. These *two* ligaments are the ligamentum sub-flava and the ligamentum nuchæ, both of which are connected with the vertebral column.

Ligaments may be divided into three principal classes: 1st, *capsular;* 2nd, *fascicular;* 3rd, *funicular.*

Capsular ligaments (from *capsula*, a small coffer or box) are barrel-shaped expansions, attached by their extremities around the margin of the articulating surfaces composing the joint.

Funicular ligaments (*funis*, a rope) are those which resemble a cord in their appearance.

Fascicular ligaments (*fascis*, a bundle) are flattened bands, more or less expanded, somewhat like a riband, and comprise the remaining varieties.

CARTILAGE is divided into two varieties, *viz.*, temporary and permanent. The latter is divided into (1) *articular*, (2) *costal*, (3) *membraniform.*

Articular cartilage is either disposed as a thin layer between two articular surfaces, or it forms an encrustation upon the articular ends of bones, entering into the composition of diathrodial or movable joints.

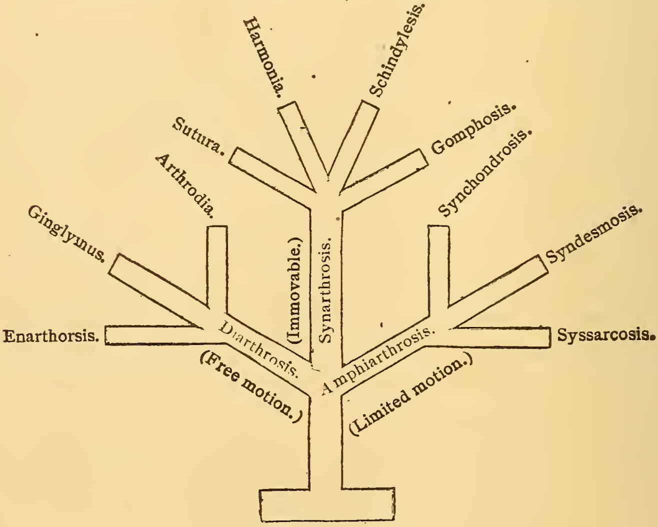
Fibro-cartilage may be either *circumferential*, where it helps to deepen cavities; 2, *connective*, where it helps to bind parts together; 3., *inter-articular*, where it tends to separate opposing bones, and 4, *stratiform*, where it lines grooves for tendons.

The *synovial membranes* of the joints may be, 1st, *articular*, where they serve simply to lubricate the joint; 2nd, *vesicular*, where they form shut sacs, called bursæ; 3rd, *vaginal*, where they form a sheath for tendons.

The following table illustrates by a tree-like figure, the three principal divisions of joints and the subdivisions of each.

It will thus be seen that *amphiarthrosis* (joints with limited motion) is divided into *three* distinct types, called respectively, synchondrosis, syndesmosis, syssarcosis; that *synarthrosis* (immovable articulations) comprises *four* types, which are respectively named sutura, harmonia, schindylesis, and gomphosis; and finally, that *diarthrosis* (joints with free motion) comprises *three* principal forms, called respectively, arthrodia, ginglymus, and enarthrosis.

Diagram of the Varieties of Joints.



Arthrology.

Each of these types will be considered in their order.

Synchondrosis, or *symphysis*, means union by cartilage.

Syndesmosis means union by ligament.

Syssarcosis means union by muscular tissue.

Suture means union of bone by a series of processes and indentations, which fit into each other. It is often divided as follows:

Sutura dentata, where the interlocking processes are large and extensive, as in the sagittal and lambdoidal sutures.

Sutura serrata, where the interlocking processes are smaller and more regularly distributed, as in the temporary suture of the frontal bone.

Sutura limbosa, where the articular surfaces are bevelled, and one overlaps the other, as in the fronto-parietal suture,

Harmonia means a mere apposition of two rough bony surfaces, as is found between the two halves of the upper jaw and in the temporo-parietal suture.

Schindylesis means the insertion of a thin plate of bone into a cleft, formed by the separation of the two plates of another bone, as is perceived in the articulation of the rostrum of the sphenoid bone with the vomer.

Gomphosis means the implantation of one bone into a process of another bone, of which the teeth, by their insertion into the alveolar process of the jaws, afford examples.

Enarthrosis means the articulation of a globular head of a long bone into a cup-shaped cavity. It is also called the *ball-and-socket joint*, and an example of it is afforded in the articulation of the femur at the hip.

Arthrodia comprises all articulations of surfaces which are flat or nearly so. It admits of only a gliding movement, which movement is never extensive. An example of this form of articulation is afforded where the acromion process of the scapula joins with the clavicle.

Ginglymus, or *hinge-joint*, includes all joints which admit of either an angular, a lateral, or a rotary motion. By some anatomists, the latter form of articulation is called *diarthrosis rotatorius*. Examples of the ginglymus form of articulation are present in the knee, ankle, elbow, in the articulation of the head of the radius and the ulna, and in the articulation of the atlas with the axis.

Joints admit of *seven varieties of motion, viz.:*

1. Flexion.
2. Extension.
3. Adduction,

4. Abduction.
5. Rotation.
6. Circumduction.
7. Gliding movement.

In the *first two* of these movements, the *hinge* and *ball-end socket* joints are most prominently useful. In the *next four*, the *ball-and-socket* joints are most chiefly used, while, in the *latter*, the *arthrodial* joints are alone implicated.

The articular lamella differs from the ordinary bone tissue (1) in containing no Haversian canals, (2) its lacunæ are larger, (3) it contains no canaliculi.

A.

ARTICULATIONS OF THE CRANIUM WITH THE SPINE.

These include the occipito-atloid, the occipito-axoid, and the atlo-axoid articulations. The latter, although not directly affecting the head, cannot well be separated from this group.

Occipito-atloid Articulation.

This joint is a *double arthrodia* between the condyles of the occipital bone and the superior articular surfaces of the atlas.

Its ligaments are *seven* in number, as follows:

Two anterior occipito-atloid.
A posterior occipito-atloid.
Two lateral occipito-atloid.
Two capsular.

The *anterior ligaments* are two in number, *viz.:* the *superficial*, which springs from the basilar process of the occipital bone, and is attached to the anterior tubercle of the atlas; and the *deep*, which extends from the anterior margin of the foramen magnum to the upper border of the anterior arch of the atlas.

The *posterior ligament* extends from the posterior margin of the foramen magnum to the upper border of the posterior arch of the atlas.

It is *perforated* by the *vertebral arteries* and *sub-occipital nerves.*

The *lateral ligaments* extend from the jugular processes of the occipital bone to the base of each of the transverse processes of the atlas.

The *capsular ligaments* surround the arthrodial articulations, and are lined by a synovial membrane, which often communicates with the synovial membrane between the odontoid process and the transverse ligament of the atlas.

The articulation of the *condyles* of the *occipital bone* with the cups of the atlas, corresponds nearly to a line drawn *through the anterior margins* of the *mastoid processes* of the temporal bone.

Occipito-axoid Articulation.

The head and the axis do not touch each other, but nevertheless, the four following connecting ligaments exist:

Occipito-axoid ligament.
Three occipito-odontoid ligaments, comprising
Two lateral or check ligaments.
A median or suspensory ligament.

The *occipito-axoid ligament* is a continuation upwards of the posterior common ligament of the bodies of the vertebræ.

The *check ligaments* extend, upon either side, from the inner side of the condyles of the occipital bone to the sides of the odontoid process of the axis, near to its apex.

The *suspensory ligament* extends from the anterior margin of the foramen magnum to the apex of the odontoid process of the axis.

Atlo-axoid Articulation.

This is a complex joint, consisting, first, of a *double arthrodia* between the articular processes of the atlas and the axis, and also of a *double diarthrosis rotatorius* between the odontoid process and the atlas.

Its ligaments are *six* in number, which are as follows:

Two anterior atlo-axoid ligaments.
A posterior atlo-axoid ligament.
A transverse ligament.
Two capsular ligaments.

The *anterior ligaments* consist of a *superficial* ligament, which extends from the anterior tubercle of the atlas to the base of the odontoid process and the body of the axis; and a *deep* ligament which extends from the lower border of the anterior arch of the atlas to the base of the odontoid process and the body of the axis.

The *posterior ligament* extends from the lower border of the posterior arch of the atlas to the upper border of the laminæ of the axis.

The *transverse ligament* divides the ring of the atlas into two portions, and *embraces the neck* of the odontoid process of the axis. It extends between the *tubercles*, on the inner surface of each of the lateral masses of the atlas.

This ligament gives off two fasciculi, one of which passes vertically upwards, and the other downwards, and thus form, with the transverse band, the so-called *cruciform ligament.*

The *capsular ligaments* surround the two arthrodial articulations.

There are *four synovial membranes* connected with this joint, one lining the inner surface of each of the capsular ligaments, one between the anterior surface of the odontoid process and the posterior surface of the anterior arch of the atlas, and the other between the posterior surface of the odontoid process and the transverse ligament of the atlas.

B.

ARTICULATIONS OF THE VERTEBRÆ.

The vertebræ are joined together by their bodies, their laminæ, their articular processes, their spinous processes, and their transverse processes.

THE BODIES are united by three sets of ligaments, *viz.:*

I. *Intervertebral discs.*

These are lenticular-shaped discs of fibro-cartilage, which are firmly adherent to the bodies of the adjoining vertebræ.

II. The *anterior common ligament.*

This ligament joins the bodies of the vertebræ, in front, and extends from the axis to the sacrum. It is attached also to each of the intervertebral discs of fibro-cartilage between the vertebræ.

III. The *posterior common ligament.*

This ligament extends between the posterior surfaces of the bodies of all the vertebræ from the axis above to the sacrum below. It is continuous, at its upper portion, with the occipito-axoid ligament.

The ARTICULAR PROCESSES are united by two ligaments called the *capsular* ligaments, which are lined internally by a synovial membrane.

The LAMINÆ are joined together by highly elastic bands, one on either side, called the *ligamenta subflava.*

The SPINOUS PROCESSES are joined together by two ligaments.

I. The *interspinous ligaments.*
These connect the adjacent margins of the adjoining spinous processes of the vertebræ.

II. The *supraspinous ligament.*
This ligament extends from the seventh cervical vertebræ to the sacrum. It connects the apices of the spinous processes of the vertebræ.

The TRANSVERSE PROCESSES are joined together by ligaments called the *inter-transverse ligaments* of the vertebral column. They are often insignificant or wanting in the cervical region, and they are attached to the adjacent margins of the adjoining transverse processes of all the vertebræ.

C.

ARTICULATIONS OF THE RIBS.

The ribs have five distinct points of articulation which may be enumerated as follows:

I. Costo-vertebral articulations.
II. Costo-transverse articulations.
III. Chondro-sternal articulations.
IV. Chondro-costal articulations.
V. Chondro-chondral articulations.

Costo-Vertebral Articulation.

These articulations consist of a *double arthrodia* between the heads of each rib and the bodies of two adjoining vertebræ. The exceptions to this rule exist in the first, tenth, eleventh, and twelfth ribs, which articulate with only one vertebra and therefore form but a single arthrodial joint. The ligaments of these articulations are three in number, *viz.*:

I. The *capsular ligament*, which surrounds the articular surfaces.

II. The *anterior costo-vertebral ligament*, or *stellate ligament*, consisting of three fasciculi, one joined to the vertebra above, another to the vertebra below, and the middle one to the intervertebral disc between them.

III. The *interarticular costo-vertebral ligament*, which connects the head of the rib to an interveterbral disc of fibrocartilage.

Costo-Transverse Articulation.

These articulations are ten in number, are *arthrodial* in character, and serve to connect the tubercles of the ten upper ribs and the transverse processes of the lower of the two vertebræ, with which the head of each rib articulates. The ligaments of these joints are three in number, *viz.*:

I. The *posterior costo-transverse ligament*, which extends from the apex of the transverse process of the vertebra to the outer part of the tubercle of the rib.

II. The *middle costo-transverse ligament*, which connects the front of the transverse process of the vertebra to the posterior portion of the neck of the rib.

III. The *anterior costo-transverse ligament*, which connects the lower border of the transverse process of that vertebra which lies above the rib, to the upper border of the neck of the rib below.

Chondro-Sternal Articulation.

These articulations are situated between the extremities of the costal-cartilages of the seven upper ribs, on either side, and the margins of the sternum. The first articulation is a *synarthrodial* joint, since it presents no synovial membrane, while the other six are *arthrodial* in character. The ligaments of these articulations are as follows:

I. The *capsular ligament*, which blends with the anterior and posterior ligaments.

II. The *anterior chondro-sternal ligament*, which connects the front of the sternum with the front of the costal-cartilage.

III. The *posterior chondro-sternal ligament*, which connects the back of the sternum to the back of the costal-cartilage.

IV. The *chondro-xiphoid ligament*, which connects the xyphoid appendix to the front of the sixth or seventh costal-cartilage.

An *interarticular fibro-cartilage* exists in the second articulation only and is attached between the manubrium and the gladiolus, on the one hand, and the tip of the costal-cartilage, on the other.

Chondro-Costal Articulation.

These articulations exist between the outer extremity of each costal-cartilage and the depression on the outer end of the corresponding rib. These parts are bound together by the blending of the periosteum and the perichondrium.

Chondro-Chondral Articulation.

These articulations are formed by the joining together of the costal-cartilages of the 8th, 9th and 10th rib. A synovial membrane is wanting in the first and the last of these articulations The ligaments of each of these joints are two in number, *viz.*, a *capsular* and an *intercostal*, which bind the cartilages together.

D.

ARTICULATIONS OF PELVIS.

The articulations of the pelvis are four in number as follows:

I. Sacro-iliac articulation.
II. Pubic articulation.
III. Sacro-coccygeal articulation.
IV. Sacro-vertebral articulation.

Each of these articulations require a separate description.

Sacro-Iliac Articulation.

This articulation is one of the *synchondroses* and presents five ligaments as follows:

I. The *anterior sacro-iliac ligament*, which connects the anterior surfaces of the sacrum and the ilium.

II. The *posterior sacro-iliac ligament*, which connects the posterior portion of the lateral surface of the sacrum with the inner surface of the projecting portion of the ilium.

III. The *oblique sacro-iliac ligament*, which connects the posterior superior spine of the ilium with the back of the third or fourth piece of the sacrum.

Ligaments between the Sacrum and Ischium.

The *great sacro-sciatic ligament*, which arises from the posterior inferior spine of the ilium, as well as from the posterior surfaces and the margins of the sacrum and the coccyx, and is inserted into the inner margin of the tuberosity and the ascending ramus of the ischium.

The *lesser sacro-sciatic ligament*, which arises from the margins of the sacrum and of the coccyx and is inserted into the spine of the ischium.

This ligament separates the *greater* and the *lesser sacro-sciatic foramina*.

Pubic Articulation.

This joint is one of the *amphi-arthrodial* joints. It posesses four ligaments as follows:

I. The *anterior pubic ligament*, which connects the front surfaces of the two pubic bones.

II. The *posterior pubic ligament*, which connects the posterior surfaces of the two pubic bones.

III. The *supra-pubic ligament*, which joins the upper border of the pubic bones.

IV. The *sub-pubic ligament*, which forms a fibrous arch between the rami of the pubic bones.

An *interarticular fibro-cartilage* exists between the bones forming this joint.

Sacro-Coccygeal Articulation.

This articulation is similar to those between the bodies of the vertebræ. It posesses three ligaments as follows:

I. The *anterior sacro-coccygeal ligament*, which connects the front of the sacrum to the front of the coccyx.

II. The *posterior sacro-coccygeal ligament*, which connects the margins of the lower orifice of the sacral canal to the back of the coccyx.

An *interarticular fibro-cartilage* exists also in this joint.

Sacro-Vertebral Articulation.

This articulation is similar to other vertebral articulations except that it has two additional ligaments, *viz.*:

I. The *lumbo-sacral ligament* (sacro-vertebral), which connects the fifth lumbar vertebræ, in front, to the sides of the base of the sacrum.

II. The *ilio-lumbar ligament* (lumbo-iliac), which connects the tip of the transverse process of the fifth lumbar vertebræ to the crest of the ilium.

E.

TEMPORO-MAXILLARY ARTICULATION.

This joint is a *double arthrodial* articulation, existing between the condyles of the lower jaw, on the one hand, and the anterior part of each glenoid cavity, on the other.

It has two synovial membranes, which are separated by an *interarticular fibro-cartilage*, and which occasionally communicate.

It has four ligaments, which are as follows:

I. The *capsular ligament*, which connects the circumference of the glenoid cavity of the temporal bone and the eminentia articularis, with the neck of the condyle of the jaw.

II. The *external lateral ligament*, which connects the outer surface and the tubercle of the zygoma with the outer surface and the posterior border of the neck of the condyle of the lower jaw.

III. The *internal lateral ligament*, which connects the spinous process of the sphenoid bone to the inner margin of the dental foramen. This ligament bears a close relation to the *internal maxillary artery* and the *inferior dental vessels* and *nerve.*

IV. The *stylo-maxillary ligament*, which connects the apex of the styloid process of the temporal bone to the angle and the posterior border of the ramus of the jaw. It separates the *parotid gland* from the *submaxillary gland.*

F.

ARTICULATIONS OF THE UPPER EXTREMITY.

The articulations of the upper extremity may be arranged in the following groups:

I. Sterno-clavicular articulation.
II. Scapulo-clavicular articulation.
III. Ligaments of the scapula.
IV. Shoulder joint.
V. Elbow joint.
VI. Radio-ulnar articulations.
VII. Wrist joint.
VIII. Articulation of the carpal bones.
IX. Carpo-metacarpal articulations.
X. Metacarpo-phalangeal articulations.
XI. Articulations of the phalanges.

Sterno-clavicular Articulation.

This joint is formed by the articulation of the sternum with the inner extremity of the clavicle. It has *two synovial membranes*, which are situated on either side of an interarticular fibro-cartilage. These two sacs occasionally communicate through an orifice produced by perforation of this cartilage, at its centre. Its ligaments are five in number, as follows:

I. The *anterior sterno-clavicular ligament*, which connects the front of the clavicle to the first piece of the sternum.

II. The *posterior sterno-clavicular ligament*, which connects the back part of the clavicle to the first piece of the sternum.

III. The *interclavicular ligament*, which connects the inner extremities of both clavicles with the margin of the sternum and with each other.

IV. The *costo-clavicular*, or *rhomboid ligament*, which connects the under surface of the clavicle to the cartilage of the first rib.

V. *The capsular ligament*, which extends from the circumference of the head of the clavicle to the sternum.

The *interarticular fibro-cartilage*, present between the bones of this joint, moves freely with the clavicle. This joint admits of slight movements in almost every direction.

The *sterno-clavicular articulation* is an important *surgical locality*, since the innominate artery and the points of origin of the subclavian and the carotid arteries, upon the *right side*, and the common carotid artery, upon the *left side*, are in close relation. The innominate vein, upon the left side, and the apices of the lungs, upon both sides, are also present in this region.

Acromio-Clavicular Articulation.

This is an *arthrodial* joint and possesses five ligaments, which are as follows:

I. The *superior acromio-clavicular ligament*, which extends from the upper part of the outer end of the clavicle to the upper surface of the acromion process of the scapula.

II. The *inferior acromio-clavicular ligament*, which connects the under surface of the outer end of the clavicle to the under surface of the acromion process of the scapula.

III. The *trapezoid ligament*, which connects the upper surface of the coracoid process of the scapula to the under surface of the clavicle. This ligament is sometimes described as one fasciculus of the *coraco-clavicular* ligament, of which the conoid ligament forms the remainder.

IV. The *conoid ligament*, which connects the base of the coracoid process of the scapula to the conoid tubercle of the clavicle.

An *interarticular fibro cartilage* is present between the bones which form this joint, and is attached to the superior acromio-clavicular ligament.

This joint has usually but one synovial membrane. The *conoid* and *trapezoid ligaments* are not properly those of a joint, but are usually described in connection with the acromio-clavicular articulation.

Ligaments of the Scapula.

The scapula has connected with it two ligaments, which do not properly belong to any joint, but which are usually described in connection with the acromio-clavicular articulation. These two ligaments are as follows :

I. The *anterior* or *coraco-acromial ligament.*

This ligament connects the acromion process of the scapula with the outer border of the coracoid process, and thus completes the vault above the head of the humerus.

II. The *transverse* or *supra-scapular ligament.*

This ligament extends from the base of the coracoid process to the inner margin of the supra-scapular notch. It converts this portion of the bone into a *foramen*, which transmits the supra-scapular nerve.

Shoulder–Joint.

This is an *enathrodial* joint and is formed by the globular head of the humerus and the glenoid cavity of the scapula. It possesses three ligaments which are as follows:

I. The *capsular ligament*, which connects the neck of the scapula, at the margin of its glenoid cavity, to the anatomical neck of the humerus.

II. The *coraco-humeral ligament*, which connects the coracoid process of the scapula with the anterior part of the greater tuberosity of the humerus. It is intimately blended with the capsular ligament.

III. The *glenoid ligament*, which is a fibro-cartilaginous ring, triangular on section, attached to the circumference of the glenoid cavity. It is continuous, above, with the *tendon* of the *long head* of the *biceps* muscle.

The *synovial membrane* of the shoulder-joint is prolonged, as a *sheath*, upon the tendon of the biceps, the tendon of the subscapularis, and the tendon of the infra-spinatus muscles. It communicates with a *bursa* beneath both the infra-spinatus and the subscapularis muscles. A *bursa* between the upper part of the capsular ligament and the deltoid muscle also exists, but it does not communicate with the synovial membrane of the shoulder joint.

The *capsular ligament* is remarkably loose and is attached around the glenoid cavity outside of the glenoid ligament, and to the humerus, where the neck springs from the tuberosities and the shaft. This ligament possesses *three openings*, through which the prolongations of the synovial membrane upon the tendons of the above named muscles take place.

The *vessels* of this joint are derived from the circumflex and the supra-scapular arteries.

The *nerves* of the shoulder-joint are derived from the circumflex and the supra-scapular trunks.

The *movements* of the shoulder-joint are very free and embrace all the varieties possible to joints.

The Elbow Joint.

This is a *ginglymus* articulation between the lower end of the humerus and the greater sigmoid cavity of the ulna and the head of the radius.

It has four ligaments, as follows:

I. The *anterior ligament*, which connects the inner condyle and the anterior portion of the humerus, with the orbicular ligament of the radius and with the under surface of the coronoid process of the ulna.

II. The *posterior ligament*, which connects the apex and sides of the olecranon process of the ulna, to the lower end of the posterior surface of the humerus, above the margin of the olecranon fossa.

III. The *external lateral ligament*, which connects the external condyle of the humerus with the *orbicular ligament* of the radius.

IV. The *internal lateral ligament*, which connects the internal condyle of the humerus with the inner border of the coronoid and olecranon processes of the ulna.

The *synovial membrane* of this joint lines the coronoid and the olecranon fossæ of the humerus and also dips down between the articular surface of the superior radio-ulnar articulation. It is also reflected over the anterior, posterior, and lateral ligaments of the joint.

The *vessels* of this joint are derived from the superior and inferior profunda, the anastomotica magna, and the radial, ulnar, and interosseous recurrent arteries.

The *nerves* to this joint are derived from the ulnar and the musculo-cutaneous nerve.

The *movements* of the elbow joint consist of *flexion* and *extension* only, although, from the direction of the articulating surfaces of the humerus, the hand during flexion moves in a plane internal to the direction of the axis of the shaft of the humerus.

Radio-Ulnar Articulations.

The bones of the forearm are connected together at their upper extremities, their shafts, and their lower extremities. Thus three articulations are formed, called the superior, the middle and the inferior.

Superior articulation.

This is a *lateral ginglymus* joint between the circumference of the head of the radius and the lesser sigmoid cavity of the ulna. The opposing surfaces of bone are covered with cartilage and a synovial membrane is interposed between them, which is continuous with that of the elbow joint. Its only ligament is called the annular or orbicular ligament.

The *orbicular ligament* is a strong flattened band of fibrous tissue, which forms four-fifths of the circumference of a circle and which surrounds the upper part of the neck of the radius. It is attached to the anterior and the posterior margins of the lesser sigmoid cavity of the ulna.

The inner surface of this ligament is *lined* with a *synovial membrane*, while the outer surface affords attachment for the *external lateral ligament* of the elbow joint.

Middle articulation.

The shafts of the ulna and the radius are joined, at their contiguous borders, by two ligaments, as follows:

The *oblique* or *round ligament*, which is a narrow fasciculus extending downwards and outwards from the tubercle, at the base of the coronoid process of the ulna, to the shaft of the radius, one half inch below its tubercle.

The *interosseous ligament*, which is a broad and thin plane of aponeurotic fibres, extending, obliquely downwards and inwards, from the interosseous ridge on the radius to that of the ulna. It is deficient, above, commencing about one inch below the tubercle of the radius; is broader in its middle portion than at either extremity; and, through the space left by its deficiency above, the *posterior interosseous vessels* pass.

Inferior articulation.

This is a *lateral ginglymus* joint formed by the head of the ulna and the sigmoid cavity of the radius. These surfaces are covered with cartilage and are connected together by the following ligaments.

1. The *anterior radio-ulnar ligament*, which connects the anterior margin of the sigmoid cavity of the radius to the anterior portion of the head of the ulna.

2. The *posterior radio-ulnar ligament*, which connects the posterior margin of the sigmoid cavity to the posterior portion of the head of the ulna.

A *triangular fibro-cartilage* also extends from the lower margin of the sigmoid cavity to the depression at the root of the styloid process of the ulna. This cartilage is lined, both upon its upper and lower surfaces, by synovial membrane, derived respectively from the radio-ulnar and the radio-carpal articulations, and is blended, at its margins, with the other ligaments of the joint.

The *synovial membrane* of this joint is very largely developed and is termed the *membrana sacciformis*. It occasionally communicates with the synovial membrane of the wrist joint through an opening in the centre of the triangular fibro-cartilage.

The Wrist Joint.

This articulation is regarded by some as an *enarthrodial*, and by others as an *arthrodial* joint. It is formed by *three* of the upper row of carpal bones, *viz.*, the scaphoid, the semilunar and the cuneiform, and by the lower surface of the radius and the triangular fibro-cartilage of the inferior radio-ulnar articulation. The ligaments of this joint are four in number and may be enumerated as follows:

I. The *external lateral ligament* (radio-carpal), which connects the apex of the styloid process of the radius to the scaphoid, the trapezium, and the anterior annular ligament of carpus.

II. The *internal lateral ligament* (ulno-carpal), which connects the apex of the styloid process of the ulna with the cuneiform and the pisiform bones, and with the anterior annular ligament of the carpus.

III. The *anterior ligament*, which connects the head of the ulna and the anterior margin of the radius and its styloid process, with the scaphoïd, semilunar, and cuneiform bones.

It is occasionally attached to the os magnum.

IV. The *posterior ligament*, which connects the posterior margin of the radius with the scaphoid, semilunar and cuneiform bones.

The *vessels* of the wrist joint are the anterior and posterior carpal branches of both the radial and the ulnar arteries, the anterior and posterior interosseous arteries, and the ascending branches of the deep palmar arch.

The *nervous* supply of the wrist joint is derived from the *ulnar* nerve.

The wrist joint admits of *all possible movements* but that of *rotation.*

The wrist joint is opened by inserting a knife, with its edge directed upwards and inwards, at the *apex* of the *styloid process* of the ulna.

Articulations of the Carpus.

Articulations of the bones of the proximal row.

The first three bones of the carpus, *viz.*, the scaphoid, the semilunar, and the cuneiform, are joined together by *two* arthrodial articulations.

The *ligaments* of these articulations consist of two dorsal, two palmar, and two interosseous ligaments.

The *pisiform bone* is joined to the cuneiform by a *separate arthrodial* joint, having a separate synovial membrane.

The two ligaments of this joint connect the pisiform bone to the unciform bone and also to the base of the 5th metacarpal bone.

Articulation of the bones of the distal row.

The four bones comprising the second row of the carpus are joined together by *three arthrodial* articulations.

The *ligaments* of these three articulations are three dorsal, three palmar and three interosseous ligaments.

Articulation of the two rows of carpal bones.

Upon each side of the wrist, *two arthrodial* articulations exist between the two rows of the carpus, and, in the *centre*, a variety of *enarthrodial* articulation is formed between the os magnum and the unciform bone above, and the scaphoid, semilunar, and cuneiform bones below.

The *inner* arthrodial joint exists between the cuneiform and the unciform bone, while the *outer* is formed between the scaphoid bone, above, and the trapezium and trapezoid bones, below.

The *ligaments* which unite the two rows of carpal bones consist of a dorsal, a palmar, and two lateral ligaments. The two lateral ligaments are continuous with the lateral ligaments of the wrist joint.

The *synovial membranes* of the carpus are five in number, and are situated as follows:

The *first* (membrana sacciformis) lines the following parts:		Lower end of the ulna. Sigmoid cavity of the radius. Upper surface of the triangular interarticular fibro-cartilage.
The *second* lies above the bones of the carpus and lines the following parts	Above.	Lower end of radius. Interarticular fibro-cartilage.
	Below.	Scaphoid. Semilunar. Cuneiform bones.
The *third* is very extensive and lines the following parts...................... ...		The contiguous surfaces of the proximal and distal rows of carpal bones. The contiguous surfaces of the distal row of carpal bones. The carpal extremities of the inner four metacarpal bones,

The *fourth* is situated between the trapezium and the metacarpal bones of the thumb.
The *fifth* is situated between the cuneiform and the pisiform bones.

The furrow between the thick skin of the palm and the skin of the forearm, on the anterior surface of the wrist, is a guide to the *upper border* of the *annular ligament* and the *articulation between* the *first* and *second rows* of the carpus.

Carpo-metacarpal Articulations.

The *trapezium* and the *metacarpal bone of the thumb* are united by a capsular ligament and are lined by a separate synovial membrane.

The *four inner metacarpal bones* unite with the carpus by *four arthrodial* joints, which are formed as follows:

2nd. *Metacarpal bone* and *trapezium*, *trapezoid*, *os magnum.*
3rd. *Metacarpal bone* and *os magnum.*
4th. *Metacarpal bone* and *os magnum* and *unciform.*
5th. *Metacarpal bone* and *unciform.*

The *ligaments* of these joints are called the dorsal, the palmar, and the interosseous ligaments.

The *dorsal ligaments* are two in number to each metacarpal bone, with the exception of the fifth, which has but one.

The *palmar ligaments* are three in number and are connected with the third metacarpal bones.

The *interosseous ligaments* connect the third and fourth metacarpal bones to the os magnum and the unciform bones.

Metacarpo–Metacarpal Articulations,

The metacarpal bone of the *thumb* is not connected to the other bones of the metacarpus.

The *four inner* metacarpal bones are connected to each other both at their carpal and at their digital extremities.

Carpal extremities,

The articulations of the carpal extremities of the metacarpal bones are three in number and are *arthrodial* in character.

The ligaments of these joints consist *first*, of an interosseous set, which pass between the bones; *second*, a dorsal set, which are mainly directed across the back of the hand, and *third*, a palmar set, which is directed also transversely across the palm of the hand.

Digital extremities.

The digital extremities of the metacarpal bones are all joined together by the so called *transverse ligament of the metacarpus.*

The *transverse ligament* of the metacarpus prevents the wide separation of the fingers. It can be felt in the interdigital folds of the hand, and the skin which covers them is much thinner on the dorsal surface of the hand than on the palmar surface. Abscesses of the palm, for that reason, often open on the back of the hand.

Metacarpo-phalangeal Articulations.

The articulations between the metacarpal bones and the corresponding phalanges are *ginglymus* in variety.

The ligaments which enter into the formation of these joints are as follows:

I. *Anterior* or *glenoid ligaments.*

These ligaments are lined with a synovial membrane. They are grooved for the passage of the flexor tendons of the fingers, and, upon either side, they become continuous with the sheaths of these tendons.

II. *Lateral ligaments.*

These ligaments connect the tubercles on the sides of the head of each metacarpal bone with the glenoid ligament, and also with the sides of the first phalanges.

Phalangeal Articulations.

The articulations between the rows of phalanges are *ginglymus* in variety.

The ligaments of each of these joints, like those of the preceding articulations, consist of an anterior and two lateral ligaments for each joint.

Points of Surgical Interest.

The three rows of projections, known as "the knuckles" are formed by the proximal bones of the respective joints and may serve as guides to amputation, if the fact that the joints lie *in front* of the line of the knuckles be remembered.

The tendons of the fingers are more closely bound to the phalanges *between the joints*, than over them, and incisions made to relieve suppuration in the region of these tendons should therefore be made in the region of the *shaft* of the phalanges rather than near to their articular extremities.

The *furrows* which *cross* the *fingers* on their palmar surface are three in number. The set, nearest to the palm, do not correspond to the joints between the bones underneath, but the *second* and *third sets* of furrows are *guides* to the articulations between the phalanges.

In *opening the joint* between the *trapezium* and the *metacarpal bone of the thumb*, the knife should be introduced between the 1st and 2d metacarpal bones at their angle, with the edge directed outwards.

G.

ARTICULATIONS OF THE LOWER EXTREMITY.

The articulations of the lower extremity comprise the following groups:

I. The hip joint.
II. The knee joint.
III. The articulations between the tibia and fibula.
IV. The ankle joint.
V. The articulations of the tarsus.
VI. The tarso-metatarsal articulations.
VII. The metatarso-phalangeal articulations.
VIII. The articulations of the phalanges.

The Coxo-femoral or Hip Joint.

This articulation is the *typical enarthrodial* joint of the body. It is formed by the reception of the globular head of the femur into the acetabulum or cotyloid cavity of the os innominatum.

The ligaments of this joint are five in number, and may be divided into two sets, namely: 1st, the *circumferential* set, and 2nd, the *connecting*. The former of these includes two and the latter the remaining three of the five ligaments of the hip, as is shown below.

Circumferential, (2 ligaments.) { Cotyloid.
Transverse.

Connecting, (3 ligaments.) { Capsular.
Ilio-femoral.
Round or ligamentum teres.

The *cotyloid ligament* of the hip joint is an incomplete fibro-cartilaginous ring, which is triangular in section, and which is attached, *by its base*, to the margin of the acetabulum.

It is deficient at the cotyloid notch and its sharp free edge closely embraces the head of the femur. Its function is to deepen and to alter the shape of the bony cavity of the acetabulum.

The *transverse ligament* of the hip is a continuation of the cotyloid ligament, which extends from one side of the cotyloid notch to the other, and thus transforms it into a complete foramen.

The *capsular ligament* of the hip arises from the margin of the acetabulum, from the transverse ligament, and, by a few fibres, from the edge of the obturator foramen, and is inserted into the base of the neck of the femur, above; in front, into the anterior intertrochanteric line; and, behind, into the posterior intertrochanteric line of the femur.

The *capsule of the hip joint* has *three accessories*, viz., the ilio-femoral or Y ligament, the ischio-femoral ligament and the pubo-femoral ligament. These three accessory ligaments are all continuous with the fibres of the capsular ligament and limit the motions of the joint in certain directions.

The *ilio-femoral* or *accessory ligament* arises at the anterior inferior spine of the ilium, and is inserted into the lower part of the anterior intertrochanteric line. The lower portion of this ligament is bifurcated, and the two forks are called, respectively, the inner and the outer.

This ligament is sometimes called the "*Y ligament*" of the hip joint, as it somewhat resembles that letter in shape. It is of great *surgical importance*, since it materially aids in reduction of dislocations at the hip-joint by movements of the femur.

The *round ligament* or *ligamentum teres* of the hip joint arises from a depression in the head of the femur in its posterior and inferior quadrant, and is inserted, by two fasciculi, into the margins of the cotyloid notch of the acetabulum.

The SYNOVIAL MEMBRANE of the hip joint embraces the greater part not only of the head, but also of the neck of the femur, and it invests the capsular ligament, the cotyloid ligament, the ligamentum teres and the cavity of the acetabulum.

It communicates often, through a small opening in the capsular ligament of the hip joint, with a bursa situated beneath the psoas and the iliacus muscles.

The *vessels* of the hip joint are derived from the obturator, the accessory obturator, the sciatic, and the internal circumflex arteries.

The *nerves* of the hip joint are derived from the great sciatic, the obturator, the accessory obturator, and branches from the sacral plexus of nerves.

MOVEMENTS OF THE HIP JOINT.

The movements of the hip joint comprise those of flexion, extension, adduction, abduction, rotation and circumduction. Of these motions, *flexion is freer than extension ;* of the lateral movements, *abduction is the freest*, unless flexion be combined with adduction so that one limb passes in front of the other; while *circumduction* is much less free in the hip than in the shoulder.

Flexion at the hip joint is checked by the *approximation of* the *soft parts* and by the *ischio-femoral* ligament.

Extension at the hip joint is checked by the *ilio-femoral* ligament. This movement of the hip is confined to a few degrees only from the line of a perpendicular, in the erect attitude, if the pelvis be prevented from participating in the movement and thus affording an apparent and not a real movement within the joint.

Abduction at the hip joint is checked by the Y or *ilio-femoral* ligament and is limited to an arc of less than 90 degrees, if the pelvis be prevented from participating in the movement.

Adduction at the hip joint is checked by the *inner fork* of the Y or *ilio-femoral* ligament, except when the thigh is flexed and that ligament is thus relaxed, when the *ischio-femoral* ligament assists in limiting this movement of the femur.

Rotation outwards of the femur at the hip joint is checked by the *ligamentum teres* and by the *outer fork* of the Y or *ilio-femoral* ligament.

Rotation inwards of the femur at the hip joint is checked by the *ischio-femoral* ligament.

The entire *arc of rotation*, which the femur is capable of performing, is about one-quarter of a circle or 90 degrees.

Points of Surgical Value Pertaining to the Hip.

The hip-joint is so constructed that atmospheric pressure alone will support the weight of the limb, even after all the soft parts around the joint have been divided. If air be allowed, however, to enter into the joint, by perforation of the acetabulum from within the pelvis, the limb will immediately drop.

The *anterior superior spine* of the *ilium* is a valuable aid in recognizing the nature of injuries of the hip joint, since the *relation* of the *trochanter* of the femur *to this point* is altered in dislocation and fracture of that bone.

A valuable *guide* to *amputation at the hip joint* is afforded by a *furrow*, which runs, from the angle between the scrotum and the thigh, outwards towards the anterior superior spine of the ilium. This furrow lies *directly over the capsule* of the joint, and when fluid is present within the joint, this furrow is obliterated and a prominence is often present.

The *great trochanter* of the femur is a most *important guide* to the diagnosis of diseased conditions and injuries of the hip-joint. Its upper border is situated, when normally placed, on a *level* with the *spine of the pubes* and about three-quarters of an inch lower than the articular head of the femur. It is superficially placed, and is separated from the integument only by the fascia of the gluteus maximus muscle and a bursa which lies beneath it.

Nelaton's guide, to detect any displacement of the femur at the hip joint, consists of a line drawn from the anterior superior spine of the ilium to the most prominent part of the tuberosity of the ischium. This line should cross the upper border of the trochanter of the femur, and it also crosses the centre of the cavity of the acetabulum. To properly apply this test, the thigh should be semi-flexed and slightly adducted.

In performing reduction of the dislocations of the femur at the hip joint by motion, a valuable guide is afforded to the inexperienced surgeon as to the *direction of the head of the femur* during the various movements required, by remembering that the head of the femur will look in the same general direction as does the inner surface of the internal condyle of that bone.

The *Y* or *ilio-femoral ligament* is a most important factor in the reduction of dislocations of femur at the hip joint by motion, since it affords a point of resistance to the steps of abduction, rotation and extension, which are required to accomplish the reduction of that bone.

THE KNEE JOINT.

The femoro-tibial articulation or knee joint, is a *ginglymus* or hinge-joint.

Three bones enter into its formation, namely, the lower articular surfaces of the femur, the upper articular surfaces of the tibia, and the posterior surface of the patella.

The ligaments may be divided into two sets, as follows:

1st. A peripheral or external set. (Extra capsular.)

2nd. A deep or internal set. (Intra capsular.)

Under the *peripheral* or *external set* are embraced the following ligaments:

The anterior ligament.
The posterior ligament.
The internal lateral ligament.
The external lateral ligament.
The capsular ligament.

Under the *deep* or *internal set* the following ligaments are included:

The internal semilunar fibro-cartilage.
The external semilunar fibro-cartilage.
The transverse ligament.
The anterior crucial ligament.
The posterior crucial ligament.

By some anatomists, two more ligaments called the *ligamentum mucosum* and the *ligamenta alaria*, are described as belonging to the internal set, but they have been here excluded, since they are more properly considered as reflections of the synovial membranes of the joint.

The *anterior ligament*, or *ligamentum patellæ*, is a continuation of the tendon of the rectus femoris muscle. It extends from the apex of the patella to the lower part of the tubercle of the tibia. It is separated from the synovial membrane of the knee joint by a mass of adipose tissue, and from the upper part of the tibia by a small bursa.

The *posterior ligament* of the knee joint, called the *ligamentum posticum Winslowii* is partly derived from, and strengthened by, the tendon of the semimembranosus muscle, It extends from the inner tuberosity of the tibia to the upper and back part of the outer condyle of the femur.

Cruveilhier describes two additional *lateral portions* of this ligament, closely connected with the tendons of the muscles of the calf, and formed chiefly of vertical fibres, but they are looked upon by many as a part of the capsular ligament.

The *internal lateral ligament* of the knee connects the inner tuberosity of the femur with the inner tuberosity and the upper part of the inner surface of the shaft of the tibia. It is *very broad* and is equal in strength to the two ligaments in the opposite side of the joint.

The *external lateral ligament* of the knee joint consists of *two portions*, a long and a short portion. The *long portion* connects the outer tuberosity of the femur to the outer part of the *head* of the fibula; while the *short portion* connects the outer tuberosity of the femur with the apex of the *styloid process* of the fibula.

The *capsular ligament* of the knee joint lies beneath the other ligaments above mentioned, and in close relation with the synovial membrane of the joint. It is attached, *above*, to the lower end of the femur, just above its articular surface; *in front*, to the upper border and the sides of the patella; and, *below*, to the margins of the head of the tibia and to the semilunar fibro-cartilages of the knee-joint. It is an *incomplete investment* of the joint, since it is present only where deficiencies exist between the other extrinsic ligaments.

The *internal semilunar fibro-cartilage* covers the corresponding articular surface of the upper end of the tibia. It is narrower and longer than the external. Its convex border is blended with the capsular ligament of the knee-joint.

The *external semilunar fibro-cartilage* covers the external articular surface of the end of the tibia. Its anterior extremity is blended with the anterior crucial ligament, while its posterior extremity is blended with the posterior crucial ligament.

The two semilunar fibro-cartilages of the knee serve to *increase* the *extent* and the *depth* of the *tibial sockets* and also to *modify their form* to a perfect adaptation to the curves of the femoral condyles, during flexion and extension of the joint.

The *transverse ligament* of the knee-joint is a small slip of fibres which connects, transversely, the two semilunar cartilages and which is situated near to their anterior extremities.

The *anterior crucial ligament* of the knee-joint arises from the tibia, between the anterior extremities of both semilunar fibro-cartilages, and is inserted into the inner and back part of the *outer condyle* of the femur.

The *posterior crucial ligament* of the knee-joint is directed nearly vertically from a point of the tibia, between the posterior extremities of both semilunar fibro-cartilages, to the anterior and outer part of the *inner condyle* of the femur and to the front of the inter-condyloid notch.

The two crucial ligaments prevent the sliding of the tibia upon the femur in a forward or backward direction.

The *synovial membrane* of the knee-joint is the largest in the body. In its reflections, it forms the following parts which deserve attention.

1. A *cul-de-sac*, which extends upwards beneath the extensor muscles of the thigh for an inch or two above the articular surface of the femur. This cul-de-sac is *supported*, during the movements of the joint, by the subcrureus muscle, which is inserted into it.

It is sometimes replaced by a bursa, which, however, usually communicates with the knee-joint.

2. On *each side of the patella*, it forms a pouch beneath the aponeuroses of the vasti muscles, which pouch invests the corresponding condyle of the femur.

3. At the *lower border* of the *patella*, it gives off a process called the *ligamentum mucosum* which is attached, in front, to the inter-condyloid notch of the femur; and two other processes, called the *ligamenta alaria*, which pass obliquely from the sides of the ligamentum mucosum and which fit into the space between the tibia, patella and femur.

The *ligamentum mucosum* tends to support the synovial membrane of the joint, when both the flexor and extensor muscles are relaxed during the erect attitude, as when the body leans against some external object.

4. It invests the semilunar fibro-cartilages, except at their convex and attached margins, and also surrounds the crucial ligaments except at their posterior portion.

5. It extends beneath the capsular ligament under the heads of the gastrocnemius muscle, and is prolonged, through an *opening* in the *capsular ligament* of the joint, beneath the tendon of the popliteus muscle.

6. Occasionally, it is found to be continued into the superior tibio-fibular articulation.

The *vessels* of the knee-joint are derived from the five articular branches of the popliteal artery, from the anastomotica magna, and from the recurrent branch of the tibial artery.

The *nerves* are derived from the anterior crural, the obturator, the internal popliteal, and the external popliteal nerves.

Points of Surgical Interest Pertaining to the Knee.

The *tubercle* upon the outer side of the head of the tibia has a surgical value, since it indicates the *level* to which the *condyles* of the femur descend and the *lowest limit* of the *synovial membrane* of the knee-joint.

In operations in the vicinity of the lower end of the femur, the *knee should be flexed*, in order to draw downwards the cul-de-sac of the synovial membrane of the joint which lies beneath the tendon of the quadriceps extensor muscle.

Deviations of the ligamentum patellæ from the *perpendicular line* indicate some displacement of that bone.

The *patella* lies almost *entirely above the condyles* of the femur, when the knee-joint is extended, and, during flexion of that joint, it lies in the inter-condyloid fossa and more upon the *external condyle* than upon the inner. In the act of kneeling the patella protects the knee-joint.

A *large deposit of fat* beneath the ligamentum patellæ is provided as a means of packing all vacancies which exist between the bones, during the various movements of the joint. This deposit of fat, when the knee is extended, protrudes upon either side of the patella and often gives an *apparent sense of fluctuation*, which might lead to a suspicion of fluid within the joint.

In the region of the ligamentum patellæ, there exist *three bursæ ;* one deep bursa, under the ligament and separating it from the tibia ; and two between it and the integument, the upper of which when enlarged creates a swelling called the house-maid's knee.

The *bony projection* on the inner side of the lower extremity of the femur, for the attachment of the fibres of the adductor magnus muscle, corresponds to the *level* of the *upper part* of the *trochlea ;* a point useful in excision of the knee-joint.

The movement of *outward rotation* at the knee-joint is checked by the lateral and the crucial ligaments, and is affected by the degree of flexion of the joint which, at the same time, exists.

A swelling in the popliteal space, often as large as a hen's egg, is produced by the enlargement of the *popliteal bursa.* As this bursa not infrequently communicates with the synovial membrane of the knee-joint, surgical interference is not without danger.

Tibio-Fibular Articulations.

The tibia articulates with the fibula at its superior, its middle, and its inferior portions.

Superior articulation.

This is an *arthrodial* joint, whose synovial membrane is sometimes continuous with that of the knee.

Its ligaments are two in number, as follows:

1. The *anterior superior tibio-fibular ligament*, which connects the front of the head of the fibula with the outer tuberosity of the tibia. It consists of two or three broad and flat bands, which pass obliquely upwards and inwards.

2. The *posterior superior tibio-fibular ligament*, which connects the back of the head of the fibula with the outer tuberosity.

It is a single broad band and is covered by the tendon of the popliteus muscle. A synovial membrane lines this joint, which often communicates with the synovial membrane of the knee-joint of the tibia.

Middle articulation.

These bones are joined, in the region of their shafts, by an interosseous membrane which connects the contiguous borders of the tibia and the fibula.

This membrane is perforated, *high up*, for the passage of the anterior tibial vessels, and, *below*, for the passage of the anterior peroneal vessel.

Inferior articulation.

This is a *amphi-arthrodial* joint, the two bones being flat, smooth, and covered with cartilage, below, to the extent of about two lines.

The ligaments of this articulation are four in number, as follows:

1. The *anterior inferior tibio-fibular ligament*, which connects the front portion of the external malleolus with the front portion of the lower end of the tibia. This ligament is flat and triangular in form, its broadest part being below. It lies in contact with the cartilage covering the astragalus.

2. The *posterior inferior tibio-fibular ligament*, which connects the back part of the external malleolus with the back part of the lower end of the tibia, and is similarly arranged to the anterior.

3. The *interosseous ligament*, which connects the contiguous rough surfaces of the tibia and the fibula, and which forms the chief bond of union between the bones.

4. The *transverse ligament*, which connects the back portion of the external malleolus with the back portion of the tibia, near to the internal malleolus.

The synovial membrane of this joint is derived from that of the ankle-joint.

THE ANKLE-JOINT.

This is a *ginglymus articulation* between the astragulus and the lower extremities of the tibia and the fibula. The two malleoli of these bones enter prominently into this articulation.

The ligaments of this joint are four in number as follows:

1. The *anterior ligament*, which connects the tibia with the astragalus, by the margins of their articular surfaces.

2. The *posterior ligament*, the fibres of which are mainly transverse and which is continuous with the inferior posterior tibio-fibular ligament.

3. The *internal lateral ligament*, which is also called the *deltoid ligament*. This ligament consists of a *superficial set* of fibres, which connect the internal malleolus of the tibia with the inner part of the scaphoid, the lesser process of the os calcis, the back part of the inner surface of the astragulus, and the inferior calcaneo-scaphoid ligament; and a *deep set* of fibres which connect the apex of the internal malleolus of the tibia with the inner surface of the astragalus.

4. The *external lateral ligament*. This ligament consists of three separate fasiculi, as follows:

The *anterior fasciculus*, which connects the external malleolus with the astragalus, in front of its articular facet.

The *middle fasciculus*, which connects the apex of the external malleolus with the outer surface of the os calcis.

The *posterior fasciculus*, which connects the back part of the external malleolus with the astragalus, behind its external articular facet.

The *synovial membrane* of the ankle-joint invests the inner surfaces of the ligaments and sends a prolongation upwards between the tibia and the fibula, for a short distance.

The *vessels* of the ankle-joint are derived from the malleolar branches of the anterior tibial and from the terminal branches of the anterior peroneal arteries.

The *nerves* of the ankle-joint are derived from the anterior tibial nerve.

The *movements* of the ankle-joint consist of flexion and extension and a slight amount of lateral motion when the foot is extended.

Articulations of the Tarsus.

Articulations of the bones of the first row.

The astragalus and the os calcis, form *two arthrodial* articulations and are joined by three ligaments, which are as follows:

1. The *interosseous calcaneo-astragalcid ligament*, which connects the two bones directly, and which forms the chief bond of union. It is one inch in breadth and is very thick and strong.
2. The *external calcaneo-astragaloid ligament*, which connects the two outer surfaces of the bones with each other. It lies in front of the middle fasciculus of the external lateral ligament of the ankle-joint.
3. The *posterior calcaneo-astragaloid ligament*, which connects the back part of the astragalus with the upper portion of the os calcis. It is a short, narrow band and is directed obliquely backwards and inwards.

The *synovial membranes* of this joint are two in number, one to each articulation. The *anterior synovial membrane* is continued between the astragalus and the scaphoid.

Articulation of the bones of the second row.

The scaphoid, the cuboid and the three cuneiform bones, are connected by *arthrodial articulations*, the ligaments of which may be divided into three sets as follows:

1. The *dorsal set*, which are numerous small bands somewhat irregular in their attachments, which pass from each bone to the neighboring bones.
2. The *plantar set*, which are less dense than the dorsal, and which are also irregularly attached.
3. An *interosseous set*, which are *four* in number and which connect the three cuneiform bones with the cuboid and with each other, and also the scaphoid and the cuboid bones. They are arranged as follows:

The *first* connects the sides of the scaphoid and cuboid bones.

The *second* connects the sides of the internal and middle cuneiform bones.

The *third* connects the sides of the middle and external cuneiform bones.

The *fourth* connects the external cuneiform bone to the cuboid.

Articulation of the two rows of tarsal bones.

Two *arthrodial articulations* are present between the two rows of the tarsus; the first of which exists between the astragalus and the scaphoid bones, and the second between the os calcis and the cuboid bone.

The ligaments of these articulations are *seven* in number, and may be enumerated as follows:

1. The *superior astragalo-scaphoid ligament*, which connects the upper surfaces of the astragalus and the scaphoid.
2. The *superior calcaneo-cuboid ligament*, which also connects the os calcis and cuboid bone, on their superior aspect.
3. The *long calcaneo-cuboid ligament*, which connects the under surface of the os calcis with the bases of the 2d, 3d, and 4th metatarsal bones. It is the *longest ligament of the tarsus.* It converts the groove, on the under surface of the cuboid bone, into a canal for the passage of the tendon of the peroneus longus muscle.
4. The *short calcaneo-cuboid ligament*, which connects the under surfaces of the os calcis and the cuboid bones. This ligament is very broad and is *lined* by the *synovial membrane* which exists in the articulation between these bones.
5. The *interosseous* or *internal calcaneo-cuboid ligament*, which directly connects the os calcis and the cuboid bones. It is very broad and strong and is blended, at its origin, with the superior calcaneo-scaphoid ligament.
6. The *superior calcaneo-scaphoid ligament*, which connects the os calcis with the outer side of the scaphoid bone. This ligament and the internal calcaneo-cuboid ligament arise from the same point, and by separating, in front, form a resemblance to the letter Y.
7. The *inferior calcaneo-scaphoid ligament*, which connects the os calcis with the under surface of the scaphoid bone. This ligament is lined, upon its *upper surface*, by a

synovial membrane continued from the anterior calcaneo-astragaloid articulation.

The articulation between the astragalus and the scaphoid is the only *enarthrodial joint* of the tarsus. In this joint, the round head of the astragalus is received into a concavity formed by the following structures:

1. The posterior surface of the scaphoid.
2. The anterior articulating surface of the os calcis.
3. The upper surface of the calcaneo-scaphoid ligament.

It possesses only one ligament, the superior astragalo-scaphoid, which is a broad band connecting the neck of the astragalus with the upper surface of the scaphoid. The inferior calcano-scaphoid ligament supplies the place of an inferior ligament to this joint.

The *synovial membranes* of the tarsus are four in number, and are situated as follows:

Synovial membranes of the tarsus......
- One for the posterior calcaneo-astragaloid articulation.
- One for the two following points:...
  - Anterior *calcaneo-astragaloid* articulation.
  - *Astragalo-scaphoid* articulation.
- One for the *calcaneo-cuboid* articulation.
- One for the following points:
  - Articulation of the *scaphoid* and the *three cuneiform* bones.
  - The *articulations* of the *three cuneiform* bones.
  - The articulation of the *external cuneiform* bone and the *cuboid.*
  - The articulations of the *middle* and *external cuneiform* bones and the *bases* of the *second* and *third metatarsal* bones.

Tarso-Metatarsal Articulations.

This set of articulations comprises a number of *arthrodial joints*, which are formed as follows:

1st *metatarsal bone* and *internal cuneiform.*
2d *metatarsal bone* and *all three cuneiform bones.*
3d *metatarsal* and *external cuneiform.*
4th *metatarsal* and *external cuneiform* and *cuboid.*
5th *metatarsal bone* and *cuboid.*

As is perceived in the *second* of these articulations, the three cuneiform bones form a *deep recess* into which the second metatarsal bone is received. This fact renders disarticulation of the tarsal bones from the metatarsus extremely difficult.

The ligaments, which enter into the formation of these above named joints, may be divided into three sets as follows:

1. *A dorsal set*, which connect each metatarsal bone with the corresponding tarsal bone. The *second metatarsal* bone has *three* dorsal ligaments, one for each of the cuneiform bones.

2. *A plantar set*, which serve the same purpose, on the plantar aspect of the foot, but which are thinner and less regular in their situation.
3. *An interosseous set*, which comprises three strong ligaments, one of which is situated between the second metatarsal bone and the internal cuneiform bone, and the other two between the external cuneiform bone and the second and third bones of the metatarsus.

Metatarso-Metatarsal Articulations.

The metatarsal bones, like the metacarpal, are connected with each other both at their tarsal and at their digital extremities.

Tarsal extremities.

The 1st and 2d metatarsal bones do not come into contact at their tarsal extremities, but between the other metatarsal bones *arthrodial articulations* exist.

The ligaments of these articulations comprise three sets namely, a *dorsal*, a *plantar* and an *interosseous* set.

Digital extremities.

These extremities of the metatarsal bones are all joined together by a *transverse band*, which crosses the whole width of the metatarsus, and which is called the *transverse metatarsal ligament.*

Metatarso-Phalangeal Articulations.

These articulations differ, in no way, from those of the metacarpo-phalangeal articulations which are described in previous pages of this volume.

The ligaments of the joints are also similar, and are two in number, viz.

1. The *anterior* or *glenoid ligments.*
2. The *lateral ligaments* (two for each joint).

Phalangeal Articulations.

These *ginglymoid joints* are similar to those of the fingers and the ligaments of each of them correspond to those of the metacarpo-phalangeal articulations.

Points of Surgical Interest in the Region of the Foot.

The level of the ankle joint lies *one half inch* above the tip of the *inner malleolus.*

The *two malleoli* are the *surgical guides* to the *ankle joint*, and present points of difference which are deserving of special notice.

The *outer malleolus* descends lower than the inner, and thus locks the joint upon its outer side. The *inner malleolus* advances more to the front, but, being broader than the outer malleolus, its posterior border corresponds with that of the outer.

In Syme's amputation, the incision should therefore run from the *apex* of the outer malleolus to the *middle point* of the inner.

A *valuable guide in adjusting a fracture* of the lower extremity below the knee joint, may be afforded, by remembering that the *inner edge* of the *patella*, the *inner malleolus*, and the *inner border of the large toe* should be in the same vertical plane, provided that the leg be well formed.

The *tubercle* of the *scaphoid bone* is the *surgical guide* to the astragalo-scaphoid articulation, and is, therefore, on the line of the amputation of Chopart.

The point of articulation between the internal cuneiform bone and the metatarsal bone of the great toe lies about *one and a half inches in front* of the *tubercle of the scaphoid bone.*

The *calcaneo-scaphoid ligament* forms a portion of the receptacle or socket into which the scaphoid bone is placed.

The articulation between the os calcis and the cuboid bone lies *midway* between the tip of the *external malleolus* and the *tarsal extremity* of the 5*th metatarsal bone.*

The projection of the *fifth metatarsal bone* is the *guide* to the articulation of that bone with the cuboid.

In amputating the toes from the metatarsal bones, it should be remembered that the folds of skin, between the toes, lie *one inch in front of the articulation.*

The power of producing *adduction of the foot*, which is possessed by the tendo Achillis, depends upon the peculiar conformation of the articulating surfaces between the os calcis and the astragalus.

MYOLOGY.

MYOLOGY.

The muscles are the active organs of motion, constituting the *source of power* that is applied to the various levers represented by the component parts of the skeleton. The movements produced are the result of that peculiar property, possessed by muscles, of shortening themselves, which is called *muscular contractility*.

Muscles are of two great classes.

A. MUSCLES of ANIMAL LIFE or VOLUNTARY MUSCLES.

B. MUSCLES of ORGANIC LIFE or INVOLUNTARY MUSCLES.

The first class are under the control of the will, and comprise the muscles of *locomotion*, *respiration*, *expression* and some others. The second class are entirely withdrawn from the control of the will, such as those of the *heart*, of the *arteries*, of the *intestinal canal*, and of the *various organs*. When we employ the term "muscular system" we refer to the first class or voluntary muscles.

The muscles of the body may be connected either with the bony skeleton, the ligaments of joints, the cartilaginous structures or the integument. When attached to ligaments only, do muscles come in *direct contact*, however, with the part on which they are destined to act, since, when attached to bone and cartilage, the fibres are connected with the periosteum and perichondrium, and, when the action of the muscle is directed upon the integument, the fibres are usually connected with the subcutaneous areolar tissue.

Muscles vary greatly, (1) in their *general form*, (2) in their *method* of *arrangement* as regards their tendon, and (3) in their *size*.

The various *forms of muscles* are influenced by their situation and the function which they are destined to perform. In the limbs, they are usually of an *elongated* form, when superficially situated, and *broad*, when deeply placed. In the trunk, they are, as a rule, *broad*, *flattened* or *expanded*, since they form either the parietes of cavities or are spread out upon the bony wall of the chest or pelvis. We therefore employ such terms as *long*, *short*, *broad*, *expanded*, etc., as indicating peculiar conformations or types of muscles.

As regards the *arrangement* of *the muscular fibres to the tendons* to which they are attached, an equal diversity is perceived. The *long* muscles usually present a tendon at either one or both extremities, towards which longitudinal fibres converge. When shorter fibres converge to the side of a tendon, which runs for the whole length of a muscle, like the plumes of a pen, the name *penniform* is applied. Examples of this type are present in the peronei muscles.

If *short fibres* converge to *both sides* of a tendon, which extends for its whole length, the muscle is called *bipenniform*, as in the rectus femoris, while a muscle is said to be *radiated*, when its fibres converge from a broad, flat surface to a narrow tendinous *insertion*, as in the temporal muscle.

The *nomenclature* of muscles is defective and often confusing. Muscles may be named (1) from their *situation;* as the peroneus, tibialis, etc. (2) From their *form*, as the trapezius, triangularis, deltoid, etc. (3) From their *function*, as flexors, extensors, pronators, abductors, levators, tensors, etc. (4) From their *attachments*, as the sterno-mastoid, sterno-hyoid, sterno-thyroid, etc. (5) From their *divisions*, as the biceps, triceps, digastric, complexus, etc.

In all *voluntary muscles* and also in the *muscular fibres of the heart*, the primitive fasiculi present fine dark lines or *striæ* running transversely across the fibre in curved or parallel lines. Longitudinal striæ are also detected, but these mark only the direction and number of the ultimate fibres or fibrillæ.

The *striated* variety of muscular fibre is present in all the *voluntary muscles*, and also in those of the pharynx, the larynx, the upper half of the œsophagus, the heart, the walls of the venæ cavæ and the muscles of the ear.

The *unstriped* or *involuntary* muscular fibres are found in the lower half of the œsophagus, and the whole of the remaining gastro-intestinal tract; in the trachea and the bronchi; in the gall bladder and the ductus communis choledochus; in the pelvis and the calices of the kidney, the ureters, the bladder and the urethra; in the *female sexual organs, viz.*, the vagina, the clitoris, the uterus, the Fallopian tubes and the broad ligaments; in the *male sexual organs, viz.*, the penis, the urethra, the prostate gland, Cowper's ducts, the vesiculæ seminales, the vas deferens, the epididymis and the dartos; in the skin and mucous membranes; in the ducts of certain glands, as in Wharton's and Cowper's ducts; and finally in the walls of the arteries, veins and lymphatics.

The muscles may be divided for the sake of convenience of description, into the four following classes, as follows:

A. MUSCLES OF THE HEAD AND NECK.
B. " " TRUNK.
C. " " UPPER EXTREMITY.
D. " " LOWER EXTREMITY.

In the following pages will be found enumerated and classified the various muscles comprised under each of these heads, and a statement of those anatomical facts pertaining to the individual muscles which are of practical importance and value.

DIVISION I.

MUSCLES OF THE HEAD AND NECK.

(A.)

MUSCLES OF THE HEAD.

The muscles of the head may be arranged under seven distinct groups. They comprise 31 pairs and one single muscle.

The seven groups above mentioned are as follows:

I. Epicranial group	1 pair.		Occipito-frontalis.
II. Auricular "	3 pairs.		Attollens aurem. Attrahens aurem. Retrahens aurem.
III. Palpebral "	3 pairs.		Corrugator supercilii. Orbicularis palpebrarum. Tensor tarsi.
IV. Nasal "	4 pairs.		Pyramidalis nasi. Levator labii superioris et nasi. Compressor naris. Depressor labii superioris et nasi.
V. Orbital group	7 pair.		Levator palpebræ superioris. Rectus superior. Rectus inferior. Rectus internus. Rectus externus. Obliquus superior. Obliquus inferior.
VI. Labial group	9 pair, 1 single.	Upper lip.	Levator labii superioris proprius. Levator anguli oris. Zygomaticus major.
		Angle.	Zygomaticus minor. Buccinator. Risorius Santorini.
		Lower lip.	Levator menti. Depressor labii inferioris. Depressor anguli oris.
			Orbicularis oris (single.)
VII. Maxillary group	4 pair.		Temporal. Masseter. External pterygoid. Internal pterygoid.

ORIGIN AND INSERTION.

I.

EPICRANIAL REGION.

(1 muscle).

OCCIPITO FRONTALIS.

Is a flat, thin muscle, consisting of two fleshy bellies, connected by an intermediate tendon or aponeurosis sometimes called the "galea capitis."

Origin.

From the external two-thirds of the superior curved line of the occipital bone and the mastoid process of the temporal bone.

Insertion.

The inner fibres are blended with those of the pyramidalis nasi muscle, the rest of its fibres anastomosing with the corrugator supercilii, the orbicularis palpebrarum and the pyramidalis nasi muscles.

Nervous supply.

Facial nerve and sometimes the occipitalis minor.

II.

AURICULAR GROUP.

(3 muscles).

ATTOLLENS AUREM.

Origin.

From the aponeurosis of the occipito-frontalis muscle on the side of the cranium.

Insertion.

Into the upper part of the cranial surface of the pinna.

Nervous supply.

Small occipital branch of the cervical plexus.

ATTRAHENS AUREM.

Origin.

From the lateral aponeurosis of the cranium.

Insertion.

Into the front part of the helix.

Nervous supply.

Branch of the facial or 7th cranial nerve.

RETRAHENS AUREM.

Origin.

From the mastoid process of the temporal bone.

Insertion.

Into the posterior portion of the cranial surface of the concha.

Nervous supply.

Branches of the facial or 7th cranial nerve.

III.

PALPEBRAL GROUP.

(3 muscles).

ORBICULARIS PALPEBRARUM.

Origin.

1. From the internal angular process of the frontal bone and the nasal process of the superior maxillary bone.
2. From the anterior surface and the borders of the tendo oculi.

Insertion.

1. Into the skin covering the eyelids, spreading into the forehead, temple and cheek.
2. Into the inner third of the lower edge of the orbit.
3. Into the lower edge of the tendo oculi.

Action.

To close the eyelids, to compress the lachrymal sac, and to force the tears into the nasal duct.

Nervous supply.

Temporal and malar branches of the facial or 7th cranial nerve.

CORRUGATOR SUPERCILII.

Origin.

From the inner extremity of the superciliary ridge of the frontal bone.

Insertion.

Into the deep surface of the orbicularis palpebrarum muscle, near the middle of the arch of the orbit.

Nervous supply.

Branch of the facial or 7th cranial nerve.

TENSOR TARSI.

Origin.

From the crest and orbital surface of the lachrymal bone.

Insertion.

By two slips, into the tarsal cartilage near to the puncta lachrymalis.

Nervous supply.

Malar branch of the facial or 7th cranial nerve.

IV.

NASAL GROUP.

(5 muscles).

PYRAMIDALIS. NASI.

Origin.

This muscle is a continuation of the fibres of the frontalis muscle.

Insertion.

It becomes blended with the compressor naris muscle.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

LEVATOR LABII SUPERIORIS ALAEQUE NASI.

Origin.

From the upper part of the nasal process of the superior maxillary bone beneath the tendo-palpebrae.

Insertion.

By one slip, into the cartilage of the ala of the nose; by the other slip, it becomes blended, in the upper lip, with the orbicularis oris.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

COMPRESSOR NARIS.

Origin.

From the canine fossa in the surface of the superior maxillary bone.

Insertion.

It joins its fellow of the opposite side and with the pyramidalis nasi.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

DEPRESSOR ALAE NASI.

Origin.

From the incisor fossa of the superior maxillary bone.

Insertion.

Into the septum and the back part of the ala of the nose.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

Depressor Labii Superioris Alaeque Nasi.

Origin.

From the incisor fossa of superior maxillary bone.

Insertion.

Into the integument of the upper lip, and the cartilage of the septum and also of the nose.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

V.

ORBITAL GROUP.

(7 muscles).

Levator Palpebrae Superioris.

Origin.

From the sphenoid bone, in front of the optic foramen.

Insertion.

Into the upper border of the upper tarsal cartilage.

Nervous supply.

Motor oculi or 3d cranial nerve.

Rectus Superior.

Origin.

From the upper margin of the optic foramen, and from the sheath of the optic nerve.

Insertion.

Into the sclerotic coat of the eyeball.

Nervous supply.

Motor oculi or 3d cranial nerve.

Rectus Externus.

Origin.

By two heads. 1. From the outer margin of the optic foramen. 2. From the ligament of Zinn and the lower margin of the sphenoidal fissure.

Insertion.

Into the sclerotic coat of eyeball. Between the two heads of the muscle pass the following structures.

1. The 3d cranial nerve.
2. Nasal branch of the 5th cranial nerve.
3. The 6th cranial nerve.
4. Ophthalmic vein.

Nervous supply.

The abducens or 6th cranial nerve.

RECTUS INTERNUS.

Origin.

From the ligament of Zinn.

Insertion.

Into the sclerotic coat of the eyeball.

Nervous supply.

Lower division of the motor oculi or 3d cranial nerve.

OBLIQUUS SUPERIOR.

Origin.

About a line above the inner margin of the optic foramen.

Insertion.

Into the sclerotic coat at the outer part of the globe of the eye, the tendon first *passing through a pulley*, near the internal angular process of the frontal bone.

Nervous supply.

The patheticus or 4th cranial nerve.

OBLIQUUS INFERIOR.

Origin.

From a depression in the orbital plate of the superior maxillary bone, external to the lachrymal groove.

Insertion.

Into the outer part of the sclerotic coat of the eyeball.

Nervous supply.

The lower division of the 3d cranial nerve.

VI.

LABIAL GROUP.

(9 pairs and one single muscle.)

LEVATOR LABII SUPERIORIS PROPRIUS.

Origin.

From the lower margin of the orbit, immediately above the infra-orbital foramen; and from the adjoining surface of the malar bone.

Insertion.

Into the skin and the muscular substance of the upper lip.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

Action.

This muscle is supposed to render the hair erect, as in the feline tribes,

LEVATOR ANGULI ORIS.

Origin.

From the canine fossa of the superior maxillary bone, immediately below the infra-orbital foramen.

Insertion.

In common with the zygomaticus major, the orbicularis oris, and the depressor anguli oris, into the angle of the mouth.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

ZYGOMATICUS MAJOR.

Origin.

From the malar bone, in front of the zygomatic suture.

Insertion.

Into the angle of the mouth.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

ZYGOMATICUS MINOR.

Origin.

From the anterior part of the malar bone immediately behind the maxillary suture.

Insertion.

In common with that of the levator labii superioris.

Nervous supply.

Infra-orbital branch of the facial or 7th cranial nerve.

BUCCINATOR.

Origin.

1. From the outer surface and border of the alveolar process of the superior maxillary bone.
2. From the inferior maxillary bone, from the first molar tooth to the last.
3. From the pterygo-maxillary ligament.

Insertion.

Into the angle of the mouth, its fibres blending with those of the orbicularis oris, the zygomatic and the depressor anguli oris.

Action.

By pressing the cheeks inward, to assist in articulation, mastication, blowing or sucking.

Nervous supply.

The facial or 7th cranial nerve and the buccal branch of the inferior maxillary nerve.

LEVATOR LABII INFERIORIS. (LEVATOR MENTI.)

Origin.

From the incisor fossa of the inferior maxillary bone, external to the symphysis of the lower jaw.

Insertion.

Into the integument of the lower lip.

Nervous supply.

The facial or 7th cranial nerve.

DEPRESSOR LABII INFERIORIS. (Quadratus Menti.)

Origin.

From the external oblique line of inferior maxillary bone.

Insertion.

Into the integument of the lower lip.

Nervous supply.

The facial or 7th cranial nerve.

DEPRESSOR ANGULI ORIS. (Triangularis Menti.)

Origin.

From the external oblique line of inferior maxillary bone.

Insertion.

Into the angle of the mouth.

Nervous supply.

The facial or 7th cranial nerve.

ORBICULARIS ORIS.

Is the sphincter muscle of the mouth and consists of two portions, an upper and lower portion, one for each lip, which have attachments to the superior and inferior maxillary bones. The fibres of each of the semicircular planes situated in the lips, decussate at the angle of the mouth and unite with the decussating fibres of the buccinator. The fibres at the free margin of the lips are continued uninterruptedly from one lip to the other.

RISORIUS.

Origin.

From the fascia upon the masseter muscle or upon the parotid gland.

Insertion.

Into the orbicularis oris and the depressor anguli oris muscles.

Nervous supply.

Supra-maxillary branch of the facial or 7th cranial nerve.

This muscle is regarded, by some anatomists, as a portion of the platysma myoides muscle.

VII.

MAXILLARY GROUP.
(4 muscles).

TEMPORAL.

Origin.

From the temporal fossa and the temporal aponeurosis.

Insertion.

Into the coronoid process of the inferior maxillary bone and sometimes into the inner portion of the ramus of the jaw.

Nervous supply.

The inferior maxillary division of the 5th cranial nerve.

MASSETER.

Origin.

1. From the anterior two-thirds of the zygoma, and from the malar process of the superior maxillary bone.
2. From the inner surface of the zygoma.

Insertion.

Into the *angle* of the jaw, the external surface of the *ramus*, and the external surface of the *coronoid process* of the jaw.

Nervous supply.

The inferior maxillary division of the 5th cranial nerve.

EXTERNAL PTERYGOID.

This muscle consists of two distinct portions, each of which has a different point of origin.

Origin.

1. From the outer surface of the external pterygoid plate and greater wing of the sphenoid.

2. From the tuberosities of the palate bone and the superior maxillary bone.

Insertion.

Into a fossa on the anterior surface of the neck of the condyle, and into the edge of the interarticular fibro-cartilage of the temporo-maxillary articulation.

Nervous supply.

The inferior maxillary division of the 5th cranial nerve.

The *internal maxillary artery* passes between its *two heads.*

INTERNAL PTERYGOID.

Origin.

1. From a fossa between the two pterygoid plates of the sphenoid bone.

2. From the hamular process of the sphenoid bone.

3. From the tuberosity of the palate bone.

Insertion.

Into the angle and inner surface of the lower jaw, as high as the dental foramen.

Nervous supply.

A branch from the anterior division of the inferior maxillary nerve.

The first two muscles of this group tend to shut the lower jaw tightly upon the upper jaw. The last two muscles of this group tend to create a *horizontal* motion of the lower jaw, when acting alternately upon either side and not conjointly.

The *gustatory*, *dental* and *chorda tympani nerves* lie in close relation to the internal pterygoid muscle, as do also the *internal maxillary artery* and *vein.*

ACTION OF THE MUSCLES OF THE HEAD.

The muscles of the head may be classified secondly, on a basis of the *function* chiefly performed by them as follows:

I. Muscles of *expression*, 20 pairs and 1 single muscle, under which may be enumerated:

The epicranial group	1	pair.
" auricular "	3	pairs.
" palpebral "	3	"
" nasal "	4	"
" labial "	9	"
Total,	20	" of muscles.

The "obicularis oris" muscle, (single.)

II. Muscles of *vision.*

The orbital group. 7 pairs.

III. Muscles of *mastication.*

The maxillary group. 4 pairs.

The *labial group* of muscles, which have been classed as muscles of expression, assists also in *mastication* and in the acts of *talking* and *singing*, but they have been classified as muscles of expression, since, as a group, this seems a most important function.

NERVOUS SUPPLY OF THE MUSCLES OF THE HEAD.

Of these several groups of muscles, the motor nerves of the *epicranial*, the *auricular*, the *palpebral*, the *nasal*, and the *labial groups* (in all twenty pairs and one single muscle) are derived from *one nerve*, *viz.*, the *facial* or 7th cranial nerve.

The *maxillary group* also derives its motor power from *one nerve*, *viz.*, the anterior or smaller branch of the *inferior maxillary division* of the 5*th cranial nerve*, while *all the muscles of the orbit* are supplied by the *motor oculi* or 3*rd cranial nerve*, except the superior oblique and the external rectus muscles, the former of which is supplied by the 4*th cranial nerve* and the latter by the 6*th cranial nerve.*

B.
MUSCLES OF THE NECK.

The muscles of the neck consist of 45 pairs and one single muscle. They may be arranged in 9 classes or groups.

I. *Superficial lateral* group :.......2 pairs.	Platysma myoides. Sterno-cleido-mastoid.
II. *Infra* or *sterno-hyoid* group :.....4 pairs.	Sterno-hyoid. Sterno-thyroid. Omo-hyoid. Thyro-hyoid.
III. *Supra* or *genio-hyoid* group :.....6 pairs.	Anterior belly of digastric. Mylo-hyoid. Genio-hyoid. Genio-hyo-glossus. Hyo-glossus. Lingualis.
IV. *Submaxillary* or *stylo-hyoid* group : 3 pairs.	(Posterior belly of digastric) Stylo-hyoid. Stylo-glossus. Stylo-pharyngeus.
V. *Prevertebral* group : ....7 pairs.	Longus colli. Rectus capitis anticus major. Rectus capitis anticus minor. Rectus capitis lateralis. Scalenus anticus. Scalenus medius. Scalenus posticus.

VI. *Posterior cervical* group : ....8 pairs.	Splenius capitis. Trachelo-mastoid. Complexus. Biventer cervicis. Obliquus capitis superior. Obliquus capitis inferior. Rectus capitis posticus major. Rectus capitis posticus minor.
VII. *Muscles* of *palate* : ....5 pairs.	Tensor palati. Levator palati. Palato-glossus. Palato-pharyngeus. Azygos uvulæ.
VIII. *Muscles* of *pharynx* :............3 pairs,	Superior constrictor. Middle constrictor. Inferior constrictor.

IX. *Muscles* of the *larynx:* 7 pairs and 1 single.	Acting on *vocal cords :* 4 pairs and 1 single muscle.	Crico-thyroid. Crico-arytenoid posticus. Crico-arytenoid lateralis. Thyro-arytenoid. Arytenoideus, (single).
	Acting upon *epiglottis :* 3 pairs of muscles.	Aryteno-epiglottideus superior. Aryteno-epiglottideus inferior. Thyro-epigiottideus.

ORIGIN AND INSERTION.

SUPERFICIAL LATERAL GROUP.
(2 muscles).

PLATYSMA MYOIDES.

Origin.

From the clavicle, the acromion process of the scapula, and the subcutaneous fascia over the pectoralis major and deltoid muscles.

Insertion.

Into the chin, the lower jaw, and the fascia covering the parotid gland.

Nervous supply.

Superficial branches of the cervical plexus and branches of the infra-maxillary division of the facial or 7th cranial nerve.

STERNO-CLEIDO-MASTOID.

Origin.

From the inner third of the clavicle and, by a tendon, from the first bone of the sternum.

Insertion.

Into the mastoid process of temporal bone and the superior transverse ridge of the occipital bone.

Nervous supply.

The deep external branches of the cervical plexus and branches of the spinal accessory or 11th cranial nerve.

The *sterno-mastoid muscle* is an important *guide* to the *carotid arteries*, since its internal border is nearly parallel with the common carotid artery and since the muscle can be rendered very prominent, by the head being turned towards the opposite shoulder. Between the sternal and clavicular points of origin of this muscle, may be perceived, in all necks that are not particularly fleshy, a fossa called the *fonticulus gutturis*, since it rises and falls during respiration, especially if labored breathing exists.

INFRA OR STERNO-HYOID GROUP.
(4 muscles).

STERNO-HYOID.

Origin.

From the inner extremity of the clavicle, the posterior surface of the first bone of the sternum, the cartilage of the 1st rib and the sternal end of the clavicle.

Insertion.

Into the lower border of the body of the hyoid bone

Nervous supply.

A branch from the loop between the descendens noni nerve and the communicans noni nerve.

STERNO-THYROID.

Origin.

From the posterior surface of the sternum and the cartilage of the 1st rib.

Insertion.

Into the oblique line on the ala of the thyroid cartilage.

Nervous supply.

A branch from the loop between the descendens noni nerve and the communicans noni nerve.

THYRO-HYOID.

Origin.

From the oblique line on the ala of the thryoid cartilage.

Insertion.

Into the lower border of the body of the hyoid bone and its greater cornu.

Nervous supply.

A branch of the hypoglossal or 12th cranial nerve.

OMO-HYOID.

Origin.

From the upper border of the scapula, near the supra scapular notch, and, occasionally, from the ligament which crosses the notch.

Insertion.

Into the lower border of the body of the hyoid bone.

Nervous supply.

From *three sources, viz.*, the hypoglossal or 12th cranial nerve, a filament of the pneumogastric or 10th cranial nerve, and a filament from the cervical plexus of nerves. It is thus associated (1) with the *movements of the tongue*, (2) with the *function of respiration*, and (3) with the *movements* of the *muscles of the neck.*

The central tendon of this muscle is attached to the clavicle by the deep cervical fascia, which forms a loop about it.

The *omo-hyoid muscle*, in long and thin necks, may be discerned through the skin as a cord running parallel with and above the line of the clavicle, and rising and falling with the acts of inspiration and of expiration. It renders tense that portion of the cervical fascia, which lies over the apex of the lung, and its *posterior belly* is, by some anatomists, considered as analogous to a serration of the serratus magnus; its *central tendon* to a rudimentary cervical rib; and its *anterior belly*, to a sterno-hyoid muscle. It is a *guide* to the *seat of election* in the operation for ligation of the *common carotid artery.*

SUPRA OR GENIO-HYOID GROUP.
(6 muscles).

DIGASTRIC.

This muscle consists of two elongated muscular bellies, united by an intervening rounded tendon. It extends from the mastoid process of the temporal bone to the symphysis of the lower jaw.

Origin.

The posterior belly arises from the digastric groove, on the inner side of mastoid process of the temporal bone, and the anterior belly from a fossa on the inner side of the symphysis of the chin.

Insertion.

The central tendon is attached to the body and greater cornu of the hyoid bone, by a broad band of aponeurotic fibres, in the form of a loop, lined by a synovial membrane. The posterior belly passes through the stylo-hyoid muscle.

Nervous supply.

The posterior belly is supplied by the *facial* or 7th cranial nerve, and the anterior belly by the *mylo-hyoid branch* of the *inferior dental nerve.*

MYLO-HYOID.

Origin.

From the whole length of the mylo-hyoid ridge of the lower jaw, from the symphysis, in front, to the last molar tooth, behind.

Insertion.

Into the whole length of the body of hyoid bone and into a tendinous line from that bone to the chin.

Nervous supply.

The mylo-hyoid branch of the inferior dental nerve.

This muscle, with its fellow of the opposite side, forms the *floor of the mouth.*

GENIO-HYOID.

Origin.

From the inferior genial tubercle, on the inside of the symphysis of the lower jaw.

Insertion.

Into the anterior surface of the body of the hyoid bone.

Nervous supply.

The hypoglossal or 12th cranial nerve.

GENIO-HYO-GLOSSUS.

Origin.

From the superior genial tubercle, on the inner side of the symphysis of the chin.

Insertion.

1. Into the body of the os-hyoides.
2. Into the pharynx, between the hyoid bone and stylo-glossus muscle.
3. Into the under surface of the tongue.

Nervous supply.

The hypoglossal or 12th cranial nerve.

Action.

To depress the middle of the tongue.

This *muscle* has been *divided to relieve stammering.*

HYO-GLOSSUS.

Origin.

From the body and the greater and the lesser cornua of the hyoid bone.

Insertion.

Into the side of the tongue, between the lingualis and stylo-glossus muscles.

Nervous supply.

The hypoglossal or 12th cranial nerve.

Action.

To depress the sides of the tongue and render the dorsum of the tongue convex.

LINGUALIS. (Superior set of fibres.)

This muscle consists of a longitudinal set of fibres running from the base to the apex of the tongue, between the genio-hyo-glossus and the stylo-glossus and hyo-glossus muscles. Some of its fibres are lost on the base of the tongue and others are attached occasionally to the hyoid bone.

Nervous supply.

Chorda tympani branch of the facial or 7th cranial nerve.

Action.

To render the dorsum of the tongue convex by drawing its extremities together.

SUB–MAXILLARY OR STYLO–HYOID GROUP.
(3 muscles).

STYLO-HYOID.

Origin,

From the posterior part of the styloid process of the temporal bone, near to its base.

Insertion.

Into the body of the hyoid bone, at its junction with the great cornu.

Nervous supply.

A branch of the facial or 7th cranial nerve.

Action.

To raise and draw backwards the hyoid bone and the tongue.

STYLO-GLOSSUS.

Origin.

From the styloid process and the stylo-maxillary ligament.

Insertion.

1. Into the side of the tongue, from the palato-glossus muscle to the tip.

2. Into the transverse fibres of the tongue, by separating the fibres of the hyo-glossus muscles.

Nervous supply.

The hypoglossal or 12th cranial nerve.

STYLO-PHARYNGEUS.

Origin.

From the base of the styloid process of the temporal bone.

Insertion.

1. Into the posterior border of the thyroid cartilage.

2. Into the sides of the pharynx.

Nervous supply.

Glosso-pharyngeal or 9th cranial nerve and also branches of the pharyngeal plexus.

Action.

To elevate and widen the pharynx.

PREVERTEBRAL GROUP.

(7 muscles).

LONGUS COLLI.

1. *Vertical* portion.

Origin. From the bodies of the three upper dorsal and the lower cervical vertebræ, and the inter-vertebral cartilages.

Insertion. Into the bodies of 2nd, 3rd and 4th cervical vertebræ.

2. *Superior oblique* portion.

Origin. From the anterior tubercles of the transverse processes of the 3rd, 4th, and 5th cervical vertebræ.

Insertion. Into the tubercle on the anterior arch of the atlas.

3. *Inferior oblique* portion.

Origin. From the bodies of the two upper dorsal vertebræ.

Insertion. Into the transverse processes of the 5th and 6th cervical vertebræ.

Nervous supply.

One of the branches of the brachial plexus, given off above the clavicle.

RECTUS CAPITIS ANTICUS MAJOR.

Origin.

From the anterior tubercles of the transverse processes of the 3rd, 4th, 5th, and 6th cervical vertebræ.

Insertion.

Into the basilar process of the occipital bone.

Nervous supply.

The sub-occipital nerve and the deep branches of the cervical plexus.

RECTUS CAPITIS ANTICUS MINOR.

Origin.

From the anterior surface, the lateral mass, and the transverse process of the atlas.

Insertion.

Into the basilar process of the occipital bone.

Nervous supply

The sub-occipital nerve and the deep branches of the cervical plexus.

RECTUS CAPITIS LATERALIS.

Origin.

From the upper surface of the transverse process of the atlas.

Insertion.

Into the jugular process of the occipital bone.

Nervous supply.

The sub-occipital nerve.

SCALENUS ANTICUS.

Origin.

From the tubercle on the inner border and upper surface of the 1st rib.

Insertion.

Into the anterior tubercles of the transverse processes the of 3rd, 4th, 5th and 6th cervical vertebræ.

Nervous supply.

A supra-clavicular branch of the brachial plexus.

SCALENUS MEDIUS.

Origin.

From the 1st rib, behind the groove for the subclavian artery.

Insertion.

Into the posterior tubercles of the transverse processes of the *six lower* cervical vertebræ.

Nervous supply.

A supra-clavicular branch of the brachial plexus.

Scalenus Posticus.

Origin.

From the outer surface of the 2nd rib, behind the origin of the serratus magnus muscle.

Insertion.

Into the posterior tubercles of the transverse processes of the *two* or *three lower* cervical vertebræ.

Nervous supply.

A supra-clavicular branch of the brachial plexus.

POSTERIOR CERVICAL GROUP.

(8 muscles).

Splenius Capitis et Colli.

Origin.

From the ligamentum nuchæ, the 7th cervical vertebra, and the spinous processes of the 1st, 2nd, 3rd, 4th and 5th dorsal vertebræ.

Insertion.

Into the posterior tubercles of the transverse processes of the three upper cervical vertebræ; also into the mastoid process of the temporal bone, the superior curved ridge of the occipital bone and a rough space below it.

Nervous supply.

Posterior branches of the cervical nerves.

Trachelo-Mastoid.

Origin.

From the articular processes of the last four cervical, and the transverse processes of the first four dorsal vertebræ.

Insertion.

Into the posterior margin of the mastoid process of the temporal bone.

Nervous supply.

Posterior divisions of the spinal nerves.

Complexus.

Origin.

From the transverse processes of the last cervical and the four or five upper dorsal vertebræ.

From the articular processes of the 4th, 5th, 6th, and 7th cervical vertebræ.

Insertion.

Into the occipital bone, between the two curved lines on its inferior surface.

Nervous supply.

From *three sources, viz.*, the great occipital nerve, the sub-occipital nerve, and the internal branches of the posterior divisions of the cervical nerves.

BIVENTER CERVICIS.

Origin.

From the transverse processes of the three or four upper dorsal vertebræ.

Insertion.

Into the occipital bone, internal to the attachment of the complexus muscle.

Nervous supply.

From the same sources as the complexus.

This muscle is often described as a *fasciculus* of the *complexus muscle.*

OBLIQUUS CAPITIS SUPERIOR.

Origin.

From the extremity of the transverse process of the atlas.

Insertion.

Into the occipital bone, between the curved lines on its inferior surface and external to the point of insertion of the complexus muscle.

Nervous supply.

Posterior branch of the sub-occipital nerve.

OBLIQUUS CAPITIS INFERIOR.

Origin.

From the spinous process of the axis.

Insertion.

Into the extremity of the transverse process of the atlas.

Nervous supply.

From *two sources, viz.*, a branch of the sub-occipital and one from the great occipital nerve.

RECTUS CAPITIS POSTICUS MAJOR.

Origin.

From the spinous process of the axis.

Insertion.

Into the inferior curved line of the occipital bone.

Nervous supply.

Posterior branch of the sub-occipital nerve.

RECTUS CAPITUS POSTICUS MINOR,

Origin.

From the tubercle on the posterior arch of the atlas.

Insertion.

By fleshy fibres, into the occipital bone between the inferior curved line and the foramen magnum.

Nervous supply.

Posterior branch of the sub-occipital nerve.

PALATE GROUP.

(5 muscles).

TENSOR PALATI.

Origin.

1. From the scaphoid fossa.
2. From the adjoining portions of the sphenoid bone.
3. From the cartilaginous portion of the Eustachian tube.

Insertion.

Into the anterior surface of the soft palate, after winding around the *hamular process* of the sphenoid bone.

Nervous supply.

A branch from the Otic ganglion.

LEVATOR PALATI.

Origin.

From the apex of the petrous portion of the temporal bone and the cartilaginous portion of the Eustachian tube.

Insertion.

Into the posterior surface of the soft palate, where its fibres blend with those of the opposite side.

Nervous supply,

A branch of the facial or 7th cranial nerve, through the vidian nerve.

PALATO-GLOSSUS.

Origin.

From the anterior surface of the soft palate, on each side of the uvula.

Insertion.

Into the side and dorsum of the tongue, where it blends with the fibres of the stylo-glossus muscle.

Nervous supply.

Palatine branches of Meckel's ganglion.

PALATO-PHARYNGEUS.

Origin.

From the soft palate, by fibres connected with those of the opposite side.

Insertion.

After uniting with the stylo-pharyngeus muscle, it is inserted into the posterior edge of the thyroid cartilage and the lateral walls of the pharynx.

Nervous supply.

Palatine branches of Meckel's ganglion.

AZYGOS UVULAE.

Origin.

From the nasal spine of the palate bone.

Insertion.

Into the uvula and the tendinous aponeurosis of the soft palate.

Nervous supply.

A branch of the facial or 7th cranial nerve.

MUSCLES OF THE PHARYNX.

INFERIOR CONSTRICTOR.

Origin.

1. From the cricoid cartilage.
2. From the oblique line on the thyroid cartilage and the cartilaginous surface behind it.
3. From the inferior cornu of the thyroid cartilage.

Insertion.

Into the posterior median fibrous raphe of the pharynx, blending, in the middle line, with that of the opposite side.

Nervous supply.

By *three sources*, *viz.*, the glosso-pharyngeal, the external laryngeal and the recurrent laryngeal nerves.

MIDDLE CONSTRICTOR.

Origin.

From the body and the cornua of the hyoid bone and from the stylo-hyoid ligament.

Insertion.

Into the median raphe of the pharynx, and, by a few fibres into the basilar process of the occipital bone.

Nervous supply.

The glosso-pharyngeal nerve and the pharyngeal plexus.

SUPERIOR CONSTRICTOR.

Origin.

1. From the internal pterygoid plate (lower third) and from the palate bone.
2. From the pterygo-maxillary ligament.
3. From the aponeurosis, arising from the petrous portion of temporal bone.
4. From the posterior part of the alveolar process of the inferior maxillary bone, above the mylo-hyoid ridge.
5. From the base of the tongue.

Insertion.

Into the median tendinous raphe of the pharynx and the basilar process of the occipital bone.

Nervous supply.

The glosso-pharyngeal nerve and the pharyngeal plexus.

ACTION OF THE VARIOUS GROUPS OF MUSCLES OF THE NECK.

The *superficial layer* of muscles assist in depression of the head, inclination of the head to one side, depression of the lower jaw, and, through the platysma myoides, in the expression of melancholy.

The *infra-hyoid group* of muscles act as *depressors of the larynx* after it has been raised during the act of deglutition. They also act as *tensors* of the *cervical fascia.*

The *supra* or *genio-hyoid group* of muscles are important agents in the *act of deglutition*, since, by them, the hyoid bone is raised, and with it, the larynx, trachea, pharynx and œsophagus ; the superior opening of the larynx is closed, and the bolus of food is controlled by the numerous movements of the tongue. In case *liquids be swallowed by suction*, the tongue is given a proper longitudinal concavity, by the hyoglossus muscle, to afford a channel for the fluid, after the vacuum in the mouth has been created.

The *stylo-hyoid group* of muscles act upon the *pharynx* and the *tongue.* During their contraction, the *pharynx is opened* and *widened* for the entrance of food during deglutition, and the base of the tongue is drawn backwards and upwards over the elevated larynx, thus closing the superior opening of the larynx and preventing the entrance of food into its interior.

The *prevertebral group* of muscles *flex the head*, by the action of the recti capitis antici muscles; they also *flex the cervical portion of the spinal column*, by means of the longi colli muscles, and they *rotate the head* upon the spinal axis, when the recti capitis antici and laterales are in action. The *spinal column*, in the cervical region, may be also *bent to one side* and *flexed*, when the *three scaleni muscles* of either side act independently, provided the trunk be a fixed point, or they may assist in preserving it in an *erect posture* when acting in unison. These muscles however become, *during inspiration*, powerful elevators of the first and second ribs, as in this case, the spinal column becomes the fixed point of resistance, and the thorax is therefore acted upon.

The *posterior cervical group* of muscles serve mainly the purpose of controlling the *erect position* of the upper portion of the spine and maintaining the *poise of the head*. With the exception of the rectus capitis major and the inferior oblique muscles, *which produce rotation of the head*, the others either tend to incline the head to one side, when acting singly, or to draw it backwards, when the pairs act simultaneously.

We may say then in summary of the muscles acting upon the head, or upon the cervical portion of the spinal column and thus indirectly affecting the head, that, each pair of muscles produce a different effect when acting singly or in unison.

Thus the head may be simply *inclined to one side* by the platysma, sterno-mastoid, splenius, complexus, and the scaleni, when acting singly, or *flexion* or *extension of the head* will be produced, if the muscles act in pairs.

The *head* may be *flexed upon the neck* by the recti capitis antici majores and minores, and the *chin approximated to the chest* by the longi colli and sterno-mastoid muscles, which cause flexion of the cervical portion of the spine; but to accomplish these effects the muscles of each side must contract simultaneously. The muscles included in the *supra* and *infra-hyoid* groups may also greatly assist in flexion of the cervical portion of the spine.

The *head* may be *rotated* by the movements of the atlas upon the axis, produced chiefly by the action of the recti capitis antici and laterales, the recti capitis postici majores and the obliqui superiores, althoug others muscles may produce rotation of the head as an indirect rather than a direct effect of their contraction.

The *head* is drawn *backwards* by the simultaneous action of the following pairs of muscles, *viz.*, the recti capiti postici majores et minores, complexi, obliqui superiores, splenii capitis et colli, trapezii and trachelo-mastoidei.

The *sixth* or *palate group* of muscles are essentially muscles of *deglutition.* By their action the palate is raised and made tense, the opening of the posterior nares is protected from regurgitation of food, the tongue and fauces are made to assist in expelling the bolus of food into the pharynx and the orifice between the pillars of the fauces is diminished in size, thus also assisting in the retention of the food within the proper channels.

The *constrictor muscles* of the *pharynx* (the *seventh* group,) are also muscles of *deglutition.* They act subsequently to the action of the elevators of the hyoid bone and the larynx. They are also important muscles in *singing*, since they tend to modulate the high notes.

The *eighth group* of muscles, the *laryngeal group*, consist of seven pairs and one single muscle. Of these, four pairs and one single muscle (the arytenoideus) act upon the vocal cords and control phonation. The action of these muscles is as follows:

Muscles which stretch the vocal cords....	The CRICO-THYROID muscles.
" " relax " " "	The THYRO-ARYTENOID muscles.
" " open the glottis..........	The CRICO-ARYTENOID POSTICI.
" " close the glottis..........	The { CRICO-ARYTENOID LATERALES. ARYTENOIDEUS.

The three muscles which are attached to the *epiglottis* act as follows:

Muscle *compressing the superior opening* of the larynx during deglutition........	ARYTENO-EPIGLOTTIDEUS SUPERORIS.
Muscle *depressing the epiglottis* during the act of deglutition....................	THYRO-EPIGLOTTIDEUS.
Muscle compressing the sacculus laryngis..	ARYTENO-EPIGLOTTIDEUS INFERORIS.

The origin and insertion of the muscles of the larynx as well as their nervous supply, which have been omitted in this chapter, will be found fully described in subsequent pages of this work, since they can only be clearly understood by a previous description of that organ.

NERVOUS SUPPLY.

In the following pages will be found the muscles of the neck tabulated with their nervous supply *indicated by lines* running from each of the muscles to the source of its motor function. These tables also show the *number of muscles* supplied by *each nerve*, as well as the *number of sources*, from which *each muscle* is supplied, in case more than one motor nerve to the muscle exists.

TABLE OF NERVE SUPPLY TO THE MUSCLES OF THE NECK.

Name of Nerve.	*Name of Muscle.*	*Name of Group.*
Spinal accessory..1	Platysma myoides........	*Superficial lateral* group .... (2)
	Sterno-cleido-mastoid.....	
Cervical plexus...1	Sterno-hyoid..	*Infra hyoid* group (4)
Descendens noni..3 (loop.)	Sterno-thyroid...........	
	Omo-hyoid.............	
Mylo-hyoid......2	Thyro-hyoid............	
	Anterior belly of digastric.	*Supra hyoid* group (6)
Facial 4	Mylo-hyoid..............	
	Genio-hyoid	
	Genio-hyo-glossus........	
Hypoglossal.....6	Hyo-glossus..............	
	Lingualis................	
Glosso-pharyngeal.1	Posterior belly of digastric.	*Stylo-hyoid* or *sub-maxillary* group (3)
	Stylo-hyoid	
	Stylo-glossus............	
Deep branches of the cervical plexus.......3	Stylo-pharyngeus.........	
	Longus colli	*Prevertebral* group (7)
	Rectus capitis anticus major	
Lower cervical nerves 4	Rectus capitis anticus minor	
	Rectus capitis anticus lateralis.	
	Scalenus anticus.........	
Sub-occipital....3	Scalenus medius....	
	Scalenus posticus........	
Total 27 muscles.		Total, 22
Deduct muscles with two sources of nervous supply....... 5		
Total 22 muscles.		

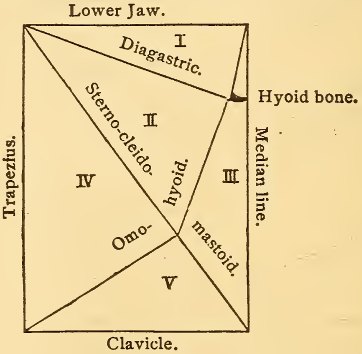
(Table continued.)

Name of Nerve.		*Name of Muscle.*	*Name of Group.*	
		Splenius capitis..........		
External posterior branches of cervical nerves.....	4	Trachelo-mastoid.........		
		Complexus...		
		Biventer cervicis.........	*Posterior cervical* group.........	(8)
Internal posterior branches of cervical nerves.....	4	Obliquus superior.........		
		Obliquus inferior..... ...		
		Rectus capit. posticus major		
		Rectus capit. posticus minor		
Vidian nerve	2	Tensor palati............		
		Levator palati		
Meckel's ganglion..	2	Palato-glossus...........	Muscles of *palate.*	(5)
Otic ganglion.....	1	Palato-pharyngeus........		
Pharyngeal plexus.	3	Azygos uvulæ............		
		Superior constrictor.......		
Glosso-pharyngeal.	3	Middle constrictor........	Muscles of *pharynx*..........	(3)
		Inferior constrictor........		
		Crico-thyroid		
Superior laryngeal.	3	Aryteno-epiglottideus super.		
		Aryteno-epiglottideus infer.		
		Thyro-arytenoid..........	Muscles of *larynx.*	(8)
Inferior laryngeal..	6	Crico-arytenoid posticus...		
		Crico-arytenoid lateralis...		
		Arytenoideus		
	28		Total,	24
Deduct muscles supplied from two sources...	4			
	24			

TRIANGLES OF THE NECK.

That portion of the neck extending from the median line, in front, to the anterior border of the trapezius muscle, behind, is divided, upon each side, into *two great triangles* by the sterno-mastoid muscles. The triangle, which lies in front of the sterno-mastoid muscle, is termed the *anterior triangle* of the neck, while the one lying behind that muscle is termed the *posterior triangle* of the neck. These two large triangles are subdivided by the *omo-hyoid muscle*, and the anterior triangle is again subdivided by the two bellies of the digastric muscle, thus forming *five* distinct triangles, which are specially named.

DIAGRAM OF THE TRIANGLES OF THE NECK.



The preceding diagram illustrates these surgical triangles, formed by the muscles of the neck. They are of interest, since their boundaries mark spaces, in which important vessels and nerves are contained. They have been named as follows:

I. The SUBMAXILLARY triangle.
II. " SUPERIOR CAROTID "
III. " INFERIOR CAROTID "
IV. " OCCIPITAL "
V. " SUBCLAVIAN "

Their boundaries are thus described:

INFERIOR CAROTID TRIANGLE.

In front, by the median line of the neck.
Behind, by the anterior margin of the sterno-mastoid muscle.
Above, by the anterior border of the omo-hyoid muscle.
The *floor* is formed by the longus colli and scalenus anticus muscles.

SUPERIOR CAROTID TRIANGLE.

Above, by the posterior belly of the digastric muscle.
Behind, by the sterno-mastoid muscle.
Below, by the anterior belly of the omo-hyoid muscle.
The *floor* is formed by the following muscles. { Hyo-glossus. Thyro-hyoid. Inferior constrictor. Superior constrictor.

SUBMAXILLARY TRIANGLE.

Above, by the lower border of the jaw, the parotid gland and the mastoid process.
Behind, by the posterior belly of the digastric and the stylo-hyoid muscles.
In front, by the middle line of the neck.
The *floor* is formed by the following muscles: { Anterior belly of digastric. Mylo-hyoid. Hyo-glossus,

Occipital Triangle.

In front, by the posterior margin of the sterno-mastoid muscle.
Behind, by the trapezius muscle.
Below, by the posterior belly of the omo-hyoid muscle.

The *floor* is formed by the following muscles:	Splenius. Levator anguli scapulæ. Scalenus medius. Scalenus posticus.

Subclavian Triangle.

Above, by the posterior belly of the omo-hyoid muscle.
Below, by the clavicle.
In front, by the posterior margin of the sterno-mastoid muscle.

The *contents* and *relations* of these triangles will be considered under the chapters descriptive of the vessels of the head and neck.

SURGICAL RELATIONS OF SPECIAL MUSCLES OF THE HEAD AND NECK.

Between the *internal* and *external pterygoid* muscles, lie the *internal maxillary artery* and *vein;* and the *dental* and *gustatory nerves* separate the internal pterygoid muscle from the ramus of the inferior maxillary bone.

Across the *buccinator* muscle, run the *facial artery* and *vein;* and this muscle is perforated by *Steno's duct*, which opens into the mouth opposite to the 2nd molar tooth of the upper jaw.

The *hypoglossal nerve* passes between the fibres of the *genio-hyo-glossus.* The *gustatory nerve* crosses the upper margin of the *hyo-glossus*, the *lingual nerve* crosses its middle portion, while, beneath it, lies the *lingual artery.*

The *external carotid artery* is separated from the *internal carotid artery* and the *jugular vein* by the *stylo-pharyngeus* and *stylo-glossus* muscles, and the *glosso-pharyngeal nerve* lies upon the outer side of the same muscle.

The *sterno-mastoid* muscle serves as a *guide* to the *common carotid artery*, as its inner border lies in close relation to it, and the *sterno-hyoid* and *sterno-thyroid* muscles, which also lie in close relation to this large vessel, require to be drawn towards the median line of the neck in case its ligature is demanded.

The *scalenus anticus* muscle lies immediately *in front* of the second portion of the *subclavian artery*, and the *brachial plexus* Anterior to the muscle but in close relation to it, lies also the *phrenic nerve*, and the *subclavian vein.*

The *cervical plexus* of nerves lies upon the *levator anguli scapulæ* and the *scalenus medius* muscles and is covered in by the sterno-mastoid muscle.

The *anterior jugular veins* pass underneath the *sterno-mastoid* muscle, at its lower portion, while the *external jugular vein* crosses in front of it, at its upper portion, and lies parallel to its posterior border, in its course down the neck.

The *posterior external jugular* vein lies between the *splenius* and the *trapezius* muscles.

The *longus colli* muscles are in relation, posteriorly, on each side, with the *first portion* of the *subclavian artery*, while the sternal origin of the sterno-mastoid and the sterno-hyoid and sterno-thyroid muscles lie in relation anteriorly with the same portion of that artery.

THE MECHANISM OF THE ACT OF DEGLUTITION.

The act of deglutition requires for its performances not only the coöperation of a large number of those muscles, included in the various groups in the region of the head and neck, but it requires, in addition, that these muscular contractions be performed in a *direct order of succession* and at a time when their action will directly and properly affect the bolus of food.

The act of deglutition has therefore been divided, for convenience of description, into three distinct stages, as follows:

1st period, comprising the passage of the bolus to the isthmus of the fauces.
2nd " comprising the passage of the bolus through the pharynx into the œsophagus.
3rd " comprising the passage of the bolus through the œsophagus.

In the *first period*, the muscles under the control of the will, *viz.*, those of the *tongue*, *lower jaw* and *soft palate* become important factors.

The mouth is first closed to assist the tongue in its action, since its attachments to the lower jaw impair its movements when the mouth is open. The tongue now becomes increased in width, save when the suction of liquids is performed, and the bolus is pressed by the tongue against the hard palate and slid backwards until it touches the soft palate. The *tensor palati* and the *palato-glossus* muscles now contract, and thus a partial resistance is made to further progress backwards of the bolus.

In the *second period* the control of the bolus is lost. A series of rapid muscular contractions of a *reflex type* ensue, which drive the bolus through the fauces and pharynx till it reaches the œsophagus.

The *larynx becomes suddenly raised* by the mylo-hyoid, genio-hyoid, stylo-hyoid, thyro-hyoid, genio-hyo-glossus, and the anterior belly of the digastric muscles; and the *pharynx* becomes simultaneously *widened* by the approximation of its two extremities.

The *soft palate* is raised, by the action of the levator palati muscle and by the pressure of the bolus; and the azygos uvulæ is grasped by the contraction of the superior constrictor muscle of the pharynx, which thus prevents the regurgitation of food into the nares.

The *isthmus of the fauces* is subsequently closed behind the bolus, as it passes that point; and, by the close approximation of the palato-pharyngeus muscles, the nares and buccal cavity are further protected from regurgitation.

The *larynx is protected* from the entrance of the food, by an adaptation of the tongue and epiglottis to its superior opening; and also by the approximation of the vocal cords and compression of the superior opening, through the action of the crico-arytenoid lateralis, the aryteno-epiglottideus superior, and the arytenoid muscles.

The successive contraction of the *three constrictor muscles* of the pharynx drives the bolus, therefore, into the œsophagus, since all other means of exit from its cavity are closed.

The *third period* is characterized by contractions of the longitudinal muscular fibres of the œsophagus, which constantly slips its mucous membrane above the bolus, and by subsequent contraction of its circular fibres, in a peristaltic action similar to that perceived in the lower portions of the alimentary canal.

MUSCLES OF THE TRUNK.

The muscles of the trunk may be divided as follows :

A. Muscles of the Abdomen.
B. Muscles of the Thorax.
C. Muscles of the Back.
D. Muscles of the Perineum.

Each of these regions will be considered separately.

A.

MUSCLES OF THE ABDOMEN.

The muscles which form the antero-lateral wall of the abdomen are six in number in the male sex, and five in number in the female. They may be thus divided :

Those between the *linea alba* and the *linea semilunaris* . . . . (2)	Rectus abdominis. Pyramidalis. (Sometimes wanting.)
Those between the *linea semilunaris* and the *vertebral column* . . . . (4)	Obliquus abdominis externus. Obliquus abdominis internus. Cremaster (in males only.) Transversalis abdominis.

ORIGIN AND INSERTION.

Rectus Abdominis.

Origin.

Arises by two tendons; one being attached to the crest of the pubes, and the other to a ligament covering the symphysis pubis.

Insertion.

1. Into the ensiform cartilage and the costo-xiphoid ligaments.

2. Into the cartilage of the 5th, 6th and 7th ribs.

This muscle is intersected by transverse tendinous slips, varying from three to five in number, which are adherent, anteriorly, to its sheath.

Nervous supply.

The lower intercostal nerves.

Pyramidalis.

Origin.

From the anterior portion of the pubes and the anterior pubic ligament.

Insertion.

Into the linea alba, midway between the umbilicus and the os-pubis.

Nervous supply.

The ilio-hypogastric nerve.

OBLIQUUS ABDOMINIS EXTERNUS. (External or descending oblique).

Origin.

By eight fleshy digitations, from the external surface and lower borders of the lower eight ribs.

Insertion.

1. By fleshy fibres, into the anterior half of the outer lip of the crest of the ilium.
2. Into the whole length of the linea alba, by means of an aponeurosis.
3. By Poupart's and Gimbernat's ligaments, into the spine of the pubes and into about one inch of the pectineal line.

Nervous supply.

The lower intercostal nerves.

Action.

To depress the ribs, to compress the viscera, to raise the pelvis if the thorax be fixed, or to flex the spine, if the pelvis be made a fixed point.

The so-called "*triangular ligament*" is a reflection of fibres from Gimbernat's ligament to the linea alba.

OBLIQUUS ABDOMINIS INTERNUS.

Origin.

1. From the external half of Poupart's ligament.
2. From the anterior two-thirds of the middle lip of the crest of the ilium.
3. From the posterior layer of the fascia lumborum.

Insertion.

1. By fleshy fibres, into the lower borders of the four inferior costal cartilages.
2. Into the linea semi-lunaris and the linea alba.
3. Into the body of the pubes and the pectineal line, in common with the fibres of the transversalis muscle, thus forming the so-called "*conjoined tendon*"

Nervous supply.

Ilio-hypogastric and ilio-inguinal nerves

TRANSVERSALIS ABDOMINIS.

Origin.

1. From the external third of Poupart's ligament.
2. From the anterior three-fourths of the internal lip of the crest of the ilium.

3. From the fascia lumborum.

4. From the inner surfaces of the cartilages of the lower six ribs.

Insertion.

1. Into the linea semi-lunaris and the linea alba, after joining with the posterior lamella of the aponeurosis of the internal oblique muscle.

2. Into the crest of the pubes, the pubic end of Poupart's ligament, and the linea pectinea, (thus helping to form the *conjoined tendon.*)

3. The internal portion of the muscle passes behind and beneath the spermatic cord, and is inserted subsequently into Poupart's ligament.

Nervous supply.

Lower intercostal nerves.

CREMASTER.

1. From the middle portion of Poupart's ligament.

2. Behind the pubic insertion of that ligament.

Insertion.

By successive loops, the spermatic cord is surrounded as well as the testicle and the tunica vaginalis.

Nervous supply.

The genito-crural nerve.

Action.

To suspend the testicle.

ACTION OF THE ABDOMINAL MUSCLES.

The abdominal muscles, when the pelvis and thorax are made fixed points, exert a *powerful influence*, during their contraction, upon the *abdominal viscera*, and in these acts the diaphragm becomes also a powerful adjunct.

Thus, in the act of vomiting, and in the expulsion of the fœtus from the womb, the act of defecation, or the evacuation of the urine from the bladder, (in cases where any obstruction to the free exit of their contents exists), *a long breath is usually taken* before the abdominal muscles contract; since, by so doing, the diaphragm presents a state of tension eminently calculated to direct the entire force of their contraction upon the viscera.

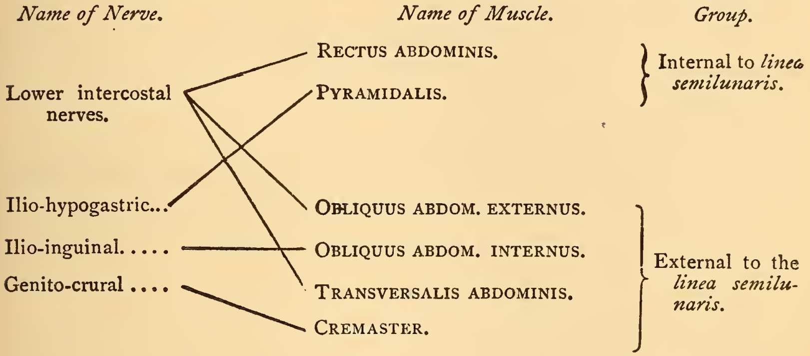
They also *assist in expiration*, by depressing the lower part of the thorax, when the spine is made a fixed point; and, in cases where the spine is relaxed, they tend to *flex the thorax* upon the pelvis, if both sides act simultaneously, or, if not, they produce a lateral displacement of the thorax, with a *partial rotation of the trunk* towards the side opposite to the muscles in contraction.

The abdominal muscles also assist greatly in *drawing the pelvis upwards*, when the thorax becomes a fixed point, as is illustrated in the act of *climbing*.

The *recti muscles* are depressors of the thorax and serve to flex the spinal column, if the pelvis be fixed; or, if the thorax be made the point of resistance, the pelvis may, by these muscles, be flexed upon the vertebral column.

The *pyramidalis muscle*, though often wanting, tends, when present, to act as a *tensor of the linea alba*.

NERVOUS SUPPLY OF THE ABDOMINAL MUSCLES.



DIRECTION OF THE FIBRES OF EACH MUSCLE.

As the abdominal walls demand a *great power of resistance* to internal pressure, we find the muscular layers arranged so as to prevent a possible separation of the various fibres, which would afford an opportunity for protrusion of viscera.

The fibres of each of the abdominal muscles are therefore directed differently, as is shown in the following:

External oblique muscle..................	downwards and inwards.
Internal oblique muscle....	upwards and inwards.
Transversalis abdominis muscle...........	horizontally.
Rectus abdominis muscle.................	upwards.
Pyramidalis muscle............	upwards.

POINTS OF SURGICAL INTEREST PERTAINING TO THE ABDOMINAL MUSCLES.

The *aponeurotic tendon* of the *internal oblique muscle* of the abdomen deserves special notice.

At the outer margin of the rectus abdominis muscle, this aponeurosis, for the *upper three-fourths* of its extent, splits into two lamellæ, one of which passes in front and the other behind the muscle, thus enclosing it in a kind of sheath, and, reuniting on the inner border of this muscle, the tendon becomes continuous with its fellow of the opposite side, and assists in forming the linea alba. The *anterior layer* of this aponeurosis becomes blended, in its passage over the rectus muscle, with the tendon of the external oblique muscle; and the *posterior layer*, during its passage behind the rectus muscle, also becomes continuous with the tendinous aponeurosis of the transversalis abdominis muscle.

In *the lower fourth* of the rectus muscle, however, the aponeurosis of the internal oblique does not separate into lamellæ, but passes, with the aponeurosis of the transversalis abdominis, entirely *in front* of that muscle.

Of these muscles the following prominent points also deserve special mention, as the parts have important surgical relations to hernial protrusions.

A. Poupart's Ligament.

This ligament is formed by the *lower fibres* of the *aponeurosis of the external oblique muscle*, and extends from the anterior superior spine of the ilium to the spine of the pubis.

B. Gimbernat's Ligament.

This ligament is a reflection of fibres derived from *Poupart's ligament*, backwards and inwards, to the *pectineal line.*

C. The Pillars of the External Ring.

The *external* and the *internal pillars* of the external abdominal ring are formed by the aponeurosis of the external oblique muscle. They enclose an opening, called the *external abdominal ring*, one-half to three-quarters of an inch in length, for the transmission of the spermatic cord, in the male, and the round ligament, in the female.

D. Triangular Ligament.

This ligament is formed by fibres, reflected from *Gimbernat's ligament*, which extend behind the internal pillar of the external abdominal ring, to the *linea alba.*

E. The Intercolumnar Fascia.

This is a prolongation of the *spermatic fascia*, which extends between the two pillars of the external abdominal ring, and which renders the opening of the external abdominal ring almost *square* in shape.

F. The Inguinal Canal.

This canal is *one and a half inches in length* and extends from the internal abdominal ring to the external abdominal ring. It has the following boundaries :

In front.	(5 structures)...	Skin. Superficial fascia (two layers). External oblique muscle, *for its entire length.* Internal oblique muscle, *for its outer third.*
Behind.	(5 structures)....	Conjoined tendon of the internal oblique and transversalis muscles. Transversalis fascia. Triangular ligament. Sub peritoneal tissue and fat. Peritoneum.
Above.	(2 structures). ...	Fibres of internal oblique muscle, Fibres of transversalis abdominis muscle.
Below.	(2 structures).....	Poupart's ligament. Transversalis fascia.

This canal lies *parallel* with *Poupart's ligament*, and is directed downwards and inwards. Its extremities are named respectively the internal abdominal ring and the external abdominal ring. It transmits the spermatic cord, in the male, and the round ligament, in the female.

G. The Femoral Ring.

This opening is oval in shape, is *one half of an inch in breadth*, and is situated underneath Poupart's ligament, *internal to the femoral vessels.* It has the following boundaries :

Above.	(2 structures).....	Poupart's ligament. Deep crural arch.
Below.	(4 structures).....	Pubic bone. Pectineus muscle. Iliac fascia. Pubic portion of fascia lata.
Internally.	(4 structures).	Gimbernat's ligament. Conjoined tendon. Deep crural arch. Transversalis fascia.
Externally.	(2 structures).	Femoral vein and septum.

From the *spine of the pubes outwards*, we find, in the normal condition, the following structures in this order:

1. *Gimbernat's* ligament.
2. Femoral *opening.*
3. Femoral *vein.*
4. Femoral *artery.*
5. Anterior crural *nerve.*

The term G. O. V. A. N. (the name of a town in Scotland,) may assist the memory by representing through its five letters the prominent italicised parts, in their order.

H. The Femoral Canal.

This canal is *one-half of an inch in length*, and extends from the *femoral ring* to the upper part of the *saphenous opening*, in the thigh. It has the following boundaries:

In front. (3 structures)...	Poupart's ligament. Fascia transversalis. Falciform process of the fascia lata.
Behind. (2 structures)....	Iliac fascia. Pubic portion of fascia lata.
Externally. (2 structures).	Femoral vein. Femoral septum.
Internally. (4 structures).	Fascia transversalis. Iliac fascia. Gimbernat's ligament. Deep crural arch.

This canal is closed, at its *upper opening*, (the femoral ring) by a fibrous septum called the *septum crurale*, which is protruded, therefore, as a covering to all hernial tumors in this region; and, at its *lower opening*, this canal is also closed by a fascia, perforated by veins and called, for that reason, the *cribriform fascia*.

Coverings of Inguinal and Femoral Hernia.

In connection with the muscles of the abdomen, the various coverings in which hernial protrusions are encased may properly be considered.

In the INGUINAL REGION, abnormal inguinal protusions of abdominal viscera or omentum may escape either *indirectly*, in which case they enter at the internal ring and pass through the whole length of the inguinal canal before they escape at the external abdominal ring; or *directly*, in which case the abdominal walls are *directly perforated* behind the external abdominal ring, and, in consequence, the hernial protusion fails to enter either the internal ring or the inguinal canal.

In *both of these varieties*, every hernial protusion *starts with two coverings* before it enters the abdominal wall. These two coverings are the *peritoneum* and the *sub-serous connective* tissue.

When the *indirect variety* enters at the internal abdominal ring, it becomes invested with a third covering, *viz.*, the *infundibuliform process* of the *transversalis fascia*, which is prolonged from this point around the cord and the testicle. Within the inguinal canal, the *cremaster muscle* is next acquired as its fourth layer. As it escapes from the external abdominal ring, the fascia covering that opening, *viz.*, the *intercolumnar fascia* becomes spread out upon the hernial sac as a fifth covering, and the *two layers* of the *superficial fascia* of the abdomen and the *skin* complete the *eight layers*, which must be divided to reach the cavity of the sac.

In *direct inguinal hernia*, the sac *starts* with the *same two coverings*, *viz.*, the *peritoneum* and the *sub-peritoneal tissue.* Since it does not enter the internal ring, it receives the *transversalis fascia*, without any specially designated portion of that tissue, as was the case in the indirect variety. As it does not enter the inguinal canal, it does not recieve the cremaster muscle as a covering, but it acquires in its place, as a fourth layer, the *conjoined tendon* which lies behind the external abdominal ring and thus protects this part which would otherwise be weak. The hernial protrusion now escapes from the external ring, acquiring, as the indirect variety did, the *intercolumnar fascia* for its fifth layer, and, with the *two layers* of the *superficial fascia* of the abdomen and its *integument*, the sum total of its coverings tallies with that of the indirect variety of hernia, *viz.*, eight.

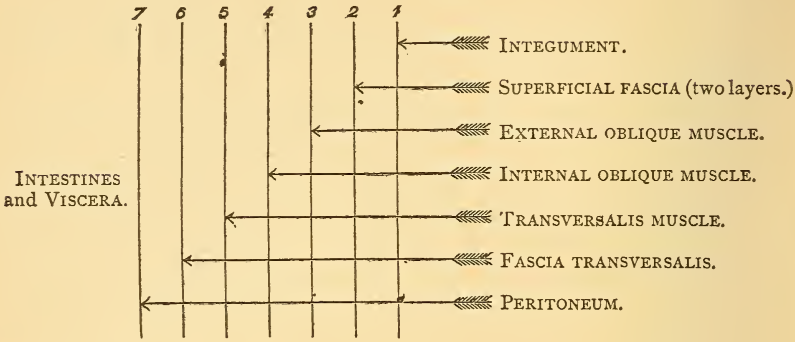
In the FEMORAL REGION, the sac starts from the *same original coverings*, *viz.*, the *peritoneum* and the *sub-peritoneal tissue.* At the femoral ring, it acquires, as a covering, the *septum crurale* which opposes its exit from the abdomen and which becomes expanded over the surface of the tumor as it passes through that opening.

As it traverses the femoral canal, the tumor becomes invested with a fourth layer, *viz.*, the *crural sheath*, in which the femoral vessels are enclosed.

At the saphenous opening, the *cribriform fascia*, which encloses that orifice, is acquired as a fifth layer ; and the two external investments which remain consist of *one layer only* of *superficial fascia* and the *integument* of the *upper portion of the thigh.*

In recapitulation, we may then state that both forms of inguinal hernia have *eight layers* of investments to the sac, while in the femoral variety only *seven layers* exist, since the deep layer of the superficial fascia of the thigh is continuous with the cribriform fascia, by which the saphenous opening is enclosed.

DIAGRAM ILLUSTRATING THE 7 LAYERS FORMING THE ABDOMINAL WALL IN THE ILIAC REGION.



This diagram is designed to show the coverings which successively are acquired by any hernial protrusions of omentum or intestine in the *inguinal* or *iliac* region. Although this diagram only represents *seven layers* as constituting the entire thickness of the abdominal wall, still the *second layer* will be perceived to consist of two separate portions. For this reason the coverings of inguinal hernia are usually described by anatomists as *eight* in number.

B.

MUSCLES OF THE THORAX.

The muscles of the thorax may be enumerated as follows:

1. The External Intercostal muscles.
2. The Internal Intercostal muscles.
3. The Infracostales.
4. The Levatores Costarum.
5. The Triangularis Sterni.
6. The Diaphragm.

ORIGIN AND INSERTION.

External Intercostales.

There are *eleven external intercostal muscles* on each side of the body. They extend from the tubercle of the ribs, behind, to the commencement of the costal cartilages, in front. Their fibres are directed downwards and forwards.

Origin.

From the outer lip of a groove on the lower border of the rib.

Insertion.

Into the upper border of the rib next below.

Nervous supply.

The intercostal nerves.

Internal Intercostales.

These muscles extend from the sternum and the anterior extremities of the false ribs, to the angle of the rib behind. Their fibres are directed downwards and backwards. They are *eleven in number* on each side.

Origin.

1. From the cartilages of the false and true ribs.
2. From the inner lip of the groove on the lower border of each rib.

Insertion.

Into the upper border of the next rib below.

Nervous supply.

The intercostal nerves.

Infra-costales.

Origin.

From the inner surface of one rib.

Insertion.

Into the inner surfaces of the first, second and third ribs below.

Nervous supply.

The intercostal nerves.

The direction of these muscles is usually parallel to that of the internal intercostals and they are most frequent on the lower ribs.

LEVATORES COSTARUM, (twelve on each side).

Origin.

From the extremities of the transverse processes of dorsal vertebræ.

Insertion.

Into the upper rough surface of the rib next below, between its tubercle and its angle.

Nervous supply.

The intercostal nerves.

The muscle for the 1st rib arises from the 7th cervical vertebra. The muscle for the 12th rib arises from the 11th dorsal vertebra.

Frequently an *inferior fasciculus* of these muscles is carried to the *second rib* below the point of origin.

TRIANGULARIS STERNI.

Origin.

1. From the lower part of the side of the sternum.
2. From the inner surface of the ensiform cartilage.
3. From the costal cartilages of the four lower true ribs.

Insertion.

Into the lower border and inner surface of the costal cartilages of the 2nd, 3rd, 4th and 5th ribs.

Nervous supply.

The intercostal nerves.

Its lowest fibres are continuous with those of the transversalis abdominis muscle.

DIAPHRAGM.

This muscle forms the dividing septum between the *cavities* of the *thorax* and *abdomen.* It is formed like a dome during its passive condition, as its central tendon is situated much higher than its circumferential attachment, but, during its contraction, it is more nearly a flat plane.

It is the most important *muscle of inspiration*, and it is per forated by *three openings* for the passage of important structures. These openings, will be found described, in detail, under the heading "openings in the abdominal walls," in subsequent pages of this volume.

Origin.

In front, from the ensiform cartilage.

Laterally, from the — Inner surface of costal cartilages. Bony portions of the seven lower ribs, (interdigitating with the transversalis abdominis.)

Behind, from the — Ligamentum arcuatum externum. Ligamentum arcuatum internum. Lumbar vertebræ.

Insertion.

Into the central tendon of the diaphragm.

Nervous supply.

The phrenic nerve, a branch of the cervical plexus.

The shortest fibres of this muscle arise from the ensiform appendix. The longest fibres of this muscle arise from the ligamentum arcuatum externum and from the sides of the chest.

The *ligamentum arcuatum internum* is a tendinous arch extending across the psoas magnus muscle, on each side of the spinal column. It is connected to the bodies of the 1st and 2nd lumbar vertebræ, at its inner extremity, and to the transverse process, at its outer extremity.

The *ligamentum arcuatum externum* is the thickened upper margin of the anterior lamella of the transversalis fascia, which arches across the quadratus lumborum muscle, on either side; and which is attached, at its inner extremity, to the transverse process of the 2nd lumbar vertebra, and, at its outer extremity, to the apex and the lower margin of the last rib.

ACTION OF THE MUSCLES OF THE THORAX.

These muscles are chiefly aids in the acts of *inspiration* and of *expiration*. They are assisted, however, in these complex muscular efforts, by certain other muscles which have been classed under the respective heads of those of the upper extremities, back, neck, and abdomen.

As the action of these muscles upon respiration is important, from a *physiological point of view*, and, as the auxiliary muscles often play a most important part in the complete performance of these acts, classified tables are appended of *all the muscles* which prominently effect either inspiration or expiration, although some of these muscles have not yet been described in this volume.

MUSCLES OF INSPIRATION.

Muscles of ordinary inspiration.....	DIAPHRAGM. SCALENUS ANTICUS. SCALENUS MEDIUS. SCALENUS POSTICUS. EXTERNAL INTERCOSTALS. STERNAL PORTION OF INTERNAL INTERCOSTALS. 12 LEVATORES COSTARUM,
Ordinary auxiliary muscles.........	SERRATUS POSTICUS SUPERIOR. STERNO-MASTOID.
Extraordinary auxiliary muscles....	LEVATOR ANGULI SCAPULÆ. TRAPEZIUS (superior portion,) PECTORALIS MINOR. PECTORALIS MAJOR (inferior portion.) SERRATUS MAGNUS.

All of these muscles tend to *increase the capacity of the chest*, when the thorax ceases to be the fixed point of resistance. They are therefore muscles of inspiration.

MUSCLES OF EXPIRATION.

Muscles of ordinary expiration.	OSSEOUS PORTION OF THE INTERNAL INTERCOSTALS. INFRA-COSTALES. TRANSVERSALIS ABDOMINIS.
Auxiliary muscles in expiration.	OBLIQUUS ABDOMINIS EXTERNUS. TRIANGULARIS STERNI. OBLIQUUS ABDOMINIS INTERNUS. SACRO-LUMBALIS.

The muscles included in this table are capable of *directly diminishing* the *capacity of the chest*, and are therefore muscles of expiration.

During inspiration, the vertical measurement of the cavity of the chest is increased from two to three inches, and the heart is drawn downwards by the diaphragm, on account of the attachment of the *pericardium* to its *central tendon.*

The cavity of the thorax is diminished in its vertical diameter, during the passive condition of the diaphragm, or when the abdominal viscera are enlarged or distended ; hence the oppression felt in the chest after a full meal, or from distension of the stomach or intestines with gas.

The *diaphragm* may, however, be an important agent in other acts than those of inspiration and expiration, since, in a state of contraction, it compresses the œsophageal opening of the stomach through its muscular fibres. It is therefore to be remembered that the cardiac end of the stomach is *closed during inspiration*, and thus the possibility of regurgitation of its contents from the pressure of the diaphragm is prevented.

In the acts of *hiccough*, *crying*, *sobbing*, *laughing* and *snuffing* of odoriferous effluvia, the diaphragm is the most important factor, as its spasmodic and involuntary contractions produce those sudden and unexpected inspirations experienced in all of these five conditions.

The *external intercostal* muscles raise the ribs and are therefore muscles of inspiration. They are, however, assisted in this act by the levatores costarum and the sternal portion of the internal intercostals.

The external intercostals are wanting in the region of the costal cartilages, being attached only to the rib.

The *intercostal muscles* can, however, elevate the ribs only after the *first rib has been made a fixed point* by the scaleni muscles, since their action is essentially from above downwards.

NERVOUS SUPPLY TO THE MUSCLES OF THE THORAX.

The *intercostal nerves* supply	External intercostals. Internal intercostals. Infra costales. Triangularis sterni. Levatores costarum.
The *phrenic nerve* supplies..	Diaphragm.

C.

MUSCLES OF THE BACK.

The muscles of the back consist of 21 pairs, and are arranged in five layers, as follows :

Muscles of 1st or superficial layer.(2)	Trapezius. Latissimus dorsi.	
Muscles of 2nd layer............(3)	Levator anguli scapulæ. Rhomboideus minor. Rhomboideus major.	
Muscles of 3rd layer............(2)	Serratus posticus superior. Serratus posticus inferior.	
Muscles of 4th layer............(9)	Trachelo-mastoid. Cervicalis ascendens. Transversalis colli.	in neck.
	Accessorius. Spinalis colli. Spinalis dorsi. Longissmus dorsi. Sacro-lumbalis.	in the back.
	Erector spinæ.	in the loins.
Muscles of the 5th layer........(8)	Semi-spinalis dorsi. Semi-spinalis colli. Multifidus spinæ. Rotatores spinæ. Supra-spinales. Inter-spinales. Extensor coccygis. Inter-transversales.	

ORIGIN AND INSERTION.

SUPERFICIAL LAYER.

(2 muscles.)

TRAPEZIUS.

Origin.

1. From the ligamentum nuchæ and the corresponding portion of the supra-spinous ligament.
2. From the spinous processes of the 7th cervical and the 12th dorsal vertebræ.
3. From the inner third of the superior curved line of the occipital bone.

Insertion.

1. Into the upper lip of the spine of scapula.
2. Into the inner margin of the acromion process.
3. Into the external third of the posterior border of the clavicle.

Nervous supply.

Spinal accessory nerve, or 11th cranial, and the deep branches of the cervical plexus.

The *lower border* of the *trapezius* muscle may be defined, upon the back of a living subject, by a line drawn from the spine of the scapula to the spine of the last dorsal vertebra.

LATISSIMUS DORSI.

Origin.

1. From the spinous processes of the lower six dorsal vertebræ and the supra-spinous ligament.
2. From the spinous processes of the lumbar vertebræ and the sacrum.
3. From the posterior third of the outer lip of the crest of the ilium.
4. From the last four ribs, by fleshy digitations.

Insertion.

Into the bottom of the bicipital groove of the humerus.

Nervous supply.

The long sub-scapular nerve, from the brachial plexus.

The *upper border* of the *latissimus dorsi* muscle may be defined, upon the back of a living subject, by a line drawn from the spine of the sixth dorsal vertebra in a horizontal direction over the inferior angle of the scapula.

ACTION OF THE SUPERFICIAL LAYER.

The action of these muscles is demanded in various movements of the head, scapula, and the humerus. If the *head be made a fixed point*, the *trapezius muscle* helps, through its upper fibres, to elevate the point of the shoulder, as in the acts of supporting weights, shrugging the shoulders, etc., while, by means of its middle and lower fibres, a partial rotation of the scapula upon the side of the chest is produced. When the *shoulders are fixed*, both of the trapezii muscles, if acting together, will draw the head directly backwards, or, if only one act, the head will be drawn towards the corresponding side.

The *latissimus dorsi*, if the *trunk be the fixed point*, acts upon the arm and draws it downwards and backwards and subsequently rotates the arm inwards, as in the act of scratching the gluteal region. If this muscle acts in connection with the pectoralis major and the teres major muscles, the *arm is adducted* and approximated to the chest wall. If the *arms be made a fixed point*, the latissimus dorsi muscle may assist in *forcible inspiration* by elevating the lower ribs (as is illustrated in the attitude assumed by asthmatic patients); or if it acts in connection with the pectoral and abdominal muscles, while the arms are made a point of resistance, the *whole trunk may be drawn forward or upward*, as is illustrated in the acts of climbing or walking upon crutches.

SECOND LAYER.

(3 muscles.)

LEVATOR ANGULI SCAPULÆ.

Origin.

From the posterior tubercles of the transverse processes of the three or four upper cervical vertebræ.

Insertion.

Into the base of the scapula, from its spine to the superior angle.

Nervous supply.

The 5th cervical nerve and deep branches from the cervical plexus.

RHOMBOIDEUS MINOR.

Origin.

From the ligamentum nuchæ and the spinous processes of the 7th cervical and the first dorsal vertebræ.

Insertion.

Into the posterior edge of the scapula, between the two roots of its spinous process.

Nervous supply.

The 5th cervical nerve.

RHOMBOIDEUS MAJOR.

Origin.

From the spinous processes of the four or five upper dorsal vertebræ.

Insertion.

Into the base of the scapula, between its spine and its inferior angle.

Nervous supply.

The 5th cervical nerve.

The *levator anguli scapulæ* raises the angle of the scapula, after it has been depressed by the trapezius; and, if the shoulder be a fixed point, it may tend to incline the neck to the corresponding side.

The *rhomboid muscles*, by carrying the angle of the scapula backwards and upwards, produce a slight rotation of the scapula upon the side of the chest. If the shoulder be made a fixed point, these muscles will draw the scapula directly backwards towards the spinal column, and, in this act, they are assisted by the middle and the inferior fibres of the trapezius.

Below the scapula, upon the back, near the 7th, 8th and 9th ribs, is a triangular space bounded by the trapezius, latissimus dorsi and the rhomboideus major muscles, where the lung can be auscultated without muscular intervention, save the intercostals. This space can be enlarged by stooping and throwing the arms forwards upon the chest, as is usually done when auscultation of the chest is performed.

THIRD LAYER.

(2 muscles.)

ORIGIN AND INSERTION.

SERRATUS POSTICUS SUPERIOR.

Origin.

1. From the ligamentum nuchæ.
2. From the spinous processes of 7th cervical and 1st 2d and 3d dorsal vertebræ.

Insertion.

Into the 2d, 3d, 4th and 5th ribs beyond their angles.

Nervous supply.

External posterior branches of the cervical nerves.

SERRATUS POSTICUS INFERIOR.

Origin.

From the spinous processes of the last two dorsal and the three upper lumbar vertebræ.

Insertion.

Into the lower borders of the last four ribs beyond their angles.

Nervous supply.

External posterior branches of the dorsal nerves.

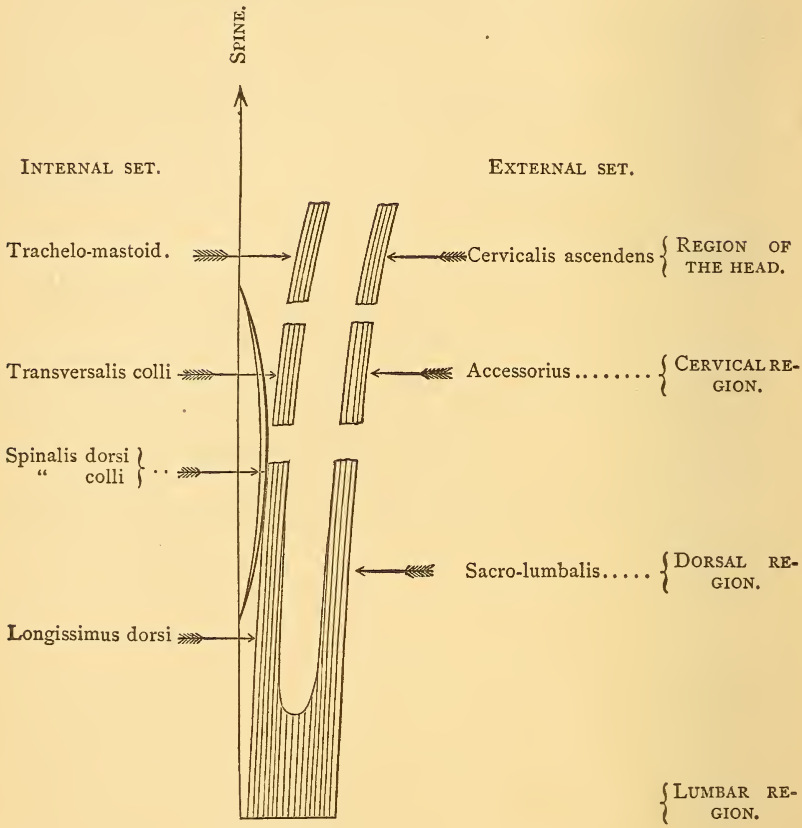
ACTION OF THE THIRD LAYER.

The *serrati* are respiratory muscles acting in antagonism to each other. The *serratus posticus superior* elevates the ribs and is, therefore, an *inspiratory* muscle ; while the *serratus posticus inferior* draws the lower ribs downwards, and is a muscle of expiration. This latter muscle is also probably a tensor of the vertebral aponeurosis.

FOURTH LAYER.

(9 muscles.)

DIAGRAM OF 4TH LAYER OF THE MUSCLES OF THE BACK.



Erector Spinæ.

A rule to remember the *external set* of this layer may be given as follows:

The first three letters of the first muscle (sacro-lumbalis) S. A. C. are the initial letters of the external set in their proper order, from below upwards.

ORIGIN AND INSERTION.

TRACHELO-MASTOID (complexus minor).

Origin.

From the articular processes of the four lower cervical vertebræ, and the four upper dorsal vertebræ.

Insertion.

Into the posterior margin of the mastoid process of the temporal bone.

Nervous supply.

The external posterior branches of the cervical nerves.

TRANSVERSALIS COLLI.

Origin.

From the transverse processes of the first four or five upper dorsal vertebræ.

Insertion.

Into the posterior tubercles of the transverse processes of the five lower cervical vertebræ.

Nervous supply.

The external posterior branches of the cervical nerves.

CERVICALIS ASCENDENS.

Origin.

From the angles of the four or five upper ribs.

Insertion.

Into the posterior tubercles of the transverse processes of the 4th, 5th and 6th cervical vertebræ.

Nervous supply.

The external posterior branches of the cervical nerves.

MUSCULUS ACCESSORIUS.

Origin.

From the angles of the six lower ribs.

Insertion.

Into the angles of the six upper ribs.

Nervous supply.

The external posterior branches of the dorsal nerves.

SPINALIS COLLI ET CAPITIS.

Origin.

From the spinous processes of the last cervical and the two or three upper dorsal vertebræ.

Insertion.

(Colli portion). Into the posterior transverse tubercles of 1st, 2d and 3d cervical vertebræ.

(Capitis portion). Into the posterior edge of the mastoid process and a rough space between the occipital curved lines.

Nervous supply.

The external posterior branches of the cervical nerves.

SPINALIS DORSI.

Origin.

From the spinous processes of the two upper lumbar and the two lower dorsal vertebræ.

Insertion.

Into the spinous processes of from four to eight of the middle and upper dorsal vertebræ.

Nervous supply.

External posterior branches of the dorsal nerves.

LONGISSIMUS DORSI.

Origin.

From the inner and largest division of the erector spinæ muscle.

Insertion.

A. (*Inner set*). 1. By separate slips into the transverse processes of all the dorsal vertebræ.

2. Into the tubercles (maxillary), on the back of the superior articular processes of the lumbar vertebræ.

B. (*Outer set*). 1. Into the posterior surfaces of transverse processes of lumbar vertebræ.

2. Into the nine lower ribs internally to their angles.

Nervous supply.

External posterior branches of the dorsal nerves.

SACRO–LUMBALIS.

Origin.

A division of the erector spinæ muscle.

Insertion.

By distinct tendons, into the angles of the upper six ribs.

Nervous supply.

External posterior branches of the lumbar nerves.

ERECTOR SPINÆ.

Origin.

1. From the posterior iliac spines.

2. From the posterior one-fifth of the crest of ilium.

3. From the spines of the sacrum and posterior eminences of sacrum.

4. From the spinous processes of all the lumbar and the three lower dorsal vertebræ.

5. By a broad and thick tendon which conceals the muscular fibres.

Insertion.

It divides, opposite the last rib, into the sacro-lumbalis and longissimus dorsi muscles.

Nervous supply.

External posterior branches of both the lumbar and the dorsal nerves.

FIFTH LAYER.

(8 muscles.)

Of these muscles the *spinales* have their point of origin and insertion in the *spinous processes* of the vertebræ. The *semi-spinales* arise from the *transverse processes* of the vertebræ and are inserted into the *spinous processes*, above the points of origin of the various muscles.

ORIGIN AND INSERTION.

SEMI-SPINALIS DORSI.

Origin.

From the transverse processes of the 5th. 6th, 7th, 8th, 9th and 10th dorsal vertebræ.

Insertion.

Into the spinous processes of the four upper dorsal and the two last cervical vertebræ.

Nervous supply.

Internal posterior branches of the dorsal nerves.

SEMI-SPINALIS COLLI.

Origin.

From the transverse processes of the four upper dorsal vertebræ.

Insertion.

Into the spinous processes of the cervical vertebræ from the axis to the 5th.

Nervous supply.

Internal posterior branches of the cervical nerves.

MULTIFIDUS SPINÆ.

This muscle fills up the groove on either side of the spinous processes of the vertebræ from the sacrum to the axis.

Nervous supply.

Internal posterior branches of both the cervical and sacral nerves.

ROTATORES SPINÆ, (eleven pairs).

Origin.

From the upper and back part of the transverse processes of the dorsal vertebræ. They are composed of the deepest fibres of the multifidus spinæ muscle lying in the dorsal region.

Insertion.

Into the lower margin and posterior surface of the laminæ and the root of the spinous process of the dorsal vertebra, situated next above their point of origin.

Nervous supply.

The internal posterior branches of the dorsal nerves.

SUPRA-SPINALES.

Are small fasciculi which lie upon the spinous processes of the vertebræ, in the cervical region.

Nervous supply.

Internal posterior branches of the cervical nerves.

INTER-SPINALES.

Are small muscles placed between the spinous processes of the vertebræ. These are usually arranged as *six pairs* between the lower six cervical vertebræ; *four pairs* in the lumbar region; and occasionally *two pairs* attached to the upper and lower dorsal vertebræ.

Nervous supply.

Internal posterior branches of the cervical nerves.

EXTENSOR COCCYGIS.

Origin.

From the posterior surface of the last bone of the sacrum.

Insertion.

Into the lower part of the coccyx.

Nervous supply.

Internal posterior branches of the sacral nerves.

INTER-TRANSVERSALES, (seven pairs.)

These muscles are most marked in the cervical region, where seven pairs exist; and are situated between the transverse processes of the vertebræ.

Nervous supply.

Internal posterior branches of the cervical nerves.

ACTION OF THE MUSCLES OF THE BACK.

The muscles of the back can be also classified on a basis of their action and function as follows:

Those which act on the *upper extremity*.	(5)	The 1st Layer. The 2nd Layer.
Those which act upon the *ribs* and are therefore respiratory muscles	(2)	The 3rd Layer,
Those which move the *vertebral column as a whole* and are extensors	(9)	The 4th Layer.
Those which move the *vertebra upon each other*	(8)	The 5th Layer.
Total,	24 pairs of muscles.	

The muscles which bend the trunk backwards are: Erector spinæ. Sacro-lumbalis. Accessorius. Longissimus dorsi. Spinalis dorsi. Multifidis spinæ.

The muscles of the back tend to constantly keep the *spine erect* and they act also as an *antagonistic force when counterbalancing heavy weights* suspended from the neck, or in cases of great abdominal enlargement as occurs in dropsy, pregnancy, or abdominal tumors.

The *multifidus spinæ* muscle tends also, when acting singly, to *rotate the trunk* towards the side opposite to the muscle in contraction, and it is chiefly by this muscle and the obliquus abdominis externus, that this motion of the trunk is performed.

The *separate fasciculi* of the *multifidus spinæ* and the *other muscles* of the back allow of constant relaxation of some parts of the muscles while others are in contraction; and it is to this arrangement that man, in contrast to quadrupeds, is enabled to endure an erect spinal posture for so long a time without fatigue.

The *musculus accessorius* possesses the power of elevating those ribs to which it is attached, provided the cervical vertebra becomes a fixed point, and might for that reason be considered an *auxillary muscle of inspiration*.

NERVOUS SUPPLY OF THE MUSCLES OF THE BACK.

All the muscles of the back, save one, are supplied with motor power from *the posterior branches of the spinal nerves*. This exception is the *latissimus dorsi* which is supplied by the long subscapular nerve.

D.

MUSCLES OF THE PERINEUM.

The muscles of the perineum, *in the male*, may be thus enumerated.

Erector Penis.
Accelerator Urinæ.
Transversus Perinæi.
Compressor Urethræ.
Sphincter Ani.
Levator Ani.
Coccygeus.

In the *female*, the erector penis becomes the erector clitoridis, the accelerator urinæ is absent, and the sphincter vaginæ is added; so that the same total of muscle is preserved.

The *anterior fibres* of the *levator ani muscle*, in the male, consist of a distinct band which descends along the sides of the prostate gland and encircles it like a sling. This portion was pictured by Santorini as a *separate muscle*, and the name *levator prostatæ* muscle has been, by many later anatomists, ascribed to it. It seems justly to lay claim to a special name, since it performs, in the male sex, a most important part in the act of micturition.

ORIGIN AND INSERTION.

Erector Penis.

Origin.

1. From the inner surface of the tuberosity of the ischium, behind the extremity of the crus-penis.
2. From the surface of the crus-penis.
3. From the adjacent portion of ramus of the pubes.

Insertion.

Into the sides and the under surface of the crus-penis.

Nervous supply.

The perineal nerve.

Accelerator Urinæ.

This muscle consists of two symmetrical halves united, in the median line, by a tendinous raphe.

Origin.

1. From the central tendon of the perineum.
2. From the median raphe.

Insertion.

This muscle invests the *bulb of the urethra*, and, at its anterior part, sends a slip to *enclose the corpora cavernosa of the penis.*

Nervous supply.

The perineal nerve.

TRANSVERSUS PERINÆI.

Origin.

From the inner surface and anterior part of the tuberosity of the ischium.

Insertion.

Into the central tendinous point of the perineum, joining with its fellow of the opposite side, and with the sphincter ani and accelerator urinæ muscles.

Nervous supply.

The perineal nerve.

This muscle, in connection with the two muscles named above, assists to form a *triangular space*, which is of surgical importance, from the relation of the vessels and nerves contained within it, in the operation of lithotomy.

This triangle is bounded, *externally*, by the erector penis; internally, by the accelerator urinæ; and, *posteriorly*, by the transversus perinæi. The *contents of this triangular space* will be found described in detail in the closing pages of this work, descriptive of the perineum.

COMPRESSOR URETHRÆ.

Origin.

From the upper part of the ramus of the pubes.

Insertion.

This muscle, after encircling the membranous portion of the urethra, unites with its fellow of the opposite side on the upper and lower surface of that tube.

Nervous supply.

The perineal nerve and sometimes by a direct branch of the pudic nerve.

LEVATOR ANI.

Origin.

1. Anteriorly, from the posterior surface of the body and the ramus of the pubes.

2. Posteriorly, from the inner surface of the spine of the ischium.

3. Between these two points, from the *pelvic fascia* at its angle of division into the *obturator* and *recto-vesical fascia.*

Insertion.

1. Into the sides of the coccyx.
2. Into the median raphe extending from the coccyx to the anus.
3. Into the sides of the rectum.
4. The anterior fibres encircle the prostate gland and join with fibres from the opposite side.

Nervous supply.

The perineal nerve and the anterior division of the 4th sacral nerve.

SPHINCTER ANI.

Origin.

1. From the tip of the coccyx.
2. From the superficial fascia, in front of the coccyx.

Insertion.

Into the tendinous centre of the perineum.

Nervous supply.

The inferior hemorrhoidal branch of the pudic nerve and by a branch from the anterior division of the 4th sacral nerve.

COCCYGEUS.

Origin.

1. From the spine of the ischium.
2. From the lesser sacro-sciatic ligament.

Insertion.

1. Into the margin of the coccyx.
2. Into the last bone of the sacrum.

Nervous supply.

The anterior division of the 5th sacral nerve.

ACTION OF THE MUSCLES OF THE PERINEUM.

The *levator prostatæ* muscle, by elevating the prostate gland through its sling-like arrangement about it, elevates at the same time the contiguous portion of the bladder and with it the uvula vesicæ.

By this action, a barrier is placed in contact with the mouth of the bladder, effectually assisting in the retention of urine within its cavity. It is to this muscle, that many authorities ascribe the *voluntary control of the bladder* and not to the existence of elastic fibres or a contractile sphincter at its neck.

This theory of the action of the muscle seems confirmed by certain observed facts during the physiological acts in which the levator ani muscle plays so important a part. Thus, in the act of defecation, while the feces are entering the cavity of the rectum and while the levator ani and sphincter ani are fully relaxed, the *flow of urine becomes almost uncontrollable*, from the corresponding relaxation of the urinary apparatus. On the other hand, during the expulsive efforts of the rectal muscles in emptying the contents of the rectum, the *evacuation of the urine becomes impossible*, from the contracted condition of the levator prostatæ muscle.

The *accelerator urinæ* muscle also performs functions of great physiological interest. By its fibres, the bulb of the urethra is compressed, and, furthermore, the *dorsal vein of the penis is obstructed* by an anterior loop of fibres enclosing the body of that organ. This muscle is undoubtedly an agent in the ejaculation of semen and in the expulsion of the last few drops of urine from the urethral canal; while, by *compression of the dorsal vein*, it also contributes to the persistence of the state of erection of the penis.

The *erector penis*, in antagonism to its naturally presupposed function, exerts no power over the erection of the genital organ. From its attachments, it may slightly compress the sheath and contents of the corpus cavernosum but it probably serves with its fellow, to maintain a *firm* and *steady position* of the organ when in a state of erection.

The *transverse perinæi* muscle, through its insertion into the central tendinous point of the perineum, tends to assist the harmonious action of the other muscles by affording for them a fixed point of resistance.

The *compressor urethræ* muscle, from its situation and action, is sometimes called the "*constrictor urethræ.*" It encloses only the *membranous portion* of the urethral canal, and is principally in action during the expulsion of the last drops of urine and the ejaculation of semen. It exerts no influence upon erection of the penis and none in the ejaculation of the secretions of Cowper's glands, whose ducts open anteriorly to it. It is a powerful adjunct in the ejaculation of irritants, when injected into the urethral canal, in which act it is assisted by the involuntary muscular fibres of the urethral walls.

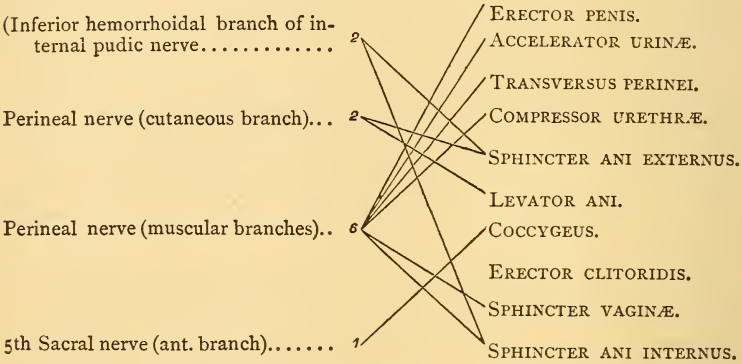
In the female the *sphincter vaginæ*, which is analogous to the accelerator urinæ muscle in the male, controls the external orifice of the vagina by its contraction. The *erector clitoridis* performs, for that organ, the same function as the erector penis in the male, but differs from it in its smaller size, since the clitoris requires less muscular support for its proper maintenance, during its erection.

The *levator ani* muscle acts as a support to the lower end of the rectum and the bladder, during their efforts to expel the feces and the urine. In the female, however, it gives additional support to the vaginal walls.

The *coccygeus muscle* supports and raises the coccyx, after it has been displaced backward during the acts of defecation or of parturition.

NERVOUS SUPPLY OF THE MUSCLES OF THE PERINEUM.

The nervous supply to all the muscles of the perineum, save one, is derived from *one source*, namely, the branches of the internal pudic nerve. The special branches of this nerve, however, which supply the muscles of the perineum are as follows:



Total, 11 muscles.

Deduct one muscle supplied from two sources (the spincter ani).

Total, 10 muscles.

CAVITIES OF THE TRUNK.

Appended to the trunk, whose muscles we have been considering in this chapter, are *two large cavities*, *viz.*, the cavity of the thorax and the cavity of the abdomen.

These cavities contain *important viscera* and *large arterial*, *venous*, and *nervous* trunks. *Important ganglia* are also located within these special regions, and the *sympathetic system* is here most extensively developed.

In the following pages, will be found the boundaries of these two cavities arranged in a tabular form, and also an enumeration of the *openings* which normally exist in the abdominal walls and the exact anatomical situation of each. Some of these openings have already been described in connection with the external oblique muscle, while others, pertaining to the diaphragm and to the pelvic region, have not been previously mentioned.

I.

ABDOMINAL CAVITY.

The cavity of the abdomen is oval in shape and is bounded as follows:

Above by the	DIAPHRAGM.
Below by the	LEVATOR ANI. } Forming the floor of the pelvis. COCCYGEUS.
The *anterior wall* consists of	RECTUS ABDOMINIS. PYRAMIDALIS. LINEA ALBA. LINEA SEMILUNARIS.
The *lateral wall* consists of	OBLIQUUS ABDOMINIS EXTERNUS. OBLIQUUS ABDOMINIS INTERNUS. TRANSVERSALIS ABDOMINIS.
The *posteriar wall* consists of	LUMBAR VERTEBRÆ. CRURA OF DIAPHRAGM. QUADRATUS LUMBORUM. PSOAS PARVUS. PSOAS MAGNUS. ILIACUS.

II.

THORACIC CAVITY.

The thoracic cavity is bounded as follows:

Above (thoracic entrance)	1st DORSAL VERTEBRA. 1st RIB. UPPER EDGE OF STERNUM.
In front by the	STERNUM. COSTAL CARTILAGES. INNER SURFACE OF THE UPPER RIBS.
Laterally by the	INNER SURFACE OF THE RIBS. INTERCOSTAL MUSCLES,
Posteriorly by the	DORSAL VERTEBRÆ. INNER SURFACE OF THE RIBS. INTERCOSTAL MUSCLES.
Below by the	DIAPHRAGM.

OPENINGS IN THE ABDOMINAL WALLS.

There are 10 openings in the abdominal walls in the male sex, and 11 openings in the female sex.

These openings may be classified as follows:

UPWARDS, through the diaphragm. (3)	"*Œsophageal*"—a muscular opening, on level of 9th dorsal vertebra—transmitting...........	ŒSOPHAGUS. PNEUMOGASTRIC NERVE.
	"*Aortic*"—a tendinous opening, on level with 12th dorsal vertebra—transmitting............	AORTA. VENA AZYGOS. THORACIC DUCT.
	"*Cava opening*," called "foramen quadratum,"—tendinous, opposite the 9th dorsal vertebra,—transmitting.................	VENA CAVA ASCENDENS.
FORWARDS. (5)	*Umbilicus*,	
	Internal abdominal rings,	(one on each side.)
	Femoral rings,	(one on each side.)
DOWNWARDS. (2 or 3)	For *urethra*,	
	" *rectum*	
	" *vagina* (in female.)	

MUSCLES OF THE UPPER EXTREMITY.

There are 62 pairs of muscles connected with the skeleton of the upper extremity, They may be thus divided :

I.	EXTRINSIC MUSCLES,	12
II.	INTRINSIC "	50
	Total	62 muscles.

By an *extrinsic* muscle is meant a muscle which serves to connect the *upper extremity* to some *other part* of the skeleton.

By an *intrinsic* muscle, is meant one which serves to connect the various *segments of the extremity* with each other.

I.

EXTRINSIC MUSCLES OF THE UPPER EXTREMITY.

The *twelve pairs of muscles* connected with the two upper extremities, may be divided into three distinct sets.

(1) Those connecting the *upper extremity* to the *head.*

(2) Those connecting the *upper extremity* to the *back of the trunk.*

(3) Those connecting the *upper extremity* to the *anterior* and *lateral walls* of the trunk.

The various muscles included under each of these groups will be shown in the following table.

Extrinsic muscles of the upper extremity:	Connecting the *upper extremity* to the *head* and the *neck*...... (3)	STERNO-MASTOID. STERNO-HYOID. OMO-HYOID.
	Connecting the *upper extremity* to the *back* .... (5)	TRAPEZIUS. LATISSIMUS DORSI. RHOMBOIDEUS MINOR. RHOMBOIDEUS MAJOR. LEVATOR ANGULI SCAPULÆ.
	Connecting the *upper extremity* to the *anterior* and *lateral parts* of the trunk.................. (4)	PECTORALIS MINOR. PECTORALIS MAJOR. SUBCLAVIUS. SERRATUS MAGNUS.
	Total, 12	

ORIGIN AND INSERTION.

TRAPEZIUS.

Origin.

1. From the external occipital protuberance.
2. From the inner third of the superior curved line of the occipital bone.
3. From the ligamentum nuchæ.
4. From the spinous processes of the last cervical, and of all the dorsal vertebræ.
5. From the supra-spinous ligament of the vertebral column.

Insertion.

1. Into the posterior border of the outer third of the clavicle.
2. Into the inner border of the acromion process of the scapula.
3. Into the whole length of the upper lip of the posterior border of the spine of the scapula.
4. Into a tubercle, near the inner extremity of the spine.

Nervous supply.

From two sources, *viz.*, the spinal accessory or 11th cranial nerve, and the deep branches of the cervical plexus.

LATISSIMUS DORSI.

Origin.

1. From the spinous processes of the 6 or 7 lower dorsal vertebræ.
2. From the posterior layer of the lumbar aponeurosis.
3. From the lumbar and sacral spines.

4. From the posterior part of the outer lip of the crest of the ilium.

5. From the last three or four ribs, interdigitating with the fibres of the external oblique muscle.

6. Occasionally from the inferior angle of the scapula.

Insertion.

Into the bottom of the bicipital groove of the humerus.

Nervous supply.

From the long subscapular nerve, derived from the brachial plexus.

RHOMBOIDEUS MINOR.

Origin.

1. From the ligamentum nuchæ of the vertebræ.

2. From the spinous process of the 7th cervical vertebra.

Insertion.

Into the posterior border of the scapula, near the *root* of the *spinous process* of that bone.

Nervous supply.

From the fifth cervical nerve, before it assists to form the brachial plexus.

RHOMBOIDEUS MAJOR.

Origin.

1. From the spinous processes of the 4 or 5 upper dorsal vertebræ.

2. From the supra-spinous ligament of the vertebræ.

Insertion.

Into a *tendinous arch*, connected with the posterior border of the scapula.

Nervous supply.

From the fifth cervical nerve, before it assists to form the brachial plexus.

LEVATOR ANGULI SCAPULÆ.

Origin.

From the posterior tubercles of the transverse processes of the upper three, four, or five cervical vertebræ.

Insertion.

Into the posterior border of the scapula between the root of the spine and the superior angle of that bone.

Nervous supply.

From the fifth cervical nerve, and from the deep branches of the cervical plexus.

PECTORALIS MAJOR.

Origin.

1. From the anterior surface of the inner half of the clavicle.

2. From the corresponding half of the front of the sternum.

3. From the cartilages of the true ribs, excepting occasionally the 1st and 7th.

4. From the aponeurosis of the external oblique muscle of the abdomen.

Insertion.

Into the anterior lip of the bicipital groove of the humerus.

Nervous supply.

From the anterior thoracic branches of the brachial plexus of nerves.

PECTORALIS MINOR.

Origin.

From the outer surface and the upper border of the 3rd, 4th and 5th ribs, near to their cartilages, and from the aponeurosis covering the intercostal muscles.

Insertion.

Into the inner border of the coracoid process of the scapula.

Nervous supply.

From the anterior thoracic branches of the brachial plexus.

SUBCLAVIUS.

Origin.

From the cartilage of the first rib, in front of the rhomboid ligament of the clavicle.

Insertion.

Into a groove on the under surface of the middle third of the clavicle.

Nervous supply.

A supra-clavicular branch of the brachial plexus.

Serratus Magnus.

Origin.

By nine fleshy digitations, from the outer surface and the upper border of the eight upper ribs. (The 2nd rib having two digitations).

Insertion.

Into the whole length of the anterior lip of the posterior border of the scapula.

Nervous supply.

From the posterior or long thoracic nerve.

ACTION OF THE EXTRINSIC MUSCLES OF THE UPPER EXTREMITY.

The action of these muscles is demanded in various movements of the head, scapula and the humerus, If the head be made a fixed point, the *trapezius muscle* helps, through its upper fibres, to elevate the point of the shoulder, as in the acts of supporting weights, shrugging the shoulders, etc.; while, by means of its middle and lower fibres, a partial rotation of the scapula upon the side of the chest is produced. When the shoulders are fixed, both of the trapezii muscles, if acting together, will draw the head directly backwards; or, if only one act, the head will be drawn towards the corresponding side.

The *latissimus dorsi muscle*, if the trunk be the fixed point, acts upon the arm and draws it downwards and backwards and subsequently *rotates* the arm inwards, as is illustrated in the act of scratching the gluteal region. If this muscle acts in connection with the pectoralis major and the teres major muscles, the arm is adducted and closely approximated to the chest wall. If the *arm be made a fixed point*, the latissimus dorsi may assist in forcible inspiration by elevating the lower ribs (as is illustrated in the attitude assumed by asthmatic patients); or if it act in connection with the pectoral and abdominal muscles, while the arms are made a point of resistance, the whole trunk may be drawn forward or upward, as is illustrated in the acts of climbing or walking upon crutches.

The *levator anguli scapulæ* raises the angle of the scapula, after it has been depressed by the trapezius; and, if the shoulder be a fixed point, it may tend to incline the neck to the corresponding side.

The *rhomboid muscles*, by carrying the angle of the scapula backwards and upwards, often produce a slight *rotation of the* *scapula* upon the sides of the chest. If the shoulder be made a fixed point, these muscles will draw the scapula directly backwards towards the spinal column; and, in this act, they are assisted by the middle and the inferior fibres of the trapezius.

The *pectoralis major muscle* acts most frequently, in conjunction with the teres major and the latissimus dorsi, in approximating the arm to the chest wall after the arm has been raised by the action of the deltoid. *If it act singly*, this muscle tends to draw the arm forwards and inwards, thus bringing it across the anterior wall of the chest. If the *arm be made a fixed* point, this muscle, in connection with the pectoralis minor, the subclavius, and the latissimus dorsi, acts upon the ribs and thus all four of these muscles become aids to *forcible inspiration.*

The *pectoralis minor muscle* tends to depress the point of the shoulder and to draw the scapula downwards and inwards towards the thorax.

The *subclavius muscle* also depresses the shoulder, by drawing the clavicle downwards and forwards.

The *serratus magnus muscle* is a most important *inspiratory muscle.* When the shoulders are fixed, it elevates the ribs and expands the chest wall and thus increases the size of the chest cavity. It also tends to *elevate the point of the shoulder*, by causing a rotation of the scapula, since it draws forwards the inferior angle and the base of the shoulder blade. It greatly assists the trapezius in supporting weights upon the shoulder, the thorax being at the same time rendered a fixed point, by preventing the escape of the included air.

II.

INTRINSIC MUSCLES OF THE UPPER EXTREMITY.

The fifty intrinsic muscles of the upper extremity may be divided into four groups, *viz.:*

(A)	Those connecting the *arm* to the *shoulder*,	7	muscles.
(B)	" situated *upon the arm*, ...	4	"
(C)	The muscles of the *fore-arm*, ...	20	"
(D)	" " " " *hand*, ...	19	"
	Total, . . .	50	

A.

MUSCLES OF THE SCAPULO-HUMERAL REGION.

A. The muscles of the SCAPULO-HUMERAL REGION, or those which connect the skeleton of the shoulder with that of the arm, include the following seven muscles:

1. Deltoid.
2. Supra-spinatus.
3. Infra-spinatus.
4. Teres minor.
5. Teres major.
6. Subcapularis.
7. Coraco-brachialis.

ORIGIN AND INSERTION.

DELTOID.

Origin.

1. From the upper surface and the anterior border of the outer half of the clavicle.
2. From the outer border of the acromion process of the scapula.
3. From the whole length of the lower lip of the posterior border of the spine of the scapula.

Insertion.

Into a rough, triangular prominence, a little above the middle of the outer surface of the humerus.

Nervous supply.

The circumflex nerve.

SUPRA-SPINATUS.

Origin.

1. From the inner two-thirds of the supra-spinous fossa of the scapula.

2. From the fascia which covers it.

Insertion.

Into the *highest* of the *three facets* upon the greater tuberosity of the humerus.

Nervous supply.

The supra-scapular nerve.

INFRA-SPINATUS.

Origin.

1. From the inner two-thirds of the infra-spinous fossa of the scapula.

2. From the fascia, which separates it from the teres major and minor muscles.

Insertion.

Into the *middle facet* upon the greater tuberosity of the humerus.

Nervous supply.

The supra-scapular nerve.

TERES MINOR.

Origin.

1. From the upper two-thirds of the dorsal aspect of the axillary border of the scapula.

2. From the inter-muscular septa, which separate it from the teres major and infra-spinatus muscles.

Insertion.

1. Into the *lowest facet* upon the greatest tuberosity of the humerus.

2. By a few fibres, occasionally, into the neck of the humerus.

Nervous supply.

A branch of the circumflex nerve.

TERES MAJOR.

Origin.

1. From the dorsal aspect of the inferior angle of the scapula.

2. From the inter-muscular septa, which separate it from the teres minor and the infra-spinatus muscles.

Insertion.

Into the posterior lip of the bicipital groove of the humerus.

Nervous supply.

The lower subscapular nerve.

SUBSCAPULARIS.

Origin.

1. From the inner two-thirds of the subscapular fossa.

2. From the aponeurosis, which separates it from teres major muscle.

Insertion.

Into the lesser tuberosity of the humerus, and, occasionally, by a few fibres into the neck of that bone.

Nervous supply.

The two upper subscapular nerves.

CORACO-BRACHIALIS.

Origin.

From the tip of the coracoid process of the scapula, in common with the short head of the biceps.

Insertion.

Into a rough ridge situated a little above the middle of the inner surface of the shaft of the humerus.

Nervous supply.

The musculo-cutaneous nerve.

ACTION OF THE MUSCLES FORMING THE SCAPULO-HUMERAL GROUP.

The *direct action* of these seven muscles may be thus classified:

Muscles producing *adduction* of the arm............	Pectoralis major (assisting). Latissimus dorsi (assisting). Teres major.
Muscles producing *abduction* of the arm.............	Deltoid. Supra-spinatus.
Muscles producing *internal rotation* of the arm.......	Teres major. Subscapularis. Latissimus dorsi.
Muscles producing *external rotation* of the arm.......	Infra-spinatus. Teres minor.
Muscles producing *flexion* of the arm	Coraco-brachialis.

The *deltoid muscle* raises the arm away from the side, so as to bring it at a right angle to the trunk. Its *anterior fibres* assist the pectoralis major in drawing the arm forwards; while its *posterior* *fibres* assist the latissimus dorsi and the teres major in drawing the arm backwards.

The *supra-spinatus muscle* assists the deltoid in raising the arm from the side, and tends to fix the head of the humerus firmly in its socket.

The *infra-spinatus* and *teres minor* muscles tend to rotate the arm outward, when the arm hangs at the side ; but, when the arm is raised, they help to sustain it in that position or to carry it backwards.

The *supra-spinatus*, *infra-spinatus*, *teres minor* and *subscapularis muscles*, in consequence of their close connection with the capsular ligament, may be styled "*capsular muscles*" ; and when they all act together, they press the head of the humerus against the glenoid cavity and thus prevent dislocation.

The *teres major muscle* assists the *latissimus dorsi* in drawing the arm downwards and backwards, when previously raised, and also to *rotate* the arm *inwards*, when it hangs parallel to the chest wall. It assists also in drawing the trunk forwards, when the arm is made a fixed point, in which act it is greatly aided by the pectoralis major and minor and the latissimus dorsi. An illustration of this function is seen in the act of climbing, or of walking upon crutches.

The *coraco-brachialis muscle* assists in the acts of flexion and of elevation of the arm.

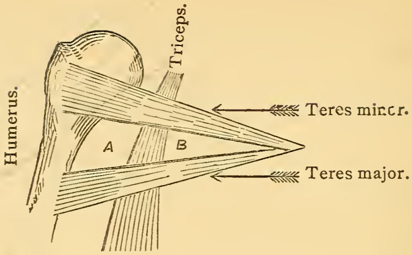
NERVOUS SUPPLY OF MUSCLES FORMING THE SCAPULO–HUMERAL GROUP.

The nerve supply of this group of muscles is as follows :

The *circumflex* nerve supplies ...	(2)	Deltoid. Teres minor.
The *supra-scapular* nerve supplies ...	(2)	Supra-spinatus. Infra-spinatus.
The *sub-scapular* nerve supplies ...	(2)	Subscapularis. Teres major.
The *musculo-cutaneous* nerve supplies ...	(1)	Coraco-brachialis.
	7	

POINTS OF SURGICAL INTEREST PERTAINING TO THE SCAPULO-HUMERAL GROUP OF MUSCLES.

There are *two important spaces* formed in this region, into the composition of which the teres major and teres minor muscles of this group enter, and through which the *circumflex* and *dorsalis scapulæ vessels* pass. These spaces are formed as follows :



(A.) A *quadrilateral space* bounded by the surgical neck of the humerus, the teres minor, the subscapular head of the triceps, and the teres major. It gives passage to the *posterior circumflex artery* and *vein* and to the *circumflex nerve.*

(B.) A *triangular space* bounded by the triceps, teres minor, and teres major muscles. It gives passage to the *dorsalis scapulæ artery* and *vein.*

The *subscapularis* is a powerful defence to the front of the shoulder joint, and tends to prevent displacement of the humerus *forwards.* The *teres minor* and *infra-spinatus* muscles protect the joint posteriorly; and the *supra spinatus* muscle and the projection of the acromion process of the scapula, shield the upper portion of the articulation.

In the *various forms* of *fracture* of the humerus, which are met with above the junction of the middle and upper third of that bone, these muscles produce special forms of displacement of the fragments, which are of great value in determining the seat of fracture.

Thus in case of the *separation* of the *greater tubercle* of the humerus, the fragment is drawn by the *infra-spinatus* and *teres minor* muscles into close contact with the dorsum of the scapula; while the humerus is rotated inwards by the subscapularis, teres major and latissimus dorsi muscles (since the antagonistic force of the external rotator muscles is removed) and the arm is approximated to the chest and drawn forwards by the pectoralis major.

In case of *fracture* of the *surgical neck* of the humerus, the upper fragment is slightly *elevated* by the muscles attached to the greater and lesser tuberosities; and the lower fragment is drawn *inwards* by the pectoralis major, the latissimus dorsi, and teres major muscles. In some cases, the *deltoid muscle* produces also a displacement of the lower fragment *obliquely outwards* from the chest and occasionally elevates it to a marked degree.

In case of *fracture* of the *shaft of the humerus* below the point of insertion of the teres major muscle, the upper fragment will be drawn forcibly inwards by the teres major, latissimus dorsi and pectoralis major muscles; and the lower fragment will be drawn upwards by the deltoid.

If the shaft of the humerus be fractured *below the point of insertion of the deltoid*, the amount of the deformity will be influenced greatly by the direction of the fracture.

If the direction of the fracture be *transverse*, only a slight deformity will ensue, since the bone still acts as a counter-extending force to the muscles; but, if the direction of the fracture be *oblique*, the biceps, brachialis anticus, and the triceps muscles will cause a marked displacement of the lower fragment upwards, since the ends of the injured bone can be easily made to slide upon each other and therefore no obstacle to muscular contraction will exist.

B.

MUSCLES SITUATED UPON THE ARM.

The four muscles situated upon the arm may be divided into two groups:

(1) Those attached to the *anterior* surface of the humerus .... (2)	Biceps flexor cubiti. Brachialis anticus.
(2) Those attached to the *posterior* surface of the humerus .... (2)	Triceps extensor cubiti Subanconeus.

ORIGIN AND INSERTION.

BICEPS FLEXOR CUBITI.

Origin.

Short head. From the tip of the coracoid process of the scapula in common with the coraco-brachialis muscle.

Long head. 1. From the top of the glenoid cavity of the scapula.

2. From the glenoid ligament of the shoulder joint.

Insertion.

Into the posterior aspect of the bicipital tuberosity of the radius.

Nervous supply.

The musculo-cutaneous nerve.

BRACHIALIS ANTICUS.

Origin.

1. From the lower half of both the inner and outer surfaces of the shaft of the humerus.

2. From an internal and an external inter-muscular septum.

Insertion.

Into a rough triangular, surface on the front part of the coronoid process of the ulna.

Nervous supply.

The musculo-cutaneous nerve and a filament from the musculo-spiral nerve.

TRICEPS EXTENSOR CUBITI.

Origin.

Long head.

1. From a depression below the glenoid cavity, and from the adjoining portion of the outer border of the scapula.

2. From the capsular ligament of the shoulder joint.

Outer head.

1. From the posterior surface of the shaft of the humerus, above the musculo-spiral groove.

2. From the outer border of the humerus.

3. From the external inter-muscular septum.

Inner head.

1. From the posterior surface of the shaft of the humerus, below the musculo-spiral groove.

2. From the inner border of the humerus.

3. From the internal inter-muscular septum.

Insertion.

By a strong tendon, into the posterior and upper part of the olecranon process of the ulna.

Nervous supply.

The musculo-spiral nerve.

SUB-ANCONEUS.

Origin.

From the posterior surface of the humerus, above the olecranon fossa.

Insertion.

Into the posterior ligament of the elbow joint.

Nervous supply.

The musculo-spiral nerve.

ACTION OF THE MUSCLES OF THE ARM.

The *biceps* first supinates the hand and then flexes the forearm ; it also renders tense the fascia of the forearm by its aponeurotic tendinous expansion.

The *brachialis anticus* muscle, from its anatomical situation, forms a most important *defence to the elbow joint* which it covers.

The *brachialis anticus* muscle also flexes the forearm, and, in cases where the forearm becomes a fixed point, this muscle and the biceps tend to flex the arm upon the forearm, as illustrated in the act of climbing.

The *triceps* extensor cubiti is the antagonist of the biceps and brachialis anticus muscles, and is an extensor of the forearm upon the arm. It becomes therefore a powerful agent in the act of striking a blow with the hand, acting in connection with the pectoralis major and the coraco-brachialis.

The *triceps* extensor cubiti, from its relation to the shoulder joint, forms a formidable barrier to displacement of the head of the humerus downwards or backwards. When the arm and the forearm are extended, the *triceps* muscle may assist the teres major and the latissimus dorsi muscles in drawing the humerus backwards.

NERVOUS SUPPLY OF THE MUSCLES OF THE ARM.

The *anterior group* is supplied by the *musculo-cutaneous* nerve.
The *posterior group* is supplied by the *musculo-spiral* nerve.

POINTS OF SURGICAL INTEREST PERTAINING TO THE MUSCLES OF THE ARM.

In those forms of fractures of the humerus, occurring *immediately above the condyles*, the muscles of the arm are agents in producing the deformity. If the fracture be oblique, from above downwards and forwards, the lower fragment is drawn upwards and backwards by the combined force of the biceps, brachialis anticus and the triceps muscles ; but if the obliquity be in the opposite direction, the displacement of the lower fragment is forwards and upwards.

In fracture of the *olecranon process of the ulna*, the triceps muscle produces a displacement of the fragment upwards for a distance varying from one-half an inch to two inches (provided the tendinous aponeurosis of that muscle is completely detached from the remaining portion of the ulna), and the *power of extension of the forearm* upon the arm is lost.

In fracture of the *coronoid process of the ulna*, the brachialis anticus muscle elevates the fragment and the *power of flexion of the elbow joint* is partially destroyed.

In fracture of the *neck of the radius*, the lower fragment is drawn upwards by the biceps muscle; and the action of the supinator brevis and the pronator radii teres muscles tend also to disturb the relation of the two fragments to each other.

The *inner border* of the *coraco-brachialis* and *biceps muscles* serves as a *guide* to the *brachial artery*, in its course down the inner aspect of the arm.

C.

MUSCLES OF THE FOREARM.

The muscles of the forearm are 20 in number, and may be divided into two sets.

1.	Those on the anterior surface,	8
2.	" " " posterior "	12
		20

On both surfaces, the muscles are arranged in two layers, *viz.*, a superficial and deep layer.

MUSCLES OF ANTERIOR SURFACE OF FOREARM.

Muscles of anterior surface of forearm.	Superficial layer,	(5)	Pronator radii teres.
			Flexor carpi radialis
			Palmaris longus.
			Flexor sublimis digitorum.
			Flexor carpi ulnaris.
	Deep layer,	(3)	Flexor longus pollicis.
			Flexor profundis digitorum.
			Pronator quadratus.
	Total	8	

The muscles of the superficial layer all arise from the *internal condyle* of the humerus, either entirely or in part.

ORIGIN AND INSERTION OF THE ANTERIOR GROUP.

SUPERFICIAL LAYER.

(5 muscles).

PRONATOR RADII TERES.

Origin.

Large or *superficial head.*

1. From the inner condyle and the inner border of the humerus.
2. From the deep fascia of the forearm.
3. From the inter-muscular septum, between it and the flexor carpi radialis.

Small or *deep head.*

1. From the inner surface of the coronoid process of the ulna.

Insertion.

Into the rough depression, situated at about the middle of the outer surface of the shaft of the radius.

Nervous supply.

The median nerve.

FLEXOR CARPI RADIALIS.

Origin.

1. By the common tendon arising from the inner condyle of the humerus.
2. From the deep fascia of the forearm.
3. From the inter-muscular septa.

Insertion.

Into the palmar surface of the base of the metacarpal bone of the index-finger.

Nervous Supply.

The median nerve.

PALMARIS LONGUS.

Origin.

1. By the common tendon,from the inner condyle of the humerus.
2. From the deep fascia of the right forearm.
3. From the inter-muscular septa.

Insertion.

1. Into the anterior annular ligament of the carpus.
2. Into the palmar fascia.

Nervous Supply.

The median nerve.

FLEXOR SUBLIMIS DIGITORUM.

Origin.

Inner head.

1. From the inner condyle of the humerus, by means of the common tendon.
2. From the internal lateral ligament of the elbow joint.

Middle head.

From a tubercle on the inner side of the coronoid process of the ulna.

Outer head.

From an oblique line on the front of the radius.

Insertion.

Into the sides of the 2d phalanges of each of the four fingers.

Nervous Supply.

The median nerve.

FLEXOR CARPI ULNARIS.

Origin.

Anterior or *inner head.*

1. From the internal condyle, by means of the common tendon.

2. From the deep fascia of the forearm.

3. From the inter-muscular septum.

Posterior or *outer head.*

1. From the inner border of the olecranon process.

2. From the upper two-thirds of the posterior portion of the shaft of the ulna.

Insertion.

1. Into the pisiform bone and slightly into the 5th metacarpal bone.

2. Into the annular ligament.

Nervous supply.

The ulnar nerve.

DEEP LAYER.

(3 muscles.)

FLEXOR LONGUS POLLICIS.

Origin.

1. From the upper two-thirds of the anterior surface of the shaft of the radius.

2. From the interosseous membrane.

3. Occasionally by a slip from the coronoid process of the ulna.

Insertion.

Into the base of the last phalanx of the thumb.

Nervous supply.

The median nerve.

FLEXOR PROFUNDIS DIGITORUM.

Origin.

1. From the inner side of the coronoid process of the ulna.

2. From the upper two-thirds of the anterior and the inner surfaces of the ulna.

3. By an aponeurosis, common to it and the flexor carpi ulnaris, from the upper two-thirds of the posterior surface of the ulna.

4. From the inner half of the interosseous membrane.

Insertion.

Into the bases of the 3d phalanges of each of the four inner fingers.

Nervous supply.

The median and ulnar nerves.

PRONATOR QUADRATUS.

Origin.

1. From the inner fourth of the anterior surface and the inner border of the ulna.

2. From an aponeurosis covering the inner portion of the muscle.

Insertion.

Into the lower fourth of the anterior surface and the outer border of the radius.

Nervous supply.

The median nerve.

ACTION OF THE MUSCLES OF ANTERIOR SURFACE OF THE FOREARM.

Muscles of anterior surface of forearm.

- Superficial layer, (5)
  - Pronator radii teres......
  - Flexor carpi radialis......
  - Palmaris longus..........
  - Flexor sublimis digitorum.
  - Flexor carpi ulnaris.......
- Deep layer, (3)
  - Flexor longus pollicis.....
  - Flexor profundus digitorum
  - Pronator quadratus.......

Action.

- 2 *Pronators.*
- 3 *Flexors of hand.*
- 3 *Flexors of fingers.*

NERVOUS SUPPLY OF THE MUSCLES OF THE ANTERIOR SURFACE OF THE FOREARM.

The *median* nerve supplies..........6½ muscles.
- Pronator radii teres.
- Pronator quadratus.
- Flexor carpi radialis.
- Flexor sublimis digitorum.
- Flexor longus pollicis.
- ½ of Flexor profundus digitorum.
- Palmaris longus.

The *ulnar* nerve supplies...........1½ muscles.
- Flexor carpi ulnaris.
- ½ of Flexor profundus digitorum.

MUSCLES OF POSTERIOR SURFACE OF FOREARM.

The muscles situated npon the posterior surface of the forearm may be thus classified:

Muscles of the posterior surface of the forearm.

- Superficial layer, (7)
  - Supinator longus.
  - Extensor carpi rad. longior.
  - Extensor carpi rad. brevior.
  - Extensor communis digitorum.
  - Extensor minimi digiti.
  - Extensor carpi ulnaris.
  - Anconeus.
- Deep layer, (5)
  - Supinator brevis.
  - Extensor ossis metacarpi pollicis.
  - Extensor primi internodii pollicis.
  - Extensor secundi internodii polli.
  - Extensor indicis

The superficial group arise entirely or in part from the *external condyle* or the *external ridge of the humerus.*

ORIGIN AND INSERTION OF THE POSTERIOR GROUP.

SUPERFICIAL LAYER.
(7 muscles.)

SUPINATOR LONGUS.

Origin.

1. From the upper two-thirds of the external condyloid ridge of the humerus.
2. From the inter-muscular septum on its outer side.

Insertion.

Into the outer side of the base of the styloid process of the radius.

Nervous supply.

The musculo-spiral nerve.

EXTENSOR CARPI RADIALIS LONGIOR.

Origin.

1. From the lower third of the external condyloid ridge of the humerus.
2. From the inter-muscular septum.

Insertion.

Into the base of the 2nd metacarpal bone.

Nervous Supply.

The musculo-spiral nerve.

EXTENSOR CARPI RADIALIS BREVIOR.

Origin.

1. By a common tendon, from the external condyle of the humerus.

2. From the external lateral ligament of the elbow joint.

3. From the deep fascia of the forearm.

4. From the inter-muscular septa.

Insertion.

Into the posterior part of the base of the third metacarpal bone.

Nervous Supply.

The posterior interosseous nerve.

EXTENSOR COMMUNIS DIGITORUM.

Origin.

1. By the common tendon, from the external condyle of the humerus.

2. From the deep fascia of the forearm.

3. From the inter-muscular septa.

Insertion.

Into the bases of the 2nd and 3rd phalanges of the four fingers.

Nervous Supply.

The posterior interosseous nerve.

EXTENSOR MINIMI DIGITI.

Origin.

1. From the external condyle of the humerus, by a common tendon.

2. From the deep fascia of the forearm.

3. From the inter-muscular septa.

Insertion.

In common with the tendon of the extensor communis digitorum, with which it is joined to the 2nd and 3rd phalanges of the little finger.

Nervous supply.

The posterior interosseous nerve.

EXTENSOR CARPI ULNARIS.

Origin.

1. By the common tendon, from the external condyle of the humerus.

2. From the middle third of the posterior border of the shaft of the ulna.

3. From the deep fascia of the forearm.

4. From the inter-muscular septum, between it and the extensor minimi digiti.

Insertion.

Into the base of the metacarpal bone of the little finger.

Nervous supply.

The posterior interosseous nerve.

ANCONEUS.

Origin.

1. From the back of the outer condyle of the humerus.

2. From the deep fascia of the forearm.

Insertion.

1. Into the outer side of the olecranon process of the ulna.

2. Into the upper third of the posterior surface of the shaft of the ulna.

Nervous supply.

The musculo-spiral nerve.

DEEP LAYER.
(5 muscles.)

SUPINATOR BREVIS.

Origin.

1. From the external condyle of the humerus.

2. From the external lateral ligament of the elbow joint.

3. From the orbicular ligament of the radius.

4. From a depression and a ridge below the lesser sigmoid cavity of the ulna.

Insertion.

1. Into the inner, the anterior and the outer surface of the radius above its tuberosity.

2. Into the oblique line upon the radius as low down as the insertion of the pronator radii teres.

Nervous Supply.

The posterior interosseous nerve.

EXTENSOR OSSIS METACARPI POLLICIS.

Origin.

1. From the outer half of the posterior surface of the shaft of the ulna.

2. From the posterior surface of the interosseous membrane.

3. From the middle third of the posterior surface of the shaft of the radius.

Insertion.

Into the base of the first metacarpal bone.

Nervous Supply.

The posterior interosseous nerve.

EXTENSOR PRIMI INTERNODII POLLICIS.

Origin.

1. From the posterior surface of the radius below the foregoing muscle.

2. From the posterior surface of the interosseous membrane.

Insertion.

Into the base of the first phalanx of the thumb.

Nervous Supply.

The posterior interosseous nerve.

EXTENSOR SECUNDI INTERNODII POLLICIS.

Origin.

1. From the middle of the outer half of the posterior surface of the shaft of the ulna.

2. From the posterior surface of the interosseous membrane.

Insertion.

Into the base of the last phalanx of the thumb.

Nervous Supply.

The posterior interosseous nerve.

EXTENSOR INDICIS.

Origin.

1. From the posterior surface of the shaft of the ulna below the foregoing muscle.

2. From the posterior surface of the interosseous membrane.

Insertion.

This tendon joins with the tendon of the extensor communis digitorum. The common tendon, so formed, is inserted into the bases of the 2nd and 3rd phalanges of the index finger.

Nervous Supply.

The posterior interosseous nerve.

ACTION OF THE MUSCLES OF POSTERIOR SURFACE OF FOREARM.

The muscles situated upon the posterior surface of the forearm may be thus classified, as to their action.

			Action.
Muscles of the posterior surface of the forearm.	Superficial layer...........(7)	Supinator longus..............	Supinators(2)
		Extensor carpi rad. longior.....	
		Extensor carpi rad. brevior.....	
		Extensor communis digitorum..	Extensors of fingers, (3)
		Extensor minimi digiti	
		Extensor carpi ulnaris	Extensors of hand, (3)
		Anconeus......................	Extensor of forearm, (1)
	Deep layer....(5)	Supinator brevis.......	
		Extensor ossis metacarpi pollicis.	
		Extensor primi internodii pollicis	
		Extensor sec. internodii pollicis.	Extensors of thumb, (3)
		Extensor indicis.............	

From the above table it is seen that of the 12 muscles on the posterior surface of the forearm,

One extends the forearm.
Two supinate the hand.
Three extend the hand.
Three extend the fingers.
Three extend the thumb.

All the pronators and supinators are inserted into the radius, principally on its outer border.

NERVOUS SUPPLY OF THE MUSCLES OF THE POSTERIOR SURFACE OF THE FOREARM.

All the posterior muscles of the forearm are supplied with nerve power from the *musculo spiral* nerve or its *interosseous* branch.

ACTION OF THE MUSCLES OF THE FOREARM IN GENERAL.

The action of the muscles of the forearm will be considered, in detail, later on in connection with the muscles of the hand.

The muscles on the anterior surface of the forearm are *flexors* and *pronators* in their action, while those on the posterior surface perform the functions of *extension* and *supination*.

They may, however, be here enumerated under the following heads:

A. Muscles acting upon the *hand as a whole*	(10)	The supinators	(2)	
		The pronators	(2)	
		The flexors of the wrist,	(3)	
		The extensors " "	(3)	
B. Muscles acting on the *fingers in common*	(3)	The flexors	(2)	Sublimis digitorum. Profundus digitorum.
		The extensor	(1)	Communis digitorum.
C. Extensors of *special fingers*	(5)	Thumb	(3)	
		Little finger	(1)	
		Index "	(1)	
D. Flexors of *special fingers*	(1)	Flexor longus pollicis.		
E. Extensor of *forearm*	(1)	Anconeus.		

GENERAL NERVOUS DISTRIBUTION TO THE FOREARM.

The nervous supply to the muscles of the forearm, *considered as a whole*, is as follows:

To the *anterior* surface..(8 muscles.)	The *median nerve* supplies	$6\frac{1}{2}$	muscles.
	The *ulnar nerve* supplies	$1\frac{1}{2}$	muscles.
To the *posterior* surface (12 muscles.)	The *interosseous nerve* supplies	9	muscles.
	The *musculo-spiral nerve* supplies	3	muscles.
	Total,	20	

GENERAL SUMMARY OF THE MUSCLES OF THE FOREARM.

All the *flexors* and *extensors* of the *wrist* are inserted into the *base of a metacarpal bone*, except the palmaris longus muscle.

Of the twenty muscles of the forearm, all except one, the anconeus, act directly or indirectly upon the hand.

Of these twenty muscles, *fifteen cross the wrist joint*, and the remaining *five*, the anconeus, 2 pronators and 2 supinators, *are inserted into the bones of the forearm*. Of these fifteen muscles which cross the wrist joint, *six* cross in front and *nine* cross posteriorly to the joint. The position of the tendons is shown in the following table:

The flexor tendons of the fingers and of the thumb pass, at the wrist joint, through a *large synovial sheath*, which is situated underneath the annular ligament and which extends upwards for a space of about one and a half inches in the forearm, and downwards to the centre of the palm. This synovial sheath communicates with the separate sheaths of the *thumb* and the *little finger* but does not communicate with those of the other fingers.

Upon the *back of the wrist* the extensor muscles of the thumb have the longest sheaths, although those of the other tendons are seldom less than two inches in length. A peculiar crepitus called "tenalgia crepitans" is produced by a local inflammation of the synovial sheaths of these tendons, which is produced by excessive and rapid use of the fingers.

- Tendons crossing the wrist joint........(15)
  - In front...(6)
    - 3 in grooves.
    - 3 above the grooves, lying superficial to the annular ligament of the wrist.
  - Behind....(9)
    - 3 canals, each enclosing 2 tendons.
    - 3 canals, each enclosing 1 tendon.

D.

MUSCLES OF THE HAND.

The muscles of the hand are 19 in number and may be arranged in three groups, as follows:

- (A.) *Radial* group, forming "*thenar eminence*," or the "*ball of the thumb*."....................4 muscles.
  - Abductor pollicis.
  - Opponens pollicis.
  - Flexor brevis pollicis.
  - Adductor pollicis.
- (B.) *Ulnar* group, forming the "*hypothenar eminence*." 4 muscles.
  - Palmaris brevis.
  - Abductor minimi digiti.
  - Flexor minimi digiti.
  - Opponens minimi digiti.
- (C.) *Palmar* group............11 muscles.
  - 4 lumbricales.
  - 7 interossei.
    - 3 *palmar* (abductors.)
    - 4 *dorsal* (adductors.)

The "*opponens*" muscles of the thumb and little finger are called also "flexor ossis metacarpi," when spoken of by some anatomists, since that name also indicates their action.

ORIGIN AND INSERTION.

A.

RADIAL GROUP.
(4 muscles).

Abductor Pollicis.

Origin.

1. Ridge on the anterior surface of the trapezium.
2. From the anterior annular ligament of the wrist.

Insertion.

Into the outer or radial side of the base of the first phalanx of the thumb.

Nervous Supply.

The median nerve.

OPPONENS POLLICIS.

Origin.

1. From the anterior surface of the trapezium.
2. From the annular ligament of the wrist.

Insertion.

Into the whole length of the outer border of the metacarpal bone of the thumb.

Nervous Supply.

The median nerve.

FLEXOR BREVIS POLLICIS.

Origin.

Outer or *superficial head.*

1. From the trapezium.
2. From the annular ligament.

Inner or *deep head.*

1. From the trapezoid bone.
2. From the os magnum.
3. From the 2nd and 3rd metacarpal bones.

Insertion.

Into either side of the base of the first phalanx of the thumb, (a sesamoid bone being frequently found in each tendon.)

Nervous Supply.

The median nerve to the outer half, and the ulnar nerve to the inner half of the muscle.

ADDUCTOR POLLICIS.

Origin.

From the lower two-thirds of the anterior surface of the third metacarpal bone.

Insertion.

Into the inner side of the base of the first phalanx of the thumb.

Nervous Supply.

The ulnar nerve.

B.

ULNAR GROUP.
(4 muscles).

PALMARIS BREVIS.

Origin.

From the annular ligament and the central palmar fascia.

Insertion.

Into the integument over the inner border of the hand.

Nervous Supply.

The ulnar nerve.

ABDUCTOR MINIMI DIGITI.

Origin.

1. From the pisiform bone.
2. Slightly from the tendon of the flexor carpi ulnaris.

Insertion.

Into the inner side of the base of the first phalanx of the little finger.

Nervous Supply.

The ulnar nerve.

FLEXOR MIMIMI DIGITI.

Origin.

1. From the unciform process of the unciform bone.
2. From the annular ligament.

Insertion.

Into the inner side of the base of the first phalanx of the little finger.

Nervous Supply.

The ulnar nerve.

OPPONENS OR ADDUCTOR MINIMI DIGITI.

Origin.

1. From the unciform process of the unciform bone.
2. From the annular ligament.

Insertion.

Into the whole length of the inner border of the metacarpal bone of the little finger.

Nervous Supply.

The ulnar nerve.

C.

PALMAR GROUP.

LUMBRICALES.

Origin.

The *first* and sometimes the *second* lumbricales arise from the outer side of the corresponding tendon of the flexor profundus digitorum.

The *third* and *fourth* lumbricales arise, respectively, from adjoining sides of the 2d and 3d, and the 3d and 4th tendons of the deep flexor.

Insertion.

Into the outer side of the expansions of the corresponding extensor tendons on the back surface of the first phalanges.

Nervous supply.

Branches of the ulnar nerve to the two inner, and of the median nerve to the two outer muscles.

INTEROSSEI MUSCLES.

The interossei muscles, like the lumbricales, are named in numerical order from the radial towards the ulnar side of the hand. They are seven in number and consist of two sets, *viz.*, a palmar set (3) and a dorsal set (4).

A. PALMAR INTEROSSEI, (Three in number).

Origin.

From the whole length of *one side* of a metacarpal bone of one finger.

Insertion.

Into the same side of the base of the first phalanx of the same finger and into the expansions of the tendon of the extensor muscle of that finger.

Nervous supply.

The deep palmar branches of the ulnar nerve.

B. DORSAL INTEROSSEI, (Four in number).

Origin.

Each muscle arises by two heads from the *adjacent sides* of the two metacarpal bones between which it is situated, but most extensively from that one which supports the finger on which the muscle acts.

Insertion.

1. Into the corresponding side of the base of the first phalanx of that finger, which lies in a direct line from the most extensive point of origin.

2. Into the expansion of the extensor tendon which covers that finger.

Nervous supply.

The deep palmar branches of the ulnar nerve.

ACTION OF THE MUSCLES OF THE HAND.

The muscles of the hand may be arranged according to their *action* as follows; the total number of muscles acting upon each finger being shown, as well as the special action of each muscle forming those totals.

Digits.	Flexors.	Adductors.	Abductors.	Total.
Acting on thumb.....	2	1	1	4
" " 2nd finger..	1	1	1	3
" " 3rd "	1	1	1	3
" " 4th "	1	1	1	3
" " 5th "	3	1	1	5
" " integument.	....	1	....	1
Total.......	8	6	5	19

NERVOUS SUPPLY OF MUSCLES OF THE HAND.

The *median nerve* supplies.......... $4\frac{1}{2}$ muscles.
- Abductor pollicis.
- Opponens pollicis.
- 1st lumbricalis.
- 2nd lumbricalis.
- *Outer half* of Flexor brevis pollicis

The *ulnar nerve* supplies..... .....$14\frac{1}{2}$ muscles.
- Palmaris brevis.
- Abductor minimi digiti.
- Flexor minimi digiti.
- Opponens minimi digiti.
- Adductor pollicis.
- 3rd lumbricalis.
- 4th lumbricalis.
- 7 interossei muscles.
- *Inner half* of Flexor brevis pollicis

Total, 19

TABLE ILLUSTRATING THE DISTRIBUTION OF THE MOTOR NERVES OF THE MUSCLES WHICH ACT UPON THE HAND AND FINGERS.

Region Supplied.		Name of the Nerve. Musculo-spiral and branch.	Median.	Ulnar.	Total.
Forearm....	Anterior surface.	....	$6\frac{1}{2}$	$1\frac{1}{2}$	8
	Posterior surface.	11	....	....	11
Hand,......	Anterior surface.	....	$4\frac{1}{2}$	$14\frac{1}{2}$	19
	Posterior surface.	....	....	....	....
Total number..	....	11 muscles.	11 muscles	16 muscles.	38 muscles.

POINTS OF SPECIAL INTEREST PERTAINING TO THE UPPER EXTREMITY IN GENERAL.

The insertions of the 19 muscles of the hand may be thus simplified :

16 are inserted into the *first phalanges.*
2 " " " *metacarpal bones.*
1 is " " the *integument of hand.*
—
19

In animals, as the type descends from that of man, the digits disappear in the following order :

The 1st digit.
" 5th "
" 2nd "
" 4th "
" 3rd "

The *height* of the individual is usually equal to the *distance between the tips of the middle fingers* when the arms are extended.

The hand is capable of *six* distinct movements, *viz.:* pronation, supination, flexion, extension, abduction and adduction.

Pronation of the hand is performed by..(2) muscles.	Pronator radii teres and pronator quadratus.
Supination " " " "..(2) "	Supinator longus and supinator brevis.
Extension " " " "..(3) "	Extensor carpi radialis longior. Extensor carpi radialis brevior. Extensor carpi ulnaris.
Flexion " " " "..(3) "	Flexor carpi radialis. Palmaris longus. Flexor carpi ulnaris.
Adduction " " " "..(2) "	Flexor carpi ulnaris. Extensor carpi ulnaris.
Abduction " " " "..(3) "	Flexor carpi radialis. Extensor carpi radialis longior. Extensor carpi radialis brevior.

The 38 muscles which *act upon the hand*, (comprising all the muscles of the forearm excepting one, the anconeus, and those of the hand itself,) may be arranged in four classes, as follows:

1st.	Those which act upon the *hand as a whole*,	10
2nd.	" " " " " *fingers in common*.	3
3rd.	" " " " " *separate fingers*,	24
4th.	" " " " " *integument*,	1
		38

In order to more clearly elucidate the action of each of these muscles, the following table has been prepared:

TABLE OF MUSCLES ACTING UPON THE HAND.

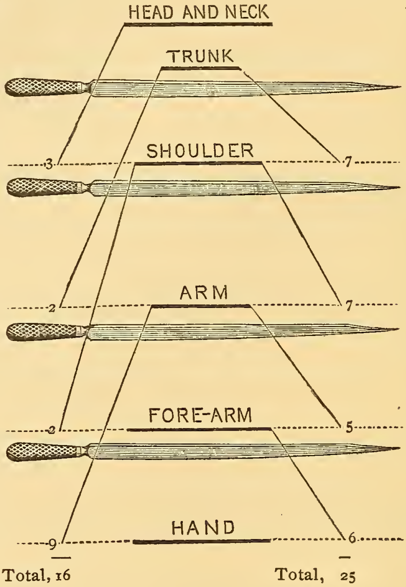
Part acted upon.	Pronators.	Supinators.	Flexors	Extensors.	Adductors.	Abductors.	Total Muscles.	Total Tendons.
Hand as a whole..	2	2	3	3	.....	......	10	10
Fingers in common	.....	......	2	1	......	......	3	
Thumb alone.....	.....	.....	3	3	1	1	8	8
Index finger alone.	......	......	1	1	1	1	4	7
Middle " "	......	.....	1	......	1	1	3	6
Ring " "	......	......	1	......	1	1	3	6
Little " "	......	......	3	1	1	1	6	9
Integument.......	......	......	......	......	......	1	1	1
Total.........	2	2	14	9	5	6	38	47

The *number of tendons* specified as belonging to *each digit* except in the thumb, represents the number of muscles acting upon it *singly*, in addition to the tendons of the three muscles acting *in common* upon the fingers.

Table of the Muscles Divided in Amputatation at any of the Joints of the Upper Extremity.

Muscles passing over *two joints.*

Muscles passing over *one joint.*



Trunk–Shoulder.

Two joints:
1 Sterno-cleido-mastoid.
2 Sterno-hyoid.
3 Omo-hyoid.

One joint:
1 Subclavius.
2 Pectoralis minor.
3 Serratus magnus.
4 Trapezius.
5 Levator anguli scapulæ.
6 Rhomboideus minor.
7 Rhomboideus major.

Shoulder–Arm.

Two joints:
1 Pectoralis major.
2 Latissimus dorsi.

One joint:
1 Deltoid.
2 Supra-spinatus.
3 Infra-spinatus.
4 Teres minor.
5 Teres major.
6 Subscapularis.
7 Coraco-brachialis.

Arm–Fore-arm.

Two joints:
1 Biceps flexor cubiti.
2 Triceps exten.cubiti

One joint:
1 Brachialis anticus.
2 Pronator radii teres.
3 Anconeus.
4 Supinator longus.
5 Supinator brevis.

Fore-arm–Hand.

Two joints:
1 Flexor carpi radialis
2 Palmaris longus.
3 Flexor sublimis dig.
4 Flexor carpi ulnaris.
5 Extensor car. radialis longior.
6 Ex. carpi rad. brev.
7 Extensor communis digitorum.
8 Extensor min. digiti
9 Extensor carpi ulnaris.

One joint:
1 Flexor long. pollicis.
2 Flexor profund. dig.
3 Ex. ossis meta. pol.
4 Ex. primi. int. pol.
5 Ex. sec. int. pollicis.
6 Extensor indicis.

Total, 16 — Total, 25

In this table *four knives* are represented as placed successively between the trunk and shoulder joints; the shoulder and the arm; the arm and forearm; and the forearm and hand; thus indicating the amputations to be performed.

On one side of the knives, are arranged the number of muscles *crossing one joint*, and, on the other side, the number of muscles *crossing two joints*, before their insertion into a bone.

The *lines crossing the blade of the knife* indicates the *sets* of muscles divided; and the numbers at the extremity of those lines indicate the *total* of each of these sets of muscles.

As an example, the *first knife* makes an imaginary amputation between the trunk and the shoulder, thus removing the scapula and the clavicle.

The *blade is crossed by three lines*, indicating that three sets of muscles are divided. These lines, if traced to their termination, disclose the three sets of muscles to be as follows:

(1) Those connecting the *head* to the *shoulder*,	passing over two joints,	3 muscles.
(2) " " " *trunk* to the *arm*,	" " " "	2 "
(3) " " " *trunk* to the *shoulder*,	" " one joint,	7 "
	Total,	12 "

The *second knife* indicates an amputation between the shoulder and the arm, (or at the *shoulder-joint*). The three *lines crossing the blade* indicate a total of 11 muscles divided if the numbers corresponding to each of these lines be added together.

MUSCLES OF THE UPPER EXTREMITY.

GENERAL SUMMARY.

In the upper extremity, the 62 muscles may be thus enumerated, in closing.

1. Muscles *passing over two joints* before insertion,	16
2. Muscles *passing over one joint* before insertion,	25
3. Muscles *passing over no joint* before insertion,	2
4. Muscles *of the hand*,	19
Total,	62

Nervous supply.

The 50 *intrinsic* muscles of the upper extremity are thus supplied with nerves.

By the *ulnar nerve*, are supplied	16 muscles.
By the *musculo-spiral nerve*, are supplied	14 muscles.
By the *median nerve*, are supplied	11 muscles.
By the *musculo-cutaneous nerve*, are supplied	3 muscles.
By the *circumflex nerve*, are supplied	2 muscles.
By the *sub-scapular nerve*, are supplied	2 muscles.
By the *supra-scapular nerve*, are supplied	2 muscles.
Total,	50

These muscles will be found classified both as regards their situation and their nervous supply in the following table.

Nervous Supply of the Extrinsic Muscles of the Upper Extremity.

Name of Nerve.	*Name of Muscle.*
	Sterno-mastoid.
Cervical plexus. ...... 8 (deep branches.)	Sterno-hyoid.
Long subscapular. ... 1	Sterno-thyroid.
	Trapezius.
Spinal accessory...... 2	Latissimus dorsi.
5th Cervical nerve.... 3	Rhomboideus major.
Descendens noni... } Communicans noni. } 3	Rhomboideus minor.
	Levator anguli scapulæ.
Anterior thoracic..... 2	Pectoralis major.
Posterior thoracic.... 1	Pectoralis minor.
	Subclavius.
	Serratus magnus.
Total, 15	
Deduct muscles with two sources of supply, 3	
12	12 muscles.

The twelve *extrinsic* muscles, as shown above, are thus supplied with nerve power.

The *anterior thoracic nerve* supplies	2 muscles.
The *posterior thoracic nerve* supplies	1 muscle.
The *subscapular nerve* supplies	2 muscles.
The 5*th cervical nerve* supplies	3 muscles.
The *spinal accessory nerve* supplies	1 muscle.
The *descendens noni nerve* } The *communicans noni nerve* } supplies	3 muscles.
	Total, 12

Action of Muscles upon the Scapula.

The scapula is moved

Upwards by....... { Trapezius. Levator anguli scapulæ. Rhomboideus minor and major.

Downwards by..... { Lower part of trapezius. Latissimus dorsi. Pectoralis minor.

Forwards by....... { Pectoralis minor. Serratus magnus.

Backwards by..... { Trapezius. Rhomboideus minor and major. Latissimus dorsi.

JPPER EXTREMITY.

MUSCLES.

SUPRA-SCAPULtus, and Infra-spinatus.

SUBSCAPULAR is, and Teres Major.
CIRCUMFLEX d Teres Minor.
MUSCULO-SPIR nconeus, Subanconeus, Supinator Longus, and Extensor Carpi lis Longior.

Post

arpi Radialis Brevior.	Supinator Brevis.
ommunis Digitorum.	Extensor Ossis Metacarpi Pollicis.
inimi Digiti.	" Primi Internodii Pollicis.
arpi Ulnaris.	" Secundi Internodii Pollicis.

and Extensor Indicis.

MUSCULO-CUT hialis, Biceps, and Brachialis Anticus.

MEDIAN, Ex. a

lii Teres.	Abductor Pollicis.
i Radialis.	Opponens Pollicis.
ongus.	First and Second Lumbricales.
limis Digitorum.	½ of the Flexor Brevis Pollicis (outer head).

Ante uadratus, Flexor Longus Pollicis and outer half of the Flexor is Digitorum.

ULNAR, Inner i Ulnaris, and inner half of the Flexor Profundus Digitorum.

Superfici revis.

Deep Pa ollicis, Abductor Minimi Digiti. Flexor Brevis Minimi Digiti, iens Minimi Digiti, 3d and 4th Lumbricales, the 7 Interossei, uter half of the Flexor Brevis Pollicis (inner head).

N.B.—tes at the same time the name and number of the muscles situated on the diff he anterior, while the Extensor and Supinator Muscles are situated on the rm and hand (27 in number), 11 are supplied by the Median, and 16 by the lied by the Musculo-Spiral, and the remaining 9 by the Posterior Interosseou

MOTOR NERVES OF THE INTRINSIC MUSCLES OF THE UPPER EXTREMITY.

NERVES.	Muscles of the Scapulo-Humeral Region or Muscles connecting the Arm with Shoulder.	Humeral Region or Muscles situated on the Arm.	Muscles of the Forearm.	Muscles of the hand.	Total.		MUSCLES.
Supra-Scapular { 5th and 6th Cervical Nerve.	2	...	...	...	2	2	Supra-spinatus, and Infra-spinatus.
Subscapular . . { From Posterior Cord of the Brachial Plexus.	2	...	...	...	2	2	Subscapularis, and Teres Major.
Circumflex ..	2	...	...	...	2	2	Deltoid, and Teres Minor.
Musculo-Spiral	...	2	3	...	5	14	Triceps, Anconeus, Subanconeus, Supinator Longus, and Extensor Carpi Radialis Longior.
Posterior Interosseous ...	...	...	9	...	9		Extensor Carpi Radialis Brevior. " Communis Digitorum. " Minimi Digiti. " Carpi Ulnaris. Supinator Brevis. Extensor Ossis Metacarpi Pollicis. " Primi Internodii Pollicis. " Secundi Internodii Pollicis. and Extensor Indicis.
Musculo-Cutaneous, Ex. Cord	1	2	...	...	3	3	Coraco-Brachialis, Biceps, and Brachialis Anticus.
Median, Ex. and In. Cord	...	...	4	4½	8½	11	Pronator radii Teres. Flexor Carpi Radialis. Palmaris Longus. Flexor Sublimis Digitorum. Abductor Pollicis. Opponens Pollicis. First and Second Lumbricales. ½ of the Flexor Brevis Pollicis (outer head).
Anterior Interosseous ...	...	...	2½	...	2½		Pronator Quadratus, Flexor Longus Pollicis and outer half of the Flexor Profundus Digitorum.
Ulnar, Inner Cord	...	...	1½	...	1½	16	Flexor Carpi Ulnaris, and inner half of the Flexor Profundus Digitorum.
Superficial Palmar	...	...	...	1	1		Palmaris Brevis.
Deep Palmar	...	...	...	13½	13½		Adductor Pollicis, Abductor Minimi Digiti, Flexor Brevis Minimi Digiti, Opponens Minimi Digiti, 3d and 4th Lumbricales, the 7 Interossei, and outer half of the Flexor Brevis Pollicis (inner head).
	7	4	20	19	50	50	

N.B.—The above table, constructed for the purpose of showing the Motor Nerves of the Intrinsic Muscles of the Upper Extremity, indicates at the same time the name and number of the muscles situated on the different segments of the limb. It should be borne in mind that the Flexors and Pronators of the forearm and hand are situated on the anterior, while the Extensor and Supinator Muscles are situated on the posterior surface of the limb. By reference to the table, it will also be found that, of the muscles of the anterior surface of the forearm and hand (27 in number), 11 are supplied by the Median, and 16 by the Ulnar Nerve and its branches; and of the muscles of the posterior surface of the forearm and hand (11 in number), 2 are supplied by the Musculo-Spiral, and the remaining 9 by the Posterior Interosseous. The Brachialis Anticus usually receives a filament from the Musculo-Spiral, as well as from the Musculo-Cutaneous Nerve.

ACTION OF MUSCLES UPON THE ARM.

The humerus is moved by

Forwards by.........
- Coraco-brachialis.
- Part of the deltoid.
- " " pectoralis major.
- Assisted by the biceps.

Backwards by........
- Part of the deltoid.
- Teres major.
- " minor.
- Long head of triceps.
- Latissimus dorsi.

Inwards by..........
- Part of pectoralis major.
- Latissimus dorsi.

Rotated inwards by...
- Subscapularis.
- Assisted by pectoralis major.
- " " latissimus dorsi.
- " " teres major.

Rotated outwards by .
- Supra-spinatus.
- Infra-spinatus.
- Teres minor.

ACTION OF MUSCLES UPON THE FOREARM.

The forearm is

Flexed by............
- Biceps.
- Brachialis anticus.
- Pronator teres.
- Asssisted by flexor carpi radialis.
- " " " sublimis digitorum.
- " " " carpi ulnaris.
- " " supinator longus.

Extended by.........
- Triceps,
- Anconeus.

Rotated inwards by...
- Pronator teres.
- Flexor carpi radialis.
- Palmaris longus.
- Flexor sublimis digitorum.
- Pronator quadratus.

Rotated outwards by..
- Biceps.
- Supinator brevis.
- Extensor secundi internodii pollicis.

MUSCLES OF THE LOWER EXTREMITY.

The muscles of the lower extremity are 60 in number and may be arranged in five groups, as follows:

A.	Muscles of the ILIAC region,	3
B.	" " FEMORAL region,	24
C.	" " POPLITEAL region,	1
D.	" " CRURAL region,	12
E.	" " PEDAL region,	20
	Total	60

A.

MUSCLES OF ILIAC REGION.

This group includes the three following muscles:

PSOAS PARVUS.
PSOAS MAGNUS.
ILIACUS.

ORIGIN AND INSERTION OF THE MUSCLES OF THE ILIAC REGION.

PSOAS PARVUS.

Origin.

1. From the sides of the bodies of the last dorsal and the first lumbar vertebræ.
2. From the corresponding intervertebral substance.

Insertion.

Into the ilio-pectineal eminence.

Nervous Supply.

The anterior branches of the lumbar nerves.

PSOAS MAGNUS.

Origin.

1. From the bases of the transverse processes of the lumbar vertebræ.
2. By five slips, from the sides of the bodies of the last dorsal and all the lumbar vertebræ and from the corresponding intervertebral substances.

Insertion.

Into the lesser trochanter of the femur.

Nervous Supply.

The anterior branches of the lumbar nerves.

Iliacus.

Origin.

1. From the iliac fossa and the inner lip of the crest of the ilium.
2. From the ilio-lumbar ligament.
3. From the base of the sacrum.
4. From the anterior superior and the anterior inferior spines of the ilium, and from the notch between them.
5. From the capsule of the hip joint (a few fibres.)

Insertion.

1. Into the lesser trochanter of the femur, in common with the tendon of the psoas magnus muscle.
2. Into a line running from the lesser trochanter to the linea aspera.

Nervous Supply.

An intra-pelvic branch of the anterior crural nerve.

ACTION OF THE MUSCLES OF THE ILIAC REGION.

The *iliacus* and *psoas magnus* muscles are powerful *flexors of the thigh*, if the fixed point during their action be the pelvis and the vertebral column. They also *rotate* the thigh *outwards* after flexion has been performed, on account of the obliquity of their insertion into the femur. If the fixed point during their action, however, be below their point of origin, these muscles tend to *bend the pelvis and the lumbar vertebræ forward.* In raising the trunk, when the body is in a recumbent position, these muscles become, therefore, powerful agents.

These two muscles tend also to assist in maintaining an erect position of the body, by supporting the spine and the pelvis upon the femur.

The *psoas parvus* is a simple tensor of the iliac fascia.

NERVOUS SUPPLY OF THE MUSCLES OF THE ILIAC REGION.

These muscles are all supplied by branches of the *lumbar plexus*, though the iliacus muscle is *indirectly* so supplied by an intrapelvic branch of the anterior crural nerve.

B.

MUSCLES OF THE FEMORAL REGION.

The muscles included in this group are 24 in number and may be arranged in four groups.

(1) The *anterior femoral* group :.............7 muscles.	Tensor vaginæ femoris. Sartorius. Rectus femoris. Vastus externus. Crureus. Vastus internus. Sub-crureus.
(2) The *internal femoral* group :.............5 muscles.	Gracilis. Pectineus. Adductor longus. Adductor brevis. Adductor magnus.
(8) The *gluteal* or *posterior superior* group :....9 muscles.	Gluteus maximus. Gluteus minimus. Gluteus medius. Pyriformis. Gemellus superior. Obturator internus. Gemellus inferior. Obturator externus. Quadratus femoris.
(4) The *posterior femoral* group :............3 muscles.	Biceps flexor cruris. Semitendinosus. Semimembranosus.

ORIGIN AND INSERTION OF THE MUSCLES OF THE FEMORAL REGION.

1. ANTERIOR FEMORAL GROUP.
(7 muscles.)

TENSOR VAGINAE FEMORIS.

Origin.

1. From the anterior superior spine of the ilium.
2. From the anterior portion of the outer lip of the crest of the ilium.

Insertion.

Into the fascia lata, on the outer aspect of the thigh.

Nervous supply.

The superior gluteal nerve.

SARTORIUS.

Origin.

1. From the anterior superior spine of the ilium.
2. From the upper half of the notch below it.

Insertion.

Into the upper part of the inner surface of the shaft of the tibia, covering the tendons of the gracilis and the semitendinosus.

Nervous supply.

The anterior crural nerve.

RECTUS FEMORIS.

Origin.

Straight tendon. From the anterior inferior spine of the ilium.

Reflected tendon. From a groove above the brim of the acetabulum.

Insertion.

Into the upper border of the patella.

Nervous supply.

The anterior crural nerve.

VASTUS EXTERNUS.

Origin.

1. From the anterior border of, and a ridge upon the greater trochanter of the femur.
2. From a rough line extending from the greater trochanter to the linea aspera.
3. From a line from the linea aspera to the outer condyle.
4. From the whole length of the linea aspera (outer lip).
5. From the inter-muscular septum.

Insertion.

Into the outer border of the patella.

Nervous supply.

The anterior crural nerve.

VASTUS INTERNUS.

Origin.

1. From a line running from the inner side of the neck of the femur to the linea aspera.
2. From the whole length of the linea aspera (inner lip).
3. From a line from the linea aspera to the inner condyle.
4. From the inner surface of the femur.
5. From the inter-muscular septum.

Insertion.

Into the inner border of the patella.

Nervous supply.

The anterior crural nerve.

CRUREUS.

Origin.

From the anterior and outer surfaces of the middle third of the femur.

Insertion.

Into the upper border of the patella, in common with the tendon of the rectus and vasti muscles.

Nervous supply.

The anterior crural nerve.

This muscle, with the three succeeding muscles, are sometimes considered as forming one muscle, which is called the *quadriceps extensor muscle* of the thigh.

SUB-CRUREUS.

Origin.

From the lower part of the anterior surface of the femur.

Insertion.

Into the upper pouch of the synovial membrane of the knee joint.

Nervous supply.

The anterior crural nerve.

INTERNAL FEMORAL GROUP.

(5 muscles.)

GRACILIS.

Origin.

1. From the inner margin of the rami of the pubes and the ischium.
2. From the body of the pubes (lower half).

Insertion.

1. Into the upper part of the inner surface of the shaft of the tibia, above the point of insertion of the semitendinosus muscle.

Nervous supply.

The obturator nerve.

PECTINEUS.

Origin.

From the ilio-pectineal line, and the surface of bone in front of it, extending from the pectineal eminence to the spine of the pubis.

Insertion.

1. Into the upper part of the line running from the lesser trochanter of the femur to the linea aspera.

2. Into the femur behind the lesser trochanter.

Nervous supply.

The obturator nerve, and often the anterior crural and the accessory obturator nerves.

ADDUCTOR LONGUS.

Origin.

From the anterior surface of the pubes, close to its angle and below its crest.

Insertion.

Into the middle third of the inner lip of the linea aspera, between the vastus internus and the adductor magnus muscles.

Nervous supply.

The obturator nerve.

ADDUCTOR BREVIS.

Origin.

From the anterior surface of the body and the ramus of the pubes.

Insertion.

Into the upper part of the linea aspera, behind the pectineus and the upper part of the adductor longus muscles.

Nervous supply.

The obturator or anterior crural nerve.

ADDUCTOR MAGNUS.

Origin.

1. From the descending ramus of the pubes (lower part.)

2. From the ascending ramus of the ischium.

3. From the outer side of the tuberosity of the ischium.

Insertion.

1. Into the whole length of the linea aspera.

2. Into a line running from the linea aspera to the inner condyle of the femur.

3. Into a tubercle above the inner condyle of the femur.

Nervous supply.

The obturator nerve.

GLUTEAL OR POSTERIOR SUPERIOR GROUP.
(9 muscles).

GLUTEUS MAXIMUS,

Origin.

1. From the dorsum of the ilium, behind the superior curved line.
2. From the sides of the sacrum and of the coccyx.
3. From a tendinous expansion over the sacrum.
4. From the posterior surface of the great sacrosciatic ligament.

Insertion.

1. Into the fascia lata, covering the outer side of the thigh.
2. Into a line running from the great trochanter of the femur to the linea aspera.

Nervous supply.

The inferior gluteal nerve.

GLUTEUS MEDIUS.

Origin.

1. From the dorsum of the ilium, between the superior and the middle curved lines.
2. From the outer lip of a portion of the crest of the ilium.
3. From an aponeurosis covering its anterior surface.

Insertion.

Into an oblique line on the outer surface of the great trochanter of the femur.

Nervous supply.

The superior gluteal nerve.

GLUTEUS MINIMUS.

Origin.

1. From between the middle and the inferior curved lines of the dorsum of the ilium.

Insertion.

Into the anterior border of the greater trochanter of the femur.

Nervous supply.

The superior gluteal nerve.

PYRIFORMIS.

Origin.

1. From the anterior surface of the sacrum, between the anterior sacral foramina.

2. From the margin of the great sacro-sciatic foramen.

3. From the anterior surface of the sacro-sciatic ligament.

Insertion.

Into the posterior part of the upper border of the great trochanter of the femur.

Nervous supply.

A muscular branch of the sacral plexus.

GEMELLUS SUPERIOR.

Origin.

From the outer surface of the spine of the ischium.

Insertion.

Into the great trochanter of the femur, by a common tendon with the obturator internus and the gemellus inferior muscles.

Nervous supply.

A muscular branch of the sacral plexus.

OBTURATOR EXTERNUS.

Origin.

From the inner two-thirds of the outer surface of the obturator membrane.

2. From the circumference of the obturator foramen.

3. From a fibrous arch over the obturator vessels and nerves.

Insertion.

Into the *digital fossa* of the femur.

Nervous supply.

The obturator nerve.

GEMELLUS INFERIOR.

Origin.

From the upper part of the outer lip of the tuberosity of the ischium.

Insertion.

In common with the tendon of the obturator internus muscle, into the great trochanter of the femur.

Nervous supply.

A muscular branch of the sacral plexus.

Obturator Internus.

Origin.

1. From the inner surface of the anterior and external wall of the true pelvis, in the region of the obturator foramen.

2. From the inner surface of the obturator membrane.

3. From the fibrous arch covering the obturator vessels.

Insertion.

Into the upper border of the great trochanter of the femur.

Nervous supply.

A muscular branch of the sacral plexus.

Quadratus Femoris.

Origin.

From the outer border of the tuberosity of the ischium.

Insertion.

Into the upper part of the linea quadrati, on the posterior aspect of the great trochanter of the femur.

Nervous supply.

A muscular branch of the sacral plexus.

POSTERIOR FEMORAL GROUP.

(3 muscles).

Biceps Flexor Cruris.

Origin.

Long head.

1. In common with the tendon of the semitendinosus, from the posterior part of the tuberosity of the ischium.

Short head.

2. From the whole length of the outer lip of the linea aspera, between the adductor magnus and the vastus externus muscles.

Insertion.

Into the outer side of the head of the fibula, where the tendon divides again into two parts for further insertion into the outer tuberosity of the tibia and the fascia of the leg.

Nervous supply.

The great sciatic nerve.

SEMI-TENDINOSUS.

Origin.

In common with the long head of the biceps flexor cruris, from the inner and lower part of the posterior surface of the tuberosity of the ischium.

Insertion.

Into the upper part of the inner surface of the shaft of the tibia, beneath the sartorius and below the gracilis muscle.

Nervous supply.

The great sciatic nerve.

SEMI-MEMBRANOSUS.

Origin.

1. From the upper and outer part of the posterior surface of the tuberosity of the ischium.

2. From the outer side of the point of origin of the biceps and semitendinosus.

Insertion.

1. Into the posterior part of the inner tuberosity of the tibia.

2. Into a groove on the inner tuberosity of the tibia (this slip passing under the internal lateral ligament of the knee).

3. Into the posterior and outer part of the condyle of the femur, thus strengthening the posterior ligament of the knee-joint.

Nervous supply.

The great sciatic nerve.

ACTION OF MUSCLES OF THE FEMORAL REGION UPON THE HIP JOINT.

The motions of the hip joint may be enumerated as follows:

Flexion.
Extension.
Adduction.
Abduction.
External rotation.
Internal rotation.

The muscles of the femoral region producing these various motions of the joint are of great interest to the surgeon, and may be thus classified, to assist the memory of the student.

(A.) Muscles producing *flexion* of the hip joint	(6)	Sartorius (after the leg has been flexed.) Psoas. Iliacus. Adductor brevis. Pectineus. Rectus femoris.
(B.) " " *extension* " " " ..	(8)	Gluteus maximus. Gluteus medius (*posterior half* of the muscle.) Gluteus minimus (*posterior fifth* of the muscle.) Pyriformis (to a very slight extent.) The four ham-string muscles (when the leg is extended.)
(C.) " " *adduction* " "	(5)	Adductor longus. Adductor brevis. Adductor magnus. Pectineus. Gracilis (when leg is extended)
(D.) " " *abduction* " "	(4)	Gluteus maximus. Gluteus medius. Gluteus minimus. Tensor vaginæ femoris.
(E.) " " *external rotation* " " ...	(13)	The six muscles of the great trochanter (except in the sitting posture.) The three adductor muscles. Pectineus, Psoas. Iliacus. Sartorius (after the leg has been flexed.)
(F.) " " *internal rotation* " "	(2½)	Tensor vaginæ femoris. Gluteus minimus. Gluteus medius (anterior half)

Of these muscles the two principal *flexors* lie in *front of the hip joint* and are inserted into the *lesser trochanter* of the femur.

The six *external rotators* lie *behind the hip joint* and are inserted into the *great trochanter* of the femur, excepting one, *viz.*, the obturator externus.

NERVOUS SUPPLY OF THE MUSCLES OF THE FEMORAL REGION.

The muscles of the *femoral* region are thus supplied with motor power.

Through the *anterior crural nerve* ....6 muscles.		The 4 muscles forming the quadriceps extensor. Sartorius. Subcrureus.
Through the *obturator nerve* ....6 muscles.		The 3 adductor muscles. Pectineus. Obturator externus. Gracilis.
Through the *sacral plexus* (muscular branches) 5 muscles.		Pyriformis. Gemellus superior. Obturator internus Gemellus inferior. Quadratus femoris.
Through the *great sciatic nerve*............3 muscles.		Biceps. Semimembranosus. Semitendinosus.
Through the *superior gluteal nerve*...........3 muscles.		Gluteus medius. Gluteus minimus. Tensor vaginæ femoris.
Through the *small sciatic nerve*...........1 muscle.		Gluteus maximus.
Total, 24		

C.

MUSCLES OF THE POPLITEAL REGION.

THE POPLITEUS.

Origin.

From a groove on the outer side of the internal condyle of the femur, situated below the tubercle for the attachment of the external lateral ligament of the knee joint.

Insertion.

Into a triangular surface on the posterior aspect of the upper portion of the tibia, above its oblique line.

Nerve supply.

This muscle is supplied with motor power through the *internal popliteal* nerve (a branch of the great sciatic).

D.

MUSCLES OF THE CRURAL REGION.

This class of muscles comprises 12 muscles, which may be arranged in *four groups* of three muscles each, as follows:

(1) The ANTERIOR group:	3 muscles.	Tibialis anticus. Extensor proprius pollicis. Extensor longus digitorum.
(2) " SUPERFICIAL POSTERIOR group	3 "	Gastrocnemius. Plantaris. Soleus.
(3) " DEEP POSTERIOR group	3 "	Tibialis posticus. Flexor longus pollicis. Flexor longus digitorum.
(4) " PERONEAL or LATERAL group	3 "	Peroneus longus. Peroneus brevis. Peroneus tertius.

ORIGIN AND INSERTION.

ANTERIOR GROUP.
(3 muscles).

TIBIALIS ANTICUS.

Origin.

1. From the tuberosity of the tibia.
2. From the upper two-thirds of outer surface of the shaft of the tibia.
3. From the interosseous membrane and the inter-muscular septum.
4. From the deep fascia of the leg.

Insertion.

1. Into the inner and under surface of the cuneiform bone.
2. Into the base of the 1st metatarsal bone.

Nervous supply.

The anterior tibial nerve.

EXTENSOR PROPRIUS POLLICIS.

Origin.

1. From the middle of the anterior surface of the shaft of the fibula.
2. From the interosseous membrane.

Insertion,

Into the base of the last phalanx of the great toe.

Nervous supply.

The anterior tibial nerve.

EXTENSOR LONGUS DIGITORUM.

Origin.

1. From the tuberosity of the tibia.
2. From upper three-fourths of the anterior surface of the fibula.
3. From the interosseous membrane.
4. From the inter-muscular septa.
5. From the deep fascia of the leg.

Insertion.

Into the bases of the second and third phalanges of the four outer toes.

Nervous supply.

The anterior tibial nerve.

THE POSTERIOR SUPERFICIAL GROUP.
(3 muscles).

GASTROCNEMIUS.

Origin.

Inner head.

1. From a depression at the upper and posterior part of the inner condyle of the femur.
2. Internal division of the linea aspera.

Outer head.

1. From a depression in the posterior surface of the outer condyle of the femur.
2. From the external division of the linea aspera.

Insertion.

In common with the tendon of the soleus, into the lower part of the posterior surface of the os calcis.

Nervous supply.

The internal popliteal nerve.

PLANTARIS.

Origin.

1. From the outer division of the linea aspera.
2. From the posterior ligament of the knee joint.

Insertion.

Into the inner border of the tendo Achillis.

Nervous supply.

The internal popliteal nerve.

SOLEUS.

Origin.

1. From the head and the upper third of the posterior surface of the fibula.

2. From the middle third of the internal border of the tibia.

3. From an oblique line on the posterior surface of the tibia.

4. From a tendinous arch, between the tibial and fibular points of origin of this muscle.

Insertion.

In common with the tendon of the gastrocnemius, thus forming the "tendo Achillis."

Nervous supply.

The internal popliteal nerve.

THE DEEP POSTERIOR GROUP.

(3 muscles).

TIBIALIS POSTICUS.

Origin.

1. From the posterior surface of the shaft of the tibia.

2. From the greater part of the posterior surface of the interosseous membrane.

3. From the upper three-fourths of the inner surface of the shaft of the fibula.

4. From the intermuscular fascia.

Insertion.

1. Into the tuberosity of the scaphoid bone.

2. Into the internal and external cuneiform bones.

Nervous supply.

The posterior tibial nerve.

FLEXOR LONGUS POLLICIS.

Origin.

1. From the lower two-thirds of the posterior surface of the shaft of the fibula.

2. From the lower part of the interosseous membrane.

3. From the intermuscular septum between it and the peroneii.

4. From the fascia covering the tibialis posticus.

Insertion.

Into the base of the last phalanx of the great toe.

Nervous supply.

The posterior tibial nerve.

Flexor Longus Digitorum.

Origin.

1. From the posterior surface of the shaft of the tibia below its oblique line.

2. From the fascia covering the tibialis posticus.

Insertion.

Into the bases of the last phalanges of the four outer toes.

Nervous supply.

The posterior tibial nerve.

THE PERONEAL OR LATERAL GROUP.

(3 muscles).

Peroneus Longus.

Origin.

1. From the head and the upper two-thirds of the outer surface of the fibula.

2. From the anterior and posterior borders of the fibula.

3. From the intermuscular septa.

4. From the deep fascia of the leg.

Insertion.

Into the outer side of the base of the first metatarsal bone.

Nervous supply.

The musculo-cutaneous branch of the external popliteal nerve.

Peroneus Brevis.

Origin.

1. From the lower two-thirds of the outer surface of the shaft of the fibula.

2. From the intermuscular septa between it and the muscles of the anterior and posterior groups.

Insertion.

Into the base of the fifth metatarsal bone.

Nervous supply.

The musculo-cutaneous branch of the external popliteal nerve.

Peroneus Tertius.

Origin.

1. From the lower one-fourth of the anterior surface of the shaft of the fibula.

2. From the lower part of the interosseous membrane.

3. From the intermuscular septum between it and the peroneus brevis.

Insertion.

Into the base of the fifth metatarsal bone.

Nervous supply.

The anterior tibial nerve.

ACTION OF THE MUSCLES OF THE CRURAL REGION.

The muscles of the crural region, all of which act upon the foot, will be found described, in respect to their mode of action, in the closing pages of this chapter, since it has been deemed more expedient to consider the action of the muscles of the crural and pedal region in common, rather than separately. The classifications found upon page 324 of this work, will merit the earnest perusal and careful study of students in anatomy, since their mastery over this difficult subject will thus be rendered comparatively easy.

NERVOUS SUPPLY OF THE MUSCLES OF THE CRURAL REGION.

The twelve muscles of the *crural* region receive their nervous motor supply from *four sources*, as follows:

The *anterior tibial* nerve supplies	..........4 muscles.	Tibialis anticus. Extensor proprius pollicis. Extensor longus digitorum. Peroneus tertius.
" *posterior tibial* " "	..........3 muscles.	Tibialis posticus. Flexor longus pollicis. Flexor longus digitorum.
" *internal popliteal* "	..........3 muscles.	Gastrocnemius. Plantaris. Soleus.
" *musculo-cutaneous* " "	..........2 muscles.	Peroneus longus. Peroneus brevis.
	Total, 12 muscles.	

E.

MUSCLES OF THE PEDAL REGION.

This group of the muscles of the lower extremity embraces 20 muscles, and may be divided into two sets.

(1.) Dorsal region	1 muscle		Extensor brevis digitorum.
(2.) Plantar region... 19 muscles.	Superior layer, (3)		Abductor pollicis. Flexor brevis digitorum. Abductor minimi digiti.
	2nd layer..... (5)		Flexor accessorius. 4 lumbricales.
	3rd layer..... (4)		Flexor brevis pollicis. Adductor pollicis. Transversus pedis. Flexor minimi digiti.
	4th layer..... (7)		4 dorsal interoseii. 3 plantar interosseii.

ORIGIN AND INSERTION.

DORSAL REGION.

Extensor Brevis Digitorum.

Origin.

1. From the outer and the upper surfaces of the greater process of the os calcis.
2. From the calcaneo-astragaloid ligament.
3. From the anterior annular ligament of the tarsus.

Insertion.

1. Into the first phalanx of the great toe.
2. Into the outer side of the long extensor tendons of the 2d, 3d and 4th toes.

Nervous supply.

The external branch of the anterior tibial nerve.

PLANTAR REGION.
(19 muscles.)

FIRST LAYER.

Abductor Pollicis.

Origin.

1. From the greater tuberosity of the os calcis.
2. From the internal annular ligament of the tarsus.
3. From the inter-muscular septum between it and the flexor brevis digitorum.

Insertion.

Into the inner side of the base of the first phalanx of the great toe.

Nervous supply.

The internal plantar nerve.

FLEXOR BREVIS DIGITORUM.

Origin.

1. From the greater tuberosity of the os calcis.
2. From the central portion of the plantar fascia.
3. From the inter-muscular septa on either side.

Insertion.

Into the sides of the second phalanges of the four outer toes.

Nervous supply.

The internal plantar nerve.

ABDUCTOR MINIMI DIGITI.

Origin.

1. From the lesser tuberosity of the os calcis.
2. From the greater tuberosity, in front of the point of origin of the flexor brevis digitorum.
3. From the inferior surface of the os calcis (to a slight extent).
4. From the plantar fascia and the inter-muscular septum between it and the flexor brevis digitorum.

Insertion.

Into the outer side of the base of the first phalanx of the little toe

Nervous supply.

The external plantar nerve.

SECOND LAYER.

FLEXOR ACCESSORIUS.

Origin.

From the inner and the under surface of the os calcis, by two heads which embrace the long plantar ligament.

Insertion.

Into the main *tendon* of the flexor longus digitorum.

Nervous supply.

The external plantar nerve.

LUMBRICALES.

Origin.

From the tendons of the flexor longus digitorum, the innermost from only one, the others from two tendons each.

Insertion.

Into the inner side of the *extensor tendons* of the toes, and into the inner sides of the bases of the first phalanges of the four outer toes.

Nervous supply.

The external plantar nerve.

THIRD LAYER.

FLEXOR BREVIS POLLICIS.

Origin.

1. From the adjoining borders of the cuboid and the external cuneiform bone.

2. From an expansion of the tendon of the tibialis posticus.

Insertion.

Into the inner and outer sides of the base of the first phalanx of the great toe.

A sesamoid bone is frequently developed in each tendon of insertion.

Nervous supply.

The internal plantar nerve.

ADDUCTOR POLLICIS.

Origin.

1. From the bases of the 2nd, 3rd and 4th metatarsal bones.

2. From the sheath of the peroneus longus muscle.

Insertion.

Into the outer side of the base of the first phalanx of the great toe.

Nervous supply.

The external plantar nerve.

TRANSVERSUS PEDIS.

Origin.

1. From the head of the 5th metatarsal bone.

2. From the transverse ligament of the metatarsus.

Insertion.

Into the outer side of the base of the first phalanx of the great toe.

Nervous supply.

The external plantar nerve.

Flexor Brevis Minimi Digiti.

Origin.

1. From the base of the 5th metatarsal bone.
2. From the sheath of the peroneus longus muscle.

Insertion.

Into the outer side of the base of the first phalanx of the little toe.

Nervous supply.

The external plantar nerve.

FOURTH LAYER.

Plantar Interossei (Three in number).

Origin.

1. From the lower or plantar half of the inner side of the shafts of the 3d, 4th and 5th metatarsal bones.

Insertion.

1. Into the inner sides of the bases of the first phalanges of the toes corresponding to each muscle.
2. Into the expansion of the *corresponding tendon* of the extensor longus digitorum.

Nervous supply.

The external plantar nerve.

Dorsal Interossei. (Four in number).

Origin.

1. From the adjacent sides of two metatarsal bones, but most extensively from the bone corresponding to the toe of insertion of the muscle.

Insertion.

Into the sides of the base of the first phalanx of the toe to which they belong.

Nervous supply.

The external plantar nerve.

NFRVOUS SUPPLY OF MUSCLES OF THE FOOT.

The *internal plantar* nerve supplies..	(5)	Abductor pollicis. Flexor brevis pollicis. Flexor brevis digitorum. Two inner lumbricales.
The *external plantar* nerve supplies.	(14)	All the rest of the muscles of the plantar region.
The *anterior tibial* nerve supplies....	(1)	Extensor brevis digitorum.
Total,	20	

ACTION OF THE MUSCLES OF THE FOOT.

The action of the various muscles connected with the bones of the foot, will be found described in detail in the closing pages of this chapter, since it has been found that the action of the muscles of the leg and foot can be more clearly understood and more easily acquired when considered as a whole, than is practicable when they are subdivided into special regions. The readers of this volume are therefore referred to page 324 for a tabular arrangement of the muscles of the foot and leg, based on the respective action of each.

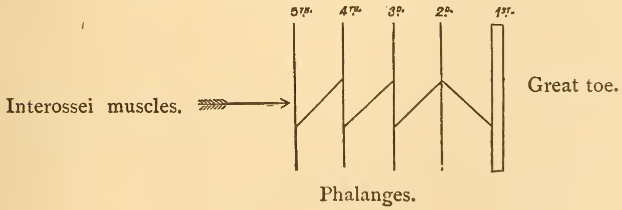
DISTRIBUTION OF THE 4TH LAYER OF THE MUSCLES OF THE FOOT.

The following table illustrates the distribution of the lumbricales and the interosseii muscles of the foot.

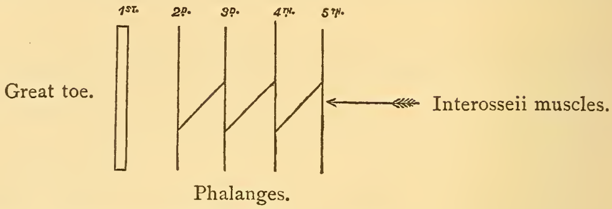
Toes.	Lumbricales.	Dorsal Interossei.	Plantar Interosseii.
2nd.	1st.	1st & 2nd,	
3rd.	2nd.	3rd.	1st.
4th.	3rd.	4th.	2nd.
5th.	4th.		3rd.

ACTION OF THE INTEROSSEI MUSCLES OF THE FOOT.

The *dorsal* interossei of left foot are thus inserted :



The *plantar* interossei of the *right* foot are thus inserted :



It will thus be seen that the four *dorsal interosseii* muscles *abduct* from the *axis of the 2d toe*, while the three *plantar interossei adduct* to the *axis of the 2d toe.*

The interossei muscles may therefore be considered, when referred to the *axis of the 2d toe*, to consist of four abductors and three adductors, but when referred to the *mesial plane of the body*, the order is reversed and they consist of three abductors and four adductors.

SUMMARY OF THE MUSCLES OF THE CRURAL AND PEDAL REGIONS.

The muscles which act upon the foot may be thus classified as to their *function* and *method of action :*

A Table illustrating both the Action and Point of Origin of the Muscles of the Leg and Foot.

Part acted upon.	Arising from *Leg.*	Arising from *Foot.*	Total No. of muscles.	Total No. of tendons,
Foot as a whole.	8	....	8	7
Toes in common	2	3	5	....
Great toe alone.	2	4	6	7
Second toe alone	....	3	3	7
Third toe alone.	... .	3	3	7
Fourth toe alone.	....	3	3	7
Fifth toe alone..	....	4	4	7
Total.......	12	20	32	42

The 8 muscles *acting upon the foot as a whole* include........	2 flexors.	Tibialis anticus. Peroneus tertius.
	3 extensors.	Gastrocnemius. Soleus. Plantaris.
	1 adductor.	Tibialis posticus
	2 abductors.	Peroneus longus. Peroneus brevis.
	8	

The *soleus* and *gastroc nemius muscles* have a *tendon in common*, thus causing only 7 tendons to exist.

The 5 muscles *acting in common upon the toes* include...	2 arising from leg.	Flexor longus digitorum. Extensor longus digitorum.
	3 arising from foot.	Flexor brevis digitorum. Extensor brevis digitorum. Accessorius.
	5	

The 6 muscles *acting on the big toe* alone include........	2 from leg.	Extensor proprius pollicis. Flexor longus pollicis.
	4 from foot.	Abductor pollicis. Adductor pollicis. Flexor brevis pollicis. Transversus pedis.
	6	

The 4 muscles *acting upon the little toe* alone include	Flexor minimi digiti. Adductor minimi digiti. One plantar interosseous. One dorsal interosseous.

The SEVEN TENDONS ACTING ON EACH TOE may be thus enumerated:

Tendons acting upon the GREAT TOE...........	1st phalanx,	5 muscles.	Extensor brevis digitorum. Abductor pollicis. Adductor pollicis. Flexor brevis pollicis. Transversus pedis.
	2nd phalanx,	2 muscles.	Extensor longus pollicis. Flexor longus pollicis.
		7	

Tendons acting upon the LITTLE TOE...........	1st phalanx,	4 muscles.	Flexor minimi digiti. Adductor minimi digiti, 3rd plantar interrosseous. 4th lumbricales.
	2nd phalanx,	1 muscle.	Flexor brevis digitorum.
	3rd phalanx,	2 muscles.	Extensor longus digitorum. Flexor longus digitorum.
		7	

Tendons acting upon the OTHER TOES...........	1st phalanx,	3 muscles.	Two interossei. Lumbricales.
	2nd phalanx,	2 muscles.	Flexor brevis digitorum. Extensor brevis digitorum.
	3rd phalanx,	2 muscles.	Flexor longus digitorum. Extensor longus digitorum.
		7	

Appended to this chapter will be found a classified table illustrative of the distribution of the motor nerves of the muscles of the lower extremity; and also a diagramatic table to assist the student in computing the number of the muscles divided in the various amputations through the hip, knee and ankle joints.

GENERAL ACTION OF THE MUSCLES OF THE LOWER EXTREMITY.

The flexor and extensor muscles are arranged alternately on *opposite sides* of the limbs. Hence it follows that when a muscle of the lower extremity *passes over any two* of the four principal joints, it flexes the one and extends the other or vice versa.

To the above rule there are only two exceptions.

1*st.* The *sartorius* muscle, which produces *flexion* of two joints.

2*d.* The *gracilis* muscle, which *flexes* the knee and *adducts* the limb, when it is extended.

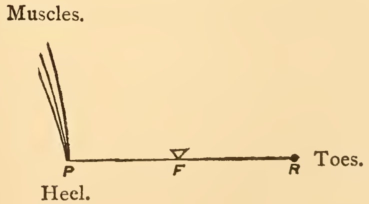
The motions of the four principal joints of the lower extremity are thus named:

Nomenclature of the Motions of the Lower Extremity.		
Joints.	If moved forwards.	If moved backwards.
Hip.	Flexion.	Extension.
Knee.	Extension.	Flexion.
Ankle.	Flexion.	Extension.
Metatarso-phalangal.	Extension.	Flexion.

PRINCIPLES OF LEVERAGE AS EXHIBITED IN THE FOOT.

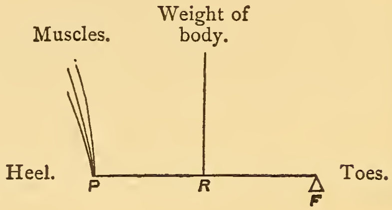
The *three different forms of levers* are beautifully represented in the foot.

The *first order* of levers, *viz.*, where the *fulcrum* is in the centre, is exhibited by tapping the floor with the toes.



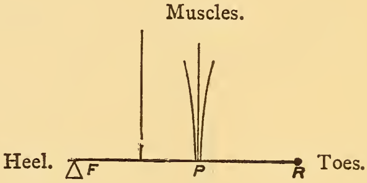
In this case, the ankle becomes the *fulcrum* (F), the muscles attached to the heel the *power* (P), the foot the *resistance* (R), to be overcome.

The *second order* of levers where the *resistance* to be overcome is in the middle,is represented, in the foot, when an effort to *stand upon the toes* is made.



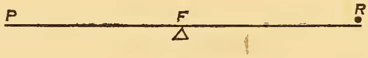
In this case, the toes become the *fulcrum* (F), the weight of the body the *resistance* to be overcome (R), and the *power* (P) remains at the heel.

The *third order* of levers, where the *power* is applied in the middle, is represented in the foot when a weight is raised, when situated upon the toes.



In this case, the heel or the ankle-joint become the *fulcrum* (F), the muscles of the anterior crural region the *power* (P), and the weight upon the toes the *resistance* to be overcome.

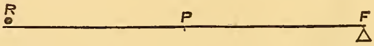
To recapitulate then, we have three orders of levers named respectively the 1st, 2nd and 3rd. These orders may be thus represented:

Lever of 1st order. 

The centre being the *fulcrum.*

Lever of 2nd order. 

The centre being the *resistance.*

Lever of 3rd order. 

The centre being the *power.*

A single *rule* can be given to remember these orders, since the centres F. R. P. rhyme with the number of the orders 1, 2, 3.

In the foot these principles of leverage have great anatomical importance.

The *first order* promotes the *equilibrium of the body.*

The *second order* tends to *overcome resistances.*

The *third order facilitates motion.*

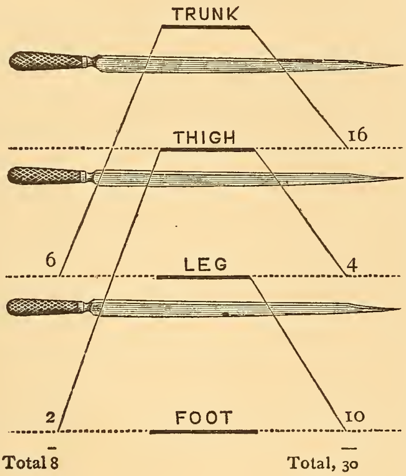
The following table indicates the number of muscles divided in *amputation* either at the hip, knee or ankle joints :

A TABLE ILLUSTRATING THE MUSCLES DIVIDED IN AMPUTATIONS THROUGH THE PRINCIPAL JOINTS OF THE LOWER EXTREMITY.

Muscles passing over *two joints.*

Sartorius.
Rectus femoris.
Gracilis.
Biceps.
Semi-tendinosus.
Semi-membranosus

Gastroc nemius.
Plantaris.



Muscles passing over *one joint.*

Psoas magnus.
Iliacus.
Tensor vaginæ femoris.
Pectineus.
Adductor longus.
Adductor brevis.
Adductor magnus.
Gluteus maximus.
Gluteus medius.
Gluteus minimus.
Pyriformis.
Gemellus superior.
Obturator internus.
Gemellus inferior.
Obturator externus.
Quadratus femoris.

Vastus externus.
Crureus.
Vastus internus.
Popliteus.

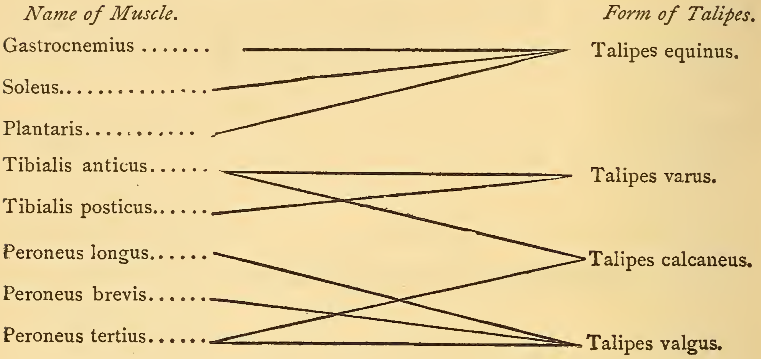
Tibialis anticus.
Extensor proprius pol.
Extensor longus dig.
Soleus.
Tibialis posticus.
Flexor longus pollicis.
Flexor longus digitorum
Peroneus longus.
Peroneus brevis.
Peroneus tertius.

This table is constructed for the purpose of enabling the student to ascertain the names and numbers of the muscles divided in cases of amputation through the principal joints of the lower extremity. The *horizontal lines* represent the segment of the limb. The *oblique lines* represent the group of muscles passing from one segment to another, and opposite which are their names.

In order to ascertain the number of muscles divided in amputation through any joint, the knife of the surgeon, placed between the various segments, necessarily intersects *two* or *more oblique lines.* Add up the respective number at the lower end of each one of these lines, and the sum will indicate the number of muscles divided.

A more detailed explanation of this table, however, will be found appended to a similarly arranged table under the chapter upon the muscles of the upper extremity on page 298 of this work.

Table Illustrating the Principal Muscles Involved in the Different Varieties of Talipes.



EXTREMITY.

NERV…	Names of the Muscles.
Lumbar Plex…	Psoas Magnus, and Psoas Parvus.
1. Ant. Cru…	Iliacus, Sartorius, Rectus Femoris, Vastus Externus, Vastus Internus, Crureus, and Subcrureus.
2. Obturator	Gracilis, 3 Adductors, Pectineus, and Obturator Externus.
Sacral Plexu…	Pyriformis, Gemellus Superior, Obturator Internus, Gemellus Inferior, and Quadratus Femoris.
1. Super. G…	Tensor Vaginæ Femoris, Gluteus Medius and Minimus.
2. Small Sci…	Gluteus Maximus.
3. Great Sci…	Biceps Semitendinosus, Semimembranosus
a. **Popli…**	Popliteus, Gastrocnemius, Soleus and Plantaris.
Poste…	Flexor Longus Pollicis, Flexor Longus Digitorum, and Tibialis Posticus.
α. In…	Abductor Pollicis, Flexor Brevis Digitorum, Flexor Brevis Pollicis, 1st and 2d Lumbricales.
β. Ex…	Abductor Minimi Digiti, Flexor Accessorius, Adductor Pollicis, 3d and 4th Lumbricales, Flexor Brevis Minimi Digiti, Transversus Pedis, and the 7 Interossei.
b. **Peron…**	
Ant…	Tibialis Anticus, Extensor Proprius Pollicis, Extensor Longus Digitorum, Peroneus Tertius, and Extensor Brevis Digitorum.
Mus…	
ne…	Peroneus Longus, and Peroneus Brevis.

N. B.—The *Pe…*om the Sciatic Nerve ; and the *Gluteus Maximus* one from the Sacral …s, and the remaining *forty-five* by the *Sacral Plexus.*

The *ner…*nted without underscoring are either subdivisions of main trunks or t…

MOTOR NERVES OF THE MUSCLES OF THE LOWER EXTREMITY.

NERVES.	Iliac Region.	Femoral Region. Anter.	Femoral Region. Int.	Femoral Region. Glut.	Femoral Region. Poster.	Popliteal Region.	Crural Region. Ant.	Crural Region. Exter.	Crural Region. Post. Sup.	Crural Region. Post. Deep.	Pedal Region Dors.	Pedal Region Plant.	Total.			Names of the Muscles.
LUMBAR PLEXUS	2	...	...	...	...	...	...	...	...	...	...	...	2	...	...	Psoas Magnus, and Psoas Parvus.
1. Ant. Crural	1	6	...	...	...	...	...	...	...	...	...	...	7	...	...	Iliacus, Sartorius, Rectus Femoris, Vastus Externus, Vastus Internus, Crureus, and Subcrureus.
2. Obturator	...	...	5	1	...	...	...	...	...	...	...	...	6	15	15	Gracilis, 3 Adductors, Pectineus, and Obturator Externus.
SACRAL PLEXUS	...	...	...	5	...	...	...	..	...	...	...	...	5	5	...	Pyriformis, Gemellus Superior, Obturator Internus, Gemellus Inferior, and Quadratus Femoris.
1. Super. Gluteal ...	...	1	...	2	...	...	...	...	...	...	...	...	3	3	...	Tensor Vaginæ Femoris, Gluteus Medius and Minimus
2. Small Sciatic ...	...	...	...	1	...	...	...	...	...	...	...	...	1	1	...	Gluteus Maximus.
3. Great Sciatic ...	...	...	...	...	3	...	...	...	...	...	...	...	3	...	...	Biceps Semitendinosus, Semimembranosus
a. Popliteal	...	...	...	...	...	1	...	...	3	...	...	...	4	...	...	Popliteus, Gastrocnemius, Soleus and Plantaris.
Poster Tibial ...	...	...	...	...	...	...	...	...	...	3	...	...	3	...	...	Flexor Longus Pollicis, Flexor Longus Digitorum, and Tibialis Posticus.
α. Int. Plantar	...	...	...	...	...	...	...	...	...	...	...	5	5	...	...	Abductor Pollicis, Flexor Brevis Digitorum, Flexor Brevis Pollicis, 1st and 2d Lumbricales.
β. Extern. Plantar	...	...	...	...	...	..	...	...	...	...	...	14	14	29	...	Abductor Minimi Digiti, Flexor Accessorius, Adductor Pollicis, 3d and 4th Lumbricales, Flexor Brevis Minimi Digiti, Transversus Pedis, and the 7 Interossei.
b. Peroneal	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	
Anter. Tibial ...	...	...	...	...	...	...	3	1	...	...	1	...	5	...	...	Tibialis Anticus, Extensor Proprius Pollicis, Extensor Longus Digitorum, Peroneus Tertius, and Extensor Brevis Digitorum.
Musculo-Cutaneous... ...	...	...	...	...	...	...	...	2	...	...	...	...	2	7	45	Peroneus Longus, and Peroneus Brevis.
	3	7	5	9	3	1	3	3	3	3	1	19	60	60	60	
	3	24				1	12				20					

N. B.—The *Pectineus* receives additional filaments from the Anterior Crural and Accessory Obturator Nerves; the *Adductor Magnus* one from the Sciatic Nerve; and the *Gluteus Maximus* one from the Sacral Plexus. It thus appears, that of the sixty muscles of the Lower Extremity, *fifteen* are supplied by the *Lumbar plexus*, and the remaining *forty-five* by the *Sacral Plexus*.

The *nerves underscored in red* are the *main nerve trunks* derived from the Lumbar and Sacral plexus, while the nerves printed without underscoring are either subdivisions of main trunks or those whose muscular branches are comparatively unimportant.

ANGIOLOGY.

THE ARTERIAL SYSTEM.

The vessels which convey the blood from the heart to the systemic capillaries are cylindrical tubes gradually decreasing in size as they recede from the central organ. To them the name of *arteries* was given, before the circulation of blood was discovered or their function suspected, from the belief that they contained *atmospheric air*, and it was not until the time of Galen that this doctrine was refuted. It was he who first directed attention to the fact, that, while in the dead body the vessels were for the most part empty, still, in the living body, they contained the blood.

The distribution of the arterial system is compared by a prominent author to a *highly ramified tree*, whose main trunk consists of the aorta, and whose ramifications extend in all directions towards the periphery of the body and the organs contained within its numerous cavities. So extensive are these ramifications that but few of the essential parts of our structure escape their presence, among which, however, may be mentioned the hairs, the nails, the epidermis, cartilage and the cornea of the eye.

Nature has considerably protected this important part of her organism from injury, by concealing the larger trunks by investing muscles and by placing them on that aspect of the limbs, *the flexor side* as a rule, which is least liable to be exposed to violence or to injury. She has moreover encased the main trunk of the arterial tree within two cavities, protected largely by bony walls, and, where not completely so protected, has covered it with soft and elastic viscera and afforded it shelter by the close proximity of the vertebral column.

The *branches of arteries* vary greatly in their mode of origin and in the angle at which they leave the parent trunk.

We occasionally find a short vessel suddenly dividing into numerous branches at the *same point*, as is the case in the cœliac and thyroid axes; again an artery will send off *shoots along its entire length* and still preserve its identity as the more important trunk, as is evidenced in the external carotids, the axillary, the brachial, the radial, the ulnar, and the arteries of the lower extremity. We find in the third place frequent *dichotomous divisions* of large arteries to which the term *bifurcation* is applied, as for example, the division of the abdominal aorta into its two terminal branches, the common iliacs; and the common carotid into its terminal branches, the external and the internal carotid arteries.

As regards the *angle of separation of arterial branches* from the main trunk we find an equal diversity. Some form an obtuse angle, some a right angle, and a few an acute angle with the trunk from which they spring.

It is to be remembered, however, that, while these arterial branches are always individually smaller in size than the vessels from which they spring, that the *area of the supplying trunk* never equals the *combined area of its branches.* Authors of works upon anatomy frequently compare the arterial system to a cone, whose *apex* only resembles the area of the aorta and whose enormous base corresponds to the combined areas of the capillaries which owe their circulation to its original contents.

The smaller arteries, in course of their distribution to the various parts of the body, communicate freely with each other in almost all portions of the body by what is termed *anastomosis* or *inosculation;* but, where such a communication occurs between vessels of larger calibre, great necessity is perceived to exist for unimpaired freedom and activity of circulation. Thus we find this condition prominent in the *brain*, especially at the circle of Willis, and also in the *mesentery*, where vessels of large size communicate; since, in these situations, circumstances tending to impede the circulation in any one trunk might otherwise be attended with consequences of the gravest import. This condition is also perceived in the circulation of the *hand* and *foot.*

Three axioms may be here stated as regards the communication of arteries, which deserve attention and which may assist memory.

A. *Every artery anastomoses with its fellow*, excepting in the extremities and a few vessels distributed to viscera.

As interesting examples of this fact, may be mentioned the anastomoses between the two anterior cerebral arteries, by the anterior communicating branch; between the two obturators, by a transverse branch; between the vertebral arteries, by their union to form the basilar; between the epigastric arteries, by a transverse branch; between the two external carotids, by the union of nearly all of their branches; and between the intercostals and the upper lumbar arteries of each side, by encircling the trunk.

The second general axiom is as follows:

B. *Every artery anastomoses with the vessel immediately above and below it.*

As marked examples of this fact, we find, *in the lower limb*, the branches of the external iliac artery and those of the femoral artery forming a great posterior and a minor anterior anastomosis; each of which is sufficient to carry on the entire circulation of the limb when required to do so.

By this arrangement of vessels, in the *upper extremity*, a chain of anastomoses may be traced along the margins of the scapula and the inner edge of the arm, till the circulation of the forearm and palmar arches is reached.

From the angle of the eye, the blood can thus flow successively through arterial anastomoses along the nose, mouth, cheeks, neck, and, by means of the internal mammary and deep epigastric arteries, along the entire chest and abdomen, till it reaches the vessels of the lower extremity.

A similar chain of anastomotic channels can be traced from the pharynx, along the œsophagus, stomach and intestines, till the rectum be reached.

The vessels of the brain and spinal cord, in a similar way, can be communicated with, throughout the length of the spinal cord, by means of small vessels, which hold numerous anastomoses with the intervertebral, intercostal, lumbar and sacral arteries.

The third axiom is that:

C. *Every artery anastomoses with itself*, by means of its branches.

As interesting examples of this, may be mentioned the branches of the external carotids, which anastomose in the neck; and those of the internal carotids, which communicate in the brain.

The branches of the cœliac axis around the stomach, the coronary arteries within the heart, and the ciliary arteries around the iris, also illustrate this rule. While the *articular arteries*, especially those of the knee; the branches of the *obturator artery*, around the foramen of that name, and the anastomoses of the vessels supplying the *sphincter muscles of the body*, are further proofs how thoroughly nature has protected the tissues from anything tending to produce impaired arterial supply.

It is due however to the general capillary circulation throughout the body, that nature so readily endures the privation of blood, dependent upon ligature of main trunks; since, by them, a so-called *collateral circulation* is rapidly accomplished, the capillaries undergoing a process of dilatation and thus greatly increasing their carrying capacity.

There is one more general statement in reference to the arrangement of the arterial system to which attention should be directed previous to entering into regional anatomy, and that is the *direction of the vessels* in the various regions of the body.

The *large arteries*, as a rule, *pursue nearly* a *straight course* but this like all rules has its exceptions. Frequently, however the configuration of certain parts demands tortuosity of vessels even of large calibre. This we see exemplified prominently in the *facial artery*, which, in the region of the lips and mouth, is extremely tortuous as are also its labial branches; since the incessant movements of the parts would be restricted, were the supplying vessels distributed in a line of direct transit to the parts destined to be supplied by them.

In the *uterus* also we find the arterial vessels extremely tortuous. This has been explained on the ground that, during uterine expansion, the arteries were thus enabled to bear with ease a strain that might otherwise be dangerous to the nutrition of the organ if not even to the arterial coats themselves.

Finally the *internal carotids* and the *vertebral arteries*, although running a course nearly if not absolutely straight, until near their entrance to the skull, suddenly become bent into a series of short and abrupt curves, as an evident attempt of nature to reduce the velocity of the blood current in the cerebral capillaries, by the friction produced by the constantly deviating channel through which it is forced to pass.

STRUCTURE OF ARTERIES.

The arteries are composed of *three coats;* an internal serous or epithelial coat, a middle or elastic coat, and an external or cellular coat. To the first, the name of *tunica intima*, and to the last, the term *tunica adventitia*, has been applied by Kölliker, to whose investigations much of our present knowledge on this subject is due.

The *two inner coats* are easily detached from the external coat, and, from their inherent elasticity, they even tend to *separate spontaneously* when a ligature is applied to a vessel with a sufficient degree of pressure to divide them without injury to the external coat. The internal coat, however, is more adherent to the middle coat, since maceration is required to produce a separation.

When the artery is fully distended the *internal coat* is smooth and offers little opportunity for friction to the blood current, but when the vessel is empty, as after death, this coat is thrown into longitudinal and transverse folds.

The *middle coat* of the arteries is distinguished from the internal coat by the *circular arrangement of its fibres*, in contradistinction to the elastic fibres of the inner coat, which are arranged in a line parallel with the axis of the vessel. In the *largest arteries*, this coat is *very thick*, yellow in color, and highly elastic, but as the vessels decrease in size it becomes thinner and is finally lost when the arteries approach the capillaries.

The *external coat* consists mainly of *connective tissue*. It is thin in the largest arteries, but becomes as thick and often thicker than the middle coat, in arteries of small calibre. It consists of *two layers*, an external layer of connective tissue and an internal layer of elastic fibres, until the vessels decrease to a medium calibre, when the internal elastic coat becomes lost; the external coat, however, remains and gradually becomes thinner as the capillary vessels are approached.

The *arterial coats*, taken as a whole, are *extremely thin*, in proportion to the size of the vessel, in certain special localities, among which may be especially mentioned the cavities of the cranium and of the spinal canal. The *arteries of the body are enveloped*, as a rule, in a fibro-areolar investment, termed their *sheaths*. In the extremities, this sheath is usually continuous with the deep fascia; but, *in the thigh*, at its upper portion, it is formed by the iliac fascia of the pelvis and the transversalis fascia of the abdomen, and, *in the neck*, by a prolongation of the deep cervical fascia. This sheath is loosely connected to the external coat of the artery by areolar tissue and in many cases it affords protection to nerves and veins accompanying the artery.

The *external coat of the larger arteries is supplied with blood-vessels*, like the organs of the body. These nutrient arteries are called *vasa-vasorum*. They arise either as branches of the artery which they supply, or from a neighboring vessel, at a point distant to their seat of distribution. *Minute veins* accompany these arteries and return their blood, by means of the venæ comites, which lie in close connection with the artery.

Arteries are also supplied with nerves, which are chiefly derived from the sympathetic system but also partly from the cerebro-spinal nerves.

Upon the *large arterial trunks* these nerves form *intricate plexuses*, while, to the smaller arteries, *single nerve filaments* are distributed.

The method of termination of the nerve filaments is still a matter of doubt.

THE AORTA.

The aorta, the main trunk of the arterial system, arises at the upper portion of the left ventricle, at a point corresponding with the inferior surface of the semilunar valves and located on the external aspect of the chest, at the *left edge* of the *sternum*, between the *costo-sternal articulations* of the *third* and *fourth ribs*. This point of origin corresponds, posteriorly, to the *sixth dorsal vertebra*, when the respiratory act reaches the end of expiration.

The aorta may be divided into two distinct portions, *viz.*, the THORACIC PORTION, and the ABDOMINAL PORTION.

The *thoracic portion* of the aorta may be subdivided into a curved portion called the ARCH OF THE AORTA and a dorsal portion to which the name THORACIC AORTA is usually applied in contradistinction to the arch, although the name is, in reality, a misnomer unless the arch itself be included.

The first portion, or the ARCH OF THE AORTA, consists of three divisions or segments, called the *ascending*, *transverse* and *descending* portions of the arch.

These segments, at their points of junction, reveal different degrees of curvature, giving to the arch, as a whole, an interrupted and not a continuous curve.

The ASCENDING PORTION of the arch commences at the inferior surface of the semilunar valves and passes upwards, at an angle towards the *right side* of the body, for a distance which varies from two to three inches. It becomes continuous, at its termination, with the transverse portion, at a point corresponding, externally, with the *right side of the sternum*, a*t its junction with the second rib.*

The direction of the first portion of the aorta is such that a continuation of the axis of the left ventricle, when that organ is in repose, impinges upon the convex surface of the aorta at a spot nearly corresponding to the point of junction between the ascending and transverse portions of the arch, but this point must vary somewhat, during life, with the rotary movement of the heart. Here is situated a bulging of the aorta, in health, called the *sinus magnum*, and it is here that we first detect disease in the form of atheromatous degeneration and aneurismal dilatations. This fact seems certainly to accord with the approximate anatomical accuracy of this statement of the direction of the ventricular axis, since the current of blood, being thrown with the greatest force in the direct axis of the ventricle would, of necessity, create upon this local point the greatest friction and degenerative changes would therefore be first manifested at this situation.

The first portion of the aortic arch presents for examination the following points of interest:

(1) The coronary arteries.
(2) The sinuses of Valsalva.
(3) A constriction at the bases of the aortic valves.

1. The *coronary arteries* are two in number, the right and the left. The *right* coronary artery arises from that sinus of Valsalva, in which the *anterior segment of the aortic valve* is lodged during the contraction of the ventricle; while the coronary artery of the *left* side arises from that sinus which lodges the *left posterior segment*. They will be described in detail in subsequent pages.

2. The *sinuses of Valsalva* are depressions in the walls of the aorta for the reception of the aortic valves. By their size and depth, they cause an increased circumferential measurement of the aorta, at a point corresponding to their situation. Thus the average circumference of the aorta over the sinuses of Valsalva, may be stated as about four inches, while immediately above them the circumference falls to three and a quarter or three and a half inches. At the situation of the sinus magnum, the aorta, however, again expands to a circumference in excess of even the neighborhood of the sinuses of Valsalva.

3. The first portion of the aortic arch presents, finally, a *constriction at the bases of the aortic valves*, due to on excess of white fibrous tissue over the elastic tissue of the aorta and which is probably destined as a source of protection to the aortic orifice against dilatation or rupture.

The ascending portion of the arch of the aorta is partly invested by the pericardium, which is prolonged upon its coats for a distance of nearly two inches.

The relation which this portion of the aorta bears to surrounding structures may be seen by reference to the following table.

PLAN OF THE RELATIONS OF THE ASCENDING PORTION OF THE ARCH OF THE AORTA.

In front.
Pulmonary artery.
Right auricular appendix.
Peircardium.
Remains of thymus gland.

Right side.
Superior vena cava.
Right auricle.

Arch of Aorta
Ascending
Portion.

Left side.
Pulmonary artery.

Behind.
Right pulmonary vessels.
Root of right lung.

THE TRANSVERSE PORTION of the arch of the aorta *begins* at a point corresponding to the *costo-sternal articulation of the second rib of the right side* and *terminates* at a point corresponding to the *superior border of the 3d dorsal vertebra.* Its direction in the thorax is oblique, since it passes from before backwards and from the right towards the left side. From its upper or convex border, arise three important arterial trunks, *viz.*, the arteria innominata, left carotid and left subclavian arteries. It varies in length from three to four inches. Its upper border is usually about an inch below the upper margin of the sternum, but it *varies in its position somewhat during respiration*, although less than the ascending portion of the arch.

PLAN OF THE RELATIONS OF THE TRANSVERSE PORTION OF THE ARCH.

Above.
1 vein..... { Left innominate vein.
3 arteries.. { Arteria innominata. Left carotid. Left subclavian.

In front.
Left pleura and lung.
3 Nerves { Left pneumogastric. Left phrenic nerve. Cardiac nerves.

Arch of Aorta
Transverse
Portion.

Behind.
Trachea.
Œsophagus.
Thoracic duct.
2 nerves. { Deep cardiac plexus. Left recurrent laryngeal nerve.

Below.
Bifurcation of pulmonary artery.
Remains of ductus arteriosus.
Left recurrent laryngeal nerve.
Left bronchus.

THE DESCENDING PORTION of the arch of the aorta *begins* at the *upper edge of the 3d dorsal vertebra* and curves downwards in a nearly straight course, until it reaches the lower border of the left side of the *4th dorsal vertebra* where the name thoracic aorta is usually applied to it.

PLAN OF THE RELATIONS OF THE DESCENDING PORTION OF THE ARCH.

In front.
Pleura.
Root of the left lung.

Right side.
Œsophagus.
Thoracic duct.

Arch of Aorta.
Descending Portion.

Left side.
Pleura.

Behind.
Left side of body of *third* dorsal vertebra.

THE ARCH OF THE AORTA AS A WHOLE.

The three segments of the arch of the aorta vary in their position within the chest *during the act of respiration*, since the diaphragm, being attached to the pericardium, and, through that membrane, to the coats of the large arterial vessels, tends to depress the aorta during inspiration. This respiratory movement of the arch of the aorta is however most marked in the *ascending* portion, much less apparent in the transverse portion, and least of all in the descending portion.

The aorta, as a tube, *shows constant variations in its calibre.* At the aortic orifice it is markedly constricted; at the sinuses of Valsalva, it enlarges to a circumference of four inches; it then becomes again constricted, immediately above the sinuses, to a circumference of about three and a quarter to three and a half inches; at the junction of the ascending and transverse portions, the enlargement known as the *sinus magnum* gives to the aorta a circumference exceeding even that of the region over the sinuses of the Valsalva; the transverse portion has a nearly uniform calibre of about three and a half inches; and finally a rapid decrease in size is again present in the descending portion of the arch.

It has already been stated that the axis of the left ventricle in repose, if prolonged into the aorta, impinged upon the right wall of that vessel, at the point of junction of the ascending and transverse portions of the arch. It is a matter of *surgical interest* that, at this point, is thoracic aneurism most frequently developed and atheromanous changes most frequently detected, and the explanation of this fact seems to be justly an anatomical one. The situation of the innominate artery being just above this weak point, and so placed that the current of blood by impinging upon the roof of the arch shall subject it to a strain second only to that borne at the sinus magnum, will also explain why this vessel is the next most frequently affected either with atheromatous degeneration or aneurism. The left carotid, from its anatomical situation, is still less frequently involved than the innominate, as it is subjected to less strain; while the left subclavian artery, from its situation and the angle at which it leaves the arch (nearly ninety degrees), is so ensured against excessive pressure that it is rarely the seat of aneurismal dilitations.

The *ascending portion of the arch*, being enclosed within the pericardium and being also the most frequently affected with aneurismal disease of any vessel in the arterial system, presents symptoms not in common with aneurismal sacs in other localities and which allow of an explanation on a purely anatomical basis.

If the *aneurismal sac be situated low down*, in the region of the aortic sinuses, the right coronary sinus of the heart becomes pressed upon early, from enlargement of the tumor in the anterior direction, since the regurgitation of blood produces the greatest pressure upon that aspect of the vessel, and the *nutrition of the heart* may thus be interfered with. In the more *advanced stages* of development, however, the tumor may by pressure impede either the current in the pulmonary artery, or in the superior vena cava; or it may possibly interfere with the free action of the right auricle or even of the right ventricle. Thus cyanosis, distended jugulars, a bruit in the pulmonary artery on auscultation, or irregular hearts action may ensue.

If the *aneurism of the ascending arch* be *higher up*, as is most common, the tumor develops, as a rule, to the right of the median line, and, when of large size, tends to approach the anterior aspect of the thorax. We frequently therefore find the sternum and the ribs of the right side undergoing rapid absorption and a pulsating tumor develops in the locality of the manubrium. By pressure of the tumor upon the neighboring parts, symptoms referred to the right lung and those to impairment of the trachea, main bronchi or œsophagus, may also simultaneously develop.

Aneurism of the transverse portion of the arch of the aorta most frequently develops on its right extremity and the posterior aspect of the vessel. At this point many important relations exist, which render the development of a tumor an inevitable associate of symptoms referred to other localities.

The trachea, œsophagus and thoracic duct lie in the closest relation posteriorly ; the recurrent laryngeal nerve winds around the aorta on the left side ; and the large arterial trunks given off from its convex or upper border furnish the blood supply to the head and the upper extremities.

Thus the pressure of an aneurismal tumor in this locality, by *affecting the bronchi* or the *trachea*, may produce dyspnoea cough, haemoptysis and stridulous respiration ; by affecting the *œsophagus*, deglutition may be impaired or destroyed ; by creating pressure on the *thoracic duct*, the patient may die of inanition.

Pressure upon the recurrent laryngeal nerve has often produced symptoms so analogous to those of inflammation of the larynx, that tracheotomy has often been performed from an error in diagnosis.

By an *obstruction of the innominate artery*, either partial or complete, the radial pulse of the right side may be either diminished in its volume or entirely absent.

By *pressure upon the innominate veins*, the venous return from the head and upper extremities may be impaired and thus cyanosis, œdema, and diminished temperature, of the parts, in which the circulation is obstructed, may result. When an aneurismal dilatation of the aorta develops to a great size in an *upward* direction, it may simulate aneurism of the arteria innominata, by appearing above and to the right of the sternum ; and, by reaching the brachial plexus of nerves in the neck, it may produce shooting pains running down the upper extremity to the tips of the fingers.

Aneurism of the descending portion of the arch of the aorta is usually situated upon the left side of the vessel and develops in a backward direction. By pressure, it most frequently causes absorption of the adjoining ribs and bodies of the vertebræ. It may, however, produce also symptoms referable to pressure upon the trachea, left bronchus, œsophagus and of the right or left lung. In case of spontaneous rupture of the sac, the blood may be poured out into the pleural cavity (usually that of the left side) ; or in rare cases, into the trachea, left bronchus, œsophagus, or into the substance of the left lung. In this variety of aneurism, an intercostal neuralgia of a severe and constant type, is produced by pressure of the growing tumor upon those intercostal nerves which lie between it and the bony ribs.

A TABLE OF THE BRANCHES OF THE ARCH OF THE AORTA.

ARCH OF THE AORTA. (5 branches.)	1. RIGHT CORONARY.		
	2. LEFT CORONARY.		
	3. INNOMINATE.	RIGHT COMMON CAROTID	RIGHT EXTERNAL CAROTID
			RIGHT INTERNAL CAROTID
		RIGHT SUBCLAVIAN.	
	4. LEFT COMMON CAROTID....		LEFT EXTERNAL CAROTID.
			LEFT INTERNAL CAROTID.
	5. LEFT SUBCLAVIAN.		

The following table of the branches of the arch of the aorta shows that *five principal arterial trunks* are given off, *viz.*, the two coronary, the arteria innominata, the left common carotid and the left subclavian arteries.

CORONARY ARTERIES.

The two coronary arteries arise from the aorta close to its point of origin.

The *right* coronary artery is largest in its size and arises from that sinus of Valsalva which lodges the *anterior segment of the aortic valve;* while the *left* coronary artery arises from that sinus of Valsalva which lodges the *left posterior segment of the aortic valve.* These two vessels form an *arterial circle* around the *base of the heart*, being lodged within the auriculo-ventricular grooves; and they also anastomose, at the *apex* of the heart, through branches which run in the groove between the ventricles.

The coronary arteries receive their blood supply during the *diastole* of the heart, the blood being forced into them partly by gravity, and partly by the elastic recoil of the aorta; although the circulation of these vessels is furthermore assisted by the relaxed condition of the heart walls. They supply the *heart substance with nutrition*, and empty their blood, through the coronary veins, into the right auricle of the heart.

ARTERIA INNOMINATA.

This artery arises from the transverse arch of the aorta at an average distance of *three and a half inches* from the aortic valve. It is separated by an interval of less than one half of an inch from its adjoining branch, *viz.*, the left common carotid artery.

In calibre it exceeds or equals the combined areas of the four remaining branches of the arch of the aorta. Its average length is about *one inch and a half.*

The arteria innominata terminates at the *right sterno-clavicular articulation*, behind and between the two points of origin of the sterno-mastoid muscle. At this point, it bifurcates into the right common carotid and the right subclavian arteries, the former arising from the anterior portion of the arteria innominata, while the latter forms a direct continuation of the curve of that vessel.

The *course* of the arteria innominata corresponds to a line drawn from the *middle of the sternum*, at the point of junction of the manibrium and the gladiolus, to the *right sterno-clavicular articulation.*

PLAN OF THE RELATIONS OF THE ARTERIA INNOMINATA.

In front.

Two muscles. { Sterno-thyroid.
Sterno-hyoid.

Remains of thymus gland.

Two veins... { Left vena innominata.
Right inferior thyroid.

Inferior cervical cardiac branch of right pneumogastric nerve.

Right side.		*Left side.*
Right vena innominata. Right pneumogastric nerve. Pleura.	**Arteria Innominata.**	Remains of thymus gland. Left carotid artery.

Behind.

Trachea.

The *inferior thyroid veins* cross the artery *low down* near its seat of origin.

The *muscles*, designated in the table of relations, separate the *upper portion* of the artery from the sternum, while the *thymus gland* and the *innominate vein* separate its *middle portion* from the sternum.

Collateral Circulation.

The arteria innominata, if tied, no longer furnishes blood to the right side of the head or to the right upper extremity. Certain indirect channels are therefore forced to carry an additional amount of blood to supply these parts with proper nutrition.

The various points of collateral circulation, which are found to exist when a subject is injected, whose arteria innominata has previously been ligated, are as follows.

1. A *regurgitant current* through the *circle of Willis*, by means of the left carotid and vertebral arteries, which fills the vessels of the right side immediately after the application of the ligature.
2. The *carotids* of *both sides* anastomose, by means of their branches which meet in the *median line*. These branches are as follows:
   - The superior thyroid arteries.
   - The lingual arteries.
   - The facial arteries.
   - The internal maxillary arteries.
   - The occipital arteries.
   - The temporal arteries.
3. The *subclavian artery* derives blood *directly* from the anastomosis of the following vessels.
   - *Superior intercostal* with *first aortic intercostal*.
   - *Profunda cervicis* with *princeps cervicis*.
   - *Lower intercostals* with *internal mammary* branches.
   - *Lower intercostals* with *axillary branches*.
   - *Internal mammary* with *deep epigastric artery*.
   - The *two inferior thyroid arteries* with each other.

COMMON CAROTID ARTERIES.

The two common carotid arteries differ in their points of origin upon the right and the left side of the neck.

The *right common carotid* arises, as one of the branches of bifurcation of the arteria innominata, behind the right sterno-clavicular articulation; while the *left common carotid* arises from the highest part of the aorta, and has therefore a thoracic and a cervical portion.

The *thoracic portion* of the *left common carotid artery* is deeply situated and terminates at the root of the neck.

PLAN OF THE RELATIONS OF THE THORACIC PORTION OF THE LEFT COMMON CAROTID ARTERY.

In front.
Sternum.
Sterno-hyoid muscle.
Sterno-thyroid muscle.
Thymus gland.
Left vena innominata.

Internally.
Arteria innominata.

Left Common Carotid Artery
Thoracic portion.

Externally (2 structures).
Left pneumogastric nerve.
Left subclavian artery.

Behind.
Trachea.
Œsophagus.
Thoracic duct.

Within the neck, the two common carotid arteries resemble each other so closely that one description will answer for both. They extend from behind the sterno-calvicular articulation of either side, in a direction upwards and outwards, to the *upper border of the thyroid cartilage*, where each artery bifurcates into the external and internal carotid arteries.

PLAN OF THE RELATIONS OF THE COMMON CARTOID ARTERY IN THE NECK.

In front.

Integument.

Superficial and deep fascia.

Muscles.
- Platysma.
- Sterno-mastoid.
- Sterno-hyoid.
- Sterno-thyroid.
- Omo-hyoid.

Veins.
- Constant...
  - Superior thyroid.
  - Middle thyroid.
  - Anterior jugular.
- Inconstant.
  - Facial.
  - Lingual.

Nerves.
- Descendens noni.
- Communicans noni.

Sterno-mastoid artery.

Externally.

Internal jugular vein.
Pneumogastric nerve.

Common Carotid Artery.
In the neck.

Internally.

Pharynx.
Larynx.
Trachea.
Thyroid gland.
Recurrent laryngeal nerve.
Inferior thyroid artery.

Behind.

Cervical vertebræ.

Muscles.
- Rect. cap. ant. major.
- Longus colli.
- Scalenus anticus.

Nerves.
- Recurrent laryngeal.
- Sympathetic.

Inferior thyroid artery.

Within the sheath of this vessel are enclosed the *internal jugular vein* and the *pneumogastric nerve.*

The common carotid artery within the neck is, at first, deeply situated but becomes superficial, near its point of termination. Its direction may be represented, upon the surface of the neck, by a line drawn from the *sternal end of the clavicle* to a point *midway between the angle of the jaw and the mastoid process* of the temporal bone.

EXTERNAL CAROTID ARTERY.

This artery arises from a point corresponding to the *upper border of the thyroid cartilage* and is directed upwards towards an interval which exists between the neck of the condyle of the jaw and the external auditory meatus, where it divides into its two terminal branches, *viz.*, the temporal and internal maxillary arteries. In its course, which is slightly curved upon itself, it presents, at its lower portion, a curve, the concavity of which looks towards the lobule of the ear; and, midway, between its points of origin and termination, it takes a sharp inclination backwards into the interval where it terminates. The *point* of *bifurcation* of the external carotid artery lies on a level with the *condyle of the jaw.* In its course through the neck it gives off *eight branches* of varying sizes, and therefore diminishes rapidly in its calibre as it approaches its point of bifurcation.

In the adult, this artery is of nearly equal size with the internal carotid although, in the fœtus, it is usually smaller. It is more superficially placed near its point of origin than at its point of termination. Its average length varies from $2\frac{5}{8}$ to $3\frac{1}{4}$ inches although it may occasionally reach a length of four inches or even fall short of the normal standard.

PLAN OF THE RELATION OF THE EXTERNAL CAROTID ARTERY.

In front.
Integument.
Superficial and deep fascia.
Muscles. { Platysma. Diagastric. Stylo-hyoid.
Veins..... { Lingual. Facial.
Hypoglossal nerve.
Parotid gland.

External Carotid Artery.

Internally.
Pharynx.
Hyoid bone.
Ramus of lower jaw.
Parotid gland.

Behind.
Nerves.. { Glosso-pharyngeal. Superior laryngeal.
Muscles.. { Stylo-glossus. Stylo-pharyngeus.
Parotid gland.

A TABLE OF THE BRANCHES OF THE EXTERNAL CAROTID ARTERY.

EXTERNAL CAROTID ARTERY. (8 branches.)

- 1 SUPERIOR THYROID
  - Hyoid.
  - Sterno-mastoid.
  - Superior laryngeal.
  - Crico-thyroid.
- 2 LINGUAL
  - Hyoid.
  - Dorsalis linguæ.
  - Sublingual.
  - Ranine.
- 3 FACIAL
  - In the *neck*
    - Inferior palatine.
    - Tonsillar.
    - Submaxillary.
    - Submental.
  - On the *face*
    - Muscular.
    - Inferior labial.
    - Inferior coronary.
    - Superior coronary.
    - Lateralis nasi.
    - Angular.
- 4 OCCIPITAL
  - Muscular.
  - Auricular.
  - Inferior meningeal.
  - Arteria princeps cervicis.
- 5 POSTERIOR AURICULAR
  - Stylo-mastoid.
  - Auricular.
- 6 ASCENDING PHARYNGEAL
  - Muscular branches.
  - Pharyngeal branches.
  - Meningeal branches.
- 7 TEMPORAL
  - Transverse facial.
  - Anterior temporal.
  - Middle temporal.
  - Posterior temporal.
  - Anterior auricular.
- 8 INTERNAL MAXILLARY
  - *Maxillary* portion (4)
    - Tympanic,
    - Middle meningeal
    - Small meningeal.
    - Inferior dental.
  - *Pterygoid* portion (4)
    - Deep temporal.
    - Pterygoid.
    - Masseteric.
    - Buccal.
  - *Spheno-maxillary* portion (6)
    - Alveolar.
    - Infra-orbital.
    - Posterior palatine.
    - Vidian.
    - Pterygo-palatine.
    - Spheno-palatine, (nasal.)

In the preceding table are shown the *eight branches* of the external carotid artery, in the order in which they are given off, as well as the *principal branches of each*, most of which are named either from the direction of their course or from the parts to which they are distributed.

These eight branches arise however from different aspects of the external carotid artery as is shown in the following classification.

The branches of the EXTERNAL CAROTID ARTERY are given off as follows:	From its *anterior* aspect	(4)	Superior thyroid. Lingual. Facial. Internal maxillary.
	From its *posterior* aspect	(3)	Occipital. Posterior auricular. Temporal.
	From its *posterior* and *internal* aspect	(1)	Ascending pharyngeal.

BRANCHES OF EXTERNAL CAROTID ARTERY.

Of the eight branches which are given off from the external carotid artery, some have no special importance, save their branches of distribution, which can be easily acquired from the tabular arrangement which has previously been given. It has been deemed sufficient therefore to enumerate only those points pertaining to the separate vessels or their branches, which possess some *surgical interest*.

SUPERIOR THYROID ARTERY.

This artery is *fourth, in point of size*, of the branches of the external carotid. It arises, on the average, about *one-eighth* of an inch from the point of bifurcation of the common carotid. It has *four* branches, three of which are constant. The *sterno-mastoid branch* is often called the *descending cervical branch.*

The superior thyroid artery supplies the muscles of the hyoid bone, the sterno-mastoid and neighboring muscles, the muscles, mucous membrane and glands of the larynx, and the upper and outer surface of the thyroid gland. It can often be distinctly felt by placing the finger upon the *upper* and *front portion* of the thyroid gland.

The *crico-thyroid branch* is often wounded in the operation of laryngotomy, while the *sterno-mastoid branch* possesses a surgical importance from its relation to the sheath of the common carotid artery. The *superior laryngeal branch* has, in several instances, caused fatal hemorrhage in attempts to relieve œdema glottidis by puncture.

LINGUAL ARTERY.

The lingual artery arises at a point situated about *three quarters of an inch* above the point of bifurcation of the common carotid artery, and, in *point of size*, is *third* of all the branches of the external carotid. In every three and a half cases, this artery, however, arises by a common trunk in connection with some other vessel.

The lingual artery lies, at first, in close relation to the greater cornu of the hyoid bone, to which its direction is nearly parallel, and then suddenly ascends in nearly a perpendicular direction, to the under surface of the tongue, where it is again deflected and passes in a tortuous course towards the tip of the tongue, under the name of the *ranine artery.*

It lies in relation with the middle constrictor muscle, in its first portion ; but is subsequently crossed by the tendon of the digastric muscle and also by the stylo-hyoid and the hyoglossus muscles. It is separated from the *hypoglossal nerve* by the hyoglossus muscle.

In the mouth, its *ranine branch* is extremely superficial and its pulsation can often be detected by the finger.

The lingual artery is often divided, near its point of origin, in cases of cut-throat or it may be involved in injuries to the mouth or in deep ulcerations of the tongue.

FACIAL ARTERY.

The facial artery arises most frequently at a distance of about one inch from the bifurcation of the common carotid artery. It is the *largest branch of the external carotid artery* and its course may be divided, for convenience of description, into a cervical portion and a facial portion.

The *cervical portion* passes obliquely upwards and forwards, beneath the body of the lower jaw, to the submaxillary gland, in which it lies imbedded in a groove.

The *facial portion* extends upward over the body of the jaw, crossing at the anterior inferior angle of the masseter muscle, and ascends upwards and forwards across the cheek to the angle of the mouth ; it then passes up the side of the nose, and terminates at the internal canthus of the eye, under the name of the *angular artery.*

This artery is remarkable for its *tortuosity*, and its pulsations can easily be detected by the finger at the point where it crosses the angle of the body of the jaw. It is accompanied, throughout its entire course by the *facial vein*, which, unlike the artery is not tortuous ; but, upon the face, it is separated from it by a considerable interval.

It is *crossed*, in the face, by the branches of the *facial nerve ;* and the *infra-orbital nerve* lies beneath it.

The branches of the facial are *ten* in number, four of which are given off in its cervical portion, and the remaining six upon the face.

The facial artery, through its numerous branches, anastomoses with the following vessels.

1. The *opposite facial*, through the branches which reach the median line.
2. The *internal maxillary*, through *four of its branches, viz.*, the infra-orbital, the nasal, the inferior dental, the posterior palatine.
3. The *lingual*, through its sublingual branch.
4. The *internal carotid*, through its ophthalmic branch.
5. The *temporal*, through its transverse facial branch.
6. The *ascending pharyngeal*, in the pharynx and the soft palate.

By means of the *fourth* of the anastomoses above mentioned, the *internal* and the *external carotid arteries* have a free point of collateral circulation; while the *second group* of anastomoses serves also to establish a free communication between the *superficial* and the *deep branches* of the *external carotid artery.*

The facial artery is liable to be the source of serious hemorrhage in wounds of the lip or in operations about the mouth or lips.

The *angular artery* (the terminal branch of the facial) has a point of practical surgical interest connected with it, from its relation to the *lachrymal sac*; since it passes through it along the inner border of the orbit, and, in case of operation for lachrymal fistula, the sac should therefore be opened upon its external portion in order to avoid a wound to this vessel.

OCCIPITAL ARTERY.

The occipital artery arises from the *posterior part* of the external carotid, nearly opposite to the point of origin of the facial artery. Its point of origin corresponds therefore nearly to the *lower border of the digastric muscle.*

This artery is partially covered, at its point of origin, by the parotid gland, and the *hypo-glossal nerve winds around it.*

The course of this vessel is long and winding, passing at first perpendicularly in front of the transverse processes of the cervical vertebræ; making a sharp turn opposite the atlas; passing in a horizontal direction along the base of the skull to the occiput; and then ramifying beneath the integument. It is in *point of size*, usually the *sixth* of the eight branches of the external carotid artery.

It *crosses*, in its course, the *internal carotid artery*, the *internal jugular vein*, the *spinal accessory* and *pneumogastric nerves.*

The occipital artery may be felt at the *middle* of a *line drawn from the occipital protuberance to the mastoid process* of the temporal bone.

This artery gives off *four branches*, as can be seen in the table of the branches of the external carotid artery, previously given.

The *arteria princeps cervicis*, the large branch of the occipital artery, possesses surgical importance, since it affords a source of *collateral circulation* in case of ligature of the common carotid artery.

The *relation* of the *occipital artery* to the *hypoglossal nerve*, which winds around it, has been explained as a possible effort on the part of nature to protect this nerve from tension during the protusion of the tongue; since it is forced to descend for some distance before becoming looped around the vessel, and thus is afforded great latitude of motion and a proportionate ability to endure strain from the elasticity of the artery, which would be absent were this nerve wound around a bony prominence.

POSTERIOR AURICULAR ARTERY.

This vessel is of small size and arises from the *posterior aspect* of the external carotid artery, in the vicinity of the *apex of the styloid process* of the temporal bone, or at a point about *two inches* from the point of bifurcation of the common carotid artery.

It is *crossed* by the *facial nerve*, in front; and by the *spinal accessory nerve*, behind, at a point corresponding to the junction of the cartilage of the ear and the mastoid process of the temporal bone.

The *stylo-mastoid branch* of this artery bears a close relation to the *facial nerve*, at the stylo-mastoid foramen, where that nerve escapes.

The *auricular branches* are distributed to the back part of the cartilage of the ear.

The *muscular branches* are distributed to the stylo-hyoid, the sterno-mastoid, and the digastric muscles.

This artery supplies *several branches* to the *parotid gland.*

The *posterior auricular artery* can be often felt at the *apex of the mastoid process* of the temporal bone.

ASCENDING PHARANGEAL ARTERY.

This artery arises from the posterior part of the external carotid, at a point situated in about *three quarters of an inch* from the point of bifurcation of the common carotid artery. It ascends vertically *between the internal carotid artery* and the *lateral wall of the pharynx*, till it reaches the base of the skull.

This artery gives off *three sets of branches* of distribution, as follows:

1st, those distributed to *muscles and nerves*, called the external set, since they are directed outwards.

2nd, those distributed to the *pharynx*, which pass towards the median line of the body.

3rd, those distributed to the *meninges of the brain*, called the vertical set, since they pass upwards to reach the cavity of the cranium.

The meningeal branches of this artery enter the cavity of the skull through the *jugular foramen*, the *foramen lacerum basis cranii* and the *anterior condyloid foramen.* They are distributed to the dura mater.

TEMPORAL ARTERY.

This artery is the smaller of the two terminal branches of the external carotid artery and appears to be its direct continuation upon the exterior surface of the skull. It arises slightly below the condyle of the lower jaw, in the *substance of the parotid gland*, and does not become superficial for the first inch of its course. This artery may be located on the exterior of the skull, at a distance of one and a quarter inches behind the external angular process of the frontal bone. It *may be compressed* at the point where it crosses the zygomatic process of the temporal bone. It gives off the following branches:

Branches to the *parotid gland.*
Branches to the *masseter muscle.*
Branches to the *temporo-maxillary articulation.*
The *transverse facial* artery.
The *middle temporal* artery.
The *anterior auricular* artery.
The *anterior temporal* artery.
The *posterior temporal* artery.

The *transverse facial* branch runs forwards parallel with the parotid or Steno's duct, and between it and the zygoma.

There are *five temporal arteries in the body*, four of which include the temporal artery and its three temporal branches, while the *deep temporal artery* is given off from the internal maxillary.

The temporal artery has been tied to relieve excessive vascular supply of the orbit, eye, or meninges of the brain. It is seldom used for bleeding, although it is very superficial, since the temporal fascia, from its inelasticity, renders subsequent compression difficult and also prevents the free escape of blood.

INTERNAL MAXILLARY ARTERY.

This artery is the deep *terminal branch* of the external carotid; which, in size if not in direction, is a continuation of that vessel.

It pursues a winding course, under cover of the ramus of the jaw, from its point of origin, where it is concealed by the parotid gland, till it reaches the spheno-maxillary fossa, where it gives off its terminal branches.

This artery is usually divided into three portions for convenience of description, as follows:

1. The *maxillary* portion.
2. The *pterygoid* portion.
3. The *spheno-maxillary* portion.

The *maxillary portion* extends from its point of origin to the anterior border of the *internal lateral ligament* of the lower jaw.

The *pterygoid portion* of this vessel is defined by its attachment to muscles through its muscular branches; although it is named from its relation to the *external pterygoid muscle*, on which it rests.

The *spheno-maxillary portion* is contained in the *spheno-maxillary fossa*, which it enters through an interval between the two heads of the external pterygoid muscle. At this point the artery lies in close relation to Meckel's ganglion.

The *branches* of the internal maxillary artery are *fourteen* in number, four of which are given off in the first portion, four in the second portion and six in the third portion. The names of these branches, in the order in which they are given off, will be found in the table of the distribution of the external carotid artery and its branches.

The *tympanic branch* enters the tympanum through the fissure of Glaser.

The *middle meningeal branch* enters the cranium through the foramen spinosum. Its branches are distributed as follows:

1. *Branches* to the *Gasserian ganglion.*
2. *Petrosal branch*, which enters the *hiatus fallopii* and *accompanies the facial nerve.*
3. *Orbital branches*, which anastomose with the vessels of the orbit.
4. *Temporal branches*, which perforate the temporal bone and join the deep temporal artery, in the temporal fossa.

The situation of the middle meningeal artery corresponds to a point on the exterior surface of the skull situated *one inch and a half behind*, and *one half inch above the external angular process of the frontal bone.*

The *small meningeal branch* enters the cranium through the *foramen ovale.*

The *inferior dental branch* enters the *inferior dental canal* and is accompanied by a nerve of the same name.

The *four branches* given off in the *pterygoid portion* of the vessel are distributed to the muscles of mastication.

The *alveolar branch*, supplies the gums, some teeth in the upper jaw, and the antrum.

The *infra-orbital branch*, accompanies the superior maxillary nerve, in its passage through the *infra-orbital canal.*

The *descending palatine branch* enters the *posterior palatine canal* and subsequently supplies the hard palate, the gums and the palatine glands. It can be felt in the mouth on the *inner side of the last molar tooth.*

The *vidian branch* passes through the *vidian canal*, and supplies the Eustachian tube, the pharynx and the tympanum.

The *pterygo-palatine branch*, so called from the canal through which it passes, supplies the Eustachian tube and the pharynx.

The *nasal* or *spheno-palatine* branch, so called from the *foramen of that name* through which it passes, supplies the mucous membrane of the nose, the antrum and the sphenoidal and the ethmoidal cells.

INTERNAL CAROTID ARTERY.

The internal carotid artery arises at the bifurcation of the common carotid artery, on a level with the *upper border of the thyroid cartilage*, and, after ascending through the neck, it passes through the carotid canal in the petrous portion of the temporal bone, into the cavity of the cranium.

During its passage through the neck, it lies in front of the transverse processes of the cervical vertebræ. After its passage through the carotid canal, it ascends along the side of the sella turcica and curves upwards by the anterior clinoid process of the sphenoid bone. It then pierces the dura mater and divides into its terminal branches.

This vessel is remarkable for the *number of abrupt curves* that it presents in the different portions of its course. These curves are explained as an effort on the part of nature to offer a mechanical obstruction to a rapid current of blood entering the brain, since increased friction is thus produced and danger of rupture of the cerebral capillaries from excessive hearts action is thus obviated.

This artery is usually studied as to its course and relations, by dividing it into four distinct portions. 1st. The *cervical portion* which includes all of the artery below the carotid canal. 2d. The *petrous portion*, including that part of the artery which lies within the carotid canal. 3d. The *cavernous portion*, which includes that part of the artery lying in relation to the cavernous sinus, and 4th. The *cerebral portion*, or the balance of the artery before it divides into its terminal branches.

The internal carotid artery is distributed to the brain, and the eye and its appendages. In point of calibre, it equals that of the external carotid artery.

Cervical portion.

This portion of the internal carotid artery lies at first upon the outer side of the external carotid artery, but soon sinks beneath the parotid gland, and becomes very deeply situated, as it passes behind and underneath that vessel.

In its course, it is separated from the external carotid artery by *two muscles*, *viz.*, the stylo-glossus and the stylo-pharyngeus muscles; and by *two nerves*, the glosso-pharyngeal and the pharyngeal branch of the pneumogastric.

PLAN OF THE RELATIONS OF THE INTERNAL CAROTID ARTERY IN THE NECK.

In front.

Integument.
Superficial and deep fascia.
Muscles.. { Stylo-glosseus. Stylo-pharyngeus.
Nerves.. { Glosso-pharyngeal. Pharyngeal branch of the pneumogastric.

Externally.
Internal jugular vein.
Pneumogastric nerve.

Internal Carotid Artery.

Internally.
Pharynx.
Tonsil.
Ascending pharyngeal artery.

Behind.
Rectus capitis anticus major muscle.
Sympathetic ganglion (upper cervical).
Superior laryngeal nerve.

Petrous portion.

In this portion of the artery, the *cavity of the middle ear is in the closest relation*, being separated from it only by a thin lamella of bone, which in a young subject is cribriform, and, in old age, is often nearly deficient from absorption.

The artery is separated from contact with the bony walls of the carotid canal by an investing tubular process of the dura mater; but has in direct contact with it the *carotid plexus* of nerves.

Cavernous portion.

On reaching the body of the sphenoid bone, after entering the cavity of the cranium, the internal carotid artery enters the cavernous sinus, having first perforated a layer of dura mater, which forms the outer border of that cavity.

Within this sinus the following relations are important, and may be shown by the following diagram.

Internally.
Internal carotid artery.
6th cranial nerve.
Carotid plexus of nerves.

Externally.
3rd cranial nerve.
4th cranial nerve.
Ophthalmic branch of the 5th cranial nerve.

Cerebral portion.

This portion of the internal carotid artery lies on the *outer side of the optic nerve*, having the 3d cranial nerve (motor oculi) external to it, and extends to the inner extremity of the fissure of Sylvius.

The *internal carotid artery* may be *wounded* by deep penetrating wounds received within the mouth, from stab wounds of the neck, or from gun shot wounds or lacerations, which envolve the deeper structures of the neck. It may also occasionally be wounded in *operations upon the tonsil* or may participate in the ulceration of severe attacks of *supurative tonsilitis.*

BRANCHES.

The internal carotid artery gives off *eight branches* as follows: one, in the petrous portion; three, in the cavernous portion; and four, in the cerebral portion. The names of these branches are shown in the following table.

A Table of the Branches of the Internal Carotid Artery.

INTERNAL CAROTID ARTERY. (8 branches.)	In *petrous portion*	(1 branch).	Tympanic.	
	In *cavernous portion*	(3 branches)	Arteriæ receptaculi.	
			Anterior meningeal.	
			OPHTHALMIC.	
	In *cerebral portion*	(4 branches)	Anterior cerebral.	
			Middle cerebral.	
			Posterior communicating.	
			Anterior choroid.	
OPTHALMIC ARTERY. (13 branches).	*Orbital branches*	(6)	Palpebral.	
			Lachrymal.	
			Supra-orbital.	
			Ethmoidal.	Anterior.
				Posterior.
			Frontal.	
			Nasal.	
	Ocular branches	(6)	Muscular..	Superior.
				Inferior.
			Ciliary....	Long.
				Short.
				Anterior.
			Arteria centralis retinæ.	

The *tympanic branch* enters the tympanum through a foramen of minute size in the carotid canal.

The *arteriæ receptaculi* include several branches, which are distributed to the pituitary body, the Gasserian ganglion, the *walls of the cavernous sinus* and the adjacent dura mater.

The *anterior meningeal branch* supplies the dura mater of the frontal region of the skull.

The OPHTHALMIC ARTERY is a large trunk which escapes from the cavity of the skull, through the *optic foramen*, where it lies on the *outer side of the optic nerve*. Within the orbit this vessel crosses the optic nerve, to reach the inner side of the orbit, and passes forwards to the inner angle of the eye, where it divides into two terminal branches, the nasal and frontal, and anastomoses with the facial artery.

The *branches* of this artery are *twelve* in number although the number is often given as nine, by leaving out the subdivisions of the ethmoidal, muscular and ciliary sets. They are divided into two groups called, respectively, the *orbital group* and the *ocular group*. The branches of each of these groups are shown in the preceding table.

The *lachrymal branch* is the largest *branch* of the opthalmic artery and it supplies the lachrymal gland and conjunctiva of the upper eyelid. It anastomoses with the deep temporal, the transverse facial, the middle meningeal, and the palpebral arteries.

The *supra-obital branch* of the ophthalmic artery passes through the supra-orbital foramen in company with the supra-orbital nerve, and supplies the pericranium, the muscles and the integument of the forehead.

The *ethmoidal arteries* are two in number, which pass through the *ethmoidal foramina*, into the cavity of the cranium. They supply the dura mater of the brain, the mucous membrane of the nose, the ethmoidal cells and the frontal sinuses.

The *palpebral arteries* are two in number and form an *arterial circle around the free margin of the eyelids*, and supply the mucous membrane of the nasal duct.

The *frontal artery* supplies the pericranium, muscles, and integument of the frontal region.

The *nasal artery* is distributed to the root of the nose, and affords a free communication with the nasal and angular branches of the facial artery.

The *short ciliary arteries* vary from *twelve to fifteen* in number and almost completely *enclose the optic nerve*. They enter the back of the globe of the eye and supply the choroid coat and the ciliary processes.

The *long ciliary arteries*, two in number also enter at the back part of the eye and supply the ciliary ligament. They form *two arterial circles*, one around the circumference, and the other around the free margin of the iris, which are connected by intermediate branches of communication.

The *anterior ciliary arteries* form an *arterial circle* around the front part of the eyeball near the circumference of the cornea.

The *muscular branches* of the ophthalmic artery are two in number and supply the muscles of the orbit.

The *arteria centralis retinæ* is one of the smallest branches of the ophthalmic artery. It *pierces the sheath and substance of the optic nerve* about one-quarter of an inch behind the eye-ball, and runs, embedded within it, until it reaches the retina, where it is distributed. In the fœtus, a small branch of this vessel passes directly through the vitreous humor within the posterior chamber of the eye, and is distributed to the posterior surface of the capsule of the lens.

The *anterior cerebral artery* is contained in the longitudinal fissure of the brain. It is connected to its fellow by an artery two lines in length, called the *anterior communicating artery*. This is the *shortest artery* in the body and forms the anterior boundary of the circle of Willis.

The *middle cerebral artery* is the largest branch of the internal carotid and is a direct continuation of that vessel. It is contained in the fissure of Sylvius, where it divides into three branches; one supplying the anterior lobe of the brain; a posterior supplying the middle lobe; and a middle supplying the island of Reil. This artery upon the left side is the most frequent seat of *embolic obstruction*, since the upward current of blood finds a nearly straight channel from the aortic arch to this vessel; the right side presenting a less direct channel on account of the angle at which the innominate artery leaves the aortic arch.

The *posterior communicating artery* serves to join the internal carotid artery with the posterior cerebral branch of the basilar artery. This artery helps to form the arterial circle at the base of the brain, called the circle of Willis.

The *anterior choroid artery* is distributed to the middle cornu of the lateral ventricle of the brain.

Circle of Willis.

A remarkable anastomosis exists between the vessels at the base of the brain by which the circulation not only of the brain but also of all structures entering into the formation of the head and neck, to a great extent, is equalized; and by which the results of any obliteration of one or even two of the larger vessels may be speedily remedied by a corresponding enlargement of the others.

This anastomosis, which is known as the *circle of Willis*, results from a series of communications between the following arteries.

1. The *two anterior cerebral* arteries are connected by the *anterior communicating* artery.
2. The *anterior cerebral* arteries, which assist in forming the circle are direct branches of the *internal carotid* artery of either side.
3. The *internal carotid* arteries of each side are united to the two posterior cerebral arteries by the *posterior communicating* branches.
4. The *posterior cerebral* arteries themselves arise from a *single trunk*, *viz.*, the *basilar* artery.

Thus, from before backwards, we perceive the *anterior communicating artery*, next the *two anterior cerebrals*, next the *internal carotid trunks*, next the *two posterior communicating arteries*, next the *two posterior cerebral arteries*, and finally the *basilar artery*, where the last mentioned vessels converge.

Within the space or area, enclosed by this vascular circle, may be found the following parts, in their respective order from before backwards.

1. The lamina cinerea.
2. The optic commissure.
3. The infundibulum.
4. The tuber cinereum.
5. The corpora albicantia.
6. The posterior perforated space.

ARTERIAL SUPPLY OF SPECIAL REGIONS OF THE HEAD AND NECK.

In recapitulation of the arteries, derived from the principal vascular trunks of the head and neck, it may be of service to the student to present, in a tabulated form, the various sources of vascular supply to *special structures*, which have at times great surgical interest.

Vascular Supply of the Meninges of the Brain.

The *meninges* of the brain and spinal cord receive arterial blood from the following sources.

1. *Anterior meningeal* artery (branch of the internal carotid).
2. *Middle meningeal* artery (branch of the internal maxillary).
3. *Small meningeal* artery (branch of the internal maxillary).
4. *Posterior meningeal* artery (branch of the vertebral artery).
5. *Inferior meningeal* artery (branch of the occipital artery).
6. *Small branches*, which are not specially named but which are still distributed to the meninges. Among these the more important ones are,
   Branches from the *ascending pharangeal arteries.*
   Branches from the *lachrymal arteries.*
   Branches from the *posterior ethmoidal arteries.*
   Branches from the *anterior ethmoidal arteries.*
   Branches from the *vertebral artery.*

Of these branches the anterior meningeal artery and the meningeal branches of the two ethmoidal and lachrymal arteries supply the *anterior fossa* of the skull; the middle and small meningeal and some branches of the ascending pharangeal, which enter the skull at the foramen lacerum basis cranii, supply the *middle fossa;* while the *posterior fossa* of the skull is supplied by the posterior and inferior meningeal arteries, and branches of the ascending pharangeal, which enter the cavity of the cranium through the jugular and the anterior condyloid foramina.

Vascular Supply of the Pharynx.

The pharynx is supplied with blood by the following vessels.

1. *Inferior* or *ascending palatine* artery (branch of the facial).
2. *Posterior* or *descending palatine* artery (branch of the internal maxillary).
3. *Spheno-palatine* artery (branch of the internal maxillary).
4. *Pterygo-palatine* artery (branch of the internal maxillary).
5. *Ascending pharangeal* (branch of the internal carotid).
6. *Small branches* from the following arteries.
   Dorsalis linguæ (branch of the lingual).
   Tonsillar artery (branch of the facial).
   Vidian artery (branch of the internal maxillary).

Vascular Supply of the Tympanum.

The tympanum receives its blood chiefly from the following sources.

1. The *tympanic branch* of the *internal maxillary*, which enters at the Glaserian fissure.
2. The *tympanic branch* of the *internal carotid*, which enters through a small foramen within the carotid canal.
3. The *stylo-mastoid artery* (a branch of the posterior auricular), which enters the *acqueductus Fallopii* through the stylo-mastoid foramen.
4. The *vidian artery* (a branch of the internal maxillary), which passes through the vidian canal and accompanies the large petrossal nerve through the *hiatus Fallopii*.
5. The *petrosal branch* of the *middle meningeal artery*, which enters at the *hiatus Fallopii*.
6. Branches from the *ascending pharangeal* artery, which enter the tympanum along the Eustachian tube.

SURGICAL TRIANGLES OF THE NECK.

The vessels of the head and neck, if examined collectively, are contained within certain spaces of a triangular form, whose boundaries are defined by the borders of certain muscles, and whose contents are of great surgical interest, as the various structures bearing relation to those vessels which have already been separately described, can in this way be studied from a surgical standpoint.

In each of these various triangles important operations are being constantly performed and only, by a thorough knowledge of their contents and relations of each, can such operations be skilfully or safely executed.

In the chapter of this volume upon the muscles of the neck, will be found a diagrammatic illustration of these triangles and subsequent explanatory text, in which the boundaries and floor of each are given. It will be needless therefore to repeat them here since the muscular boundaries and the floor of these triangles are properly and best considered under the head of myology.

Without entering, therefore, into a description of the limits of the various triangles, the *gross contents* of each will first be enumerated, in order to assist the memory of students and subsequently the *relations of the more important structures* will be given.

The INFERIOR CAROTID triangle is situated low down near the root of the neck and anterior to the sterno-mastoid muscle. It is covered by the integument, the superficial cervical fascia, the platysma muscle, the deep cervical fascia, the sterno-thyroid, sterno-hyoid muscles and the anterior margin of the tendon of the sterno-mastoid muscle.

It contains the following structures which possesses surgical importance.

- 3 Arteries..
  - Common carotid.
  - Inferior thyroid.
  - Vertebral.
- 3 Veins....
  - Internal jugular.
  - Vertebral.
  - Middle thyroid,
- 6 Nerves..
  - Superficialis colli; branch of cervical plexus).
  - Pneumogastric.
  - Descendens noni; (branch of hypoglossal nerve).
  - Communicans noni; (branch of cervical plexus).
  - Recurrent laryngeal; (branch of pneumogastric).
  - Sympathetic.
- 3 Organs..
  - Trachea.
  - Thyroid gland.
  - Lower part of larynx.

Within this triangle the common carotid artery lies in its sheath; in which are also enclosed the internal jugular vein and the pneumogastric nerve, the *vein* lying *outside* of the artery and the *nerve between* and *behind the artery and the vein.*

In front of and *upon this sheath* are seen the filaments of the *descendens* and *communicans noni nerves;* while, in front also, the filaments of the *superficialis colli nerve* ramify between the deep cervical fascia and the platysma muscle, and the *middle thyroid vein* frequently crosses the artery.

Behind the sheath are seen the *inferior thyroid artery*, and the *recurrent laryngeal nerve;* and the *vertebral vein* and *artery* lie upon the *floor of the triangle* between the scalenus anticus and the longus colli muscles, below the level of the 6th cervical vertebra.

On the *inner side of the sheath*, the *trachea*, the lower portion of the *larynx* and the *thyroid gland* can be discerned.

Within this triangle the common carotid is tied, if the seat of election be *below the omo-hyoid muscle.*

The SUPERIOR CAROTID triangle is covered by the integument, the superficial cervical fascia, the platysma muscle and the deep cervical fascia, and lies immediately above the preceding triangle and anterior to the sterno-mastoid muscle.

It contains the following structures:

8 Arteries..
- Common carotid (bifurcaiion of).
- External carotid.
- Internal carotid.
- Superior thyroid.
- Lingual.
- Facial.
- Occipital.
- Ascending pharyngeal.

6 Veins...
- Internal jugular.
- Superior thyroid.
- Lingual.
- Facial.
- Occipital.
- Pharyngeal.

8 Nerves..
- Facial branches (cranial).
- Superficialis colli (branch of cervical plexus).
- Descendens noni (branch of the hypoglossal).
- Hypoglossal (cranial).
- Pneumogastric (cranial).
- Spinal accessory (cranial).
- Superior laryngeal (branch of pneumogastric).
- External laryngeal branch of superior laryngeal.

2 Organs..
- Lower part of pharynx.
- Upper part of larynx.

Within this triangle the three larger vessels of the neck, *viz.*, the common, external, and internal carotid arteries, are somewhat concealed from view by the edge of the sterno-mastoid muscle, which overlaps them. The external and internal carotids lie, side by side, on a line corresponding to the *level of the upper border of the thyroid cartilage*, which corresponds to their point of origin; the *external carotid* lying to the *inner side*.

Above this line are seen, within this triangle, the first *five branches* of the *external carotid*, three of which (the superior thyroid, lingual, and facial arteries) pass forwards towards the median line of the neck; one passes backwards (the occipital artery); while the remaining one (the ascending pharyngeal artery) runs upwards nearly parallel with, and to the inside of, the internal carotid artery.

The *veins*, with the exception of one (internal jugular) correspond to and *accompany the arteries of the same name*, while the internal jugular vein runs in connection with the internal and common carotid arteries, lying to the *outer side of each*, and receive the blood from the other five veins contained within this triangle.

The *nerves* contained within this space are numerous, and of great surgical importance.

Upon the sheath of the common carotid, lies the *descendens noni nerve*, not having yet reached the filaments of the communicans noni nerve. The *hypoglossal nerve curves around the occipital artery* and crosses *in front* of *both the carotids*.

The *sympathetic nerve* lies *behind* the sheath of the common carotid; *within this sheath*, lies the *pneumogastric nerve;* and, on the *outer side* of the larger vessels, the *spinal accessory nerve* runs for a short distance, before it pierces the sterno-mastoid muscle.

The branches of the *superficialis colli* and *facial nerves* ramify underneath the platysma muscle and above the deep cervical fascia. On the inner side of the internal carotid artery, just below the hyoid bone, the *superior laryngeal nerve* may be perceived, on its way to the larynx; while, lower down and in the same relation to the artery, the *external laryngeal branch* of the *superior laryngeal nerve* can be detected.

The upper part of the larynx and the lower part of the pharynx, which lies behind the former, are also perceived on the inner wall of this space.

The SUBMAXILLARY TRIANGLE corresponds to that portion of the neck lying immediately below the lower jaw. It is covered by the integument, the superficial cervical fascia, the platysma muscle, and the deep cervical fascia.

This space contains the following structures:

8 Arteries	Internal carotid. External carotid. Facial. Sub-mental. Mylo-hyoid. Posterior auricular. Temporal. Internal maxillary.
7 Veins	Internal jugular. Facial. Parotid veins. Temporal. Internal maxillary. Temporo maxillary. Posterior auricular.
5 Nerves	Facial. Pneumogastric. Mylo-hyoid. Glosso-pharyngeal. Superficial cervical.
2 Glands	Submaxillary gland. Parotid gland.

In the front portion of this space, the submaxillary gland contains, embedded within a groove on its surface, the *facial artery* and *vein;* and, beneath this gland, lie the *submental artery* and the *mylo-hyoid artery* and *nerve.*

The posterior portion of this triangle is separated from the anterior portion by the stylo-maxillary ligament. Within this portion of the triangle lies the external carotid artery, deeply imbedded within the parotid gland. This vessel here lies in front of, and superficial to, the internal carotid artery. In this situation, the *facial nerve* crosses the internal carotid and sends some of its filaments in company with the *superficial cervical nerve* to ramify beneath the platysma muscle.

Within the substance of the parotid gland, the external carotid artery also gives off the posterior auricular branch and divides into its two terminal branches, the temporal and internal maxillary vessels.

The *internal carotid artery* is more deeply situated than the external carotid and is separated from it, in this triangle, by the stylo-glossus and the stylo-pharyngeus muscles and also by the glosso-pharyngeal nerve. It is accompanied by the internal *jugular vein* and the *pneumogastric nerve*, the vein lying to the *outside* of the internal carotid artery.

The *veins* mentioned in the table of contents of the submaxillary triangle correspond, in most instances, to the arteries also contained, although a few of the superficial veins of this region receive special names from their situation. As veins are extremely liable to vary in their situations, nothing can be positively asserted as to their exact relations, save in the case of a few special veins, as the internal jugular vein for example.

The OCCIPITAL TRIANGLE is the largest division of the posterior triangle of the neck. It is covered by the integument, the superficial fascia, the platysma muscle and the deep cervical fascia.

Its contents may be thus enumerated:

1 Artery...	Transversalis colli.
2 Veins....	Transversalis colli vein. Posterior external jugular.
3 Nerves..	Ascending branches of the cervical plexus. Spinal accessory. Descending branches of the cervical plexus.
Glands....	A chain of lymphatics running from the mastoid process to the root of the neck.

Within this surgical triangle these parts are thus arranged.

The artery runs along the *lower portion of the triangle*, in a direction nearly horizontal, and the *transverse cervical vein* accompanies it.

The *posterior external jugular vein*, passes from above downwards, between the splenius and the trapezius muscles, in a line nearly parallel with the posterior margin of the sterno-mastoid muscle, till it opens into the external jugular vein, at about its centre.

The *spinal accessory nerve* is directed obliquely across this space, after escaping from the sterno-mastoid muscle, which it pierces, till it reaches the trapezius muscle, to which some of its terminal filaments are distributed.

The *branches of the cervical plexus* are very superficial in their situation and ramify subcutaneously over the entire space.

The SUBCLAVIAN TRIANGLE is much smaller than the preceding triangle and lies between the inferior border of the posterior belly of the omo-hyoid muscle and the clavicle. Its dimensions admit of variations in size, being dependent upon, 1. The height of the omo-hyoid muscle in the neck. 2. The extent of the attachment of the trapezius muscle. 3. The extent of the clavicular portion of the sterno-mastoid muscle, and 4. The position of the arm, which, if raised, greatly diminishes the size of this space by altering the relative position of the clavicle to the omo-hyoid muscle, or if depressed, tends to increase its normal area.

This space is covered by the integument, the platysma muscle and the superficial and deep cervical fascia. It contains the following structures:

3 Arteries.	Subclavian (3rd portion). Supra-scapular. Transversalis colli.
5 Veins . . .	Subclavian (occasionally). Supra-scapular. Transversalis colli. External jugular. Small vein crossing the middle of the clavicle from the cephalic vein.
3 Nerves. .	Descending branches of the cervical plexus. Brachial plexus (formed by 5th, 6th, 7th, 8th cervical and 1st dorsal nerves). The nerve to the subclavius muscle.
Glands. . . .	Lymphatic glands.

These various structures are arranged within this triangle in the following manner.

The *subclavian artery* lies just below the level of the clavicle, curving outwards and downwards, from the outer border of the scalenus anticus muscle, to the lower border of the first rib. The level of this artery is often higher than the normal, and may, in extreme cases, reach a point one inch and a half distant from the upper border of the clavicle.

Occasionally also it passes *in front* of, or *pierces* the scalenus anticus muscle, thus changing or obliterating the limits of its three portions.

The *subclavian vein* usually lies *behind the clavicle*, and, for that reason, is only occasionally seen in this space. It may, however, in extreme cases, reach the highest point at which the artery is ever perceived, and, in a few instances, it has been known to pass *behind* the scalenus anticus muscle in connection with the subclavian artery.

The *brachial plexus* lies *above the artery* and in close contact with it. The *supra-scapular vessels* run transversely along the clavicular margin of this space, and the *transversalis colli vessels*, traverse its upper angle in the same direction.

The *external jugular vein* runs vertically downwards, either close to, or underneath, the outer margin of the sterno-mastoid muscle, and terminates in the subclavian vein. The *transversalis colli* and *supra-scapular veins* often form a plexus in front of the subclavian artery.

ARTERIES OF THE UPPER EXTREMITY.

The arterial trunk, which furnishes blood to the upper limb, continues undivided from the commencement of the subclavian artery, at a point corresponding, on the right side, to the right sterno-clavicular articulation, and, on the left side, at the aortic arch, till the elbow is reached on either side. This continuous vessel however has been given names in different portions of its course according to the regions of the body through which it passes. This division, however artificial it may be, serves greatly to facilitate reference and to aid in the description of the vessel.

From the commencement of the vessel as far as the outer border of the first rib, the name *subclavian artery* is applied, from its position beneath the clavicle; from the first rib to the lower border of the teres major muscle, which marks the termination of the axillary space posteriorly, it is named the *axillary artery;* and from this point to the bifurcation at the bend of the elbow it is termed the *brachial artery.*

THE SUBCLAVIAN ARTERY.

In most cases, the description of one side serves for both; but this is not true of the subclavian artery since this vessel arises, on the two sides, from different points, and therefore causes extreme variations in the relations of the *first portion* of the course of the subclavian artery of the right and the left side. It has been customary therefore to divide the subclavian artery, of each side, into three distinct portions, since by so doing the description of the vessel may be greatly simplified. These three portions are indicated by the relation which the vessel bears to the *scalenus anticus muscle;* the *first portion* extending from the point of origin of the subclavian, on each side, to the inner border of this muscle; the *second portion*, on each side lying behind this muscle, as the artery passes over the first rib; and the *third portion* lying to the outside of the external border of the same muscle and extending to the point of termination of the subclavian artery, at the lower border of the first rib.

Each of these parts will now be examined in detail. The first portion of the artery will require, however, a separate description for the right and the left side, since in it alone, is there any material difference in the anatomical description of the two vessels.

First Portion of the Right Subclavian Artery.

The subclavian artery upon the right side commences at the bifurcation of the innominate, opposite to the sterno-clavicular articulation of the right side and terminates at the inner border of the scalenus anticus muscle.

In this portion the artery ascends slightly above the clavicle as a rule, although the height of the vessel in the neck varies in different subjects, and lies in a direction which points upwards and outwards, from its seat of origin.

In this portion the right subclavian artery presents the following immediate relation to the important structures which surround it.

PLAN OF THE RELATIONS OF FIRST PORTION OF RIGHT SUBCLAVIAN ARTERY.

In front.

Three muscles. { Sterno-mastoid (clavicular origin). Sterno-hyoid. Sterno-thyroid.

Two veins... { Internal jugular. Vertebral.

Three nerves.. { Pneumogastric. Cardiac. Phrenic.

Right Subclavian Artery.
1st portion.

Beneath.
Pleura.

Behind.

Two nerves { Recurrent laryngeal. Sympathetic.

Longus colli muscle.

Transverse process of 7th cervical vertebra.

These parts *bear also to each other*, some special relations, which are of surgical interest. The origins of the sterno-mastoid, sterno-hyoid and sterno-thyroid muscles separate the artery from the superficial structures, which have first to be divided in the operation for ligation of this portion of the artery. These superficial structures are the integument, the superficial cervical fascia, the platysma muscle and the deep cervical fascia.

The *two large veins* (internal jugular and vertebral) and the *three nerves* (pneumogastric, phrenic and cardiac) all cross the *anterior wall* of the artery and lie in close relation to it, being situated below the three deep muscles. The pleural covering of the lung lies in close relation to the *inferior wall* of the artery, since the apex of that organ rises high up within the neck, and it should be avoided in attempting to pass a ligature in this locality.

The *subclavian vein* lies *below* the *level of the artery*, and is therefore not mentioned among the structures which bear a direct relation with it. The *recurrent laryngeal nerve*, on this side, *winds around* the subclavian artery and reaches the closest contact with it at its posterior surface.

Behind the artery the sympathetic system of nerves, the longus colli muscle, and the transverse processes of the 7th cervical and of the 1st dorsal vertebræ, are in close relation but are still separated from it by a cellular interval.

First Portion of the Left Subclavian Artery.

The left subclavian artery arises from the end of the transverse portion of the arch of the aorta, and extends to the inner border of the scalenus anticus muscle.

From the peculiarity as to its point of origin it differs from the first portion of the opposite subclavian artery in its *length*, *direction* and the *structures* to which it bears immediate relation.

It is much *longer* than the right subclavian in its first portion, and instead of arching upwards, it ascends almost *vertically* from within the chest.

Commencing as it does from the deepest portion of the arch of the aorta, this vessel is, at its origin, situated close to the vertebral column and behind the left lung. The left subclavian presents in this portion of the artery the following relations.

PLAN OF THE RELATIONS OF FIRST PORTION OF LEFT SUBCLAVIAN ARTERY.

In front.

Three muscles.. { Sterno-mastoid. Sterno-hyoid. Sterno-thyroid.

Two veins..... { Left internal jugular. Innominate.

Three nerves... { Pneumogastric. Phrenic. Cardiac.

Left carotid artery.
Lung of left side and pleura.

Innner side.
Œsophagus.
Trachea.
Thoracic duct.

Left Subclavian Artery.
1st portion.

Outer side.
Pleura of left lung.

Behind.
Œsophagus.
Thoracic duct.
Vertebral column.
Longus colli muscle.
Inferior cervical ganglion of the sympathetic system.

The pneumogastric, phrenic and cardiac nerves lie almost *parallel with*, and *in front* of the artery. The pleura of the left lung invests it on its *anterior* and *lateral wall* forming a depression in which it rests. The three muscles of the sternal region separate it, as on the opposite side, from the integument, the superficial cervical fascia, the platysma muscle and the deep cervical fascia.

The artery, from its deep situation within the chest, also gains relations, *posteriorly*, with the œsophagus, thoracic duct, vertebral column and its longus colli muscle, and the inferior cervical ganglion of the sympathetic nervous system; while, to its inner side, the trachea, œsophagus and thoracic duct also bear an intimate relation.

In order to assist the memory of students in the anatomy of this artery, by the aid of contrast, the following arrangement of these relations and other points of interest, pertaining to the first portion of the subclavian artery of the right and the left side may prove of value.

Table of Contrast.

Relations of the first portion of the RIGHT SUBCLAVIAN ARTERY.	Relations of the first portion of the LEFT SUBCLAVIAN ARTERY.
In front.	
3 Muscles. { Sterno-mastoid (clavicular portion.), Sterno-hyoid., Sterno-thyroid.	3 Muscles. { The same as on right side.
2 Veins.... { Right internal jugular., Vertebral.	2 Veins... { Left internal jugular., Innominate.
3 Nerves.. { Pneumogastric., Phrenic., Cardiac.	3 Nerves.. { The same as on the right side.
	1 Artery... { Left carotid.
	Left lung and pleura.
Behind.	
7th cervical vertebra.	Vertebral column (dorsal region).
2 Nerves.. { Recurrent laryngeal., Sympathetic.	Inferior sympathetic ganglion of the cervical region.
1 Muscle.. { Longus colli.	1 Muscle (same as on right side).
	Œsophagus.
	Thoracic duct.
OTHER RELATIONS.	
Right pleura lies *beneath* the artery.	Leftpleura lies to the *outer side* of the artery, as well as *in front* of it.
The artery from its direction admits of *no relations towards the median line* of the body.	The artery is related *internally* to the following structures : 1. Œsophagus. 2. Trachea. 3. Thoracic duct.
Length.	
The right subclavian artery varies in the length of its first portion from $\frac{3}{4}$ to $1\frac{1}{2}$ inches.	The left subclavian artery varies in the length of its first portion from $1\frac{1}{2}$ to 3 inches.
Point of Origin.	
The right subclavian commences behind the *right sterno-clavicular articulation.*	The left subclavian begins at the *left extremity* of the *transverse portion* of the *aortic arch.*

SECOND PORTION OF SUBCLAVIAN ARTERY.

The *second portion* of each subclavian artery lies *behind* the scalenus anticus muscle, and is necessarily very short. It forms the highest portion of the arch, described by the vessel, and is therefore the most distant from the line of the clavicle. This portion is less deeply situated than the first portion of the artery. Its relations to contiguous structures are as follows :

PLAN OF THE RELATIONS OF SECOND PORTION OF THE SUBCLAVIAN ARTERIES.

In front.
1 Muscle.. Scalenus anticus.
1 Nerve... Phrenic.
1 Vein.... Subclavian.

Above.
Brachial plexus of nerves.

Subclavian Artery.
2nd portion.

Below.
Pleura.

Behind.
Scalenus medius muscle.
Pleura.

The three structures, mentioned as *in front*, are situated beneath the superficial layers of the neck, *viz.*, the integument, the superficial cervical fascia, the platysma muscle and the deep cervical fascia. The *phrenic nerve* and the *subclavian vein* lie upon the anterior surface of the scalenus anticus muscle and therefore do not actually touch the artery. The vein, however, is nearer the line of the clavicle than the artery at this point.

Behind the artery, the scalenus medius muscle is in the closest relation and the *brachial plexus* of nerves, which passes between the same muscles as the artery, lies *above* that vessel and situated closely to it. *Below* the artery, the apex of the lung and its pleural covering lie in close relation.

THIRD PORTION OF SUBCLAVIAN ARTERY.

The *third portion* of the subclavian artery passes, in a direction downwards and outwards, from the external border of the scalenus anticus muscle to the *lower border* of the *first rib*, where it becomes the axillary artery.

In this part of its course, the artery lies in a small triangular space, the sides of which are formed by the scalenus anticus and the omo-hyoid muscles, and its base by the clavicle. It is within this triangle that the artery approaches *nearer to the surface* of the neck than in any portion of its course, although the artery, as it approaches its termination, sinks deeper and passes under the clavicle and the subclavius muscle.

Its relations within this space will be found tabulated below.

PLAN OF THE RELATIONS OF THIRD PORTION OF THE SUBCLAVIAN ARTERY.

In front.

Integument.

Two fasciæ.. { Superficial cervical. / Deep cervical.

Two muscles { Platysma. / Subclavius,

Three veins.. { External jugular. / Supra-scapular. / Transverse cervical.

Supra-scapular artery.

Filaments of the cervical plexus.

Nerve to the subclavius muscle.

The clavicle.

Above.
Brachial plexus.
Omo-hyoid muscle.

Subclavian Artery.
3rd portion.

Below.
First rib.

Behind.
Scalenus medius muscle.

Compression of the subclavian artery must be performed at its point of crossing the first rib, and the pressure must be directed *downwards* and *inwards* to prove effectual.

Of the numerous structures, which lie in front of the artery, the integument, cervical fasciæ and the platysma muscle lie superficially and the nerve filaments of the cervical plexus ramify subcutaneously. At the inner side of the artery, the *external jugular* vein crosses it, and also, at about the same point, the *supra-scapular* and the *transverse cervical veins*, which often form a plexus in front of the artery.

The *subclavian vein* lies on a plane below the level of the artery and close behind the clavicle.

The *brachial plexus* of nerves lies *above* and to the *outer side* of the artery. The *first rib*, over which the artery passes lies *below* it and a small nerve supplying the subclavius muscle can usually be perceived crossing this portion of the artery.

COLLATERAL CIRCULATION.

After direct communication between the head and the axillary artery is cut off, by the application of a ligature to the subclavian artery, the supply of blood to the arm is obtained by anastomoses between certain vessels carrying blood derived from the subclavian and arterial branches deriving their supply from other sources.

These branches of communication vary with the point at which the ligature is applied to the subclavian artery.

Should the *first portion* of that artery be tied, the *vertebral* affords a *direct* blood supply to the arm through the circle of Willis; and the *princeps cervicis* (a branch of the occipital artery), joins with the *profunda cervicis* (a branch of the superior intercostal artery). The *superior thyroid* (a branch of the external carotid) also sends blood into the *inferior thyroid* (a branch of the thyroid axis); while the *superior epigastric* (a branch of the internal mammary artery) anastomoses with the *deep epigastric* (a branch of the external iliac artery).

The *intercostal branches* of the thoracic aorta also anastomose with the *branches* of the *axillary artery* upon the chest wall.

If the *second portions* be ligated, the direct blood supply is no longer cut off from the branches of the subclavian, viz., the thyroid axis, the internal mammary, the vertebral, and the superior intercostal arteries. The collateral circulation therefore gains in the *number of points of communication*, but loses some of those previously mentioned. Thus the vertebral no longer becomes of aid, since it arises internal to the point of ligature. The inferior thyroid no longer needs an indirect current from the superior thyroid since it receives a direct supply from the subclavian artery. The internal mammary no longer needs to draw on the deep epigastric for blood, since it now has also its normal supply unimpaired.

The *internal mammary* artery, however, from its direct supply, sends blood to the empty *thoracic branches* of the *axillary*. The *supra-scapular* artery (a branch of the thyroid axis) joins with the *acromio-thoracic* (a branch of the axillary). The *transversalis colli* (through its posterior scapular branch) sends blood to the *subscapular artery* (a branch of the axillary); and the *dorsalis scapulae* branch of the subscapular artery anastomoses with the *subscapular* branch of the thyroid axis.

To recapitulate then, as a guide to memory, these various points of anastomosis after ligation of the subclavian artery has been performed we have the following:

A.

When the first portion is tied.

The subclavian artery receives blood from the *circle of Willis* through the *vertebral artery.*

The subclavian artery receives blood from the *carotid* through the *superior thyroid artery.*

The subclavian artery receives blood from the *carotid* through the *princeps cervicis artery.*

The subclavian artery receives blood from the *thoracic aorta* through the *posterior intercostals.*

The subclavian artery receives blood from the *external iliac* through the *deep epigastric artery.*

B.

When the second or third portions are tied.

The *supra scapular* (branch of thyroid axis) anastomoses with *acromio-thoracic* (branch of axillary).

The *supra scapular* (branch of thyroid axis) anastomoses with *dorsalis scapulæ* (branch of subscapular).

The *posterior scapular* (branch of the subclavian or the transversalis colli) anastomoses with *subscapular* (branch of axillary).

The *posterior scapular* (branch of the subclavian or the transversalis colli) anastomoses with *dorsalis scapulæ* (branch of subscapular).

The *internal mammary* (branch of subclavian) anastomoses with *short thoracic* (branch of subscapular).

The *internal mammary* (branch of subclavian) anastomoses with *long thoracic* (branch of subscapular).

The *posterior intercostals* (branch of thoracic aorta) anastomoses with thoracic branches of the axillary.

BRANCHES OF THE SUBCLAVIAN ARTERY.

From the subclavian artery, four vessels spring as direct branches, although there are seven important arterial trunks, which directly and indirectly arise from this source, and which require description.

The following table illustrates not only the four principal trunks which arise, but also the distribution of their various branches.

A TABLE OF THE BRANCHES OF THE SUBCLAVIAN ARTERY.

- SUBCLAVIAN ARTERY. (4 branches,)
  - 1 VERTEBRAL. (7 branches.
    - In the *neck*....
      - Lateral spinal.
      - Muscular branches.
    - In the *cavity of the skull*....
      - Posterior meningeal.
      - Anterior spinal.
      - Posterior spinal.
      - Inferior cerebellar.
      - Basilar.
        - Transverse branches
        - Anterior cerebellar.
        - Superior cerebellar.
        - Posterior cerebral.
  - 2 INTERNAL MAMMARY......... (8 branches).
    - Superior phrenic.
    - Mediastinal.
    - Pericardiac.
    - Sternal.
    - Anterior intercostal.
    - Perforating.
    - Musculo-phrenic.
    - Superior epigastric.
  - 3 THYROID AXIS. (3 branches.)
    - *Inferior thyroid.*
      - Ascending cervical.
      - Laryngeal.
      - Tracheal.
      - Œsophageal.
    - *Transversalis colli*.... ....
      - Superficial cervical.
      - Posterior scapular.
    - *Supra scapular.*
  - 4 SUPERIOR INTERCOSTAL.......
    - Profunda cervicis.
    - Intercostal branches.

By some anatomists, the *posterior scapular artery* is given as a branch of the 3d portion of the subclavian artery, since it arises from that source perhaps as frequently as from the transversalis colli artery. It will, however, be described in this volume under the latter point of origin.

Of the four primary branches given off by the subclavian artery, *three* arise from the *first portion* of the vessel, *viz.*, the vertebral, thyroid axis and internal mammary, and *one* from the *second portion* of the artery, *viz.:* the superior intercostal. Of these four branches, the vertebral arises from the upper and back part of the circumference of the vessel; the thyroid axis from the front portion; the internal mammary from the under or lower aspect of the artery, but nearer to its anterior than its posterior surface; and the superior intercostal branch from the lower and posterior aspect of the artery, after the subclavian passes beneath the scalenus anticus muscle. By some anatomists the superior intercostal artery is given as a branch of the first portion upon the *left side*, but it is questionable if the percentage of dissections will verify this as the point of normal origin.

The first three branches, upon both sides of the body, arise *close together*, a space, varying usually from *one-half* of an inch to *an inch*, existing between the point of origin of the vertebral and the commencement of the vessel, upon the *right side;* while upon the *left side*, the distance from the point of origin of the subclavian to the point of origin of the vertebral varies, in the larger percentage of cases, from *one and a quarter* to *two and one-eighth inches.*

VERTEBRAL ARTERY.

The vertebral artery arises, in the average of dissections, at a point situated about one-third of an inch from the inner border of the scalenus anticus muscle towards the median line, upon the *right side* of the body; while upon the *left side*, it is almost invariably present at the point of abrupt change in the course of the subclavian artery, as it arches over the first rib, which however corresponds to nearly the same relative point.

The *left* vertebral artery is usually the *larger than the right*, and, at its point of origin, its axis lies more nearly in the direct line of the current of blood than that of the right side. This perhaps accounts for the increased size of the left vertebral artery.

The vertebral artery, upon either side, ascends through a *foramen in the transverse process* of each of the first six cervical vertebræ, and after pursuing a winding course at the base of the skull, enters the cranium through the *foramen magnum* and terminates, in front of the medulla oblongata, by uniting with its fellow of the opposite side to form the *basilar artery.*

The vertebral artery, previous to its entrance to the skull, is *contained within a triangular space*, which is bounded, *internally* by the rectus capitis posticus major muscle; *externally*, by the obliquus capitis superior; and, *below*, by the obliquus capitis inferior muscle.

On the *left* side of the body, the *thoracic duct* passes in front of the vertebral artery, on its way to empty into the subclavian vein.

Within the canal, formed by the transverse processes of the vertebræ, the vertebral artery is accompanied by a *plexus* of *sympathetic nerves*, and by the *vertebral vein*, which lies in front of the artery.

The *cervical nerves*, at their escape from the intervertebral foramina, lie *behind* the vertebral artery as it ascends through the bony canal.

Within the cavity of the skull, as the artery winds around the medulla oblongata, it is located *between* the *hypo-glossal nerve* and the *anterior branch* of the *suboccipital nerve.*

BRANCHES.

The branches of the vertebral artery are *six* in number and may be divided into two sets, *viz.*, those given off within the *neck* and those given off within the *cranium.* The branches comprised in each set will be found enumerated in the table of the branches of distribution of the subclavian artery on page 380.

The *lateral spinal branches* enter the cavity of the spinal axis through the *intervertebral foramina.*

The *muscular branches*, which are given off in the vicinity of the atlas, supply the *deep seated muscles* of the *cervical region.*

The *posterior spinal branch* arises from the vertebral artery after its entrance to the cranium. It anastomoses, through the intervertebral foramina with small cervical and dorsal vessels.

The *anterior spinal branch* unites, at the border of the foramen magnum, with the artery of the opposite side to form a common trunk.

The *posterior meningeal artery* ramifies between the dura mater and the bone, in the posterior fossa of the skull.

The *inferior cerebellar artery* is the largest branch of the vertebral and arises from that vessel near the pons varolii. It passes *between* the *hypo-glossal* and the *pneumogastric nerves.* This artery supplies blood to the *choroid plexus* within the substance of the brain.

BASILAR ARTERY.

This vessel is formed by the union of the two vertebral arteries and is so-called, since it lies upon the basilar process of the occipital bone.

It extends from the *posterior* to the *anterior border* of the *pons varolii.*

BRANCHES.

This artery bifurcates into the two posterior cerebral arteries and, in its course, gives off the anterior cerebellar, the posterior cerebellar, and transverse branches.

One of the *transverse branches* accompanies the auditory nerve within the auditory canal, and is called the *auditory artery.*

Another of the *transverse branches*, which is of large size, receives the name of the *anterior inferior cerebellar artery.*

The *superior cerebellar branch* and the *posterior cerebral artery* are separated, at their point of origin, by the *third cranial nerve.*

THE THYROID AXIS.

This large arterial trunk arises from the anterior aspect of the subclavian artery, at a point slightly internal to the inner margin of the scalenus anticus muscle. Its *average length* is about *one quarter of an inch.* It divides into three large trunks called as follows:

Inferior thyroid artery.
Transversalis colli artery.
Supra-scapular artery.

INFERIOR THYROID ARTERY.

This vessel passes *beneath* the sheath of the *common carotid* artery (which encloses also the jugular vein and the pneumogastric nerve) and *in front* of the *vertebral* artery, before it reaches its point of distribution within the body of the thyroid gland.

The *middle cervical ganglion* of the sympathetic nerves frequently lies upon this artery, after it has passed underneath the carotid sheath.

The branches of the inferior thyroid artery are:

Laryngeal.	Œsophageal.
Tracheal.	Ascending cervical.

The *laryngeal branch* supplies the mucous membrane of the larynx and the muscles of that region.

The *tracheal branch* is distributed to the trachea and anastomoses with the bronchial arteries (branches of the thoracic aorta).

The *œsophageal branches* are distributed to the œsophagus.

The *ascending cervical* branch is irregular in its point of origin. It ascends the neck in close relation with the phrenic nerve.

SUPRA-SCAPULAR ARTERY.

This artery passes downwards and inwards from its point of origin, and, under protection of the clavicle, reaches the supra-scapular fossa. In its course it crosses the phrenic nerve and passes between the subclavian artery and its vein. It anastomoses in the supra-scapular fossa, with the dorsalis scapulæ artery (a branch of the subscapular) and the acromial thoracic artery (a branch of the axillary). It supplies the shoulder joint.

Its branches are as follows:

Muscular.	Supra-acromial.

The *muscular branches* are distributed to the adjacent muscles along its course.

The *supra-acromial branch* anastomoses, upon the acromion process of the scapula, with the acromial thoracic branch of the axillary artery.

THE TRANSVERSALIS COLLI ARTERY.

This artery is one of the branches of the thyroid axis. It crosses the scalenus anticus muscle and the phrenic nerve, passes beneath the omo-hyoid muscle, pierces between the main branches of the brachial plexus of nerves, and is distributed to the trapezius muscle.

It gives off two principal branches as follows.

Superficial cervical. Posterior scapular.

The *superficial cervical* branch is distributed to muscles, glands, and the integument.

The *posterior scapular artery* may be either a branch of the transversalis colli or of the third portion of the subclavian artery. Some authorities report a percentage of relative frequency in favor of the *latter point* as its normal seat of origin.

This vessel runs downwards along the *posterior margin of the scapula* as far as the inferior angle of that bone. It supplies the neighboring muscles of the back and *anastomoses with the subscapular*, the *supra-scapular* and the *posterior branches of the neighboring intercostal arteries.*

INTERNAL MAMMARY ARTERY.

This artery arises from the anterior and lower part of the subclavian, close to the inner margin of the scalenus anticus muscle. It passes downwards within the cavity of the thorax, parallel with the edge of the sternum, but lying about one-half an inch to the outer side of it.

At its point of origin, it is covered, like the other large branches of the subclavian artery, by the internal jugular vein. This vessel also passes behind the subclavian vein and is crossed in front, by the phrenic nerve. It is accompanied in the chest by two veins for the greater portion of its course, but, in the upper part of the chest, these veins unite to form a single vein.

The internal mammary artery terminates, at the interval between the 6th and 7th ribs, by dividing into its two terminal branches.

BRANCHES.

The branches of the internal mammary artery are eight in number, as follows.

Comes nervi phrenici. (Superior phrenic).	Anterior intercostal.
Pericardiac.	Musculo-phrenic.
Mediastinal.	Perforating.
Sternal.	Superior epigastric.

The *superior phrenic branch accompanies the phrenic nerve* in its course through the chest; and, like that nerve, is distributed to the diaphragm.

The *mediastinal branches* supply the thymus glands and the connective tissue of the anterior mediastinum.

The *pericardic branches* supply the upper portion of the pericardium.

The *sternal branches* supply the triangularis sterni muscle, and both surfaces of the sternum.

The *anterior intercostal branches* are two in number to each intercostal space. They supply the intercostal and pectoral muscles, and also the mammæ and the integument. They anastomose with the *posterior intercostal vessels*, which are branches of the thoracic aorta.

The *musculo-phrenic branch* is one of the *terminal branches* of the internal mammary. It penetrates the diaphragm at the 8th or 9th rib, and terminates at the last intercostal space.

The *superior epigastric artery* is a terminal branch and a direct continuation of the internal mammary vessel. It becomes superficial upon the wall of the abdomen at the 7th costal cartilage, and lies behind the sheath of the rectus abdominis muscle. *This artery anastomoses with the deep epigastric artery* (a branch of the external iliac) and with its fellow of the opposite side.

SUPERIOR INTERCOSTAL ARTERY.

This artery arises from the posterior part of the subclavian artery, near its lower border and close to the inner border of the scalenus anticus muscle. Its course is at first directed backwards. It gives off, early in its course, one important branch (the *profunda cervicis*) which anastomoses with the princeps cervicis artery (a branch of the occipital) and thus establishes an important collateral circulation. The main artery bends downwards and backwards in front of the neck of the 1st rib and often of the 2d rib, and terminates either in the first or second intercostal space.

Opposite the neck of the 1st rib, the *first dorsal ganglion of the sympathetic system* lies upon the inner side of this vessel.

This vessel sends branches 1. To the first or second intercostal spaces (intercostal branches). 2. To the posterior spinal muscles, 3. To the spinal cord and its membranes.

The *profunda cervicis branch* runs upwards in the neck, between the complexus and the semispinalis colli muscles, as high as the axis, where it anastomoses with the arteria princeps cervicis and with branches of the vertebral artery. It supplies the muscles in the neighborhood of its course.

THE AXILLARY ARTERY.

The axillary artery is a direct continuation of the subclavian artery and intervenes between that artery, above, and the brachial artery, below. It commences at the *lower border* of the *first rib* and terminates at the *lower border* of the *latissimus dorsi* and *teres major muscles*, which mark, posteriorly, the inferior limit of the axilla. In its course, this artery passes through the axillary space; and its direction varies with the relative position of the arm to the trunk.

When the arm hangs freely by the side, the artery describes a curve whose concavity looks downwards and inwards towards the chest; while, when the arm is extended at a right angle to the body, this vessel is nearly straight, and, if the limb be elevated to a perpendicular position, the artery is rendered concave with its concavity looking upward.

This artery is deeply seated during the upper portion of its course, but becomes superficial near its point of termination, and most markedly so when the arm is raised. At the lower portion of the axillary space, therefore, pressure can be readily applied to the artery and its circulation easily controlled. This pressure should however always be directed *outwards*, since the humerus alone affords a resistance sufficient to ensure compression of the vessel.

This vessel is usually described as consisting of *three distinct portions*, which, like the subdivisions of the subclavian artery, depend upon the relation of the vessel to a muscle, *viz.*, *the pecporalis minor muscle.*

The *first portion* of the artery lies *above* this muscle; the *second portion* lies *beneath* it; and the *third portion* lies *below* it.

These three portions differ in their relations, and in their surgical importance. They will therefore be considered separately.

RELATIONS OF THE FIRST PORTION OF THE AXILLARY ARTERY.

In front.
Pectoralis major muscle.
Subclavius muscle.
Cephalic vein.
Costo-coracoid membrane.

Outer side.
Brachial plexus.

Axillary Artery.
1st portion.

Inner side.
Axillary vein.

Behind.
1st intercostal muscle.
1st serration of the serratus magnus.
Posterior thoracic nerve.
1st intercostal space.

The *second portion* of the axillary artery lies *behind* the pectoralis minor muscle.

RELATIONS OF THE SECOND PORTION OF AXILLARY ARTERY.

In front.
Muscles... { Pectoralis major.
Pectoralis minor.

Outer side.
Outer cord of brachial plexus.

Axillary Artery.
2nd portion.

Inner side.
Axillary vein.
Inner cord of brachial plexus.

Behind.
Subcapularis muscle.
Posterior cord of brachial plexus.

The *third portion* of the axillary artery lies *below* the pectoralis minor muscle.

RELATIONS OF THE THIRD PORTION OF THE AXILLARY ARTERY.

In front.
Pectoralis major muscle.

Outer side.
Nerves.. { Median. External cutaneous.
Coraco-brachialis muscle.

Axillary Artery.
3rd portion.

Inner side.
Nerves.. { Ulnar. Internal cutaneous.
Axillary vein.

Behind.
Muscles... { Teres major. Latissimus dorsi. Subscapularis.
Nerves.... { Musculo-spiral. 2 Circumflex.

These plans of relations show, in detail, the following anatomical facts worthy of memory.

1. The *axillary vein* lies *internal* to the artery in each of its three portions.
2. The *brachial plexus* of nerves lies to the *outer side* of the first portion, *surrounds* the second portion *with its three cords*, and *surrounds* the third portion *with its terminal branches.*
3. The *pectoralis major muscle* covers the *entire artery* on its anterior aspect.
4. The *pectoralis minor muscle* bears relation only to the *second portion* of the vessel.
5. The *cephalic vein*, which joins the axillary vein at the level of the lower margin of the deltoid muscle, is in relation only with the *first portion* of the axillary artery.

In the plan of relations of each of the three portions of the axillary artery, the individual mention of the integument and the fascia which invests the structures covering each and every portion of the vessel, have been omitted; since they must of necessity be understood to exist and since they possess no special interest.

THE AXILLARY SPACE.

The *axilla* or the *axillary space*, through which the axillary artery passes, is pyramidal in form, its apex being above and its base corresponding to the integument and fascia which binds the arm to the side of the trunk.

This space is situated between the arm and the lateral wall of the chest, and is covered in front by the pectoral muscles.

Its boundaries are as follows:

In front...	2 Muscles..	Pectoralis major.
		Pectoralis minor.
	Costo coracoid membrane.	
Behind....	3 Muscles.	Teres major.
		Latissimus dorsi.
		Subscapularis.
Internally..	The 1st, 2nd, 3rd, and 4th ribs.	
	5 Muscles.	The first four intercostals.
		Serratus magnus.
Externally.	The Humerus.	
	2 Muscles.	Coraco-brachialis.
		Biceps flexor cubiti.

The contents of this space may be enumerated in groups, before the separate relation and position of each structure is considered.

Contents of the Axillary Space.

A. 8 Arteries:.........	Axillary artery and its 7 branches	Superior thoracic.
		Acromio-thoracic.
		Thoracica longa.
		Thoracica alaris.
		Subscapular.
		External circumflex.
		Internal circumflex.
B. 9 Veins:............	Axillary.	
	Cephalic.	
	7 Veins corresponding to the arterial branches above mentioned.	
C. 16 Nerves, counting the 3 cords of the brachial plexus.....	Brachial plexus (the 3 cords).	
	12 branches of brachial plexus.....	Internal anterior thoracic.
		External anterior thoracic.
		Internal cutaneous.
		External cutaneous (musculo-cutaneous).
		Ulnar.
		Median.
		Musculo-spiral.
		Circumflex.
		3 Subscapular.
		Posterior thoracic nerve.
	Intercosto-humeral nerve.	
D. Glands:............	Numerous scattered lymphatics.	
E. Abundant fat and areolar tissue.		

Position of the various structures.

The *axillary artery and vein* and the *brachial plexus of nerves* extend, in an oblique position, along the *outer wall* of the axillary space, from its apex to its base, and are placed much nearer to the anterior wall than to the posterior.

The *vein* lies to the inner side of the artery and almost entirely conceals it.

The *thoracic branches* of the axillary artery and their accompanying veins lie close to the pectoral muscles, which form the anterior wall of the space, and the *long thoracic artery* runs close to the lower border of that muscle.

In the *back part* of the space, in contact with the lower portion of the subscapularis muscle, lie the *subscapular artery* and *vein;* and the *three subscapular nerves* are distributed to the muscles of this locality. Winding around the lower border of this muscle, the *dorsalis-scapulæ artery* (a branch of the subscapular) and its *accompanying* vein can be perceived; and, at the outer extremity of the muscle near the shoulder joint, the *posterior circumflex artery* and *vein* and the *circumflex nerve* curve backwards towards the shoulder.

Upon the *inner* or *thoracic side* of the axilla no large vessels exist, but the *posterior thoracic* and the *intercosto-humeral nerves* can be here detected. The former of these nerves supplies the serratus magnus muscle and is often called the "external respiratory nerve of Bell," since it lies external to the chest and affects inspiration, and was so named by Bell in consequence. The intercosto-humeral nerve is a branch of the second intercostal nerve which *crosses* the axillary space and descends along the inner side of the arm, to join the lesser internal cutaneous nerve.

BRANCHES OF THE AXILLARY ARTERY.

The branches of the axillary artery are *seven* in number, two of which are given off from the first portion of the vessel, two from the second portion, and three from the third portion.

These branches are as follows:

From 1*st portion*.....	(2)	Superior thoracic. Acromial thoracic.
From 2*nd portion*....	(2)	Thoracic longa. Thoracic alaris.
From 3*rd portion*....	(3) —	Subscapular. Anterior circumflex. Posterior circumflex.
Total,	7	

We thus have *four* branches (those arising from the first and second portions of the artery) which are distributed to the *muscles* of the *external* aspect of the chest; *one* large branch (the subscapular) to the *muscles* of the *shoulder;* and *two* smaller vessels (the circumflex) which supply the *shoulder joint* and the *upper portion* of the *arm.*

The *superior thoracic branch* is small in size, and arises either from the axillary artery as a direct branch, or from a trunk in common with the acromial thoracic. Its seat of origin is usually just above the upper border of the pectoralis minor muscle. It passes forwards and inwards between the pectoral muscles and is distributed to these muscles and the wall of the chest. It anastomoses with branches of the internal mammary artery, and the intercostal vessels of the first and second intercostal spaces.

The *acromial thoracic branch* arises from the anterior aspect of the axillary artery, and is a large and, by far the most constant branch of this vessel. It passes forwards at the level of the upper border of the pectoralis minor muscle, and soon divides into two sets of branches which pass in opposite directions, one going inwards to the chest wall, and the other outwards to the acromion process of the scapula. Its *thoracic branches* supply the serratus magnus and the pectoral muscles, and anastomose with the internal mammary and intercostal arteries, and with the thoracic branches of the axillary. The *acromial branches* may be divided into an ascending and a descending set. The former pass upwards to the upper surface of the acromion process, and there anastomose with branches of the supra-scapular and posterior circumflex arteries. The latter pass downwards, in company with the cephalic vein, in the interval formed between the inferior edge of the deltoid and the substance of the pectoralis major muscle, and sends branches of nutrition to both of these muscles during its descent.

The *thoracica longa* runs along the lower border of the pectoralis minor muscle in a direction forwards and inwards till the mammary gland is reached. It has been called by some anatomists the "*external mammary artery*" from this peculiarity of course and distribution. It sends branches to the serratus magnus and the pectoralis major and minor muscles, and anastomoses with the intercostals and the internal mammary arteries. It sends also branches to the lymphatic glands and the cellular tissue of the axillary space.

The *thoracica alaris* is often wanting. It is distributed, when present, to the glands and areolar tissue of the axilla. Its place is supplied, when the artery is wanting, by branches of the subscapular and the acromial and long thoracic arteries.

The SUBSCAPULAR ARTERY is the largest branch of the axillary. It arises from that vessel close to the lower border of the subscapular muscle, and is the last branch of the second portion of the axillary artery. It proceeds along the lower border of the subscapular muscle, in a direction backwards and downwards, and gives off, midway in its course, a large vessel the *dorsalis scapulæ* branch. From this point it extends, considerably diminished in size, to the inferior angle of the scapula, accompanied by the subscapular nerve. This artery supplies the subscapular, serratus magnus, teres major and latissimus dorsi muscles, and anastomoses directly with the posterior scapular branch of the transversalis colli artery.

The *dorsalis scapulæ branch* turns backwards from the subscapular artery, about one inch and a half from the point of origin of that vessel. It is larger than the direct continuation of the subscapular. It leaves the axilla through a *triangular space* bounded, above, by the teres minor; below, by the teres major; and in front, by the long head of the triceps.

Three sets of branches are then given off by the dorsalis scapulæ, one to the subscapular fossa, one to the infra-spinous fossa and one to the axillary border of the scapula.

The first set supplies the subscapular muscle and anastomoses with the posterior scapular and supra-scapular vessels. The second set (properly a continuation of the vessel itself) supplies, after winding around the axillary border of the scapula, the contents of the infra-spinous fossa; while the third or median branch runs along the axillary border of the scapula, passing between the teres major and minor muscles and anastomoses, at the inferior angle of the bone, with the posterior scapular artery.

The *circumflex arteries* are the two last branches of the axillary artery. They arise from the third portion of that vessel, below the pectoralis minor muscle close to the commencement of the brachial artery, and are called circumflex from the course which they take around the neck of the humerus. They are distinguished as anterior and posterior from the direction which they respectively take around the bone.

The *posterior circumflex artery* is the larger of the two vessels. It passes backwards immediately after its origin and winds around the humerus, lying in a quadrilateral space situated between the bone and the long head of the triceps muscle, and bounded above by the teres minor and below by the teres major muscles. It is *accompanied by the circumflex nerve.* This artery terminates within the deltoid muscle and upon the *shoulder joint.* It anastomoses with the anterior circumflex, the acromial thoracic and the supra-scapular arteries.

The *anterior circumflex artery* arises lower down than the posterior circumflex and is smaller in its size. It passes outwards and forwards under the coraco-brachialis and the inner head of the biceps muscle, and thus reaches the bicipital groove of the humerus. At this point, it usually divides into two branches, one of which passes upwards along the long head of the biceps muscle and is *distributed to the shoulder joint* and the head of the bone; while the other continues outwards in its original direction, and, after supplying the deltoid muscle, anastomoses with the posterior circumflex and the acromio thoracic vessels.

In the accompanying table is represented, in a tabulated form, the branches of the axillary artery which are given off in each of its *three portions*, as well as the *more important sub-divisions* of each.

A Table of the Branches of the Axillary Artery.

Axillary Artery. (7 branches.)	In its 1*st portion*..(2)	Superior thoracic.	
		Acromial thoracic.	Acromial branches. Thoracic branches. Humeral branches.
	In its 2*nd portion*.(3)	Thoracica longa.	
		Thoracica alaris.	
		Subscapular.	Dorsalis scapulæ.
	In its 3*rd portion*.(2)	Posterior circumflex.	
		Anterior circumflex.	
	Total, 7		

BRACHIAL ARTERY.

The brachial artery is a direct continuation of the axillary artery. It commences at the *lower border* of the *tendons* of the *teres major* and *latissimus dorsi muscles*, which form the posterior boundary of the axillary space; and divides into the radial and ulnar arteries at a point *opposite* the *neck* of the *radius*, which is situated about half an inch below the bend of the elbow.

This artery runs in a groove on the inner and anterior aspects of the arm, and its course may be represented by a line drawn from the centre of the axillary space to a point midway between the condyles of the humerus. It is in relation with the inner borders of the coraco-brachialis and biceps muscles; and the *latter muscle*, whose outlines are very distinct upon the arm, is used as an anatomical guide to the artery.

Relations.

In front of this artery, the *median nerve passes*, at about the centre of its course; since this nerve crosses from the outer to the inner side of the vessel.

Behind the artery, the superior profunda branch takes its origin and the *musculo-spiral nerve* is in intimate relation.

On the *inner side* of the artery, the *internal cutaneous nerve* and the *basilic vein* are in relation, for the greater portion of its course; while, in its *upper part*, the *ulnar nerve* is in close relation, and, in its lower part, the *median nerve* is also in close contact.

On the *outer side* of the artery, the humerus is in close relation, as well as the coraco-brachialis and biceps muscles.

At the *bend of the elbow*, the brachial artery has relations *in front*, with the median basilic vein, the anterior branches of the internal cutaneous nerve and the bicipital fascia. *Behind* the vessel, the elbow joint and the brachialis anticus muscle are perceived. On the *inner side* of the artery, the pronator radii teres muscle and the median nerve are present; while on the *outer side* of the artery, the tendon of the biceps, the supinator longus, and the musculo-cutaneous and the musculo-spiral nerves are present.

The brachial artery can be most effectually compressed at about its *centre*, since it lies in close relation to the tendon of the coraco-brachialis muscle at this point.

The relations of the brachial artery, at the bend of the elbow, are frequently designated, to assist the memory of students, by the three letters T. A. N., which represent, from without inwards, the following parts, *viz.*, 1. *Tendon* of biceps. 2. *Artery*. 3. Median *nerve*.

BRANCHES.

The branches of the brachial artery, including the two terminal branches, are *seven* in number as enumerated in the following table:

A TABLE OF THE BRANCHES OF THE BRACHIAL ARTERY.

BRACHIAL ARTERY. (7 branches.)	1	*Muscular* (coraco-brachialis, biceps, brachialis anticus.)	
	2	*Nutrient* branch to humerus.	
	3	*Superior profunda.*	
	4	*Inferior profunda.*	
	5	*Anastomotica magna.*	
	6	ULNAR. .	Terminal branches.
	7	RADIAL .	

The *muscular branches* are irregular in their number and point of origin, and are distributed to the coraco-brachialis, biceps, and brachialis anticus muscles.

The *nutrient artery* supplies the humerus with blood and enters the nutrient canal of that bone, passing *downwards* towards the elbow joint.

The *superior profunda branch* accompanies the *musculo-spiral nerve* in the groove of the same name. It gives an articular branch to the elbow joint.

The *inferior profunda branch* bears a close relation to the *ulnar nerve.*

The *anastomotica magna* forms an arch, above the olecranon fossa of the humerus, with the articular branch of the superior profunda artery.

The *last three branches* of the brachial artery, by anastomosis with each other and with recurrent branches from the vessels of the forearm, afford nutrition to the *elbow joint* and the investing structures.

If *compression of the brachial artery* is required in the upper part of the arm, the force should be directed upon the artery from within outwards ; and, if in the lower part of the arm, from before backwards. The most favorable situation, however, is near the point of insertion of the coraco-brachialis muscle.

The *lower part* of the *brachial artery*, on account of its relation to the veins most commonly opened in venesection, is of great surgical interest. The *median basilic vein*, which is the largest and most prominent, lies in *close relation* with the brachial artery, and, in case it should be selected for the operation, that portion of the vein which is not in contact with the artery, should be opened.

RADIAL ARTERY.

The radial artery is the smallest of the two terminal branches of the brachial artery, and takes its origin at a point, one-half of an inch below the bend of the elbow. It passes down along the *outer side* of the *anterior surface* of the forearm to the styloid process of the radius. It then curves around the outer side of the carpus beneath the extensor tendons of the thumb, to the upper part of the first interosseous space of the hand, where it passes between the two heads of the abductor indicis muscle ; then over the bases of the metacarpal bones, passing beneath the flexor tendons, the lumbricales muscles and the nerves of the palm of the hand, till it reaches the base of the 5th metacarpal bone, where it inosculates with the communicating branch of the ulnar artery, and thus forms the *deep palmar arch.*

The deep palmar arch lies about *a finger's breadth above* the level of the superficial palmar arch, and in making incisions in the palm of the hand for pus, it is well to remember that the superficial palmar arch lies at about the junction of the inferior and middle thirds of the palm; and that the *middle line* of the individual fingers is the *line of safety*, below the level of the arch, since the digital arteries run in the spaces between the metacarpal bones.

RELATIONS.

The relations of this artery within the forearm are principally muscular, except in the *middle third* of the artery, where the *radial nerve* lies in close relation with the *outer side of the vessel.*

The radial artery is frequently ligated in cases of wounds either of its trunk or of some of its branches or in case of aneurism. If the artery should be tied in its middle third the radial nerve and the veins which accompany the artery must be avoided.

BRANCHES.

The radial artery gives off *twelve* distinct branches; four of which are given off in the forearm; four at the back of the wrist, and four in the palm of the hand. The following table gives the names and location of these various branches.

A TABLE OF THE BRANCHES OF THE RADIAL ARTERY.

RADIAL ARTERY. (12 branches.)	In the *forearm*. (4)	Radial recurrent.	
		Muscular branches.	
		Anterior carpal.	
		Superficialis volæ.	
	At *back* of *wrist* (4)	Posterior carpal.	3rd dorsal interosseous. 4th dorsal interosseous.
		Metacarpal—or 2nd dorsal interosseus.	
		Dorsalis pollicis.	Correspond to a 1st dorsal interosseous.
		Dorsalis indicis.	
	In the *palm* of the *hand*... (4)	Princeps pollicis.	Correspond to a 1st palmar interosseous.
		Radialis indicis.	
		Perforating—(3 in number).	
	—	Deep palmar interossei—(3 or 4 in number).	
	Total, 12		

The *recurrent branch* of the radial anastomoses with the superior profunda and the interosseous recurrent arteries.

The *muscular branches* of the radial artery are distributed to the muscles on either side of it.

The *anterior carpal branch* passes beneath the deep flexor tendons, and, with the anterior carpal branch of the ulnar artery, forms an anastomosis, which gives off branches to the articulations of the carpus.

The *superficialis volæ branch* completes, by its junction with the main trunk of the ulnar artery, the *superficial palmar arch.*

The *posterior carpal branch*, by anastomosing with the posterior carpal branch of the ulnar artery, forms the *posterior carpal arch*, beneath the extensor tendons of the forearm. This arch gives off *dorsal interosseous branches* to the third and fourth spaces of the hand, which anastomose with the perforating branches of the deep palmar arch.

The *metacarpal branch* corresponds to the dorsal interosseous artery of the second space. It arises beneath the extensor tendons of the thumb.

The *dorsalis indicis* and the *dorsalis pollicis*, correspond together, to a first dorsal interosseous artery, supplying the back of the thumb and the outer side of the back of the index finger.

The *princeps pollicis* and the *radialis indicis* corresponds together, to a first palmar interosseous artery, supplying both sides of the palmar surface of the thumb and the outer side of the front part of the index finger.

The *perforating branches* of the radial artery are *three* in number and pass through the three inner interosseous spaces to anastomose with the corresponding dorsal interosseous arteries.

The *deep palmar interosseous branches* of the radial artery are usually *three* or *four* in number. They descend in front of the interosseous spaces, and, at the base of the fingers, join with the superficial palmar interosseous branches from the superficial palmar arch, and then bifurcate to form digital branches to three and a half fingers on the inner side of the hand.

ULNAR ARTERY.

The ulnar artery is the largest branch of bifurcation of the brachial artery, and arises, like the radial artery, from a point opposite the *neck of the radius* or half an inch below the bend of the elbow.

This artery is deeply situated, till it reaches the middle of the inner border of the forearm, where it becomes superficial and enters into close relation with the *ulnar nerve.* It crosses the anterior annular ligament of the wrist, on the outer side of the pisiform bone and slightly in front of the ulnar nerve. From this point the ulnar artery crosses the palm of the hand, in front of the flexor tendons and the terminal filaments of the median and ulnar nerves, and, by *joining with the superficialis volæ branch of the radial*, it forms the *superficial palmar arch.*

The *superficial palmar arch* lies on a level with the *lower border of the thumb, if abducted*, and a finger's breadth below the deep palmar arch.

BRANCHES.

The ulnar artery gives off *seven* branches as follows: In the forearm, three branches; at the wrist, two branches; in the hand, two branches.

The following table gives the name and situation of each of these seven branches.

A TABLE OF THE BRANCHES OF THE ULNAR ARTERY.

ULNAR ARTERY. (7 branches.)	In the *forearm*.	(3)	Anterior ulnar recurrent.		
			Posterior ulnar recurrent.		
			Interosseous.	Anterior.	
				Posterior..	Recurrent interosseous.
	At the *wrist*.	(2)	Anterior carpal		
			Posterior carpal.		
	In the *hand*.	(2)	Deep or communicating branch.		
			Digital (superficial palmar interossei)—usually four in number.		
	Total,	7			

The *anterior recurrent branch* of the ulnar is small, and passes between the pronator radii teres and the branchialis anticus muscle, on its way to the *elbow joint*.

The *posterior recurrent branch* of the ulnar artery is larger in size than the preceding branch, and passes beneath the flexor sublimis digitorum and flexor carpi ulnaris muscles, on its way to the *elbow joint*.

The *interosseous branch* is one inch in length and divides, at the upper border of the interosseous membrane, into two trunks called the anterior and posterior interosseous arteries.

The *anterior interosseous artery* is in close relation with the corresponding branch of the median nerve, upon the anterior surface of the interosseous membrane.

The *posterior interosseous artery* gives off an *interosseous recurrent branch*, which ascends to the elbow joint; and the main artery joins the *posterior carpal arch*, formed by the posterior carpal branches of the radial and ulnar arteries.

The anterior and posterior interosseous arteries are given off from the main trunk of the interosseous artery at a point situated about *two inches* below the elbow joint; so that in amputation of the forearm, made in the region of four inches below the joint, four arteries of medium calibre would require a ligature.

The *anterior carpal branch* of the ulnar joins, beneath the deep flexor tendons, the same branch of the radial artery.

The *posterior carpal branch* of the ulnar artery helps to form the *posterior carpal arch* beneath the extensor tendons of the forearm.

The *communicating branch* of the ulnar artery, by its junction with the main trunk of the radial artery, *completes the deep palmar arch.*

The *superficial palmar interosseous branches*, called also *digital branches*, are usually four in number, and join with the deep palmar interosseous branches which arise from the deep palmar arch. The trunks so formed divide, at the *clefts between the fingers*, to form *digital branches to three and a half fingers* on the inner side of the hand.

ARTERIES OF THE TRUNK.

THORACIC AORTA.

The aorta, at the termination of the descending portion of the arch, descends through the posterior mediastinum of the chest, curving slightly forwards and towards the right side, and passing through the aortic opening of the diaphragm, situated in front of the 12th dorsal vertebra, it becomes the abdominal aorta.

The so-called thoracic portion of the aorta exclusive of the arch which is properly a part of the thoracic aorta, may then be said to extend from the lower border of the 4th dorsal vertebra to the 12th dorsal vertebra.

Relations.

The dorsal portion of the thoracic aorta has the following relations, within the thorax.

PLAN OF THE RELATIONS OF THE THORARIC AORTA.

In front.
Left pulmonary artery.
Left bronchus.
Pericardium.
Œsophagus—(in lower portion).

Right side.
Œsophagus (above).
Vena azygos major.
Thoracic duct.

Thoracic Aorta.

Left side.
Pleura.
Left lung.
Œsophagus (below).

Behind.
Vertebral column.
Vena azygos minor.

It will be perceived that the œsophagus bears a triple relation to this vessel, being situated in front, and on the left and right sides of the artery. This seeming contradiction is due to the fact that the œsophagus *constantly alters its relation* to the thoracic aorta, on account of the curve taken by that vessel in its descent through the chest.

BRANCHES.

In the following table are enumerated the *five sets* of branches of the thoracic aorta and their points of distribution.

A TABLE OF THE BRANCHES OF THE THORACIC AORTA.

THORACIC AORTA. (5 sets of branches).

- PERICARDIAC (irregular in number and location).
- BRONCHIAL. (2)
  - Right bronchial.
  - Left bronchial.
- ŒSOPHAGEAL (four or five in number).
- POSTERIOR MEDIASTINAL (several small branches).
- AORTIC INTERCOSTALS (10 on each side).
  - *Anterior* branch.
    - Superior costal.
    - Inferior costal.
  - *Posterior* branch.
    - Muscular branches.
    - Spinal branches to spinal cord.

The *pericardiac branches* are small and irregular in their origin and number. They are distributed to the pericardium.

The *bronchial arteries* are the *nutrient vessels of the lungs*, and vary in number, size, and origin. That of the right side arises from the *first aortic intercostal;* or, by a *common trunk with the left bronchial*, from the front of the thoracic aorta. Those of the left side, *usually two in number*, arise from the *thoracic aorta*, one a little lower than the other. Each vessel is directed to the back part of the corresponding *bronchus*, along which they run, dividing and subdividing, upon the bronchial tubes ; and supplying them, the cellular tissue of the lungs, the bronchial glands, and the œsophagus.

The *œsophageal branches* are usually *four* or *five* in number and are given off from the anterior aspect of the aorta.

The *posterior mediastinal branches* are distributed to the glands and the cellular tissue of the mediastinum.

The *aortic intercostal arteries* are usually *ten* in number *upon each side* and are given off from the back of the aorta. Each intercostal artery divides into an anterior and a posterior branch.

The *anterior branch* or *proper intercostal branch* divides between the two intercostal muscles into branches, which supply the ribs.

The *posterior* or *dorsal branch* divides into *spinal* branches, which enter the intervertebral foramina and are distributed to the spinal cord and its membranes ; and *muscular* branches which are distributed to the deep muscles of the back.

ABDOMINAL AORTA.

The abdominal aorta extends from the aortic opening, in front of the 12th dorsal vertebra, to the body of the 4th lumbar vertebra, where it bifurcates into the two common iliac arteries.

In its course, it curves slightly backwards and towards the left side. Its greatest convexity corresponds to the 3d lumbar vertebra. It is about *four inches in length.*

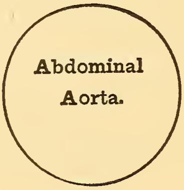
PLAN OF THE RELATIONS OF THE ABDOMINAL AORTA.

In front.

Lesser omentum and stomach.
Branches of cœliac axis and solar plexus
Splenic vein.
Pancreas.
Left renal vein.
Transverse duodenum.
Mesentery.
Aortic plexus.

Right side.

Right crus of diaphragm.
Inferior vena cava,
Vena azygos.
Thoracic duct.
Right semilunar ganglion.



Left side.

Sympathetic nerve.
Left semilunar ganglion.

Behind.

Left lumbar veins.
Receptaculum chyli.
Thoracic duct.
Vertebral column,

The abdominal aorta divides into its two terminal branches, the two common iliac arteries, opposite a point situated on the exterior of the abdomen at about *one inch and a half below the umbilicus.* This point also corresponds to the level of the highest part of the crest of the ilium.

The abdominal aorta can be compressed with the least danger to surrounding tissues and with the greatest ease, at a point situated *one inch below* and *slightly to the left of the umbilicus*, since at this point the aorta approaches nearest to the anterior wall of the abdomen.

BRANCHES.

The branches of the abdominal aorta are *twenty* in number. The following table shows the order in which these branches are given off and also the branches of distribution of each.

A TABLE OF THE BRANCHES OF THE ABDOMINAL AORTA.

ABDOMINAL AORTA. (9 branches.)

- INFERIOR PHRENIC .... (2)
  - External branches
    - Thoracic.
    - Capsular (to supra-renal capsule).
  - Internal branches.
- COELIAC AXIS......
  - Gastric (coronaria ventriculi).
  - Hepatic,..
    - Pyloric.
    - Gastro duodenalis.
      - Gastro epiploica dextra.
      - Superior pancreatico-duodenalis
    - Cystic.
  - Splenic....
    - Pancreaticæ parvæ.
    - Pancreatica magna.
    - Vasa brevia.
    - Gastro-epiploica sinistra.
- SUPERIOR MESENTERIC.........
  - Inferior pancreatico-duodenalis.
  - Vasa intestini tenuis (10 or 12).
  - Ileo-colic.
    - Ascending branch.
    - Descending branch.
  - Colica dextra.
    - Ascending branch
    - Descending branch.
  - Colica media.
- SUPRA-RENAL......... (2)
  - Right.
  - Left.
- RENAL OR EMULGENT... (2)
  - Right.
  - Left.
- SPERMATIC. (2)
  - Right............
  - Left..............
- INFERIOR MESENTERIC............
  - Colica sinistra.
    - Ascending.
    - Descending.
  - Sigmoid.
  - Superior hemorrhoidal.
- LUMBAR. (8)
  - Abdominal branches.
  - Dorsal branches....
- SACRA-MEDIA.

These twenty branches may be arranged on a *basis of their distribution* in three sets, as follows :

- I. To PARIETES OF ABDOMEN.. (11 branches)
  - Phrenics (2).
  - Lumbar (8).
  - Middle sacral (1).
- II. To ALIMENTARY CANAL..... (3 branches)
  - Coeliac axis.
  - Superior mesenteric.
  - Inferior mesenteric.
- III. To GENITO-URINARY organs. (6 branches)
  - Supra-renal (2).
  - Renal (2).
  - Spermatic (2).

Total, 20 branches.

The *inferior phrenic branches* of the abdominal aorta are two in number and are distributed to the diaphragm, the sides of the thorax and the suprarenal capsule.

The CŒLIAC AXIS springs from the aorta between the two crura of the diaphragm. It gives off three principal branches *viz.*, the gastric, the hepatic and the splenic.

The *gastric branch* supplies the lesser curvature of the stomach. It is often called coronaria ventriculi.

The *hepatic branch* gives off three specially-named arterial trunks, *viz.*, the pyloric, the gastro-duodenalis, and the cystic.

The *pyloric branch* supplies the pyloric end of the stomach.

The *gastro-duodenalis* branch of the hepatic, by dividing into two branches, whose names can be found by referring to the table of the branches of the abdominal aorta, supplies the greater curvature of the stomach and a portion of the duodenum.

The *cystic branch* of the hepatic supplies the gall bladder and the liver.

The hepatic artery bears important relations, at the *transverse fissure of the liver* with the hepatic duct and the portal vein. It will be found described more in detail in the description of that organ.

The *splenic artery*, by its four branches whose names are given in the table of the branches of the aorta, supplies the *pancreas* and the *splenic end* and *greater curvature of the stomach;* although its main distribution, as its name indicates, is to the *spleen*.

The *superior mesenteric artery* arises from the front of the aorta behind the pancreas, between which and the duodenum, it passes to be distributed between the layers of the mesentery. Its *five* branches, mentioned in the table of the branches of the abdominal aorta, are distributed to the various portions of the mesentery and to the *whole length of the small intestine*, excepting the upper part of the duodenum. It also supplies the caecum and the ascending and transverse portions of the colon. This artery assists in forming, by its colica dextra and colica media branches, the *largest anastomosis in the human body*.

The *suprarenal branch* of the aorta is distributed to the suprarenal capsula.

The *renal branches* of the aorta are two in number and are distributed to the kidneys, the ureter, and the suprarenal capsule.

The *spermatic branches* of the aorta are the *longest arteries in the body*, and, after passing through the inguinal canal, are distributed to the testicle of either side, in the male; and, in the female, to the ovaries of either side, the round ligament, and the labia.

The *inferior mesenteric artery* arises from the left side of the aorta, about two inches above bifurcation. Its *three* branches are distributed to the descending and sigmoid flexure of the colon and the rectum.

The *lumbar arteries* are four in number upon either side, and arise from the back part of the abdominal aorta. They are distributed to the parietes of the abdominal cavity.

The *middle sacral artery* arises from the abdominal aorta, at its point of bifurcation, and passes, down into the pelvis, upon the middle of the sacrum. It affords a point of anastomosis, in case of ligature of the common iliacs, with the lateral sacral arteries.

COLLATERAL CIRCULATION.

The collateral circulation, in case the abdominal aorta be tied, varies with the situation of the ligature. It is chiefly performed however by the anastomoses between the following vessels.

Internal mammary (branch of subclavian) with the *deep epigastric* (a branch of external iliac).

Lumbar arteries (branches of aorta) with *ilio-lumbar* (branch of internal iliac).

Branches of the superior mesenteric with *branches of the inferior mesenteric.*

Branches of inferior mesenteric with *branches of the internal pudic.*

ARTERIES OF THE PELVIS.

The arteries of the pelvis, as enumerated in the following table, are derived from the trunks of the two common iliac arteries, which are the branches of bifurcation of the abdominal aorta.

A TABLE OF THE ARTERIES OF THE PELVIS.

- COMMON ILIAC ARTERY.
  - EXTERNAL ILIAC. (2 branches.)
    - Deep epigastric..
      - Cremasteric.
      - Pubic.
    - Circumflex iliac.
  - INTERNAL ILIAC. (12 branches.)
    - *Anterior* trunk (9)
      - Superior vesical.
      - Middle vesical.
      - Inferior vesical.
      - Middle hemorrhoidal.
      - Uterine.
      - Vaginal.
      - OBTURATOR.
      - SCIATIC.
      - PUDIC.
    - *Posterior* trunk (3)
      - Ilio-lumbar.
      - Lateral sacral.
      - GLUTEAL.
        - Superficial.
        - Deep.

Total, 12

COMMON ILIAC ARTERY.

This artery, upon either side of the body, extends downwards and outwards, from the bifurcation of the aorta, at the left side of the 4th lumbar vertebra, to opposite the *sacro-iliac synchondrosis,* where it bifurcates into the external and internal iliac arteries. The right common iliac artery is slightly longer than the left, since the aorta lies upon the left side of the vertebral column.

The common iliac artery possesses different relations upon the right and the left side of the body, as will appear in the plan of relations pertaining to each.

PLAN OF RELATIONS OF RIGHT COMMON ILIAC ARTERY.

In front.
Peritoneum.
Small intestines.
Sympathetic nerves.
Ureter.

Right Common Iliac Artery.

Outer side.
Vena cava.
Right common iliac vein.
Psoas muscle.

Behind.
Right and left common iliac veins.

PLAN OF RELATIONS OF LEFT COMMON ILIAC ARTERY.

In front.
Peritoneum.
Sympathetic nerves.
Rectum.
Superior hemorrhoidal artery.
Ureter.

Inner side.
Left common iliac vein.

Left Common Iliac Artery.

Outer side.
Psoas muscle.

Behind,
Iliac vein.

COLLATERAL CIRCULATION.

The principal agents in carrying on the collateral circulation after the application of a ligature to the common iliac, are,

1. The anastomoses of the hemorrhoidal branches of the internal iliac with the *superior hemorrhoidal branch* of the inferior mesenteric.

2. The anastomoses of the *uterine* and *ovarian arteries*, and of the *vesical arteries* of *opposite sides.*

3. The *lateral sacral* with the *middle sacral* artery ;

4. The *epigastric artery* with the *internal mammary*, *inferior intercostal* and *lumbar arteries ;*

5. The *ilio-lumbar* with the *last lumbar* artery.

6. The *obturator artery*, by means of its pubic branch, with the *vessel of the opposite side*, and with the *internal epigastric.*

7. The *gluteal* with the *posterior branches of the sacral arteries.*

EXTERNAL ILIAC ARTERY.

This artery extends from the bifurcation of the common iliac artery, opposite to the sacro-iliac synchondrosis, *to beneath Poupart's ligameut* midway between the anterior superior spine of the ilium and the symphysis pubis, where it becomes the femoral artery.

In adult life, the external iliac artery is somewhat larger than the internal iliac, although, in the foetus, it is usually much smaller. It has the following relations within the pelvis.

PLAN OF RELATIONS OF EXTERNAL ILIAC ARTERY.

In front.
Peritoneum, intestines, and iliac fascia.

Near Poupart's Ligament.
- Spermatic vessels.
- Genito-crural nerve.
- Circumflex iliac vein.
- Lymphatic vessels and glands.

Outer side.
Psoas magnus.
Iliac fascia.

External Iliac Artery.

Inner side.
External iliac vein and vas deferens (at femoral arch.)

Behind.
External iliac vein.

BRANCHES.

This artery gives off, in its course, two branches called the epigastric and the circumflex iliac arteries.

The *epigastric artery* is larger than its accompanying branch, and arises near to Poupart's ligament, from the front of the external iliac artery. As it descends obliquely upwards and inwards in the subperitoneal areolar tissue, it passes behind the inguinal canal and to the *inner side* of the *internal abdominal ring*, and *encircles the vas deferens* in the male, and, in the female, the *round ligament*. It then ascends behind the sheath of the rectus muscle and, at its termination *anastomoses* with the *superior epigastric branch* of the internal mammary artery. The union of these two vessels establishes the *longest anastomosis in the human body*.

The *epigastric artery* gives off two branches as follows :

1. A *cremasteric branch*, which descends upon the spermatic cord, and supplies the cremaster muscle.

2. The *pubic branch*, which descends behind the pubes, on the inner side of the femoral ring, and which anastomoses with the obturator artery.

The *circumflex iliac* artery arises near Poupart's ligament, and runs upwards and outwards, along the inner lip of the crest of the ilium, to join with the gluteal artery.

Collateral Circulation.

The principal anastomoses in carrying on the collateral circulation, after the application of a ligature to the external iliac, are,

(1) The *ilio-lumbar* with the *circumflex iliac*.
(2) The *gluteal* with the *external circumflex*.
(3) The *obturator*, with the *internal circumflex*.
(4) The *sciatic* with the *profunda femoris*.
(5) The *internal pudic* with the *external pudic*, and with the *internal circumflex*.

When the obturator artery arises from the epigastric, the external iliac is supplied with blood by branches, either from the internal iliac, the lateral sacral, or from the internal pudic. The *epigastric branch* receives its supply after the external iliac is tied from the internal mammary and inferior intercostal arteries, and from the internal iliac, by the anastomoses of its branches with the obturator.

INTERNAL ILIAC ARTERY.

The internal iliac artery, one of the branches of bifurcation of the common iliac, is a short trunk, which extends from the *sacro-iliac synchondrosis* to the *upper border* of the *great sacro-sciatic foramen*, where it divides into an anterior and a posterior trunk. Its length is usually about *one and a half inches*.

PLAN OF THE RELATIONS OF THE INTERNAL ILIAC ARTERY.

In front.
Peritoneum.
Ureter.

Outer side.
Psoas magnus.

Internal Iliac Artery.

Behind.
Internal iliac vein.
Lumbo-sacral nerve.
Pyriformis muscle.

BRANCHES.

The internal iliac artery, through its two divisions, gives off *twelve* branches. These branches have been also divided into two sets, termed the *visceral* and the *non-visceral* branches. The former set include the first six branches arising from the anterior trunk, and, in addition, a hemorrhoidal branch of the pudic artery; while the latter comprise the remaining branches of the internal iliac artery.

The branches given off from the *internal iliac* artery may be again arranged, on a *basis of their distribution*, in three distinct sets as follows:

I. Those which *pass out* of the pelvis	(4)	Obturator. Gluteal. Sciatic or ischiatic. Internal pudic.
II. Those *distributed to the walls* of the pelvic cavity	(2)	Lateral sacral. Ilio-lumbar.
III. Those *distributed* to *pelvic viscera*	(6)	Vesical arterius (3). Middle hemorrhoidal. Uterine. Vaginal. } In female only.
Total,	12	

The *vesical branches* are usually three in number, and are distributed to the bladder, the prostate gland, and the vesiculæ seminales. From the superior vesical branch, a twig is given off called the *artery of the vas deferens*.

The *middle hemorrhoidal branch* joins with the superior hemorrhoidal branch of the inferior mesenteric, and with the inferior hemorrhoidal branch of the internal pudic artery.

The *uterine* branches, distributed in the folds of the broad ligament, supply the neck and body of the uterus.

The *vaginal* branch descends upon the vagina to the neck of the bladder and the rectum.

The OBTURATOR ARTERY usually arises from the anterior trunk of the internal iliac artery. It has frequent abnormalities of origin, however, which are of great surgical importance, since in some cases the operation for strangulated femoral hernia is complicated by an inevitable wounding of this artery. In one, out of *three and a half cases*, it arises as a branch of the epigastric artery; in one out of *seventy-two cases*, it arises both from the internal iliac and the epigastric arteries; while occasionally it arises from the external iliac artery. It is said to arise from the epigastric *more frequently in females* than in males.

This artery passes through the *obturator foramen*, and subsequently sends an articular branch to the hip-joint, which enters the joint through the cotyloid notch. It anastomoses with the circumflex and sciatic arteries.

The SCIATIC ARTERY is the largest of the two terminal branches of the anterior trunk of the internal iliac artery. It passes through the *great sacro-sciatic foramen*, below the pyriformis muscle, and between the great sciatic nerve and the pudic vessels and nerve. It gives off the following branches.

Muscular.	Coccygeal.	Inferior gluteal.
Articular (to hip joint).		Comes nervi ischiadici.

The PUDIC ARTERY is the smallest of the two terminal branches of the anterior division of the internal iliac artery. It descends in front of the pyriformis muscle and the sacral plexus of nerves, till it reaches the *great sacro-sciatic foramen*, through which it escapes in company with the pudic nerve. It then winds around the spine of the ischium and again enters the pelvis, in company with the pudic nerve, through the *lesser sacro-sciatic foramen*.

The *guide to the pudic artery*, as it passes over the spine of the ischium, consists of a line drawn from the posterior superior spine of the ilium to the outer side of the tuberosity of the ischium; the junction of the *middle* and the *lower thirds* of this line will be found to lie directly over this artery.

The pudic artery gives off *six branches* in the vicinity of the perineum, as follows:

PUDIC ARTERY. (6 branches.)
- Inferior hemorrhoidal.
- Superficial perineal.
- Transverse perineal.
- Artery of the bulb.
- Artery of the corpora cavernosa.
- Dorsal artery of the penis.

The inferior hemorrhoidal branches supply the lower part of the rectum and the anus, having previously crossed the ischio-rectal fossa.

The *superficial perineal branch* supplies the integument of the scrotum and labia.

The *artery of the bulb* supplies Cowper's glands and the bulb of the corpus spongiosum.

The *dorsal artery* of the penis penetrates to the suspensory ligament and supplies the integument, glans penis, and prepuce.

The ILIO-LUMBAR ARTERY arises from the posterior division of the internal iliac artery. It supplies the muscles of the lumbar and iliac regions.

The LATERAL SACRAL ARTERIES are usually two in number. They supply, through the anterior sacral foramina, the contents of the spinal canal; and, after escaping through the posterior sacral foramina, the skin and muscles on the back of the sacrum.

The GLUTEAL ARTERY is the largest branch of the internal iliac artery, and is a direct continuation of its posterior trunk. It passes through the *great sacro-sciatic foramen* above the pyriformis muscle and supplies, by its superficial and deep branch, the glutei muscles and the integument over the sacrum.

The *surgical guide to the gluteal artery*, at its point of escape, consists of a line drawn from the posterior superior spine of the ilium to the upper border of the great trochanter of the femur, when that bone is rotated inwards; the junction of the *upper* and the *middle thirds* of this line will be found to lie over this artery, as it emerges from the sciatic notch.

Collateral Circulation.

The principal agents in carrying on the circulation in the parts supplied by the internal iliac, after that artery be tied, would be

(1) The anastomosis of the *uterine* and *ovarian arteries.*

(2) The anastomosis between *opposite vesical arteries.*

(3) The *hemorrhoidal branches of the internal iliac* with those from the *inferior mesenteric.*

(4) The *obturator artery*, by means of its pubic branch, with the *vessel of the opposite side*, and with the *epigastric* and *internal circumflex.*

(5) The *circumflex* and *perforating branches of the femoral*, with the *sciatic.*

(6) The *gluteal* with the *posterior branches of the sacral arteries.*

(7) The *ilio-lumbar* with the *last lumbar.*

(8) The *lateral sacral* with the *middle sacral.*

(9) The *circumflex iliac* with the *ilio-lumbar* and *gluteal.*

G.

ARTERIES OF THE LOWER EXTREMITY.

The arteries of the lower extremity are principally derived from the femoral artery, although some of the branches of the internal iliac are distributed to the gluteal region of the hip.

FEMORAL ARTERY.

This artery commences *beneath Poupart's ligament*, being a direct continuation of the external iliac, and, passing down the front and the inner side of the thigh, terminates at the junction of the middle and lower third of the thigh, at an *opening* in the lower part of the adductor magnus muscle. It here becomes the popliteal artery.

This artery is, at first, contained in a space called *Scarpa's triangle;* and, in the middle third of the thigh, in a canal, called *Hunter's canal*, between the vastus internus and the tendons of the adductor longus and the adductor magnus muscles.

The following table illustrates the branches of the femoral artery.

A TABLE OF THE BRANCHES OF THE FEMORAL ARTERY.

FEMORAL ARTERY. (7 branches.)	SUPERFICIAL EPIGASTRIC.		
	SUPERFICIAL CIRCUMFLEX ILIAC.		
	SUPERFICIAL EXTERNAL PUDIC.		
	DEEP EXTERNAL PUDIC.		
	PROFUNDA FEMORIS.	*External circumflex.*	Ascending. Descending. Transverse.
		Internal circumflex..	Ascending. Descending. Articular.
		Perforating........	Superior. Middle. Inferior.
	MUSCULAR BRANCHES.		
	ANASTOMOTICA MAGNA..........		Superficial branch. Deep branch.

SCARPA'S SPACE.

Scarpa's triangle is bounded as follows: *Above*, by Poupart's ligament; *internally*, by the adductor longus muscle; *externally*, by the sartorius muscle. The *floor of this space* is formed, from without inwards, by the iliacus, psoas, pectineus, adductor longus, and a part of the adductor brevis muscles. This triangle contains, 1. The *femoral artery*, which runs from its base to its apex; 2. The *femoral vein*, which, at the upper part of the triangle, lies upon the *inner side* of the artery, but, lower down, upon the *posterior* aspect of the vessel; 3. The *anterior crural* and *long saphenous nerves*, which lie upon the outer side of the artery; and 4. The *internal cutaneous nerve* and *branches* of the *genito-crural nerve* which lie in front of the artery.

The *sartorius muscle* is the *main guide* to the *femoral artery*, and can be made prominent underneath the integument by instructing the patient to raise the leg.

The *direction* of the *femoral artery* can be defined upon the surface of the body by drawing a line from the centre of Poupart's ligament to the tubercle on the inner side of the femur near to the knee, to which the fibres of the adductor magnus muscle are attached.

The femoral artery lies beneath this line *for the upper two-thirds of its extent.*

Compression of the femoral artery high up in its course should be made immediately below Poupart's ligament and in a direction *upwards* and *backwards*, so as to impinge the artery against the pubes.

Compression of the femoral artery, may also be made near to the *apex* of Scarpa's triangle, and the pressure should, in this case, be directed *outwards* so as to crowd the artery against the shaft of the femur.

The incision for ligature of the femoral artery in scarpa's triangle should commence about a hand's breadth below Poupart's ligament and should be continued in a line of the artery for about three inches. By this incision the profunda femoris is avoided and the artery is tied below its branches.

BRANCHES.

The *superficial epigastric branch* passes through the *saphenous opening* and then upwards and inwards, in the superficial fascia of the abdomen.

The *superficial circumflex iliac branch* pierces the fascia lata and is distributed to the crest of the ilium.

The *superficial external pudic branch* passes through the *saphenous opening* and crosses the spermatic cord or the round ligament to reach its point of distribution, in the integument of the abdomen, scrotum, and labia.

The PROFUNDA FEMORIS branch or *deep femoral artery* is by some authors described as a branch of bifurcation of the femoral artery. It arises from the outer and back part of the femoral artery, one or two inches below Poupart's ligament; and nearly equals, in point of size, the superficial part of the femoral artery.

PLAN OF THE RELATIONS OF THE PROFUNDA ARTERY.

In front.
Femoral and profunda veins.
Adductor longus.

Outer side.
Vastus internus.

Profunda.
Femoris.

Behind.
Iliacus.
Adductor brevis.
Adductor magnus.

The branches of the profunda femoris artery are divided into three sets called respectively the external circumflex, the internal circumflex, and the perforating branches.

The *external circumflex* artery divides into an ascending, descending, and transverse branch. These three branches supply anastomotic branches to the knee, and the muscles on the *outer aspect* of the thigh.

The *internal circumflex* artery also divides into an ascending, descending, and articular branch. These three branches supply the muscles on the *inner aspect* of the thigh and the *hip-joint.*

The *perforating arteries* are usually three in number and are called the superior, middle, and inferior perforating arteries. They supply the muscles at the *back part* of the thigh. The inferior perforating artery also gives off the *nutrient branch of the femur.*

All the branches of the profunda femoris artery anastomose freely with each other as well as with the vessels of the gluteal region and some of the branches of the popliteal artery.

The MUSCULAR BRANCHES of the femoral artery are numerous, and are given off along the entire course of the vessel.

The ANASTOMOTICA MAGNA arises from the femoral artery in Hunter's canal. Its superficial branch accompanies the internal saphenous nerve to the integument of the inner side of the knee; while its deep branch anastomoses with other arteries in front of the knee.

Collateral Circulation.

After ligation of the femoral artery, the three following vessels maintain the circulation of the limb, by anastomotic channels, formed as indicated below.

External circumflex, with 3 arteries.	Gluteal. Ilio-lumbar. Circumflex iliac.
Internal circumflex, with 2 arteries.	Obturator. Sciatic.
Perforating arteries, with 1 artery.....	Comes nervi ischiadici.

POPLITEAL ARTERY.

This artery commences at an *opening* in the lower part of the *adductor magnus muscle*, and, passing downwards and outwards to the back of the knee joint and then vertically downwards It terminates at the *lower border* of the *popliteal muscle*, where it divides into the anterior and posterior tibial arteries.

Popliteal space.

This artery is contained in a lozenge-shaped space called the *popliteal space*, with the following boundaries.

Internally. The semimembranosus muscle, the inner head of gastrocnemius muscle, and the inner condyle of the femur.

Externally. The biceps muscle, the outer head of gastrocnemius muscle, the plantaris muscle, and the outer condyle of the femur.

The *floor of this space* is formed by the posterior surface of the femur, the posterior ligament of the knee joint, the popliteus muscle, and the upper part of the tibia.

This space contains the popliteal artery, popliteal vein, the internal popliteal nerve, the external popliteal nerve, the small sciatic nerve, the articular branch of the obturator nerve, the external saphenous vein, and lymphatic glands and adipose tissue.

The relations of the important parts contained within this space are as follows.

The *popliteal artery* lies *nearest to the floor*.

The *popliteal vein* lies *superficial* to the artery and slightly *external* to it.

The *internal popliteal nerve* lies *superficial* to the vein and slightly *external* to it.

The *external popliteal nerve* lies close to the tendon of the biceps muscle.

The popliteal artery bifurcates into the anterior and posterior tibial arteries, at a point situated *one inch* below the level of the tubercle of the tibia; and the peroneal artery is given off *two inches* below the tubercle. If amputation be performed, therefore, one inch below the level of the knee joint, only *one* large artery will require a ligature; if two inches below the knee, *two* large arteries will require a ligature, *viz.*, the anterior and posterior tibials; if three inches below the knee, *three* large arteries will require a ligature, *viz.*, the two tibials and the peroneal.

BRANCHES.

The following table enumerates the seven branches of the popliteal artery, which are given off within the popliteal space.

POPLITEAL ARTERY. (7 branches.)	Superior external articular.	
	Superior internal articular.	
	Inferior external articular.	
	Inferior internal articular.	
	Azygos articular.	
	Muscular branches..	Superior.
		Inferior or sural.
	Cutaneous.	

The *muscular branches* are distributed, above, to the hamstring and vasti muscles; and, below, to the gastrocmenius and plantaris muscles.

The *cutaneous branches* supply the integument of the back part of the leg.

The *superior articular branches* supply the femur, the knee-joint, and the vasti muscles.

The *azygos articular branches* pierce the posterior ligament of the knee-joint and supply its internal structures.

The *inferior articular branches*, which pass beneath the lateral ligament of the knee-joint upon either side, form an arterial anastomosis in front of the knee.

ANTERIOR TIBIAL ARTERY.

This artery arises at the bifurcation of the popliteal artery, at the *lower border* of the *popliteus muscle*, and, passing between the two heads of the tibialis posticus muscle and through an opening in the interosseous membrane, extends down the front of the leg to the *ankle-joint*, where it becomes the dorsalis pedis artery.

The *anterior tibial nerve* is, at first *external*, then *anterior*, and then *external* to this artery, in its course down the leg.

This artery has two *venæ comites*, which lie upon either side of it.

The *anterior tibial artery* corresponds in its direction with the *outer border* of the *tibialis anticus muscle*, and, if this muscle be put in action, a guide to the incision necessary to ligate this vessel will be afforded.

BRANCHES.

The anterior tibial gives off three branches as follows.

ANTERIOR TIBIAL ARTERY. (3 branches.)	Recurrent tibial,	
	Muscular branches.	
	Malleolar..	Internal. External.

The *recurrent tibial* branch is distributed to the front of the knee.

The *muscular branches* supply the muscles upon either side of the artery.

The *malleolar branches* are two in number and pass beneath the tendons at the inner and outer sides of the ankle, to anastomose with the posterior tibial, the internal plantar, the peroneal and the tarsal arteries.

DORSALIS PEDIS ARTERY.

This artery extends, as a continuation of the anterior tibial, from the *bend of the ankle*, along the tibial side of the foot, to the *back part* of the *first interosseous space*, where it divides into two branches, *viz.*, the dorsalis hallucis and the communicating.

This artery has the *anterior tibial nerve* on its *outer* side.

The course of dorsalis pedis artery may be described upon the surface of the dorsum of the foot by a line drawn from the central point in front of the ankle, to the space between the 1st and 2d metatarsal bone.

BRANCHES.

The dorsalis pedis artery gives off five branches as follows.

DORSALIS PEDIS ARTERY. (5 branches,)	Tarsal.	
	Metatarsal.	3rd, 4th and 5th interosseous.
	Dorsal artery of great toe (1st interosseous).	
	Communicating.	
	Interosseous.	

The *tarsal branches* anastomose with the metatarsal, external malleolar and external plantar arteries.

The *metatarsal* branch gives off the three outer dorsal interosseous arteries, which are joined by the anterior and posterior perforating arteries, and which supply digital branches to the dorsum of three and a half toes on the outer side of the foot.

The *dorsal artery* of the great toe corresponds to a first dorsal interosseous artery, and supplies digital branches to the dorsum of *one and a half toes* on the *inner side of the foot.*

The *communicating branch* dips downwards between the two heads of the first dorsal interosseous muscle, and, by joining with the external plantar artery *completes* the *plantar arch.* It also gives off, on the sole of the foot, digital branches *to one and a half toes* on the *inner side of the foot.*

POSTERIOR TIBIAL ARTERY.

This artery arises, as a branch of bifurcation of the popliteal artery, at the *lower border* of the *popliteus muscle.* It divides in the vicinity of the *internal malleolus*, into the two plantar arteries. The most frequent point of division into the plantar arteries may be described by a line drawn from the tip of the internal malleolus to the middle of the convexity of the heel, which will intersect the artery at its point of bifurcation ; and any variations from this point are usually below rather than above the level of this line.

The *internal popliteal nerve* is, at first, *posterior* and *internal* to the artery, but it soon crosses to its *outer* side.

The direction of the *posterior tibial artery* may be indicated by a line drawn from the central point of the upper part of the calf to a point behind the ankle and one half inch posterior to the tibia, where the artery can often be felt to pulsate.

BRANCHES.

The posterior tibial artery gives off *seven* branches, including its two terminal trunks, as is shown in the following table.

POSTERIOR TIBIAL ARTERY. (7 branches.)	Peroneal.	Muscular.
		Nutrient to fibula.
		Communicating with post tibial.
		Anterior peroneal.
	Muscular branches.	
	Nutrient to tibia.	
	Communicating to peroneal.	
	Internal calcanean.	
	INTERNAL PLANTAR.	Terminal branches.
	EXTERNAL PLANTAR.	

The PERONEAL branch is given off about one inch below the lower border of the popliteus muscle, and it extends to the outer side of the os-calcis, where it joins with the external malleolar and the external plantar arteries. It supplies the soleus, the three peronei, and the muscles of the deep layer of the leg. It also gives off a *nutrient artery to the fibula*, a communicating branch to the posterior tibial artery, and a large branch, called the *anterior* *perineal artery*, which anastomoses, at the outer side of the tarsus, with the external malleolar and tarsal arteries.

The *muscular branches* of the posterior tibial artery are distributed to the soleus and the deep layer of muscles.

The *nutrient artery* of the tibia is *very large* and runs towards the ankle.

The *internal calcanean* branches supply the integument about the heel and the fat about the tendo Achillis. They are also distributed to the muscles on the inner side of the sole of the foot. They are occasionally derived from the external plantar artery.

PLANTAR ARTERIES.

The plantar arteries are branches of bifurcation of the posterior tibial vessel.

The INTERNAL PLANTAR artery is the smallest of the two, and ends, at the *extremity* of the *first metacarpal bone*, in a small branch which runs along the inner border at the great toe.

The EXTERNAL PLANTAR artery passes at first outwards, and then forwards, upon the sole of the foot, as far as the base of the 5th metatarsal bone. It then turns obliquely inwards to the interval between the bases of the 1st and 2d metatarsal bone, where it joins with the *communicating branch* from the dorsalis pedis artery, and thus *completes the plantar arch.*

The first portion of the course of the external plantar artery may be described, upon the sole of the foot, by a line drawn from the hollow behind the inner malleolus to the base of the 5th metatarsal bone; but, from this point, its course runs transversely across the sole of the foot, where it lies in relation with the bases of the metatarsal bones.

BRANCHES.

The external plantar artery gives off two sets of branches, which comprise ten vessels as shown in the following table.

EXTERNAL PLANTAR. (2 sets of branches.)	3 *Posterior perforating.*	
	7 *Digital..*	4 plantar interosseous branches.
		3 anterior perforating.
Total,	10	

The *posterior perforating* branches pass through the *back part* of the *three outer interosseous spaces*, and anastomose with the dorsal interosseous branches of the metatarsal artery.

The *digital branches* are divided into two sets, as is shown in the table above.

The *plantar interosseous arteries* supply digital branches to the plantar surface of *three and a half toes on the outer side* of the foot.

The *anterior perforating arteries* pass through the *front part* of the *outer three interosseous spaces*, and, like the posterior perforating, join with the dorsal interosseous branches of the metatarsal artery.

THE VEINS OF THE BODY.

The system of veins which accompany the arteries of the various portions of the body, are in many instances given the same name as the artery which they accompany, thus rendering a separate description of them unnecessary; while, with others, their points of origin are too irregular to admit of any positive statements concerning them. Certain venous trunks possess a greater importance than others, since either from their situation, their tributaries, or their relation to other parts, they are associated with points of practical interest and value.

Some veins unlike the arteries contain *valves* in their interior, which consist of pouches adherent to their walls, and which tend, when present, to prevent the backward flow of blood, when the circulation is in opposition to gravity. We therefore fail to find them in the larger venous trunks, where the circulation, if in opposition to gravity, is assisted greatly by the vacuum created within the thorax during the act of inspiration; and in certain veins, where the current of blood is accelerated by gravity, as in the neck, Nature, no longer requiring these valves as a protective measure, has omitted them either entirely or in part.

Veins admit of a three-fold division, *viz.*, into superficial veins, deep veins, and sinuses.

The *superficial veins* return the blood from the integument and the superficial structures of the body, and take their course, as a rule, between the layers of superficial fascia, until they reach convenient situations for their termination in the deep veins. Since they are usually unaccompanied by arteries, they are the ones selected as a rule, for *venesection.*

The *deep veins* are usually enclosed, in the limbs, in the sheath of some large artery which they accompany; but, if the accompanying artery be of secondary calibre, these deep veins are usually placed upon either side of the artery and are termed *venæ comites.*

Sinuses differ from veins in their structure and mode of distribution and are confined to special organs, within whose substance or their investing coverings they are usually situated.

Veins communicate with each other more frequently than arteries, both in the larger and the smaller trunks; thus the *venæ comites* constantly communicate, in their course, by transverse branches, which cross the artery; and the various venous plexuses of the body afford another striking example of the tendency of veins towards frequent anastomosis. This tendency to frequent communication has been explained, as an effort on the part of nature to obviate the obstructions to which the veins are particularly liable, from the thinness of their coats; and also on account of their inability to overcome any impediment, from the weak force of their current.

The veins, like the arteries, have walls composed of three distinct coats.

The *internal coat* resembles that of the arteries and is serous in character.

The *middle coat* has less muscular fibre in its structure than exists in the arteries; and is also much thinner than in arteries of corresponding calibre.

The *external coat* is composed chiefly of connective tissue and longitudinal elastic fibres.

In the *large veins connected with the heart*, *viz.*, the venæ cavæ and the four pulmonary veins, the muscular fibres of that organ are continued for some distance in their walls.

The circulation within the venous system is due partly to the *pressure transmitted from the arteries;* partly to *muscular pressure* aided by the valves; partly to *gravity*, especially in the veins of the head, neck and thorax; and partly to the *suction created* by the *vacuum* formed within the pleural and pericardial sacs during inspiration.

TABLE OF THE CHIEF VEINS OF THE HEAD AND NECK.

THE INNOMINATE VEIN is formed by the union of......

- INTERNAL JUGULAR vein.
  - 1. Lateral sinus.
    - Superior longitudinal sinus.
    - Inferior longitudinal sinus.
    - Straight sinus.
    - Occipital sinuses.
    - Ophthalmic vein.
    - Superior petrosal sinus.
    - Inferior petrosal sinus.
  - 2. Ascending pharyngeal.
    - Meningeal veins.
    - Pharyngeal veins.
  - 3. Lingual.....
    - Superficial dorsal.
    - Lingual.
    - Ranine.
  - 4. Facial.......
    - Angular ....
      - Supraorbital.
      - Frontal.
      - Palpebral.
      - Nasal.
    - Inferior palpebral.
    - Dorsal and lateral. Nasal veins.
    - Anterior internal maxillary.
      - Alveolar branches.
      - Infraorbital.
      - Descending palatine.
      - Naso-palatine.
      - Vidian.
    - Coronary.............
      - Superior.
      - Inferior
    - Buccal.
    - Masseteric.
    - Labial.
    - Submental.
    - Inferior palatine.
    - Tonsillar.
    - Glandular.
  - 5. Occipital....
    - Mastoid vein.
    - Cervical.
  - 6. Superior thyroid.
    - Thyroid.
    - Laryngeal.
  - 7. Middle thyroid.
- SUBCLAVIAN vein.
  - 1. Vertebral....
    - Spinal.
    - Deep cervical.
    - Ascending cervical.
  - 2. External jugular.
    - 1. Internal maxillary.
      - Middle meningeal.
      - Inferior dental.
      - Deep temporal.
      - Pterygoid.
      - Masseteric.
    - 2. Temporal.........
      - Anterior.
      - Posterior.
      - Middle temporal.
      - Parotid.
      - Anterior auricular.
      - Transverse facial.
    - 4. Posterior auricular.
      - Auricular.
      - Stylo-mastoid.
    - 4. Branch to the internal jugular.
    - 5. Supra-scapular....
      - Supra-spinal.
      - Infra-spinal.
    - 6. Transverse cervical.
      - Superficial cervical.
      - Posterior scapular.
  - 3. Anterior jugular.

SINUSES OF THE DURA MATER.

The sinuses of the skull are channels, formed by the dura mater, for the transmission of blood, although their inner coat is formed by a continuation of the inner or serous coat of the veins. They are *fifteen* in number and may be divided as follows:

Single Sinuses ....(5)	Superior longitudinal sinus. Inferior longitudinal sinus. Straight sinus. Circular sinus. Transverse sinus.
Pairs of Sinuses.....(5)	Occipital sinuses. Lateral sinuses. Cavernous sinuses. Superior petrosal sinuses. Inferior petrosal sinuses.

The *superior longitudinal sinus* commences at the foramen cœcum, through which it frequently communicates with the veins of the nose and with a vein from the frontal sinus, and runs backwards along the upper margin of the falx cerebri, till it reaches the torcular Herophili. It receives the superficial veins of the convexity of the hemispheres, and veins from the diplœ and the dura mater; and also the parietal veins from the pericranium, at the posterior extremity of the sagittal suture.

The situation of the superior and inferior longitudinal sinuses of the dura mater may be represented upon the external portion of the cranium by a line drawn over the middle line of the convexity of the skull from the *root of the nose* to the *external occipital protuberance*.

The *inferior longitudinal sinus* runs along the *free margin* of the falx cerebri and opens into the anterior extremity of the *straight sinus*, behind the venæ Galeni.

The *straight sinus* runs downwards and backwards along the line of junction of the falx cerebri with the tentorium cerebelli and opens into the torcular Herophili. It receives blood from the venæ Galeni, the inferior longitudinal sinus, the inferior median cerebral vein, and the superior cerebellar veins.

The *circular sinus* is enclosed in a ring of dura mater, which surrounds the pituitary body. Its posterior half is larger in calibre than its anterior.

The *transverse sinus* crosses the basilar groove and connects the two *cavernous* and *inferior petrosal* sinuses of either side. It is sometimes double.

The *occipital sinuses* are contained in the falx cerebelli, and, passing backwards and upwards from the posterior border of the foramen magnum, they open into the torcular Herophili.

The *lateral sinuses* commence at the torcular Herophili and pass outwards, upon either side of this cavity, in the posterior attached margin of the tentorium cerebelli to the base of the petrous portion of the temporal bone; they then curve downwards and inwards in a groove in the mastoid portion of the temporal bone, and also in the occipital bone, and terminate, at the *jugular foramen*, in the internal jugular vein. These sinuses receive blood from the *cavernous sinus*, through the superior and inferior petrosal sinuses, and, from the inferior cerebral and the inferior cerebellar veins, and, occasionally, from some veins of the diploë.

The course of the greater part of the lateral sinuses of the dura mater corresponds to a line drawn upon the external portion of the skull from the external occipital protuberance to the anterior border of the mastoid process.

The *cavernous sinuses* are large and short. They extend, on either side of the sella turcica, from the sphenoidal fissure to the apex of the petrous portion of the temporal bone. They *communicate with each other*, through the circular and transverse sinuses, and, with the *lateral sinuses*, by the two petrosal sinuses. In the *inner wall* of this sinus, separated from the blood by the lining membrane of the sinus, are the following structures, *viz.* The *internal carotid artery*, the 6*th nerve*, the *carotid* and *cavernous plexuses* of the sympathetic system. In the *outer wall* of this sinus, are enclosed the following structures, in their order from above downwards and from without inwards; *viz.*, the *third*, the *fourth*, and the *ophthalmic nerves.*

The *superior petrosal sinuses* extend along the upper border of the petrous portion of the temporal bone, and are enclosed by the tentorium cerebelli. They serve to connect the cavernous and the lateral sinuses of the same side.

The *inferior petrosal* sinuses lie in a groove in the *petro-occipital suture* of the skull, and serve to connect the cavernous sinus of either side with the points of termination of the lateral sinuses, in the jugular foramina.

The EXTERNAL JUGULAR vein commences in the substance of the parotid gland and descends down the neck superficially, to open into the subclavian vein. It has *two valves*, one situated at its point of termination, the other about an inch and a half above the clavicle.

The external jugular vein is the *chief superficial vein* of the neck and it is rendered prominent by putting the sterno-mastoid muscle into action, or by anything creating pressure upon the lower end of the vein, which corresponds with the middle of the clavicle.

The INTERNAL JUGULAR vein is a continuation of the *lateral sinus* of the skull. It extends from the *jugular foramen*, downwards, to the subclavian vein, where it has *one pair of valves.* This vein is in relation with the internal carotid artery and the common carotid artery, being contained in the sheath of the latter vessel, and also with the 9th, 10th, 11th and 12th pairs of cranial nerves (according to the classification of Sœmmering).

The RIGHT INNOMINATE vein is an *inch and a half* in length, is smaller than that of the left side, and is nearly vertical in direction. It is separated from the right lung by the pleura and the right phrenic nerve. It joins the left innominate vein, below the *cartilage of the first rib*, to form the superior vena cava.

The LEFT INNOMINATE vein is *three inches* in length, and decends obliquely from the left *sterno-clavicular articulation* to its point of junction with the right innominate vein.

The SUPERIOR VENA CAVA is a thick trunk, about *three inches* in length, which enters the pericardial sac, about an inch and a half above the heart, and terminates at the *upper* and *front part* of the *right auricle.* It has no valves.

The INFERIOR VENA CAVA is formed by the junction of the two common iliac veins, at the *right side of and between the 4th and 5th lumbar vertebræ.* It lies on the right side of the abdominal aorta and passes behind the border of the mesentery, the transverse portion of the duodenum, the pancreas, and the portal vein. It is also lodged in a groove in the posterior border of the liver, where the *hepatic veins* join it. It perforates the *central* tendon of the diaphragm and thus enters the pericardial sac; and subsequently terminates at the *lower* and *back part* of the *right auricle* of the heart. Its length is about *eight inches.*

THE AZYGOS VEINS.

These veins serve as a *connecting link* between the *superior* and *inferior venæ cavæ.* They also collect the blood from the intercostal spaces. They are *three* in number, and are called as follows.

VENA AZYGOS MAJOR, or RIGHT AZYGOS.
VENA AZYGOS MINOR, or LEFT LOWER AZYGOS.
LEFT SUPERIOR AZYGOS.

The *right vena azygos* arises either from the lumbar vein, the inferior vena cava, or the right renal vein. It passes through the *aortic opening* of the *diaphragm*, and here lies upon the right side of the thoracic duct, and behind and to the right of the aorta. It empties into the *superior vena cava*, on a level with the 3d dorsal vertebra, having previously received the ten lower intercostal veins of the right side, the vena azygos minor, the right bronchial vein, and several small œsophageal, mediastinal and spinal veins.

The *vena azygos minor* arises either from the left lumbar vein or from the left renal vein. It leaves the abdominal cavity through an opening in the *left crus* of the *diaphragm*, and, having collected the blood of the five lower intercostal veins of the left side, and some small mediastinal, œsophageal, and spinal veins, it crosses the spinal column behind the aorta and the thoracic duct and opens into the vena azygos major, on a level with the 6th dorsal vertebra.

The *left superior azygos vein* collects the blood from the upper intercostal veins of the left side, and terminates in the vena azygos major. It may be absent.

PORTAL SYSTEM OF VEINS.

The portal vein, which carries blood to the transverse fissure of the liver, is formed by the junction of four large veins, *viz.:*

Gastric vein.
Splenic vein.
Superior mesenteric vein.
Inferior mesenteric vein.

The *gastric vein* empties the blood of the stomach either into the main portal trunk or into the right branch of the portal vein.

The *splenic vein* arises by five or six branches, which emerge from the hilum of the spleen; and it also receives blood from the veins which correspond to the branches of the splenic artery.

The *superior mesenteric vein* receives blood from those veins which correspond to the branches of the artery of the same name.

The *inferior mesenteric vein* also receives, as tributaries, veins corresponding to the branches of the artery of the same name. This vein affords an outlet, in the rectum, for portal blood, in case of portal obstruction.

The portal system will be considered, in detail, under the description of the liver.

VEINS OF THE PELVIS.

The veins of the pelvis include the internal iliac veins and those veins which correspond to the branches of the artery of the same name, with the exception of the umbilical arteries. These veins may be enumerated as follows:

INTERNAL ILIAC (11 tributaries.)	*Visceral* branches	Hemorrhoidal.
		Vesical.
		Prostatic.
		Uterine.
		Vaginal.
	Non-visceral branches	Obturator.
		Sciatic.
		Pudic.
		Ilio-lumbar.
		Lateral sacral.
		Gluteal.

The *hemorrhoidal veins*, as before mentioned, are of special importance, since they afford a *point of communication between the portal system of veins and the general system of veins.*

The *vesical* and the *prostatic veins* often join together to form a single vein, called the *vesico-prostatic vein.*

The other veins, enumerated in the table, follow the course of the arteries of the same name.

VEINS OF THE UPPER EXTREMITY.

The veins of the upper extremity consist of a superficial and a deep set. The two sets include the following veins.

SUPERFICIAL VEINS. (8)	Radial.
	Anterior ulnar.
	Posterior ulnar.
	Median.
	Median cephalic.
	Median basilic.
	Cephalic.
	Basilic.
DEEP VEINS. (2)	Axillary vein.
	Subclavian vein.

In addition to the deep veins above mentioned, there are *venæ comites* to each of the arteries, except the axillary and the subclavian.

Many of the veins included in the superficial and the deep sets of the upper extremity, require no special consideration, as their name indicates their situation.

The relation of the *median cephalic* and the *median basilic veins* to the *brachial artery*, at the bend of the elbow, give to these veins a surgical importance, as venesection is most often performed in this locality.

The *cephalic vein* ascends the arm in a groove at the outer side of the biceps muscle, and ends in the axillary vein, between the coracoid process of the scapula and the clavicle. It has one pair of valves at its point of termination.

The *basilic vein* ascends the arm in a groove at the inner side of the biceps muscle, and terminates in the axillary vein, with which it is continuous.

The *axillary vein* corresponds, in its situation and length, with the artery of the same name. It lies upon the *inner side* of this vessel.

The *subclavian vein*, which is the direct continuation of the axillary vein, also corresponds, in length and direction, with the artery of the same name. Its relations to the artery, however, are slightly different in the three portions of that vessel, but it lies, as a rule, *in front* of the artery and on a plane *below* it. It receives, in addition to the blood from the arm, the contents of the *external*, the *internal*, and the *anterior jugular veins*.

VEINS OF THE LOWER EXTREMITY.

The veins of the lower extremity consist of a superficial and a deep set. These two sets include the following veins:

SUPERFICIAL VEINS..(2)	External or short saphenous. Internal or long saphenous.
DEEP VEINS........(3)	Popliteal. Femoral. External iliac.

The *short saphenous vein* extends from the outer side of the dorsum of the foot and opens into the *popliteal vein*. It has two valves, near to its point of termination.

The *long saphenous vein* extends from the inner side of the dorsum of the foot and opens into the *femoral vein*, at a point about one and a half inches below Poupart's ligament. This vein accompanies the long saphenous nerve, for the greater portion of its course, and contains from two to six valves, which are most abundant in the thigh.

The *popliteal vein* lies superficial and external to the artery of the same name. It receives the blood from the short saphenous vein, and the venæ comites of the arteries of the leg.

The *femoral vein* lies *posteriorly* to the artery, in Hunter's canal, but reaches the *inner side* of that vessel, in Scarpa's space.

It receives the blood from the long saphenous vein as well as from those veins, which correspond to the branches of the artery of the same name.

The *external iliac vein* differs, in its relation to the artery of the same name, upon the two sides of the body. It receives the blood of the epigastric and circumflex iliac veins, and joins with the internal iliac vein to form the common iliac veins. Its points of surgical interest will be found under the description of the external iliac artery.

THE LYMPHATIC SYSTEM.

The lymphatic system of the body possesses the property of absorbing certain materials from the tissues and conveying them into the circulation. The name "lymphatics" was originally applied to these vessels from the appearance of the fluid which is contained within them, which has a resemblance to water (*lympha*, water).

The lymphatic system includes various glands, called lymphatic glands, through which the lymphatic vessels pass; also innumerable small lymphatic vessels, which are scattered throughout every part of the body; and, finally, the lacteal vessels, which are the lymphatic vessels of the small intestines, but to which the name *lacteals* was applied, from the fact that they contained a milky fluid after or during the process of digestion. These lacteal vessels also pass through glands, called *mesenteric glands*, and finally, empty their contents, through the thoracic duct, into the subclavian vein of the left side.

The *coats* of the lymphatic vessels are delicate and nearly transparent, and the fluid, contained within them, can be readily perceived through their walls. They contain a few valves, which are located regularly along their course, and which give to the lymphatic vessels an occasionally beaded appearance.

In almost all portions of the body the lymphatic vessels are arranged in a *superficial* and a *deep* set, the former of which lie either near the integument or in the submucous tissue, while the latter lie in close relation to the larger blood-vessels, and, although fewer in number, are individually of larger size than those of the superficial set. These two sets, however, frequently communicate with each other, and, in their total aggregate, vastly exceed the veins in number, but as a rule are much smaller in size.

Certain structures in the body are said to be destitute of lymphatics, among which may be mentioned, the substance of the brain and spinal cord, the tendons of muscles, cartilage, the eye, the nails, the hair, the placenta, and the umbilical cord.

The *lymphatic glands*, called also *conglobate glands*, are usually of a pinkish gray color, to which rule there are but few exceptions, and are situated in the course of the lymphatic and lacteal vessels. They usually have a hilus along one border and are divided into a cortical and medullary portion; the latter occupying the centre of the gland except at the hilus, where it becomes superficially situated. The vessel which supplies the gland, previous to its entrance, divides into branches, which are called the *afferent vessels* of the gland, and the vessels which escape from the glands are called the *efferent vessels.* Within the gland the lymphatics form a plexus and are much thinner than elsewhere, since they lose their external coat, which becomes continuous with the capsule of the gland.

The largest vessels of the lymphatic system are known as the thoracic duct and the right lymphatic duct.

The THORACIC DUCT commences in a dilated pouch, called the *receptaculum chyli*, which lies in front of the 2d lumbar vertebra, behind the aorta and between it and the vena azygos major. It receives the trunks of all lacteal vessels and four or five large trunks, from the lumbar lymphatic glands. It passes through the *aortic opening* of the diaphragm, and, in its course through the chest, is situated behind the œsophagus, and for a portion of its course, between the aorta and the vena azygos major. On a level with the 4th dorsal vertebra, it inclines towards the left side of the body and passes behind the arch of the aorta and the first portion of the left subclavian artery. On a level with the 7th cervical vertebra, it arches forwards above the pleura and in front of the scalenus anticus muscle, and opens into the angle of junction of the left internal jugular and the left subclavian veins, which opening is guarded by a pair of valves. Throughout its course it contains valves which give it, at intervals, a constricted appearance, and it also varies in its size, being largest at its upper and lower portions. It is the common trunk of all the lymphatics of the body, excepting those of the right side of the head, neck, and thorax, and the right upper limb, right lung, right side of the heart, and part of the convex surface of the liver. It is about sixteen and a half inches long.

The RIGHT LYMPHATIC DUCT is a short thick trunk, about one line and a half in diameter, and about *one inch in length*, which collects the lymph from those portions of the body, which are unconnected with the thoracic duct. It opens into the angle of junction between the right internal jugular and the right subclavian veins, this opening being also guarded, as on the left side of the body, by a pair of valves.

The *lymphatics of the head and neck* consist of superficial and deep lymphatic vessels and superficial and deep lymphatic glands. The important vessels accompany the larger arterial trunks of the head and neck, while the glands are principally situated in the lateral regions of the neck and in the vicinity of the base of the skull and the angle of the lower jaw.

The *lymphatics of the thorax* may be divided into those situated upon the walls of the chest and those connected with the viscera. The *parietal* set are arranged, as in other portions of the body, into a superficial and a deep layer of lymphatic glands and vessels; while the *visceral* lymphatics are connected with the lungs and bronchi, the heart, the œsophagus, and the thymus gland.

The *lymphatics* of the *upper extremity* comprise a superficial and a deep layer of lymphatic vessels and a superficial and a deep layer of lymphatic glands. The superficial layer of lymphatic vessels are more numerous upon the inner than upon the outer side of the arm; while the deep layer of vessels accompany the larger arteries of the forearm and of the arm, and open into the glands of the axilla and the subclavian region.

The lymphatic glands of the upper extremity comprise two or three small superficial glands, in the vicinity of the inner condyle of the humerus, and a chain of deep lymphatic glands, which are most abundant in the vicinity of the brachial, axillary, and, subclavian arteries.

The *lymphatics of the abdomen*, like those of the chest, comprise a parietal set and a visceral set. The *parietal* set are situated in the hypogastric, lumbar, and epigastric regions, and accompany the epigastric, the circumflex iliac, and the lumbar arteries. The *visceral* set are connected with the following organs: 1. principally with the *intestine*, where they number over one hundred, and are called the *mesenteric glands;* 2. with the *liver*, where they are arranged upon its upper surface, its under surface, and in the portal canals; 3. in the *stomach*, where they are placed beneath the peritoneum and also in the submucous coat; 4. in the *spleen*, where they form a superficial and a deep set; and 5. in the *kidney*, where a superficial and deep set is also present.

The *lymphatics of the pelvic cavity* consist of glands and lymphatic vessels. The vessels are distributed over the entire surfaces of the various organs of the pelvis, while the glands form chains upon the external and internal iliac arteries, and are also present in large numbers upon the sacrum and in front of the lumbar vertebrae.

The *lymphatics of the lower extremity* comprise a superficial and a deep set of vessels, and a superficial and a deep set of glands. The superficial lymphatic vessels arise from the integument of the foot and terminate either in the lymphatic glands of the groin or of the popliteal space; while the deep set of lymphatic vessels accompany the tibial and peroneal arteries in the leg, and the gluteal and sciatic vessels in the upper portion of the thigh. The efferent vessels of the popliteal glands accompany the femoral artery.

The *superficial lymphatic glands* of the lower extremity are nine or ten in number, and are situated in the vicinity of Poupart's ligament and the upper portion of the saphenous vein ; while the *deep set* of *lymphatic glands* are chiefly distributed along the anterior tibial, the popliteal, the gluteal, and the sciatic arteries, while a few small glands accompany the femoral artery and communicate, through the saphenous opening, with the superficial set.

NEUROLOGY.

NEUROLOGY.

Nerve tissue consists of two varieties, *viz.*, grey and white matter. The *grey matter* is found principally in the *nerve centres* and in the various *ganglia.*

By some anatomists the nerve tissue, found in the sympathetic system of nerves, is considered as a separate form, and is called *gelatinous nerve tissue.*

The *grey nerve tissue* is often called the *vesicular* nervous substance, as it consists of vesicles, called *nerve corpuscles*, imbedded in a fine granular substance.

The *white nerve tissue* is also called the *fibrous* or *tubular* nerve substance, since it exists in the form of nerve fibres.

Each nerve is a bundle of nerve fibres bound together in a sheath, formed of connective tissue and called the *perineurium.* Each of the primitive nerve fibres are also enclosed in a sheath, which is more delicate than the perineurium and which is termed the *neurilemma* or *epineurium.*

NERVES are divided, on a basis of their distribution, into those of *animal life* and those of *organic life.* The former subserve the higher functions of special sense, volition, sensation, etc.; while the latter control nutrition and growth.

The nervous system of *animal life* consists of two principal parts, as follows:

1. A *central portion*, called the CEREBRO-SPINAL AXIS.
2. A *peripheral portion*, called NERVES, GANGLIA, ETC.

CEREBRO-SPINAL AXIS.

This portion of the nervous system is, conventionally, divided into five parts, namely:

THE CEREBRUM.
THE CEREBELLUM.
THE PONS VAROLII.
THE MEDULLA OBLONGATA.
THE SPINAL CORD.

Of these five parts, which make up the cerebro-spinal axis, *the first four* are contained within the *cavity of the cranium, viz.:* the cerebrum, cerebellum, pons Varolii, and medulla oblongata; and, when taken collectively, are called the *encephalon* or *brain.*

The *encephalon* extends to the upper border of the atlas or 1st cervical vertebra, at which point it becomes continuous with the spinal cord.

The *spinal cord* extends from the plane of the upper border of the atlas to the lower part of the 1st, or the upper part of the 2nd lumbar vertebra, where it becomes divided into a bundle of nerves, called, from their resemblance to a horse's tail, the *cauda equina*, and terminates in a slender filament, called the *filum terminale* or *central ligament* of the spinal cord.

The nerves, which proceed from the cerebro-spinal axis, are 43 in number, and are symmetrically arranged upon either side of the body. They may be divided as follows:

A. CRANIAL NERVES	Twelve pairs	12	pairs.
B. SPINAL NERVES. (31 pairs.)	Cervical	8	"
	Dorsal	12	"
	Lumbar	5	"
	Sacral	5	"
	Coccygeal	1	"
	Total,	43	"

A *cerebral* or *cranial nerve* is one which arises from some portion of the cerebro-spinal axis, and *which passes through one or more foramina of the cranium.* They are named, in numerical order, from before backwards, in the order in which they escape from the base of the cranium.

The term *cerebro-spinal nerve*, is applied to any nerve, which arises from *any portion of the cerebro-spinal axis;* and is used in contra-distinction to the nerves derived from the sympathetic system of the body.

Each of the nerve filaments of the cerebro-spinal system, excepting in the substance of the brain and the spinal cord, is composed of the following parts:

A *sheath*, called the *neurilemma* or *epineurium.*

A *central portion*, called the *axis cylinder*, which is composed of grey nerve matter.

An *investing substance* of a whitish color, called the " white substance of Schwann," which is situated between the neurilemma and the axis-cylinder. This substance is not always present. It is often called the *medullary sheath*, and also the *endoneurium* of the nerve.

The small isolated spots on cerebro-spinal nerves where the white substance of Schwann is wanting, are called *nodes of Ranvier*. In the olfactory nerves, although belonging to the cerebro-spinal system, the white substance of Schwann is absent throughout their entire extent.

The *sensory nerves* of the cerebro-spinal axis are found to terminate in one of four ways, as follows:

In plexuses.
In end-bulbs.
In tactile corpuscles.
In Pacinian bodies.

The *motor nerves* terminate in small expansions within the muscles termed *motorial end-plates.*

The *nerves* of the *sympathetic system*, on the other hand, are distinguished from cerebro-spinal nerves by their reddish grey color, their smaller size, and their softer consistence.

Cerebro-spinal nerves are divided into two great classes, on a basis of their function, called respectively the *motor* and the *sensory* nerves. To the *latter* class, collections of grey nerve matter, called *ganglia*, are often attached.

Membranes.

The coverings of the brain and the spinal cord are three in number and are called,

1st. The dura mater.
2nd. The pia mater.
3rd. The arachnoid.

The *dura mater* is a thick, dense, fibrous membrane, which is lined, internally, by the parietal layer of the arachnoid. It serves, in the cranium, the following purposes:

1. It acts as a *periosteal covering* to the interior of the *skull.*
2. It *protects the brain* from possible injury, especially in early life, when the bones of the cranium are separate and imperfectly formed.
3. It *supports the principal divisions of the encephalon* by forming *septa*, which are lodged between its different portions.
4. It assists in forming *venous sinuses.*
5. It furnishes *sheaths of protection* for *nerves.*

The dura mater of the brain differs from that of the spinal cord, in not performing the *first*, *third*, and *fourth* of the above-mentioned functions.

These reflections or septa formed by the dura mater of the brain are called,

1. The falx cerebri.
2. The falx cerebelli.
3. The tentorium cerebelli.

The arachnoid is, like all serous membranes, a shut sac which serves the purpose of *lubrication* and which invests the cerebro-spinal axis. The surface which invests the organs is called the visceral layer, while the surface which lines the dura mater is called the parietal layer.

Between the visceral layer of the arachnoid and the pia mater, a cavity exists called the *subarachnoidean space*, which usually communicates with the general ventricular cavity in the brain substance, through an opening in the floor of the 4th ventricle. This space is most extensively developed at the base of the brain and around the spinal cord. It contains the *cerebro-spinal fluid.*

The *pia mater* is a delicate vascular membrane which invests the brain and spinal cord, and whose function is that of *nutrition.* It is everywhere intimately adherent to the nerve substance, and, at the *transverse fissure of the brain*, it penetrates into the ventricular cavities of that organ and forms the *choroid plexuses* and the *velum interpositum.*

The *pia mater of the spinal cord* differs from that which invests the brain, in being thicker, less vascular, and in forming a series of ligaments, called the *ligamenta denticulata*, which unite the sides of the cord to the dura mater, and thus support it and protect it from injury.

THE BRAIN OR ENCEPHALON.

The brain forms the largest part of the cerebro-spinal axis and is contained in the cavity of the skull.

In order to remove the brain, for the purposes of examination, the following structures have to be divided:

1. The scalp.
2. The calvarium and the two temporal muscles.
3. The three membranes or meninges.
4. The twelve cranial nerves.
5. The four arterial trunks, *viz.:* the two internal carotid and the two vertebral arteries.
6. The cerebral veins and sinuses.
7. The medulla oblongata, at its junction with the spinal cord.

DIAGRAM OF THE BRAIN IN PROFILE.

This cerebrum is represented in this diagram as separated from the cerebellum more than it naturally should be, in order to show certain important parts. A, the *cerebrum;* B, the *cerebellum;* C, the *pons Varolii;* D, the *medulla oblongata;* E, the *crus cerebri;* F, the *olivary body;* G, the *tubercula quadrigemina;* S, the *fissure of Sylvius;* R, the *fissure of Rolando; a, peduncles of cerebrum; b, superior peduncles of the cerebellum; c, middle peduncle of the cerebellum: d, inferior peduncles of the cerebellum;* b, E, a, form the *isthmus encephali.*

GANGLIA.

The brain consists of *twelve distinct ganglias*, which may be enumerated as follows:

Three large ganglia...(3).		Cerebrum.
		Cerebellum.
		Medulla oblongata.
Nine smaller ganglia..(9).		Olfactory bulbs (2).
		Corpora striata (2).
		Optic thalami (2).
		Tubercula quadrigemina (2).
	—	Tuber annulare.
Total,	12	

The CEREBRUM fills the greater part of the cavity of the skull, excepting the posterior fossa which contains the cerebellum and the medulla oblongata. It consists of two distinct lateral halves, called the *hemispheres of the cerebrum*, which are separated by a longitudinal fissure. This fissure contains one of the prolongations or septa formed by the dura mater, called the *falx cerebri.* The anterior and middle portions of each hemisphere rest on the bony floor of the skull, while the posterior portion of each is separated from the upper surface of the hemispheres of the cerebellum by a prolongation of the dura mater, called the *tentorium cerebelli*, which affords it support and prevents injury to the brain in case of concussion being transmitted to it through the spinal column.

The *cerebellum* lies within the posterior fossa of the skull and is divided into two lateral hemispheres, which are connected by a median lobe. It is in relation, *above*, with the posterior portion of the cerebrum ; and, *in front*, with the medulla oblongata.

The *medulla oblongata* is the upper enlarged part of the spinal cord. It is contained in the posterior fossa of the skull ; lying upon the basilar groove of the occipital bone and situated anterior to the cerebellum and between its two hemispheres.

The *olfactory bulbs* are connected with the hemispheres of the cerebrum by two bands, called the *olfactory tracts ;* and are situated upon either side of the cribriform plate of the ethmoid bone. As their name indicates, they are the two ganglia of the special sense of smell, and are connected with the olfactory nerves.

The *corpora striata* are two ganglia, situated within the substance of the hemispheres of the cerebrum, one on either side; and which lie in front of the optic thalamus of each hemisphere. They are prominently seen upon the *floor of each of the lateral ventricles* of the brain.

The *optic thalami* are two ganglia, placed within the substance of the hemispheres of the cerebrum posterior to the corpus striatum of either side. They assist to form the *floor* of the *lateral ventricles* and also the *sides* of the *third ventricle* of the brain.

The *tubercula quadrigemina* are four small rounded eminences, separated by a crucial suture. They are considered as forming, together, two single ganglia. They are situated on the exterior of the brain, at or near the point of union of the cerebrum and cerebellum; and they can be best exposed by lifting the posterior portion of the cerebrum from the tentorium cerebelli. The term *nates* and *testes* is frequently applied to them from, a fancied resemblance to those parts in miniature.

The *tuber annulare* is a ganglion situated in the substance of the pons Varolii. By some the term is used as synonomous with the pons Varolii; while, by others it is regarded only as its distinct ganglionic centre.

Later on, in a description of the component parts of the brain in detail, many points pertaining to these ganglia will be considered, which are now omitted in this general description, since it is impossible to enter into detail without the frequent use of terms which have not, as yet, been mentioned.

COMMISSURES.

In addition to the ganglia, which we have been considering, certain *connecting bands* of brain substance exist, which are called *commissures*. These may be divided into two sets, viz: the longitudinal and the transverse. Each of these sets include portions of the brain, to which special names have been applied.

Longitudinal commissures .... (11)
(Which lie with their long axis in the *antero-posterior* direction).

- Olfactory tracts.
- Striæ longitudinales.
- Taenia semicircularis.
- Crura cerebri.
- Processes e cerebello ad testes.
- Peduncles of the pineal gland.
- Fornix.
- Infundibulum.
- Lamina cinerea.
- Gyrus fornicatus.
- Fasciculus unciformis.

Transverse commissures .... (9)
(Which run in the *transverse* direction).

- Anterior of 3rd ventricle.
- Middle of 3rd ventricle.
- Posterior of 3rd ventricle.
- Corpus callosum.
- Pons Varolii.
- Valve of Vieussens.
- Fornix.
- Posterior medullary velum.
- Optic commissure.

Total, 20

These various commissures are situated in different portions of the brain, and the consideration of each, where deemed important, will be found in subsequent pages, under the description of those regions where they are chiefly developed.

It will be seen by the preceding tables that the *fornix* is both a longitudinal and a transverse commissure.

The brain is *convoluted upon its external surface*, in order to afford a larger expanse of grey nerve matter, which is most extensively distributed to this region. Within its substance, it contains *five cavities*, which have been respectively named as follows.

The two lateral ventricles.
The third ventricle.
The fourth ventricle.
The fifth ventricle.

The two *lateral ventricles* are contained in the *two hemispheres of the cerebrum;* the *fifth ventricle* is situated *between the two lateral ventricles;* the *third ventricle* is situated *between the two optic thalami;* and the *fourth ventricle* is comprised between the *cerebellum and the medulla oblongata.*

The two lateral ventricles and the fifth ventricle lie upon the *same plane*, within the brain substance; the third ventricle lies on a plane *below* that of the lateral ventricles, and reaches the *floor* of the brain; while the fourth ventricles lies *below the plane of the hemispheres of the cerebrum*, being situated in the region of the medulla oblongata.

The two lateral ventricles communicate with the third ventricle through the *foramina of Monroe;* and the third ventricle communicates with the fourth ventricle, through a canal termed the *iter e tertio ad quartum ventriculum.*

Each of these ventricles have special boundaries, which merit description.

THE LATERAL VENTRICLES.

These two cavites are situated within the substance of the hemispheres of the cerebrum. They can be best exposed by separating the hemispheres, and by dividing, at the bottom of the median fissure, the great transverse commissure of the hemispheres, called the *corpus callosum*, upon either side, at its line of junction with the cerebrum. A cavity will be thus perceived to exist within each hemisphere, which presents a central portion or body and three cornua. The various points of interest pertaining to the *central cavity* or *body*, can be best described by enumerating its boundaries.

Lateral Ventricles (boundaries).

In front	Brain substance and anterior cornu.
Behind.	Brain substance and posterior cornu.
Externally	Brain substance and middle cornu.
Internally	Septum lucidum.
Above	Corpus callosum.
Below (6 points of interest)	Corpus striatum. Taenia semicircularis. Optic thalamus. Choroid plexus of veins. Corpus fimbriatum. Fornix.

Each of the lateral ventricles presents *three prolongations* into the brain substance which are known as the *anterior*, *middle*, *and posterior cornua*, and which have been mentioned in the boundaries of the main cavity.

The *anterior cornu* passes forwards and outwards over the anterior extremity of the corpus striatum.

The *middle cornu* is curved like the horn of a ram, and the direction of its five curves may be represented, in their order from the ventricle to its point of termination, by the initial letters, B. O. D. F. I. On its floor is seen, (1) an eminence called the *hippocampus major;* (2) a few rounded masses resembling the paw of an animal and called the *pes hippocampi;* (3) an eminence called the *pes accessorius* or *eminentia collateralis;* (4) a projection formed by a continuation of the posterior pillar of the fornix called the *corpus fimbriatum;* (5) a continuation of the pia mater into the interior of the brain forming the *choroid plexus;* (6) a serrated band of grey matter, the *fascia dentata;* and (7) the *transverse fissure* of the brain.

The *posterior cornu* curves backwards, downwards and outwards into the occipital lobe of the cerebrum, and then backwards, downwards and inwards. On its floor is a longitudinal eminence called the *hippocampus minor*.

In the table of boundaries it will be perceived that *upon the floor* of each lateral ventricle are present two of the ganglia of the brain, *viz.*, the *corpus striatum* and the *optic thalamus;* a semicircular-shaped band of fibres between these ganglia called the *tænia semicircularis*, which extends from the anterior crus of the fornix to the middle or descending cornu; a plexus of veins derived from the pia-mater of the brain, and called the *choroid plexus;* a portion of the *corpus fimbriatum*, which has been described in connection with the middle cornu; and the *fornix*, which will receive a special description in subsequent pages of this volume.

THE THIRD VENTRICLE.

This is a narrow median fissure *comprised between the two optic thalami.* Its floor is situated on a lower relative plane than that of the two lateral ventricles and is formed by the structures comprised in the *inter-peduncular space* at the base of the brain. It communicates with both the lateral and with the fourth ventricles. It is exposed by turning back the body of the fornix from the floor of the lateral ventricles, and by the subsequent removal of the velum interpositum, which forms the root of the ventricle.

THIRD VENTRICLE (boundaries).

In front	Crura of fornix. Anterior transverse commissure.
Behind....................	Posterior transverse commissure. Iter e tertio ad quartum ventriculum.
Sides	The optic thalami. Peduncles of the pineal gland.
Above......................	Velum interpositum (pia mater). Under surface of the fornix.
Below (5 points of interest)..	Lamina cinerea. Tuber cinereum. Infundibulum. Corpora albicantia. Posterior perforated space.

This ventricle is crossed by three bands or commissures, called respectively, the *anterior*, the *middle* or *soft*, and the *posterior commissures.* The anterior is composed of white nerve substance, the middle of gray or vesicular substance, and the posterior of white nerve tissue.

Between the crura of the fornix and the *optic thalami*, in the anterior portion of the ventricle, are the *foramina of Monroe*, which transmit the *vessels of the velum interpositum* to form the choroid plexuses of the lateral ventricles.

On the floor, in the fœtus, the *cavity of the pituitary body* communicates with this ventricle by a canal through the infundibulum. This canal sometimes remains pervious.

Posteriorly, this ventricle communicates with the fourth ventricle by a passage, beneath the posterior commissure, called the *iter e tertio ad quartum ventriculum.*

This ventricle of the brain may therefore possess *four openings*, as follows:

Foramina of Monroe (2).
Opening into the fourth ventricle.
Opening of the infundibulum (in the fœtus only).

The points of interest pertaining to the floor of this ventricle will be found separately considered under the description of the under surface of the cerebrum.

THE FOURTH VENTRICLE.

This cavity of the brain is *rhomboidal in form* and is comprised between the posterior surface of the medulla oblongata and the cerebellum. It is enclosed, inferiorly, by the pia mater which binds these parts together. It is situated on a plane below the level of the base of the brain. It communicates with the cavity of the third ventricle by means of the *iter e tertio ad quartum ventriculum* or *aqueduct of Sylvius;* and also with the sub-arachnoidean space of the brain and spinal cord, by means of an opening in the pia mater, near the floor of the ventricle. Into this cavity, the pia mater of the brain is prolonged as a vascular fold, called the *choroid plexus*, which derives its blood chiefly from the inferior cerebellar artery.

By some authorities, this ventricle is considered to be a dilated portion of the central canal of the spinal cord; and the aqueduct of Sylvius is also regarded as a continuation of the same canal.

FOURTH VENTRICLE (boundaries).

In front		Posterior surface of medulla and pons Varolii.
Behind		Substance of the cerebellum.
Above		Valve of Vieussens. The cerebellum.
Sides	Above	Processus e cerebello ad testes.
	Below	Posterior pyramids. Restiform bodies.

The *floor of this cavity* presents for examination the following points, which have been specially named.

The *posterior median fissure.*

The *orifice* of the *central canal* of the spinal cord.

The *locus cœruleus* (named from its blue tint).

The *tænia violacea* (also of blue color).

The *fasiculi teretes* (two spindle-shaped elevations).

Various eminences, indicating the position of the nuclei of origin of certain of the cranial nerves.

FIFTH VENTRICLE (boundaries).

This ventricle is formed by a separation of the *two layers* of the *septum lucidum* and is situated between the two lateral ventricles. It is bounded, *above*, by the corpus callosum, and it usually contains fluid. In the foetus, it communicates with the cavity of the third ventricle, by an opening between the pillars of the fornix.

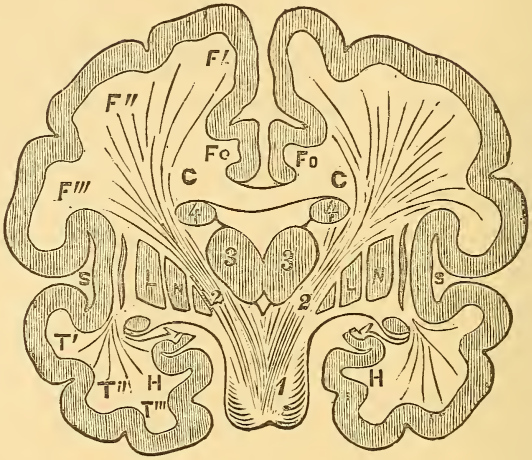


DIAGRAM OF BRAIN IN TRANSVERSE VERTICAL SECTION.

1. Crus cerebri.
2. Internal capsule.
3. Optic thalamus.
4. Corpus striatum.
C. C. Corpus callosum.
L. N. Lenticular nucleus.
S. Fissure of Sylvius.

Fo. Gyrus fornicatus.
F'. First frontal convolution.
F''. Second frontal convolution.
F'''. Third frontal convolution.
T'. First temporal convolution.
T''. Second temporal convolution.
T'''. Third temporal convolution.
H. Gyrus hippocampi.

THE CEREBRUM.

The cerebrum, in man, constitutes the largest portion of the brain. Its upper surface is of an ovoidal form, broader behind than in front, convex in its general outline, and divided into two lateral halves or hemispheres, the right and left, by the great longitudinal fissure. This fissure extends throughout the entire length of the cerebrum in the middle line, reaching down to the base of the brain in front and behind, but interrupted in the middle by a broad transverse commissure of white matter, the *corpus callosum*, which connects the two hemispheres together. This fissure lodges the falx cerebri, and indicates the original development of the brain by two lateral halves.

Each hemisphere presents for examination an *outer surface*, which is convex, to correspond with the vault of the cranium ; an *inner surface*, flattened, and in contact with the opposite hemisphere, the two inner surfaces forming the sides of the longitudinal fissure; and an *under surface* or *base*, of more irregular form, which rests, in front, on the anterior and middle fossæ at the base of the skull, and, behind, upon the tentorium cerebelli.

Each hemisphere presents *five principal lobes* and *four important fissures* which mark the boundaries of each lobe. These may be enumerated as follows:

The Principal Lobes of the Cerebrum.

Each hemisphere has five principal lobes, which are called the *anterior* or *frontal lobe*, the *parietal lobe*, the *posterior* or *occipital lobe*, the *central lobe* or the *island of Reil*, and the *middle* or *temporo-sphenoidal lobe*.

The *frontal lobe* comprises the anterior half of the hemisphere and is bounded, below, by the fissure of Sylvius, and, behind, by the fissure of Rolando. Its lower portion rests upon the orbital plate of the frontal bone and it has been called by some authors the *orbital lobe*.

The *parietal lobe* is situated behind the frontal lobe, on the convexity of the cerebrum. It extends downwards as far as the fissure of Sylvius. It is bounded, in front, by the fissure of Rolando, and, behind, by the parieto-occipital fissure.

The *occipital lobe* is separated from the parietal lobe by the parieto-occipital fissure and rests upon the tentorium cerebelli.

The *temporo-sphenoidal lobe* projects into the middle fossa of the skull and lies below the parietal and the occipital lobes. It is bounded in front by the fissure of Sylvius.

The *central lobe* is also called the *island of Reil* and lies in the fissure of Sylvius. It is triangular in shape and is overlapped by the frontal and the temporo-sphenoidal lobes. It consists of six short and straight convolutions, called the *gyri operti*. Internally it corresponds with the outer surface of the lenticular nucleus, and it is that part of the cortex of the brain which is in the most immediate proximity to the ganglia within the substance of the cerebrum. Externally it is concealed from view, because that portion of the cerebral hemisphere included between the two branches of the Sylvian fissure projects downward from above, and overhangs it like a cover. For that reason this portion is named the "*operculum*."

The Principal Fissures of the Cerebrum.

Each hemisphere of the cerebrum has four fissures on its external surface, called the *median longitudinal*, the *fissure of Sylvius*, the *fissure of Rolando*, and the *external parieto-occipital fissure*.

These fissures separate the lobes of the hemispheres and are of value in describing the situation of certain special convolutions on the external surface of the cerebrum.

The *median longitudinal fissure* separates the two hemispheres of the cerebrum.

The *fissure of Sylvius* extends from the anterior perforated space, at the base of the brain, to about the middle point on the outer edge of the hemisphere. It then divides into a short anterior or *ascending limb*, and a long posterior or *horizontal limb*. It contains the *central lobe* or *island of Reil*. The triangular-shaped portion of brain comprised between these two limbs is called the "*operculum*."

The *fissure of Rolando* extends between the frontal and the parietal lobes, from the longitudinal fissure to the outer extremity of the horizontal limb of the fissure of Sylvius. It is accompanied by two convolutions having a similar direction, one in front of it and one behind, which are called the "*anterior* and *posterior central convolutions*."

The *external parieto-occipital fissure* extends from the median longitudinal fissure, at a point midway between the origin of the fissure of Rolando and the posterior extremity of the hemisphere, on the external surface of the cerebrum, for a distance of about an inch. It may be often indistinctly defined. It marks the division between the parietal and occipital lobes.

Inner Surface of the Cerebrum.

If we open the great longitudinal fissure and look at the inner surface of the hemisphere, we see the general arched form of its convolutions. A little above the corpus callosum is an important longitudinal fissure—the *fissura calloso-marginalis*. It runs for some distance parallel with the upper border of the corpus callosum, and then turns upward, in an ascending branch, to the upper border of the hemisphere.

In the occipital portion of this surface is the *fissura parieto-occipitalis*, directed obliquely downward and forward, and the *fissura calcarina*, nearly horizontal. These two fissures meet in front at an acute angle, and include between them a wedge-shaped lobule, the *cuneus*.

In front of the cuneus is a quadrangular lobule, the *præcuneus*, bounded behind by the fissura parieto-occipitalis, and anteriorly by the ascending branch of the fissura calloso-marginalis. In front of the præcuneus may also be perceived a region called the *para-central lobule,* because it corresponds in situation with the

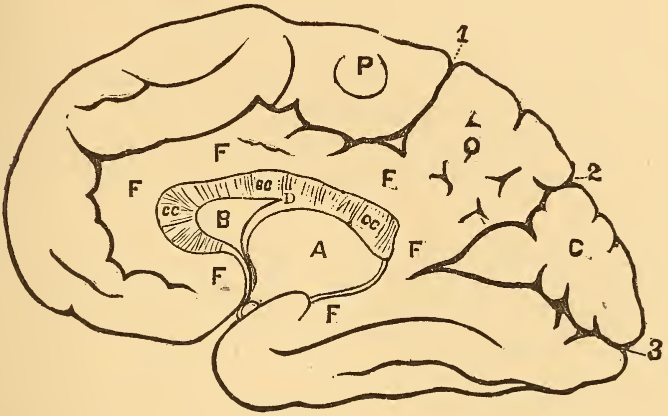


DIAGRAM OF BRAIN IN LONGITUDINAL MEDIAN SECTION.

1. Calloso-marginal fissure.
2. Parieto-occipital fissure.
3. Calcarine fissure.

A. Third ventricle.
B. Fifth ventricle.
D. Anterior crura of fornix.

C. Cuneus.
Q. Precuneus.
P. Paracentral lobe.

C. C. Corpus callosum.
F. Gyrus fornicatus.

fissure of Rolando, and the two central convolutions on the outside of the brain.

The most important feature pertaining to the inner surface of the cerebrum is a convolution which lies immediately above the corpus callosum. It is called the *gyrus fornicatus*, because it has an arched or vaulted form; and it encircles the corpus callosum, the cerebral ganglia, and the crus cerebri in a continuous longitudinal curve.

It starts from the inferior part of the anterior lobe, just in front of the Sylvian fissure, and winds around the anterior extremity of the corpus callosum, and along its upper border. Here it is included between the corpus callosum, below, and the fissura calloso-marginalis above. It extends backward, in this part of its course, as a single independent convolution, as far as the ascending branch of the fissura calloso-marginalis. It then curves round the posterior extremity of the corpus callosum, passes beneath the crus cerebri, and runs downward and forward to a point just behind the fissure of Sylvius, almost exactly opposite the place from which it started. In this lower portion of its course it is often designated as the "*gyrus hippocampi.*"

The Floor of the Brain.

The base of the brain, upon its under surface, is formed mainly by the inferior surface of each hemisphere of the cerebrum.

The various points of interest exposed to view, on the *under surface of the cerebrum*, in or near the median line, are here arranged in the order in which they are met with, from before backwards.

1. Longitudinal fissure.
2. Corpus callosum and its peduncles.
3. Lamina cinerea.
4. Olfactory nerves.
5. Fissure of Sylvius.
6. Anterior perforated space.
7. Optic commissure.
8. Tuber Cinereum.
9. Infundibulum.
10. Pituitary body.
11. Corpora albicantia.
12. Posterior perforated space.
13. Crura cerebri.

The *longitudinal fissure* separates the two hemispheres of the cerebrum.

The *corpus callosum* is the great transverse commissure of the brain and connects the two hemispheres.

The *lamina cinerea* is a thin layer of grey matter which connects the corpus callosum with the tuber cinereum, passing beneath each of the optic tracts, near the optic commissure.

The *fissure of Sylvius* separates the anterior lobe of the cerebrum from the temporo-sphenoidal lobe and lodges the middle cerebral artery. It has been described in preceding pages.

The *anterior perforated space* admits vessels to the corpora striata.

The *optic commissure* or *chiasm* is formed by the union of the optic tracts, in front of the tuber cinereum. From it the two optic nerves are given off. It is composed of four varieties of fibres, as follows:

1. The *inter-cerebral fibres*, which pass from one hemisphere of the cerebrum to the other.
2. The *inter-retinal fibres*, which connect the retina of one eye with that of the other.
3. *Longitudinal fibres*, which connect the brain with the retina of the same side.
4. *Decussating fibres*, which connect the hemispheres of the

cerebrum with the retina of the opposite side; and which cross each other at the point of union of the optic tracts.

The *tuber cinereum* is a lamina of gray matter which extends from the corpora albicantia to the optic commissure, to which it is attached in front. In the median line, it is prolonged into the infundibulum.

The *infundibulum* is a process of brain substance which connects the base of the brain at the floor of the third ventricle with the pituitary body. It is hollow, and, in the fœtus, affords a channel of communication between a cavity in the pituitary body and the third ventricle of the brain.

The *corpora albicantia* or *mamillaria* are two round, white eminences, situated in front of the posterior perforated space and united to each other in the median line. They are formed by the anterior crura of the fornix and are sometimes called the *bulbs of the fornix*.

The *posterior perforated space* performs the same function for the optic thalami as did the anterior space for the corpora striata.

The *crura cerebri* connect the cerebrum with the spinal cord, the cerebellum, and the medulla oblongata. Through them pass the fibres which enter the corpora striata and the optic thalami, and which subsequently radiate to the convolutions of the cerebrum. They form, in connection with the optic tracts, the boundaries of a lozenge-shaped space, called the *inter-peduncular space*.

The *pituitary body* lies in a cavity on the upper surface of the body of the sphenoid bone, called the *sella turcica*.

Internal Parts of the Cerebrum.

The *white* or *peduncular fibres* of the cerebrum connect (1) the grey matter of its surface with the anterior cerebral ganglia (the corpora striata and optic thalami), which fibres are called the *corona radiata;* and (2) the interior cerebral ganglia with the *pons Varolii*, thus forming the *crura cerebri*.

Within the hemispheres of the cerebrum are contained the following points of special interest: (1) *the ventricles*, whose points of interest have already been described; (2) *four ganglia*, *viz.*, the corpora striata and the optic thalami; and (3) *two great commissures*, *viz.*, the corpus callosum and the fornix.

The *corpus striatum* is divided into two parts. One of them is the *intra-ventricular* portion, visible from the lateral ventricle, which has a bulging anterior extremity or *head*, and a slender posterior continuation, like a *tail*, called the "*caudate nucleus*" of the corpus striatum. The other part is the *extra-ventricular* portion. It is not visible from the lateral ventricle, but is imbedded in the substance of the brain. In some planes of section it shows a tolerably regular lens-like figure, and is therefore called the "*lenticular nucleus.*" According to this nomenclature, the optic thalamus is a separate and complete ganglion by itself; while the corpus striatum consists of two portions, namely, an intra-ventricular portion, or the *caudate nucleus*, and an extra-ventricular portion, or the *lenticular nucleus*. The name "corpus striatum" is often applied, however, to the intra-ventricular or caudate portion, while the other part is known simply as the "lenticular nucleus."

The corpus striatum, if taken as a whole, has the *shape of a ring* if viewed laterally, after a section has been made which completely exposes the lateral ventricle and its prolongations into the brain substance.

This annular form is due to the tail-like projection from the body of the ganglion, which curves over the posterior extremity of the optic thalamus and then descends into the inferior cornu of the ventricle, following its curve as far as the anterior extremity of that cornu. It thus *encircles the crus cerebri* and the *internal capsule*, and it is sometimes called the *surcingle* of the corpus striatum from this peculiarity in its course.

That portion of white substance, running upward and outward, between the corpus striatum and the lenticular nucleus, is known as the "*internal capsule.*"

The corpus striatum differs from the optic thalamus in respect to the arrangement of its grey matter; since, in the former, the nerve fibres pass through its gray matter in *distinct bundles*, while, in the latter, the fibres are intermixed with the gray matter giving it a uniform color and appearance.

The *thalamus opticus* (posterior cerebral ganglion) is of oval shape and rests upon the corresponding crus of the hemispheres. It is bounded, on the outer side, by the corpus striatum and the tænia semicircularis. The part which is seen in the lateral ventricle is called the *anterior tubercle;* while the part situated beneath the fornix is called the *posterior tubercle*. Each of the thalami optici enters into the construction of both lateral ventricles and the third ventricle. Its gray matter is evenly distributed between the nerve fibres which pass through it, thus giving it a uniform color.

The *fornix* is a longitudinal lamella of fibrous matter, situated beneath the corpus callosum, with which it is continuous behind; but it is separated from it, in front, by the septum lucidum. It may be described as consisting of two symmetrical halves, one for either hemisphere. These two portions are joined together, in the middle line, where they form the *body of the fornix*, but are separated from one another in front and behind; in front, forming the *anterior crura*, and behind, the *posterior crura of the fornix*.

The *body* of the fornix is triangular in form; narrow in front, broad behind. Its upper surface is connected, in the median line, to the septum lucidum, in front, and the corpus callosum behind. Its under surface rests upon the velum interpositum, which separates it from the third ventricle, and the inner portion of the optic thalami. Its lateral edges form, on each side, part of the floor of the lateral ventricles, and are in contact with the choroid plexuses.

The *anterior crura* of the fornix arch downwards towards the base of the brain, separated from each other by a narrow interval. They are composed of white fibres, which descend through a quantity of grey matter in the lateral walls of the third ventricle, and are placed immediately behind the anterior commissure. At the base of the brain, the white fibres of each crus form a sudden curve upon themselves, spread out and form the outer part of the corresponding *corpus albicans*. The anterior crura of the fornix are connected, in their course, with the optic commissure, the white fibres covering the optic thalamus, the peduncle of the pineal gland, and the superficial fibres of the tænia semicircularis.

The *posterior crura* of the fornix, at their commencement, are intimately connected by their upper surfaces with the corpus callosum; diverging from one another, they pass downwards into the descending horn of the lateral ventricle, being continuous with the concave border of the hippocampus major. The lateral thin edges of the posterior crura have received the name *corpus fimbriatum*, already described. On the under surface of the fornix, towards its posterior part, between the diverging posterior crura, may be seen some transverse lines, and others longitudinal or oblique. This portion of the fornix has been termed *the lyra*, from the fancied resemblance it bears to the strings of a harp.

Between the anterior pillars of the fornix and the anterior extremities of the thalami optici, an oval aperture is seen on each side, the *foramen of Monroe*. These two openings descend towards the middle line, and, joining together, lead into the upper part of the third ventricle. These openings communicate with the lateral ventricles on each side, and below with the third ventricle.

The *corpus callosum* is a thick stratum of transverse fibres, exposed at the bottom of the longitudinal fissure. It connects the two hemispheres of the brain, forming their *great transverse commissure;* and forms the roof of a space in the interior of each hemisphere, the lateral ventricle. It is about four inches in length, extending to within an inch and a half of the anterior, and to within two inches and a half of the posterior part of the brain. It is somewhat broader behind than in front, and is thicker at either end than in its central part, and is thickest behind. It presents a somewhat arched form, from before backwards, and terminates anteriorly in a rounded border, which curves downwards and backwards, between the anterior lobes to the base of the brain. In its course, it forms a distinct bend, named the *knee* or *genu*, and the reflected portion, named the *beak or rostrum*, is attached to the anterior cerebral lobe, and is connected, through the lamina cinerea, with the optic commissure. The reflected portion of the corpus callosum gives off, near its termination, two bundles of white substance, which, diverging from one another, pass backwards, across the anterior perforated space, to the entrance of the fissure of Sylvius. They are called the *peduncles of the corpus callosum.* Posteriorly, the corpus callosum forms a thick, rounded fold, which is free for a little distance, as it curves forwards, and is then continuous with the fornix. On its upper surface, its fibrous structure is very apparent to the naked eye, being collected into coarse, transverse bundles. Along the middle line, is a linear depression, *the raphe*, bounded laterally by two or more slightly elevated longitudinal bands, called the *striæ longitudinales or nerves of Lancisi;* and, still more externally, other longitudinal striæ are seen, beneath the convolutions, which rest on the corpus callosum. These are the *striæ longitudinales laterales.*

THE MESO-CEPHALON.

The parts which help to form the connecting link between the cerebrum, cerebellum, and medulla oblongata, when taken as a whole, are termed the meso-cephalon. Under this head certain parts are included which have been already described in detail, since they pertain chiefly to other regions, while some others have been only casually referred to.

The meso-cephalon comprises the following structures:

(1) The pons Varolii.
(2) The crura cerebri.
(3) The inferior peduncles of the cerebellum.
(4) The superior peduncles of the cerebellum.
(5) The valve of Vieussens.
(6) The tubercula quadrigemina.
(7) The pineal gland or conarium.

The *pons Varolii* is the great transverse commissure which binds the hemispheres of the cerebellum to each other and to the medulla oblongata. It passes across the front of the medulla and lies on a plane between that of the superior and inferior peduncles of the cerebellum. Its lateral portions are often called the *middle peduncle* of the cerebellum.

The *crura cerebri* comprise the *peduncular fibres of the cerebrum*, in contra-distinction to the commissural fibres and the corona radiata. They are *three-quarters of an inch in length*, and extend from the upper border of the pons Varolii to the corpora striata and the optic thalami. They are crossed by the optic tracts, and they form the posterior boundary of the *inter-peduncular space*. Each crus contains a central mass of grey matter called the *locus niger*. The fibres of each crus, which pass above this central mass, form a layer called the *tegmentum*, while those which pass below it form a bundle called the *fasciculated portion*.

The *valve of Vieussens* is a thin lamina of white matter which forms the roof of the aqueduct of Sylvius. It presents a median ridge, called the *frenulum*.

The *tubercula quadrigemina* (nates and testes) are situated above the valve of Vieussens and posterior to the third ventricle of the cerebrum. Bands of white matter, called *brachia anteriora* connect the two *nates* or *anterior lobes* with the optic thalami and the optic tracts ; while similar bands, called *brachia posteriora* connect the *testes* or *posterior lobes* with the same parts. The nates are larger and darker colored than the testes.

The *pineal gland* or *conarium* is a small conical body of a reddish-grey color situated between the *nates*. It has two processes on each side, called *the superior* and *inferior peduncles of the pineal gland*. The superior set run forwards over the inner surface of each optic thalamus and become united to the anterior crura of the fornix ; while the inferior set descend vertically upon the inner surface of each optic thalamus. This gland has one or two small cavities which often communicate with the third ventricle of the cerebrum. The contents of these cavities is termed the *acervulus cerebri*.

THE MEDULLA OBLONGATA.

This ganglion of the brain is the upper and enlarged part of the spinal cord and extends from the lower border of the pons Varolii to the point of decussation of the anterior pyramids of the spinal cord, which point corresponds nearly to the upper border of the atlas. Its anterior surface rests upon the basilar groove of the occipital bone, while its posterior surface forms a portion of the *fourth ventricle* and is continuous with the posterior surface of the spinal cord.

The medulla oblongata is divided into two lateral halves by an *anterior* and a *posterior median fissure*, the former of which is interrupted, in part, by the decussations of the anterior pyramids.

Each half of the medulla oblongata presents the following points to which a special name has been applied :

1. The *anterior pyramid*, which is formed by the anterior and the lateral columns of the spinal cord.
2. The *olivary body*, which is a prominent oval mass behind the pyramid, from which it is separated by a groove, called the *groove of the hypoglossal nerve.*
3. The *lateral tract*, which lies behind the anterior pyramid and the olivary body and in front of the restiform body of the medulla. It is continuous with the lateral column of the cord. The groove between it and the restiform body gives origin to the 9th, 10th, and 11th nerves.
4. The *restiform body* or the *fasciculus cuneatus* is the outer and larger portion of the posterior portion of the medulla.
5. The *posterior pyramid* or *fasciculus gracilis* is the inner portion of the posterior part of the medulla and is chiefly formed by the fibres of the posterior columns of the spinal cord. It enters into the formation of the 4th ventricle of the brain.

The *grey matter of the medulla oblongata* is scattered throughout its entire substance and has special interest, since, in the 4th ventricle, it affords separate nuclei, from which the 5th, 6th, 7th, 8th, 9th, 10th, 11th, and 12th nerves are said to arise either in part or entirely.

In the medulla, are supposed to exist the nerve centres for the performance of the acts of respiration, deglutition, phonation, mastication, and expression ; and centres for the vaso-motor nerves of the sympathetic system and for the cardiac nerves. It will thus be more clearly understood why injury to this ganglion is so rapidly fatal.

THE CEREBELLUM.

This ganglion of the brain is situated within the posterior fossa of the skull, and is in close relation, *in front*, with the medulla oblongata ; while, *above*, it is separated from the occipital lobe of the cerebrum by the tentorium cerebelli.

In shape, this ganglion is *oblong*, from side to side, and *flattened* from above downwards. It therefore presents two surfaces, an upper and an lower surface, and a circumference.

The cerebellum consists of two lateral lobes and a central or connecting lobe called the *vermiform process*. This central lobe is usually described as consisting of two parts, the superior and the inferior portion.

Upper Surface of the Cerebellum.

This surface presents for examination the following parts, which are specially named and which deserve enumeration.

1. The upper surface of each lateral hemisphere.
2. The superior surface of the vermiform process.

Each *lateral hemisphere* may be seen to present, on its upper surface, two distinct portions.

The *anterior portion* or the *square lobe*.
The *posterior portion* or the *semilunar lobe*.

The *vermiform process*, on the upper aspect, is also seen to present three slight elevations called respectively, from before backwards.

The *lobulus centralis*.
The *monticulus cerebelli*.
The *commissura simplex*.

Under Surface of the Cerebellum.

This surface is rounded and elevated on the sides, and in the centre, it is depressed into a groove between the two lateral lobes of the cerebellum, which depression is called the *vallecula* or valley. It presents, as did the upper surface, the three following parts for examination.

1. The under surface of each lateral hemisphere.
2. The inferior surface of the vermiform process.

The *lateral hemispheres* may be seen to present upon this surface, *five distinct lobes*, called as follows :

The *flocculus*, *sub-peduncular lobe*, or *pneumogastric lobule*.
The *amygdala lobe* or the *tonsil*.
The *digastric lobe*.
The *slender lobe*.
The *posterior inferior lobe*.

The *vermiform process*, on its under surface, presents the following parts which have been specially named:

The *pyramid*.
The *uvula*.
The *commissura brevis*, which connects the two surfaces of the vermiform process.

The Circumference of the Cerebellum.

This portion of the cerebellum presents for examination the following parts:

Two vertical fissures, called:

The *incisura cerebelli anterior*.
The *incisura cerebelli posterior*.

A great horizontal fissure, which extends from the middle peduncle of one hemisphere to the same point upon the opposite side.

Processes of the Cerebellum.

The cerebellum is connected to the medulla oblongata, the pons Varolii, and the cerebrum, by three processes, which are called, from below upwards, as follows.

The *inferior*, or *processus e cerebello ad medullam*.
The *middle*, or *processus e cerebello ad pontem*.
The *superior*, or *processus e cerebello ad testes*.

The *grey matter of the cerebellum* consists of three distinct parts or layers, as follows:

(1) *External layer of small cells*, both round and polar in form, and nerve fibres.

(2) *Middle layer* of *cells with long processes* penetrating into the external layer, called the *cells of Purkinje*.

(3) *Internal layer*, called the *granular layer*, formed by dense masses of granular corpuscles.

GENERAL SUMMARY.

The grey matter of the brain is arranged in two main divisions, occupying two different localities. These divisions comprise: First, the *exterior convolutions*, forming the cortex of the brain and spread out upon its surface; and, secondly, the *interior cerebral ganglia*, situated at its base, and known as the corpus striatum and optic thalamus.

The white matter, on the other hand, is derived from a continuation of the *longitudinal columns of the spinal cord*, which pass upward through the medulla oblongata to the interior cerebral ganglia and then continue their course to terminate in the convolutions.

In the cerebro-spinal system, counting from without inward, there are three principal deposits or centres of grey matter:

1st. The *grey matter of the spinal cord*, extending upward on the floor of the fourth ventricle, and around the aqueduct of Sylvius, forming what is known as the grey matter of the medullary canal.

2d. The *interior cerebral ganglia* at the base of the brain.

3d. The *convolutions* of the *hemispheres*.

There are also three sets of fibres, forming the white substance:

1st. The nerves and nerve-roots, connecting the external organs of the body with the *grey matter of the medulla*.

2d. The fibres connecting the *grey matter of the medulla oblongata* with the *interior cerebral ganglia*.

3d. Those uniting the *interior cerebral ganglia* with the *convolutions of the cortex*.

Of the *nine ganglia*, which have been named as the smaller ganglia of the brain, *four* are situated outside of the brain, *viz.*, the two olfactory and the tubercula quadrigemina; and *five* within the substance of the brain, *viz.*, the corpus striatum of either side, the optic thalamus of either side, and the tuber annulare, which is located in the substance of the pons Varolii.

The *copora striata* enter into the formation of the lateral ventricles; the *optic thalami* enter into the formation of both the lateral and the third ventricles.

The *tubercula quadrigemina* can be exposed, by separating the posterior lobe of the cerebrum from the cerebellum, when it will be seen at the point of junction of the two.

The *sinuses of the brain* have already been considered in the chapter upon the venous system.

The *weight* of the brain averages about 49 ounces in the male, and about 44 ounces in the female, but it appears to bear a general relation to the intellectual capacity of the individual.

The *spaces between the convolutions* of the brain substance are called *sulci.*

The so-called *grey matter* of the convolutions is arranged in *alternate layers of grey and white nerve tissue*, which vary from four to six in number.

The *cells of the brain* are usually characterized by prolongations from their bodies and are therefore termed *polar* cells. They are divided, however, into four classes, *viz., apolar, monopolar, bipolar and multipolar*, in accordance with the number of poles which they present.

The *ventricles* of the brain contain more or less fluid, which is called the ventricular fluid; and the general ventricular cavity of the brain communicates, through a hole in the floor of the fourth ventricle, with the cavity of the subarachnoidean space.

The *level of the base* of the *anterior portion of the cerebrum* corresponds to a line drawn between two points situated just above the external angular processes of the frontal bone.

The *axis of the base of the brain* in the *anterior and middle fossæ of the skull* may be approximately represented by a line drawn from the external angular process of the frontal bone to the upper part of the external auditory meatus.

The *level of the posterior* lobe of the cerebrum corresponds to a line drawn from the upper part of the external auditory meatus to the external occipital protuberance.

THE SPINAL CORD.

The spinal cord is *sixteen and a half inches* long, and extends from the upper border of the atlas to the lower border of the 1st lumbar vertebra, where it terminates in the cauda equina. It *weighs one ounce and a half*, when divested of its membranes. It presents *two enlargements*, situated in the cervical and the lumbar regions, which are called the cervical and the lumbar enlargements.

The spinal cord presents *four columns*, called the anterior, the lateral, the posterior, and the posterior-median columns; and *five fissures*, called the antero-median, the postero-median, the antero-lateral, the postero-lateral, and, in the cervical region, a fissure, described by Sappey, called the postero-intermediary fissure.

The spinal cord gives origin to *thirty-one pairs of nerves*, each of which arises by *two roots*, called the anterior and posterior roots, which subsequently unite to form a single nerve.

The *posterior root* of each spinal nerve, being *sensory* in its function, has developed upon it, like all sensory nerves, a *ganglion*. The *anterior root* has no ganglion, since it is a motor nerve.

The *grey matter* of the spinal cord, which is best seen upon a transverse section of the cord, consists of *two crescentic masses*, each of which are situated in one of the lateral halves of the spinal cord, and which are joined together by a *transverse commissure*. These two crescentic masses form, by their extremities, the *anterior* and *posterior horns* of grey matter, within either half of the cord. In each of the posterior horns, a collection of cells at the extremity of the horn is termed the *substantia gelatinosa;* while a group of cells at the inner side of the posterior horn, is called the *posterior vescicular column*.

The *anterior roots* of the *spinal nerves* arise from the region of the anterior horn, while the *posterior roots* of the spinal nerves arise from the region of the posterior horn of grey matter.

The thirty-one pairs of nerves, which are given off from the spinal cord, form, by their *anterior branches*, plexuses of nerves, in various parts of the body. The four most important plexuses, so formed, are called the *cervical*, the *brachial*, the *lumbar*, and the *sacral plexuses*.

The nerve fibres of the *posterior columns* of the spinal cord decussate throughout the entire length of the cord, while those of the *anterior columns* decussate only in the medulla oblongata.

The spinal cord is perforated, throughout its centre, by a *canal*, which opens, at its upper part, into the 4th ventricle of the brain, and which is lined, throughout, with columnar ciliated epithelium.

The *commissure of the spinal cord*, which connects the two lateral halves and which limits the depth of the two median fissures of the cord, consists of two parts called the white and the grey commissures. The *white commissure* lies anteriorly; and the *grey commissure* connects the cresentic masses of grey matter in the lateral halves of the cord.

The *white nerve substance of the spinal cord* entirely surrounds the grey matter except at the posterior grey commissure of the cord.

The *fibres of the columns* of the spinal cord pass upwards and downwards for variable distances and connect the cells of the different segments of the cord together; although some fibres are supposed to pass uninterruptedly upwards to the ganglia at the brain. These fibres are not to be confounded with the *fibres of the spinal nerves*, some of which are distributed in a totally different manner within the substance of the cord, although some accompany the proper fibres of the columns.

The *fibres* of the *anterior columns* of the spinal cord are chiefly prolonged into the *anterior pyramid* of the *medulla oblongata*, although they also assist to form the *olivary fasciculus* and the *inferior peduncles of the cerebellum.*

The *fibres* of the *lateral columns* of the cord are prolonged into the *pyramid* of the *medulla oblongata*, and also in the *fasciculi teretes* and the *inferior peduncle of the cerebellum.*

The *fibres* of the *posterior columns* of the cord are prolonged into the *restiform bodies* of the *medulla oblongata*, and the *fasciculi teretes.*

The *fibres* of the *roots of the spinal nerves* are distributed within the substance of the spinal cord as follows.

Those of the ANTERIOR ROOTS pass at first horizontally till they reach the *anterior horn* of grey matter, where they divide into three sets which are distributed as follows:

(1) Internal set.	Fass through the *white commissure* to the opposite side of the spinal cord. Are then distributed to the *anterior* and *lateral columns* of that side.
(2) Middle set.	Ascending fibres to *gray substance* of same side. Descending fibres to *gray substance* of same side. Antero-posterior fibres to *gray substance* of same side.
(3) Outer set.	To *anterior* and *lateral columns* of the side of the spinal cord at which the nerve entered.

Those of the POSTERIOR ROOTS enter at first the *substantia gelatinosa* of the side opposite to the peripheral distribution of the nerve, since the *posterior spinal fibres decussate;* and at that point they also divide into three sets, which are distributed as follows

(1) Oblique set.	These fibres pass upwards and downwards in company with the *proper fibres of the columns* of the spinal cord.
(2) Internal set.	Pass through the *gray commissure* of the cord to the opposite side. Are then distributed to the *lateral* and *posterior columns* of that side.
(3) Outer set.	To the *anterior* and *lateral columns* of that side of the spinal cord at which the nerve entered. These fibres intermingle with those of the anterior roots.

THE CEREBRO-SPINAL NERVES.

In the chapter of this work upon myology, a detailed description has already been given to the reader of most of the important motor nerves of the body; and many tables have been there incorporated which, by their classified arrangement, are intended to assist the anatomical student in mastering their points of distribution.

It is therefore been deemed unnecessary to again give, in detail, a separate distribution of those nerves, which already have been so exhaustively considered; but, in place of it, is appended a *tabulated arrangement* of the nerves of the body, which illustrates, with tolerable completeness and accuracy, all points which are of special value.

Occasional explanatory text will be found introduced, between these various tables, for the purpose of attracting attention to *some points of special interest* included in them, or for the purpose of recording some facts, which cannot well be embraced in a tabular form of statement, without creating confusion. This text will only be found valuable, however, if used in conjunction with the tables which precede it.

In these tables the nerves which arise from the cerebro-spinal axis will be found considered in the following order.

A. THE CRANIAL NERVES.
B. THE NERVES OF THE CERVICAL REGION.
C. THE NERVES OF THE UPPER EXTREMITY.
D. THE NERVES OF THE DORSAL REGION.
E. THE NERVES OF THE LUMBAR REGION.
F. THE NERVES OF THE SACRAL REGION.
G. THE NERVES OF THE LEG AND FOOT.

CRANIAL NERVES.

- 1st Cranial (OLFACTORY).
  - 1st set—to roof of nose.
  - 2nd set—to upper third of septum.
  - 3rd set—to superior and middle turbinated bones.
- 2nd Cranial (OPTIC)....
  - Retinal branches.
- 3rd Cranial (MOTOR OCULI).
  - (1) *Superior* branch (to superior rectus and levator palpebræ).
  - (2) *Inferior* branch to
    - Internal rectus.
    - Inferior rectus.
    - Inferior oblique....
      - Branch to *ciliary ganglion.*
- 4th Cranial — TROCHLEARIS, or PATHETICUS...
  - Supplies the superior oblique muscle
- 5th Cranial (TRIGEMINUS).
  - A. OPHTHALMIC nerve.
    - (1) *Lachrymal* branch.
    - (2) *Frontal* branch.
      - Supra-orbital nerve.
      - Supra-trochlear nerve.
    - (3) *Nasal* branch.
      - Ganglionic nerve (to ciliary ganglion).
      - Long ciliary nerves.
      - Infra-trochlear nerves.
      - Internal set..
        - To septum of nose.
      - External set.
        - Mucous membrane and *integument* of nose.
  - B. SUPERIOR MAXILLARY.
    - In spheno-maxillary fossa.
      - Orbital or temporo-malar nerve.
      - Spheno-palatine nerves (to Meckel's ganglion).
      - Posterior dental nerve.
        - Superficial dental branches.
        - Deep dental branches.
    - In infra-orbital canal.
      - Anterior dental nerve.
    - On the face
      - Palpebral branches.
      - Nasal branches.
      - Labial branches.
  - C. INFERIOR MAXILLARY.
    - From anterior trunk.
      - (1) *Masseteric* branch.
      - (2) *Deep temporal.*
        - Anterior.
        - Posterior.
      - (3) *Buccal* branch.
      - (4) *Pterygoid.*
        - Internal.
        - External.
    - From posterior trunk.
      - (1) *Auriculo-temporal* nerve.
        - Auricular.
        - Temporal.
      - (2) *Gustatory* nerve.
      - (3) *Inferior dental* nerve.
        - Mylo hyoid.
        - Incisor.
        - Mental.
        - Dental.
- 6th Cranial (ABDUCENS).
  - Supplies the external rectus muscle.

7th Cranial (FACIAL)
- *Branches of communication.*
  - In the *auditory canal.*
    - Branch to auditory nerve.
  - In the *aqueductus Fallopii.*
    - *Large petrosal* (to Meckel's ganglion),
    - *Small petrosal* (to Otic ganglion).
    - *External petrosal* (to meningeal plexus.
  - At its exit from the *stylo-mastoid foramen*, with the following nerves.
    - Great auricular.
    - Auriculo-temporal,
    - Pneumogastric.
    - Glosso-pharyngeal.
    - Carotid plexus.
  - On the face.
    - Branches to 5th nerve.
- *Branches of distribution.*
  - In the *aqueductus Fallopii.*
    - *Tympanic* nerve.
    - *Chorda-tympani* nerve.
  - Near the *stylo-mastoid foramen.*
    - Posterior auricular nerve.
    - Digastric branch.
    - Stylo hyoid branch.
  - On the *face.*
    - Temporo-facial nerve.
    - Cervico-facial nerve.

8th Cranial (AUDITORY)
- *Vestibular* branch
  - Filaments to the utricle.
  - Filaments to the saccule.
  - Filaments to the ampullæ.
- *Cochlear* branch
  - Cochlear plexus.
  - Radiating fibres.
  - Filaments to organ of Corti.

9th Cranial (GLOSSO-PHARYNGEAL).
- (1) Tympanic, or "*Jacobson's nerve.*"
  - *Communicating* nerves
    - Large petrosal.
    - To carotid plexus.
    - Small petrosal.
  - Branches of distribution to
    - Fenestra ovalis.
    - Fenestra rotunda.
    - Eustachian tube.
- (2) Carotid branches.
- (3) Pharyngeal branches (help to form *pharyngeal plexus*).
- (4) Muscular branches (to muscles of pharynx).
- (5) Tonsillar branches (help to form *tonsillar plexus*).
- (6) Lingual branches.

- 10th Cranial. PNEUMOGASTRIC.
  - (1) *Auricular branch* (Arnold's nerve).
    - *Integument* of pinna.
    - Ascending filaments (join facial nerve).
    - Descending filaments (join auricular branch of the facial nerve).
  - (2) Pharyngeal branches (help to form pharyngeal plexus).
  - (3) SUPERIOR LARYNGEAL nerve.
    - External laryngeal branch.
    - Internal laryngeal branch.
  - (4) RECURRENT LARYNGEAL nerve
    - Supplies the *muscles of phonation.*
  - (5) Cardiac branches......
    - *Cervical cardiac* nerves.
    - *Thoracic cardiac* nerves.
  - (6) Pulmonary branches...
    - *Anterior pulmonary.*
    - *Posterior pulmonary.*
  - (7) Œsophageal branches.
  - (8) Gastric branches.
  - (9) Hepatic branches.

- 11th Cranial (SPINAL ACCESSORY)....
  - *Accessory* portion (by means of sheath of *pneumogastric nerve.*)
    - Branches to pharyngeal plexus.
    - Branches to *superior laryngeal nerve.*
    - Branches to *recurrent laryngeal nerve.*
  - *Spinal portion*......
    - Branch to sterno-mastoid muscle.
    - Branch to trapezius muscle.
    - *Communicating branches* to....
      - 2nd cervical nerve.
      - 3rd cervical nerve.
      - 4th cervical nerve.
      - 5th cervical nerve.

- 12th Cranial (HYPOGLOSSAL) .....
  - Branches of *communication.*
    - To *ganglion of the trunk* of the pneumogastric.
    - To *superior cervical ganglion* of the sympathetic.
    - To loop between the 1st and 2nd cervical nerves.
    - To the *gustatory* nerve.
  - Branches of *distribution.*
    - *Descendens noni nerve.*
    - To thyro-hyoid muscle.
    - To genio-hyoid muscle.
    - To stylo-glossus muscle.
    - To hyo-glossus muscle.
    - To genio-hyo-glossus muscle.
    - To the substance of the tongue.

SUMMARY OF THE CRANIAL NERVES.

The cranial nerves may be subdivided, according to the peculiar *function* of each, into four groups, which may be enumerated as follows:

A.

Nerves of Special Sense.

Olfactory (smell).
Optic (sight).
Auditory (hearing).
Part of glosso-pharyngeal. } Taste.
Gustatory branch of fifth ? } Taste.

B.

Nerves of Motion.

Motor oculi.
Patheticus or trochlearis.
Part of third division of 5th.
Abducens or 6th nerve.
Facial.
Spinal accessory.
Hypoglossal.

C.

Nerves of Common Sensation.

Fifth (greater portion).
Part of glosso-pharyngeal.

D.

Mixed Nerves.

Pneumogastric.

All of the cranial nerves possess what is called a *superficial* and a *deep point of origin* from the substance of the brain; and all escape from one or more of the cranial foramina.

In the preceding tables, both the points of origin and the foramina of escape have been omitted, since the first can best be memorized by arranging the point of origin of the twelve separate nerves together, and since the latter has already been fully given in a *preceding table of the foramina of the skull* and *the parts contained in each*, which will be found in the closing pages, descriptive of the *skull in general.* The deep points of origin of the cranial nerves will not be given in this work, since they are, at present, too much matters of dispute to allow of any positive or absolute statement.

Apparent Origin of the Cranial Nerves.

(1) Olfactory nerve	From the *olfactory bulbs.*
(2) Optic nerve	By the *optic tracts*, from the *corpora quadrigemina.*
(3) Motor oculi nerve	*Front part* of *pons Varolii.*
(4) Trochlear nerve	*Upper part* of *valve of Vieussens.*
(5) Trifacial nerve	*Side* of the *pons Varolii.*
(6) Abducens nerve	*Corpus pyramidale*, close to pons Varolii.
(7) Facial nerve	*Lateral tract* of *medulla oblongata.*
(8) Auditory nerve	*Lineæ transversæ* of 4th ventricle.
(9) Glosso-pharyngeal nerve	*Groove* between *olivary* and *restiform bodies* in medulla oblongata.
(10) Pneumogastric or vagus nerve	*Lateral tract* of medulla oblongata.
(11) Spinal accessory nerve	*Lateral tract* of medulla oblongata and the *spinal cord* (to 5th cervical).
(12) Hypoglossal nerve	*Groove* between *olivary* and *pyramidal bodies* in medulla oblongata.

The *first pair* of cranial nerves resemble the nerves of the *sympathetic system*, since they are small in size, soft in texture, and destitute of the white substance of Schwann. The *olfactory tracts*, by some anatomists, are described as a part of the olfactory nerve.

The *second pair* of cranial nerves are each pierced by the arteria centralis retinæ, and are distributed to one of the layers of the retina. An association of an important character exists between these nerves and the third pair of nerves, which regulates the *adaptation of the pupil* to the amount of light required by the eye.

The *third pair* of nerves, from their association with the ciliary ganglia of the orbits, control the *contraction of the pupils*, in addition to being the *great motor nerves of the muscles of each eyeball.*

The *first four pairs of cranial nerves*, in addition to the *first branch of the fifth pair* (ophthalmic nerve), have important relations within the cavernous sinus, before their exit from the cranial cavity; and they bear relations also with each other, both during their passage through and after their exit from the sphenoidal fissure, and subsequently within the orbit.

The nerves which go to the *orbit* comprise the 2nd, 3d and 4th cranial nerves, the ophthalmic branch of the 5th, the orbital branches of the superior maxillary nerve and of Meckel's ganglion, and the 6th nerve. Some of these nerves have important relations in one or all of the three following situations: 1. In the cavernous sinus. 2. In the sphenoidal fissure. 3. In the cavity of the orbit itself.

The relations in the *cavernous sinus* will be found in the description of that sinus, in the chapter upon the veins.

In the *sphenoidal fissure*, the 4th nerve, and two branches of the ophthalmic pass *above the external rectus* muscle of the eye, *viz.*, the frontal and lachrymal branches; while *four nerves pass between the two heads of that muscle*, in the following order from above downwards; *viz.*, the superior division of the 3d nerve, the nasal branch of the ophthalmic nerve, the lower division of 3d and the 6th nerve.

In the *orbit*, *three nerves lie above the muscles* in close contact with the periosteum, *viz.*, the ones which pass above the external rectus muscle, in the sphenoidal fissure; and the *other four nerves* lie in the same order from above downwards in the orbit, as they did between the two heads of that muscle.

Each of the FIFTH PAIR of nerves after its exit from the skull, has connected with it *four ganglia* of the sympathetic system; each of which receives a *motor*, a *sensory*, and a *sympathetic* nerve filament, and which gives off subsequent branches of *distribution*. These ganglia are called the ciliary ganglion (ophthalmic or lenticular), the spheno-palatine or Meckel's ganglion, the Otic ganglion, and the submaxillary ganglion. The formation and distribution of each of these ganglia is as follows.

CILIARY GANGLION.

This ganglion is often called the *ophthalmic ganglion*, from its relation with the ophthalmic artery and nerve, and the *lenticular ganglion*, from its shape. It is the size of a pin's head, and is situated at the back of the orbit, upon the outer side of the optic nerve.

Its *sensory root* arises from the nasal branch of the ophthalmic.

Its *motor root* arises from the third cranial nerve.

Its *sympathetic root* arises from the cavernous plexus.

Its *branches* are distributed to the *ciliary muscle* and the *iris*.

MECKEL'S GANGLION.

This ganglion, called the *spheno-palatine ganglion*, is connected with the *second division* of the fifth pair of cranial nerves. It is situated in the spheno-maxillary fossa, and is of large size.

Its *sensory root* arises from the superior maxillary nerve.

Its *motor root* is derived from the Vidian nerve (by means of a branch of the facial).

Its *sympathetic* root is derived from the carotid plexus.

The two latter roots of Meckel's ganglion are both conveyed to it by means of the Vidian nerve, which, in reality consists of carotid filaments and the large petrosal branch of the facial nerve.

The *branches of distribution* of Meckel's ganglion are as follows:

By its *anterior palatine branch*, to the hard palate and nares.

By its *posterior palatine branch*, to the tonsils and soft palate.

By its *superior nasal branch*, to the nares and antrum.

By its *naso-palatine branch*, to the roof of the nose, the septum, and the hard palate.

By its *pterygo-palatine branch*, to the mucous membrane of the pharynx.

Otic Ganglion.

This ganglion is situated on the inferior maxillary nerve, just below the foramen ovale.

Its *sensory root* arises from the auriculo-temporal nerve.

Its *motor root* arises from the internal pterygoid nerve.

Its *sympathetic root* springs from a plexus on the middle meningeal artery.

Its *branches of distribution* supply the tensor palati and the tensor tympani muscles.

Submaxillary Ganglion.

This ganglion is situated between the gustatory nerve and the submaxillary gland. It is about the size of a pin's head.

Its *sensory root* arises from the gustatory nerve.

Its *motor root* arises from the chorda tympani nerve.

Its *sympathetic root* arises from a plexus around the facial artery.

Its *branches of distribution* supply the submaxillary gland and its duct.

The fifth nerve, before its division into branches, has developed upon *its sensory portion* a swelling, called the *Gasserian ganglion*, which is crescentic in shape, and which is situated at the apex of the petrous portion of the temporal bone.

The *superior maxillary division* of the fifth nerve passes, through the foramen rotundum, into the spheno-maxillary fossa, then into the infra-orbital canal, then through the infra orbital foramen, upon the face. It is thus divided into three distinct portions, from each of which branches are given off, as shown on page 466 of this work.

The *inferior maxillary division* of the fifth nerve joins, after its exit through the foramen ovale, with the motor root of that nerve, and thus becomes both a *motor and a sensory nerve*.

The *auriculo-temporal nerve* is pierced by the middle meningeal artery.

The FACIAL nerve, as is represented in the table of its branches, on page 467, pursues a very indirect course. It passes successively through the internal auditory canal, the aqueductus Fallopii, the stylo-mastoid foramen, and is then distributed upon the face. In each of these four portions, it gives off branches, some of which are of great importance. The facial nerve supplies all the muscles of expression.

The *large petrosal branch* escapes into the cranium through the hiatus Fallopii; it then passes out of the skull, through the foramen lacerum medium; then unites with filaments of the carotid plexus to become the Vidian nerve; and then passes through the Vidian canal to join with Meckel's ganglion.

The *chorda tympani nerve* passes first through a canal, parallel with the aqueductus Fallopii; it then enters the tympanum through the iter chordæ posterius; then runs along the upper border of the drum membrane of the ear; then enters the iter chordæ anterius, then passes through the canal of Huguier; then joins the gustatory nerve, between the two pterygoid muscles; and is subsequently distributed to the lingualis muscle and the submaxillary gland. By some authorities, the origin of this nerve is traced to a filament called the *portio intermedia*, or the *nerve of Wrisberg.*

This nerve is now supposed to give to the gustatory nerve the power of *appreciating taste*, and for that reason is classed by some as a nerve of special sense.

THE GLOSSO-PHARYNGEAL nerve gives the sense *of taste* to the *posterior third of the tongue.* Its tympanic branch is called *Jacobson's nerve* and is distributed to the internal structures of the ear. This nerve has *two ganglia* developed upon it, one of which is called the *ganglion of Andersch*, and the other the *jugular ganglion.*

The PNEUMOGASTRIC nerve, called also the *vagus nerve*, is one of the most important nerves in the human body. In the neck, it bears an intimate relation to the internal and common carotid arteries and to the internal jugular vein; by its laryngeal branches, it controls the muscles of voice; by its cardiac branches, it exerts a powerful influence over the heart's action; by its pulmonary branches, it becomes the great excitory nerve of respiration; while, by its gastric and hepatic branches, it exerts some influence upon the digestive functions. It has *two ganglia upon it*, one in, and one below the jugular foramen, which are called, respectively, the *jugular ganglion* or the *ganglion of the root*, and the *inferior ganglion* or the *ganglion of the trunk.*

The *recurrent laryngeal nerve*, so called because it winds around the subclavian artery upon the right side, and, upon the left side, around the aorta, before it ascends to the larynx, is the great *nerve of phonation.* It is said to consist principally of fibres derived from the *spinal accessory nerve*, which have simply used the sheath of the pneumogastric nerve for protection, during their course through the neck.

The SPINAL ACCESSORY nerve, by its branches of communication with the pneumogastric nerve, as above mentioned, gives origin, through fibres derived from its accessory portion, to the *two nerves of phonation.* The fibres derived from its spinal portion are mostly distributed to muscles and the cervical nerves of the upper portion of the neck.

This nerve has been often called the "*superior respiratory nerve of Bell*," since it affords the motor power to the muscles which open the glottis, previous to each inspiration, and thus it allows air to enter the lung without impediment.

The HYPOGLOSSAL nerve gives off only one branch which possesses any surgical interest, *viz.*, the *descendens noni nerve*, which descends in front of the sheath of the common carotid artery, and communicates with the communicans noni nerve, a branch derived from the cervical plexus.

NERVES OF THE CERVICAL REGION.

- 1ST CERVICAL NERVE (*Sub-occipital*)..
  - Posterior division.
    - Branch to posterior division of 2nd cervical.
    - Branches to the *posterior cranio-vertebral set* of muscles.
    - Branch to complexus muscles.
    - Branch to *integument of occiput.*
  - Anterior division.
    - Branch to rectus cap. ant. major.
    - Branch to rectus cap. ant. minor.
    - Branch to rectus cap. lateralis.
    - *Communicating branches* to
      - 2nd Cervical.
      - Pneumogastric.
      - Hypoglossal.
      - Superior cervical ganglion.
- 2ND CERVICAL NERVE..
  - Posterior division (very large in size).
    - External branch (Supplying)..
      - Splenius.
      - Cervicalis ascendens.
      - Transversalis colli
      - Trachelo-mastoid.
      - Complexus.
    - Internal branch. (*Great occipital nerve.*
      - Joins with 1st cervical nerve.
      - Supplies integument of occiput as far as vertex.
  - Anterior division.
    - Filament to sterno-mastoid.
    - Ascending branch (to 1st cervical nerve)
    - Descending branch (to 3d cervical nerve)
    - Filament to communicans noni nerve.
    - *Small occipital nerve* (occipitalis minor).
- 3RD CERVICAL NERVE..
  - Posterior division.
    - External branch (Supplying)..
      - Splenius.
      - Cervicalis ascendeus.
      - Transversalis colli
      - Trachelo-mastoid.
    - Internal branch. (Supplying)..
      - *Integument of occiput.*
  - Anterior division.
    - Ascending branches.
      - *Auricularis magnus.*
      - *Superficial cervical*
      - Branch to second cervical nerve.
      - Branch to the spinal accessory.
    - Descending branches.
      - Filament to fourth nerve.
      - Filament to levator anguli scapulæ.
      - *Supra-clavicular.*

- 4TH CERVICAL NERVE..
  - Posterior division..(distributed to muscles of the back).
  - Anterior division..
    - Filament to 3rd cervical nerve.
    - Filament to 5th cervical nerve.
    - Filament to *phrenic nerve.*
    - Filament to scalenus medius.
    - Filaments to *supra-clavicular nerve*

CERVICAL PLEXUS OF NERVES.

- Anterior branch of 1st CERVICAL nerve. / Anterior branch of 2D CERVICAL nerve. / Anterior branch of 3D CERVICAL nerve. / Anterior branch of 4TH CERVICAL nerve.
  - CERVICAL PLEXUS.
    - SUPERFICIAL BRANCHES. (integumentary).
      - Ascending set.
        - Occipitalis minor.
        - Auricularis magnus.
        - Superficialis colli.
      - Descending set.
        - Supra-clavicular branches.
    - DEEP BRANCHES.
      - Internal set.
        - Communicating.
        - Muscular
          - Rect. cap. ant. major.
          - Rect. cap. ant. minor.
          - Rect. cap. lateralis.
        - *Communicans noni.*
        - PHRENIC.
      - External set.
        - Muscular
          - Sterno-mastoid.
          - Levator anguli scap.
          - Trapezius.
          - Scalenus med.
        - Communicating.

SUMMARY OF THE CERVICAL NERVES.

The *posterior division* of each of the cervical nerves as shown in the preceding tables, are principally distributed to muscles and have no special names, with the exception of one branch which is derived from the second cervical nerve, and which is called the *great occipital nerve.*

The *anterior divisions* of the first four cervical nerves, however, enter into the formation of the *cervical plexus*, while those of the lower four cervical nerves enter into the formation of the *brachial plexus*, which is not shown in the preceding tables, since the distribution of the latter plexus causes it to be more properly classed among the nerves of the upper extremity.

It will be seen by reference to the preceding table that the cervical plexus is first subdivided into branches which lie near the surface and those more deeply placed; that the *superficial set* comprise *three nerves* which supply the integument, and which pass upwards towards the head ; and *one nerve* with its branches which descends upon the clavicle. The *deep branches* are also divided into two sets, four being called *internal branches*, since they pass towards the median line of the body, and two being called *external branches*, since they pass away from the median line.

Of these ten nerve trunks given off from this cervical plexus, the PHRENIC NERVE is the most important. This nerve arises by three heads, derived from the 3rd, 4th and 5th cervical nerves, and descends along the inner aspect of the chest, being situated in the middle mediastinum, and is principally distributed to the diaphragm. It was named by Sir Charles Bell, and is still often called the *internal respiratory nerve*, since it passes internal to the chest wall. This nerve bears important relations to the subclavian artery, in the first and second portions of that vessel, and therefore possesses great surgical importance. Below the diaphragm, the phrenic nerves assist to form some of the plexuses of the sympathetic.

The *comunicans noni nerve* also possesses surgical importance since it joins with the descendens noni nerve and ramifies on the front part of the sheath of the common carotid artery.

The rest of the branches of the cervical plexus are distributed either to muscles or the integument, or act as branches of communication to other nerves.

The *cervical plexus* of nerves lies beneath the sterno-mastoid muscle, and in front of the levator anguli scapulæ and the scalenus medius muscles.

NERVES OF THE UPPER EXTREMITY.

THE BRACHIAL PLEXUS.

- From *outer* cord of
  - Anterior division of 5TH CERVICAL nerve.
  - Anterior division of 6TH CERVICAL nerve.
  - Anterior division of 7TH CERVICAL nerve.
- From *inner* cord of......
  - Anterior division of 8TH CERVICAL nerve.
  - Anterior division of 1ST DORSAL nerve.

BRACHIAL PLEXUS.

- Branches *above* the clavicle.
  - Posterior thoracic (*external respiratory nerve of Bell*).
  - Supra-scapular.
    - Supra-spinatus.
    - Infra-spinatus.
    - Shoulder joint.
  - Muscular.. (8)
    - Rhomboidei muscles
    - Subclavius.
    - Scaleni muscles.
    - Longus colli.
    - Levator anguli scapulæ.
  - Communicating (to phrenic nerve).
- Branches *below* the clavicle.
  - From *inner* cord......
    - Internal anterior thoracic.
    - Internal cutaneous.
    - Lesser internal cutaneous (Wrisberg's nerve).
    - Inner head of median nerve.
    - Ulnar nerve.
  - From *outer* cord......
    - External anterior thoracic.
    - External cutaneous.
    - Outer head of median nerve.
  - From * *posterior* cord..
    - 1st subscapular nerve
    - 2d subscapular nerve
    - 3d subscapular nerve
    - Musculo-spiral nerve
    - Circumflex nerve.

* The *posterior cord* of the brachial plexus is formed by a branch from both the inner and outer cord.

BRANCHES OF THE BRACHIAL PLEXUS.

OUTER CORD.

Branches of the OUTER CORD of the Brachial Plexus.

- (1) EXTERNAL ANTERIOR THORACIC.
  - Pectoralis major.
- (2) EXTERNAL or MUSCULO CUTANEOUS.
  - Anterior branch.
    - *Integument* of the front of forearm.
    - *Integument* of ball of thumb.
    - Joins with the radial nerve.
  - Posterior branch.
    - *Integument* of radial side of back of forearm
    - Joins with the radial nerve.
    - Joins with the external cutaneous branch of the musculo-spiral.
- (3) MEDIAN.
  - In forearm.
    - Muscular. . .
      - Pronator radii teres.
      - Flexor carpi radialis.
      - Palmaris longus.
      - Flexor sublimis digitorum.
    - Anterior Interosseous.
      - Flexor longus pollicis.
      - Flexor profundus digitorum
      - Pronator quadratus.
    - Palmar Cutaneous.
      - *Integument* of palm.
      - *Integument* of ball of the thumb.
  - In the hand. . .
    - External Branch.
      - Abductor pollicis.
      - Opponens pollicis.
      - Flexor brevis pollicis (outer head).
      - Digital to thumb.
      - Digital to index finger.
    - Internal Branch.
      - Digital to contiguous sides of index, middle, and ring fingers.
      - Filaments to the two outer lumbricales muscles.

BRANCHES OF THE BRACHIAL PLEXUS.

INNER CORD.

Branches of the INNER CORD of the Brachial Plexus.

- (1) INTERNAL ANTERIOR THORACIC.
  - Both Pectoral muscles.
- (2) INTERNAL CUTANEOUS.
  - Anterior branch.
    - *Integument* of the anterior surface of the inner side of the forearm as low as the wrist.
  - Posterior branch.
    - *Integument* of the posterior surface of the inner side of the forearm to near the wrist.
- (3) LESSER INTERNAL CUTANEOUS. (Wrisberg.)
  - *Integument* of the posterior surface of the lower third of the arm.
- (4) ULNAR.
  - In the forearm.
    - Articular (to elbow joint).
    - Muscular....
      - Flexor carpi ulnaris.
      - *Inner* half of flexor profundus digitorum.
    - Palmar cutaneous.
      - *Integument* of front of wrist and palm of hand.
    - Dorsal cutaneous.
      - *Integument* at back of wrist and $1\frac{1}{2}$ fingers on inner side of dorsal surface of hand.
    - Articular....
      - To wrist joint.
  - In hand.
    - Superficial branches.
      - Palmaris brevis.
      - *Integument* of inner $1\frac{1}{2}$ fingers on palm.
    - Deep branches.
      - Muscles of little finger.
      - Interossei muscles.
      - The two inner lumbricales.
      - Adductor pollicis.
      - Flexor brevis pollicis (inner head).

BRANCHES OF THE BRACHIAL PLEXUS.

POSTERIOR CORD.

Branches of the POSTERIOR CORD of the Brachial Plexus.

- (1) SUBSCAPULAR NERVES.
  - The *upper* or 1st. — Subscapular muscle.
  - The *long* or 2nd. — Latissimus dorsi.
  - The *lower* or 3rd. — Teres major.
- (2) CIRCUMFLEX
  - Superior branch.
    - Deltoid.
    - *Integument* over the shoulder.
  - Inferior branch.
    - Teres minor.
    - Deltoid (posterior portion).
    - *Integument* over the shoulder.
- (3) MUSCULO-SPIRAL.
  - *Muscular* branches
    - Triceps.
    - Anconeus.
    - Brachialis anticus.
    - Supinator longus.
    - Extensor carpi radialis longior.
  - *Cutaneous* branches
    - *Integument* of the inner and posterior portions and the outer and anterior portion of arm.
    - *Integument* of the outer aspect of the forearm
  - RADIAL.
    - External branch.
      - *Integument* of outer side of thumb.
      - *Integument* of ball of the thumb.
    - Internal branch.
      - *Integument* of $3\frac{1}{2}$ fingers on radial side of dorsum of hand.
  - POSTERIOR INTEROSSEOUS.
    - All muscles on back of forearm except three ....
      - Anconeus.
      - Supinator longus.
      - Ext. carp. rad. long.
    - Filaments to wrist joint.

SUMMARY OF THE NERVES OF THE UPPER EXTREMITY.

The BRACHIAL PLEXUS consists of three cords, called the outer cord, the inner cord, and the posterior cord. The outer and inner cords are formed directly by the anterior branches of the spinal nerves, while the posterior cord is formed independently of the spinal nerves, by a branch given off from each of the other two cords. This plexus of nerves lies between the scalenus anticus and the scalenus medius muscles, and is very broad at its commencement, but becomes constricted as it enters the arm.

The brachial plexus of nerves bear an important surgical relation to the second and third portions of each subclavian artery, and to the first and second portions of each axillary artery. The third portion of each axillary artery bears relation to its branches, but not to its main cords.

The brachial plexus, within the neck, is pierced by the transversalis colli artery. The following branches of special importance are given off above the line of the clavicle.

1. A *communiating* branch, which completes the phrenic nerve.
2. The *posterior thoracic nerve*, which arises by two heads, one from the fifth and one from the sixth cervical nerves, and which is distributed to the serratus magnus muscle. Since it assists inspiration, and as it passes down upon the external aspect of the chest, it is frequently called the "*external respiratory nerve of Bell.*"

The brachial plexus of nerves, below the level of the clavicle, lies to the *outside* of the *first portion* of the axillary artery, while in the *second portion* of that vessel, its three cords *surround* it, and, in the *third portion* of that vessel, the *branches* of each of the three cords bear a relation to the artery.

The MEDIAN NERVE is the most important branch of the outer cord, and bears relations with the brachial artery, in the arm and at the bend of the elbow. It passes between the two heads of the pronator radii teres muscle, and is distributed, in the hand, to the integument of the *outer three fingers and half of the palm*. The muscles supplied by this nerve are shown on page 479 of this volume, and also in a table inserted in the chapter on myology.

The ULNAR NERVE is the most important branch of the inner cord of the brachial plexus. It bears an important relation to ths elbow-joint at the inner condyle of the humerus, where it passes between the two heads of the flexor carpi ulnaris muscle. It is frequently jarred by blows, in that vicinity, giving the sensation, called "injury to the funny bone." In the incision of the elbow-joint, this nerve has particularly to be avoided. It supplies the *elbow* and *wrist joints*, and the integument of the *internal one and a half fingers*, on both the *palmar* and the *dorsal surface of the hand.*

The muscles supplied by this nerve are shown on page 480 of this volume, and in a previous table under myology.

The MUSCULO-CUTANEOUS NERVE pierces the coraco-brachialis muscle and is often called, for that reason, the "perforans Casserii."

The CIRCUMFLEX NERVE is an important branch of the posterior cord of the brachial plexus and supplies the *shoulder-joint*, the deltoid and teres minor muscles, and the integument of the shoulder. It accompanies the posterior circumflex vessels.

The MUSCULO-SPIRAL NERVE arises from the posterior cord of the brachial plexus, and is the largest branch of that plexus. At the external condyle of the humerus, which it reaches by passing around that bone in the spiral groove, it divides into two nerves called the *radial* and the *posterior interosseous nerves.* Before its division, it supplies two muscles of the arm and three of the forearm, and the integument of portions of both the arm and forearm.

The RADIAL NERVE, a branch of the musculo-spiral nerve, lies on the *outer side* of the radial artery and in close relation to it in the middle portion of the forearm. It supplies the outer side and the ball of the thumb, and the integument of the *outer three and a half of fingers*, upon the *back* of the hand.

The POSTERIOR INTEROSSEOUS NERVE, a branch of the musculo-spiral, supplies *all the muscles on the back of the forearm*, excepting the three which are supplied by the musculo-spiral before this nerve was given off. It also sends a filament to the wrist-joint.

NERVES OF THE DORSAL REGION.

DORSAL NERVES.	POSTERIOR DIVISIONS.	*External* branches	In upper 6 nerves.	Filaments to transversalis colli.
				Filaments to longissimus dorsi.
				Filaments to trachelo-mastoid.
				Filaments to levatores costarum.
				Filaments to sacro-lumbalis.
				Filaments to accessorius.
			In the lower six nerves.	Same muscles as in preceding bracket.
				Integument of the back.
		Internal branches	In upper six nerves.	Filaments to semispinalis dorsi.
				Filaments to multifidus spinæ.
				Integument of back.
			In lower six nerves.	Same muscles as in preceding bracket.
				No cutaneous filaments.
	ANTERIOR DIVISIONS.	Six upper or *thoracic* intercostals.	Muscular branches	Intercostals.
				Triangularis sterni.
			Lateral cutaneous.	*Integument* of chest and mammæ.
				Upper part of external oblique muscle.
			Anterior cutaneous.	*Integument* over *upper* part of latissimus dorsi and the scapular region.
		Six lower or *thoracico-abdominal* intercostals.	Muscular branches	Intercostals.
				Abdominal muscles.
			Lateral cutaneous	*Integument* of abdomen, as far as the edge of rectus.
				Integument over *lower* part of latissimus dorsi.
			Anterior cutaneous	Upper part of rectus and *integument* in front part of abdomen.

SUMMARY OF THE NERVES OF THE DORSAL REGION.

In the preceding table, which illustrates the distribution of the nerves of the dorsal region, it will be perceived that the largest proportion of the branches are distributed to the muscles of the back, the muscles of the abdomen, and the integument of the trunk in general. The integumentary distribution of special nerves is rapidly assuming a great practical importance, since, by a thorough knowledge of these branches, lesions of nerve trunks and of the spinal cord itself can often be localized with precision.

The *posterior divisions* of the dorsal nerves are distributed to the muscles and integument, chiefly of the back; while the *anterior divisions* of the dorsal nerves are distributed to the thoracic and abdominal muscles and to the integument of the various regions of the chest and abdomen.

The *first intercostal nerve* enters almost entirely into the formation of the *brachial plexus;* but it gives off also an intercostal branch which runs along the first intercostal space and terminates at the front part of the thorax.

The *lateral cutaneous branch* of the second intercostal nerve, perforates the second intercostal space and is called the *intercostol-humeral* nerve. It either joins with the *nerve of Wrisberg*, after crossing the axillary space, or it supplies the place of that nerve in case it be wanting.

NERVES OF THE LUMBAR REGION.

- LUMBAR NERVES.
  - POSTERIOR DIVISIONS.
    - *External* branches.
      - Filaments to erector spinæ muscle.
      - Filaments to intertransversales.
      - Filaments to *integument* of back part of gluteal region.
    - *Internal* branches.
      - Filaments to multifidus spinæ muscle
      - Filaments to *integument* near spinal column.
  - ANTERIOR DIVISIONS.
    - 1ST LUMBAR nerve.
    - 2ND LUMBAR nerve.
    - 3RD LUMBAR nerve.
    - 4TH LUMBAR nerve.
    - LUMBAR PLEXUS.
      - Given off by the 1ST LUMBAR NERVE.
        - Ilio-hypogastric nerve.
        - Ilio-inguinal nerve.
        - Communicating to 2nd lumbar.
      - Given off by the 2ND LUMBAR NERVE.
        - Genito-crural nerve.
        - External cutaneous nerve.
        - Communicating to 3rd lumbar.
      - Given off by the 3RD LUMBAR NERVE.
        - Part of anterior crural nerve.
        - Part of obturator nerve.
        - Part of accessory obturator nerve.
        - Communicating to 4th lumbar.
      - Given off by the 4TH LUMBAR NERVE.
        - Part of anterior crural nerve.
        - Part of obturator nerve.
        - Part of accessory obturator nerve.
        - Lumbo-sacral cord.

In this table, the formation of the *lumbar plexus* is shown, as well as the branches which are given off from each nerve which assists to form it.

It will be perceived that three important nerves, *viz.*, the *anterior crural*, the *obturator*, and *accessory obturator* nerves, are formed by branches both of the 3d and 4th lumbar nerves, and therefore may be said to arise by two heads. The *accessory obturator nerve*, however, arises occasionally by a branch derived only from the 4th lumbar nerve; its other head being a branch given off from the obturator nerve.

DISTRIBUTION OF THE BRANCHES OF THE LUMBAR PLEXUS.

LUMBAR PLEXUS.

- (1) ILIO-HYPOGASTRIC.
  - *Iliac branch.* — *Integument* of gluteal region.
  - *Hypogastric branch.* — *Integument* of the hypogastric region.
- (2) ILIO-INGUINAL.
  - Internal oblique muscle.
  - *Integument* of upper and inner portion of thigh.
  - *Integmuent* of scrotum.
  - *Integument* of penis.
  - *Integument* of labium.
- (3) GENITO-CRURAL.
  - *Genital branch.*
    - Cremaster muscle.
    - Scrotum.
    - Round ligament of female.
  - *Crural branch* — *Integument* of the front and upper portion of the thigh.
- (4) EXTERNAL CUTANEOUS.
  - *Anterior branch.* — *Integument* on the anterior and outer aspect of thigh, as low as the knee.
  - *Posterior branch.* — *Integument* of the posterior and outer aspect of the thigh.
- (5) ANTERIOR CRURAL.
  - Anterior division.
    - *Middle cutaneous nerve*
      - The sartorius muscle.
      - *Integument* of anterior aspect of thigh, as low as the knee.
    - *Internal cutaneous nerve.*
      - External branch. — *Integument* of inner and outer sides of knee.
      - Posterior branch. — *Integument* of inner sides of the thigh and the leg.
    - *Long* or *internal saphenous nerve.* — *Integument* of knee joint and front and inner sides of the leg and foot
  - Posterior division.
    - *Muscular* branches. — All the muscles on front of thigh except the *tensor vaginæ femoris* and the *sartorius.*
    - *Articular* branches. — Two in number. Distributed to capsule of knee-joint.

BRANCHES OF LUMBAR PLEXUS.

CONTINUED.

- LUMBAR PLEXUS. (continued)
  - (6) OBTURATOR NERVE
    - Anterior branch.
      - Articular branches.
        - To *hip-joint.*
      - Muscular branches.
        - To gracilis.
        - To adductor longus.
        - To pectineus.
        - To adductor brevis.
      - Anastomotic branches.
        - With internal cutaneous nerve.
        - With internal saphenous nerve.
    - Posterior branch.
      - Articular branches.
        - To *knee-joint.*
      - Muscular branches.
        - Obturator externus.
        - Adductor magnus.
  - (7) ACCESSORY OBTURATOR NERVE..............
    - Muscular branch.
      - To pectineus.
    - Articular branches.
      - To *hip-joint.*
    - Cutaneous branches.
      - To the *integument* of thigh and leg.

SUMMARY OF THE NERVES OF THE LUMBAR REGION.

In the preceding tables, which illustrate the distribution of the nerves of the lumbar region, it will be perceived that the posterior divisions of the lumbar nerves are of little importance as compared with the anterior divisions.

The LUMBAR PLEXUS of nerves is formed from the anterior division of the *first four* lumbar nerves, each one of which nerves gives off, in addition to a communicating branch, some special branches of its own, which are included among the various branches of the lumbar plexus.

This plexus is situated in the *substance of the psoas magnus muscle.*

The ANTERIOR CRURAL NERVE arises by two heads from the 3rd and 4th lumbar nerves. It bears an important relation, in Scarpa's space, with the femoral artery and its accompanying vein; since all three pass underneath Poupart's ligament. It sends an articular branch to the *knee-joint.*

The OBTURATOR NERVE arises by two heads, derived respectively from the 3rd and 4th lumbar nerves, and, after its exit from the pelvis, bears an intimate relation with the capsular ligament of the hip-joint, to which joint, as well as to the knee, it sends articular filaments. It is on account of this nerve, whose distribution to *two joints* has been mentioned, that disease of the hip-joint frequently manifests itself, in its early stages, by pain within the knee.

The *accessory obturator nerve*, if it exists, usually arises by two heads derived from the 4th lumbar and the obturator nerves. It sends a filament to the hip-joint.

NERVES OF THE SACRAL REGION.

- SACRAL NERVES.
  - Posterior divisions.
    - External branches.
      - Form anastomotic loops on back part of sacrum and on the posterior aspect of the great sacro-sciatic ligament.
      - Terminate in *cutaneous branches* in the gluteal region.
    - Internal branches.
      - Are distributed to the multifidus spinæ muscle.
      - The back part of the coccyx is supplied by the lower two nerves.
  - Anterior divisions.
    - Lumbo-sacral cord.
    - 1ST SACRAL nerve.
    - 2ND SACRAL nerve.
    - 3RD SACRAL nerve.
    - PART of 4TH SACRAL nerve.
    - (all forming the) SACRAL PLEXUS.
      - (1) SUPERIOR GLUTEAL NERVE.
      - (2) MUSCULAR BRANCHES.
      - (3) SMALL SCIATIC NERVE.
      - (4) GREAT SCIATIC NERVE.
      - (5) PUDIC NERVE.

DISTRIBUTION OF THE BRANCHES OF THE SACRAL PLEXUS.

SACRAL PLEXUS

- SUPERIOR GLUTEAL.
  - *Superior* branch
    - Gluteus medius muscle.
    - Gluteus minimus muscle.
  - *Inferior* branch.
    - Gluteus medius muscle.
    - Gluteus minimus muscle.
    - Tensor vaginæ femoris.
- MUSCULAR branches.
  - Pyriformis.
  - Obturator internus.
  - Gemellus superior.
  - Gemellus inferior.
  - Quadratus femoris
- ARTICULAR branches.
  - To hip-joint.
- SMALL SCIATIC.
  - *Inferior gluteal* branch.
    - Gluteus maximus muscle.
  - *Inferior pudendal* branch.
    - *Integument* of perineum.
    - *Integument* of upper and inner part of the thigh.
    - *Integument* of scrotum or labium.
  - Cutaneous branch.
    - Ascending.
      - *Integument* over gluteus maximus muscle.
    - Descending.
      - *Integument* of inner and outer sides of posterior aspect of the thigh.
- GREAT SCIATIC.
  - Articular (to *hip-joint.*)
  - Muscular......
    - Adductor magnus.
    - Semimembranosus.
    - Semitendinosus.
    - Biceps flexor cruris.
  - Terminal......
    - EXTERNAL POPLITEAL.
    - INTERNAL POPLITEAL.
- PUDIC NERVE.
  - *Perineal*.......
    - *Cutaneous* or *superficial perineal.*
      - *Integument* of anal region, scrotum, penis and labia.
      - Sphincter ani muscle.
    - Muscular....
      - Muscles of the perineum.
  - Inferior hemorrhoidal.
  - *Dorsal nerve* of *penis.*
    - *Integument* of the dorsum and sides of penis.
    - Branch to corpora cavernosa.

SUMMARY OF THE NERVES OF THE SACRAL REGION.

The SACRAL PLEXUS is seen, in the preceding tables, to be formed by the *four upper sacral nerves*, and, in addition, by the *lumbo-sacral cord*. It is triangular in shape and rests upon the pyriformis muscle. It is covered by the pelvic fascia and the two terminal branches of the anterior trunk of the internal iliac artery.

The *lumbo-sacral cord*, which by some is not included in the sacral plexus of nerves, gives origin to the *superior gluteal nerve*, which, for that reason, is occasionally omitted from the branches of the sacral plexus.

The SUPERIOR GLUTEAL NERVE accompanies the gluteal vessels through the *upper part* of the *great sacro-sciatic foramen*, and in this situation, lies above the pyriformis muscle. Its branches are shown in a preceding table.

The SMALL SCIATIC NERVE accompanies the sciatic vessels through the *lower part* of the *great sacro-sciatic foramen*, and, in this situation, lies below the pyriformis muscle. Its distribution is given in the preceding table.

The GREAT SCIATIC NERVE arises by five heads, *viz.*, the lumbo-sacral cord and the upper four sacral nerves, and is, in reality, a direct continuation of the sacral plexus. It is the *largest nerve of the body*, and escapes from the cavity of the pelvis, through the great sacro-sciatic foramen, where it lies on the outer side of the pudic vessels and nerve. It sends an articular branch to the *hip-joint*, supplies four muscles to the back of the thigh, and, by its terminal branches, supplies all the muscles of the leg and foot.

The *great sciatic nerve* can be most easily felt at the *fold of the nates*, by pressing between the great trochanter of the femur and the tuberosity of the ischium. The sitting posture of the body, therefore, if directed long towards one side, is liable to produce numbness of the parts supplied by this nerve, on account of the pressure created upon the main nerve trunk.

The PUDIC NERVE arises from the lower part of the sacral plexus and accompanies the pudic artery through both the *greater sacro-sciatic foramen* and the *lesser sacro-sciatic foramen*. Through the former it escapes from the cavity of the pelvis, and, through the latter, it again enters the cavity of the pelvis, having, between these two foramina, wound around the *spine of the ischium*. This peculiar course of the pudic artery and nerve has been explained by some, as an effort on the part of nature to prevent pressure upon these parts, at the spine of the ischium, during labor, since this portion of bone greatly assists in producing rotation of the head of the child.

NERVES OF THE LEG AND FOOT.

EXTERNAL POPLITEAL NERVE. (PERONEAL.)

- (1) Articular branches.
  - Three in number.
  - Distributed to knee-joint.
- (2) Cutaneous branches
  - Two or three in number.
  - Supply *integument* of outer and back part of the leg.
- (3) ANTERIOR TIBIAL NERVE.
  - *Muscular* (to muscles in front part of leg and to the peroneus tertius.)
  - *External* branch.
    - Extensor brevis digitorum.
    - Articulations of the tarsus.
  - *Internal* branch.
    - *Integument* of the adjoining sides of the great and 2nd toes.
- (4) MUSCULO-CUTANEOUS NERVE.
  - *Muscular.*
    - Peroneus longus.
    - Peroneus brevis.
  - *External* branch.
    - *Integument* of outer side of foot and ankle.
    - *Integument* of the adjoining sides of 3rd, 4th and 5th toes.
  - *Internal* branch.
    - *Integument* of the inner side of the foot and ankle.
    - *Integument* of the adjoining sides of 2nd and 3rd toes and inner side of great toe.

NERVES OF THE LEG AND FOOT—Continued.

INTERNAL POPLITEAL NERVE.

- (1) Articular.
  - Three in number.
  - Distributed to knee-joint.
- (2) Muscular.
  - Gastrocnemius.
  - Plantaris.
  - Soleus.
  - Popliteus.
- (3) External Saphenous Nerve.
  - Formed by two filaments, one from each of the popliteal nerves.
  - *Integument* of the outer side of foot and the little toe.
- (4) Posterior Tibial Nerve.
  - Muscular ..
    - Flexor longus pollicis.
    - Flexor longus digitorum.
    - Tibialis posticus.
  - Plantar cutaneous.
    - *Integument* of heel and inner part of sole of foot.
  - Internal Plantar.
    - Digital branches.
      - *Integument* of the 3½ toes on inner side of foot.
    - Muscular ..
      - Flexor brevis digitorum.
      - Abductor pollicis.
      - Flexor brevis pollicis.
      - 2 inner lumbricales muscles.
    - Articular (to tarsus).
    - *Cutaneous* (to sole of foot).
  - External Plantar.
    - Muscular...
      - Flexor accessorius.
      - Abductor minimi digiti.
    - *Superficial* branch.
      - 1½ outer toes.
      - Flexor brevis minimi digiti.
      - 4th interosseous muscle.
    - *Deep* branch.
      - 3rd and 4th lumbricales.
      - Rest of interossei.
      - Adductor pollicis.
      - Transversus pedis.

SUMMARY OF THE NERVES OF THE LEG AND FOOT.

The nerves of the leg and foot are indirectly derived from the great sciatic nerve; since its two terminal branches supply these regions, by the aid of numerous branches of their own, to which special names have been applied.

The EXTERAL POPLITEAL or PERONEAL NERVE is the smaller of the two terminal branches of the great sciatic nerve, but, since it passes along the *outer side* of the popliteal space, it bears no special relation to the popliteal artery. It divides into the anterior tibial and the musculo-cutaneous nerves, about one inch below the head of the fibula. From its close relation with the biceps muscle it is liable to be divided in tenotomy of that muscle.

The *anterior tibial nerve* bears a relation to the anterior tibial artery, and also to the dorsalis pedis artery, by means of its internal branch. Its points of distribution are given in detail, in the preceding tables.

The *musculo-cutaneous nerve* runs between the peronei muscles and the extensor longus digitorum, and divides, after piercing the deep fascia, into its terminal branches, at about the lower third of the anterior aspect of the leg.

The INTERNAL POPLITEAL NERVE is the largest of the two terminal branches of the great sciatic nerve. In the popliteal space, it lies in *intimate relation with the popliteal artery and vein*. At the lower border of the popliteus muscle, after giving off articular and muscular branches, and a branch to assist in forming the external saphenous nerve, it becomes the posterior tibial nerve.

The *posterior tibial nerve* is at first internal and posterior to the posterior tibial vessel, but soon passes to the outer side. It divides into the two plantar nerves in an interval between the inner malleolus and the heel.

The *internal plantar nerve* supplies the *integuuient of three and a half toes on the inner side of the foot*, in addition to some muscles.

The *external plantar nerve* supplies the *integument of one and a half toes on the outer side of the foot* in addition to some muscles.

The *nervous supply of the toes* is as follows:

External saphenous nerve..	Outer side of dorsum of the foot and of the little toe.
Musculo-cutaneous nerve..	Inner $4\frac{1}{2}$ toes on the dorsum of the foot.
Anterior tibial nerve......	Adjoining sides of 1st and 2nd toes on the dorsum of the foot.
Internal plantar nerve....	Inner $3\frac{1}{2}$ toes on the sole of the foot.
External plantar nerve....	Outer $1\frac{1}{2}$ toes on the sole of the foot,

THE SYMPATHETIC NERVES.

The sympathetic nerves are called the nerves of *organic life*, in contra-distinction to the cerebro-spinal nerves, which are called the nerves of animal life. The term "sympathetic" was originally applied to them from the belief that, by means of these nerves, distant organs were made to undergo similar changes through sympathy. This system of nerves controls, to a great extent, nutrition and growth, since its filaments are principally distributed to the *muscular coat of the blood-vessels;* and, by effecting the contraction or relaxation of these muscular fibres, they are enabled to increase or diminish the calibre of the blood-vessels and thus proportionately to increase or diminish the amount of blood distributed to the various portions of the body.

The sympathetic nerves are distributed, like those of the cerebro-spinal system, to all portions of the human body, and are thus enabled to affect the various tissues which enter into the formation of the human framework. The main nerve and its branches are most extensively distributed, either in connection with, or in relation to, the larger trunks of the cerebro-spinal system, and its points of special interest are found in the cranium, the cervical region and in the thoracic, abdominal and pelvic cavities.

The sympathetic system of nerves may be stated, in general, to consist of the following parts:

1. Ganglia.
2. Cords of communication.
3. Branches of distribution.
4. Plexuses.

The GANGLIA of the sympathetic system, are chiefly in relation either with the main divisions of the cerebro-spinal axis, the vertebral column, the various sensory nerve trunks, or the various viscera. They may be divided therefore into those of the cranium, the prevertebral set, the ganglia of the spinal nerves, and the ganglia of the viscera.

Within the *cranium*, and in its *immediate region*, there are found the following ganglia:

Ganglion of Ribes.
Gasserian ganglion.
Meckel's ganglion.
Ciliary ganglion.
Otic ganglion.
Submaxillary ganglion.

Of these ganglia, *five* are connected with the great sensory nerve of the face, namely, the 5*th cranial nerve;* while the remaining *one*, namely, the ganglion of Ribes, is situated upon the *anterior communicating artery* and serves to connect the sympathetic nerves of the *two sides of the body.*

With *each* of the *thirty-one pairs of nerves*, which arise from the spinal cord, there is found to exist a *ganglion* upon the *posterior* or *sensory root* of the nerve. These ganglia may properly be classed with the Gasserian ganglion and the ganglia on the roots of the glosso-pharyngeal and pneumogastric nerves; since they indicate, simply, the intimate communication which exists between the *sensory nerves* of the cerebro-spinal system and the *sympathetic* nerves, in contra-distinction to the absence of such affinity in the motor nerves of the cerebro-spinal axis.

In the *cervical region*, *three ganglia* of the sympathetic system exist which are called as follows:

Superior cervical ganglion.
Middle cervical ganglion, (*thyroid ganglion*).
Inferior cervical ganglion.

The *first* of these is the largest and is situated opposite to the 2d and 3d cervical vertebræ; the *second* is the smallest of the three, and is situated upon the inferior thyroid artery, at a point opposite to the 5th cervical vertebra; while the *third* is situated between the neck of the 1st rib and the transverse process of the last cervical vertebra, and is in relation with the superior intercostal artery.

The *prevertebral set of ganglia* are situated in the vicinity of the head of the ribs and are smaller than the cervical ganglia just mentioned, which, however, properly belong to this set. This group includes the *three* cervical ganglia just mentioned, *eleven* or *twelve* dorsal ganglia, *four* or *five* lumbar ganglia, *five* sacral ganglia, and *one*, which is located upon the coccyx, and which is called the *ganglion impar.*

The *ganglia connected with the viscera* are numerous and are placed principally in the thoracic and the abdominal cavities.

The PLEXUSES of the sympathetic system of nerves are very numerous. The more important ones are as follows:

Carotid plexus.
Cavernous plexus.
Meningeal plexus.
Facial plexus.
Cardiac plexuses.
Coronary plexuses.

Solar or epigastric plexus.
Phrenic plexus.
Cœliac plexus.
Gastric plexus.
Hepatic plexus.
Superior mesenteric plexus.
Suprarenal plexus.
Renal plexus.
Spermatic plexus.
Aortic plexus.
Hypogastric plexus.
Pelvic plexuses.

Most of these plexuses, as their names would indicate, are developed upon *some vessel* and are continued upon its branches; some of the plexuses, above mentioned, are formed to a greater or less extent by nerves derived from larger and more important plexuses; while others possess, from the parts to which they are distributed, special importance.

The *carotid* and *cavernous plexuses* are developed upon the internal carotid artery; the former just before, and the latter after its entrance into the cavernous sinus.

The *cardiac plexuses* are termed the *superficial* and the *deep*; and the two *coronary plexuses* are secondary to them, since they derive from them their principal filaments, although the *pulmonary* plexuses also assist to form them. The *superficial cardiac plexus* is situated beneath the arch of the aorta and in front of the right pulmonary artery, while the *deep*, or *great cardiac plexus* is situated between the trachea and the arch of the aorta. The *anterior coronary plexus* accompanies the left coronary artery, while the *posterior coronary plexus* accompanies the right coronary artery. They are both formed by branches from the cardiac and pulmonary plexuses.

The *solar* or *epigastric plexus* lies behind the stomach and surrounds the cœlic axis and the root of the superior mesenteric artery. It consists of a network of nerves and ganglia, the two largest of which ganglia lie in front of the crura of the diaphragm, and, from their shape are called the *semi-lunar ganglia*. The solar plexus is mainly formed by the *splanchnic nerves* and the *right pneumogastric nerves*, although the left pneumogastric and both of the phrenic nerves have been traced to it. By means of this plexus, the phrenic, the cœliac, the superior mesenteric, the suprarenal, the renal, the spermatic, and the ovarian plexuses are, to a greater or less extent, formed.

The *aortic plexus*, which is also formed largely by the solar plexus, but partly also from other sources, is situated in front of the aorta, between the superior and inferior mesenteric arteries.

The *hypogastric plexus* covers and lies between the two common iliac arteries, and is in close relation with the promontory of the sacrum.

The *pelvic plexuses* are two in number and are situated on either side of the rectum. They are formed by the hypogastric plexus, the sacral ganglia, and the first four sacral nerves. They assist in forming numerous small plexuses, which accompany the various branches of the internal iliac artery, and to which names have been applied, corresponding to the artery upon which the filament are distributed.

The CORDS OF COMMUNICATION which exist between the various parts of the sympathetic system of nerves, may be divided into the following sets.

1. Those connecting the *ganglia of the cranium*, as well as the *prevertebral ganglia*, to the *cranial nerves*.
2. Those connecting the *prevertebral ganglia with each other*, thus forming the *two grand cords* of the sympathetic system, upon either side of the vertebral column.
3. Those connecting the various *prevertebral ganglia* to the *spinal nerves*, which are usually two for each ganglion.
4. Those connecting the *prevertebral ganglia* to the *visceral ganglia*.
5. Those connecting the *various ganglia of the viscera* with each other.

The BRANCHES OF DISTRIBUTION of the sympathetic nerves pass, as a rule, through some of the above mentioned plexuses, and are then scattered among the various organs contained within the thoracic and the abdominal cavities, or are distributed to the various arteries of the trunk, the head and neck, the upper extremity, or the lower extremity.

Among the more important nerves, which belong to the sympathetic system, may be mentioned the following.

1. The superior cardiac nerves.
2. The middle cardiac nerves.
3. The inferior cardiac nerves.
4. The great splanchnic nerve.
5. The lesser splanchnic nerve.
6. The small splanchnic nerve.

The *superior cardiac nerves* of either side, descend from the superior cervical ganglion to the cardiac plexuses.

The *middle cardiac nerves*, the largest of the three, connect the middle cervical ganglion of either side with the deep cardiac plexus.

The *inferior cardiac nerves* connect the inferior cervical ganglia with the deep cardiac plexus.

The *great splanchnic nerve* is formed by branches from several of the thoracic ganglia, and descends, through the posterior mediastinum, till it perforates the crus of the diaphragm, after which it terminates in the semilunar ganglion.

The *lesser splanchnic nerve* arises from the tenth and eleventh thoracic ganglia, pierces the diaphragm with the preceding nerve, and terminates in the cœliac plexus.

The *small splanchnic nerve* arises from the twelfth thoracic ganglion, and, after piercing the diaphragm, terminates in the renal plexus, and in the lower part of the cœliac plexus.

SPLANCHNOLOGY.

THE HEART.

The heart is the hollow muscular organ which propels the blood in the arteries, during life. It is situated within the thoracic cavity, between the lungs, with its base nearly parallel with the median line, and its apex corresponding to the 5th intercostal space and situated one inch to the left of a perpendicular line drawn through the left nipple. It is five inches in length, three and one-half inches in breadth, and two and one-half inches in thickness. In the male, it weighs from ten to twelve ounces, and in the female from eight to ten ounces.

It has *four distinct cavities*, which are named the right and left ventricle, and the right and left auricle. Of these, the ventricles are the more capacious and their walls are of greater thickness. They are lined by a serous membrane, called the *endocardium*, which is continuous with the lining coat of the blood-vessels.

The heart is attached at its base, by means of the aorta, to the posterior wall of the thorax, while its apex is free and capable of a limited amount of motion.

The whole organ is enveloped in a fibrous sac, called the *pericardium*, which is attached, at the base of the heart, to the great vessels, and which is lined internally by a serous membrane. It contains normally about one dram of fluid, for the purpose of lubrication. It is continuous, below, with the central tendon of the diaphragm, and is separated from the chest wall, except at a limited area, by lung tissue.

The *relative weight* of the heart to that of the body varies greatly in the fœtus and in the adult, and it shows also a variation in the two sexes, but by no means in so marked a degree. Thus, in the fœtus, the heart represents one-fiftieth of the entire weight of the body; while, in the adult male, it represents only one one-hundred and sixty-ninth, and, in the adult female one one-hundred and forty-ninth of the total weight.

The area upon the anterior surface of the chest which corresponds to the situation of that portion of the heart, where it is in close relation to the chest wall and is uncovered by lung tissue, can be approximately defined by describing a circle, whose diameter shall be two inches, taking as its centre a point midway between the left nipple and the end of the sternum.

The external surface of the heart is traversed by *two grooves* which mark the division into its four separate cavities. These grooves are called the *interventricular* and the *auriculo-ventricular grooves*. The first lies between the two ventricles on the anterior and posterior surface of the heart, and runs longitudinally, or in the long axis of that organ; while the second marks the junction of the auricles and ventricles, and runs transversely across the heart.

Cavities of the Heart.

The RIGHT AURICLE receives the venous blood from the two venæ cavæ and empties it into the right ventricle. The right auricle presents a principal cavity or *sinus* and a small appendix, resembling in shape the ear of a dog, and called for that reason the *auricular appendix*.

It has *two large openings* in its interior, for the vena cava ascendens and the vena cava descendens; and a *smaller opening*, called the *coronary sinus*, for the coronary vein which returns the blood from the substance of the heart itself. It presents also another large opening, called the *auriculo-venticular opening*, through which the blood flows into the ventricle and which is closed during the contraction of the ventricle by the tricuspid valve. This opening in health should have a capacity sufficiently large to admit three fingers of an adult.

The cavity of the right auricle presents also *small minute orifices* called the "*foramina Thebesii*," at which points venous blood from the small veins of the heart is returned. These openings are sometimes closed by reduplications of the endocardium, although their orifices are so minute as to be probably occluded by muscular pressure when the auricle is in a state of contraction.

The *walls* of this cavity are thinner than in any portion of the heart, measuring only a line in thickness. They are composed of two layers of muscular fibres, arranged as an external and an internal set. The *outer layer* is *common to both of the auricles*, while the *internal layer* is *distributed to each auricle separately*. The internal muscular layer consists of looped and circular bands of muscle. The former arise from fibrous rings, situated between the auricle and the ventricle, while the circular fibres encircle the auricular appendix, and the openings of the veins, into which they extend for a short distance. It is through these circular fibres, that the venous openings are diminished in size during the contraction of the auricle, and thus regurgitation of blood into the venæ cavæ is partially obstructed, although the absence of valves at their auricular openings prevents their total closure during the systolic action of the heart. The coronary veins, however, are provided with one or two valvular folds, the *coronary valves*, which exclude the possibility of regurgitation of venous blood into the muscular substance of the heart.

During fœtal life, the right auricle allows of the passage of blood from the vena cava ascendens, through the muscular septum, into the adjoining auricle. The opening for this purpose is called the "*foramen ovale*," and the blood from the descending vena cava is prevented from entering it by a septum called the *Eustachian valve*, which deflects the upper current of blood into the right ventricle, while it causes the inferior current to pass through the foramen ovale. After birth, however, this valve decreases greatly in size, and the communication between the auricles becomes destroyed by the closure of the opening; so that, in adult life, a simple depression in the auricular septum termed the "*fossa ovalis*," and a circumscribing ring called the *annulus ovalis* or *isthmus of Vieusseus*, mark the seat of its former existence.

The aperture between the auricles fails, however, to become entirely closed in about fifty per cent of all the hearts opened for inspection, a small aperture being usually discovered on the upper margin of the fossa ovalis; but it is too small in extent to have any important effect upon the muscular power of the auricle.

Two other points only within this cavity require mention, one of which is a small tubercle, supposed by Lower to assist in directing the current of blood through the tricuspid orifice, and called, from the discoverer, the "*tubercle of Lower;*" and certain small prominent muscular columns, in the auricular appendix, to which the name "*musculi pectinati*" has been applied, from their supposed resemblance to the teeth of a comb.

The *cavity* of the right auricle has been ascertained to be capable of containing about *two ounces* of fluid when moderately distended.

The LEFT AURICLE of the heart is slightly smaller than the right auricle, and has thicker walls; measuring from one-half to two lines in thickness. It receives blood from the lungs by the four pulmonary veins, which empty into its cavity by *four distinct openings*. These openings have no valves. The left auricle, like that of the right side, opens into the corresponding ventricle, by an *auriculo-ventricular orifice* which is closed by the mitral valve.

The arrangement of the muscular fibres of this auricle differs in no respect from that of the right side.

The VENTRICLES, in all warm blooded animals, constitute the bulk of the heart. They are characterized by the great thickness of their walls, and have a fluid capacity in excess of that of the auricles. The *right ventricle*, by the experiments of Robin, is said to contain about *one-eighth more than that of the left side.* It is by the powerful action of the ventricles, that blood is propelled through the systemic and pulmonary vessels.

The cavities of both ventricles are conoidal in form and present a triangular-shaped section. The cavity of the right ventricle is broader and shorter than that of the left ventricle.

The inner surface of both of the ventricles present for inspection prominent muscular ridges and papillæ, called *columnæ carneæ.* These are of three distinct varieties; the first variety being attached to the wall of the heart by their *entire length*, the second by the *two extremities only*, and the third by *one extremity only.* From these columnæ carneæ, fibrous cords, called *chordæ tendineæ* arise and pass to the free border of the mitral and tricuspid valves, which close the two auriculo-ventricular openings. These fleshy columns, the columnæ carneæ, interlace in every direction, giving the internal surface of the ventricles a reticulated appearance. This arrangement evidently assists in the complete expulsion of the contents of the ventricle during its contraction.

The *walls* of the left ventricle are thicker than those of the right ventricle. Bouillard gives from his researches, the thickness of the *left* ventricle as *seven lines*, and that of the *right* ventricle as *two lines and a half.*

The *muscular fibres of the ventricles* are arranged in two layers, a superficial and a deep set. The superficial layer is common to both ventricles. The fibres composing it arise from *fibrous rings* at the auriculo-ventricular orifices, and pass in a spiral direction from right to left, from the base to the apex of the heart. At this point they dip into the substance of the heart, and, passing to its interior, become lost in the columnæ carneæ, which are chiefly formed by these fibres. The *deep set* of fibres are circular, and invest each ventricle separately.

The *muscular fibres of the heart* differ, in four ways, from those of voluntary muscles in their microscopical appearance and arrangement. They are, in the first place, *smaller* in their size than ordinary muscular fibres and are granular in their structure; again they *join* with each other, while ordinary muscular fibres run as separate structures from their point of origin to their point of insertion, being enveloped in an investing sheath. In the third place they are, as a rule, *beyond the control of the will*, although they possess the *striated appearance* of voluntary muscle; and finally they are *destitute of sarcolemma.*

In each of the ventricles, two orifices are perceived; of these, the auriculo-ventricular openings, have been already considered in the description of each of the auricles, the other two are termed respectively the aortic and pulmonary openings, and serve to allow of the escape of the blood, during the contraction of the ventricles, into the arteries bearing the same name as these openings.

That portion of the right ventricle, which approaches the orifice of the pulmonary artery, is conical in shape and is called the *conus arteriosus*, or *infundibulum.*

That part of the left ventricle adjoining the root of the aorta is sometimes called the *aortic vestibule of Sibson.* Its walls are fibrous in character, and it remains uncollapsed during systole and disastole.

Valves of the Heart.

The valves of the heart are *four* in number, and close the two auriculo-ventricular, the aortic, and pulmonary openings.

The *mitral* valve and the *tricuspid* valves perform the first office, in the left and right heart respectively; while to the *aortic* and *pulmonary* valves the name "*semilunar*" is applied, from the shape of each of the three flaps, of which they are composed.

The MITRAL VALVE, which closes the *left auriculo-ventricular opening*, consists of *two segments* or flaps, which, when closed together, prevent the regurgitation of blood from the left ventricle into the left auricle. Its flaps have no inherent rigidity, as exists in the semilunar valves, but are prevented from passing into the auricle by the chordæ tendineæ, which serves to attach them, either to the columnæ carneæ, or directly to the walls of the heart. These chordæ tendineæ are also present in the same relation to the tricuspid valve in the right heart. The two flaps or segments forming the mitral valve are of unequal size, the largest segment lying in front and the smaller one posteriorly.

The larger segment, when not closed, *lies nearly over the aortic orifice*, and is supposed to prevent the blood from entering the aorta, during the distension of the left ventricle.

The mitral valve is situated, in health, at a point corresponding with the 3*d intercostal space*, upon the external surface of the chest, and about one inch from the left border of the sternum.

The two segments of the mitral valve arise from the fibrous rings situated at the auriculo-ventricular opening, and consist of a reduplication of the endocardium, or lining membrane of the heart, strengthened by a layer of fibrous tissue and a few muscular fibres. The chordæ tendineæ are attached to the segments of the mitral valve in three situations. 1st, at the *edge* nearest the point of origin, 2d, at the *centre* of each segment, where the valve is specially thickened for that purpose, and 3d, at the *marginal border* of each segment.

The same arrangement can also be found at the tricuspid valve, but the number of tendinous fibres attached to the mitral valve, is much smaller than those of the tricuspid valve, and their size and strength is greatly increased, to bear the excessive strain dependent on the powerful contraction of the left ventricle.

The TRICUSPID VALVE is situated in the right ventricle and closes the *right auriculo-ventricular opening.* It consists of *three segments* or *flaps* which are triangular in shape, and to which the chordæ tendineæ of the right ventricle are attached.

Like the mitral valve, its segments possess no inherent rigidity. They are, however, *adherent to each other* at that portion of their free margins, which is nearest the fibrous ring from which they arise, and they thus form a continuous membranous band at the immediate circumference of the auriculo-ventricular opening.

The *largest* of the *three segments* is placed at that portion of the auriculo-ventricular orifice, which is *nearest to the pulmonary artery*, and doubtless serves to prevent the blood from entering that vessel during the auricular systole of the heart.

The *chordæ tendineæ* attached to the segments of the tricuspid valve are finer and more numerous than those attached to the mitral valve.

The SEMILUNAR VALVES protect the *aortic* and the *pulmonary orifices* of the heart. By them the blood, thrown from the cavities of the two ventricles, is prevented from again returning to the heart during its period of rest or *diastole.*

They consist of three semi-circular folds so attached to the walls of the arteries as to present a concave surface, which looks towards the cavity of the vessel when the valves are closed.

The *free margin* of each segment is thicker than in its central portion, being strengthened, in that part, by a bundle of tendinous fibres. It presents also a fibro-cartilaginous nodule, called the "*corpus Arantii.*" From this nodule, tendinous bands radiate in every direction towards the attached margin of the valve, except at two *narrow lunated spots*, called *lunulæ*, on each side of the nodule, where only the reduplicated endocardium exists, thus rendering the valve extremely thin at these points. During the passage of blood from the ventricles, during the systole of the heart, the segments of these valves disappear within recesses in the coats of the aorta and pulmonary artery, the *sinuses of Valsalva*, thus affording uninterrupted escape for the blood-current; but, during the diastole of the ventricle, when the current of blood in the large vessels is checked, and partly thrown back by their own elastic coats, these segments become immediately expanded and effectually close the orifice at the entrance to the tube. It is during the period of closure of the semilunar valves, that we are enabled to perceive the function of the corpora Arantii and the thin lunated portion of each of the three segments.

These segments when closely approximated, being circular in shape, would leave a central orifice were not the cartilaginous nodules so formed as to completely fill the empty space; while the thinned condition of the valve assists in a more perfect adaptation of these cartilaginous nodules, than would be ensured were the valves rigid and unyielding.

The segments of the semilunar valves differ from those of the mitral and tricuspid valves in the following respects.

1st. They possess from their form and large supply of fibrous tissue, an *inherent rigidity* and tenacity of shape, not present in the auriculo-ventricular valves.

2d. They open *out of the ventricle* and not into its cavity.

3d. They possess *no chordæ tendineæ*, being able to resist pressure without assistance.

The *semilunar valves* of the *aortic* and *pulmonary orifices* also differ from each other in the following points of interest.

1st. The segments, composing the aortic valve, are *thicker* and *stronger* than those of the pulmonary valve.

2d. The *lunulæ* are *more distinct* in the aortic valve.

3d. The *corpora Arantii* are *larger* and *more prominent* in the aortic valve.

4th. The *openings* of the *coronary arteries* are in close relation with the aortic valves.

5th. The *sinuses of Valsalva*, in the aorta, (*sinuses aortici*) are *deeper* than those in the pulmonary artery, in order to accommodate the increased thickness of the segments of the aortic valve.

Vessels and Nerves of the Heart.

The heart substance derives its nutrition from blood conveyed to it by the *coronary arteries*, during the diastole of the heart; the propelling power of the coronary circulation being the force of gravity and the elastic recoil of the aorta, although it is assisted by the relaxed condition of the walls of the heart.

The *veins* of the heart comprise 1. the *great cardiac* vein, 2. the *smaller* or *anterior cardiac* veins, and 3. the *venæ cordis minimæ* (*venæ Thebesii*). These veins accompany the arteries and return their blood into the cavity of the right auricle.

The *lymphatic vessels* of the heart terminate in the right lymphatic ducts and in the thoracic duct.

The *nerves* distributed to the heart assist in forming the *superficial* and the *deep cardiac plexuses*, and also the *posterior* and the *anterior coronary plexuses*. These plexuses are formed by sympathetic nerve fibres, derived from various sources, and by filaments from certain cranial nerves. A description of these plexuses and their distribution will be given in the pages descriptive to the sympathetic system.

Rings of the Heart.

The heart has *four fibrous rings* within its substance, which are situated at the two arterial and the two auriculo-ventricular openings. These rings serve as points of attachment for the *muscular fibres*, for the *valves of the heart*, and for the *coats of the blood-vessels.*

THE PERICARDIUM.

The pericardium is a fibro-serous sac, which contains the heart and the commencement of the large vessels. It is conical in shape and is attached, at its base, to the central tendon of the diaphragm, and, at its apex, to the great vessels, upon which it is prolonged for a space of two inches.

It is continuous *above*, with the deep layer of the cervical fascia; it is in relation, *posteriorly*, with the roots of the lungs, the œsophagus, and the descending aorta; it is invested, *laterally*, by the pleura, and is in close relation with the phrenic nerve; and *in front*, the thymus gland, the lungs, the pleuræ, the sternum and the left costal cartilages are in close proximity to it.

IRCULATION OF THE BLOOD.

pillaries. 4th. Veins.

1.—Th ht, while its apex looks downwards, forwards, and to the left.
2.—It ise, and the Ventricles, especially the left, towards the apex of the cone.

3.—Th "Septum;" that portion which separates the Auricles being termed Septum Cordis" is employed in an absolute manner, the Septum of the

4.—Be the blood passes.
5.—*Th* ame of the "Pulmonic Heart," and contain venous blood; while that ood.
6.—Int icular, blood passes out into a Ventricle.
7.—In e latter it leaves the Ventricle.
8.—At from the Auricle, but prevents it from passing back; the other, named

9.—It Auricle and Right Ventricle, called "Tricuspid," and another between ulmonary Artery and the Aorta, and are known respectively as the "Pul-

10.—T stole" and "Diastole" of the Heart, we invariably refer to the condi-

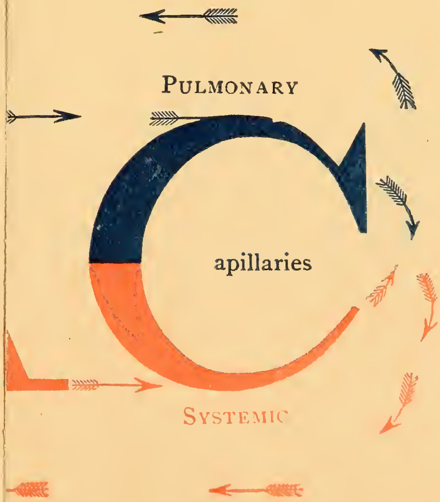
11.—T ic names are alternate. Thus, the two Auricles are in a state of con- les are dilating, and *vice-versa*.
12.—O sound is heard, the Ventricles are contracting and the Auricles are

13.—D he second, the Auriculo-Ventricular valves are open, and the Arterial

14.—W is called Regurgitation; when proceeding from a valve that should be

15.—W whose name begins with V, it enters one whose name begins with A, one beginning with V, as shown by the following diagram:

ebesii.



SYNOPSIS OF THE STRUCTURE OF THE HEART, AND THE CIRCULATION OF THE BLOOD.

The Organs of Circulation are — 1st. The Heart. 2d. Arteries. 3d. Capillaries. 4th. Veins.

1.—The Heart is a conical-shaped organ, situated in the thorax in such a manner that its base looks upwards, backwards, and to the right, while its apex looks downwards, forwards, and to the left.

2.—It is a hollow organ. In its interior are four cavities, viz.: two Auricles and two Ventricles. The Auricles are situated at the base, and the Ventricles, especially the left, towards the apex of the cone. These cavities are designated respectively the Right and Left Auricle, and the Right and Left Ventricle.

3.—The cavities of the right side have no direct communication with those on the left, being separated by a vertical partition called a "Septum;" that portion which separates the Auricles being termed "Septum Auricularum," while that which separates the Ventricles is called "Septum Ventriculorum." When the the term "Septum Cordis" is employed in an absolute manner, the Septum of the Ventricles is invariably meant.

4.—Between the cavities of the same side there is a free communication by an opening, called the Auriculo-Ventricular, through which the blood passes.

5.—*The Cavities* on the right side of the Septum, consisting of the Right Auricle and Right Ventricle, are frequently known by the name of the "Pulmonic Heart," and contain venous blood; while that portion on the left, containing the Left Auricle and Left Ventricle, is styled the "Systemic Heart," and contains arterial blood.

6.—Into each Auricle there are five openings; by four of these, the mouths of veins, the blood enters, and by one, the Auriculo-Ventricular, blood passes out into a Ventricle.

7.—Into each Ventricle there are two openings, viz.: the Auriculo-Ventricular and the Arterial. By the former the blood enters, by the latter it leaves the Ventricle.

8.—At each opening of a Ventricle is placed a valve, one of which, called the Auriculo-Ventricular, allows the blood to enter the cavity from the Auricle, but prevents it from passing back; the other, named Arterial, allows the blood to leave the Ventricle. but prevents it from returning.

9.—It thus appears that there are four valves employed in the transmission of the blood through the Heart, viz.: one between the Right Auricle and Right Ventricle, called "Tricuspid," and another between the Left Auricle and Left Ventricle, named "Mitral," and sometimes "Bicuspid." The two other valves are situated in the Pulmonary Artery and the Aorta, and are known respectively as the "Pulmonic" and "Aortic" valves.

10.—The contraction of the walls of the cavity is called its "Systole," and the relaxation its "Diastole." When we speak of the "Systole" and "Diastole" of the Heart, we invariably refer to the condition of the Ventricles.

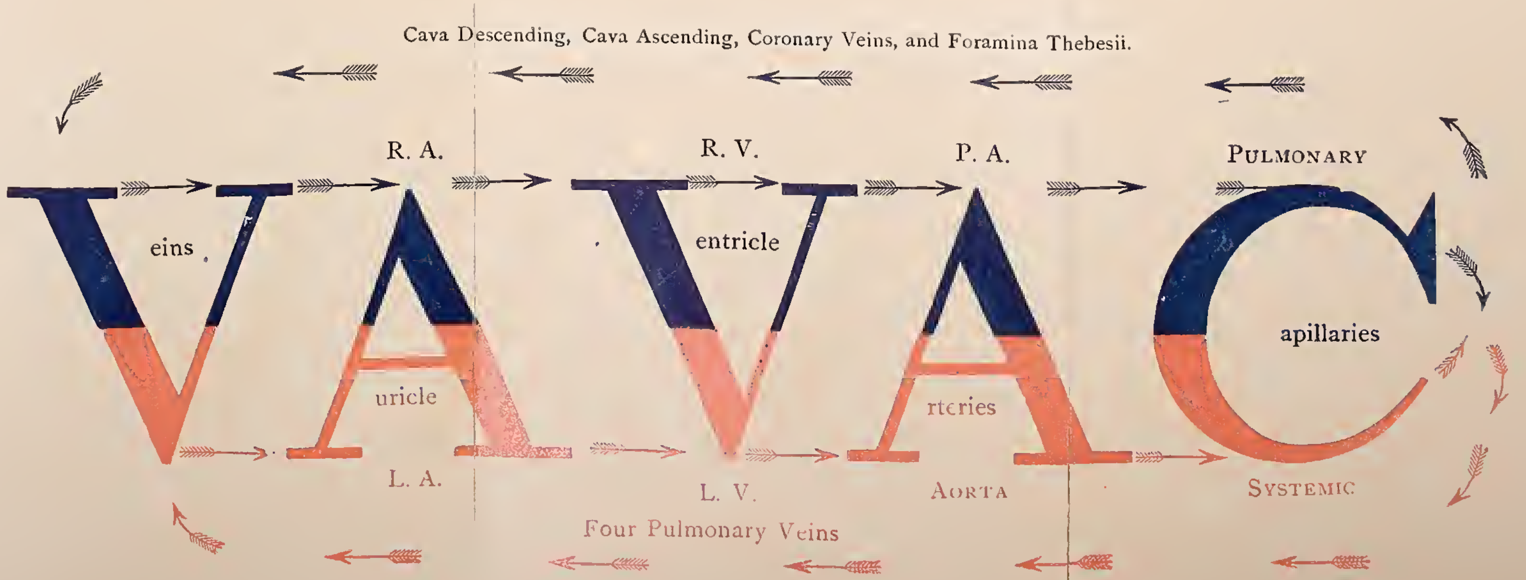
11.—The contraction and dilatation of cavities of the same generic name are synchronous and isochronous, while those of different generic names are alternate. Thus, the two Auricles are in a state of contraction and dilatation at the same time, as is also the case with the Ventricles, but when the Auricles are contracting the Ventricles are dilating, and *vice-versa*.

12.—On listening over the region of the Heart, two sounds are heard, known as the "First" and "Second" sounds. When the first sound is heard, the Ventricles are contracting and the Auricles are dilating, while during the second sound, the Auricles and the Ventricles are filling with blood.

13.—During the first sound of the Heart, the Auriculo-Ventricular valves are shut and the Arterial valves are are open; while, during the second, the Auriculo-Ventricular valves are open, and the Arterial valves are closed.

14.—When an abnormal sound proceeds from a valve that should be shut, it shows that the blood is taking a retrograde direction, and is called Regurgitation; when proceeding from a valve that should be open, it then is said to be "Obstruction."

15.—With regard to the course of the blood through the Heart, it may be stated in general terms that, when the blood leaves an organ whose name begins with V, it enters one whose name begins with A, and *vice-versa;* while in the tissues, when it leaves an organ beginning with A. it enters one beginning with C, and passes into one beginning with V, as shown by the following diagram:



The internal or *serous layer* of the percardium forms a sheath for the aorta and the pulmonary artery for the first two inches of their extent; and is then reflected upon the venæ cavæ, the pulmonary veins, the external surface of the heart, and subsequently upon the inner surface of the fibrous layer.

The *fibrous layer* of the pericardium is prolonged upwards upon the great vessels of the neck, and becomes continuous with the deep layer of the cervical fascia.

THE ORGANS OF DIGESTION.

Digestion of food is carried on within a group of connecting organs, termed the alimentary canal. Associated with it are certain accessory organs, that also contribute greatly to the proper performance of digestion and assimilation.

The alimentary canal, if considered as an *individual structure*, is a musculo-membranous tube, which is lined throughout with a mucous membrane, and which extends from the mouth, above, to the anus, below. Its length has been variously estimated from twenty-seven to thirty feet, and its different component parts have each received a special name.

In the mouth, we find provision made for the mechanical division of the food (mastication), and, through the glands of the mouth, for the admixture of a fluid, the saliva; between this point and the stomach, are comprised the organs of deglutition, *viz.*, the pharynx and œsophagus, which convey the food to the stomach; in the cavity of the stomach, chemical changes occur, and the reduction and solution of some of the elements of food takes place; in the small intestine, which is connected with the stomach, the admixture of bile and the pancreatic fluid occurs, by which complete digestion of food is accomplished, and most of its nutritive properties are here absorbed, through the blood-vessels and lacteals; finally, in the large intestine, the waste matter contained within the food is voided, and, to a certain extent, excretion of waste products is carried on.

The following table shows the subdivisions of the alimentary canal and the accessory organs connected with it.

Alimentary Canal.

(1) Mouth.	(5) Small intestine.	Duodenum. Jejunum. Ileum.
(2) Pharynx.		
(3) Œsophagus.	(6) Large intestine.	Cæcum. Colon. Rectum.
(4) Stomach.		

Accessory Organs.

(1) Teeth.		
(2) Salivary glands..	Parotid. Submaxillary. Sublingual.	(3) Liver. (4) Pancreas. (5) Spleen.

The alimentary canal may be again divided into *two parts*, as follows.

1. The part located *above* the diaphragm, which may be called the supra-diaphragmatic portion.
2. The part situated *below* the diaphragm, which may be called the infra-diaphragmatic portion.

Each of these portions may be subdivided into three parts, as is indicated below.

Supra-diaphragmatic portion...	Mouth (oral, or buccal cavity).	
	Pharynx.	
	Œsophagus or gullet.	
Infra-diaphragmatic portion...	Stomach.	
	Small intestine.	Duodenum.
		Jejunum.
		Ileum.
	Large intestine.	Cæcum.
		Colon
		Rectum.

The *supra-diaphragmatic portion* is *ingestive* in function, and has as appendages, the tonsils, the parotid, the submaxillary, and sublingual glands.

The *infra-diaphragmatic portion* is *digestive* and *egestive* in function, and has as appendages, the liver, the spleen, and the pancreas. The first *two* organs contained in this portion, *viz.*, the stomach and the small intestine, comprise the digestive apparatus, while the *remaining portion*, the large intestine, comprises the egestive apparatus.

When the *intestinal canal* is spoken of, it designates that portion of the alimentary canal, which extends from the pyloric orifice of the stomach to the anus.

THE MOUTH.

The buccal cavity, which is the superior portion of the alimentary canal, contains, for special examination, the following parts:

1. The tonsils.
2. The tongue.
3. The salivary glands.

The *bony structures* which enter into the formation of the mouth, with the exception of the teeth, which will not be considered in this volume, have already been described in the chapter on osteology.

The TONSILS are small, slightly elongated bodies, which lie in the space between the anterior and posterior pillars of the soft palate, and which correspond, in their situation, to the angle of the jaw. They contain twelve or fifteen large spaces within their substance, from which smaller follicular depressions extend into the structure of the gland. These spaces and depressions are lined by a continuation of the mucous membrane and the epethelial layer of the throat. The tonsils are in close relation with the internal carotid and the ascending pharyngeal arteries.

The TONGUE presents for examination a base, an apex, an upper surface or dorsum, and an under surface.

The tongue is *composed* of a median fibrous septum, of a hyoglossal membrane, of a mucous membrane, which is extremely thick upon its upper surface, of an extrinsic and an intrinsic set of muscles, and of vessels and nerves.

The *base* of the tongue is attached to the hyoid bone, to the epiglottis, and, by means of muscles, to the soft palate and to the pharynx.

The *dorsum* of the tongue contains three varieties of papillæ, called the *filiform papillæ*, the *fungiform papillæ*, and the *circumvallate papillæ*, by which the special sense of taste is chiefly performed. The first set lie upon the *sides* of the tongue, the second set in the *centre* of the dorsum, while the third set are arranged, in the form of a *semi-circle*, at the *base* of the tongue. These papillæ are named from their peculiar shape and formation.

The *under surface* of the tongue is connected with the hyoid bone and the lower jaw. Its mucous membrane is reflected, over the floor of the mouth, to the inner surface of the gums, and, in front, forms a prominent fold, called the *frœnum linguœ.*

The *extrinsic muscles* of the tongue comprise the stylo-glossus, the hyo-glossus, the genio-hyo-glossus, and the palato-glossus muscles.

The *intrinsic muscles* of the tongue comprise the transverse lingual fibres, the superior lingual fibres, the inferior lingual fibres, and the perpendicular fibres of the organ.

The *glands* of the tongue comprise two sets, namely, a follicular set, which are aggregated upon the posterior third of the dorsum of the tongue, and a racemose set, which lie upon the dorsum, the sides, and the under surface of the tongue.

Glands of the Mouth.

The salivary glands are three in number, and are called the parotid, the submaxillary, and the sublingual glands.

The *parotid gland* lies below and in front of the external ear, and is of large size. Within it, are contained large vessels and nerves, which are forced to pass through it, either to reach the skull or to escape from its cavity. Its duct is called *Steno's duct.* It opens opposite the *second molar tooth of the upper jaw*, by penetrating the substance of the cheek and running obliquely beneath its mucous membrane.

The *submaxillary gland* is intermediate in size between the parotid and the sublingual glands. Its duct is called *Wharton's duct.* It is about *two inches long*, and opens at the summit of a small papilla on the *side of the frœnum* of the tongue.

The submaxmillary gland lies in close relation with the facial artery, and the submaxillary ganglion.

The *sublingual gland* is the smallest of the three glands of the mouth. It is of an elongated shape, and lies beneath the mucous membrane of the floor of the mouth, where it forms a prominence near the frænum of the tongue. Its ducts are from *eight* to *eighteen* in number, and are called the *ducts of Rivinus.* They open into the mouth, near the frænum linguæ or into the duct of Wharton.

One of the ducts of Rivinus is longer than the others and is often called the *duct of Bartholine.*

Within the cavity of the mouth the following points may be felt and perceived, which have a practical bearing.

1. The *coronoid process* of the lower jaw, whose anterior border is quite prominent.
2. The *hamular process* of the sphenoid bone, which can be felt behind the last molar tooth of the upper jaw.
3. The lower portion of the *pterygoid fossa* and the *internal pterygoid plate* of the sphenoid bone, in about the same situation as the hamular process.
4. A *space* between the *coronoid process* and the *tuberosity* of the lower jaw, where deep temporal abscesses may require puncture.
5. The *posterior palatine artery*, which escapes at the inner side of the last molar tooth, and about one-third of an inch in front of the hamular process of the sphenoid.
6. The *pterygo-maxillary ligament*, which forms a prominent fold behind the last molar tooth, when the mouth is wide open.
7. The *gustatory nerve*, whose situation close to the last molar tooth of the lower jaw can be detected by the sense of extreme tenderness to pressure. This nerve is often

divided, in this situation, to relieve pain in cancer of the tongue.

8. A *space behind the last molar tooth*, of sufficient size to allow of introduction of a tube for the purpose of feeding a patient, suffering from spasmodic contraction of the muscles of the lower jaw.

THE PHARYNX.

The pharynx is a musculo-membranous sac, *four inches and a half* in length, which extends from the base of the skull to the lower border of the cricoid cartilage of the larynx, where it becomes continuous with the œsophagus.

It is bounded, *above*, by the petrous portion of the temporal bone and by the basilar process of the occipital bone; *behind*, it is in relation with the recti capitis antici muscles, the longi colli muscles, and the first five cervical vertebræ; *below*, it is continuous with the œsophagus; *in front*, it is incomplete, and is attached, from above downwards, to the internal pterygoid plate, the pterygo-maxillary ligament, the lower jaw, the base of the tongue, the cornua of the hyoid bone, the stylo-hyoid ligament, the thyroid cartilage, and the cricoid cartilage; *laterally*, it is in relation with the styloid process of the temporal bone, the styloid and pterygoid muscles, the internal carotid artery, the internal jugular vein, the glosso-pharyngeal, pneumogastric, spinal accessory, hypoglossal and sympathetic nerves; and, in its lower portion, with the lateral lobes of the thyroid gland, the common carotid and lingual arteries, the sterno hyoid muscle, and the lingual nerve.

Openings.

The pharynx has *seven openings*, as follows: the two posterior nares, the openings of the two Eustachian tubes, the opening into the mouth, the superior aperture of the larynx, and the opening into the œsophagus.

Coats.

The pharynx has *three coats*, which, from without inwards, are called the muscular, the fibrous, and the mucous coats. The middle coat is often called the *pharyngeal aponeurosis*.

Muscles.

The pharynx has *five muscles*, *viz.*, the superior constrictor, the middle constrictor, the inferior constrictor, the stylo-pharyngeus and the palato-pharyngeus. The origin and insertion of these muscles, as well as their source of nervous supply, can be found in the chapter on myology.

Mucous Membrane.

The *mucous membrane* is covered with squamous epithelium, below the level of the floor of the nares; and, above that point, with columnar ciliated epithelium. It contains *three varieties of glands*, namely, simple follicular, compound follicular, and racemose glands. The latter variety are most abundant in the upper part of the pharynx.

Arteries.

The *arteries* are four in number, *viz.*, the ascending pharyngeal, the pterygo-palatine, the descending palatine, and branches of the superior thyroid artery.

Nerves.

The *nerves* are derived from the pharyngeal plexus.

THE ŒSOPHAGUS.

The œsophagus is a musculo-membranous tube, which commences in the median line of the neck, opposite to the 5*th cervical vertebra* and the lower border of the cricoid cartilage of the larynx, and terminates, after passing through the diaphragm, at the cardiac opening of the stomach, on a level with the 9*th dorsal vertebra*. It is *nine inches long*, and has relations, in the *neck*, with the trachea, the left lobe of the thyroid gland, the left recurrent laryngeal nerve, the left common carotid artery; and, in the *thorax*, with the bifurcation of the trachea, the left bronchus, the arch of the aorta, the thoracic duct, the vena azygos major, the heart and pericardium, and the pneumogastric nerves. It passes through the *œsophageal opening* of the diaphragm, in company with the pneumogastric nerves.

Its *muscular fibres* consist of a longitudinal and a circular set.

Its *cellular coat* forms a loose connection between its muscular and mucous coats, and contains its arteries, before they enter the mucous membrane.

Its *mucous membrane* is pale in color, is very thick, is thrown into longitudinal folds, except when the bolus of food is passing through it, and contains small compound racemose glands, which are most abundant in its lower part.

Its *vessels* are principally derived from the thoracic aorta, and its veins empty into the vena azygos major.

Its *nerves* are derived from the pneumogastric and sympathetic.

THE STOMACH.

The stomach, or the chief organ of digestion, is situated in the left hypochondriac, the epigastric, and a part of the right hypochondriac regions. It consists, like the intestinal canal, of *four coats*, *viz.*, the serous, the muscular, the cellular, and the mucous coats. It presents for examination two surfaces, an anterior and a posterior, two extremities, two curvatures or borders, and two openings.

The *anterior surface* is in contact with the under surface of the liver, the diaphragm, and the anterior wall of the abdomen.

The *posterior surface* is covered with peritoneum, and, by it, is separated from the great vessels of the abdomen, the solar plexus of nerves, the pancreas, and the diaphragm.

The *splenic end*, or *fundus* of the stomach, is connected with the spleen by the gastro-splenic omentum.

The *pyloric end* is in relation with the wall of the abdomen, the under surface of the liver, and the neck of the gall-bladder.

The *greater curvature* gives attachment to the great omentum and lies above the transverse colon.

The *lesser curvature* is connected to the diaphragm by the gastro-phrenic ligament, and, to the transverse fissure of the liver, by the lesser or gastro-hepatic omentum.

The *œsophageal* or *cardiac opening* corresponds to the level of the 9th dorsal vertebra.

The *pyloric opening* is situated at the pyloric extremity.

Coats of the Stomach.

The *serous coat* of the stomach covers its whole surface, except at the points of attachment of the gastro-splenic, the greater, and the lesser omenta.

The *muscular coat* consists of three sets of fibres, called from their direction, the longitudinal, the circular, and the oblique fibres. The circular fibres form a sphincter muscle, at the pyloric orifice ; the longitudinal fibres are continuous with those of the œsophagus and the intestinal canal ; while the oblique fibres are a continuation of the circular fibres of the œsophagus.

The *cellular coat* serves for the division of the blood-vessels, before they enter the mucous membrane of that organ.

The *mucous membrane* of the stomach is thick at the pyloric orifice and thin at the cardiac extremity. It has a *honey-combed* appearance, due to depressions upon its surface, called *aveoli*, into which depressions the glands of the stomach empty. It contains two kinds of glands, called *peptic* and *mucous follicles*, and a few scattered *solitary glands*, along its lesser curvature. The latter are considered by some as not true solitary glands, but as masses of lymphoid tissue.

The *peptic follicles* are situated near the cardiac extremity, and consist of tubes which are lined, in their upper fourth, with columnar epithelium, and, in their deeper portion, with nucleated cells.

The *mucous glands* are situated near the pyloric extremity, and are subdivided into from two to six tubular branches, which are lined, throughout their whole extent, with columnar epithelium.

VESSELS, NERVES, AND LYMPHATICS.

The *vessels*, *lymphatics*, and *nerves of the stomach* have been described in preceding chapters of this work.

THE INTESTINAL CANAL.

The intestinal canal extends from the pyloric orifice of the stomach to the anus.

It comprises the three divisions of the small intestine, and the three divisions of the large intestine. It is partly ingestive and partly egestive in function, since the small intestine performs the greater part of absorption of the food, and aids also in the digestive processes; while the large intestine does not participate in either.

The intestinal canal comprises the following parts, which demand a special description.

INTESTINAL CANAL.......	Small intestine.....	Duodenum.	
		Jejunum.	
		Ileum.	
	Large intestine. ...	Cæcum	
		Colon	Ascending colon.
			Transverse colon.
			Descending colon.
		Rectum	Sigmoid flexure.

The DUODENUM, so called from its correspondenee, in length, to the *breadth of twelve fingers*, is ten inches long and is divided into three portions, called the ascending, the descending, and the transverse portions. Its shape is something like that of a horse-shoe, and its three portions measure respectively two and one-half inches, three and one-half inches, and four inches in length. It presents, on the inner wall of its descending portion, the *openings* of the *pancreatic* and *bile ducts*, which are usually contained within a small papilla upon its mucous surface.

The JEJUNUM, the second portion of the small intestine, commences at the *left of the 2d lumbar vertebra* and is crossed by the superior mesenteric artery. It is larger and thicker than the ileum, and, as no line of division exists, its point of termination, and therefore its length, must remain a matter of measurement only.

Its name is given to it from the fact that this portion of the intestine is usually found *empty* after death. Its length is usually given as *two-fifths of the balance* of the small intestine, after the length of the duodenum has been deducted.

The coils of the jejunum lie in the immediate vicinity of the umbilicus, while those of the ileum lie below that level.

The ILEUM comprises the remaining *three-fifths of the balance* of the small intestine, after the length of the duodenum has been deducted, and terminates at the *ileo-cæcal valve*, where it joins the first division of the large intestine. Its name is given from its twisted course.

The CÆCUM, the first division of the large intestine, is a cul-de-sac, about two and a half inches in length and the same in width, which is situated in the right iliac fossa of the abdomen, where it is retained in position by a fold of the peritoneum, called the *meso-cæcum*. It presents a tubular prolongation, called the *appendix vermiformis*, which varies from two to six inches in length, is of the diameter of a goose quill, is connected with the lower and back part of the cæcum, and is usually directed upwards and inwards behind it and is there retained by a fold of peritoneum. The *ileo-cæcal valve*, called also the ileo-colic valve, and the valve of Bauhin and of Tulpius, is formed by two crescentic folds of the mucous and submucous coats of the intestine and by the circular fibres of the intestine.

The COLON, or second portion of the large intestine, is usually subdivided, from the direction of its course, into four distinct portions, called respectively the ascending colon, the transverse colon, the descending colon and the sigmoid flexure.

The *ascending colon* extends upwards to the under surface of the liver where it curves to the left, forming the hepatic flexure of the colon; the *transverse colon*, called also the *arch of the colon*, continues from this point to the left hypochondriac region, where it bends downwards, forming the splenic flexure of the colon; the *descending colon* extends from this point to the crest of the ilium, where it becomes the *sigmoid flexure*, and, finally, this latter portion terminates in the rectum, at a point opposite the left sacro-iliac synchondrosis.

The close relation of the colon to the gall bladder often causes a staining of that portion of the intestine after death.

The *ascending colon* is bound down by the peritoneum to the quadratus lumborum muscle and the right kidney; the *transverse colon* is extremely movable, since it is comprised between the two ascending layers of the great omentum; the *descending colon* is also partially connected to the left kidney, the left crus of the diaphragm, and the quadratus lumborum muscle; while the *sigmoid flexure* of the colon is again freely movable, being retained only by a loose fold of peritoneum.

The RECTUM commences at the *left sacro-iliac synchondrosis* and terminates at the anus. It is about *eight inches* long and is divided into three portions called, respectively, the upper, the middle, and the lower portions. It is smooth and cylindrical in form, and, in this respect, differs from the other portions of the large intestine, which are saculated.

The *first portion* extends to the third piece of the sacrum, and is about *four inches* long. It is almost completely surrounded by a fold of peritoneum, called the *meso-rectum*, and rests upon the sacral plexus of the left side.

The *middle portion* extends from the third bone of the sacrum to the tip of the coccyx, and is about *three inches* long. It is in relation, in the male sex, with the *triangular space* at the base of the bladder, which corresponds to the *trigone*, and also with the vesiculæ seminales and the under surface of the prostate gland. This relation is of surgical importance, if puncture of the bladder through the rectum be attempted.

The *lower portion* of the rectum extends from the *tip of the coccyx* to the anus, and is about *one inch* in length. It is invested by the two sphincter muscles of the rectum and by fibres of the levator ani muscle; and is separated by a triangular space, called the perineum, from the bulb of the urethra, in the male, and from the vagina in the female.

The LARGE and SMALL INTESTINE each consist of *four coats*, *viz.*, the serous, the muscular, the cellular, and the mucous coats. The serous coat is formed by the peritoneum, the muscular coat consists of circular and longitudinal fibres, the cellular coat affords an opportunity for the division of vessels before they enter the mucous membrane, and the mucous coat forms the internal lining of the tubes. The small intestine contains the following points of interest.

1. *Valvulæ conniventes*, which are crescentic reduplications of the mucous and submucous coats, extending into the intestine for about two-thirds of its circumference. They begin about two inches below the pyloric orifice of the stomach and are largest and most numerous immediately below the opening of the pancreatic duct and in the middle of the jejunum, while they nearly disappear in the lower part of the ileum.
2. *Villi*, which are minute projections on the mucous membrane, about *one thirty-fifth of an inch in height*, and which are conical, cylindrical, or club-shaped. They are most numerous in the upper part of the small intestine.
3. *Glands* or *Crypts of Lieberkühn*, which are minute *tubular depressions*, found all over the small intestine and even in the large intestine and stomach. They are lined with columnar epithelium.
4. *Solitary glands*, which are most abundant in the lower part of the small intestine, and which are usually situated upon the free margins of that tube, at a point most distant from its border of attachment. These glands are also arranged in groups along the course of the intestine, which are called *Peyer's patches*. The total number of these patches varies from twenty to thirty.
5. *Brunner's glands*, which are small conglomerate glands, and which exist chiefly in the duodenum and the commencement of the jejunum.

The LARGE INTESTINE differs, in its construction, from the SMALL INTESTINE in the following respects.

1. It is only about *one-quarter of the length* of the small intestine.
2. It is *sacculated*, while the small intestine is not.
3. It is much *larger in its diameter*.
4. It is much *less movable*, being attached, for the greater portion of its length, closely to the parietes of the abdomen, and the parts to which it bears relation.
5. The *valvulæ conniventes* are indistinct, and, in some places, absent.
6. The *villi* are either absent or are few in number.
7. The *glands of Brunner* are absent.
8. The *solitary glands* and *Peyer's patches* are absent, excepting at its upper portion.
9. The *tubular glands* of *Lieberkühn* are larger and more numerous than in the small intestine.

10. Its longitudinal muscular layer is arranged as *three distinct bands*, while, in the small intestine, it is evenly distributed over its entire circumference.
11. The *serous covering* of the large intestine does not completely surround it, in all of its portions, and forms pouches, called *appendices epiploicæ*.

THE PERITONEUM.

The peritoneum is the serous membrane which lines the abdominal cavity, and which invests the viscera. Its numerous prolongations and reflections may be arranged under three heads as follows:

1. OMENTA or EPIPLOA.
2. MESOS or MESENTERIES.
3. LIGAMENTS.

The *three following rules* will assist the student as guides to the proper use and application of these terms.

I. When a fold of the peritoneum connects the STOMACH to *an adjoining organ*, the fold is termed an omentum or epiploon.

Of these there are three within the abdomen, *viz.*

1. Gastro-hepatic or lesser omentum.
2. Gastro-colic or greater omentum.
3. Gastro-splenic omentum.

II. When a process or fold of peritoneum connects any portion of the INTESTINAL CANAL (except the duodenum) to the *abdominal wall*, it is called a meso or mesentery, and a special name of any particular portion, process, or fold is obtained, by prefixing the word *meso* to the attached portion of the intestinal canal. As examples of this we have the following terms.

Meso-cæcum.
Meso-colon.
Meso-rectum.

III. When the peritoneum connects either a *solid* or *hollow organ* which is not a part of the intestinal canal, to *the adjacent parts*, it is called a ligament. Thus we have formed certain ligaments of the liver, the spleen, the uterus, the bladder, etc.

The peritoneum may be divided into *two layers* termed the parietal and the visceral layer. The former covers the walls of the abdominal cavity, and the latter is reflected upon the numerous viscera contained within it.

The *visceral layer* of the peritoneum affords a partial covering only to some organs, a complete covering to others, while portions of organs are destitute of any peritoneal covering.

Below will be found enumerated the conditions of the various viscera of the abdominal cavity, in respect to their peritoneal covering.

COVERED WITH PERITONEUM.
Liver (almost entirely).
Stomach (almost entirely).
Spleen.
Duodenum, ascending portion.
Jejunum.
Ileum.
Transverse arch of colon.
Sigmoid flexure of colon.
Upper third of rectum.
Ovaries.
Posterior portion of bladder.
Uterus.

PARTIALLY COVERED WITH PERITONEUM.
Duodenum (descending and transverse portions).
Colon, ascending and descending.
Rectum, middle portion.
Vagina (upper part of).

NO COVERING OF PERITONEUM.
Rectum, lower part.
Bladder, lower part and neck.
Bladder, anterior surface.

The *mesentery*, which connects the small intestine with the abdominal parietes, has its *root* from the left side of the 2nd lumbar vertebra to the right sacro-iliac synchondrosis. It extends therefore over a space of about *six inches*. The anterior border of the mesentery is from twenty to twenty-five feet in length, while its breadth is about four inches. It contains, besides the small intestine, the arteries, veins, glands, and lacteal vessels of the mesentery.

The *great* or *gastro-colic omentum* consists of *four layers*, of which the most anterior and the most posterior layer belong to the *greater cavity* of the peritoneum, and the two internal layers belong to the *lesser cavity*. The two anterior layers descend from the greater curvature of the stomach and from the spleen, while the two posterior layers ascend to the transverse colon.

The *lesser* or *gastro-hepatic omentum* extends from the transverse fissure of the liver to the lesser curvature of the stomach. Its free border, on the right side, contains the hepatic artery, the bile duct, and the portal vein, and forms the anterior boundary of the foramen of Winslow, which connects the greater and lesser cavities of the peritoneum. The relations of these parts in the transverse fissure of the liver, are as follows: *duct*, *vein*, *artery*, (D. V. A)., from right to left, the vein lying slightly behind the hepatic artery and the hepatic duct.

The *ligaments*, which are formed by the peritoneum, comprise one of the stomach, four ligaments of the liver, five ligaments of the bladder, six ligaments of the uterus, and the suspensory ligament of the spleen.

THE LIVER.

The liver is the largest glandular organ in the body, and is mainly intended for the secretion of bile, although other functions of perhaps equal importance are performed by it. It is situated in the right hypochondriac, the epigastric, and the left hypochondriac regions ; and it weighs from three to four pounds, when of normal size. It measures from ten to twelve inches in a transverse direction, from six to eight inches in the antero-posterior direction, and about three inches in the vertical direction, in its thickest portion, which corresponds with the back portion of the right lobe.

The liver presents for examination an upper surface, an under surface, an anterior border, a posterior border, a right extremity, and a left extremity.

The *upper surface* is convex, and lies in relation with the diaphragm. It is divided into two lobes of unequal size, called the right and left lobes of the liver, by a fold of peritoneum called the suspensory or broad ligament of the liver.

The *under surface* is also divided by a fissure, called the longitudinal fissure, into two unequal portions, which form the right and left lobes. It presents also certain portions of the liver substance to which the names lobulus quadratus, lobulus Spigelii and lobulus caudatus are applied; and also certain *grooves*, to which the names fissures are given, and which contain, respectively, the vena cava, the gall-bladder, and the ductus venosus, and a deep depression called the transverse fissure, or the *gateway of the liver*, where the portal vein and the hepatic artery enter, and the hepatic duct escapes. This surface is in relation with the stomach and duodenum, the hepatic flexure of the colon, and the right kidney and its supra-renal capsule.

The *right extremity* is thick and rounded, and is in relation with the diaphragm and ribs.

The *left extremity* is thin and flattened, and is in relation with the stomach and sometimes with the spleen.

The *anterior border* corresponds, in male adults, with the free border of the ribs, but, in women and children, frequently extends below it. It affords attachment, by a deep notch, to a portion of the broad ligament of the liver. The free border of the liver can be most easily detected, by the uneducated hand, *below the ensiform cartilage*, since it extends in this region, nearly half the distance between the end of the sternum and the umbilicus.

The *posterior border* is in relation with the aorta, the inferior vena cava, and the diaphragm; to the latter of which it is attached.

The liver is covered with peritoneum, with the exception of a small portion, situated at its posterior border, where the peritoneum is absent.

The liver has five lobes, five ligaments, five fissures, and five vessels, as follows.

Ligaments.	Vessels.
Suspensory or broad.	Hepatic artery.
Right lateral.	Portal vein.
Left lateral.	Hepatic veins.
Coronary.	Hepatic duct.
Round.	Lymphatic vessels.

Lobes.	Fissures.
Right lobe.	Longitudinal.
Left lobe.	Fissure for vena cava.
Lobulus quadratus.	Transverse.
Lobulus Spigelii.	Fissure for gall bladder.
Lobulus caudatus.	Fissure for ductus venosus.

LIGAMENTS.

The *longitudinal ligament* (broad, falciform, or suspensory ligament) receives its various names from its direction, its width, its shape, and its function. Its base, or broadest portion is attached to the posterior surface of the sheath of the rectus muscle of the right side, as low down as the umbilicus, and to the under surface of the diaphragm. It hepatic margin extends from the anterior border of the liver to its posterior border, and is contained in the groove, on the upper surface, between the right and the left lobe. This ligament consists of two layers of peritoneum; and the anterior portion of its *free edge* contains, between its two layers, the round ligament of the liver.

The two *lateral ligaments* are triangular in shape, and are composed of two layers of peritoneum. They serve to connect the extremities of the posterior border of the liver to the diaphragm.

The *coronary ligament* also connects the posterior border of the liver to the diaphragm and is composed of two layers of peritoneum; but it differs from the lateral ligaments of the liver in that it is connected with the *middle portion* of the posterior border, while the lateral ligaments are attached at either extremity of that border. The coronary ligament is divided into two parts, by a *deep notch* or *canal*, in which is lodged the inferior vena cava, and at which point the *hepatic veins* of the liver commmunicate with that vessel.

The *round ligament* is a fibrous cord which consists of the obliterated umbilical vein of the fœtus. It is contained in the free margin of the longitudinal ligament, until it reaches the anterior border of the liver, when it passes through the longitudinal fissure on the under surface of that organ, and is continued, from that point, as the remains of the ductus venosus, in the fissure of that name, as far back as the inferior vena cava.

FISSURES.

The five fissures of the liver are grooves upon its under surface, which separate the five lobes of the liver.

The *longitudinal fissure* is a deep groove which extends from the anterior border to the centre of the organ, as the *umbilical fissure*, and, from that point, it is continued, as the *fissure for the ductus venosus*, to the posterior border of the liver. It joins the transverse fissure at a right angle; this point of junction marking the line of division between its two portions, *viz.*, the umbilical fissure and the fissure for the ductus venosus. It is occasionally bridged over by a band of liver tissue, called the *pons hepatis.*

The *fissure for the ductus venosus* is the posterior half of the longitudinal fissure of the liver, which lodges in the fœtus, the ductus venosus, and, in the adult, a slender fibrous cord, which the obliterated remains of that vessel.

The *transverse* or *portal fissure* is *two inches* in length, and is the deepest fissure of the liver. It extends transversely across the organ and joins the longitudinal fissure, at about its middle, at a right angle. It gives passage to the vessels of supply of the liver, and affords a point of exit for the hepatic duct. The relations of the hepatic artery, the hepatic duct and the portal vein, within this fissure, are from right to left, as follows: the *hepatic duct* lies to the *right*, the *portal vein* lies *between the artery and the duct*, but behind them both; and the *hepatic artery* lies to the *left*. The connective tissue which holds these parts together is called the *capsule of Glisson*. It extends into the substance of the liver and invests the branches of each of these vessels.

The *fissure for the gall-bladder* lies parallel with the longitudinal fissure of the liver, and extends from the anterior border of that organ to a point nearly corresponding to the right extremity of the transverse fissure.

The *fissure for the vena cava* is occasionally a complete canal, and extends from the right extremity of the transverse fissure to the posterior border of the liver, where it joins the fissure of the ductus venosus. In this fissure is perceived a *deep fossa*, at the bottom of which the hepatic veins of the liver escape to open into the inferior vena cava.

LOBES.

The five lobes of the liver present the following points of interest.

The *right lobe* is very large, equalling or exceeding in size the combined volume of the four remaining lobes. It occupies the right hypochondriac region, and is separated from the left lobe by the suspensory ligament, upon its upper surface; upon its lower surface, by the longitudinal fissure; and, in front, by a deep notch upon its anterior border. Its under surface presents *five points of interest*, *viz.*, the transverse fissure, the fissure for the gall-bladder, the fissure for the inferior vena cava, and two shallow depressions, which lodge the hepatic flexure of the colon and the right kidney with its supra-renal capsule.

The *left lobe* of the liver is situated in the epigastric and the left hypochondriac regions, and is smaller than the right lobe and flattened in its form. It occasionally extends to the spleen with which it then bears a relation, as well as with the stomach; but with the latter it always lies in close relation.

The *lobulus quadratus* is so called from its square outline, and lies upon the under surface of the liver. Its boundaries are as follows;

In front, by the free margin of the lobe.
Behind, by the transverse fissure.
On the right, by the fissure for the gall bladder.
On the left, by the umbilical fissure.

The *lobulus Spigelii* lies at the back part of the under surface of the right lobe of the liver, and is bounded as follows.

In front, by the transverse fissure.
Behind, by the free margin of the lobe.
On the right, by the fissure for the vena cava.
On the left, by the fissure for the ductus venosus.

The *lobulus caudatus* is so called from its resemblance to a *tail* to the right lobe. It *connects the right lobe to the lobulus Spigelii*, and separates the transverse fissure from the fissure for the vena cava.

VESSELS.

The vessels of the liver are five in number, and present the following points of interest.

The *hepatic artery* arises from the cœliac axis, and enters the transverse fissure of the liver. It is the vessel of *nutrition* of the organ. It probably terminates in the lobular plexus of veins in the centre of each of the lobules of the liver, but, according to some authorities its branches do not extend into the lobules.

The *portal vein* is the main trunk of the portal system, and conveys blood from the intestinal tract, the stomach, and the spleen, to the transverse fissure of the liver. Its relations to the hepatic artery and duct, at this point, have been given in the description of the transverse fissure. The portal vein gives off the following branches:

1st. Right and left portal.
2d. Vaginal branches.
3d. Inter-lobular branches.
4th. Lobular branches.

The *first two branches* are distributed to the lobes of the same names.

The *vaginal branches* are the main trunks of the portal system, after the vessels enter the substance of the liver.

The *inter-lobular branches* are given off by the vaginal branches within the portal canals, and pass *between the lobules* of the liver. They give off converging branches, called *lobular branches*, which penetrate the substance of the lobules and assist to form the central vein of each lobule, to which the name *intra-lobular vein* is applied.

The numerous *lobular branches* of each interlobular vein anastomose within the lobule and thus form what is called the *lobular plexus* of veins.

The *openings* of the *portal canals* of the liver can be discerned from those of the *hepatic veins*, on section of the liver, since the latter stand wide open, being closely attached to the substance of that organ, while the portal veins are either entirely or partially closed, on account of the connective tissue which intervenes between them and the walls of the liver (capsule of Glisson).

The *hepatic veins* are a direct continuation of the veins of the portal system, within the substance of each lobule of the liver. They arise from the lobular plexus of veins, and in reality, begin as the central or *intra-lobular vein* of each lobule. These intra-lobular veins escape at the *base of each lobule* as the *sub-lobular veins*, and these, by their union, assist to form the so-called hepatic veins. The hepatic veins open into the inferior vena cava, at a *deep depression* in the posterior border of the liver.

The *biliary ducts* are the vessels which convey the bile from the liver, and which form, by their union, the *hepatic duct*.

The method of origin of the biliary ducts is a matter of uncertainty.

The *lymphatic vessels* consist of a superficial and a deep set. They principally accompany the blood-vessels.

The *nerves* are derived from the solar plexus and from the left pneumogastric and the right phrenic nerves.

The *substance of the liver* may be said to consist principally of liver cells, arranged in groups, to which the name *lobules* is applied. These lobules are connected together by connective tissue, blood-vessels, ducts, and lymphatics. Each lobule is polygonal in shape, on transverse section, and leaf-shaped, on perpendicular section, and measures about one-twentieth of an inch in diameter. It consists of the following component parts:

1st. Liver cells.
2d. A plexus of *lobular* veins.
3d. The *central* or *intra-lobular* vein.
4th. A plexus of lymphatic vessels.
5th. A plexus of nerves.
6th. A plexus of bile ducts (possibly).

The *external bile ducts* comprise the following parts which deserve special consideration.

1st. The hepatic duct.
2d. The cystic duct.
3d. The ductus communis choledochus.
4th. The gall bladder.

The *hepatic duct* is formed by the junction of the two large excretory ducts of the right and left lobes of the liver. It is contained between the two layers of the gastro-hepatic omentum.

The *cystic duct*, the duct of the gall-bladder, is about *one inch* in length. It assists to form the ductus communis choledochus.

The *ductus communis choledochus* is formed by the junction of the cystic and the hepatic ducts, and is about *three inches* in length. It descends between the head of the pancreas and the descending portion of the duodenum, and, after perforating the muscular coat of the intestine, it opens into the cavity of the duodenum at the summit of a small papilla upon its inner wall, at a point about three inches from the pyloric orifice of the stomach, and usually in common with the duct of the pancreas.

The *gall-bladder* is a pear-shaped sac, intended as a reservoir for the bile. It is *three* or *four inches* in length, and is capable of containing from eight to twelve drachms. It lies in a fissure upon the under surface of the liver, called the fissure for the gall-bladder, and empties its contents through the cystic duct.

The external bile ducts of the liver as well as the gall-bladder consist of a *peritoneal coat*, a *fibro-muscular coat*, and a *mucous coat.*

THE PANCREAS.

The pancreas is a long flattened organ, of a reddish cream-color, situated opposite to the 2nd lumbar vertebra. It lies behind the stomach, and presents the following points of interest.

A *head* or right extremity.
A *body* or central portion.
A *tail* or left extremity.
A *duct* or the *canal of Wirsung.*

The *head* is contained within the cavity of the duodenum, and is in close relation with the ductus communis choledochus and the pancreatico-duodenal arteries.

The *body* is flattened, and extends transversely across the cavity of the abdomen. It has the following relations with surrounding parts.

In front...Stomach and Peritoneum.

Behind..
- Left kidney and its capsule.
- Vessels, (5)
  - Inferior vena cava.
  - Aorta.
  - The mesenteric arteries. { Superior. Inferior.
  - Portal vein.
  - Left renal vessels.
- Crura of the diaphragm.
- Left quadratus lumborum muscle.

Above.....Coeliac axis, splenic artery and vein.

Below.....Duodenum and superior mesenteric vessels.

The *tail* lies in contact with the kidney of the left side and with the spleen.

The *duct*, called the canal of Wirsung, communicates with the cavity of the pancreas, which extends throughout the entire length of the body of the gland. It joins with the ductus communis choledochus and opens, in common with it, at the summit of the small papilla on the inner aspect of the descending portion of the duodenum. In exceptional cases, however, it opens by a separate papilla of its own.

The pancreas consists of a glandular structure, arranged as a *racemose* or *conglomerate gland*, and is similar in its appearance to the salivary glands.

The *arteries* are derived from the splenic and the pancreatico-duodenal arteries.

The *veins* open into the portal system, while its *lymphatics* open into the lumbar glands.

The *nerves* are derived from the solar plexus.

THE SPLEEN.

The spleen is one of the accessory organs of digestion, and is situated in the left hypochondriac region of the abdomen, where it embraces the left extremity of the stomach. It is oval in its form, is of a dark reddish-blue color, and is connected to the stomach by the gastro-splenic omentum. It presents for examination two surfaces, two extremities, and two borders.

The *outer surface* is convex, and is in relation with the diaphragm. It corresponds with the 9th, 10th and 11th ribs.

The *inner surface* is concave and, at its middle portion, it presents a vertical fissure, called the *hilnm*, where the vessels, nerves, and lymphatics enter. It is in relation with the stomach, the tail of the pancreas, and the diaphragm.

The *upper extremity* is attached to the diaphragm by the *suspensory ligament* of the spleen.

The *lower extremity* is in relation with the splenic flexure of the colon.

The *anterior border* is thin, and presents a notch at about its centre.

The *posterior border* is thick, and is in relation with the left kidney.

The *spleen* is one of the *ductless glands* of the body, and is therefore classed with the thyroid and the thymus glands, and the supra-renal capsules. It consists of an investing serous, and a fibro-elastic coat, which enclose the proper substance of the spleen.

The substance of the spleen consists of a soft, pulpy mass, of a reddish-brown color, which is contained in meshes of fibro-elastic tissue, derived from the elastic coat of the spleen, since that coat is prolonged into the interior of the organ as sheaths upon its vessels. This pulpy mass is perceived, by the microscope, to consist of the following elements;

1st. *Malpighian corpuscles.*
2d. *Colored elements.*
3d. *Colorless elements.*

The *Malpighian corpuscles* are whitish bodies, which vary from one twenty-fifth to one-sixtieth of an inch in size, and are developed principally upon the arteries. The larger ones are perceptible to the naked eye.

The *colored elements* are composed of *free blood corpuscles*, *pigment granules*, and *crystalline bodies* whose composition resembles hæmatin.

The *colorless elements* consist of *cells*, with and without nuclei, *free nuclei*, and *finely granulated matter* of an albuminous character.

The VESSELS of the spleen comprise the splenic artery and its branches, the splenic vein, and the lymphatics of that organ.

The *splenic artery* is very tortuous and of large size. It divides, at the hilum of the spleen, into five or six branches which supply the various portions of the organ. Some of its branches open into spaces in the substance of the spleen, called *lacunæ*, while others open directly into veins.

The *splenic vein* carries the blood from the spleen, and assists in forming the portal vein.

The *lymphatics* of the spleen open into the thoracic duct.

The *nerves* are derived from the solar plexus, the semi-lunar ganglia, and the right pneumogastric nerve.

REGIONS OF THE ABDOMEN.

The abdomen is usually described as consisting of three zones and nine distinct regions. The three zones of the abdomen are represented by describing two horizontal lines across the anterior surface of the abdomen, which shall respectively join the *highest points of the crests* of the two ilia with each other, and the *two cartilages* of the *ninth pair of ribs.*

The two lines, which subdivide these three zones, and thus form nine spaces or regions, descend, upon either side, from the *cartilage* of the *eighth rib* to the *middle of Poupart's ligament.*

The *spaces* or *regions*, situated at the *sides of the trunk*, are named as follows, from above downwards.

The two hypochondriac regions.
The two lumbar regions.
The two iliac regions.

The spaces, in the *middle line of the abdomen*, are named as follows, from above downwards:

The epigastric region.
The umbilical region.
The hypogastric region.

The parts contained within these various regions are as follows.

Right Hypochondriac.

Ascending part of duodenum.
Hepatic flexure of colon.
Right lobe of liver.
Gall bladder.
Upper half of right kidney and its capsule.

Left Hypochondriac.

Cardiac end of stomach.
Splenic flexure of colon.
Left lobe of liver.
Spleen.
Upper half of left kidney and its capsule.

Right Lumbar.

Descending part of duodenum.
Lower half of right kidney.
Convolutions of small intestine.
Head of pancreas.
Ascending colon.

Left Lumbar.

Descending colon.
Lower half of left kidney.
Convolutions of small intestine.

Right Iliac.

Caecum.
Right Ureter.
Right spermatic vessels.
Small intestine.

Left Iliac.

Sigmoid flexure of colon.
Left ureter.
Left spermatic vessels.
Small intestine.

Epigastric.

Stomach.
Left lobe of liver.
Aorta.
Inferior vena cava.
Vena azygos major.
Thoracic duct.
Semilunar ganglia.
Coeliac axis.

Umbilical.

Transverse colon.
Body of pancreas.
Transverse part of duodenum.
Aorta.

Hypogastric.

Convolutions of small intestine.
The uterus (in pregnancy).
The normal bladder, in children.
The distended bladder, in adults.

THE LARYNX.

The larynx is the essential organ of voice. It is composed of cartilages, united by ligaments, moved by muscles, lined with a mucous membrane, and supplied by vessels and nerves.

CARTILAGES.

The cartilages which compose the larynx are nine in number, three single and three pairs.

Single cartilages.	*Pairs of cartilages.*
Thyroid cartilage.	Arytenoid cartilages.
Cricoid cartilage.	Cuneiform cartilages.
Epiglottis.	Cornicula laryngis.

The THYROID CARTILAGE resembles a shield in form and is composed of two quadrilateral plates or *alæ*, joined together, in front, at an acute angle; the highest part of which junction is called the *pomum Adami.*

To its *outer surface*, are attached three muscles, *viz.*, the sterno-thyroid, the thyro-hyoid, and the inferior constrictor muscles.

To its *inner surface*, are attached the true and false vocal cords, the apex of the epiglottis, the thyro-epiglottic ligament, and the thyro-arytenoid and the thyro-epiglottidei muscles. It is covered by mucous membrane.

To its *upper border*, which is irregularly curved, is attached the thyro-hyoid membrane.

To the *lower border*, which is shorter and less curved than the upper, is attached the crico-thyroid membrane and the crico-thyroid muscle.

The *posterior border* of each ala affords attachment to the stylo-pharyngeus and the palato-pharyngeus muscles. Its upper and lower extremities are called the *superior cornu* and the *inferior cornu.*

The *superior cornu* affords attachment to the thyro-hyoid ligament.

The *inferior cornu* articulates with the cricoid cartilage and thus affords a point of motion between the thyroid and cricoid cartilages. This capability of motion allows of the *relaxation* and *tightening* of the vocal cords, when the crico-thyroid muscles act.

The CRICOID CARTILAGE is shaped like a ring, and is broad behind and narrow in front. It is thicker and stronger than any of the cartilages of the larynx.

To its *outer border*, are attached the crico-arytenoideus muscle, and the longitudinal fibres of the œsophagus. This border affords articulation also for the inferior cornu of each ala of the thyroid cartilage.

The *lower border* is connected with the first ring of the trachea.

The *upper border* affords attachment, in front and at its sides, to the crico-thyroid membrane and the crico-arytenoidei laterales muscles; and it also presents, at its posterior part, two *oval facets* for its articulation with the arytenoid cartilages.

The cricoid cartilage is a valuable *surgical guide* to the air passage, since it is always perceptible even in fat necks. It corresponds to the level of the lower border of the *fifth cervical vertebra.* It is also of surgical value, in affording a guide to the point of crossing of the *omo-hyoid muscle* over the *common carotid artery*, since a horizontal line drawn across the neck on a level with this cartilage will cross the line of the carotid at the same point.

The ARYTENOID CARTILAGES are two in number and resemble in their form a truncated pyramid. They rest upon the posterior portion of the upper border of the cricoid cartilage, upon which they are capable of motion.

Each cartilage presents for examination three surfaces, a base and an apex.

The *anterior surface* affords attachment to the *false vocal cord.*

The *posterior surface* affords attachment for the arytenoideus muscle.

The *internal surface* is covered with mucous membrane and looks towards the corresponding surface of the opposite cartilage.

The *base* presents a smooth *concave depression* for articulation with the cricoid cartilage, and also *two projections*, which are called the anterior and posterior angles of the arytenoid cartilage.

The *anterior angle* is long and pointed, and affords attachment for the *true vocal cord* and for the thyro-arytenoideus muscle.

The *posterior angle* is short and rounded, and affords attachment for the crico-arytenoideus lateralis and the crico-arytenoideus posticus muscles.

The *apex* affords articulation for the cartilage of Santorini.

The CORNICULA LARYNGIS or the CARTILAGES of SANTORINI are two small *nodules* of yellow elastic cartilage which articulate with the apices of the arytenoid cartilages.

The CUNEIFORM CARTILAGES or CARTILAGES of WRISBERG are two small *rods* of yellow elastic cartilage which are contained in the free border of the aryteno-epiglottidean folds.

The EPIGLOTTIS is a flat lamella of yellow elastic cartilage, which resembles a *leaf* in shape, and which is connected, at its pointed extremity, with the angle of the thyroid cartilage and with the base of the tongue and the hyoid bone. It presents for examination an apex, a base, an anterior surface, a posterior surface, and two lateral margins.

The *apex* is attached to the angle of the thyroid cartilage by the thyro-epiglottidean ligament.

The *base* is unattached, and is broad and rounded.

The *anterior surface* is attached, at its lower part, to the hyoid bone, by the hyo-epiglottic ligament; and, higher up, to the tongue, by the three glosso-epiglottidean folds. Its upper part is unattached and curves over the base of the tongue.

The *posterior surface* covers the superior aperture of the larnyx, when the bolus of food is passing through the pharynx. It presents numerous small depressions, in which are lodged mucous glands.

The lateral margins are connected to the arytenoid cartilages by the aryteno-epiglottidean folds.

MUSCLES.

The muscles of the larynx are divided into two sets as follows:

Muscles of the *glottis.*

Crico-thyroid.
Thyro-arytenoid.
Crico-arytenoid lateralis.
Crico-arytenoideus posticus.
Arytenoideus.

Muscles of the *epiglottis.*

Thyro-epiglottideus.
Aryteno-epiglottideus inferior.
Ayrteno-epiglottideus superior.

ORIGIN AND INSERTION.

CRICO-THYROID.

Origin.

From the front and sides of the cricoid cartilage.

Insertion.

Into the *lower border* and *inferior cornua* of thyroid cartilage.

Nervous supply.

The superior laryngeal nerve.

Action.

By *tilting the thyroid cartilage forwards*, it elongates and tightens the vocal cords.

THYRO-ARYTENOID.

Origin.

From the lower part of the receding angle of the thyroid cartilage, and the posterior surface of the crico-thyroid membrane.

Insertion.

Into the *anterior surface*, and the *internal angle* of the base of the arytenoid cartilage.

Nervous supply.

The recurrent laryngeal nerve.

Action.

By *drawing the arytenoid cartilage forwards*, it shortens and relaxes the vocal cords.

CRICO-ARYTENOID LATERALIS.

Origin.

From the side and upper border of the cricoid cartilage.

Insertion.

Into the *external* or *posterior angle* of the arytenoid cartilage.

Nervous supply.

The recurrent laryngeal nerve.

Action.

By *rotating the arytenoid cartilages*, it approximates the anterior angles of these cartilages, and thus closes the opening of the glottis.

CRICO-ARYTENOID POSTICUS.

Origin.

From the posterior surface of the cricoid cartilage.

Insertion.

Into the *external* or *posterior angle* of the arytenoid cartilage.

Nervous supply.

The recurrent laryngeal nerve.

Action.

By *rotating the arytenoid cartilages*, it separates the anterior angles of those cartilages, and thus opens the glottis.

ARYTENOID.

This is a single muscle, and is situated in the median line of the larynx between the two arytenoid cartilages.

Origin.

From the posterior surface and outer border of either arytenoid cartilage.

Insertion.

By oblique and transverse fibres, into the opposite cartilage.

Nervous supply.

From two sources, *viz.*, the superior and the recurrent laryngeal nerves.

Action.

By *approximating the arytenoid cartilages*, it closes the glottis, especially at its posterior part.

THYRO-EPIGLOTTIDEUS.

Origin.

From the inner surface of the thyroid cartilage, external to the point of origin of the thyro-arytenoid muscle.

Insertion.

Into the margin of the epiglottis and the aryteno-epiglottidean fold.

Nervous supply.

The recurrent laryngeal nerve.

Action.

To *depress the epiglottis* and to *create compression of the sacculus laryngis.*

ARYTENO-EPIGLOTTIDEUS INFERIOR.

Origin.

From the arytenoid cartilage, just above the false vocal cord.

Insertion.

Into the margin of the epiglottis.

Nervous supply.

The recurrent laryngeal nerve.

Action.

To *depress the epiglottis*, and to *assist in compressing the sacculus laryngis.*

ARYTENO-EPIGLOTTIDEUS SUPERIOR.

Origin.

From the apex of the arytenoid cartilage.

Insertion.

Into the aryteno-epiglottidean fold.

Nervous supply.

The recurrent laryngeal nerve.

Action.

To *constrict the superior aperture of the larynx* during the second act of deglutition.

Of these muscles, the arytenoideus and the thyro-epiglottideus are situated in the *median line*, while the other muscles are spread out upon those surfaces of the cartilages of the larynx which are not situated in the median line of the body.

LIGAMENTS.

The ligaments of the larynx may be divided into two sets as follows:

Extrinsic Ligaments.	*Intrinsic Ligaments.*
Thyro-hyoid membrane.	Crico-thyroid membrane.
Lateral thyro-hyoid ligaments.	Hyo-epiglottic ligament.
	Crico-thyroid capsular ligaments.
	Posterior crico-arytenoid ligaments.
	Thyro-epiglottic ligament.
	Crico-arytenoid capsular ligaments.

It will thus be perceived that the *three* extrinsic ligaments of the larynx connect the organ with the hyoid bone, and that the *six* intrinsic ligaments serve to bind the component parts of the organ together. The names which are applied to the various ligaments indicate the parts which they connect.

The *lateral thyro-hyoid ligaments* connect the superior cornua of the thyroid cartilage to the hyoid bone.

The *thyro-hyoid membrane* connects the upper border of the thyroid cartilage to the hyoid bone.

The *crico-thyroid membrane* connects the inferior border of the thyroid cartilage with the cricoid cartilage.

The *capsular ligaments* enclose the articulations between the thyroid and the cricoid cartilages on either side, and also the articulations between the cricoid cartilage and the two arytenoid cartilages.

The *posterior crico-arytenoid ligaments* connect the bases of the arytenoid cartilages with the posterior surface of the cricoid cartilage.

The *thyro-epiglottic ligament* connects the apex of the epiglottis with the receding angle of the thyroid cartilage.

The *hyo-epiglottic ligament* connects the anterior surface of the epiglottis with the upper border of the hyoid bone.

Cavity of the Larynx.

The interior of the larynx is divided into *two portions*, by the margins of the true vocal cords, and the space between the arytenoid cartilages. This opening is termed the *rima glottidis*, and measures, in the adult, from three-quarters of an inch to an inch in length. The shape of this opening varies, since it is affected by all the muscular efforts required in respiration and in the production of sound. During tranquil breathing, it is *triangular* in shape with its base directed backwards, while, in violent respirations, it is *lozenge-shaped*, and, when sound is produced, it is transformed into a *narrow slit*.

The *true vocal cords* lie below the false vocal cords, and consist of strong bands of yellow elastic tissue, which is continuous with the crico-thyroid membrane, and which is in relation with the thyro-arytenoideus muscle. They are inserted into the anterior angles of the arytenoid cartilages, and the receding angle of the thyroid cartilage.

The *superior aperture* of the larynx is triangular in form and is bounded, in front, by the epiglottis, and, upon either side, by the aryteno-epiglottidean folds.

The *false vocal cords* are situated higher up in the larynx than the true vocal cords, and extend from the receding angle of the thyroid cartilage to the anterior surface of the arytenoid cartilages.

In making an incision through the crico-thyroid membrane, the *vocal cords are liable to be wounded*, and the direction of the incision should therefore be transverse, and as near to the upper border of the cricoid cartilage as possible.

The space, which exists upon either side, *between the true and the false vocal cords* is called the *ventricle* of the larynx.

A space exists between the thyroid cartilage and the superior vocal cord, called the *sacculus laryngis*, which is a prolongation of the ventricle of the larynx, and which is covered by the thyro-epiglottideus and the two thyro-arytenoid muscles. It contains the openings of a large number of mucous glands, whose secretion serves to lubricate the true vocal cords.

Mucous Membrane.

The mucous membrane of the larynx is continuous with that of the pharynx and of the trachea. It is thin and of a pale pink color, and is covered, below the level of the superior vocal cords, and also, in front, as high as the middle of the epiglottis, with *ciliated* epithelium, and, in the remaining portion of the larynx, with *squamous* epithelium.

The *glands* of this mucous membrane are of a simple tubular and also of a conglomerate character. A large collection of glands, called the *arytenoid glands,* exist in the aryteno-epiglottidean folds; and, in the sacculus laryngis, some sixty separate glands exist.

VESSELS.

The vessels include branches of the superior thyroid and the inferior thyroid arteries, the superior, middle, and inferior thyroid veins, and lymphatic vessels.

NERVES.

The nerves comprise the superior laryngeal and the inferior or recurrent laryngeal nerves, both of which are derived from the pneumogastric nerve, and filaments from the sympathetic.

The *superior laryngeal nerve* enters the cavity of the larynx through a hole in the thyro-hyoid membrane, and is distributed to the mucous lining of the organ and to the crico-thyroid and the arytenoid muscles.

The *inferior* or *recurrent laryngeal nerve* enters the cavity of the larynx, at its posterior portion, passing behind the articulation of the inferior cornu of the thyroid cartilage and the external surface of the cricoid cartilage. It supplies *all the muscles of phonation,* with the exception of the crico-thyroid muscle.

THE TRACHEA.

The trachea is a cartilagino-membranous tube, which extends from the cricoid cartilage of the larynx, at a point corresponding to the 5*th cervical vertebra*, to the 3*d dorsal vertebra*, where it bifurcates into the right and left bronchus. It is rounded in its form, and is composed of cartilaginous rings connected together by a fibrous membrane. It is lined upon its interior surface with a mucous membrane, which is continuous with that of the larynx.

The *cartilages* are usually twenty in number, and each forms two-thirds of a circle. They are supplied at their incomplete portion, which lies posteriorly, with muscular fibres, to which the name *trachealis muscle* is applied.

The *first* and *last* of these cartilages present special characteristics. The lower edge of the last cartilage is prolonged downwards at its centre, and presents the openings of two imperfect rings which form the commencement of the bronchial tubes of either side; while the first cartilage is thicker and broader than the rest.

The *fibrous membrane*, which connects the cartilages of the trachea with each other, embraces both surfaces of each cartilage by dividing into two layers, which unite with each other at its upper and lower border.

The *muscular fibres* of the trachea are situated chiefly at its posterior portion, between the incomplete portion of the cartilaginous rings, and consist of a longitudinal and transverse set.

The *mucous membrane* is pink in color, and is covered with columnar ciliated epithelium.

The *glands* are of the conglomerate variety, and are found scattered beneath the mucous membrane, and also between the layers of the fibrous membrane which connects the cartilaginous rings.

The *arteries* of the trachea are derived from the inferior thyroid and the bronchial arteries, and the veins terminate in the thyroid plexuses and in the bronchial vein.

The *nerves* are derived from the pneumogastric, the recurrent laryngeal, and the sympathetic.

The *length* of the trachea is four and one-half inches. It corresponds to the length of the pharynx, and is one-half of the length of the œsophagus, which fact may help the memory of the student, in recalling either of the three.

The trachea is very deeply situated in the lower portion of the neck, and is reached with difficulty except at its upper part, since, in cases of extreme dyspnoea, the head is usually drawn forwards, and the approximation of the chin to the sternum shortens the working space for the Surgeon. In addition, the swelling of the thyroid veins, and the rigidity of the sternal muscles add to the difficulties of reaching the trachea.

The distance between the lower border of the larynx and the upper border of the sternum is modified greatly by the position of the head, but it measures only one and a half inches in the normal attitude, and when the head is fully extended, three quarters of an inch is added. It will thus be perceived that only about eight rings of the trachea are above the sternum.

The *relations* of the trachea within the neck and the thorax are important, and may be enumerated as follows:

In front.

The isthmus of the thyroid gland.
The arteria thyroidea ima.
The inferior thyroid vein.
The remains of the thymus gland.
The left vena innominata.
The arch of the aorta.
The arteria innominata and the left common carotid artery.
The great cardiac plexus.
The bifurcation of the pulmonary artery.
The sternum, sternal muscles, fascia, and integument.

Behind.

The œsophagus.
The right recurrent laryngeal nerve.

Laterally.

The lateral lobes of the thyroid gland.
The common carotid arteries.
The internal jugular veins.
The pneumogastric and sympathetic nerves.
The inferior thyroid arteries.
The left recurrent laryngeal nerve.

In the thorax on the right side. $\left\{\begin{array}{l}\text{Right vena innominata.}\\ \text{Right phrenic nerve.}\end{array}\right.$

In the thorax on the left side. $\left\{\begin{array}{l}\text{Left subclavian artery.}\\ \text{Left phrenic nerve.}\end{array}\right.$

THE BRONCHI.

The right and left bronchi commence at the bifurcation of the trachea, at a point corresponding to the *3d dorsal vertebra*, and a little to the left of the median line of the spinal column.

The *right bronchus* is wider than the left, and lies more horizontally. It is about *one inch* in length, and enters the root of the right lung on a level with the *4th dorsal vertebra.* In its course, it lies behind the superior vena cava and the right auricle of the heart, while the right pulmonary artery lies at first below it, but becomes anterior to it, before it enters the lung. The vena azygos major arches over it, passing from behind forwards.

The *left bronchus* is the smaller of the two, is more oblique in its direction, and is nearly *two inches* in length. It enters the root of the left lung on a level with the *5th dorsal vertebra.* In its course, it passes beneath the arch of the aorta, and in front of the descending portion of the arch of the aorta, the œsophagus, and the thoracic duct. The pulmonary artery of the left side lies at first above it, and then in front of it.

The bronchi present the same general appearance on section as does the trachea, since the cartilaginous rings are continued in the bronchi, even after they enter the substance of the lung. These rings are evidently intended by Nature as a source of protection against any outside pressure which might produce impairment to the free entrance of air into the lung.

The bronchi, immediately after their entrance into the lung, divide into large primary divisions, which, in the right lung, are *two* in number, and, in the left lung, are *three* in number. This point may be easily remembered by recalling the fact that the primary divisions of the bronchial tubes are in antagonism to the respective number of lobes which each lung presents, since the right lung has three lobes and two main bronchi; while the left lung has two lobes and three main bronchi.

The *cartilaginous rings* of the *bronchi* extend to the second or third bifurcation of the bronchus within the lung substance, when the rings give place to plates of cartilage, scattered within the walls of the bronchial tubes.

These *plates* of *cartilage* disappear altogether when the tubes reach a diameter of about *one-thirtieth* to *one-fiftieth* of an inch, since they are no longer required as a protective measure against obstructed entrance to air.

Within the substance of the lung the bronchial tubes divide and subdivide dichotomously until they reach a diameter of about one-fiftieth of an inch, when they *penetrate the various lobules* of the lung, and, since they then pass between the air cells, they are called *intercellular passages.*

The bronchial tubes, within the substance of the lung are usually found to be placed between corresponding branches of the pulmonary artery and vein.

THE LUNGS.

The essential organs of respiration are contained within the cavity of the thorax and are characterized by their light density, their porous structure, their crepitation on pressure, and their elasticity.

At the time of birth, their color is of a pinkish white, but, in the adult, a mottled grey color is developed, and, as age advances, the mottling becomes darker and frequently almost black.

The lungs present for examination an outer and an inner surface, an anterior and a posterior border, a base, and an apex.

The *outer surface* is convex, and, at its posterior portion extends deeper in the cavity of the chest than in its anterior portion. Upon either side, may be perceived a deep fissure which extends obliquely downwards and forwards from the region of the apex towards the base ; and, in the right lung, another fissure which extends obliquely upwards and forwards from about the central point of the fissure above mentioned. These fissures divide the lungs into their respective lobes. The left lung is divided into two lobes, while the right lung is divided into three. The lower lobes of both lungs are of large size. In the right lung, the middle is the smallest of the three lobes. The outer surface of each lung lies in close relation with the parietes of the chest and is separated from it by its pleural investment.

The *inner surface* of the lung is concave, and, upon the left side, is deeply excavated in order to afford a space for the heart and the pericardium. This surface of the lung assists in forming the space called the *middle mediastinum* of the chest, in which are contained the heart, the pericardium, all the great vessels connected with the heart, the phrenic nerves, and the bifurcation of the trachea.

The *anterior border* of the lung is shorter than the posterior border and comes in contact with the corresponding border of the opposite lung at about the middle of the sternum; but, below that point, the two diverge and leave a portion of the pericardium exposed.

The *posterior border* of the lung is more vertical in direction, and is longer than the anterior border. It differs also in being thicker and more rounded than the anterior.

The *base* of each lung is broad, concave, and directed obliquely downwards and backwards. It is in relation with the diaphragm, and its circumference is received into the groove formed between the diaphragm aud the internal surface of the ribs. The base of the left lung descends lower in the thorax than that of the right lung, since the liver is situated upon the right side. The upper border of the liver, therefore, although it corresponds to the level of the ninth dorsal vertebra at its highest point, would still be wounded were any injury received in the anterior aspect of the chest, which caused perforation at the space between the sixth and seventh ribs, provided the intervening lung were likewise perforated.

The *apex* of each lung passes up into the root of the neck for about an inch above the first rib, where it lies in close relation with the first and second portions of the subclavian artery, and under the cover of the scaleni muscles.

The ascent of the apex of the lung into the neck has a bearing upon the diagnosis of tuberculous disease, which usually is first developed in this region of the lung; and also upon the diagnosis of injuries received at the root of the neck, since, if the lung be involved, a peculiar crackling sound, due to the infiltration of air into the surrounding tissues, will often be detected.

The *root* of the lung is that portion where the bronchus, the pulmonary and bronchial vessels, the lymphatic vessels, and the nerves, derived from the pneumogastric and sympathetic plexuses, are afforded a means of entrance into the lung. These parts are bound together by areolar tissue, and are enclosed in a protective covering formed by the pleura. The following relations, between important structures, exist within the root of the lung and are deserving of special mention.

A. *From before, backwards.*

1. The *pulmonary veins*, and the anterior pulmonary plexus.
2. The *pulmonary artery.*
3. The *bronchus*, with its vessels, lymphatics, and the posterior pulmonary plexus.

These relations are the same upon each side of the body, and may be, perhaps, more easily remembered by the initial letters of the more important structures, *viz.*, V. A. B.

B. *From above, downwards.*

On the *right side* of the body. { Bronchus. / Pulmonary artery. / Pulmonary veins.

On the *left side* of the body. { Pulmonary artery. / Bronchus, / Pulmonary veins.

It will thus be perceived that the relations from above, downwards differ on the two sides of the body and may be represented by the initial letters of B. A. V. and A. B. V. This difference is produced by the *obliquity* of the *left bronchus*, which falls below the level of the artery upon the left side of the body.

The *root* of the *right lung* lies posteriorly to the superior vena cava and the right auricle of the heart, and the vena azygos major arches over it from behind forwards.

The *root* of the *left lung* passes beneath the arch of the aorta, and in front of the descending portion of the arch, the œsophagus, and the thoracic duct.

The *root* of *each lung* has also in front of it the phrenic nerve, and behind it the pneumogastric nerve.

STRUCTURE OF THE LUNG.

The intimate structures of the lungs may be grouped under three main divisions, *viz.:*

THE PARENCHYMA.
THE SEROUS COAT OR THE PLEURA.
THE SUBSEROUS AREOLAR TISSUE.

PARENCHYMA of the LUNGS.

The parenchyma, or the true structure of the lungs, embraces the following structures:

1. Bronchial tubes.
2. The lobules of the lung.
3. The pulmonary vessels.
4. The bronchial vessels.
5. The lymphatic vessels.
6. The nerves of the lung.
7. The connective tissue between the lobules.

The *bronchial tubes* have already been described, as subdivisions of the main bronchus.

The *lobules* of the lung are arranged upon the terminal extremities of the smaller bronchial tubes, like leaves upon the twigs of a tree. Each lobule is, in its form and general appearance, a minature lung, which is pyramidal in its outline, and whose base is directed outwards. The average size of each lobule is about one-twelfth of an inch. It is usually divided, in its interior, into compartments, called air cells, whose diameters vary from one seventy-second to one two-hundredth of an inch.

The *interior* of *each lobule* reveals not only the different compartments, called the *air cells*, but also communicating passages between these air cells, which are continuations of the bronchial tubes, and which are called the *intercellular passages* of the lobule. These passages vary from four to nine in number to each lobule, and their walls are characterized by saccular dilatations. They differ in their construction from the bronchial tubes in that they possess no cartilage, muscular fibres, or glands, and in that the epithelium which invests their walls is of the squamous variety in place of the ciliated variety, which lines the bronchial tubes.

The *air cells*, or *alveoli*, are small chambers which are contained within the lobules of the lung, and which are separated from each other by thin septa, named *alveoli*. The variations in their size has been already mentioned. Each air cell consists of the following component parts, in their order from within outwards, which enter into the construction of the walls.

1. Pavement epithelium.
2. A basement membrane.
3. Six plexuses.......... { Pulmonary arteries. Pulmonary veins. Bronchial arteries. Bronchial veins. Nervous plexus. Lymphatic vessels }
4. Elastic tissue of the lungs.

These four layers may be compared, in order to assist memory, to the construction of the ordinary partitions between the rooms of a dwelling, where the paper represents the epithelial covering ; the plaster, the basement membrane ; the laths, the six plexuses ; and the brickwork behind all, the elastic tissue of the lobule.

The *pulmonary vessels* comprise the branches of the pulmonary artery, which carries blood from the right ventricle, and the pulmonary veins, which empty their blood by four large orifices, into the left auricle of the heart. This set of vessels has little if anything to do with the nutrition of the lung substance, but is intended alone for the purpose of promoting *oxygenation* of the blood, after it has become impregnated with carbonic acid by its circulation through the systematic capillaries.

The *bronchial vessels* comprise the bronchial arteries, whose main trunks are derived from the thoracic aorta ; and the bronchial veins, which empty into the vena azygos, upon the right side, and, upon the left side, into the left superior intercostal vein. These vessels supply the lung substance with *nutrition*, and have nothing to do with the process of oxygenation.

The *lymphatic vessels* are arranged in two sets, called the superficial and the deep set, and terminate in the bronchial glands.

The *nerves* are derived from the anterior and the posterior pulmonary plexuses, which are formed by filaments from the pneumogastric nerves and from the sympathetic.

The *cellular tissue*, between the lobules of the lung, serves to bind the component parts of the lung together. In the fœtus this tissue is imperfectly developed, so that the lobules of the lung can be easily separated from each other, but, in the adult, such a separation is impossible. In this tissue, as age advances, a peculiar coloring matter, composed of animal matter and carbon, is deposited.

THE PLEURA.

The serous covering of the lung consists, like other serous membranes, of a shut sac, and invests the entire lung as well as its root. As each lung has a pleura of its own, the two sacs are distinct and separate, although they meet at the point of junction of the anterior borders of the two lungs, which corresponds with the middle of the sternum.

Each pleura may be traced as two folds over the outer and inner surfaces, the apex, the base, and the root of the lung which it invests. It is thin and adherent, where it invests the diaphragm, and where it comes in direct contact with the lung substance ; and it is thicker and less adherent, where it lines the parietes of the chest.

The reflection of the pleura, which binds the root of the lung to the upper surface of the diaphragm, is called the *ligamentum pulmonis latum*.

That portion of the pleura, which invests the apex of the lung, is brought in close relation with the subclavian artery, and the scaleni muscles.

The *arteries* of the pleuræ are derived from the following sources.

1. The intercostal arteries.
2. The internal mammary arteries.
3. The phrenic arteries.
4. The inferior thyroid arteries.
5. The pericardiac arteries.
6. The bronchial arteries.

The *veins*, which return the blood from the pleuræ, follow the same general course as the arteries.

The *lymphatic vessels* of the parietal layers of the pleuræ, join with those of the mediastina and the walls of the thorax; while those of the visceral layers empty into the lymphatic vessels of the lung.

The *nerves*, which supply the pleuræ, are derived from the two pulmonary plexuses, which lie in relation with the roots of the lungs; a few filaments from the phrenic nerves and from the sympathetic, however, directly supply it.

THE THYROID GLAND.

This gland lies in front of the upper part of the trachea, and at the sides of the œsophagus, the lower portion of the pharynx, and the larynx. It is soft in consistence, brownish in color, and is very vascular. Its average weight is about *one and a half ounces*, although it is usually somewhat larger in females than in males.

This gland, at its lateral portions, covers entirely or in part, the following structures.

1. The common carotid arteries.
2. The inferior thyroid arteries.
3. The internal jugular veins.
4. The pneumogastric nerves.
5. The recurrent laryngeal nerves.
6. The filaments of the sympathetic.

The thyroid gland presents for examination the following points of interest.

1. Two lateral lobes.
2. A connecting band called "the isthmus."
3. A small lobe called "the pyramid."

The *lateral lobes* are broader below than above, since they become constricted at the isthmus of the gland. They are about two inches long, at their broadest part, and three-quarters of an inch in depth. They extend from the inferior cornua of the thyroid cartilage of the larynx, to the level of the fifth cartilage of the trachea.

The *isthmus* of the thyroid gland connects the two lateral lobes and lies transversely across the trachea on a level, in the majority of subjects, with the third or the fourth ring, although the line of crossing varies.

The *pyramid* or *third lobe* of the thyroid gland is often absent, but, when present, it is situated between the hyoid bone and the isthmus, to both of which it is often attached, although it may be connected to the lateral lobe of either side.

The thyroid gland is enclosed within a *capsule*, and is composed of a multitude of small *closed vesicles*, which are flattened somewhat by pressure, and which are connected together by areolar tissue. It has no duct, and its function is not positively known.

The *arteries* are remarkable for their size, and for their frequent anastomoses.

The *veins* open into the superior, the middle, and the inferior thyroid veins.

The *nerves* are derived from the middle and the inferior cervical ganglia of the sympathetic.

THE THYMUS GLAND.

The thymus gland is a soft lobulated mass of a pinkish-grey color, which is situated in the upper part of the anterior mediastinum, and in the lower part of the neck, at the time of its most extensive development, which occurs at the end of the second year.

When fully developed, this gland weighs about half an ounce, and measures nearly two inches in length, but, as atrophy soon begins, it decreases rapidly in size, and, by the age of puberty, almost all signs of glandular structure have disappeared.

The thymus gland, when fully developed, presents a base, an apex, an anterior surface, and a posterior surface.

The *base* rests upon the upper portion of the pericardial sac.

The *apex* often reaches to the lower border of the thyroid gland.

The *anterior surface* is convex, and is in relation with the two upper pieces of the sternum, the internal mammary arteries and veins, and the sterno-thyroid and sterno-hyoid muscles.

The *posterior surface* is concave, and rests upon the pericardium, the arch of the aorta, the left innominate vein, the four large arterial trunks given off from the upper portion of the transverse arch of the aorta, and the anterior aspect of the trachea.

The *intimate structure* of the *thymus gland* presents the following points of interest.

1. The investing capsule.
2. The central cavity or reservoir.
4. The lobules.

The *capsule* sends trabeculæ into the substance of the gland, and invests its entire outer surface.

The *reservoir*, the central cavity, is of large size, and penetrates into the lobes and lobules of the gland.

The *lobules* vary in size from a pin's head to that of a pea, and are bound together by areolar tissue. They are divided into primary and secondary lobules, the latter of which are contained within the former, and, of necessity, are of smaller size.

The *arteries* of the gland are derived from the following sources.

1. The internal mammary arteries.
2. The inferior thyroid arteries.
3. The superior thyroid arteries.
4. Occasional branches from the common carotid and subclavian arteries.

The *veins* open into the left innominate vein, and into the thyroid veins.

The *nerves* are derived from the pneumogastric nerves and the sympathetic system.

THE KIDNEY.

The kidneys are two glandular organs, which are situated upon either side of the body, in the back part of the abdominal cavity. They extend from the 11th rib to the level of the crest of the ilium, although the right kidney usually lies somewhat lower than the left, on account of the liver.

The kidneys are each about four inches long, two inches broad and one inch in thickness. They each present for examination two surfaces, two borders, and two extremities.

The *anterior surface* is in relation, upon the right side, with the right lobe of the liver, the descending duodenum, and the ascending colon; while, upon the left side, it is in relation with the tail of the pancreas, the descending colon, and the lower portion of the spleen. This surface is convex, and is covered in part by peritoneum.

The *posterior surface* is flat, and is in relation with the crus of the diaphragm, the 11th and 12th ribs, the psoas magnus muscle, the aponeurosis of the transversalis, and the quadratus lumborum muscle. This surface is not covered with peritoneum.

The *superior extremity* is the largest and the thickest of the two extremities of the organ, is directed inwards, and is capped by the suprarenal capsule.

The *inferior extremity* is small, flattened in shape and is directed outwards. It corresponds nearly with the crest of the ilium.

The *outer border* is convex, and is directed outwards and backwards.

The *inner border* is concave, is directed forwards and downwards, and is marked by a depression or fissure, called the *hilum* of the kidney, which leads into the cavity of the organ and which gives passage, from before backwards, to the renal vein, the renal artery, and the ureter.

The kidney is enveloped in a *fibrous capsule*, which is thin, smooth, and firm, and which is loosely connected with the substance of the organ.

On a longitudinal section of the organ being made, the kidney is perceived to consist of *two portions*, which differ in their color, appearance, and general structure.

The *inner portion*, which is called the *medullary portion* of the kidney, is arranged in the form of *pyramids*, from eight to eighteen in number, whose bases are directed towards the surface of the organ and whose apices are directed inwards and terminate as little projections, to which the name *papillæ* is applied, into the cavity of the kidney.

This portion of the kidney is dark in color, striated in appearance, and of dense consistence; and is formed by the straight uriniferous tubes, (the tubes of Bellini), and by looped uriniferous tubes, (the tubes of Henle). Each of the large pyramids of the medullary substance is called a "*pyramid of Malpighi*," and, as before stated, these pyramids vary from eight to eighteen to each kidney.

The *outer portion* of the kidney, which comprises about three-fourths of the entire organ, is termed the *cortical substance* of the kidney. It is soft in consistence, reddish in color, and granular in appearance. It sends prolongations between each of the pyramids of Malpighi, which prolongation are called the *columns of Bertin.* The cortical substance of the kidney is found to consist of the following component parts:

1. Uriniferous tubes, of various forms.
2. Malpighian bodies or corpuscles.
3. Blood-vessels.
4. Nerves.
5. Lymphatics.
6. Connective tissue, (inter-tubular stroma).
7. A granular matrix.

The varieties of URINIFEROUS TUBES, which are met with in the kidney, are named as follows:

1. The *convoluted tubes*, so named from their twisted course. These tubes form the greater portion of the cortical substance of the kidney, and are continuous, at one extremity, with the Malpighian corpuscles, and, at the other extremity, with the looped tubes of Henle.

The *looped tubes of Henle* are so called from the course which they take, and from their discoverer. They form an anastomosing link between the convoluted tubes and the straight uriniferous tubes, although an additional variety of tube is now believed to exist between these points, to which the name *communicating tube* has been applied. The tubes of Henle are subdivided into a descending and an ascending portion, since they form a loop extending into the medullary portion of the kidney.

The *straight uriniferous tubes* are also called the "*tubes of Bellini.*" They have been also named, when found in the cortical portion, the *tubes of Ferrein.*

The *tubes of Bellini* compose the greater portion of the medullary substance of the kidney, and give to that portion of the organ the striated appearance, which is characteristic of it.

The *tubes of Ferrein* are a direct extension of the straight tubes of Bellini upwards into the cortical portion of the kidney. They are generally arranged in the form of small pyramids, to which the name "*pyramids of Ferrein*" is applied.

The *Malpighian bodies* or *corpuscles* are, in the majority of instances, a dilated extremity of a convoluted uriniferous tube, and average about one one-hundred and twentieth of an inch in diameter. They consist of an investing capsule, called the "*capsule of Müller*" and a tuft of blood-vessels, called the "*Malpighian tuft.*"

The VESSELS of the kidney are derived from the renal artery and terminate in the renal vein ; but, as the circulation of the kidney has some points of special interest connected with it, a rapid enumeration of the parts, to which special names have been applied, seems demanded.

The renal artery first divides into four or five *primary branches*, and subsequently into as many subdivisions as there are columns of Bertin, into each of which two vessels enter. These vessels, at the base of each pyramid, join with their fellow of the opposite side, to form *arterial arches* over each pyramid.

These arterial arches give off branches which *ascend* into the cortical portion of the kidney, and *descending* branches which supply the pyramids with nutrition.

Each *ascending branch* subdivides, along its entire course, into arteries, which go to the various Malpighian bodies, and which are called "*afferent vessels.*"

Each *afferent vessel* forms, within the Malpighian body, an arterial tuft, called the "*Malpighian tuft.*"

The vessels of each Malpighian tuft again unite to form a single vessel called the "*efferent vessel.*" The question of the arterial or venous character of the efferent vessel is not yet positively decided.

The *efferent vessels* of the various Malpighian tufts, after their escape from the capsule of Müller, immediately break up into a *venous plexus upon the convoluted portions of the uriniferous tubes.*

From these venous plexuses, veins ascend to the surface of the kidney, where they form stellate plexuses, called the *stars of Verheyen.*

The *veins* of the kidney return in the same general way as the arteries entered, and therefore comprise both *descending* and *ascending veins*, which assist in forming *venous arcades.* These subsequently form the *primary veins* of the kidney, which unite to form the *renal vein.*

The blood which is distributed to the kidney passes, therefore, through the following named vessels before its exit from the organ.

1. Renal artery.
2. Primary branches of renal artery.
3. Arterial arcades (over the bases of the pyramids).
4. Ascending and descending branches.
5. Afferent arteries.
6. Malpighian tufts.
7. Efferent vessels.

8. Uriniferous plexuses.
9. Stars of Verheyen, (venous plexuses).
10. Ascending and descending veins.
11. Venous arcades, (over bases of pyramids).
12. Primary veins.
12. Renal vein.

The NERVES of the kidney are derived from the renal plexus and from the lesser splanchnic nerve.

The LYMPHATICS comprise a superficial and a deep set, and open into the lumbar glands.

THE URETER.

The ureter is the excretory duct of the kidney, and, by its upper or expanded portion, it forms the internal cavity of that organ.

The pelvis of the kidney, which is but another name for the upper end of the ureter, may be subdivided into the following portions:

The pelvis proper.
The infundibula.
The calices.

The *infundibula* are large prolongations, usually three in number, from the main cavity of the pelvis.

The *calices* are smaller prolongations from the three infundibula, which vary from seven to thirteen in number, and which embrace the papillæ of the kidney. They serve to collect the urine as it escapes from the small openings of the straight tubes of that organ, and to convey it to the ureter.

The *ureter* is from sixteen to eighteen inches in length, and is of the diameter of an ordinary quill. As it passes downward to open into the bladder, near to its base, it bears an important *surgical relation* to the common iliac artery, to which vessel, in cases where its ligation is demanded, it is often used as a guide.

The ureter, in all of its portions, has *three coats*, to which the names fibrous, muscular, and mucous coats are applied.

The *epithelium* of the mucous coat is *spheroidal* in character and differs from that of the urethra, bladder, or the uriniferous tubes. This is an anatomical point of practical value, since, in cases of inflammatory diseases of the genito-urinary tract, the variety of epithelium detected in the urine is of great value in deciding upon the locality of the disease.

SUPRA-RENAL CAPSULES.

These are small *crescentic* bodies, of a yellowish-brown color, which lie upon the upper and front part of the kidney. They weigh about two drachms each. The left capsule is the largest and highest in its situation.

They are *ductless glands*. They consist of a fibrous capsule, a striated cortical substance, an imperfectly developed medullary structure, blood-vessels, lymphatics, and nerves.

They are supposed, by some, to be a part of the sympathetic system; by others, to be a ductless gland only; and by Kölliker, to perform both functions, the medullary part being the nervous portion, and the cortical part the glandular.

THE BLADDER.

The bladder differs in its situation in the two sexes; and also in its situation and its shape, whether it be distended or empty.

In the male, when empty, it is deeply situated behind the pubes and in front of the rectum; while, in the female, it lies in front of the uterus and the vagina.

The shape of the bladder is conical in children, and reaches a higher point within the pelvis than in the adult; while the adult bladder is rounded in form, when moderately distended, and egg-shaped when fully distended.

The male bladder, when distended, lifts the peritoneum for a distance of about two inches above the pubes, and thus affords a space where puncture or incision can be made without danger of injury to the peritoneum.

The bladder presents for examination the following parts, namely: four surfaces, an anterior, a posterior, and two lateral surfaces, and an apex, a base, and a neck.

The *anterior surface* is uncovered by peritoneum, and is in relation with the following structures.

The pubes.
The pubo-prostatic ligaments.
The triangular ligament of the urethra.
The anterior wall of the abdomen (in children and in adults, if distended).

The *posterior surface* is separated, by the intestine, from the rectum, in the male, and, in the female, from the uterus. It is covered by peritoneum.

The *lateral surfaces* are in relation with the following structures:

The pelvic fascia.
The obliterated hypogastric arteries.
The ureters.
The vasa deferentia, (in the male sex).

It is covered by peritoneum, above and behind the obliterated hypogastric arteries, while, in its other portions, it is destitute of such a covering, since it rests upon the pelvic fascia.

The *apex* of the bladder is attached to the umbilicus by the *urachus* and the obliterated hypogastric arteries, and it is covered, behind that point, by the peritoneum.

The *base* or *fundus* of the bladder is in relation, in the male sex, with the second portion of the rectum, while, in the female sex, the anterior wall of the vagina and the neck of the uterus is in relation with it. That portion of the male bladder, which is in close relation with the rectum, corresponds with a triangular space which is bounded as follows:

In front, by the prostate gland.
Laterally, by the vesiculæ seminales.
Behind, by the reflection of the peritoneum.

The *neck* of the bladder is surrounded, in the male sex, by the prostate gland. In the erect position of the body, in both sexes, the neck of the bladder is the lowest part of that organ, and is directed downwards and forwards.

The bladder has *five true* and *five false ligaments*, the latter of which are formed by reflections of peritoneum. These ligaments may be enumerated as follows:

True ligaments.	*False ligaments.*
Two anterior or pubo-prostatic.	Two posterior false ligaments.
Two lateral ligaments.	Two lateral false ligaments.
Superior ligament or the urachus.	Superior false ligament.

The *pubo-prostatic ligaments* extend from the pubes to the prostate gland and the neck of the bladder.

The *lateral ligaments*, of the true set, are formed by the pelvic fascia, and are attached to the sides of the prostate gland and the sides of the bladder.

The *superior ligament* or the *urachus* consists of a fibro-muscular cord, which connects the apex of the bladder with the umbilicus.

The *posterior false ligaments* contain the obliterated hypogastric arteries.

The *lateral false ligaments* connect it with the sides of the pelvis.

The *superior false ligament* is a reflection of peritoneum, over the urachus and the obliterated hypogastric arteries, to the region of the umbilicus.

The COATS of the bladder are four in number, and are called, from without inwards, as follows:

The serous coat.
The muscular coat.
The cellular coat.
The mucous coat.

The *serous coat* is formed by the peritoneum, and is deficient in certain portions of the organ. It is most marked upon the posterior surface, the sides, and the posterior portion of the base of the bladder.

The *muscular coat* consists of three distinct sets of fibres distributed over the entire organ, and two additional sets connected with the ureters. The former group are named, respectively, the external longitudinal fibres, the intermediate circular fibres, and the internal longitudinal or sub-mucous fibres. The two sets of fibres connected with the ureters comprise a transverse set, which connect the orifices of the tubes; and the muscles of the ureters proper, which connect each tube with the middle lobe of the prostate gland.

The *cellular coat* of the bladder is situated between the muscular and the mucous coats of that organ, and is most closely attached to the mucous coat.

The *mucous coat* of the bladder is of a light color, and is loosely connected to the muscular coat, except at two specially designated localities within that organ, called the *trigonum vesicæ* and the *uvula vesicæ*. In cases where the muscular coat of the bladder has undergone changes, either of hypertrophy or of separation of its fibres, the mucous lining of the organ is thrown either into proportionate ridges or depressions, thus forming the so-called *fasciculated* bladder, and the *sacculated* bladder.

The *trigonum vesicæ* is a triangular space at the base of the interior of the bladder, which is distinguished by its pale color and the close intimacy which exists between its mucous and muscular coats. It is bounded as follows:

In front, by the urethral opening.
Behind, by the orifices of the ureters.
Laterally, by two folds of mucous membrane.

This space corresponds to that portion of the bladder, which lies in intimate relation with the rectum, and it is in this space that puncture of the bladder, through the rectum, is performed; since the close contact of the organs, and the almost entire absence of connective tissue, renders the escape of the urine, in other channels, difficult.

The *uvula vesicæ* is an elevation of the mucous lining of the bladder, situated near to the mouth of that organ. It is supposed, by some of the more recent investigators, to assist in preventing the escape of the urine, by being lifted by the anterior fibres of the levator ani muscle, and thus applied, as a valve, to the internal orifice of the bladder. In this region, the mucous coat is in very close relation with the muscular coat of the bladder.

The VESSELS of the bladder comprise arterial branches, derived from the internal iliac artery; and its veins open into the vein oi the same name, after having formed an intricate plexus upon the sides and the base of the organ.

The *lymphatics* communicate with the glands of the lumbar region.

The NERVES arise from the hypogastric and sacral plexuses; from the former of which the upper portion of the organ is supplied, while, from the latter, the base and the neck of the organ are supplied.

THE PENIS.

The genital organ of the male sex consists of erectile tissue, enclosed in three compartments, called the two corpora cavernosa and the corpus spongiosum. Each of these compartments is enclosed in a sheath of its own, which is composed of fibrous tissue, and, by prolongations of these sheaths inwards, called *trabeculæ*, each of the three compartments is subdivided into numerous minute spaces, in which are contained the blood-vessels of the erectile tissue of the organ.

The two *corpora cavernosa* lie, side by side, upon the upper surface of the penis, while the corpus spongiosum lies behind the other two compartments, being contained in the groove between the corpora cavernosa. At the anterior extremity of the organ, this portion of the penis expands into a conical shaped mass, called the *glans penis*, which embraces and conceals the anterior extremity of the two corpora cavernosa, which, at this point, become united.

The corpora cavernosa arise from the two tuberosities of the ischium and from either of the ascending rami of that bone, and partly also from the descending rami of the pubes, and, after meeting beneath the symphysis, they pass, side by side, till they join, in front, to form a rounded extremity, which fits into a depression in the glans penis. The grooves, between the corpora cavernosa, contain the dorsal vessels and nerves, above, and the corpus spongiosum, below.

The fibrous sheath, which invests the corpora cavernosa, forms a *septum* between them for the posterior two-thirds of their extent, after they join in the median line, but is deficient in the anterior third, thus affording a communication between the cavities of each. The comb-like fibres, which mark the gradual disappearance of this septum, form the "*septum pectiniforme.*"

The *corpus spongiosum* commences at the point of union of the corpora cavernosa, in a swelling called the *bulb* of the corpus spongiosum, where it is penetrated by the membranous portion of the urethral canal; and passes forwards as an erectile tube, which encloses the urethra, till it expands into its anterior extremity, the *glans penis.*

The *glans penis* is the anterior extremity of that organ, and is protected by a prolongation of the integument of the penis, to which the term *prepuce* is applied. It presents the following portions to which special names have been applied:

The *meatus*, or mouth of the urethra.
The *cervix*, or constricted portion.
The *corona*, or ridge of the glans.
The *frænum preputii*, or bridle of the prepuce.

The integument of the penis differs from the integument of other localities, in being *destitute of fat*, in being *darker colored*, and in being *more loosely connected* to the adjacent parts.

The ERECTILE TISSUE of the penis is composed of three sets of vessels, called,

Afferent arteries.
Efferent veins.
Venous plexuses.

The *afferent arteries* of the penis are chiefly derived from the artery of the bulb, and the artery of the corpora cavernosa; and they assist in forming capillary plexuses and long tortuous arteries, called *helicine arteries.*

The *efferent veins* of the penis emerge from the corona glandis, from the upper and lower surfaces of the corpora cavernosa, and from the root of the penis. Those which emerge from the three first situations empty into the dorsal vein of the penis, while those which emerge from the root, empty into the prostatic plexus of veins and the pudic vein.

The *venous plexuses* of the erectile tissue of the penis are developed to a remarkable degree and are extremely intricate.

THE URETHRAL CANAL.

The urethral canal of the two sexes differs to so great a degree, that the female urethra will be considered in the description of the female genitals, and the urethra of the male sex alone will be here considered.

The male urethra is about *eight and a half inches* in length, and is usually divided into three portions, called from their situation, the prostatic, the membranous, and the spongy portion.

The urethra is also often divided into two portions, called the *fixed* portion, which lies beneath and behind the pubic arch, and the *pendulous* portion, which is included within the spongy portion of the penis. The curve of these two portions differs; the former presenting a concavity which looks upwards, and the latter a concavity which looks downwards.

The former division of the urethra, however, best affords a clear idea of the situation, the function, and the surgical importance of the parts contained.

The PROSTATIC PORTION comprises that part of the urethral canal which pierces the prostate gland. It is spindle-shaped, is the most dilatable and the widest portion of the urethral canal, and measures about *one inch and a quarter* in length.

Upon its *floor*, may be perceived the following points of special interest:

The *verumontanum* or *caput gallinaginis.*
The *prostatic sinus.*
The *sinus pocularis* or *uterus masculinus.*
The *orifices* of the *seminal ducts.*
The *orifices* of the *prostatic ducts.*

The first point of interest, above mentioned, is so-called from its form and from a fancied resemblance to the comb of a rooster. It is often also called the "*urethral crest.*" It consists of a longitudinal ridge, three quarters of an inch in length, and is, by some, supposed to be the chief seat of sensation during sexual intercourse.

The *prostatic sinuses* are situated upon either side of the verumontanum, and, into them, open the *ducts of the prostate gland.*

The *sinus pocularis* is a small cul-de-sac, which extends into the *middle lobe of the prostate*, and resembles, in its shape, the female organ of conception.

The *seminal ducts* open into the anterior part of the prostatic portion of the urethra.

The MEMBRANOUS PORTION of the urethral canal is contained between the *two layers* of the *triangular ligament* of the perineum. It is so called from the character of its coats, which are almost entirely destitute of erectile tissue, and which are therefore extremely thin. This portion of the urethra allows of great latitude of motion to the penis, and, from the absence of abundant erectile tissue, the danger of fracture of that organ, when erected, is therefore greatly diminished.

The membranous portion of the urethra is shorter upon its lower than upon its upper surface, on account of the *projection backwards of the bulb of the urethra*, which encroaches upon its lower surface.

The ducts of Cowper's glands are perceived upon the sides of this portion of the urethra, external to its coats, on their way to open into the bulb of the urethra.

The SPONGY PORTION of the urethra comprises the remainder of the canal, and is contained within the corpus spongiosum. It is about six inches in length, and presents two enlargements, one at either end, called the *bulb* of the urethra, and the *fossa navicularis.*

The *bulb* of the urethra is situated at the posterior part of the corpus spongiosum, and the *fossa navicularis* is situated at the anterior extremity, within the glans penis. Both of these localities are of larger calibre than the balance of the spongy portion, and possess points of surgical interest, which render their anatomical situation important.

The urethra has three coats, called, respectively, the muscular, the mucous, and the erectile coats.

The *muscular coat* consists of a layer of involuntary or unstriped muscular fibres, which lie under the mucous coat of the canal. Two voluntary muscles are also connected with the urethra, which are not properly a portion of the muscular coat of the canal, but which are of physiological importance in assisting in the voidance of urine and the ejaculation of semen. These two muscles are called the compressor urethræ and the accelerator urinæ. They are usually described in connection with the anatomy of the perineum.

The *mucous coat* of the urethra extends throughout the entire length of the canal, and is covered, for the greater portion of its extent, with columnar epithelium. In the fossa navicularis, however, the epithelial covering is of the squamous variety.

The mucous coat differs in its color in certain portions of the canal, being pale in the prostatic portion, and of a deeper red color in the two remaining portions. It is also smooth in the prostatic portion, and is thrown into longitudinal folds in the remaining portions, except when the canal is distended with urine.

The *glands of the mucous coat* are called the glands of Littre, and are of surgical importance, since their mouths open forwards, and thus often afford an obstruction to the introduction of instruments into the bladder. They are most abundant in the spongy portion of the urethra.

The *erectile coat* of the urethra is very extensively developed in the spongy portion, since it forms the corpus spongiosum, and it is also distributed as a thin layer over the membranous and the prostatic portions. In the latter situation, the erectile coat forms the caput gallinaginis.

The urethral canal of a child is longer in its membranous portion, in proportion to the entire length of the canal, than in the adult, since the prostate gland is small and imperfectly developed. The curve of the urethra of the child is also greater than in the adult, since the bladder is placed higher up in the abdomen; and the coats of the canal furthermore are thin and delicate, and are, therefore, liable to be injured in attempts at catheterism.

THE TESTICLE.

The testicle is the organ which secretes the seminal fluid. It is of oval form, and is suspended by the spermatic cord. Within the scrotum, it hangs obliquely, and presents an upper and lower extremity, two lateral surfaces, and an anterior and a posterior border.

It is protected by the following external coverings:

Integument of the scrotum.
Dartos of the scrotum.
Intercolumnar or external spermatic fascia.
Cremasteric layer.
Fascia propria or infundibuliform process.
Tunica vaginalis, (two layers.)

The *integument of the scrotum* is closely united to the dartos, and is divided, by the median raphe of the scrotum, into two lateral halves.

The *dartos* is the contractile layer of the scrotum, and forms a septum between the two testicles, called the "septum scroti."

The *external spermatic fascia* is derived from the margins of the external abdominal ring during the descent of the testicle.

The *cremasteric layer* consists of a thin covering of the fibres of the cremaster muscle, gathered by the testicle during its descent.

The *fascia propria* is a covering of the testicle, which corresponds to that process of the transversalis fascia, which accompanies the testicle in its descent through the inguinal canal.

The *tunica vaginalis* is derived from the peritoneum, and, like other serous membranes of the body, consists of a visceral and a parietal layer. It communicates, soon after the descent of the testicle, with the cavity of the peritoneum, but afterwards closes and becomes a shut sac.

The EPIDIDYMIS is an appendix to the testicle, which lies on the posterior border, and the back part of the outer surface of that organ.

Its *upper extremity* or *head* is attached to the testicle, and gives passage to its efferent ducts.

Its *central portion*, called its *body*, is attached to the posterior border of the testicle by the tunica vaginalis.

Its *lower extremity* is pointed, and is attached to the testicle by a dense band of fibrous tissue.

The testicle has, in addition to its serous layer, which has been already mentioned, a fibrous and a vascular layer.

The *fibrous layer* is called the *tunica albuginea*, and lies underneath the serous covering of the organ. It is reflected, at the posterior and upper border of the organ, into the interior of the testicle, where it assists in supporting the vessels, nerves, and excretory ducts of the organ, and also, by forming *trabeculæ*, it divides the testicle into compartments, which contain the substance of the gland. The vertical septum, which is formed in the interior of the gland by the tunica albuginea, is called the *mediastinum testis* or the *corpus Highmorianum.*

The *vascular covering* is called the *tunica vasculosa.* The vessels, contained within this covering, penetrate into the substance of the gland and supply it with blood.

The *glandular structure* is composed of lobules, each of which may be shown to consist of a few small tubules, called *tubuli seminiferi.* The length and size of these tubes has been variously estimated, and an equal diversity exists as regards their number.

The seminal tubes, after their escape through the mediastinum testis, are called *vasa recta*, and these again, by joining with each other, form a collection of tubes, called the *rete testis*.

The *rete testis* forms, in the region of the globus major of the epididymis, some fifteen or twenty ducts called *vasa efferentia*, which perforate the testicle and escape into the epididymis.

The *vasa efferentia* soon become convoluted and grouped into conical shaped bundles, called *coni vasculosi*, which constitute the greater portion of the globus major.

The *coni vasculosi* finally empty into the *canal of the epididymis*, which consists of a tube, that measures about twenty feet in length, and which opens into the vas deferens. This tube constitutes the true structure of the epididymis. It is usually connected with an additional tube, called the *vas aberrans of Haller*, which occasionally opens into the vas deferens, but usually ends in a blind extremity.

The VAS DEFERENS is the tube, by which the semen is conveyed from the epididymis to the point of origin of the ejaculatory duct. Its course is as follows:

1. Along the inner side of epididymis and the testicle.
2. Along the *back part* of the spermatic cord, to the external abdominal ring.
3. Through the two rings of the abdomen and the inguinal canal.
4. Between the bladder and the rectum, to the inner side of the vesicula seminalis.
5. Joins, at the base of prostate, with the duct of the vesicula seminalis, to form the ejaculatory duct.

The *vesiculæ seminales* are two sacculated pouches, which act as reservoirs for semen, and which are filled by a regurgitant current from the vas deferens of either side. They are about *two* and *a half inches* in length, and are situated between the bladder and the second portion of the rectum. They consist of a tube, coiled upon itself, which measures about six inches in length.

The *ejaculatory ducts* are formed, by the junction of the ducts of the vesiculæ seminales and the vasa deferentia, upon either side of the body. They are about three-quarters of an inch in length, and they terminate at the anterior extremity of the prostatic portion of the urethra, upon either side of the verumontanum.

THE PROSTATE GLAND.

The prostate gland encircles the neck of the bladder of the male, and measures one and one-quarter to one and one-half inches in its antero-posterior diameter, one and three-quarter inches in its greatest transverse diameter, and about three-quarters of an inch in depth. It is of a pale color, and consists, to a great extent, of involuntary muscular tissue, the glandular portion being decidedly subordinate to the muscular element. Its ducts open into the prostatic portion of the urethra, and its secretion serves to dilute the semen.

This gland consists of two lateral lobes of large size, and, in the deep notch between them at its posterior part, of a small triangular mass, to which the name " middle lobe of the prostate " is applied.

The size of the prostate gland, especially of its middle lobe, varies; since, as life advances, the gland tends to increase in size, on account of hypertrophy of its structures.

The prostate gland is enveloped in a fibrous capsule, which is derived from the pelvic and the deep perineal fasciæ.

The *arteries*, which are distributed to this gland, are derived from the internal pudic, the vesical arteries, and the middle hemorrhoidal artery. The *veins* form large plexuses at the sides and the base of the gland, and empty into the internal iliac vein.

The *nerves* are derived from the hypogastric plexus of the sympathetic system.

The various points of interest, contained within the internal cavity of the gland, have already been described as pertaining to the prostatic portion of the urethral canal.

The prostate gland lies in close relation with the rectum. An invaluable means of diagnosis, in case of disease of this gland, is thus afforded by rectal touch. The posterior edge of this gland is used as a guide, in puncture of the bladder through the rectum.

THE SPERMATIC CORD.

The spermatic cord extends from the globus minor of the epididymis to the internal abdominal ring. It is about four inches in length, and is composed of the following structures:

1. The vas deferens.
2. Spermatic artery.
3. Cremasteric artery.
4. Artery of the vas deferens.
5. Spermatic veins.
6. Spermatic plexus of nerves.
7. A branch of the ilio-inguinal nerve.
8. A branch of the genito-crural nerve.
9. Vas aberrans of Haller.
10. Coverings.
11. Lymphatics.

Of these various structures, the vas deferens lies at the posterior portion of the cord, while the veins form a plexus both in and upon it, and are sometimes called the *pampiniform plexus.*

The *vas aberrans of Haller* is a narrow and tortuous tube, which arises either from the vas deferens or from the canal of the epididymis. It passes upwards in the spermatic cord, where it usually ends in a blind extremity. It varies in its length from two to fourteen inches.

The coverings of the spermatic cord differ in the various parts of its course. Two coverings, *viz.*, the *fascia propria* of the testicle and spermatic cord, and the *cremasteric fascia*, invest it for the greater portion of its length; while, below the external abdominal ring, the *tunica vaginalis*, the *intercolumnar fascia*, the *dartos*, and the *integument* also protect and partially cover it.

All the parts, which enter into the formation of the spermatic cord, are bound together by a delicate areolar tissue.

GENITAL ORGANS OF THE FEMALE.

The *external genitals* of the female comprise the following parts, which are specially named:

1. The mons veneris.
2. The labia majora.
3. The labia minora or nymphæ.
4. The clitoris.
5. The meatus urinarius.
6. The vestibule.
7. The hymen.
8. The aperture of the vagina.

The *mons veneris* is a collection of fat, in front of the pubes. It is covered with hair after puberty, and it forms a rounded eminence, which serves as a protection against injury to the deeper parts, during coition or in case of accidental violence.

The *labia majora* are the two anterior and the thickest lips of the vulva. They form, by their points of junction, the *anterior* and the *posterior commissures* of the vulva. They are covered externally by integument and mucous membrane, and they contain, in their interior, areolar and dartoid tissues.

The *nymphæ* are two small folds which are attached above, thus forming a preputial covering for the clitoris, and which are lost, below, upon the sides of the labia majora.

The *clitoris* is the analogous organ to the penis in the male sex. It differs from that organ, however, in being *smaller* in size and *imperforate*, and in *possessing no corpus spongiosum*. It has analogous muscles, and possesses a suspensory ligament, two crura, a glans, a body, and a prepuce.

The *meatus urinarius* is situated upon the upper wall of the vagina, at a point about one inch below the clitoris.

The *vestibule* is a triangular space, at the upper and anterior part of the vulva, which is bounded, upon either side, by the nymphæ, and, behind, by the meatus urinarius.

The *hymen* is a fold of mucous membrane, which varies greatly in its form and its extent. It may be a complete septum, which encloses the entire outlet of the vagina, or a perforated septum, with one central orifice or numerous smaller openings, or, finally, a semilunar fold with a free concave border. In some cases, the hymen is absent, and, in others, the remnants only of a previous hymen exist, in the form of small irregular eminences, called *carunculæ myrtiformes*.

The *aperture of the vagina* is surrounded by the sphincter vaginæ muscle, and, in the virgin, is often closed by the hymen.

The *internal organs* of generation of the female comprise,

1. The vagina.
2. The uterus.
3. The appendages to the uterus.

The VAGINA is a musculo-erectile tube, which serves to establish a communication between the cavity of the uterus and the external world. It is curved to accommodate itself to the axis of the pelvic cavity, and measures about four inches in length, upon its anterior wall, and from five to six inches, upon its posterior wall.

The *anterior wall* of the vagina is in relation with the urethra and the base of the bladder; the *posterior wall* is in relation with the rectum, in its lower three-fourths, and, in its upper fourth, it is covered by peritoneum; while its *lateral walls* are in relation with the broad ligaments of the uterus, the levator ani muscle, and the pelvic fascia.

The *coats* of the vagina are three in number, and are called, from within outwards, the mucous, the erectile, and the muscular coats.

Near to the aperture of the vagina, may be perceived two points of anatomical interest, called the *bulbs of the vestibule*, and the *glands of Bartholine.*

The *bulbs of the vestibule* consist of two distinct plexuses of veins intermixed with erectile tissue, which are supposed to be analogous to the two halves of the bulb of the male urethra.

The *glands of Bartholine* are situated upon either side of the vaginal aperture, and are analogous to the glands of Cowper, in the male sex.

The vagina serves the three-fold purpose, of a channel for the escape of menstrual blood, a means of exit for the child in parturition, and a means of entrance for the seminal fluid to the cavity of the uterus.

The FEMALE URETHRA, although not properly one of the organs of the genital apparatus, differs markedly from that of the male, and is best considered in connection with the vagina, since it is contained between its coats.

This canal is about one and a half inches long, and possesses a very high degree of dilatability. It passes between the coats of the anterior wall of the vagina, and opens at the posterior part of the vestibule. It pierces, like the urethra of the male sex, the triangular ligament of the female perineum, and is surrounded also by the compressor urethræ muscle. Its coats consist of a mucous, an erectile, and a muscular coat.

THE UTERUS.

The organ of conception is pear-shaped, and is flattened from before backwards. It is situated between the bladder and the rectum, and its neck protrudes into the cavity of the vagina. It is retained in its position, principally, by the *broad* and the *round ligaments* of the organ.

The uterus presents for examination the following parts, which possess special interest:

1. A fundus.
2. A body.
3. A cervix or neck.
4. A cavity.
5. Eight ligaments.
6. Three coats (a serous, a muscular, a mucous).
7. Vessels and nerves.
8. Appendages.

The *fundus* of the organ is that portion which is directed upwards. It is broad and covered with peritoneum.

The *body* of the organ is adherent to the bladder in front, at its lower part, and is covered by peritoneum, at the upper part; behind, it is covered by peritoneum and is in close relation with the small intestine; while, at the sides, the Fallopian tubes, the round ligaments, and the ovarian ligaments are attached to it.

The *neck* of the organ affords attachment for the upper end of the vagina. It measures, in length, nearly the same as does the body of the organ, *viz.*, about one and a half inches.

The *cavity of the uterus* is divided into two portions, called the cavities of the body, and of the cervix.

The *cavity of the body* is triangular, and communicates with the two Fallopian tubes. The mucous lining of this cavity presents peculiarities, which will be considered when the mucous membrane of the organ is described.

The *cavity of the cervix* is fusiform, and measures about one inch and a quarter in length. The point of junction of the two cavities is called the *os internum*, while the lower opening of the cavity of the cervix is called the *os externum.*

The LIGAMENTS of the uterus are eight in number, and may be divided into two sets as follows:

True ligaments.	*Formed by the peritoneum.*
Two *round* ligaments.	Two *broad* ligaments.
	Two *anterior* ligaments.
	Two *posterior* ligaments.

The *anterior ligaments* connect it with the bladder

The *posterior ligaments* connect it with the rectum.

The *broad ligaments* extend from the sides of the organ to the sides of the pelvis, and form three folds, which enclose, respectively, the ovaries, the Fallopian tubes, and the round ligaments, in their order from behind forwards.

The *round ligaments* arise at the superior angle of that organ, and, after passing in the *anterior fold* of the broad ligament of either side, enter the inguinal canals and terminate in the labia majora. The tubular process of the peritoneum, which accompanies this ligament, in the inguinal canal, is called the *canal of Nuck;* but it seldom exists, as a distinct canal, except in the fœtus.

COATS.

The *muscular coats* of the uterus are three in number and are called respectively, the outer, the middle, and the inner layers.

The *outer layer* is the thinnest stratum of the three, and is arranged as transverse fibres, which extend upon the various ligaments of the uterus, after they reach the borders of that organ.

The *middle layer* is a thick stratum, and consists of fibres which run in every direction.

The *inner layer* is arranged as *two cones*, whose apices correspond to the orifices of the Fallopian tubes, and which become united in the median line of the uterus. The direction of its fibres varies, therefore, with the portion of the uterus which is examined, being circular, in some localities, and transverse in other situations.

The *serous coat* covers the anterior surface, for its upper three-fourths, the fundus, and the whole of the posterior surface of the organ.

The *mucous coat* differs in its appearance in the body and in the cervix of the organ, as follows:

IN THE BODY.	IN THE CERVIX.
Is *smooth.*	Is thrown into *rugae.*
Is *thin.*	Is *thick.*
Is *firmly adherent* to the uterus.	Is *loosely attached.*
Has *ciliated* epithelium upon it.	Has *squamous* epithelium.
Has *utricular follicles.*	Has *glands* of *Naboth.*
Has a *thin* secretion.	Has a *thick* and *viscid* secretion.

The VESSELS comprise branches of the uterine and the ovarian arteries, the accompanying veins, and the lymphatic vessels of the fundus and of the cervix.

The NERVES are derived from the inferior hypogastric and the ovarian plexuses, and from the third and fourth sacral nerves.

The APPENDAGES to the uterus comprise the following structures:

The Fallopian tubes
The ovaries.
The ligament of the ovary.
The organ of Rosenmüller.

The *Fallopian tubes* commence at the upper extremities of the cavity of the body of the uterus, where they each present a small opening, called the *internal opening* of the tube, and extend outwards, in the *middle fold* of the broad ligament of the uterus, to expand into a trumpet-shaped extremity, called the *fimbriated extremity* of the tube, since it is surrounded by a fringe-like series of processes, the fimbriæ, which connect the outer extremity of the tube to the ovary. This tube is perforated by a canal which transmits the ovum, during the period of menstruation. The Fallopian tube is composed of three coats, the serous, the muscular, and the mucous coats.

The *serous coat* is composed of a reflection of the peritoneum.

The *muscular coat* is formed by a continuation of the longitudinal and the circular fibres of the uterus.

The *mucous coat* is lined with ciliated epithelium, and is continuous, externally, with the peritoneum.

The OVARIES are two oval bodies, which lie in the *posterior fold* of the broad ligament, below the external extremities of the Fallopian tubes. They are composed of a serous coat, a fibrous coat, called the *tunica albuginea*, and a stroma.

The *serous covering* invests the entire structure, except at its anterior margin, where the *hilum* of the organ may be perceived.

The *tunica albuginea* differs, in no way, from the fibrous coat of all those organs, where this covering is firm and dense.

The *stroma* or the *true substance* of the ovary is principally composed of small sacs, called *Graafian vesicles* or *ovisacs*, in a condition of more or less perfect development.

Each of these vesicles may vary, in point of size, from one-eightieth to one-sixth of an inch in diameter, according to its state of development, and, when perfectly formed and matured, presents the following component parts.

An external *fibro-vascular* covering.
An internal coat, called the *ovi-capsule.*
A layer of nucleated cells, called the *membrana granulosa.*
An *albuminous* fluid.
The *ovum*, surrounded by the *proligerus disc.*

The matured Graafian vesicles are found near to the surface of the ovary, forming small projections upon it.

The *ovum*, in all perfectly matured vesicles, measures about one hundred and twentieth of an inch in diameter, and presents the following component parts.

The *vitelline membrane* or *zona pellucida.*
The *yolk* or *vitellus.*
The *germinal vesicle.*
The *germinal spot.*

The rupture of a Graafian vesicle is always associated with the development of a spot within the ovary, which exhibits an abnormal appearance and arrangement, and which is called the *corpus luteum.* In case of impregnation of the discharged ovum, the corpus luteum continues to develop, and, for that reason, two kinds of corpora lutea are recognized, *viz.*, the *true*, when impregnation has occurred, and the *false*, when impregnation has not occurred.

The *artery* of the ovary is derived from the internal iliac artery and enters at the hilum of the organ. The *ovarian vein* escapes at the same situation and opens into the inferior vena cava, on the right side, and, on the left side, into the left renal vein.

The *nervous supply* is derived from the ovarian plexus of the sympathetic.

The *organ of Rosenmüller* or *parovarium*, consists of a group of scattered tubules, situated between the layers of the broad ligament and between the ovary and the Fallopian tube.

These tubules are lined with epithelium, but have no external opening. They converge, however, to one large duct, which ramifies in the broad ligament, and which is called the *duct of Gœrtner.*

THE EYE.

The organ of vision is situated within the cavity of the orbit, and is there retained by its muscles, by the optic nerve, and by areolar tissue and the conjunctival attachments.

The eye may be described as consisting of three coats, and three refracting media, namely:

Coats of the eye.	*Refracting media.*
Sclerotic coat and the cornea.	Aqueous humor of the eye.
Choroid coat and the iris.	The lens and its capsule.
The retina.	The vitreous humor and its hyaloid membrane.

The SCLEROTIC COAT of the eye consists of a strong fibrous membrane, which covers the posterior five-sixths of the entire globe of the eye, and which is continuous, in front, with the cornea.

Its *outer surface* is white in color and affords attachment to the muscles of the eye-ball. It is covered by the ocular reflection of the conjunctiva,

Its *inner surface* is brown in color and is in close relation with the choroid coat, to which it is attached by a cellular membrane, called the *lamina fusca*. It is also grooved for the transmission of the ciliary vessels and nerves. To this surface of the sclerotic coat of the eye, is attached the ciliary muscle, at its anterior portion; and a circular groove may be perceived in this region, which marks the outer wall of the canal around the circumference of the iris, *the canal of Schlemm.*

At the *posterior portion* of the eye-ball, the sclerotic coat is pierced by the optic nerve and is continuous with the sheath of that nerve. It is also perforated, at about this point, by the arteria centralis retinæ, and by numerous nerve filaments. The term *lamina cribrosa* is applied to this portion, on account of its numerous openings.

The CORNEA is the covering of the anterior sixth of the eye-ball and is continuous with the sclerotic coat, from which it differs however, in its transparency, its structure, and its curve. Its circumference is nearly circular in its outline, and it is more prominent than the rest of the eye-ball, since its curve forms an arc of a smaller circle. The degree of its curvature varies greatly, however, both in individuals, and as age advances.

The cornea has been found to consist of the following structures:

The *anterior epithelial* coating (two or three layers).
The *anterior elastic* layer.
The *body* of the cornea, (fifty or sixty layers of cells).
The *posterior elastic* layer.
The *posterior epithelial* coating, (one layer).

The CHOROID coat of the eye is a vascular and pigmentary layer, which is continuous, in front, with the iris, the ciliary processes, the ciliary muscle, and the ligamentum pectinatum.

This layer possesses a dark brown color, is thickest at its posterior portion, lies between the sclerotic and the retina, and allows of the passage of the vessels, which are distributed to the anterior portions of the eye. It is pierced by the optic nerve, at its posterior portion; and, on its outer surface, it is grooved for the vessels which it transmits, while, on its inner surface it is smooth and lies in contact with the retina.

The choroid coat may be described as consisting of three distinct layers, namely:

The external or venous layer (layer of venæ vorticosæ).
The middle or capillary layer (tunica Ruyschiana).
The internal or pigmentary layer.

The choroid coat of the eye is prolonged, in the anterior part of that organ, into a curtain-like expansion behind the iris, to which the name "*ciliary processes*" is applied, since it presents numerous folds. These processes are similar in their structure to the choroid, but are less vascular. They are attached to the suspensory ligament of the lens, and to the adjacent portion of the retina.

The IRIS is a perforated curtain, which prevents the entrance of light into the chamber of the eye, except through the opening within it, which is called the *pupil.* It is continuous, at its free edge, with the ciliary muscle, the ciliary processes, the choroid coat, and, by means of the ligamentum pectinatum, with the cornea and the sclerotic coat of the eye. A canal extends around the circumference of its attached border, which is called the *sinus circularis iridis* or the *canal of Schlemm.*

The *posterior surface* of the iris is purple in color, and is called, from its resemblance to the inside portion of a grape skin, the *uvea.*

The *anterior surface* of the iris varies in its color in different individuals, and is marked by wavy lines which converge.

The iris is composed of a stroma formed by two sets of muscular fibres, the circular and the radiating set; and, in addition, some pigment cells, which give color to the pupil.

The *arteries* of the iris are derived from the long ciliary arteries, and from those of the ciliary processes.

The *nerves* of the iris are derived from the ciliary nerves, which are intimately associated with the 3d pair of cranial nerves, at the ciliary ganglion of the orbit. It is through this nerve, that the reflex act of contraction of the pupil is performed, when the optic nerve is oppressed by an excessive amount of light within the chamber of the eye.

The RETINA is the nervous layer of the eye, by which the special sense of vision is afforded. During life, the retina is translucent and of a pinkish color, but, after death, it becomes opaque and whitish in appearance.

The retina lines the posterior *four-fifths* of the eye, and is carried forwards to the base of the iris. Its external surface lies upon the choroid coat, which affords for it a dark background, while its internal surface lies in contact with the hyaloid membrane of the vitreous humor. Its anterior margin is called the *ora serrata*, from its ragged outline.

Upon the *posterior portion* of the retina may be perceived the following points of interest:

The *colliculus*, where the optic nerve escapes.
The *yellow spot* (macula lutea, limbus luteus of Sömmering).
The *fovea centralis*, in the centre of the yellow spot.
The *orifice of escape* of the arteria centralis retinæ.

The *structure* of the retina, although still a subject of investigation, presents the following points of practical anatomical importance.

The pigmentary layer.
The layer of Jacob's rods and cones.
The layer of granules, or the middle layer.
The layer of expanded nerve fibres and of nerve cells.
The membrana limitans.

The *rods* and the *cones*, which form the characteristic feature of the external layer, are arranged perpendicularly, and the bulbous ends of the cones are directed towards the internal surface of the retina. No rods are present in the macula lutea.

The *granules* of the middle layer vary in their size and appearance, and this layer is therefore, by some, subdivided into from three to five layers. These layers are traversed by fibres, called *sustentacular fibres* or the *fibres of Müller*.

The *nervous layer* is the most internal, except the membrana limitans, and the nerve cells, contained within it, communicate with the expanded fibres of the optic nerve. It is often divided into two layers, called the ganglionic, and the nervous layer.

The *arteries* of the retina are derived from the arteria centralis retinæ, which pierces the optic nerve before it enters the eye.

The AQUEOUS HUMOR of the eye is contained within a space between the anterior surface of the lens of the eye and the posterior surface of the cornea. This space contains also the iris, which floats in the aqueous humor, and, by some anatomists, the cavity of the aqueous humor is divided, by it, into an *anterior* and a *posterior aqueous chamber*. The aqueous humor differs slightly from water, as it contains chloride of sodium and a trace of other solid matters.

The LENS of the eye is a double convex, transparent body, whose convexity is most marked at its posterior surface. It is enclosed in a capsule of its own, and is held in position by a suspensory ligament. It is situated between the iris and the vitreous humor, and its circumference is surrounded by a canal, called the *canal of Petit.*

The *structure* of the lens consist of superimposed layers which are parallel with the surfaces of the lens, and each of these layers may be also subdivided into three segments, which are of nearly equal size.

The *capsule* of the lens is very elastic and brittle in its nature, and, when ruptured, it tends to curl up spontaneously. It affords attachment to the suspensory ligament of the lens, and is attached, behind, to the hyaloid membrane. It is separated from the anterior surface of the lens, by a layer of cells, which, after death, absorb moisture and break down into a fluid, called the *liquor Morgagni.*

The *suspensory ligament* of the lens is sometimes called the zonula of Zinn. It is attached to the capsule of the lens and is separated from the hyaloid membrane by the canal of Petit. Its anterior surface is thrown into small radiating folds, called the *processus zonulæ*, which are received between the ciliary processes.

The VITREOUS HUMOR is contained within the posterior chamber of the eye, between the posterior surface of the lens and the retina. It is enclosed in a capsule, called the *hyaloid membrane*, and it is excavated, in its anterior portion, for the reception of the lens.

The *hyaloid membrane* is closely attached to the posterior surface of the capsule of the lens, and forms the posterior boundary of the canal of Petit.

The *vitreous humor* is a thick albuminous fluid, which, in the fœtus, is characterized by a reticulated structure within its substance; but in the adult, it is destitute of any internal structure.

The *ciliary muscle* of the eye is a ring of involuntary muscular tissue, which is situated at the anterior part of the choroid coat and upon the outer side of the ciliary processes. It is of great physiological importance, since it serves to *adjust the vision to distances*, by altering the shape of the lens of the eye by the pressure which it exerts upon it.

The *ligamentum pectinatum* is a fibrous band, which unites the middle and outer coats of the eye, although it is also connected with the posterior elastic layer of the cornea and the iris, into the latter of which it gives off fibres, from whose appearance the ligament receives its name.

APPENDAGES TO THE EYE AND LACHRYMAL APPARATUS.

The eye has the following appendages, which demand a separate description.

The eyebrows.
The eyelids.
The conjunctiva.

The *eyebrows* consist of a thickened fold of integument, which is covered with hair and which corresponds to the upper edge of the orbital cavity.

The *eyelids* are two movable folds, which afford a protective covering to the eyeball and which are joined at either extremity, where their angles of junction are called the *external* and the *internal canthus*.

The external angle of the eyelids is *higher* than the internal angle, as a rule, and the *size of the fissure* between the eyelids gives the appearance of increased size to the eyes, which is often mistaken for an actual rather than an apparent increase of development.

The *inner canthus* of the eye presents the following points which have been specially named:

The lacus lachrymalis.
The caruncula lachrymalis.
The plica semilunaris.

The *lacus lachrymalis* is a triangular space, in which is perceived the *caruncula lachrymalis;* and the *plica semilunaris* is a fold of mucous membrane, which often encloses a piece of cartilage.

The *upper eyelid* is the largest of the two lids, and is the most movable, since it connected to the levator palpebræ muscle.

When the eye is shut, the *eyeball is moved upwards* and *inwards* so that the cornea is covered by the upper lid. This is explained as a measure on the part of Nature to protect the cornea from dirt and also to prevent the entrance of light into the eye in case of separation of the eyelids.

The lower lid, when in the act of closing, is not only raised, but is also *drawn inwards* for a distance of about one-twelfth of an inch, by which movement all particles of dust remaining, as well as any excessive moisture, is swept towards the inner canthus.

The EYELIDS are composed of the following parts, which are specially named:

Integument.
Subcutaneous areolar tissue.
Fibres of the orbicularis muscle.
The tarsal cartilages.
Tarsal ligaments.
The tendo oculi.
The tensor tarsi muscle.
The levator palpebræ muscle (in upper lid).
Palpebral conjunctiva.
Meibomian glands.
Eyelashes.

The *conjunctiva* is usually divided into two portions, called the *palpebral* and the *ocular* portions. The palpebral portion is the thickest, the most opaque, and the most vascular. The ocular portion is often divided into the corneal and the sclerotic portions, since they differ somewhat in their construction.

The LACHRYMAL APPARATUS comprises the lachrymal gland, the lachrymal canals, the lachrymal sac, and the nasal duct.

The *lachrymal gland* is situated in a depression in the roof of the orbit, and is about the size of an almond. It gives off six or eight ducts, which empty into the upper fold of the conjunctiva.

The *lachrymal canals* commence at minute orifices, upon the margin of the lids, called the *puncta lachrymalia*, and pass in a curved direction, at either border of the lacus lachrymalis, till they terminate in the lachrymal sac, which receives the tears as they escape.

The *lachrymal sac* is the upper and the dilated portion of the nasal duct. It lies in the lachrymal groove and is crossed, in front, by the tendo oculi, and behind, by the tensor tarsi muscle.

The *lower* punctum lachrymalis is *larger* and *more external* than the upper, and the *mouths* of both are *directed backwards* so as to afford the most easy and direct access for the tears. In facial paralysis, cicatrices, or other conditions which tend to alter the direction of the mouths of these ducts, the tears no longer are assisted to flow in their proper channels, and they escape over the cheek.

The *tendo oculi*, to which the cartilages and the muscles of the eyelids are attached, lies over the lachrymal sac, and, by being made tense during the shutting of the eyelids, is supposed to create alternating pressure upon the sac and *thus to act as a pump* to draw the tears into the nasal duct.

The *nasal duct* is a membranous canal, three-quarters of an inch in length, and is contained within the osseous canal, formed by the superior maxillary, the lachrymal, and the inferior turbinated bones. Its lower orifice is partially closed by a fold of the mucous membrane of the nasal cavity. This canal is narrowest at its middle portion. Its lower opening is within the inferior meatus of the nasal cavity, and is situated about one-quarter of an inch behind the bony edge of the nose.

THE EAR.

The organ of hearing is composed of the following divisions.

1. The external ear.
2. The middle ear or tympanum.
3. The internal ear or labyrinth.

EXTERNAL EAR.

The external ear consists of two distinct portions called the pinna or auricle, and the external auditory canal.

The PINNA is composed of cartilage, and forms that projecting portion which assists in directing sound into the external auditory canal. Its surface is irregular in form, and certain names are applied to the various depressions and elevations upon it.

The *concha* is the central depression which leads to the auditory canal.

The *tragus* is a conical projection on its under surface, which is usually covered with a few hairs.

The *anti-tragus* is an eminence of smaller size, situated behind the tragus, and separated from it by a deep notch called the *incisura antitragica.*

The *helix* is the external curved margin of the cartilage of the ear.

The *fossa of the helix* is the groove which lies underneath the helix, throughout nearly its whole extent.

The *antihelix* is a prominence upon the cartilage of the ear which lies nearly parallel with the helix. It forms the posterior boundary of the central depression or concha, and, at its upper portion, it bifurcates to form a depression called the *fossa*.

The *fossa of the antihelix* is bounded by the bifurcation of the antihelix, and also in front by the helix.

The *lobule* of the ear is the soft pendulous portion, which hangs from the lower part of the cartilage of the ear.

The *cartilage* which composes the *pinna* is not an entire structure, but is deficient in some places, where it is joined together by ligaments. The cartilage, as a whole, is also united to the skull by certain ligaments, which are called the *extrinsic ligaments* of the pinna, in contra-distinction to the ligaments which connect the separate parts of the cartilage, which are called the *intrinsic ligaments* of the pinna.

The *muscles* of the pinna are also divided into an *intrinsic* and an *extrinsic set*, since some act upon only parts of the cartilage, while others act upon the whole pinna.

The *integument* which covers the cartilage of the pinna is very closely adherent and is richly supplied with sebaceous glands, especially in the regions of the concha and the fossa of the helix. It is also supplied with vessels and nerves.

The EXTERNAL AUDITORY CANAL is that portion of the external ear, which extends from the concha inwards to the membrana tympani of the ear. It is one and a quarter inches in length, and is directed differently in different portions of its course. If the pinna be drawn upwards and backwards, however, the canal will be rendered more nearly straight. Its floor is longer than its roof on account of the obliquity of the membrana tympani.

This canal is usually divided into a cartilaginous and a bony portion, the former of which is a continuation of the pinna, and the latter is comprised within the temporal bone.

The *cartilaginous portion* is about one-half of an inch in length, and is firmly attached to the circumference of the external auditory meatus in the temporal bone. At the upper and back part of the canal, the cartilage is absent and is replaced by fibrous tissue.

The *osseous portion* is about three-quarters of an inch in length, and, at its outer extremity, is expanded into a rough margin for the attachment of the pinna.

The *integument* of this canal is thin and closely adherent to the cartilaginous portion. It contains hair follicles and sebaceous glands, near its external opening, and numerous ceruminous glands throughout its entire length.

MIDDLE EAR OR TYMPANUM.

The cavity of the middle ear is situated between the external auditory canal and the labyrinth of the ear, from side to side; between the carotid canal and the mastoid cells, from before backwards; and between the anterior surface of the petrous portion of the temporal bone and the jugular fossa, from above downwards. It presents for examination the following parts:

An outer wall.
An inner wall.
A posterior wall.
An anterior wall.
A floor.
A roof.

The OUTER WALL is formed by the membrana tympani, and by the small portion of bone surrounding it. It presents two openings for the chorda tympani nerve, called the *iter chordæ posterius* and the *iter chordæ anterius* or the *canal of Huguier*, and a fissure called the *fissure of Glaser*. Through this latter opening, protrudes the long process of the malleus, and, through it, enters also the tympanic branch of the internal maxillary artery, and, according to some authorities, the tendon of the laxator tympani muscle, while by others the existence of such a muscle is denied.

The INNER WALL presents the following points of interest, to which special names have been applied:

1. The *promontory*, which is a large rounded eminence formed by the first turn of the cochlea. Its surface is grooved for the filaments of Jacobson's nerve.
2. The *fenestra ovalis*, which is an opening into the vestibule, and which is closed by the stapes and its annular ligament.
3. The *fenestra rotunda*, which is an opening into the scala tympani, and which is closed by the internal membrane of the tympanum (*membrana tympani secondaria.*)
4. The *pyramid*, which is the enclosing cavity of the stapedius muscle, and, at the apex of which, the orifice, through which the tendon of that muscle escapes, may be perceived.

5. The *ridge of bone*, which indicates the course of the aquæductus Fallopii, as it passes backwards and downwards.

The POSTERIOR WALL presents the openings of the mastoid cells, which are contained within the mastoid process of the temporal bone.

The ANTERIOR WALL presents four points of special interest as follows:

1. The *internal opening* of the *Eustachian tube*, which is situated near to the floor of the cavity.
2. The *opening* for the *tensor tympani muscle*, which is situated near to the roof of the cavity.
3. The *anterior pyramid*, which is a prominence of bone surrounding the opening for the tensor tympani muscle.
4. The *processus cochleaformis*, which is a thin plate of bone between the openings of the Eustachian tube and the canal of the tensor tympani muscle.

The FLOOR corresponds to the jugular fossa of the petrous portion of the temporal bone, and lies directly above it. It presents a small opening, through which Jacobson's nerve enters the tympanum.

The ROOF is separated from the cranial cavity by a thin plate of bone, and corresponds to a depression on the anterior surface of the petrous portion of the temporal bone.

BONES OF THE TYMPANUM.

The tympanum has, within its cavity, three small bones, which serve to connect the membrana tympani with the annular ligament which covers the opening of the fenestra ovalis, and thus to allow of the transmission of the sound impulse to the scala vestibuli of the internal ear or labyrinth. These three bones are called the malleus, the incus, and the stapes.

The MALLEUS, so called from its resemblance to a hammer, is the most external bone and is connected to the membrana tympani by a process called the manubrium, which is inserted between the mucous and the fibrous coats of that membrane. It presents the following points of interest:

A head.
A neck.
The manubrium.
A processus gracilis.
A processus brevis.

The *head* articulates with the incus, and is connected to the roof of the tympanum by a suspensory ligament.

The *neck* affords attachment to the laxator tympani muscle.

The *manubrium* or *handle of the malleus* is inserted into a space between the mucous and fibrous layers of the membrana tympani.

The *processus gracilis* is an extremely long and delicate projection, which extends forwards and outwards into the fissure of Glaser.

The *processus brevis* of the bone projects, from the root of the manubrium, outwards towards the upper portion of the membrana tympani, and affords attachment to the tensor tympani muscle.

The INCUS, so-called from its resemblance to an anvil, although it is perhaps more like a bicuspid tooth with its roots widely separated, is the central bone of the cavity of the tympanum and articulates with the malleus and the stapes. It presents the following points of interest:

A body.
A long process.
The os orbiculare.
A short process.

The *body* articulates with the malleus, and is connected to the roof of the tympanum by a suspensory ligament.

The *long process* lies nearly parallel with the manubrium of the malleus, and terminates in nodule of bone termed the "os orbiculare."

The *os orbiculare* is sometimes described as the *fourth bone* of the tympanum, since it is separate from the incus in the fœtus. It articulates with the head of the stapes.

The *short process* is attached to the posterior wall of the tympanum by the posterior ligament.

The STAPES is the most internal bone of the tympanum and is so-called from its resemblance to a stirrup. It articulates with the os orbiculare of the incus, and is attached to the annular ligament around the edge of the fenestra ovalis. It presents the following points of interest:

A head.
A neck.
Two crura.
A base.

The *head* articulates with the long process of the incus through the os orbiculare.

The *neck* is the constricted portion below the head. It affords attachment to the stapedius muscle.

The *two crura* serve to connect the neck of the bone with the base.

The *base* is broad, and is connected to the annular ligament around the margin of the fenestra ovalis. It thus conveys the sound impulse to the labyrinth.

The MUSCLES of the tympanum are three in number, and may be described as follows:

The tensor tympani.
The laxator tympani.
The stapedius.

TENSOR TYMPANI.

Origin.

From the under surface of the petrous portion of the temporal bone, and from the cartilaginous portion of the Eustachian tube.

Insertion.

Into the manubrium and the processus brevis of the malleus, near to the root of that process.

LAXATOR TYMPANI.

(The existence of muscular fibres is denied by some authorities, and it is probably a fibrous cord only.)

Origin.

From the spine of the sphenoid bone, and the Eustachian tube.

Insertion.

Into the processus gracilis of the malleus, and occasionally into the neck of that bone.

STAPEDIUS.

Origin.

From the interior of the pyramid, on the inner wall of the tympanum.

Insertion.

Into the back part of the neck of the stapes.

The *tensor tympani* muscle draws inwards the membrana tympani and thus increases the tension of that membrane; the *laxator tympani* muscle produces an antagonistic effect upon the membrana tympani; while the *stapedius* muscle, by inclining the stapes backwards, is supposed to compress the fluid contents of the vestibule.

The ARTERIES of the tympanum are derived from the following sources:

Forming an *arterial circle* around the *membrana tympani.*	Tympanic branch of internal maxillary. Stylo-mastoid branch of posterior auricular.
Distributed to *other portions* of the *tympannm.*	Petrosal branch of middle meningeal. Tympanic branch of internal carotid. Branches of ascending pharyngeal.

The VEINS empty into the middle meningeal and the pharyngeal veins.

The NERVES are derived from the following sources:

Branch of otic ganglion..........	To tensor tympani muscle.	
Tympanic of facial nerve........... ...	To stapedius and laxator tympani muscles.	
Tympanic of glosso-pharyngeal (Jacobson's nerve). Chorda tympani branch of facial nerve.	To the mucous membrane. Communicating branches to	Carotid plexus. Great petrosal nerve. Otic ganglion.

The *cavity of the tympanum* is lined with a mucous membrane, and, through the Eustachian tube, communicates with the cavity of the pharynx. It is through this latter communication, that air is permitted to enter the cavity of the tympanum, and thus the membrana tympani is allowed to vibrate between two bodies of air whose density is equal, and thus to truly perceive the quality and tone of the notes which it is called upon to record.

The abnormal sounds, perceived when the Eustachian tube is obstructed by swelling of the mucous lining during attacks of severe influenza, are due, in great measure, to the impaired entrance and exit of air. It is customary for gunners, when firing large cannon, to stand with the mouth open, since, by so doing, the vibrations of the air produced by the explosion are transmitted through the Eustachian tube as well as through the auditory canal, and, by neutralizing each other, the drum membrane stands almost motionless, and little if any sound is perceived.

THE INTERNAL EAR OR LABYRINTH.

The internal ear consists of a series of cavities channelled out of the temporal bone, called the osseous labyrinth. It is lined, throughout its whole extent, by a thin fibro-serous membrane, whose function is to secrete a fluid called the *liquor Cotunnii* or the *perilymph*, in which fluid floats a membranous sac, which resembles in its shape the outline of the osseous labyrinth, and which is called the membranous labyrinth. The membranous labyrinth, is itself filled with a fluid, called the *endolymph.*

THE OSSEOUS LABYRINTH.

The osseous portion of the internal ear may be subdivided into three distinct parts, to which the following names have been applied :

The vestibule.
The semi-circular canals.
The cochlea.

The VESTIBULE is the main cavity of the labyrinth, and is situated in its central portion, at the inner side of the cavity of the middle ear. It communicates, at its anterior part, with the *scala vestibuli* through a large opening, and, by five small openings, on its posterior wall, with the *semi-circular canals.*

Upon its *outer wall* is a large opening called the *fenestra ovalis*, through which it would communicate with the cavity of the tympanum, were this opening not closed by the annular ligament of the stapes, and by the lining membrane of both cavities.

The *inner wall* of the vestibule presents the following points of interest, to which special names have been applied :

The fovea hemispherica.
The macula cribrosa.
The pyramidal eminence.
The opening of the aquæductus vestibuli.

The *fovea hemispherica* is a small circular depression, which corresponds to the situation of the *saccule.*

The *macula cribrosa* are numerous small openings, which give passage to branches of the saccular division of the vestibular nerve.

The *pyramidal eminence* consists of a vertical ridge of bone, which separates the fovea from the opening of the aquæductus vestibuli.

The aquæductus vestibuli is a canal, which extends to the posterior part of the petrous portion of the temporal bone, and opens into the middle fossa of the cranium.

The *roof* of the vestibule presents the following points of interest.

Part of the fovea hemispherica.
Part of the pyramidal eminence.
The fovea semi-elliptica.

The first two, of these three points of interest, have already been described as pertaining chiefly to the inner wall of the vestibule.

The *fovea semi-elliptica* is a small oval depression, whose transverse diameter is the longest, and which corresponds to the situation of the *utricle*. It is perforated by small foramina, forming the so-called *macula cribrosa*, for the transmission of filaments of the utricular and ampullar branches of the vestibular nerve.

The SEMI-CIRCULAR CANALS are three in number, and are situated posterior to, and above the cavity of the vestibule. They are called the superior, the posterior, and the external canals. Each one lies at a right angle to the other two.

The *superior canal* is directed vertically, and its axis lies at a *right angle* with the posterior surface of the petrous portion of the temporal bone.

The *posterior canal* is also directed vertically, but its axis lies *parallel* to the posterior surface of the petrous portion of the temporal bone.

The *external canal* is directed *horizontally outwards* and *backwards*.

Each canal presents a dilated extremity, called the *ampulla*, and the superior and posterior canals join with each other at their outer extremities, while the inner extremities of the superior and the posterior canals, and both extremities of the external canal open into the cavity of the vestibule.

The *ampullæ of the three canals* are all situated at that extremity which opens into the vestibule. The horizontal or external canal has, however, only one ampulla, although both ends communicate with the vestibule.

The function of the semi-circular canals is not positively determined. By some, they are supposed to appreciate the *direction of sound*, while by others, they are supposed to have some influence in maintaining equilibrium.

The COCHLEA is an excavation in the substance of the petrous portion of the temporal bone, which resembles the interior of the shell of the snail, and which is situated in front of the vestibule.

The *base* looks inwards, and corresponds to the bottom of the internal auditory canal. It is pierced by numerous small filaments of the *cochlear branch* of the *auditory nerve*.

The *apex* is directed forwards and outwards.

It presents the following points of interest, to which special names have been applied.

1. The modiolus or central axis.
2. The spiral canal.

3. The lamina spiralis.
4. The scala tympani.
5. The scala vestibuli.
6. The scala media.

The *modiolus* is the central axis of the cochlea, and is broader at its base than at its apex, thus presenting a conical form. The apertures, mentioned as pertaining to the base of the cochlea, are in reality, openings in the base of the modiolus. Its apex becomes expanded and blends with the walls of the cupola. The cavity of the modiolus is called the *tubulus centralis modioli*, and, from this central canal, numerous smaller canals open to the outer surface of the modiolus and transmit small vessels and the filaments of the cochlear nerve.

The *spiral canal* is a space between the modiolus and the outer wall of the cochlea. It is so called from its spiral direction, since it makes two and a half complete turns around the modiolus. It gradually decreases in size as it ascends, and terminates in a cul-de-sac, called the *cupola*, which corresponds to the apex of the cochlea. It communicates with three openings as follows:

The *fenestra rotunda*, which is closed during life by the membrana tympani secundaria.

The *opening* into the *cavity of the vestibule*, which has already been described.

The *opening* of the *aquæductus cochleæ*, which transmits a small vein to the inferior surface of the petrous portion of the temporal bone.

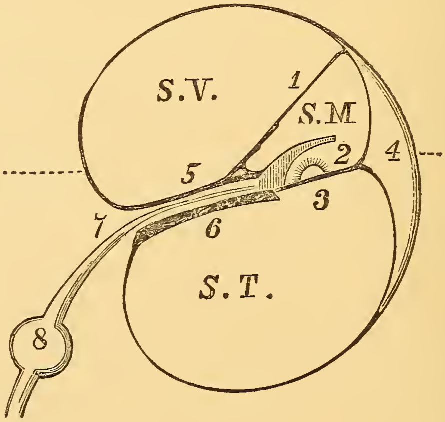
The *lamina spiralis* is a bony projection, which separates the spiral canal partially into its component parts, by winding around the modiolus and by extending only about one-half of the distance across the cavity of the cochlea. This thin osseous zone consists of *two layers*, between which the filaments of the cochlear nerve pass, and the intervening space between its edge and the outer wall of the cavity of the cochlea is filled by a membrane, called the *membrana basilaris*, which is continuous with the periosteum covering the lamina spiralis.

The *scala tympani* is that portion of the spiral canal of the cochlea, which lies *below the lamina spiralis and the membrana basilaris*. Its name is applied from its termination at the fenestra rotunda, which is situated upon the inner wall of the *tympanum*, and which is closed by the membrana tympani secundaria. It communicates with the aquæductus cochleæ.

The *scala vestibuli* is situated *above the lamina spiralis and the* *membrana basilaris.* It is not as large a canal as the scala tympani, since the scala media is cut off from it by a membrane, called the *membrane of Reissner.* The scala vestibuli communicates with the cavity of the vestibule; and, at the apex of the cochlea, the two scalæ communicate with each other, in a space, called the *helicotrema*, created by the absence of the lamina spiralis in the last half coil of the canal.

The *scala media* is a triangular portion of the space above the lamina spiralis and the membrane basilaris, which is separated from the scala vestibuli by a membrana, called the *membrane of Reissner*, and which contains the organ of hearing, called from its discoverer the *organ of Corti.* This space has been described by some authors under the names of the *canalis cochleæ*, and the *canalis membranacea.*

The following diagram will perhaps make the construction of the *three divisions* of the *spiral canal* of the cochlea more clearly understood by the student.



A Longitudinal Section of the Spiral Canal of the Cochlea (diagrammatic.)

S. V. *Scala vestibuli.*
S. T. *Scala tympani.*
S. M. *Scala media.*

1. *Membrane of Reissner.*
2. *Organ of Corti.* covered by the "*membrana tectoria,*" or the "*membrane of Corti.*".
3. *Membrane basilaris.*
4. *Ligamentum spiralis.*
5. Upper layer of *lamina spiralis ossea.*
6. Lower layer of *lamina spiralis* ossea.
7. *Nerve filament* escaping from the *modiolus* and supplying the *organ of Corti.*
8. *Ganglion spirale* of the nerve to the organ of Corti.

THE MEMBRANOUS LABYRINTH.

The membranous labyrinth is a closed sac which is contained within the osseous labyrinth. It is prolonged into the semi-circular canals, and lines the vestibule, and, according to some authorities, the canalis cochleæ of Reissner.

The portion contained within the vestibule consists of two sacs, called the saccule and the utricle, which do not communicate with each other, except indirectly through the aquæductus vestibuli.

The *saccule* is afforded a free communication with the prolongation of the membranous labyrinth into the *scala media*, through a small canal called the *canalis reuniens*, and lies in relation with the fovea hemispherica.

The *utricle* opens into the prolongations of the membranous labyrinth within the semicircular canals, and lies within the depression of the fovea semielliptica.

The *membranous semicircular canals* are only one-third of the size of the osseous canals, except at the *ampullæ*, where they nearly fill the entire space. They open into the utricle by *five openings*, since one opening is common to two canals.

The *membranous labyrinth*, as a whole, is filled with a fluid, called the *endolymph*, and is separated from the osseous labyrinth by an external fluid, called the *perilymph*. Upon its membranous structure, which lies between these two fluids, ramify the minute filaments of the vestibular nerve.

Small bodies, called *otoliths*, are found upon that portion of the membrane, which invests the saccule and utricle, in close relation to the point of distribution of the nerves. These bodies are supposed by some to afford, by jarring against the nerve filaments, appreciation of the *intensity of sound*.

The NERVES of the internal ear are derived from the auditory nerve, which, at the bottom of the internal auditory canal, divides into two branches called the vestibular and the cochlear nerves.

The *vestibular nerve* divides into three branches, which pass through small openings at the *bottom* of the *internal auditory canal* and are distributed to the ampullæ, the utricle, and the saccule. In the two latter situations, these nerve filaments bear a close relation to the masses of calcareous material, previously described as the otoliths.

The *cochlear nerve* divides into numerous small filaments, which enter openings in the *base of the modiolus*, and, after passing into its central canal, escape from the small canals which are directed outwards towards the lamina spiralis, and are distributed to the *organ of Corti*, in the scala media of the cochlea, and to the *membrana basilaris*.

The ARTERIES of the internal ear are derived chiefly from three sources, *viz.*:

1. The auditory artery (a branch of the basilar artery).
2. The stylo-mastoid artery (a branch of the posterior auricular artery).
3. The petrosal branch of the middle meningeal artery.

MECHANISM OF HEARING.

In the act of hearing, the vibrations, produced within the membrana tympani by the waves of sound, are transmitted to the membrane covering of the fenestra ovalis, by means of the chain of bones within the cavity of the tympanum, and, through secondary vibrations produced within this membrane, the impulse is transmitted to the fluids of the vestibule. According to some authorities, the jarring of the otoliths against the filaments of the vestibular nerve affords, at this latter point, a perception of the *intensity* of the sound which is being appreciated by the ear.

The vibrations now travel along the fluids of the scala vestibuli of the cochlea and of the semicircular canals, thus passing in two different directions. In the semicircular canals, according to some observers, the *direction* from which the sound springs is perceived, while the vibrations carried along the scala vestibuli are transmitted to the filaments of the auditory nerve in the organ of Corti and those connected with the membrana basilaris, thus affording the perception of the *note* and the *quality* of the sound perceived. After reaching the apex of the cochlea, the vibrations are transmitted from the scala vestibuli downwards along the course of the scala tympani till they reach the membrana tympani secundaria, which covers the *fenestra rotunda*, where the vibrations are lost; being no longer transmitted, on account of the absence of any conducting medium.

The free entrance of air to the cavity of the tympanum, or the middle ear, affords an equal density of air upon either side of the membrana tympani, and thus insures a vibration of that membrane in absolute unison with the vibrations of the sound which it is called upon to record.

The function of the organ of Corti, of the membrana basilaris, or of the otoliths, cannot be stated with any positive degree of certainty, since new discoveries are constantly being made; although some theories of their function have been given above.

The minute construction of the scala media and its contained organs can be found by reference to more exhaustive treatises.

THE PERINEUM.

That portion of the outlet of the pelvis, which lies anterior to the line drawn between the two tuberosities of the ischia, is called the *perineum*, while the portion, which lies posterior to this line, is called the *ischio-rectal fossa*.

The structures which compose the perineum differ in the two sexes, but, as the male perineum is the chief seat of operation for stone in the bladder and for surgical conditions of the deep urethra, and therefore possesses great surgical importance, the following text will be specially understood to apply to that sex, unless the female perineum be specially mentioned.

The perineal space is triangular in shape, and is bounded as follows :

Anteriorly, by the symphysis pubis.

Laterally, by the rami of the pubes and the ischia.

Posteriorly, by the line between the tuberosities of the ischia.

The average *width* of the perineum is about *two and three-quarter inches*, and the variations from this standard are of importance in the operation of lithotomy.

The *cutaneous surface* of the perineum is convex, in the median line, and slightly depressed at its outer borders.

The perineum is composed of the following structures, each of which merits a special description.

The integument.

The *anal group* of muscles........... (3)
- Sphincter ani.
- Levator ani.
- Coccygeus.

The *genito-urinary group* of muscles,... (4)
- Accelerator urinæ.
- Erector penis.
- Transversus perinei.
- Compressor urethræ.

Fasciæ ....
- Superficial perineal.
  - Superficial layer.
  - Deep layer.
- Deep perineal (or *triangular ligament*).
  - Anterior layer.
  - Posterior layer.
- Buck's fascia.
- Pelvic fascia.
  - Obturator fascia.
  - Ischio-rectal fascia.

Arteries	Pudic artery. Artery of the bulb. Transverse perineal artery. Inferior hemorrhoidal artery. Superficial perineal artery.
Nerves	Inferior hemorrhoidal. Superficial perineal. Pudic.
Other important structures	Membranous portion of the urethra. Bulbous portion of the urethra. Prostatic portion of the urethra. Rectum. Prostate gland. Cowper's glands. Neck of the bladder.

The SKIN of the perineum is dark in color, is freely movable, is covered with short crisp hairs, and is thrown into a *median raphe*, which is supplied with abundant sebaceous follicles.

The TWO GROUPS of MUSCLES have already been described in the chapter pertaining to myology.

The SUPERFICIAL FASCIA of the perineum is in close relation with the skin, and is composed of *two layers*, called the superficial and the deep layers.

The *superficial layer* is continuous with the subcutaneous fascia of the thighs, and is heavily ladened with fat. It is thick, and areolar in structure.

The *deep layer* is thin and aponeurotic in structure, and lies in close contact with the muscles of the perineum, and serves to bind them down to the root of the penis. It is attached, upon either side, to the rami of the pubes and ischia, thus enclosing the entire perineal structures, and, posteriorly, it *becomes blended* with the *anterior layer of the triangular ligament*, after passing beneath the lower border of the transversus perinei muscle. It is continuous, in front, with Buck's fascia.

BUCK'S FASCIA, so called from the American surgeon, who first, in 1846, made its existence prominently recognized, is a continuation of the *deep layer* of the *superficial perineal fascia* forwards upon the penis as far as the glans penis; the body of which organ it completely invests, and, with the suspensory ligament of which, it is continuous, above. This fascia, which now is frequently demonstrated, seems to establish the fact that the *deep layer* of the superficial fascia of the perineum is not continuous, in front, with the *dartos* of the scrotum, as is stated in many of the exhaustive treatises. In cases of urinal infiltration of the perineum, this fascia modifies, until perforated, the direction of the infiltration, in a forward or upward direction, and is therefore of great surgical importance.

The DEEP PERINEAL FASCIA, or the *triangular ligament* of the perineum, serves to support the urethra and the prostate gland, and to close the anterior part of the outlet of the pelvis. It is composed of two layers, called the anterior and the posterior layers, each of which take a different course, and, between which, is contained the space called the *cavity* of the *triangular ligament.*

The *anterior layer* is thicker than the posterior, and extends downwards and forwards upon the membranous portion of the urethra, and becomes blended with the *bulb of the urethra*, before it passes to its insertion into the central tendinous point of the perineum. It is attached, above, to the pubic arch and the sub-pubic ligament, and, upon either side, to the rami of the pubes and the ischia.

The *posterior layer* of the triangular ligament has the same points of origin and insertion as the anterior layer, which has just been described. It passes upwards and backwards, and, after passing in front of the *apex of the prostate gland*, it descends to become inserted into the central tendinous point of the perineum, at which point it becomes continuous with the pelvic fascia. It bears an intimate relation, after leaving the apex of the prostate gland, to the *posterior wall* of the *membranous portion* of the urethral canal.

The *urethra passes through the triangular ligament*, at a point situated about one inch below the symphysis pubis. An obstruction to the introduction of a catheter is often encountered at this point, since the point of the instrument is liable to impinge against this fascia.

The *cavity* of the *triangular ligament* is the space contained between the two layers of the deep perineal fascia. It contains the following structures.

The membranous portion of the urethra.
The compressor urethræ muscle.
The pudic vessels.
The pudic nerve.
The artery of the bulb.
The nerve of the bulb.
The glands of Cowper, and their ducts.
Fat, and connective tissue.

The PELVIC FASCIA is continuous, above, with the fascia over the psoas and iliacus muscles, and with the fascia transversalis. It splits, at the point of attachment between it and the fibres of the levator ani muscle, into two layers, which are called the *obturator*, and the *recto-vesical fasciæ*. It covers the sacral plexus of nerves and the pyriformis muscle, and is perforated by the internal iliac vessels.

The *obturator fascia* forms a canal for the pudic vessels and nerves. It gives off a thin layer to the third portion of the rectum, which is called the *anal* or the *ischio-rectal fascia*, and is attached to the pubic arch and the sacro-sciatic ligaments.

The *recto-vesical fascia* forms the pubo-prostatic ligaments, and encloses the prostate gland and the prostatic plexus of veins. It also forms the true lateral ligaments of the bladder, and sends a prolongation between the bladder and the rectum, which invests the vesiculæ seminales. It is situated upon the inner surface of the levator ani muscle.

The ARTERIES of the perineum have been described in the chapter of this work upon angiology, but the surgical importance of each may be here mentioned.

The *pudic artery*, of each side, lies close to the ramus of the pubes and the ischium, and is liable to be wounded in lithotomy, if the incision be carried too far outwards.

The *artery of the bulb* is a source of serious hemorrhage in lithotomy, if the incision be made too far in front; and, in urethrotomy of the deeper portions of that canal. It enters the bulb of the urethra, between the two layers of the triangular ligament.

The *transverse perineal artery* lies parallel with the muscle of the same name, and is almost always wounded in the lateral operation for stone, since that muscle is usually divided.

The *inferior hemorrhoidal artery* is distributed to the lower part of the rectum and the anus.

The *superficial perineal artery* distributes its branches to the scrotum and the dartos. Its branches are usually divided in any incision which involves the superficial fascia of the perineum.

The NERVES of the perineum are in relation with the arteries of the same name.

PARTS ASSOCIATED WITH THE OPERATION OF LATERAL LITHOTOMY.

In the operation of lateral lithotomy, certain structures are of necessity wounded, and certain structures should be carefully avoided.

The central tendinous point of the perineum corresponds to a locality, situated, externally, midway between the junction of the scrotum with the perineum, and the centre of the anus. In the operation of lithotomy, the incision should never be carried *above this point*, since the membranous portion of the urethra lies immediately behind it.

The parts, *which are divided* in this operation, are as follows:

1. Integument.
2. Superficial fascia.
3. Inferior hemorrhoidal vessels and nerves.
4. Superficial perineal vessels and nerves.
5. Transversus perinei muscle.
6. Accelerator urinæ muscle (posterior fibres).
7. Deep perineal fascia (anterior layer).
8. Compressor urethræ muscle.
9. Levator ani muscle (anterior fibres).
10. Membranous and prostatic portions of urethra.
11. Prostate gland and posterior layer of the deep perineal fascia.

The structures, *which are to be especially avoided*, are as follows:

1. The bulb of the urethra and its artery.
2. The rectum.
3. The pudic artery.
4. Entire division of the prostate gland.

The *first*, of these four structures, is to be avoided by keeping the incision as far backwards as possible, without endangering other structures.

The *rectum* is to be avoided, by not carrying the incision too far *backwards*.

The *pudic artery* is to be avoided, by not carrying the incision too far *outwards*.

The *width* of the *incision* in the *prostate gland* is to be regulated by the size of the cutting instrument, and, if a scalpel be used, by not allowing the incision of the deeper structures to be carried too far *backwards*.

THE FEMALE PERINEUM.

The perineum of the female differs from that of the male in its size, and somewhat in its construction.

It extends, from a line drawn between the two tuberosities of the ischia, upwards to the symphysis pubis, and is *triangular* in its form. It is perforated by the *opening of the vulva*, which corresponds to the situation of the scrotum of the male, and which embraces the external orifice of the vagina; and it extends upwards between the rectum and the posterior wall of the vagina, as a triangular-shaped prolongation, sometimes called the *perineal body*.

The *lower commissure* of the *vulva* is separated from the anal opening by a space of about an inch, although the anus is relatively farther back than in the male.

At the *superior commissure* of the *vulva*, may be perceived the clitoris, which is analogous to the penis of the male, and which possesses the same muscles.

The *superficial fascia*, as in the male, consists of two layers, but both are incomplete on account of the aperture of the vulva. This fascia is continued forwards into the labia majora, as high up as the clitoris; and it thus supports the analogy between the labium and the scrotum. It becomes joined to the deep perineal fascia, after passing beneath the lower border of the transversus perinei muscles.

The *triangular ligament* or the *deep perineal fascia* of the female is rendered less apparent than in the male by the large aperture of the vagina, but it nevertheless presents two distinct layers which transmit the urethra, as in the male sex.

The *muscles* of the female perineum comprise one not met with in the male, which is situated at the orifice of the vagina, and to which the name *sphincter vaginæ* has been applied, from its circular arrangement. It is analogous to the accelerator urinæ muscle of the male; which is not present in the female, as the clitoris has no corpus spongiosum, and as the urethra is not called upon for forcible ejaculation.

The *arteries* and *nerves* of the perineum of both sexes are identical in their situation and their general distribution.

The perineum of the female performs an *important function*, since it tends to support the posterior wall of the vagina, and, indirectly, the anterior vaginal wall, the bladder, and the uterus. Laceration of the perineum, therefore, is, in the female, a most serious condition, if not promptly relieved by surgical measures.

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THE END.