OF

MASSAGE

AND REMEDIAL GYMNAST

BY

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PREFACE TO SECOND EDITION

In preparing the present edition many amplifications and additions have been made to the text in both parts of the work, and this has entailed a certain amount of rearrangement of the existing matter. The additions have been made in order to provide a more useful text-book and book of reference for students of massage, and also in the hope of meeting the requirements of those who are qualifying as medical gymnasts.

In Part I. the chapter on the Skeleton has been extensively amplified, and certain additions have been made to the chapters on the Articulations and the Nervous System. Some rearrangement of the Tables of the Muscles has been made, and an additional column, giving their action, has been inserted.

In Part II. Chapter II. an alteration has been made in the classification of the various massage movements. Formerly in many British Schools pétrissage and kneading have been synonymous terms, also effleurage and stroking. In the Swedish Schools, on the contrary, there is a distinction between the terms in each case. This difference of nomenclature leads to a good deal of unnecessary confusion in the minds of those students who happen to pass from one training school to the other. Therefore, in the present edition it has seemed expedient to adopt the more minute classification which pertains in the Swedish Schools. An additional chapter on Remedial Gymnastics has been introduced and is arranged in tabular form; the author wishes to express her indebtedness here to Dr. Arvedsen and to Professor Wide, M.D., whose works she has consulted in compiling this part of the book. In subsequent chapters more space has been devoted to the Theory of Disease and to Applied Treatment, and tables of exercises for various conditions have been added. In the last chapter a description of Ionic Medication, Radiant Heat and Light treatment, and Diathermy has been given.

My special thanks are again due to Dr. R. Atkinson Stoney for his generous help in reading and criticising my manuscript and in correcting the proofs. I have also much pleasure in acknowledging my indebtedness to Dr. F. Barrie Lambert, to Dr. R. T. Timberg, and to Dr. W. S. Haughton for reading and criticising certain portions of Part II. My thanks are due to Messrs. Spencer, Heath, and George for their kindness in lending blocks for the illustrations of the gymnastic apparatus, and I am also grateful for permission to use some of the new illustrations from Cunningham's *Text-Book of Anatomy* to illustrate Part I.

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Co. Dublin.

October 1914.

PREFACE TO FIRST EDITION

My aim in writing this Text-Book has been to embody in concise form such a knowledge of the Theory of Massage, as well as the principles of Elementary Anatomy and Physiology, as is indispensable to all those desirous of taking up Massage as a profession. Although I have endeavoured to give a full description of most of the various movements employed in Massage, too much stress cannot be laid upon the necessity of learning the practical work from a competent teacher.

I take this opportunity of acknowledging my great indebtedness to Dr. R. Atkinson Stoney, F.R.C.S.I., for the invaluable help he has given me with the letterpress, and for the series of photographs which he has taken to illustrate Part II. My thanks are also due to Mr. A. H. Tubby, F.R.C.S., for his kind permission to use three illustrations from his book *Deformities*; to Dr. Mina L. Dobbie for her helpful criticisms on the chapter dealing with Spinal Curvature: and to Dr. Ella Webb and others for many valuable suggestions. The use of some of the anatomical drawings from Cunningham's *Text-Book of Anatomy* has made it possible to illustrate Part I. of this book in a manner which could not otherwise have been attempted, and for this permission I am very grateful. I am also much indebted to Messrs. K. Schall & Son for their kind loan of blocks to illustrate Chapter XI., Part II.

LOUISA L. DESPARD.

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FOREWORD

Massage has now secured its position as a recognised therapeutic measure, useful alike in medical and surgical cases; but it is an agent which, if it is to be used to advantage, must be employed with knowledge and skill, as well as with a perfect attention to detail. I cordially welcome the appearance of Miss Despard's treatise.

The work appears to me to be not a superficial Handbook, but a complete treatise going thoroughly into the requisite anatomical details, as well as describing minutely the various forms of massage; and any masseuse engaged in the daily work of her calling who will from time to time refer to Miss Despard's descriptions, and to the admirably selected illustrations in the text, should keep fresh in her mind a knowledge of the structures which lie beneath her hand, and should in consequence deal more intelligently with the part on which she is operating. Still more valuable are the physiological explanations of the functions of the body: they serve to explain how and in what way the manipulations of the masseuse prove beneficial. The enumeration of the various medical and surgical ailments in which massage has been found useful, and of the precautions to be adopted, and the manner in which it is to be applied in each case, is admirable, and really leaves nothing to be desired by one who is anxious to thoroughly master the subject, and to practise the art intelligently. Massage cannot be learned from any book, however admirable, as Miss Despard candidly avows; it must be learned from a good teacher by practice on the human subject. More than this, as it has appeared to me, there are only a certain number of those who adopt it as a profession who have the physical and the mental qualities necessary for its successful practice—the tact, the judicious firmness, the wise reticence, the sympathetic disposition, without which success is not to be obtained; but as far as any detailed description of the science and art of massage can help, the work to which I gladly write this foreword will assuredly do so.

JAMES LITTLE.

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INTRODUCTION

MASSAGE

(From the French *masser*, "to knead")

MASSAGE is the scientific manual application of certain movements, such as *effleurage*, *stroking*, *pétrissage*, *kneading*, and *tapôtement*, to the human body, by which morbid conditions of the tissues are relieved.

The beneficial results of such manipulations were well known to the inhabitants of Eastern countries, and ancient documents testify to the fact that massage was practised by them many years before the birth of Christ. We read that at the commencement of the Christian era, as well as antecedent to that time, celebrated Greek and Roman physicians prescribed the treatment for their patients, and that Plato classified the movements as being either active or passive. Massage is known to have been employed on the Continent for some centuries, but its practice in England dates only from the beginning of 1800. The present system owes much to Professors Ling, Mezger of Amsterdam, von Mosengeil, Klein, and others. Professor Ling was a native of Sweden. He lived 1776–1839, and it was he who elaborated the "Swedish Medical Gymnastic" system and introduced it in Stockholm in the year 1813.

The following writers amongst others have contributed largely to our scientific and practical knowledge of massage: Weir Mitchell, Playfair, Eccles, Ostrom, Murell, Stretch Dowse, Klein, Bennett, Killogg, and Graham Douglas. Their works should be read by all who wish to extend their knowledge of the subject.

The practice of massage should be undertaken only by educated persons who both by nature and training are qualified for the work. The natural qualifications are health; soft, dry, well covered pliable hands; a sympathetic "touch"; trustworthiness, refinement, kindliness, and tact. The training should include thorough instruction in the following subjects: Elementary Anatomy and Physiology, Theory of Massage, Practical Massage, Remedial Exercises, and Bandaging. A valuable adjunct to the above is a knowledge of the care and use of the Galvanic and Faradic apparatus, as electricity is frequently employed in conjunction with massage.

The following rules should be observed by all who practise massage:—

1. No case should be undertaken except under the direction or at least with the consent of a doctor.
2. Absolute loyalty and obedience to the doctor in charge of the case should be observed, and also strict reticence in regard to the patient's name and private concerns.
3. Freshness and neatness in person and dress are essential. The nails should be carefully trimmed and the hands kept soft and smooth. No rings, bracelets, or superfluous jewellery of any kind should be worn when attending a case.
4. Punctuality in arriving at the patient's house at the appointed time should be observed, and if possible the masseuse should not arrive either wet, hot, or tired.
5. The hands should be washed immediately before giving massage. They should also be washed again before applying massage to the head or face after

other parts have been manipulated. If the hands are cold they should be warmed before touching the patient.

6. The masseuse should enter and leave the room quietly, without fuss or haste, and before going away should see that the patient is comfortable and all immediate wants supplied.

Massage is contra-indicated in the cases of tumour, abscesses, aneurysms, in the early stages of thrombosis, tubercular joints, diseases of the skin, acute inflammation of the kidneys, extreme fatty degeneration of the heart, acute neuritis, and in acute constitutional disease.

PART I

CHAPTER I

THE STRUCTURES OF THE BODY

The science of Anatomy treats of the structure and relationship of the different parts of the body.

The science of Physiology treats of the functions of the different parts of the body.

The body consists of both fluids and solids.

The fluid constituents of the body are—Blood, lymph, chyle, and the secretions of various glands. These will be described in later chapters.

The solid constituents of the body are composed of cells, which possess the powers of growth and of reproduction, and intercellular substance in varying proportions.

According to the relative amount of cells and intercellular substance, these may be divided into two main classes—(*a*) The connective tissues in which the intercellular substance predominates over the cells; and (*b*) the epithelial tissues, which consist mainly of cells.

Each of these classes may be subdivided as follows:—

Connective Tissues.	*Epithelial Tissues.*
Areolar tissue.	Skin.
Fibrous ,,	Mucous membrane.
Elastic ,,	Nerve tissue.
Adipose ,,	Glands
Lymph ,,	
Muscular ,,	
Cartilage.	
Bone.	

Areolar tissue consists of interlacing bundles of white fibres which run in wavy bands in every direction. Between these are spaces or areolæ. There are also a few fibres which run a straight course; these are yellow or elastic fibres. Scattered throughout are cells of various kinds. This tissue is found in the deeper layers of the skin and mucous membranes and between the muscles, etc.

Fibrous tissue is almost wholly composed of bundles of white fibres running parallel to one another, and between these bundles are cells. It forms tendons, ligaments, and certain membranes, dura mater, fibrous pericardium, fasciæ of limbs, etc.

Elastic tissue is composed almost entirely of yellow or elastic fibres; it is found in the walls of the air tubes, uniting the cartilages of the larynx and forming part of the walls of the blood vessels, specially the arteries.

Adipose tissue consists of cells filled with fat, collected into lobules and supported by areolar tissue and a network of capillary vessels. It is found chiefly in the subcutaneous tissue, forming a complete envelope for the body, also under the serous membranes, especially the peritoneum. Yellow marrow is largely composed of fat.

Lymph or adenoid tissue consists of a network of fine fibres, the meshes of which are filled by small cells called lymph corpuscles. It forms the lymph glands and the adenoid tissue found in connection with the alimentary canal, also the spleen.

MUSCULAR TISSUE

It is by means of muscles that all movements of the body are performed. Muscular tissue is of two kinds—

(1) Striated or voluntary.
(2) Unstriated or involuntary.

Every voluntary muscle is composed of bundles of fibres called fasciculi, held together by a connective tissue called epimysium; these are again made up of a number of fibrillæ or long-shaped muscle cells, enclosed in a delicate sheath called the perimysium, which connects the sarcolemma or wall of the muscle cell with the epimysium. The striated appearance of voluntary muscles is caused by microscopical dark lines which pass transversely across the muscle cells. Voluntary muscles are those whose actions can be controlled by the will, and of these the muscular system of the skeleton is composed. Every muscle is enveloped in a membranous sheath called fascia or aponeurosis, which in some cases forms the means of attachment of the muscle to a bone or to another muscle. Most voluntary muscles are attached to bones by means of tendons.

Besides the muscles lying on the outside of the skeleton, the muscles of the ear, larynx, tongue, and pharynx and the upper half of the œsophagus are composed of striped muscular fibres, though the two latter are not under voluntary control.

Involuntary muscles are made up of bundles of cells held together by fibrous connective tissue. All the hollow internal organs are largely composed of unstriped muscular tissue.

The heart is composed of striated though involuntary muscle fibres, which differ from those composing voluntary muscles by being smaller and less distinctly striated.

Muscles are plentifully supplied with nerves, blood and lymph vessels.

CARTILAGE

Cartilage is a tough flexible substance, having neither nerves nor blood vessels, found in various parts of the body, but in adults chiefly in the joints.

Cartilage is divided into—

(1) Hyaline cartilage.
(2) Fibrous cartilage.
(3) Yellow or elastic cartilage.

(1) Articular, temporary, and costal cartilage all come under the head of hyaline cartilage. Articular cartilage covers the joint surfaces of bones, enabling them to glide smoothly over each other, while being elastic it breaks the shock of any concussion. Temporary cartilage is that of which the skeleton of the fœtus is mainly composed, so called because it is afterwards replaced by bone. Costal cartilage joins the ribs to the sternum and to one another.

(2) Fibro-cartilage consists of white fibrous and cartilaginous tissue.

Fibro-cartilages are arranged into three groups—

Interarticular, connecting, and circumferential. Interarticular fibro-cartilages are flat plates of cartilage of varying forms. They lie between the articular cartilage covering the bones of the mandibular, sterno-clavicular, acromio-clavicular, wrist and knee joints.

Connecting fibro-cartilages are those which are found between the bodies of the vertebræ and in the symphysis pubis.

Circumferential cartilages are rings of cartilage which deepen the articulating surfaces of some joints, as for instance the cotyloid cavity of the hip and the glenoid cavity of the shoulder.

(3) The yellow elastic cartilages are those which form the cartilaginous parts of the ear, the epiglottis, and the cornicula laryngis.

BONE

Bone is composed of two kinds of tissue, a dense, compact, extremely porous tissue which forms the exterior part of the bone, and a cancellous tissue which forms the internal part and is also porous. Bones are plentifully supplied with blood vessels, lymphatics, and nerves, which traverse the hard tissue by means of openings in the bones called Haversian canals.

Bones are covered by a fibrous membrane called periosteum, which closely adheres to their surface, especially at their extremities, where it often becomes incorporated with the tendons and ligaments attached to the bone. It is formed of two layers—the outer which consists of connective tissue, and the inner consisting of a dense network of fine elastic fibres and a layer of cells which have the power of forming bone. The interior cavities of the bone contain a substance called marrow, and are lined with the medullary membrane or internal periosteum, which is plentifully supplied with blood vessels; the yellow marrow found in the shafts of the long bones contains a very high percentage of fat.

Red marrow is found in the bones of the cranium, sternum, ribs, and bodies of the vertebræ, also in the cancellous tissue at the ends of the long bones. It contains more blood than the yellow marrow and very little fat.

Bone is a tissue with considerable elasticity.

OSSIFICATION AND GROWTH OF BONES

Most of the bones of the body are developed from cartilage, but those of the cranial vault and some of the other bones are developed from membrane. If a long bone is taken as an example, we find that up to about the second month of intra-uterine life it is represented by a mass of cartilage having more or less the shape of the adult bone; about this time a mass of osseous material appears in the centre of the shaft, this is called the primary centre of ossification; this gradually spreads till the greater part of the cartilage is converted into bone. At a later period (with only one exception, after birth) secondary centres, as they are called, appear in the ends of the bone which are still cartilaginous. The portion of the bone formed from the primary centre is called the diaphysis, and that from the secondary centre the epiphysis. The epiphysis remains separated from the diaphysis by a plate of cartilage called the epiphyseal cartilage until growth is complete, the date varying in different bones from about the seventeenth to the twenty-fifth year.

Bone grows in length by the conversion of the epiphyseal cartilage first into calcified cartilage and then into true bone, and in girth by the laying down of new bone by the periosteum. In each case the actual agents in this bone formation are cells called osteoblasts. The medullary cavity and cancellous spaces are formed by the action of cells called osteoclasts, which have the power of absorbing the bone.

In the case of the short bones the process is the same as that in the long bones, except that there are usually no epiphyseal centres, and the primary centre frequently does not appear till after birth.

In "membrane bones" ossification proceeds directly in the membrane without the intermediate formation of cartilage or of calcified material. The bones forming the cranial vault and the mandible (O.T.[1] inferior maxilla) and clavicle are of this kind.

[1] Throughout this book the nomenclature agreed upon by the Basle International Commission in 1895 has been used. This has now been adopted in all or nearly all English standard works on Anatomy. Where these terms differ markedly from those formerly in general use the latter are placed in brackets preceded by the letters O.T. which designate Old Term.

EPITHELIUM AND ENDOTHELIUM

Epithelium consists of one or more layers of cells called epithelial cells, which cover the outside surface of the skin (where it is called the epidermis). It also lines the whole length of the alimentary canal and the respiratory system, and all ducts and glands connected with these, as well as the genito-urinary organs.

Endothelium is closely related to epithelium, and differs from the latter only in its origin and in the fact that it lines all the closed cavities of the body and the blood and lymph vessels. It consists of a single layer of flat cells fitted edge to edge.

Neither epithelium nor endothelium contain blood vessels, but are nourished by those of the surrounding tissues. Their chief uses are to protect, to secrete, to lubricate, and to regulate temperature.

The cells vary very much in shape and size according to their various functions.

THE SKIN

The functions of the skin are—

(*a*) Protection of underlying tissue.
(*b*) Sensation.
(*c*) Excretion.
(*d*) Absorption.
(*e*) Regulation of the temperature of the body.

Skin consists of the epidermis or cuticle and the dermis or true skin.

The Epidermis is composed of epithelial cells. Its use is to protect the surface of the true skin and the nerves and blood vessels which it contains. It also serves to regulate temperature by limiting the evaporation of the moisture of the body. It is non-vascular and has no nerves.

The Dermis or true skin is composed of fibro-areolar tissue, and is plentifully supplied with blood vessels, nerves, and lymph vessels. In it are found the sweat glands, hair follicles, and sebaceous glands. Projecting from the surface of the dermis are a number of eminences called papillæ. These papillæ are highly sensitive, each being supplied with at least one nerve fibre, and many of them, in the more sensitive parts of the body, as the lips and palms of the hands, containing tactile or touch corpuscles, which are the special end organs of some of the sensory nerves.

Sebaceous Glands consist of ducts connected with clusters of small sacs; they secrete an oily matter which serves to lubricate the roots of the hair.

Sudoriparous or Sweat Glands are found in almost all parts of the skin, and in large numbers in the palm of the hand. They consist of a coiled-up tube, and are connected with the surface of the skin by a spiral duct. By means of these glands large quantities of waste watery matter is secreted and carried away from the tissues. These glands vary in size, being largest in the groin and in the axillæ.

The Hairs which grow on almost every part of the surface of the body and the nails found on the fingers and toes are developments of the epidermis.

Hair Follicles are the depressions in the skin which contain the roots of the hairs; these depressions may be either oblique or curved, which accounts for the straight or curly hairs of the individual. Attached to each hair follicle are involuntary muscular fibres, which on contraction cause the hair to stand on end; the hair follicles then become prominent, causing a roughness of the skin known by the popular term of goose-skin. The different colours of the various races and the different colour of the hair of individuals are caused by the presence of pigment or colouring matter in the layers of the skin.

MUCOUS MEMBRANE

Mucous membrane consists of one or more layers of epithelial cells, and the areolar tissue, which supports it, contains glands in addition to blood vessels; these glands secrete a fluid called mucus, for lubricating purposes. The whole of the alimentary canal is lined by mucous membrane.

NERVE TISSUE

Nerve tissue consists of nerve cells and nerve fibres embedded in a network of supporting tissue called neuroglia, itself composed of cells and fibrils. The brain and spinal medulla consist of this tissue, from the cells of which nerve fibres originate and convey impulses to and from all parts of the body. A complete description of the structure of the nerve centres and of the nerves emanating from them will be found in the chapter on the nervous system.

SECRETING GLANDS

Glands are organs, consisting of epithelial cells, which take up or elaborate from the blood certain elements either to be expelled from the body or for further use in the system. Some glands, such as the liver and the salivary glands, have ducts by means of which their secretions are conveyed; others, such as the spleen, thyroid, and lymph glands, pour their secretions into the blood and lymph vessels passing through their substance and are known as "ductless" glands.

A serous membrane consists of a single layer of flat endothelial cells in the form of a closed sac, on a groundwork of connective tissue, containing blood vessels, out of which a secretion is obtained. The peritoneum which invests the abdominal viscera, and the pericardium which surrounds the heart, are composed of serous membrane.

Synovial membrane is a delicate structure composed of connective tissue supplied by vessels and nerves, and lined by a layer of endothelial cells—in fact, it is a modified serous membrane. It resembles a tube in form, the open ends of which are attached to the edges of the articular surfaces of the bones. It lines the capsules of all diarthrodial joints, and is found in a rudimentary form in amphiarthrodial joints. It secretes a fluid called synovia, which, by lubricating the joint, prevents friction in it during movement.

CHAPTER II

WASTE AND REPAIR OF THE TISSUES

The tissues of the body are composed of twelve or possibly thirteen elementary substances which enter into combination with each other, forming what are known as chemical compounds. These elements are both solid and gaseous. The most important are oxygen, nitrogen, hydrogen, and carbon; the three former, besides combining with others to form chemical compounds, exist separately as gases.

An internal burning or combustion takes place continually in the body. Oxygen is mainly for combustion, and combines with the carbon of the food, or burns it, in the same way that coal is burnt in a fire, with the production of heat and energy. During this process of combustion carbonic acid gas is formed; this is a waste and poisonous substance, and is expelled from the body by means of the lungs and skin. Hydrogen is combined with oxygen to form water, which is got rid of by the skin and kidneys, and, in the form of vapour, by the lungs.

Urea is another product of chemical action. It consists of oxygen, hydrogen, nitrogen, and carbon, and is the main vehicle for the excretion of nitrogen from the body, being removed from the blood by the kidneys.

The temperature of the body, which varies normally within slight limits, is taken as 98°·4 F. This heat, which under general circumstances is considerably above that of the surrounding air, is caused and maintained by chemical action and movement constantly taking place in the body; in other words, largely by oxidation or combustion. The tissues of the body are therefore constantly being used up in this process and must be replaced by food, while the waste products, in the form of carbonic acid gas, urea, and water, are eliminated from the system by the skin, lungs, and kidneys.

The tissues are repaired and built up and vital energy is supplied by means of food.

The proximate constituents of the food may be divided into three main classes —*proteids, fats, and carbohydrates.*

Proteids contain carbon, hydrogen, oxygen, and nitrogen. Fats and carbohydrates contain the same elements without nitrogen, and differ from one another in the fact that in the carbohydrates the hydrogen and oxygen are in the proportion to form water, so that carbon is the only element which requires to be oxidised, whereas in the fats there is not sufficient oxygen to combine with the hydrogen to form water. More oxygen is required to burn up a fat than a carbohydrate, and the use of the former as food will therefore produce more heat in the body than the use of the latter.

Proteid, as the only food which contains nitrogen, is the most important; it can to a large extent replace the other two kinds of food and form fat in the body, but they, though interchangeable, cannot replace it.

Thus proteid forms the main portion of the living tissue of the body, and it is in the combustion and breaking down of it that urea is produced.

It is obtainable from both the animal and the vegetable part of our diet, that, however, from the animal being more easily absorbed.

The chief nitrogenous foods are—

PROTEIDS

Albumin	—Extracted from	meat and white of egg.
Casein	„	cheese.
Legumen	„	peas and beans.
Gluten	„	cereals.

The other two classes of food, fats and carbohydrates, are to a large extent burnt up at once to produce heat and energy without ever entering into the formation of the living tissues.

The chief of these non-nitrogenous foods are—

CARBOHYDRATES

Starch and sugar.
Cellulose found in green vegetables (is not digestible in human intestine, but is in herbivora).

FATS

Olein (fluid).	Stearin (solid).
Palmitin.	

In addition to these three proximate principles, water and salts form a necessary part of our food, the most important of the salts being sodium chloride (common salt), calcium carbonate, and calcium phosphate. The latter two salts are the chief constituents of the bones and teeth. These minerals exist in both animal and vegetable food, and in addition common salt and water are taken into the system separately.

CHAPTER III

THE SKELETON

The skeleton is the bony framework of the body upon which all the softer tissues are built up, and it protects the organs within it. It consists of—

The spine or vertebral column, containing in the adult	26	bones.
Cranium	8	„
Face	14	„
Os hyoides, sternum and ribs	26	„
Upper extremities	64	„
Lower extremities	62	„
Ossicles of the ear	6	„
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Sesamoid bones are small bones which are often developed in tendons, especially in the regions of the fingers and toes. The patellæ are the largest examples of this kind of bone, and are the only ones included in the above list.

There are four kinds of bone—long, short, flat, and irregular.

Long Bones of the Body	Those forming the limbs.
Short Bones	Those forming the carpus and tarsus.
Flat Bones	The occipital, parietal, frontal, nasal, lacrimal, vomer, scapula, os coxæ (O.T. innominate), sternum, and patella.
Irregular	The vertebræ, sacrum, coccyx, temporal, sphenoid, ethmoid, zygoma (O.T. malar), maxilla (O.T. superior maxillary), mandible (O.T. inferior maxillary), palate, conchæ inferiores (O.T. inferior turbinate), and hyoid.

Long bones consist of a shaft with two expanded extremities. The shaft is hollow and contains soft cellular marrow. Round this hollow, called the medullary canal, the bone tissue is loose, but becomes hard and compact as it reaches the circumference of the shaft. The extremities are composed of cancellous tissue, in the interspaces of which marrow is found.

Short bones are composed of cancellous tissue with a thin confining layer of compact tissue.

Flat bones consist of a layer of soft cancellous tissue, called the diploë, placed between two compact layers of osseous tissue.

Irregular bones consist of cancellous tissue enclosed in a compact hard layer of bone.

The Vertebral Column is composed of thirty-three bones, called vertebræ. They take their names from the regions in which they are found. There are seven in the cervical region, twelve in the thoracic, five in the lumbar, five in the sacral, and four in the coccygeal (Fig. 1).

The cervical, thoracic, and lumbar vertebræ are called *true* vertebræ, because they are always separate from each other. The vertebræ in the sacral and coccygeal regions are called *false*, as, in the adult, they are fused together, forming in each region one bone.

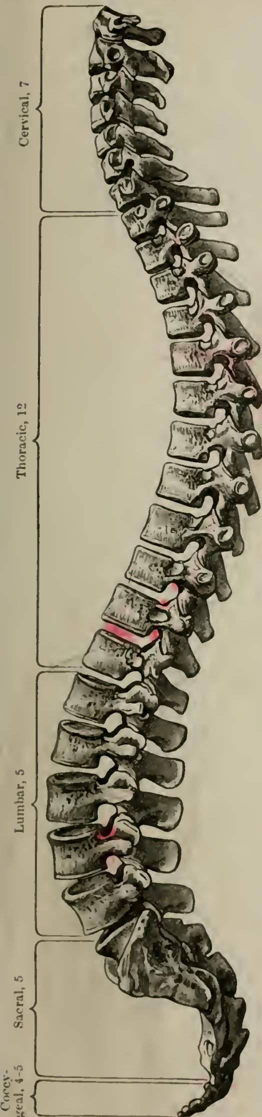


FIG. 1.—VERTEBRAL COLUMN, FROM THE LEFT SIDE.

DESCRIPTION OF VERTEBRÆ

Each vertebra consists of an anterior part or *body* and a posterior part or *arch*.

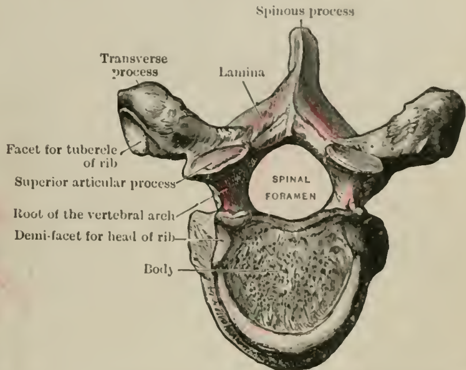


FIG. 2.—FIFTH THORACIC VERTEBRA AS VIEWED FROM ABOVE.

The *arch* is formed of *two roots* (O.T. *pedicle*), *two laminæ, four articular processes, two transverse* and *one spinous process.*

The arches form a cylinder behind for the protection of the *spinal medulla.*

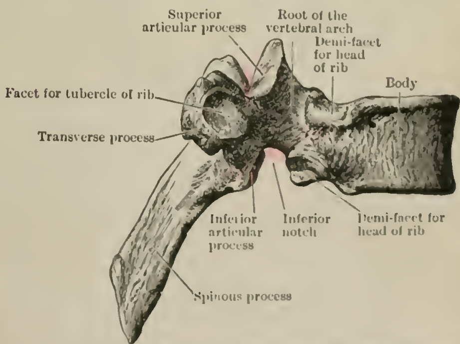


FIG. 3.—FIFTH THORACIC VERTEBRA AS VIEWED FROM THE RIGHT SIDE.

The *roots* of the vertebral arches project backwards from the upper part of the body of the vertebra. The grooves on their upper and lower surface are called *intervertebral grooves* or *notches.* When the vertebræ are placed, one above the other, these grooves form spaces which are bounded in front by the bodies of the vertebræ and the intervertebral discs and behind by the articular processes. These spaces communicate with the vertebral canal and are for the passage of the spinal vessels and nerves. They are called *foramina intervertebralia.*

The *laminæ* are the two broad plates of bone which complete the vertebral arch behind.

FIG. 4.—FOURTH CERVICAL VERTEBRA, FROM ABOVE AND FROM THE RIGHT SIDE.

1. Bifid spine.
2. Lamina.
3. Inferior articular process.
4. Superior articular process.
5. Root of the vertebral arch.
6. Posterior tubercle.
7. Transverse process.
8. Anterior tubercle.
9. Foramen transversarium.

1. Superior articular process.
2. Superior notch.
3. Foramen transversarium.
4. Anterior tubercle.
5. Groove for nerve.
6. Posterior tubercle.
7. Inferior notch.
8. Inferior articular process.
9. Spinous process.

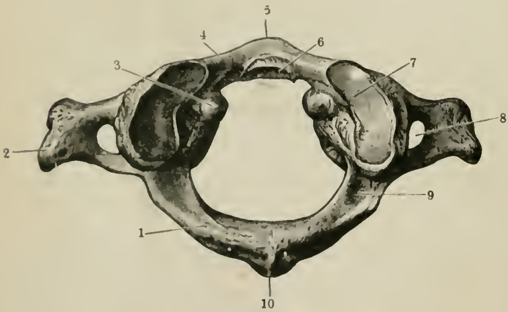


FIG. 5.—THE ATLAS, FROM ABOVE.

1. Posterior arch.
2. Transverse process.
3. Tubercle for transverse ligament.
4. Anterior arch.
5. Anterior tubercle.
6. Surface for articulation with the dens.
7. Superior articular process.
8. Foramen for vertebral artery.
9. Groove for vertebral artery.
10. Posterior tubercle.

The *articular processes* serve to articulate the different vertebræ; they spring from the junction of the roots of the vertebral arch and the laminæ.

The *transverse* and *spinous processes* serve as levers for the attachment of muscles (Figs. 2 and 3). The transverse processes project laterally on each side from the arch at the junction of the root of the arch and the lamina. The spinous processes project backwards in the median plane from the point where the two laminæ are joined.

Pads of fibro-cartilage, called *intervertebral discs,* are found between the bodies of the vertebræ.

CHARACTERISTICS OF THE DIFFERENT VERTEBRÆ

Cervical Vertebræ.—The *bodies* are smaller than in other regions of the spine. They are oblong in form and wider in their transverse diameter than from back to front. The *superior surface* is concave from side to side, the *inferior surface* is concave from back to front. The *vertebral foramen* is larger than in other parts of the spine and is semilunar in shape. The *transverse processes* are pierced by the *foramen transversarium* for the transmission of the vertebral artery and vein. The *spinous processes* are short and bifurcated.

The *articular processes* are flat and oblique; the upper pair look backwards and upwards, the lower downwards and forwards (Fig. 4).

Peculiar Cervical Vertebræ are—The *first*, or *atlas*, which consists of two lateral masses and an anterior and posterior arch. It has no body. It is the vertebra upon which the head rests,—hence its name (Fig. 5). The *lateral masses* support two pairs of articular processes. The superior pair have oval facets for articulation with the condyles of the occipital bone. The inferior pair are circular and are for articulation with the epistropheus (O.T. axis).

The *transverse processes* arise by two roots from the lateral part of the lateral masses. A *tubercle* (*tuberculum posterius*) projects backwards from the posterior arch in the middle line; it represents the spinous process. On the medial side of each lateral mass is a tubercle for the attachment of the transverse ligament, which passes across the space between the lateral masses and retains the dens of the epistropheus in position. There is a circular facet on the posterior surface of the anterior arch for articulation with the dens.

The *second*, or *epistropheus* (O.T. *axis*), has a prominent process, called the *dens* or tooth (O.T. odontoid process), which is the pivot upon which the head rotates. It rises from the upper part of the body of the vertebra. It presents on its *anterior*

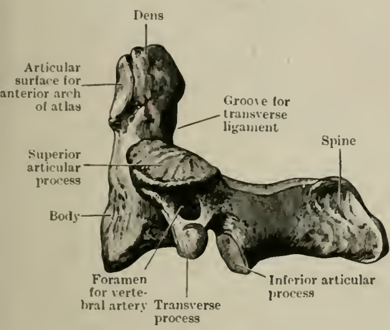


FIG. 6.—EPISTROPHEUS, FROM THE LEFT SIDE.

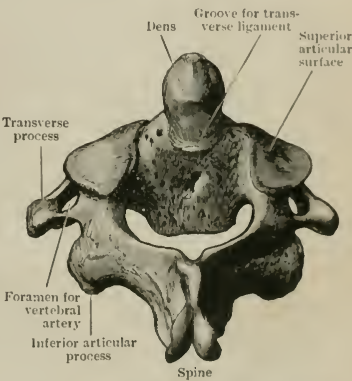


FIG. 7.—EPISTROPHEUS FROM BEHIND AND ABOVE.

surface a facet which articulates with that on the posterior surface of the anterior arch of the atlas. On its *posterior surface* there is a groove for the transverse ligament to pass over. The superior pair of articular processes are nearly horizontal and rest on the junction of the body and the roots of the vertebral arch (Figs. 6 and 7).

The *seventh cervical*, or *vertebra prominens*, has a very long spinous process which is not bifid. The foramen transversarium is sometimes absent on one side or the other.

Thoracic Vertebræ.—The *bodies* of the thoracic or dorsal vertebræ are described as being characteristically heart-shaped, though in the upper and lower dorsal regions they approach the cervical and lumbar vertebræ in shape. They are thicker behind than in front, and are marked on each side near the root of the vertebral arch by two costal demi-facets. The ribs are attached to the twelve thoracic vertebræ. The *transverse processes* present clubbed extremities for articulation with the tubercles of the ribs. The *spinous processes* are long, slope downwards, and overlap one another. The *articular processes* are flat and vertical, the upper pair looking almost directly backwards, the lower pair forwards. The peculiar thoracic vertebræ are the first, ninth, tenth, eleventh, and twelfth (Fig. 8).

The *first thoracic vertebra* has, on each side of the body, an entire costal facet for the head of the first, and a demi-facet for the head of the second rib.

The *ninth thoracic* has usually no demi-facet below.

The *tenth dorsal* has an entire costal facet above, on each side,—no demi-facet below.

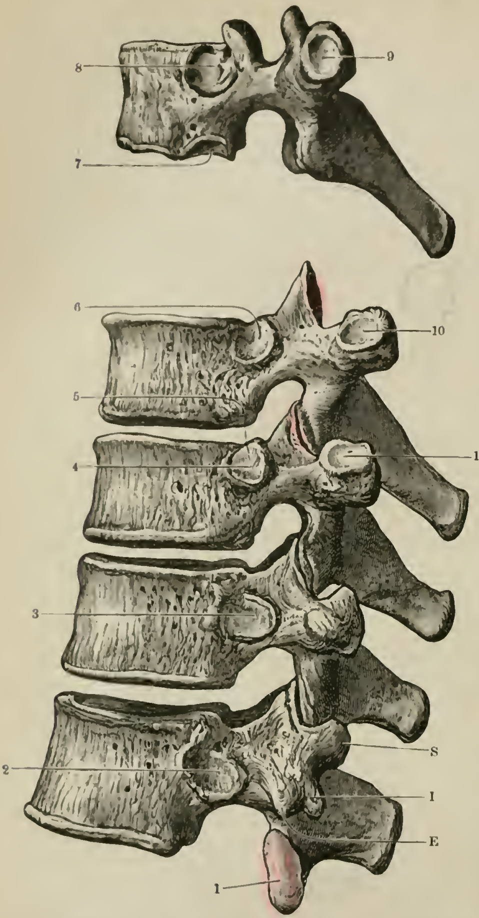


FIG. 8.—FIRST, NINTH, TENTH, ELEVENTH, AND TWELFTH THORACIC VERTEBRÆ, FROM THE LEFT SIDE.

1. Inferior articular process with out-turned facet.
2. Single facet for head of twelfth rib; no facet on transverse process.
3. Single facet for head of eleventh rib; no facet on transverse process.
4. Single or demi-facet for head of tenth rib.
5. Occasional demi-facet for head of tenth rib.
6. Demi-facet for head of ninth rib.
7. Demi-facet for head of second rib.
8. Single facet for head of first rib.
9. Facet on transverse process for tuberosity of first rib.
10. Facet on transverse process for tuberosity of ninth rib.
11. Facet on transverse process for tuberosity of tenth rib, in this particular instance well marked.

S. Superior, I. Inferior, E. External — Tubercles corresponding to Mammillary, Accessory, Transverse of lumbar.

In cases which sometimes occur, where the ninth dorsal vertebra has a demi-facet below, the tenth is found to have only a demi-facet on each side above.

The *eleventh thoracic* is larger than the other dorsal vertebræ, more like those in the lumbar region. The *transverse processes* are very short and have no articular facets for the tubercles of the ribs. The *spinous process* is short and almost horizontal.

The *twelfth* differs from the eleventh by the inferior articular processes being convex and turned outwards like those in the lumbar region.

Lumbar Vertebræ.—These are the largest segments of the vertebral column. The *bodies* are thicker in front than behind. Their *spinous processes* are horizontal and shorter than those of the dorsal vertebræ. The *articular processes* are curved and vertical, the upper pair are concave and look inwards, the lower pair are convex and look outwards. The *fifth lumbar vertebra* differs from the others by the larger size of its transverse processes, by the greater thickness of its body in front, by the smaller size of its spinous process, and by the fact that the lower pair of articular processes are as widely separated as the upper (Figs. 9 and 10).

The Sacrum and the **Coccyx** are regarded as bones of the pelvis rather than of the spine.

The Sacrum is a triangular bone, placed very obliquely. It consists of five (modified) vertebræ, fused together. It has four surfaces, anterior, posterior and two lateral; a base and an apex.

The *anterior surface* is concave from above downwards. There are four ridges which appear on the central part of the bone. These indicate the lines of fusion of the vertebræ. There are four pairs of foramina, called *foramina sacralia anteriora*, for the transmission of the sacral nerves. Lateral to the foramina on each side is a *lateral mass*. This gives attachment to the piriformis muscle between and lateral to the first,

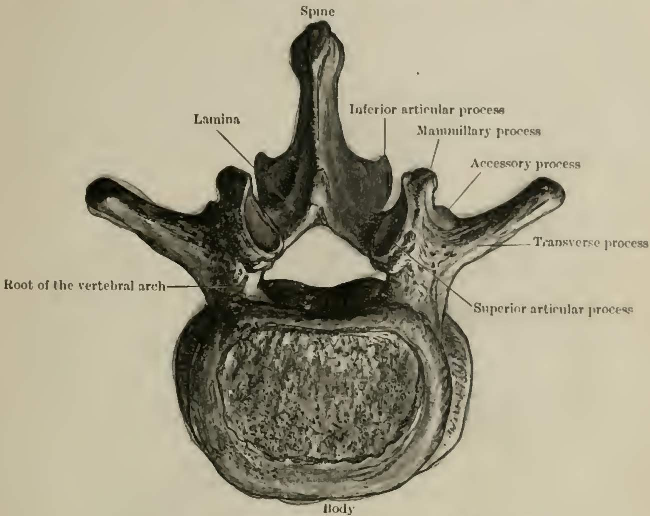


FIG. 9.—THIRD LUMBAR VERTEBRA, FROM ABOVE.

second, third, and fourth foramina; also to the coccygeus muscle below and on the lateral side of the fourth foramen.

The *posterior surface* is convex from above downwards and narrower than the anterior surface.

In the median plane is a crest—*crista sacralis media*—upon which are four

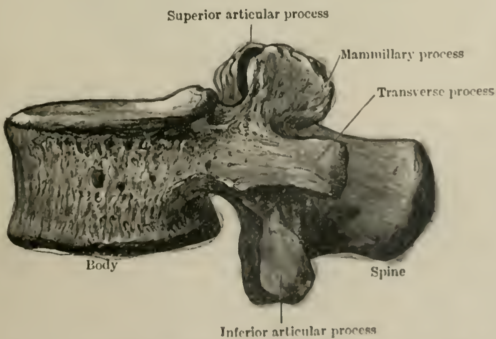


FIG. 10.—THIRD LUMBAR VERTEBRA, FROM THE LEFT SIDE.

tubercles representing the spines of the upper four spinous processes. On either side of the crest is a groove called the *sacral groove*, which gives attachment to the sacro-spinalis, multifidus spinæ, and latissimus dorsi muscles. The fusion of the articular processes of the sacral vertebræ gives rise to a series of tubercles. They form indistinct ridges on the bone, called *crista sacralis articulares*, and are found lateral to the sacral grooves. The spinous process of the fifth sacral vertebra is absent and the laminæ do not meet behind, thus making a gap in the posterior wall of the sacral canal (*hiatus sacralis*). The tubercles which correspond to the inferior articular processes of the fifth sacral vertebra are directed downwards in the form of processes known as *cornua sacralia.* These are connected to the cornua of the coccyx. Lateral to the cristæ sacralis articulares are the *foramina sacralia posteriora*—four pairs—for the passage of the posterior rami of the sacral nerves. Lateral to the third and fourth foramina and on the edge of the bone attachment is given to the gluteus maximus.

The *lateral surface* is broad above, and becomes thinner below. The upper part articulates with the ilium and is auricular in shape. It is known as the *facies auricularis.* Behind it the bone is rough and has three depressions for the

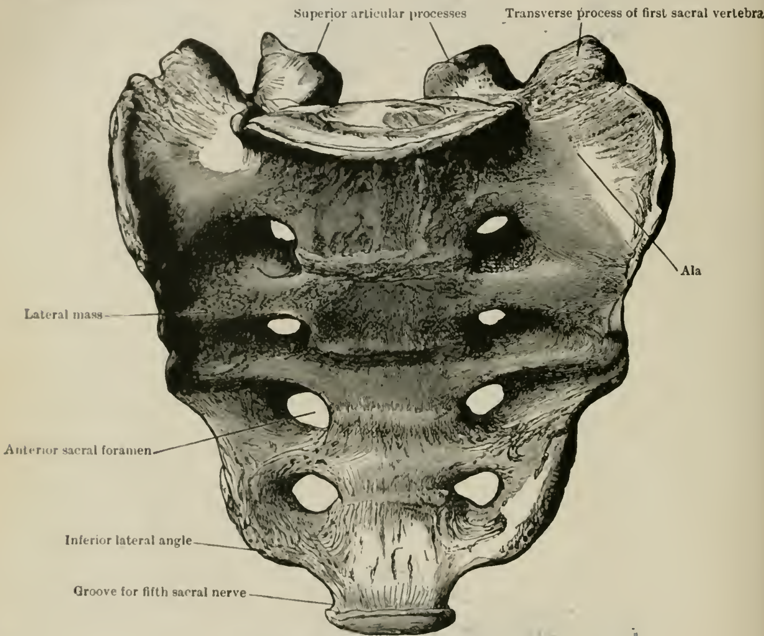


FIG. 11.—THE SACRUM (Anterior View).

attachment of the posterior sacro-iliac ligament. The lower part of the lateral surface gives attachment to the sacro-tuberous (O.T. great sacro-sciatic) and sacro-spinous (O.T. small sacro-sciatic) ligaments; also to a few fibres of the gluteus maximus posteriorly and to the coccygeus anteriorly.

The *base* of the sacrum is broad. In the centre and front is the body, the upper surface of which articulates with the under surface of the last lumbar vertebra by means of an intervertebral disc. Behind the body is the sacral canal, triangular in form. On either side is a fan-shaped surface called the *ala sacralis.*

The *apex* or lower end of the sacrum presents an oval facet for articulation with the coccyx (Figs. 11 and 12).

The Coccyx, so called from its likeness to a cuckoo's beak, consists of four, and occasionally five or three, segments of bone, separate from each other in early life, and tending to become fused in later life. It has two surfaces, two borders, a base, and an apex. The *anterior surface* is concave and is marked by three grooves which lie transversely and which represent the lines of junction of the coccygeal egments. The *posterior surface* is convex and gives attachment to the gluteus maximus. The *lateral borders* are narrow and give rise to the coccygei and levatores ani muscles and to the sacro-tuberous and sacro-spinous ligaments. The *base* articulates with the sacrum. Posteriorly are two processes, the *cornua coccygea*, which extend upwards and unite with the cornua of the sacrum. The *apex* gives attachment to the sphincter ani muscle.

The *vertebral canal*, formed by the arches of the vertebræ, contains the *spinal medulla*. It is largest in the cervical and lumbar regions. In the adult the spinal medulla occupies about two-thirds of the canal, terminating in a slender filament of grey substance. In a child the medulla extends lower down the canal.

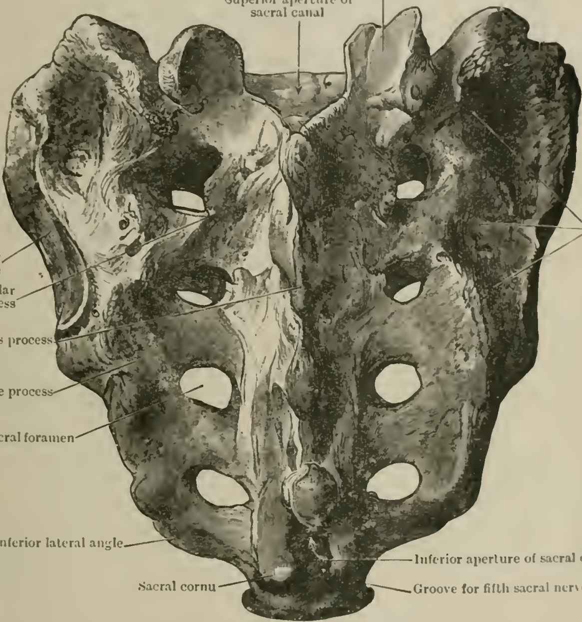


FIG. 12.—THE SACRUM (Posterior View).

The *vertebral groove* lies on either side of the spinous processes, and in these grooves are the deep muscles of the back, which support the vertebral column. Viewed laterally, the vertebral column is seen to be curved forwards in the cervical and lumbar regions, backwards in the dorsal and sacral. The two last are called primary curves, as they exist in fœtal life; the two first secondary, as they only make their appearance when the child begins to sit up and walk. There is often a slight lateral curvature in the dorsal region of the spine, with the convexity usually to the right. The vertebral column supports the head and trunk, affords protection to the spinal medulla, and gives attachment to muscles.

THE SKULL

The skull consists of twenty-two bones—eight of which form the cranium or brain case—namely, occipital, two parietal, frontal, two temporal, sphenoid, and ethmoid. The face is composed of the remaining fourteen bones—namely, two maxillæ (O.T. superior maxillary), two nasal, two zygomatic (O.T. malar), two lacrimali (O.T. lachrymal), two ossa palatine, two conchæ inferiores (O.T. inferior turbinal), vomer, and mandible (O.T. inferior maxillary).

CRANIAL BONES

The Occipital Bone

The Occipital Bone is situated at the back and base of the skull. It is pierced by the *foramen magnum*, a large, oval-shaped opening through which pass the lower part of the medulla oblongata, the spinal part of the accessory nerves (O.T. spinal accessory), the vertebral arteries, and the vessels of the meninges of the upper part of the spinal medulla. It consists of four parts, namely, the squama occipitalis (the tabular part), the two lateral or condylic parts, and the basilar process.

The Squama Occipitalis is curved from side to side and from above downwards, the outer surface being convex. It lies behind the foramen magnum. Near the middle of the external surface is a prominence (*protuberantia occipitalis externa*) which gives attachment to the ligamentum nuchæ. From either side of this prominence two curved lines extend outwards, called *linea nuchæ suprema* and *linea nuchæ superior.* The former gives attachment to the epicranial aponeurosis, the latter to the origin of the trapezius and epicranius (O.T. occipito-frontalis) muscles and the insertion of the sterno-mastoid and splenius capitis muscles. The *linea nuchæ suprema* and *superior* divide the external surface of the squama into an upper and lower portion called respectively *planum occipitale* and *planum nuchale.* The nuchale plane is divided into two lateral halves by the *linea nuchæ mediana* (O.T. *external occipital crest*) which extends in the median line from the protuberantia occipitalis externa to the posterior border of the foramen magnum. About the middle of the nuchal plane and crossing it transversely is the *linea nuchæ inferior.* Above this line attachment is given to the semispinalis capitis (O.T. complexus) and obliquus superior. On and below it are attached the rectus capitis posterior major and minor.

The internal surface of the squama is concave and is divided into four fossæ by vertical and horizontal ridges and grooves. Near the centre is an elevation called the *protuberantia occipitalis interna.* A ridge extending between it and the foramen magnum, called the *crista occipitalis interna*, gives attachment to the falx cerebelli, a process of dura mater which divides the two hemispheres of the cerebellum.

The lateral or condylic parts of the occipital bone lie on either side of the foramen magnum. On their inferior surface are the *condyles* which articulate with the atlas. These are oval in form and convex from back to front. The *anterior condylic fossa* lies in front of and lateral to the condyle. Opening into this is the *anterior condylic foramen* which transmits the hypoglossal nerve. The *posterior condylic fossa* lies behind the condyle, and the *posterior condylic foramen* opens into it. The edge of the foramen magnum behind the condyle is frequently grooved for the vertebral artery.

Extending out from the posterior part of each condyle is the *jugular process.* Its under surface is rough and gives attachment to the rectus capitis lateralis.

The basilar part of the occipital bone extends forwards and upwards from the foramen magnum. On its upper surface is a wide, shallow groove on which lies the medulla oblongata. Its lower surface gives attachment to the longus capitis (O.T. rectus capitis anticus major) and rectus capitis anterior (O.T. rectus capitis anticus minor). It articulates in front with the body of the sphenoid. The occipital bone articulates above and in front with the parietal bones, in front and below with the sphenoid; on each side with the temporal bones, and with the atlas through the medium of its condyles.

The Parietal Bones

The Parietal Bones are two in number and form the sides and roof of the skull. They articulate in front with the frontal below with the temporals and sphenoid, behind with the occipital, and above with each other. The external surface is convex from back to front and from above downwards. Near its centre is an eminence called the *tuber parietale*, which indicates the place where ossification commenced. Crossing the middle of the bone and lying more or less parallel with its lower border are two curved lines, called the *linea temporalis superior* and *linea temporalis inferior*. The former gives attachment to the temporal fascia, the latter defines the upper limit of the origin of the temporal muscle. Below these lines the bone forms part of the *planum temporale* (*temporal fossa*) and gives attachment to the origin of the temporal muscle.

The Frontal Bone

The Frontal Bone consists of an anterior part which corresponds with the region of the forehead; an orbital part forming the roof of the orbits; and a nasal part forming part of the roof of the nasal fossæ.

The frontal part extends upwards from the orbital arches. Its external surface is convex. About $1\frac{1}{4}$ inch above the supraorbital margins and on either side of the median line are the *tubera frontalia* (O.T. *frontal eminences*), which indicate where ossification commenced. Below these are the *arcus superciliares* (O.T. *superciliary ridges*). On either side of the median line and forming the lower margin of the frontal part of the bone are the *margines supraorbitales*. These margins terminate laterally in the *lateral angular process* and medially in the *medial angular process*. Near the medial third of each margin is the notch, or *foramen supraorbitalis* (O.T. *supraorbital notch*), through which pass the supraorbital nerve and artery.

A ridge (*linea temporalis*) extends upwards from the lateral angular process and arches backwards across the lateral aspect of the bone. This divides the temporal from the anterior or frontal part of the bone.

The orbital part consists of two curved plates of triangular shape which form the vaults of the orbits. Their medial edges are separated by the *incisura ethmoidalis* (O.T. *ethmoid notch*), which is occupied by the ethmoid.

In front of the incisura ethmoidalis is the *nasal notch*, from which a process continues downwards and forwards and terminates in the *spina nasalis*. This lies between and articulates with the ethmoid and nasal bones.

The orbital margin and the lateral angular process form a hollow, *fossa glandulæ lacrimalis*, for the lacrimal gland.

The frontal bone articulates with the parietal bones, the sphenoid, the zygomatic bones, the nasal bones, the maxillæ, the lacrimal bones, and the ethmoid.

The Temporal Bones

The Temporal Bones lie at the sides and base of the skull. Each bone consists of three parts: the squamous, the tympanic, and the petro-mastoid portions.

The squamous part is a thin plate of bone placed vertically. Its external surface is smooth and convex and enters into the formation of the temporal fossa, giving attachment to the temporal muscle. From the lower and front part of the bone an arched process, the *zygomatic*, projects forwards and articulates with the *zygomatic process* of the zygomatic bone (O.T. malar bone); the lower margin and inner surface of this gives attachment to the masseter muscle. Posteriorly the upper and lower edges of the process divide and constitute respectively the *posterior* and *anterior roots* which connect it with the squamous portion of the bone. On the inferior surface of the anterior root is a process, the *articular tubercle*, and behind this is the *mandibular fossa* (O.T. *glenoid*). There is a rounded *tubercle* at the point where the two roots diverge from each other, which gives attachment to the fibres of the external lateral ligament of the temporo-mandibular joint.

The inner surface of the squamous portion is marked by depressions which correspond to the convolutions of the temporal lobe of the brain, also by grooves for the transmission of the branches of the middle meningeal artery.

The tympanic part of the temporal bone consists of a curved plate and forms the anterior part of the posterior and lower wall of the external acoustic meatus.

The petro-mastoid part of the temporal bone consists of the *mastoid process* and the *petrous portion.* The mastoid process lies behind the external acoustic meatus. Its external surface and lower border give attachment to the sterno-mastoid, splenius capitis, and longissimus capitis (O.T. trachelo-mastoid) muscles. On its inner side is a well-marked groove for the attachment of the posterior belly of the digastric muscle. Medial to this there is a shallow groove for the occipital artery.

The petrous part of the petro-mastoid is pyramidal in form. It is united to the internal surfaces of the squamous and tympanic parts of the bone by its base. Its apex is directed medially, forwards, and a little upwards. It has three surfaces: superior or anterior, posterior, and inferior; and three borders, namely, anterior, superior, and posterior. The *anterior surface* is marked by impressions for the convolutions of the inferior surface of the temporal lobes of the brain. Near the apex is the termination of the carotid canal, and above this is a depression for the semilunar ganglion on the sensory root of the trigeminal cerebral nerve. Near the middle of the bone is the *eminentia arcuata,* which indicates the position of the *superior semicircular duct* of the internal ear.

The *posterior surface* of the petrous part is marked near its centre by a large opening, the *internal acoustic meatus,* which transmits the acoustic and facial nerves. The *inferior surface* is marked by the *styloid process,* which projects downwards, forwards, and medially, and which gives attachment to the stylo-glossus, stylo-hyoideus, and stylo-pharyngeus muscles, also to the stylo-hyoid and stylo-mandibular ligaments. Between the styloid and mastoid processes is the *stylo-mastoid foramen* for the passage of the facial nerve. Close to the apex is the inferior opening of the carotid canal. The *jugular fossa,* which lodges the internal jugular vein, lies medial to the styloid process and behind the orifice of the carotid canal.

The petrous part contains the organs of hearing and is remarkable for its hardness and density.

The temporal bones articulate with the occipital and parietal bones, the sphenoid, the zygomatic bones, and with the mandible through the medium of a movable joint.

The Sphenoid Bone

The Sphenoid is a wing-shaped bone which articulates with all the other bones of the cranium. It lies at the anterior part of the base of the skull. It consists of a body, the two great wings, the two lesser wings, and the pterygoid processes.

The body is hollow and somewhat cuboid in shape.

The anterior surface is marked by a crest, the *sphenoidal crest,* which lies in the median line and is continuous with the ethmoidal spine above and the rostrum below. This crest articulates in front with the perpendicular plate of the ethmoid.

On the inferior surface is the *rostrum,* a triangular spine which articulates with the vomer.

The lateral surfaces of the body are united to the great wings and also partly to the roots of the pterygoid processes. Above the attachment to the great wings is a curved groove, the *carotid groove,* in which lies the internal carotid artery.

On *the superior surface* of the body, in front, is the *ethmoidal spine,* a pointed process which articulates with the cribriform plate of the ethmoid. Behind this is a smooth elevation behind which lies the *optic groove,* which passes laterally on either side to become continuous with the *optic foramen.* More posteriorly is the *olivary eminence,* and behind this the bone is hollowed out in the shape of a Turkish saddle, called the *sella turcica* or *hypophyseal fossa,* as it contains the *hypophysis* (O.T. *pituitary body*). This hollow is bounded behind by a high ridge called the *dorsum sellæ,* and the posterior surface of this slopes down to the basilar portion of the occipital bone.

The great wings are curved processes of bone which extend laterally, upwards, and backwards from the body of the bone. The *posterior part* of each extends backwards and laterally, ending in a pointed process, the *angular spine* (O.T. *sphenoidal spine*), which is directed downwards and which gives attachment to the medial lateral ligament of the temporo-mandibular joint.

The superior or *cerebral surface* is concave. It is pierced by three foramina, namely, the *foramen spinosum* near the angular spine, which transmits the middle meningeal artery and a recurrent branch from the mandibular division of the trigeminal nerve; anterior and slightly medial to this is the *foramen ovale*, which transmits the motor root and the mandibular division of the trigeminal nerve: while near the front of the great wing is the *foramen rotundum* for the passage of the maxillary division of the trigeminal nerve.

The lateral surface is divided into two parts by a well-defined ridge, the *infratemporal crest.* The upper portion enters into the formation of the temporal fossa and affords an extensive attachment to the fibres of the temporal muscle. The lower portion, *facies infratemporalis*, enters into the formation of the zygomatic fossa and affords attachment for the upper head of the external pterygoid muscle. The *anterior surface* of the great wing forms the posterior part of the lateral wall of the orbit. It is bounded medially by a ridge which separates it from the superior orbital fissure.

The small wings are two plates of bone, triangular in form, which extend forwards and laterally from the upper part and front of the body on each side. They are connected to the body by two roots, enclosed between which are the *optic foramina* for the passage of the optic nerves and ophthalmic arteries.

The superior surface is smooth and enters into the formation of the anterior cranial fossa.

The inferior surface forms the posterior part of the upper wall of the orbit and the upper boundary of the superior orbital fissure.

The anterior border is serrated and articulates with the frontal bone.

The superior orbital fissure affords communication between the cranium and the orbit. It separates the great from the small wing, and transmits the oculomotor, trochlear, and abducent nerves and the three branches of the ophthalmic division of the trigeminal nerve.

The pterygoid processes project downwards on each side from the points of junction between the body and the great wings. Each process consists of two plates, lateral and medial. These are joined together anteriorly, but diverge posteriorly, enclosing between them the *pterygoid fossa.* The *lateral* plate gives attachment laterally to the external pterygoid muscle and medially to the internal pterygoid muscle.

The Ethmoid Bone

The Ethmoid Bone lies in front of the sphenoid and between the orbital plates of the frontal. It enters into the formation of the anterior part of the cranial fossa, the walls of the orbit and of the nasal fossæ. It is composed of very light osseous tissue, and consists of a horizontal plate, a vertical plate, and two lateral masses.

The horizontal plate, or **lamina cribrosa** (O.T. **cribriform**), is lodged in the space between the orbital plates of the frontal bone. It connects the lateral masses and the vertical plate. From the middle of this plate a process called the *crista galli* projects upwards and attached to it is the falx cerebri; on either side of the crista galli are two grooves for the olfactory lobes of the brain.

Numerous foramina are found in this part of the bone for the passage of the olfactory nerves.

The vertical plate, or **lamina perpendicularis,** forms the upper part of the nasal septum. It extends downwards from the inferior surface of the lamina cribrosa.

The lateral masses consist of thin bone enclosing a number of air cells. They are bounded laterally by the orbital plate, which enters into the formation of the medial wall of the orbit, and medially by part of the nasal fossa.

The ethmoid articulates with the sphenoid, frontal, nasal, maxillæ, lacrimals, inferior conchal bones (O.T. inferior turbinate), palatine bones, and the vomer.

THE BONES OF THE FACE (14)

The Maxillæ (O.T. Superior Maxillæ)

The Maxillæ, two in number, unite to form the upper jaw. They enter into the formation of the roof of the mouth, the floor of the orbits, and the sides and

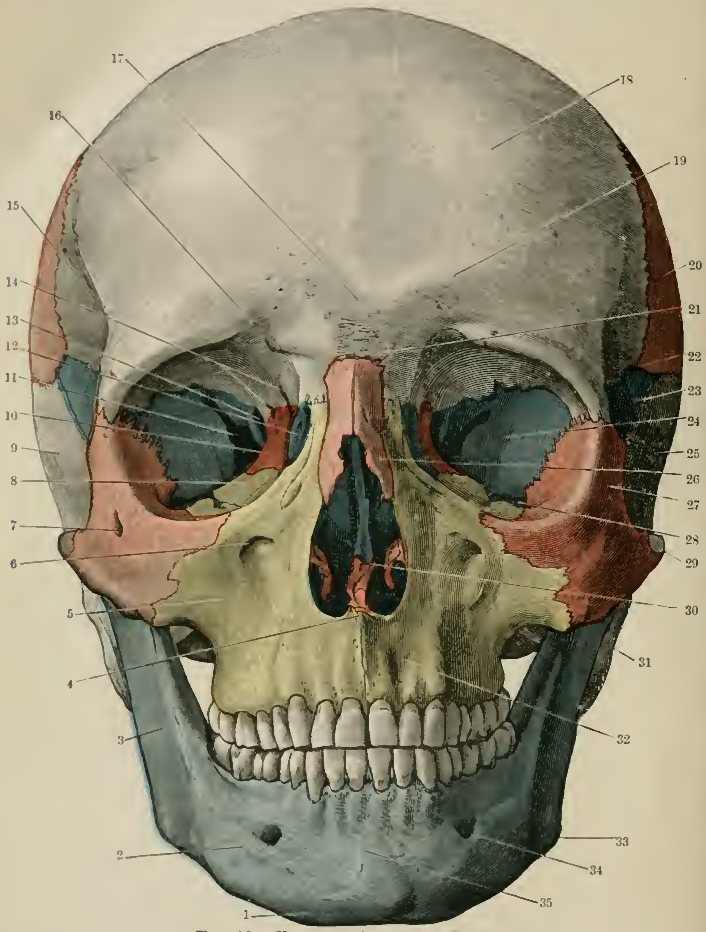


FIG. 13.—FRONTAL ASPECT OF SKULL.

1. Mental protuberance.
2. Body of mandible.
3. Ramus of mandible.
4. Anterior nasal spine.
5. Canine fossa.
6. Infraorbital canal.
7. Zygomatic foramen.
8. Orbital surface of maxilla.
9. Temporal fossa.
10. Lamina papyracea of ethmoid.
11. Superior orbital fissure.
12. Lacrimal bone and groove.
13. Optic foramen.
14. Orbital foramina.
15. Temporal ridge.
16. Supraorbital notch.
17. Glabella.
18. Frontal eminence.
19. Superciliary ridge.
20. Parietal bone.
21. Fronto-nasal suture.
22. Pterion.
23. Great wing of sphenoid.
24. Orbital surface of great wing of sphenoid.
25. Squamous part of temporal.
26. Left nasal bone.
27. Zygoma.
28. Inferior orbital fissure.
29. Zygomatic arch.
30. Anterior nasal aperture, displaying nasal septum and inferior and middle conchæ.
31. Mastoid process.
32. Incisor fossa.
33. Angle of jaw.
34. Mental foramen.
35. Symphysis.

floor of the nasal fossæ. Each consists of a body, hollowed out and forming a large air cavity, called the maxillary sinus, and four processes—zygomatic, frontal, alveolar, and palatal.

The body has four surfaces—an antero-lateral or facial, a postero-lateral or zygomatic, a supero-lateral or orbital, and a medial or nasal.

On *the antero-lateral* or *facial surface*, just below the infraorbital margin, is the

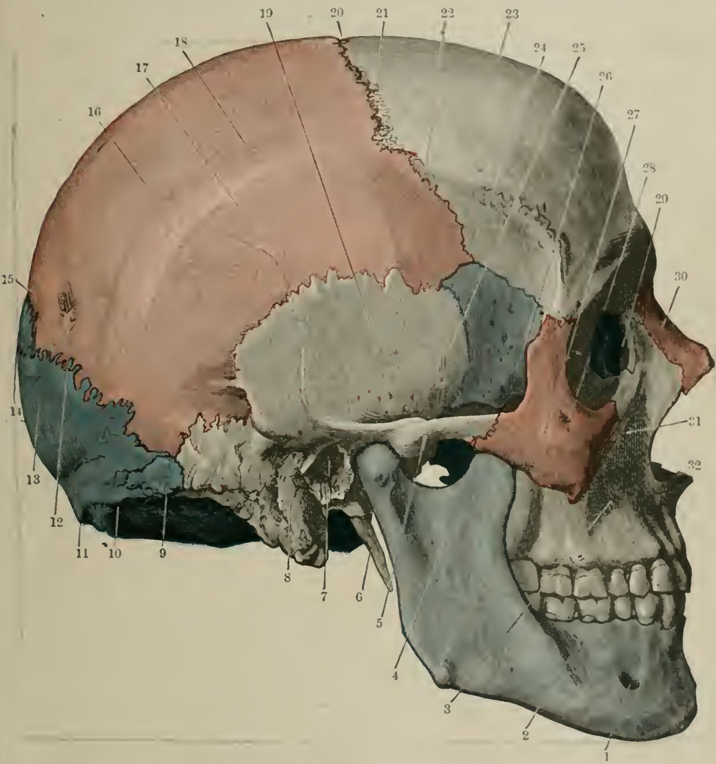


Fig. 14.—Lateral Aspect of Skull.

1. Mental foramen.
2. Body of lower jaw.
3. Maxilla.
4. Ramus of lower jaw.
5. Zygomatic arch.
6. Styloid process.
7. External acoustic meatus.
8. Mastoid process.
9. Asterion.
10. Superior curved line of occipital bone.
11. External occipital protuberance.
12. Lambdoid suture.
13. Occipital bone.
14. Lambda.
15. Obelion placed between the two parietal foramina.
16. Parietal bone.
17. Lower temporal ridge.
18. Upper temporal ridge.
19. Squamous part of temporal bone.
20. Bregma.
21. Coronal suture.
22. Stephanion.
23. Frontal bone.
24. Pterion.
25. Temporal fossa.
26. Great wing of sphenoid.
27. Zygoma.
28. Zygomatic foramen.
29. Lacrimal bone.
30. Nasal bone.
31. Infraorbital canal.
32. Anterior nasal aperture.

infraorbital foramen, which gives passage to the infraorbital nerve and artery. Below and lateral to this is a depression, the *canine fossa*. Medial to this and on a lower level is the *incisive* or *myrtiform fossa*. On the lower aspect of the facial surface are a series of eminences, corresponding to the roots of the teeth.

The supero-lateral or *orbital surface* forms part of the floor of the orbit. It is marked posteriorly by the *infraorbital groove*. This terminates in the *infraorbital canal*, which traverses the substance of the bone and opens below the margin of the orbit.

The internal or *nasal surface* is marked by an opening into the maxillary sinus In front of the sinus is the *lacrimal groove* and anterior to this is the *conchal crest* or *inferior turbinated crest*, for articulation with the inferior conchal (O.T. inferior turbinate) bone.

The zygomatic or **malar process** lies on the antero-lateral side of the body. Its upper surface is rough and articulates with the zygomatic bone (O.T. malar).

The frontal or **nasal process** extends upwards, medially, and backwards from the upper and front part of the body. It forms the side of the nose.

The alveolar process projects from the under surface of the body of the bone. It is curved and, with its fellow of the opposite side, forms the alveolar arch, in which the roots of the teeth of the upper jaw are embedded, and its posterior extremity gives attachment to the buccinator muscle.

The palatine process lies horizontally, projecting medially from the internal surface of the bone. Its superior surface, with that of its fellow, forms the floor of the nasal fossæ. Its inferior surface forms part of the hard palate of the corresponding side. The posterior border of this process articulates with the horizontal plate of the palate bone.

The Zygomatic Bones (O.T. Malar)

The Zygomatic Bone of each side is a quadrangular bone. It forms the prominent part of the cheek and is often called the cheek bone for this reason. It is situated on the lateral side of the orbital cavity, of which it forms the lateral border and floor. Inferiorly it is united to the maxilla. Posteriorly it helps to form *the zygomatic arch* (Figs. 13 and 14).

The Nasal Bones

The Nasal Bones, two in number, and of quadrangular form, are placed in the space between the frontal processes of the maxillæ. Together they form the bridge of the nose. They articulate above with the nasal notch of the frontal bone and laterally with the frontal process of the maxilla on each side.

The Lacrimal Bones

The Lacrimal Bones, two in number, are small, thin, and fragile. They enter into the formation of the medial orbital wall. They have two surfaces. On the lateral or orbital surface is the *posterior lacrimal crest*, which lies vertically. The *lacrimal groove*, for the lacrimal sac, lies in front of this crest.

The Inferior Conchal Bones (O.T. Inferior Turbinated)

The Inferior Conchal Bones are two in number. They lie horizontally along the lower part of the lateral wall of the nasal fossa. They each consist of a plate of spongy bone of shell-like form. They have two curved borders and two surfaces, medial and lateral. The *medial surface* is convex and forms the floor of the middle meatus, a nasal passage situated below and to the lateral side of the middle conchal bone. The *lateral surface* is concave and forms part of the inferior meatus, a nasal passage between the inferior conchal bone and the floor of the nasal fossa.

The Vomer Bone

The Vomer Bone is quadrilateral in shape. It lies in the hinder part of the nasal septum. It has four borders and two surfaces. The inferior border articulates with the nasal crest of the maxillæ and palatine bones.

The Palatine Bones

The Palatine Bones, two in number, are of irregular shape. They enter into the formation of the floor and lateral wall of the nose, the posterior part of the hard palate and the orbit. Each consists of a horizontal and vertical plate united so as to form a bone resembling the letter L. The anterior border of the horizontal plate articulates with the posterior edge of the palatine process of the maxilla, and with its fellow forms the posterior third of the hard palate.

The Mandible (O.T. Inferior Maxillary)

The Mandible, besides being the largest and strongest, is the only movable bone in the face. It consists of a body or horizontal part which contains the lower teeth, and two vertical portions called the rami. The body is curved like a horseshoe, and the rami, directed upwards from the back part of the bone, form with it a right angle.

The body is marked in the median line in front by a vertical ridge, the *symphysis*, which indicates the junction of the two halves from which the bone is developed. This ridge bifurcates inferiorly and encloses a triangular area at the lower angles of which are the *mental tubercles.* Midway between the upper and lower borders of the jaw the *mental foramen* pierces the bone. This is the anterior opening of the *inferior alveolar canal*, and it is for the transmission of the mental vessels and nerves. On either side of the symphysis is a depression, the *incisor fossa*, which gives attachment to the mentalis (O.T. levator menti) muscle. Running up and back from the mental tubercle on each side is the *linea obliqua* (O.T. *external oblique line*), a faintly marked ridge, which gives attachment to the quadratus labii inferioris (O.T. depressor labii inferioris) and triangularis (O.T. depressor anguli oris). Below it the platysma is attached. The *superior* or *alveolar border* presents a series of cavities for the reception of the teeth of the lower jaw. Its outer lip gives attachment to the buccinator muscle as far forward on either side as the first molar tooth. The *digastric fossæ* are found on the *base* of the body on either side of the symphysis. They give attachment to the anterior bellies of the digastric muscles.

The medial surface is marked by the *mylo-hyoid ridge* (O.T. *internal oblique line*), an oblique line which passes up and backwards from the lower part of the symphysis. It gives attachment to the origin of the mylo-hyoid muscle and also to the superior constrictor of the pharynx.

Below the back part of this ridge is the fossa for the submaxillary gland. The sublingual gland lies above the front part of the mylo-hyoid ridge.

The ramus has two surfaces, four borders, and two processes.

The lateral surface gives attachment to the masseter muscle. The middle of the *medial surface* is marked by the *mandibular foramen*, the large opening of the *mandibular canal* (O.T. *inferior dental canal*) which transmits the inferior alveolar vessels and nerves. The margin of the mandibular foramen is marked in front by a pointed spine of bone, the *lingula*, to which the spheno-mandibular ligament of the temporo-mandibular articulation is attached. Extending for a short way downwards and forwards from the mandibular foramen is the *mylo-hyoid groove*, for the transmission of the mylo-hyoid vessels and nerve. Behind this groove is a rough surface for the attachment of the internal pterygoid muscle.

The lower border of the ramus is continuous with that of the body of the bone. Its junction with the *posterior border* forms the angle of the bone, which is rounded and rough on each side for the attachment of the masseter laterally and the internal pterygoid medially. The angle also gives attachment to the stylo-mandibular ligament at a point between the above-named muscles.

The anterior border is confluent below with the oblique line.

The posterior border, thick and rounded, is covered by the anterior surface of the parotid gland. It is confluent above with the neck of the condyle.

The upper border presents the *coronoid process* in front and the *condylar process* behind, separated by a deep depression, the *mandibular notch* (O.T. *sigmoid notch*).

The coronoid process is triangular in shape. Its anterior margin is convex and is continuous below with the anterior border of the ramus. Its posterior margin is curved and forms the anterior boundary of the mandibular notch.

Its lateral surface gives attachment to the temporal and masseter muscles.

Its medial surface gives attachment to the temporal muscle.

The condylar process consists of the *head* of the mandible or *condyle* and the *neck*. The latter is the constricted portion of bone which supports the condyle. The condyle articulates with the mandibular fossa of the temporal bone. It is marked, at its lateral extremity, by a *tubercle* to which the lateral ligament of the temporo-mandibular joint is attached.

The anterior surface of the neck is marked by a depression for the insertion of the external pterygoid muscle.

THE HYOID BONE

The hyoid bone lies in the neck, above the larynx. In the adult it comprises a body, which forms a central part, and four processes, called the greater and lesser horns. The two greater horns are directed backwards from the body on either side. The two lesser are small prominences, also directed backwards and upwards, and found at the angle formed by the union of the body with the greater horns.

The hyoid bone affords attachment to the muscles of the tongue.

THE THORAX

The thorax contains the principal organs of respiration and circulation, namely, the lungs and heart. It is formed in front by the sternum and costal cartilages of the ribs, on each side by the ribs, and behind by the bodies of the thoracic vertebræ.

The Sternum

The Sternum is situated in the middle of the upper part of the chest in front. It consists of three parts—the upper part, called the manubrium or handle; the corpus or body, which is the central part; and the xiphoid process.

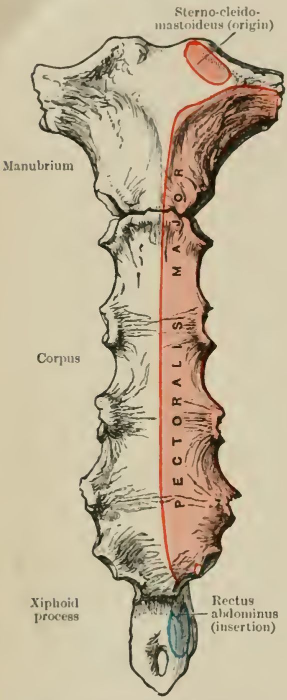


FIG. 15.—THE STERNUM (Anterior Aspect), SHOWING MUSCLE ATTACHMENTS.

The manubrium is triangular in form. It has two surfaces and four borders

The anterior surface gives origin on either side to part of the pectoralis major and sterno-mastoid muscles.

The posterior surface gives origin on either side to part of the sterno-hyoid and sterno-thyroid muscles.

The superior border presents in the centre a notch, the *jugular notch*, and on either side of this a hollow articular surface for the sternal extremity of the clavicle *The inferior border* displays an oval surface for articulation with the body. Each *lateral border* is marked by two facets, the upper of which is for articulation with the first costal cartilage and the lower for articulation with part of the second costal cartilage.

The body is longer and narrower than the manubrium; it has two surfaces and four borders. *The anterior surface* is marked by three transverse ridges which indicate the line of union between the four segments from which it is formed. It gives an extensive origin on either side to part of the pectoralis major muscle.

The posterior surface is faintly marked by three transverse lines which correspond to those in front. It gives attachment inferiorly on either side to part of the transversus thoracis muscle.

The superior border articulates with the manubrium. *The inferior border* articulates with the xiphoid cartilage. Each *lateral border* is marked superiorly by a facet, which, together with the facet on the manubrium, is for the reception of the cartilage of the second rib. Below this are four hollows for the cartilages of the third, fourth, fifth, and sixth ribs. Inferiorly each lateral border presents a facet which, in conjunction with another on the xiphoid cartilage, receives the cartilage of the seventh rib.

The xiphoid cartilage is the smallest of the three portions of the sternum, and presents many varieties of form. It is attached above to the body and has a free lower extremity. It is cartilaginous in early life and remains more or less so until middle age, when it usually becomes ossified especially at its upper part where it unites with the body. It gives insertion anteriorly to part of the rectus abdominis muscle. Its posterior surface affords attachment to some fibres of the diaphragm and the transversus thoracis muscle. Laterally the process gives attachment to the aponeurosis of the abdominal muscles, while the inferior extremity or apex gives attachment to the linea alba.

The sternum articulates above with the clavicle and laterally with the cartilages of the seven upper ribs (Fig. 15).

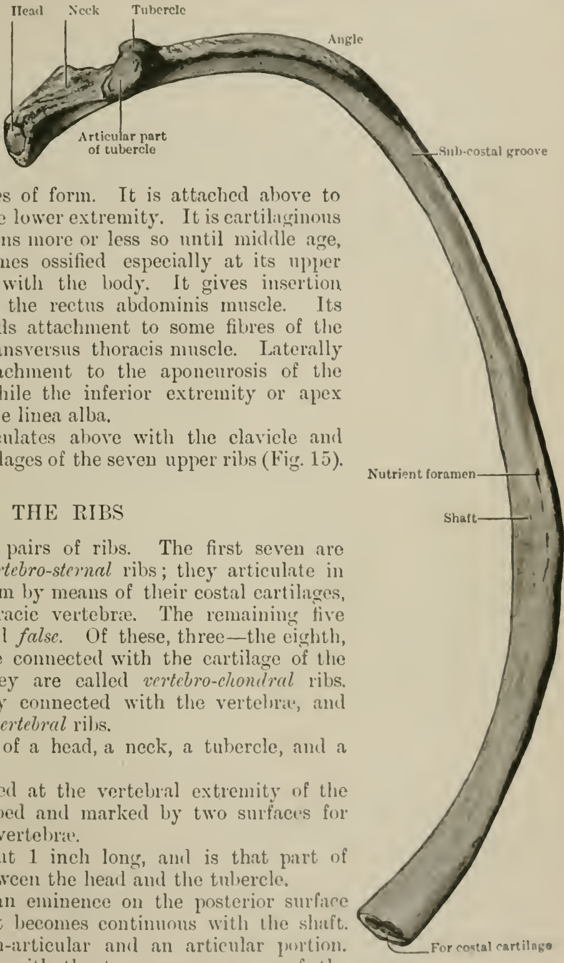


FIG. 16.—FIFTH RIGHT RIB AS SEEN FROM BELOW.

THE RIBS

There are twelve pairs of ribs. The first seven are called the *true* or *vertebro-sternal* ribs; they articulate in front with the sternum by means of their costal cartilages, behind with the thoracic vertebræ. The remaining five pairs of ribs are called *false*. Of these, three—the eighth, ninth, and tenth—are connected with the cartilage of the rib next above. They are called *vertebro-chondral* ribs. The last two are only connected with the vertebræ, and are called *floating* or *vertebral* ribs.

Each rib consists of a head, a neck, a tubercle, and a shaft (Fig. 16).

The head is placed at the vertebral extremity of the rib. It is wedge-shaped and marked by two surfaces for articulation with the vertebræ.

The neck is about 1 inch long, and is that part of the rib which lies between the head and the tubercle.

The tubercle is an eminence on the posterior surface of the neck, where it becomes continuous with the shaft. It consists of a non-articular and an articular portion. The latter articulates with the transverse process of the lower of the two dorsal vertebræ to which the head is joined. It lies below the non-articular portion and is internal to it.

The shaft is thin, flat, and curved, and its length varies in different ribs. It is also twisted so that the part of the external surface behind the angle is directed downwards, and that in front of the angle somewhat upwards. The shaft has two surfaces, external and internal, and two borders, superior and inferior. That part of the shaft where the curve is most acute is called the *angle*, and is marked on its *external surface* by a rough, oblique ridge which gives attachment to the ilio-costalis lumborum, ilio-costalis dorsi, and ilio-costalis cervicis muscles. The external surface gives attachment also, between the angle and the tubercle, to the longissimus dorsi muscle. The *internal surface* is marked by a groove, called the *costal groove*, which lodges the intercostal vessels and nerves. The superior lip of this groove gives attachment to the internal intercostal muscle; the inferior lip, corresponding to the inferior border of the rib, gives attachment to the external intercostal muscle.

The superior border has an outer and inner lip, and gives attachment to the external and internal intercostal muscles.

The inferior border is sharp, and gives attachment to the external intercostal muscle.

The sternal extremity of the shaft displays an oval depression for the reception of the costal cartilage.

Peculiar Ribs.—These are the first, second, tenth, eleventh, and twelfth.

The first rib is very short and much curved. It has no angle, and the shaft is not twisted but lies horizontally. Its *head* has only one surface for articulation with the first thoracic vertebra. The *neck* is narrow, with a rounded anterior border, and a rough edge behind for the attachment of ligaments. The *tubercle* is prominent. The upper surface of the shaft displays two grooves; the anterior groove lodges the subclavian vein, the posterior the subclavian artery. Between the latter groove and the tubercle is a rough surface which affords attachment to the scalenus medius. On the inner border of the shaft, between the grooves for the subclavian artery and vein, is the *scalene tubercle* which gives attachment to the scalenus anterior. The outer border gives attachment, behind the groove for the subclavian artery, to the first digitation of the serratus anterior and to the external and internal intercostal muscles of the first intercostal space. The inferior surface is smooth, with no subcostal groove.

The second rib is larger than the first, but like it very much curved, and has no twist on its shaft. It lies obliquely; its outer surface is directed outwards and upwards and gives attachment, near the middle, to part of the first and the whole of the second digitation of serratus anterior, and behind this to the scalenus posterior. The inner surface is directed inwards and downwards.

The tenth rib has only one articular surface on the head, and in many cases has none on the tubercle.

The eleventh and **twelfth ribs** have a single articular surface on the head; they are pointed at the ends, and have only slightly perceptible angles and tuberosities. The twelfth rib is shorter than the eleventh.

BONES OF THE UPPER EXTREMITY

The Clavicle

The Clavicle forms the front part of the shoulder girdle. It is a long bone, the shaft of which displays a double curve, with convexity forwards in the medial two-thirds and backwards in the lateral third of its extent. The medial end articulates with the sternum and is called the sternal extremity, the lateral end articulates with the acromion of the scapula and is called the acromial extremity.

The shaft is flattened from above downwards in its lateral third. It is prismatic in form in the medial two-thirds of its extent.

The lateral third of the shaft has a superior and inferior surface and an anterior and posterior border.

The superior surface is flat and gives attachment in front to the deltoid and behind to the trapezius muscle. The part between theso two muscular attachments is smooth and subcutaneous.

The inferior surface is marked by a rough ridge, called the *oblique ridge*, which extends in an oblique direction, from behind, forwards and laterally. The posterior extremity of this ridge forms the *coracoid tuberosity*. The oblique ridge and the coracoid tuberosity give attachment respectively to the trapezoid and conoid parts of the coraco-clavicular ligament.

The anterior border is sharply defined and gives attachment to the deltoid.

The posterior border is rough and gives attachment to the trapezius.

The medial two-thirds of the shaft may be described as having three surfaces—anterior, posterior or cervical, and inferior or subclavian, separated by three borders—anterior, superior, and posterior or subclavian.

The anterior border is confluent with the anterior border of the lateral third of the bone; passing backwards in its medial part it forms the lower boundary of the clavicular attachment of the pectoralis major.

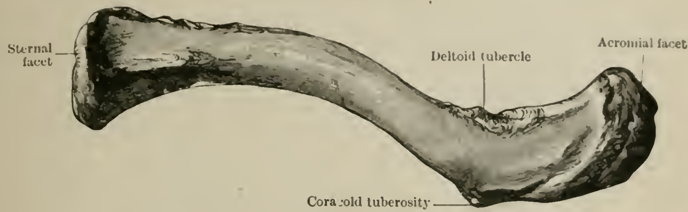


FIG. 17*a*.—THE RIGHT CLAVICLE, SEEN FROM ABOVE.

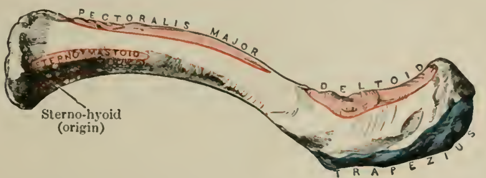


FIG. 17*b*.—THE UPPER SURFACE OF THE RIGHT CLAVICLE, WITH MUSCLE ATTACHMENTS.

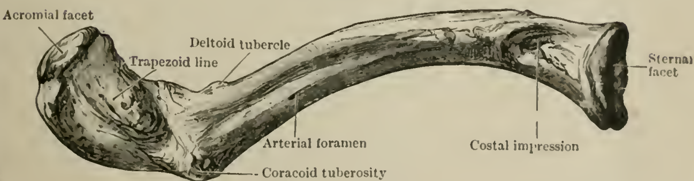


FIG. 18*a*.—RIGHT CLAVICLE AS SEEN FROM BELOW.

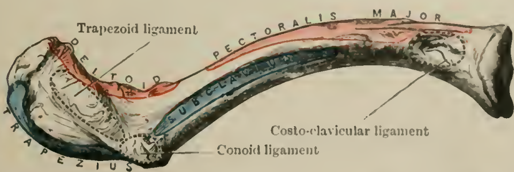


FIG. 18*b*.—THE UNDER SURFACE OF THE RIGHT CLAVICLE, WITH MUSCLE ATTACHMENTS.

The superior border is a continuation of the posterior border of the lateral third of the bone. It ends medially at the upper angle of the sternal extremity. It separates the anterior and posterior surfaces and gives attachment to the sterno-mastoid.

The posterior or subclavian border extends from the coracoid tuberosity to the costal tubercle. It separates the posterior and inferior surfaces and forms the posterior boundary of the subclavian groove, into which the subclavius muscle is inserted

The anterior surface lies between the anterior and superior borders. Its lateral part presents a smooth, convex surface, which is directed upwards and is confluent with the superior surface of the lateral third of the bone. It is only covered by the platysma muscle. Its medial part gives attachment, above, to the sternocleido-mastoid, and below this, to the pectoralis major muscle.

The posterior or cervical surface is bounded, above, by the superior border; below, by the posterior or subclavian border, and extends from the coracoid tuberosity to the margin of the sternal extremity. It presents a smooth surface and gives attachment to part of the sterno-hyoid muscle near its sternal end.

The inferior or subclavian surface lies between the anterior and posterior or subclavian borders. It is continuous with the inferior surface of the lateral third of the bone. It is marked at its sternal end by a rough impression, the *costal tubercle*, for the attachment of the costo-clavicular ligament. More laterally is a groove which extends almost to the coracoid tubercle, into which the subclavius muscle is inserted.

The sternal extremity is triangular in form. It rests upon the meniscus of fibro-cartilage which lies between it and the clavicular facet on the upper and lateral angle of the manubrium sterni. It also rests upon part of the medial end of the first costal cartilage. Its articular surface is slightly convex vertically and concave in the antero-posterior direction. The edge of the articular surface is roughened on its anterior and posterior sides and below it is smooth and rounded.

The acromial extremity is marked by an oval facet, for articulation with the acromion of the scapula. The margins of this facet give attachment to the capsule of the joint.

The Scapula

The Scapula is a triangular, thin, flat bone, and forms the back part of the shoulder girdle. It has two surfaces, ventral or costal, and dorsal; three margins, superior, axillary, and vertebral; and three angles, medial, inferior, and lateral.

The ventral *or* **costal surface** is concave and forms the subscapular fossa. It is marked by three or four ridges which run obliquely upwards towards the neck of the bone and give attachment to the tendinous intersections of the subscapularis muscle. A rounded, well-marked ridge of bone extends downwards from the neck towards the inferior angle, and this, together with the floor of the fossa, gives attachment to the fleshy fibres of the subscapularis. The ventral surface is bounded medially by the anterior edge of the vertebral margin, which gives attachment to the serratus anterior. The triangular areas on the ventral aspects of the medial and inferior angles also give attachment to this muscle.

The dorsal surface is divided into two fossæ by a prominent process of bone, of triangular form, called the *spine*. The fossa above the spine is called the *supra-spinous fossa*. It has a curved surface and gives attachment to the supraspinatus muscle.

The fossa below the spine, larger than the above, is called the *infraspinous fossa*. The greater part of this surface provides attachment for the infraspinatus muscle.

From a point on the vertebral border, about an inch above the inferior angle, a ridge extends upwards and laterally, on the dorsal aspect of the bone, to the lower part of the glenoid cavity. This ridge gives attachment to the aponeurosis, which divides the infraspinatus muscle from the teres major and minor. The area between it and the axillary margin gives attachment in its upper two-thirds to the teres minor and in its lower third to the teres major.

An oblique line extending between the axillary margin and the ridge gives attachment to the aponeurosis, which separates the teres major and minor. Sometimes a few fibres of the latissimus dorsi take their origin from the dorsal aspect of the inferior angle.

The spine extends across the upper part of the dorsum of the bone. It is directed obliquely laterally and somewhat upwards from the vertebral margin towards the posterior edge of the glenoid cavity. It is separated from the latter by the *great scapular notch*, which affords communication between the supra- and infraspinous fossæ and gives passage to the transverse scapular artery and suprascapular nerve. It ends in the *acromion*, which overhangs the glenoid cavity.

The spine has two surfaces and three borders.

The superior surface is directed upwards. It is concave and enters into the formation of the supraspinous fossa. It gives attachment to part of the supraspinatus. The *inferior surface* is concave and is directed downwards. It enters into the formation of the infraspinous fossa and affords attachment to part of the infraspinatus.

The anterior border is attached to the back of the body of the bone.

The posterior border or *crest* of the spine is lipped at its superior and inferior

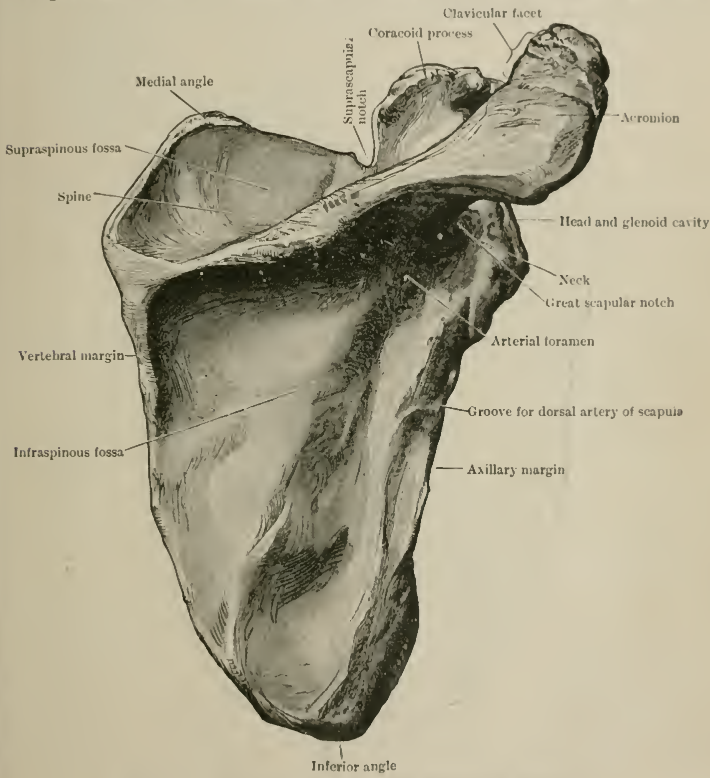


FIG. 19*a*.—THE RIGHT SCAPULA AS SEEN FROM BEHIND.

edges for the attachment respectively of the trapezius and deltoid muscles. The interval between the edges is subcutaneous and varies in breadth. Medially the posterior border displays a smooth triangular surface where it becomes confluent with the vertebral margin. The tendon of the trapezius muscle passes over this triangular surface.

The lateral border or *base* of the spine forms the medial boundary of the great scapular notch. It is confluent above with the inferior surface of the acromion and below with the neck of the scapula.

The acromion is a compressed process which arches laterally forwards and upwards and overhangs the glenoid cavity. Its *superior surface*, rough and subcutaneous, is directed upwards, backwards, and outwards. Its *inferior surface* is smooth.

Its *lateral margin* gives attachment to the deltoid muscle.

Its *medial margin* gives attachment to part of the trapezius. It is concave and is marked by a small oval facet for articulation with the acromial end of the clavicle.

The point at which the external and internal margins meet is called the *apex*. It gives attachment to the coraco-acromial ligament.

The superior margin of the *scapula* is thin and sharp. It extends from the medial (O.T. superior) angle towards the root of the coracoid process, from which it is separated by the suprascapular notch. This notch is converted into a foramen by the transverse ligament and transmits the suprascapular nerve. The posterior belly of the omo-hyoid is attached to the superior margin close to the suprascapular notch.

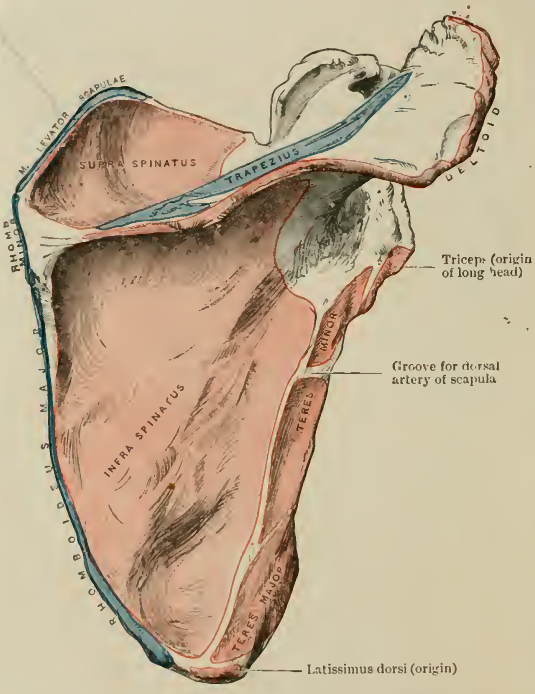


FIG. 19*b*.—MUSCLE ATTACHMENTS TO THE SCAPULA (Posterior Aspect).

The axillary or **lateral margin**, thicker than either of the others, extends between the lower part of the glenoid cavity and the inferior angle. A rough impression, the *infraglenoid tubercle*, lies immediately below the glenoid cavity and gives attachment to the long head of the triceps. Below this the margin is usually crossed by a groove for the dorsal artery of the scapula.

The vertebral or **medial margin** is the longest of the three, and extends between the medial and the inferior angles. It is irregular in outline and displays an anterior and posterior lip and an interspace.

The anterior lip gives attachment to the serratus anterior. *The interspace* affords attachment to the levator scapulæ, rhomboideus minor, and rhomboideus major. *The posterior lip* limits the attachment of the supraspinatus above and the infraspinatus below the spine.

The medial angle of the scapula is that formed by the junction of the superior and vertebral margins. It gives attachment to some fibres of the levator scapulae.

The inferior angle is formed by the junction of the axillary and vertebral margins. It gives attachment, not infrequently, to some fibres of the latissimus dorsi.

The lateral angle or **head** of the scapula is the thickest part of the bone. It supports the *glenoid cavity* and the *coracoid process*. The glenoid cavity articulates with the head of the humerus. Its border gives attachment to the glenoid ligament,

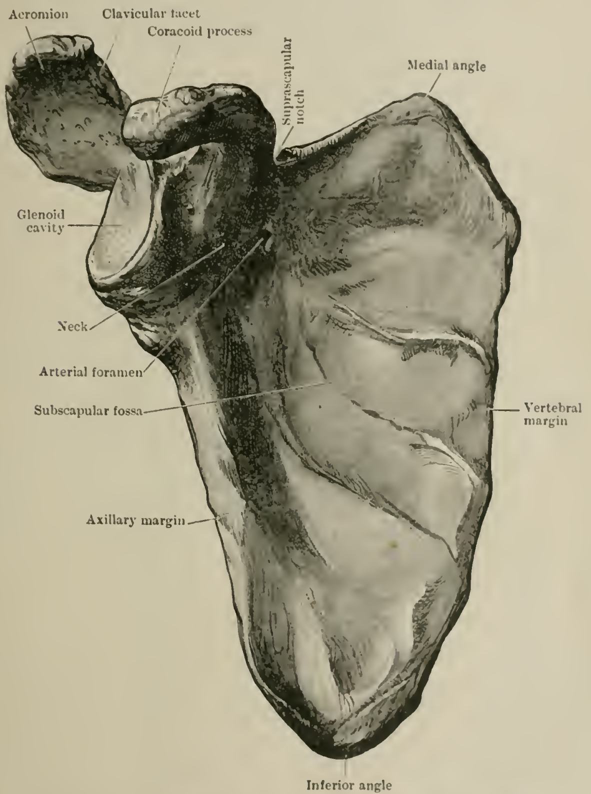


FIG. 20*a*.—THE RIGHT SCAPULA AS SEEN FROM THE FRONT.

which helps to deepen the cavity. Confluent with the apex or upper part of the margin of the cavity is the *supraglenoid tubercle*, which gives attachment to the long head of the biceps muscle.

The coracoid process rises from the upper part of the head of the scapula. It is directed at first upwards, then laterally and forwards, so that it overhangs the glenoid cavity. Its *upper surface* gives attachment, near the suprascapular notch to the conoid ligament, and, more laterally, and slightly in front of this, is a ridge for the trapezoid ligament. Its *posterior border* gives attachment to the coraco-acromial ligament. Attached to its extremity is the conjoined origin of the biceps and coraco-brachialis. Its *anterior border* gives attachment to the pectoralis minor.

The neck of the scapula is the constricted part of the bone supporting the head. The scapula articulates with the clavicle and humerus (Figs. 19 and 20).

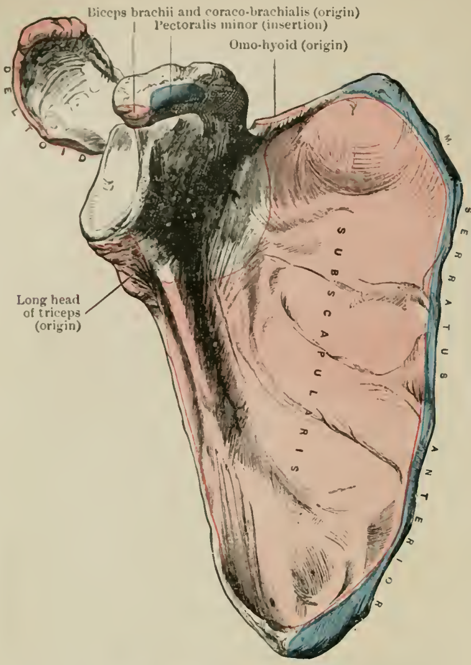


FIG. 20*b*.—MUSCLE ATTACHMENTS TO THE SCAPULA (Anterior Aspect).

The Humerus

The Humerus, like all the other long bones, consists of a central portion or shaft and two expanded extremities.

The proximal extremity consists of the head, the anatomical neck, and the larger and smaller tubercles.

The head is hemispherical, smooth, and is covered by articular cartilage. It is directed upwards, medially, and somewhat backwards, and articulates with the glenoid cavity of the scapula.

The anatomical neck is the constricted portion of the bone which separates the head from the tubercles, and gives attachment to the capsule of the shoulder joint.

The larger tubercle lies on the lateral side of the head and smaller tubercle, from which latter it is separated by a deep groove, called the *intertubercular groove.* It is marked by three facets. The highest of these gives insertion to the supraspinatus, the middle to the infraspinatus, and the lowest to the teres minor.

The small tubercle forms a marked prominence in front of the lateral half of the head. It is marked above and in front by an impression for the insertion of the subscapularis muscle.

The surgical neck is that narrower part of the bone just distal to the tubercles. It is so called because it is at this place that the bone is very liable to fracture.

The intertubercular groove extends distally and slightly medially between the great and small tubercles. It lodges the tendon of the long head of the biceps muscle and also gives attachment to the latissimus dorsi.

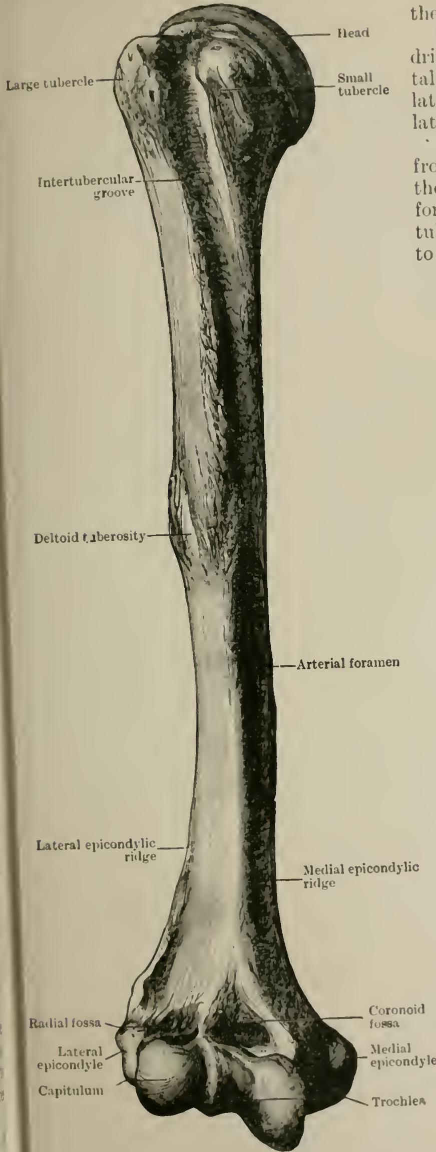


FIG. 21*a*.—ANTERIOR VIEW OF THE RIGHT HUMERUS.

The shaft of the humerus is cylindrical in form proximally, flattened distally. It has three borders, anterior, lateral, and medial; and three surfaces, lateral, medial, and posterior.

The anterior border extends distally from the front of the great tubercle to the coronoid fossa. Its proximal part forms the lateral lip of the intertubercular groove and gives attachment to the pectoralis major. Its distal part

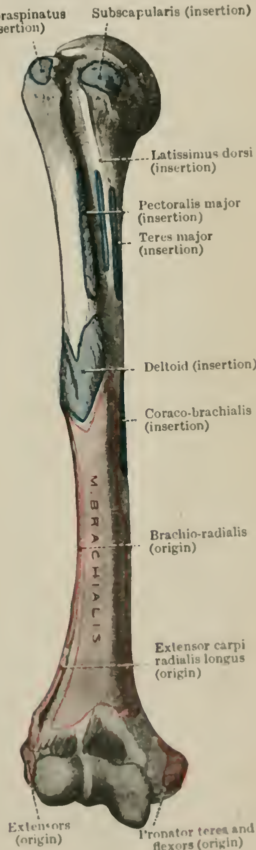


FIG. 21*b*.—THE ANTERIOR ASPECT OF THE HUMERUS, WITH MUSCLE ATTACHMENTS.

gives attachment to the brachialis. The central portion limits the attachment of the deltoid muscle in front. This border separates the lateral and medial surfaces.

The lateral border extends from the back of the great tubercle proximally to the lateral epicondyle distally, and separates the lateral and posterior surfaces. It gives attachment, in its upper part, to the distal fibres of insertion of the teres minor, and distal to this to the origin of the lateral head of the triceps. About half-way down it is crossed by the *radial groove.* This groove crosses the bone obliquely behind, passing distally and laterally, and then winding forwards round the lateral side of the bone just below

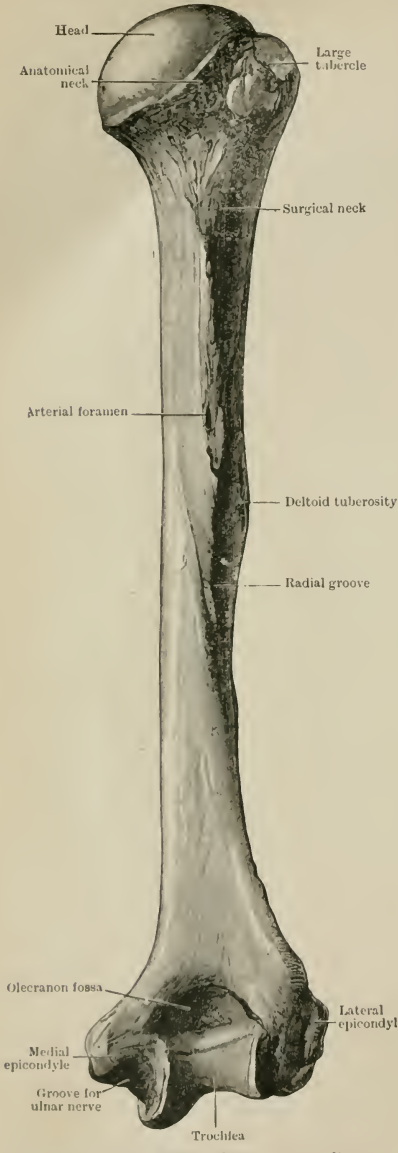


FIG. 22*a*.—POSTERIOR VIEW OF THE RIGHT HUMERUS.

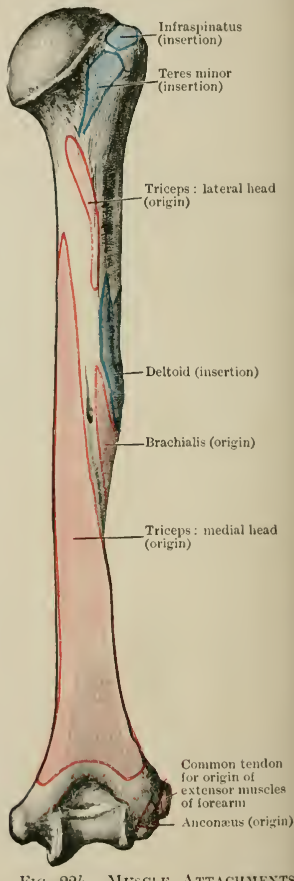


FIG. 22*b*.—MUSCLE ATTACHMENTS TO THE BACK OF THE RIGHT HUMERUS.

the deltoid tuberosity. It contains the radial nerve and the profunda brachii artery. The distal part of the lateral border forms the lateral margin. This is a prominent rough ridge with lipped edges and an interspace. The anterior lip gives attachment in its proximal two-thirds to the origin of the brachio-radialis, and in its distal third to the extensor carpi radialis longus. The posterior lip affords attachment to the medial head of the triceps, and the interspace to the lateral intermuscular septum.

The medial border extends from the small tubercle proximally to the medial margin. It separates the medial and posterior surfaces. Its proximal third forms the medial lip of the intertubercular groove and gives attachment to the teres major. About half-way down is an impression which marks the insertion of the coraco-brachialis. The distal third of this border forms the medial margin, which has an anterior and posterior lipped edge and an interspace.

The anterior lip gives origin to the brachialis and pronator teres, the posterior lip to the medial head of the triceps, and the intermediate surface affords attachment to the medial intermuscular septum.

The lateral surface lies between the anterior and lateral borders. It is covered by the deltoid muscle proximally. About the centre of this surface is a rough elevation, the *deltoid tubercle*, which gives insertion to the deltoid. The *radial groove* lies obliquely below this, and more inferiorly origin is given to part of the brachialis muscle.

The medial surface lies between the medial and anterior borders. Its proximal part forms the floor of the intertubercular groove, where attachment is given to the latissimus dorsi. A slightly roughened area about the middle of this surface gives insertion to the coraco-brachialis. The distal part gives origin to the brachialis.

The posterior surface lies between the medial and lateral borders. It gives origin in its proximal and lateral part to the lateral head of the triceps, and in its medial and posterior part to the medial head of that muscle. The radial groove separates the two heads.

The distal extremity of the humerus consists of two articular surfaces separated from each other by a shallow groove. The lateral surface articulates with the radius and is called the *capitulum* of the humerus. The medial or *trochlear* surface fits into the semilunar notch of the ulna. On either side of these articulating surfaces are the *lateral* and *medial epicondyles*.

Above the trochlea, in front, is a depression called the *coronoid fossa*, into which the coronoid process of the ulna fits when the forearm is flexed. On the front of the bone just above the capitulum is a shallow depression, the *radial fossa*, which receives the anterior margin of the head of the radius when the forearm is fully flexed. Above the trochlea behind is a larger depression, called the *olecranon fossa*, which receives the olecranon of the ulna when the elbow is extended.

The superior margins of the coronoid and radial fossæ give attachment to the anterior part of the capsule of the elbow joint. The proximal border and lateral edges of the olecranon fossa give attachment to the posterior ligament of the joint.

The medial epicondyle is larger and more prominent than the lateral. It affords attachment to the ulnar collateral ligament and to the pronator teres and the superficial muscles of the forearm.

The lateral epicondyle gives attachment to the radial collateral ligament and to the common tendon of origin of the extensor muscles.

The humerus articulates with the scapula, ulna, and radius (Figs. 21 and 22).

The Ulna

The Ulna is the medial bone of the forearm and consists of a shaft and two extremities.

The proximal extremity is strong and thick. It supports two processes, the *olecranon* behind, which forms the point of the elbow, and the *coronoid* in front.

The olecranon is situated at the proximal and posterior part of the ulna. Its posterior surface, triangular in shape, is smooth and subcutaneous, and is covered by a bursa. Its superior surface affords insertion to the triceps, and the anterior border of the process gives attachment to the posterior ligament, and to part of the ulnar collateral ligament of the elbow joint. Its anterior surface is smooth and concave, and enters into the formation of the semilunar notch. The medial margin gives origin to part of the flexor carpi ulnaris.

The coronoid process projects forwards from the proximal and anterior part of the shaft. Its superior surface is smooth and concave, and enters into the formation of the semilunar notch. Its inferior surface is rough, slopes backwards and distally, and becomes continuous with the front of the shaft. It affords attachment to the brachialis and to the anterior ligament of the elbow joint. At its distal extremity there is an eminence, the *tubercle* of the ulna, which gives attachment to part of the brachialis and to the oblique ligament.

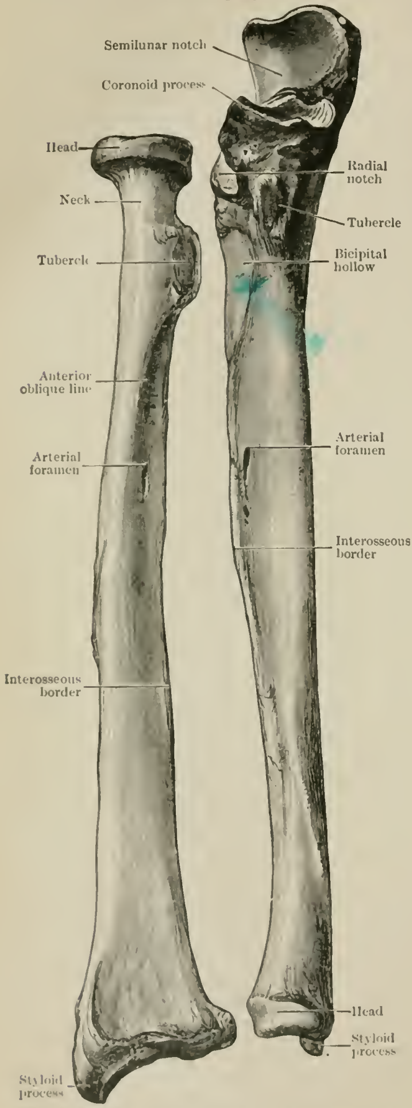


FIG. 23*a*.—THE RIGHT RADIUS AND ULNA AS SEEN FROM THE FRONT.

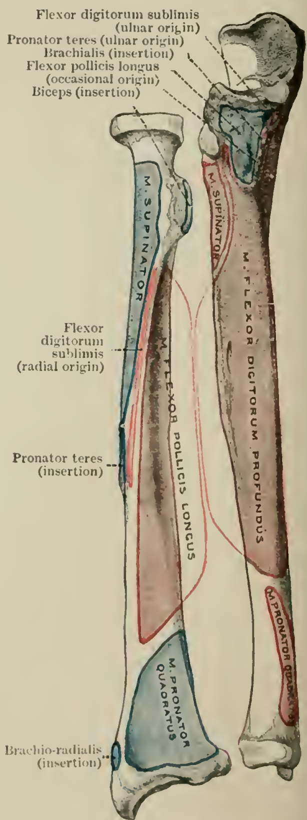


FIG. 23*b*.—THE RIGHT RADIUS AND ULNA, WITH THEIR MUSCLE ATTACHMENTS (Anterior Aspects).

The margin of the medial surface of the coronoid process gives attachment to part of the ulnar collateral ligament. The anterior part of this surface is usually marked by a tubercle which gives origin to one of the heads of the flexor sublimis digitorum. Behind this attachment is given to part of the origin of the flexor

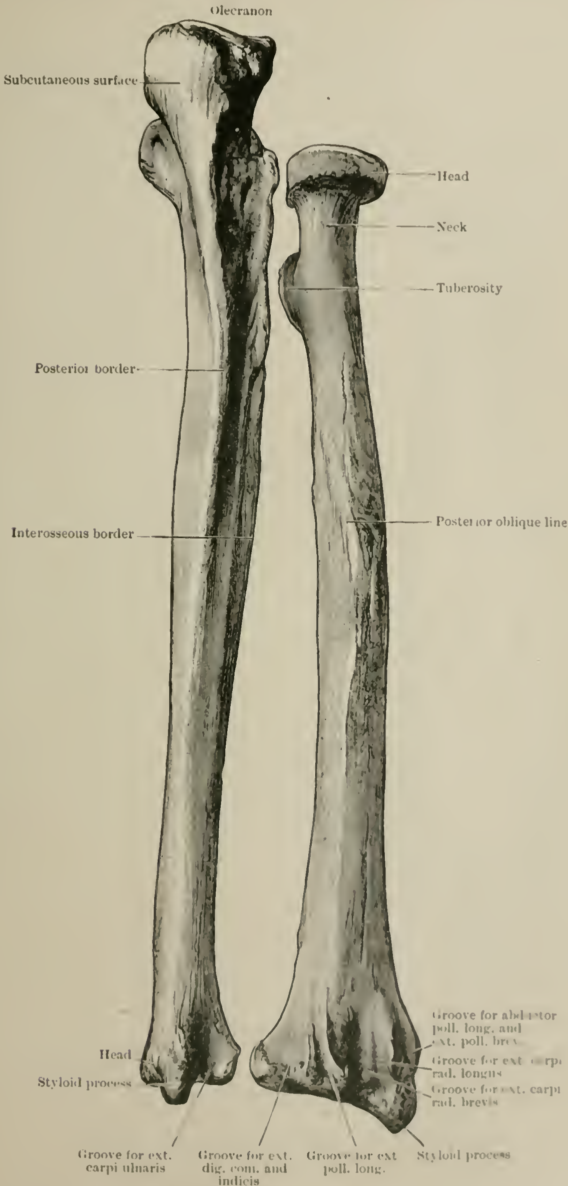


FIG. 24a.—THE RIGHT RADIUS AND ULNA AS SEEN FROM BEHIND.

profundus digitorum. Below the tubercle the medial surface furnishes origins for the pronator teres and sometimes for the flexor pollicis longus.

The semilunar notch is the large cavity which is formed by the anterior surface of the olecranon and the proximal surface of the coronoid process. It articulates with the trochlear surface of the humerus.

The radial notch is situated on the lateral side of the coronoid process and is for articulation with the head of the radius. The annular ligament of the radius is attached to its anterior and posterior margins.

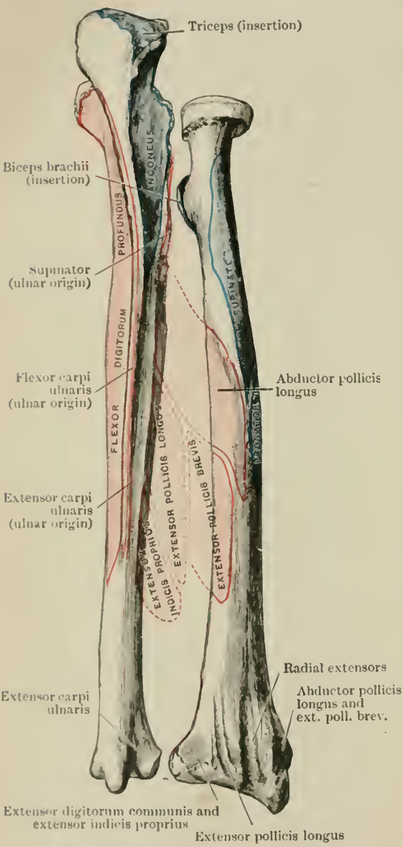


Fig. 24*b*.—The Right Radius and Ulna, with their Muscle Attachments (Posterior Aspects).

The shaft has three borders, volar, dorsal, and interosseous; and three surfaces, volar, dorsal, and medial.

The volar border extends distally from the medial angle of the coronoid process to the styloid process, and separates the volar from the medial surface. It provides origin for the flexor profundus digitorum in its proximal three-fourths, and for the pronator quadratus in its distal fourth.

The dorsal border extends between the triangular subcutaneous surface on the back of the olecranon proximally and the posterior surface of the styloid process below. It separates the dorsal from the medial surface. It is well defined above but becomes faint and rounded below. It gives attachment to the aponeurosis common to the flexor carpi ulnaris, extensor carpi ulnaris, and flexor profundus digitorum.

The interosseous border extends distally, from the junction of the two lines which enclose the triangular space distal to the radial notch, to the head of the ulna. It is well defined and sharp in its proximal three-fourths, but becomes rounded in its lower fourth. It separates the volar from the dorsal surface and gives attachment to the interosseous membrane. The triangular depression distal to the radial notch gives attachment to the supinator muscle. It is called the bicipital hollow, as it supports the bicipital tubercle when the forearm is pronated.

The volar surface lies between the volar and the interosseous borders. It gives origin to the flexor profundus digitorum in its proximal three-fourths, and to the pronator quadratus in its distal fourth. A ridge called the *oblique* or *pronator ridge* limits the attachment of the pronator quadratus proximally.

The dorsal surface is included between the dorsal and interosseous borders. An oblique ridge runs distally from about an inch below the posterior edge of the radial notch towards the dorsal border. The triangular surface proximal to this line affords attachment to the anconaeus. The supinator obtains its ulnar origin from the proximal part of the oblique line.

Below the triangular area the dorsal surface is subdivided by a faintly marked longitudinal ridge. The medial half presents a smooth surface covered by the extensor carpi ulnaris. The lateral half gives origin, from above distally, to the abductor pollicis longus, extensor pollicis longus, and extensor indicis proprius.

The medial surface gives origin in its proximal three-fourths to the flexor profundus digitorum and is subcutaneous below.

The distal extremity of the ulna consists of a round *head*, from the medial and posterior portion of which projects the *styloid process*.

The distal surface of the head rests upon the superior surface of the triangular fibro-cartilage of the wrist joint. The lateral part of the circumference of the head articulates with the ulnar notch of the radius.

The distal surface of the head is separated from the root of the styloid process by a depression which gives attachment to the apex of the triangular fibro-cartilage of the wrist joint. A groove on the lateral and posterior surface of the styloid process separates it from the posterior surface of the head, and lodges the tendon of the extensor carpi ulnaris.

The ulnar collateral ligament is attached to the extremity of the styloid process.

The ulna articulates with the humerus and radius.

The Radius

The Radius is the lateral bone of the foramen, and lies parallel with the ulna. It presents for examination a shaft and two extremities.

The proximal extremity consists of a head, a neck, and a tubercle.

The head is button-shaped, with a slightly concave surface superiorly for articulation with the capitulum of the humerus. The circumference of the head is smooth, and on its medial side has a broad articular surface for the radial notch of the ulna, within which it rotates in movements of pronation and supination. It is encircled by the annular ligament of the radius.

The neck is the constricted portion of the bone distal to the head. It gives insertion behind to part of the supinator muscle.

The radial tubercle lies distal to the neck on the medial side of the bone. The rough, posterior portion of this tubercle gives insertion to the tendon of the biceps. The anterior part is smooth and is covered by a bursa.

The shaft has three borders, volar, dorsal, and interosseous; and three surfaces, volar, dorsal, and lateral.

The volar border extends distally from the radial tubercle to the front of the base of the styloid process. It separates the volar and the lateral surfaces. The upper part of this line is sometimes called the *anterior oblique line*, from the obliquity of its direction distally and laterally. It gives attachment to the radial origin of the flexor digitorum sublimis, and laterally it limits the insertion of the supinator muscle; distally and medially it limits the origin of the flexor pollicis longus. At the distal extremity of the border there is a small *tubercle* which gives attachment to the tendon of insertion of the brachio-radialis.

The dorsal border extends distally from the posterior aspect of the neck to the back of the base of the styloid process. It separates the dorsal and lateral surfaces. It is only in its middle third that it is distinctly defined.

The interosseous border extends distally from the back of the tubercle. It is indistinct above, but becomes prominent and sharp in the middle third of the bone. Below this it divides into two faintly marked lines which extend downwards to the anterior and posterior margins of the ulnar notch. The triangular area formed by these lines gives attachment to part of the insertion of the pronator quadratus. This border separates the volar and dorsal surfaces and gives attachment to the interosseous membrane.

The volar surface lies between the volar and interosseous borders. It provides an extensive area, extending to the distal limit of the middle third of the bone, for the origin of the flexor pollicis longus. The distal fourth of this surface is broad and flat and gives insertion to the pronator quadratus.

The dorsal surface is situated between the dorsal and the interosseous borders. It is overlaid by the supinator in its proximal third. It gives origin to the abductor pollicis longus in its middle third—the upper limit of attachment of this muscle being defined by the posterior oblique line. Below this the dorsal surface affords attachment to the extensor pollicis brevis.

The lateral surface lies between the volar and the dorsal borders. It is rounded proximally and becomes more prominent and thinner distally. It gives attachment to the insertion of the supinator muscle, in its upper third. About the middle a rough impression marks the insertion of the pronator teres. Inferiorly this surface is covered by the tendons of the abductor pollicis longus and extensor pollicis brevis.

The distal extremity has two articular surfaces—*the carpal articular surface* on the distal aspect of the bone, and *the ulnar notch* on its medial side, which receives the head of the ulna.

The carpal articular surface is concave and divided into two parts by a slight antero-posterior ridge. The lateral part is triangular in shape and articulates with the navicular bone; the medial part is quadrilateral and articulates with the lunate bone. The ulnar notch and the carpal articular surface are separated from each other by a ridge to which is attached the base of the triangular fibro-cartilage. The *anterior border* of the distal extremity is rough and prominent, and gives attachment to the volar radio-carpal ligament. The *posterior border* gives attachment to the dorsal radio-carpal ligament and is grooved for the transmission of tendons. These grooves may be described as follows, in order from the medial to the lateral side of the bone: The first is broad and shallow, for the tendons of the extensor digitorum communis and extensor indicis proprius. The second is well marked, and passes obliquely distally and laterally. It transmits the tendon of the extensor pollicis longus. The third is broad and is subdivided by a slight ridge into two parts; the medial part transmits the tendon of the extensor carpi radialis brevis, and the lateral part the tendon of the extensor carpi radialis longus.

The styloid process is the cone-shaped prolongation of the lateral surface of the distal extremity of the radius. Its *lateral surface* is marked by a shallow groove which transmits the tendons of the abductor pollicis longus and extensor pollicis brevis. The tendon of the brachio-radialis is attached to either lip of this groove. The radial collateral ligament is attached to the apex of the styloid process.

The radius articulates with the humerus, ulna, navicular, and lunate bones.

The Carpus

The Bones of the Wrist or Carpus are eight in number, arranged in two rows: those in the proximal row from the radial to the ulnar border are **the navicular, lunate. triquetral, and pisiform**; those in the distal row, in the same order, are the **greater multangular, the lesser multangular, the capitate, and the hamate.** With one exception, the pisiform, the carpal bones have six surfaces. *The dorsal and volar surfaces* are non-articular and are rough for the attachment of ligaments. *The lateral surface* of the greater multangular and the navicular, and the *medial surface* of the triquetral, hamate, and pisiform, are also non-articular. The bones of the carpus articulate with each other and collectively form a sort of arch, convex dorsally and concave anteriorly from side to side. The pisiform bone and the hook of the hamate medially, and the prominent ridge of the greater multangular and the tuberosity of the navicular bone laterally, serve to deepen the cavity. The volar carpal ligament is attached to these prominences on either side, and forms an arch under which the flexor tendons of the fingers and the median nerve pass. *The proximal surfaces* of the navicular and lunate bones articulate with the radius. *The distal surfaces* of the distal row of carpal bones articulate with the metacarpal bones.

The Metacarpus

The Metacarpal Bones are five in number, forming the skeleton of the palm. They consist of a shaft and two extremities.

The carpal extremity, or **base** of each, articulates with the carpal bones. Their **digital extremities** or **heads** articulate with the first phalanges of the fingers. The *second, third, fourth,* and *fifth metacarpal bones* articulate by their bases with each other, and are connected together at their phalangeal extremities by ligaments.

The shafts are separated from each other by the interosseous spaces. They are convex posteriorly and concave anteriorly, and have three *surfaces,* two *lateral* and one *dorsal.* A prominent ridge, on the anterior surface of the bone, separates the lateral surfaces from each other. These surfaces are grooved for the origins of the interosseous muscles. The dorsal surface presents a smooth triangular area which is overlaid by the tendons of the extensor muscles.

The digital extremity or **head** has a convex surface for articulation with the

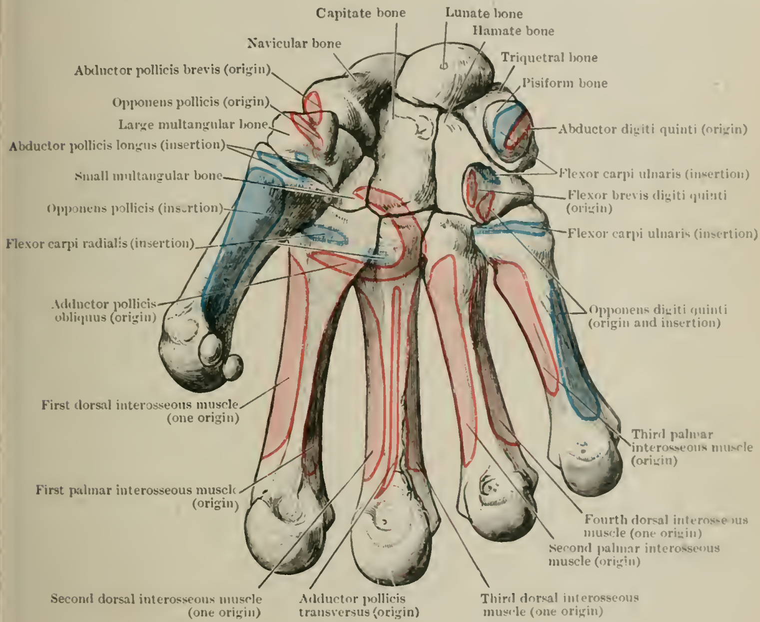


Fig. 25.—The Palmar Aspect of the Carpus and Metacarpus, with Muscle Attachments.

proximal phalanx of the finger. It is notched on its *volar aspect* for the transmission of the flexor tendons. Its *dorsal surface* is flat and is overlaid by the extensor tendons. On either side of the head is a *tubercle* to which is attached the collateral ligament of the metacarpo-phalangeal joint.

The Phalanges

The Phalanges are the finger bones. They are fourteen, three for each finger and two for the thumb.

The proximal extremity of each bone in the **first phalanx** has an oval, concave surface for articulation with the corresponding metacarpal bone. On either side of this is a rough surface for the attachment of the collateral ligaments of the metacarpo-phalangeal joints and of the interosseous muscles. *The dorsal surface* of **the shaft** is convex and supports the extensor tendons. *The volar surface* is flat and is marked on either side by two borders which afford attachment to the sheath of the flexor muscles. The shaft becomes smaller towards its **distal extremity**, where it articulates with the second phalanx.

The second phalanx is smaller than the first. The divided tendon of the flexor digitorum sublimis is attached to the margin on either side of its *volar surface*, near **the proximal end** of the bone, and the central tendon of the extensor digitorum communis is attached to its *dorsal surface*, near the same extremity.

The third, or **terminal, phalanx** is smaller than either of the others. It affords insertion *anteriorly* and near its **proximal end** to the tendon of the flexor digitorum profundus, and *dorsally*, near the same extremity, it gives insertion to the terminal part of the tendon of the extensor digitorum communis.

Sesamoid Bones.—Small sesamoid bones are often found lodged in the tendons and ligaments of the metacarpo-phalangeal articulations of the hand, on the palmar surface, most frequently in the first, second, and last of these articulations.

BONES OF THE LOWER EXTREMITY

The Os Coxæ

The Os Coxæ or hip bone is large, flat, and of irregular shape. In a young child it consists of three distinct portions, called the ilium, the ischium, and the pubis; but as the growth of the subject proceeds these parts become united in one.

The acetabulum is a deep, circular depression on the outer side of the bone, for the reception of the head of the femur. It is formed by portions of the ilium, the ischium, and the pubis, and fusion between these three parts takes place within and about it. It has a prominent margin to which the glenoid lip is attached, which also serves for the attachment of the capsule of the hip joint. The lower part of the margin displays a deep notch, *the acetabular notch*, whose edges give attachment to the ligamentum teres of the femur and to the transverse ligament. The latter stretches across the notch, thus converting it into a foramen for the transmission of vessels and nerves. Continuous with the notch above is *the acetabular fossa*, a rough depression at the bottom of the acetabulum, which lodges a large mass of fat. Around this area is the articular surface.

The obturator foramen is the large opening which lies below, and medial to, the acetabulum. It is bounded in front and above by the pubis, and behind and below by the ischium. It presents above and in front *the obturator groove*. This is converted into a canal for the passage of the obturator vessels and nerve by a ligamentous band which extends between the tubercles usually found on either side of and below the groove. The margin of the obturator foramen is thin, for the attachment of the obturator membrane which stretches across the aperture from side to side.

The Ilium is that larger part of the bone which lies above the acetabulum, and may be described as having a crest, an anterior and posterior border, and a lateral and medial surface.

The crest or superior curved border of the ilium terminates at either end in the *anterior* and *posterior superior iliac spines*, two projections which mark its junction with the anterior and posterior borders respectively. The crest presents for examination an external and internal lip and an intermediate space. *The external lip* is marked by a tubercle situated about 2½ inches from its anterior extremity. It gives attachment to the tensor fasciæ latæ, obliquus externus abdominis, latissimus dorsi, and the fascia lata (the deep fascia of the thigh). *The internal lip* gives attachment to the transversus abdominis, quadratus lumborum, sacro-spinalis, and iliacus. *The intermediate space* affords attachment to the obliquus internus abdominis.

The anterior border of the ilium extends from the anterior superior iliac spine above to the margin of the acetabulum below. The *anterior superior iliac spine* gives attachment laterally to the fascia lata and tensor fasciæ latæ; medially to the iliacus, and anteriorly to the inguinal ligament and the sartorius. The latter muscle also gains origin from the notch below the anterior superior spine. The anterior border is marked below by a projection—*the anterior inferior iliac spine*—which gives origin to the straight head of the rectus femoris, and affords attachment to the ilio-femoral ligament of the hip joint.

The posterior border of the ilium extends from the *posterior superior iliac spine* to the *posterior inferior iliac spine*, these two projections being separated by a

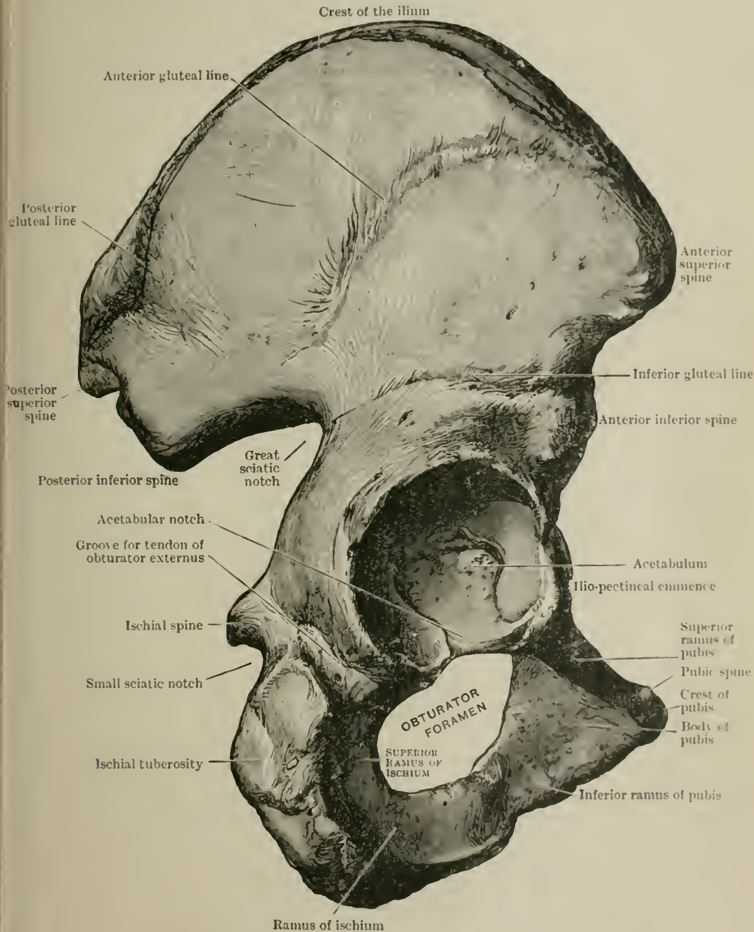


FIG. 26*a*.—THE RIGHT OS COXÆ (Outer Aspect).

notch. Below the posterior inferior iliac spine is the *greater sciatic notch* which is converted into a foramen by the sacro-spinous ligament, and transmits the piriformis, the superior and inferior gluteal vessels and nerves, the sciatic nerve, and the nerves to the obturator internus and quadratus femoris.

The lateral surface of the ilium is divided into an upper or gluteal part, called the dorsum ilii, and a lower or acetabular part.

The dorsum ilii presents an expanded, smooth surface, concave behind and convex in front. It is marked, sometimes indistinctly, by three curved lines—the posterior, the anterior, and the inferior gluteal lines.

The posterior gluteal line passes downwards and forwards from the iliac crest, about 2½ inches in front of its posterior extremity, towards the upper margin of the greater sciatic notch. The surface above and behind this line is rough and gives origin to part of the gluteus maximus. *The anterior gluteal line* leaves the iliac crest about an inch and a half behind its anterior extremity, and curves backwards and downwards to the upper part of the greater sciatic notch. The space between this and the posterior gluteal line affords origin to the gluteus medius. *The inferior gluteal line* commences above the anterior inferior iliac spine and curves backwards towards the middle of the greater sciatic notch. The area between this and the preceding line gives origin to the gluteus minimus. The

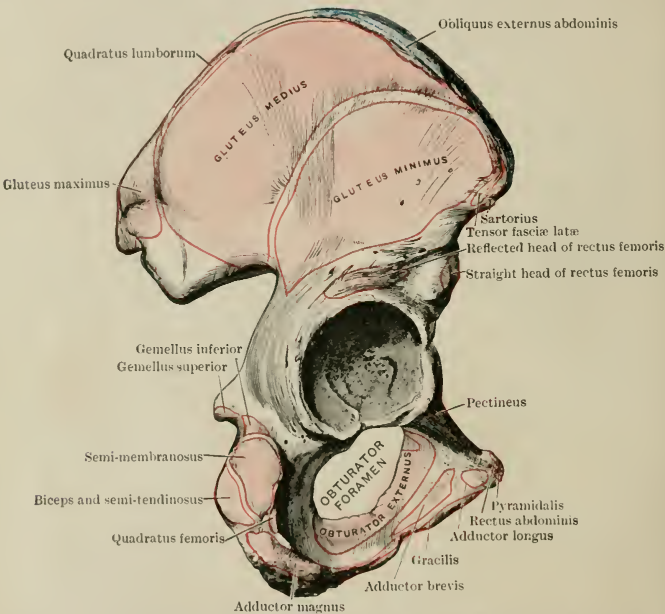


FIG. 26*b*.—THE RIGHT OS COXÆ, WITH MUSCLE ATTACHMENTS (Outer Aspect).

reflected head of the rectus femoris arises from the groove between the inferior gluteal line and the margin of the acetabulum.

The acetabular part enters into the formation of the acetabulum. It is separated from the gluteal surface by the margin of the acetabulum.

The medial surface of the ilium displays posteriorly an auricular smooth surface for articulation with the sacrum. Behind and above this is a rough elevation, *the iliac tuberosity*, which gives attachment to the posterior sacro-iliac ligaments, and, where it becomes continuous with the internal lip of the crest, to the origins of the sacro-spinalis and multifidus.

The anterior and upper portion of the medial surface is smooth and concave above where it forms the iliac fossa and gives origin to the iliacus. The lower portion forms part of the true pelvis and gives origin to some of the fibres of the obturator internus. It is separated from the iliac fossa by a ridge, *the ilio-pectineal line*, which extends obliquely downwards and forwards from the auricular surface to the medial side of *the ilio-pectineal eminence*. The latter is a prominence which is situated in front of the acetabulum and marks the point of fusion of the ilium and the pubis. The shallow groove between it and the anterior inferior iliac spine is for the lodgment of the ilio-psoas muscle.

The Ischium constitutes the lower and back part of the hip bone. It consists of a body, a tuberosity—which is that part of the bone which supports the body in

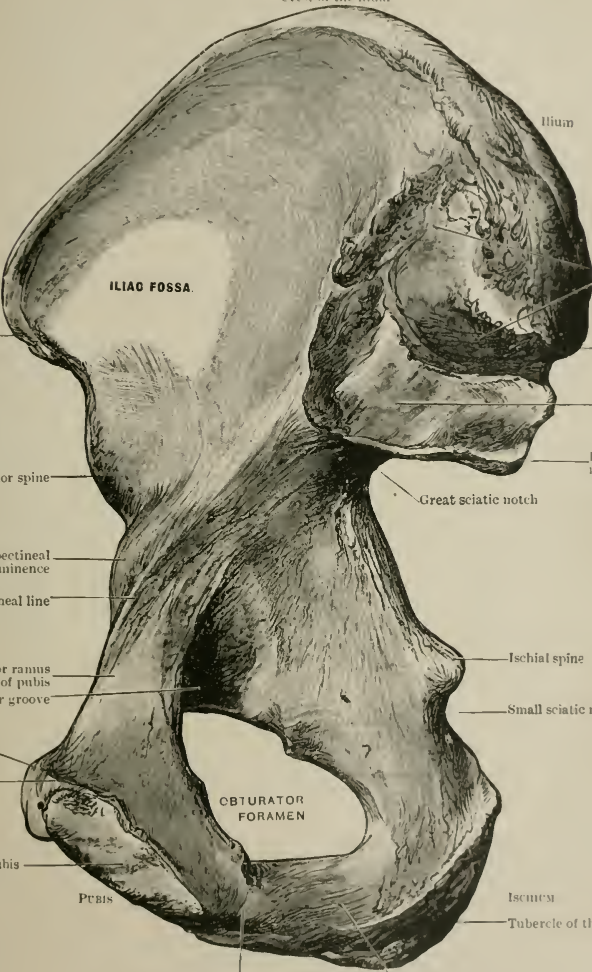


Fig. 27.—The Right Os Coxæ (Inner Aspect).

sitting—and a ramus, which is the thinner part of the bone extending upwards from the tuberosity to the point at which it becomes united to the ramus of the pubis.

The body displays a lateral, medial, and posterior surface, and a lateral, medial, and posterior border.

The lateral surface is smooth and concave, and represents that portion of the ischium which enters into the formation of the acetabulum. It is grooved just below the rim of the latter for the tendon of the obturator externus.

The medial surface is smooth and slightly concave. It forms a portion of the wall of the true pelvis and gives attachment to part of the obturator internus.

The posterior surface presents a smooth area, bounded laterally by the margin of the acetabulum, posteriorly by the posterior border, and below by the tuberosity. It is overlaid by the piriformis, gemelli, and obturator internus muscles. The groove for the tendon of the obturator externus is continued on the lower part of this surface.

The lateral border is represented by the margin of the acetabulum, and gives attachment to the glenoid lip.

The medial border forms the lateral boundary of the obturator foramen.

The posterior border, confluent above with the ilium, is marked by *the spine of the ischium*, a pointed prominence which gives attachment laterally to the gemellus superior, by its apex to the sacro-spinous ligament, and medially to the coccygeus and levator ani muscles.

Inferior to this is *the lesser sciatic notch*, which transmits the tendon of the obturator internus muscle and the obturator nerve.

The tuberosity displays a lateral, medial, and posterior surface. *The lateral surface* lies between the posterior margin of the obturator foramen and a well-defined border which separates it from the posterior surface. The groove for the tendon of the obturator externus limits it above, and below it is confluent with the ramus.

The medial surface forms part of the wall of the true pelvis.

The posterior surface is divided by an oblique ridge into two parts, the upper and lateral of which gives origin to the semimembranosus, while the lower and medial affords attachment to the long head of the biceps and to the semitendinosus. Its medial lip gives attachment to the sacro-tuberous ligament. Its lateral lip gives origin to the quadratus femoris. Below and in front origin is given to part of the adductor magnus. Above, where the tuberosity becomes confluent with the posterior surface of the body, origin is given to the gemellus inferior.

The ramus is the thin, flat part of the bone which extends upwards and medially from the tuberosity to the point at which it becomes united to the descending ramus of the pubis. Its lateral surface is rough, and gives origin to part of the obturator externus and adductor magnus. Its medial surface is smooth and forms part of the wall of the true pelvis.

The pubis constitutes the front part of the hip bone. It has a superior or ascending and an inferior or descending ramus. The body is that broader part of the bone where the two rami meet.

The body has two surfaces, anterior and posterior, and three borders, superior, medial, and lateral.

The anterior surface is rough, and gives origin to the adductor longus, to some fibres of the obturator externus, and to the adductor brevis and gracilis.

The posterior surface is smooth, and forms part of the front wall of the true pelvis. It gives origin to the levator ani.

The superior border or crest extends from the medial extremity of the bone to the pubic tubercle. It gives origin to the rectus abdominis and pyramidalis, and attachment to the conjoint tendon (falx aponeurotica) of the obliquus internus and transversus abdominis. The junction of the medial extremity of the crest with the medial border forms what is known as *the angle*.

The pubic tubercle gives attachment to the medial extremity of the inguinal ligament.

The medial border displays an oval roughened surface covered with cartilage, for articulation with its fellow of the opposite side. The joint thus formed by the pubic bones is known as *the symphysis pubis*.

The lateral border has a thin edge. It forms part of the margin of the obturator foramen and gives attachment to the obturator membrane.

The superior ramus extends upwards and laterally from the body towards the acetabulum. It has three surfaces, superior, inferior, and posterior; and a lateral extremity, which enters into the formation of the acetabulum.

The superior surface is of triangular shape and extends from the pubic tubercle to the ilio-pectineal eminence. It is bounded in front by the *obturator crest*, a ridge which extends from the pubic spine to the cotyloid notch. A line which extends upwards and laterally from the pubic tubercle and becomes continuous with the ilio-pectineal line limits the superior surface behind. It is known as the pubic portion of the ilio-pectineal line, and, together with the surface of the bone in front of it, gives origin to the pectineus.

The inferior surface is grooved at its lateral extremity for the transmission of the obturator vessels and nerve. It forms the superior boundary of the obturator foramen.

The posterior surface forms part of the anterior wall of the true pelvis.

The inferior ramus extends downwards and laterally from the lower part of the body of the pubis to unite with the ramus of the ischium. Its *anterior surface* gives origin to the gracilis, adductor brevis and magnus, and to some fibres of the obturator externus muscles. The *posterior surface* is smooth. Its *lateral border* forms part of the margin of the obturator foramen and gives attachment to the obturator membrane. Its *medial border* is thick, rounded, and everted.

The hip bone articulates with the sacrum, the femur, and with its fellow of the opposite side.

The Femur

The Femur or Thigh Bone.—This is the largest and longest bone in the body. It consists of a proximal extremity, a shaft, and a distal extremity.

The proximal extremity comprises a head, a neck, and two trochanters.

The head is globular and is directed upwards, medially, and somewhat forwards. Near its centre is a hollow, the fossa of the head of the femur, for the attachment of the round ligament of the femur.

The neck connects the head and the shaft; it is directed upwards, medially, and a little forwards, and forms with the shaft an angle of about 125°. It has two surfaces, anterior and posterior, and two borders, superior and inferior.

The anterior surface is pierced by many vascular foramina. It is separated from the shaft by the proximal part of the *intertrochanteric line*. This is a ridge which extends obliquely, distally, and medially, from the tubercle which marks the junction of the proximal and anterior part of the neck with the great trochanter, to about 2 inches distal to the lesser trochanter, where it terminates in the *linea aspera*. It gives attachment in the proximal part of its extent to the ilio-femoral ligament of the hip joint.

The posterior surface affords attachment to the posterior portion of the capsule of the hip joint. It is separated from the shaft by the *intertrochanteric crest*, which extends from the top of the great trochanter distally and medially to the small trochanter. A little above the middle of this ridge is a fulness or tubercle which indicates the proximal limit of the insertion of the quadratus femoris and is known as the *quadrate tubercle*.

The superior border is broad and short and is bounded laterally by the great trochanter.

The inferior border passes slightly backwards and terminates at the small trochanter.

The great trochanter is a large quadrangular process which marks the junction of the proximal and lateral part of the shaft with the neck. It displays a lateral and a medial surface, and superior, inferior, anterior, and posterior borders.

The lateral surface is convex and irregular in form. It is traversed by a well-marked line which passes obliquely from the posterior superior to the anterior inferior angle, and which gives attachment to the gluteus medius. Above and below this line the bone is overlaid by bursæ which are interposed between it and the tendons of the gluteus medius and maximus.

The medial surface slightly overhangs the proximal and posterior part of the neck. At its junction with the latter is the *fossa trochanterica*, a depression which gives insertion to the obturator externus. Above this is the facet for the insertion of the obturator internus and the gemelli.

The superior border separates the lateral and medial surfaces. It is curved and irregular and gives insertion to the piriformis.

The inferior border is the ridge which separates the lateral surface of the great trochanter from the lateral side of the shaft. It affords origin to the proximal part of the vastus lateralis.

The anterior border extends distally and laterally from the tubercle at the proximal extremity of the intertrochanteric line. It gives insertion to the gluteus minimus.

The posterior border is rounded and forms the proximal part of the intertrochanteric crest.

The small trochanter is the cone-shaped process which projects from the back of the medial and proximal part of the shaft at its junction with the neck; it gives insertion to the ilio-psoas muscle.

The shaft is cylindrical in form. Viewed from the side it presents a forward curve. It is smooth, except at the back, which is marked by a rough longitudinal ridge, the *linea aspera*.

The shaft displays for examination three borders, medial, lateral, and posterior; and three surfaces, medial, lateral, and anterior.

The medial border extends from the spiral line, at a point level with the small trochanter, to the front of the medial condyle. It limits the attachment of the vastus intermedius (O.T. crureus) medially.

The lateral border extends from the anterior inferior angle of the great trochanter to the front of the lateral condyle.

The posterior border is represented by the linea aspera, which extends distally along the middle third of the posterior aspect of the shaft. It consists of a *medial* and a *lateral lip* enclosing a narrow, rough space. Above it diverges into three ridges; the outer of these, called the *gluteal ridge*, extends upwards towards the great trochanter and gives insertion to the gluteus maximus. The medial ridge constitutes part of the *spiral line*, and the intermediate ridge extends from the intermediate space of the linea aspera upwards to the small trochanter. It is known as the *pectineal line* and gives insertion to the pectineus muscle.

Distally the two lips of the linea aspera pass towards the *medial* and *lateral epicondyles*, forming the *medial* and *lateral epicondylic lines* and enclosing a space called the *popliteal surface*.

The medial epicondylic line displays a faintly marked groove above for the popliteal artery. It terminates distally, on the proximal and medial surface of the medial epicondyle, in the *adductor tubercle*, which gives attachment to the tendon of the adductor magnus.

The spiral line, the medial line of the linea aspera, and the medial epicondylic line give origin to the vastus medialis. The medial lip also gives insertion in its middle third to the adductor longus.

The intermediate space, the medial epicondylic line, and the adductor tubercle give insertion to the adductor magnus. Between the pectineus and the adductor longus medially and the adductor magnus laterally insertion is given to the adductor brevis.

The lateral lip of the linea aspera and the lateral epicondylic line give origin to the short head of the biceps femoris, which arises below the insertion of the gluteus maximus; more laterally they also give origin to the vastus lateralis. The vastus intermedius muscle also arises from the distal half of the lateral lip and from the proximal part of the lateral epicondylic line.

The anterior surface of the shaft lies between the lateral and the medial borders. It gives origin in its proximal two-thirds to the vastus intermedius, and in its distal fourth to the articularis genu (O.T. sub-crureus).

The lateral surface comprises that part of the shaft which lies between the lateral border and the lateral lip of the linea aspera. It gives origin in its proximal two-thirds to the vastus intermedius.

The medial surface comprises the portion which lies between the medial border and the medial lip of the linea aspera. It is overlaid by the vastus medialis.

FIG. 28.—RIGHT FEMUR AS SEEN FROM THE FRONT.

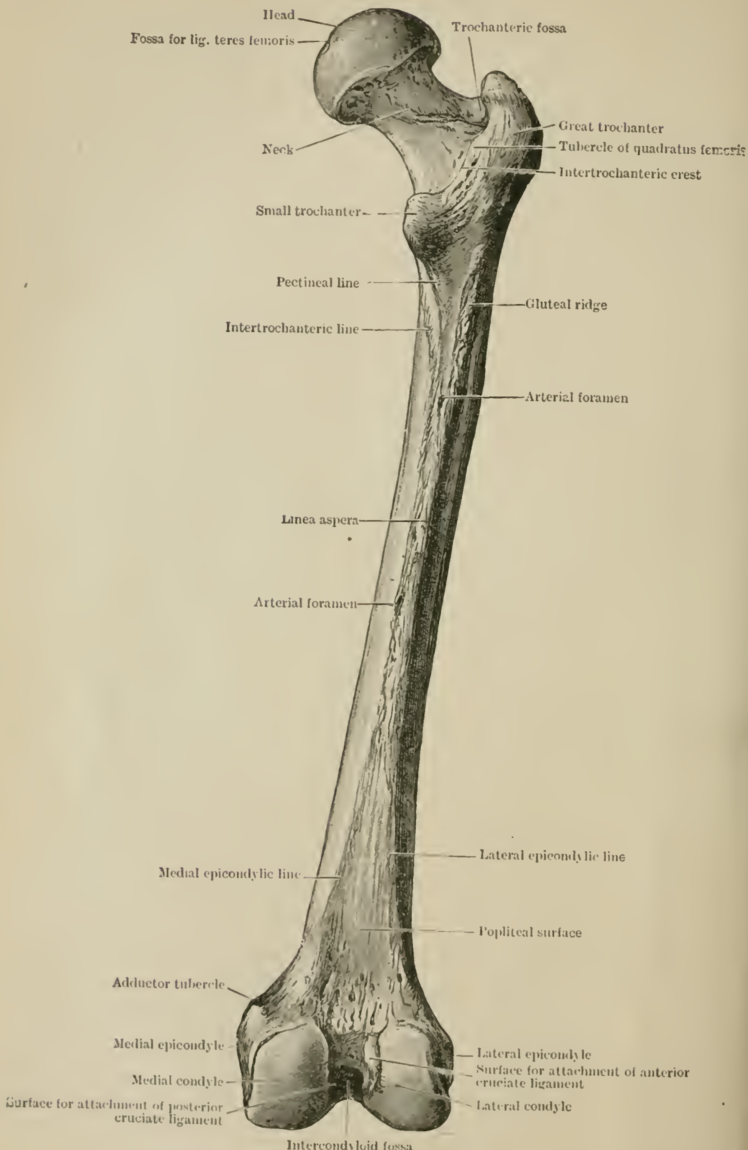


FIG. 29.—RIGHT FEMUR AS SEEN FROM BEHIND.

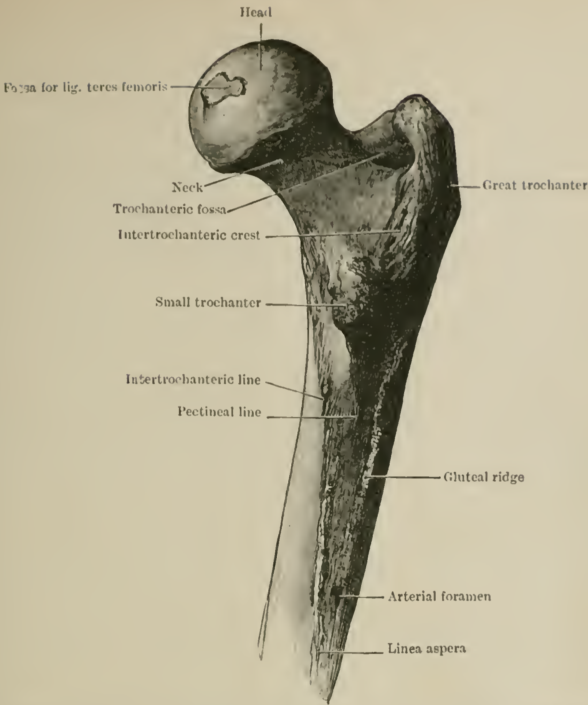


FIG. 30*a*.—POSTERIOR VIEW OF THE PROXIMAL END OF THE RIGHT FEMUR.

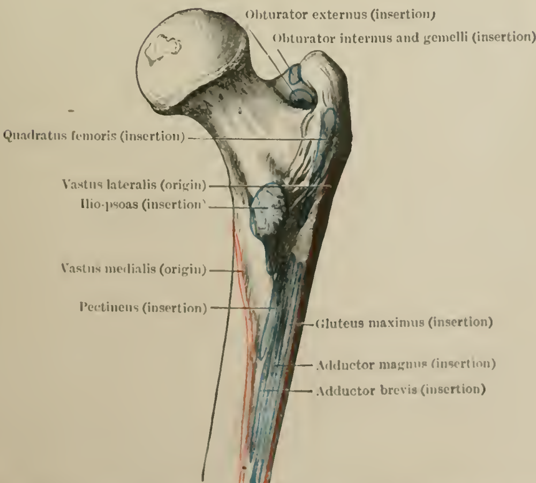


FIG. 30*b*.—POSTERIOR ASPECT OF THE PROXIMAL PORTION OF THE RIGHT FEMUR, WITH ITS MUSCLE ATTACHMENTS.

The distal extremity of the femur consists of two *condyles* which coalesce in front, forming a smooth articular surface for the patella. They are separated from each other behind by a deep depression called the *intercondyloid fossa.* The medial surface of the lateral condyle forms the lateral boundary of the fossa and gives attachment posteriorly to the anterior cruciate ligament. The lateral surface of the medial condyle forms the medial boundary of the fossa. Near its distal and anterior part attachment is given to the posterior cruciate ligament. On the lateral side of the lateral condyle and on the medial side of the medial condyle are rough elevations, called respectively the *lateral* and *medial epicondyles.*

The lateral epicondyle is smaller than the medial. It gives attachment behind its most prominent part to the fibular collateral ligament of the knee joint. Just below this is a depression which gives origin to the popliteus, and extending proximally and backwards from this depression is a groove which lodges the tendon of the popliteus when the leg is flexed. In the extended position the tendon passes over the distal lip of the groove. Above the surface which gives attachment to the fibular collateral ligament origin is given to the lateral head of the gastrocnemius muscle, and close to this is the origin of the plantaris.

The medial epicondyle gives attachment to the tibial collateral ligament of the knee joint. Just proximal to it is the *adductor tubercle* and behind this is an impression for the medial head of the gastrocnemius muscle.

The articular surface for the patella occupies the anterior portion of the lower extremity where the two condyles meet, and is known as the *patellar surface* or *trochlea.* The tibial articular surfaces occupy the distal and posterior aspects of the condyles; they are convex and are for articulation with the tibia.

The femur articulates with the os coxæ, the patella, and the tibia.

The Patella

The Patella or Knee-cap.—The patella is a sesamoid bone of triangular form situated in front of the knee joint. It is developed in the tendon of the quadriceps extensor and presents for examination an anterior and posterior surface, and proximal, medial, and lateral borders. The distal angle of the bone is known as the apex.

The anterior surface is slightly convex and is overlaid by the expansion of the quadriceps extensor tendon. A bursa is interposed between this surface and the skin.

The posterior surface is divided by a longitudinal ridge into two parts for articulation with the condyles of the femur. The more lateral of these articular areas is the wider and deeper. Distal to the smooth articular surface is a rough area, the under part of the apex, which is covered proximally by synovial membrane and gives attachment in its distal half to the ligamentum patellæ.

The proximal border or *base* gives attachment to the common tendon of the quadriceps extensor.

The medial and lateral borders give attachment respectively to the vastus medialis and vastus lateralis muscles.

The patella articulates with the femur.

The Tibia

The Tibia is the medial bone of the leg and presents for examination a shaft and two extremities.

The proximal extremity, called the *head* of the tibia, consists of two *condyles, medial* and *lateral*, each having a smooth surface above for articulation with the corresponding condyle of the femur. A ridge of bone, called the *intercondyloid eminence*, lies between these articular surfaces. The uneven depressions found in front of and behind the intercondyloid eminence give attachment to the lateral and medial meniscus and to the cruciate ligaments. The medial condyle is grooved transversely on its postero-medial aspect for the insertion of the tendon of the semimembranosus muscle. Proximal to this groove attachment is given to the posterior portion of the tibial collateral ligament of the knee joint. The lateral condyle has a small articular facet on its posterior surface for the head of the fibula. Its antero-lateral surface gives attachment to the tractus iliotibialis (O.T. ilio-tibial band) and below this origin is given to part of the extensor digitorum longus.

The medial and lateral condyles are confluent with each other in front, presenting a flat surface below which is an eminence called the *tubercle* of the tibia, for the attachment of the ligamentum patellæ. Behind, the condyles are separated by the *popliteal notch*, which gives attachment to part of the oblique popliteal ligament and to the posterior cruciate ligament of the knee joint.

The shaft is triangular in cross-section, having an anterior crest, a medial border, and an interosseous or lateral border, and medial, lateral, and posterior surfaces.

The anterior crest, commonly known as the shin, extends from the tubercle proximally to the anterior border of the medial malleolus distally. It is subcutaneous throughout its whole length.

The medial border extends from the postero-medial part of the medial condyle proximally to the posterior border of the medial malleolus distally. It gives insertion in the proximal 2 inches of its extent to a few fibres of the popliteus; in its middle third it gives origin to part of the soleus muscle.

The interosseous or lateral border gives attachment to the interosseous membrane. It extends from the lateral part of the lateral condyle, just in front of the facet for the fibula, to about 2 inches from the distal part of the bone; here it bifurcates, enclosing a triangular surface for articulation with the fibula and giving attachment to the interosseous ligament, which connects the contiguous non-articular surfaces of the tibia and fibula.

The medial surface is subcutaneous except in its proximal fourth, where it gives insertion to the sartorius, gracilis, and semitendinosus, and behind these to the anterior portion of the tibial collateral ligament of the knee.

The lateral surface gives origin in its proximal two-thirds to the tibialis anterior. Its distal third is directed forwards to the front of the bone and is overlaid by the tendons of the tibialis anterior, extensor hallucis longus, and extensor digitorum longus.

The posterior surface is crossed above by the *popliteal* or *oblique line*, which extends distally and medially from the articular facet for the fibula to the distal limit of the proximal third of the medial border and gives origin to part of the soleus. The popliteus muscle gains insertion into the triangular surface above the popliteal line. A vertical ridge extending distally from the middle of the popliteal line, divides the posterior surface of the shaft in its middle third into two parts. The medial portion gives origin to the flexor digitorum longus, the lateral to part of the tibialis posterior. The distal part of this surface is covered by the tendons of the tibialis posterior, flexor digitorum longus, and flexor hallucis longus.

The distal extremity displays five surfaces, namely, distal, anterior, posterior, medial, and lateral.

The distal surface is quadrangular in form and is smooth for articulation with the proximal surface of the body of the talus. It is confluent medially with the articular surface on the lateral aspect of the medial malleolus.

The anterior surface is smooth above, where it is overlaid by the tendons of the extensors of the toes; below, it is grooved transversely for the anterior ligament of the ankle.

The posterior surface is marked, sometimes faintly, by a groove for the tendon of the flexor hallucis longus.

The medial surface projects distally and forms the *medial malleolus*; this is rounded and subcutaneous medially; laterally it is smooth for articulation with the talus; its anterior border and apex and the notch behind the latter give attachment to the deltoid ligament of the ankle joint. A broad groove runs obliquely distally and medially over the posterior surface of the medial malleolus for the tendons of the tibialis posterior and flexor digitorum longus.

The lateral surface of the distal extremity comprises the triangular depression, which articulates below with the fibula and presents a rough surface above for the interosseous ligament.

The tibia articulates with the femur, the fibula, and the talus.

The Fibula

The Fibula is the lateral bone of the leg, and consists of a shaft and two extremities. The proximal and distal extremities are so much alike that it is difficult for the student to distinguish between them, and also to determine whether the bone under examination belongs to the right or left side. It may therefore be of use to note here that the distal extremity has a deep, rough depression behind its articular surface and that it is shaped like a pyramid, whereas the proximal extremity is more rounded in form. Having distinguished between the proximal and distal extremities, the bone should be held upright and turned so that the depression on the distal extremity is behind the articular surface, the lateral non-articular surface is then directed towards the side to which the bone belongs.

The proximal extremity or **head** of the fibula has on its lateral side a pointed eminence directed proximally, called the *apex* of the head. Medial to this and directed proximally and medially is an articular facet for articulation with the lateral condyle of the tibia. At the lateral and proximal part of the head, in front of the apex, attachment is given to the fibular collateral ligament of the knee joint and to the biceps femoris muscle. The fibular collateral ligament splits the tendon of the biceps femoris muscle at its insertion, and the two portions are attached to the head of the fibula on either side of the ligament. The apex gives attachment to the short fibular collateral ligament[1] of the knee joint and to part of the tendon of the biceps femoris. The *anterior surface* of the head gives attachment to the anterior superior tibio-fibular ligament, and is also usually marked by a tubercle for the origin of part of the peroneus longus. The *posterior surface* of the head gives attachment to the posterior superior tibio-fibular ligament and presents a tubercle for the origin of the proximal part of the soleus.

The shaft is slender and very irregular, and has four borders—antero-lateral, antero-medial, postero-lateral, and postero-medial, separating four surfaces—anterior, lateral, posterior, and medial.

The antero-lateral border extends distally from the front of the head to the apex of the triangular subcutaneous surface above the lateral malleolus. It gives attachment to the intermuscular septum which separates the dorsi-flexors of the ankle—extensor digitorum longus, extensor hallucis longus, and peroneus tertius—from the peroneus longus and brevis.

The antero-medial border or *interosseous ridge* lies on the medial side of the preceding border. It extends from just below the head of the bone to about 2 inches above the anterior border of the lateral malleolus. It gives attachment to the interosseous membrane which separates the dorsi-flexor muscles of the ankle, which lie on the front of the bone, from the plantar flexors on its posterior and medial aspect.

The postero-lateral border extends from the root of the apex above to the posterior border of the lateral malleolus below. It gives origin in its proximal third to part of the soleus and affords attachment to the intermuscular septum which separates the peroneal muscles from the flexor hallucis longus.

The postero-medial border extends from the medial side of the head distally to the distal limit of the middle third of the bone, where it becomes continuous with the interosseous ridge. It affords attachment to the aponeurosis which covers the tibialis posterior and separates it from the soleus and flexor hallucis longus.

The anterior surface lies between the antero-medial or interosseous and the

[1] An inconstant structure.

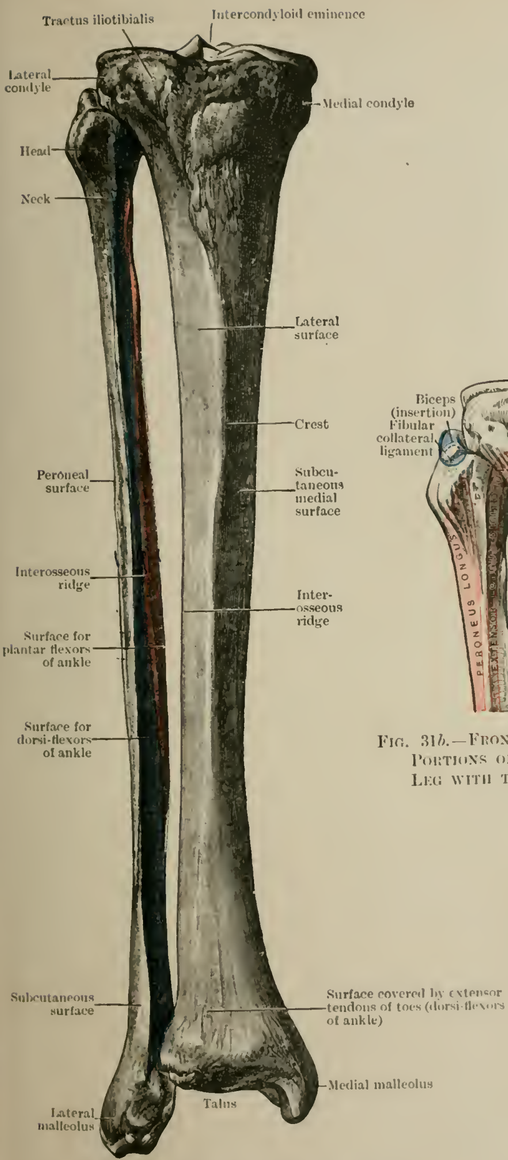


FIG. 31*a*.—RIGHT TIBIA AND FIBULA AS SEEN FROM THE FRONT.

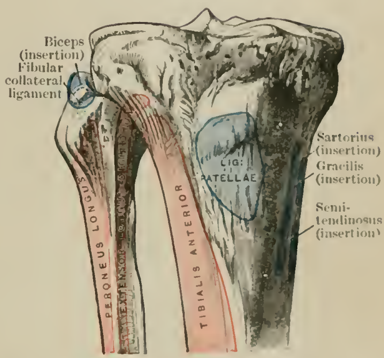


FIG. 31*b*.—FRONT ASPECT OF THE PROXIMAL PORTIONS OF THE BONES OF THE RIGHT LEG WITH THEIR MUSCLE ATTACHMENTS.

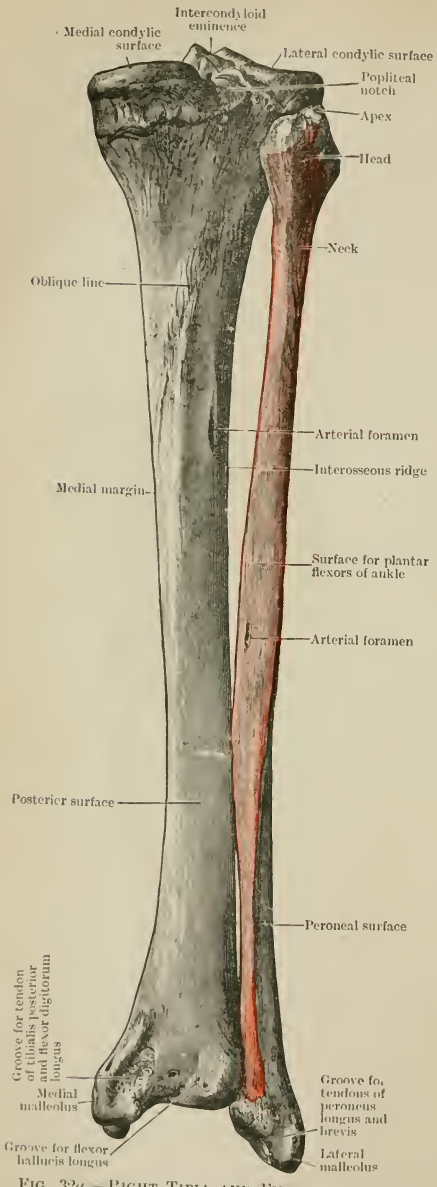


FIG. 32*a*.—RIGHT TIBIA AND FIBULA AS SEEN FROM BEHIND.

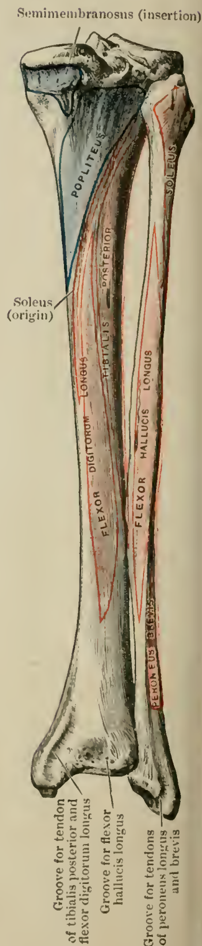


FIG. 32*b*.—RIGHT TIBIA AND FIBULA AS SEEN FROM BEHIND, WITH MUSCLE ATTACHMENTS.

antero-lateral borders. It gives origin to the dorsi-flexors of the ankle—the extensor digitorum longus, extensor hallucis longus, and peroneus tertius.

The lateral or *peroneal surface* lies between the antero-lateral and the postero-lateral borders. It is directed laterally in its proximal, and backwards in its distal third, where it is confluent with the groove for the tendons of the peroneus longus and brevis on the back of the lateral malleolus. It gives origin to the peroneus longus and brevis.

The posterior surface occupies the space between the postero-lateral and the postero-medial borders. It is directed backwards above and medially below It gives origin in its proximal third to part of the soleus; below this to the flexor hallucis longus, and distally it presents a triangular surface proximal to the articular facet on the medial surface of the lateral malleolus which gives attachment to the interosseous ligament.

The medial surface is limited behind by the postero-medial and in front by the antero-medial border. It presents a groove for the origin of the tibialis posterior.

The distal extremity is pyramidal in shape and forms what is known as the lateral malleolus. On its medial side is a triangular facet for articulation with a similar surface on the lateral aspect of the body of the talus. Behind and below this is a depression which affords attachment to the posterior talo-fibular ligament of the ankle joint. The *lateral surface* is rounded and subcutaneous and forms the projection of the lateral ankle. The *anterior border* gives attachment to the anterior talo-fibular ligament of the ankle, while the *apex* gives attachment to the calcaneo-fibular ligament of the same joint. The *posterior border* is grooved for the tendons of the peroneus longus and brevis.

The fibula articulates with the tibia and the talus.

THE TARSUS

The Calcaneus

The Calcaneus is the largest bone of the tarsus. It articulates above with the talus and in front with the cuboid bone. Its long axis is directed forwards and somewhat laterally, and its posterior extremity or tubercle forms the heel. It presents six surfaces—superior, inferior, medial, lateral, anterior, and posterior.

The superior surface consists of a non-articular portion behind and an articular part in front. The latter displays a facet, directed upwards and forwards, for articulation with the posterior calcanean facet on the inferior surface of the talus. In front of this is a deep groove which gives attachment to the interosseous ligament. More anteriorly and on the medial side of the superior surface is another facet, often divided so as to form two, for articulation with corresponding surfaces on the inferior aspect of the talus. The lateral side of the upper surface is rough in front for the attachment of ligaments, and gives origin to the extensor digitorum brevis.

The inferior surface displays two tubercles posteriorly. Of these the medial one is the larger and gives origin to the flexor digitorum brevis, abductor hallucis, and to some fibres of the abductor digiti quinti. The lateral tubercle also gives origin to part of the last-named muscle. The surface in front of the tubercles gives attachment to the long plantar ligament, from either side of which origin is given to the quadratus plantæ muscle. Near the anterior extremity of the inferior surface is a tubercle with a groove in front of it, both of which afford attachment to the short plantar ligament.

The medial surface of the calcaneus is concave and is directed downwards and forwards. It gives origin to the medial head of the quadratus plantæ, and transmits the plantar vessels and nerves. This surface is overhung, in front and above, by a process called the *sustentaculum tali*, the distal aspect of which is grooved for the tendon of the flexor hallucis longus. The upper surface of the process presents an articular facet for articulation with the middle calcanean facet on the under surface of the talus; its medial border gives attachment to part of the deltoid ligament of the ankle, and its anterior border to the plantar calcaneo-navicular ligament.

The lateral surface is broader behind than in front. It is grooved anteriorly for the tendons of the peroneus longus and brevis, the latter occupying the upper groove. A prominence called the *trochlear process* lies between these grooves and gives attachment to the lateral annular ligament. A tubercle near the centre of this surface gives attachment to the calcaneo-fibular ligament of the ankle joint; above and in front attachment is given to the lateral talo-calcanean ligament.

The anterior surface presents a facet for articulation with the cuboid bone. Its medial border gives attachment to the plantar calcaneo-navicular ligament.

The posterior surface is smooth above, and is overlaid by a bursa; below this a rougher area gives insertion to the tendo calcaneus and to the plantaris.

The Talus

The Talus is the second largest bone of the tarsus. It articulates above with the tibia, on either side with the malleoli, below with the calcaneus, and in front with the navicular bone. It consists of a body, a neck, and a head.

The Body.—*The superior surface* of the body displays a smooth surface called the *trochlea tali*, for articulation with the tibia. *The inferior surface* presents behind a facet, known as the *posterior calcanean facet*, for articulation with a corresponding surface on the superior aspect of the calcaneus. In front of this is a deep groove, the *sulcus tali*, which gives attachment to the interosseous ligament, and which separates the *posterior* from the *middle calcanean facet*. The latter occupies the surface immediately in front of the sulcus tali, and articulates with the facet on the upper surface of the sustentaculum tali of the calcaneus.

The medial surface has above a facet, confluent with the trochlea, for articulation with the medial malleolus; below it is rough, and gives attachment to the deeper fibres of the deltoid ligament of the ankle joint.

The lateral surface presents a large facet, triangular in form, for articulation with the lateral malleolus, in front of which attachment is given to the anterior talo-fibular ligament of the ankle joint.

The posterior surface presents two *tubercles*, the lateral and larger of which gives attachment to the posterior talo-fibular ligament of the ankle joint. These two tubercles are separated by a groove which passes obliquely downwards and medially, and lodges the tendon of the flexor hallucis longus.

The neck is the narrower portion of the bone between the body and the head.

The head is pointed forwards and medially. Its anterior surface is smooth and rounded for articulation with the navicular bone.

The Navicular

The Navicular.—The navicular bone is so called because of the resemblance of the hollow on its posterior surface to a boat. It is found on the medial side of the foot, and articulates *posteriorly* with the head of the talus; its *anterior surface* is convex, and is marked by three facets for articulation with the first second, and third cuneiform bones. Its *dorsal surface* is convex and is rough for the attachment of ligaments; its *plantar surface* is irregular, and gives attachment to ligaments. The *lateral surface* sometimes presents a facet for articulation with the cuboid bone. The *medial surface* is marked by a prominence called the *tubercle of the navicular*, which gives attachment to part of the tendon of the tibialis posterior muscle.

The navicular articulates with the talus, the three cuneiforms, and sometimes with the cuboid.

The Cuboid

The Cuboid.—The cuboid is situated on the lateral side of the foot, and presents for examination six surfaces.

The posterior surface is smooth and triangular for articulation with the calcaneus.

The anterior surface is marked by two facets for articulation with the fourth and fifth metatarsal bones.

The medial surface has a facet for articulation with the third cuneiform bone, in front of and behind which are rough surfaces for the attachment of ligaments.

The lateral surface is notched by the *peroneal groove*, which is continued on the plantar surface of the bone.

The superior surface is rough and gives attachment to ligaments.

The inferior or *plantar surface* is marked by a groove through which the tendon of the peroneus longus muscle passes; it also gives insertion to part of the tibialis posterior. Behind this groove is a ridge affording attachment to the calcaneo-cuboid or long plantar ligament, and terminating at its lateral extremity in a prominence called the *tubercle of the cuboid*; on the lateral surface of this is a facet for the sesamoid bone generally developed in the tendon of the peroneus longus muscle. Behind the ridge attachment is given to the short plantar ligament and to the flexor hallucis brevis.

The cuboid articulates with the calcaneus, the third cuneiform, the fourth and fifth metatarsal bones, and sometimes with the navicular.

The Cuneiform Bones

The Cuneiform Bones, so called from being wedge-shaped, are three in number. They articulate posteriorly with the navicular, anteriorly with the first, second, and third metatarsal bones. They are called first, second, and third, reckoning from the medial side of the foot.

The first cuneiform bone is the largest of the three. It articulates behind with the navicular and in front with the first metatarsal bone. *The lateral surface* articulates with the second cuneiform and the second metatarsal bone, and gives insertion to part of the tendon of the peroneus longus. *The medial surface* presents in front and inferiorly an impression for part of the insertion of the tibialis anterior; the remainder of the surface is rough for the attachment of ligaments. *The superior surface* is also rough for the attachment of ligaments. *The inferior* or *plantar surface* gives insertion behind to part of the tendon of the tibialis posterior, and anteriorly to part of the tendon of the tibialis anterior.

The first cuneiform articulates with the navicular, first and second metatarsal, and second cuneiform bones.

The second cuneiform articulates behind with the navicular and in front with the second metatarsal bone. *The lateral surface* displays posteriorly a facet for articulation with the third cuneiform bone. *The medial surface* articulates with the first cuneiform. *The superior* or *dorsal surface* affords attachment to the dorsal ligaments. *The inferior* or *plantar surface* is rough for the attachment of the plantar ligaments and gives insertion to part of the tibialis posterior.

The second cuneiform articulates with the navicular, second metatarsal, and first and second cuneiform bones.

The third cuneiform articulates behind with the navicular and in front with the third metatarsal bone. *The lateral surface* displays a facet posteriorly for articulation with the cuboid, and anteriorly a second for articulation with the medial side of the base of the fourth metatarsal bone. *The medial surface* also displays two facets, one along its anterior border for articulation with the lateral side of the base of the second metatarsal bone, the other along the posterior border for articulation with the second cuneiform. *The superior* or *dorsal surface* gives attachment to the dorsal ligaments of the foot. *The inferior* or *plantar surface* gives attachment to the plantar ligaments and insertion to part of the tibialis posterior.

The third cuneiform articulates with the navicular, second cuneiform, cuboid, second, third, and fourth metatarsal bones.

The Metatarsus

The Metatarsal Bones are five in number. They consist of a shaft and two extremities. They are called first, second, third, fourth, and fifth, counting from the medial side of the foot. Each bone articulates, by its *proximal extremity* or *base*, with one or more of the tarsal bones, and by its *distal extremity* or *head* with the first row of the phalanges of the toes.

The first is the largest and shortest of the metatarsal bones. The medial

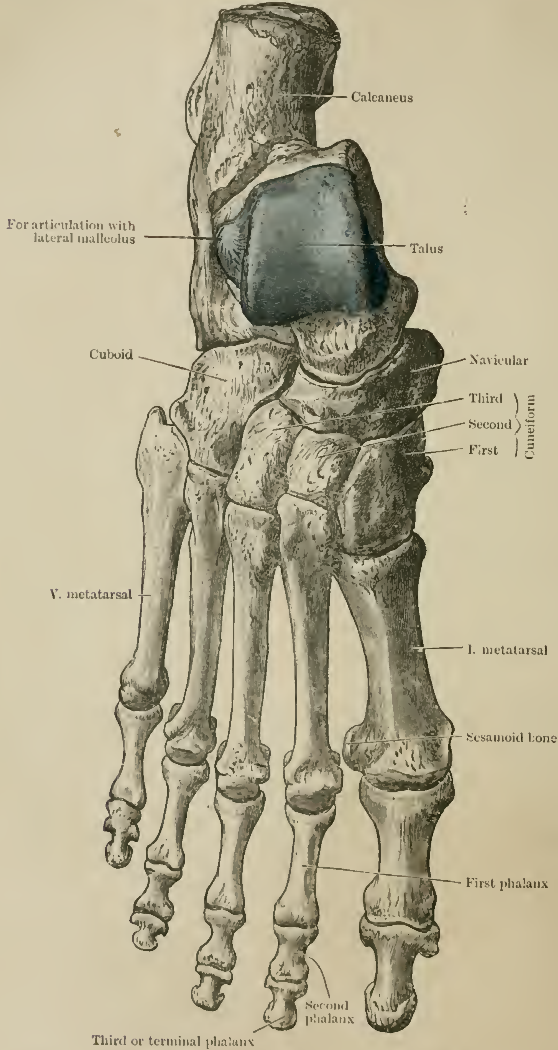


FIG. 33.—BONES OF THE RIGHT FOOT AS SEEN FROM ABOVE.

aspect of the base gives insertion to part of the tendon of the tibialis anterior, while the inferior angle, which projects backwards and slightly laterally, gives insertion to the peroneus longus.

The second is the longest of the metatarsal bones; it, together with the **third** and **fourth** of the series, gives origin, on the plantar surface of the posterior extremity, to the adductor obliquus hallucis and insertion to some slips of the tibialis posterior.

The fifth metatarsal is characterised by a prominent *tubercle* on the lateral aspect of its base; this gives insertion on its posterior extremity and dorsal surface to the peroneus brevis. On the medial side of the dorsal aspect of the base insertion is given to the peroneus tertius. The flexor digiti quinti brevis arises from the plantar surface of the tuberosity, while more medially insertion is given to a slip of the tibialis posterior.

Sesamoid Bones.—Sesamoid bones are generally found in two shallow grooved facets on the plantar or under surface of the head of the first metatarsal bone. They may also be found lodged in the tendons and ligaments in other parts of the foot, the most usual being that developed in the tendon of the peroneus longus.

CHAPTER IV

ARTICULATIONS OR JOINTS

An articulation or joint constitutes the mode of union between any two separate bones of the skeleton.

Joints may be divided into three classes—

Synarthrosis.
Amphiarthrosis.
Diarthrosis.

Synarthrosis is a joint which allows of practically no movement; the two bones entering into its formation are united by a thin layer of fibrous tissue continuous with the periosteum; this form of joint is seen in the sutures of the skull. In other cases the two bones are united by a piece of hyaline cartilage; these joints are termed synchondroses, and are seen between some of the skull bones and between the epiphyses and diaphyses of the long bones.

Amphiarthrosis is a joint which allows of a certain amount of movement; here the two bones are united by a mass of fibro-cartilage which is attached to a thin plate of hyaline cartilage covering the ends of each of the bones. Amphi-arthrodial joints are found only in the middle line of the body, *i.e.* between the bodies of the vertebræ and in the symphysis pubis.

Diarthrosis is a joint which allows of a more or less extensive amount of movement. The ends of the bones are covered by hyaline cartilage, and are united by a sac of fibrous tissue called the capsule; this is lined by *synovial membrane,* and is thickened along the lines of least movement; these thickenings are called *capsular ligaments.* The synovial membrane secretes a thick glairy fluid, like uncooked white of egg, called *synovia,* which lessens friction of the opposing bony surfaces.

The diarthrodial joints are subdivided, according to the kind of movement that takes place at them, into—

Gliding		Example	Carpal and tarsal.
Hinge	Single	,,	Elbow and knee.
	Double	,,	Wrist and metacarpo-phalangeal.
Rotary		,,	Radio-humeral.
			Radio-ulnar, proximal and distal.
Ball and socket		,,	Shoulder and hip.

Bursæ are spaces lined by a synovial membrane which is kept moist by the constant secretion of synovial fluid; they are found superficially when they lie between the skin and a bony prominence, such as the olecranon and patella, or deeply when they lie between tendons and muscles and bones or the capsules of joints; in the latter case they frequently have a communication with the joint.

Adipose tissue is frequently found in joints, under the synovial membrane, where it acts as a pad in filling up vacant spaces.

THE DIFFERENT KINDS OF MOVEMENT ADMITTED IN JOINTS

The gliding movement is common to all diarthrodial joints, but when it is the only movement possible, as in the carpal and tarsal, sterno- and acromio-clavicular articulations, they are called gliding joints.

Angular movement only takes place between the long bones. It may be either forwards and backwards—called flexion and extension, or medially or laterally—called adduction and abduction. Single hinge joints are only capable of flexion and extension, but double hinge joints are also capable of adduction and abduction.

Rotation is the movement of a bone upon its axis. An example of this form of movement is seen when the atlas rotates round the dens, also when the head of the radius rotates within the radial notch of the ulna.

Circumduction is the kind of motion specially characteristic of ball-and-socket joints. The free end of the limb describes a circle, while the fixed end moves only in a limited degree in its articular cavity; it is really a combination of angular and rotatory movements.

ARTICULATIONS OF THE VERTEBRAL COLUMN

The different vertebræ of the spine are joined together by ligaments; there are five sets—

(1) Those connecting the bodies of the vertebræ.
(2) „ „ laminæ of the vertebræ.
(3) „ „ articular processes of the vertebræ.
(4) „ „ spinous processes of the vertebræ.
(5) „ „ transverse processes of the vertebræ.

1. **Ligaments connecting the bodies**—

Anterior longitudinal ligament.
Posterior longitudinal ligament.
Intervertebral fibro-cartilages.

The **anterior longitudinal ligament** consists of a wide band of fibres which extends from the front of the epistropheus to the front of the upper part of the sacrum. It lies in front of and is attached to the intervertebral discs. Some of the fibres are short and only extend between the margins of adjacent vertebræ, others connect three or more vertebræ together.

The **posterior longitudinal ligament** lies inside the vertebral canal, extending from the body of the epistropheus to the sacrum. It rests upon the posterior surface of the vertebral bodies, and is attached to the adjacent margins of the latter and to the intervertebral discs.

The **intervertebral fibro-cartilages** lie between the bodies of the vertebræ to which they are adherent. They are composed, at their circumference, of oblique parallel fibres which extend between the vertebræ, and in the centre of a soft, elastic substance. They vary in thickness in different parts of the vertebral column. In the cervical and lumbar regions they are thicker in front than behind, thus helping the formation of the forward curve in these regions. In the thoracic region the discs are thinner in front than behind.

2. **Ligaments connecting the laminæ**—

Ligamenta flava. The **ligamenta flava** occupy the spaces between the laminæ from the epistropheus to the sacrum. Each ligament is attached to the anterior surface of the lamina above, not far from its inferior border, and to the posterior surface and superior border of the lamina below.

3. **Ligaments connecting articular processes**—

Capsule ligaments. The **capsules** invest the articular surfaces, and are lined by synovial membrane. They are looser in the cervical region than elsewhere.

4. **Ligaments connecting spinous processes—**
   Interspinous.
   Supraspinous.

   The **interspinous ligaments** extend between the spinous processes of contiguous vertebræ from the root to the apex.

   The **supraspinous ligament** extends between and is attached to the tips of the vertebræ. In the cervical region it is strongly developed and is known as the *ligamentum nuchæ.*

5. **Ligaments connecting transverse processes—**
   Intertransverse. The **intertransverse ligaments** extend between the transverse processes. They are frequently absent in the cervical and upper thoracic regions.

The spine is capable of flexion, extension, lateral movement, rotation, and circumduction.

Table of Muscles which produce the Movements of the Spinal Column

Flexion.	*Extension.*
Longus colli.	Serrati posteriores.
Longus capitis.	Splenius capitis.
Scaleni anteriores (acting together).	Splenius cervicis.
Psoas major.	Sacro-spinalis.
Psoas minor.	Spinalis dorsi.
Rectus abdominis.	Semispinalis cervicis.
Pyramidalis.	Semispinalis capitis.
Obliquus externus abdominis.	Multifidus.
Obliquus internus abdominis.	Interspinales.
Transversus abdominis.	

(Muscles of both sides acting together.)

Lateral Movement and Rotation.

Levator scapulæ.	Longus capitis.
Serrati posteriores.	Scalenus anterior.
Splenius cervicis.	,, posterior.
Sacro-spinalis.	,, medius.
Semispinalis capitis.	Psoas major.
Semispinalis cervicis.	,, minor.
Multifidus.	Quadratus lumborum.
Rotatores dorsi.	Obliquus externus abdominis.
Inter-transversales.	Obliquus internus abdominis.
Longus colli.	Transversus abdominis.
	Rectus abdominis.
	Pyramidalis.

(Muscles of one side only acting.)

ARTICULATION OF THE ATLAS WITH THE EPISTROPHEUS

The anterior arch of the atlas articulating with the dens of the epistropheus forms a rotatory joint, while gliding joints are formed between the articular processes of the two bones.

The **ligaments** are—

Three capsules.
Anterior atlanto-epistropheal.
Posterior atlanto-epistropheal.
Transverse.

The three joints are each surrounded by a **capsule** lined by synovial membrane.

The **anterior atlanto-epistropheal ligament** connects the anterior arch of the atlas to the front of the body of the epistropheus.

The **posterior atlanto-epistropheal ligament** connects the posterior arch of the atlas to the upper edge of the arch of the epistropheus.

The **transverse ligament** stretches across the atlas behind the dens. There is a tubercle on the medial surface of the lateral portion of the atlas on either side, to which it is attached.

ARTICULATION OF THE SPINE WITH THE CRANIUM

The two articulations between the atlas and the occipital bone form two gliding joints.

The **ligaments** are—

Two capsules.
Anterior atlanto-occipital.
Posterior atlanto-occipital.

The **capsules** surround each of the articulating surfaces, and are lined by synovial membrane.

The **anterior atlanto-occipital ligament** connects the anterior portion of the foramen magnum to the anterior arch of the atlas.

The **posterior atlanto-occipital ligament** connects the posterior portion of the foramen magnum to the posterior arch of the atlas.

The occiput is joined to the axis by means of the following ligaments—

Membrana tectoria.
Ligamentum cruciatum atlantis.
Ligamenta alaria.
Ligamentum apicis dentis.

The **membrana tectoria** is a continuation of the posterior longitudinal ligament of the bodies of the vertebræ. It lies within the neural canal, and is attached above to the basilar groove on the occiput and below to the posterior surface of the body of the epistropheus.

The **ligamentum cruciatum atlantis** lies beneath the preceding. It is a cruciform arrangement of fibres, the transverse portion of which is composed of the superficial fibres of the ligamentum transversum atlantis. The superior longitudinal portion extends upwards in the middle line from the transverse part to its attachment on the occiput. The inferior longitudinal portion extends downwards from the transverse part to the posterior surface of the body of the epistropheus.

The **ligamenta alaria** extend from either side of the apex of the dens laterally to the tubercle on the medial aspect of the condyles of the occipital bone.

The **ligamentum apicis dentis** extends upwards from the summit of the dens to the anterior margin of the foramen magnum.

Movements at these Joints

Flexion and extension of the head takes place at the joints between the occipital bone and the atlas.

The cranium and atlas together rotate upon the epistropheus, this movement being regulated by the alar ligaments. There is also lateral movement at the joint between the atlas and the epistropheus.

TABLE OF MUSCLES WHICH PRODUCE THE MOVEMENTS OF THE HEAD

Flexion.	*Extension.*
Digastric.	Sterno-mastoid.
Stylo-hyoid.	Splenius capitis.
Stylo-pharyngeus.	Longissimus capitis.
Mylo-hyoid.	Semispinalis capitis.
Hyo-glossus.	Obliquus capitis inferior.
Sterno-hyoid.	Recti capiti posterior (major and minor).
Sterno-thyroid.	
Omo-hyoid.	
Longus capitis.	
Rectus capitis anterior.	

(Muscles of both sides acting together.)

Lateral Movement.	*Rotation.*
Sterno-mastoid.	Sterno-mastoid.
Splenius capitis.	Splenius capitis.
Longissimus capitis.	Longissimus capitis.
Semispinalis capitis.	Semispinalis capitis.
Obliquus capitis superior.	Obliquus capitis inferior.
Rectus capitis lateralis.	,, capitis superior.
	Recti capiti posterior (major and minor).

(Muscles of one side only acting.)

ARTICULATION OF THE SACRUM WITH THE SPINE

Lumbo-Sacral Joint

The lumbo-sacral joint has, in addition to the ligaments which connect the typical vertebræ together, an accessory ligament, called the **lateral lumbo-sacral ligament.** It extends from the front of the lower border of the transverse process of the fifth lumbar vertebra to the front of the lateral surface of the sacrum.

ARTICULATIONS OF THE PELVIS

Sacro-Iliac Joint

The sacro-iliac is a diarthrodial joint, and is formed by the articulation of the sacrum with the ilium. The articular surfaces are covered by hyaline cartilage, and are held together by the following **ligaments**—

Anterior sacro-iliac.
Posterior sacro-iliac.

Accessory ligaments are—

Ilio-lumbar.
Sacro-tuberous.
Sacro-spinous.

The **anterior sacro-iliac ligament** is a weak band stretching across the front of the joint from the sacrum to the ilium. It is merely a thickened portion of the capsule.

The **posterior sacro-iliac** is a very powerful ligament stretching across the back of the joint from the sacrum to the ilium. The deeper fibres are short, and run directly from one bone to the other; the superficial fibres are longer, and run obliquely distally and medially from the ilium to the sacrum.

The **ilio-lumbar ligament** extends almost horizontally laterally, from the tip of the transverse process of the fifth lumbar vertebra to the inner lip of the crest of the ilium.

The **sacro tuberous ligament** is attached medially to the posterior inferior iliac pine, to the posterior surface of the transverse tubercles, and the sides of the hird, fourth, and fifth sacral, and first coccygeal segments. It passes distally and aterally to its attachment on the medial side of the tuberosity of the ischium. Its nedial border is continued upwards and forwards to the medial aspect of the ramus of the ischium, and is known as the falciform ligament.

The **sacro-spinous ligament** is a triangular ligament attached by its base to the ateral margins of the sacrum and coccyx, and by its apex to the ischial spine.

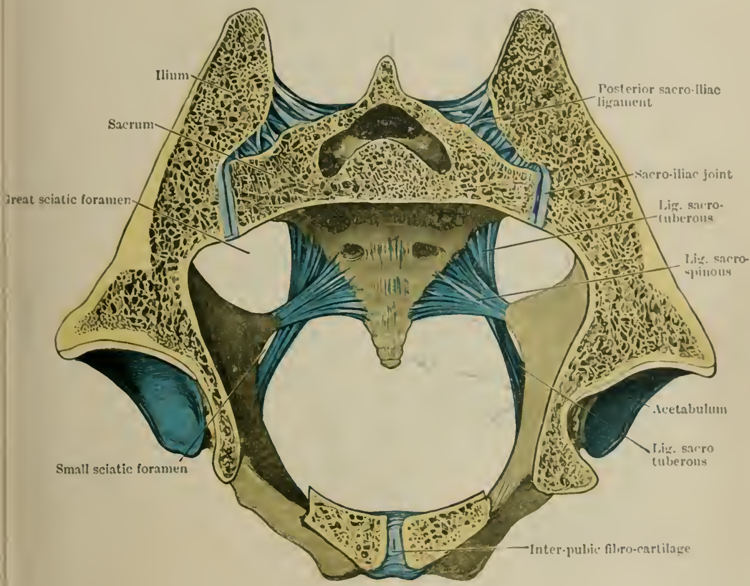


FIG. 34.—CORONAL SECTION OF PELVIS.

The Symphysis Pubis

The symphysis pubis is an amphiarthrodial joint, formed by the articulaon of the bodies of the pubic bones. The two bones are covered with hyaline rtilage, and united by a disc of fibro-cartilage which usually has a small cavity eveloped in its centre. The joint is strengthened on all sides by ligaments: in ont the **anterior pubic,** behind the **posterior pubic,** above the **superior pubic,** nd below the **inferior** or **subpubic ligament** (Figs. 34 and 35).

Temporo-Mandibular Joint

This is a gliding joint, in which the condyle or head of the mandible articulates ith the mandibular fossa of the temporal bone. A layer of cartilage covers the ticular surfaces of the bones.

The joint is surrounded by a **capsule.** This is thin on the medial side, and the teral wall forms the *temporo-mandibular ligament*, which is divided into two rtions, anterior and posterior. These are attached above to the tubercle and lower border of the zygomatic arch, and below to the lateral side and posterior border of the neck of the mandible.

Within the capsule there is an **interarticular disc** of **fibro-cartilage** moulded

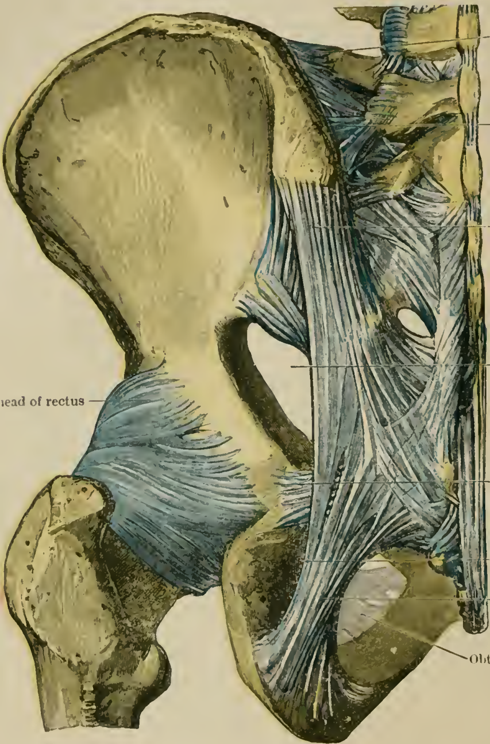


Fig. 35.—Posterior View of the Pelvic Ligaments and of the Hip Joint.

to the shape of the articulating surfaces, which divides the joint cavity into an upper and lower part. These two compartments are lined by **synovial membrane.**

Movements at the Temporo-Mandibular Joint

Opening, closing, protrusion, retraction, and lateral movements of the jaw.

Table of Muscles which produce these Movements

Opening.	*Closing.*
Digastric.	Masseter.
Mylo-hyoid.	Temporal.
Genio-hyoid.	Internal pterygoid.
Genio-hyo-glossus.	
Infra-hyoid muscles.	

Protrusion.	*Retraction.*
External pterygoid. Internal " Temporal (anterior fibres).	Temporal (posterior fibres).

Lateral Movement.

External pterygoid } Acting on one side only.
Internal " }

SOME ARTICULATIONS OF THE THORAX

Costo-Vertebral Joints

These may be classified as follows—

1. **Costo-central,** or the articulations between the heads of the ribs and the bodies of the thoracic vertebræ.
2. **Costo-transverse,** or the articulations between the tubercles of the ribs and the transverse processes of the vertebræ.

The costo-central are hinge joints, and are held together by the following ligaments—

Capsular.
Stellate or anterior costo-vertebral.
Interarticular.

The **capsular ligament** surrounds the joint, and is attached to the head of the rib and to the margin of the articular cavity formed by the bodies of two contiguous vertebræ.

The **stellate ligament** consists of three fasciculi which radiate from the front of the head of the rib. The superior fasciculus is attached to the body of the vertebra above, the middle fasciculus to the intervertebral disc, and the inferior fasciculus to the body of the vertebra below.

The **interarticular ligament** lies within the joint and divides it into two compartments, which are lined by two distinct synovial membranes. It is attached to the ridge between the two facets on the head of the rib, and to the intervertebral disc. It is absent in the first, tenth, and eleventh ribs, which only articulate with the body of one vertebra.

The costo-transverse are gliding joints. The parts entering into the formation of each are the tubercle of the rib and the articular facet on the anterior surface of the transverse process of the lower of the two vertebræ with which the head of the rib articulates. (This articulation is absent in the last two ribs.)

Each joint cavity is surrounded by a **capsular ligament** and lined by **synovial membrane.**

Accessory ligaments connected with the joint are—

Anterior or superior costo-transverse.
Posterior costo-transverse.
Middle costo-transverse.

The **anterior costo-transverse ligament** extends from the upper border of the neck of the rib to the inferior border of the transverse process above. (Absent in the first rib, and either absent or rudimentary in the twelfth.)

The **posterior costo-transverse ligament** extends from the tip of the transverse process to the rough non-articular surface of the tubercle of the rib.

The **middle costo-transverse ligament** extends from the posterior surface of the neck of the rib to the anterior surface of the transverse process. (Rudimentary in the eleventh and twelfth ribs.)

Costo-Sternal Joints

The costo-sternal are gliding joints, and are formed by the articulation of the cartilages of the true ribs with the sternum.

The **ligaments** are—

Capsular.
Anterior costo-sternal.
Posterior costo-sternal.
Interarticular.

The **capsular ligament** invests the joint, and is attached to the margins of the articular surfaces of the parts forming the articulation.

The **anterior costo-sternal ligament** is a broad band which radiates from the anterior surface of the sternal end of the costal cartilage to the front of

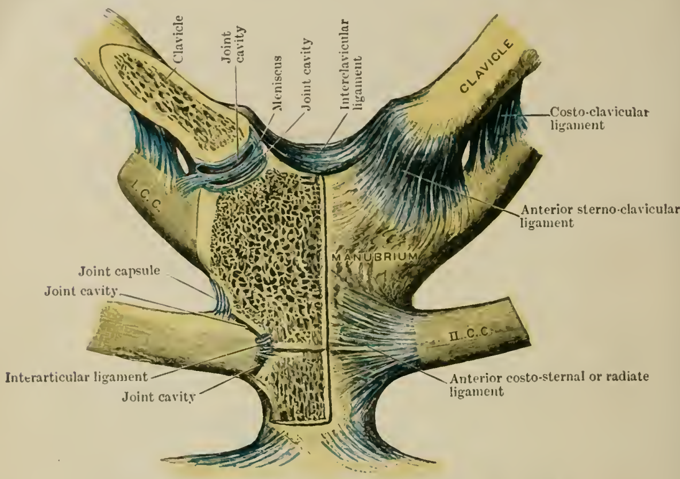


FIG. 36.—STERNO-CLAVICULAR AND COSTO-STERNAL JOINTS.

the sternum. It interlaces with its fellow of the opposite side to form the membrana sterni which covers the anterior surface of the sternum.

The **posterior costo-sternal ligament** extends from the back of the sternal end of the costal cartilage to the back of the sternum.

The **interarticular** corresponds to the ligament of the same name in the costo-central joints, and attaches the extremity of the costal cartilage to the apex of the V-shaped gap in the lateral margin of the sternum (Fig. 36).

SOME ARTICULATIONS OF THE UPPER EXTREMITY

The Sterno-Clavicular Joint

The sterno-clavicular is a diarthrodial joint of the gliding variety. The parts which enter into its formation are—(1) The sternal end of the clavicle; (2) an articular facet on the lateral part of the superior border of the manubrium sterni; and (3) the upper surface of the first costal cartilage.

The **ligaments** are—

Capsular.
Anterior sterno-clavicular.
Posterior sterno-clavicular.
Interarticular meniscus.

Two accessory ligaments connected with the joint are—

Interclavicular.
Costo-clavicular.

The **capsular ligament** completely invests the joint, but is very thin on its inferior aspect.

The **anterior sterno-clavicular ligament** forms part of the capsule. It extends from the anterior surface of the sternal end of the clavicle to the front of the superior surface of the manubrium and the front of the first costal cartilage.

The **posterior sterno-clavicular ligament** also helps to form the capsule. It is situated on the posterior aspect of the joint, and extends from the medial end of the clavicle to the sternum.

The **interclavicular ligament** passes across the interclavicular notch from the sternal end of one clavicle to that of the other. It is closely attached by some of its fibres to the superior border of the sternum.

The **costo-clavicular ligament** consists of a band of strong, short fibres, attached below to the superior surface of the first costal cartilage and above to the costal impression on the inferior aspect of the medial end of the clavicle.

The **interarticular meniscus** is a disc, thicker at its circumference than at its centre, and almost circular in shape, which divides the joint into two cavities. It is attached above to the superior border of the clavicle, below to the sternal extremity of the first costal cartilage, and by its circumference to the capsule.

A **synovial membrane** lines each joint. Occasionally the meniscus is perforated, and communication is then established between the two synovial cavities.

The Acromio-Clavicular Joint

The acromio-clavicular is a diarthrodial joint of the gliding variety, formed by the articulation of the lateral extremity of the clavicle with the medial surface of the acromion of the scapula. The articular surfaces are covered with cartilage.

The **ligaments** are—

Superior acromio-clavicular.
Inferior acromio-clavicular.
Meniscus.
Coraco-clavicular (accessory) { Trapezoid. Conoid.

The **superior acromio-clavicular ligament** extends between the superior part of the lateral extremity of the clavicle and the superior surface of the acromion.

The **inferior acromio-clavicular ligament** extends from the inferior surface of the lateral extremity of the clavicle to the adjacent surface of the acromion.

These two ligaments form a complete capsule for the joint.

A **meniscus,** generally incomplete and sometimes absent, lies obliquely in the joint cavity, and is attached to the capsule by its margins. It rarely completely divides the joint cavity; when it does, there are two synovial membranes.

The **coraco-clavicular** is an accessory ligament which connects the lateral end of the clavicle to the coracoid process of the scapula. It consists of two parts, called the trapezoid and conoid ligaments.

The **trapezoid ligament** is attached below to the upper surface of the posterior half of the coracoid process and above to the oblique ridge on the inferior surface of the acromial end of the clavicle.

The **conoid** is a cone-shaped ligament attached by its apex to the upper surface of the coracoid process, near the suprascapular notch, and by its base to the coracoid tuberosity on the inferior surface of the clavicle. It lies slightly behind and to the medial side of the trapezoid ligament.

The Shoulder Joint

The shoulder is a ball-and-socket joint. The bones which form it are the glenoid cavity of the scapula, and the head of the humerus. The glenoid cavity is a shallow fossa overhung by the acromion and coracoid processes, which with the tendons and ligaments surrounding the joint serve to protect it from displacement. A layer of cartilage covers the articular surfaces of the bones.

The **ligaments** are—

Capsule.	Glenoid.
Transverse humeral.	Coraco-humeral.

The **capsule** completely invests the joint. It is attached by its upper extremity

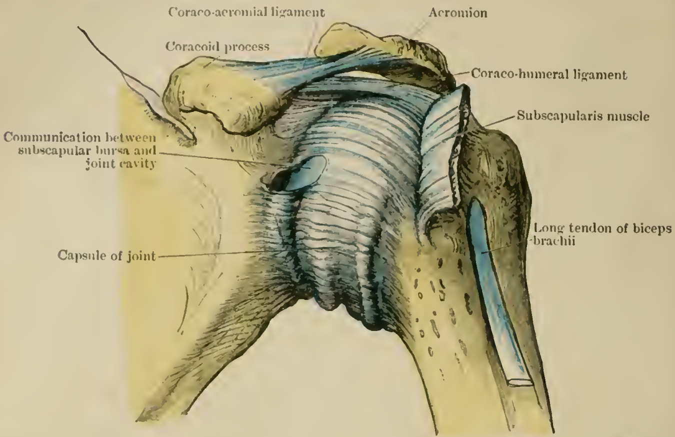


FIG. 37.—CAPSULE OF THE SHOULDER JOINT AND CORACO-ACROMIAL LIGAMENT.

to the circumference of the glenoid cavity, and by its lower to the anatomical neck of the humerus. The longitudinal fibres of the anterior portion of the capsule are arranged in the form of three flat bands, known as the **gleno-humeral ligaments,**

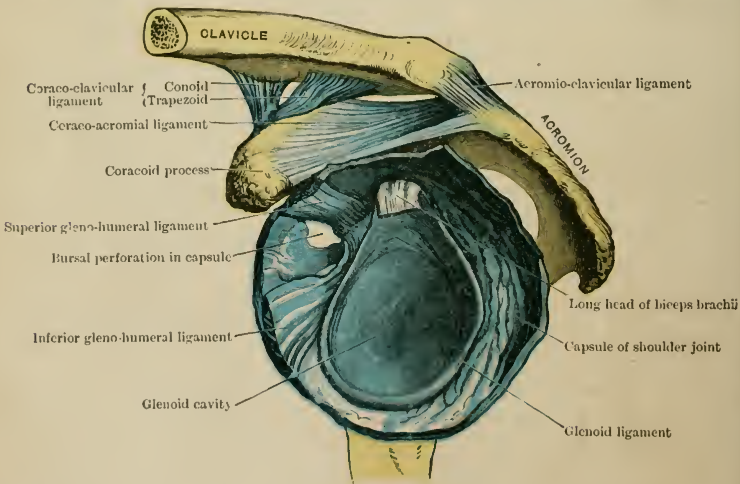


FIG. 38.—CAPSULAR LIGAMENT OF SHOULDER JOINT CUT ACROSS AND HUMERUS REMOVED.

which extend from the anterior border of the glenoid fossa to the anterior surface of the neck of the humerus.

The **transverse humeral ligament** is a continuation of the capsule, and crosses the intertubercular groove between the tubercles of the humerus.

The **glenoid ligament** is a band of strong fibro-cartilaginous tissue attached to the rim of the glenoid cavity, which it serves to deepen.

The **coraco-humeral ligament** is a flat band extending from the lateral border of the base of the coracoid process to the neck of humerus near the large tubercle.

A **synovial membrane** lines the capsule. It also invests that part of the long tendon of the biceps muscle which lies inside the capsule of the joint.

Bursæ.—The *subscapular bursa* lies underneath the tendon of the subscapularis muscle, and communicates with the joint cavity by an opening in the capsule. It is really a continuation of the articular synovial membrane.

Sometimes a second but smaller bursa is found between the capsule and the tendon of the infraspinatus muscle.

The *subdeltoid* or *subacromial bursa* is a large bursa, not communicating with the joint cavity. It is found underneath the deltoid muscle.

The muscles which surround and, together with other muscles given below, act upon the shoulder joint, are—the deltoid, supraspinatus, infraspinatus, teres major and minor, and subscapularis.

Movements at the Shoulder Joint

Flexion (forward movement), extension (backward movement), abduction, adduction, rotation, and circumduction.

Table of Muscles which produce these Movements

Flexion.	*Extension.*
Deltoid (anterior fibres).	Deltoid (posterior fibres).
Subscapularis.	Teres major.
Pectoralis major.	Infraspinatus.
Coraco-brachialis.	Latissimus dorsi.
Biceps brachii.	Triceps brachii (long head).

Adduction.	*Abduction.*
Teres major.	Deltoid.
„ minor.	Supraspinatus.
Pectoralis major.	
Latissimus dorsi.	
Coraco-brachialis.	
Biceps brachii (short head).	
Triceps brachii (long head).	

Medial Rotation.	*Lateral Rotation.*
Deltoid (anterior fibres).	Deltoid (posterior fibres).
Teres major.	Infraspinatus.
Pectoralis major.	Teres minor.
Latissimus dorsi.	Supraspinatus.
Subscapularis.	

Circumduction.

Combination of muscles given above.

Arterial Supply.—Articular branches of the anterior and posterior circumflex arteries of the humerus and transverse scapular artery.

Nerve Supply.—Axillary.
Suprascapular.

The Elbow Joint

The elbow is a typical hinge joint.

The bones entering into its formation are the humerus, ulna, and radius.

The trochlea of the humerus articulates with the semilunar notch of the ulna.

The capitulum of the humerus articulates with the superior surface of the head of the radius.

The articular surfaces are covered with a layer of cartilage.

Ligaments { Anterior.
Posterior.
Ulnar collateral.
Radial collateral.

These ligaments surround the joint so as to form a complete capsule.

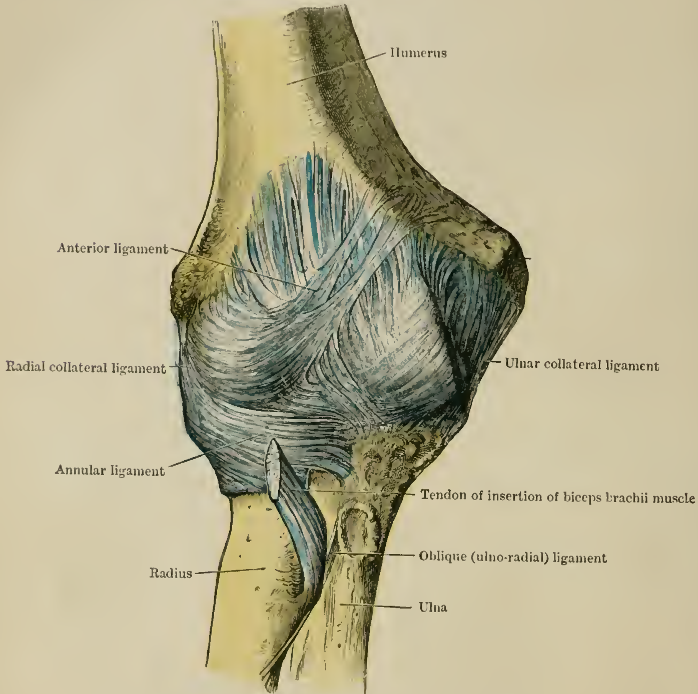


FIG. 39.—ANTERIOR VIEW OF ELBOW JOINT.

The **anterior ligament** is attached to the upper margins of the coronoid and supracapitular fossæ above, and below to the anterior surface of the coronoid process of the ulna and to the annular ligament of the proximal radio-ulnar joint.

The **posterior ligament** is attached superiorly to the humerus above the olecranon fossa, inferiorly to the olecranon.

The **ulnar collateral ligament** is a triangular band extending from the anterior, posterior, and inferior surfaces of the medial epicondyle of the humerus to the medial margin of the semilunar notch.

The **radial collateral ligament** extends from the lateral epicondyle of the humerus above to the annular ligament and anterior and posterior margins of the radial notch below.

The **annular ligament** may also be reckoned as one of the ligaments of the elbow joint. It encircles the head and the upper part of the neck of the radius, and is attached at each end to the anterior and posterior margins of the radial notch.

A **synovial membrane** lines the entire capsule of the joint, and covers the pads of fat which are situated in the coronoid, supracapitular, and olecranon fossæ, but is absent from the articular ends of the bones which are covered with cartilage.

The muscles in relation to the joint are the brachialis in front, triceps brachii and anconeus behind, supinator and the common tendon of origin of the extensor

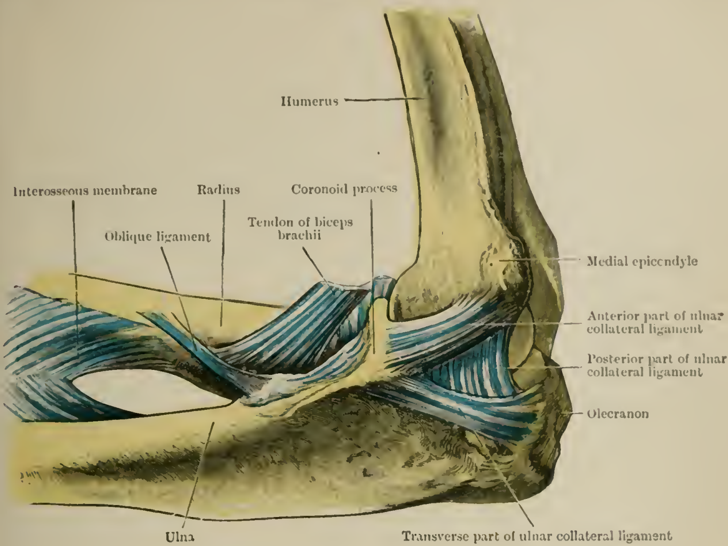


FIG. 40.—ELBOW JOINT (Medial Aspect).

muscles laterally, the common tendon of origin of the flexor muscles and flexor carpi ulnaris medially.

MOVEMENTS AT THE ELBOW JOINT

Flexion and extension.

TABLE OF MUSCLES WHICH PRODUCE THESE MOVEMENTS

Flexion.	*Extension.*
Biceps brachii.	Triceps brachii.
Brachialis.	Anconæus.
Brachio-radialis.	Extensors of wrist and fingers (in supination).
Pronator teres.	
Flexors of wrist and fingers.	
Extensors of wrist (in pronation).	

Arterial Supply.—Branches of the radial collateral, superior ulnar collateral brachial, ulnar, and radial arteries form a network round the joint.

Nerve Supply.—Ulnar and median.

Proximal Radio-Ulnar Articulation

The proximal radio-ulnar is a rotatory joint. The parts which enter into its formation are the side of the head of the radius and the radial notch of the ulna. The articular surfaces are covered with cartilage, which is a continuation of that which covers the articular surfaces of the bones entering into the formation of the elbow joint, as is also the synovial membrane which lines the capsule.

Ligament.—Annular.—The **annular ligament** encircles the proximal part of the neck of the radius, and is attached by each end to the anterior and posterior borders of the radial notch. The head of the radius is thus securely held in its place.

Distal Radio-Ulnar Articulation

The distal radio-ulnar is a rotatory joint. The parts which enter into its formation are the side of the head of the ulna, which articulates with the ulnar notch at the distal end of the radius. The articulation of the head of the ulna with the triangular fibro-cartilage is also included in this joint.

A layer of hyaline cartilage covers the articular surfaces, and the **synovial membrane** is extensive, being prolonged upwards between the radius and ulna. It also covers the proximal surface of the triangular fibro-cartilage.

Ligaments.—Anterior radio-ulnar, posterior radio-ulnar, triangular interarticular fibro-cartilage.

The **anterior** and **posterior radio-ulnar ligaments** extend transversely from the radius to the ulna on the anterior and posterior aspects of the joint.

The **triangular interarticular fibro-cartilage** lies beneath the head of the ulna; it is attached by its apex to the root of the styloid process of the ulna, and by its base to the ridge between the ulnar notch and the carpal articulating surface of the radius, thus holding together the distal ends of the radius and ulna. Between the radio-ulnar articulations are two ligaments, the oblique and interosseous ligaments, by which the shafts of the radius and ulna are connected together. The **oblique** ligament extends from the coronoid process of the ulna to that part of the radius immediately distal to the tubercle. The **interosseous ligament** is a strong membrane which extends across the space between the radius and ulna, and is attached to the interosseous border of each bone. It extends distally from about 1 inch below the tubercle of the radius.

Movements at the Radio-Ulnar Articulations

Pronation and Supination.—At the proximal radio-ulnar joint the head of the radius rotates within the radial notch of the ulna, while at the distal joint the radius rotates upon the head of the ulna. Rotation forwards is called pronation, rotation backwards supination. In the former position the palm of the hand is directed downwards, and the radius lies obliquely across the front of the ulna; in the latter the palm of the hand is directed upwards, and the bones of the forearm lie parallel to each other. These movements are checked in their extent by the anterior and posterior radio-ulnar ligaments.

Muscles which produce these Movements

Pronation.	*Supination.*
Pronator teres.	Supinator.
Pronator quadratus.	Biceps brachii. Triceps brachii
Brachio-radialis.	Brachio-radialis.
Flexor carpi radialis.	Extensors of thumb and fingers.

(The brachio-radialis muscle acts as a supinator when the hand is in the prone position, and as a pronator when the hand is in the supine position.)

The Radio-Carpal or Wrist Joint

The wrist has some of the characteristics of both a ball-and-socket and gliding joint, but strictly speaking is a double hinge or biaxial joint, movement taking place about two axes at right angles to each other.

The parts which form it are the lower end of the radius and the inferior surface of the triangular fibro-cartilage above, and the navicular, lunate, and triquetral bones below.

The articular surfaces are covered with cartilage.

The **ligaments** are—

Radial collateral.
Ulnar collateral.
Volar radio-carpal.
Dorsal radio-carpal.

The **radial collateral ligament** extends from the styloid process of the radius to the tubercle of the navicular bone.

The **ulnar collateral ligament** extends from the styloid process of the ulna to the triquetral and pisiform bones.

The **volar radio-carpal ligament** extends from the anterior border of the distal end of the radius and the styloid process of the ulna to the palmar surfaces of the navicular, lunate, and triquetral bones.

The **dorsal radio-carpal ligament** extends from the posterior border of the lower end of the radius to the dorsal surfaces of the navicular, lunate, and triquetral bones.

These ligaments completely surround the joint so as to form a capsule, and are lined by **synovial membrane.**

FIG. 41.—LIGAMENTS ON ANTERIOR ASPECT OF RADIO-CARPAL, CARPAL, AND CARPO-METACARPAL JOINTS.

The extensor tendons cover the back of the wrist, while the front is covered by the flexor tendons. The radial and ulnar arteries lie also in relation to it.

MOVEMENTS AT THE WRIST JOINT

Flexion, extension, abduction, adduction.

Table of Muscles which produce these Movements

Flexion.	*Extension.*
Flexor carpi radialis.	Extensor carpi radialis longus.
Palmaris longus.	„ „ brevis.
Flexor carpi ulnaris.	Extensor carpi ulnaris.
Long flexors of thumb and fingers.	Extensors of thumb and fingers.

Adduction.	*Abduction.*
Flexor carpi ulnaris.	Flexor carpi radialis.
Extensor carpi ulnaris.	Extensor carpi radialis longus.
	„ „ brevis.
	Extensors of thumb.

Arterial Supply.—Radial and ulnar arteries.
Nerve Supply.—Dorsal interosseous and volar interosseous.

The Carpal Joints

The articulations of the carpal bones with each other are called arthrodial or gliding joints. For description they may be divided into—

1. Articulations between the bones forming the proximal row.
2. Articulations between the bones forming the distal row.
3. Articulation between the proximal and distal rows, called the transverse or mid-carpal articulation.

I. **Articulations of the Proximal Row.**—The ligaments binding the navicular, lunate, and triquetral bones together consist of three sets, namely, palmar or anterior (two in number), dorsal or posterior (two in number), interosseous (two in number).

The **anterior ligaments** pass transversely between the palmar surfaces of the bones.

The **posterior ligaments** pass in the same way between the dorsal surfaces.

The **interosseous ligaments** lie transversely on a level with the proximal surfaces of the bones.

The ligaments connecting the pisiform bone to the triquetral consist of a capsule and two ligaments—piso-hamatum and piso-metacarpeum.

The **piso-hamate ligament** extends from the inferior and medial side of the pisiform bone to the hook of the hamate bone.

The **piso-metacarpal ligament** extends from the same part of the pisiform bone to the base of the fifth metacarpal bone.

II. **Articulations of the Distal Row.**—The ligaments connecting the large and small multangular bones, the capitate, and the hamate are—anterior or palmar (three in number), posterior or dorsal (three in number), interosseous (two or three in number).

The **anterior** and **posterior ligaments** have a similar arrangement to those of the proximal row. The **interosseous ligament** connecting the large and small multangular bones is often absent.

III. **The Transverse Carpal Joint.**—This is formed by the articulation of the proximal and distal rows of the carpus.

The ligaments are—palmar or anterior, dorsal or posterior, radial collateral carpal, and ulnar collateral carpal.

The **anterior ligaments** extend from the capitate bone to the navicular, triquetral, and pisiform bones.

The **posterior ligaments** extend between the dorsal surfaces of the two rows of the carpus.

The **radial collateral carpal ligament** connects the navicular and large multangular bones

The **ulnar collateral carpal ligament** connects the triquetral and hamate bones. Both these ligaments are continuations respectively of the radial and ulnar collateral ligaments of the wrist joint.

An extensive **synovial membrane** lines the transverse carpal joint and is reflected between the adjacent surfaces of the bones forming the proximal and distal rows.

The articulation between the pisiform and triquetral bones has a separate synovial membrane.

The Intermetacarpal Joints

The four medial metacarpal bones articulate with each other at their carpal extremities or bases. They belong to the gliding variety of joint (arthrodial diarthroses), and are connected together by **dorsal, palmar,** and **interosseous ligaments.** These lie transversely on the dorsal, palmar, and interosseous aspects of the joints. Prolongations of the **synovial membrane** of the carpo-metacarpal joints line the joint cavities.

The digital extremities of the four medial metacarpal bones are connected together anteriorly by the **transverse metacarpal ligament.**

The Carpo-Metacarpal Joints

1. **Articulation of the first metacarpal bone with the large multangular bone.** The articular surfaces are saddle-shaped, and it is known as a reciprocal-reception joint. It is surrounded by a **capsule** and is lined by a separate **synovial membrane.** This joint is capable of flexion, extension, abduction, adduction, and circumduction.

2. **Articulations of the four medial metacarpal bones and those forming the distal row of the carpus.** These are gliding joints connected together by **dorsal, palmar,** and **interosseous ligaments.** A **synovial membrane** lines the joints and is usually continuous with that of the intermetacarpal and intercarpal joints.

The Metacarpo-Phalangeal Joints

With the exception of the thumb, which is a ginglymus or hinge joint, these articulations may be classed as belonging to the ball-and-socket variety. They are formed by the articulation of the spherical head of the metacarpal bone and the shallow oval hollow upon the proximal extremity of the first phalanx. The ligaments are—palmar or anterior, and two collateral. Expansions of the extensor tendons take the place of dorsal ligaments.

The **palmar ligament** is a thick structure of fibro-cartilage attached to the metacarpal bone and the first phalanx. It lies on the palmar surface of the joint between the collateral ligaments, with which it blends. The **collateral ligaments** extend between the tubercle and depression on each side of the head of the metacarpal bone and the sides of the base of the first phalanx. The **transverse metacarpal ligament** mentioned above forms an accessory ligament for the four medial metacarpo-phalangeal joints.

Movements at the Four Medial Metacarpo-Phalangeal Joints

Palmar flexion and extension, and in some cases dorsi flexion. Abduction and adduction from and to the median line of the hand and modified circumduction.

The Interphalangeal Joints

These belong to the hinge variety. The ligaments are—**palmar** and **collateral.** These are arranged as in the metacarpo-phalangeal joints. The dorsal aspect of each articulation is supported by the extensor tendons.

A **synovial membrane** lines each joint.

Movements at the Interphalangeal Joints

Palmar flexion and extension.

SOME ARTICULATIONS OF THE LOWER EXTREMITY

The Hip Joint

The hip is a perfect example of a ball-and-socket joint. The articular surfaces which enter into its formation are the head of the femur and the acetabulum, into which it is received. These surfaces are covered by a layer of cartilage—with the exception of the depression on the head of the femur and the centre of the acetabulum.

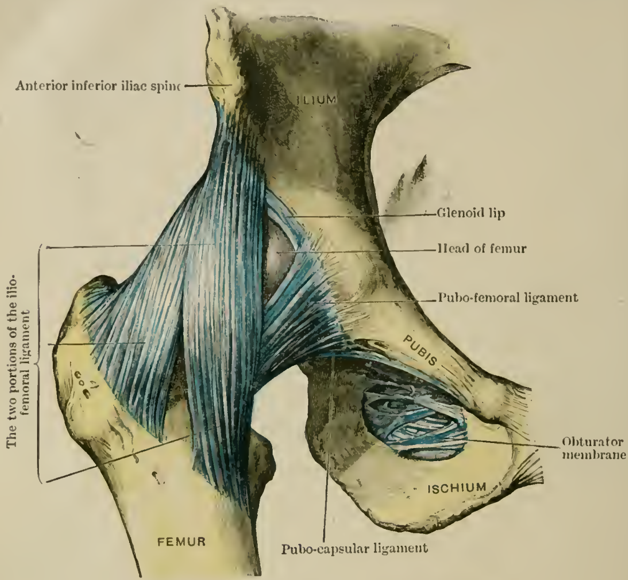


FIG. 42.—DISSECTION OF THE HIP JOINT FROM THE FRONT.

The **ligaments** are—

- Transverse.
- Glenoid lip.
- Round ligament of the femur.
- Capsule.

The **transverse ligament** stretches across the notch at the lower part of th acetabulum and is attached to its margin at either side. There is an opening lef beneath, through which vessels and nerves enter the joint.

The **glenoid lip** is attached to the brim of the acetabulum, which it serve to deepen ; it consists of a ring of fibro-cartilage.

The **round ligament of the femur** is attached by one end to the depressio near the centre of the head of the femur, and by the other to the margins c the acetabular notch, becoming blended with the transverse ligament.

The **capsule** completely invests the joint, surrounding the acetabulum above an the neck of the femur below. It is very strong, but of varying thickness throughou

The longitudinal fibres form three separate bands, namely—

- Ilio-femoral.
- Pubo-femoral or pubo-capsular.
- Ischio-capsular.

The **ilio-femoral ligament** is attached above to the anterior inferior iliac spin and rim of the acetabulum, below to the intertrochanteric line of the femur.

The **pubo-capsular ligament** passes from the lateral extremity of the horizont ramus of the pubis and the ilio-pectineal eminence to the capsule of the joint and the neck of the femur.

The **ischio-capsular ligament** passes from the ischium and becomes merged in the zona orbicularis or circular fibres of the general capsule.

There is a large mass of adipose tissue at the bottom of the acetabulum. These pads of fat, as already stated, are found variously developed in many joints, and are called Haversian glands.

A **synovial membrane** lines the capsule and covers part of the neck of femur. It invests the interarticular ligament, both surfaces of the glenoid and transverse ligaments, and also covers the Haversian gland.

Behind the tendon of the ilio-psoas muscle is a synovial **bursa** which sometimes communicates with the joint cavity by an opening in the anterior part of the capsule.

The muscles surrounding the joint are—

Psoas and iliacus in front.
Straight head of rectus and gluteus minimus laterally.
Obturator externus and pectineus medially.
Piriformis, gemellus superior, gemellus inferior, obturator internus and externus, and quadratus femoris behind.

Movements of the Thigh at the Hip Joint

Flexion, extension, abduction, adduction, rotation, and circumduction.

Table of Muscles which produce these Movements

Flexion.	*Extension.*
Sartorius.	Gluteus maximus.
Iliacus.	„ medius.
Psoas major.	„ minimus.
Rectus femoris.	Biceps femoris.
Pectineus.	Semitendinosus.
Adductor longus.	Semimembranosus.
Gracilis.	Adductor magnus.
Obturator externus.	

Adduction.	*Abduction.*
Pectineus.	Tensor fasciæ latæ.
Adductor longus.	Gluteus medius.
„ brevis.	„ minimus.
„ magnus.	Obturator externus.
Gracilis.	Piriformis . . . } during flexion.
Quadratus femoris.	Obturator internus } during flexion.
Gluteus maximus (lower fibres).	Gemelli . . . . } during flexion.
	Sartorius . . . . } during flexion.
	Gluteus maximus (upper fibres) . } during flexion.

Medial Rotation.	*Lateral Rotation.*
Tensor femoris latæ.	Obturator externus.
Gluteus medius (anterior fibres).	Gluteus maximus (lower fibres).
Gluteus minimus (anterior fibres).	Quadratus femoris.
	Gluteus medius . } (posterior fibres).
	„ minimus } (posterior fibres).
	Piriformis . . . } during extension.
	Obturator internus } during extension.
	Gemelli . . . . } during extension.
	Sartorius.
	Ilio-psoas.
	Pectineus.
	Adductor longus, brevis, and magnus.
	Biceps femoris.

Arterial Supply.—Obturator and medial circumflex.

Nerve Supply.—Articular branches from sciatic, obturator, and femoral.

The muscles which, when the pelvis is fixed, flex and extend the thigh on the abdomen will, when the limb is fixed, flex and extend the abdomen on the thigh.

The Knee Joint

The knee is a hinge joint. The bones entering into its formation are the articular surfaces of the femur, tibia, and patella, which are covered by a layer of cartilage.

The **ligaments** are—

External.	*Internal.*
Anterior, or ligamentum patellæ.	Anterior cruciate.
Oblique popliteal.	Posterior cruciate.
Tibial collateral.	Lateral meniscus.
Fibular collateral.	Medial meniscus.
Capsule.	Transverse.
	Coronary.

The **anterior ligament** is attached proximally to the apex of the patella and its adjoining margins, distally to the tubercle of the tibia. Its superficial fibres pass across the patella and are a continuation of those of the tendon of the quadriceps extensor muscle, of which it is the final insertion.

The **oblique popliteal ligament** is attached proximally to the condyles and popliteal surface of the femur, distally to the posterior border of the head of the tibia.

The **tibial collateral ligament** consists of two portions, an anterior or long and a posterior or short portion. They are attached proximally to the medial epicondyle of the femur, and distally the anterior portion is attached to the proximal part of the medial surface of the shaft of the tibia, while the posterior portion is attached to the posterior part of the medial condyle of the tibia, just proximal to the insertion of the semimembranosus tendon.

The **fibular collateral ligament** is attached proximally to the lateral epicondyle of the femur, distally to the lateral side of the head of the fibula, in front of the styloid process.

The **short fibular collateral ligament** is an inconstant fibrous band lying behind the preceding. It is attached proximally to the lower and hinder part of the lateral epicondyle of the femur, and distally to the apex of the head of the fibula.

The **capsule** does not completely surround the joint, as it is absent above, where its place is taken by the quadriceps extensor tendon. It is a thin, strong membrane, augmented by the tendons of the surrounding muscles and also by the fascia latæ. Proximally it is attached to the femur, distally to the sides of the patella, the margins of the head of the tibia, and to the menisci.

The **cruciate ligaments** lie within the joint, and cross each other like braces.

The **anterior cruciate** is attached distally to the medial side of the rough depression in front of the intercondyloid eminence of the tibia; proximally it is attached to the medial and posterior surface of the lateral condyle of the femur.

The **posterior cruciate** is attached distally to the posterior part of the depression behind the intercondyloid eminence of the tibia, and proximally to the lateral and anterior part of the medial condyle of the femur.

The **lateral** and **medial menisci** are two crescent-shaped fibro-cartilages. They are found between the articular surfaces of the femur and tibia and are attached to the margins of the latter, the surface of which they serve to deepen.

The horns of both cartilages are attached to the proximal surface of the tibia, those of the lateral meniscus lying between those of the medial meniscus.

The **transverse ligament** connects the anterior margins of the lateral and medial menisci.

The **coronary ligaments** consist of a number of short fibrous bands which help to attach the menisci to the margins of the head of the tibia.

A wedge of fat is found between the patella, the tibia, and the condyles of the femur. It is called the infra-patellar pad. Deposits of fat are also found about the folds of the synovial membrane.

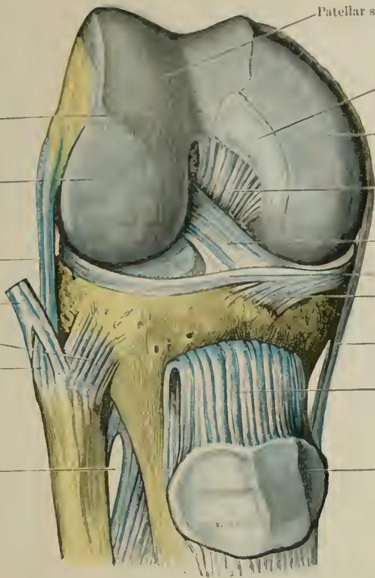


FIG. 43.—DISSECTION OF THE KNEE JOINT FROM THE FRONT: PATELLA THROWN DOWN.

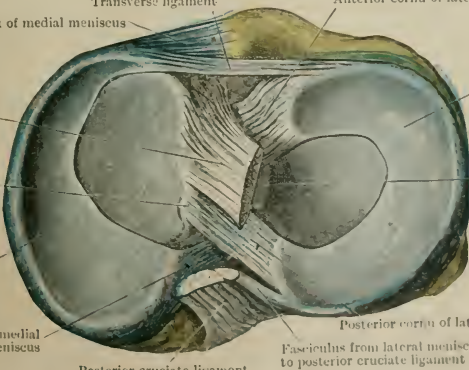


FIG. 44.—UPPER END OF TIBIA, WITH MENISCI AND ATTACHED PORTIONS OF CRUCIATE LIGAMENTS.

The **synovial membrane** is the largest in the body and very elaborately arranged. It lines the capsule, invests the menisci, and, partially, the cruciate ligaments; it also lines the deep surface of the common extensor tendon, and is prolonged for a variable distance upon the distal part of the front of the shaft of femur.

A large **bursa** is found above the joint on the front of the femur, with which the synovial membrane of the joint is usually continuous.

Bursæ are also found between the anterior surface of the patella and the skin covering it, between the ligamentum patellæ and the tubercle of the tibia, and in relation to the tendon of the semimembranosus muscle and the medial head of the gastrocnemius muscle.

Movements at the Knee Joint

Flexion, extension, and slight medial and lateral rotation during partial flexion.

Table of Muscles which produce these Movements

Flexion.	*Extension.*
Sartorius.	Quadriceps extensor.
Gracilis.	
Semitendinosus.	
Semimembranosus.	
Biceps femoris.	
Gastrocnemius.	
Plantaris.	
Popliteus.	

Medial Rotation.	*Lateral Rotation.*
Popliteus.	Biceps femoris.
Sartorius.	
Gracilis.	
Semitendinosus.	
Semimembranosus.	

Arterial Supply.—Branches of the femoral, popliteal, and anterior tibial.
Nerve Supply.—Obturator, femoral, peroneal, and tibial.

The Ankle Joint

The ankle is a hinge joint. The bones which enter into its formation are the lower ends of the tibia and fibula and the talus.

A layer of cartilage covers the articular surfaces of the bones.

The **ligaments** are—

Anterior.	Deltoid.
Posterior.	Anterior talo-fibular.
	Posterior talo-fibular.
	Calcaneo-fibular.

The **anterior ligament** is attached proximally to the distal border of the tibia, distally to the proximal border of the head of the talus.

The **posterior ligament** extends from the distal border of the tibia behind to the talus. The back of the joint is also strengthened by the transverse tibio-fibular ligament, which extends between the distal border of the tibia and the lateral malleolus.

The **deltoid ligament** extends from the distal part of the medial malleolus to the navicular, talus, and calcaneus.

The **anterior talo-fibular ligament** extends from the anterior border of the lateral malleolus to the talus, in front of its lateral articular surface.

The **calcaneo-fibular ligament** extends from the apex of the lateral malleolus to the lateral side of the calcaneus.

The **posterior talo-fibular ligament** extends from the depression on the medial and posterior aspect of the lateral malleolus in a horizontal direction to the posterior surface of the talus.

These ligaments completely surround the joint so as to form a capsule.

A **synovial membrane** lines the ligaments, covers the pads of fat which are found about the joint, and extends upwards for a short distance between the tibia and fibula.

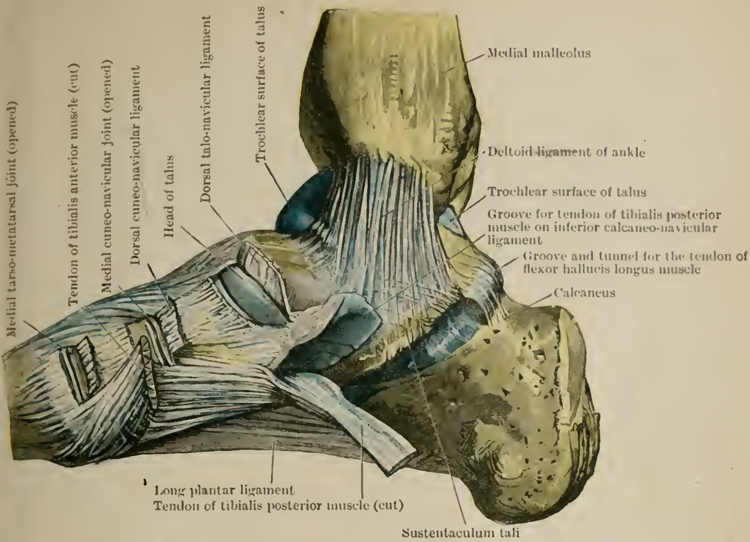


FIG. 45.—ANKLE AND TARSAL JOINTS FROM THE TIBIAL ASPECT.

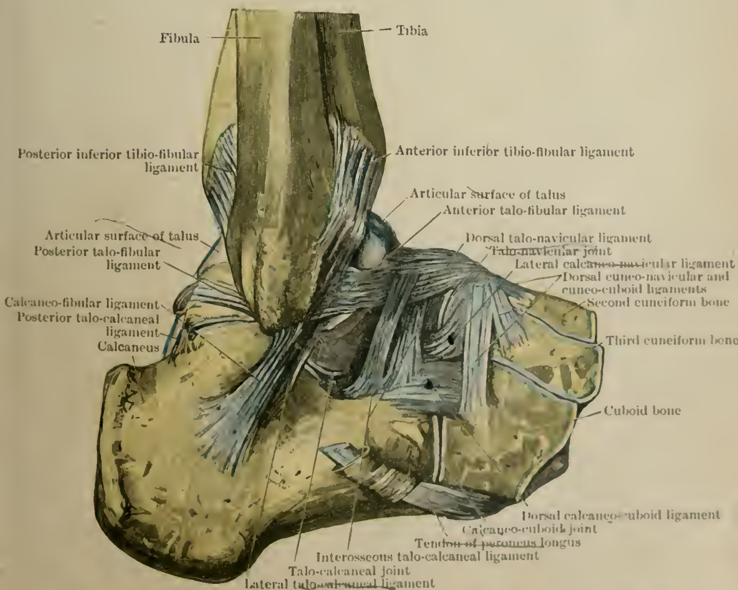


FIG. 46.—LIGAMENTS ON THE LATERAL ASPECT OF THE ANKLE JOINT AND ON THE DORSUM OF THE TARSUS.

Movements at the Ankle Joint

Dorsi-flexion and plantar-flexion.

Table of Muscles which produce these Movements

Dorsi-flexion.	*Plantar-flexion.*
Tibialis anterior.	Gastrocnemius.
Extensor digitorum longus.	Plantaris.
Extensor hallucis longus.	Soleus.
Peroneus tertius.	Tibialis posterior.
	Peroneus longus.
	„ brevis.
	Flexor digitorum longus.
	Flexor hallucis longus.

It is usually considered that a certain amount of lateral movement may be produced by the application of external force at the ankle joint when it is plantar-flexed.

The movements of inversion (rotating the foot so that it rests on its lateral border) and eversion (rotating the foot so that it rests on its medial border) take place at the intertarsal joints, mainly the talo-calcaneal.

Table of Muscles which produce these Movements

Inversion.	*Eversion.*
Tibialis anterior.	Peroneus tertius.
„ posterior.	„ longus.
	„ brevis.

Arterial Supply.—Malleolar branches of the anterior tibial and peroneal.
Nerve Supply.—Deep peroneal.

The Intertarsal Joints

These are gliding joints.

The Talo-Calcanean Joint

This is situated between the posterior facet on the inferior surface of the talus and the facet corresponding to it on the superior surface of the calcaneus.

Ligaments.—Lateral talo-calcaneal.
Medial talo-calcaneal.
Anterior talo-calcaneal.
Posterior talo-calcaneal.
Interosseous talo-calcaneal.

These ligaments form a capsule round the joint, which is also strengthened by the deltoid and fibular collateral ligaments of the ankle.

The **lateral talo-calcaneal ligament** extends between the lateral surface of the talus, below the facet for the lateral malleolus, and the lateral surface of the calcaneus.

The **medial talo-calcaneal ligament** extends obliquely between the medial tubercle on the posterior surface of the talus and the posterior border of the sustentaculum tali.

The **anterior talo-calcaneal ligament** extends from the anterior and lateral aspect of the neck of the talus to the superior surface of the calcaneus.

The **posterior talo-calcaneal ligament** extends between the lateral tubercle of the talus to the adjacent superior surface of the calcaneus.

The **interosseous talo-calcaneal ligament** is attached above to the groove on the inferior surface of the talus, below to the corresponding groove on the superior surface of the calcaneus.

The Talo-Calcaneo-Navicular Joint

The articular elements entering into the formation of this joint are the rounded head of the talus, which fits into a cavity formed by the posterior surface of the navicular bone, the superior surface of the sustentaculum tali, and the superior surface of the plantar calcaneo-navicular ligament.

This joint is invested by a **capsule** formed behind by the **interosseous talo-calcaneal ligament,** on its medial and lateral inferior aspects by the **calcaneo-navicular ligaments,** and superiorly by the **talo-navicular ligament.** This latter extends between the neck of the talus and the dorsal surface of the navicular bone. It consists of three parts—superior, medial, and lateral.

The capsule is lined by a **synovial membrane.**

The calcaneus and navicular bone do not directly articulate with each other, but are connected by **dorsal calcaneo-navicular ligaments** and **plantar calcaneo-navicular ligaments.**

The **dorsal calcaneo-navicular ligament** arises from the groove between the talus and calcaneus, and extends forwards from the anterior part of the dorsal surface of the calcaneus to the lateral side of the navicular bone.

The **plantar calcaneo-navicular ligament** extends from the anterior border of the sustentaculum tali to the plantar surface of the navicular bone. Some of its upper fibres blend with the front part of the deltoid ligament of the ankle. Its upper surface supports the head of the talus; its inferior surface rests upon the tendon of the tibialis posterior. It is a powerful ligament and the chief one concerned in maintaining the arch of the foot.

The Calcaneo-Cuboid Joint

The ligaments connecting the calcaneus and cuboid bones form a capsule round the joint. They are as follows:—

The **internal calcaneo-cuboid** or **interosseous ligament** extends from the groove on the calcaneus, between it and the talus, to the medial side of the cuboid bone.

The **dorsal calcaneo-cuboid ligament** connects the dorsal surfaces of the bones.

The **external calcaneo-cuboid ligament** connects the lateral contiguous surfaces of the two bones.

The **inferior calcaneo-cuboid ligaments** are two in number, namely, the long plantar ligament and the plantar calcaneo-cuboid ligament.

The **long plantar ligament** extends from the inferior surface of the calcaneus in front of the tuberosities to the ridge on the inferior surface of the cuboid bone, many of its more superficial fibres passing forwards to their attachments on the bases of the third, fourth, and fifth metatarsal bones.

The **plantar calcaneo-cuboid ligament** is a deeper structure than the preceding. It extends from the anterior part of the inferior surface of the calcaneus to the inferior surface of the cuboid bone behind the ridge. These two plantar ligaments are, next to the plantar calcaneo-navicular, the principal agents in maintaining the longitudinal arch of the foot.

The capsule is lined by a **synovial membrane.**

The Cuneo-Navicular Joint

The navicular and the three cuneiform bones are connected by **dorsal** and **plantar ligaments.** These consist of short bands extending in a longitudinal direction on the dorsal and plantar aspects of the joint. A **synovial membrane** lines the joint and is prolonged between the cuneiform bones; it also frequently communicates with the cubo-cuneiform articulation and with the cubo-navicular cavity.

The Naviculo-Cuboid Joint

Dorsal, plantar, and **interosseous ligaments** connect these two bones together

The Intercuneiform Joints

The three cuneiform bones are connected to each other by **dorsal, plantar,** and **interosseous ligaments.**

The Cuneo-Cuboid Joint

This is the articulation between the third cuneiform bone and the cuboid. The two bones are connected by **dorsal, plantar,** and **interosseous ligaments.** The **synovial membrane** is often separate, but sometimes forms part of that of the cuneo-navicular and naviculo-cuboid articulations.

The Tarso-Metatarsal Joints

These are gliding joints in which the tarsal and metatarsal bones are connected together by **dorsal, plantar,** and **interosseous ligaments.**

The articulation between the first cuneiform and the first metatarsal bone is lined by a separate **synovial membrane,** as is also that between the cuboid and fourth and fifth metatarsals. The joint between the second and third cuneiform and the bases of the second and third metatarsal bones is lined by part of the large tarsal **synovial membrane.**

The Intermetatarsal Joints

The bases of the four lateral metatarsal bones are connected together by **dorsal, plantar,** and **interosseous ligaments.**

The heads of all the metatarsal bones are bound together on their plantar aspect by the **transverse metatarsal ligament.**

The Metatarso-Phalangeal Joints

These articulations have a similar construction to the corresponding joints of the hand.

The Interphalangeal Joints

These articulations have also a similar construction to the corresponding joints of the hand.

CHAPTER V

THE MUSCULAR SYSTEM

The various movements of the body are caused by the contraction of muscles.

The skeletal muscles are under the control of the will, and are supplied by one or more nerves. They are of varying sizes and shapes, and are enclosed in a fibrous membrane called fascia, which may also form their means of attachment to bones, cartilages, and to neighbouring fascia. Muscles are also connected with bones, cartilages, and ligaments by means of tendons.

Most muscles are capable of causing movement of either of their attachments, but the contraction generally produces movement of one particular end; this, the more generally movable attachment, is called the insertion, the other attachment is called the origin.

FASCIA

The fasciæ have been divided into two classes—superficial and deep.

The former underlies the skin of the whole body and connects it with the deep fascia. It is composed of areolar tissue, contains a variable quantity of fat, and is supplied by the cutaneous vessels and nerves.

Deep fascia is a fibrous membrane, containing no fat, which invests muscles both individually and collectively, sometimes forming their means of attachment. It also forms sheaths for the vessels and nerves, and invests the glands and viscera.[1]

APONEUROSIS

Aponeurosis is a term usually given to a layer of dense fibrous tissue, like a thin tendon, which serves as an attachment for muscles to bones or to other muscles.

[1] At the wrist and ankle the deep fascia is strengthened by transverse fibres, and gives rise in the first instance to the two carpal ligaments, and in the latter to the three annular ligaments.

Carpal Ligaments.—The **transverse carpal ligament** extends from the navicular and large multangular bone to the pisiform and hamate bones. It contains two compartments, one for the tendons of the flexor muscles of the fingers and the median nerve, and the other for the flexor carpi radialis.

The **dorsal carpal ligament** extends from the lateral border of the distal end of the radius to the styloid process of the ulna, the carpus, and the ulnar collateral ligament of the wrist. It is divided into six compartments for the transmission of the tendons of the extensor muscles of the wrist and fingers.

Annular Ligaments of the Ankle.—The **ligamentum laciniatum** extends from the medial malleolus to the tuberosity of the calcaneus. The tendons of the tibialis posterior, flexor digitorum longus, and flexor hallucis longus pass beneath it, also the posterior tibial vessels and the tibial nerve.

The **lateral annular ligament** extends from the lateral malleolus to the calcaneus. It binds down the tendons of the peronei muscles.

The **anterior annular ligament** consists of two parts. The proximal band—**lig. transversum cruris**—extends across the front of the ankle between the malleoli, binding down the tendons of the tibialis anterior and the extensor muscles of the toes. The distal part of the anterior annular ligament—**lig. cruciatum cruris**—is attached laterally to the lateral border of the anterior extremity of the calcaneus. As it passes medially over the dorsum of the foot it divides into a proximal part which is attached to the medial malleolus, and a distal part attached to the plantar fascia. The lig. cruciatum cruris has three compartments, one for the tendon of the tibialis anterior, another for the tendon of the extensor hallucis longus, and a third for the tendon of the extensor digitorum longus and peroneus tertius.

TENDONS

Tendons are strong, white, inelastic bands of fibrous tissue, which bind the muscles to bones, cartilages, and ligaments. They are of varying length and size. The larger ones are supplied with nerves and blood vessels, but not plentifully.

SOME MUSCLES OF THE CRANIUM AND FACE

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Epicranius.	Posterior belly from superior curved line of occipital bone; anterior belly from the epicranial aponeurosis.[1]	Becomes blended with orbicularis oculi and corrugator supercilii at the superciliary ridge.	Raises eyebrow; moves scalp.	Branches of the facial.
Orbicularis oculi.	Sphincter muscle surrounding the circumference of the orbit and occupying the eyelid.		Closes eyelids.	Facial.
Corrugator supercilii.	Nasal eminence.	Under surface of orbicularis oculi.	Wrinkles forehead vertically. Draws medial half of eyebrow upwards.	,,
Levator palpebræ superioris.	Margin of optic foramen.	1. Orbicularis oculi and skin of upper lid. 2. Upper border superior tarsus. 3. Conjunctiva. 4. Upper border of margin of orbital opening.	Elevates upper eyelid.	Oculo-motor.
Caput infra-orbitale.	Lower margin of orbit.	Orbicularis oris and skin of upper lip.	Draws lip upwards.	Facial.
Caninus.	Canine fossa of upper jaw.	Orbicularis and skin at angle of mouth.	,,	,,
Zygomaticus.	Zygomatic portion of zygomatic arch.	Orbicularis oris and skin at angle of mouth.	Raises upper lip, and draws it backwards, as in laughing.	,,
Caput zygomaticum.	Zygomatic bone.	Orbicularis oris.	,,	,,
Mentalis.	Incisor fossa of lower jaw.	Skin of chin.	Raises skin of chin and protrudes lower lip.	,,
Quadratus labii inferioris.	Outer surface of lower jaw.	Orbicularis oris and skin of lower lip.	Draws lower lip downwards and laterally.	,,
Triangularis.	External oblique line of lower jaw and platysma.	Orbicularis oris and skin at angle of mouth.	Depresses angle of mouth.	,,

[1] The epicranial aponeurosis is a membrane which extends between the anterior and posterior bellies of the epicranius muscle. It is attached laterally to the temporal ridge, and behind to the linea nuchæ suprema of the occipital bone.

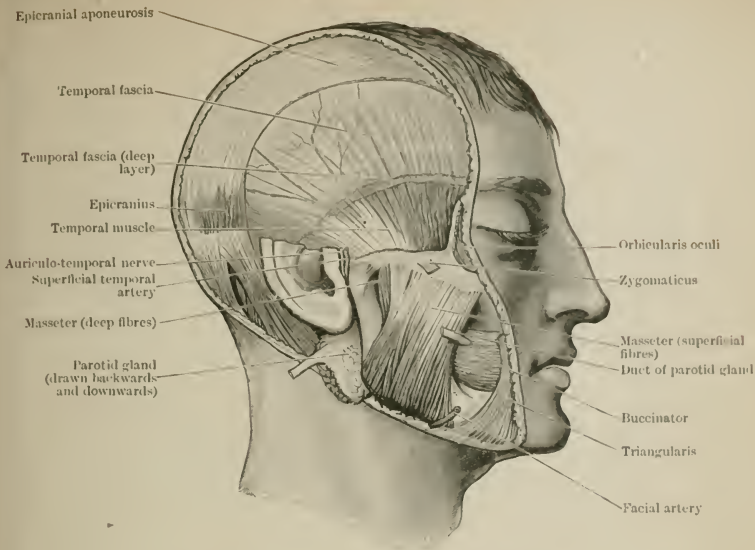


FIG. 47.—MUSCLES OF MASTICATION (Superficial View).

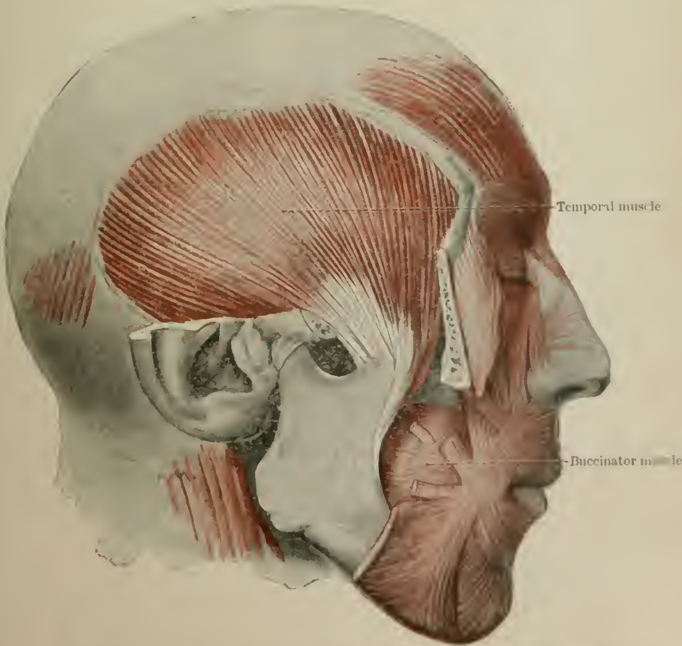


FIG. 48.—THE RIGHT TEMPORAL MUSCLE (the Zygoma and the Masseter Muscle have been removed).

SOME MUSCLES OF THE CRANIUM AND FACE—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Orbicularis oris.	Continuous with other muscles converging towards mouth; is a sphincter muscle surrounding mouth.		Closes lips.	Facial.
Risorius.	Fascia over masseter.	Orbicularis oris and skin at angle of mouth.	Draws back angle of mouth.	,,
Platysma.	Deep fascia of the pectoral region and clavicle.	Lower jaw and angle of mouth.	Depresses lower jaw and angle of mouth.	,,
Buccinator.	Alveolar processes of upper and lower jaws.	Orbicularis oris.	Retracts angle of mouth. Contracts and compresses cheek, bringing it into contact with the teeth.	,,

MUSCLES OF MASTICATION

Buccinator (given above). Masseter. Temporal.	Pterygoideus internus. Pterygoideus externus.

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Masseter.	1. Lower border of zygomatic arch. 2. Medial surface of zygomatic arch.	Lateral surface of ramus and angle of lower jaw and coronoid process.	Raises the lower jaw against the upper.	Maxillary nerve of trigeminal.
Temporal.	Whole of temporal fossa and temporal fascia covering it.	Coronoid process and anterior border of ramus of lower jaw.	Raises the lower jaw against the upper; posterior fibres retract the jaw; anterior fibres protract.	,, ,,
Internal pterygoid.	1. Pterygoid fossa (sphenoid bone). 2. Tuberosity of upper jaw.	Medial surface of lower jaw between mylohyoid groove and angle of bone.	Raises the lower jaw against the upper; draws it sideways and forwards.	,, ,,
External pterygoid.	1. Under surface of great wing of sphenoid. 2. Lateral surface of lateral pterygoid plate.	1. Neck of condyle of lower jaw. 2. Interarticular meniscus and capsule of mandibular articulation.	Draws lower jaw forwards and sideways.	,, ,,

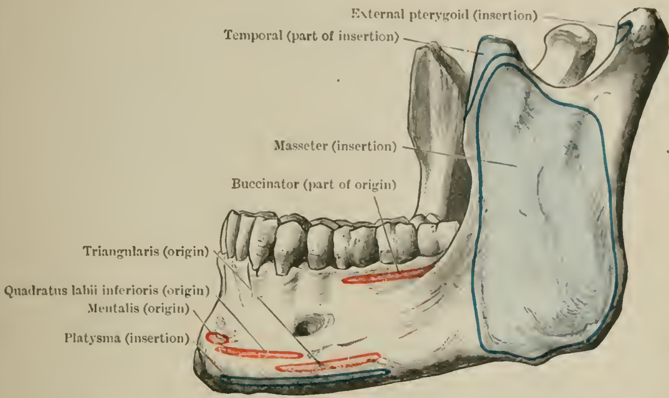


FIG. 49.—MUSCLE ATTACHMENTS TO THE LATERAL ASPECT OF THE LOWER JAW.

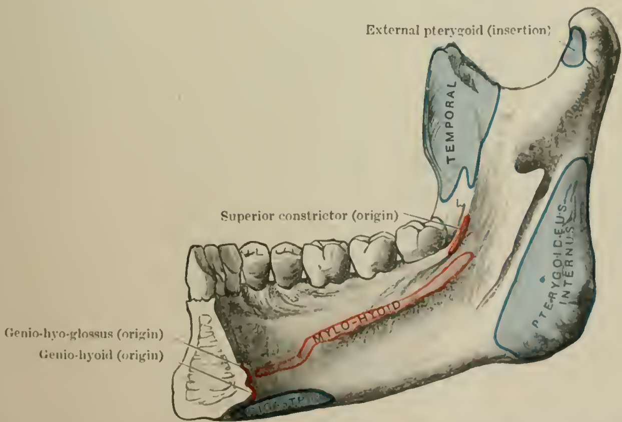


FIG. 50.—MUSCLE ATTACHMENTS ON THE MEDIAL SIDE OF THE LOWER JAW.

MUSCLES OF THE NECK

SUPERFICIAL MUSCLES, CERVICAL REGION

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Platysma.	Deep fascia of the pectoral region and clavicle.	Lower jaw and angle of mouth.	Depresses lower jaw and angle of mouth.	Facial.
Sterno-cleido-mastoid.	By two heads— 1. Sternum. 2. Clavicle.	Mastoid process and superior curved line of occipital bone.	(*o*)[1] One side acting alone rotates face to opposite side and bends the head to same side. Both sides acting together extend the head. (*i*)[2] Raises clavicle and helps in forced inspiration.	Accessory and branch from cervical plexus (c. 2).

INFRA-HYOID MUSCLES, CONNECTING THE HYOID BONE TO THE THORAX, SCAPULAR, AND THYROID CARTILAGE

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Sterno-hyoid.	Medial extremity of clavicle; upper and posterior portion of sternum.	Body of hyoid bone.	Depresses hyoid bone.	Ansa-hypoglossi (loop formed by the descending branches of cervical and hypoglossal nerves).
Sterno-thyroid.	Upper and posterior portion of sternum and first costal cartilage.	Thyroid cartilage.	Depresses thyroid cartilage.	Ansa-hypoglossi.
Thyro-hyoid.	Oblique line of thyroid cartilage.	Body and great cornu of hyoid bone.	Depresses hyoid bone.	Thyro-hyoid branch of hypoglossal.
Omo-hyoid.	Superior margin of scapula; suprascapular ligament.	Lower border of body of hyoid bone.	(*o*) Depresses hyoid bone. (*i*) Slightly raises shoulders.	Ansa-hypoglossi.

SUPRA-HYOID MUSCLES, CONNECTING THE HYOID BONE TO THE MANDIBLE, CRANIUM, AND TONGUE

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Digastric (two bellies, posterior and anterior).	(Posterior) Groove beneath mastoid process. (Anterior) Intermediate tendon connected with hyoid bone.	Lower border of jaw close to symphysis.	When posterior belly is fixed and hyoid bone depressed, it depresses jaw. When attachment of anterior belly is fixed, it raises hyoid bone.	Facial and mylo-hyoid branch of inferior alveolar nerve.
Stylo-hyoid.	Styloid process of temporal bone.	Body of hyoid bone.	Raises and draws back hyoid bone and tongue.	Facial.
Mylo-hyoid.	Mylo-hyoid ridge on inner surface of lower jaw.	Upper border of body of hyoid bone.	Raises hyoid bone and tongue.	Mylo-hyoid branch of inferior dental.

[1] The letter *o* in brackets signifies the action of the muscle when its origin is the fixed point.
[2] The letter *i* in brackets signifies the action of the muscle when its insertion is the fixed point.

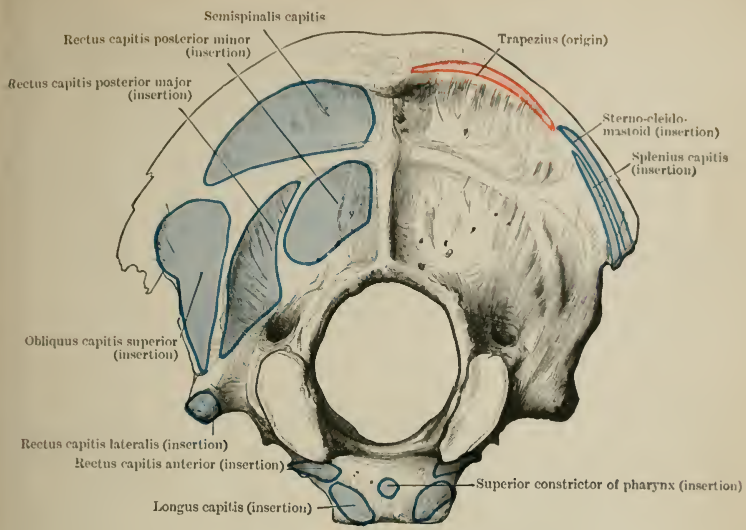


FIG. 51.—MUSCLE ATTACHMENTS TO OCCIPITAL BONE.

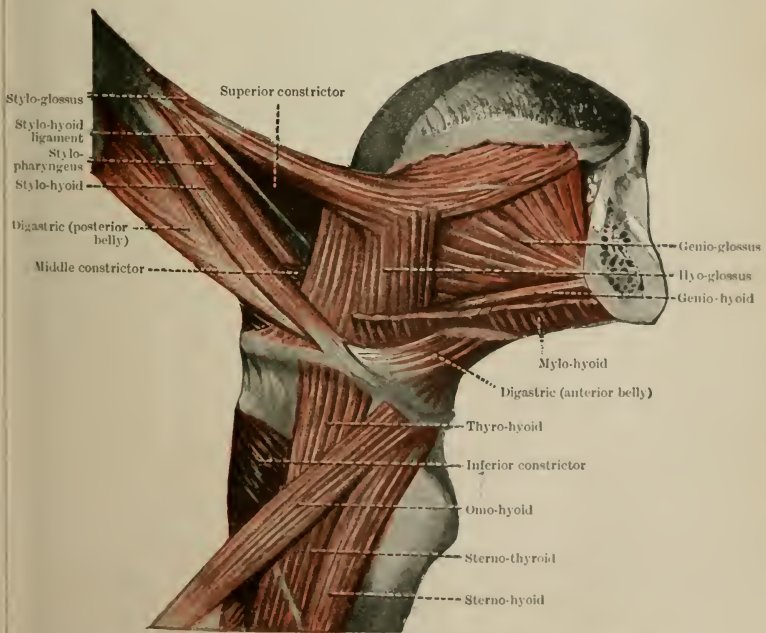


FIG. 52.—THE MUSCLES OF THE TONGUE AND HYOID BONE (Right Side).

MUSCLES OF THE NECK—*continued*

EXTRINSIC MUSCLES OF THE TONGUE

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Genio-glossus.	Upper mental spine on posterior surface of lower jaw.	Body of hyoid bone and inferior surface of tongue in its whole length.	Depresses tongue and raises hyoid bone. Posterior fibres protrude tongue. Anterior fibres retract.	Hypoglossal.
Hyo-glossus.	Body and great cornu of hyoid bone.	Side of tongue.	Depresses tongue.	,,
Stylo-glossus.	Lower end of styloid process and stylo-mandibular ligament.	Side and inferior surface of tongue.	Elevates and retracts tongue.	,,

MUSCLES OF THE PHARYNX

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Superior constrictor.	Lower half posterior border of medial pterygoid plate; pterygo-mandibular ligament. Mylo-hyoid ridge of lower jaw; mucous membrane of mouth.	Fibrous raphe in median line of posterior wall of pharynx.	Forces food towards œsophagus in the act of swallowing.	Pharyngeal plexus.
Middle constrictor.	Stylo-hyoid ligament and both cornua of hyoid bone.	,,	,,	,,
Inferior constrictor.	Oblique line thyroid cartilage; side of cricoid cartilage.	,,	,,	Pharyngeal plexus; external laryngeal; inferior laryngeal.

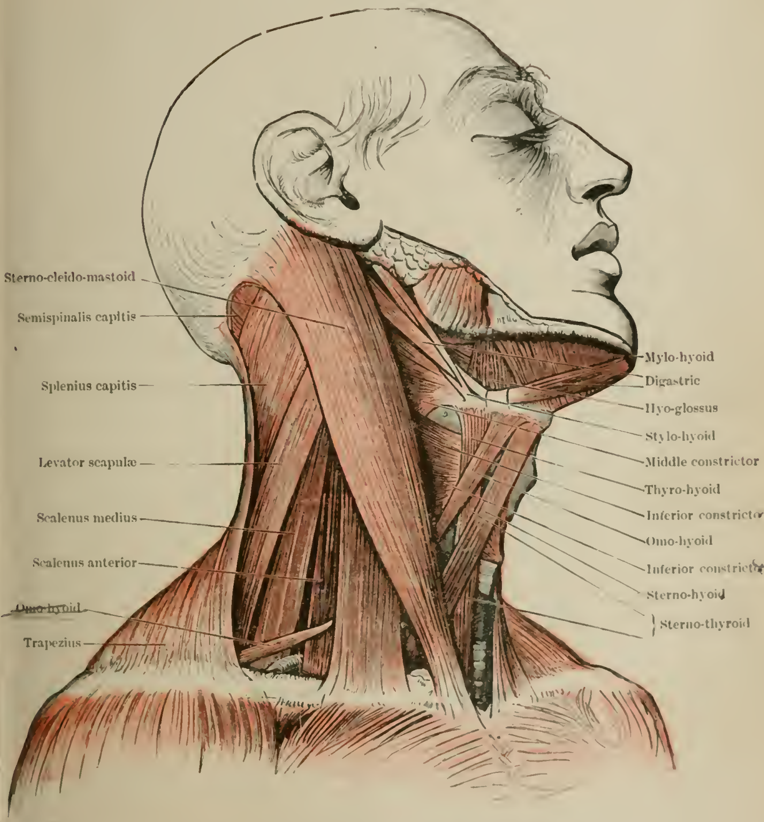


FIG. 53.—THE TRIANGLES OF THE NECK (Muscles).

DEEP MUSCLES OF THE ANTERIOR VERTEBRAL REGION

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Longus capitis.	Anterior tubercles of transverse processes of third, fourth, fifth, and sixth cervical vertebræ.	Basilar process of occipital bone.	Flexes head and cervical spine.	Anterior primary divisions, cervical spinal nerves.
Rectus capitis anterior.	Anterior arch of atlas.	,, ,,	Flexes head.	,, ,,
Rectus capitis lateralis.	Transverse process of atlas.	Jugular process of occipital bone.	Bends head laterally.	Anterior ramus of first cervical.
Longus colli— (*a*) Vertical portion.	Bodies of the first three thoracic vertebræ. Bodies of the last three cervical vertebræ.	Bodies of the second, third, and fourth cervical vertebræ.	Flexes cervical spine.	Anterior rami, cervical nerves.
(*b*) Lower oblique portion.	Bodies of the first three thoracic vertebræ.	Anterior tubercles of the transverse processes of fifth and sixth cervical vertebræ.	,, ,,	,, ,,
(*c*) Upper oblique portion.	Anterior tubercles of transverse processes of third, fourth, and fifth cervical vertebræ.	Anterior tubercle of atlas.	,, ,,	,, ,,

DEEP MUSCLES OF THE LATERAL VERTEBRAL REGION

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Scaleni (three)— (1) Scalenus anterior.	Anterior tubercles of transverse processes of third, fourth, fifth, and sixth cervical vertebræ.	Scalene tubercle on inner border and upper surface of first rib.	(*o*) Raises ribs in inspiration. (*i*) Flexes cervical spine: bends neck to same side and rotates it.	Anterior rami, cervical nerves.
(2) Scalenus medius.	Posterior tubercles of transverse processes of cervical vertebræ, second to sixth inclusive.	Upper surface of first rib behind scalene tubercle.	(*o*) Raises ribs in inspiration. (*i*) Bends cervical spine laterally and rotates it.	,, ,,
(3) Scalenus posterior.	Posterior tubercles of transverse processes of fourth, fifth, and sixth cervical vertebræ.	Linear impression on outer side of second rib.	,, ,,	,, ,,

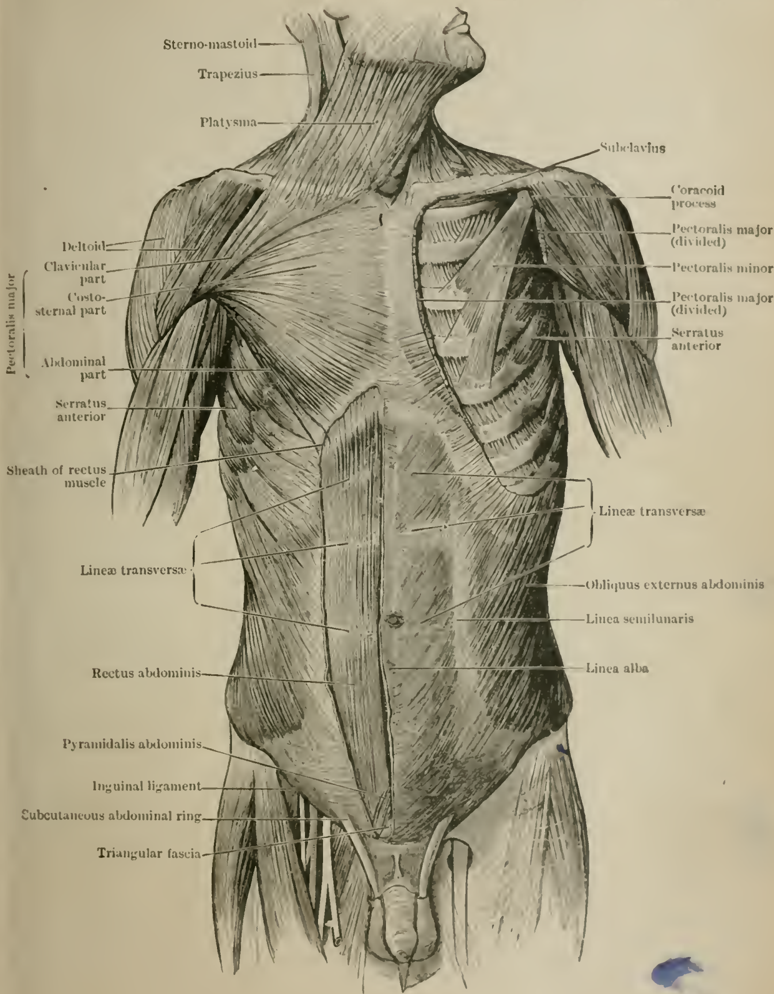


FIG. 54.—ANTERIOR MUSCLES OF THE TRUNK.

DEEP MUSCLES OF THE POSTERIOR VERTEBRAL REGION

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Rectus capitis posterior major.	Spinous process of epistropheus.	Inferior curved line of occipital bone and surface immediately below it.	Extends head.	Sub-occipital (posterior primary division of first cervical) and posterior ramus of second cervical.
Rectus capitis posterior minor.	Spinous process of atlas.	Rough surface beneath inferior curved line of occipital bone.	,, ,,	Sub-occipital.
Obliquus capitis inferior.	Spinous process of epistropheus.	Transverse process of atlas.	Extends head and rotates face to same side.	,, ,,
Obliquus capitis superior.	Transverse process of atlas.	Occipital bone above inferior curved line.	Bends head laterally and rotates face to opposite side.	,, ,,

TABLE OF CHIEF MUSCLES WHICH PRODUCE THE MOVEMENTS OF THE HEAD

Flexion.	Extension.	Lateral Movement.	Rotation.
Digastric.	Sterno-mastoid.	Sterno-mastoid.	Sterno-mastoid.
Stylo-hyoid.	Splenius capitis.	Splenius capitis.	Splenius capitis.
Sterno-hyoid.	Longissimus capitis.	Longissimus capitis.	Longissimus capitis.
Sterno-thyroid.	Semispinalis capitis.	Semispinalis capitis.	Semispinalis capitis.
Omo-hyoid.	Obliquus capitis inferior.	Obliquus capitis superior.	Obliquus capitis inferior.
Longus capitis.	Rectus capitis posterior major.	Rectus capitis lateralis.	Obliquus capitis superior.
Rectus capitis anterior.	Rectus capitis posterior minor.		Recti capiti posteriores major and minor.
Muscles of both sides acting.		Muscles on one side only acting.	

THE UPPER LIMB

MUSCLES OF THE BACK, FIRST LAYER

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Trapezius.	Medial half superior curved line of occipital bone; ligamentum nuchæ; spinous process of seventh cervical and those of all the thoracic vertebræ; supraspinous ligaments.	Lateral half posterior border clavicle, medial margin acromion, upper border spine of scapula, and tubercle base of spine of scapula.	(*o*) Upper fibres elevate the shoulder girdle and lower depress it. All working together draw it backwards. (*i*) Flexes head laterally.	Accessory; cervical plexus (c. 3 and 4).
Latissimus dorsi.	Spinous processes of six lower thoracic and those of lumbar and sacral vertebræ; supraspinous ligaments; external lip crest of ilium; three or four lower ribs; inferior angle of scapula.	Floor of intertubercular groove of humerus.	(*o*) Draws the arm downwards and backwards, and rotates it medially. (*i*) Raises trunk towards arm as in climbing. Raises ribs in forced inspiration.	Thoraco-dorsal.

MUSCLES OF THE BACK, SECOND LAYER

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Levator scapulæ.	Posterior tubercles of the transverse processes of three or four upper cervical vertebræ.	Vertebral border of scapula from the medial angle to the root of the spine.	Elevates the scapula.	Cervical plexus (c. 3 and 4) and dorsal nerve of scapula (c. 5).
Rhomboideus minor.	Ligamentum nuchæ; spinous processes of seventh cervical and first thoracic vertebræ.	Vertebral border of scapula opposite root of spine.	Elevates scapula and draws it back.	Dorsal nerve of scapula (c. 5).
Rhomboideus major.	Spinous processes four or five upper thoracic vertebræ and supraspinous ligaments.	Vertebral margin of scapula from root of spine to inferior angle.	,, ,,	,, ,,

MUSCLES OF THE ANTERIOR AND LATERAL THORACIC REGIONS

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Pectoralis major.	Anterior surface medial half of clavicle; anterior surface of sternum; cartilages of first six ribs and aponeurosis of external oblique muscle.	Lateral border intertubercular groove of humerus.	(*o*) Flexes shoulder. Adducts and medially rotates the arm. (*i*) Raises trunk towards arm in climbing. Helps in forced inspiration.	Lateral and medial anterior thoracic.

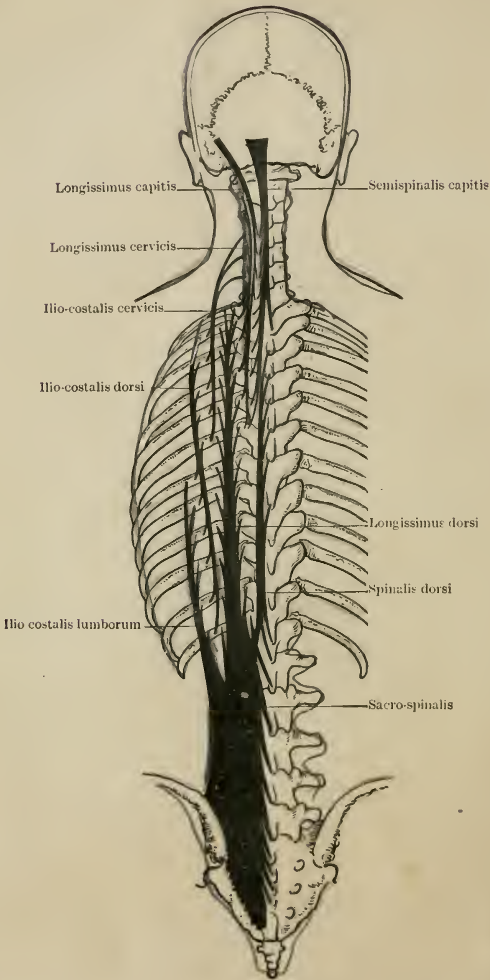


FIG. 55.—SCHEMATIC REPRESENTATION OF THE PARTS OF THE LEFT SACRO-SPINALIS MUSCLE.

THE UPPER LIMB—*continued*

MUSCLES OF THE ANTERIOR AND LATERAL THORACIC REGIONS—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Pectoralis minor.	By three tendinous digitations from upper margin and outer surface of third, fourth, and fifth ribs near their cartilages, and aponeurosis covering the intercostal muscles.	Coracoid process of scapula.	Depresses scapula and draws it forward.	Medial anterior thoracic.
Subclavius.	Cartilage of first rib.	Groove on under surface of middle third of clavicle.	Depresses clavicle.	Nerve to subclavius from junction of fifth and sixth cervical nerves.
Serratus anterior.	By nine fleshy digitations from upper eight ribs.	Whole length anterior aspect of the vertebral margin of scapula and medial and inferior angles.	Draws scapula forwards. Rotates inferior angle of scapula forwards and upwards, thus helping to raise arm. Helps in forced inspiration.	Long thoracic (c. 5, 6, and 7).

MUSCLES OF THE SHOULDER

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Deltoid.	Lateral third anterior border of clavicle; lateral border acromion, whole length lower border of spine of scapula.	Rough prominence middle of lateral surface of humerus.	Abducts arm; anterior fibres flex shoulder and rotate humerus medially; posterior fibres extend shoulder and rotate humerus laterally.	Axillary.
Subscapularis.	Whole of subscapular fossa except at angles.	Small tubercle of humerus.	Flexes shoulder and rotates humerus medially.	Upper and lower subscapular.
Supraspinatus.	Supraspinous fossa of scapula.	Highest facet on large tubercle of humerus.	Abducts and rotates humerus laterally.	Suprascapular
Infraspinatus.	Infraspinous fossa of scapula.	Middle facet on large tubercle of humerus.	Extends shoulder and rotates humerus laterally.	,, ,,

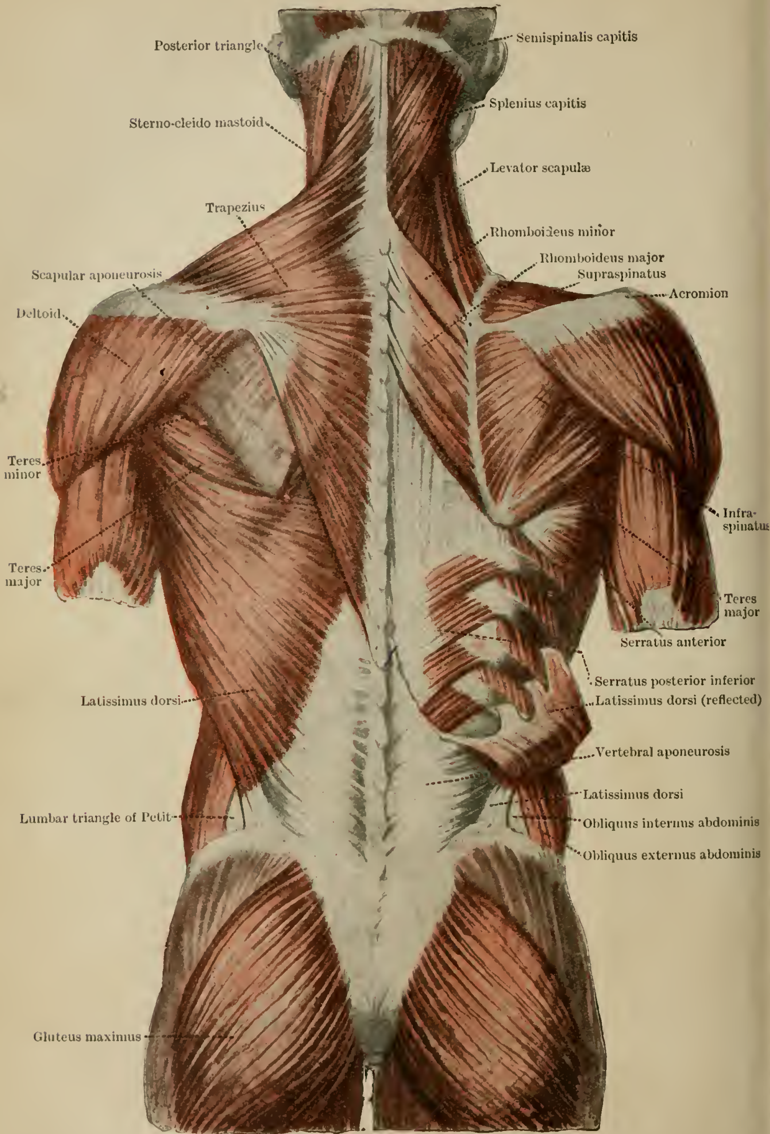


FIG. 56.—SUPERFICIAL MUSCLES OF THE BACK AND VERTEBRO-SCAPULAR MUSCLES.

MUSCLES OF THE SHOULDER—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Teres minor.	Upper two-thirds dorsal aspect axillary margin of scapula.	Lowest facet on large tubercle of humerus and surface immediately distal to it.	Adducts and rotates humerus laterally.	Axillary.
Teres major.	Lower third of dorsal aspect of axillary margin of scapula.	Medial border intertubercular groove of humerus.	Extends, adducts, and rotates humerus medially.	Lower subscapular.

MUSCLES OF THE ARM

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Coraco-brachialis.	Tip of coracoid process of scapula.	Middle of medial side of shaft of humerus.	Flexes shoulder and adducts humerus.	Musculo-cutaneous.
Biceps brachii (two heads).	1. Short head—tip of coracoid process of scapula. 2. Long head—upper margin of glenoid cavity.	Tubercle of radius.	Flexes shoulder; flexes and supinates forearm; short head adducts shoulder.	,, ,,
Brachialis.	Distal two-thirds of front of humerus and intermuscular septa.	Coronoid process of ulna.	Flexes elbow.	Musculo-cutaneous and radial.
Triceps brachii (three heads).	1. Long or middle head—lower margin of glenoid cavity. 2. Lateral head—posterior surface of shaft of humerus, proximal to groove for radial nerve. 3. Medial head—posterior surface of shaft of humerus distal to groove for radial nerve; intermuscular septa (processes of deep fascia attached to the epicondylic ridges of the humerus).	Olecranon of ulna and deep fascia of forearm.	Extends shoulder and forearm; long head adducts humerus.	Radial.
Sub-anconeus (occasionally present).	Distal end of humerus.	Posterior ligament of elbow joint.	In extension of elbow lifts synovial membrane out of the olecranon fossa.	,,

MUSCLES OF THE FOREARM AND HAND

MUSCLES ON THE FRONT OF THE FOREARM

Superficial Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Pronator teres (two heads).	1. Medial epicondyle of humerus. 2. Coronoid process of ulna.	Middle of lateral surface of shaft of radius.	Flexes elbow and pronates hand.	Median.
Flexor carpi radialis.	Medial epicondyle of humerus.	Base of metacarpal bones of first and second fingers.	Flexes elbow and wrist; pronates and abducts hand.	,,
Palmaris longus.	Medial epicondyle of humerus.	Transverse carpal ligament; palmar fascia.	Flexes elbow and wrist; makes palmar fascia tense.	,,
Flexor carpi ulnaris (two heads).	1. Medial epicondyle of humerus. 2. Medial margin olecranon process and posterior border of ulna.	Pisiform bone.	Flexes elbow and wrist; adducts hand.	Ulnar.
Flexor digitorum sublimis (three heads).	1. Medial epicondyle of humerus. 2. Coronoid process of ulna. 3. Oblique line and middle third of lateral border of radius.	Sides of second phalanges of fingers.	Flexes elbow, wrist, carpal, metacarpal, and first interphalangeal joints.	Median.

Deep Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Flexor digitorum profundus.	Proximal two-thirds of anterior and medial aspects of ulna; middle third of medial half of interosseous membrane; deep fascia of forearm behind origin of flexor carpi ulnaris.	Bases of terminal phalanges of fingers; palmar aspect.	Flexes wrist, metacarpal, phalangeal, and all interphalangeal joints.	Ulnar and volar interosseous.
Flexor pollicis longus.	Anterior surface of shaft of radius in its middle two-fourths and interosseous membrane.	Base of distal phalanx of thumb.	Flexes wrist and all joints of thumb.	Volar interosseous.
Pronator quadratus.	Distal fourth anterior border and surface of ulna.	Distal fourth anterior surface of radius.	Pronates hand.	,, ,,

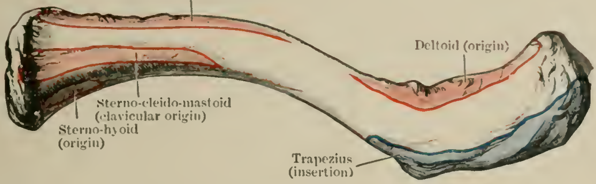


FIG. 57.—MUSCLE ATTACHMENTS TO THE RIGHT CLAVICLE (Upper Surface).

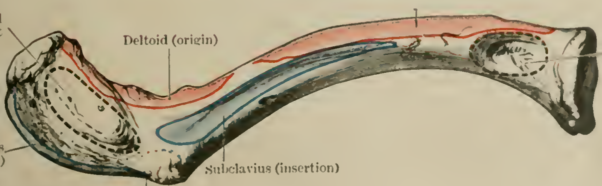


FIG. 58.—MUSCLE ATTACHMENTS TO THE RIGHT CLAVICLE (Under Surface).

MUSCLES OF THE FOREARM AND HAND—*continued*

MUSCLES ON THE BACK OF THE FOREARM

Superficial Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Brachio-radialis.	Proximal two-thirds of lateral epicondylic ridge of humerus.	Base of styloid process of radius.	Flexes elbow. In prone position assists supination. In supine position assists pronation, in each case bringing the hand from the extreme to the intermediate position.	Radial.
Extensor carpi radialis longus.	Distal third of lateral epicondylic ridge of humerus.	Posterior aspect base of metacarpal bone of index finger.	In pronation flexes, and in supination extends elbow; supinates, extends, and abducts hand.	,,
Extensor carpi radialis brevis.	Lateral epicondyle of humerus.	Posterior aspect base of metacarpal bone of middle finger.	,, ,,	Dorsal interosseous.
Extensor carpi ulnaris.	1. Lateral epicondyle of humerus. 2. Middle two-fourths posterior border of ulna.	Posterior aspect base of metacarpal bone of little finger.	In pronation flexes, and in supination extends elbow; supinates, extends, and adducts hand.	,, ,,
Extensor digitorum communis.	Lateral epicondyle of humerus.	Second and third phalanges of fingers.	In pronation flexes, in supination extends elbow; supinates and extends wrist; extends fingers.	,, ,,
Extensor digiti quinti proprius.	,, ,,	Common extensor on dorsum of first phalanx of little finger.	In pronation flexes, in supination extends elbow; supinates and extends hand; extends little finger.	,, ,,
Anconeus.	Back of lateral epicondyle of humerus.	Lateral side of olecranon and posterior surface shaft of ulna.	Extends elbow.	Radial.

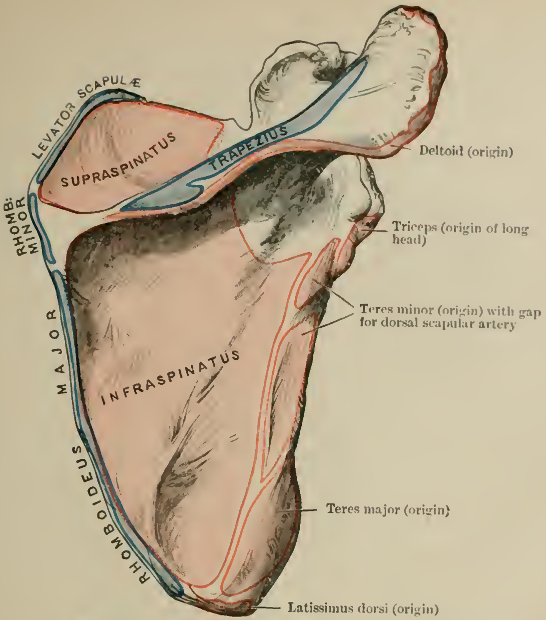


Fig. 59.—Muscle Attachments to the Scapula (Posterior Aspect).

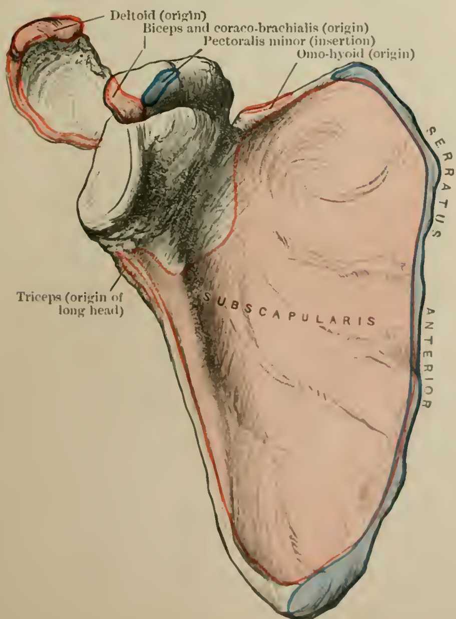


Fig. 60.—Muscle Attachments to the Scapula (Anterior Aspect).

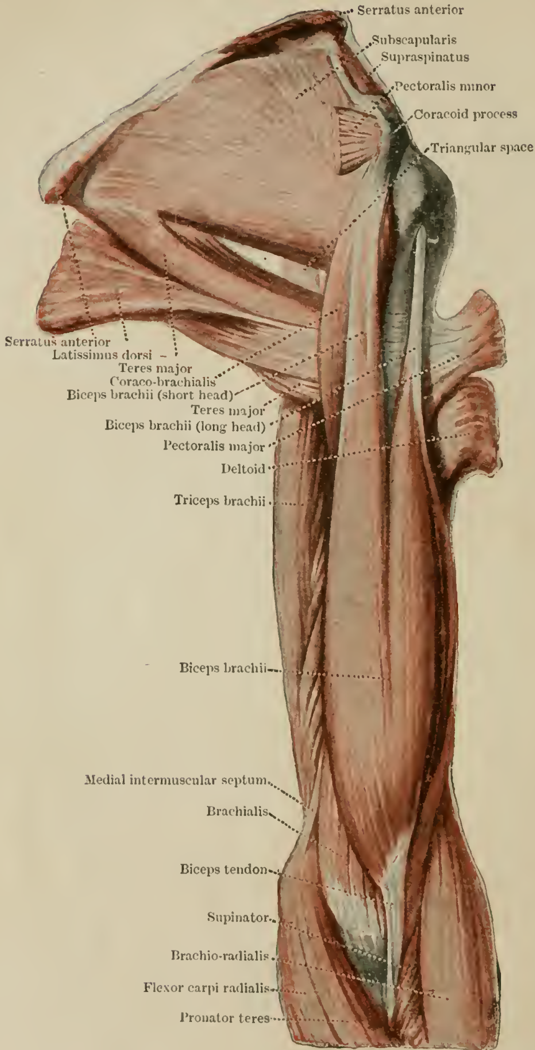


FIG. 61.—MUSCLES OF POSTERIOR WALL OF LEFT AXILLA AND FRONT OF ARM.

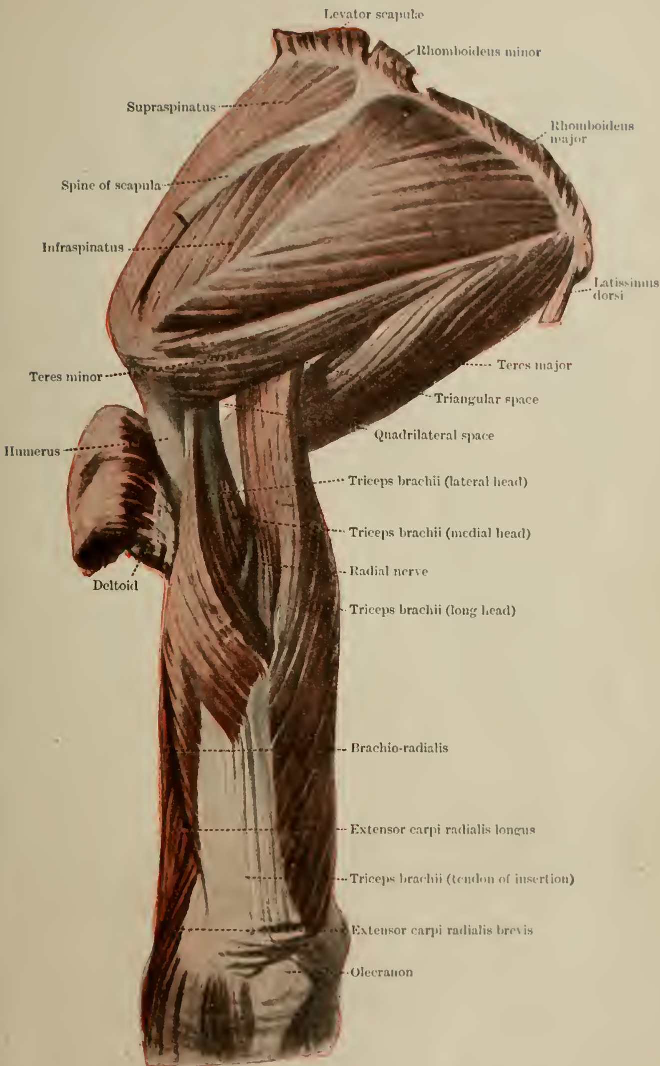


FIG. 62.—LEFT SCAPULAR MUSCLES AND TRICEPS BRACHII.

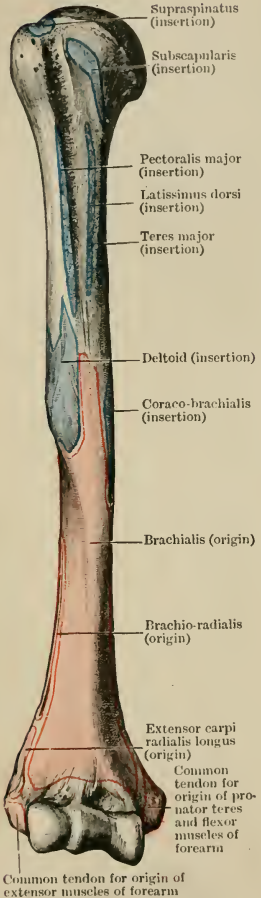


FIG. 63.—MUSCLE ATTACHMENTS TO THE FRONT OF THE RIGHT HUMERUS.

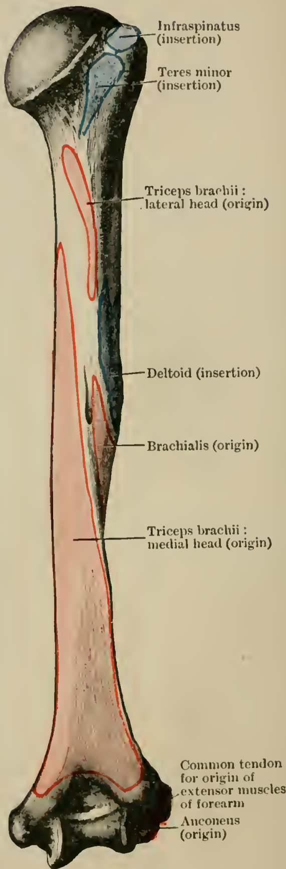


FIG. 64.—MUSCLE ATTACHMENTS TO THE BACK OF THE RIGHT HUMERUS.

MUSCLES OF THE FOREARM AND HAND—*continued*

MUSCLES ON THE BACK OF THE FOREARM—*continued*

Deep Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Supinator.	Lateral epicondyle of humerus; radial collateral, and annular ligaments of elbow joint; shaft of ulna distal to radial notch.	Anterior and lateral surface of proximal third of radius.	Supinates hand.	Dorsal interosseous.
Abductor pollicis longus.	Posterior surfaces shafts of ulna and radius; interosseous membrane.	Lateral side of base of metacarpal bone of thumb.	Assists supination; extends first carpometacarpal joint; abducts hand.	,, ,,
Extensor pollicis brevis.	Shaft of radius, posterior surface, distal to origin of preceding muscle; interosseous membrane.	Base of first phalanx of thumb.	Assists supination; extends and abducts wrist; extends first phalanx of thumb.	,, ,,
Extensor pollicis longus.	Posterior surface of shaft of ulna and interosseous membrane distal to abductor pollicis longus.	Base of second phalanx of thumb.	Assists supination; extends and abducts wrist; extends all joints of thumb.	,, ,,
Extensor indicis proprius.	Shaft of ulna, posterior surface, distal to origin of extensor pollicis longus; interosseous membrane.	Common tendon on dorsum of first phalanx of index finger.	Extends wrist and all joints of index finger.	,, ,,

SHORT MUSCLES OF THE HAND

MUSCLES OF THE THUMB, THENAR EMINENCE

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Opponens pollicis.	Ridge on great multangular bone and volar surface of transverse carpal ligament.	Radial half of volar surface of first metacarpal bone.	Draws first metacarpal bone medially over the palm.	Median.
Flexor pollicis brevis.	(*a*) (Superficial part) Transverse carpal ligament. (*b*) (Deep part) Medial side of base of first metacarpal bone.	(*a*) Lateral side of base of first phalanx of thumb. (*b*) Medial side of base of first phalanx of thumb.	Flexes first carpo-metacarpal and metacarpo-phalangeal joint and adducts thumb.	,,

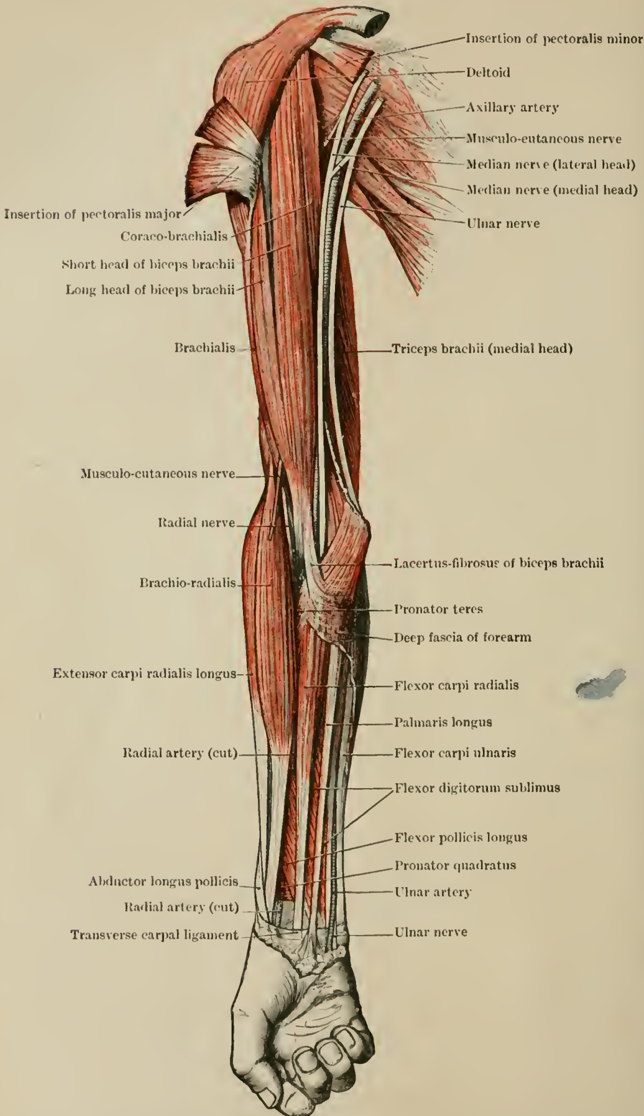


FIG. 65.—SUPERFICIAL MUSCLES ON THE FRONT OF THE ARM AND FOREARM.

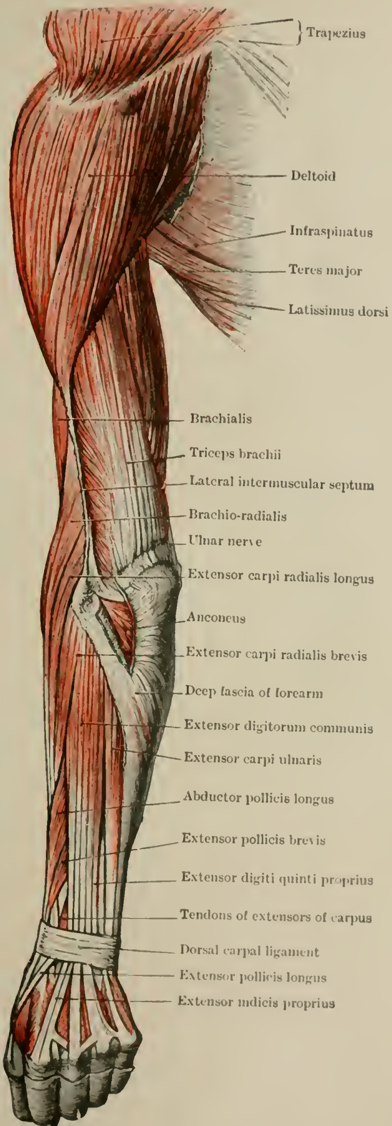


FIG. 66.—THE MUSCLES ON THE BACK OF THE ARM, FOREARM, AND HAND.

SHORT MUSCLES OF THE HAND—*continued*

MUSCLES OF THE THUMB, THENAR EMINENCE—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Adductor pollicis obliquus.	Anterior surfaces of great and small multangular bones, capitate bone, and bases of second and third metacarpal bones.	Base of first phalanx of thumb, medial side.	Flexes first carpo-metacarpal and metacarpo-phalangeal joint and adducts thumb.	Ulnar.
Adductor pollicis transversus.	Distal two-thirds anterior surface of third metacarpal bone.	Medial side of base of first phalanx of thumb.	,, ,,	Ulnar.
Abductor pollicis brevis.	Ridge of great multangular bone; transverse carpal ligament; and tubercle of the navicular bone.	Base of first phalanx of thumb, lateral side.	Abducts thumb and draws it forward.	Median.

MUSCLES OF THE LITTLE FINGER, HYPOTHENAR EMINENCE

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Abductor digiti quinti.	Pisiform bone.	Medial side of base of first phalanx of little finger.	Abducts little finger.	Ulnar.
Opponens digiti quinti.	Transverse carpal ligament and hook of hamate bone.	Whole length of medial margin of fifth metacarpal bone.	Draws fifth metacarpal bone forward so as to deepen the hollow of the hand.	,,
Flexor digiti quinti brevis.	,, ,,	Medial side of first phalanx of little finger.	Flexes little finger.	,,

THE INTEROSSEOUS MUSCLES

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Palmar interossei (three in number).	Ulnar side of second and radial sides of fourth and fifth metacarpal bones.	Dorsal expansions extensor tendons; capsules of metacarpo-phalangeal joints and sides of first phalanges of fingers. (Ulnar side of index and radial side of ring and little fingers.)	Adduct fingers to middle line of hand; flex metacarpo-phalangeal and extend interphalangeal joints.	Ulnar.
Dorsal interossei (four in number).	By two heads from sides of metacarpal bones.	Same as palmar interossei (the first into radial side of index finger, the second and third into the radial and ulnar sides respectively of middle finger, the fourth into ulnar side of ring finger).	Abduct fingers from middle line of hand; flex metacarpo-phalangeal and extend interphalangeal joints.	,,
Lumbricales (four in number).	Tendons of flexor digitorum profundus.	Capsules of metacarpo-phalangeal joints; tendons of extensor digitorum communis on dorsal aspect of first phalanx.	Flex metacarpo-phalangeal and extend interphalangeal joints.	Median and ulnar.

TABLE OF MUSCLES WHICH PRODUCE THE MOVEMENTS OF THE SHOULDER GIRDLE

Elevation.	Depression.	Forward Movement.	Backward Movement.
Trapezius (upper fibres). Levator scapulæ. Rhomboidei. Sterno-mastoid. Omo-hyoid.	Trapezius (lower fibres). Subclavius. Pectoralis major (lower fibres). Pectoralis minor. Latissimus dorsi.	Serratus anterior. Pectoralis major. Pectoralis minor.	Trapezius. Rhomboidei. Latissimus dorsi.

The above muscles produce various movements of the shoulder girdle at the sterno-clavicular and acromio-clavicular joints. At the latter, rotation of the scapula upon the clavicle takes place. An alteration in the direction of the glenoid cavity is thus effected, by which its relation to the head of the humerus is maintained during movements of the arm.

TABLE OF MUSCLES WHICH PRODUCE MOVEMENT AT THE SHOULDER JOINT

Flexion (forward movement).	Extension (backward movement).	Adduction.	Abduction.
Deltoid (anterior fibres). Subscapularis. Pectoralis major. Coraco-brachialis. Biceps brachii.	Deltoid (posterior fibres). Teres major. Infraspinatus. Latissimus dorsi. Triceps brachii.	Teres major. Teres minor. Pectoralis major. Latissimus dorsi. Coraco-brachialis. Biceps brachii (short head). Triceps brachii (long head).	Deltoid. Supraspinatus. (These muscles bring the arm to a right angle with the trunk, the arm is raised above the head by the elevators of the shoulder girdle.)

Medial Rotation.	Lateral Rotation.
Deltoid (anterior fibres). Teres major. Pectoralis major. Latissimus dorsi. Subscapularis.	Deltoid (posterior fibres). Infraspinatus. Teres minor. Supraspinatus.

Circumduction.
(Combination of muscles given above.)

TABLE OF MUSCLES WHICH PRODUCE MOVEMENT AT THE ELBOW JOINT

Flexion.		Extension.
Biceps brachii. Brachialis. Bracho-radialis. Pronator teres.		Triceps brachii. Anconeus. Extensors of wrist and fingers (in supination).
Flexors of wrist and fingers	Flexor carpi radialis. Palmaris longus. Flexor digitorum sublimis. Flexor carpi ulnaris.	
Extensors of wrist (in pronation)	Extensor carpi radialis longus. Extensor carpi radialis brevis. Extensor carpi ulnaris. Extensor digitorum communis. Extensor digiti quinti proprius.	

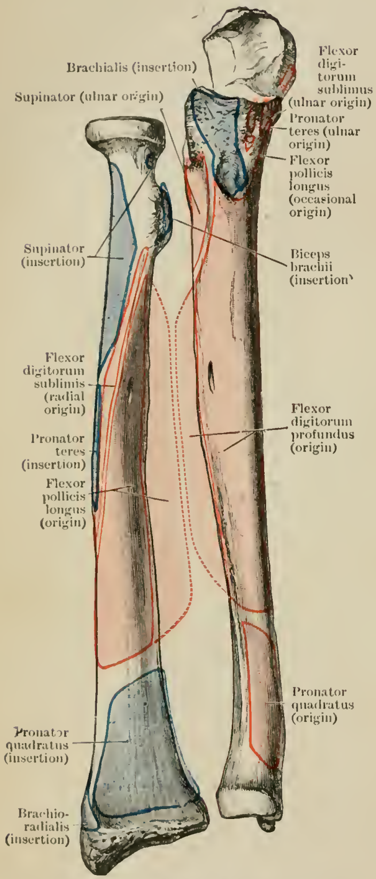


FIG. 67.—MUSCLE ATTACHMENTS TO THE RADIUS AND ULNA (Anterior Aspects).

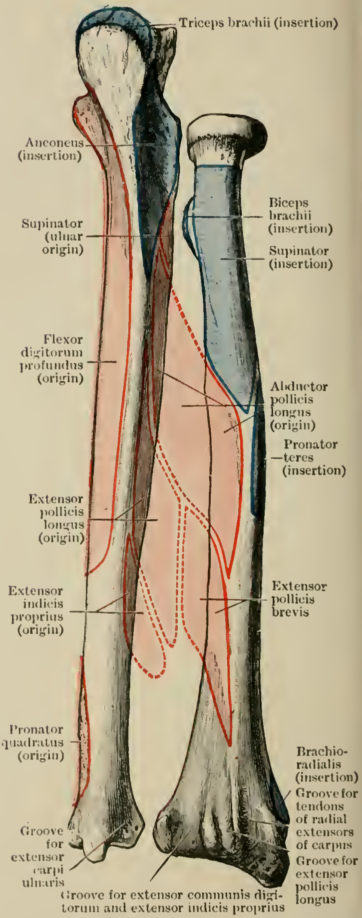


FIG. 68.—MUSCLE ATTACHMENTS TO THE RADIUS AND ULNA (Posterior Aspects).

TABLE OF MUSCLES WHICH PRODUCE MOVEMENT AT THE RADIO-ULNAR JOINTS

Pronation.	Supination.
Pronator teres.	Supinator.
Pronator quadratus.	Biceps brachii.
Brachio-radialis (when forearm is in the supine position).	Brachio-radialis (when forearm is in the prone position).
Flexor carpi radialis.	Extensors of thumb { Abductor pollicis longus. Extensor pollicis brevis. Extensor pollicis longus.
	Extensors of wrist and fingers.

TABLE OF MUSCLES WHICH PRODUCE MOVEMENT AT THE WRIST JOINT

Flexion.	Extension.	Adduction.	Abduction.
Flexor carpi radialis.	Extensor carpi radialis longus.	Flexor carpi ulnaris.	Flexor carpi radialis.
Palmaris longus.	Extensor carpi radialis brevis.	Extensor carpi ulnaris.	Extensor carpi radialis longus.
Flexor carpi ulnaris.	Extensor carpi ulnaris.		Extensor carpi radialis brevis.
Long flexors of thumb and fingers.	Extensors of thumb and fingers.		Extensors of thumb.

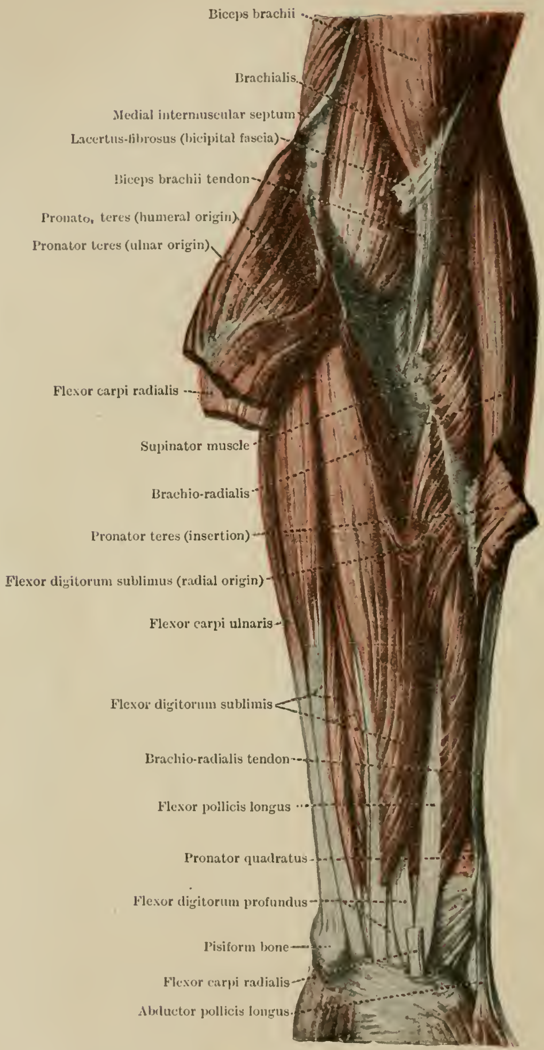


FIG. 69.—DEEPER MUSCLES OF THE LEFT FOREARM.

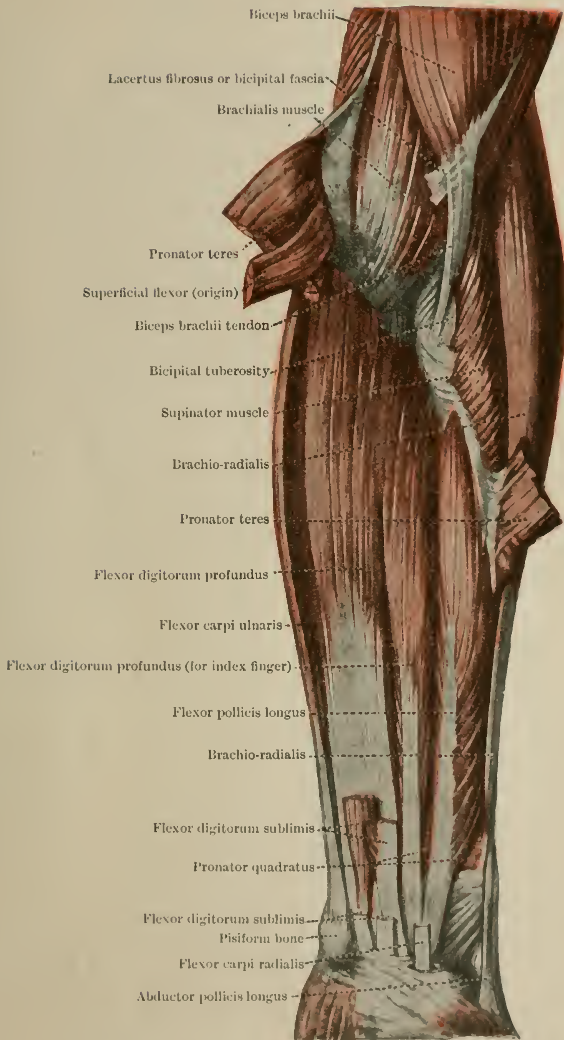


FIG. 70.—DEEPEST MUSCLES ON THE FRONT OF THE LEFT FOREARM.

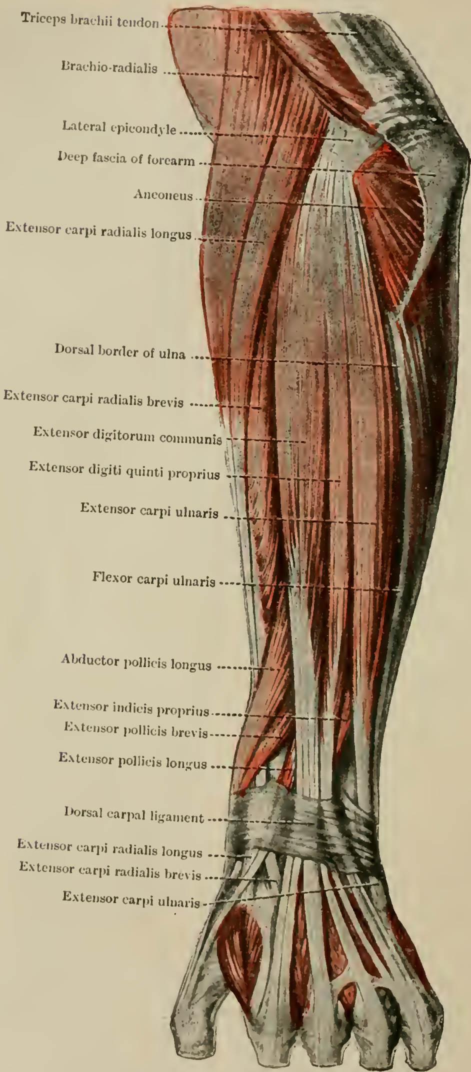


FIG. 71.—SUPERFICIAL MUSCLES ON THE BACK OF THE LEFT FOREARM.

TABLE OF MUSCLES WHICH PRODUCE MOVEMENTS OF THE FINGERS

Flexion.	Extension.	Abduction.	Adduction.
Flexor digitorum sublimis. Flexor digitorum profundus. Flexor digiti quinti brevis. Lumbricales. Interossei. } First phalanges.	Extensor digitorum communis. Extensor indicis proprius. Extensor digiti quinti proprius. Lumbricales. Interossei. } Second and third phalanges.	Abductor digiti quinti. Opponens digiti quinti. Flexor digiti quinti brevis. } From ulnar side of hand. Dorsal interossei. } From median line of middle finger.	Palmar interossei. } To middle finger.

TABLE OF MUSCLES WHICH PRODUCE MOVEMENTS OF THE THUMB

Flexion.	Extension.	Adduction.	Abduction.
Opponens pollicis. Flexor pollicis brevis. Flexor pollicis longus. Adductor pollicis obliquus. Adductor pollicis transversus. Abductor pollicis brevis.	Abductor pollicis longus. Extensor pollicis brevis. Extensor pollicis longus.	Adductor pollicis obliquus. Adductor pollicis transversus. Flexor pollicis brevis. Opponens pollicis.	Abductor pollicis brevis Extensors of thumb.

MUSCLES OF THE BACK

The muscles of the back may be divided into five layers, the two first of which, comprising the trapezius, latissimus dorsi, levator anguli scapulæ, and the rhomboids, have already been described in connection with the upper limb.

Third Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Serratus posterior superior.	Ligamentum nuchæ and spinous processes of seventh cervical and three or four upper thoracic vertebræ.	Upper border second, third, fourth, and fifth ribs beyond angles.	Raises ribs in inspiration; extends spine. One side only acting, flexes spine laterally.	Posterior rami cervical and upper thoracic.
Serratus posterior inferior.	Spinous processes of last two thoracic and two or three upper lumbar vertebræ.	Lower borders four lower ribs, beyond angles.	Draws lower ribs down and backwards, thus elongating thorax; fixes ribs for diaphragm to act from; extends spine; flexes it laterally when only one side works.	Posterior rami thoracic.

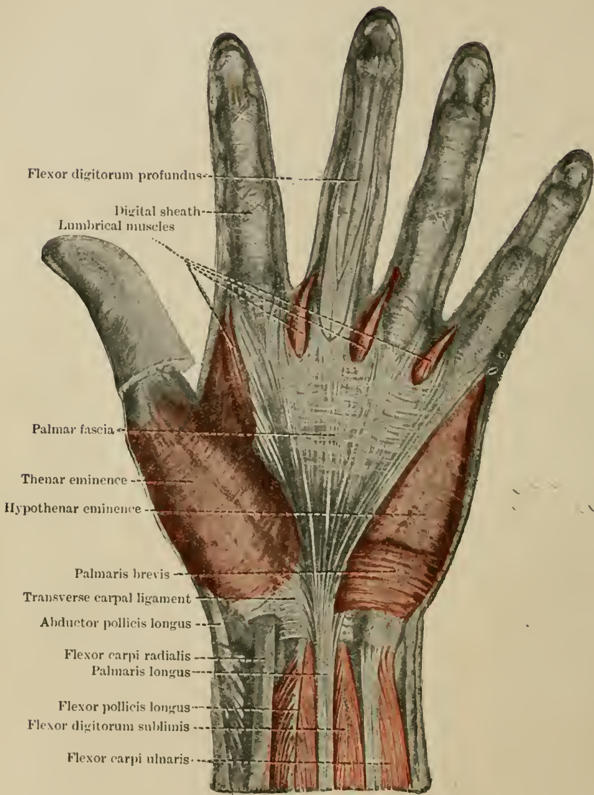


FIG. 72.—THE LEFT PALMAR FASCIA.

MUSCLES OF THE BACK—*continued*

THIRD LAYER—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Splenius capitis.	Lower half ligamentum nuchæ, spinous processes of last cervical and six upper thoracic vertebræ.	Mastoid process and lateral part of superior nuchal line of occipital bone.	Extends head and spine; bends head laterally and rotates the face to the same side.	Posterior rami of cervical and upper thoracic.
Splenius cervicis.	Same as splenius capitis.	Posterior tubercles of the transverse processes of upper three or four cervical vertebræ.	Extends cervical spine; flexes spine laterally and rotates it to same side.	,, ,,
		FOURTH LAYER		
Sacro-spinalis. Divided into three muscular columns.				
Lateral column. (*a*) Ilio-costalis lumborum.	Iliac crest; posterior sacro-iliac ligament; back of sacrum; spines of upper sacral and all the lumbar vertebræ.	Angles of lower six ribs.	Keeps spine erect. Bends trunk backwards. One side only acting, flexes spine laterally and rotates it.	Posterior rami lumbar nerves.
(*b*) Ilio-costalis dorsi.	Angles of lower six ribs.	Angles of upper six ribs.	,, ,,	Posterior rami thoracic nerves.
(*c*) Ilio-costalis cervicis.	Angles of upper six ribs.	Posterior tubercles, transverse processes, fourth, fifth, and sixth cervical vertebræ.	,, ,,	Posterior rami lower cervical and upper thoracic.
Middle column. (*d*) Longissimus dorsi.	Same as ilio-costalis lumborum.	Medially into transverse processes of thoracic and upper lumbar vertebræ; laterally into nearly all the ribs.	,, ,,	Posterior rami lumbar and thoracic.
(*e*) Longissimus cervicis.	Transverse processes upper six thoracic vertebræ.	Transverse processes cervical vertebræ from the second to the sixth.	,, ,,	Posterior rami upper thoracic and cervical.
(*f*) Longissimus capitis.	Transverse processes upper six thoracic and articular processes of four lower cervical.	Mastoid process.	Extends head; bends it laterally and rotates it.	,, ,,
Medial column. (*g*) Spinalis dorsi.	Spinous processes of upper two lumbar and lower two thoracic vertebræ.	Spinous processes of fourth, fifth, sixth, seventh, and eighth thoracic vertebræ.	Keeps spine erect. Bends trunk backwards. One side only acting, flexes spine laterally and rotates it.	Posterior rami thoracic.
Semispinalis capitis.	Transverse processes of six upper thoracic vertebræ; articular processes fourth, fifth, sixth, and seventh cervical vertebræ and spine of seventh cervical vertebra.	Occipital bone.	Extends head. Bends head laterally and rotates face to opposite side.	Posterior rami of cervical and upper thoracic.

MUSCLES OF THE BACK—*continued*

Fifth Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Semispinalis dorsi.	Transverse processes lower six thoracic vertebræ.	Spinous processes last two cervical and first four thoracic vertebræ.	Extends spine. One side only acting, flexes spine laterally and rotates it towards opposite side.	Posterior rami lower cervical and upper thoracic.
Semispinalis cervicis.	Transverse processes upper six thoracic and articular processes of lower four cervical vertebræ.	Spines of cervical vertebræ from the second to the fifth.	,, ,,	,, ,,
Multifidus.	Sacrum; posterior sacro iliac ligament; mammillary processes lumbar vertebræ: transverse processes thoracic vertebræ; articular processes lower four cervical vertebræ.	Spines of the vertebræ up to and including the epistropheus.	,, ,,	Posterior rami lumbar, thoracic, and cervical.
Rotatores dorsi, eleven in number, occupying vertebral groove in thoracic region.	Transverse process thoracic vertebra.	Lamina of vertebra directly above.	Flex spine laterally and rotate it towards opposite side.	Posterior rami thoracic.
Interspinales, placed in pairs between the spinous processes of the vertebræ, one on either side of the interspinous ligament.			Extend spine.	Posterior rami cervical, thoracic, and lumbar.
Inter-transversales, placed between the transverse processes of the vertebræ.			Flex spine laterally.	,, ,,

MUSCLES OF THE ABDOMINAL WALL

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Retus abdominis.	Crest and symphysis of pubis.	Xiphoid cartilage; seventh, sixth, and fifth costal cartilages.	Flexes spine. Supports and compresses viscera. Helps expiration and expulsion. (*o*) Draws down thorax. (*i*) Draws up pelvis; one side only acting, flexes trunk laterally and rotates it to opposite side.	Lower intercostals; last thoracic, ilio-hypogastric, and ilio-inguinal.
Obliquus externus abdominis.	By eight fleshy digitations from the external surfaces of the lower eight ribs.	The lower fibres are inserted into the anterior half outer lip of crest of ilium. The upper and middle fibres terminate in a broad aponeurosis extending from the lower border of pectoralis major to the anterior superior spine of ilium. That portion between the spine of os pubis and spine of ilium is a broad band, folded inwards, and called the inguinal ligament. The linea alba extends from the xiphoid cartilage to the symphysis pubis, and is formed by the interlacing of the aponeurotic fibres of the muscle with those of the opposite side.	Flexes spine. Supports and compresses viscera. Helps expiration and expulsion. One side only acting, flexes trunk laterally and rotates it to opposite side.	,, ,,
Obliquus internus abdominis.	1. The lumbar fascia. 2. Lateral half of the inguinal ligament. 3. Anterior half of iliac crest.	1. The three lower ribs. 2. Seventh, eighth, and ninth costal cartilages. 3. Linea alba. 4. Crest and spine of pubis. 5. Ilio-pectineal line.	,, ,,	,, ,,

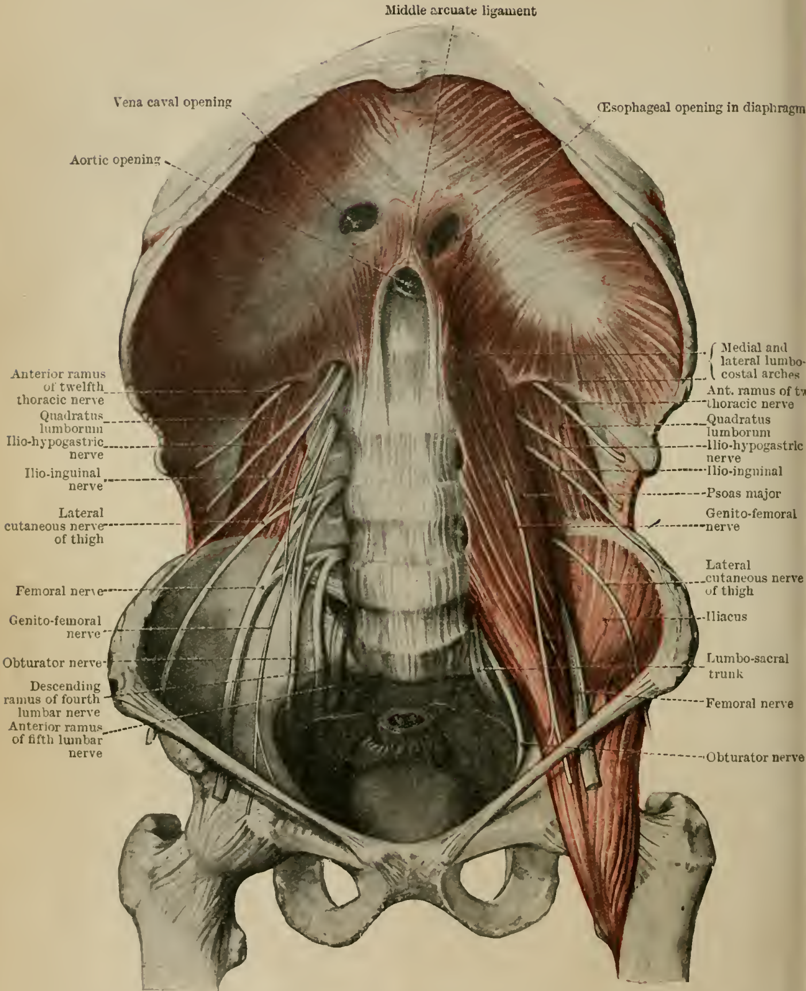


Fig. 73.—View of the Posterior Abdominal Wall, to show the Muscles and the Nerves of the Lumbo-Sacral Plexus.

MUSCLES OF THE ABDOMINAL WALL—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Transversus abdominis.	1. Costal cartilages of the lower six ribs. 2. Lumbar fascia. 3. Anterior half inner lip of iliac crest. 4. Lateral third of the inguinal ligament.	Xiphoid cartilage and linea alba; crest and spine of pubis and ilio-pectineal line, forming the aponeurotic inguinal falx with obliquus internus.	Flexes spine. Supports and compresses viscera. Helps expiration and expulsion. One side only acting, flexes trunk laterally and rotates it to opposite side.	Lower intercostals; last thoracic, ilio-hypogastric, and ilio-inguinal.
Pyramidalis (frequently absent).	Pubic crest in front of rectus.	Linea alba, halfway between pubis and umbilicus.	Makes linea alba tense.	Last thoracic.
Quadratus lumborum.	Posterior part of iliac crest; ilio-lumbar ligament; transverse processes of lower lumbar vertebræ.	Lower border of twelfth rib and transverse processes of upper four lumbar vertebræ.	Draws down last rib. Assists in fixing origin of diaphragm and thus acts as a muscle of inspiration. Extends spine. Flexes spine and pelvis laterally when one side only works.	Last thoracic and first and second lumbar.

MUSCLES OF THE THORAX

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Diaphragm.	Whole of internal circumference of thorax; attached in front to xiphoid cartilage, on either side to inner surface of cartilages and bony portions of six or seven lower ribs, and behind to lumbar vertebræ.	Central tendon.	Elevates ribs and draws down central tendon, thus increasing transverse, antero-posterior, and vertical diameters of thorax and helping inspiration.	Phrenic.
External intercostals (eleven in number on each side).	Outer lip of groove on lower border of each rib, extending from tubercle behind to cartilage of rib in front.	Outer edge of upper border of rib below.	Elevate ribs and help inspiration.	Anterior rami thoracic (intercostal).
Internal intercostals (eleven in number on each side).	Inner lip of groove on lower border of each rib, extending from angle of rib behind to side of sternum in front.	Inner edge of upper border of rib and costal cartilage below.	Probably elevate ribs and help inspiration.	,, ,,
Levatores costarum (twelve in number on each side).	Transverse processes of last cervical and upper eleven thoracic vertebræ.	Upper surface of rib below, between tubercle and angle.	Elevate ribs and help inspiration.	,, ,,
Tranversus thoracis.	Posterior surface of xiphoid cartilage and body of sternum.	Costal cartilages of all true ribs except the first and the seventh.	Depresses ribs and helps expiration.	Anterior rami thoracic.

MUSCLES OF RESPIRATION

Muscles of Inspiration.	Muscles of Expiration.
Ordinary— Diaphragm. Intercostals. Scaleni. Serrati posteriores. Levatores costarum. Accessory— Quadrati lumborum. Pectorales. Serrati anteriores. Sterno-mastoid. Latissimus dorsi. Infra-hyoid muscles. Extensors of spine.	Transversus thoracis. Abdominal muscles.

THE LOWER LIMB

MUSCLES OF THE ILIAC REGION

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Psoas major.	Intervertebral discs, bodies, and transverse processes of last thoracic and all lumbar vertebræ.	Small trochanter of femur.	(*o*) Flexes thigh on trunk, and rotates it laterally. (*i*) Flexes trunk on thigh; flexes lumbar spine forward or laterally when one side only works.	Femoral.
Psoas minor (often absent).	Bodies and intervertebral discs last thoracic and first lumbar vertebræ.	Ilio-pectineal line.	Flexes spine forwards and laterally.	Branch from lumbar plexus.
Iliacus.	Around margin of iliac fossa, anterior sacro-iliac, lumbo-sacral, and ilio-lumbar ligaments.	Tendon of psoas muscle; small trochanter; capsule of hip joint.	(*o*) Flexes thigh on trunk, and rotates it laterally. (*i*) Flexes trunk on thigh.	Femoral.

MUSCLES ON THE FRONT OF THE THIGH

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Sartorius.	Anterior superior spine of ilium and half of notch below it.	Medial surface shaft of tibia, just distal to medial condyle.	Flexes hip and knee; abducts and rotates thigh laterally; rotates leg medially.	Femoral.
Tensor fasciæ latæ.	Iliac crest, lateral surface of anterior superior iliac spine.	Fasciæ forming the ilio-tibial tract distal to the level of the great trochanter of the femur.	Abducts and medially rotates femur. Owing to its insertion in the ilio-tibial tract it helps to support the knee in the extended position.	Superior gluteal.

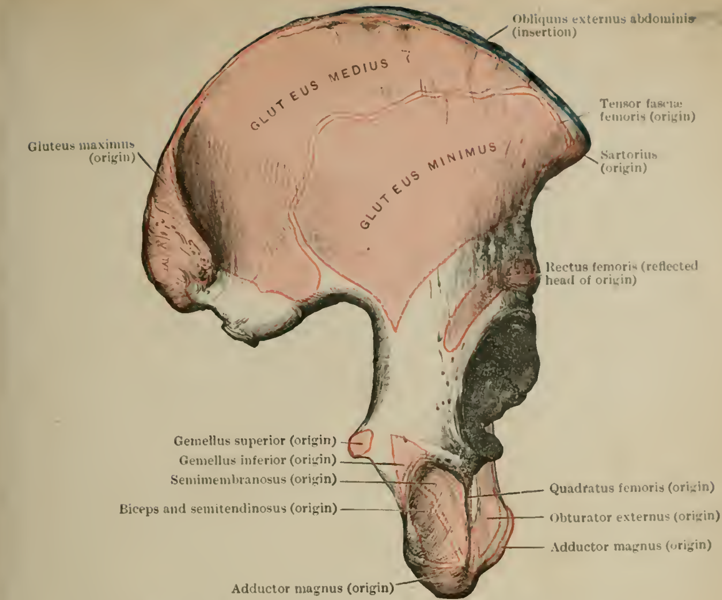


FIG. 74.—MUSCLE ATTACHMENTS TO THE DORSUM ILII AND TUBER ISCHII.

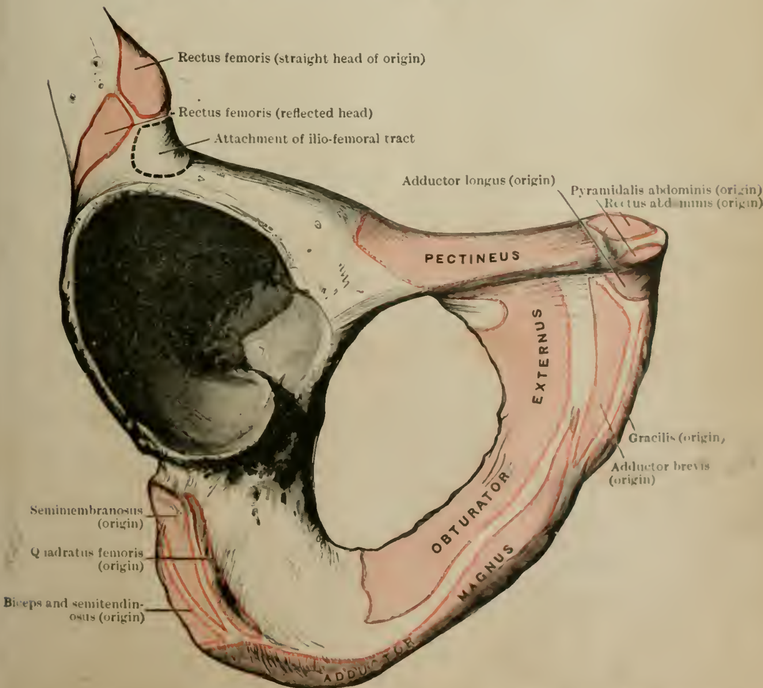


FIG. 75.—MUSCLE ATTACHMENTS TO THE OUTER SURFACE OF THE PUBIS AND ISCHIUM.

THE LOWER LIMB—*continued*

MUSCLES ON THE FRONT OF THE THIGH—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Quadriceps femoris. **Rectus femoris** (two heads).	1. Straight head: anterior inferior spine of ilium. 2. Reflected head: groove above acetabulum.	Proximal border of patella.		Femoral.
Vastus intermedius.	Proximal two-thirds anterior and lateral surfaces of shaft of femur; distal half lateral lip of linea aspera.	Proximal border of patella and deep surface of tendons of rectus and vasti.		,,
Vastus lateralis.	From the proximal half of the anterior intertrochanteric line along distal border of great trochanter, gluteal ridge, and proximal half lateral lip of linea aspera; fascia lata.	Proximal and lateral border of patella; lateral border of tendon of rectus; capsule of joint.	Extend knee; rectus also flexes hip.	,,
Vastus medialis.	Shaft of femur—lower two-thirds of spiral line, medial lip of linea aspera and proximal two-thirds of line leading from linea aspera to medial condyle of femur.	Proximal and medial border of patella; medial border of tendon of rectus; capsule of joint.		,,

MUSCLES ON THE MEDIAL SIDE OF THE THIGH.

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Gracilis.	Edge of symphysis and descending ramus of pubis.	Medial surface of shaft of tibia just distal to medial condyle, behind sartorius.	Flexes hip and adducts thigh; flexes knee and rotates leg medially.	Obturator.
Pectineus.	Ilio-pectineal line of pubis and pubic bone in front of it.	Pectineal line between small trochanter and linea aspera.	Flexes hip; adducts thigh and rotates it laterally.	Femoral.
Adductor longus.	Front of pubis, in angle between crest and symphysis.	Middle third of medial lip of linea aspera.	,, ,,	Obturator.
Adductor magnus.	Rami of pubis and ischium; tuberosity of ischium.	Space distal to insertion of quadratus femoris and whole length of linea aspera; medial epicondylic line of femur; adductor tubercle on medial condyle of femur.	Extends hip; adducts and rotates thigh laterally.	Obturator and sciatic.
Adductor brevis.	Front of body and upper part of descending ramus of pubis.	Distal two-thirds of line leading from small trochanter to linea aspera and proximal fourth of linea aspera.	Adducts and rotates thigh laterally.	Obturator.

THE LOWER LIMB—*continued*

MUSCLES OF THE GLUTEAL REGION

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Gluteus maximus.	1. Dorsum ilii above posterior curved line. 2. Posterior surface sacrum and coccyx. 3. Tendon of sacro-spinalis. 4. Sacro - tuberous ligament.	Fascia lata over great trochanter; gluteal ridge of femur.	(*o*) Extends the thigh; lower fibres adduct thigh and rotate it laterally; upper fibres abduct thigh during flexion. (*i*) Draws pelvis backwards when it has been inclined forwards.	Inferior gluteal.
Gluteus medius.	1. Lateral surface of ilium between posterior and anterior curved lines. 2. Fascia lata which covers its anterior surface.	Oblique line on lateral surface of great trochanter.	Extends and abducts thigh; anterior fibres rotate thigh medially, posterior fibres laterally.	Superior gluteal.
Gluteus minimus.	Lateral surface of ilium between anterior and inferior curved lines.	Anterior surface of great trochanter.	,, ,,	,, ,,
Piriformis.	1. Pedicles of second, third, and fourth sacral vertebræ. 2. Upper margin of greater sciatic notch. 3. Sacro - tuberous ligament.	Proximal border of great trochanter.	Rotates thigh laterally during extension and abducts during flexion.	Sacral plexus.
Obturator internus.	1. Margin of obturator foramen. 2. Obturator membrane. 3. Pelvic surface of hip bone behind and above obturator foramen.	Medial surface of great trochanter above trochanteric fossa.	,, ,,	Nerve to obturator internus from sacral plexus.
Gemellus superior.	Gluteal surface of spine of ischium.	Proximal margin of tendon of obturator internus muscle.	,, ,,	,, ,,
Gemellus inferior.	Upper part of the gluteal surface of the tuberosity of ischium.	Distal margin of tendon of obturator internus muscle.	,, ,,	Nerve to quadratus femoris from sacral plexus.
Obturator externus.	Outer surface of rami of pubis and ischium; medial two-thirds of outer surface of obturator membrane.	Trochanteric fossa.	Flexes hip; abducts thigh and rotates it laterally.	Obturator.
Quadratus femoris.	Lateral border of tuberosity of ischium.	Quadrate tubercle and quadrate line of femur.	Adducts and rotates thigh laterally.	Nerve to quadratus femoris from the sacral plexus.

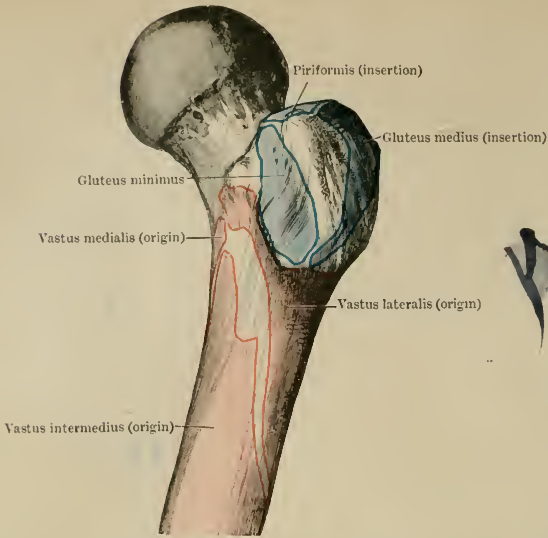


FIG. 76.—MUSCLE ATTACHMENTS TO THE ANTERIOR SURFACE OF THE PROXIMAL PART OF THE FEMUR.

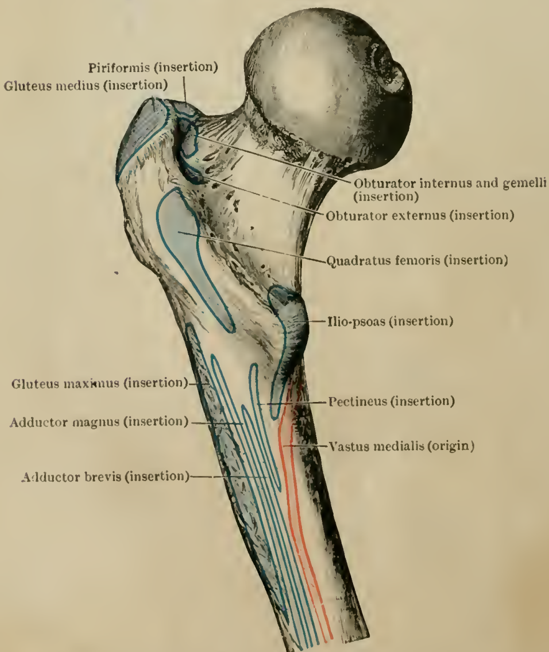


FIG. 77.—MUSCLE ATTACHMENTS TO THE POSTERIOR ASPECT OF THE PROXIMAL PART OF THE FEMUR.

THE LOWER LIMB—*continued*

MUSCLES ON THE BACK OF THE THIGH

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Biceps flexor cruris (O.T. Biceps femoris).	1. Tuberosity of ischium, lower and medial facet. 2. Lateral lip of linea aspera and proximal part of lateral epicondylic ridge of femur.	Head of fibula.	Extends and rotates thigh laterally; flexes and rotates leg laterally.	Sciatic.
Semitendinosus.	Tuberosity of ischium, in common with previous muscle.	Medial surface of shaft of tibia distal to medial condyle and distal to gracilis.	Extends thigh, flexes knee, and rotates leg medially.	,,
Semimembranosus.	Tuberosity of ischium, upper and lateral facet.	Horizontal groove on medial and back part of the medial condyle of tibia; strong slip to oblique popliteal ligament of knee joint.	,, ,,	,,

MUSCLES OF THE LEG

MUSCLES ON THE FRONT OF THE LEG

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Tibalis anterior.	Proximal two-thirds lateral surface shaft of tibia; intermuscular septum and deep fascia.	Medial and under surface of first cuneiform and base of first metatarsal bone.	Dorsi-flexion of ankle and inversion of foot.	Deep peroneal.
Extensor digitorum longus.	Lateral condyle of tibia; proximal two-thirds anterior surface shaft of fibula.	By four tendons into the second and third phalanges of the four lateral toes.	Dorsi-flexion of ankle; extension of toes.	,, ,,
Extensor hallucis longus.	Front of fibula in middle three-fifths and interosseous membrane.	Base of terminal phalanx of big toe, dorsal aspect.	Dorsi-flexion of ankle; extension of great toe.	,, ,,
Peroneus tertius (part of extensor digitorum longus).	Distal part of anterior surface of fibula; interosseous membrane.	Dorsal surface, base of fifth metatarsal bone.	Dorsi-flexion of ankle and eversion of foot.	,, ,,

MUSCLES ON THE BACK OF THE LEG

Superficial Layer

Gastrocnemius (two heads).	1. Lateral condyle of femur. 2. Medial condyle of femur.	By tendo-calcaneus into posterior surface of calcaneus.	Flexion of knee; plantar flexion of ankle.	Tibial.
Plantaris.	Lateral epicondylic line of femur; oblique popliteal ligament of knee joint.	Medial side tubercle of calcaneus, or tendo-calcaneus, or medial annular ligament.	,, ,,	,,

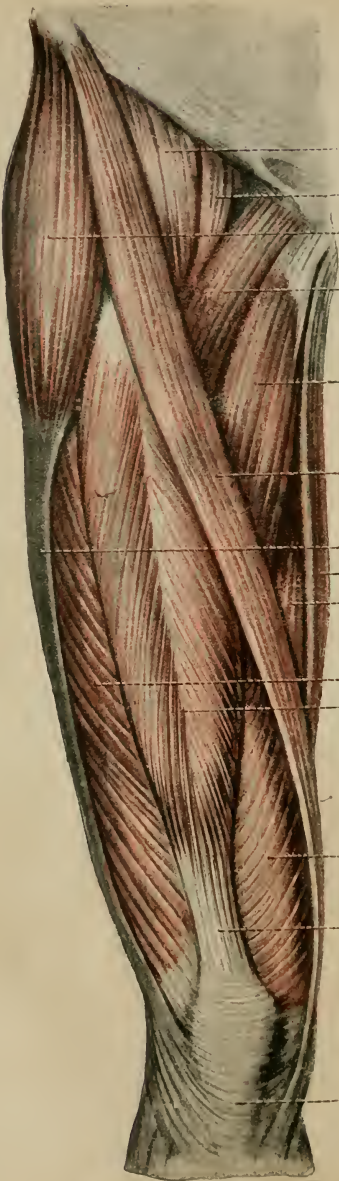


FIG. 78.—THE MUSCLES OF THE FRONT OF THE RIGHT THIGH.

MUSCLES OF THE LEG—*continued*

MUSCLES ON THE BACK OF THE LEG—*continued*

Superficial Layer—*continued*

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Soleus.	Posterior surface head and upper third of shaft of fibula; oblique line and middle third medial border of tibia; fibrous arch over tibial vessels.	By tendo-calcaneus into posterior surface of calcaneus.	Plantar flexion of ankle.	Tibial.

Deep Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Popliteus.	Lateral side lateral condyle of femur.	Triangular surface on back of tibia, proximal to oblique line.	Flexes knee and rotates leg medially.	Tibial.
Flexor hallucis longus.	Distal two-thirds back of shaft of fibula.	Base of terminal phalanx of great toe (plantar aspect).	Plantar flexion of ankle; flexion of great toe.	,,
Flexor digitorum longus.	Posterior surface shaft of tibia distal to the oblique line.	By four tendons into bases of terminal phalanges of four lateral toes (plantar aspect).	Plantar flexion of ankle; flexion of four lateral toes.	,,
Tibialis posterior.	Posterior surfaces shafts of fibula and tibia in middle three-fifths; interosseous membrane.	Tubercle of navicular; plantar surface cuboid, calcaneus, cuneiform bones; plantar surface second, third, and fourth metatarsal bones.	Plantar flexion of ankle; inversion of foot.	,,

MUSCLES ON THE LATERAL SIDE OF THE LEG

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Peroneus longus.	Head and proximal two-thirds lateral surface shaft of fibula.	Lateral side of first cuneiform and base of first metatarsal bone.	Plantar flexion of ankle; eversion of foot.	Superficial peroneal.
Peroneus brevis.	Distal two-thirds lateral surface shaft of fibula.	Dorsal surface, base of fifth metatarsal bone.	,, ,,	,, ,,

MUSCLES OF THE FOOT

DORSAL REGION

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Extensor digitorum brevis.	Upper surface of calcaneus; ligamentum cruciatum.	Four medial toes.	Extends toes.	Deep peroneal.

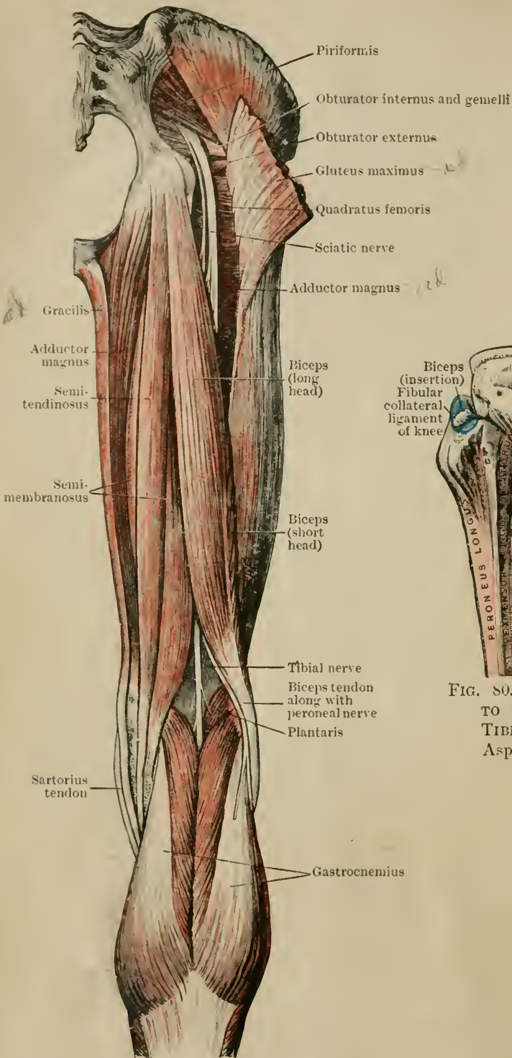


FIG. 79.—THE MUSCLES ON THE BACK OF THE RIGHT THIGH.

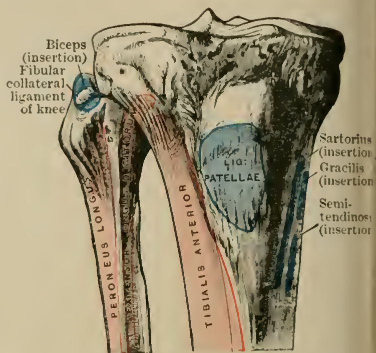


FIG. 80.—MUSCLE ATTACHMENTS TO THE UPPER PART OF THE TIBIA AND FIBULA (Anterior Aspects).

MUSCLES OF THE FOOT—*continued*

PLANTAR REGION

First Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
.bductor hallucis.	Medial tubercle on under surface of calcaneus; ligamentum laciniatum and plantar fascia.	Medial side base of first phalanx of great toe.	Abducts great toe from median line of second toe.	Medial plantar.
.bductor digiti quinti.	Medial and lateral tubercles on under surface of calcaneus; plantar fascia.	Lateral side base of first phalanx of little toe.	Abducts little toe from median line of second toe.	Lateral plantar.
'lexor digitorum brevis.	1. Medial tubercle on under surface of calcaneus. 2. Plantar fascia.	By four tendons into second phalanges of four lateral toes.	Flexes metatarso-phalangeal joints and first interphalangeal joints of toes.	Medial plantar.

Second Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
)uadratus plantæ (two heads).	1. Medial surface of calcaneus and medial border of long plantar ligament. 2. Lateral border of under surface of calcaneus and lateral border of long plantar ligament.	Tendon of flexor digitorum longus.	Flexes toes.	Lateral plantar.
.umbricales (four in number).	Tendons of flexor digitorum longus.	Extensor tendon; metatarso-phalangeal capsule; base of first phalanx.	Flex metatarso-phalangeal joints; extend interphalangeal joints.	Lateral and medial plantar.

Third Layer

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Flexor hallucis brevis.	Under surface of cuboid bone; tendon of tibialis posterior.	Medial and lateral sides base of first phalanx of great toe.	Flexes great toe.	Medial plantar.
Adductor hallucis (two parts).	1. Oblique head—Sheath of peroneus longus; plantar surface posterior extremities second, third, and fourth metatarsal bones.	Lateral side base of first phalanx of great toe.	Adducts great toe to medial line of second toe.	Lateral plantar.
	2. Transverse head—Capsules of lateral four metatarso-phalangeal joints: transverse metatarsal ligament.	,, ,,	,, ,,	,, ,,
Flexor digiti quinti brevis.	1. Sheath of peroneus longus. 2. Base of metatarsal bone of little toe.	Lateral side base of first phalanx of little toe.	Flexes metatarso-phalangeal joint of little toe.	,, ,,

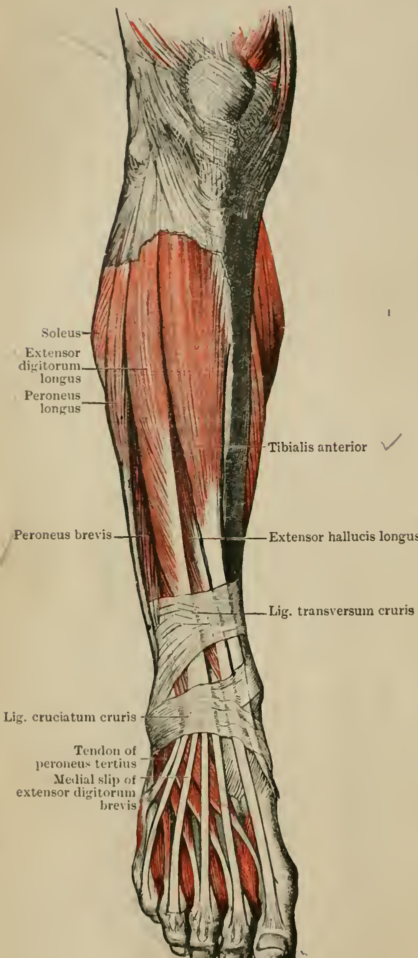


FIG. 81.—MUSCLES OF THE FRONT OF THE RIGHT LEG AND DORSUM OF THE RIGHT FOOT.

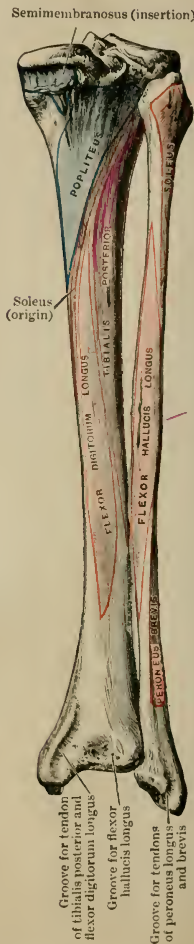


FIG. 82.—MUSCLE ATTACHMENTS TO THE TIBIA AND FIBULA (Posterior Aspects).

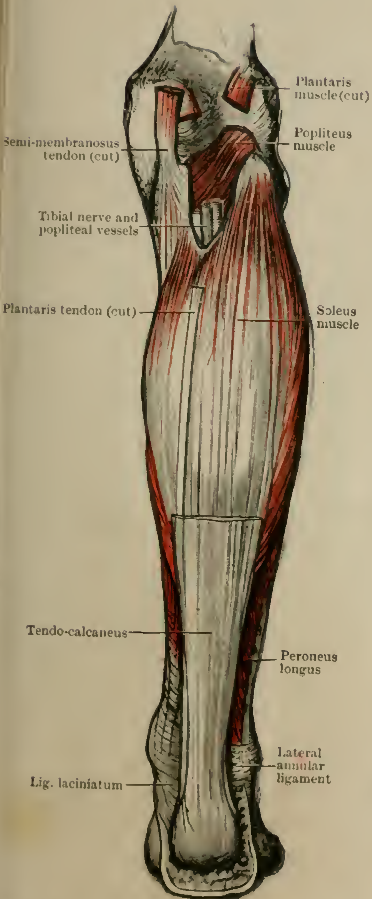


FIG. 83.—THE RIGHT SOLEUS MUSCLE.

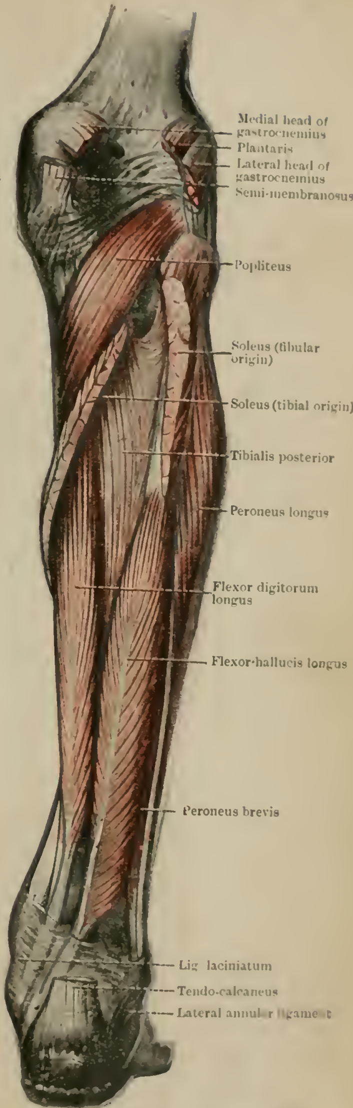


FIG. 84.—THE DEEP MUSCLES ON THE BACK OF THE RIGHT LEG.

MUSCLES OF THE FOOT—*continued*

PLANTAR REGION—*continued*

FOURTH LAYER

Interosseous Muscles

Muscle.	Origin.	Insertion.	Action.	Nerve Supply.
Dorsal interossei (four in number).	Each by two heads from adjacent margins of shafts of metatarsal bones.	Side of first phalanx of toes; metatarso-phalangeal capsule; extensor tendon; the first two on either side of second toe, the third and fourth on the lateral side of the third and fourth toes.	Abduct from the median line of the second toe.	Lateral plantar.
Plantar interossei (three in number).	Medial side of third, fourth, and fifth metatarsal bones.	Medial side of third, fourth, and fifth toes.	Adduct to the median line of the second toe.	,, ,,

TABLE OF MUSCLES WHICH PRODUCE MOVEMENT OF THE THIGH AT THE HIP JOINT

FLEXION.	EXTENSION.	ABDUCTION.	ADDUCTION.
Psoas major. Iliacus. Sartorius. Rectus femoris. Gracilis. Pectineus. Adductor longus. Obturator externus.	Gluteus maximus. ,, medius. ,, minimus. Biceps flexor cruris (Biceps femoris). Semitendinosus. Semimembranosus. Adductor magnus.	Tensor fasciæ latæ (Tensor fasciæ femoris). Gluteus medius. ,, minimus. Obturator externus. Piriformis . . } during flexion. Obturator internus . . } Gemelli . . } Sartorius . . } Gluteus maximus (upper fibres) . . }	Adductor longus. ,, brevis. ,, magnus. Pectineus. Gracilis. Quadratus femoris. Gluteus maximus (lower fibres).

LATERAL ROTATION.	MEDIAL ROTATION.
Obturator externus. Quadratus femoris. Gluteus maximus (lower fibres). ,, medius . } (posterior fibres). ,, minimus } Piriformis . . . } during extension. Obturator internus } Gemelli . . . . } Sartorius. Iliacus. Psoas major. Pectineus. Adductor longus. ,, brevis. ,, magnus. Biceps flexor cruris.	Gluteus medius (anterior fibres). ,, minimus (anterior fibres). Tensor fasciæ latæ.

The pelvis is flexed and extended on the thigh by the same muscles which flex and extend the thigh on the pelvis; the most powerful action of the gluteal muscles is to help to draw the pelvis backwards to the upright position when it has been inclined forwards.

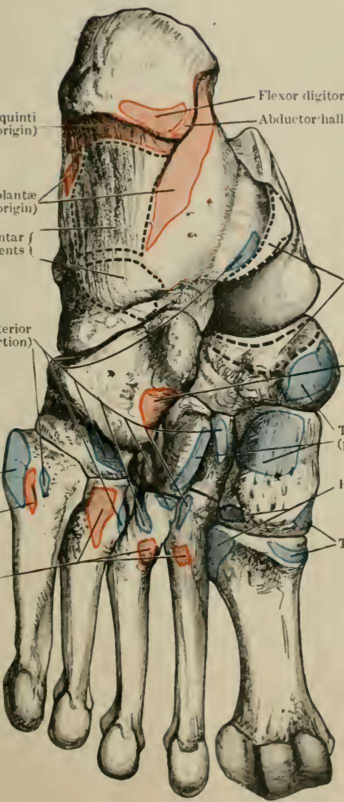


FIG. 85.—MUSCLE ATTACHMENTS TO TARSUS AND METATARSUS (Plantar Aspect).

TABLE OF MUSCLES WHICH PRODUCE MOVEMENT AT THE KNEE JOINT

Flexion.	Extension.	Lateral Rotation.	Medial Rotation.
Sartorius. Gracilis. Semitendinosus. Semimembranosus. Biceps flexor cruris Gastrocnemius. Plantaris. Popliteus.	Rectus femoris . } Quadriceps extensor. Vastus intermedius Vastus lateralis . Vastus medialis .	Biceps flexor cruris.	Sartorius. Gracilis. Semitendinosus. Semimembranosus. Popliteus.

TABLE OF MUSCLES WHICH PRODUCE MOVEMENT AT THE ANKLE JOINT

Dorsi-flexion.	Plantar Flexion or Extension.	Eversion.	Inversion.
Tibialis anterior. Extensor digitorum longus. Extensor hallucis longus. Peroneus tertius.	Gastrocnemius. Plantaris. Soleus. Tibialis posterior. Peroneus longus. ,, brevis. Flexor hallucis longus. ,, digitorum longus.	Peroneus tertius. ,, longus. ,, brevis.	Tibialis anterior. ,, posterior.

TABLE OF MUSCLES WHICH PRODUCE MOVEMENTS OF THE TOES

Flexion.	Extension.	Abduction.	Adduction.
Flexor digitorum longus. Quadratus plantæ. Lumbricales. Flexor hallucis longus. Flexor hallucis brevis. Flexor digitorum brevis. Flexor digiti quinti brevis. Interossei.	Extensor digitorum longus. Extensor digitorum brevis. Extensor hallucis longus.	Abductor hallucis. Dorsal interossei. Abductor digiti quinti.	Adductor hallucis. Plantar interossei.

CHAPTER VI

THE NERVOUS SYSTEM

The Nervous System consists of two parts, the Cerebro-Spinal and the Sympathetic.

CEREBRO-SPINAL SYSTEM

The cerebro-spinal system consists of the brain, spinal medulla, and the nerves connected with them. The brain and spinal medulla are composed of white and grey matter. The white matter consists of nerve fibres, each of which is surrounded by a cylinder of fatty substance, called myelin or white substance of Schwann, which acts as an insulating material. The grey matter consists of nerve cells from which the nerve fibres originate, and neuroglia. It is more largely supplied by blood vessels than the white. Impulses and impressions are supposed to originate in it, while they are conducted by means of the fibres of which nerves are composed.

THE BRAIN

The brain almost completely fills the cranial cavity, and forms the upper part of the cerebro-spinal axis. It is invested by three membranes,—the dura mater, the arachnoid, and the pia mater.

The dura mater, the outer covering, is a tough fibrous membrane which lines the cranial cavity, and is plentifully supplied with blood vessels and nerves. The arachnoid is a fine, transparent membrane which lies between the dura mater and the pia mater. The pia mater lies next the surface of the brain, and is a very delicate membrane consisting of a fine network of blood vessels held together by connective tissue; from this membrane the cortex of the brain receives its blood supply. The brain is divided into five parts, namely, the cerebrum, the mesencephalon or mid-brain, the cerebellum, the pons, and medulla oblongata.

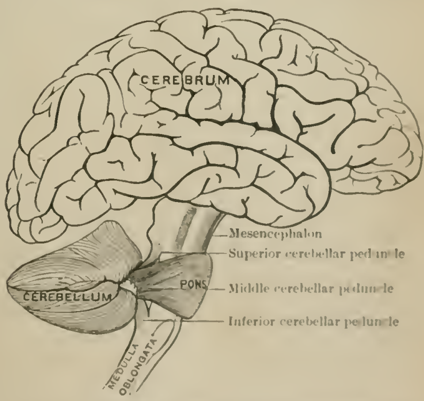


FIG. 86.—SCHEMA, showing the connections of the several parts of the Brain.

The Cerebrum is the largest part of the brain, and fills the upper and front part of the cranium. It is divided into right and left hemispheres by a deep longitudinal fissure. The external part is composed of grey matter, arranged in folds or convolutions. It is believed that the mental powers of the individual are proportionate to the number, size, and depth of these convolutions. The internal part consists of white matter. The cerebrum is the seat of intelligence, sensation, volition, and emotion.

The Cerebellum lies beneath the back part of the cerebrum. It consists of two hemispheres, each composed externally of grey matter, internally of white substance. The surface of the cerebellum is not arranged in convolutions, but is traversed by curved fissures. Its function is the co-ordination of muscular movement, whereby harmonious action is ensured. It has no power to originate movement, only to regulate it.

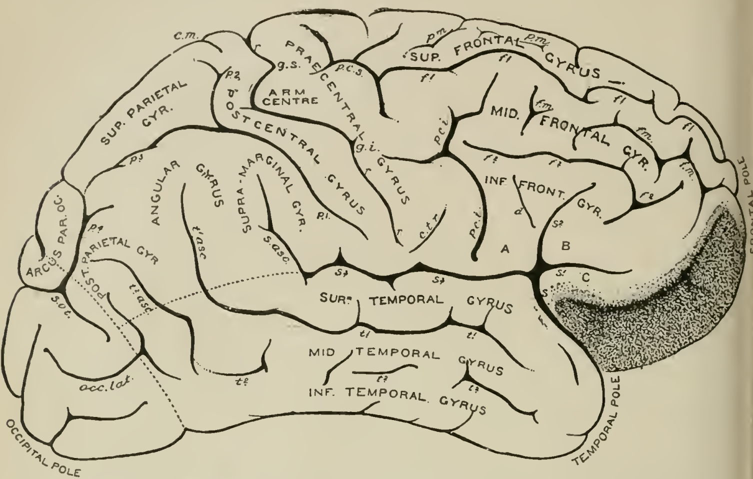


FIG. 87.—CONVOLUTIONS AND FISSURES, on the Lateral Surface of the Cerebral Hemisphere.

- f^1. Sulcus frontalis superior.
- f^2. Sulcus frontalis inferior.
- f.m. Sulcus frontalis medius.
- p.m. Sulcus paramedialis.
- A. Pars basilaris.
- B. Pars triangularis.
- C. Pars orbitalis.
- S. Lateral cerebral fissure.
- S^1. Anterior horizontal limb.
- S^2. Ascending limb.
- S^3. Posterior horizontal limb.
- s.asc. Ascending terminal part of the posterior horizontal limb.
- p.c.i. Inferior præcentral sulcus.
- p.c.s. Superior præcentral sulcus.
- r. Fissure of Rolando.
- g.s. Superior genu.
- g.i. Inferior genu.
- d. Sulcus diagonalis.
- t^1. Superior temporal sulcus.
- t^2. Inferior temporal sulcus.
- p^1. Inferior postcentral sulcus.
- p^2. Superior postcentral sulcus.
- p^3. Ramus horizontalis.
- p^4. Ramus occipitalis.
- s.o.t. Sulcus occipitalis transversus.
- occ.lat. Sulcus occipitalis lateralis.
- c.m. Calloso-marginal sulcus.
- c.t.r. Inferior transverse furrow.

The Mesencephalon or Mid-Brain is the connection between the cerebrum above and the cerebellum and spinal medulla below; it consists mainly of strands of white fibres passing from the cerebrum to the pons and so to the medulla oblongata and spinal medulla, and other strands passing from the medulla and cerebellum up to the cerebrum; it also contains some grey matter.

The Pons is a band composed of white fibres and grey matter which forms a bridge between the two hemispheres of the cerebellum, and at the same time connects the mesencephalon to the medulla oblongata.

The Medulla Oblongata is about $1\frac{1}{4}$ inch long. It is the continuation of the upper part of the spinal medulla, and extends from the upper border of the atlas to the pons. Contrary to the arrangement of the brain substance, and like the spinal cord, it is composed internally of grey matter surrounded by white. It is the only connecting medium between the brain and the spinal medulla, and it governs the movements of the heart and the lungs, consequently instant death is caused by its destruction.

In the medulla oblongata many of the nerve fibres cross the median line, so that if one side of the head be injured the opposite side of the body is affected.

THE SPINAL MEDULLA

The spinal medulla is that part of the cerebro-spinal axis which lies in the vertebral canal. It extends from the medulla oblongata to the lower border of the first lumbar vertebra, where it terminates in a slender thread of grey matter called the filum terminale, which is continued to the back of the coccyx.

The spinal medulla is, like the brain, surrounded by three membranes, and a considerable interval is left between the medulla and the bony canal which contains it. It has two enlargements—one in the cervical region, extending from the third cervical to the first dorsal vertebra; the other in the lumbar region, opposite the last dorsal vertebra. The nerve trunks of the upper extremities are attached to the former, those of the lower extremities to the latter enlargement. As in the medulla oblongata, the grey nerve substance of the spinal medulla is placed internally and surrounded by the white. The medulla is divided into right and left halves by two clefts or fissures which extend down its entire length: the one on its anterior aspect is called the antero-median fissure, that on its posterior aspect the postero-median fissure.

The grey matter in each half is arranged in the shape of a crescent, with convexity inwards; one horn projects forwards and is called the anterior cornu, the other backwards, called the posterior cornu. These crescents are connected together in the centre by a band of nerve substance called the grey commissure, in the middle of which is the small canal which runs through the entire length of the medulla, called the central canal of the spinal medulla.

If this central canal is traced upwards it is found to open out into large spaces called ventricles in the various portions of the brain; thus between the medulla oblongata and pons in front and the cerebellum behind is the fourth ventricle; traversing the mesencephalon is the aqueduct of Sylvius, in the base of the cerebrum is the third ventricle, and in each cerebral hemisphere is the lateral ventricle.

NERVES

Nerves are formed of bundles of nerve fibres. The fibres vary in composition, but one constituent is common to all, namely, the axis cylinder, which is a transparent thread-like band.

In some nerve fibres the axis cylinder is enclosed in a sheath called myelin, they are then called myelinated or medullated fibres; in others this sheath is absent, and the fibres are called non-myelinated or non-medullated. Both myelinated and non-myelinated fibres in their course outside the brain and cord have an external sheath called neurilemma. The axis cylinder, however, is always naked near the origin and termination of every nerve fibre.

The cerebro-spinal nerves consist almost entirely of myelinated fibres.

Afferent or sensory nerve fibres convey impressions, made upon their peripheral terminations, to the nerve centres; and by their means the mind is made conscious of external objects and of sensations. Efferent nerve fibres convey impulses sent out by the brain and spinal cord. Most of these fibres terminate in the muscles, causing their contraction, and are called motor; others terminate in the glands, and are called secretory; others convey impulses to restrain movement or secretion, and these are called inhibitory. Some nerves are composed of both sensory and motor fibres; they are known as "mixed" nerves.

Most motor fibres which arise in the brain descend to the front of the medulla oblongata and, crossing over, pass down in the spinal medulla on the opposite side to that of their origin, a few fibres continuing down the same side; even these, however, cross to the other side in the spinal medulla before they leave it. The sensory fibres for the most part pass up the cord on the same side as they enter it as far as the medulla oblongata, where they then cross and enter the brain on the opposite side. Some cross immediately to the opposite side on reaching the spinal medulla.

The joining together of two or more nerves is called a "plexus."

The "peripheral" termination of a nerve is that end of it which is farthest from the nerve centre. Nerves are supplied with blood and lymph vessels.

REFLEX ACTION

The spinal medulla, besides being the conducting medium of impressions to and from the brain, is also a centre for reflex actions—that is, it has the power, in itself, of receiving and transmitting impulses; thus if the spinal medulla is severed, or injured, sensation and voluntary movement cease in the parts supplied by nerves coming from the spinal medulla below the injury, but if irritation is applied to the afferent nerve endings of such a part a response is made by the efferent nerves of the same part, and involuntary movement is the result.

Reflex actions are those, then, which can take place entirely without the consciousness or will of the individual, though under normal conditions many of them are modified or restrained by the higher centres in the brain.

CEREBRAL NERVES

Twelve pairs of nerves arise from the brain and pass through openings in the base of the skull. Some of these are nerves of special sense, others of ordinary sensation, and others again are motor nerves.

They are—

1. Olfactory.	7. Facial.
2. Optic.	8. Acoustic.
3. Oculo-motor.	9. Glosso-pharyngeal.
4. Trochlear.	10. Vagus.
5. Trigeminal.	11. Accessory.
6. Abducent.	12. Hypoglossal.

The First or Olfactory (Sensory) Nerve consists of several fine twigs which spring from the olfactory bulb, which is attached to the under surface of the cerebrum; they pierce the ethmoid bone, and are distributed to the nose. It is the special nerve of the sense of smell.

The Second or Optic (Sensory) Nerve arises from the mesencephalon, passes through the optic foramen, enters the orbit, and is distributed to the retina of the eye. It is the special nerve of the sense of sight.

The Third or Oculo-motor Nerve arises from the mesencephalon, enters the orbit through the superior orbital fissure, and supplies the muscles of the eyeball and orbit.

The Fourth or Trochlear (Motor) Nerve arises from the roof of the fourth ventricle, enters the orbit through the superior orbital fissure, and supplies the superior oblique muscle of the eyeball.

The Fifth or Trigeminal Nerve arises by two roots, one sensory, the other motor, from the pons. It is the largest of the cerebral nerves, and is the chief nerve of sensation for the face and head, besides being the motor nerve of the muscles of mastication. Underneath the dura mater, at the apex of the petrous portion of the temporal bone, the sensory root forms a large ganglion, and from it three large branches are given off, namely, the ophthalmic, the maxillary, and the mandibular.

The motor root passes forward with the sensory root as far as the apex of the petrous portion of the temporal bone; here it passes beneath the ganglion and outside the cranium, becomes incorporated with the mandibular branch of the nerve.

The ophthalmic (sensory) nerve enters the orbit through the superior orbital fissure, and supplies branches to the eyeball, the lacrimal gland, the nose, the skin of the eyebrow, forehead, and nose.

The maxillary (sensory) nerve leaves the skull through the foramen rotundum, then enters the orbit, and finally terminates by dividing into several branches in the face. It supplies in its course the nose, lower eyelid, skin of the cheek and temple, the upper jaw, and mucous membranes of the nose, pharynx, and mouth.

The mandibular (sensory and motor) nerve arises by two roots, sensory and motor; these pass out of the skull by the foramen ovale, and join together to form a single trunk, the branches of which are distributed to the teeth and gums of the lower jaw, the skin of the temple and ear, the lower part of the face and the muscles of mastication. It also supplies the tongue with a special nerve of the sense of taste, which is given to it by the facial.

The Sixth or Abducent (Motor) Nerve arises from the junction of the pons with the medulla oblongata, enters the orbit through the superior orbital fissure, and supplies the lateral rectus muscle of the eye.

The Seventh or Facial (Motor) Nerve arises from the pons, enters the internal acoustic meatus, and, after traversing the petrous portion of the temporal

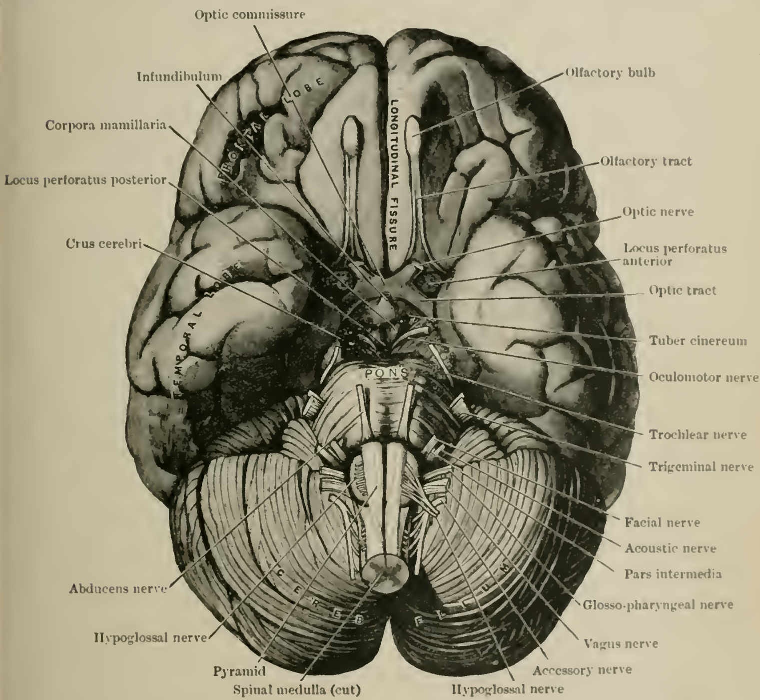


FIG. 88.—THE BASE OF THE BRAIN, WITH THE CEREBRAL NERVES ATTACHED.

bone, emerges through the base of the cranium by the stylo-mastoid foramen. It then passes forward and, below the ear, divides into several branches which are distributed to the muscles of the face and control its various expressions; branches also pass to the superficial muscles of the side of the head, and to those of the upper part of the neck.

The Eighth or Acoustic (Sensory) Nerve arises from the pons; it enters the internal acoustic meatus and supplies the internal parts of the ear. It is the special nerve of the sense of hearing.

The Ninth or Glosso-Pharyngeal (Sensory) Nerve arises from the medulla oblongata, and supplies the tongue and pharynx.

The Tenth or Vagus (Sensory) Nerve arises from the medulla oblongata; it passes into the neck through the jugular foramen with the glosso-pharyngeal and accessory nerves, descends in front of the vertebral column within the sheath of the carotid vessels, enters the thorax, and continues to the upper part of the abdomen. It is the most extensive of the cerebral nerves in its distribution and length, supplying in its course the pharynx, larynx, œsophagus, lungs, heart, stomach and liver, etc.

The Eleventh or Accessory (Motor) Nerve consists of two parts: one, accessory to the vagus nerve, arises from the medulla oblongata and supplies the muscles of the palate, pharynx, larynx, œsophagus, stomach and intestines, etc.; the other, the spinal part, arises from the spinal medulla and controls the trapezius and sterno-mastoid muscles.

The Twelfth or Hypoglossal (Motor) Nerve arises from the medulla oblongata and supplies the tongue. It leaves the cranium through the anterior condylic foramen.

SPINAL NERVES

There are thirty-one pairs of spinal nerves.

Each nerve arises by an anterior and a posterior root from the spinal medulla. The anterior root consists of motor, the posterior root of sensory, fibres. They arise respectively from the anterior and posterior cornua of the grey matter of the medulla. On the posterior root a ganglion or enlargement is found, and just beyond

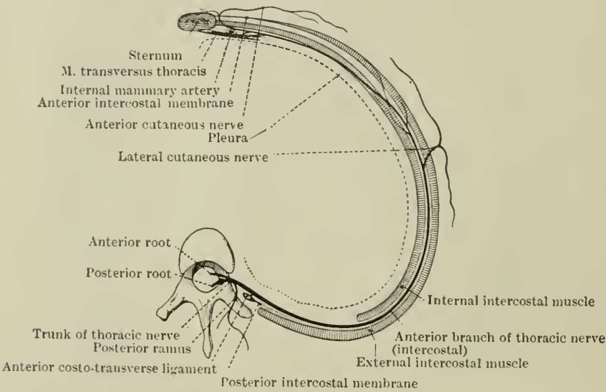


FIG. 89.—DIAGRAM OF ONE OF THE UPPER INTERCOSTAL NERVES.

this the two roots unite and pass out of the vertebral canal as a single nerve trunk; this trunk, however, immediately divides into an anterior and a posterior ramus, for distribution to the anterior and posterior parts of the body. Each of these divisions is composed of sensory and motor fibres from both roots, and as the union between the two roots occurs before the spinal nerves leave the vertebral canal they are spoken of as mixed nerves.

The spinal nerves supply the skeletal muscles and the skin of the trunk and limbs. The efferent or motor fibres terminate in the muscles, and cause their contraction.

The afferent or sensory fibres terminate in the skin and subcutaneous tissue.[1]

If the anterior root of a nerve is injured the result will be the loss of the power of voluntary movement in the part supplied, while sensation remains.

If the posterior root is injured the power of movement remains while sensation is lost.

[1] The spinal nerves also communicate, by means of small branches called white rami communicantes, with the sympathetic nervous system, and by its medium motor, sensory, and secretory fibres which originally come from the brain are conveyed to the viscera, vessels, and glands.

Should a mixed nerve be injured both sensation and the power of voluntary movement are destroyed in the part supplied.

The spinal nerves are named according to the part of the vertebral column from which they emerge—

Cervical	8 pairs.
Thoracic	12 ,,
Lumbar	5 ,,
Sacral	5 ,,
Coccygeal	1 pair.

As has been mentioned above, the spinal nerves divide into posterior and anterior rami on emerging from the vertebral canal.

POSTERIOR RAMI OF THE SPINAL NERVES

The posterior rami pass directly backwards from the intervertebral foramina, and are distributed to the skin of the back of the head, trunk, shoulder and buttock, and to the longitudinal muscles of the back.

They usually divide into medial and lateral trunks. The cutaneous supply for the upper half of the body comes as a rule from the medial trunks, that for the lower half from the lateral trunks.

CERVICAL REGION

First Cervical or Sub-occipital Nerve.—This nerve does not divide into medial and lateral branches. It emerges from the vertebral canal above the posterior arch of the atlas, enters the sub-occipital triangle, and supplies the muscles forming it, namely, recti capiti posteriores major and minor, obliquus capitis superior, obliquus capitis inferior, and semispinalis capitis.

It has no cutaneous branches.

A communicating branch joins the second cervical nerve.

Second Cervical Nerve.—This nerve passes backwards between the atlas and epistropheus, and gives off some small muscular and communicating branches After piercing the semispinalis capitis and trapezius muscles close to the occipital bone, the medial or main branch ascends on the back of the head with the occipital artery as the great occipital nerve. It supplies the skin of the skull as far as the vertex and communicates with the great auricular, the posterior auricular, the small and the least occipital nerves.

The muscular branches supply the semispinalis capitis, obliquus capitis inferior, semispinalis cervicis, and multifidus muscles.

Its communicating branches form the posterior cervical plexus which supplies neighbouring muscles.

Third Cervical Nerve.—Its medial branch forms the nervus occipitalis minimus, which pierces the trapezius and supplies the skin over the lower part of the back of the head. It lies to the medial side of the great occipital nerve and communicates with it.

The lateral branch supplies filaments to neighbouring muscles.

The Fourth, Fifth, and Sixth Cervical Nerves are smaller than the preceding. They divide into lateral muscular and medial cutaneous branches. The latter supply the skin of the back of the neck.

The Seventh and Eighth Cervical Nerves do not as a rule give off cutaneous branches, but terminate in the deep muscles of the back.

THORACIC REGION

The posterior rami of the thoracic nerves divide into medial and lateral branches. The medial branches of the upper six thoracic nerves are cutaneous in their distribution, only giving off small muscular branches; the lateral branches are muscular. In the case of the lower six thoracic nerves the lateral branches become cutaneous, while the medial innervate the multifidus and longissimus dorsi muscles.

LUMBAR REGION

The posterior rami of the first three lumbar nerves divide into medial and lateral branches. The medial are muscular, and are distributed to the deep muscles of the back; the lateral are cutaneous, and supply the skin of the buttock to below the level of the great trochanter.

The fourth and fifth lumbar nerves have no cutaneous branches, but supply muscular branches to the deep muscles of the back.

SACRAL AND COCCYGEAL NERVES

The first three sacral nerves divide into medial and lateral branches. Muscular branches for the multifidus arise from the former, and cutaneous branches from the latter, to supply the skin of the sacrum and back of the buttock.

The lower two sacral nerves do not divide into medial and lateral branches. They unite with the small posterior ramus of the coccygeal nerve to form the *posterior coccygeal* nerve, which pierces the sacro-tuberous ligament, and supplies the skin over the coccyx and neighbouring parts.

ANTERIOR RAMI OF THE SPINAL NERVES

The anterior rami of the spinal nerves supply the front and sides of the body, and the limbs. They give rise to three important plexuses—the cervical, the brachial, and the lumbo-sacral.

THE CERVICAL PLEXUS

The cervical plexus is formed by the anterior rami of the first four cervical nerves. It is found opposite the four upper vertebræ, under cover of the sterno-mastoid muscle. Its branches may be divided into two groups — superficial and deep.

- **Superficial** (Cutaneous) . .
  - Ascending
    - Small occipital
      - Auricular.
      - Mastoid.
      - Occipital.
      - Cervical.
    - Great auricular
      - Mastoid.
      - Auricular.
      - Facial.
    - Cutaneus colli (O.T. superficial cervical).
  - Descending
    - Anterior supraclavicular, supplying skin of neck and chest.
    - Middle supraclavicular, supplying the skin over the pectoral and deltoid muscles.
    - Posterior supraclavicular, supplying skin of upper and back part of shoulder.
- **Deep** (Muscular and communicating)
  - Lateral (directed towards posterior triangle of neck)
    - Muscular branches to
      - Sterno-mastoid.
      - Trapezius.
      - Levator scapulæ.
      - Scalenus medius.
      - Scalenus posterior.
    - Communicating branches to accessory nerve.
  - Medial (directed towards anterior triangle of neck)
    - Muscular branches to
      - Prevertebral muscles.
      - Infra-hyoid.
      - Diaphragm (phrenic nerve).
    - Communicating branches to
      - Vagus.
      - Hypoglossal.
      - Sympathetic.

The Small Occipital Nerve arises from the second and third cervical nerves. It passes backwards underneath the sterno-mastoid muscle and then ascends along its posterior border.

It pierces the deep fascia near the cranium, and divides into auricular, mastoid, and occipital branches. The auricular branch supplies the skin of the cranial surface of the auricle. The other branches supply the scalp. Small cervical branches are supplied to the upper part of the neck. The small occipital nerve communicates on the scalp with the great occipital and the great auricular nerves, and also with the posterior auricular branch of the facial nerve.

The Great Auricular arises from the second and third cervical nerves. It passes round the posterior border of the sterno-mastoid muscle, then upwards upon that muscle and underneath the platysma towards the ear. Near this it subdivides; through its facial branches it supplies the parotid gland and the skin of the face over it; its auricular branches are distributed to the back of the ear, and the mastoid branches to the skin behind the ear.

The Nervus Cutaneus Colli arises from the second and third cervical nerves. It winds round the posterior border of the sterno-mastoid about its middle, then passes across that muscle underneath the platysma and the external jugular vein and divides into two branches which supply the skin covering to the anterior triangle of the neck.

The Phrenic is the most important nerve of the plexus; it is one of the muscular branches, and arises from the third, fourth, and fifth cervical nerves. It descends obliquely in the neck in front of the scalenus anterior muscle, enters the chest between the subclavian artery and vein, and passes downwards to the diaphragm, where it divides into the numerous branches which supply that muscle. It also sends branches to the pleura, the pericardium, the inferior vena cava, the suprarenal gland, and the liver.

THE BRACHIAL PLEXUS

The brachial plexus is formed by the four lower cervical and first thoracic nerves, together with a branch from the second thoracic nerve. These nerves emerge between the scalenus anterior and scalenus medius muscles; the plexus extends from the lower part of the side of the neck to the axilla. Here three fasciculi—a lateral, medial, and posterior—are formed by the union of the nerves of the plexus, and branches are derived from these which supply the shoulder and arm.

BRANCHES OF THE BRACHIAL PLEXUS

Those nerves which arise from the plexus above the clavicle are called supraclavicular; those given off below it are called infraclavicular.

- **Supraclavicular** . .
  - Anterior branches
    - Nerves to scalenus anterior.
    - ,, longus colli.
    - Communicating nerve to phrenic.
    - Nerve to subclavius muscle.
  - Posterior branches
    - Nerves to scalenus medius.
    - ,, ,, posterior.
    - Dorsal nerve of scapula.
    - Long thoracic nerve.
    - Suprascapular nerve.
- **Infraclavicular** . .
  - Lateral fasciculus
    - Lateral anterior thoracic.
    - Lateral head of median.
    - Musculo-cutaneous.
  - Medial fasciculus
    - Medial anterior thoracic.
    - Ulnar.
    - Medial head of median.
    - Medial cutaneous nerve of forearm.
    - ,, ,, ,, arm.
  - Posterior fasciculus
    - Axillary.
    - Radial
      - Superficial ramus.
      - Deep ramus.
    - Two subscapular nerves.
    - Thoraco-dorsal nerve.

CHIEF NERVES OF THE UPPER EXTREMITY

Musculo-Cutaneous Nerve.—The musculo-cutaneous nerve arises from the lateral fasciculus of the brachial plexus, it passes downwards through

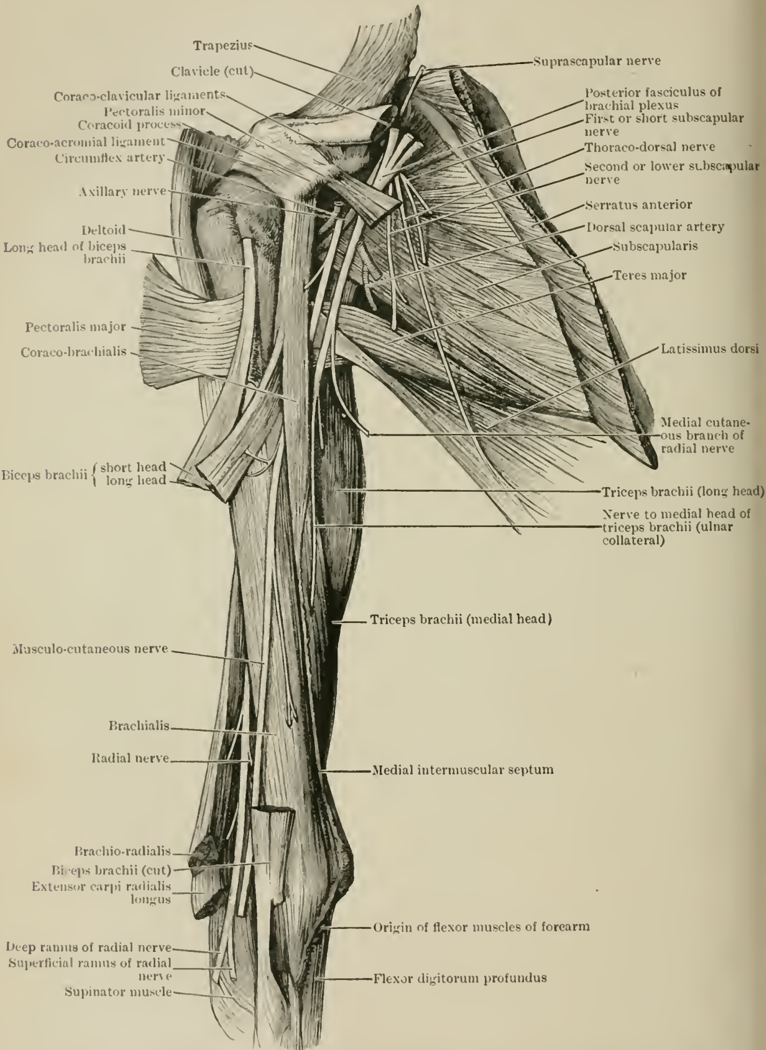


FIG. 90.—THE POSTERIOR WALL OF THE AXILLA AND THE FRONT OF THE ARM (the Biceps brachii being divided).

the coraco-brachialis muscle, and continues in a slightly oblique direction between the biceps brachii and brachialis muscles towards the outside of the arm. It terminates in front of the elbow in branches which supply the skin of the lateral side of the forearm.

BRANCHES—

Muscular—Supplying the biceps brachii, brachialis, and coraco-brachialis.

Cutaneous—1. An anterior branch supplying the skin on the anterior aspect of the lateral side of the forearm and the ball of the thumb. 2. A posterior branch supplying the skin on the posterior aspect of the lateral side of the forearm in its proximal three-fourths.

Median Nerve.—The median nerve arises by two roots from the medial and lateral fasciculi. It descends in the arm first on the lateral, then on the medial side of the brachial artery. At the bend of the elbow it lies between the brachialis muscle and the lacertus fibrosus (O.T. bicipital fascia). In the forearm it passes between the two heads of the pronator teres, and extends between the superficial and deep muscles to the wrist, passing beneath the transverse carpal ligament into the palm of the hand, where it terminates in six branches.

BRANCHES.—The median nerve gives off no branches in the upper arm. In the forearm four branches are given off; they are—

1. *Articular*—Supplying the front of the elbow joint.
2. *Muscular*—Supplying pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum sublimis.
3. *Volar interosseous nerve of forearm*—Supplying flexor pollicis longus, the lateral half of the flexor digitorum profundus, pronator quadratus, interosseous membrane, articular filaments to the radio-carpal articulation.
4. *Palmar* ramus—Supplying the skin of the palm of the hand. (Not always present.)

In the hand muscular and cutaneous branches are given off. The *muscular branch* supplies—

Abductor pollicis brevis.
Opponens pollicis.
Superficial head of flexor pollicis brevis.

The *cutaneous branches* are five in number; they supply the palmar aspect of both sides of the thumb, index and middle fingers, and the radial side of the ring finger. From two of these muscular branches arise for the two lateral lumbricals.

Ulnar Nerve.—The ulnar nerve arises from the medial fasciculus of the brachial plexus. At its commencement it lies between the axillary artery and vein, and extends along the medial side of the brachial artery to the middle of the arm; then passing in front of the medial head of the triceps brachii muscle it reaches the groove between the olecranon and the medial epicondyle of the humerus. It enters the forearm between the two heads of the flexor carpi ulnaris muscle and passes down the ulnar side, between the flexor carpi ulnaris and flexor digitorum profundus muscles. In the distal half of the forearm it is more superficially placed, and lies on the medial side of the ulnar artery. At the wrist it crosses the transverse carpal ligament and passes into the palm of the hand, where it terminates in two branches, superficial and deep.

BRANCHES.—The ulnar nerve gives off no branches in the arm. In the forearm it gives off—

1. *An articular branch*, supplying the elbow.
2. *Muscular branches*, supplying flexor carpi ulnaris and the medial half of flexor digitorum profundus.
3. *Cutaneous branches* $\begin{cases} \text{Palmar.} \\ \text{Dorsal.} \end{cases}$

The *palmar cutaneous branch* supplies the palm of the hand, gives branches to the ulnar artery, and often joins the medial cutaneous nerve of the forearm and the palmar ramus of the median nerve.

The *dorsal cutaneous branch* passes to the back of the arm above the wrist, and divides into branches which supply the skin of the wrist and hand, both sides of the little finger, and the ulnar side of the ring finger on their dorsal aspect.

In the hand a small *muscular branch* is given off to the palmaris brevis muscle.

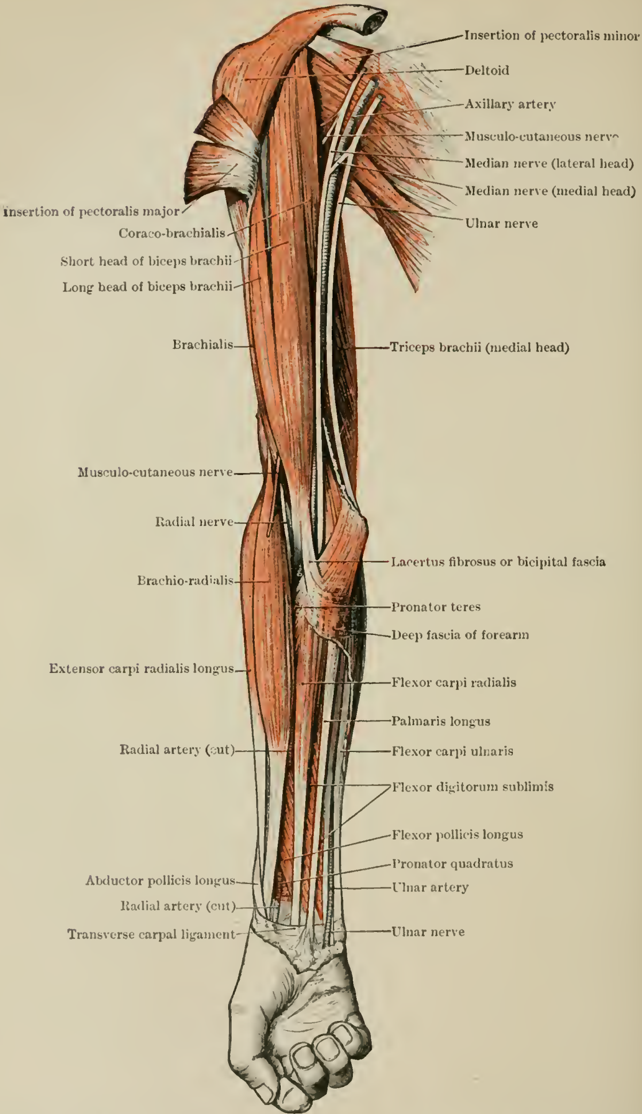


Fig. 91.—Anterior View of the Right Arm and Forearm, showing the Superficial Muscles.

TERMINAL BRANCHES—

(a) *Superficial*—Supplying the skin on the palmar aspect of both sides of the little finger and the medial side of the ring finger.

(b) *Deep*—Supplying the following muscles:—

Flexor digiti quinti brevis.
Abductor digiti quinti.
Opponens digiti quinti.
Deep part of flexor pollicis brevis.
Three palmar interossei.
Four dorsal interossei.
Adductor pollicis {Transversus. Obliquus.
Two lumbricals.

Axillary Nerve.—The axillary nerve arises from the posterior fasciculus of

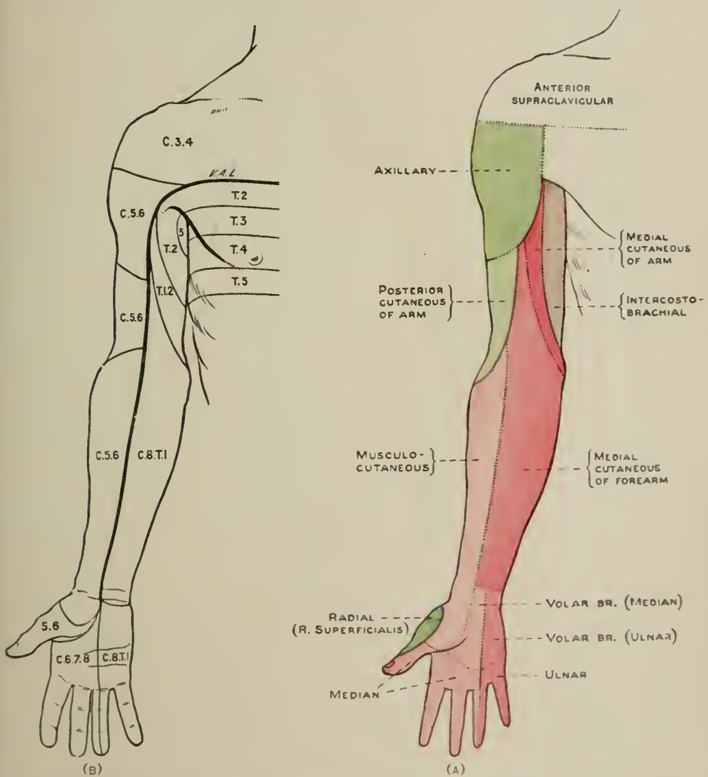


FIG. 92.—THE DISTRIBUTION OF CUTANEOUS NERVES ON THE FRONT OF THE ARM AND HAND.

(B) is a schematic representation of the areas supplied by the above nerves, the lettering indicating the spinal origin of the branches of distribution to each area. *V.A.L.*, Ventral axial line.

the brachial plexus. It passes distally and laterally behind the axillary artery, winds round the back of the surgical neck of the humerus, and terminates under the deltoid muscle.

BRANCHES—

Muscular—Supplying teres minor and deltoid.

Articular—To the shoulder joint.

Cutaneous—Supplying the skin over the distal part of the deltoid muscle.

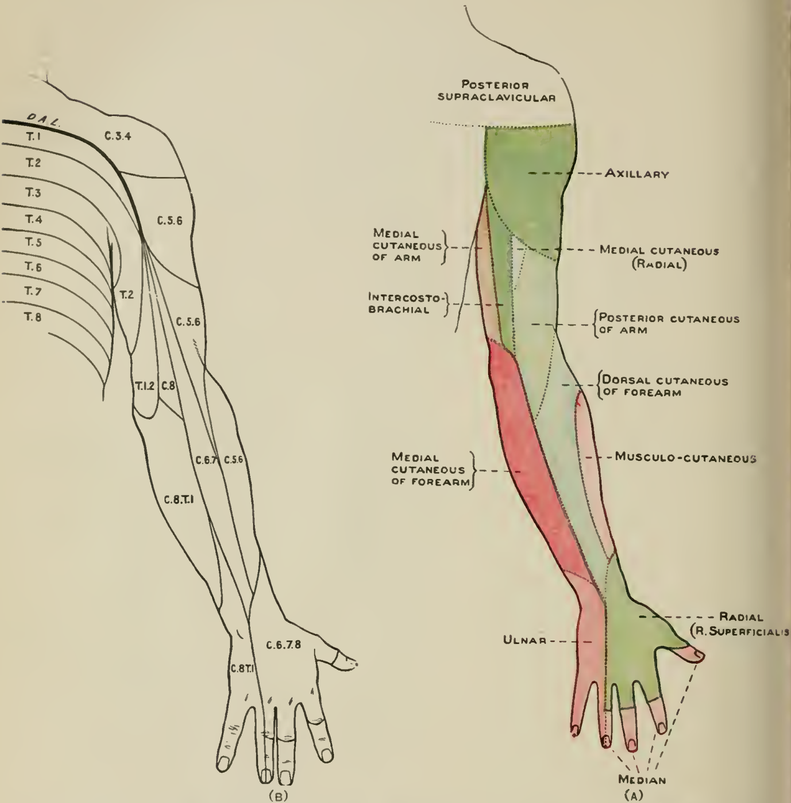


FIG. 93.—THE DISTRIBUTION OF CUTANEOUS NERVES ON THE BACK OF THE ARM AND HAND.

(B) is a schematic representation of the areas supplied by the above nerves, the lettering indicating the spinal origin of the branches of distribution to each area. *D.A.L.*, Dorsal axial line.

Medial Cutaneous Nerve of Forearm.—The medial cutaneous nerve of the forearm arises from the medial fasciculus of the brachial plexus. It is superficially placed in relation to the axillary and brachial arteries, and becomes cutaneous about the middle of the arm, dividing into two terminal branches (volar and ulnar) in front of the elbow. Above the elbow a branch is given off to supply the skin of the distal half of the front of the arm on its medial side. The *volar terminal branch* supplies the skin of the medial side of the front of the forearm to the wrist. The *ulnar terminal branch* passes over the medial epicondyle, and supplies the skin of the medial side of the back of the forearm in its proximal two-thirds.

Medial Cutaneous Nerve of Arm.—The medial cutaneous nerve of the arm arises from the medial fasciculus of the brachial plexus. At the beginning of

; course it lies between the axillary artery and vein; it then descends either over under the latter, pierces the deep fascia, and supplies the integument on the edial side of the arm sometimes as far distally as the medial epicondyle.

Radial Nerve.—The radial nerve arises from the posterior fasciculus of the achial plexus. At its commencement it lies behind the axillary artery and in ont of the teres major and latissimus dorsi uscles; it winds round the humerus, from the edial to the lateral side, in the radial groove, ssing between the medial and lateral heads of e triceps brachii muscle. It descends to the ont of the lateral epicondyle of the humerus be- een the brachialis and brachio-radialis muscles, here it divides into superficial and deep terminal anches.

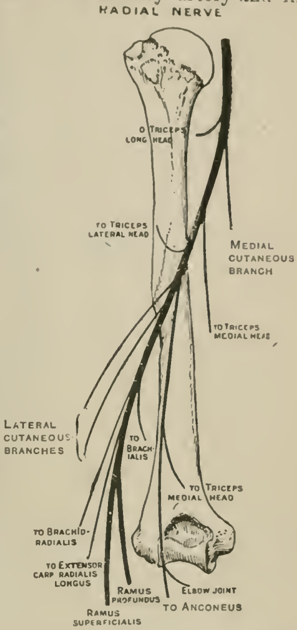


FIG. 94.—DIAGRAMMATIC REPRESENTATION OF THE BRANCHES OF THE RADIAL (O.T. Musculo-spiral) NERVE.

BRANCHES.—*Muscular*, supplying the triceps achii, brachialis, extensor carpi radialis longus, iconeus, and brachio-radialis muscles. It also nds a twig to the elbow joint.

Cutaneous—{Medial / Lateral {Proximal. / Distal.

The *medial cutaneous nerve* pierces the fascia ar the axilla, and supplies the skin on the back the proximal third of the arm.

The *proximal lateral branch* supplies the skin the lateral side and back of the distal third of ie arm, and the proximal part of the back of the rearm.

The *distal lateral branch* supplies the skin of ie back of the radial side of the forearm in its oximal two-thirds.

TERMINAL BRANCHES—

Superficial ramus (O.T. *radial nerve*).

Deep ramus (O.T. *posterior interosseous nerve*).

Superficial Ramus of the Radial erve.—The superficial ramus arises at the end of the elbow and descends, underneath the rachio-radialis muscle, along the front of the dial side of the forearm to its distal third; it then passes beneath the tendon of ie brachio-radialis to the lateral side of the forearm, where it divides into two ranches which supply the skin of the back of the wrist, the lateral side and back f the hand, both sides of the back of the thumb, index and middle fingers, and the idial border of the ring finger.

Deep Ramus of the Radial Nerve.—The deep ramus arises at the end of the elbow beneath the brachio-radialis muscle; it passes round the iteral side of the radius to the back of the forearm and descends to the wrist, here it ends in a ganglion or enlargement from which branches proceed to the arpal joints.

BRANCHES.—*Articular* to the carpal joints.

Muscular—Supplying—

Extensor carpi radialis brevis.
„ digitorum communis.
„ digiti quinti proprius.
„ carpi ulnaris.
Abductor pollicis longus.
Extensor pollicis longus.
„ „ brevis.
„ indicis proprius.
Supinator.

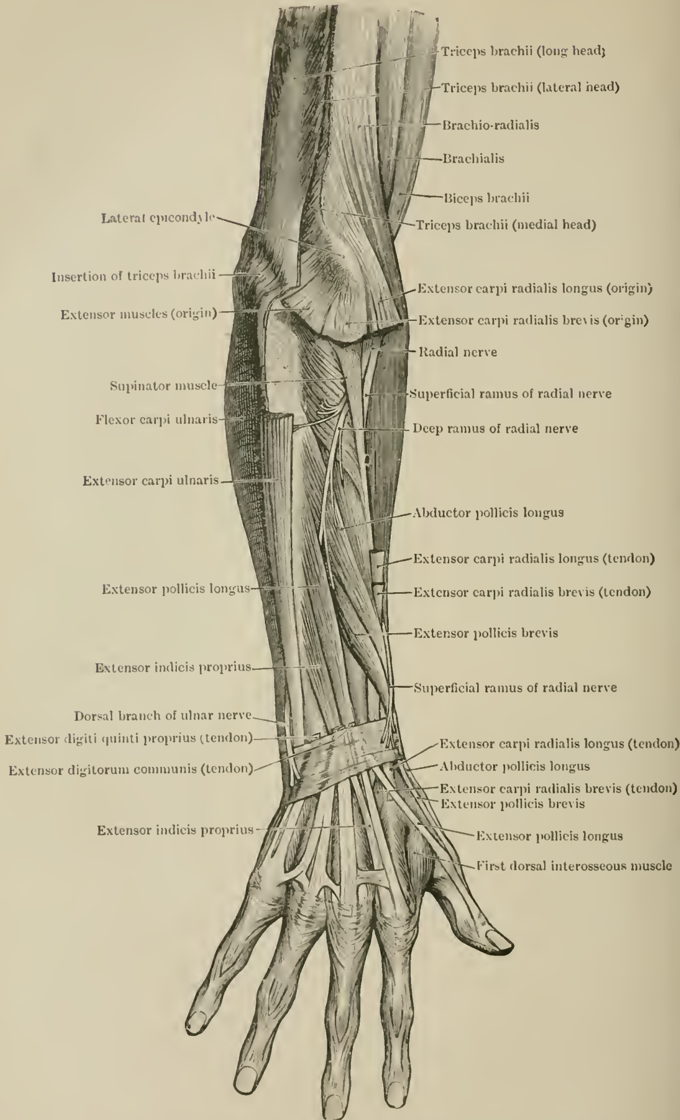


FIG. 95.—THE MUSCLES OF THE BACK OF THE FOREARM (the superficial muscles have been reflected).

THORACIC NERVES

There are twelve pairs of thoracic nerves. Each pair emerges on either side ·om the vertebral canal, beneath the corresponding vertebra, and immediately ivides into a posterior and an anterior ramus (intercostal nerve).

The *anterior rami* supply the walls of the chest and abdomen, and are nown as the *intercostal nerves* owing to their position in the intercostal spaces, ıch nerve lying under its corresponding rib. The *upper six thoracic nerves* ıpply the intercostal muscles, while the *lower six* supply the intercostal and bdominal muscles.

The *first thoracic nerve* enters into the formation of the brachial plexus. The *velfth* is called the last thoracic instead of intercostal.

LUMBO-SACRAL PLEXUS

The lumbo-sacral plexus is formed by the anterior rami of the lumbar, sacral, ıd coccygeal nerves; sometimes a branch of the twelfth thoracic nerve also ıters into its formation. This plexus may be divided into two parts—lumbar and ıcral.

LUMBAR PLEXUS

The lumbar plexus is formed by the anterior rami of the four upper lumbar ·rves, and is frequently joined by a branch from the last thoracic nerve. It is tuated in front of the transverse processes of the lumbar vertebræ, in the ıbstance of the psoas muscle.

Branches of the Lumbar Plexus—

1. *Muscular rami* to the psoas and quadratus lumborum.
2. *Ilio-hypogastric*
3. *Ilio-inguinal* } Supplying skin of buttock, lower part of abdomen, and medial side of thigh, also muscles of abdominal wall.
4. *Lateral cutaneous nerve of thigh*—Supplying skin of lateral side and front of thigh and lateral side of buttock below great trochanter.
5. *Genito-femoral.*
6. *Obturator.*
7. *Femoral.*

The Obturator, one of the chief nerves of the lower extremity, arises in the ·oas muscle, passes downwards and forwards to the obturator foramen, and vides into two branches, anterior and posterior, before entering the thigh.

The **anterior** (O.T. **superficial**) **branch** passes down the medial side of the ıigh beneath the pectineus and adductor longus muscles in the proximal part of s course, and then along the medial border of the latter muscle, finally terinating in two slender filaments.

Branches of Anterior Portion of Nerve—

(1) An *articular* branch to hip joint.
(2) *Muscular* branches supplying adductor longus, gracilis, and adductor brevis.
(3) A terminal *cutaneous* branch supplying the skin of the medial and distal part of the thigh.
(4) A *terminal* branch to the femoral artery.

The **posterior** (O.T. **deep**) **part of the obturator nerve** passes down the medial le of the thigh, between the adductor brevis and adductor magnus muscles, to the pliteal space, where it pierces the oblique ligament and supplies the knee joint.

Branches of Posterior Portion of Nerve—

(1) *Muscular*—Supplying obturator externus, adductor magnus, and sometimes adductor brevis.
(2) *Articular* terminal to knee joint.

The Femoral (O.T. anterior crural) is the largest nerve of the lumba plexus, and supplies the muscles and skin of the front of the thigh. It passe downwards between the psoas and iliacus muscles, to which latter a branch i

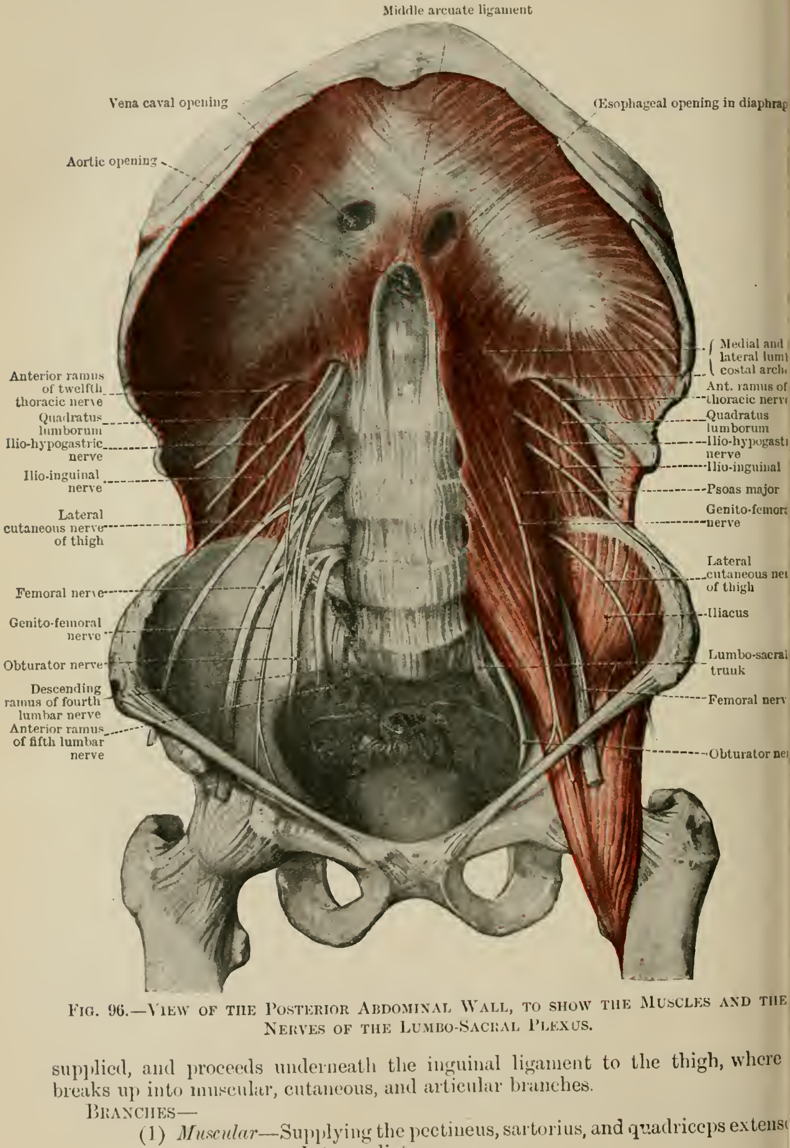


Fig. 96.—View of the Posterior Abdominal Wall, to show the Muscles and the Nerves of the Lumbo-Sacral Plexus.

supplied, and proceeds underneath the inguinal ligament to the thigh, where breaks up into muscular, cutaneous, and articular branches.

Branches—

(1) *Muscular*—Supplying the pectineus, sartorius, and quadriceps extens

(2) *Cutaneous*— Intermediate. Medial. Saphenous.

(3) *Articular* to the hip and knee joints.

The intermediate cutaneous nerve divides into two branches which pierce the iscia lata at the proximal third of the sartorius muscle and supply the skin of the ront of the thigh.

The medial cutaneous nerve lies at first on the lateral side of the femoral essels. It crosses the latter at the apex of the femoral triangle and passes either hrough or over the sartorius muscle to the distal third of the thigh. It gives off hree branches—proximal, middle, and distal. The proximal branch supplies the kin of the proximal part of the thigh on its medial aspect. The middle branch upplies the skin of the distal half of the medial side of the thigh and helps to form he patellar plexus. The distal branch communicates with the obturator and aphenous nerves to form the obturator plexus. On the medial side of the knee enters into the formation of the patellar plexus. It is the terminal branch of he medial cutaneous nerve.

The saphenous is a continuation of the femoral nerve; it descends beside the emoral artery to about the distal third of the thigh, where it leaves the artery, asses along the medial side of the knee between the sartorius and gracilis tendons, nd becomes cutaneous. The nerve then accompanies the large saphenous vein own the medial side of the leg, passes in front of the medial malleolus, and erminates at the medial side of the foot.

BRANCHES—

1. *Communicating* with branches of the obturator nerve to form the obturator plexus.
2. *Infrapatellar ramus* entering into the formation of the patellar plexus.
3. *Articular* (occasionally) to knee.
4. *Terminal*, supplying the skin of the anterior and medial aspects of the leg, the posterior part of the dorsum, and medial side of the foot.

THE SACRAL PLEXUS

The sacral plexus is formed by the union of the anterior rami of part of the ourth lumbar, the fifth lumbar, the first sacral, and part of the second and third acral nerves. The fourth and fifth lumbar nerves are joined together before they nite with the other nerves, forming what is known as the lumbo-sacral trunk. This plexus is situated in the pelvis, in front of the piriformis muscle; it is eparated from the viscera by the pelvic fascia.

BRANCHES OF THE SACRAL PLEXUS—

1. *Muscular*—Supplying . . .
   - Piriformis.
   - Gemelli.
   - Obturator internus.
   - Quadratus femoris.
2. *Superior Gluteal*—Supplying .
   - Gluteus medius.
   - Gluteus minimus.
   - Tensor fasciæ latæ.
3. *Inferior Gluteal*—Supplying gluteus maximus.
4. *Internal Pudendal*—Supplying perineum.
5. *Articular*—Supplying hip joint.
6. *Small Sciatic*—Supplying integument of lower part of buttock, back of thigh, leg, and perineum.
7. *Sciatic* . .
   - Muscular—Nerves to hamstring muscles, and adductor magnus muscle.
   - Articular—To hip and knee joints.
   - Tibial, Posterior tibial
     - Medial plantar.
     - Lateral plantar.
   - Common peroneal . .
     - Deep peroneal . .
       - Medial branch.
       - Lateral branch.
     - Superficial peroneal
       - Medial branch.
       - Lateral branch.
     - Recurrent tibial.

The Sciatic Nerve supplies the muscles of the back of the thigh, and it terminal branches those of the leg and foot. It passes out of the pelvis througl the great sciatic foramen, between the piriformis and superior gemellus muscles In the lower part of the buttock it lies midway between the great trochanter o the femur and the tuberosity of the ischium, and descends down the back of th thigh, where it is at first superficially and then more deeply placed underneatl

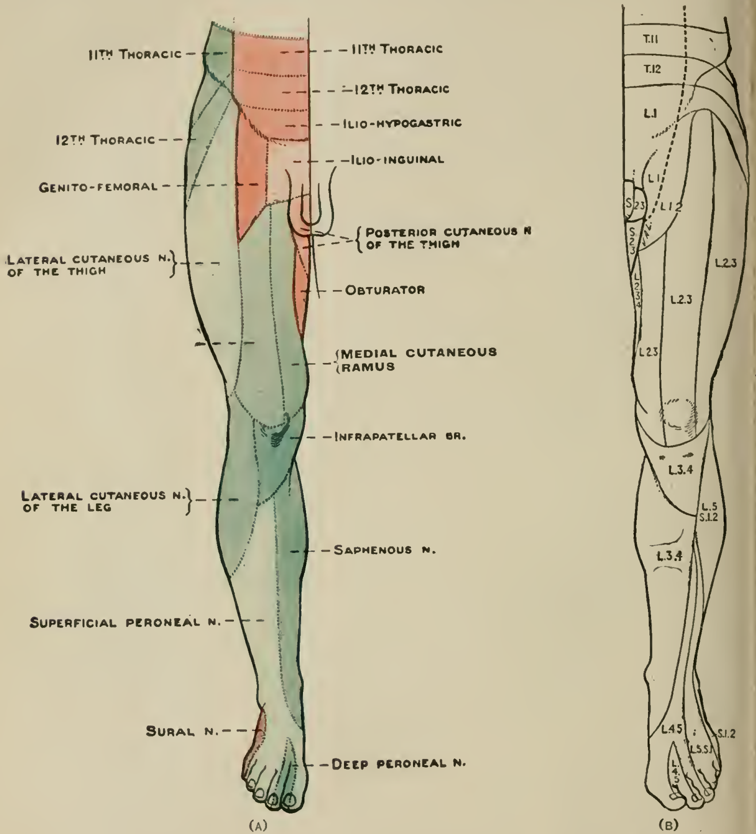


FIG. 97.—DISTRIBUTION OF CUTANEOUS NERVES ON THE FRONT OF THE LOWER LIMB.

(A) On the left side the distribution of the several nerves is represented in colour.
(B) On the right side a schematic representation is given of the areas supplied by the above nerves, the figures indicating the spinal origin of the branches of distribution to each area.

the hamstring muscles. Usually at about the lower third of the thigh the sciati nerve terminates by dividing into the tibial and the common peroneal nerve During its course in the thigh it gives off *muscular* branches to the hamstrin and adductor magnus muscles and an *articular* branch to the hip joint.

Tibial Nerve.—The tibial nerve descends through the middle of the poplitea fossa to the distal border of the popliteus muscle, where it enters the posterio tibio-fibular compartment. It is covered in the upper part of the popliteal spac by the hamstring muscles. It crosses to the medial side of the popliteal vessels and below this it rests upon the popliteus muscle under cover of the gastrocnemius and plantaris muscles.

In the back of the leg the tibial (O.T. posterior tibial) nerve descends, between the superficial and deep muscles, from the distal border of the popliteus muscle to the space between the medial malleolus and the heel, where it terminates by dividing into the lateral and medial plantar nerves.

Branches of the Tibial Nerve in the Popliteal Space—

Muscular—Supplying popliteus, gastrocnemius (two heads), plantaris, soleus.

Articular — To the knee joint.

Cutaneous—Medial cutaneous nerve of the calf.

The medial cutaneous nerve of the calf passes out of the popliteal space between the two heads of the gastrocnemius muscle. It pierces the deep fascia in the middle of the back of the leg and joins the peroneal anastomotic ramus from the common peroneal nerve to form the nervus suralis (nerve of the calf). The latter winds round the back of the lateral malleolus and supplies the skin of the distal part of the lateral side and back of the leg, the ankle, heel, and lateral side of the foot and little toe. It also sends articular branches to the ankle and tarsal joints.

Branches of the Tibial Nerve in the Back of the Leg—

Muscular — Supplying soleus, tibialis posterior, flexor digitorum longus, and flexor hallucis longus.

Cutaneous—Medial calcanean nerve supplying the skin of the heel and the posterior part of the sole of the foot.

Terminal—Medial and lateral plantar.

The plantar nerves supply the muscles and skin of the sole of the foot and the toes, and also the tarsal and tarso-metatarsal articulations.

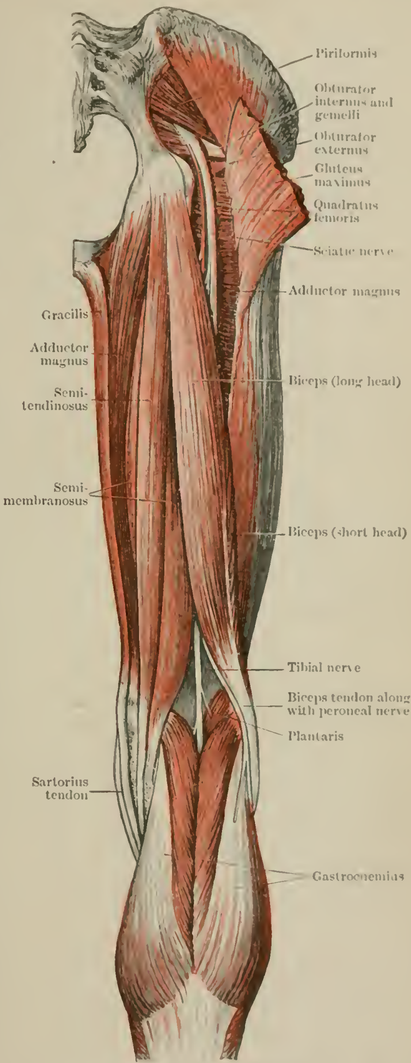


Fig. 98.—The Muscles and Nerves of the Back of the Right Thigh.

Common Peroneal Nerve.—The common peroneal nerve descends in an oblique line down the lateral side of the popliteal surface, on the medial side of the tendon of the biceps muscle, to behind the head of the fibula, just below which it divides into the deep peroneal, superficial peroneal, and recurrent tibial nerves.

BRANCHES OF THE COMMON PERONEAL NERVE—

Cutaneous—{ Lateral sural.
Peroneal anastomotic nerve.

The lateral sural branch supplies the lateral side and back of the leg in its proximal two-thirds.

The peroneal anastomotic nerve arises in the popliteal space and passes to the middle third of the leg, where it joins with the medial cutaneous nerve of the calf from the tibial nerve to form the nervus suralis.

Deep Peroneal Nerve.—The deep peroneal nerve passes down the front of the leg, deeply placed upon the interosseous membrane. It crosses the ankle joint beneath the transverse and cruciate ligaments, and divides on the dorsum of the foot into a medial and lateral branch.

BRANCHES OF THE DEEP PERONEAL NERVE—

Muscular—Supplying the tibialis anterior, extensor hallucis longus, extensor digitorum longus, peroneus tertius.

Articular—To the ankle joint.

Terminal—Medial and lateral.

The medial branch passes to the first interosseous space on the lateral side of the dorsalis pedis artery. It then divides into two branches, which supply the adjacent sides of the first and second toes and communicate with the superficial peroneal nerve. Branches are also sent to supply the medial tarso-metatarsal and metatarso-phalangeal joints.

The lateral branch passes outwards, beneath the extensor digitorum brevis, and ends in a ganglion from which branches arise to supply the extensor digitorum brevis and the tarsal, tarso-metatarsal, and metatarso-phalangeal articulations.

Superficial Peroneal Nerve.—The superficial peroneal nerve passes down the leg in front of the fibula, between the peronei and extensor digitorum longus muscles. At about the distal third of the leg it becomes cutaneous and terminates in a medial and lateral branch.

BRANCHES OF THE SUPERFICIAL PERONEAL NERVE—

Muscular—Supplying peroneus longus and brevis.

Terminal cutaneous—Medial and lateral.

The medial branch passes distally over the ankle, sends offshoots to the distal part of the leg and the dorsum of the foot, and divides into branches which supply the medial side of the great toe and the adjacent sides of the second and third toes. It communicates with the saphenous nerve and with the medial branch of the deep peroneal nerve.

The lateral branch supplies the distal part of the leg, the dorsum of the foot, and the adjacent sides of the third, fourth, and fifth toes. It communicates with the sural nerve.

Recurrent Tibial Nerve.—The recurrent tibial nerve divides below the lateral condyle of the tibia into branches which supply the superior tibio-fibular articulation, the knee joint, and the proximal part of the tibialis anterior muscle.

THE SYMPATHETIC NERVOUS SYSTEM

The sympathetic system consists of two gangliated trunks which extend on either side of the vertebral column from the base of the skull to the coccyx. It also includes those ganglia which are more internally placed in the thorax, abdomen, and pelvis.

The special functions of the sympathetic system are to distribute nerve fibres, motor, sensory, secretory, and inhibitory, to the viscera, vessels, and glands, and to be the medium by which certain branches of the spinal nerves are directed to the same purpose, *i.e.* the control of the involuntary movements of respiration, digestion, secretion, and the circulation of the blood. That part of the trunk between the ganglia is called the commissure, and is composed of grey and white nerve fibres. The ganglia or enlargements of the trunk are of varying sizes, are composed of nerve cells traversed by nerve fibres, and are enclosed in a membranous capsule. From each of the ganglia nerve fibres (for the most part non-medullated) are distributed in various directions as follows:—

(*a*) Some fibres to help to form the commissural trunk between the ganglia.

(*b*) Fibres to the spinal nerves, called grey rami communicantes, which may also arise from the commissural trunk. They accompany the spinal nerves, and are distributed to the involuntary muscles, vessels, and glands.

(*c*) Fibres proceeding directly to the arteries, viscera, and to other ganglia more internally placed.

Besides the nerve fibres which pass from the gangliated cord to the spinal nerves, the two nervous systems, as mentioned before, are linked together by medullated nerve fibres, called white rami communicantes, which proceed from the anterior rami of the spinal nerves to the sympathetic trunk. These fibres are motor and secretory: some of them terminate in the sympathetic ganglia with which they are directly connected, while others proceed up or down the trunk, and end in more distantly situated ganglia.

The nerves which control the blood vessels are called vaso-motor. They are of two kinds—vaso-dilators, which cause the arteries to dilate so that an increase in the supply of blood to the part takes place; and vaso-constrictors, which cause the arteries to contract so that a contrary result is effected.

DIVISIONS OF THE SYMPATHETIC TRUNK AND DISTRIBUTION OF NERVES

The Cervical part of the sympathetic trunk extends from the base of the skull to the root of the neck, and lies upon the longus capitis muscle. It supplies nerve fibres to the glands and the vessels of the head, neck and thorax, the pharynx, and the heart, helping with the vagus nerve to form the cardiac plexus. From the upper extremity of this part a branch is continued upwards which allies itself to the internal carotid artery, with which it enters the cranial cavity.

The Thoracic part of the sympathetic trunk lies in front of the heads of the ribs, and supplies the viscera and vessels of the thorax and abdomen.

Its Chief Branches are—

1. *Pulmonary*—Helping to form the pulmonary plexus.
2. *Aortic*—To the upper part of the thoracic aorta.
3. *Splanchnic nerves*—
   - (*a*) Great splanchnic, supplying the œsophagus and descending thoracic aorta and ending in the solar plexus.
   - (*b*) Small splanchnic, ending in the solar plexus.
   - (*c*) Least splanchnic, ending in the renal plexus. These nerves are so called from the "splanchnic" area which they supply, *i.e.* the region where the digestive and urinary organs are situated.

The Lumbar part of the sympathetic trunk lies in front of the bodies of the lumbar vertebræ. It supplies branches to the abdominal aorta.

The Sacral part of the sympathetic trunk lies in front of the sacrum, and supplies the pelvic viscera, uniting with the cord of the opposite side in a single ganglion situated on the front of the coccyx.

SYMPATHETIC PLEXUSES

Numerous nerve plexuses are formed around the chief vessels and organs of the body, either wholly or in part by the nerves of the sympathetic system.

The chief of these are—

The cardiac plexuses
The solar plexus.
The hypogastric plexus.

The Cardiac Plexuses are two in number, superficial and deep.

The superficial cardiac plexus lies underneath the arch of the aorta, and is composed of nerves from the cervical part of the sympathetic system, a cardiac branch of the pneumogastric, and a small ganglion. It sends branches to the deep cardiac, the left anterior pulmonary, and the right coronary plexuses. **The deep cardiac plexus** lies behind the arch of the aorta, and on the bifurcation of the trachea. It is composed of nerves from the cervical ganglia of the sympathetic system, and from the vagus and laryngeal nerves. It is distributed to the heart and lungs.

The Solar Plexus lies behind the stomach and in front of the aorta, and consists of the *cœliac plexus* and two ganglia, called the *semilunar ganglia.* It is joined by the splanchnic and vagus nerves, and gives rise to numerous minor plexuses, namely—

(1) *The diaphragmatic*, supplying the diaphragm, the inferior vena cava, and the œsophagus.
(2) *The suprarenal*, supplying the suprarenal gland.
(3) *The renal*, supplying the kidney.
(4) *The superior mesenteric*, supplying the intestines.
(5) *The aortic*, supplying the aorta.
(6) *The hepatic*, supplying the liver, gall bladder, stomach, pancreas, and duodenum.
(7) *The coronary*, supplying the œsophagus and stomach.
(8) *The splenic*, supplying the spleen, pancreas, and stomach.

All these plexuses are more or less continuous with one another.

The Hypogastric Plexus lies in front of the sacrum on either side of the rectum. It is formed by the hypogastric nerves which connect it with the aortic plexus, and it gives rise to the *pelvic plexuses* which supply the viscera of the pelvis.

CHAPTER VII

THE VASCULAR SYSTEM

There are two divisions of the vascular system, namely, the blood vascular and the lymph vascular system.

THE BLOOD VASCULAR SYSTEM

Blood consists of plasma or liquor sanguinis, containing fibrinogen, a precursor of fibrin, and blood cells or corpuscles. Blood corpuscles are of two kinds, white and red. The latter are far more numerous than the former, and are coloured by a substance called hæmoglobin. When drawn from the body blood separates into two parts—a fluid called serum and a clot consisting of the blood corpuscles, and of fibrin which has been held in solution in the circulating blood in the form of fibrinogen. Venous blood is of a dark red or purple colour; arterial blood is bright red.

The chief uses of blood are as follows—

(*a*) It conveys nourishment which has been absorbed from the food to the different parts of the body.

(*b*) It conveys oxygen to the tissues.

(*c*) It distributes the heat formed in the deeper parts of the body, and thus maintains the constancy of the body temperature.

(*d*) It carries away waste material.

The heart is the central organ of the circulation. By its contraction the blood is propelled through the vessels of the system, namely, the arteries, capillaries, and veins.

Arteries convey the blood from the heart. They are tubes of varying size, which ramify all through the body, with the exception of the epithelium and its appendages, the cartilages and cornea.

Arteries unite together freely during their course,—this union is called an anastomosis.

They have three coats—

(1) An inner coat, consisting of endothelial cells, connective tissue, and yellow elastic tissue.

(2) A middle coat, consisting of unstriped muscle fibres and elastic tissue in varying proportions.

(3) An external coat, consisting of connective tissue and elastic fibres.

In addition they are, with few exceptions, enclosed in a sheath of connective tissue, formed by a prolongation of the deep fascia of the neighbouring parts.

Arteries are supplied with small blood vessels called vasa vasorum. They are also supplied with lymph vessels and nerves from both the sympathetic and cerebro-spinal systems.

Capillaries are microscopical vessels, which form a network all over the body and connect arteries and veins together. The small arteries which terminate in them are called *capillary arterioles*, and the veins which arise from them are called *capillary veins*. The walls of capillaries are composed of endothelial cells, joined edge to edge. The larger ones have a sheath of connective tissue also surrounding them. The chief work of the blood is accomplished in the capillaries, owing to the thinness of their walls, which enables liquid matter to pass through them. In this way the blood gives to the tissues the nutriment it has absorbed from the food, and receives in return some of the waste matter of the system, which it carries away to the organs of excretion, namely, the skin, kidneys, and lungs.

Veins are more numerous than arteries, and are found in almost every tissue of the body. They arise from capillaries and unite together, growing in size until they finally form the large vessels which convey the blood from all parts of the body to the heart. They are tubular vessels, having thinner walls than arteries, but having like them three coats. The middle coat has, however, fewer muscular and elastic fibres, while the inner coat of most veins is arranged, at intervals, in folds to form valves. These folds are usually found in pairs. Their free ends are

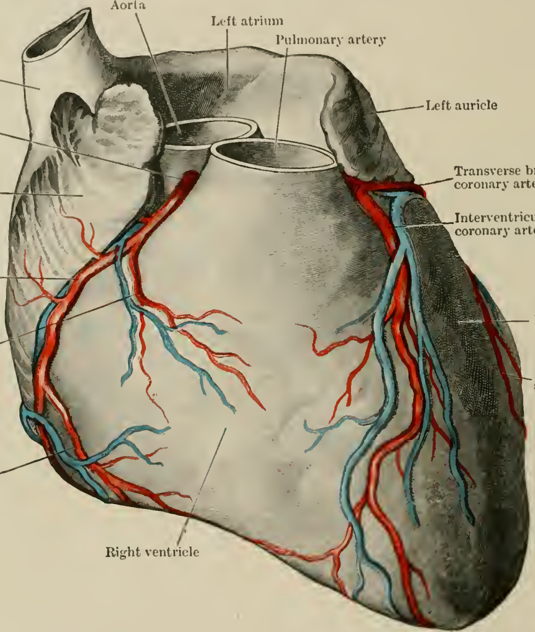


FIG. 99.—THE ANTERO-SUPERIOR SURFACE OF THE HEART.

directed towards the heart. They serve to prevent the backward flow of blood, and are most frequent in the veins of the lower extremity. They do not occur in the smallest veins, nor in the venæ cavæ, the hepatic or portal veins. Veins are supplied with blood and lymph vessels and with nerves.

The Heart is a hollow muscular organ, enclosed in a membranous sac called the *pericardium*.

It is placed obliquely, almost in the middle of the chest, between the lungs, and rests below upon the diaphragm. Its broad end or base lies uppermost and to the right, its apex is directed downwards, forwards, and to the left, and is situated behind the fifth intercostal space, 2 inches below and 1 inch to the sternal side of the left nipple.

The heart is longitudinally divided into right and left halves. Each of these halves is divided into an upper chamber called an *atrium* and a lower chamber called a *ventricle*. The atria and ventricles communicate with each other by means of the *auriculo-ventricular* apertures, which are guarded by valves to prevent the return of the blood which is passed from the atria to the ventricles. That on the right side is called the *tricuspid valve*, because it consists of three cusps or folds. That on the left is called the *bicuspid* or *mitral valve*, and consists of two large cusps.

The right atrium receives the impure or venous blood by means of the *superior* and *inferior venæ cavæ*. These veins open into it above and below on its posterior aspect. The superior vena cava conveys the blood from the upper, while the inferior vena cava conveys it from the lower parts of the body. Other openings into the right atrium are—the *coronary sinus*, which returns the blood from the walls of the heart itself and is guarded by the valve of the coronary sinus, and the *foramina* of the smallest veins of the heart. These veins also return the blood from the walls of the heart. The right ventricle has two openings—the *auriculo-ventricular*, mentioned above, and the opening of the pulmonary artery, which is guarded by the *semilunar valve*, in which there are three segments.

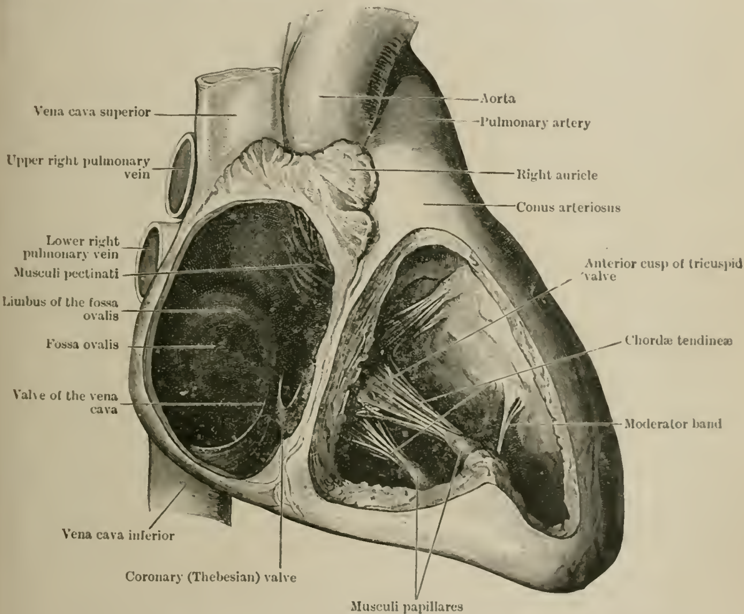


FIG. 100.—THE CAVITIES OF THE RIGHT ATRIUM AND RIGHT VENTRICLE OF THE HEART.

The walls of the right atrium and ventricle are thinner than those of the left.

The left atrium receives the purified blood from the lungs by means of the *pulmonary veins*. These veins are four in number, and enter the atrium on the upper part of its posterior surface—two on the right and two on the left side. They have no valves. The left ventricle is longer than the right, and very much thicker. The opening of the aorta lies on its upper surface and is guarded by the *semilunar valve*. All the chambers of the heart are lined by a membrane called *endocardium*, consisting of a layer of endothelial cells, connective tissue, and elastic fibres.

Size of the Heart.—In the adult it is about 5 inches long, $3\frac{1}{2}$ inches broad at its widest part, and measures about $2\frac{1}{2}$ inches through from the anterior to the posterior surface.

Capacity.—Each ventricle can contain about 4 ounces of blood; each auricle a little less.

Arterial Supply.—The coronary arteries, which arise from the commencement of the aorta.

Nerve Supply.—The cardiac plexuses, which are derived partly from the cerebral and partly from the sympathetic nerve system.

The heart is also supplied with numerous lymph vessels.

The Pulse is caused by the distension of the arterial walls after the contraction of the ventricles. Both auricles contract simultaneously, and both ventricles do likewise. Their contraction is called the heart's "systole," and their dilatation its "diastole."

The normal pulse in the adult is from 65 to 80 per minute.

THE GENERAL CIRCULATION OF THE BLOOD

The blood which has circulated through all parts of the body is poured into the right atrium by means of the superior and inferior venæ cavæ. It is dark in colour owing to the carbonic acid gas which it contains. The right atrium contracts and the blood passes into the right ventricle, which in its turn contracts and the blood is forced into the pulmonary artery. Just outside the heart this artery divides into two branches, one conveying the blood to the right, the other to the left lung. In the lungs these arteries divide into numerous capillaries, which surround the air cells, and it is here that the blood gives up the carbonic acid gas which it contains and receives in return a supply of oxygen. It is now bright red in colour owing to its oxygenated condition, and is returned to the left atrium by the four pulmonary veins—two from each lung. It is then passed into the left ventricle, and on its contraction is forced into the aorta—the main trunk of the arterial system, and so distributed through the body.

It may here be noticed that the pulmonary artery is the only one in the system which contains impure blood, while the pulmonary veins are the only ones which contain pure blood.

The course which the blood takes through the body from the left ventricle to the right atrium is called the *greater or systemic circulation*. The course which the blood takes through the lungs from the right ventricle to the left atrium is called the *lesser or pulmonary circulation*. The course which the blood takes through the substance of the heart itself is called the *coronary circulation*. In this system it enters by the coronary arteries—two in number, which arise from the aorta close to its origin. It then passes through the capillaries, is collected by the cardiac veins, and poured into the right atrium.

The *portal circulation* is the circulation of the blood through the liver. The hepatic artery supplies this organ with pure arterial blood for the nourishment of its own substance. It springs from the cœliac artery, a branch of the abdominal aorta. The liver also receives a supply of blood from the portal vein, which is derived from the gastric, mesenteric, and splenic veins. This blood, laden with the products of digestion, affords the material from which bile and glycogen are elaborated, the process taking place in the liver cells.

Within the liver the hepatic artery and the portal vein divide and subdivide, finally breaking up into interlobular branches, which surround the lobules and enter their substance as capillaries. The portal vein is peculiar, in that it thus breaks up like an artery into capillaries. The blood which has circulated through the liver is collected and returned to the general circulation by the following veins:—

1. Intralobular, which lie in the centre of each lobule and are formed by capillary branches from the interlobular veins.
2. Sublobular, which lie outside the lobules and are joined by the intralobular veins.
3. Hepatic veins, which are formed by the union of numerous sublobular veins. These hepatic veins unite to form two large veins, which empty the blood into the inferior vena cava.

CHIEF ARTERIES

THE AORTA

The aorta arises from the upper part of the left ventricle. It passes upwards to the level of the second costal cartilage on the right side, then arches backwards and to the left, passes over the root of the left lung and descends through the thorax on the left side of the vertebral column, it finally passes into the abdomen, through the aortic opening in the diaphragm, and terminates, at the level of the fourth lumbar vertebra, in the two common iliac arteries.

That part of the aorta which is situated above the diaphragm is called the thoracic aorta, the part which lies below it the abdominal aorta.

The thoracic aorta has three divisions, namely, the ascending portion, the arch, and the descending portion.

SYSTEMIC ARTERIES

TABLE SHOWING THE DIVISIONS AND SUBDIVISIONS OF THE AORTA

- AORTA
  - Thoracic (three divisions)
    - ASCENDING . . . .
      - Right coronary.
      - Left coronary.
    - ARCH
      - Innominate
        - Right subclavian .
          - Vertebral.
          - Axillary. Brachial
            - Radial
              - Deep volar arch.
            - Ulnar
              - Superficial volar arch.
        - Right common carotid
          - Internal carotid.
          - External carotid.
      - Left common carotid
        - Internal carotid.
        - External carotid.
      - Left subclavian
        - Vertebral.
        - Axillary. Brachial
          - Radial . . Deep volar arch.
          - Ulnar . . . Superficial volar arch.
    - DESCENDING . . . .
      - Visceral . . . .
        - Bronchial.
        - Œsophageal.
        - Pericardial.
        - Mediastinal.
      - Parietal . . . .
        - Intercostal.
        - Subcostal.
        - Diaphragmatic.
  - Abdominal
    - VISCERAL . . . . .
      - Middle suprarenal.
      - Renal.
      - Spermatic, or Ovarian.
      - Cœliac artery . .
        - Gastric.
        - Hepatic.
        - Splenic.
      - Superior mesenteric.
      - Inferior mesenteric.
    - PARIETAL . . . . .
      - Inferior phrenic.
      - Lumbar.
      - Middle sacral.
      - Common iliac . .
        - Hypogastric.
        - External iliac, Femoral, Popliteal
          - Posterior tibial
            - Medial plantar.
            - Lateral plantar.
          - Anterior tibial
            - Dorsalis pedis.

BRANCHES OF THE ASCENDING AORTA

Coronary Arteries.—These are two in number, a right and left coronary artery. They spring from the aorta, just above the semilunar valve; they are distributed to the heart principally, but small branches supply the pericardium and the commencement of some of the large vessels.

BRANCHES OF THE ARCH OF THE AORTA

Innominate.
Left Common Carotid.
Left Subclavian.

These arteries and their subdivisions supply the head, neck, arms, and part of the wall of the thorax.

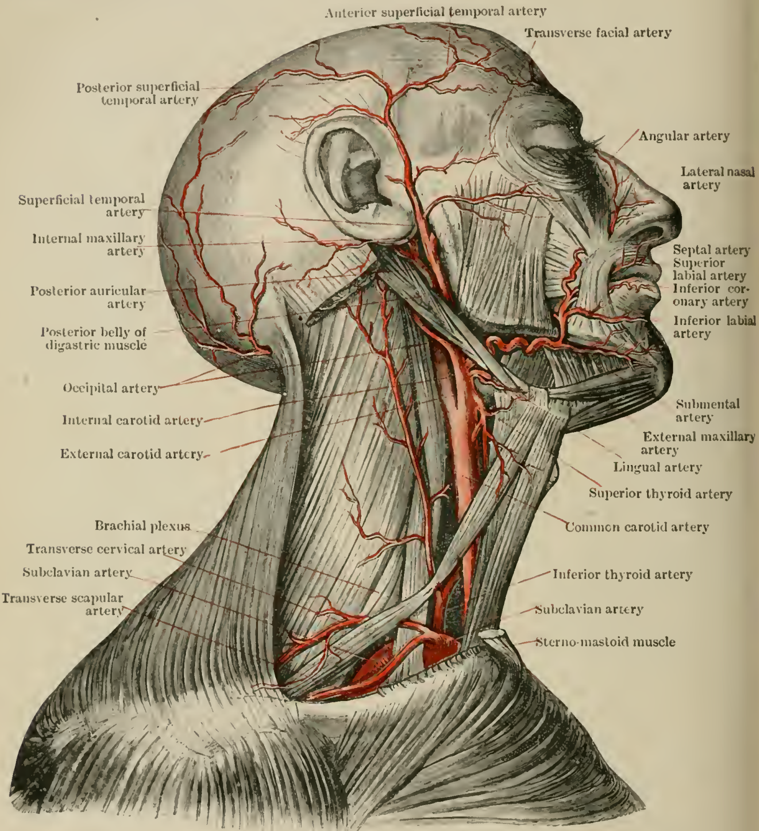


FIG. 101.—THE CAROTID AND SUBCLAVIAN ARTERIES AND THEIR BRANCHES.

The Innominate Artery springs from the arch of the aorta near its right extremity. It ascends to opposite the right sterno-clavicular articulation, where it terminates in the right subclavian and right common carotid arteries. It varies in length from $1\frac{1}{2}$ to 2 inches.

ARTERIES OF THE HEAD AND NECK

The Right Common Carotid Artery arises from the innominate artery and passes obliquely upwards in the neck on the right side, to the level of the thyroid cartilage, where it divides into the external and internal carotid arteries.

The Left Common Carotid Artery arises from the highest part of the rch of the aorta; it passes upwards in the neck on the left side as far as the hyroid cartilage, where it also divides into external and internal carotid arteries.

The common carotid arteries and their branches constitute the main blood upply of the head and neck, the contents of the cranium receiving their supply

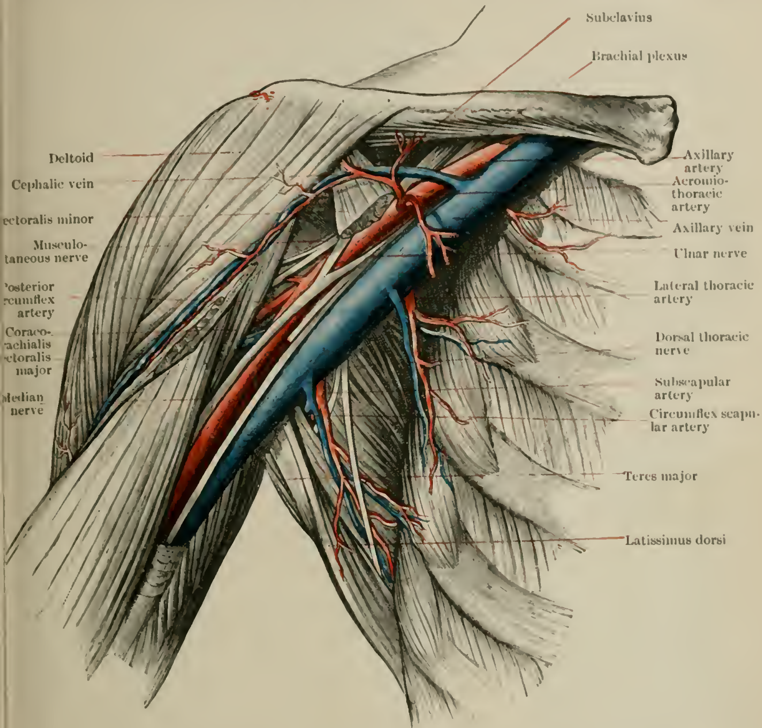


FIG. 102.—THE AXILLARY ARTERY AND ITS BRANCHES AND RELATIONS.

rom the internal carotid arteries while the structures more externally placed, such s the muscles of the face and neck, the tongue, ear, etc., are supplied by the xternal branches.

The brain also receives a supply of blood from the vertebral arteries.

ARTERIES OF THE UPPER EXTREMITY

THE SUBCLAVIAN ARTERIES

The Right Subclavian Artery arises from the innominate artery, at a oint behind the right sterno-clavicular articulation, and arches laterally across he base of the neck behind the scalenus anterior muscle to the lateral border of he first rib, where it enters the axillary space and becomes the axillary artery.

The Left Subclavian Artery arises from the arch of the aorta, and is thus a little longer than its fellow of the opposite side. It passes upwards to the root f the neck, and from this point the courses of the two arteries are identical.

The Axillary Artery, the direct continuation of the subclavian, extends rom the outer border of the first rib to the lower border of the teres major muscle, vhere it becomes the brachial artery.

The Brachial Artery is the continuation of the axillary. It passes down the medial side of the arm, extending from the lower border of the teres major to about half an inch below the bend of the elbow, where it terminates in the radial and ulnar arteries.

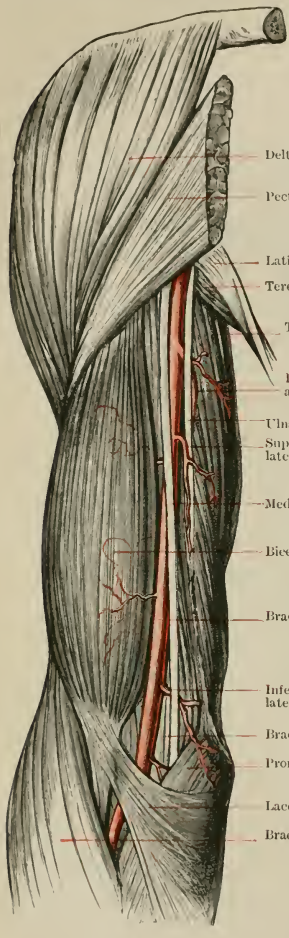


FIG. 103.—THE BRACHIAL ARTERY AND ITS BRANCHES.

The Radial Artery passes down the front of the forearm on the radial side to the styloid process of the radius: it then winds round the radial side of the wrist and passes between the first and second metacarpal bones to the palm of the hand, where it joins the deep volar ramus of the ulnar artery, forming what is known as the deep volar arch.

The Ulnar Artery is larger than the radial. It begins just distal to the elbow, passes along the ulnar border of the forearm to the wrist, then enters the palm of the hand and terminates in the superficial volar arch, which is completed by the superficial volar ramus of the radial artery.

BRANCHES OF THE DESCENDING THORACIC AORTA

The branches of the descending thoracic aorta may be divided into two groups—those supplying the organs contained in the thorax, called visceral branches, and those supplying its walls, called parietal (Latin, *paries* = a wall) branches. They also help to supply the vertebral column, the spinal cord, and the upper part of the walls of the abdomen.

Visceral Branches.	*Parietal Branches.*
Bronchial.	Intercostal.
Œsophageal.	Subcostal.
Pericardial.	Diaphragmatic.
Mediastinal.	

The Bronchial Arteries supply the walls of the bronchial tubes, the lungs, the bronchial glands, the pulmonary vessels, the œsophagus, and the pericardium.

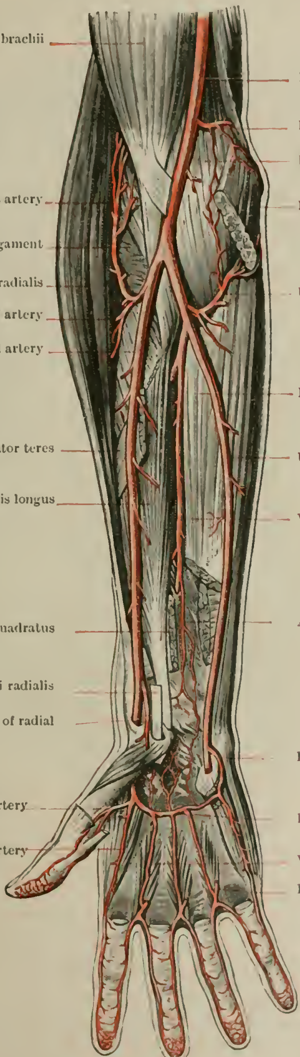
The Œsophageal Arteries supply the œsophagus.

The Pericardial Arteries supply the pericardium.

The Mediastinal Arteries supply the posterior portion of the diaphragm and the glands and areolar tissue in the posterior mediastinal space.

The Intercostal Arteries arise from the back of the aorta. They are in nine pairs, and they supply the lower nine intercostal spaces. The right intercostal arteries pass across the bodies of the vertebræ and are longer than the left, owing to the position of the aorta on the left side of the vertebral column. In other respects the arteries of both sides correspond closely. They pass laterally and run along the upper border of the intercostal spaces, terminating in front by anastomosing with other arteries. Dorsal, muscular, and cutaneous branches are iven off to supply the vertebræ, the spinal medulla, and the muscles and skin of he back. A vein and a nerve accompanies each intercostal artery.

The Subcostal Arteries are two in number, and are the last pair given off



G. 104.—Deep Dissection of the Front of the Forearm and Hand, showing the radial and ulnar arteries and their branches, and the deep volar arch and its branches.

m the thoracic aorta. They are similar to the intercostal arteries, and are tuated below the last ribs.

Each of the upper two intercostal spaces is supplied by an artery corresponding that in the lower spaces, but the two branches come off from a single vessel called the superior intercostal, which arises on either side from the subclavia artery.

The Diaphragmatic Arteries are small vessels arising from the low part of the thoracic aorta; they help to supply the diaphragm.

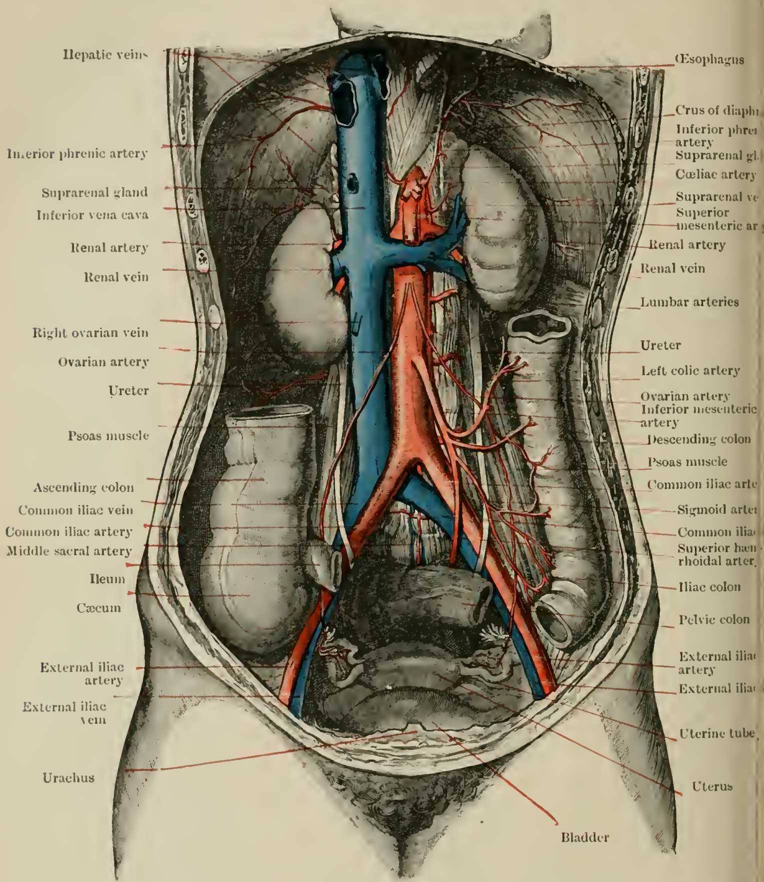


FIG. 105.—THE ABDOMINAL AORTA AND ITS BRANCHES.

BRANCHES OF THE ABDOMINAL AORTA

The abdominal aorta gives off branches which supply the organs, and oth which supply the walls of the abdomen; small branches are also distributed to t vertebral column and to the spinal medulla.

Visceral.	*Parietal.*
Suprarenal.	Inferior phrenic.
Renal.	Lumbar.
Spermatic or Ovarian.	Middle sacral.
Cœliac.	Common iliac.
Superior mesenteric.	
Inferior mesenteric.	

The Suprarenal Arteries consist of three sets—superior, middle, and inferior. The superior and inferior spring respectively from the inferior phrenic and from the renal arteries. The middle consists of two small branches which arise directly from the aorta; they anastomose with the superior and inferior suprarenal arteries and are distributed to the suprarenal glands.

The Renal Arteries are two in number; they supply the kidneys.

The Cœliac Artery arises from the beginning of the abdominal aorta, just below the diaphragm. It divides into three branches—

(*a*) *The gastric artery*, which supplies the stomach.
(*b*) *The hepatic artery*, which supplies the liver.
(*c*) *The splenic artery*, which supplies the spleen, and sends branches to the stomach and pancreas.

The Superior Mesenteric Artery supplies the small intestine, the cæcum, the ascending and transverse colon, and sends a branch to the pancreas.

The Inferior Mesenteric Artery supplies the descending colon, the iliac colon, the pelvic colon, and a large part of the rectum. The terminal portion of it after it has crossed the brim of the pelvis, is called the superior hæmorrhoidal.

The Inferior Phrenic Arteries are two in number; they supply the diaphragm.

The Lumbar Arteries are very similar, in their origin and distribution, to the intercostal arteries. They supply the muscles and integument of the back and sides in the lumbar region.

The Common Iliac Arteries are the terminal divisions of the aorta. The bifurcation occurs opposite to, but slightly to the left of, the fourth lumbar vertebra. They pass downwards and laterally, and when on a level with the lumbo-sacral articulation they divide into the hypogastric and external iliac arteries.

The Hypogastric Artery supplies the walls and the contents of the pelvis and the medial side of the thigh and buttock.

The External Iliac Artery is the principal artery which supplies the lower limb. It commences at the bifurcation of the common iliac artery mentioned above, passes downwards and laterally along the medial border of the psoas muscle to behind the inguinal ligament, where, at a point midway between the symphysis pubis and the anterior superior spine of the ilium, it enters the thigh and becomes the femoral artery.

ARTERIES OF THE LOWER EXTREMITY

The Femoral Artery is the direct continuation of the external iliac. It passes, from the inguinal ligament, down the anterior and medial aspect of the thigh to the commencement of its distal third, where, after passing through an opening in the adductor magnus, it becomes the popliteal artery.

The Popliteal Artery lies in the popliteal space; it commences at its proximal and medial part, passes obliquely downwards and laterally, and terminates at the distal border of the popliteus muscle, in the anterior and posterior tibial arteries.

The Posterior Tibial Artery passes down the back of the leg on its tibial side between the superficial and deep muscles of the calf, to a point between the medial malleolus and the heel, where it terminates in the medial and lateral plantar arteries.

The Medial Plantar Artery passes along the medial border of the foot to the head of the first metatarsal bone. It then anastomoses with a branch from the dorsalis pedis artery and is distributed to the medial side of the great toe.

The Lateral Plantar Artery passes from the medial side of the foot to the base of the fifth metatarsal bone; it then turns medially and terminates at the lateral side of the base of the first metatarsal bone by uniting with the dorsalis pedis artery. That part of the artery which curves medially from the base of the fifth metatarsal bone to the first metatarsal bone is called the *plantar arch*.

The Anterior Tibial Artery passes forwards, from its origin, through t opening between the bones above the interosseous membrane, to the front of t leg; it then descends, deeply seated, to the bend of the ankle joint, where becomes more superficial and terminates in the dorsalis pedis artery.

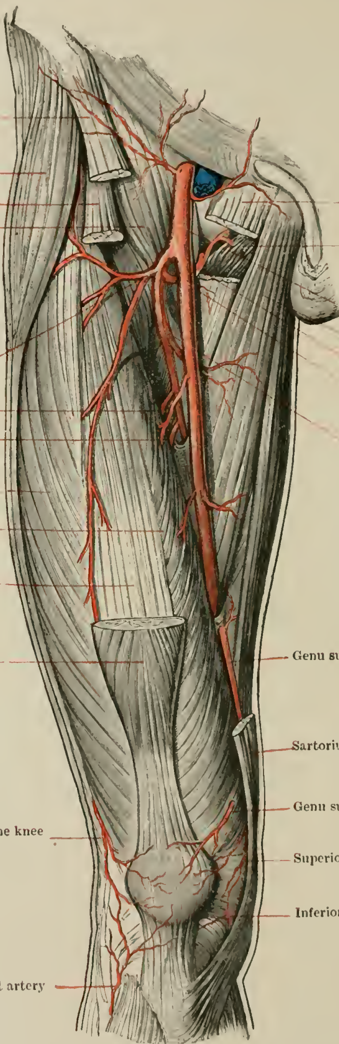


Fig. 106.—The Femoral Artery and its Branches.

The Dorsalis Pedis Artery extends from the front of the ankle to posterior part of the first interosseous space. It then passes to the plantar asp of the foot and completes the plantar arch by anastomosing with the late plantar artery.

THE VEINS

Veins may be divided into three groups, those belonging to—

(*a*) The systemic circulation.
(*b*) The pulmonary circulation.
(*c*) The portal system.

The veins of the systemic system convey the impure blood from all parts of

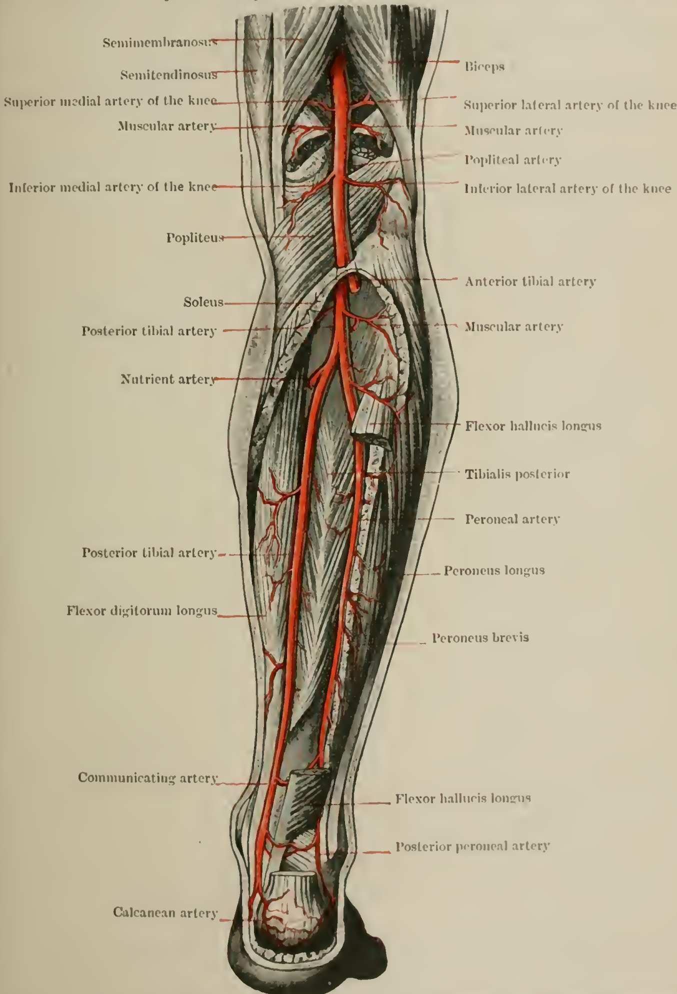


FIG. 107.—THE POPLITEAL AND POSTERIOR TIBIAL ARTERIES AND THEIR BRANCHES.

the body to the right atrium of the heart: those which come from the head, neck, upper extremities, walls of the thorax, and the upper part of the posterior abdominal wall unite to form the *superior vena cava*; those which come from the lower extremities and the walls and contents of the abdomen and pelvis form the *inferior vena cava*, while those coming from the walls of the heart join together to form the *coronary sinus*.

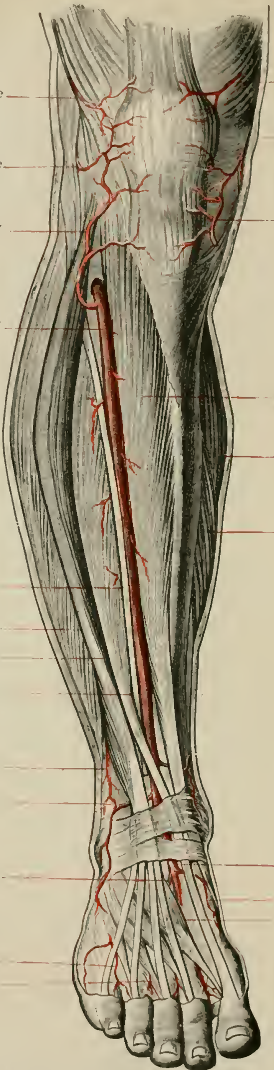


FIG. 108.—THE ANTERIOR TIBIAL ARTERY AND ITS BRANCHES.

SYSTEMIC VEINS

The systemic veins may be divided into—

Superficial veins. | Deep veins.

The Superficial Veins are found in the superficial fascia; they return the blood from it and from the integument, and, passing through the deep fascia, terminate in the deep veins.

The Deep Veins accompany the arteries, and are called *venæ comites.* The smaller arteries have usually two accompanying veins, while the larger vessels, such as the subclavian, the axillary, and the femoral arteries, have only one.

CHIEF VEINS OF THE NECK

Internal jugular.	External jugular.

The Internal Jugular Vein returns the blood from the contents of the cranium, from parts of the face and from the neck. It commences at the base of the skull, descends down the side of the neck, under the sterno-mastoid muscle, at first lying beside the internal and then beside the common carotid artery, and terminates behind the sternal end of the clavicle by joining with the subclavian of that side to form the innominate vein.

The External Jugular Vein returns most of the blood from the external parts of the cranium and from the deeper tissues of the face. It arises a little behind and below the level of the angle of the jaw, passes over the sterno-mastoid muscle, descends vertically down the neck, and terminates in the subclavian vein.

VEINS OF THE UPPER EXTREMITY

The veins of the upper extremity are divided into two groups, superficial and deep.

The Deep Veins lie on each side of the arteries after which they are named, and all finally unite in a common trunk called the axillary vein.

The Axillary Vein accompanies the axillary artery through the axilla, and, at the outer border of the first rib, becomes the subclavian vein.

The Subclavian Vein commences at the outer border of the first rib, and terminates behind the sternal end of the clavicle by joining the internal jugular to form the innominate vein.

The Innominate Veins of each side unite with each other, just below the cartilage of the first rib on the right side, to form the superior vena cava.

The Superior Vena Cava descends through the thorax, and terminates in the upper and back part of the right auricle of the heart.

The Superficial Veins of the upper extremities arise in the superficial fascia of the hand.

SUPERFICIAL VEINS OF THE FOREARM

Median.	Anterior Ulnar.
Radial.	Posterior Ulnar.

The Median Vein commences at the lower part of the back of the thumb. It passes up the middle line of the front of the forearm to the bend of the elbow; here it is connected with the deep veins by the deep median vein, and directly afterwards divides into the median cephalic and median basilic branches.

The Median Cephalic is the lateral branch; it unites with the radial vein to form the cephalic vein.

The Median Basilic is the medial branch; it is joined by the anterior and posterior ulnar veins and becomes the basilic vein.

The Radial Vein arises from the dorsal venous plexus of the hand; it passes up the radial side of the forearm, and, joining the median cephalic at the elbow, it becomes the cephalic vein.

The Anterior Ulnar Vein commences at the ulnar side of the hand, and passes up the front of the forearm, on the ulnar side, to the elbow, where it terminates in the median basilic branch of the median vein.

The Posterior Ulnar Vein commences on the ulnar side of the back of the hand; it passes up the posterior aspect of the forearm on the ulnar side, and at the bend of the elbow it unites with the median basilic to form the basilic vein.

SUPERFICIAL VEINS OF THE UPPER ARM

The Cephalic. The Basilic.

The Cephalic Vein commences at the junction of the radial and the median cephalic veins at the lateral side of the bend of the elbow. It passes up the arm along the lateral border of the biceps muscle, then pierces the deep fascia, passes between the pectoralis major and deltoid muscles, and terminates below the clavicle in the axillary vein.

The Basilic Vein is formed by the union of the median basilic with the posterior ulnar vein at the medial side of the bend of the elbow. It passes up the medial side of the biceps muscle, and when about half-way up the arm pierces the deep fascia and continues its course beside the brachial artery. It terminates as the axillary vein.

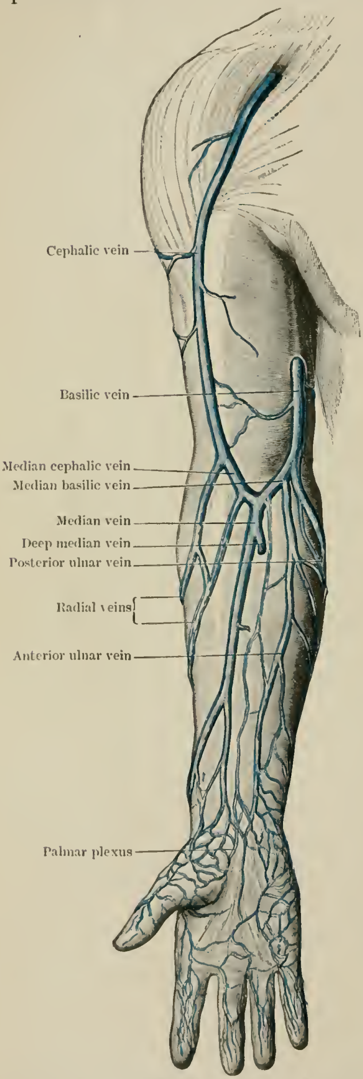


FIG. 109. — SUPERFICIAL VEINS ON THE FLEXOR ASPECT OF THE UPPER EXTREMITY.

VEINS OF THE LOWER EXTREMITY

The veins of the lower extremity are divided into two groups, superficial and deep.

Two Deep Veins, or Venæ Comites, accompany each artery except the popliteal and femoral arteries which have only one accompanying vein.

The Popliteal Vein commences at the distal part of the popliteal surface. It is formed by the union of the veins which accompany the tibial arteries. Above the popliteal surface it becomes the femoral vein.

The Femoral Vein passes up the medial side of the thigh with the femoral artery. It then enters the pelvis under the inguinal ligament, and becomes the external iliac vein.

The External Iliac Vein joins the hypogastric vein opposite the lumbosacral joint to form the common iliac vein.

The Common Iliac Veins of each side unite at the right side of the body of the fifth lumbar vertebra to form the inferior vena cava.

The Inferior Vena Cava passes upwards in front and on the right side of the spine, pierces the diaphragm, and terminates in the lower part of the right atrium of the heart.

SUPERFICIAL VEINS

Great Saphenous.
Small Saphenous.

The Great Saphenous Vein arises from the medial end of the venous arch on the dorsum of the foot. It ascends the medial side of the leg and thigh, passing in front of the medial malleolus and behind the medial condyle of the femur.

About 1½ inch below the inguinal ligament it pierces the deep fascia and terminates in the femoral vein.

The Small Saphenous Vein arises from the lateral end of the venous arch. Its course is along the lateral side of the foot, behind the lateral malleolus, and up the back of the leg to the lower part of the popliteal surface, where, piercing the deep fascia, it ends in the popliteal vein.

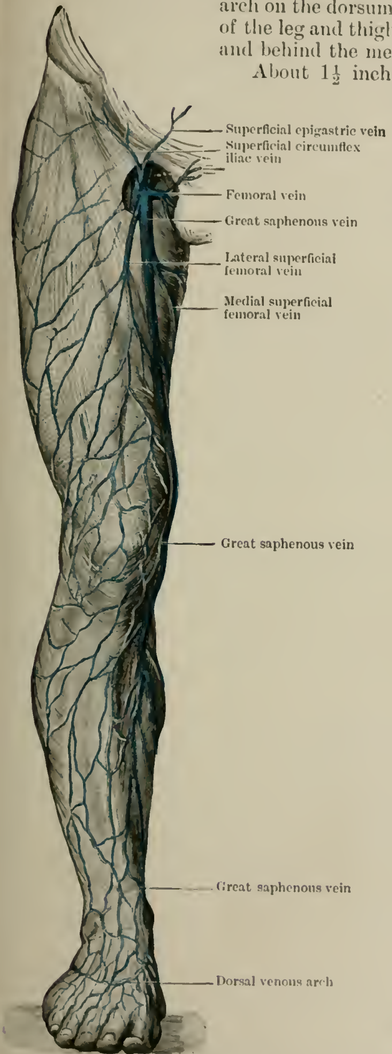


Fig. 110.—The Great Saphenous Vein and its Tributaries.

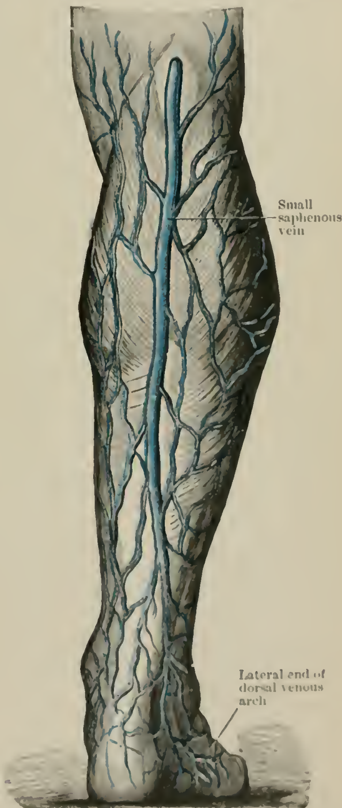


Fig. 111.—The Small Saphenous Vein and its Tributaries.

PULMONARY VEINS

The pulmonary veins are four in number. Two come from each lung and convey the purified blood to the left atrium of the heart. They are formed by the union of numerous small veins which arise from the capillaries in the walls of the air cells, and differ from other veins chiefly in having no valves and in containing arterial instead of venous blood.

VEINS OF THE PORTAL SYSTEM

The veins of the portal system have been described with the portal circulation on page 174.

THE LYMPH VASCULAR SYSTEM

The lymph vascular system is also known as the "absorptive" system, because of the property which its vessels possess of absorbing certain materials from the tissues.

Lymph is a colourless fluid containing many white corpuscles. It oozes through the walls of the capillaries into the lymph "spaces," which are intervals in the connective tissue. Here it bathes and nourishes the tissues and organs, and what still remains is conveyed by the lymph vessels to the innominate veins, where it enters the blood system.

The lymph system consists of lymph capillaries, vessels, and glands. It forms a network all through the tissues of the body, with the exception of the brain, spinal medulla, eyeballs, cartilages, tendons, nails, hair, and cuticle.

The lymph capillaries commence as mere spaces or clefts in the tissues; their walls are formed of a single layer of flat cells, and they are larger than the lymph vessels which arise from them.

Lacteals (Latin *lac* = milk) are the lymph capillaries of the digestive canal which originate in the villi or minute projections on the mucous membrane which lines it. They absorb fatty matter from the products of digestion, and are called lacteals, because while digestion is going on they contain a milky fluid called chyle; at other times they contain a clear fluid resembling that found in the other lymph capillaries.

The lymph vessels accompany the superficial and deep veins. They are provided with valves, and the larger ones have three coats. They have frequent anastomoses.

The lymph glands are small bodies composed of adenoid tissue found in the connective tissue—some superficially, but the greater number deeply placed. They are very numerous in the axilla, groin, mesentery, and along the course of the great blood vessels. These glands act as filters, and it is believed that another of their uses is the formation of white corpuscles. All the lymph of the body passes through one or more of these glands, and thus there is an increase in the number of white corpuscles in it before it reaches the general circulation. The chyle passes through the glands of the mesentery, and in doing so loses some of its fat and takes up white blood corpuscles.

The lymph vessels which enter the glands are called "afferent," those leaving them "efferent."

The right lymph duct and the thoracic duct are the two vessels in which all the other lymph vessels of the system terminate.

The Right Lymph Duct is not quite an inch long; it lies in the root of the neck, on the right side, and receives the lymph from the right side of the head and neck, the right arm, the right side of the thorax, including the right lung, the right half of the heart and the upper part of the liver, also the right half of the diaphragm. It opens into the right innominate vein. The right lymph duct is very often absent, as the three main trunks which form it may all terminate separately in the innominate vein.

The Thoracic Duct in the adult is about 19 inches long; it lies in front of the vertebral column, extending from the second lumbar vertebra to the root of the neck, where, opposite the seventh cervical vertebra, it arches laterally and terminates in the angle of union between the left subclavian and left internal jugular veins; its lower end is dilated and is called the chyle cistern, because here it receives the chyle from the intestines.

The thoracic duct is provided with valves, of which the most perfect is the one which is found at the opening into the innominate vein.

The lymph vessels from all parts of the body except those drained by the right duct empty their contents into it.

LYMPH GLANDS AND VESSELS OF THE UPPER EXTREMITY

The lymph glands and vessels of the upper extremity are arranged into two groups, superficial and deep.

The Superficial Glands are found in the subcutaneous tissue, and are very few in number. There are sometimes two or three at the bend of the elbow, and one or two are found above the medial epicondyle of humerus, lying near the basilic vein.

The Deep Glands are divided into two groups, axillary and subclavian.

The Axillary Glands surround the blood vessels in the axillary space, and are subdivided into four groups—(1) lateral, (2) anterior, (3) posterior, (4) central.

The lateral group consists of about six glands which lie along the course of the axillary vessels from the lower border of the pectoralis major to the outer border of the first rib. They receive superficial and deep afferent vessels from the whole of the arm.

The anterior glands lie in the front part of the axilla under the lateral edge of the pectoral muscles, and receive superficial afferent vessels from the side and front of the upper part of the trunk.

The posterior glands lie on the posterior part of the axilla. They receive the superficial afferent vessels of the side and back of the upper part of the trunk.

The central group lies at the base of the axilla and receives afferent vessels from the other three sets of axillary glands.

The Subclavian Glands are found beneath the clavicle, close to the upper part of the axillary and the subclavian vessels. They receive the efferent vessels from the axillary glands and also vessels from the lateral side of the hand and arm.

A few glands are sometimes found in relation to the arteries of the forearm and arm.

The Superficial Vessels of the upper extremity commence in the network of lymph capillaries on the palmar surface of the fingers and hand.

Those coming from the fingers join together to form four trunks, which lie two on either side of each finger; these anastomose on the back of the hand and, passing to the front of the forearm, join the vessels which arise from the palmar plexus. They then accompany the radial, median, and ulnar veins up the forearm, some of them terminating in the glands at the elbow and those above it, others continuing to the axillary glands.

The Deep Vessels commence in the deep tissues and accompany the main blood vessels. Some of them end in the deep glands of the arm; the greater number, however, pass upwards to the axillary glands.

LYMPH GLANDS AND VESSELS OF THE LOWER EXTREMITY

The lymph glands and vessels of the lower extremity are arranged in two sets, superficial and deep.

The Superficial Glands are all situated in the groin. They consist of three groups, namely—

1. The superior or inguinal.
2. The inferior superficial femoral.
3. The internal or pubic.

The superior group lies just below the inguinal ligament.

The inferior group lies along the proximal part of the large saphenous vein.

The internal group lies near the spine of the pubis. These three groups receive the superficial vessels of the foot, leg, thigh, buttocks, and part of the abdominal wall, while their efferents pass through the saphenous opening and terminate either in the deep femoral or external iliac glands.

The Deep Glands are the anterior tibial, the popliteal, and the deep femoral glands.

The anterior tibial gland is found beside the anterior tibial artery, at the proximal part of the leg, in front of the interosseous membrane.

The popliteal glands are found in relation to the popliteal artery.

The deep femoral glands lie beside the femoral vein just below the inguinal ligament.

The Superficial Vessels commence in the network of lymph capillaries on the plantar surface of the toes and foot. Their arrangement is very similar to that of the lymph vessels of the upper extremity. They form a network all over the leg, and the greater number of them pass upwards beside the large saphenous vein and terminate in the superficial femoral glands.

The Deep Vessels commence in the deep tissues, accompany the main arteries, and terminate in the deep glands.

CHAPTER VIII

THE RESPIRATORY SYSTEM

THE organs of respiration are—

The Larynx.	The Bronchi.
The Trachea.	The Lungs.

THE LARYNX

The larynx—the organ of voice—lies between the base of the tongue and the trachea, in the front part of the neck and about on a level with the bodies of the fourth, fifth, and sixth cervical vertebræ. Its upper part opens into the pharynx, while below it is continuous with the trachea. The walls of the larynx are composed of cartilages which articulate with each other, and are also joined together by membranes. Of these cartilages the thyroid is the largest, and forms the greater part of the front and sides of the larynx. It consists of two plates called the alæ, which meet in front, at an angle of varying degree, and form the projection known as the prominence of the thyroid. The cricoid cartilage forms the lower part of the wall of the larynx. It is broader behind than in front, and is the only complete ring in the air tube. The vocal folds are elastic bands which stretch across from the anterior to the posterior aspect of the larynx.

The epiglottis is a leaf-shaped cartilage found in front of the opening of the larynx, behind the tongue; it projects upwards, and its free edge is directed forwards. Various muscles are connected with the larynx, which control the movements of the cartilages and thus regulate voice production, the quantity of air taken into the system, and also the closing of the superior opening of the larynx during the passage of food through the pharynx. The larynx is lined by mucous membrane and supplied by blood vessels and nerves.

THE TRACHEA

The trachea or windpipe is a tube of about 4 inches long, extending from the lower part of the larynx to a point opposite the lower border of the fourth thoracic vertebra, where it divides into the right and left bronchus. Its wall consists of a series of rings of hyaline cartilage, imperfect behind, held together by a fibrous and elastic membrane in which they are embedded. Muscular fibres form part of the posterior wall of the tube. Its internal surface is lined by mucous membrane. The trachea is separated from the vertebral column by the œsophagus.

THE BRONCHI

The right and left **bronchi** pass downwards and laterally and enter the right and left lung respectively. The right bronchus is wider and shorter than the left. On entering the lungs the bronchi divide and subdivide into numerous branches, each of which finally terminates in the air cells or alveoli. The walls of the bronchi are similar in structure to that of the trachea, except that the cartilage is in the form of small nodules and there is a complete ring of muscular tissue. As these tubes become smaller their walls become thinner. The bronchial tubes are lined by mucous membrane.

THE LUNGS

The lungs are cone-shaped organs, situated in the thorax; they are two in number, and are distinct from one another. Each lung is invested by a serous membrane called the pleura, which closely adheres to it, penetrating each fissure, and so dividing the lobes from each other. Having completely invested the lung as far as its root, this membrane then folds backwards, as it were, upon itself, and lines the cavity of the chest, to the walls of which it is attached. This is called the parietal layer of the membrane, the former the visceral layer. Between the two layers a small quantity of serous fluid is found which prevents friction between the lungs and the chest wall during the movements of respiration. The *base* of each lung rests upon the upper surface of the diaphragm, the *apex* extends into the root of the neck above the first rib. The right lung is divided into three lobes; it is larger than the left and shorter, the diaphragm on that side being raised owing to the large size of the right lobe of the liver which lies underneath it. The left lung is divided into two lobes, and is narrower than its fellow owing to the projection of the heart towards the left side.

The Root is the name given to the structures which pass in and out of the lung on its mediastinal surface. These are the pulmonary veins, the pulmonary artery, the bronchus, the bronchial arteries and veins, the pulmonary nerves, lymph vessels, and glands, which are all enclosed together by the pleura.

Structure of the Lungs.—The lungs consist of numerous lobules, connected together by areolar tissue; each of these lobules is composed of a bronchial tube, the air cells in which it terminates, and of blood vessels, lymph vessels, and nerves. All these are held together by connective tissue which forms the framework of the entire lung, and is remarkable for the large amount of elastic tissue present in it.

RESPIRATION

The act of respiration includes two movements of an opposite nature; one, that of *inspiration*, effects the enlargement of the cavity of the chest by means of certain muscles. Some of these muscles by their contraction elevate the sternum and ribs, while the diaphragm descends by its contraction, thus making the chest cavity deeper; the lungs, being enclosed in the air-tight pleural cavities, must enlarge at the same time, and then the air enters the lungs. The other movement is that of *expiration*; this is effected by the elasticity of the lungs, the relaxation or elevation of the diaphragm, the weight of the chest walls, and by the action of the transversus thoracis and the abdominal muscles.

The muscles of inspiration are as follows—

Ordinary.	*Accessory (in forced inspiration).*
Diaphragm.	Quadratus lumborum.
Intercostals.	Pectorales.
Scaleni.	Serratus anterior.
Serrati posteriores.	Sterno-mastoid.
Levatores costarum.	Latissimus dorsi.
	Infra-hyoid.
	Extensors of spine.

The object of respiration is to take oxygen into the system and to give out carbonic acid gas.

Air enters by the nostrils and the mouth (if open); it then passes through the upper part of the pharynx, enters the larynx, and proceeds through the trachea and bronchial tubes to the air cells of the lungs. Here the blood capillaries, which form minute plexuses round the cells, receive their supply of oxygen and give up rbonic acid gas and other impurities. This exchange of matter is rendered ossible by the extreme thinness of the walls of the air cells and capillaries, so at the air and the blood are brought into close relationship.

Pure atmospheric air contains about—

79	per cent.	nitrogen.
21	„	oxygen.
0·04	„	carbonic acid gas and a variable proportion of water vapour.

Expired air contains—

79	per cent.	nitrogen.
16	„	oxygen.
5	„	carbonic acid gas, as well as a certain amount of decomposing animal matter, and is fully saturated with water vapour.

Tidal air is the name given to that which enters and leaves the lungs in rdinary breathing.

Stationary air is the name given to that which remains in the lungs after rdinary expiration. By means of forced expiration about half the stationary air an be expelled, while half remains, so that the lungs are never empty.

Adult normal respiration is from sixteen to twenty times per minute.

CHAPTER IX

THE DIGESTIVE SYSTEM

The organs of the digestive system are—

The alimentary canal, the teeth, salivary glands, the liver, pancreas, and splee

The alimentary canal consists of the

Mouth.
Pharynx.
Œsophagus.
Stomach.
Small Intestine.
Large Intestine.

THE PHARYNX

The Pharynx is about 5 inches long; it is a muscular tube, commun cating with the mouth, the nose, and the larynx. It extends downwards t the level of the sixth cervical vertebra, where it becomes continuous with tl œsophagus.

THE ŒSOPHAGUS

The Œsophagus is a muscular tube about 10 inches long. It extends from tl pharynx, opposite the sixth cervical vertebra, through the lower part of the nec and through the thorax, then, piercing the diaphragm, it terminates at the cardi orifice of the stomach, which is on a level with the eleventh thoracic vertebr The œsophagus lies behind the trachea and the arch of the aorta, and in front o the vertebral column; below the bifurcation of the trachea it passes forwards an to the left, lying in front of the aorta throughout the lower part of its course.

The œsophagus has three coats—

(*a*) Muscular (external).
(*b*) Submucous (middle).
(*c*) Mucous (internal).

Besides these coats it has a loose outer covering of connective tissue whic unites it to the neighbouring structures.

THE ABDOMEN

The abdomen will here be generally described, as the other organs of t digestive system under consideration are situated in it.

The Abdomen is naturally divided into two parts—the abdomen proper, an the pelvic cavity.

The *abdomen proper* extends from the diaphragm to the brim of the sma pelvis, which is formed by the crest of the pubis, the ilio-pectineal line, and t base of the sacrum.

The *pelvic cavity* or *small pelvis* lies below this line of demarcation.

The abdomen proper is artificially divided by anatomists, for localisation of its ontents, into nine regions, namely—

Right hypochondriac.	Epigastric.	Left hypochondriac.
Right lumbar.	Umbilical.	Left lumbar.
Right iliac.	Hypogastric.	Left iliac.

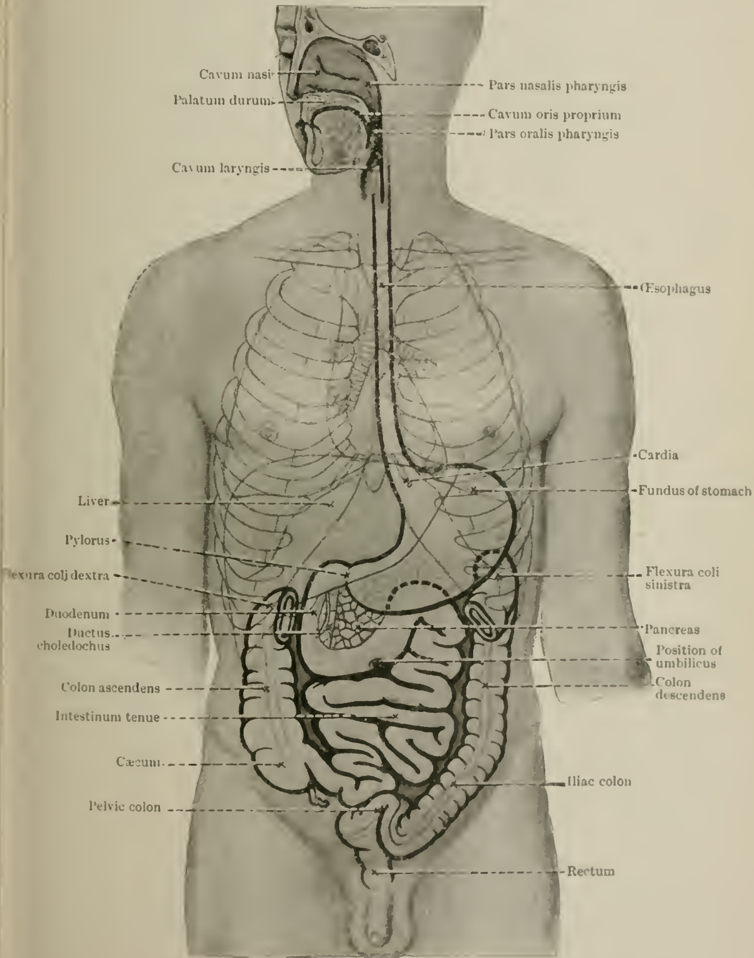


FIG. 112.—GENERAL VIEW OF THE DIGESTIVE SYSTEM (Diagrammatic).

The three upper divisions comprise the costal zone, the three middle the umbilical zone, and the three lower the hypogastric zone.

The contents of the abdomen proper are—

The Stomach.	Suprarenal glands.
Intestines.	Ureters.
Liver.	Blood vessels.
Pancreas.	Nerves.
Spleen.	Lymph vessels and glands.
Kidneys.	

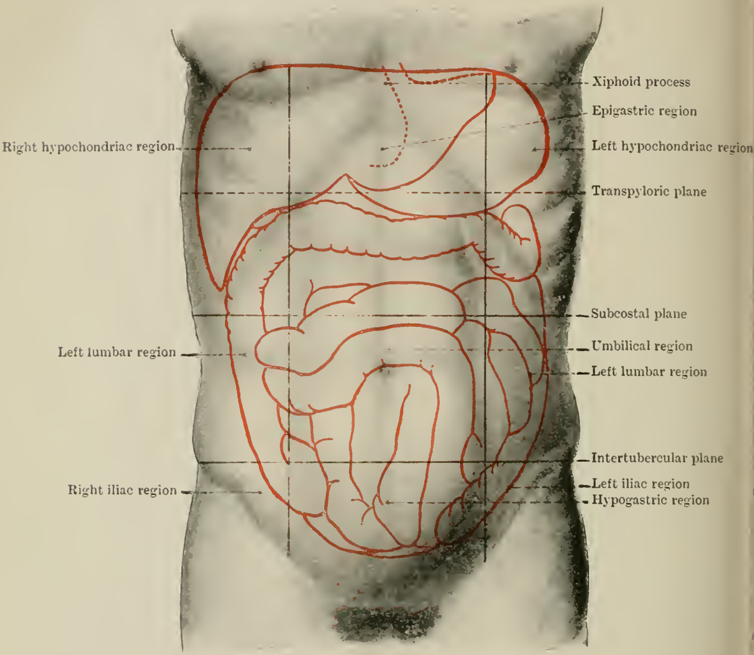


FIG. 113.—THE FRONT OF THE BODY, showing the subdivisions of the abdominal cavity and the position of the chief viscera.

The contents of the small pelvis are—

In the female:

The bladder.
,, uterus and its appendages.
,, rectum.

In the male:

The bladder.
Rectum.

All the abdominal viscera are attached to the posterior abdominal wall, eithe by connective tissue or through the medium of the blood vessels and folds of th peritoneum.

THE PERITONEUM

The Peritoneum is a closed membranous sac, composed of elastic and fibrou tissue, which lines the abdominal walls and surrounds most of the viscera. Tha art which forms the lining of the walls is called the parietal, the other the isceral layer. The membrane secretes a small amount of fluid for lubricating urposes.

The folds of the peritoneum have various names.

The **omenta** are those folds which connect the stomach with other organs. hey are three in number—

(*a*) *The great or gastro-colic omentum*, which passes from the greater curvature of the stomach to the transverse colon.

(*b*) *The lesser or gastro-hepatic omentum*, which passes from the lesser curvature of the stomach to the liver.

(*c*) *The gastro-splenic omentum*, which passes from the stomach to the spleen.

The **mesenteries** are those folds which connect the intestines with the osterior abdominal wall. The mesentery proper is the one which unites the junum and ileum to it, and there are several others.

The **ligaments** are those folds which connect the organs, other than the igestive canal, either to each other or to the abdominal wall.

The peritoneum is united to the abdominal walls and to the viscera by a layer f tissue called the extra-peritoneal or subperitoneal connective tissue, which also erves to connect the viscera to each other and to the abdominal wall. Deposits f fat are found embedded in this tissue in very variable quantities.

THE STOMACH

Shape and Position.—The **stomach** is a somewhat pear-shaped organ, urved upon itself. Its wide or *cardiac end* (fundus) extends upwards, backwards, nd to the left; while the narrow or *pyloric extremity* is directed to the right, and ommunicates with the duodenum, *i.e.* the first part of the small intestine. It has wo curvatures, a greater and a lesser; two surfaces, superior and inferior; and two rifices or openings by which it communicates with the upper and lower part of he alimentary canal. The *greater curvature* extends between the two orifices on he lower aspect of the stomach, and is more than three times as long as the lesser urvature. The *lesser curvature* extends between the two orifices on the upper spect of the organ. The *cardiac orifice* is that which communicates with the ower end of the œsophagus or gullet. It is found at the upper end of the lesser urvature.

The *pyloric orifice* is that which affords communication between the stomach nd duodenum. It lies a little to the right of the median plane about on a level vith the cartilage of the eighth rib. When empty or only moderately distended he stomach lies in the left hypochondrium and the left half of the epigastrium, but when much distended it may reach down to the umbilical and left lumbar regions. t lies below the left lobe of the liver and the diaphragm, and its under surface ests upon the left kidney, the spleen, pancreas, and, when distended, upon the ransverse colon. (When the stomach is empty the transverse colon lies in front f and above it.)

Structure.—The stomach has four coats, namely—

1. Peritoneal (the outer coat).
2. Muscular (three layers).
3. Submucous.
4. Mucous (internal coat).

In the mucous coat are found glands; these secrete the gastric juice, which acts upon the proteids of the food, converting them into peptones, which are absorbed. This secretion is acid from the presence of hydrochloric acid, and viscid from the presence of mucus.

Size and Capacity.—The stomach, when distended, is about 10 inches lo[ng] and 4 or 5 inches in diameter.

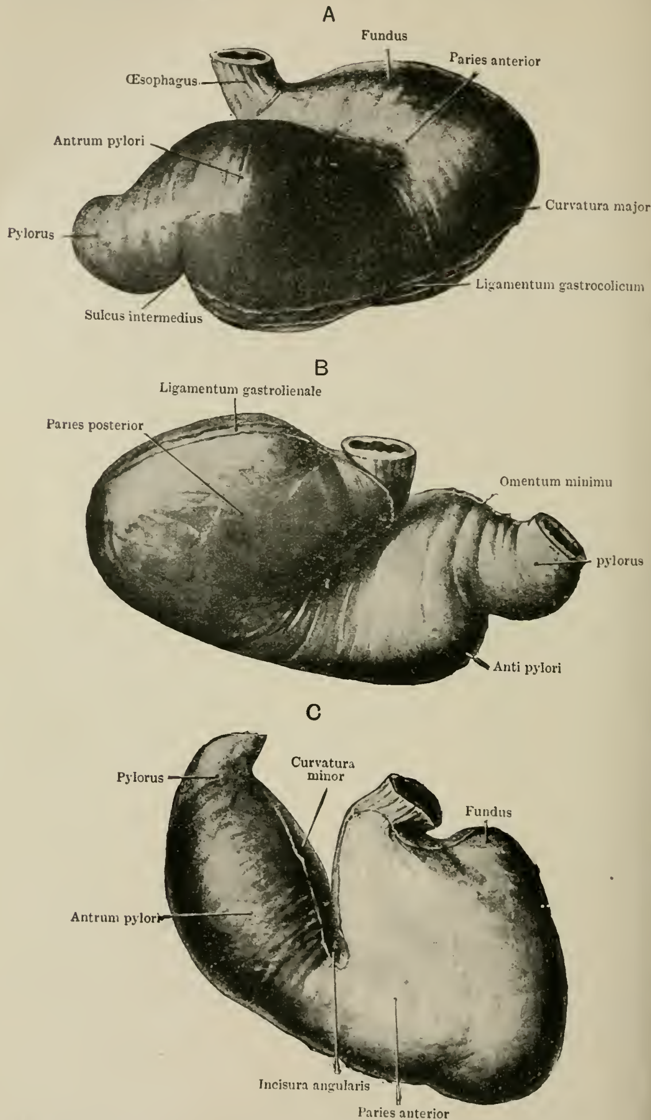


FIG. 114.—MODERATELY DISTENDED STOMACH, viewed, A, from front; B, from inner or right side; and C, from the outer or left side.

It can contain about 1 quart.

The *nerve supply* is derived from the right and left vagus nerves, and from t[he] solar plexus of the sympathetic system. It is also plentifully supplied with blo[od] and lymph vessels.

THE INTESTINES

The intestinal tube consists of—

The small intestine, with its three divisions—

(*a*) Duodenum.
(*b*) Jejunum.
(*c*) Ileum.

The large intestine, comprising the following parts—

(*a*) Cæcum.

(*b*) Colon . . .	Ascending. Right flexure. Transverse. Left flexure. Descending. Iliac. Pelvic.

(*c*) Rectum.

THE SMALL INTESTINE

The **small intestine** (usually over 20 feet long) lies coiled up in the central and lower part of the abdomen. The **duodenum,** 11 inches long, is the name given to the first part of this tube; it communicates above with the pyloric end of the stomach, and lower down becomes the **jejunum,** about 8 feet long, which in its turn becomes continuous with the **ileum,** the last part of the small intestine, which measures about 12 feet in length. The ileum opens into the cæcum; this orifice is guarded by the *valvula coli.*

THE LARGE INTESTINE

The Cæcum.—The cæcum when distended is about $2\frac{1}{2}$ inches long and 3 inches across. It lies in the right iliac region, just behind the anterior wall of the abdomen, and above the lateral half of the inguinal ligament. The *ileo-cæcal orifice* lies at the inner and back part of the cæcum. The *vermiform process* opens out of the cæcum about $1\frac{1}{2}$ inch below the above-mentioned orifice; it is a narrow tube, varying in length from $\frac{3}{4}$ inch to 9 inches.

The Colon.—The *ascending part* of the colon, about 3 inches long, is continuous with the cæcum, and extends upwards, through the right lumbar region, to the under surface of the liver, where it bends forwards and to the left, forming the right flexure. Its posterior surface is in relation to the posterior abdominal wall; its anterior surface lies immediately beneath the anterior abdominal wall, except where portions of the small intestine intervene. The *transverse colon,* about 19 inches long, extends across the abdomen, from right to left, beginning at the right flexure. It lies in the right hypochondriac, epigastric, umbilical, and left hypochondriac regions, terminating in the latter under cover of the stomach, where it forms the left flexure. It lies below the liver, gall bladder, the stomach, pancreas, and spleen, and above the small intestine. Its anterior surface is covered by the abdominal wall, and also, near its termination, by the stomach.

The *descending colon,* about 5 inches long, extends down the left side of the abdomen, from the left flexure to the upper part of the left iliac fossa, where opposite the iliac crest it terminates in the iliac colon. It lies in the left hypochondriac and left lumbar regions, is very deeply placed in the abdomen, and is covered anteriorly by the small intestine.

The *iliac colon*, about 5 inches long, is a continuation of the descending colon. It passes downwards and medially, from the upper part of the iliac fossa and ends in the small pelvis by becoming the pelvic colon.

The *pelvic colon* is usually about 16 or 17 inches long; it lies coiled in the

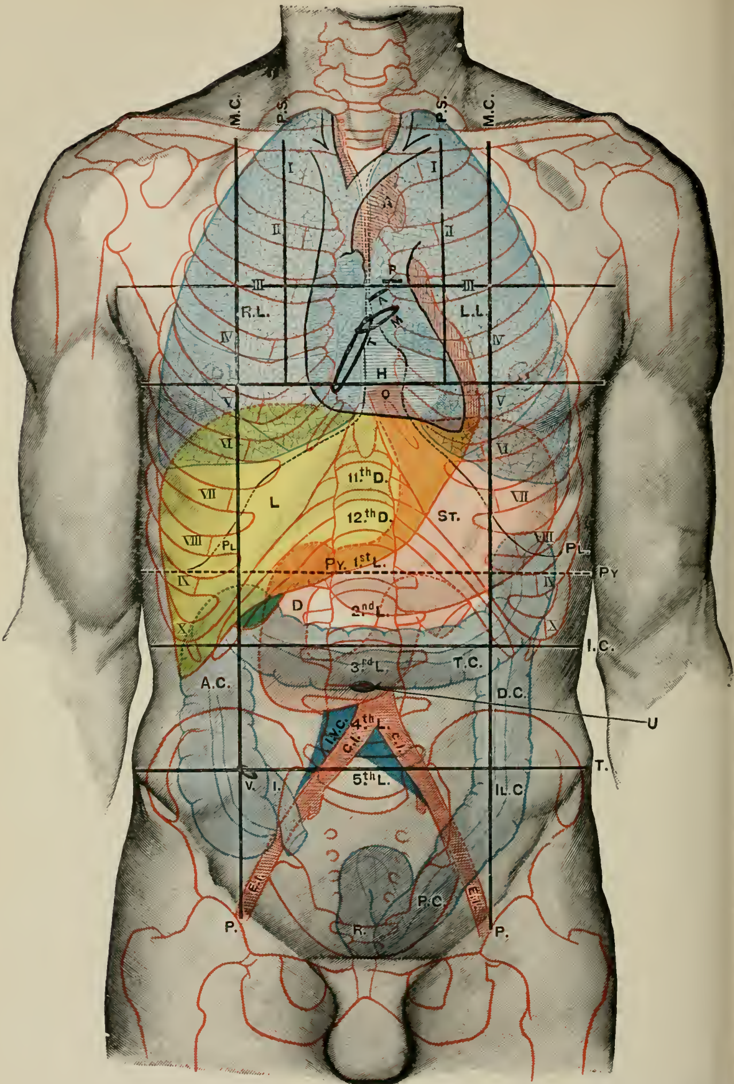


FIG. 115.—ANTERIOR ASPECT OF TRUNK, SHOWING SURFACE TOPOGRAPHY OF VISCERA.

M.C.	Mid-clavicular line.	T.	Tricuspid orifice.	A.C.	Ascending colon.
P.S.	Para-sternal line.	R.L.	Right lung.	T.C.	Transverse colon.
P.	Vertical inguinal line.	L.L.	Left lung.	D.C.	Descending colon.
I.C.	Infracostal line.	PL.	Pleura.	IL.C.	Iliac colon.
T.	Intertubercular line.	L.	Liver.	P.C.	Pelvic colon.
PY.	Transpyloric line of Addison.	O.	Œsophagus.	R.	Rectum.
A.	Aorta.	ST.	Stomach.	C.I.	Common iliac artery.
H.	Heart.	PY.	Pylorus.	E.I.	External iliac artery.
P.	Pulmonary orifice.	D.	Duodenum.	I.V.C.	Inferior vena cava.
A.	Aortic orifice.	I.	Ileum.	U.	Umbilicus.
M.	Mitral orifice.	V.	Valvula coli.		

cavity of the pelvis, and terminates by passing into the rectum. The iliac and pelvic colon form what is commonly called the *sigmoid flexure*.

The Rectum, the last part of the large intestine, is about 5 inches long. It begins at the end of the pelvic colon on a level with the third sacral vertebra, from whence it descends in a curved line in front of the sacrum and coccyx to its termination at the anus.

The last 1½ inch of the rectum is called the *anal canal*.

STRUCTURE OF THE SMALL INTESTINE

The wall of the small intestine is composed, like that of the stomach, of four coats, namely—

1. Serous (the outer coat).
2. Muscular (two layers).
3. Submucous.
4. Mucous (the inner coat).

The *serous coat* is formed of peritoneum, which affords a complete covering for the whole of the small intestines with the exception of the duodenum, which it only covers on its anterior and lateral aspects.

The *muscular coat* consists of two layers of smooth muscle fibres, an outer in which the fibres are placed longitudinally and an inner in which they are placed circularly. They are both complete.

The *mucous membrane* or *internal coat* is, throughout the whole extent of the small intestine, thrown into folds called *plicæ circulares*. The entire surface is thickly studded with minute projections called *villi*; in the centre of each villus is a lacteal vessel for the absorption of fats. In addition to these the surface is covered with small tube-like depressions called *Lieberkühn's glands*, which secrete the intestinal juice, a viscid secretion having a digestive action on starches and sugars. Lastly, small masses of lymph or adenoid tissue, called *solitary glands*, are scattered throughout the submucous tissue; in some places, especially the lower part of the ileum, these are collected together into large patches, called *agminated glands* (*Peyer's patches*), which produce an elevation of the mucous membrane.

The *nerve supply* of the small intestine is derived from the solar plexus.

STRUCTURE OF THE LARGE INTESTINE

The wall of the large intestine is similar to that of the small intestine, except that the peritoneal coat is incomplete in some places and that there are no plicæ circulares, villi, or agminated glands found on the surface of the mucous membrane, only *solitary* and *Lieberkühn's glands*.

The *outer muscular coat* does not form a complete covering, but is arranged in three separate bands. The *inner coat* is, however, complete.

The *nerve supply* of the large intestine comes from the superior mesenteric, derived from the solar plexus, and the inferior mesenteric, derived from the aortic plexus.

THE SALIVARY GLANDS

The chief **salivary glands** are the parotid, the submaxillary, and the sublingual.

The **parotid glands** lie on each side of the head, in front of and underneath the ear, between the sterno-mastoid muscle and the ramus of the mandible.

The **submaxillary glands** lie underneath the angles and body of the mandible.

The **sublingual glands** lie under the side of the tongue. These glands secrete a fluid called saliva, which is composed of water, mucus, mineral salts, and other matters, and is conveyed by means of ducts from the glands to the mouth. The chief use of saliva is to aid digestion, by converting the starchy matter contained in food into sugar, which is soluble, and which is absorbed into the blood system through the mucous membrane. Saliva also acts mechanically by moistening the mouth and the food, and thus facilitates the acts of mastication and of swallowing

THE LIVER

Position.—The **liver** lies in the right hypochondriac, the epigastric, and extends some way into the left hypochondriac region; it generally also reaches downwards for a short distance into the right lumbar region. Its upper surface is convex, and fits into the under surface of the diaphragm; its inferior surface lies upon the right kidney, the intestines, and stomach.

The exact position of this gland varies in individuals, and according to the distension or contraction of the underlying viscera, but it may be fairly accurately described in relation to the anterior surface of the body as follows.

Its upper surface, following the curves of the diaphragm, extends from the fifth rib on the right side in the mammillary line, *i.e.* an imaginary vertical line drawn downwards from the nipple, to the fifth intercostal space in the same line on the left. On the right side it extends downwards from the diaphragm to about half

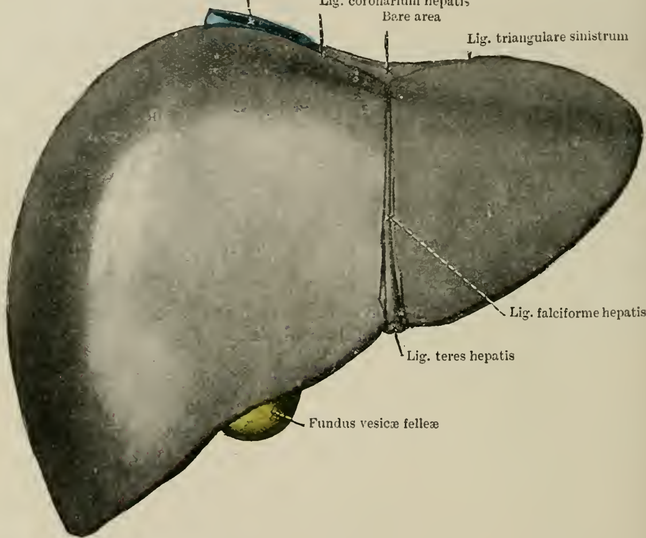


FIG. 116.—THE LIVER FROM THE FRONT, showing the superior, right, and anterior areas of the parietal surface.

an inch below the tip of the tenth rib. Its lower margin passes from this point obliquely upwards; it follows the curve of the costal arch for a little way, then crosses the middle line at a point about half-way between the umbilicus and the junction of the xiphoid cartilage with the sternum, and joins the left extremity of the upper surface at the fifth intercostal space. The liver is divided into right and left lobes by the attachment of a ligament above and in front, and by the umbilical or longitudinal fissure underneath and behind. The right lobe is larger than the left, and is subdivided into three secondary lobes. The left lobe lies upon the upper surface of the stomach.

Size.—The liver is the largest gland in the body, measuring transversely about 7 or 8 inches, in the vertical direction (on the right side) from 6 to 7 inches, and about 6 inches from back to front at its thickest part, *i.e.* the right side.

Structure.—The liver is composed of lobules, held together by connective tissue, and of blood vessels, lymph vessels, and nerves, the whole being invested by a serous and a fibrous coat. The *lobules* consist of cells, blood vessels, and bile ducts, and are about the size of a pin's head.

The vessels connected with the liver are—

The hepatic artery, which conveys arterial blood to the liver.
The portal vein, which conveys blood to the liver from the stomach, intestines, pancreas, and spleen.
The hepatic veins, which convey blood from the liver to the inferior vena cava.
The hepatic duct, which conveys bile from the liver to the small intestine.

These vessels enter and leave the liver on its inferior surface.

Functions.—The chief functions of the liver are—(1) The secretion of bile from the blood, which process takes place in the cells lying between the blood

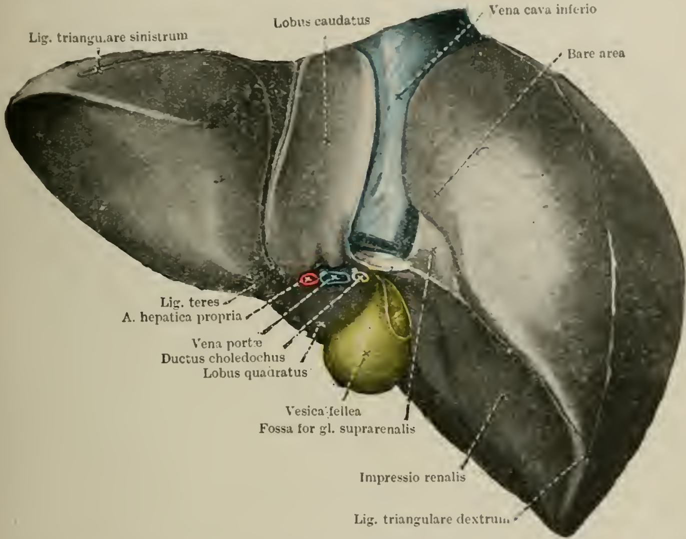


Fig. 117.—The Liver from Below and Behind, showing the whole of the visceral surface and the posterior area of the parietal surface.

capillaries and bile ducts in the lobules of the liver. (2) The conversion of the excess of sugar formed in the intestine during digestion and conveyed to the liver by the portal vein, into a substance called glycogen. Glycogen is stored in the liver until the process of digestion is over, when it is reconverted into sugar and conveyed as wanted into the circulation again by the hepatic veins. (3) The liver is also known to take an important part in the changes which occur in the conversion of proteids into urea. (4) By its cellular activity it helps to maintain the temperature of the body.

The nerve supply of the liver comes from the left vagus nerve and from the hepatic plexus, which is derived from the solar plexus of the sympathetic system.

THE GALL BLADDER AND BILE DUCTS OF THE LIVER

The Gall Bladder lies underneath the right lobe of the liver, with which it is connected by the peritoneum and also by connective tissue. In it is stored the bile, which passes into the small intestine only during digestion. Bile renders fats digestible and also stimulates peristaltic action. The bile or excretory ducts are as follows:—

(1) **Ductus biliferi,** microscopic canals which pass between the cells in the lobules of the liver.
(2) **Interlobular ducts,** which lie outside the lobules and are joined by the ductus biliferi.
(3) **Right** and **left hepatic ducts,** which come from the right and left lobe of the liver. and are formed by the union of the smaller ducts in the substance of that organ.
(4) **Hepatic duct,** formed just outside the liver by the union of the right and left hepatic ducts.
(5) The **cystic duct,** which comes from the gall bladder.
(6) The **bile duct,** formed by the union of the hepatic and cystic ducts, which conveys the bile to the duodenum.

THE PANCREAS

The Pancreas, about 6 inches long, is an irregular-shaped gland lying transversely on the posterior wall of the abdomen and behind the stomach. Its right extremity or head curves downwards and rests upon the duodenum; its left extremity, called the tail, is narrow, and extends to the lower part of the spleen.

It secretes a fluid called pancreatic juice, which is carried into the duodenum by the pancreatic duct through a common opening with the bile duct, and there acts on all classes of food, converting proteids into peptones, starch into sugar, and emulsifying fats.

The *nerve supply* of the pancreas comes from the hepatic and splenic plexuses, which are derived from the solar plexus of the sympathetic.

THE SPLEEN

The Spleen, one of the ductless glands, is an oblong body about 5 or 6 inches long, deeply placed in the abdomen, behind the stomach. It lies obliquely, chiefly in the left hypochondriac region, but its upper extremity extends medially to the epigastrium. Its upper and lateral surface is convex, and is in contact with the under surface of the posterior part of the diaphragm; its medial surface is concave, and rests anteriorly upon the posterior or inferior curved wall of the stomach and the tail of the pancreas, posteriorly upon the left kidney. It is plentifully supplied with blood and lymph vessels, and with nerves, which enter into its substance through a longitudinal cleft on its medial surface called the *hilum.* The spleen is dark red or purple in colour; it is a soft pulpy organ, consisting of cells and intercellular substance, and is very vascular. It is believed that important changes are effected in the blood during its passage through the spleen, and that some of the colourless blood corpuscles may originate there, but the functions of this organ are not yet definitely known.

The *blood supply* of the spleen comes from the splenic artery, which divides and subdivides into arterioles which terminate in capillaries. These capillaries ramify all through the substance of the spleen, and are peculiar in that they terminate in spaces in the splenic tissue with no proper walls except the cells of the spleen, so that the blood is thus brought into direct contact with the elements which form the spleen pulp. The blood, having thus circulated through the spleen, is collected by veins, which all unite to form the *splenic vein,* and this in its turn unites with the superior mesenteric to form the *portal vein.* The *nerve supply* of the spleen comes from the splenic plexus, which is derived from the cœliac part of the solar plexus.

THE PROCESS OF DIGESTION

The process of digestion is that by which food substances are altered and so rendered capable of being absorbed into the system by the blood and lymph capillaries. In the mouth the teeth crush up the food, and the saliva acts upon it, converting most of the starch into sugar, which is rapidly absorbed into the system through the mucous membrane. The food then, having been moistened by the saliva, is formed into a bolus, and carried by the tongue to the back of the mouth, where it passes over the superior opening of the larynx, through the pharynx, and

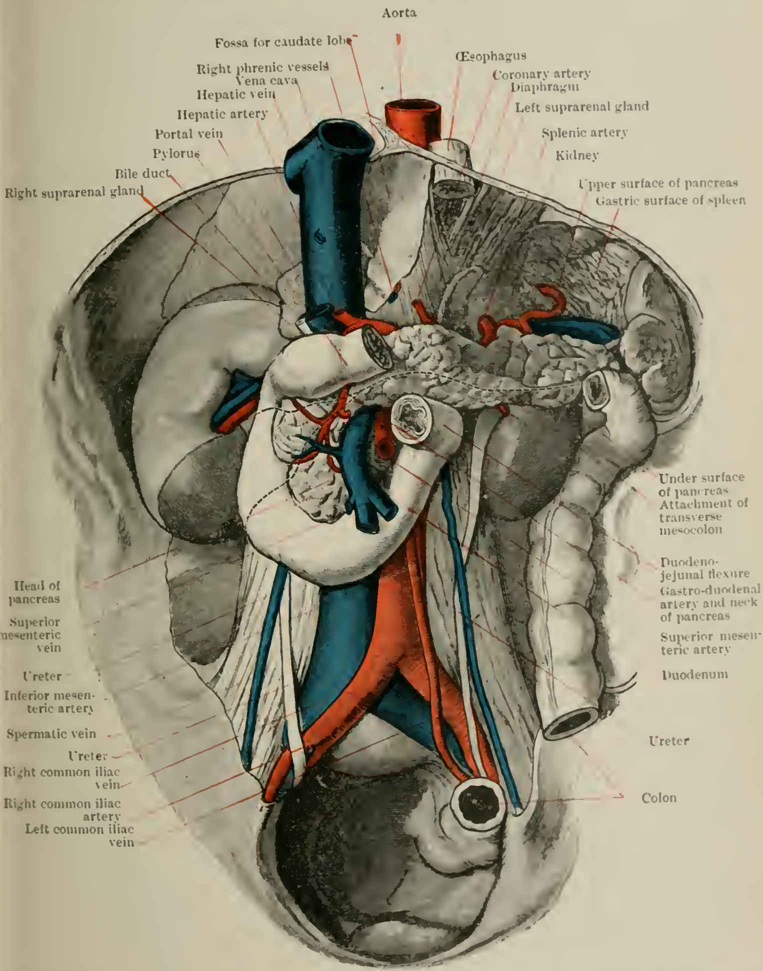


Fig. 118.—The Viscera and Vessels on the Posterior Abdominal Wall. The stomach, liver, and most of the intestines have been removed. The stomach bed is well shown

enters the œsophagus. A wave of contraction, termed peristalsis, passes along the pharynx and œsophagus, and by this means the food is carried down the tube and enters the stomach through the cardiac orifice. Here it is mixed with the gastric juice secreted by the mucous membrane of the stomach; this acts upon the proteids and converts them into peptones, which are soluble and are absorbed by the blood vessels. The partially digested food then passes into the small intestine through the pyloric orifice. It is now called chyme, and consists of starches which have escaped the action of the salivary glands, proteids which have escaped that of the gastric juice, fats which have not been acted upon at all, indigestible substances, and also a certain amount of saliva and gastric juice. In the duodenum the chyme meets with two fluids—bile from the liver, and pancreative juice from the pancreas. Bile acts upon the fats; pancreatic juice, aided also by the secretions of the intestinal glands, acts upon the proteids and starches, so that all kinds of food are here rendered digestible. The chyme now becomes of a milky appearance owing to the emulsification of fatty matter, and is called chyle, which passes through the small and large intestines, digestion and absorption continuing until only waste matter remains.

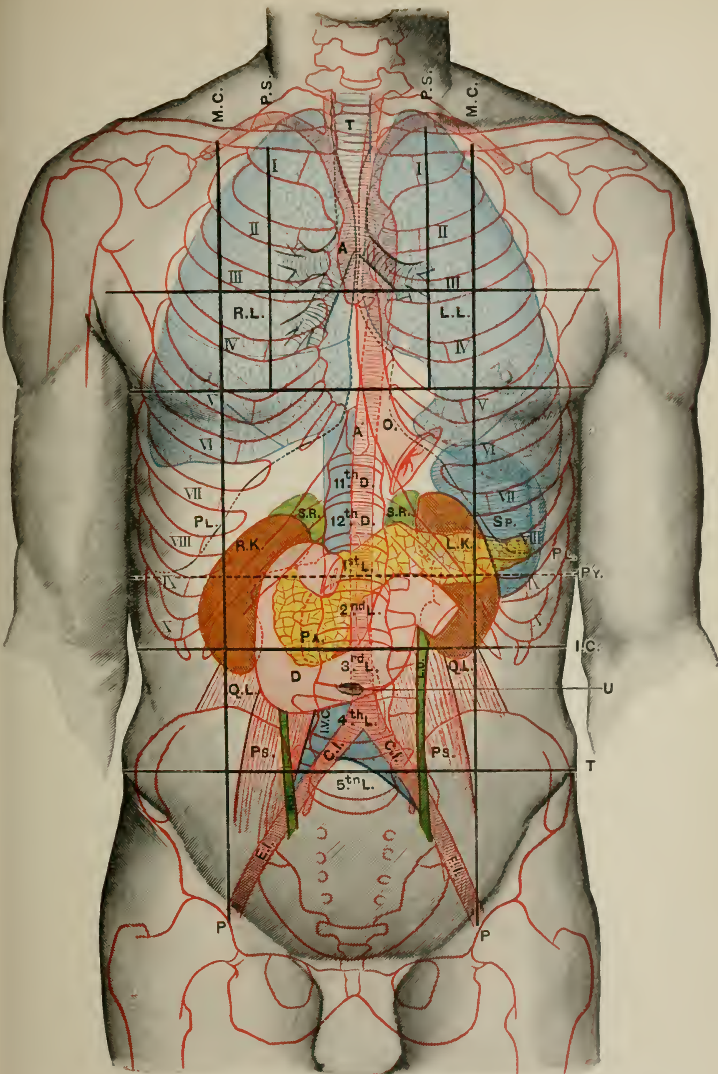


FIG. 119.—ANTERIOR ASPECT OF TRUNK, showing surface topography of viscera.

M.C. Mid-clavicular line.
P.S. Para-sternal line.
P. Vertical inguinal line.
I.C. Infracostal line.
T. Intertubercular line.
Py. Transpyloric line.
T. Trachea.
A. Aorta.
R.L. Right lung.
L.L. Left lung.
PL. Pleura.
O. Œsophagus.
R.K. Right kidney.
L.K. Left kidney.
SP. Spleen.
S.R. Suprarenal gland.
PA. Pancreas.
D. Duodenum.
Q.L. Quadratus lumborum.
Ps. Psoas.
R.U. Right ureter.
L.U. Left ureter.
C.I. Common iliac artery.
E.I. External iliac artery.
I.V.C. Inferior vena cava.
U. Umbilicus.

CHAPTER X

THE URINARY ORGANS AND THE SUPRARENAL CAPSULES, THE UTERUS AND THE OVARIES

The Urinary Organs are—

The kidneys.
The ureters.
The bladder.
The urethra.

The Kidneys are a pair of bean-shaped glands which lie on either side of the spine in the lumbar region, behind the peritoneum. They are about $4\frac{1}{2}$ inches long, 2 inches wide, $1\frac{1}{4}$ inch thick, and weigh about $4\frac{1}{2}$ ounces. They are closely invested by a thin fibrous capsule, are embedded in fat, and are further surrounded by a loose sheath called *fascia renalis*. The upper extremity of the right kidney is on a level with the last thoracic vertebra, its lower extremity usually reaches to a point about $1\frac{1}{4}$ inch above the highest part of the crest of ilium; the left kidney generally lies a little higher than its fellow. They rest posteriorly upon the diaphragm, and upon the psoas and quadratus lumborum muscles, and are kept in position by the neighbouring structures and by the fascia renalis, which is connected with that enveloping the diaphragm and other muscles. On the medial and anterior surface of each kidney is an opening called the *hilum*, which communicates with the *renal sinus* or cavity of the gland, and through which the ureter, vessels, and nerves pass. The substance of the kidney consists of minute tubes and of blood vessels held together by connective tissue. It obtains its *blood supply* from the *renal artery*, which springs direct from the aorta. This blood, having traversed the substance of the kidney, is collected by veins, which unite to form the *renal vein*, and is finally conveyed by it to the inferior vena cava. The kidneys are supplied by lymph vessels as well as blood vessels, and their *nerve supply* comes from the renal plexus. The *function* of the kidneys is to separate urine from the blood. Urine is a product of chemical action, and consists of urea and uric acid, which are nitrogenous matters, also water, in which are dissolved salts and gases.

The Ureters are two tubes for the conveyance of urine, about 10 inches long directed downwards and slightly medially from the hilum of each kidney to the bladder, which they pierce very obliquely on its posterior surface on each side. When the bladder is distended these two openings are a little more than 2 inches apart; the long oblique course of the ureters through the bladder wall makes their openings valvular, and prevents the backward flow of urine.

The Bladder is a muscular sac for the reception of urine. It lies in the anterior part of the small pelvis. When empty its apex or summit comes to about the level of the upper border of the symphysis pubis, but when distended it reaches into the abdominal cavity. Its shape alters according to the amount of fluid it contains. When empty it is somewhat triangular, when distended it assumes an oval form. In a normal condition it can contain about a pint. The opening into the urethra is situated on its under surface. It is supplied by blood and lymph vessels. Its *nerve supply* comes from the vesical, an offset of the hypogastric plexus.

The Urethra in the female is about $1\frac{1}{2}$ inch long, and conveys the urine from the bladder to the exterior. The fibres of the upper part of the muscular coat of this passage are arranged so as to form a sphincter muscle.

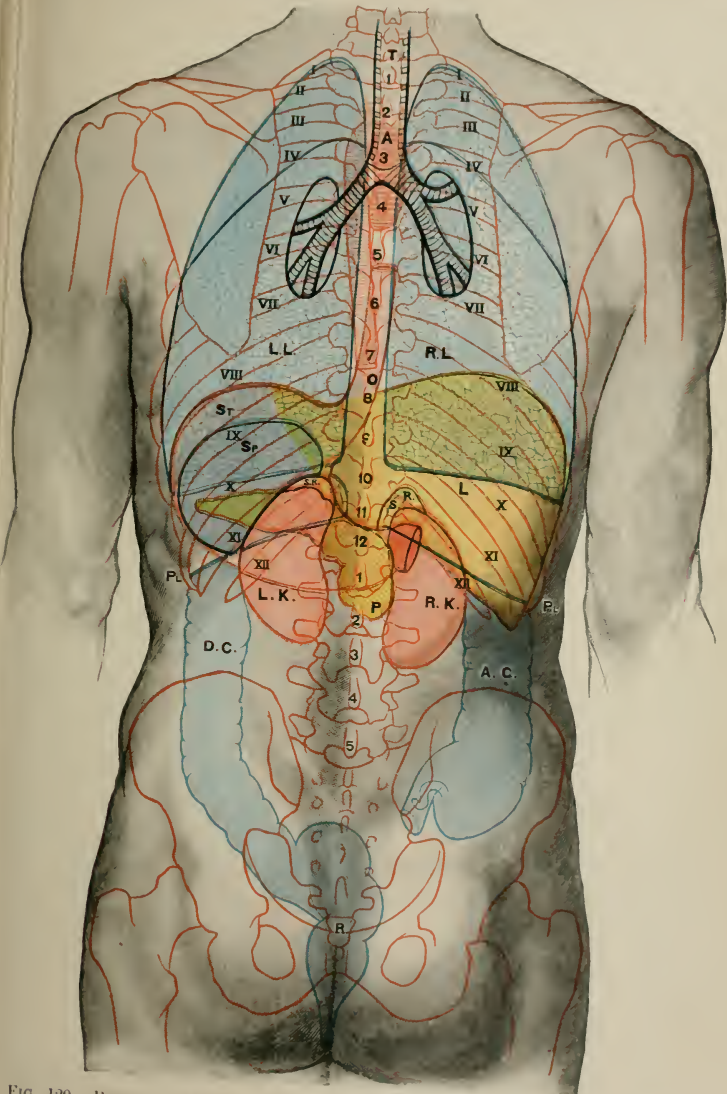


FIG. 120.—POSTERIOR ASPECT OF TRUNK, showing surface topography of viscera.

T. Trachea.
A. Aorta.
L.L. Left lung.
R.L. Right lung.
ST. Stomach.

SP. Spleen.
L. Liver.
S.R. Suprarenal gland.
L.K. Left kidney.
R.K. Right kidney.

P. Pancreas.
PL. Pleura.
D.C. Descending colon.
A.C. Ascending colon.
R. Rectum.

THE SUPRARENAL GLANDS

The Suprarenal Glands are two small ductless glands which rest upon t upper surfaces of the kidneys. Their functions are not clearly known. They a plentifully supplied with blood from three arteries—the aorta, the inferior phren and the renal, and with nerves from the solar plexus.

THE UTERUS AND THE OVARIES

The Uterus is a hollow muscular organ which lies in the pelvic cavity of t female, between the bladder and the rectum. It is invested by the peritoneu folds of which connect it with the bladder in front and with the rectum behin while one, called the *broad ligament*, extends from each side of the uterus to t wall of the pelvis. The *nerve supply* of the uterus comes from the plexus uter vaginalis, a continuation of the hypogastric plexus; it also receives fibres direct from the hypogastric and from the vesical plexus.

The Ovaries are two oval-shaped solid bodies, about 1½ inch long, which l against the wall of the pelvic cavity on each side of the uterus, to which they a united by a rounded cord called the *ligament of the ovary*. Their anterior surfac are closely connected with the broad ligament of the uterus.

Running along the upper border of the broad ligament is the *uterine tube*; t is hollow, and by its medial end communicates with the cavity of the uterus, a by its lateral end with the abdominal cavity. The latter extremity is surround with finger-like projections or fimbriæ, one of which is connected with the ovary.

PART II

THEORY OF MASSAGE

CHAPTER I

THE INFLUENCE OF MASSAGE UPON THE NERVOUS, BLOOD VASCULAR, LYMPH VASCULAR, RESPIRATORY, AND MUSCULAR SYSTEMS, UPON DIGESTION AND ELIMINATION, UPON BONE

THE NERVOUS SYSTEM

Massage profoundly influences the entire nervous system, and through it, as well as directly by mechanical means, affects all the tissues of the body. According to the method employed, the effects of massage upon the nerves may be either stimulative, promoting increased activity of the muscles, vessels, and glands governed by them; or sedative, producing relief of pain and of nervous irritability. Massage promotes the nutrition of nerves by its beneficial effect upon digestion and circulation.

THE BLOOD VASCULAR SYSTEM

Massage, by direct pressure and by stimulation of the vaso-motor nerves, accelerates the flow of blood through the system. It also increases the amount of blood in the parts under treatment. Deep manipulations, if the area treated is sufficiently large, cause a decrease in the rate of and an increase in the strength of the heart beat. This is due to the fact that the vessels in the tissues under treatment are dilated, consequently resistance is lessened. The back pressure of arterial blood upon the heart being thus relieved, it is able to contract more fully and so to empty its cavities more completely.

THE LYMPH VASCULAR SYSTEM

Massage accelerates the flow of lymph through the system by centripetal pressure over the vessels and glands and by active and passive movements of the joints, the lymph being forced onwards at each contraction of the muscles. Pressure upon the tissues promotes absorption, so, when massage is employed, waste and poisonous substances are taken into the lymphatic circulation and eliminated from the system more quickly than they would otherwise be.

THE RESPIRATORY SYSTEM

Manipulation of the muscles improves the circulation and causes increased combustion and consequent formation of carbonic acid gas in the tissues. More work is thus thrown upon the lungs, and the result is increased respiratory activity, the movement of inspiration being deeper and that of expiration more complete. Besides pulmonary or external respiration, a constant exchange of gases takes place in the tissues, oxygen being absorbed by them and carbonic acid gas taken up by the blood. This is called internal or tissue respiration, and is increased in activity by massage.

DIGESTION

Massage aids digestion in the following ways: (1) It stimulates the nerves which control the abdominal viscera, so causing improved circulation and glandular activity, resulting in increased secretion of digestive juices by the stomach, intestines, liver, and pancreas. (2) It promotes peristaltic activity by exciting reflex action of the nerves which control the movements of the stomach and intestines, and by increasing the amount of bile secreted by the liver. (3) It promotes the absorption of digested food substances by the blood and lymph capillaries, as a result of the improved circulation in the walls of the alimentary canal. (4) It strengthens the muscular walls of the intestines and abdomen.

ELIMINATION

Massage increases oxidation and absorption and improves the circulation of blood and lymph. As a result, more carbonic acid gas, water, and urea are produced in the tissues, and are carried more quickly to the organs by which they are eliminated from the system, namely, the lungs, skin, and kidneys. The influence of massage upon the respiratory system has already been described, its effects upon the skin are to improve its nutrition and activity. The cutaneous nerves are stimulated so that secretory activity in the sweat and sebaceous glands is promoted, while effete matter is forced out of the ducts which connect these glands with the surface of the body.

Abdominal massage promotes kidney activity directly by stimulation of the renal plexus.

THE MUSCULAR SYSTEM

Massage improves the nutrition of muscles, and consequently promotes their development. More arterial blood is brought to the parts under manipulation, while effete matter in the veins and lymphatics is forced onwards. Certain movements produce muscular contractions, while others allay nervous irritability and muscle fatigue.

BONE

Bone is indirectly influenced by massage treatment. Any increase in the circulation of blood and lymph in the muscles leads to improved circulation in the bones underlying them. Manipulation of the muscles and joint movement therefore promotes the nutrition and growth of bone.

CHAPTER II

CLASSIFICATION AND DESCRIPTION OF MASSAGE MOVEMENTS: EFFLEURAGE, STROKING, FRICTION, KNEADING, PÉTRISSAGE, TAPÔTEMENT, AND VIBRATION; THEIR PHYSIOLOGICAL AND THERAPEUTIC EFFECTS

Massage movements are grouped under one of the following heads:—

Effleurage.
Stroking.
Massage à Friction.
Kneading.
Pétrissage.
Tapôtement.
Vibration.

EFFLEURAGE

Effleurage is a stroking movement performed with the whole of one or both hands or with the palmar surface of the fingers and thumb. The hand of the

Fig. 121.—Effleurage of the Flexor Muscles of the Wrist.

operator should be carefully moulded to the parts under treatment. Pressure, of varying degree according to the nature of the case, is made in the direction of the venous blood and lymph flow. For soothing effects the movement should be carried out slowly, rhythmically, and gently. For stimulating effects the strokes should be quick and strong (Fig. 121).

Physiological Effects.—Effleurage acts upon the cutaneous nerves an superficial vessels. It aids the return circulation of blood and lymph and increas the glandular activity of the skin.

Therapeutic Effects.—Effleurage accelerates the venous and lymph circul tions, promotes absorption, and is thus beneficial in relieving congestion such follows in cases of sprains and dislocations. It also relieves muscular spasm an prevents muscle waste to some extent. It is useful in cases of insomnia on accou of its soothing effect, and for the same reason, as well as to help the circulatio it is employed before, after, and between other movements in general and loc massage.

STROKING

The strokings employed in medical gymnastic work must not be confused wit effleurage proper. In carrying out the former, pressure is often made in t centrifugal direction. They are frequently done over the patient's clothing and a primarily intended to influence the nervous rather than the circulatory syste

Fig. 122.—Stroking the Arm.

They are much used after other movements for sedative effects, and should th be carried out slowly and with gentle pressure.

Soothing Strokings. — 1. *Sitting head stroking.* — Done with the palm surface of the hands from the forehead, over the head and down the back and si of the neck.

2. *General soothing strokings.*—The patient lies in the supine position wi the arms by the sides. The stroking begins at the head and is continued slow and gently down the sides and front of the arms, trunk, and legs to the feet.

3. *Back stroking.*—This is done with the patient either in the prone (forwa lying) position or sitting or standing with the hands resting against a wall other support. The strokings are carried out down the back with the palm surface of the hands, one placed on either side of the spine, or the hands may drawn downwards directly over the vertebræ one after the other.

4. *Stroking over the region of the heart* in local heart treatment.—The patie is in the half-lying position and the stroking is done gently with alternate han after the hacking movement.

5. *Arm and leg strokings.*—These are performed with one or both hands, wh are drawn slowly and gently down the limbs in the centrifugal direct (Figs. 122 and 123). (If stimulating effects are required, this movement is d quickly and vigorously and mainly with the tips of the fingers.)

Strokings have also a reflex effect and promote the functional activity of the internal parts governed by the same nerve centre which supplies the skin. For this reason, lumbar side stroking and cross abdominal stroking are given in cases of constipation and indigestion to promote glandular, vascular, and peristaltic activity. Light stroking over the gluteal reflex area is useful in cases of atony of the rectum. Strong stroking along the course of the colon mechanically helps to carry forward its contents besides helping peristalsis by reflex action.

Lumbar side stroking.—The stroking is done quickly and vigorously from the sides of the abdomen in a downward and forward direction over the ascending and descending colon.

Cross abdominal stroking.—A series of semicircular strokes are made quickly and somewhat strongly from the middle line laterally, proceeding downwards from the epigastrium.

FIG. 123.—STROKING THE LEG.

Colon stroking.—(*A*) The palmar surface of the hand, with the fingers directed upwards, is used in stroking up the ascending colon. The hand is then turned, the fingers are directed towards the left, and pressure is made along the transverse colon. The hand is again turned, with the fingers directed upwards, and the stroking continues along the descending colon. Deep pressure with the fingers should be made at the last part of the movement.

(*B*) The right hand is placed upon the descending, the left on the ascending colon, with the fingers of both directed upwards. Each hand is then moved simultaneously, the right downwards with firm pressure over the descending colon, the left upwards with equal pressure over the ascending, and then from right to left over the transverse portion of the large intestine.

FRICTION

Friction is carried out with the palmar surface of the hand and fingers, or with the tips of the latter or the tip or ball of the thumb. Also with the dorsal aspect of the middle phalanges of the fingers. It is a deep movement in which the tissues are moved in a circular direction upon the underlying structures. In performing it the elbow should be in the extended position, so that the weight of the body may be thrown into the movement.

Nerve frictions may be carried out as follows:—

The tips of the thumb and index finger are placed against each other and applied to the nerve. Small frictions are then made as the fingers are drawn gradually along it. *Local* or *static nerve frictions* are so named when th movement is only carried out on one particular point of the nerve.

Colon friction is performed with the palmar surface of the first three finger held in close apposition to each other, or with the tips of the three first fingers c both hands placed back to back. Small circular frictions are then made with fin pressure over the cæcum and along the ascending, transverse, and descendin portions of the colon (Fig. 124).

Physiological Effects.—Friction increases the glandular activity of the ski and accelerates the flow of blood and lymph through the parts under treatmen Local temperature is thus raised and absorption is promoted.

Therapeutic Effects.—Friction is one of the most useful of all the pro cedures of massage for breaking up inflammatory products and promoting th absorption of effusion. It is therefore employed in the later treatment of sprain dislocations, and in inflammation of joints. When acute inflammation is presen friction should not be applied directly to the inflamed joint, but to the parts abov it, so as to relieve congestion and to draw the blood away from the affected are

Fig. 124.—Colon Friction.

Friction is employed in cases where the functional activity of the skin is impaire as in chronic myositis and chronic subcutaneous fibrositis. Frictions over th forehead and head are useful in cases of neuralgia. They are employed along th nerve trunks in cases of paralysis and tabes dorsalis to improve and maintain th nutrition and function of the nerves and muscles. Also in neuritis and neuralgi to break up the products of inflammation, promote their absorption, and improv nutrition.

Friction along the course of the colon strengthens its walls, helps peristalsi mechanically helps forward the intestinal contents, breaks up and promotes th absorption of inflammatory products, and stretches adhesions.

KNEADING

Kneading is a modified form of friction, more superficial and extensive, and i distinct from pétrissage. In the movements which come under this heading th muscles are pressed and rolled upon the underlying tissues.

They are carried out as follows :—

1. *Arm and leg kneading.*—The hands are placed one on either side or on th front and back of a limb. The tissues are then pressed between them and at th same time a large circular movement is made, the hands working in differer

directions and in such a way that the tissues are moved round under them. This circular movement is repeated three or four times over a part, the hands are then moved without losing contact with the patient, and the movement is repeated

FIG. 125.—KNEADING THE DELTOID MUSCLE.

until the whole part has been manipulated. It is used in manipulating the arm and thigh. This movement, done superficially, is sometimes called "rolling."

2. *Ironing.*—The hands are placed, a few inches apart, upon the back and are kept in firm contact with the skin of the underlying part. A circular movement is then made in which the hands and the muscles upon which they rest are brought

FIG. 126.—KNEADING THE TISSUES OVER THE ANKLE JOINT.

towards and then carried away from each other, causing alternate compression and stretching of the tissues. Suitable only for the back. (Fig. 127.)

3. *Abdominal kneading.*—(*a*) Transverse kneading.—The hand is placed upon the abdomen. A pushing movement from side to side is then performed by the heel of the hand and the fingers, working alternately. This movement can be made stronger by placing one hand over the other. (*b*) Circular kneading.—The

hand is placed on the centre of the abdomen. A circular movement is then carried out, in which pressure is made alternately with the wrist, radial border of the hand tips of the fingers, and ulnar border of the hand. To make this movement stronger one hand may be placed upon the other. (*c*) Deep circular movements are made over the cæcum and ascending colon by the palmar surface of the fingers, over the transverse colon by the ulnar border of the hand, and over the descending colon by the ball of the thumb. (Figs. 149 and 150.)

Physiological Effects.—Kneading stimulates the nerves, promotes the functional activity of the skin, accelerates the venous and lymphatic circulations and brings a larger supply of arterial blood to the parts under treatment. Consequently glandular activity is promoted, and oxidation (heat production), absorption and elimination are increased.

Therapeutic Effects.—Kneading promotes the nutrition and development of muscles, and the absorption of inflammatory exudations; it relieves venous congestion, and prevents the thickening of muscles.

Fig. 127.—Ironing the Back.

Kneading of the abdomen improves the tone of the abdominal muscles and also that of the walls of the intestines. It causes increased secretion of digestive juices and mechanically forces on the intestinal contents when employed along the course of the colon. Kneading should therefore be employed in the treatment of constipation and indigestion; in all cases where there is muscular weakness or atrophy, as in paralysis, spinal curvature, or rheumatoid arthritis; in muscular rheumatism and writers' cramp; in the later stages of neuritis, sprains and dislocations, and in fractures when union of the bone has taken place. It is also used in treating certain disordered conditions of the heart, and in cases of diabetes and obesity.

PÉTRISSAGE

In **pétrissage** the tissues are grasped in one or both hands, raised from their attachments and subjected to an intermittent double pressure.

1. The movement commonly known as *picking up* is perhaps the pétrissage movement most widely used. It is carried out as follows: The muscles, either singly or in groups, are grasped between the fingers and thumb of each hand and lifted from the underlying tissues. They are then compressed alternately between the fingers of one hand and the thumb of the other, the hands moving onwards between each compression until the whole part has been manipulated. This movement is applicable to the limbs, to the abdomen, to the fleshy parts of the face, and to the neck.

2. The muscle or group of muscles is grasped in one hand, the thumb on one side and the fingers on the other. The tissues are first pressed down upon the underlying structures, then raised up and at the same time squeezed. This movement is applicable to the deltoid, biceps, triceps, and muscle groups of the forearm. It is also used in manipulating the quadriceps extensor group, but is then carried out with both hands and is known as the *butterfly* movement. The thumb of the right hand overlaps the dorsal surface of the first finger of the left (or *vice versa*), the fingers of each are extended and held in close juxtaposition. The muscle group is then grasped between the palmar surfaces of the fingers of both hands and manipulated as above. The masseuse should work with her elbow joints extended in carrying out this movement, so as to put her body weight into it.

3. *Pétrissage for the calf muscles.*—The muscles are grasped at the top of the calf by both hands, one placed a little above the other; they are then carried from side to side with slight upward traction in such a way that a semicircle is described.

FIG. 128.—PÉTRISSAGE—PICKING UP THE MUSCLES OF THE CALF.

The hands are moved by degrees downwards until the whole group has been manipulated. This movement is only applicable to the calf of the leg. To carry it out, the patient's knee must be flexed and the foot supported.

4. *Skin rolling.*—The fingers of both hands are placed upon the part, and the tissues are rolled towards them by the thumbs. This movement is carried out in the transverse direction on the limbs and trunk, and is used in cases of chronic subcutaneous fibrositis.

The general physiological and therapeutic effects of pétrissage are similar to those of kneading. In massage of the abdomen it has no direct mechanical effect upon the viscera, but assists in toning up the abdominal walls. It is a particularly useful form of movement for stretching contracted muscles and in atonic muscular conditions.

TAPÔTEMENT

In **tapôtement** a series of blows are administered in rapid succession, the hands striking alternately, and from the wrist joint only. The best effects are obtained when the muscles are in a state of tension and when they are struck transversely. All the different percussive movements may be classified as follows:—

1. **Clapping.**—The palmar aspect of the whole hand is made concave by slightly flexing the fingers and contracting the palm. It is used in applications to the back, chest, and limbs.

Chest clapping is carried out as follows:—

The patient usually stands in the heave grasp position.[1] The gymnast stands in front, and the clapping is done all over the back of the chest, beginning at the top and working laterally from the middle line towards the shoulders and sides, and downwards. The clapping is then done on the sides of the chest; on the sternum a gentle hacking is given with the fingers, and the clapping is continued on the front of the chest. The movement is repeated three or four times, and may be finished by drawing the chest forward with a long stroking movement while the patient takes a deep breath. The clapping is done with both hands working alternately, and should be fairly strong on the back but more gentle on the sides and front, especially so on the upper part of the front of the chest.

Chest clapping is also done in other positions, namely:—

Neck firm standing
Stretch grasp standing
Yard grasp standing
Heave grasp sitting } chest clapping.

Chest clapping promotes cellular activity in the lungs and bronchial tubes, and

FIG. 129.—CLAPPING.

facilitates the interchange of gases in the lungs. It loosens the mucus from the mucous membrane of the bronchii, and facilitates expectoration. It is employed in cases of emphysema, chronic bronchitis, in the milder forms of bronchial asthma, and in cases of curvature and general weakness.

2. **Hacking.**—Hacking is carried out in the following ways:—

(*a*) With the ulnar surface of the three medial fingers, which are separated and slightly flexed (Fig. 130).

(*b*) With the palmar surfaces of the three medial fingers, which are separated and in the extended position.

In arm lean standing, arm lean sitting, or forward lying back hacking either of the above methods may be employed. The hacking is given either lengthways, with the hands striking alternately on either side of the spine, starting from the top and going down the back; or else in the divergent manner, the strokes being made laterally from and then towards the spine, and continued downwards from the shoulders until the whole back has been hacked. The process is repeated three or four times.

[1] For a description of this and other positions mentioned in this chapter the student is referred to Chap. III. Part II.

Back hacking promotes reflex action and has a stimulating effect upon the hole nervous system. It is used in cases of neurasthenia, locomotor ataxia, iseases of the heart and lungs, and general muscular weakness.

Hacking on the side of the chest is frequently given to promote cellular ctivity.

(*c*) Hacking with the ulnar surface of the little fingers, used in applications o the head and over the region of the heart. The little fingers of both hands re abducted and strike alternately. In heart hacking the strokes are very gently one. The movement causes stronger contractions of the heart.

(*d*) Hacking with the ulnar surface of the whole hand. This is a severe iethod, and is used sometimes over the muscles of the lower extremities.

(*e*) Hacking with the tips or palmar surfaces of the three middle fingers. Employed in hacking the head when treating for insomnia, headaches of rheumatic rigin, and nervous affections. For stimulating effects the tips of the fingers are sed, for sedative effects the palmar surfaces of the fingers.

(*f*) Tapôtement à air comprimé. Used in local heart treatment. The hand is rought towards the region of the heart with the interphalangeal joints of the

FIG. 130.—HACKING.

ingers extended and the metacarpo-phalangeal joints slightly flexed. The latter oints are then fully extended so that the palm is made convex as it strikes the hest over the region of the heart. The strokes should be light and springy. This movement stimulates the heart.

3. **Beating.**—The fist is half closed and either its ulnar or palmar aspect rought into contact with the surface of the body. This method of percussion is nly applicable to the buttocks and to the fleshy part of the thigh. Sacral beating s given for atony of the rectum and bladder, and is much used in treating contipation. It is given in the arm lean stride standing, arm lean stoop stride standng, or in the arm lean stoop stride sitting position. The toes should be turned lightly in the medial direction. The gymnast stands at one side, supports the atient with one hand on the abdomen, and with the other performs the beating. The strokes are made with the palmar surface of the half-closed hand, either in series of gradually descending semicircular lines, extending from one trochanter o the other over the sacrum and gluteal region, or else in a series of oblique ines downwards and laterally from the sacrum over the gluteal region.

Beating over the hips is given in rheumatic cases, and over the gluteal region and thigh for sciatica when the acute stage has passed.

PHYSIOLOGICAL EFFECTS.—Gentle tapôtement causes contraction of the superficial vessels, while strong applications cause their dilatation and raise the tempera ture of the part. Percussion of tendons, when extended, and of the muscle themselves, particularly when applied over reflex areas, gives rise to muscula contractions. Tapôtement over the spine and reflex areas causes stimulation o the nerve centres, and consequently increases the functional activities of th viscera. Prolonged and strong tapôtement has a benumbing effect on the part This is due to over-stimulation and consequent exhaustion of the nerves.

THERAPEUTIC EFFECTS.—Tapôtement improves defective circulation, and i beneficially employed when the functional activity of the skin is impaired. It i one of the most useful procedures of massage for promoting the nutrition an development of weak and wasted muscles, and for this reason is a valuable move ment in cases of paralysis, rheumatoid arthritis, and other disorders which ar followed by muscular weakness and atrophy. Neuralgic pains are often relieve by strong percussive applications. In cases of torpid liver tapôtement over th region of that organ increases its functional activity. Tapôtement over th abdomen and sacrum promotes peristalsis, and is therefore beneficial in cases o constipation. Employed over the sacrum it is also useful in cases of atony o the bladder. It is used in affections of the chest, to stimulate cellular activity loosen mucus and facilitate expectoration, and in heart disease to stimulate th action of the heart. Tapôtement is contra-indicated in hyperesthesia and in flammation, in cases of chorea, in neurasthenia where there is much nervous ex citability, and upon the contracted muscles in cases of spinal curvature, wry neck writer's cramp, etc.

VIBRATION

By **vibration** is meant a trembling movement of the tissues performed by th hand or fingers. **Shaking** is a larger movement, as the name indicates, but may b classed with vibration.

Vibration of special nerve trunks is performed with the tip of one or mor fingers. These vibrations may be continued along the course of the nerve or ma be employed locally.

General nerve pressures are given on the limbs and back. The part is graspe with the tips of all the fingers of both hands and pressed and vibrated.

Nerve vibrations stimulate. They promote reflex action and nutrition, an help to restore or maintain the functions of the nerves and the muscles supplie by them. They are for this reason employed in treating diseases of the nervou system, such as paralysis and tabes dorsalis. They promote the absorption of in flammatory products, and are given in cases of neuritis and other diseases of th peripheral nerves. Nerve vibrations are used in cases of heart disease to stimulat the heart in a reflex manner and to promote stronger contractions. When em ployed over the region of the heart they should be carried out very gently.

The principal **shakings** are:—

1. *Hook half lying stomach pit shaking.*—The masseuse stands on the right sid of and facing the patient. The finger tips of both hands, palmar surfaces in app sition, are placed midway between the umbilicus and the ensiform cartilage. A the patient breathes out, the fingers are pushed in an upward direction under th chest and a shaking is performed. This movement acts on the pyloric end of th stomach and stimulates the cœliac plexus. It promotes peristalsis and the secretio of gastric juice to some extent, and is used in the treatment of chronic catarrh an in atonic and dilated conditions of the stomach. The movement should be repeat several times.

2. *Hook half lying stomach shaking.*—The masseuse stands on the left side the patient and facing towards the latter's feet. The fingers are separated an the tips are placed on the abdomen about 2 inches below the left margin of th thorax. The shaking is given with firm pressure made in an upward direction an towards the middle line. It promotes absorption and the secretion of gastric juic helps peristalsis, loosens mucus, and alleviates pain and discomfort. It strengthe the muscular coat of the stomach and is a particularly useful movement in cas

of dilatation and the disorders consequent on such a condition. Wide says that both the above movements should be given for from five to ten minutes.

3. *Hook half lying cross abdominal shaking.*—The masseuse places one hand on the patient's abdomen. The latter takes a deep breath, and during expiration the masseuse carries out a shaking movement, gradually increasing in strength and extent, from side to side. This movement promotes peristalsis, secretion, and absorption. It loosens mucus, helps to stretch adhesions, and tones up the walls of the intestines. It is used in cases of atony, constipation, chronic catarrh, and diarrhœa. In the latter case it should be very gently given.

4. *Hook half lying abdominal side shaking*, sometimes called *lumbar side shaking.*—The masseuse faces towards the patient and places the hands on the abdomen above the hip bone on each side. The shaking is done by moving the hands alternately backwards and forwards. It is a quick movement, in which the pressure is directed downwards and medially. It is used in cases of constipation and chronic catarrh, and has the same effect on the colon as cross abdominal stroking has upon the small intestines.

The above shakings of the stomach and intestines are contra-indicated in cases of gastric ulcers, inflammation of the alimentary canal, or malignant growths.

5. *Hook half lying* or *lax stoop stride sitting bladder shaking.*—The masseuse stands or sits in front of the patient. The palmar surface of the hands directed downwards, with the fingers close together, are placed on the abdomen a little above the symphysis pubis. The intestines are pushed out of the way to allow the hands to lie over the bladder as far as possible. The patient is directed to take a deep breath, and during expiration the shaking is given strongly with pressure directed downwards and somewhat forwards. The movement is repeated several times with short intervals of rest. It is used in cases of chronic cystitis, also paresis and relaxed and atonic conditions of the bladder. It causes contraction of the muscles of the bladder and their consequent development, promotes cellular activity and absorption, and loosens mucus.

6. *Arm lean standing*, or
Arm lean sitting, or
Heave grasp standing
} *back tremble shaking.*

The hands are placed, one over the other, in the middle of the back, and a gentle shaking is given during expiration. The movement is repeated several times. It is employed in treating heart cases on account of its soothing effect, and is also used in cases of neurasthenia, tabes dorsalis, chronic myelitis, and progressive muscular atrophy.

7. *Heave grasp standing side chest shaking.*—The hands are placed on the sides of the chest, the patient is directed to take a deep breath, and during expiration the shaking is carried out and a strong pressure given at the end over the lower part of the thorax so that the sides are pressed towards each other. This movement is used in emphysema. Its general effects are the same as chest clapping.

8. *Half lying chest lift shaking.*—The masseuse stands at the patient's side and places her hands on either side of the patient's back. The patient's body is then lifted slightly upwards and forwards, and the shaking is carried out while the hands are brought down over the back and forwards over the sides of the thorax. The patient breathes in during the first part of the movement, and out as the hands are brought forward towards the front of the chest. This movement is repeated from four to six times and is generally followed by chest lift stroking, in which the patient is lifted in the same way and a stroking movement performed down the back and over the sides of the chest. Chest lift shaking helps respiration. It is a mild and comfortable movement, and is given in cases of heart and lung disease.

9. *Hook half lying under kidney trembling.*—This is given in cases of movable kidney, which must first be replaced.

The masseuse places both hands on the abdomen, about $2\frac{1}{2}$ inches below the margin of the thorax on one side. As the patient breathes out a continuous tremble shaking is given, the hands being pressed deeply medially and obliquely upwards towards the kidney. The movement is said to have a stimulating effect on the tissues round the kidney, so helping them to retain it in position.

10. *Sitting pharynx and sitting larynx shaking.*—The masseuse supports the patient's head with one hand and grasps the larynx or pharynx between the thumb and index finger of the other hand. A shaking movement from side to side is then carried out. This movement loosens mucus and has a stimulating effect on the parts. It is used in cases of chronic pharyngitis and chronic laryngitis.

General Physiological Effects.—Vibrations and shakings stimulate the nervous system. They increase glandular and vascular activity, and, if very vigorously applied, cause muscular contractions. Instruments for carrying out vibratory movements are now much used, and produce more powerful effects that can be obtained by manual applications.

General Therapeutic Effects.—Vibrations and shakings stimulate the nerves and the muscles supplied by them, thus improving their nutrition and helping to restore or maintain function. They are therefore much used in cases where there is loss of nerve power, either partial or complete, as in paralysis and in the various forms of occupation neurosis. They are also useful in cases of neuralgia and in neurasthenia. They increase the functional activities of the organs of digestion, promote peristalsis, and are therefore valuable movements in cases of indigestion and constipation. They are employed in cases of anæmia and general weakness, also in non-acute inflammatory conditions to break up and promote the absorption of the products of inflammation. They are used in certain cases of heart disease on account of their soothing and strengthening effect; also in chest affections to help the interchange of gases, loosen mucus, and help expectoration. By their means deeply seated organs can be influenced. Gentle vibrations and shakings can be given in cases when stronger manipulations could not be borne. Vibrations and shakings should be avoided when marked hyperesthesia and inflammation are present.

Rules to be Observed in Carrying out Massage Movements

1. The patient should be placed in a comfortable position, and should be directed to breathe freely throughout the treatment.
2. The masseuse should place herself in as convenient a position as possible for carrying out the manipulations, and should breathe freely throughout their performance.
3. The rate of movement and the vigour of the applications must vary according to the nature of the case and the condition of the patient, but in *every* instance, at the beginning of a course of massage, the applications should be of a gentle nature, and gradually increase in vigour and duration as the condition of the patient improves.
4. Care should be taken to support the limbs comfortably while they are being manipulated.
5. All movements should be performed rhythmically.
6. Except in giving percussion, the muscles under manipulation should be relaxed.

CHAPTER III

SWEDISH REMEDIAL GYMNASTICS

DESCRIPTION OF PASSIVE AND ACTIVE MOVEMENTS—THE FUNDAMENTAL POSITIONS AND THOSE DERIVED FROM THEM

LL movements may be divided into two classes, passive and active.

Passive Movements are of two kinds:—

(1) Those in which the patient's joints are moved by the gymnast, or by some echanical apparatus, without voluntary effort on the part of the patient.

(2) Massage movements. These are carried out by the gymnast on some rtion of the patient's body, the muscles of the latter being in a quiescent state.

Active Movements are those performed by voluntary contraction of the uscles on the part of the patient. They include free, assistive, and resistive uplicate) movements, and holdings.

Free Movements are those carried out voluntarily by the patient without her assistance or resistance.

Assistive Movements are those in which the gymnast co-operates with the tient in performing the movement.

Resistive Movements are of two kinds: concentric and excentric. Con-ntric movements are those performed by the patient while the gymnast sists. Excentric movements are those carried out by the gymnast while the tient resists. In concentric work the muscles become shorter in spite of an posing force: in excentric work they contract, to oppose the movement which being carried out by the gymnast or some external agency, but the contraction overcome by the latter and the muscle lengthens during the movement.

In concentric movements the amount of resistance given is determined by the mnast. In excentric movements the patient controls the resistance and, for is reason, excentric movements should precede concentric ones in treating tients with very weak muscles, as in cases of pareses and others.

Concentric and excentric movement for the same group of muscles is given hen it is desirable to exercise that group to the exclusion of the antagonising uscles. For example: When the triceps is stretched and weak and the biceps ntracted, the patient is directed to extend the forearm while the gymnast resists oncentric work for the triceps); the patient is then told to resist while the mnast flexes the forearm (excentric work for the triceps).

The following points should be observed in carrying out concentric move-ents:—

(1) The opposition made at the beginning of a course of treatment should be ight at first and should gradually increase as the patient gains in strength, but should never be so great as to overcome the complete contraction of the muscles gaged in the movement.

(2) The resistance made by the operator during each movement should be aduated. It should be slight at the beginning, gradually increase, and then adually decrease towards the end.

(3) When the patient has contracted the muscles to their fullest voluntary tent against resistance, the gymnast should assist in completing the movement d so cause the further forcible contraction of the muscles engaged.

Holdings.—In holdings or static muscle work the muscles are actively engaged in maintaining a certain position although no actual movement is taking place. They are used chiefly to teach the patient to assume a correct position of the body and also to exercise the muscles. They are sometimes given to cause the strong contraction of one group and to stretch the muscles and ligaments on the opposite side.

Gymnastic Positions.—

The five *fundamental positions* are:—

Standing, sitting, kneeling, lying, and hanging. A number of other positions known as *derived positions*, arise from these.

I. Standing Fundamental Position

Heels together.

Feet forming an angle of not more than 45°.

Knees fully extended.

Hips fully extended.

Head erect and chin slightly drawn in.

Shoulders held well back and drawn down.

Arms hanging by the sides.

Fingers not fully extended.

Palmar surface of the hand in contact with the lateral side of the thigh.

This position innervates all the muscles of the back of the neck, the back extensors of the leg and thigh, and others. It expands the chest and maintains the pelvis in a correct position.

II. Sitting Fundamental Position

The patient sits upon a chair or stool with the thighs supported along their whole length.

The hip, knee, and ankle joints are kept at right angles.

The feet rest on the floor or other support.

The legs are kept slightly apart.

The body and head are held erect as in the previous position.

The arms hang by the sides.

In this position the muscles of the neck and those of the back are innervated.

III. Kneeling Fundamental Position

The patient kneels upon the low plinth, or upon the floor, with the knees and feet close together, the latter plantar flexed. The head, body, and arms are maintained as in the standing fundamental position.

The muscles innervated are for the most part the same as in the fundamental standing position.

IV. Lying Fundamental Position

The patient lies on the back with the legs together and the arms close to the sides, so that the whole body is supported. Once the position has been taken there need be no muscle work.

V. Hanging Fundamental Position

The patient grasps a bar, boom, or some similar apparatus, fixed at such a height that the feet do not touch the ground while the patient is suspended. The hands should be slightly more than the width of the shoulders apart. They are pronated in making the grip. The arms, trunk, and legs are fully extended. The head is held erect or may be thrown slightly back.

In this position the shoulder and arm muscles should work to some extent to ·event the entire weight of the body coming on the hands. The muscles engaged maintaining the position are the flexors of the fingers and the muscles just entioned.

Derived Positions.—

Various positions are derived from the five fundamental positions by moving ıe arms, the legs, and the trunk.

(A) Positions Derived from the Fundamental Standing Position by Moving the Arms

(1) *Wing or Hips Firm Standing.*—The palmar surfaces of the hands are aced upon the crest of the ilium on either side. The fingers are extended, held apposition and are directed forwards; the thumbs are directed backwards. The bows are carried slightly backwards.

(2) *Bend Standing.*—The forearms are flexed, the elbows are kept close to the les, the wrist and fingers are slightly flexed, and the tips of the latter are placed far back as possible upon the shoulders. Bend standing is the initial position r arm extensions.

(3) *Forward Bend or Swim Standing.*—The forearms are bent and the elbows ised until the upper arms are on the same level and in the same plane as the ıoulders. The elbows are kept well back. The palms are directed downwards ıd the fingers are extended.

(4) *Speech Standing.*—The arms and hands are rotated laterally.

(5) *Yard Standing.*—The arms are stretched out sideways and raised to the vel of the shoulders. The palms are directed downwards and the fingers are tended.

(6) *Heave Standing.*—(*a*) Derived from yard standing by supinating the fore-rms and bringing them upwards to right angles with the upper arms, palms rected medially. (*b*) Derived from yard standing by carrying the forearms for-ard so that they form right angles with the upper arms.

(7) *Reach Standing.*—The arms are carried forwards and upwards until they e on a level with the shoulders. The elbows are kept in full extension, the ınds on a line with the arms, palms facing, and the width of the shoulders apart.

(8) *Neck Firm or Neck Rest Standing.*—The finger tips of each hand are placed ·on the lower part of the neck so that they touch each other. The elbows should kept well back, the wrist and fingers extended, the head erect.

(9) *Think Standing.*—This position is derived from the preceding one by acing the fingers against the forehead.

(10) *Stretch Standing.*—This position arises from bend standing by stretching ıe arms upwards over the head, palms directed medially, wrists straight, and elbows ıd fingers fully extended. The hands should be somewhat more than the width the shoulders apart.

(11) *Crutch Standing.*—The arm is placed over a boom so that the body is xed. This position is used in giving side flexions in the cervical region in cases scoliosis.

Yard, *Heave*, *Reach*, and *Stretch Grasp Standing* arise by taking the yard, eave, reach, and stretch positions with the hands grasping some support, such as ıe poles or rib stool.

(B) Positions Derived from the Fundamental Standing Position by Moving the Legs

(1) *Close Standing.*—The feet are parallel and their medial borders are in ontact with each other.

(2) *Stride Standing.*—The feet are moved laterally about one foot length ıch, the same angle being maintained between them as in the fundamental osition.

(3) *Walk Standing.*—One foot is placed about two foot lengths straight forwards or forwards and laterally. The weight of the body should rest equally upon the two legs.

(4) *Toe Standing.*—Arises by raising the heels off the ground and at the same time keeping them in contact with each other.

(5) *Knee Bend or Curtsey Standing.*—The knees are flexed and separated.

(6) *Toe Knee Bend Standing.*—Is a combination of the two preceding positions.

(7) *Half Hook Standing.*—The knee is raised until the thigh forms a right angle with the trunk and the leg. The toes are pointed downwards.

(8) *Step Standing.*—Same as the preceding except that the foot is supported.

(9) *Instep Lean Standing.*—One knee is bent and the dorsal surface of the foot is supported upon a stool behind.

(10) *Heel Lean Standing.*—The leg is extended forward with the heel of the foot resting upon a stool.

(11) *Fall Out Standing.*—One leg is moved forwards three foot lengths, and the knee is bent until it is directly over the toes. The other leg is extended. The trunk is inclined forwards, so as to be in line with the posterior leg.

(*C*) Positions Derived from the Fundamental Standing Position by Moving the Trunk

(1) *Stoop Standing.*—Flexion takes place at the hip joints. The body is inclined forwards, the spine is kept straight, the head is bent slightly backwards, the arms hang downwards, the knees are kept fully extended.

(2) *Stoop Leg Lean Standing.*—This position is the same as the preceding, except that the thighs are supported against a boom.

(3) *Lax Stoop Standing.*—The trunk is inclined forwards and downwards flexion taking place in the hips and spine, chiefly the lumbar region.

(4) *Arch or Backward Bend Standing.*—The trunk is bent backwards, extension taking place chiefly in the dorsal region.

(5) *Fall Standing.*—In taking this position the gymnast must stand behind and firmly support the patient's shoulders and neck. It arises by allowing the trunk to fall backwards from the ankle joints. The spine and legs are kept straight as in the fundamental standing position.

(6) *Side Arch or Side Bend Standing.*—The whole spine is bent to one or other side. To take this position correctly no forward or backward rotation of the vertebræ should be allowed.

(7) *Turn Standing.*—The body is turned or twisted as far as possible to either side. The relative positions of the head and shoulders should not be altered in taking this position.

New positions can arise by combining two or more of the preceding derived positions.

Examples: Wing Close Standing, Yard Stoop Stride Standing.

(*A*) Positions Derived from the Fundamental Sitting Position by Moving the Arms

(1) *Wing Sitting.*
(2) *Yard Sitting.*
(3) *Heave Sitting.*
(4) *Reach Sitting.*
(5) *Neck Firm Sitting.*
(6) *Stretch Sitting.*

These are taken in the same way as from the fundamental standing position.

(*B*) Positions Derived from the Fundamental Sitting Position by Moving the Legs

(1) *Long Sitting.*—The patient sits with the legs outstretched and supported along their whole length, the trunk and thighs forming a right angle.

(2) *Half Sitting.*—The patient stands on one leg, and the thigh of the other is laced across a high plinth or other apparatus so that it forms a right angle with ie trunk. It should be supported along its whole length. The lower leg hangs own.

(3) *Stride Sitting.*—This arises from the fundamental sitting position by parating the legs so that the feet are two foot lengths apart.

(4) *Ride Sitting.*—The patient sits astride a plinth or stool. It is called *High ide Sitting* when the position is taken on a high plinth.

(*C*) Positions Derived from the Fundamental Sitting Position by Moving the Trunk

(1) *Arch Sitting.*
(2) *Stoop Sitting.*
(3) *Lax Stoop Sitting.*
(4) *Turn Sitting.*

These four positions are taken as from the fundamental standing position previously described.

(5) *Fall Sitting.*—The patient inclines the trunk backwards from the hips as ar as possible. Support must be given to the patient's knees or feet.

(6) *Spring Sitting.*—This is very like the fall out standing position; one leg bent forwards and the thigh is supported upon a stool, the other leg is stretched ackwards and rests upon the toes. The trunk is inclined forwards from the hips that it is on a line with the posterior leg.

This position is much used in cases of scoliosis. In cases of lumbar scoliosis he leg on the side of the convexity of the curve is bent forwards. If there is curve in the dorsal region as well, the arm on the side of the dorsal concavity extended upwards above the head, and the arm on the side of the convexity is tretched backwards along the side of the posterior thigh.

(*A*) Positions Derived from the Fundamental Kneeling Position by Moving the Arms

Wing, yard, neck firm, stretch, etc.

(*B*) Positions Derived from the Fundamental Kneeling Position by Moving the Legs

Stride knee standing.

(*C*) Positions Derived from the Fundamental Kneeling Position by Moving the Trunk

Arch knee standing.
Turn knee standing, etc.

These arise in the same way as in the fundamental standing position, but are not much used.

(*A*) Positions Derived from the Fundamental Lying Position by Moving the Arms

(1) *Wing Lying.*
(2) *Neck Firm Lying.*
(3) *Stretch Lying.*

Taken as already described in the other fundamental positions.

(*B*) Positions Derived from the Fundamental Lying Position by Moving the Legs

(1) *Stride Lying.*—The feet are separated by about two foot lengths.
(2) *Hook Lying.*—The knees are bent and the feet are supported.
(3) *Sit Lying.*—The legs from the knee downwards hang over the edge of the plinth or couch.

(*C*) Positions Derived from the Fundamental Lying Position by Moving the Trunk

(1) *Half Lying.*—This position arises by supporting the back in the midway position between sitting and lying. The legs are outstretched and supported, or else bent at the knees, with the feet resting on the floor.

(2) *Hook Half Lying.*—Same as the preceding, excepting that the knees are bent up and the feet are supported upon the plinth. Position used in massage of the abdomen.

(3) *Forward Lying.*—The patient lies prone on a plinth or couch. Position used in back massage.

(4) *Leg Forward Lying.*—The patient takes this position by kneeling on the high plinth at such a distance from the end that the thighs will be supported when the trunk is lowered to the horizontal plane. The ankles are firmly secured by a strap to the plinth, or an oversitter may sit upon the patient's legs. The patient's hands are then placed upon the gymnast's shoulders, and the latter places his under the patient's arm-pits in front and then lowers the trunk to the horizontal position. To return to the kneeling position the patient bends the hips, the gymnast supporting.

(5) *Arch Leg Forward Lying.*—Derived from the preceding position by hyper-extension of the spine, particularly in the thoracic region.

(6) *Side Leg Lying.*—The patient lies with the whole of the side of one of th lower limbs supported on a plinth. The uppermost leg lies behind the other Both are secured at the ankles by a strap. The trunk projects sideways over th end of the plinth. The arm on the under side is placed in the neck firm positio the other arm is extended by the side. The spine should be in a straight lin throughout its entire length.

(7) *Side Arch Leg Lying.*—Derived from the preceding position by the patier bending the spine upwards and maintaining this position.

There are many combinations of these positions which give rise to others.
Examples: Yard Leg Forward Lying.
Stretch Sit Lying.

Positions Derived from the Fundamental Hanging Position

(1) *Heave Hanging.*—The elbows are flexed and the body is drawn up unt the shoulders and elbows are on a level with each other.

(2) *Hook Hanging.*—This position is taken on the rib stool. It arises from tl fundamental hanging position by drawing up the knees so that the thighs are right angles to the trunk and legs. The toes are pointed downwards.

(3) *Arch Hanging.*—The patient grasps a boom which is on a level with t shoulders. The legs are in turn stretched out backwards until the weight of t body comes upon the extended arms. The toes rest upon the floor. The he should be held slightly back and the chin in.

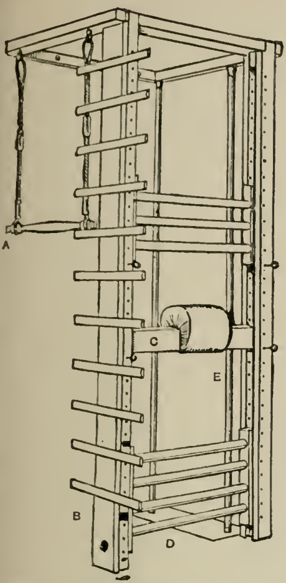


Fig. 131.—Combined Apparatus consisting of (*A*) Trapeze, (*B*) Peg Post, (*C*) Boom, (*D*) Rib Stool, (*E*) Upright Poles.

Fig. 132.—Rib Stool.

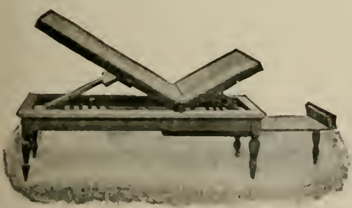


Fig. 133.—Low Plinth.

Fig. 134.—High Plinth.

(The above illustrations show the apparatus, referred to in the text, which is used in carrying out many of the exercises.)

CHAPTER IV

TABLES OF SWEDISH REMEDIAL GYMNASTICS

ALL the movements in remedial gymnastics come under the following names:—

Flexion.	Raising.
Extension.	Falling.
Abduction.	Swinging.
Adduction.	Carrying.
Rolling (Circumduction).	Drawing.
Lifting.	Twisting.
Heaving.	Hanging.
Expansion.	Holding.

Wringing.

And besides these the various massage movements previously given.

TABLES]

PRINCIPAL MOVEMENTS FOR THE UPPER EXTREMITY

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Flexion and extension of fingers— (*a*) Sitting. (*b*) Half lying.	Phalangeal.	Flexors and extensors of fingers.	To increase mobility, improve the circulation, and exercise the muscles. Is given after massage of the forearm and hand in a general treatment, and also in cases of weakness and stiffness.	Sitting Flexion and Extension of the Fingers.—The patient rests the elbow on the gymnast's knee, the latter being in the step standing position. The gymnast fixes the wrist joint with one hand and with the palmar surface of the last phalanges of the fingers of the other hand gives resistance during flexion over the palmar surface of the patient's fingers, and during extension upon their dorsal surfaces. The four medial fingers are worked together, the thumb is treated separately.
Finger rolling— (*a*) Sitting. (*b*) Half lying.	Metacarpo-phalangeal.	No active muscle work.	To increase mobility and improve the circulation. Is given in the cases enumerated above.	Sitting Finger Rolling.—The patient's elbow is supported as in the previous movement. The gymnast fixes the metacarpal bones with one hand, grasps the four fingers with the other, and carries out the rolling or circumduction. The thumb is treated separately.
Wrist flexion and extension— (*a*) Sitting. (*b*) Half lying.	Wrist.	Flexors and extensors of wrist.	The same as in finger flexion and extension.	Sitting Wrist Flexion and Extension.—The patient's elbow rests upon the gymnast's knee as in the preceding movement, or the forearm may rest upon a table. The gymnast grasps the patient's forearm just above the wrist with one hand, to fix it, and grasps the hand over the metacarpal bones with the other. The patient flexes and extends the wrist while the gymnast resists, or the movement may be given passively.
Radial and ulnar flexion— (*a*) Sitting. (*b*) Half lying.	,,	Abductors and adductors of wrist.	,, ,,	Sitting Radial and Ulnar Flexion.—Position and grasp as in the preceding. The patient bends the hand to the radial and ulnar side alternately, while the gymnast resists. Is also given passively.
Wrist rolling— (*a*) Sitting.	,,	No active muscle work.	The same as finger rolling.	Sitting Wrist Rolling.—Position and grasp as in wrist flexion and extension. The wrist is rolled alternately medially and laterally.

Pronation and supination—Sitting, sometimes called forearm twisting.	Radio-ulnar.	Pronators and supinators of forearm.	[illegible] the circulation, mobilises the joints. Used in the same cases as the previous exercises.	[illegible] forearm is bent to a right angle with the upper arm and supported. The gymnast grasps the patient's hand (as in shaking hands) with one hand and the lower end of the forearm with the other, fingers on the flexor aspect and thumbs on the dorsal aspect of the limb. The patient performs supination and pronation under the gymnast's resistance, the wrist being kept straight. To carry it out passively the hand or lower end of the forearm is grasped in one hand and the elbow supported by the other.
Flexion and extension of forearm— (*a*) Sitting. (*b*) Half lying.	Elbow.	Flexors and extensors of forearm.	,, ,,	Sitting Forearm Flexion and Extension.—The gymnast supports the patient's elbow with one hand and grasps the lower end of the forearm with the other. The patient then flexes and extends the forearm while the gymnast resists. It may also be given as a passive movement. It is sometimes given in the back lean standing position, both arms working simultaneously.
Single arm flexion and extension— Sitting.	Shoulder and elbow, acromio-clavicular and sterno-clavicular.	Flexors and extensors of shoulder, and those producing forward and backward movement in the shoulder girdle, and the flexors and extensors of forearm.	,, ,,	Sitting Arm Flexion and Extension.—The patient's forearm is flexed to a right angle with the arm. The gymnast grasps the patient's hand and the arm just above the elbow. The patient extends the forearm, and at the same time flexes the shoulder so that the whole limb is stretched forwards while the gymnast resists; the patient then flexes the forearm, and at the same time extends the shoulder against the gymnast's resistance. Another method is as follows: The patient is in heave B. sitting position; the gymnast grasps the patient's hand and arm as described in the preceding. The arm is then carried forward obliquely across the chest and extended backwards three or four times. Usually given passively.
Double arm swinging forwards and backwards— Standing.	Shoulder, acromio-clavicular and sterno-clavicular joints.	Flexors and extensors of shoulder and those producing forward and backward movement in the shoulder girdle.	To mobilise the joints and improve the circulation. Is an exercise sometimes given in cases of paralysis.	Standing Double Arm Swinging Forwards and Backwards.—This is a free exercise in which the patient swings the arms simultaneously forwards and backwards.

PRINCIPAL MOVEMENTS FOR THE UPPER EXTREMITY—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Arm abduction and adduction—Sitting.	Shoulder; the acromio-clavicular and sterno-clavicular joints also, if the shoulder is stiff.	Abductors and adductors of arm.	To mobilise the joint and exercise and develop the muscles.	SITTING ARM ABDUCTION AND ADDUCTION.—The patient's forearm is flexed to a right angle with the upper arm. The gymnast grasps the patient's arm just above the elbow with one hand and the patient's hand with the other. The patient raises the arm in the frontal plane to the horizontal position while the gymnast gives resistance on the lateral side of the arm; the patient then adducts the arm while the gymnast gives resistance on the medial side of the arm. This movement is frequently carried out with concentric and excentric work for the abductors, and is also given passively.
Double arm raising laterally and sinking downwards—Standing	Shoulder.	Abductors of arm, concentric and excentric.	Expands the chest. Is a mild respiratory movement.	STANDING DOUBLE ARM RAISING LATERALLY AND SINKING DOWNWARDS.—The patient raises the arms sideways to the horizontal plane while breathing in, and lowers them to the sides again while breathing out.
Single arm rolling—Sitting.	Shoulder, sterno-clavicular and acromio-clavicular. The first named only if the acromio-clavicular joint is fixed.	No active muscle work except in maintaining the position.	To increase mobility and improve the circulation. Much used in cases of stiff shoulder.	SITTING SINGLE ARM ROLLING.—This movement can be carried out in two ways:— (*a*) The gymnast grasps the patient's forearm just below the elbow and fixes the acromio-clavicular joint with the other hand, the fingers directed forwards and the thumb backwards. The patient's forearm and hand rests upon the gymnast's forearm, and the latter carries out the movement. By this method the movement is limited to the shoulder joint. (*b*) The patient is in heave B. position; the hand and the arm just above the elbow are grasped by the gymnast, and the rolling carried out. This latter method is used when movement in the shoulder is very limited and it is desirable to increase the mobility of the sterno-clavicular and acromio-clavicular joints, also when the movement is given for circulation.

Arm rotation, or arm twisting laterally and medially— Heave B. sitting.	Shoulder.	Medial and lateral rotators of the shoulder.	Increases mobility, improves the circulation, and exercises the muscles.	HEAVE SITTING ARM ROTATION.—The gymnast supports the patient's arm just above the elbow with one hand and gives resistance at the wrist with the other, while the patient rotates the upper arm alternately laterally and medially. This movement may also be carried out passively.
Arm rotation with staff— Half wing, half yard sitting.	Shoulder and radio-ulnar.	Medial and lateral rotators of the shoulder; pronators and supinators of forearm and flexors of fingers.	,, ,,	HALF WING, HALF YARD SITTING ARM ROTATION WITH STAFF.—The patient grasps the middle part of a short staff, the gymnast holding it at both ends and giving resistance during the movement of rotation. May be carried out passively.
Arm rotation— Half wing, half yard sitting.	,, ,,	,, ,,	,, ,,	HALF WING, HALF YARD SITTING ARM ROTATION.—Same as the preceding, only that the patient and gymnast grasp hands instead of holding a staff. When the patient is rotating the right arm the gymnast resists with the right hand, and *vice versa.* May also be carried out passively.
Double arm lifting upwards and sinking downwards to the horizontal plane— Yard standing.	Shoulder, acromio-clavicular and sterno-clavicular.	Elevators of shoulder girdle, concentric and excentric.	Expands chest and is a respiratory exercise.	YARD STANDING DOUBLE ARM LIFTING UPWARDS AND SINKING DOWNWARDS.—This is a free exercise performed in time with respiration.
Double arm lifting upwards and down pressing— Yard sitting.	,, ,,	,, ,,	Exercises the muscles and expands the chest.	YARD SITTING DOUBLE ARM LIFTING UPWARDS AND DOWN PRESSING.—The gymnast in the step standing position supports the patient's back. The patient raises the arms, palms upwards, to the stretch position, gymnast resisting. The gymnast brings them down to the yard position, patient resisting.
Double arm carrying forwards, upwards, laterally, and downwards— Standing.	,, ,,	Flexors of the shoulder and those producing forward movement in the shoulder girdle, concentric. Elevators of the shoulder girdle, concentric and excentric. Abductors of the arm, excentric. Extensors of the elbows, wrist, and fingers, statically.	Is a good respiratory movement. It expands the chest and exercises the muscles.	STANDING DOUBLE ARM CARRYING FORWARDS, UPWARDS, LATERALLY, AND DOWNWARDS.—This is a free movement and is done slowly in time with respiration. The arms are carried forwards and upwards to the stretch position, palms facing, while the patient breathes in through the nose; they are then carried laterally and downwards to the sides as the patient breathes out through the mouth. When the arms reach the horizontal plane they are rotated medially so that the palms are directed downwards during the last part of the movement. During the forward and upward movement the arms should be slightly more than the width of the shoulders apart.

PRINCIPAL MOVEMENTS FOR THE UPPER EXTREMITY—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Double arm carrying laterally, upwards, laterally, and downwards— Standing.	Shoulder, sterno-clavicular and acromio-clavicular.	Abductors of arm and elevators of shoulder girdle, concentric and excentric.	Is a good respiratory movement. It expands the chest and exercises the muscles.	STANDING DOUBLE ARM CARRYING LATERALLY, UPWARDS, LATERALLY, AND DOWNWARDS.—A free movement performed in time with respiration. In treating patients with heart disease the arms are usually raised only to the horizontal plane.
Double plane arm carrying— (*a*) Yard walk standing. (*b*) Yard stride standing. (*c*) Yard stoop stride standing. (*d*) Yard fall standing. (*e*) Yard leg lean standing. (*f*) Yard leg forward lying.	,, ,,	Extensors of shoulder, excentric and concentric, and those producing backward movement of the shoulder girdle, excentric and concentric.	Expands the chest and strengthens the muscles so that the position of the shoulders is improved in cases of winged scapulæ. Much used both in a general table and in cases of kyphosis.	YARD WALK STANDING DOUBLE PLANE ARM CARRYING.—The patient is in the yard walk standing position, palms directed forwards. The gymnast, in the walk standing position, grasps the patient's wrists (fingers behind, thumbs in front), and carries the arms forwards to the reach position, patient resisting, and the patient then carries the arms backwards to the yard position, gymnast resisting.
Double arm rolling— (*a*) Yard sitting. (*b*) Stretch sitting. (*c*) Stretch half lying. (*d*) Heave sitting.	,, ,,	No active muscle work, except in maintaining the position.	In yard sitting position it is given: (1) Slowly for respiration; (2) quickly for the circulation; (3) as a chest expansion in cases of kyphosis. (In heart cases the arms need not be carried above the horizontal plane.) It is given in stretch sitting or stretch half lying to mobilise the joints. It is given in the heave sitting position to expand the chest, improve the circulation, and to help mobility.	YARD SITTING DOUBLE ARM ROLLING.—The gymnast stands close behind the patient, so as to support the latter's back, grasps the elbows and carries the arms forwards, upwards, backwards, and downwards. When given as a chest expansion, a small cushion should be placed behind the patient's shoulders and kept in position by the gymnast's hip. STRETCH SITTING AND STRETCH HALF LYING DOUBLE ARM ROLLING—The gymnast stands on the back of the plinth or on a stool behind the patient; they grasp each other's thumbs, and the gymnast carries out the rolling rapidly and in small circles. In this position the movement may be followed by double arm flexion and extension. HEAVE A. SITTING DOUBLE ARM ROLLING.—The gymnast stands behind the patient on a stool and gives support with the knee. They then grasp each other's wrists, and the gymnast performs the rolling.

Double arm flexion and extension— (*a*) Stretch standing. (*b*) Stretch stride sitting. (*c*) Stretch stoop stride sitting. (*d*) Stretch lying. (*e*) Stretch half lying. (*f*) Stretch sit lying. (*g*) Stretch leg forward lying.	Shoulder, acromio-clavicular, sterno-clavicular, and elbow.	*During flexion.*—Flexors of the fingers and elbow. Adductors of the arm. Depressors of the shoulder girdle. Those drawing the scapula backwards (rhomboidei, trapezius, and latissimus dorsi). *During extension.*—Flexors of the fingers. Extensors of the elbow. Abductors of the arm. Elevators of the shoulder girdle. Those drawing the scapula forwards (serratus magnus, pectorales).	Is a good exercise for the arm and shoulder muscles. Helps respiration. Stretches the spine, and is employed in treating curvature. Is strongly depleting from the viscera.	Stretch Standing Double Arm Flexion and Extension.—The patient flexes and extends the arms in time with respiration. In the *stretch stride sitting*, *stretch lying*, *stretch half lying*, and *stretch sit lying* positions the gymnast stands behind the patient; they grasp each other's hands, or the gymnast uses the thumb grasp, and resistance is made while the patient flexes and extends the arms. When given for respiration, no resistance is given. It may be carried out as a free or passive movement. When given for scoliosis, resistance is only given during flexion.
MOVEMENTS FOR THE LOWER EXTREMITY				
Foot rolling (single)— Half lying.	Ankle.	No active muscle work.	Is used after massage of the foot and leg to improve the the circulation and, in cases of stiffness in the ankle joint, to increase mobility.	Half Lying Single Foot Rolling.—The gymnast sits on a stool beside the patient. The leg of the latter rests upon the gymnast's knees. The gymnast steadies the leg just above the ankle with one hand and grasps and circumducts the foot with the other. The movement should be as extensive as possible and may be repeated from ten to twenty times, first in the medial and then in the lateral direction.
Foot rolling (double)— Half lying.	Ankle. Hip joint slightly.	" "	" "	Half Lying Double Foot Rolling.—The patient's feet rest, about 12 inches apart, upon a stool. The gymnast, in half kneeling position in front, grasps a foot with each hand and performs, first, medial circumduction with each foot simultaneously, and then lateral circumduction, from ten to twenty times in each direction.
Foot rolling (double)— (*a*) Half lying. (*b*) Sitting.	Ankle.	Muscles of the leg.	Exercises all the muscles of the leg. Increases mobility in the ankle joints and improves the circulation of the feet and legs.	Half Lying or Sitting Double Foot Rolling.—A free movement in which the patient half lies or sits with the legs extended and the feet crossed. When the right foot is uppermost the movement of circumduction is carried out towards the left, and when the left foot is uppermost towards the right. From ten to twenty times each way.

MOVEMENTS FOR THE LOWER EXTREMITY—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Plantar and dorsi flexion of the foot (single)— (*a*) Half lying. (*b*) Sitting.	Ankle.	Plantar and dorsi flexors of the foot, concentric or excentric, or concentric and excentric for either group.	Given to exercise the muscles and improve the circulation. In cases of paralysis may be given excentrically and concentrically for one group only.	HALF LYING OR SITTING PLANTAR AND DORSI FLEXION OF FOOT.—The gymnast supports the patient's leg on her knees, clasps her hands round the foot, and gives resistance on the dorsal and plantar aspects during dorsal and plantar flexion respectively. From three to six times. This movement may also be carried out passively.
Plantar and dorsi flexion of foot (double)— (*a*) Half lying. (*b*) Sitting.	,,	Plantar and dorsi flexors of foot.	,, ,,	HALF LYING OR SITTING DOUBLE FOOT PLANTAR AND DORSI FLEXION.—The patient's legs are extended, and the heels are supported on a stool. The gymnast, in half kneeling position in front, places the fingers on the dorsal and the thumb on the plantar aspect of each foot. The patient performs the movements of plantar and dorsi flexion while the gymnast resists. The movement should end with dorsi flexion. This movement may also be carried out passively.
Plantar and dorsi flexion of the foot (single)— High reach grasp standing.	,,	,, ,,	In this position the weight of the body on the heel fixes the limb and isolates the movement.	HIGH REACH GRASP STANDING PLANTAR AND DORSI FLEXION OF THE FOOT.—The patient stands on a stool and grasps the rib stool or boom with both hands. The heel of one foot is placed upon the edge of the stool so that plantar flexion can be fully carried out. The gymnast, in half kneeling position beside the patient, steadies the heel with one hand and gives resistance with the other while the patient performs the movement. From three to six times.
Alternate plantar and dorsi flexion of the foot (double)— Standing.	,,	,, ,,	An easy balance movement.	STANDING ALTERNATE PLANTAR AND DORSI FLEXION. —A free movement in which the patient stands alternately on the toes and heels. It may at first be carried out in the reach grasp position.
Inversion and eversion of foot— Half lying.	Transverse tarsal chiefly.	Invertors and evertors of foot.	Inversion is given concentrically and excentrically for flat foot. Eversion concentrically and excentrically for talipes varus.	HALF LYING FOOT INVERSION AND EVERSION.—The gymnast sits on a stool and supports the patient's leg on her knees. The foot is grasped with both hands, fingers on the plantar and thumbs on the dorsal aspect, in such a way that the medial and lateral edges of the foot rest in the fork made between the fingers and thumb of each hand. The foot should be in the dorsi flexed position throughout the exercises. The patient performs the move-

				... of inversion or eversion while the gymnast resists; the latter then carries the foot back to the mean position while the patient resists. From three to six times. This movement may also be carried out passively.
Inversion of foot— Close standing.	Chiefly transverse tarsal.	Invertors of foot.	Used in cases of flat foot.	Close Standing Foot Inversion.—The patient stands on the lateral sides of the feet, which should be parallel and close to each other. The toes should be flexed. The position is maintained for a short time and then taken again.
Knee flexion and extension (usually called knee pumping)— (*a*) Half lying. (*b*) Sitting.	Knee.	No active muscle work.	Improves the circulation and is used in cases of stiff joints to promote mobility; also in paralysis to prevent contractions and to help the circulation.	Knee Pumping.—If the right leg is to be flexed and extended, the gymnast sits on a stool on the right-hand side of the patient; she then supports the latter's thigh upon her own left knee, places her left hand above the patient's knee to steady it, while her right hand grasps the leg above the ankle, and carries out the movement. Ten to fifteen times rather quickly. To flex and extend the left leg, the position of the gymnast is reversed.
Knee flexion and extension— (*a*) Half lying. (*b*) Sitting.	,,	Flexors and extensors of knee, concentric, or may be performed concentrically and excentrically.	Strengthens the muscles involved. Used after massage of the thigh. Draws blood from the head and upper part of the body.	Half Lying or Sitting Knee Flexion and Extension.—The position and grasp is the same as in the preceding. The patient extends and flexes the leg while the gymnast resists above the ankle. May be performed from three to six times.
Knee flexion and extension— Wing half sitting.	,,	,, ,,	Same as the preceding but more difficult, as the origin and insertion of rectus femoris are nearer to each other than in the half lying position.	Wing Half Sitting Knee Flexion and Extension.—The patient stands on one leg and places the thigh of the working limb across the high plinth with the leg hanging down. The gymnast stands beside the patient, fixes the thigh, just above the knee, with one hand and gives resistance above the ankle with the other. From three to six times.
Knee flexion and extension (double)— Forward lying.	,,	,, ,,	Suitable for children. The trunk is well fixed in this position.	Forward Lying Double Knee Flexion and Extension.—The gymnast stands beside the patient, fixes the thighs just above the knee joints with one hand and gives resistance above the ankles with the other. From three to six times.
Knee flexion and extension (double)— Sit lying.	,,	,, ,,	This position makes the exercise easier. As both legs are working, more blood is drawn from the upper part of the body.	Sit Lying Double Knee Flexion and Extension.—The gymnast stands beside the patient, places one hand across both knees to fix them, and gives resistance with the other above the ankles. From three to six times.

MOVEMENTS FOR THE LOWER EXTREMITY—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Leg updrawing (single)—Half lying.	Hip and knee.	Flexors of hip and knee, concentric and excentric.	Strengthens the flexors of the hip and knee. Is used in a general table and for constipation.	HALF LYING SINGLE LEG UPDRAWING.—The gymnast stands beside the patient, places one hand on the patient's knee and grasps the ankle with the other. The patient draws the knee upwards and slightly laterally while the gymnast gives resistance both at the knee and the ankle. The gymnast then draws the leg down to the starting position while the patient resists. Three or four times.
Leg updrawing (double)—Half lying.	Hip and knee and lumbar spine.	Flexors of the hip and knee and lumbar spine, concentric and excentric.	Same as the above but stronger, owing to the double muscle work. Is used for lordosis.	HALF LYING DOUBLE LEG UPDRAWING.—The gymnast stands in front of the patient and grasps both ankles. The patient draws both knees up and slightly laterally towards the shoulders while the gymnast resists; the latter then draws the legs downwards while the patient resists. Three or four times.
Leg updrawing (single)—Stretch grasp lying.	Hip and knee.	Flexors of hip and knee, concentric and excentric.	This position fixes the trunk and is suitable for children.	STRETCH GRASP LYING SINGLE LEG UPDRAWING.—Same as half lying single leg updrawing.
Leg updrawing (double)—Short sitting.	Hip, knee, and lumbar spine.	Flexors of hip, knee, and lumbar spine, concentric and excentric.	Given in cases of lordosis.	SHORT SITTING DOUBLE LEG UPDRAWING.—Performed with two gymnasts. The patient sits on the edge of the end of the high plinth. One gymnast sits astride the plinth behind the patient and gives support by passing both arms round the trunk of the latter. The other gymnast grasps the patient's ankles. The movement is carried out with concentric and excentric work for the muscles as in half lying double leg updrawing.
Leg outstretching—Hook half lying.	Hip and knee.	Extensors of hip and knee, concentric, and excentric also if the patient resists while the gymnast bends the leg. The lower part of sacro-spinalis works statically to fix the pelvis.	Is a good exercise for the extensors, and can be modified to suit the patient. Used in general strengthening treatment and for weakness of the extensor muscles.	HOOK HALF LYING LEG OUTSTRETCHING.—To work the extensors of the left hip and leg the gymnast stands in the fall out position on the left side of the patient. The right hand is placed underneath the patient's left heel; the forearm supports the leg, and the shoulder rests against the patient's knee. The left hand grasps the foot. The patient extends the leg while the gymnast resists; the gymnast then bends the leg while the patient either remains

Hip downpressing and raising— Wing knee standing.	”	Extensors of the hip and knee, excentric and concentric. In this movement the origins and insertions of the above muscles are reversed, the former representing the movable attachment.	Is a stronger exercise than the preceding. Owing to the position, the weight of the body is added to the resistance offered by the gymnast.	WING KNEE STANDING HIP DOWNPRESSING AND RAISING.—The patient kneels upon the low plinth. The gymnast stands behind and places the hands upon the patient's hips. The patient resists while the gymnast presses the hips downwards so that the thighs are flexed upon the legs; the gymnast resists while the patient rises to the kneeling position.
Heel raising and knee bending— (*a*) Reach grasp standing. (*b*) Wing standing. (*c*) Neck firm standing. (*d*) Stretch standing. (*e*) Stretch grasp standing. (*f*) Toe support standing. (*g*) Stretch grasp arch swing toe support standing.	Hip, knee, and ankle.	Extensors of the hip and knee, excentric and concentric. Plantar flexors of the ankle, concentric and excentric during parts 1 and 2 of the movement respectively (see description), and again concentric and excentric during parts 3 and 4 respectively (see description). The extensors of the spine and neck work statically to keep the back straight and the head erect.	Is a good exercise for the muscles and for co-ordination of movement. Is given in a general table in the first four positions. It should be given in the reach grasp position for beginners to help to balance, and also for patients who need support and cannot take it as a free exercise. It is given in the stretch grasp standing position for scoliosis; in the toe support standing position it gives stronger work for the muscles as the weight of the body falls on one leg only, and in the stretch grasp arch swing toe support standing to take blood to the pelvis in certain cases of amenorrhœa.	HEEL RAISING AND KNEE BENDING.—REACH GRASP STANDING HEEL RAISING AND KNEE BENDING.—The patient places both hands upon the rib stool or boom, then (1) raises the heels, (2) bends the knees laterally, (3) extends the knees, and (4) sinks the heels. The back should be kept straight and erect during the movement, and the head held in a good position. WING STANDING HEEL RAISING AND KNEE BENDING.—A free movement. As no support is given, the exercise is more difficult, and is a good balance movement. NECK FIRM AND STRETCH STANDING HEEL RAISING AND KNEE BENDING.—The movement taken in these positions is more difficult than in the preceding, as the centre of gravity, normally a point between the third and fourth sacral vertebræ, is raised. STRETCH GRASP STANDING HEEL RAISING AND KNEE BENDING.—The gymnast, standing on a stool behind the patient, grasps the latter's hands and gives slight resistance to the movement. The exercise in this position is useful in scoliotic cases to influence and correct the carriage of the trunk and head. TOE SUPPORT STANDING HEEL RAISING AND KNEE BENDING.—The patient stands upon the leg which is to be exercised and supports the toes of the other upon a stool behind. STRETCH GRASP ARCH SWING TOE SUPPORT STANDING HEEL RAISING AND KNEE BENDING.—The gymnast stands on a stool behind the patient and grasps the latter's hands. As the patient extends the knees the gymnast swings the trunk forwards and then arches it backwards.

MOVEMENTS FOR THE LOWER EXTREMITY—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Leg forward drawing—Back lean standing.	Hip.	Extensors of hip, excentric and concentric.	Strengthens the extensor group and is depleting from the pelvis. May be used in a general table or for special weakness in the working muscles.	BACK LEAN STANDING LEG FORWARD DRAWING.—The patient stands with the back resting against the rib stool. To move the right leg the gymnast stands on the right-hand side and somewhat in front of the patient, places the left hand upon the patient's left hip to steady it, and grasps the patient's right leg just above the ankle with the right hand. The patient resists while the gymnast draws the right leg forwards, and the gymnast resists while the patient carries it back to the starting position. To move the left leg the position of the gymnast is reversed. From three to six times for each leg.
Leg outward carrying and impressing—High reach grasp standing.	Hip and lumbar spine.	Abductors of moved leg, concentric and excentric. Abductors of standing leg, concentric and excentric. Side flexors of lumbar spine on the side of the moving leg, concentric and excentric.	Used in the treatment of lumbar scoliosis for one side only, the moving leg being that on the side of the lumbar convexity.	HIGH REACH GRASP STANDING LEG OUTWARD CARRYING AND IMPRESSING.—The patient stands on a stool with arms stretched forwards and the hands grasping the boom or rib stool. The gymnast stands behind, places one hand upon the hip of the side of the moving leg, the other grasps the latter just above the ankle. The patient abducts the leg while the gymnast gives resistance on the lateral side of the leg; the gymnast then carries the leg back to the starting position while the patient resists.
Leg twisting or rotation (single)—Half lying.	Hip.	Medial and lateral rotators of the hip, concentric, or concentric and excentric for each group.	Exercises the muscles and increases mobility.	HALF LYING SINGLE LEG ROTATION.—The gymnast grasps the foot with one hand and the ankle with the other as in foot rolling, and gives resistance as the patient alternately rotates the hip medially and laterally. The leg should be extended at the knee joint during the movement and the foot kept in the position of dorsi-flexion.

Leg carrying in circles—High reach grasp standing.	Hip and lumbar spine.	Circumductors of the thigh. Side flexors of the lumbar spine on the side of the moving leg.	Exercises the muscles, improves the circulation, and increases mobility. Is used in general strengthening treatment.	HIGH REACH GRASP STANDING LEG CARRYING IN CIRCLES.—The patient, standing on a stool with the hands grasping the boom, carries the leg in a circular direction forwards, laterally, backwards, and medially several times. It is also given with resistance for stronger muscle work. In this case the gymnast stands behind the patient and grasps the leg just above the ankle with both hands, giving resistance first in front, then on the lateral, back, and medial sides of the leg as the patient carries the limb forwards, laterally, backwards, and medially as in the preceding.
Leg rolling (single)—Half lying.	Hip and knee.	No active muscle work.	It promotes mobility, improves the circulation, and brings blood to the abdomen and pelvis. It increases peristalsis, and is used in cases of constipation.	HALF LYING SINGLE LEG ROLLING.—The gymnast stands beside the patient, grasps the foot with one hand, and places the other under the upper part of the leg. The movement is then carried out in one of the following ways, according to the effect aimed at:— 1. *For mobility.*—The gymnast describes small circles with the knee, while at the same time circumducting the thigh both medially and laterally, and making the movement as extensive as possible. 2. *For circulation.*—The thigh is circumducted in the lateral direction only, and is not carried over the median line of the body. 3. *To affect the abdominal organs.*—The thigh is circumducted in the lateral direction only, and is strongly flexed upon the abdomen in the upward movement. In performing this movement in any of the above ways the gymnast should be careful to move the patient's foot up and down in the sagittal plane only and not in a circular direction; also, a constant pull should be kept upon the thigh throughout the movement.

MOVEMENTS FOR THE LOWER EXTREMITY—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Leg abduction and adduction (double or single)—Half lying.	Hip.	Abductors and adductors of the hip, concentric, or concentric and excentric for either group.	Is used in a general table to strengthen the working muscles, and, with specially adapted resistance, as a corrective exercise for knock-knee. Abduction concentric and excentric is depleting from the pelvis. Adduction concentric and excentric is repleting to the pelvis.	HALF LYING SINGLE OR DOUBLE LEG ABDUCTION AND ADDUCTION.—Two gymnasts stand in the walk position on either side of the patient and facing each other. The patient's legs are extended. Each gymnast grasps one leg at the ankle and holds it against her thigh, just above the knee. Resistance is given by each gymnast with the thigh on the lateral side of the ankle, during abduction, and with the hand, on the medial side of the ankle, during adduction. This movement may be given by one gymnast, who then stands facing the patient, grasps both ankles, and gives resistance while the patient abducts and adducts the leg. Abduction concentric and excentric and adduction concentric and excentric are given, when it is desirable to exercise one group to the exclusion of the other. The position and grasp are then the same as in the foregoing. HALF LYING DOUBLE LEG ABDUCTION AND ADDUCTION FOR KNOCK KNEE.—Performed with two gymnasts, who support the patient's ankles upon their thighs, as before described, with one hand; the other hand is placed on the medial side of the patient's knee. The latter abducts the legs while the gymnasts resist on the lateral side of the ankles; the patient adducts the legs while the gymnasts resist on the medial side of the knees.
Leg abduction and adduction (double)—Hanging.	,,	Abductors and adductors of the hip; (also arm and shoulder muscles to maintain the position).	Used in cases of curvature. The ligaments and muscles of the spine are stretched owing to the position.	HANGING DOUBLE LEG ABDUCTION AND ADDUCTION.—The patient in the fundamental hanging position abducts and adducts the legs. In cases of lumbar curvature both legs are carried to the side of the convexity.

Knee abduction and adduction double— Hook half lying.	,,	Abductors and adductors of the hip, concentric, or concentric and excentric for either group.	Is used concentrically for both groups in general strengthening treatment as a good exercise for the muscles; and for patients during the lying-in period to tone up the muscles and to improve the circulation through the pelvis. Abduction concentric and excentric is employed to relieve congestion of the pelvic organs; adduction concentric and excentric to draw blood to the pelvis as in cases of amenorrhœa.	Hook Half Lying Double Knee Abduction and Adduction.—The gymnast stands either in front of or beside the patient and gives resistance, during abduction on the lateral, and during adduction on the medial side of the patient's knees. From three to six times. Hook Half Lying Double Knee Abduction, Concentric and Excentric.—The patient abducts the knees while the gymnast resists on the lateral side of each knee; the patient resists while the gymnast carries the knees towards each other. Hook Half Lying Double Knee Adduction, Concentric and Excentric.—The patient adducts the knees while the gymnast gives resistance on the medial side of each knee; the patient resists while the gymnast separates the knees.
Pelvic raising— Hook lying. (Frequently combined with knee abduction and adduction, or with knee abduction concentric and excentric, and knee adduction concentric and excentric.)	Hips and lumbar spine.	Extensors of hip and lumbar spine, concentric and excentric, or, if the position is maintained, statically. (If combined with knee abduction and adduction, the abductors and adductors of the hip also work.)	Improves the position of the viscera in cases of enteroptosis. Draws blood from the abdomen and pelvis especially when combined with knee abduction concentric and excentric. Combined with knee adduction the depleting effects are somewhat counteracted. Is used for patients during the lying-in period to relieve congestion, and in conjunction with knee abduction and adduction to tone up the structures of the pelvic cavity.	Hook Lying Pelvic Raising.—The patient lies upon her back with the knees bent and the feet resting on the bed. The sacrum is then raised so that the upper part of the back, the head, and the feet only are supported. Repeat from three to six times. Pelvic Raising and Knee Abduction and Adduction.—The patient raises the sacrum and at the same time abducts the knees, the patient then lowers the body while adducting the knees. The abduction and adduction may be performed either with or without resistance.
Alternate knee upward bending— Wing standing.	Hip.	Flexors of the hip, concentric and excentric. Extensors of the spine statically, to keep the body upright. Abdominal muscles statically.	An excellent balance movement, much used in a general or special table to cultivate coordinate movement. Is also a good exercise for the muscles. It helps peristalsis, and is therefore given for constipation.	Wing Standing Alternate Knee Upward Bending.—The patient flexes each hip joint alternately, raising the knee as high as possible. The leg and foot hang passively downwards. This movement may at first be carried out in the reach grasp standing position to help to balance.

MOVEMENTS FOR THE LOWER EXTREMITY—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Knee updrawing and downpressing (single)— (*a*) Half lying. (*b*) Stretch grasp standing. (*c*) Back lean standing.	Hip.	Flexors of the hip, concentric and excentric, and abdominal muscles statically.	Is used in treating constipation, as it is repleting to the abdomen and helps peristalsis. It is a strong movement, and renders respiration somewhat difficult, so should only be used for strong patients.	Half Lying Knee Updrawing and Downpressing.—The gymnast stands beside the patient and places one hand upon the latter's shoulder and the other upon the knee of the same side. The patient then flexes the hip and draws the knee up as high as possible and slightly laterally towards the shoulder while the gymnast resists; the latter then presses the knee downwards under the patient's resistance. In the *stretch grasp standing* and *back lean standing* positions the patient stands against the rib stool, and the movement is carried out as above.
Knee updrawing and downpressing (double)— (*a*) Lying. (*b*) Half lying. (*c*) Stretch grasp lying. (*d*) Stretch grasp standing. (*e*) Hanging.	Hip and lumbar spine.	Flexors of the hip, concentric and excentric. Abdominal muscles, concentric and excentric.	Same as the preceding, but as both legs are working it is a stronger exercise, and is also a good corrective movement for lordosis.	Double Knee Updrawing and Downpressing.—Carried out as in the preceding, but both legs are working simultaneously. The positions in which it may be given are enumerated in the first column in the order of difficulty, the first named being the easiest. From three to four times.
Knee updrawing and leg outstretching (double)— Stretch grasp lying.	Hip, lumbar spine, and knee.	In knee updrawing the flexors of the hip, concentric, and abdominal muscles, concentric. In leg outstretching the abdominal muscles, excentric, extensors of the leg first concentric then excentric. Flexors of the hip, excentric.	Same as the preceding, but there is more extensive muscle work as the extensors of the legs are working.	Stretch Grasp Lying Double Knee Updrawing and Leg Outstretching.—The patient lies with the arms extended above the head and grasping a support. The knees are first drawn up as in the preceding, then extended and lowered slowly to the couch or plinth. About three times.

Leg lifting (single)— (*a*) Lying (*b*) Stretch grasp lying.	Hip.	Flexors of hip, concentric and excentric. Abdominal muscles statically. Vasti medialis, lateralis, and intermedius statically to keep the leg extended.	To strengthen the muscles and to promote peristalsis. Is repleting to the abdomen and pelvis. Used for patients who are not strong enough to raise both legs together.	Lying Single Leg Lifting.—The patient lies on a couch or plinth. The leg is lifted as high as possible and then slowly lowered to the supporting surface. The knee should be kept fully extended throughout the movement, which may be repeated three or four times for each limb. Stretch Grasp Lying Single Leg Lifting.—Given in this position for children, to fix the trunk.
Leg lifting (double)— (*a*) Lying. (*b*) Stretch grasp lying.	Hip and lumbar spine.	Flexors of hip, concentric and excentric. Abdominal muscles, concentric and excentric. Vasti medialis, lateralis, and intermedius statically to keep the knee extended.	Is a stronger exercise than the preceding. Is used for constipation and as a corrective exercise for lordosis. May be given after arch leg forward lying to counteract the forward bending in the lumbar spine which this movement tends to produce.	Lying Double Leg Lifting.—Same as the preceding, but both legs are lifted together.
Leg lifting and downpressing (single)— Lying. Stretch grasp lying.	Hip.	Flexors of hip, concentric and excentric. Abdominal muscle statically. Vasti medialis, lateralis, and intermedius statically to keep the leg extended.	Same as single leg lifting, but stronger.	Lying or Stretch Grasp Lying Single Leg Lifting and Downpressing.—The patient raises the leg as described in single leg lifting while the gymnast gives resistance over the front of the ankle with one hand. The gymnast then presses the leg downwards to the starting position while the patient resists. About three times for each leg.
Leg lifting and downpressing (double)— Lying. Stretch grasp lying.	Hip and lumbar spine.	Flexors of hip, concentric and excentric. Abdominal muscles, concentric and excentric. Vasti medialis, lateralis, and intermedius statically to keep the knee extended.	Same as double leg lifting, but the effects are stronger.	Lying or Stretch Grasp Lying Double Leg Lifting and Downpressing.—The patient raises both legs while the gymnast gives resistance over the ankles; the latter then presses the legs downwards while the patient resists. May be repeated about three times.

MOVEMENTS FOR THE HEAD AND NECK

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Head extension— Reach grasp standing. Reach grasp sitting. Stretch leg forward lying. Lying. Heave grasp standing. Hanging. Arch hanging.	Occipito-atlantoid and cervical.	Extensors of the head and cervical spine, concentric and excentric.	Increases mobility, strengthens the working muscles, and improves the carriage of the head. Is depleting from the head.	In the REACH GRASP STANDING and REACH GRASP SITTING positions the gymnast stands beside the patient and places one hand upon the upper part of the forehead and the other upon the occiput. The patient extends the head while the gymnast resists. The gymnast then bends it forwards while the patient resists. In performing this movement the chin should be kept in until the end of the first part, so that the joints of the cervical spine are extended before the atlanto-occipital joint. In forward flexion the chin is drawn in first. The most comfortable way of grasping the head in the preceding positions is as follows: The gymnast's thumb is abducted, the palm of the hand is directed downwards, and the forehead and base of the skull are supported in the fork thus made by the thumb and forefinger of each hand. Head extension is much given in the reach grasp standing and sitting positions, as the trunk is firmly fixed. In STRETCH LEG FORWARD LYING the gymnast stands in front of the patient in the walk-standing position; the patient places the hands upon the gymnast's shoulders or hips for support. The gymnast gives resistance to the movement upon the back of the head with both hands. The movement is carried out in this position for scoliosis. In LYING HEAD EXTENSION the patient lies with the back supported on a plinth, and the head and neck beyond the edge. The gymnast sits behind and gives resistance on the back of the head with two hands during the extension. It is given in this position for children. HEAVE GRASP STANDING HEAD EXTENSION.—Taken between two upright poles. The gymnast stands in front with the forearms resting upon the patient's shoulders and the hands placed one upon the other

				on base of the patient's occiput. The trunk is well fixed in this position. In Hanging and Arch Hanging Head Extension the gymnast stands beside the patient, places one hand on the base of the occiput and the other in front upon the waist to steady the patient. The movement is given in this position for scoliosis.
Head side flexion and upward raising— Free standing. Crutch standing. Speech grasp standing. Reach grasp standing. Reach grasp sitting. Lying.	Cervical	Those producing lateral movement of the head and cervical spine. The trapezius, levator scapulæ, and rhomboid muscles (with the shoulder fixed) effect lateral movement and rotation in the cervical spine to some extent.	Increases mobility, exercises the working muscles, and stretches the ligaments and muscles of the opposite side. Used in cases of stiff neck. Given to one side only in cases of a lateral curve in the cervical region. Is depleting from the head.	Free Standing Head Side Flexion.—This is a free movement in which the patient bends the head sideways to left and right alternately. No rotation should be allowed. Crutch Standing and Speech Grasp Standing.—These positions are used in cases of scoliosis in the cervical region when the movement is carried out to one side only. The gymnast stands behind the patient and places the hands on either side of the latter's head above the ears, using the grasp described in head forward flexion (palms downwards, fingers directed forwards and the thumbs backwards). The patient bends the head towards the side of the cervical convexity while the gymnast resists. The gymnast raises the head to the erect position again while the patient resists. In the *reach grasp standing and sitting* positions the movement can be carried out in the following ways:— (1) With concentric work for the muscles of both sides. The patient bends the head to each side alternately while the gymnast resists. (2) With concentric and excentric work for the muscles on the same side as that towards which flexion takes place. The patient bends the head sideways while the gymnast resists. The gymnast raises the head while the patient resists. (3) With excentric and concentric work for the muscles on the opposite side to that towards which flexion takes place. The gymnast bends the head sideways while the patient resists; the patient then raises the head while the gymnast resists. Lying Head Side Flexion.—The patient lies as in lying head extension, and bends the head alternately to left and right.

MOVEMENTS FOR THE HEAD AND NECK—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Head rotation— Standing. Reach grasp standing. Reach grasp sitting. Lying.	Atlanto epistropheal and cervical.	Rotators of the head and cervical spine.	To mobilise the joints and exercise the muscles. Employed in cases of stiffness, and for weak muscles. Depleting from the head.	The movement is taken as a free one in the STANDING and LYING positions. In REACH GRASP STANDING and REACH GRASP SITTING the gymnast stands behind the patient and grasps the head as in head side flexion. The movement of rotation, with concentric and excentric work for the muscles, can be carried out as described for head side flexion. It can also be given passively.
Head rolling— Hips firm standing. Reach grasp standing. Reach grasp sitting. Lying.	Occipito-atlantoid and cervical.	Flexors and extensors of head and cervical spine, also those concerned in the lateral movement of the head and cervical spine.	To mobilise the joints concerned and to exercise the muscles and improve the circulation. Is given in cases of stiffness and sometimes for insomnia. It is depleting from the head.	HIPS FIRM STANDING HEAD ROLLING.—This is a free movement in which the patient circumducts the head several times towards the left and then several times towards the right. The movement should be as extensive as possible, and no rotation allowed. REACH GRASP STANDING AND SITTING HEAD ROLLING.—This is a passive movement in which the gymnast stands behind the patient, grasps the sides of the head as in head side flexion, and performs circumduction. LYING HEAD ROLLING.—A free movement. The position of the patient is the same as in lying head extension.

MOVEMENTS FOR THE TRUNK

A. PASSIVE

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Chest lifting— (*a*) Sitting. (*b*) High ride sitting.	Costo-vertebral, costo-sternal, sterno-clavicular, and acromio-clavicular.	Inspiratory.	Is an excellent respiratory movement which can be modified for weak patients. Mobilises the joints of the thorax, expands the chest. Is used in heart cases and in diseases of the chest.	Sitting Chest Lifting.—The gymnast stands behind the patient and gives support with the hip of one side. A cushion may be placed behind the patient's shoulders as well. The hands are passed over the patient's shoulders and placed under the armpits so that the fingers are directed backwards. As the patient takes a deep breath the chest is lifted and the shoulders are carried back by the gymnast. Care should be taken to support the back firmly during the lifting and carrying back, so as to expand the chest and not draw the whole trunk back. The shoulders are lowered as the patient breathes out. High Ride Sitting Chest Lifting.—Same as the above, except that the gymnast's grasp is somewhat different, the hands being placed under the patient's armpits from behind, with the fingers directed forwards; also the support is given with the gymnast's chest instead of the hip.
Chest lifting in different planes— Sitting.	,, ,,	,,	Same as the above; but, owing to the turn position, mobility in the joints is increased, and the chest and lungs are more completely influenced.	Sitting Chest Lifting in Different Planes.—The movement is given as described above in sitting chest lifting. The patient sits first facing forwards, then turns the trunk to either right or left, and the movement is repeated.
Chest lift stroking— Half lying.	Costo-vertebral and costo-sternal.	,,	Is a gentle respiratory movement in which pressure of varying degrees can be given over the ribs to help expiration. It is given in cases of emphysema with firm pressure.	Half Lying Chest Lift Stroking.—The gymnast stands in front or on the right-hand side of the patient and places both hands high up under the back. During inspiration the patient is lifted slightly upwards and forwards, and the gymnast then draws the hands down the back and forwards over the lower part of the sides of the chest, finishing with a suitable degree of pressure over the front of the ribs as the patient breathes out.

MOVEMENTS FOR THE TRUNK—*(continued)*

A. PASSIVE—*(continued)*

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Chest expansion— (*a*) Neck firm standing. (*b*) Heave grasp standing. (*c*) Stretch grasp standing. (*d*) Heave sitting. (*e*) Long sitting. (*f*) High ride sitting.	Costo-vertebral, costo-sternal, acromio-clavicular, and sterno-clavicular.	No active muscle work.	It is given strongly to expand the chest in cases of kyphosis and flat chest, and it also draws the shoulder blades back into a good position. It may be used as a respiratory exercise, but in this case the expansion should not be a forcible one.	Neck Firm Standing Chest Expansion.—The gymnast stands behind the patient and gives support to the back with her own chest; a cushion may be placed between to increase the expansion. The gymnast then grasps the patient's elbows and draws them backwards during inspiration. This movement is repeated several times with short pauses between. Heave Sitting Chest Expansion.—The gymnast stands behind and supports the patient with one hip, or a cushion may be placed between the gymnast and the patient. They grasp each other's elbows, and the gymnast draws the patient's arms backwards several times. Heave Grasp Standing Chest Expansion.—The patient stands between, and grasps, two upright poles. The gymnast, standing behind in the fall out position, places one hand between the patient's shoulders, the other grasps a strap which is placed round the patient's thighs. The gymnast then pushes the patient forward, and at the same time fixes the latter's pelvis by keeping a strong pull on the strap. This movement should be repeated several times with short intervals between. Long Sitting Chest Expansion.—The expansion is given in this position in cases of lordosis, as it prevents any extra forward movement in the lumbar spine during the expansion. The patient's arms may be in either the neck firm or heave position. A cushion is placed behind the patient's shoulders, and support is given behind by the gymnast's knee. The grasp and movement is the same as in neck firm standing or heave sitting.

Trunk rolling— Wing high ride sitting.	Spine, chiefly lumbar. Hip joints to some extent.	„	„	Increases mobility, and is used for this reason in cases of curvature in the lumbar region. It improves the circulation, especially that of the portal system, stimulates the secretion of digestive juices, and increases peristalsis by direct mechanical pressure. It is therefore used for diseases of the digestive system. It helps respiration if the trunk is not carried too far back.	WING HIGH RIDE SITTING TRUNK ROLLING.—The patient sits astride on the high plinth with the thighs fixed by a strap. The gymnast stands behind the patient, with the right hand on the latter's right shoulder and the left upon the sacrum. The gymnast then makes a large circle with the patient's trunk, moving it forwards and to the left, backwards and to the right, several times. The gymnast then changes the position of the hands, placing the left hand on the patient's left shoulder and the right hand on the sacrum, and repeats the movement in the reverse direction. It is easier to carry out this movement with the help of a second gymnast.
Side wringing, or wringing in the frontal plane— Hips firm high ride sitting.	Spine.	„	„	Promotes cellular activity in the lungs. Loosens mucus. Is used in treating emphysema. Has a sedative effect, and so is given in cases of insomnia.	HIPS FIRM HIGH RIDE SITTING SIDE WRINGING is carried out by two gymnasts, who stand behind the patient on each side. The gymnast on the right grasps the right arm of the patient near the shoulder with the right hand, and places the left upon the side of the patient's chest under the armpit on the left side. The gymnast on the left places his hands in a similar way on the left arm and under the right armpit. The arms of the two cross behind the patient's back. The patient is then pushed from side to side several times, with a short pause at the limit of each side flexion. There is then an interval of rest, and the movement is repeated.
Forward backward wringing, or wringing in the sagittal plane— Wing long sitting.	„	„	„	Is used in cases of lordosis to stretch the muscles and ligaments in the lumbar region of the back.	WING LONG SITTING WRINGING IN THE SAGITTAL PLANE is performed by two gymnasts, who stand on each side of and slightly behind the patient. The gymnast on the right slips his right arm through the patient's corresponding arm from the front, and grasps the other gymnast's left hand, which has been passed in the same way through the patient's left arm. The free hand of each is placed, one above the other, on the back of the patient's head, with the forearms resting against and supporting the back. The patient is then pushed forwards and pulled backwards several times and somewhat quickly. The movement is repeated after an interval of rest.

MOVEMENTS FOR THE TRUNK—(*continued*)

A. PASSIVE—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Circle turning— Wing high ride sitting.	Intervertebral, costo-vertebral, and costo-sternal. The movement takes place chiefly in the thoracic part of the spine.	No active muscle work.	Helps the circulation and especially that of the portal system. Helps respiration and improves mobility. It is a gentle, comfortable movement, and can be given to weak patients such as heart patients and weak scoliotics.	WING HIGH RIDE SITTING CIRCLE TURNING.—This is a movement combining side flexion and rotation of the spine. The gymnast stands behind the patient and passes the right arm over the latter's right shoulder and under the arm from the front, so that the back of the gymnast's forearm and hand rests against the patient's back. The gymnast's left hand is passed under the patient's left arm and placed upon the front of the latter's left shoulder. The patient's head rests upon the gymnast's right shoulder. The gymnast carries the trunk sideways towards the right, backwards and forwards, so that a circle, or, more correctly speaking, an ellipse, is described. This is repeated several times and then the position of the gymnast's hands is reversed, the patient's head is placed upon the left shoulder and the movement is carried out several times to the left. The side flexion should take place only in the dorsal region, and as the trunk is rotated backwards and carried forwards the gymnast should at the same time slightly lift it upwards. When given as a respiratory movement it is carried out slowly, the patient inhales during the rotation of the trunk and exhales at the completion of the movement. When given for the circulation the movement is carried out more quickly and is more limited in extent. When used to influence the portal circulation especially, a larger ellipse is described and side flexion and rotation are increased. For heart patients the movement should be slowly carried out, so that respiration may not be hindered.

Screw twisting— (a) Wing stoop stride sitting. (b) Wing high ride sitting.	Spine.	" "	Promotes the exchange of gases in the lungs. Stretches adhesions in the pleura and loosens mucus. Increases mobility in the joints of the spine. It is used therefore in treating for emphysema and chronic bronchitis, and also to prevent or stretch adhesions and to improve the general condition after pleurisy. Stimulates the functional activity of the digestive organs.	WING STOOP STRIDE SITTING SCREW TWISTING.—Two gymnasts stand behind the patient. They each place a hand, one above the other, on the patient's back between the shoulder blades, the other hand in each case is placed in front of the shoulder. The trunk is then twisted to left and right alternately from ten to twelve times. A pause is then made and the movement is repeated. The extent and rate of the twistings are gradually increased at the beginning and decreased towards the end. The movement is given in this position to influence the abdominal organs. WING HIGH RIDE SITTING SCREW TWISTING.—The position and grasp of the gymnasts are the same. The movement in this position affects the organs of the thorax more especially.
B. MOVEMENTS GIVING STATIC WORK FOR THE EXTENSORS OF THE SPINE AND ACTIVE WORK FOR THE EXTENSORS OF THE HIP				
Trunk falling forwards and raising— (a) Wing standing. (b) Neck firm standing. (c) Stretch standing.	Hip and spine.	Extensors of the hip, excentric and concentric. Extensors of the spine statically, and at the end of the movement concentrically. The abdominal muscles excentric (when the trunk is arched backwards) and concentric (to raise it to the vertical from the backward position).	Exercises the muscles. Helps respiration. Is depleting from the abdomen and pelvis.	WING STANDING TRUNK FALLING FORWARDS AND RAISING.—This is a free movement in which the patient bends forwards from the hips as far as possible, keeping the spine straight, then raises the trunk and arches it slightly backwards. The patient breathes out during the forward movement and inspires while rising. It is sometimes combined with stretch standing trunk bending forwards and downwards, in which flexion takes place in all the joints of the spine from below upwards. The arms are kept in the same relation to the head throughout the movement. This exercise may be repeated from three to six times. NECK FIRM and STRETCH STANDING positions are used to make the exercise more difficult.

MOVEMENTS FOR THE TRUNK—(*continued*)

B. MOVEMENTS GIVING STATIC WORK FOR THE EXTENSORS OF THE SPINE AND ACTIVE WORK FOR THE EXTENSORS OF THE HIP—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Trunk bending backwards and raising— Wing high ride sitting.	Hip.	Extensors of hip, concentric and excentric. Extensors of spine statically.	Exercises the muscles, and is an easy trunk movement.	WING HIGH RIDE SITTING TRUNK BENDING BACKWARDS AND RAISING.—The gymnast, with arms in the wing position, places her back against that of the patient, and gives resistance as the latter bends the trunk backwards from the hips. The backs must be kept in close apposition so that that of the patient is well supported throughout its entire length. The gymnast bends the knees and stoops forwards in giving the resistance. The patient resists as the gymnast rises to the upright position.
Trunk raising— Yard stoop stride sitting.	,,	,, ,,	Used in cases of kyphosis and winged scapulæ. Is depleting from the abdomen.	YARD STOOP STRIDE SITTING TRUNK RAISING.—This movement is carried out by two gymnasts, who stand beside the patient. They each put a hand, one above the other, upon the patient's back between the shoulder blades, and with the others grasp the patient's wrist. The patient rises from the stoop position while the gymnasts resist at the wrists and on the back. The movement is finished when the patient is in the upright position by carrying the arms of the latter backwards, and giving slight pressure upon the back so as to expand the chest. The patient resists a little as the gymnasts bend the trunk forwards to the stoop position.

C.—MOVEMENT GIVING STATIC WORK FOR THE EXTENSORS OF THE SPINE AND HIP

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Holding— (*a*) Wing leg forward lying. (*b*) Wing arch leg forward lying.	Spine and hip.	Extensors of the hip, back, and neck statically.	Is an excellent corrective position, and is used in treating curvature. Is a strong exercise for the muscles of the back.	WING LEG FORWARD LYING HOLDING.—For description see p. 230. WING ARCH LEG FORWARD LYING HOLDING.—For description see p. 230. This is a specially useful movement in cases of kyphosis and winged scapulæ owing to the strong contractions of the muscles of the back. It should always be followed by half lying double leg updrawing or lying double leg

Trunk raising, with head support— Lax stoop stride sitting.	Hip and spine.	Extensors of the hip, concentric and slightly excentric. Extensors of the spine, concentric and slightly excentric.	Mobilises the joints of the spine. Is a good exercise for the back muscles, and is used in cases of curvature and in general strengthening treatment.	LAX STOOP SITTING TRUNK RAISING WITH HEAD SUPPORT.—The patient is in the lax stoop sitting position with the hands on the upper part of the thighs and the fingers directed medially. The gymnast stands beside the patient, places one hand between the shoulders and the other on the back of the head. The patient raises the trunk to the upright position, helping to do so with the arms while the gymnast resists. The gymnast then bends the trunk forward to the starting position while the patient resists slightly. The patient breathes in after the trunk raising and out during the forward bending. In raising the trunk the movement should take place from below upwards—that is, the pelvis should be extended first, then the vertebræ of the lumbar region and the dorsal and cervical regions in succession. In returning, the reverse order should be observed.
Trunk raising— Lax stoop stride sitting.	”	” ”	” ”	LAX STOOP STRIDE SITTING TRUNK RAISING.—The gymnast stands in front of the patient and places the hand, fingers directed downwards, on either side of the spine in the upper dorsal region. The patient raises the trunk as in the preceding exercise, while the gymnast resists; and at the end of the raising the latter gives firm pressure with the fingers. During the raising and afterwards the patient breathes in and exhales as the trunk is bent again to the stoop position.
Trunk raising, with back stroking— Wing lax stoop stride sitting.	”	” ”	Same as the preceding, but the chest is well expanded. It is therefore a useful movement in treating narrow-chested patients.	WING LAX STOOP STRIDE SITTING TRUNK RAISING WITH BACK STROKING.—The movement is carried out with two gymnasts, who stand on either side of the patient. They each place one hand in front of the patient's shoulders and the other on the back between the scapulæ, one hand above the other. When the patient has raised the trunk to the vertical position the gymnasts pull the shoulders back, at the same time stroking with firm pressure downwards over the spine.

MOVEMENTS FOR THE TRUNK—(*continued*)

D. MOVEMENTS GIVING ACTIVE WORK, MAINLY CONCENTRIC, FOR THE EXTENSORS OF THE SPINE AND HIP—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Trunk raising— Grasp lax stoop leg lean standing.	Hip and spine.	Extensors of the hip, concentric and slightly excentric. Extensors of the spine, concentric and slightly excentric.	This is a stronger movement for the muscles than the raisings previously described, and must only be given for fairly strong patients.	GRASP LAX STOOP LEG LEAN STANDING TRUNK RAISING.—The patient stands behind and supports the front of the thighs against the boom. The gymnast sits in front of the patient and places one foot against the boom. They then grasp each other's wrists, and the patient raises the trunk from below upwards, as in the preceding raisings, while the gymnast resists. The gymnast then draws the patient down to the starting position. The patient should take a deep breath after the raising, and be careful to draw the shoulders well back and down. Expiration takes place during the forward movement.
Trunk raising in different planes— Grasp lax stoop stride sitting.	,,	Same as the preceding, and also rotators of the trunk.	This is a stronger movement than any of the other trunk raisings. Is a very good mobilising exercise for the joints of the spine, and is used in cases of curvature, and especially where there is deformity of the chest.	GRASP LAX STOOP STRIDE SITTING TRUNK RAISING IN DIFFERENT PLANES.—The gymnast stands in front of the patient and grasps the latter's wrists as in the preceding movement. The patient first raises the trunk upwards in the sagittal plane, as described above, two or more times; then the raising takes place from the turn stoop position, two or three times from the right and left, and ending with raising in the sagittal plane. Support is given to the patient's foot by that of the gymnast during the turn stoop sitting trunk raising.

E. MOVEMENTS GIVING ACTIVE WORK FOR THE SIDE FLEXORS OF THE SPINE

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Side flexion and raising— (*a*) Free standing. (*b*) Wing standing. (*c*) Neck firm standing. (*d*) Stretch stride standing.	Spine. Costo-vertebral and costo-sternal.	Those which lie on the side of the spine opposite to that towards which the flexion takes place—excentric and concentric. Those on the same side as that towards which flexion takes place work slightly concentrically at the beginning of the flexion, and also at the end to	Is a good mobilising exercise. Is used to stretch adhesions remaining after pleuritic effusion. The ribs of the side opposite to that of the flexion are raised and separated so that the lung of that side is expanded. As a free movement side flexion is not used for curvature owing to the muscles involved.	The patient stands in one of the positions enumerated in the opposite column, and bends the trunk sideways. The bending should take place in the dorsal region as far as possible, and rotation of the spine should be avoided. Expiration should take place during the bending, inspiration during the raising. Sometimes the movement is given in the *turn standing* position, side flexion taking place towards the same side as the turning. The effects are stronger than in the preceding position, and the rotators of the spine are involved as well as those producing

Side flexion and raising, with resistance— (*a*) Wing high ride sitting. (*b*) Half wing half neck firm high ride sitting.	„	„	the spine as that towards which the bending takes place.	C-shaped scoliosis. Flexion takes place to the side of the convexity, causing strong contraction of the muscles of that side.	RAISING, WITH RESISTANCE.—The gymnast stands behind the patient and places the hands on the back of the side of the chest. The patient bends the trunk sideways while the gymnast resists, the gymnast then raises the trunk while the patient resists. HALF WING HALF NECK FIRM HIGH RIDE SITTING TRUNK FLEXION.—The arm on the side of the dorsal concavity is placed in the neck firm position, the other arm is in the wing position. The gymnast stands behind the patient and places one hand on the back of the side of the chest on the convex side. The other hand grasps the patient's arm on the concave side just below the elbow. The movement is performed as in the preceding position.
Side flexion with pressure—Half neck firm half wing high ride sitting.	„	„	Those producing lateral movement which lie on the side of the spine towards which the bending takes place.	Used for a dorsal or lumbar scoliosis when there is rotation of the vertebræ. The movement stretches the ligaments and muscles on the concave side, and exercises the muscles on the side of the convexity. The pressure helps to correct the rotation.	HALF NECK FIRM HALF WING HIGH RIDE SITTING SIDE FLEXION WITH PRESSURE.—In the case of a left dorsal scoliosis the patient sits on the high plinth with the right arm in the neck firm position and the left in the wing position. The thighs are fixed by a strap. The gymnast stands behind the patient with the left foot supported on a stool and the elbow of that side resting against the medial side of the knee. The left wrist is kept straight. The fingers are flexed at the metacarpo-phalangeal joints, and the dorsal surface of the first phalanges are placed upon the highest point of the dorsal convexity at the angle of the ribs. The gymnast's right arm is passed under that of the patient. The latter bends the *spine* in a diagonal direction, slightly backwards and towards the left, while the gymnast adducts the left knee so that strong pressure medially and forwards is made upon the angle of the backward rotated ribs. The gymnast assists the movement of flexion with the right arm. In a case of right dorsal scoliosis the position of the gymnast's hands is reversed, and the patient bends slightly backwards and towards the right. If a pure side flexion is performed, the direction of the pressure must be wrong or at best ineffectual. The direction of both, *i.e.* bending and pressure, should be that of the longest diagonal diameter of the deformed chest. For a lumbar curve the pressure is given on the transverse processes of the lumbar vertebræ.

MOVEMENTS FOR THE TRUNK—(*continued*)

E. MOVEMENTS GIVING ACTIVE WORK FOR THE SIDE FLEXORS OF THE SPINE—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Leg side lying correcting with pressure, or side arch leg lying holding—Half neck firm.	Spine. Costo-vertebral and costo-sternal.	Those producing lateral movement which lie on the side of the spine towards which the bending takes place.	Used for a dorsal curve. When there is no rotation the movement is carried out without pressure.	HALF NECK FIRM LEG SIDE LYING CORRECTING WITH PRESSURE.—In the case of a left dorsal scoliosis the patient lies on the right side. The arm of that side is placed in the neck firm position, the left arm is extended along the side of the trunk and thigh. The gymnast stands behind and places the right arm under the patient's right shoulder; the left hand is placed on the angle of the ribs on the left side at the highest point of the convexity, as in the preceding movement. The patient then bends the spine upwards, the gymnast assisting the movement with the right arm, and giving a firm pressure forwards and medially with the other hand. Three or four upward flexions are made in this way, and the movement ends with holding in the side arch position. In the case of a right dorsal scoliosis, the position of the patient is reversed, and flexion takes place towards the right.
Side flexion with pressure—Half neck firm hip lean walk standing.	,, ,,	Those producing lateral movement which lie on the side of the spine towards which the flexion takes place.	Given in cases of dorsal and lumbar scoliosis to exercise the muscles on the convex side, and to stretch the ligaments and muscles on the opposite side. Also to correct the rotation.	HALF NECK FIRM HIP LEAN WALK STANDING SIDE FLEXION WITH PRESSURE.—In the case of a left dorsal curve, the patient in the walk standing position supports the side of the right hip against the boom. The right arm is in the neck firm, and the left in the wing position. The gymnast stands on the other side of the boom, passes the arms round the patient on either side, and places both hands, one above the other, upon the angle of the ribs on the convex (left) side. The patient performs three or four quick side flexions to the left while the gymnast gives firm pressure forwards and medially with the hands. For a right dorsal curve the position of the patient and direction of the bending is reversed. In cases of lumbar curvature the movement is the same, but the pressure is given upon the transverse

F. MOVEMENTS FOR THE ...

Backward drawing and raising— Wing high ride sitting.	Hip.	Flexors of the hip, excentric and concentric. Abdominal muscles statically.	Exercises the muscles. Is repleting to the pelvic organs. Helps peristalsis. Employed in treating constipation, and can be modified for weak patients. Respiration is hindered as the thorax is fixed.	Wing High Ride Sitting Backward Drawing and Raising.—The patient's thighs are firmly fixed by a strap. The gymnast stands behind the patient and passes the hands under the latter's armpits to rest upon the front of the shoulders. The gymnast draws the patient's trunk back while the latter resists; the patient then rises to the starting position while the gymnast resists. The spine should be kept straight, and the gymnast should keep a slight upward pull on the trunk during the movement.
Backward falling and raising— (*a*) Wing high ride sitting. (*b*) Neck firm high ride sitting. (*c*) Stretch high ride sitting.	"	" "	Same as the above, but cannot be made so easy for weak patients.	Wing High Ride Sitting Backward Falling and Raising.—The patient's thighs are firmly fixed as in the preceding exercise. The spine is kept straight and the head is not allowed to bend forwards during the movement. The patient allows the trunk to fall backwards from the hip joints and then rises to the starting position. The extent of the backward falling varies according to the strength of the patient. At first and with weak patients the trunk is only allowed to fall slightly back, and the gymnast gives support from behind.
Backward falling and raising— Wing toe support sitting.	Hip and ankle.	Flexors of the hip, excentric and concentric. Abdominal muscles statically. Flexors of the knee and dorsi-flexors of the ankle statically.	Same as the preceding. It is stronger than in the high ride sitting position, as the origin and insertion of the rectus femoris are nearer to each other.	Wing Toe Support Sitting Backward Falling and Raising.—The patient sits on a stool with the feet fixed in the rib stool, and performs the backwards falling and raising.
Raising and backward falling— (*a*) Wing sit lying. (*b*) Neck firm sit lying. (*c*) Stretch sit lying.	Hip.	Flexors of the hip, concentric and excentric. Abdominal muscles statically, and generally concentric and excentric to some extent at the beginning and towards the end of the movement respectively.	Same as the preceding, but cannot be so well modified in this as in some of the other positions. When taken correctly, with the shoulders drawn back and the head in a good position, it expands the chest, and is used in treating patients with round shoulders and narrow chests.	Wing Sit Lying Raising and Backward Falling.—The gymnast, in front, fixes the patient's knees during the movement. The patient raises the trunk to the upright position, and, after a pause for respiration, allows it to fall slowly backwards to the starting position. Forward bending of the head in rising from the plinth and in sinking backwards should be avoided, and the spine should be kept quite straight during the movement. Weakly patients and beginners may be given some help in rising. The movement is more difficult when taken in the *neck firm* and *stretch* positions.

MOVEMENTS FOR THE TRUNK—(*continued*)

F. MOVEMENTS FOR THE FLEXORS OF THE TRUNK (CHIEFLY ABDOMINAL) AND THE FLEXORS OF THE HIP—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Backward drawing and raising— (*a*) Wing loin lean standing. (*b*) Neck firm loin lean standing. (*c*) Stretch loin lean standing.	Spine, chiefly lumbar.	Abdominal muscles, excentric and concentric. Flexors of the hip statically.	Exercises the abdominal muscles. Is repleting to the pelvis. Helps peristalsis.	Wing Loin Lean Standing Backward Drawing and Raising.—The patient stands with the sacrum resting against the boom. The gymnast stands behind and grasps the patient's shoulders as in high ride sitting backward drawing. The gymnast draws trunk backwards while the patient resists; the patient raises the trunk while the gymnast resists.
Backward drawing and raising— Wing knee stride standing.	Spine, lumbar region, and knee joints.	Abdominal muscles, excentric and concentric. Flexors of hip statically. Extensors of the knee, excentric and concentric.	Exercises the muscles, and is more repleting to the pelvis than the foregoing. It is used to bring on menstruation.	Wing Knee Stride Standing Backward Drawing and Raising.—The patient's sacrum is supported against the gymnast's knee. The grasp of the latter is the same as in the foregoing position. The backward drawing involves the lumbar spine first and then the knee joints; in raising the latter are extended before the lumbar spine is straightened. As in the previously described backward drawings the gymnast takes the trunk backwards under the patient's resistance, while the latter raises the trunk under the gymnast's resistance.
Backward drawing to the vertical plane and forward bending— Wing high ride lax stoop sitting.	Hips and spine, chiefly lumbar.	Flexors of the hip, excentric and concentric. Abdominal muscles, excentric and concentric.	Strengthens and causes strong contraction of the abdominal muscles. Is depleting from the abdomen and pelvis. Used in cases of floating kidney and in relaxed conditions of the abdominal muscles.	Wing High Ride Lax Stoop Sitting Backward Drawing to the Vertical Plane and Forward Bending.—The gymnast's position and grasp is the same as in high ride sitting backward drawing. The patient resists while the gymnast draws the trunk backwards to the vertical position; the gymnast resists while the patient bends forward to the starting position. It is important that a slight upward lift should be given in drawing the trunk backwards and in resisting as the patient bends forwards.

Trunk rolling— Wing stride standing.	Lumbar spine and hips.	Flexors and extensors and lateral flexors of the lumbar spine. Flexors and extensors of the pelvis.	Exercises the working muscles and increases mobility in the lumbar spine. Is used in a general table; for curvatures to increase mobility in the lumbar region, and for constipation.	WING STRIDE STANDING TRUNK ROLLING.—The patient describes a circle with the trunk, bending it forwards and to the left, backwards and to the right, from three to six times. The movement is then repeated in the reverse direction. No rotation of the spine or pelvis should be allowed, and the head should be kept in a good position and in the same relation to the shoulders throughout the movement.
G. MOVEMENTS FOR THE ROTATORS OF THE TRUNK				
Trunk twisting— (*a*) Wing close standing. (*b*) Yard stride standing.	Spine and hips.	In turning to the right: The right rotators of the trunk (*i.e.* the right abdominal and the left spinal muscles), the medial rotators of the right hip, and the lateral rotators of the left hip. In turning to the left: The left rotators of the trunk (*i.e.* the left abdominal and the right spinal muscles), the medial rotators of the left hip, and the lateral rotators of the right hip. The work is concentric for the above groups.	Is a good mobilising movement; exercises the muscles and improves the circulation. It is used in cases of curvature and in general strengthening treatment. It assists peristalsis, and is therefore given in treating constipation.	WING CLOSE STANDING OR YARD STRIDE STANDING TRUNK TWISTING.—This is a free movement in which the patient turns the trunk alternately to the right and left. It may be done slowly or quickly, the latter if the strongest effects are desired.

MOVEMENTS FOR THE TRUNK—(*continued*)

G. MOVEMENTS FOR THE ROTATORS OF THE TRUNK—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Trunk twisting— (*a*) Wing high ride sitting. (*b*) Neck firm high ride sitting.	Spine and hips.	The right and left rotators of the trunk, concentric, or excentric and concentric for each group.	Is a good mobilising movement; exercises the muscles and improves the circulation. It is used in cases of curvature and in general strengthening treatment. It assists peristalsis, and is therefore given in treating constipation.	WING HIGH RIDE SITTING TRUNK TWISTING.—This movement may be carried out in two ways: (*a*) With concentric work for the right and left rotators. The gymnast stands behind the patient. When the movement is to the right the right hand is placed behind the patient's right shoulder and the left in front of the left shoulder. In turning to the left the position of the gymnast's hands is reversed. The patient turns to the right and left alternately under the gymnast's resistance. When the patient has gone as far round as possible to right or left the gymnast reverses the position of the hands and completes the movement. The grasp is then right for rotation in the reverse direction. The patient takes a deep breath after each twisting. (*b*) With excentric and concentric work for the right and left rotators. The gymnast turns the patient's trunk to the right under the latter's resistance, the patient turns forwards under the gymnast's resistance. In turning forwards the patient takes a deep breath and the gymnast lifts the patient's shoulders slightly. The latter then breathes out and the movement is repeated to the other side. To give the movement in this way the gymnast's grasp is as follows: In turning the patient to the right and in returning to the forward position the right hand is placed in front of the patient's right shoulder and the left behind the left shoulder. In turning the patient to the left, the position of the hands is of course reversed.
Trunk twisting— (*a*) Wing close sitting. (*b*) Wing stoop stride sitting. (*c*) Heave grasp stoop	Spine.	Left and right rotators of the trunk, excentric and concentric, or may be performed concentrically for both groups.	To improve mobility, exercise the muscles, and increase peristalsis. Performed in the stoop positions the movement is depleting from the	(*a*) WING CLOSE SITTING TRUNK TWISTING.—The gymnast stands in front of the patient with one leg on either side of the patient's knees to fix the latter. In turning the patient to the right and back to the forward position the gymnast's left hand is placed

(*d*) Stretch stoop stride sitting.				the right hand behind the patient's left shoulder. The gymnast turns the patient towards the right while the latter resists; the patient turns forward and at the same time takes a deep breath while the gymnast resists. There is a pause while the patient breathes out. The gymnast then reverses the position of the hands in relation to the shoulders, and the movement is repeated to the left side. As the patient turns forward the gymnast lifts the shoulders slightly to help inspiration. (*b*) Wing Stoop Stride Sitting Trunk Twisting.—The grasp of the gymnast is the same as in the preceding position, but the patient's knees are not fixed. The patient remains in the stoop position while the movement is carried out as above. (*c*) and (*d*) Heave Grasp and Stretch Stoop Stride Sitting.—The gymnast stands upon a stool in front of the patient. In the heave grasp position they grasp each other's forearms, in the stretch grasp position they grasp each other's hands or wrists, and the movement is carried out as above.
Trunk twisting— (*a*) Wing knee stride standing. (*b*) Wing arch knee stride standing.	Spine and hip.	Rotators of the spine and pelvis, excentric and concentric.	Same as the preceding, but the movement in these positions, and particularly in wing arch knee stride standing, brings more blood to the abdomen and pelvis.	(*a*) Wing Knee Stride Standing Trunk Twisting.—The patient kneels upon the low plinth. The gymnast, in the step standing position behind, supports the patient's sacrum with her knee. The position of the hands and the movement correspond to those in wing close sitting.
Trunk twisting— Wing close standing.	"	Rotators of the spine and pelvis, concentric and excentric.	The general effects are the same as in other trunk twistings. Owing to the position of the feet the hip joints are freer, and there is more extensive muscle work. Done from the turn position the movement is a harder one.	Wing Close Standing Trunk Twisting.—This movement is usually taken from the turn position. The gymnast stands in front and places her foot against that of the patient on the side from which the turning takes place. The position of the hands is the same as that previously described. The patient turns the trunk round as far as possible while the gymnast resists; the gymnast then turns the patient to the starting position while the latter resists. The patient inspires during the forward turning.

MOVEMENTS FOR THE TRUNK—(*continued*)

G. MOVEMENTS FOR THE ROTATORS OF THE TRUNK—(*continued*)

Name and Position.	Joints Involved.	Muscles.	Uses.	Description.
Hip alternate twisting—Heave grasp close standing.	Lower part of spine and hip.	Rotators of pelvis and spine, excentric and concentric for each group.	In this position the movement gives stronger work for the muscles. The upper part of the trunk is fixed, and more resistance can be offered as the pelvis is twisted. A variation of this movement is given for scoliosis in cases with pelvic rotation, and is described elsewhere.	HEAVE GRASP CLOSE STANDING HIP ALTERNATE TWISTING.—The gymnast stands in front of the patient, and places one hand in front of one hip and the other behind that of the opposite side. The gymnast twists the pelvis to the turn position while the patient resists; the latter turns forward under the gymnast's resistance. The movement is then repeated to the opposite side.
Forward turning—Wing high ride fall turn sitting.	Spine.	Rotators of spine, concentric and excentric for each group.	This is a strong exercise for the muscles. It is used in cases of constipation, but not for weak patients, as respiration is hindered. It is repleting to the abdomen and pelvis.	WING HIGH RIDE FALL TURN SITTING FORWARD TURNING.—To work the left rotators of the spine the gymnast stands behind the patient with the right foot a pace behind the left. The right arm is passed over the patient's right shoulder and then under the arm so that the forearm and back of the gymnast's hand rest against and firmly support the patient's back, as in circle turning. The left hand is passed under the patient's left armpit and placed in front of the left shoulder. The patient's head rests upon the gymnast's right shoulder. The latter carries the patient's trunk backwards to a point midway between the vertical and horizontal plane, then turns it to the right. The patient is now in the starting position. The movement consists of turning forwards under the gymnast's resistance, and then offering resistance as the latter turns the trunk back to the starting position. This movement is repeated three or four times; then the grasp and stance is changed for working the right rotators of the spine.
Forward turning—Half wing half stretch high ride fall turn sitting.	"	Rotators of the spine, concentric and excentric.	Same as the preceding, but more difficult.	HALF WING HALF STRETCH HIGH RIDE FALL TURN SITTING FORWARD TURNING.—To work the left rotators of the spine the gymnast stands behind the patient, as in the foregoing. The patient's right arm is stretched upwards, the left is in the wing posi-

				tion. The gymnast grasps the patient's right wrist with the right hand; the left arm is flexed, and the back of the forearm placed upon the right side of the patient's back so that the dorsal aspect of the hand supports the patient under the axilla. The patient is then drawn backwards and turned towards the right side to the starting position as in the preceding. The forward turning with concentric and excentric work for the left rotators is then carried out as in the previous exercise. To work the right rotators the position of the patient's arms and the gymnast's grasp is reversed. The gymnast should keep the outstretched arm fully stretched during the movement.
Plane twisting— (*a*) Wing high ride sitting. (*b*) Half wing half stretch high ride sitting.	Spine and hip.	Rotators of the spine, excentric and concentric. Flexors of the hip, excentric and concentric.	Same as wing high ride fall turn sitting forward turning, but more muscles are involved, and it has a stronger effect upon peristalsis.	(*a*) Wing High Ride Sitting Plane Twisting.—The position and grasp of the gymnast are the same as in wing high ride fall turn sitting forward turning. To exercise the left rotators the patient resists while being carried backwards to the horizontal plane, or nearly so, and turned to the right. The patient then turns forwards and rises to the upright position while the gymnast resists. The movement is repeated three or four times to one side and then to the other. (*b*) Half Wing Half Stretch High Ride Sitting Plane Twisting.—The position of the patient and the grasp of the gymnast is the same as in half wing half stretch forward turning. The movement is carried out as above.
Arch twisting— Half wing half stretch high ride sitting.	Spine and hips.	Side flexors and rotators of the spine, excentric and concentric. Flexors of the hip, excentric and concentric.	Same as in plane twisting, but is a stronger movement, and specially influences the portal circulation.	Half Wing Half Stretch High Ride Sitting Arch Twisting.—The gymnast stands behind the patient, facing towards the side to which the latter is to be carried and giving support to the trunk with the shoulder and arm. The grasp is the same as in half wing half stretch plane twisting. The gymnast first bends the patient sideways towards the side of the stretched arm, then carries the trunk backwards in the turn position until it is on a line with the plinth. The gymnast then stretches the extended arm as fully as possible, and the patient turns forward and rises to the upright position while the gymnast resists.

THE EFFECTS OF ACTIVE MOVEMENTS

1. Upon the Circulation—

With every contraction of the muscles the blood contained in their vessels is forced onwards, and at every relaxation there is therefore an increased capacity for a further supply of blood to the part. At the joints concerned in the movement the vessels are alternately shortened and lengthened and the flow of blood facilitated here also. This acceleration of the blood by active movements leads to increased action of the heart, so that the increased supply of venous blood may be discharged from the right side of the heart through the pulmonary circuit, and, when oxygenated, from the left ventricle through the systemic system. Those changes in the circulation are of course proportionate to the number of muscles engaged in the movements, and to the strength, extent, and continuance of the latter. By means of active movements, then, the supply of blood to different parts of the body can be regulated to some extent, as, if more blood is brought to one part of the body there must be a corresponding diminution in other parts.

2. Upon Respiration—

The effect of active movements upon respiration is to increase the depth, and frequency at first, of the respiratory act. This is normally governed by "the respiratory centre, the vagus nerves, and the chemical condition of the blood" (Halliburton). During exercise the increased tension of carbon dioxide present in the blood which supplies the respiratory centre stimulates the latter to greater activity, so that the increased need for oxygen in the lungs and tissues can be met. Breathlessness is caused by undue exertion and want of training. It is due to a disproportion between the output of carbonic acid gas and the intake of oxygen and is an effort of nature to restore the balance between the interchange of these gases in the lungs.

3. Upon Digestion—

Active exercises have a very stimulating effect upon digestion both directly and indirectly. Movements of the trunk upon the legs and of the legs upon the trunk exercise a mechanical pressure upon the abdominal viscera and cause a more rapid flow of blood through them; the digestive secretions are thus increased and absorption and peristalsis are more rapid. There is probably a reflex nervous connection between the voluntary abdominal muscles and the involuntary muscle of the alimentary canal, so that massage and exercises of the former stimulate and improve the condition of the latter.

4. Upon Elimination—

The effects of active movements upon elimination are the same as those enumerated previously as being caused by massage.

5. Upon the Nervous System—

Every voluntary movement implies an impulse transmitted by the nerves to and from the nerve centres; this exercise of the nervous system improves its function, just as muscles are strengthened and developed by use. Further, the better circulation of the blood improves the nutrition of the whole nervous system so that mental as well as physical activity is promoted.

6. Upon the Muscular System—

The effects of active movements upon the muscular system are to develop and strengthen it and to improve its function. The increased oxidation which takes place during exercise causes increased heat and reduces fat in the muscular tissue.

7. Upon Bone—

The effect of exercise upon bone is the same as that exercised by massage, but to a greater extent.

THE EFFECTS OF PASSIVE JOINT MOVEMENTS

Passive movements of the joints improve the circulation of blood in the joint and working muscles, promote nutrition, and increase glandular and respiratory activity to some extent. They are employed to prevent and break down newly formed adhesions, such as occur in cases of sprain, fracture, or dislocation, while, later on in such cases, free and resistive movements are employed to promote muscular development. In cases of stiff joints, arising from rheumatism or other causes, passive movements are employed to promote (*a*) mobility, (*b*) the nutrition of the joint and of the muscles which act upon it, (*c*) the absorption of exudations, and (*d*) the stretching of contracted muscles. Passive movements are also employed in treating for paralysis, chorea, and in all cases of general debility, to prepare the way for active exercises.

RESPIRATORY EXERCISES

The value of respiratory exercises cannot be overestimated, and they form a very important part of massage treatment in most cases.

Deep breathing develops the muscles and mobilises the joints of the thorax. It exercises the lungs throughout their whole extent, thus strengthening them and increasing their functional activities. It improves both the systemic and pulmonary circulations.

In breathing, the inspirations should be slow, full, and deep; the lower part of the chest should be expanded, and the air should enter through the nose; expiration should be complete. Inspiration is assisted by raising the arms upwards, or by extending them backwards. Expiration is assisted by compressing the arms by the sides of the chest.

Breathing exercises are especially useful in cardiac cases, in certain diseases of the organs of respiration, in spinal curvature, in anæmia, neurasthenia, and in all cases for abdominal massage.

A detailed description of some respiratory exercises is given in Chapter VIII.

GENERAL RULES FOR GYMNASTIC TREATMENT

In giving gymnastic treatment not only must the movements and starting positions be chosen with the view of effecting the desired changes,—be they for correcting some deformity, for improving defective circulation, or helping the digestive processes, etc.,—but the age and strength of the patient must be taken into consideration, also her or his general condition, as the treatment may have to be considerably modified if any concurrent disease or weakness is present.

In arranging a gymnastic table a definite order of movements must be observed, and the gymnast should write out the latter and have the programme to refer to during the treatment.

Dr. Arvedsen's scheme is usually taken as the model one for a general table, and it would be difficult to find a better one. It is as follows: (1) Respiratory movement; (2) extremity movement (arm, leg, or both); (3) one affecting the abdominal organs (usually a passive trunk movement); (4) neck and head; (5) chest and back; (6) abdominal and side; (7) extremity (arm, leg, or both); (8) respiratory.

The above scheme illustrates the rules—(*a*) that active movements involving the same group or groups of muscles must not immediately succeed each other; (*b*) that, when possible, the treatment should be a general one, to include the limbs, the trunk, and the muscles moving the head, so that all parts of the body may be influenced; (*c*) that a respiratory exercise should be given at the beginning and end of the gymnastic table. This should also be repeated at intervals between other exercises at the gymnast's discretion.

In spinal curvature and other deformities passive corrective movements should be followed by an active one for the same part. The following is a list of some passive movements and the active ones which follow them:—

1. Neck firm sitting chest expansion, followed by yard walk standing doubl plane arm carrying.

2. Stretch grasp side standing forward drawing, followed by half wing hal neck firm high ride sitting side flexion with pressure; or by side arch leg lyin holding.

3. Forward lying passive double leg carrying to one side with pressur followed by high reach grasp standing leg outward carrying, or by spring sittin holding, trunk rolling, or hip updrawing.

4. Leg forward lying, correcting with two pressures, followed by neck fir stoop leg lean standing trunk raising with two pressures.

5. Crook sitting holding, followed by lying double leg lifting.

In treating scoliosis a definitely corrective exercise or group of exercises shoul be preceded and followed by others of a more general nature. It is often advisabl in the middle of a table, or after some of the stronger exercises, to give a purel passive movement, such as back massage, so as to rest the patient. In these an in other cases it may be necessary for the patient to have a short interval of res after each active exercise. Exercises of an educational nature, such as balanc movements, marching, etc., are very desirable in many cases, and should be intro duced between others of a definitely remedial nature.

Tables of treatment should be gradually progressive as regards length, strengtl and difficulty. Easy movements and short tables should be given at first, and a the patient becomes stronger and proficient in doing the exercises the latter ma be increased in number, and more difficult ones may be given. Towards the en of a course the treatment should be modified. Each treatment during the cours should begin and end with the easiest movements, and the more difficult on should be given in the middle of the programme.

Massage movements are frequently necessary and advisable before activ movements for the same part, in order to prepare the way for the latter, b improving the circulation and stimulating the nerves. If, however, a reflex c soothing effect is desired, massage should not be immediately followed by activ exercises for the same part.

The treatment should not be so strong as to cause undue fatigue, nor shoul the patient be in a tired condition before it begins. At its conclusion the latt should rest in the recumbent position, otherwise the full benefits of the treatme will not be obtained. The patient should be suitably clothed for the treatme so that the movements may not be restricted in any way. Both patient an gymnast should breathe freely during the exercises, and no unnecessary talkin should be allowed during the treatment.

CHAPTER V

DESCRIPTION OF MASSAGE

General—Head and Face—Abdominal—Weir Mitchell Treatment

GENERAL MASSAGE

GENERAL massage means massage of the entire body. The temperature of the patient's room should be from 65° to 70° F. The bed should be placed so that the masseuse can manipulate the patient from either side. It should be about 3 feet wide and conveniently high. It is perferable for the patient to wear only a loose dressing-gown, and to lie between blankets. Care should be taken to avoid all unnecessary exposure, and to keep the patient warm. For these reasons only the part which is being manipulated should be uncovered, and one or two shawls should always be at hand for covering purposes. If the patient suffers from cold feet, bed-socks may be put on when the feet and legs have been manipulated, or if the patient prefers it, a hot-water bottle may be placed in the bed.

Position of Patient.—The patient should lie on her back for massage of the limbs, chest, and abdomen, with the head and shoulders supported by pillows. While the abdomen is being manipulated, the knees should be drawn up and held apart, in order to relax the abdominal muscles. A pillow should be placed underneath the thighs.

While the back is being masseéd, the patient should lie, if possible, in the forward lying position, with the forehead resting upon the hands. If, from weakness or other cause, this position cannot be taken, the patient must lie upon one side or lean forward upon some support.

Position of Masseuse.—It is usually convenient for the operator to stand on the right-hand side of the patient when manipulating the right leg, the right arm, the chest, and the abdomen, and on the left-hand side when manipulating the left leg and the left arm, but when masseéing a helpless patient in a large bed it may be often necessary to work entirely from either the right or the left side.

A good division of the time, for a séance of one hour's duration, is as follows:—

Legs	20 minutes.
Arms	10 ,,
Chest	5 ,,
Abdomen	15 ,,
Back	10 ,,

One and a half hours should elapse after a meal before general massage is given.

The patient should always rest for at least thirty minutes, and usually for an hour after general massage, and in most cases some light refreshment should be taken at the conclusion of the treatment.

The Menstrual Period.—It is usual to omit massage of the abdomen and loins during this period, and in some cases it is well to suspend treatment altogether for two or three days. If menstruation is unduly frequent, or the discharge profuse, the massage treatment given beforehand should not be very vigorous.

ORDER OF MOVEMENTS

The Lower Limb—

1. Effleurage of the foot and leg. (*a*) Starting on the dorsum of the foot th hand is passed firmly upwards, first on the lateral side and then round to the bacl

FIG. 135.—KNEADING THE DORSUM OF THE FOOT AND FRONT OF THE ANKLE.

of the leg, the stroke ending under the knee. (*b*) Starting on the sole of the fo the hand is passed over the heel and up the back of the leg.

The Foot—

2. Effleurage of the foot. The hands are placed, one on the dorsum and tl

FIG. 136.—KNEADING THE MUSCLES ON THE FRONT OF THE LEG WITH BOTH THUMBS.

other on the plantar aspect of the foot and toes, fingers directed medially. T stroke is then made from the toes to the ankle and heel.

3. Friction of the toes, carried out with the thumbs.
4. Kneading of the foot. (*a*) Place one hand on the dorsum of the foot

ready it, and knead the sole of the foot and on either side of the heel with the ball the thumb of the other hand. (*b*) Support the sole with one hand and knead the orsum of the foot and the front of the ankle with the palmar surface of the other and.

5. Deep effleurage between the metacarpal bones with the thumb of one hand.

FIG. 137.—PÉTRISSAGE—PICKING UP THE MUSCLES OF THE CALF.

6. Deep effleurage on the sole of the foot with the ball of the thumb.
7. Friction on the dorsum of the foot and round the ankle joint with the umbs or pads of the fingers.
8. Stroking round the malleoli with the pads of the fingers.

FIG. 138.—KNEADING ROUND THE KNEE JOINT WITH THE BALL OF THE THUMB.

he Leg—

9. Effleurage of the leg from the ankle to the knee with both hands, the stroke nding under the knee.
10. Kneading the muscles on the front of the leg, either with the heel of the and or the thumbs.

11. Pétrissage of the calf of the leg.
12. Tapôtement of the leg (clapping).
13. Effleurage of the leg from ankle to knee as before.
14. Frictions round the knee joint.
15. Kneading round the knee joint.

FIG. 139.—MOVING THE ANKLE JOINT.

The Thigh—

16. Effleurage of the thigh with both hands. The strokes begin in the poplit[e]al space and finish in the groin. In making the first stroke the hands are usua[lly]

FIG. 140.—LEG ROLLING OR CIRCUMDUCTION OF THE THIGH. (ONE METHOD.)

brought to the front of the thigh at once and then up towards the groin; [the] second and third strokes are carried farther up the back of the thigh before com[ing] towards the front.

17. Pétrissage of the thigh. Picking up or "butterfly" movement.

18. Circular kneading (*a*) on the medial and lateral sides of the thigh and on the superior and inferior aspects of the thigh.
19. Clapping.
20. Effleurage of the thigh as before.

FIG. 141.—RESISTIVE PLANTAR AND DORSI-FLEXION OF THE FOOT.

FIG. 142.—KNEADING THE PALM OF THE HAND.

JOINT MOVEMENTS—

1. Rolling and plantar and dorsi-flexion of the toes, *en bloc.*
2. Foot rolling.
3. Plantar and dorsi-flexion of the foot.
4. Flexion and extension of the leg at knee.
5. Leg rolling.

The Upper Limb—

1. Effleurage of the hand and arm. The stroke starts on the back of th fingers, where it is carried out with the flat of the hand, fingers directed upwards At the wrist the hand is curved round so as to encircle the arm. Firm, equa pressure is made, and the stroke is finished at the axilla.

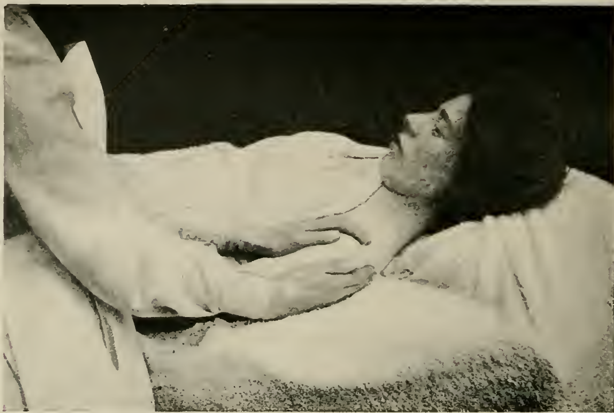


Fig. 143.—Circular Kneading of the Deltoid.

The Hand—

2. Effleurage of the palmar and dorsal surface of the hand and fingers with th palmar surface of one hand.

3. Kneading the fingers with the index finger and thumb.

4. Kneading the dorsum and the palm of the hand.

5. Frictions on the back and front of the wrist joint with the pads of th fingers.

Fig. 144.—Flexing the Forearm.

The Forearm—

6. Effleurage of the forearm.

7. Pétrissage of the muscles of the forearm.

8. Kneading of the forearm muscles with the palmar surface of the hand.

9. Frictions with the pads of the fingers round the elbow joint. (The patient's arm should be extended when working on the back of the joint, and partially flexed when working on the front.)
10. Clapping.
11. Effleurage of the whole arm.

FIG. 145.—SUPINATING THE FOREARM.

The Upper Arm—

12. Pétrissage of the biceps brachii, triceps brachii, and deltoid muscles.
13. Circular kneading of the above muscles.
14. Clapping.
15. Frictions round the shoulder joint.

FIG. 146.—KNEADING THE PECTORAL MUSCLES.

JOINT MOVEMENTS—

1. Finger rolling.
2. Flexion and extension of the fingers.
3. Wrist rolling.

4. Flexion and extension of the hand.
5. Flexion and extension of the forearm.
6. Pronation and supination of the forearm.
7. Arm rolling.
8. Flexion and extension of the arm.

FIG. 147.—STROKING BETWEEN THE RIBS.

FIG. 148.—KNEADING THE MUSCLES OVER THE STOMACH.

N.B.—In massage of the arm and leg it is equally correct to begin manipulations either at the distal or proximal extremity of limb; but, if the movements are commenced at the shoulder (af a preliminary effleurage of the whole limb) in the case of the a they must also be commenced at the upper part of the thigh manipulating the lower limb, and *vice versa*.

The Neck and Chest—

1. Effleurage of the muscles of the neck with the palmar surface of the fingers, working downwards.
2. Knead the muscles of the neck.
3. Repeat effleurage.

FIG. 149.—KNEADING THE TRANSVERSE COLON WITH THE ULNAR BORDER OF THE HAND.

FIG. 150.—KNEADING THE DESCENDING COLON WITH THE BALL OF THE THUMB.

4. Knead the pectoral muscles with the palmar surface of the hands, working from the middle line towards the axillæ.
5. Place the palms of both hands upon the middle of the chest and stroke upwards and laterally towards the axillæ (V movement).
6. Knead the intercostal muscles. In this movement one hand is placed over the other.
7. Stroke between the ribs.

The Abdomen—

1. A respiratory exercise such as chest lift stroking.
2. Knead the muscles over the stomach with the right hand, working deeply in the left half of the epigastric region with the heel of the hand. The right hand may be reinforced by placing the left upon it.

FIG. 151.—EFFLEURAGE OF THE BACK.

3. Stroke the muscles over the stomach with alternate hands, working towards the middle line.
4. Vibrate over the stomach. (Stomach shaking and stomach pit shaking.)
5. Knead over the region of the liver.

FIG. 152.—KNEADING THE BACK ("IRONING").

6. Vibrate over the liver.
7. Tapôte gently over the liver.
8. Circular kneading (for the small intestine).
9. Transverse kneading on the lower part of the abdomen.

10. Colon stroking.
11. Colon kneading.
12. Pétrissage of the abdominal wall.
13. Cross abdominal shaking.

FIG. 153.—CLAPPING.

14. Lumbar side stroking.
15. Light stroking round the umbilicus.
16. Respiratory exercise.

FIG. 154.—STROKING ON EITHER SIDE OF THE SPINOUS PROCESSES WITH THE FINGERS.

The Back—

1. Effleurage of the whole back. Beginning at the lowest part, a series of firm, even strokes are made upwards and laterally with the palmar surface of both hands. Each stroke extends higher than the preceding one until the axillæ are reached; the hands are then placed upon the neck, and a downward and lateral

stroke is made upon the neck towards the shoulders. In the upward stroking th fingers should not be kept on to the very end of the movement, which should b finished with the heel of the hand.

2. Kneading of the neck muscles.
3. Kneading of the whole back.
4. Frictions on either side of the spine with the thumbs or pads of the fingers.
5. Hacking or clapping.
6. Stroke upwards with the whole hand over the spine and downwards betwee the spinous and transverse processes with the tips of the first and second fingers.
7. Effleurage as before.
8. Effleurage of the gluteal region. A series of strokes are made, directe laterally from the sacrum.
9. Kneading the gluteal muscles and over the sacrum.
10. Pétrissage (picking up) of the gluteal muscles.
11. Hacking or beating over the gluteal region and sacrum.
12. Effleurage of the gluteal muscles.

> *N.B.*—All the above movements for "General Massage" need not neces sarily be carried out—a selection of the most suitable ones for th case should be made.

MASSAGE OF THE HEAD AND FACE

The Head.—Massage of the head is useful in cases of insomnia, headach and neuralgia. It is usually omitted in cases for general massage unless th patient is suffering from any of the above-mentioned complaints.

FIG. 155.—CIRCULAR STROKING OF THE FOREHEAD.

MOVEMENTS—

1. Place the tips of the fingers of both hands upon the temples and the thum upon the mid-line of the forehead. Then stroke (in cases of insomnia, lightly) in lateral direction with the thumbs, first over the forehead in three lines, then abo and below the orbits, and gently over the closed eyelids.
2. Work over the forehead in overlapping circles with the tips of the fingers both hands. In cases of insomnia this movement should be carried out with lig contact (Fig. 155).
3. Place the hand upon the forehead, the fingers directed towards one side, t thumb towards the other; then stroke backwards from the eyebrows over the t of the head.

4. Friction of the scalp, from the forehead to the occiput, carried out with the fingers of one hand, while the other hand steadies the head.

5. Percuss the head from the forehead to the occiput.

FIG. 156.—FRICTION OF THE SCALP.

FIG. 157.—STROKING THE NECK.

The Face.—Massage of the face is employed for the relief of facial neuralgia, and in cases of paralysis of the facial nerve. It also develops the facial muscles, and is thus instrumental in removing wrinkles.

MOVEMENTS—

1. Place the fingers of both hands upon the sides of the head. Then stroke in a lateral direction with the thumbs over the forehead, round the orbits, and on either side of the nose and mouth.
2. Circular Stroking. (*See* "Massage of the Head," Movement 2.)
3. Place the tips of the fingers upon the cheek, and knead the tissues in a circular direction.
4. Pick up the tissues of the cheek between the fingers and thumbs of both hands.
5. Stroke with the palmar surface of the fingers of both hands along the inferior border of the lower jaw, from the back and front of the ears alternately.
6. In cases of facial paralysis, vibrate with the tips of the fingers over the branches of the facial nerve.
7. Percuss the cheek muscles gently.

ABDOMINAL MASSAGE

Abdominal massage is ordered for the relief of indigestion and constipation and in cases where the action of the kidneys is deficient.

Its effects are briefly—

1. Increased activity of the organs of digestion.
2. Increased absorption of food substances into the system.
3. Diminution and expulsion of gases generated in the stomach and intestines.
4. Increased peristaltic activity.
5. Increased renal activity.
6. Development of the abdominal muscles and the muscular walls of the intestines.
7. The absorption of fat.

Those results are brought about in four ways—

1. By direct mechanical pressure over the organs of digestion.
2. By stimulation of the abdominal sympathetic ganglia. This is done by reflex stroking, by vibratory movements, and by pressure over certain nerve plexuses.
3. By manipulation of the muscles of the abdominal wall.
4. By passive and active movements in which the abdominal muscles are concerned.

Massage of the abdomen should not be given until two hours have elapsed after a meal. As the parts are frequently very sensitive, it is well for the masseuse, at the beginning of treatment, to pass her hand firmly over the abdomen, to find out if there are any tender spots. If such exist they should be carefully encroached upon so as to avoid causing pain.

In preparing a patient for abdominal massage in bed a couple of pillows should be placed under the head and shoulders; the knees should be drawn up and separated, and another pillow placed under them. The arms should lie by the sides. The bladder should be emptied before the manipulations are commenced. The patient should be directed to breathe deeply and regularly.

During the menstrual period, massage of the abdomen should be discontinued.

MASSAGE MOVEMENTS

All the movements previously given for the abdomen and loins in "General Massage" should be employed. In treating cases of constipation a good deal of vibration should be given over the liver and intestines, also light tapôtement over the former, and deep frictions and kneading round the colon. Sacral beating is also useful. When possible a general gymnastic table may be carried out, which includes exercises to help the portal circulation and to strengthen the abdominal muscles.

MASSAGE IN WEIR MITCHELL CASES

The Weir Mitchell treatment is one consisting of rest in bed, either partial or complete seclusion from relatives and friends, frequent feeding, and massage—either with or without applications of electricity. It is named after Dr. Weir Mitchell, of Philadelphia, who was the first to make it a systematic treatment. It is employed in cases of neurasthenia, hysteria, chorea, chronic dyspepsia, overwork, delayed convalescence after fevers, etc. The aims of the treatment are, broadly speaking, to effect a complete change in the mental atmosphere, to increase the quantity and improve the quality of the blood, and to increase the weight of the patient.

The effects of massage upon the system have been already detailed: it is sufficient to say here that it forms part of the Weir Mitchell treatment, in order that the muscles may be exercised without causing the patient the undue fatigue which voluntary effort entails, and that by it the evils attendant upon prolonged rest, namely, retarded circulation, a weakened digestion, loss of appetite, and constipation, may be counteracted. The treatment usually lasts from six weeks to two months—sometimes longer—and is modified to suit each individual case. Some patients are not at first allowed to sit up in bed, or even to feed themselves. Writing and receiving letters are, as a rule, strictly prohibited, and reading, at all events during the first weeks of treatment, is in most cases forbidden, although patients may be read aloud to by the nurse if they desire it. Nourishment is given at frequent intervals according to the doctor's orders. Dyspeptic patients are usually confined for a week or a fortnight exclusively to a milk diet, while extreme cases of this kind, and also cases of obesity, may be kept on it during the whole time of treatment. In ordinary cases the milk is supplemented by a general diet after the first few days. Should a patient dislike milk, or find it difficult to digest, a teaspoonful of barley water may be added to each ounce, or it may be flavoured by the addition of a little tea, coffee, or caramel. If acidity is caused by the milk, lime, rice, or barley water may be added, in the proportion of a teaspoonful to the ounce. The milk given to the patient should be either cold or warm, and should only be boiled in cases of diarrhœa. It should be obtained fresh twice a day, and great care should be exercised in regard to its source and preservation. The skimming of the milk, when necessary in certain cases, should be thoroughly carried out. Massage may be ordered from the first, or it may be postponed till the fourth or fifth day of treatment. Half an hour is sufficient to begin with, and the time may be gradually increased, by a few minutes every day, to an hour or an hour and a quarter. Frequently massage applications are ordered twice a day, for an hour or more in the morning, and for the same time in the evening. In the morning the best time is from an hour and a half to two hours after the patient's breakfast; the second application may be given at 4.30 or 5 p.m., or at 8.30 p.m. if the patient suffers from insomnia. At this later hour it is usually advisable to omit the manipulations for the abdomen, as abdominal massage frequently causes restlessness when given at night; most attention should then be paid to the limbs and back (*see* "Massage for Insomnia").

The massage applications should be gentle in every case at first, and increase gradually in vigour as the patient becomes accustomed to the treatment. The movements previously given for "General Massage" should be employed, and a good proportion of the time should be given during the morning hour to manipulation of the abdomen. Very vigorous rubbing is not conducive to the formation of fat, and is unnecessary and inadvisable for emaciated patients. In cases of obesity it is necessary to work deeply in order to reach the tissues through the deposits of fat. These cases bruise very easily, and the tissues should be carefully prepared for deep, vigorous work by gentle preliminary manipulations. The best movements for promoting the absorption of fat are pétrissage, kneading, and rapid stroking.

Neurasthenic patients may suffer from colitis. In such cases special attention should be given to massage of the abdomen, as there is often an accumulation of mucus in the colon, and peristaltic action is weakened, causing disinclination for food and general depression. A good deal of deep kneading should be employe along the course of the colon, beginning at the splenic flexure. The abdomina muscles, being wasted and flabby, are unable to afford normal support to th underlying viscera, therefore great care should be taken not to cause any viscera displacement when carrying out the deeper movements. Constipation is commo in these cases.

Neurasthenic patients also often complain of "sore spots" along the course o the spine, and sometimes between the ribs. These should be carefully encroache upon, and kneaded gently with the tips of the fingers. After a time it will gener ally be found that these sore places cease to exist. The daily massage usuall continues until a week or ten days before the patient gets up and begins to wal about. It is then employed only on alternate days.

Dr. Weir Mitchell's plan, during the last weeks of treatment, was to have th patient's limbs exercised for half an hour by slow, passive, extreme flexions an over-extensions. These passive movements were then followed, after a few days by assistive, then by free, and, lastly, by resistive movements. It is usual now t employ joint movements after the rubbing from the first.

For Weir Mitchell cases it is not as a rule desirable that the offices of nurs and masseuse should be combined in the same person, as the variety made by th daily visits of the masseuse is pleasant to the patient, and acts beneficially upo her. The latter should be discouraged from talking about her ailments, and th nurse or masseuse, on their side, should avoid all conversation about illness. It i very essential that the environment, mental and otherwise, of the patient shoul be made as cheerful and healthful as possible.

CHAPTER VI

MASSAGE FOR SPRAINS, DISLOCATIONS, RECENT FRACTURES, AND STIFF JOINTS

prained Knee—Slipped Cartilage—Lawn-Tennis Leg—Sprained Ankle—Sprained Wrist—Dislocation of the Jaw—Dislocation of the Shoulder—Fractures of the Neck of the Femur—Fracture of the Patella—Fracture of the Tibia and Fibula—Pott's Fracture—Fracture of the Humerus—Fracture of the Olecranon Process—Colles's Fracture—Stiff Shoulder—Stiff Knee—Diseases of the Tendon Sheaths—Non-Infective Bursitis.

SPRAINS

1. **Articular Sprains.**—When a joint is forced to move beyond its natural mits in any direction, so that the soft structures which bind the bones together re overstretched or torn across, it is said to be sprained or strained.

Simple articular sprains are those involving only the soft parts of the joint, uch as the ligaments and synovial membrane. In a slight injury of this kind one r more of the ligaments which surround the joint are overstretched. It is escribed as a strain, and the symptoms are pain, stiffness, and some loss of power; welling is absent. In severe cases the ligaments may be either partially or ompletely torn across or severed from their attachment to the bone. Swelling is resent in addition to the pain and loss of function. If this is immediate, it is due the outpouring of blood from ruptured vessels; if deferred for some hours or ays, it is due to serous effusion.

Complicated sprains are those in which the tendons, muscles, and nerves in the eighbourhood of the joint are injured as well as the ligaments. A small fracture s sometimes also involved in a sprain, when a ligament tears away the portion of ne of the bones to which it is attached.

The pain in a recent sprain is caused by injury to the nerves supplying the art, and by pressure upon them due to inflammation and effusion.

If a severe sprain is neglected the consequences are as follows:—

1. The extravasated blood becomes clotted and develops into strong fibrous or car tissue which binds ligaments and often bones together, causing extreme stiffess, or, in the latter case, immobility of the joint. The other structures, muscles, endons, vessels, and nerves in the region of the injury also become matted ogether, and the result is pain and further stiffness.

2. The ruptured ligaments may not heal properly owing to defective circulaion through the congested part, and this leads to permanent weakening of the oint.

3. The muscles which act upon the injured joint become wasted through naction or from injury to the nerve supply, and the result is a weak or flail joint.

Massage, including passive and active movements, aims at preventing the above onsequences in the following ways:—

1. It improves the circulation, and this leads to the better and more speedy epair of the injured tissues.

2. It promotes absorption.

3. It prevents the formation of adhesions, and consequent pain and stiffness, y the removal of the coagulated blood and lymph from the injured area and by arly movement of the joint.

4. It takes the place of exercise, so preventing atrophy of the muscles which ct upon the joint.

Treatment of Articular Sprains in General by Massage and Other Methods

The bandages having been carefully removed, the injured limb is placed in comfortable, easy position, so that the muscles are relaxed. It is also raised possible, in order to aid the return circulation. Effleurage and gentle frictio movements only are employed at first, and these should be centripetally directe In carrying them out the masseuse should steady the injured joint with one han and with the other gently manipulate the parts above and about the seat of injur This hastens absorption and clears the venous and lymph passages, so promotin the return of blood and lymph from the injured area. The injured joint itself then approached, the most tender spots being manipulated last. In three or fo days, or whenever the effusion and consequent pain have subsided or almost sub sided, the effleurage and friction applications may be made with greater firmnes and passive or active joint movements, according to directions, commenced. The should be carefully graduated, and given with due regard to the particular lig ments or tendons involved in the injury. Sir Wm. Bennett says in this connectio in his book, *Massage and Early Passive Movements in Fractures and other Commo Surgical Injuries*, that "the first movements used should be those of the simple kind,—for example, flexion and extension in the hip and knee, antero-posteri movement in the shoulder; abduction and adduction should then follow, an finally, rotation and circumduction in joints permitting of that movement. Th sequence, however, is always interrupted for the following reason, which is paramount importance: the last movement to be practised should be that whic so far as can be ascertained, was concerned in the production of the injury." I cases of sprained ankle the toes may be gently moved from the first but not their fullest extent, and in cases of sprained wrist the metacarpo-phalangeal join may be slightly flexed and extended on the first or second day after the injur Passive joint movements, while they prevent and break down adhesions, do litt to prevent the wasting of muscles; free and, later, resistive movements shou therefore be commenced as soon as possible, as they promote muscular develo ment. In every case these movements must be preceded by massage, when possib of all the muscles which act upon the joint, from their insertion to their origi It is well when moving a sprained joint to extend first and then flex it, as exte sion causes less pain than flexion.

Recent writers advocate the use of firm elastic pressure in the treatment recent sprains with effusion, combined, in cases of simple sprain, with early acti rather than passive, movements. In Whitelocke's *Sprains and Allied Injur to Joints* the following passage occurs: "Active or voluntary movements a physiologically and are of the greatest service. Their application is alm universal, and, with certain simple and rare limitations, may be employed at stages and in all conditions of sprain, whether articular or muscular. A volunta movement implies the passage of a voluntary nervous impulse such as controls t whole process of nutrition in the tissues of the body. . . . In urging early volunta movements it must be understood that it is not suggested that all the muscles an injured part should be exercised or that they should be vigorously moved; f on the contrary, it is often of the greatest importance that the movements at fi should be of the gentlest possible kind, and only just sufficient to ensure t passage downwards of nervous impulses. It is also important that until rep is fairly advanced, the particular muscles which have borne the brunt of t incidence of the violence should be subjected to very little or no strain, while t neighbouring muscles, tendons, and ligaments are freely exercised."

By elastic pressure is meant, not bandaging with a strong rubber bandage, t with one made of domette or soft flannel firmly applied round the joint over lay s of gamgee tissue.

In a very interesting paper, the report of which appeared in the *Lancet* f 4th May 1912, Messrs. Morton Smart and Rowley Bristowe describe their met of treating sprains, both articular and muscular, by stimulation of the muscles wh the induced (Faradic) current. The latter is gradually increased and decreas ıen the electrodes are in position (by means of the central core in some coils, or ŀ the Lewis Jones interruptor if taking the current from a multostat), so that graduated contraction and relaxation of the muscles takes place. The writers the paper, while not belittling other methods, claim that quicker results are btained by this means than by massage and movements, and the cases which they ıote certainly seem to justify this conclusion. They have also used it with good sults in certain cases of fracture, chronic joint disease, in the post-operative eatment of certain lesions, and in chronic constipation.

Frequency and Duration of Massage Applications

These will, of course, be decided by the surgeon in charge of the case. It is sual for treatment to be ordered once, often twice, in the twenty-four hours, hile the length of the application varies from ten to thirty minutes, the time being xtended by a few minutes every day. If there is any continued increase of heat, ain, or swelling in the joint which has been manipulated, the treatment should be ıterrupted until the surgeon has been consulted.

2. **Muscular Sprains.**—Overstretching, rupture, and dislocation of muscles nd tendons come under this heading, of which lawn-tennis leg, rider's sprain, etc., re examples. In rupture of a muscle there is sudden pain in a definite spot, with erhaps a sensation of tearing in the part or of being struck. If there is a omplete rupture a gap in the muscles can be felt. There is swelling and tenderess about the part, and more or less loss of power according to the extent of the ıjury. Predisposing factors are want of training, and age.

The treatment of a ruptured muscle consists of approximation of the torn bres by strapping or a bandage, and in cases of complete rupture operative ıeasures may be necessary. The bandage or strapping prevents further extravasaion, and gives support to the part so that passive and active movements may be arried out when the swelling has subsided. Massage is also given.

SPRAINED KNEE

This is usually the result of a strain or wrench. There is more or less stretching ›r tearing of the ligaments, with effusion into the synovial cavity (synovitis). This ffusion is due to inflammation of the synovial membrane, and may subside in a short time or it may become chronic and relapsing if neglected.

Treatment.—The patient lies in the recumbent position, and a pillow is placed under the leg and knee. For the first two or three days, in cases of moderate njury, gentle effleurage and friction should be applied to the joint and to the parts ıbout it. The ankle may be moved slightly and actively from the first, and when the swelling subsides the knee joint should be slightly flexed and extended, this movement being preceded by gentle massage of the leg and thigh. Kneading of the parts should be commenced as soon as possible. In cases of sprained knee the tibial collateral ligament is the one usually injured, therefore care should be taken not to cause any lateral deviation of the leg when carrying out the passive movements. Rotation should be practised last, if not omitted altogether. It should be borne in mind that the quadriceps extensor, sartorius, and semimembranosus muscles send fibrous expansions to augment the capsule of the knee joint, and that its tone and the consequent stability of the joint is largely determined by the tone of these muscles. The tendons of the gastrocnemius, biceps femoris, semitendinosus, and gracilis muscles pass over and also support the knee joint; while the gluteus maximus and tensor fasciæ latæ muscles are connected indirectly with it through the ilio-tibial tract,[1] and, though remotely situated, very materially affect the joint. Therefore, in rubbing for sprains and all other injuries to the knee, all the muscles mentioned above should be masséed throughout their whole extent as soon as it is possible to do so, special attention being given to the quadriceps extensor muscle, as it generally shows an early tendency to waste.

[1] This is a band of thick fascia which lies along the outer side of the thigh, extending from the iliac crest above to the capsule of the knee joint and to the lateral condyle of the tibia below. It receives the insertions of the tensor fasciæ latæ and part of the gluteus maximus muscles.

In cases of very severe sprain, where there is acute inflammation of the join the patient is kept in bed and elastic pressure applied. Slight active movemen of the ankle may be performed from the first, but massage and passive movemen of the knee itself are not commenced until the effusion has subsided. If massag is ordered before this, it should be confined to the parts above and below tl joint.

When the swelling has disappeared, the knee itself should be masséed ve gently, effleurage and superficial frictions only being employed at first. Sligl flexion and extension of the joint may also be carried out, this movement bei preceded by massage of the leg and thigh. Deeper frictions round the knee shoul be gradually introduced, and kneading of the leg and thigh should be commence as soon as possible. A pillow should be placed under the leg and knee so th the limb may be in a comfortably relaxed position for the treatment.

DISLOCATED MENISCUS (SEMILUNAR CARTILAGE), POPULARLY CALLED SLIPPED CARTILAGE

This is the displacement of one of the menisci of the knee, usually the medi one, which may be partially or completely separated from its attachment to tl head of the tibia, the coronary ligaments being either stretched or torn. Tl injury occurs during the movement of rotation of the leg or the thigh when tl knee is in the slightly flexed position. It may be caused quite simply, by a sudd lateral or medial twist of the foot when walking or running. The immedia result is that the displaced meniscus becomes wedged between the articular surfac of the femur and tibia. Intense pain and inability to extend the leg upon tl thigh follow, but these symptoms disappear directly the meniscus has been slipp into place again. The after-effects of this injury are more or less effusion into tl joint cavity and loss of tone and injury to the capsule, due to distension. Aft reduction of the displaced cartilage, the early treatment consists of elastic pressu and rest for the joint. The ankle may be moved actively from the first to pr mote the nutrition of the limb. Massage is usually postponed until the effusi has subsided. After this, graduated active movements may be carried o avoiding any rotation of the leg. Massage prevents the wasting of the thi muscles, which is remarkably rapid in these cases, and is a powerful factor in t tendency to a recurrence of the accident.

SPRAINED OR LAWN-TENNIS LEG

The symptoms of a strained leg are as follows: A sudden, acute pain is f in the back of the leg, and the patient is unable to put the heel to the grou through the contraction of the gastrocnemius muscle. Swelling and great d coloration follow. This injury may be caused either by the rupture of a mus or tendon in the back of the leg—the plantaris muscle is the one commor supposed to be affected—or by the rupture of a large vein. In either case massa treatment is beneficial in hastening the removal of extravasated blood and in p venting the formation of adhesions. If the injury is caused by the rupture a muscle or tendon no joint movements must be given which would cause a drag upon the torn tissues. Thus dorsi-flexion of the foot must be delay until repair is fairly advanced. Complete union takes place in two or thr weeks. When the swelling has subsided the patient should be encouraged walk, keeping the heel on the ground, the bandage having first been reapplied. boot or shoe with a flat heel may be worn.

If it is a case of a ruptured vein, plantar and dorsi-flexion of the ankle may carried out after the rubbing from the first, but before doing so the band should be reapplied.

The patient should lie on a couch with the limb well raised while the mani lations are carried out. These should begin with effleurage from the ankle beyond the knee; kneading of the parts should follow as soon as possible. movements which tend to stretch the muscles at the back of the leg should employed, but care must be taken in the case of a ruptured muscle or its tendon not to do so before union has taken place.

Treatment of a Severely Sprained Ankle in which the Lateral Ligament of One Side is Torn

The patient lies on a couch, and a pillow is placed lengthways under the foot and leg.

First Day.—Gentle effleurage and superficial friction of the parts above and about the seat of injury, gradually encroaching on the painful area.

Joint movements: Plantar and dorsi-flexion of the toes.

Second and Third Days.—Effleurage and friction, followed by movements of the toes as before.

Fourth Day.—Effleurage and friction, applied with greater firmness.

Joint movements: Plantar and dorsi-flexion of the toes.

Fifth Day.—Effleurage and friction as before, increasing in firmness as the state of the injured part allows.

Joint movements: (1) Plantar and dorsi-flexion of the toes; (2) slight plantar and dorsi-flexion of the foot.

On each succeeding day it will be found possible to work more deeply and to move the joints more fully. Great care should be taken to steady the joint with one hand while rubbing with the other, and also to keep the foot perfectly straight when giving passive movements to the ankle, so as not to cause any drag on the injured ligament.

Movements of inversion, in the very usual case of injury to the anterior and posterior talo-fibular and calcaneo-fibular (O.T. external lateral) ligaments, and of eversion in the case of the same to the deltoid (O.T. internal lateral) ligament, should not be carried out until the rupture has quite healed, which will not be for about six weeks if the ligament has been badly torn.

In cases where a piece of bone has been detached with the ligament, massage treatment should be given as in the above case, but the joint must not be moved until the bone has united, which will not be for two or three weeks.

In cases of slight sprain it will be found possible to gently manipulate the most tender parts from the first, and to commence movement of the joint on the second day.

SPRAINED WRIST

In a case of this kind the procedure is the same as that given above for the ankle. All the muscles which act upon the fingers and wrist should be carefully masséed, from their insertions to their origins. Gentle passive and active movements should be given as soon as possible, to the fingers first, and then to the wrist, followed by pronation and supination of the forearm.

DISLOCATIONS

A dislocation is the displacement of the articular surface of one or more of the bones which enter into the formation of a joint.

In an injury of this kind the capsule and other structures surrounding the joint are torn, and the aim of massage is to prevent muscular wasting and the formation of adhesions.

Treatment of Dislocations in General

Massage may be commenced immediately on the reduction of the dislocation. As in the case of sprains and fractures, the manipulations should begin each day, until the effusion has subsided, on the proximal side of the injured joint. Effleurage and gentle friction movements only should be employed at first. Later careful kneading and pétrissage movements may be added. All the muscles which act on the joint should be manipulated, special attention being given to those lying directly over it, while care should be taken not to over-tire the muscles by eithe too prolonged or too vigorous rubbing. Passive joint movements may follow th massage on the third day. Sir William Bennett says in his *Lectures* that "thi passive movement may be very free in all directions save that which is toward the muscles which tend to waste. For example, in the case of the shoulde abduction of the arm from the trunk should not be practised for a week or ten day after the injury, because the strong action of the adductors, unopposed for th time being by the weakened deltoid, tends to displace the head of the humeri inwards. For the same reason, in the first week, no voluntary movement shoul be allowed, all movements being passive."

DISLOCATION OF THE JAW

In dislocation of the jaw the head of the mandible slips downwards an forwards. The dislocation may be either unilateral or bilateral. It is due to lax condition of the ligaments, tendons, and muscles of the joint, and may l chronic or recurring. Laughing or yawning may cause the dislocation. Massag may begin at once, and should consist of gentle friction of the muscles whic move the joint. Light tapôtement may be added on the third or fourth da The patient should be directed to open the jaw slightly from the first, while tl masseuse places her fingers in front of the joint to prevent the condyle fro slipping forwards.

DISLOCATION OF THE SHOULDER

Massage is particularly useful in dislocations of the shoulder, as, owing to tl shallowness of the glenoid cavity and the looseness of the capsule, the bones a mainly held in position by the muscles and tendons overlying the joint. Tl forearm should be carefully supported during the treatment.

First and Second Days.—Steady the shoulder with one hand and with the oth apply gentle effleurage first to the muscles on the proximal side of the joint, relieve tension in the swollen area, and then to the deltoid, biceps brachii ar triceps brachii muscles.

Third Day.—Effleurage as before.

Passive joint movement: Flexion and extension of the shoulder.

On the fourth and succeeding days the massage may gradually increase in vigo and duration, and other movements may be added. Percussion may be give when the inflammation has completely subsided.

Passive joint movements: Flexion and extension of the shoulder, follow by rotation and circumduction, and, after a week or ten days, by abduction ar adduction. Voluntary movements may usually commence on the eighth day the same order, namely, flexion, extension, rotation, and circumduction, abducti and adduction, and may increase in range daily as the muscles regain their tone.

In massage of the shoulder the latissimus dorsi muscle must not be neglecte as, though remotely situated, it acts powerfully upon the joint.

FRACTURES

There are three kinds of fractures, namely:—

1. True fractures.
2. Greenstick fractures.
3. Epiphysial fractures.

True fractures may be either simple or compound, and each of these again m be either comminuted, multiple, or complicated.

A simple fracture is one in which the bone is broken, but in which th is no skin wound by means of which the air comes into contact with the brok bone.

A compound fracture differs from a simple one in that either the broken bo is forced through the skin, or there is a wound which forms a communicati

Comminuted simple or compound fractures are those in which one or both ends f the bone have been broken or splintered into several pieces.

Multiple simple or compound fractures are those in which the bone has been roken in more than one place.

Complicated simple or compound fractures are those in which a large artery, ein, or nerve in the neighbourhood of the fracture is injured, or where a joint is nvolved, such as is the case with fractured patella or fracture of the olecranon rocess. An impacted fracture is one in which one end of the broken bone has een driven into the other.

Greenstick fractures occur in children; in them the bone is only broken or plintered through part of its thickness and is then bent.

An epiphysial fracture is one in which an epiphysis or centre of growth at ne or other end of a bone has been separated or displaced. This kind of fracture an occur only in young people before their bones have completely developed.

Pathology of Fractures

When a fracture occurs all the tissues in its neighbourhood are more or less involved in the injury. Muscles, tendons, nerves, and vessels are torn. Blood is poured into the surrounding parts, which, if not soon removed, leads to the formation of "scar" tissue and consequent binding of the softer parts to each other and to the bone. Neuritis of the nerve or nerves involved follows, causing intense pain. Almost immediately after the injury a blood clot forms around the ends of the bone; this is gradually converted into callus by the deposit in it of lime salts, and ultimately into new bone tissue. It is by this means that union of the broken bone is effected and begins to take place about a week after the injury has occurred. Excessive callus occurs where there has been much laceration of the periosteum; it entombs and compresses the vessels, nerves, muscle fibres, and tendons in the neighbourhood of the fracture, and this is also a source of pain and stiffness. The joint in the neighbourhood of the fracture is always affected by it to a greater or less degree. Adhesions may form, due either to the outpouring of blood into the joint cavity or to the adhering together of the loose folds of the capsule, which occurs when a joint has been kept at rest for any length of time.

The matting together of the muscles and tendons near the fracture and their frequent adhesion to the bone are also common causes of joint stiffness, as well as the contraction which often takes place in a muscle which has been torn, during its process of healing by the formation of scar tissue.

MASSAGE IN RECENT FRACTURES

In removing the bandages and splints and in carrying out the movements the greatest care must be taken to adequately support the fracture so as not to cause the smallest displacement of the broken ends of the bone. Very light effleurage only should be employed at first and should be slowly, smoothly, and rhythmically performed. The strokes should always be made in the direction of the venous flow or of the muscular fibres, and the hand, in performing the movement, should mould itself to the parts under treatment. In the case of a limb the massage should begin each day, until the swelling has subsided, by gentle effleurage of the parts proximal to the seat of the fracture. The strokes may then commence distal to the latter, and the hand is passed up the limb, avoiding pressure upon the actual site of the fracture. After this general effleurage of the limb has been carried out, more local treatment of the muscles immediately round the fracture may be given gently with the thumbs or pads of the fingers. It is essential that the whole limb should be masséed to prevent the muscular wasting consequent upon inaction; for instance, in fractures of the leg, the thigh should receive attention as well as the lower part of the limb.

As soon as possible, passive movements of all the joints of the injured limb should be carried out. These should be slight at first and gradually increased in range, and they should include all the movements of which the joint is capable.

They should always be preceded by massage and should never cause pain. In th case of some joints (such as the toes in fracture of the bones of the leg) movemen in all directions may be carried out from the first, in others it must be postpone till union is further advanced; and certain movements, such as rotation in the cas of a fractured humerus, must be delayed for some time after other movements ca be safely carried out. In all cases before union is quite firm the site of th fracture must be carefully steadied. Early active movements of certain joints ma also be given; for instance, in a case of Colles's fracture, the fingers and thumb ma be moved actively as well as passively from the very beginning.

Massage treatment is ordered in cases of recent fracture in order to reliev muscular spasm and consequent pain, and to prepare the way for passive mov ments. It is very important that the patient's muscles should be in an absolute relaxed condition while the latter are being carried out, so that the movement a really passive one and not either resisted or assisted by the patient.

In compound or in simple fractures, when the skin has been injured as well a the deeper tissues, it will only be possible at first to manipulate the parts in th neighbourhood of the injury, but passive movements may be carried out as in th other cases.

Any continued increase of heat, pain, and swelling in the joint or par manipulated is an indication that massage must be discontinued until the surgeo in charge of the case has been consulted.

FRACTURES OF THE NECK OF THE FEMUR

Intracapsular.—This is a fracture which commonly occurs in old peopl and owing to the danger of bed-sores and pneumonia no splints are used as a rul and union of the bone cannot generally be expected. Smooth rubbing may b commenced immediately to allay muscular spasm and pain.

By degrees stroking may be followed by kneading movements, first superfici and then deep, the whole thigh being manipulated as well as the parts immediate round the hip joint.

Passive joint movements may begin on the second day. These should b limited, for the first week, to flexion and extension of the thigh. Movements abduction and adduction may then follow, and at the end of about a fortnigh circumduction may be commenced.

Extracapsular.—These fractures usually occur in younger patients, an may be treated like fractures elsewhere by splints. Massage and joint mov ments are not usually commenced till late, the latter may then be carried out the order given above.

FRACTURES OF THE PATELLA

In fractures of the patella the bone is, in nearly every instance, broke transversely, and the object of massage and passive movements is to prevent th formation of adhesions and consequent fixation of the upper fragment of th patella to the anterior surface of the femur.

If the patella has not been wired, exceptional care must be taken in carryin out the movements, so as not to cause any separation of the fragments. For th reason they should be fixed together by the finger and thumb of one hand whi the manipulations are performed by the other. These should at first consist on of gentle stroking movements, special attention being paid to the parts round th upper fragment. The posterior aspect of the knee must also be treated, and f this the heel must be carefully raised a little and supported. When the effusion h begun to subside the patella should be moved to and fro. In doing this the tw fragments should be firmly fixed together, each being held between a finger an thumb. After a few days the strokings may become firmer. These should b applied to the leg and thigh as well as to the parts immediately around th fracture area, in order to maintain the nutrition of the limb and to prepare f passive movement of the knee joint. Special attention should be given to th

In doing this the masseuse should grasp the upper portion of the patella and push it firmly downwards, so as to prevent disunion between the fragments.

FRACTURE OF THE SHAFT OF THE TIBIA (USUALLY ABOUT FOUR INCHES ABOVE THE ANKLE JOINT, AND ACCOMPANIED BY FRACTURE OF THE FIBULA AT A HIGHER LEVEL)

The limb is placed upon a back splint with a foot-piece, and is secured to it by bandages, at the ankle and knee only if early massage is to be employed. This enables the masseuse to manipulate the parts about the fracture area and to give passive movements to the toes without, at first, removing the bandages. Straight side splints are applied on either side of the leg, and fixed by webbing or straps. Sometimes sandbags are used instead.

Smooth massage may begin any time after the bone has been set, to allay muscular spasm.

The side splints are first carefully removed. The masseuse steadies the limb with one hand, and with the other very gently strokes the parts above the fracture for two or three minutes. Then, starting from below, the hand is passed over the injured area, but without pressure upon the actual site of the fracture. In carrying out this movement the leg should be grasped firmly and gently, the whole palmar surface of the hand and fingers being applied to the limb and then passed smoothly upwards.

The treatment is given daily for from ten to twenty minutes. On the third or fourth day, or even earlier, after the usual rubbing, the toes may be moved *en bloc*. The masseuse steadies the seat of fracture with one hand, and gives dorsi-flexion of the toes with the other. This moves the muscles and tendons on the front of the leg and prevents the formation of adhesions round the fracture. In doing this the bandage round the ankle need not be removed, the masseuse can bend the toes forward by inserting her fingers between them and the foot-piece.

On the fifth, sixth, or seventh day, according to the progress made, the ankle joint may be moved. The bandage round it is removed and the foot and ankle, as well as the leg, are masséed for fifteen minutes. The masseuse then steadies the fracture with one hand, grasps the foot firmly with the other, and gently carries out movements of the ankle to a very small extent in all directions two or three times. These movements should gradually extend in range every day. About the tenth day it will be possible to begin to manipulate the leg more thoroughly and for a longer time. Free movements of the ankle may now be practised, the fracture being steadied by the operator's hand. In three weeks' time the knee joint may be moved, the thigh having been previously rubbed as well as the leg and the joint itself. The safest way to carry out this movement is to support the fracture by two short side splints held in place by webbing or straps. The masseuse then grasps the foot with one hand, places the other under the knee, and bends the joint very slightly two or three times.

There is another method of carrying out this movement, which should, however, only be practised by those who are very experienced in the handling of fractures. It is as follows: the masseuse, discarding side splints, places one hand under the knee and carefully bends it, while the other hand supports the leg below the fracture.

During the fourth week the leg and thigh may be thoroughly masséed in the ordinary way, and free movements of the knee joint encouraged.

At the end of a month resistive movements of the ankle and knee may be practised.

POTT'S FRACTURE

Pott's fracture is a combined fracture and dislocation. The fibula is broken near its lower end, and the deltoid ligament of the ankle is ruptured and followed by lateral dislocation of the foot.

Massage may be ordered from the outset or it may be delayed for a few days.

Treatment.—Great care should be taken, in carrying out the treatment, not to drag upon the injured ligament by any lateral deviation of the foot, and also tc support the ankle firmly with one hand while rubbing with the other.

First, second, and third days.—Gentle effleurage of the leg and foot. Passive joint movements; plantar and dorsi-flexion of the toes, moving each one singly.

Fourth day.—Effleurage of the leg and foot, as before, followed by very gentle manipulation of the parts about the injured area with the two thumbs or the pads of the fingers. Passive joint movements; plantar and dorsi-flexion of the toes. Slight plantar and dorsi-flexion of the ankle, the masseuse steadying the seat of fracture with one hand. Each succeeding day the strokings may be firmer, and the passive movements of the ankle gradually extended in range and carried out in all directions. Some surgeons now advocate the use of very early active movements in these cases, and postpone the massage and passive movements for two or three weeks.

FRACTURE OF THE HUMERUS NEAR THE SHOULDER JOINT

In fractures of this kind the arm is usually put in a sling and a leather or poroplastic shoulder cap worn, which can be easily removed for the daily rubbing. For the first four days slight antero-posterior movements of the arm may follow the smooth rubbing. On the fifth and following days movements of abduction and adduction may be given, and in a fortnight circumduction and rotation. All these movements should be very gently carried out. In doing them the masseuse should support the patient's forearm upon her own, and steady the fracture with the hand of the other side. The muscles of the forearm and shoulder should be treated as well as those of the upper arm. The fingers and wrist should be moved from the first day.

FRACTURE OF THE OLECRANON PROCESS

If there is wide separation between the fragments an operation is necessary Massage may be postponed for a week or ten days or may be commence immediately. For treatment the position for the patient is the recumbent one with the forearm comfortably supported on a pillow and the hand half-way between pronation and supination; the elbow should be flexed to a point midway between full extension and flexion to a right angle. Massage should be given daily for fifteen or twenty minutes and should include the whole arm and the shoulde muscles. The finger and wrist joints may be moved after the massage in al directions. Slight and gradually increasing supination and pronation may also b given. Flexion of the forearm should not be increased beyond the right angle fo the first fortnight, nor should full extension be allowed. The shoulder should als be moved, but to a limited degree at first. In cases of slight separation, when th aponeurotic expansion of the triceps is not torn, and operation has not bee necessary, massage and early passive movements may be given as above. Grea care must be taken not to displace the upper fragment. In performing flexion th operator should press the detached portion of the bone downwards so as to mak it move with the forearm, otherwise there is danger of its becoming adherent t the humerus. When this takes place the triceps muscle, having no attachment t the forearm, loses its power to extend the joint.

COLLES'S FRACTURE

Colles's fracture is a fracture of the radius less than an inch above the wris joint, and is always complicated by a strain of the joint. It is put up in splint so applied that the fingers can be moved at will, the patient being encouraged t do this from the first as frequently as possible.

Treatment.—The back splint is removed and the patient's arm rests on th anterior splint on a table. The massage treatment consists for the first week effleurage of the arm and of the dorsal aspect of the hand and forearm for ten fifteen minutes. The parts about the wrist joint may receive special attention movements of the thumb and fingers may be carried out, also passive movements of the elbow and shoulder.

In a week's time the wrist may be moved. The masseuse steadies the seat of the fracture firmly with one hand and with the other very slightly extends the joint. After this, flexion, extension, adduction, and abduction of the wrist may be carried out daily.

STIFF JOINTS

Massage for Stiff Shoulder (Chronic Case)—

1. Effleurage of the whole arm.
2. Kneading of the biceps brachii and triceps brachii muscles.
3. Pétrissage of the deltoid muscle.
4. Frictions with the finger-pads round the joint.
5. Manipulation (stroking and kneading) of all the muscles which move the joint.

Fig. 158.—Special Wringing Movement for Stiff Knee.

6. Frictions with the finger-pads along the cervical and upper dorsal regions of the spine.
7. Percussion.
8. Vibrate upon the motor points of the muscles surrounding the joint.
9. Effleurage.

Joint Movements—

1. Flexion and extension of the forearm.
2. Flexion and extension of the arm.
3. Abduction and adduction of the arm.
4. Arm rolling and arm rotation.

Massage for Stiff Knee—

1. Effleurage and pétrissage of the calf muscles.
2. Effleurage, kneading, and pétrissage of the thigh.
3. Support the knee with one hand, and knead the tissues all round the joint with the heel of the other (the right and left hand are used alternately).
4. Frictions round the patella and on either side of the articulation with the thumbs.
5. Frictions beneath the knee in the popliteal space with the tips of the fingers of both hands.
6. Effleurage beneath the knee with the palmar surface of each hand alternately.

7. Place one hand above and the other below the knee joint, squeeze the tissue together and work the hands alternately backwards and forwards (wringing, se Fig. 158).

8. Grasp and move the patella.

9. Give vibration and percussion over the stretched muscles, and percussion wit cupped hands round the joint.

10. General effleurage of the limb.

Joint Movements—

1. Plantar and dorsi-flexion of the foot.
2. Flexion and extension of the leg.
3. Leg rolling.

DISEASES OF THE TENDON SHEATHS

Teno-Synovitis Crepitans. This is an inflammation of the synovial membran which lines the tendon sheath. It is caused by overuse of the muscles or strain c a tendon. A rheumatic constitution is a predisposing factor.

The *symptoms* are swelling and tenderness along the tendon, with pain an crepitation on movement. The tendons of the radial extensors of the wrist, th tendo calcaneus, and the peronei are those most frequently affected.

The *treatment* in the acute stage consists of rest, hot fomentations, or Bier passive congestion. In chronic cases hot air and massage are indicated. Th massage should consist of effleurage and deep frictions to reduce the thickening in the tendon.

Suppurative teno-synovitis is not treated by massage, but when all inflamma tion has subsided passive and active movements must be commenced.

Tuberculous teno-synovitis is not treated by massage and exercises.

NON-INFECTIVE BURSITIS

"Housemaid's knee" and "Miner's" or "Student's" elbow are commo examples of this form of bursitis. The causes are (1) injury and (2) occupation.

The *symptoms* of the simple acute form are swelling of the bursal sac wit pain on pressure and restricted movement. In chronic cases the changes in tl bursa are, variably, as follows: Hydrops (watery effusion) of the bursa with fibrinous deposit on the inner wall; the formation of fibrous bands across tl cavity; melon-seed bodies are sometimes formed in the wall of the bursa an become detached.

The *treatment* of the acute form consists at first of rest, hot fomentations, ar perhaps blistering. Operative measures are necessary in certain chronic case The after-treatment of acute simple bursitis consists of massage (effleurage ar frictions mainly) and passive and active movements.

BOOKS RECOMMENDED FOR FURTHER STUDY

Sprains and Allied Injuries of Joints (Second Edition), by Whitelocke.
Fractures and their Treatment, by Pringle.
Treatment of Fractures by Mobilisation and Massaje, by Mennell.

CHAPTER VII

PARALYSIS

HEMIPLEGIA—PARAPLEGIA—FACIAL—ULNAR AND MEDIAN—STERNO-MASTOID AND TRAPEZIUS MUSCLES — DELTOID MUSCLE — ERB'S — RADIAL (MUSCULO-SPIRAL) — INFANTILE — PROGRESSIVE MUSCULAR ATROPHY—DISSEMINATED SCLEROSIS—LOCOMOTOR ATAXIA—LITTLE'S DISEASE.

PARALYSIS is caused by some injury or lesion, occurring either in the brain, spinal cord, or in the nerve trunks, which interferes with the transmission of nervous impulses. As a result the power of voluntarily contracting either one or more muscles is lost (Motor paralysis).

This loss of power may or may not be accompanied by loss of sensation in the affected part (Sensory paralysis).

The various forms of paralysis may be divided into three primary groups, namely, those of cerebral, spinal, and peripheral origin.

Paralysis of cerebral origin is nearly always hemiplegic in type (involving one side of the body). Paralysis of spinal origin, on the other hand, is generally paraplegic (involving both sides of the body).

1. **Paralysis of Cerebral Origin.**—*Hemiplegia.*—Here one side of the brain is affected and the opposite side of the body is paralysed, either partially or completely. The sensibility of the affected part is usually not noticeably diminished. Hæmorrhage is a very usual cause of the paralysis, but it may be due to cerebral embolism or thrombosis. Crossed or alternate hemiplegia is a condition showing paralysis of one or more of the cranial nerves of one side, with loss of power on the opposite side of the body. It is due to lesions in the crus cerebri, the pons varolii or medulla.

In hemiplegia the upper extremity is as a rule more affected than the lower, and the proximal parts of a limb recover more quickly than the distal. The muscles of the arm which are most affected are the extensors of the wrist and fingers, the supinators and extensors of the forearm, and the lateral rotators of the arm. Those of the leg which are most and longest affected are the abductors of the thigh (particularly gluteus medius), the flexors of the leg, and the dorsi-flexors of the foot. The upper part of the trapezius muscle is the most noticeably affected muscle of the trunk. The muscles show no "reaction of degeneration." If the lesion is a slight one the limbs may regain their power completely in a few days. In severer cases secondary changes occur. The knee jerk is generally increased on the paralysed side, and ankle clonus (spasm of some of the muscles moving the joint) may be present. Post-hemiplegic chorea may develop. Contractures of the muscles frequently occur and give rise to deformity, which may be prevented or at least diminished by passive movements following massage, by stimulation of the weak muscles by electric currents, and by mechanical contrivances.

Atrophy of the muscles in hemiplegic cases does not occur at first as a rule, but develops after a time from disuse of the limb. Massage and passive movements are usually commenced from two to three weeks after the attack. All treatment should be most cautiously given. At first gentle massage of the extremities is sufficient, to be followed by graduated passive movements of the joints in every direction. In severe cases it is perhaps safer to postpone the latter until a little later. After some time gentle nerve vibrations and tapôtement may be adde Professor Osler advises stimulation by the faradic current after the lapse of a for night, or, in severe cases, a month, as being of great service, "especially if applied t the antagonists of the muscles which ordinarily undergo contracture." Combine galvanism and faradism is sometimes ordered and, in cases of late rigidity, th sinusoidal current. When some voluntary power has returned, the patient shoul perform some movements with assistance from the gymnast, and when possibl resistive exercises, first excentric and then concentric, should be given. In th latter case very slight resistance should be offered at first. Massage of th abdomen should not be given until several weeks after the onset of the attacl and then should be of a very gentle nature, as deep manipulations and compressio of the tissues there cause a temporary rise in the blood pressure and might caus further mischief. When the patient's strength permits a more general treatmen may be given to include the non-paralysed part of the body. In old hemiplegi cases, where there is contracture of the muscles and great stiffness in the joints, very great improvement in the condition can be made by massage, exercises, an electrical stimulation, especially if preceded by radiant heat treatment.

2. **Paralysis of Spinal Origin.**—Here the disease or injury involves bot halves of the cord, and consequently both sides of the body are affected in varyin degrees (*Paraplegia*). There is generally loss of power, either partial or complet in the parts supplied by the cord below the lesion, usually the lower extremiti and the lower half of the trunk; the arms are sometimes also affected. There ma or may not be a diminution of sensibility in the affected parts; this depends c the severity and extent of the injury.

3. **Paralysis of Peripheral Origin.**—This form of paralysis is caused l disease or injury somewhere in the course of a motor nerve trunk, and is follow by loss of power in the muscle or muscles which are supplied by the affect nerve. As there are very few purely motor nerves, this form of paralysis is usual accompanied by some loss of sensation which corresponds to the distribution of tl affected nerve to the skin.

The Reaction of Degeneration.—In severe cases of peripheral paralysis, and al when the disease or injury is situated in the nuclei of origin of motor nerve fibr either in the grey matter of the brain or of the spinal cord, a change in the e citability of the affected nerve or nerves, and of the muscles supplied by the takes place when tested by electric currents, and this change is known as t reaction of degeneration.

The reaction of degeneration is characterised by the complete loss of excitabili in the nerves to both the galvanic and faradic currents, while the muscles on respond to the former in a sluggish manner, and lose their excitability to rapid interrupted (faradic) currents completely. In addition, the muscles may be mo easily stimulated when the anode is the active and the kathode the indiffere electrode. Normally the reverse obtains.

Partial Reaction of Degeneration.—This is the term which is applied to cas in which the muscles contract feebly to rapidly interrupted currents, wh responding sluggishly to the continuous (galvanic) current.

Massage treatment is ordered, in certain cases of paralysis, not in the hope f setting up beneficial changes at the seat of disease or injury, whether it be i brain, spinal cord, or the nerve trunks, but in order to maintain the nutrition f the muscles, so that they may be able to respond to the action of the nerves wh the functional activity of the latter is restored; passive and active movements a given, also to prevent contractures and to re-educate the affected muscles.

FACIAL PARALYSIS

Facial paralysis is usually due to some disease of, or injury to, the trunk of the facial nerve (peripheral paralysis), but it may also be of central origin. If caused by disease of the trunk of the nerve, the seat of the affection is usually in that p t of the nerve which lies in the narrow canal in the temporal bone—the Fallop n aqueduct, where even a slight amount of effusion causes compression of the ner

Disease of the ear, hæmorrhage, exposure to cold, etc., may be the cause of such effusion.

In severe cases the patient is unable to move any of the muscles on one side of the face, and consequently the power of moving the mouth, of dilating the nostril, of frowning, or of closing the eyelid on that side, is lost, while the muscles become wasted and flabby. When the face is at rest the angle of the mouth on the affected side is depressed, and in smiling the lips are drawn towards the healthy side.

Massage Movements.—Pétrissage (picking up), percussion (tapping), and vibration should be employed upon the affected side of the face. The vibratory movements should be especially employed over the three main branches of the facial nerve. The muscles on the unaffected side may be stroked in order to prevent them from shortening.

When some return of power has taken place, or in cases where the paralysis is not complete, the patient should be encouraged to exercise the muscles on the affected side of the face, by frowning, closing the eyelids, and moving the lips.

PARALYSIS OF THE STERNO-MASTOID AND TRAPEZIUS MUSCLES

Paralysis of the sterno-mastoid and trapezius muscles is caused by disease or injury of the accessory nerve trunk, or of its nucleus of origin. The muscles usually waste rapidly, and show the reaction of degeneration. When the sterno-mastoid muscle is affected the power of rotation of the head to the opposite side is diminished. Paralysis of the trapezius muscle is recognised by the lowered position of the shoulder, and by a less pronounced curve from the neck to the tip of the shoulder on the affected side; while the vertebral margin of the scapula, instead of lying parallel to the spinal column, forms an angle with it, its inferior angle being nearer to, and its medial angle farther away from, the middle line of the back.

Massage Movements.—The affected muscles should be stroked and thoroughly kneaded. Percussion (hacking) and vibratory movements should be freely given. Deep frictions with the fingers should be carried out along the cervical region of the spine.

Joint Movements (*Passive*)—

1. Rotation of the head towards the unaffected side.
2. Flexion and extension of head.
3. Elevation of the arm above the head.

These movements should be actively carried out as soon as possible, and, later, resistive exercises for the affected muscles should be given.

When voluntary power has to some extent returned, the patient should be encouraged to elevate, depress, and to rotate the shoulder girdle backwards.

PARALYSIS OF THE DELTOID MUSCLE

Paralysis of this muscle is due to injury, either to the trunk or to the intramuscular branches of the axillary (circumflex) nerve. Dislocation of the shoulder joint, a blow upon the shoulder, and pressure on the nerve through the use of a crutch are common causes of the paralysis. If the trunk of the nerve is injured the teres minor muscle is involved, as well as the deltoid. In paralysis of the deltoid the shoulder presents a flattened appearance, the acromion process becomes unduly prominent, and the patient is unable to abduct the arm. In severe cases, if the muscle is allowed to atrophy, there may be partial dislocation of the head of the humerus.

Where paralysis of the deltoid has a spinal origin the lesion very frequently involves the suprascapular nerve also, in which case the supraspinatus and infraspinatus muscles are paralysed in addition to the deltoid, and the power of lateral rotation of the arm is then lost, as well as that of abduction.

Massage Movements.—The affected muscles should be kneaded and percussed, and vibration should be given over their motor points. Deep friction with the finger-tips and vibratory movements should be carried out in the lower cervic region of the spine over the origin of the axillary (circumflex) and suprascapul nerves (fifth and sixth cervical). Finger vibration should also be given over Erl motor point, which is situated in the neck 1 inch above the clavicle and a litt to the outer side of the external border of the sterno-mastoid muscle.

JOINT MOVEMENTS—

1. Flexion and extension of the arm.
2. Rotation of the arm.
3. Arm rolling.
4. Abduction and adduction of the arm.

If the muscles are in a very wasted condition, great care should be taken carrying out these movements, as complete dislocation of the head of the humer may easily occur. They should therefore be limited in range until the conditi of the muscles has improved. Voluntary movements should be encouraged early as possible.

ERB'S PARALYSIS

This is the name which has been given to paralysis of the deltoid, bice brachii, coraco-brachialis, brachialis, brachio-radialis, and, occasionally, the spina muscles. It is also known as "root paralysis," because it is caused by injury disease of the two upper roots of the brachial plexus, namely, the fifth and six cervical nerves. In cases of Erb's paralysis the arm hangs by the side, and t palm of the hand is directed backwards. Sometimes the triceps brachii and t extensor muscles of the wrist become weak.

MASSAGE MOVEMENTS.—The whole arm and shoulder should be thorough masséed in the usual way, special attention being given to the affected muscl Deep frictions with the fingers should be employed in the cervical regi Vibration should be given over the motor points of the paralysed muscles, a upon Erb's point.

JOINT MOVEMENTS (*Passive*)—

1. Extension of the wrist (if the extensor muscles of the wrist are weak).
2. Flexion and extension of the forearm.
3. Supination and pronation of the forearm.
4. Flexion and extension of the arm.
5. Rotation and circumduction of the arm.
6. Abduction and adduction of the arm.

Free and resistive movements should begin as soon as possible.

RADIAL (MUSCULO-SPIRAL) PARALYSIS

The characteristic sign of paralysis of this nerve is wrist drop. The extens of the wrist and fingers, and the brachio-radialis and supinator muscles are usua affected. Sometimes, if the injury is high up in the arm, the triceps brachii mus is also involved. Radial paralysis is usually caused by pressure upon the ner. It often occurs in people who fall into a heavy sleep with the weight of the bo resting upon the arm. The use of a crutch may also cause pressure upon the ner. In such cases the axillary (circumflex), the ulnar, or the median nerve are som times also involved. It is one of the commonest forms of paralysis resulting fr chronic poisoning, *i.e.* lead poisoning.

MASSAGE MOVEMENTS.—All the ordinary movements for the arm and shoul may be given, with the addition of percussion upon the back of the forearm, a finger vibration upon the motor points of the affected muscles, and upon Er point. Most time should of course be expended upon the paralysed parts. T cervical region of the spine on the affected side should be kneaded with the tips the fingers.

JOINT MOVEMENTS—

1. Extension of the hand.
2. Flexion and extension of the forearm.
3. Supination and pronation of the forearm.

4. Flexion and extension of the arm.
5. Abduction and adduction of the arm.
6. Arm rolling.

Passive movements should be succeeded by free and resistive exercises when possible.

PARALYSIS OF THE HAND

Injury of the ulnar and median nerves near the wrist causes loss of power and of sensation, wasting, and the reaction of degeneration in the intrinsic muscles of the hand and fingers. Division of the former nerve produces the deformity known as "claw hand," in which, as the result of paralysis of the two inner lumbricals and the interossei, the proximal phalanges of the fingers become over extended, while the distal phalanges remain in the flexed position. There is also loss of sensation over both surfaces of the little finger, the ulnar side of the ring finger, and the corresponding part of the palm and back of the hand. Division of the median nerve at the wrist causes paralysis and wasting of abductor pollicis brevis, opponens pollicis, and flexor pollicis brevis (superficial head). The thumb is everted and there is loss of sensation on the palmar aspect of both sides of the thumb, index, and middle fingers, and the radial side of the ring finger.

Massage Movements.—The whole hand should be thoroughly manipulated first, then the arm and shoulder should be rubbed in the usual way. Vibration should be given along the course of the median and ulnar nerves, and also in the region of the lower cervical spine.

Joint Movements (*Passive*)—

1. Extension of the distal and flexion of the proximal phalanges of the fingers.
2. Finger rolling.
3. Abduction and adduction of the fingers, away from and towards the middle line.
4. Movement of the metacarpal bones.
5. Flexion and extension of the hand.
6. Wrist rolling.
7. Pronation and supination of the hand.
8. Flexion and extension of the forearm.
9. Flexion and extension of the arm.
10. Arm rolling.

Free, followed by resistive, movements should begin as soon as possible.

INFANTILE PARALYSIS

(Acute Anterior Polio-Myelitis; Acute Polio-Encephalitis)

Infantile paralysis is due to an acute infection which may involve any part of the brain, cord, and spinal ganglia, but which chiefly affects the grey matter of the anterior horns of the cord. Dr. L. G. Parsons describes it thus: "The symptoms are due to hyperæmia and œdema of the infected area, its infiltration with small round cells and the resulting destruction of the nerve cells. Symptoms due to the destruction of the nerve cells are permanent, *e.g.* the permanent palsies; those due solely to œdema are recovered from."

The disease usually attacks children of from one to five or six years of age, but younger and older children and adults may also be affected. The cause of the disease is unknown as yet, as the infective germs are ultra-microscopic and pass through the finest filter. It usually occurs during the summer months. The infective agent is said to enter the system through the nasal passages, or possibly through a lesion in the skin, the virus travelling up inside a nerve sheath to the brain or cord. There may be an epidemic of the disease, several people in a certain district being attacked. The nasal passages of any infected person should be disinfected and the nasal discharges should be destroyed, as they may contain the infectious germ.

Acute Anterior Polio-Myelitis (Infection of the Grey Matter of the

Anterior Horns of the Cord).—The attack usually begins with fever or gastro intestinal disturbance. There may be headache and severe pain in the back an limbs. After a day or two paralysis sets in. The function of motion is impaired t a greater or less degree, not that of sensation. The paralysis is at first usuall extensive and may involve more than one limb. It gradually becomes mor limited as the œdema in the cord resolves, and in the end usually involves only on or more groups of muscles. In mild cases there is only slight muscular weakness but the severer forms are characterised by complete loss of voluntary power in th affected muscles, which tend to waste rapidly and to show the "reaction of degenera tion." Other symptoms are: loss of the deep reflexes, coldness and flaccidity c the affected limbs, and tenderness on pressure, which may persist for a considerabl time. The lower limbs are much more often affected than the upper, and certai groups of muscles are more liable to be affected than others; for example, th tibialis anterior, peronei, and the extensor muscles of the leg, and the deltoid an brachialis muscles in the arm.

Improvement usually begins in about a week, and the progress may continu slowly for weeks or years. There may be complete recovery although the paralys has been at first extensive. The prognosis is good if the muscles have not los their excitability to faradic currents at the end of two weeks. Even in severel damaged muscles improvement to a varying extent is effected by massage, exercise and electrical treatment. Spinal curvature and talipes are common results c infantile paralysis if not guarded against by special treatment. *Massage* an *passive movements* should be commenced as soon as the acute symptoms have dis appeared. Effleurage, pétrissage, and kneading should be given for the affecte groups, and should be carried out gently at first, as the parts may be very tend and the muscles tire easily. Later, percussion and vibration should be added. Th antagonising groups should be manipulated with a view to stretching them. I treating the back, special attention should be given to the region of the cord i which the lesion occurs. When possible, active movements should be substitute for passive ones, and should be introduced in the following order: assistive or fre excentric resistive, and finally concentric resistive. All movements should l carefully selected so as to develop and exercise the affected muscles and to stretc the antagonising groups. Great care should be taken to keep the patient war during the treatment, and to give very gentle and short applications at first so not to cause fatigue.

Acute Polio-Encephalitis.—The *symptoms* vary according to the part the brain affected. There may be infantile hemiplegia, ataxia, palsy, slow tremo hypertonus of the limbs, facial paralysis, or bulbar paralysis, which frequent terminates fatally.

PROGRESSIVE MUSCULAR ATROPHY

Progressive muscular atrophy is due to a chronic degenerative change in t cells of the anterior horn. It occurs more frequently in men than women, a usually develops in middle life. Its cause is obscure. It has followed trauma a lead poisoning. The atrophy and weakness usually begins first in the hand, t muscles forming the thenar eminence, the interossei, and the lumbricales wasti early. The extensor muscles of the wrist and fingers, the deltoid, biceps, serrat anterior, and the middle and lower parts of the trapezius are then usually involv The triceps, the upper part of the trapezius, and the latissimus dorsi may not affected. The extensors of the head are generally wasted. The muscles of t upper extremity and the trunk may be much atrophied before those of the low limbs are involved, and these latter may be spared altogether. The muscles of t face are attacked late in the course of the disease. Sensation is unimpair There may be diminution or disappearance of the deep reflexes. Fibrillary trem in the muscles are common. The limbs may be cold and numb. The wast muscles show diminished excitability to both galvanic and faradic curren Contracture and deformity are secondary results.

The prognosis is bad. So far no treatment has been found to cure the disea although massage, exercises, and galvanism may arrest it temporarily or retard its progress. The *gymnastic treatment* indicated in these cases is of a general nature, consisting of massage and passive and active movements, regulated to suit the patient's strength. To gain the best results the treatment must be commenced at as early a stage as possible and continued for a long time.

DISSEMINATED SCLEROSIS

This is a chronic affection in which there is degeneration of the nerve elements in certain scattered areas of the brain and cord, the normal nerve tissue being either in part replaced or overgrown by patches of neuroglia. The exciting causes may be influenza, scarlet fever, or other infectious diseases. Nervous heredity may be partly responsible for its onset.

The *symptoms* are variable, and include weakness and stiffness of the legs, paræsthesia, vertigo, increased reflexes, sphincteric weakness, constipation, rapid movement of both eyes (nystagmus), optic atrophy, intention tremor of the arms and legs (the patient trembles when attempting to perform some movement, the head may also shake when walking), staccato speech, mental changes. Inability to walk is an ultimate symptom. Contractures of the lower extremities occur, and the patient becomes bed-ridden. The disease is common in persons under forty. The patient often improves in health and there may be long periods of relief from the disease. Relapses, however, always occur unless some intercurrent disease proves fatal. The *treatment* consists of rest, massage, gymnastics, and electricity. The patient should not be fatigued by too strong massage or exercises, and the electrical stimulation should be mild. The spine should be treated only by rhythmic stroking and vibrations. The aims of the treatment are to preserve the nutrition of the muscles and nerves, to promote co-ordination of movement by double-sided exercises, and to relieve the tremor by nerve frictions and strokings.

LOCOMOTOR ATAXIA

(Tabes Dorsalis)

Locomotor ataxia is the name given to a disease of the nervous system in which there is loss of co-ordination in the movements of the limbs, those of the lower extremities being the earliest and most markedly affected. There is not necessarily any weakness or paralysis, but the movements are uncertain and frequently exaggerated. Locomotor ataxia is due to the degeneration of the posterior columns of the cord, of the posterior roots, and sometimes of the spinal ganglia. Degenerative changes may also occur in the cranial nerves and their nuclei.

Symptoms.—Lightning pains in the legs and sometimes also in the arms and trunk (usually an early symptom). Ocular trouble. Trophic disturbances (ulcers, Charcot's joint, atrophy of the muscles, etc.). Loss of the knee and ankle jerks. Sensations of constriction and of numbness and tingling in the extremities. Diminution or loss of cutaneous sensibility in certain areas. Diminution or loss of sensibility in muscles, tendons, and joints, causing ataxy (the patient walks in a peculiar way, cannot preserve his balance with his eyes shut, and, in advanced cases, is unable to stand or walk, even with the eyes open). Diminution of muscular tone, known as the hypertonic condition. When this is present the joints can be flexed and extended to an abnormal degree, owing to the relaxation of certain muscle groups. Hyperextension of the knee is frequent in these cases, owing to hypertonus of the flexor muscles, and the patient can flex the thigh completely upon the pelvis with the leg in the extended position for the same reason.

The course of the disease is slow. It may progress gradually from the incipient stage—marked by lightning pains, loss of reflexes, ocular and other symptoms, but showing little loss of co-ordination—to the markedly ataxic, and finally to the paralytic stage; or it may be arrested for a considerable time and may never advance beyond the first stage.

Treatment.—As the chief disabilities of the disease are due to a loss of muscle sense—the means by which we know in what position the limbs and their joints are and the state of contraction of the muscles—it is necessary to educate the patient to replace this loss, chiefly by the use of his sight. This is done by active free exercises which in some cases cure and in others greatly improve the ataxy Massage is also indicated to improve the tone of the muscles and to relieve anæsthesia and paræsthesia. Particular attention should be paid to the region of the spine, where vibrations, percussion, and frictions may be carried out.

Dr. H. S. Frenkel has elaborated an excellent system of treatment by exercises for this disease, which he describes in his book, *The Treatment of Tabetic Ataxia* translated by Dr. L. Freyberger.[1] He divides the exercises for the extremities into four groups—(1) Those done in the lying position; (2) in the sitting position (3) in the erect position; and (4) various evolutions carried out when walking.

Some of these are as follow:—

1. EXERCISES OF THE LEGS IN THE LYING POSITION

First Group

Fundamental Position.—The patient lies with the head and shoulders raised and the legs extended. He should be directed to watch and concentrate his attention upon each movement so as to make it as definite as possible. The heel should be kept on the bed throughout the exercise and the foot should be dorsi-flexed. The movement should be carried out slowly and should not be repeated more than four times. It should also be of normal extent so as not to further stretch the relaxed structures.

(*a*) Flexion and extension of one leg at the knee and hip joints.

(*b*) Flexion of one leg at the knee and hip, followed by abduction and adduction of the bent leg, and finally extension.

(*c*) Flexion of one leg to half the normal angle, and extension.

(*d*) Flexion of one leg as in the preceding, followed by abduction, adduction and extension.

Later on, both legs may be moved together and the same exercises may be varied by halts, either voluntary or by command, during flexion and extension.

Second Group

(*a*) Flexion and extension of one leg but with the heel raised from the bed

(*b*) The leg is flexed and the heel is placed upon some part of the other leg such as the patella, the middle of the tibia, the ankle, or the toes Between each exercise the leg is extended or the heel may be made to touch two or three points upon the other leg before extension.

These exercises may be repeated with halts, either voluntarily or by command.

(*c*) The leg is flexed and the heel placed upon the knee of the other leg The heel is then made to glide down the tibia to the ankle.

(*d*) The leg is flexed. The heel is placed upon the knee of the other leg and made to glide down the tibia to the ankle and up to the knee again; the leg is then extended.

The above may be varied by halts.

(*e*) Flexion and extension of both legs with the knees and ankles held close together.

(*f*) Flexion of one leg during extension of the other.

(*g*) Flexion and extension of one leg during abduction and adduction of the other.

(*h*) The gymnast places a finger upon some spot on the patient's leg, the patient tries to touch the finger with the heel of the other foot.

(*i*) The patient tries to put his foot into the gymnast's hand which constantly moved about.

The above movements may be varied in many ways, and when the patient improves some simple exercises may be given with the eyes shut.

[1] Rebman Ltd., 129 Shaftesbury Avenue, London, W.C., and 10 West Twenty-Third Street, New York.

Special apparatus may be used for exercises in the lying position, such as a board with holes in which to place the heels, and a bar which can be fixed across the bed at different heights and at varying distances from the foot of the bed and upon which the patient places his foot.

2. EXERCISES IN THE SITTING POSITION

(*a*) Maintaining the fundamental sitting position for a few minutes at a time.
(*b*) Raising each knee alternately and placing the foot firmly on the ground upon a traced footprint.
(*c*) Adduction of the knees between other exercises. The patient should also be taught how to rise from a chair and to sit down. In rising he should draw the feet back until the heels are on a line with or slightly behind the front legs of the chair, he should then bend the trunk forwards and gradually raise it to the erect position as the knees are extended.

To sit down, the knees should be flexed slightly at first, then the body should be bent forward a little and flexion in the knees and trunk should be continued until the movement is completed.

3. EXERCISES IN THE ERECT POSITION

These consist of walking exercises in which every kind of variation is made. Some of these are as follow:—

(*a*) Walking slowly forwards for a distance of about 20 yards. The patient should carefully watch every movement and try to correct the lateral rotation of the legs.
(*b*) Walking forwards as before, but upon a narrower base.
(*c*) Walking in which the patient is directed to keep the feet nearly parallel and to bring the heels together after each step.
(*d*) Walking forwards with steps of medium length.
  " " " short steps.
  " " " long "
(*e*) Walking, each leg taking alternately a long and a short step.
(*f*) Walking sideways, walking backwards, turning, walking along a zigzag border, walking and standing with bent knees, walking up and down a staircase, walking with the arms raised, or carrying a parcel or basket, are some of the many exercises used by Dr. Frenkel. For the walking exercises he advises the use of certain floor markings. These can be painted on linoleum and take the form of long black stripes of different widths, some of which are divided by white lines into sections to mark the distance of a full or half-step. A zigzag stripe is for another exercise, and pairs of footprints are also marked out. For a full description of these and of other apparatus and details of treatment, the translation of Dr. Frenkel's book should be obtained and studied.

The treatment for the upper extremities consists of simple active free movements, writing and drawing exercises, and those done with apparatus. A perforated board is one appliance used. The holes are numbered and the patient places the tip of the forefinger in a certain hole at the word of command. Catching suspended coloured balls is another exercise, also piling round discs one on top of the other. Endless exercises can be devised by the gymnast in order to re-educate the patient in accuracy and rhythm of movement. Special exercises to innervate the muscles of the trunk may be necessary, and may include such movements as wing lax stoop stride sitting trunk raising and wing close or stride sitting trunk twisting. Patients are said to derive great benefit from the slight stretching and relaxation which occurs in the cord and spinal roots during flexion and extension of the trunk, probably due to better circulation of blood and lymph through the parts.

Tabetic patients become very easily tired and excited. For this reason they should rest between the exercises, and the latter should be most carefully graduated. The pulse should be frequently taken, as it may be the only reliable indication of the fatigue caused by the exercise, the patients in these cases being more or less unconscious of feeling tired. Two courses in the day is the average amount of practice recommended by Dr. Frenkel, except in the case of stronger and more advanced patients, who may take three, the third perhaps being a short walk with frequent rests on the way. Very careful supervision is necessary when the patient is doing any exercise in the erect position, as he may at any moment suddenly lose his balance and fall down. The gymnast or an attendant should be close at hand to support the patient under the armpits at the first sign of loss of balance. Dislocations easily occur in these cases owing to relaxation of the joint structures, and for this reason patients should not be supported by the arms or hands. In bad cases belts with handles are used to hold the patient up during the exercises.

SPASTIC PARALYSIS OF CHILDREN (LITTLE'S DISEASE)

This condition is due to some lesion which may occur at birth, or it may be due to acute encephalitis, fevers, etc.

The *symptoms* are weakness and stiffness of the limbs, the spastic condition as a rule being more marked and frequent in the legs than in the arms; inco-ordinate movement is another symptom. In some cases the child is unable to walk, or cannot stand properly, or the gait is spastic, and there may be constant irregular movements of the arms, hands, and head. There is no atrophy of the muscles, and sensation is unimpaired. The deep reflexes are increased. Paraplegia is the name given to the condition when the legs only are affected, diplegia when the arms are involved as well. There may be mental symptoms, and epilepsy is common.

Massage and gymnastics are given in these cases to relieve the spastic condition, to strengthen the muscles, and to promote co-ordination of movement. The *treatment* should consist of effleurage, soothing strokings, passive movements, and simple active exercises for co-ordination.

CHAPTER VIII

DEFORMITIES

Spinal Curvature—Talipes—Flat-foot—Knock-knee—Wry-neck

SPINAL CURVATURE

Viewed laterally there are four curves in the normal spine, two with convexity backwards in the dorsal and sacral regions, and two with convexity forwards in the cervical and lumbar regions. The two backward curves are called "primary," as they exist in fœtal life; the two forward are called secondary or compensatory curves, as they only appear after birth,—that in the cervical region when the child begins to sit up and extend its head, that in the lumbar region when it begins to walk.

We have spinal curvature in its different forms when the natural curves of the spine are abnormally increased, or reversed, or when it deviates in a lateral direction. It is sometimes congenital, but is much more frequently an acquired deformity. Its predisposing causes are muscular and constitutional weakness.

When the curvature arises from disease of the bones of the spine, such as rickets or inflammation, either of tubercular origin or as the result of a blow or a fall, it is called an "osseous" curve; when it originates with some abnormal condition of the muscles, it is called a "muscular" curvature. Osseous curvatures, however, rapidly affect the muscles, shortening them on the side of the concavity and stretching them on that of the convexity; while muscular curvatures, if neglected, lead to changes in the shape and position of the bones.

Bone disease being absent, it is by the perfect antagonising action of the muscles connected with the trunk that the equilibrium of the spine is maintained, and any occupation, position, or infirmity which tends to the development of one group of these muscles to the exclusion, either partial or complete, of the opposing group, may lead to spinal curvature in some form.

Thus prolonged and frequent bending over some occupation, or cycling on a machine with a low handle-bar, tends to shorten the flexor and to stretch the extensor muscles of the spine. In such cases the latter muscles become weakened through inaction, and so are unable in time to make any sustained effort in opposing the action of the flexor group. The deformity commonly known as "round shoulders" or round back is the result. Short sight is also conducive to this form of curve.

Again, lateral deviation of the spine may be caused by continually carrying a heavy weight on one arm or in one hand. In order to maintain the upright position or balance of the body, the muscles on the opposite side of the weight-bearing hand or arm must be strongly contracted, and consequently the spine will be inclined to that side. If it is the right arm that is most used in this way, a curve with convexity to the right will in time be formed, and *vice versa*.

Another and later theory as to the cause of lateral curvature is that it is a consequence of broncho-pneumonia or pleurisy, with simple or purulent effusion, in childhood. In cases of pleuritic effusion, the pleura of one side becomes thickened and adhesions are formed. Respiratory movements are diminished and contraction of the lung of the diseased side takes place. The growth of that side of the thorax is retarded, but proceeds normally on the opposite side. The result is lateral curvature with concavity on the diseased side. Professor Leduc, in his book *The Theory of Electric Ions* recommends chlorine ionisation to resolve the sclerous formations, and so, provided the treatment is given in time, to prevent curvature.

Massage and exercises are contraindicated when inflammatory bone disease is present: it is therefore with muscular curvatures and with those arising from rickets that the gymnast is chiefly called upon to deal.

The aim of the treatment of spinal curvature by massage and exercises is to strengthen the weak and to stretch the shortened muscles, and also to maintain or improve the mobility of the spine.

Examination of the Spine.—Before beginning to treat for curvature the spine should be examined and the exact amount of its deviation from the normal carefully noted. For this the back should be uncovered to below the level of the hips, where the clothes can be fastened by a strap. The patient should stand with the feet straight and slightly apart and the arms hanging by the sides. The appearance of the back having been noted from behind, the patient should be directed, in cases of lateral curvature, to bend forwards from the hips until the trunk is at right angles to the legs, the arms being allowed to hang straight down. The spine should be examined in this position from the front. The chest measurement should be taken, first during the pause after expiration, and then with the lungs fully expanded. To ascertain if both sides of the thorax are equally developed a measurement should be taken on each side from the spinous processes to the sternum. This can best be done with two measuring tapes pinned together. To measure the length of the legs the patient should lie in the supine position, and the measurement should be taken from the upper border of the great trochanter of the femur to the lateral malleolus. To ascertain if there is rotation of the pelvis a measurement should be taken from the umbilicus to the anterior superior spine of the ilium on either side. The distance between these two points will be greatest on the side of the backward rotation. The mobility of the spine may be tested by making the patient take the hanging position. In the case of dorsal scoliosis it may also be done by arm upstretching (free), and in lumbar scoliosis by weight carrying to the leg of the convex side.

RESPIRATORY EXERCISES

The following may be given in the intervals between the other exercises:—

1. Sitting Arm Rolling for Respiration.—The patient's arms are carried forwards, upwards, laterally, and downwards by the gymnast. The patient breathes in during the forward upward movement, and out as they are carried down to the sides.

2. Standing or Sitting Arms Raising Sideways and Deep Breathing.—The patient raises the arms sideways until they are on a line with the shoulders while breathing in, and lowers them to the sides again while breathing out.

3. Standing, Lying, or Hook Lying Arms Raising Forwards, Upwards, Laterally, and Downwards in Time with Respiration.—The last-named position (hook lying) is used in cases of lordosis, as it corrects the forward curve in the lumbar region. The patient breathes in as the arms are carried forwards and upwards, and out as they are lowered laterally and downwards. If given in the standing position the heels may be raised as the arms are brought forwards and upwards, and lowered during the last half of the movement.

4. Standing or Sitting Head Extension, Arm Rotation, and Deep Breathing.—During inspiration, the patient rotates the arms until the palms of the hands are directed laterally and at the same time bends the head backwards; during expiration the arms and head are brought back to the starting position. The chin should be held in during the first part of this movement, so that extension of the cervical spine takes place from below upwards. In returning to the starting position the movement takes place first at the occipito-atlantoid joint; then in the cervical spine from above downwards.

5. Arms Raising Sideways and Deep Breathing in the general correcting position, with the back against the doorpost of an open door.

6. Deep Breathing in the Side Lying Position.—Suitable for a patient with dorsal scoliosis. The patient lies on a plinth or upon the floor on the side of the

ısts with the angles of the ribs upon the supporting surface. The patient is rected to take several deep breaths in this position.

7. Deep Breathing in the Lying Position.—Suitable for a patient with rotation the dorsal region. The gymnast places one hand in front and the other behind oon the protruding ribs, and presses correctively as the patient breathes out.

8. Where there is a sinking in of one side of the chest, such as occurs after npyema or simple pleuritic effusion, respiratory exercises for that side should be ven to expand the collapsed lung. The arm on the healthy side is fixed, either by cking it tightly round the boom, or by flexing the forearm and holding the arm ghtly to the side. The other arm may be raised sideways and lowered to the side ain, or raised forwards, upwards, laterally, and downwards in time with respiration.

EXERCISES TO PROMOTE MOBILITY OF THE SPINE

ead rolling	For the cervical spine.
ead flexion and extension	” ”
ead side flexion	” ”
ead rotation	” ”
angings	For the thoracic and lumbar spine.
retch stride standing trunk bending forwards and downwards (commonly called "hewing")	” ” ”
end stride standing arm and forearm flexion and extension (commonly called "sawing")	For the thoracic spine.
runk rollings	For the lumbar spine.
ard stride standing trunk twisting . .	For the whole spine.
runk side flexion	” ”
ead suspension	” ”

Head suspension is carried out by means of the head suspension apparatus. he patient is in the standing position. The head is supported under the chin ıd at the back by carefully arranged straps, and is gently drawn upwards by eans of a pulley, until the spine is stretched as far as possible. It is used chiefly r cervical curves.

All these have been previously described with the exception of "hewing" and sawing."

"Hewing."—The patient bends the trunk forwards and downwards and then ises it again. This exercise should be quickly performed. The arms and head ıould remain in the same relation to each other, and the knees should be kept raight throughout the movement.

"Sawing."—The patient, from the bend position, with closed hands, extends ıe forearm forwards in the sagittal plane, then flexes it, and at the same time raws the elbow back as far as possible. The arms are worked alternately, one ing thrust forwards as the other is drawn back. This exercise should be performed vigorously, so that rotation of the spine takes place to each side alternately. is often combined with trunk bending forwards and downwards, and the movement is then called "hewing and sawing." This is a strong and very effective xercise for mobility. It acts also as a specific corrective of "winged scapulæ," y bringing the serratus magnus muscles into powerful use.

BALANCE MOVEMENTS

Tiptoe Marching and Tiptoe Marching along a Line.

Cock Step.—1. The patient bends one knee quickly upwards, as in alternate nee upbending, so that the leg hangs straight down and the foot is plantar flexed. The leg is extended and the toes are pointed downwards. 3. The foot is wered to the ground a little in advance of its fellow on the opposite side. The ıme movement is then repeated with the other leg, and the patient "steps" in ıis way up and down the gymnasium or room three or four times. The arms ıay be either in the neck-firm or hips-firm position.

Walking on the Balance Bars.

Heel Raising and Knee Bending.

Walking combined with Leg Circling.—The patient, with the hands on th hips, carries each leg alternately (in the extended position) forwards, laterall and backwards, medially and then forwards, placing the foot on the ground a litt in advance of its fellow.

This movement may also be combined with arm circling in the following way:–

1. Leg forwards . . . . . Arms forward in the sagittal plane.
2. Leg laterally . . . . . Arms upwards above the head.
3. Leg backwards and medially . Arms laterally on a line with the shoulder
4. Leg forwards in front of its fellow Arms lowered to the sides.

Balance movements promote perfect control of the muscles and consequen grace or rhythm of movement. Motor impulses are sent from the brain certain muscles to cause their contraction, while inhibitory impulses are co veyed to others to restrain or check their movement. Exercises of this natu have a very special value, requiring, as they do, so much mental concentratic for their performance, and one at least should be included in every gymnastic tabl

Pathological Curves.—There are three different forms of spinal curvature–

1. Lordosis or anterior curvature.
2. Kyphosis { Arcuata or posterior curvature (round back). Angularis or Pott's disease.
3. Scoliosis or lateral curvature.

LORDOSIS

Lordosis is usually an abnormal development of the natural forward curve the lumbar region. Some of the exciting causes are as follows:—

Fig. 159.—Lordosis (result of Flexion of Hip).

1. Congenital dislocation of th hips.
2. Flexion of one or both h joints, which may be due to hi joint disease.
3. Weakness of the abdomin muscles.
4. Bearing heavy weights abo the neck and shoulders.
5. Rickets.
6. Large pendulous abdomen a large abdominal tumours and pre nancy.

The pathological changes induc by this form of curvature are follows:—

1. The lumbar spinous process become approximated.
2. The intervertebral discs becon compressed posteriorly.
3. The bodies of the verteb become thinner posteriorly.
4. The back part of the pelv brim is tilted up and the front pa is lowered (technically known "increased pelvic inclination").
5. A compensatory backwa curve is usually induced in th spine above the anterior convexi (*i.e.* kyphosis).
6. The anterior common ligame is stretched in the lumbar regio

7. The muscles in the lumbar region of the back are shortened, and those of the abdomen are stretched and weakened.

Massage for Lordosis

The patient takes the forward lying position, the arms by the sides or folded underneath the head. A pillow is placed underneath the abdomen. All the ordinary movements for the back may be employed as far as it is possible to do so. Percussion must be avoided upon the contracted muscles in the lumbar region, and all stroking and kneading movements should be carried out so as to stretch the tissues in the hollow of the back as much as possible. The patient then takes the half lying position. The muscles of the abdomen are thoroughly masséed: a good deal of percussion and that form of pétrissage known as "picking up" may be given, these two movements tending to promote the nutrition and development of muscles more than any others.

If there is a compensating backward curve in the dorsal region the muscles of the chest will be contracted, and should therefore be masséed in the usual way.

CORRECTIVE EXERCISES FOR LORDOSIS

1. Half lying or short sitting double leg updrawing.
2. Lying, half lying, stretch grasp lying, or stretch (grasp) hanging double knee updrawing and downpressing.
3. Lying double leg lifting.
4. Stretch stride standing trunk bending forwards and downwards.
5. General correcting position.
6. Heave or stretch grasp crook sitting holding.
7. Long sitting correcting position.
8. Long sitting on high plinth forward and backward wringing.

The above movements have been previously described with the exception of the following:—

General Correcting Position.—The patient takes the lax stoop stride standing position with the sacrum resting against a doorpost, or the side of the rib stool. The trunk is then raised from below upwards, so that the spinous process of each vertebra in the lumbar and dorsal region respectively is brought in contact with the door post. Care should be taken to keep the lumbar vertebræ, as far as possible, in contact with the post while the upper part of the spine is being straightened. When the exercise has been repeated three or four times the arms are raised either sideways, or forwards, upwards, laterally, and downwards in time with deep breathing. At first the feet may be placed a short distance in front of the post, as this makes the movement easier to carry out; later, the patient should stand nearer the post and with the legs closer together.

Crook Sitting Holding.—The patient sits upon the floor with the back against the rib stool and the arms in the heave or stretch grasp position. The knees are bent and drawn up as close as possible to the trunk. They are then secured in that position by a strap which is passed round the legs and trunk and fastened to the rib stool. The position is maintained for about five minutes.

Long Sitting Correcting Position.—(*a*) The patient sits on the floor with the legs stretched straight out and the hands on the hips.

(*b*) The patient sits on the floor with the legs extended as in the above and the fingers touching the toes. The position should be maintained for a few seconds, then the trunk should be straightened and the position taken again three or four times.

TABLE FOR LORDOSIS

1. Stretch sitting double arm rolling for respiration.
2. Stoop stride sitting double plane arm carrying.
3. Wing high ride sitting trunk rolling (passive).

4. Stretch stride standing trunk bending forwards and downwards.
5. Wing standing heel raising and knee bending.
6. Neck firm long sitting chest expansion.
7. Swim standing double arm backwards flinging.
8. Reach grasp sitting head extension.
9. Heave or stretch grasp crook sitting holding.
10. Lying double leg lifting.
11. Hook lying arms raising forwards, upwards, laterally, and downwards time with respiration.
12. Lax stoop lean standing general correcting position.
13. Tiptoe marching.
14. Standing head extension, arm rotation, and deep breathing.
15. Forward lying back massage.

KYPHOSIS ARCUATA

This is a backward curve which usually occurs in the dorsal region as a exaggerated condition of the normal curve, but it may also involve other regio of the spine. It is familiarly know as "round shoulders" or "rou back," and can occur at any age. infancy it is caused either by ricke or general weakness of the ba muscles; in youth the predisposi causes are muscular weakness, owi to rapid growth, poor nutrition, both, while the exciting causes a usually bad positions in sitting a standing, and wearing clothes whi are too tight across the chest. It frequent in old age, owing to t absorption of the anterior portions the intervertebral discs. Short-sig is also conducive to this form of cur

Fig. 160.—Kyphosis Arcuata.

The pathological changes are follows:—

1. The bodies of the vertebræ a approximated anteriorly.
2. The intervertebral discs a compressed anteriorly.
3. The spinous processes of t vertebræ are separated.
4. The ribs become approximat anteriorly.
5. The head is bent downwar and forwards.
6. The ligaments of the back the dorsal spine are stretched, a the anterior common ligament shortened in the dorsal region.
7. The muscles of the back are stretched and those of the chest contracted.
8. The thoracic organs are compressed, and full respiration is greatly interfer with.

Massage for Cases of Kyphosis

All the ordinary movements for the back may be carried out. A good de of percussion is useful in these cases. The muscles of the chest should also

CORRECTIVE EXERCISES FOR KYPHOSIS

Chest expansions.
Hanging with a cushion behind the shoulders.
Arch hanging.
Standing or sitting with the arms in the neck firm position.
Double plane arm carrying, in all positions.
Head extension.
Yard stoop stride sitting trunk raising.
Lax stoop stride sitting trunk raising with head support.
Wing lax stoop stride sitting trunk raising with back stroking.
Grasp lax leg lean standing trunk raising.
Trunk raising in different planes.
Leg forward lying holding.
Wing or neck firm arch leg forward lying holding.
General correcting position.
Stretch or heave grasp crook sitting holding, with a small cushion behind the houlders.

TABLE FOR KYPHOSIS

1. Sitting double arm rolling for respiration and for kyphosis.
2. Yard walk standing double plane arm carrying.
3. Neck firm standing heel raising and knee bending.
4. Yard close standing trunk twisting.
5. Reach grasp sitting head extension.
6. Heave grasp standing chest clapping.
7. Hanging on the rib stool with a cushion behind the shoulders, abducting ad adducting the legs.
8. Arm lean standing back hacking.
9. Wing arch leg forward lying holding.
10. Stretch grasp half lying double leg updrawing.
11. Back massage in the forward lying position.
12. Swim standing arms flinging laterally.
13. Grasp lax leg lean standing trunk raising.
14. Cock step.
15. Standing head extension, arm rotation, and deep breathing.

TABLE FOR KYPHO-LORDOSIS

1. Sitting double arm rolling for respiration and kyphosis.
2. Stoop stride sitting double plane arm carrying.
3. Wing standing heel raising and knee bending.
4. Yard close standing trunk twisting.
5. Hanging double knee updrawing and downpressing.
6. Heave grasp standing chest clapping.
7. Reach grasp sitting head extension.
8. Wing leg forward lying holding.
9. Lying double leg lifting.
10. Back massage, in the forward lying position.
11. Long sitting chest expansion.
12. Grasp lax leg lean standing trunk raising.
13. Heave or stretch grasp crook sitting holding.
14. Half lying double leg updrawing.
15. Tiptoe marching.
16. Standing head extension, arm rotation, and deep breathing.

KYPHOSIS ANGULARIS

Kyphosis angularis, commonly known as Pott's disease, is an inflammatory isease of the bones of the spine which causes the destruction of the bodies of the ertebræ. It usually occurs in the dorsal region, and is of tubercular origin.

The deformity is characterised by a backward projection, caused by the und prominence of one or more of the spinous processes, and by the absolute rigidi of the part. This class of curvature is never treated by massage and exercis while the disease is active, as absolute rest is essential. At a later period, whe the disease is arrested, massage, gentle respiratory and mild strengthening exercis may be given, but any stretching of the spine should be avoided.

SCOLIOSIS

Lateral curvature is sometimes congenital, but is more often acquired, an some of the exciting causes are as follows :—

1. Disease of the bones of the spine.
2. Torticollis.
3 Short-sight and deafness.
4. Infantile paralysis.
5. Pleurisy with simple or puru lent effusion (empyema).
6. Broncho-pneumonia.
7. Obliquity of the pelvis due t the unequal length of the low extremities.
8. Bearing weights on one ar or in one hand.
9. Bad postures in sitting an standing.

FIG. 161.—SCOLIOSIS—LEFT TOTAL CURVE.

Bad positions in sitting ar standing are perhaps the mo frequent causes of lateral curvatur Resting more on one buttock tha the other when seated, and stan ing continually on one and the san leg cause obliquity of the pelvis ar a lateral deviation of the spine t wards the side upon which t weight of the body is thrown. this weight is continually throw upon the same buttock or the san leg the muscles on that side becon contracted, those on the other si stretched and weakened ; alteratio in the shape and position of t vertebræ follow in time, and t curve becomes permanent.

Lateral curvatures may be eith simple or compound. A *simple C-shaped curve* is one in which there is deviation to one side only, with no co pensating bend in the opposite direction. A simple curve may involve one more regions of the spine or its entire length. It is called a right or left cur according to its convexity, and is further designated according to the region of t spine involved. For instance, a curve in the cervical, dorsal, or lumbar region called either right or left cervical, dorsal, or lumbar. A curve involving the cervic and dorsal regions or any part of them is called a right or left cervico-dorsal curv if it involves the dorsal and lumbar regions it is called a right or left dorso-lumb curve ; if it embraces the whole spine it is called a right or left total curve.

A *compound curvature* is one in which two and sometimes three curves a present. The first curve which appears is called primary, the other is called secondary or compensatory curve. The convexity of a secondary curve is alwa opposite to that of the primary curve ; thus, if there is a curve with convexity the left in the lumbar region the convex side of the compensating curve will the right in the dorsal region. If there are three curves the convexity of the iddle one will be opposite in direction to that of the curves above and below it. ie most frequent form of compound curvature is one with convexity to the right the dorsal region and to the left in the lumbar region. It is known as a right orsal, left lumbar curve.

Incipient scoliosis is recognised by the fact that it disappears in the recumbent · suspended position, or by voluntary effort on the part of the patient either ith or without assistance. The curvature at this stage generally consists of a -shaped total or postural bend, and this is usually directed towards the left; but may only involve a portion of the spine, such as the lumbar or dorsal region both these regions. There is no alteration as yet in the shape of the bones. he muscles on the concave side are slightly contracted, those on the convex side retched. The shoulder on the convex de is higher than that on the conve side, and may be inclined slightly rward, while that on the concave de is carried correspondingly downards and backwards. If nothing is me to correct this lateral deviation the removal of the exciting cause eversing bad positions, etc.) alterans in the shape and position of the rtebræ take place and it becomes adually a permanent deformity, iown as structural or confirmed oliosis.

FIG. 162.—TRIPLE SCOLIOSIS (primary dorsal curve to the right with compensatory cervical and lumbar curves to the left).

The transitional stage between cipient and confirmed scoliosis is arked by rotation of the vertebræ, d generally also by the appearance compensatory curves.

Rotation.—With all side bending ere is a certain amount of rotation etween the vertebræ, and in cases of teral curvature, if not arrested at e early stage, the bodies of the rtebræ turn towards the line of ast resistance, namely, the conxity of the curve, while the spinous ocesses incline towards the concave le. As a consequence, the transrse processes of the vertebræ in the orsal region, with their attached ribs, rm a marked prominence on the le of the convexity, while those on e side of the concavity are carried forward. The whole shape of the thorax is us altered; in front the ribs are flattened on the side of the dorsal convexity, d protrude on that of the concavity; on the side of the convexity the ribs come abnormally separated from each other, while they approach, and in severe ses press against each other, on that of the concavity. The shoulder girdle also ffers alteration in shape and position in cases of rotation; it is carried back on e side of the dorsal concavity and forward on that of the convexity, while the stance between the vertebral margin of the scapula and the spinal column is creased on the side of the convexity. The scapula also sometimes adapts itself shape to the increased angle of the ribs on the convex side.

In the lumbar region rotation is marked, on the side of the convexity, by a otuberance caused by the transverse processes of the lumbar vertebræ, and also a partial or complete obliteration of the waist line, while on the concave side e waist is sunken and so gives greater prominence to the hip of that side.

In very severe cases of this kind the whole pelvis also suffers alteration i position and shape, the os coxæ being displaced either forwards or backward on the side of the lumbar convexity; thus in the case of severe compound curva ture the pelvis and the thorax may be twisted in different directions.

Besides alteration in position, the vertebræ also undergo changes in shape i cases of confirmed scoliosis. Owing to pressure on the side of the concavity growth is retarded on that side while it proceeds unchecked on that of the con vexity. As a result the bodies of the vertebræ become more or less wedge-shaped particularly at the most marked point of the curve. The intervertebral discs als become compressed on the side of the concavity, and eventually, in some sever and long-standing cases, are completely absorbed on that side, causing friction be tween the bodies of the vertebræ, which leads in time to bony ankylosis.

In certain cases of confirmed scoliosis there is a good deal of rotation withou much lateral bending. A simple curve may also continue as such, but as a genera rule one and in some cases two compensatory curves are formed in order to main tain the equilibrium of the body. The muscles of the back undergo a good dea of alteration in cases of scoliosis, especially when there is much deviation of th

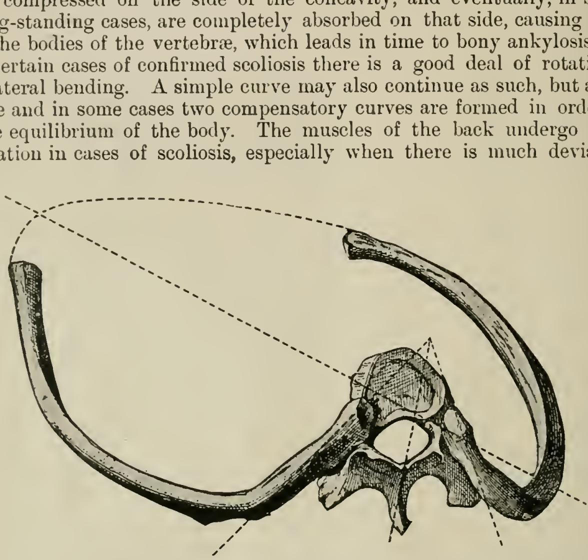


Fig. 163.—Illustrating the Alteration in the Shape of the Ribs, and the Deviation of the Transverse Diameter of the Thorax in a case of Scoliosis. (After Rédard.)

This plate is reproduced by the kind permission of Mr. A. H. Tubby.

spine from the middle line. Those on the convex side are stretched and atrophie and in many cases show signs of fibrous degeneration; they are consequent weaker than those on the side of the concavity, which are shortened and thickene

The ligaments which connect the vertebræ also undergo alteration; those on t convex side are stretched and atrophied, and those on the opposite side shortened

Accompanying lateral curvature there may also be variations in the norm antero-posterior curves of the spine.

Round shoulders frequently co-exist with lateral deviation, and the deformit is then known as kypho-scoliosis; but on the other hand the normal backwa curve in the dorsal region is sometimes decreased. Flat-foot often accompani cases of lateral curvature, and must be treated at the same time by massage a exercises.

Massage for Scoliosis

Position.—The patient takes the forward lying position, and is placed so as bring the spine as far as possible into the middle line. Thus, in a dorsal cur the arm on the side of the concavity may be brought away from the side a placed so that the back of the hand touches the forehead, while that on the si of the convexity is held straight and close to the trunk. If there is a curve ie lumbar region a small pillow may be placed under the hip on the side of the oncavity. In these ways the position of the patient can be made as corrective ; possible.

Movements.—These consist of those ordinarily given for the back, namely, fleurage, kneading, and deep frictions on either side of the spine.

EXERCISES

Asymmetrical exercises can be employed with safety in cases of simple ırvatures, but must be used with caution when the curve is a compound one, as ıey tend to improve one curve at the expense of the other.

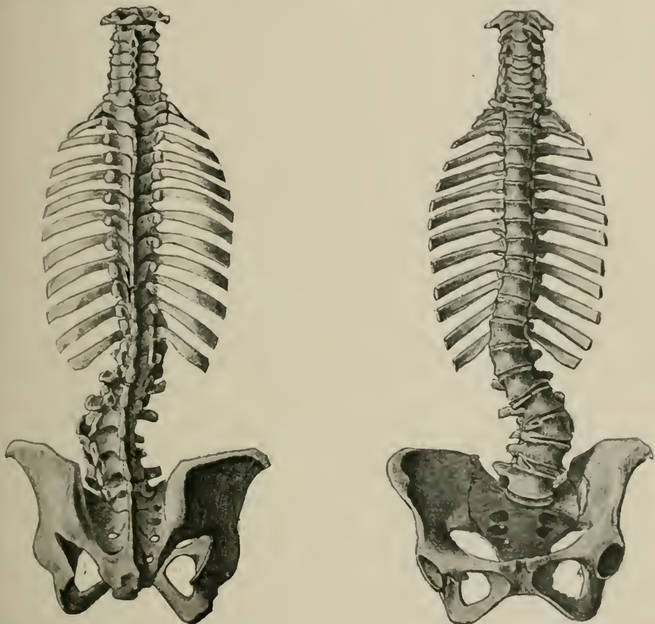


FIG. 164.—*A*. THE BACK VIEW OF A SCOLIOTIC SPINAL COLUMN, IN WHICH THE SPINOUS PROCESSES ARE SEEN TO BE ALMOST IN A RIGHT LINE, DESPITE THE EXCESSIVE ROTATION OF THE LUMBAR VERTEBRÆ. (Guy's Hospital Museum, 1006[90].)

B. THE FRONT VIEW OF THE SAME SPINAL COLUMN, IN WHICH THE EXCESSIVE ROTATION OF THE LUMBAR VERTEBRÆ AND DEFORMITY OF THE VERTEBRAL BODIES ARE WELL SEEN.

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The effect of each exercise upon the spine should be carefully noticed, and for is reason the patient's back should always be uncovered while the exercises are ing carried out.

CORRECTIVE EXERCISES FOR A CURVE IN THE CERVICAL REGION

Half Speech Grasp Standing or Half Crutch Standing Head Side Flexion.—ead side flexion in the half speech grasp standing position is used when the oulder on the side of the cervical convexity is higher than that of the opposite le. In the case of a right cervical curve where the right shoulder is higher than e left, the patient stands beside and grasps the rib stool with the right hand.

The patient bends the head towards the side of the convexity while the gymnas resists; the latter raises the head while the patient resists. This movement give concentric and excentric work for the weak muscles.

Head side flexion is given in the half crutch standing position when there i a curve in the thoracic region opposite in direction to the cervical curve an causing a lowering of the shoulder on the side of the convexity of the latter. Th arm on the side of the low shoulder is placed across a boom, and the movemen carried out as above. Head rolling, head extension, head rotation, and head sus pension may be used to increase mobility.

CORRECTIVE EXERCISES FOR A DORSAL OR TOTAL CURVE

1. Hanging and Half Neck Firm Side Arch Leg Lying Holding.

2. Stretch Grasp Side Standing Forward Drawing.—In the case of a left dorsa or total curve the patient stands with the left side against the rib stool an grasps the handles of a strap, which is passed round one of the rungs of th apparatus at a suitable height. The gymnast stands to the right and somewha in front of the patient and places her right foot on one of the lower rungs c the rib stool. She passes her arms round the patient's trunk and places he hands upon the angles of the ribs at the highest point of the convexity. Th patient's trunk is then carried somewhat forwards and laterally while stron pressure is made diagonally in the direction of the greatest diameter. This move ment stretches the soft structures on the concave side.

Partial Suspension by One Arm with Other Arm and Leg Locked (Lovett).— In the case of a left dorsal or total curve the patient stands by a ladd or under a bar that can be reached without rising on the toes, and grasp a rung of the ladder or the bar with the right hand. The left thigh is flexe at the hip and is supported by the left arm, which is passed under the knee. Th patient flexes the supporting leg, in this instance the right, so that the weigh of the body comes upon the right arm. This position is maintained for a fe seconds at a time with intervals of rest. It causes the stretching of ligaments an muscles on the concave side.

Half Wing Half Yard Sitting Stretching Sideways.—In the case of a lef dorsal or total curve. The patient sits on a stool with the right arm in the yar and the left in the wing position. The gymnast places one hand about 6 inche away from and on a line with the patient's right hand. The latter then stretche sideways so that the right hand touches the gymnast's hand. This movemen reverses the curve and is a very good corrective exercise. The position shoul be maintained for a few seconds and then repeated three or four times.

Half Speech Half Bend Standing Single Arm Upstretching.—If a left dors or total curve, the left hand grasps the rib stool, and the right arm is extende upwards above the head from ten to twelve times.

Half Wing Half Bend Stoop Stride Sitting Single Arm Upstretching wit Resistance.—In the case of a left dorsal or total curve the patient's left hand i placed upon the hip, the right arm is flexed. The gymnast stands upon a sto in front and places her right hand upon the left side of the patient's back upon th point of the highest convexity; the left hand grasps the patient's right forear and the latter grasps the gymnast left forearm. The patient extends the righ arm upwards over the head against gentle resistance on the part of the gymnas who at the end of the movement further forcibly stretches the arm, at the sam time pressing slightly on the convexity with the right hand. The patient the resists while the gymnast presses the arm downwards to the starting positio This movement causes contraction of the muscles on the convex side and stretche the ligaments and muscles of the opposite side. In performing it the arm shoul be kept in the frontal plane.

Half Speech Grasp Standing Shoulder Raising.—When the curve is on with convexity to the left the patient grasps the rib stool with the left hand, th right arm hangs by the side. The gymnast stands behind and places the left han upon the patient's right shoulder and grasps the right wrist with the other hand.

The patient raises the right shoulder while the gymnast resists; the patient esists while the gymnast draws the arm downwards.

Trunk Side Flexion with Pressure.—Previously described.

CORRECTIVE EXERCISES FOR A CURVE IN THE LUMBAR REGION

Weight Carrying to the Leg of the Convex Side.—The patient flexes the knee n the side of the lumbar concavity, so that the weight of the body is thrown on the g of the opposite, or convex, side. The movement should be carried out quickly nd repeated several times.

Hanging on Rib Stool or Forward Lying Passive Double Leg Carrying to ne Side with Pressure.—The gymnast carries the patient's legs towards the de of the convexity with one hand, while giving strong pressure forwards and edially, on the same side, upon the transverse processes of the lumbar vertebræ ith the other hand. In the forward lying position the patient fixes the upper art of the body by grasping the sides of the plinth. The movement in this osition is often carried out by two gymnasts, one of whom gives the pressure with ne hand while fixing the upper part of the trunk with the other. The second ymnast carries the legs to the side.

Stretch Grasp Side Standing Forward Drawing.—The movement is given as reviously described, but the gymnast's hands are placed upon lumbar convexity.

Half Wing Half Neck Firm Spring Sitting Trunk Rolling with Pressure.—or this movement the high plinth is placed lengthways a short distance from, nd in front of, the rib stool. In the case of a left lumbar curve the patient places e left leg across the high plinth; the right leg is stretched backwards and the oot (plantar flexed) is firmly inserted between the rungs of the rib stool. The ght arm is in the neck firm and the left in the wing position.

The gymnast stands behind the patient, astride the latter's right leg, her left and is placed upon the transverse processes of the lumbar vertebræ on the nvex side, her right arm is passed under that of the patient and the hand is laced upon the front of the patient's right shoulder. The patient bends forwards d to the left, backwards, slightly to the right and then forwards, repeating the ovement several times. The gymnast, with her right arm, assists the patient to erform the movement and gives pressure with her left hand as the patient bends wards that side.

Hanging Active Double Leg Carrying to One Side.—The patient carries both gs towards the convex side.

Stretch Grasp Forward Lying or High Reach Grasp Standing Hip Updrawing.—he gymnast grasps the patient's ankle on the side of the convexity. The patient raws up the hip of that side while the gymnast resists; the patient resists while e gymnast draws the hip down.

High Reach Grasp Standing Single Leg Outward Carrying and Inpressing.—he patient stands upon a stool. The gymnast places one hand on the hip of the onvex side and the other on the lateral aspect of the ankle of the same side. The atient abducts the leg while the gymnast resists at the ankle; the patient resists hile the gymnast adducts the leg.

Half Wing Half Neck Firm High Ride Sitting Side Flexion with Pressure.—ame as previously described for a dorsal curve, except that the pressure is given the transverse processes of the lumbar vertebræ, instead of in the dorsal region.

Half Neck Firm Side Arch Leg Lying Holding.—As previously described, cept that the pressure is given in the lumbar instead of the dorsal region.

Spring Sitting or Fall out Standing Holding.—The leg on the concave side of e lumbar curve is stretched backwards; the arm on the concave side is extended wards above the head.

CORRECTIVE EXERCISES FOR A SIGMOID OR DOUBLE CURVATURE

Hanging with Pressure on both Curves and on the Front of the Chest.—arried out by two gymnasts, one of whom stands behind and gives pressure on the rsal and lumbar convexities, the other stands in front and gives pressure at the same time upon the front of the chest, in the direction of the greatest diagonal diameter.

Half Wing Half Neck Firm Stoop Leg Lean Standing Trunk Raising with Two Pressures.—The patient stands with the front of the thighs supported against the boom. In the case of a right dorsal, left lumbar curve, the right arm is in the wing, the left in the neck firm position. The gymnast stands behind the patient and, as the latter raises the trunk, gives a strong pressure forwards and medially upon each convexity. It is well, if possible, to get an assistant to place both hands upon the front of the patient's shoulders to help the latter to rise, a stronger pressure can then be given.

Leg Forward Lying Correction with Two Pressures.—One gymnast stands in front of the patient, who grasps the former round the waist. In the case of a right dorsal, left lumbar curve, the patient's head is kept close to the gymnast's right hip. The gymnast grasps the patient below the left shoulder with the right hand and places the left upon the angles of the ribs on the maximum point of the dorsal convexity. The trunk is first carried slightly to the right and then to the left, while a second gymnast or assistant gives pressure forwards and medially upon the lumbar convexity. The first gymnast then flexes the dorsal region of the spine to the right, while giving firm pressure in a diagonal direction forwards and medially upon the dorsal convexity. In this way the soft structures of both lumbar and dorsal concavity are stretched and rotation corrected.

Half Wing Half Neck Firm High Ride Sitting Flexion to Side of Dorsal Convexity with Two Pressures.—The patient bends to the side of the dorsal convexity while the gymnast gives a pressure on the angles of the ribs; a second gymnast gives pressure on the lumbar convexity at the same time.

Spring Sitting or Fall Out Standing Holding.—The arm on the side of the dorsal concavity is extended above the head. The leg on the side of the lumbar concavity is stretched backwards.

Some of the movements previously given for single dorsal and lumbar curves may also be used for double curvatures.

EXERCISES FOR PELVIC ROTATION

Hanging Passive Correction.—The gymnast stands beside the patient and places one hand in front of the forward inclined hip, and the other upon the lumbar convexity. The gymnast then presses the hip backwards and at the same time gives pressure on the convexity of the lumbar curve. If possible, it is well to have the thorax fixed by an assistant.

Heave Grasp Close Standing Forward Rotation of the Pelvis on the Side of the Backward Rotated Hip.—The patient stands between the upright poles or in an open doorway. The gymnast stands in front and places one hand in front of the backward rotated hip and the other behind the forward rotated hip. The patient rotates the backward rotated hip forwards as far as possible while the gymnast resists; the patient resists while the gymnast draws the pelvis back to the frontal plane.

TABLE FOR A LEFT TOTAL CURVE OF THE FIRST DEGREE

1. Standing head extension, arm rotation, and deep breathing.
2. Hanging on an uneven boom, right arm highest, abducting and adducting the legs.
3. Heave grasp standing chest clapping.
4. Wing close standing trunk twisting.
5. Cock step.
6. Left side against rib stool, stretch grasp standing forward drawing.
7. Side arch leg lying holding (lying on right side).
8. Arm lean standing back hacking.
9. Wing lax stoop stride sitting trunk raising.
10. Neck firm sitting chest expansion.
11. Yard walk standing double plane arm carrying.

12. Lying double leg lifting.
13. General correcting position.
14. Spring sitting holding (right arm up, right leg back).
15. Standing heel raising, knee bending.
16. Forward lying back massage.

TABLE FOR A RIGHT DORSAL, LEFT LUMBAR CURVE

1. Sitting double arm rolling for respiration and kyphosis.
2. Tiptoe marching along a line.
3. Wing high ride sitting trunk rolling (passive).
4. Stride standing sawing.
5. Leg forward lying correcting with two pressures.
6. Spring sitting holding (left arm up, right leg back).
7. Heave grasp standing chest clapping.
8. Swim standing arms flinging laterally.
9. Stoop leg lean standing back raising with two pressures (left arm neck firm, right arm wing).
10. Half lying double leg updrawing.
11. Stretch grasp sitting double arm flexion concentric and excentric.
12. Weight carrying to the left leg.
13. High reach grasp standing left leg abduction concentric and excentric.
14. General correcting position.
15. Standing heel raising and knee bending.
16. Standing head extension, arm rotation, and deep breathing.
17. Forward lying back massage.

TABLE FOR A RIGHT CERVICAL, LEFT DORSAL, AND RIGHT LUMBAR CURVE WITH PELVIC ROTATION, THE RIGHT HIP BEING ROTATED BACKWARDS

1. Standing head extension, arm rotation, and deep breathing.
2. Yard stride standing trunk twisting.
3. Cock step.
4. Reach grasp sitting head rolling and head side flexion to the right.
5. Heave grasp standing chest clapping.
6. Walk standing double plane arm carrying.
7. Stretch grasp side standing forward drawing.
8. High ride sitting side flexion to the left with pressure.
9. High ride sitting trunk rolling (passive).
10. Forward lying double leg carrying to the right with pressure (passive).
11. Hanging double leg carrying to the right (active).
12. Forward lying back massage.
13. Leg lean stoop stride standing trunk raising with two pressures.
14. Spring sitting holding (right arm up, left leg back).
15. Heave grasp standing forward rotation of right hip.
16. Standing arm raising forwards, upwards, laterally, and downwards with deep breathing.

TALIPES (CLUB-FOOT)

There are four primary forms of talipes, as follows:—

1. *Talipes equinus*, in which the muscles of the calf are contracted so that the heel is raised, while the toes only touch the ground.
2. *Talipes varus*, in which the muscles which invert the foot are contracted, so that the medial side is raised while the lateral edge of the foot rests upon the ground. This form is frequently combined with talipes equinus, and the deformity is then known as talipes equino-varus.

FIG. 165.—TALIPES EQUINUS (Slight Varus).

FIG. 166.—TALIPES VARUS (Slight Equinus).

3. *Talipes calcaneus.*—This is a rare form of the deformity, in which the toes are raised while the heel touches the ground.
4. *Talipes valgus,* also rare, in which the foot is everted. This form is sometimes combined with talipes equinus and talipes calcaneus.

Talipes is frequently the result of infantile paralysis. When this is so, rapid atrophy of the affected muscles sets in, their antagonising power is lost, and the foot is pulled in the direction of the opposing groups of muscles. More or less crippling quickly ensues if treatment by massage and exercises is not commenced as soon as the acute symptoms have disappeared. The whole of the affected limb should be stroked and kneaded first, and then the paralysed muscles should be thoroughly manipulated, as previously described in the paragraph on infantile paralysis. In talipes equinus resulting from this disease the affected muscles are tibialis anterior, extensor digitorum longus, and extensor hallucis longus. If talipes varus is the result of infantile paralysis, the deformity is due to loss of power of the everters of the foot, namely, peroneus longus, brevis, and tertius, which makes them unable to oppose the action of the antagonising muscles, tibialis anterior and posterior.

EXERCISES FOR TALIPES EQUINUS

Passive—

1. Circumduction of the foot (foot rolling).
2. Plantar and dorsi-flexion of the foot. (The foot should be held in the dorsi-flexed position for some seconds and overstretched.)

Resistive—

Dorsi-flexion of the foot, concentric and excentric. The patient performs the movement of dorsi-flexion while the gymnast resists; the latter then draws the foot down, but only as far as the middle position, while the patient resists.

If combined with talipes varus, the movements of eversion, concentric and excentric, should be added; if with talipes valgus, those of inversion, concentric and excentric. In the excentric movements care should be taken to bring the foot back only as far as the middle line.

EXERCISES FOR TALIPES VARUS

Passive—

1. Circumduction of the foot.
2. Eversion of the foot. (Hold the foot in the everted position for some seconds.)

While giving this exercise the foot should be held as far as possible at right angles to the leg.

Resistive—

Eversion of the foot, concentric and excentric. The patient everts the foot while the gymnast resists; the latter then brings the foot back to the middle line while the patient resists.

TALIPES CALCANEUS AND VALGUS

In treating the former, all movements and exercises which promote the contraction of the plantar flexors and which stretch the dorsi-flexors of the foot should be employed. In dealing with the latter, the masseuse should work with the object of promoting the contraction of the inverters, and of stretching the everters of the foot.

The only common form of congenital talipes is equino-varus; this may be treated with or without operation; in either case massage will be required. All the muscles of the leg should be manipulated, the plantar flexors of the foot being stroked and thoroughly kneaded so as to stretch them as much as possible.

For exercises, those given above for talipes equinus and varus should be employed.

FLAT-FOOT

The bones of the foot are arranged so as to form two arches, namely, a longitudinal and a transverse, which intersect each other at right angles. The astragalus forms the keystone of the former arch, the posterior portion or pier

FIG. 168.—TALIPES VALGUS.

FIG. 169.—TALIPES EQUINO-VARUS (Congenital).

FIG. 170.—TALIPES EQUINO-VALGUS.

being formed by the calcaneus, and the anterior pier by the navicular, cuneiforms, cuboid, and metatarsal bones. Flattening of this arch, or the deformity known as "flat-foot," may be brought about either by softening of the bones which form it (rickets), by rheumatism, or by muscular debility, and this last is the most frequent predisposing cause.

People who stand overmuch are very subject to the deformity. The long-continued pressure of the weight of the body upon the foot stretches the ligaments, tendons, and fascia which connect the piers of the arch together, causing their undue separation, and flattening of the foot results.[1]

Massage Movements—

1. Effleurage of the foot.
2. Kneading and frictions on the plantar aspect of the foot.
3. Percussion on the sole of the foot. This is one of the useful procedures for flat-foot, and should be freely given.
4. Kneading of the tissues on the dorsum of the foot with the palmar surface of the hand.
5. Stroking round the malleoli with the palmar surface of the fingers of both hands.
6. Kneading the heel on either side with the ball of the thumb of one hand, while the other hand supports the leg.

When the foot has been thoroughly masséd, more especially of course on its plantar aspect, the following movements should be employed for the leg:—

1. Effleurage of the leg from the ankle to the knee with both hands.
2. Pétrissage of the calf muscles.
3. Tapôtement of the muscles of the calf.
4. Vibration of the calf muscles with one hand.
5. Effleurage of the tibialis anterior muscle.
6. Kneading of the tibialis anterior muscle.
7. Tapôtement of the tibialis anterior muscle.

While the calf muscles are being manipulated the patient's leg should be drawn up so that the sole of the foot rests upon the supporting surface. In this way the muscles of the back of the leg are thoroughly relaxed, and the deep layers can be more easily reached.

EXERCISES

Passive—Medial circumduction of the foot.

Resistive—

1. Plantar flexion of the foot, concentric and excentric. The patient performs the movement of plantar flexion while the gymnast resists; the latter then brings the foot back to the middle position while the patient resists.
2. Inversion of the foot, concentric and excentric. In this movement the patient inverts the foot while the gymnast resists; the latter then brings the foot back to the middle line while the patient resists.

Free—

1. Standing with the hands on the hips and the feet close together.

Action —

(1) Rise on tiptoe, heels together.
(2) Separate heels.
(3) Heels down, toes together.
(4) Lift each foot alternately, and return to the starting position.

[1] The chief ligaments concerned in maintaining the integrity of the longitudinal arch of the foot are the inferior calcaneo-navicular ligament, which extends from the calcaneus to the navicular bone; and the inferior calcaneo-cuboid ligaments, which extend from the calcaneus to the cuboid bone. The tendon of the tibialis posterior muscle also helps to maintain the arch of the foot, as does the plantar fascia, which connects together its two extremities, the inferior tubercle of the calcaneus behind and the bases of the first phalanges in front.

2. Tiptoe walking.—Walk on tiptoe along a straight line; this can be chalked upon the floor, or a seam in the carpet will do as well.

3. Running on tiptoe.

4. Wing standing heel raising knee bending.

Passive Correction—Sitting with the legs crossed, tailor-wise.

KNOCK-KNEE

Knock-knee is caused either by an inward bending of the femur and tibia or by relaxation of the ligaments and fascia on the medial side of the joint.

The deformity is very conducive to flat-foot.

Treatment.—The whole limb should be masséed, giving special attention to the knee-joint. The tissues on the lateral side should be stretched as much as possible.

EXERCISES

Resistive—

1. Half lying leg abduction and adduction. The gymnast gives resistance over the lateral malleolus during abduction, and above the knee on the medial condyle during adduction.

2. Half lying knee updrawing and downpressing. The gymnast places one hand on the patient's thigh, just above the knee, while the other grasps the leg above the ankle. The patient draws the knee up as far as it will go, while the gymnast gives resistance at the knee; the latter then presses the knee downwards until the foot rests upon the floor, while the patient resists. In carrying out this exercise the operator should guide the knee in the lateral direction.

Free—

Wing standing heel raising and knee bending.

Passive Correction—

Sitting with a pad between the knees and the ankles tied together.

TORTICOLLIS, OR WRY-NECK

Torticollis may be either congenital or acquired. **Congenital torticollis** is due to a shortening of the sterno-mastoid muscle, and may be of pre-natal origin or caused by injury to the muscle during birth. The splenius capitis, levator scapulæ and trapezius muscles may be involved secondarily. Some of the *symptoms* of congenital wry-neck are as follows:—

1. The head is flexed laterally, the face is rotated to the opposite side, and the chin is raised.

2. Movement is limited

3. There is more or less asymmetry of the face.

4. In advanced cases there is a curve in the cervico-dorsal region of the spine with convexity towards the unaffected side. A compensatory curve may occur lower down.

Acquired torticollis may be caused by spasm of one or more of the muscles which move the head, due to irritation, either direct or reflex, of the nerve or nerves supplying them. It may also be caused by rheumatism, inflamed glands, contracting cicatrices, defective eyesight, etc.

In spasmodic wry-neck the principal *symptom* is a sudden spastic contraction of the sterno-mastoid or trapezius muscle, or of both, causing the head to be bent towards the affected side and the face rotated to the opposite side; sometimes both sides are affected and the head is jerked backwards (retrocollic spasm); sometimes other muscles are involved and the deformity is increased. The spasmodic contractions vary very much in severity. They may be either tonic (uninterrupted) or clonic (contractions and relaxations occurring in quick succession). The affected muscles become hypertrophied from excessive exercise and more or less contracted. The opposing muscles also become hypertrophied.

TREATMENT of Spasmodic Torticollis.—Massage combined with exercises has proved useful in mild cases and in the early stages of the disease. Effleurage movements only should be employed. Carefully regulated free movements of the head in all directions should be given in order to exercise the controlling nerve centres.

In treating other forms of torticollis, effleurage, kneading, and pétrissage movements, carried out so as to stretch the tissues as much as possible, should be employed upon the affected side.

For the opposite side, besides the above movements, percussion and vibration may be employed freely, the object here being to tone up and cause the contraction of the stretched and weakened muscles, and to stimulate the nerves, which are generally below normal in point of excitability.

In these cases the following corrective exercises may be given:—

Passive—

1. Circumduction of the head.
2. Rotation. Rotate the head towards the affected side.
3. Lateral bending. Bend the head away from the affected side.

Resistive—

1. Rotation, concentric and excentric. In this exercise the patient rotates the head towards the affected side, while the gymnast resists; the latter then brings the head back until the face is in the middle line, while the patient resists.
2. Lateral bending, concentric and excentric. The patient bends the head away from the affected side, while the gymnast resists; the latter brings the head back to the middle line while the patient resists.

BOOKS RECOMMENDED FOR FURTHER STUDY

Deformities, by A. H. Tubby.
Medical and Orthopædic Gymnastics, by Anders Wide.

CHAPTER IX

DISEASES OF THE RESPIRATORY AND CIRCULATORY SYSTEMS

Chronic Pharyngitis—Chronic Laryngitis—Bronchial Asthma—Emphysema—Pleurisy—Heart Disease—Arterio-Sclerosis—High Blood Pressure—Thrombosis—Phlegmasia Alba Dolens—Varicose Veins—Hæmorrhoids—Anæmia.

CHRONIC PHARYNGITIS

Chronic pharyngitis or relaxed throat is a condition in which the mucous membrane is relaxed, congested, of a deep red colour, and is frequently covered with adherent mucus. In granular pharyngitis or clergyman's throat there is hypertrophy of the lymphoid tissue, which, in the form of roundish granular bodies, projects beyond the mucous membrane on the lateral or posterior sides of the pharynx. The above changes may be caused by frequent acute attacks of pharyngitis and by excessive use or misuse of the voice. Excessive smoking or drinking may also cause or aggravate the complaint, and it is frequently associated with anæmia, dyspepsia, and chronic nasal catarrh.

The *symptoms* are irritation, soreness and dryness in the throat, coughing and hawking.

Massage for the throat may be ordered to improve the circulation and to stimulate the cells in the membrane. For this, throat shaking and effleurage are useful. If associated with anæmia or dyspepsia these conditions are treated by general massage or a general strengthening gymnastic table.

CHRONIC LARYNGITIS

In chronic laryngitis the mucous membrane and underlying tissues of the larynx are in a condition of low inflammation. In some cases the vocal cords are congested. If neglected, chronic laryngitis may lead to permanent thickening of the tissues, and to hypertrophy of the mucous membrane.

Massage stimulates the nerves which supply the larynx, and improves the circulation of the blood and lymph through the part; congestion, if present, is thus relieved, while the nutrition of the vascular walls and the muscles and membranes of the larynx is promoted.

For massage of the larynx the patient should be seated or, if in bed, should have the head and shoulders well raised. Deep breathing should be insisted upon before the manipulations are commenced, as well as throughout the treatment.

Movements—

1. *Effleurage.*—(*a*) Stand behind the patient and place the palmar surface of the fingers of each hand under the jaw on either side; then pass the hands downwards, exerting pressure with the fingers over the jugular veins.

(*b*) Stroke downwards from the occiput on either side of the cervical vertebra with the palmar surface of the fingers.

2. *Kneading.*—Knead the muscles on either side of the larynx with the pads of the fingers.

3. *Vibration.*—Grasp the larynx between the fingers and thumb of one hand and vibrate.

4. *Raising the Larynx.*—Grasp the larynx between the finger and thumb of one hand at the inferior border of the thyroid cartilage; then direct the patient to swallow; the larynx ascends in so doing, and when it is at its highest point fix it in this position and direct the patient to swallow again.

This is a useful movement in cases of throat deafness, as it helps to clear the Eustachian[1] tube of mucous secretion.

BRONCHIAL ASTHMA

Bronchial asthma is probably due to the swelling and congestion of the mucous membrane of the bronchial tubes, and massage and respiratory exercises are ordered to relieve it. The patient should be directed to breathe deeply for some minutes before the manipulations are commenced, and to continue to breathe as regularly as possible during the treatment. The neck and chest should first be stroked and kneaded, and a good deal of percussion (clapping) given over the latter region. Screw twisting is a useful movement, also chest lift shaking and other exercises to help the interchange of gases in the lungs and to facilitate expectoration. The treatment should conclude with a respiratory exercise.

EMPHYSEMA

In emphysema the essential change consists of dilatation of the air-cells with atrophy and rupture of their walls. Dr. Harold Pritchard's description of the sequel to this change is as follows: "Owing to these lesions the capillary area of the lungs available for aeration of the blood is considerably reduced. The capillaries are thus in part destroyed, and new vessels appear which serve to short circuit the blood from the venous to the arterial side without it having been fully aerated. Lymphatic destruction also takes place, so that inflammatory products which may accumulate in the course of any disease of the lungs are removed with greater difficulty, and so the danger of any such disease is increased. A degree of fibrosis also occurs, and this by its contraction tends to increase the lesion."

The consensus of opinion is that the condition is brought about by forcible expiration, causing increased tension in the air-sacs, degeneration or defective development of the lung tissue being a primary factor. There is frequently an hereditary tendency to the disease. Occupations entailing muscular exertion and performed with the glottis closed are a frequent exciting cause, as are also glass blowing and playing on wind instruments. Prolonged coughing attacks, such as occur in whooping cough and bronchitis, are also instrumental in bringing on the disease.

Symptoms and Signs.—Dyspnœa, on slight exertion in the earlier stages, and becoming persistent as the disease advances. Cyanosis is common and may be very marked. Chronic valvular disease and chronic bronchitis are frequently associated with emphysema and give rise to further symptoms. The cough which is usually present is due to bronchitis. The thorax undergoes changes in shape. It is increased in all its diameters and becomes "barrel shaped." The ribs are separated; the clavicle, sternum, and costal cartilages stand out prominently; the curve of the thoracic spine is increased. Diminished elasticity of the lung tissue causes respiratory changes, inspiration is short and quick and there is little or no expansion of the chest during the movement, expiration is prolonged. The heart may compensate for the condition of the lungs for some time, but when compensation fails, obstruction of the pulmonary circulation occurs to a greater or less extent, leading to general circulatory disturbances with probably, in time, fatal results. The course of the disease is slow and there is no cure for it, but the condition can be much relieved and improved by suitable gymnastic treatment, which may have to be repeated from time to time.

This *treatment* aims at—(1) Helping respiration, and particularly the move-

[1] The Eustachian tube conveys air from the naso-pharynx to the tympanic cavity of the ear.

ment of expiration, by respiratory exercises such as half lying chest lift stroking, with pressure upon the lower part of the thorax during expiration, half lying chest lift shaking, heave grasp standing side chest shaking, wing sitting or wing standing trunk bending forwards and raising in time with respiration. Standing head extension arm rotation and deep breathing, sitting double arm rolling for respiration, and other breathing exercises may also be employed.

(2) Stimulation of the lung tissue, to promote better aeration of the blood, by means of such movements as heave grasp standing chest clapping and side chest shaking, half lying chest lift shaking, wing high ride sitting side wringing, wing high ride sitting screw twisting, and vibrations.

(3) Loosening mucus in cases of bronchitis by the preceding movements.

(4) Improving the general circulation by effleurage, muscle kneadings, and passive and active movements. Local heart treatment may be necessary.

(5) Promoting the better contraction of the muscles of respiration by massage —frictions and chest clapping chiefly, not omitting manipulation of the intercostal muscles.

(6) Expansion of the thorax and lungs by side flexions of the trunk and deep breathing.

Dyspepsia, flatulence, and constipation, when present, should be treated by abdominal massage and, in the latter case, by movements which specially influence the portal circulation, such as wing high ride sitting circle turning and wing stride standing trunk rolling.

PLEURISY

Pleurisy or inflammation of the pleura may be of the dry variety or accompanied by effusion, either serous or purulent (empyema).

The *causes* are chill or some sort of microbic invasion. It may be a primary affection or secondary to some other disease, such as acute pneumonia or pulmonary tuberculosis. The onset may be insidious or quite sudden.

The *symptoms* are—dyspnœa; pain, perhaps severe, in the side or back or referred to the abdomen; dry cough; frequent shallow respirations and fever.

The chronic form may set in insidiously, without any acute symptoms, or it may be the sequel to an acute attack. The process of absorption of pleuritic effusion may take place quickly or more or less gradually according to the severity of the case. Thickening of the pleura and adherence of the layers; fibrous adhesions; sinking in of the thorax on the affected side, and shrinkage of the lung, causing incomplete respiration and leading to scoliosis, may be consequent changes. On the other hand, in many cases the function of the lung remains unimpaired.

When the acute stage has passed, *gymnastic treatment* may be given to hasten the absorption of the fluid, to prevent the formation of adhesions or to stretch those already formed, also to improve the mobility of the chest and to expand the lung by respiratory movements. The following movements are indicated in these cases: Half lying chest lift stroking, half lying chest lift shaking, wing high ride sitting circle turning, wing or neck firm standing or sitting side flexion, side arch grasp standing chest clapping, wing high ride sitting screw twisting, wing high ride sitting side wringing, etc. Massage and movements (passive at first, later active) may also be given to improve the general condition. All treatment should be very gentle; at first only the mild respiratory exercises should be given, stronger ones and chest expansions being gradually introduced.

CHRONIC VALVULAR DISEASE OF THE HEART

The most common form of chronic valvular disease is caused by endocarditis (inflammation of the endocardium or lining membrane of the heart and valves). This condition is most commonly secondary to rheumatic fever and it is also associated with other acute specific fevers. Minute vegetations are formed on the valves, these become organised, being replaced by connective tissue, and there is consequent sclerosis (hardening), shrinking, and deformity of the valves.

The other form of chronic valvular disease is marked by a slowly progressive hardening of the segments, usually of the aortic valves, associated with sclerosis of the first part of the aorta; there may also be degeneration of the mitral valve. This type is a symptom of arterio-sclerosis.

The changes in both forms may give rise either to *incompetence*, in which case the valves do not close completely, and regurgitation occurs, or to *stenosis*, a narrowing of the orifice, which more or less obstructs the passage of the blood. Incompetence and stenosis may exist together or separately.

Mitral incompetence is most often combined with **mitral stenosis.** The former causes enlargement of the left ventricle, the latter enlargement of the right ventricle.

The *symptoms* are—dyspnœa and palpitation on exertion, weak irregular action of the heart, cough, a high colour, and dropsy. There is a tendency to bronchitis and usually some cyanosis.

Aortic incompetence is marked by hypertrophy and dilatation of the left ventricle. The *symptoms* are—headache, giddiness, faintness, dyspnœa, pallor, pain, cough, and œdema of the feet. Anæmia is common and angina pectoris is more frequent in this form than in others.

In **aortic stenosis** the heart is hypertrophied, especially the left ventricle. The *symptoms* are vertigo, shortness of breath, indefinite pain in the præcordial area, and faintness. The pulse is infrequent, small, and slow.

Tricuspid incompetence is a common form of valvular disease. It is most often caused by emphysema, changes in the lungs, and lesions of the mitral valve. The *symptoms* are the same as those of mitral insufficiency.

Tricuspid stenosis is infrequent. The condition is generally combined with mitral stenosis. The *symptoms* are cyanosis and dropsy.

The result of either obstruction to the flow of blood or regurgitation is that dilatation of one or more of the chambers of the heart occurs. If temporarily overtaxed, the heart is able to cope with the extra work without undergoing any physiological change, as it has a great deal of reserve power. If, however, dilatation of the chambers is prolonged, as in gross valvular disease, the heart muscle hypertrophies in order to do its work effectively. This accommodation of the heart to abnormal conditions is called "compensation," and as long as the lesions in the valves are well compensated for in this way no symptoms appear. A hypertrophied heart, however, has less reserve power than in its normal condition, and compensation may gradually decrease or fail altogether if the valvular trouble is progressive.

GENERAL HEART TREATMENT BY MASSAGE AND EXERCISES

The system employed may be on the ordinary Swedish, or modified Swedish lines; in which case the following movements are the most suitable: effleurage; kneadings of the arms and legs; gentle abdominal kneading; chest clapping; back hacking; and back vibrations. Respiratory movements, such as chest lifting, chest lift stroking and shaking, and double arm rolling in time with respiration (taking care in the last named not, in certain cases, to bring the arms higher than the level of the shoulders). Passive movements of the legs, arms, and trunk, such as foot rolling, foot and leg flexion and extension, and leg rolling; similar movements for the arms, and circle turning for the trunk. Active movements of the extremities, given with a variable degree of resistance, and active trunk movements such as sitting or standing trunk twisting, trunk side flexion and trunk forward bending, which may be given free or with resistance.

In giving massage the patient should be placed in a comfortable position with the head and shoulders raised, and should be directed to breathe regularly. In masséeing the abdomen, the patient's legs should be flexed and adequately supported by pillows. The manipulations for this part should not be very forcibly carried out. When manipulating the back the patient may be made to lean forward upon pillows, or some comfortable support, as the forward lying position is, as a rule, inadvisable in these cases.

In arranging a table of treatment great care should be taken in the selection of suitable movement and exercises for each individual patient. In severe cases gentle kneading of the legs and arms, passive movements of the feet and hands, and local heart treatment may be all that can be given at first; the number of joints moved may be gradually increased and active movements introduced as the patient grows stronger. Active movements of the legs can be more easily borne by heart patients than active arm movements, and should, therefore, be employed first. Resistive movements should replace the passive ones as soon as possible. At first, in many cases, the exercises must be carried out in the half lying position. Later, and in some cases from the first, many of them can be given in the sitting and standing positions. No movement should be given in the forward lying or hanging positions; nor should any exercise be given which strongly expands the chest, or which hinders breathing. If the patient is inclined to hold in the breath, he or she should be directed to count slowly in a whisper during the exercise. The resistance offered should be very slight at first and gradually increase. The exercises should be slowly and evenly carried out. There should be an interval of some seconds between each one, during which the patient may be directed to take a deep breath. The pulse should be taken before, after, and, in some cases, during the treatment.

The masseuse should watch carefully so as to be able to detect any sign of fatigue in the patient at once; hurried breathing, perspiring, dilatation of the nostrils, pallor, yawning, and palpitation are indications that treatment should be suspended immediately. Light, comfortable clothing should be worn during the exercises. The patient should have absolute rest for at least an hour in many cases after the treatment. Half an hour may be sufficient for others.

The object of giving massage and exercises in heart disease is, by improving the general circulation, to relieve the backward pressure of the blood upon the heart, which is thus able to contract more fully, and to produce a full, strong pulse. The coronary circulation is also acted upon by the treatment, so that the nutrition of the heart itself is improved; and on this account, and also because of its ability to contract more freely, the heart muscle grows stronger. Oxidation of the blood is also increased by treatment, especially by respiratory exercises, and by chest clapping and chest lift shaking.

Local Heart Treatment.—This consists of gentle stroking, vibrations, tapôtement á air comprimé, and hacking over the præcordial region. It is given to stimulate the heart to more normal function. Another method is as follows:—

The patient lies in the supine position with the head and shoulders raised The masseuse stands in front and places her hands high up on each side of the patient's chest. The patient is directed to take a deep breath, and during expiration the operator's hands are drawn downwards and forwards with gradually increased pressure so that the lower part of the chest is compressed at the completion of the expiration. This movement, by direct pressure, increases the flow of blood through the heart muscle, and so promotes its nutrition.

The Nauheim methods of the treatment of heart disease consist of the Nauheim baths, some highly carbonated, others of the warm salt variety from which calcium, iron salts, and CO_2 have been eliminated, and the Schott exercises.[1] The baths stimulate the cutaneous nerves, cause dilatation of the capillaries and stimulation of the venous flow, so that an overloaded heart is relieved and its action made stronger and less frequent.

Dr. L. C. Thorne Thorne states in the *Practitioner's Encyclopædia of Medicine and Surgery* that the Nauheim methods are especially useful in the following classes of heart affections:—

1. Cardiac dilatation with weak muscular walls, the sequela of influenza, typhoid, malaria, acute or sub-acute rheumatism, anæmia, or any wasting or debilitating illness.

2. Valvular disease, accompanied by cardiac dilatation and muscular weakness.

3. Cardiac dilatation secondary to high arterial tension, and commencing arterial degeneration in middle-aged people.

[1] Elaborated by Doctors August and Theodor Schott.

4. Cardiac weakness and irritability produced by the excessive use of tobacco r alcohol.

5. Nervous affections of the heart.

6. Obesity, in which there is usually cardiac dilatation and fatty overgrowth.

THE SCHOTT EXERCISES

1. The patient stands with the arms extended forwards at the same level as e shoulders and with the palms of the hands together. The gymnast, in the alk standing position in front of the patient, places the palmar surface of the ngers on the back and the thumb on the front of the patient's wrist of either le, so that the latter rests in the fork made by the gymnast's thumb and first nger. The patient carries the arms back into the frontal plane (on a line with e shoulders) while the gymnast gives resistance on the back of the wrists. The asp is then changed by reversing the position of the gymnast's thumbs and ngers, and resistance is given on the front of the patient's wrists as the arms are rried forward to the starting position.

2. Flexion and extension of the forearm. The patient stands with the arm inging by the side and the palm directed forwards. The gymnast stands beside e patient and gives resistance on the front of the wrist with the palmar surface the hand during flexion and on the dorsal aspect of the wrist during extension. ne upper arm should not move during this exercise and the fingers should touch e shoulders at the completion of the first part of the movement. This movement given to each arm in succession.

3. The patient stands with the arms hanging by the sides, palms directed rwards. The arms are carried laterally and upwards until the thumbs meet oove the head and are then brought back to the starting position. The gymnast ands in front and gives resistance by placing the palmar surface of the fingers 1 the radial aspect of the wrist during the upward movement and on the ulnar rface during the downward movement.

4. The fingers are bent at the first interphalangeal joints and the second ıalanges of the right hand are placed firmly against those of the left; the thumbs e kept straight and touch at their extremities. The elbows are bent so that e hands, in apposition as described, lie in front of the abdomen. The arms are ıen raised until the hands reach the top of the head and are then lowered to the arting position. The gymnast stands in front and gives resistance on the radial pect of the wrists with the fingers during the upward movement. For the ›wnward movement the grasp is changed; the gymnast places the thumbs on ıe back and the fingers on the front of the wrists, which rest in the fork thus ade, and gives resistance on the ulnar aspect of the joints.

5. The patient stands with the arms hanging by the sides, palms directed edially. The arms are first carried forwards and upwards until they are extended ›ove the head and then forwards and downwards to the starting position. The mnast stands in front and gives resistance during the first part of this movement 1 the radial aspect of each wrist with the fork formed by the thumb and forenger. As the arms are brought upwards to near the level of the shoulders the mnast's fingers are made to glide over and rest upon the radial surface of the rists. In this way resistance is given until the arms are extended above ıe head. During the first part of the return movement resistance is made by ıe fork of the hand, thumbs on the palmar and fingers on the dorsal surfaces of ıe patient's wrists. As the arms are being lowered to the level of the shoulders the mnast's thumbs are gradually moved laterally and the fingers medially, so that reverse fork is formed whereby resistance can be continued on the ulnar surface the wrist during the downward movement. As the arms are still further wered and are being brought back to the sides, the gymnast's fingers should be lded round the ulnar surface so that a uniform resistance can be maintained ıtil the completion of the movement.

6. The patient stands with the knees straight, bends the trunk forwards and ıen raises it to the erect position.

The gymnast stands beside the patient during the forward movement, one hand is placed upon the upper third of the sternum and the other upon the lumbar region. During extension of the trunk resistance is given on the upper part of the back.

7. Standing, rotation of the trunk to each side. The patient should end the movement by turning forwards to the starting position. The gymnast, standing in front of the patient, gives resistance by placing one hand in front of the forward turning shoulder, the other is placed over the back of the backward rotating shoulder.

8. Flexion of the trunk, first to one side, then over to the other, finally returning to the erect position.

The gymnast stands in front of the patient. When the movement is to the left, resistance is given on the left side of the chest under the axilla with the right hand, while the other is placed upon and supports the patient's right hip. When the movement is to the right, the position of the gymnast's hands is reversed.

9. The same as No. 2, namely flexion and extension of the forearm but with the fist closed. The forearms are flexed in succession.

10. Flexion and extension of the forearm with the fist clenched and rotated laterally. The forearms are flexed in succession.

11. Standing, with the arms hanging by the sides, palms directed medially. Each arm is alternately circumducted forwards, upwards, backwards, and downwards. The palm of the hand is directed laterally before the arm is carried back and down.

The gymnast stands beside the patient with the fingers of one hand upon the radial aspect of the wrist. Resistance is given during the forward, upward movement with one hand, and during the backward, downward movement with the other.

12. Standing, with the arms hanging by the sides and the palms directed medially. The arms are carried backwards and upwards as far as possible without forward flexion of the trunk.

The gymnast stands behind. The backward movement is resisted with the fork of the hands on the ulnar aspect of the wrist and the forward and downward movement by the fingers, which are then folded round the radial aspect of the joint.

13. The patient stands with one hand resting upon some support. The thigh of the opposite side is flexed as far as possible and then extended until the starting position is regained. During flexion the leg should hang straight down from the knee joint. Resistance is given above the knee with one hand during flexion, and below the lower part of the thigh or on the plantar aspect of the foot during extension.

14. Standing, as in the preceding movement. The patient carries each of the lower extremities in succession forwards, then backwards as far as possible, and finally forwards to the starting position. The knee must be kept straight during the movement.

The gymnast resists the forward movements in front of and above the ankle and the backward movement behind the latter.

15. The patient stands with both hands holding a chair or rib stool in front. Each leg in succession is flexed upon the thigh and then extended. Resistance is given during flexion upon the heel and during extension just above the front of the ankle.

16. The patient holds a chair with one hand and abducts and adducts the leg of the opposite side. Resistance is given on the lateral and medial side of the ankle by the gymnast.

17. The patient in the half yard standing or sitting position twists or rotates the arm laterally and medially. The gymnast resists by grasping the ulnar aspect of the hand (metacarpal part), or by circling the wrist with the thumb and first finger.

18. The hand is first extended, then flexed and finally brought back to the starting position, *i.e.* on a line with the forearm.

The gymnast resists on the dorsal aspect of the hand during extension and on the palmar aspect during flexion.

19. Dorsi and plantar flexion of the feet, in succession. Resistance is given on the dorsal and plantar aspects respectively.

The foregoing exercises are arranged so as to bring most of the voluntary muscle groups of the body successively into action. Each movement should be slowly and evenly carried out once, and should take on an average thirty seconds to perform. The resistance given by the gymnast must be modified to suit each individual case, and gradually increased as the patient grows stronger.

It may often not be possible, especially at first, for the patient to carry out all the exercises in the erect position; in which case many of them can be given lying, with the head and shoulders raised, or sitting. It may also not be possible at the beginning of a course of treatment to give all the exercises enumerated above, and many of them must be modified to suit each patient. For instance, if the right side of the heart is overloaded, the arms should not be raised above the level of the shoulders, so as to avoid facilitating the flow of blood from the brachial veins.

All the points and precautions previously enumerated should be observed in carrying out the Schott exercises.

MYOCARDITIS (MYOCARDIAL DEGENERATION AND DILATATION OF THE HEART)

"There are two main forms of primary myocardial disease, the acute and the chronic form. The histological changes underlying the acute form are parenchymatous degeneration, especially fatty degeneration, with or without cellular infiltration of the interstitial tissue. The histological changes underlying the chronic form are fatty degeneration and fatty overgrowth, with fibrosis of the interstitial tissue. In both forms dilatation of the chambers, with thinning of the walls of the heart, are consequent changes if death does not occur before such changes can take place" (T. J. Horder, *Practitioner's Encyclopædia of Medicine and Surgery*).

The *causes* of acute myocarditis are the poisons of acute specific fever, such as rheumatism, diphtheria, pneumonia, typhoid fever, influenza, etc.

Mortality is high in these cases, in some the patient only recovers partially and is left with a permanently weakened heart.

The *causes* of the chronic form are: (1) Influenza, other fevers are not a common cause; (2) strain, physical and mental; (3) alcoholism; (4) arteriosclerosis; (5) failure of compensation in valvular disease.

Symptoms.—These vary in different types of case. In primary myocardial degeneration they are: dyspnœa on exertion, pain and distress in the præcordial region, palpitation, fainting attacks, inability to lie flat, some cyanosis, and coldness of the feet and hands. Later signs are: œdema of the feet and legs, a diminished amount of urine, and general visceral congestion.

Treatment.—In convalescence after myocarditis careful massage and passive movements may be given. The former should consist at first of local heart treatment and gentle effleurage of the limbs, followed later by kneadings and more general treatment. The passive movements in the early days of treatment should be limited to those for the ankle, knee, and joints of the arm, and these should be gradually introduced. Active movements should be postponed till later. Mild respiratory exercises, such as chest lifting and chest lift stroking, may be given.

When massage is ordered in convalescence after acute myocarditis (caused by infective processes) the treatment should be as above, but most cautiously increased in strength, extent, and duration.

PERICARDITIS (INFLAMMATION OF THE PERICARDIUM)

Causes.—Acute rheumatism, scarlet and other fevers, chorea, tuberculosis. It may also be caused by trauma and by extension from the lungs and other neighbouring organs. It is often a terminal condition in acute and chronic nephritis.

Pericarditis may be either acute or chronic. In **acute pericarditis** there are two stages: acute fibrinous pericarditis (*i.e.* pericarditis without liquid effusion) and pericarditis with liquid effusion. The disease may terminate before the second stage occurs.

Symptoms of Acute Fibrinous Pericarditis.—There may be none, or there may be pain, dyspnœa, palpitation, and fever.

Symptoms of Pericarditis with Liquid Effusion.—Pain, dyspnœa, and fever are usual. Cyanosis may be present, also restlessness, insomnia, and delirium.

In slight cases of pericarditis, without liquid effusion, the inflammatory exudates are completely resolved, but in the majority pericardial adhesions remain.

Chronic Adhesive Pericarditis.—Cases, if they do not terminate fatally in the acute stage, may become chronic, and the layers of the pericardium become much thickened. The *symptoms* are those of hypertrophy and dilatation, and, at a later stage, of cardiac insufficiency.

Treatment.—When the disease has completely subsided, massage of the limbs and trunk may be commenced. Local heart treatment and passive and gentle respiratory movements may be also carried out. No strong chest expansion should be given. Active movements may be gradually introduced as the patient gets stronger.

HYPERTROPHY OF THE HEART

This is a secondary condition denoting an increase in the size of the heart muscle. It is brought about by extra work causing distension of the chambers of the organ, and it is dependent upon a proper supply of blood to the myocardium. The fibres of the latter increase in size. There may be hypertrophy of the entire heart, or of one side, or even one chamber of it.

Valvular disease, arterio-sclerosis, chronic interstitial nephritis, and excessive muscular exertion are causes of hypertrophy.

The *symptoms* are those of the cause, and also of any accompanying affection, such as anæmia and dyspepsia.

Hypertrophy is, in itself, a satisfactory condition, and is an effort of nature to compensate for a lesion somewhere in the circulatory system. It is, therefore, not directly treated. The cause, however, if possible is relieved, or prevented from making further progress, as in marked cases of hypertrophy degenerative changes occur in the muscle and sooner or later compensation begins to fail. The treatment also aims at maintaining a good supply of blood to the muscle of the heart itself. All strain, physical and mental, should be avoided, and anæmia or any digestive disturbance should receive attention.

ANGINA PECTORIS

Angina pectoris is associated with organic disease of the heart and vessels and most usually with sclerosis of the first part of the aorta and the coronary arteries. Its *causes* are those of arterio-sclerosis and of heart disease. It is more common in men.

The *symptoms*, in a severe case, are violent cramp-like pains in the region of the heart, which extend to the arm and neck. There is a feeling of imminent death, the patient becomes pallid, and the lips livid. Other symptoms are sweating, faintness, restlessness, anxiety, exhaustion. The patient may die during an attack, or without any warning. Paroxysms may recur several days in succession or during a long period of years.

The attacks are brought on by either physical or mental exertion, or emotion, by cold, or by flatulence of the stomach.

Some theories to account for angina pectoris are, that it is neuralgia of the cardiac nerves, cramp of the heart-muscle, or spasm of the coronary arteries.

There is a neurotic form of angina which occurs in hysterical and neurasthenic cases and is never fatal, the attacks of pain being due to neuralgia of the cardiac nerves.

Another form is due to poisoning by tobacco, tea, or coffee, which in some cases brings on severe pain, anginal in character.

Dr. Bezly Thorne in his book, *The Schott Methods of the Treatment of Chronic Diseases of the Heart*, mentions that he has been witness of improvement amounting to practical or actual cure in cases, amongst others mentioned, showing the physical signs which usually indicate angina pectoris, apparently both of neurotic and organic origin. This improvement has been due to treatment by Nauheim baths and exercises. Very detailed instructions should be obtained from the physician before attempting to treat cases of organic causation by massage and exercises.

GENERAL CHANGES IN THE CIRCULATION IN ORGANIC HEART DISEASE

In organic heart disease there is a loss of balance between the power of the heart and the resistance which it has to overcome in keeping up the circulation of the blood. In valvular disease when compensation fails, and in degeneration, the heart cannot empty itself completely, and the results are that the circulation in the arteries is diminished and there is congestion in the capillaries and veins. The pulse and blood pressure are altered, and oxidation of the blood both in the tissues and lungs is hindered; increased exudation takes place through the walls of the capillaries, due to malnutrition, leading to increased resistance to the blood-stream and causing œdema of the lower extremities; the viscera become congested, giving rise to digestive disturbances; there is general weakness, due to the preceding and to malnutrition of the nervous system, which also gives rise to nervous symptoms. Other general symptoms are cyanosis, dyspnœa, palpitation on exertion, and coldness of the extremities.

FUNCTIONAL DISORDERS OF THE HEART

Palpitation is a condition in which the heart beats are so forcible as to be perceptible to the patient; they may also be irregular. There are varying degrees of palpitation, from a mild fluttering to violent action of the heart. It is a common symptom in neurasthenia and hysteria. Dyspepsia is frequently an exciting cause, also the excessive use of tea, coffee, alcohol, and tobacco. It may be associated with organic disease, but is most usually a nervous affection.

All *treatment* is directed towards removing the cause of the disturbance if possible. Massage, modified to suit each individual case, may be given, with passive and active movements. Local heart treatment may be necessary.

Other functional disorders are: (1) **Arrhythmia,** or irregularity or intermittence of the pulse, the commonest form of which is the extra systole; (2) **tachycardia,** or rapid action of the heart; and (3) **bradycardia,** or slow action of the heart.

ARTERIO-SCLEROSIS

This is a condition of thickening, diffuse or circumscribed, which takes place in the arteries of the body, so that they lose their elasticity, and become, in the case of the large arteries of the body, tortuous and inexpansile. This process leads, in the larger arteries, to what is known as atheroma.

Causes.—It is a natural accompaniment of old age; it may be due to various chronic intoxications, alcohol, lead, gout, and syphilis. It may also result from over-eating, overwork of the muscles, and renal disease.

Arterio-sclerosis is not itself treated by massage and exercises; but if a patient suffering from it is undergoing treatment for cardiac disease or any other complaint, greater care even than usual must be taken not to overtax the heart, whose work is increased by the sclerosed condition of the blood-vessels. In marked cases of this kind resistive exercises had better be avoided altogether.

HIGH BLOOD PRESSURE

Normal blood pressure is dependent on the perfect balance maintained betwee the vaso-constrictors and vaso-dilators of the vessels, and these are controlled b centres in the medulla and in the cord. The latter control is local. It preside for instance, over the dilatation of the vessels of the digestive organs after a mea with a corresponding constriction of the peripheral vessels to preserve the balanc of arterial tension.

The function of the medullary centre is general. It causes a general constrictio of the vessels and consequent rise in blood pressure—(*a*) when there is a loc loss of balance caused by an insufficient supply of blood to the medulla; (*b*) whe irritated by toxins circulating in the blood, as in gout, uræmia, etc.; (*c*) ment excitement; and (*d*) stimulation of a sensory nerve.

"The normal systolic pressure in a young and healthy male adult may b taken as 120 mm. Hg. In women it is rather lower, say 100–110 mm. Hg; i children lower still, say 90–100 mm. Hg. The blood pressure tends to rise wit advancing years. At fifty years of age a pressure of 150 is not abnormal, at sixt years of age it may be 160 without exciting alarm, and from seventy years on wards it may reach 200 mm. Hg with apparent impunity" (Leonard William *Practitioner's Encyclopædia of Surgery and Medicine*).

High blood pressure, if the cause is not removed, causes degenerative chang in the arteries (arterio-sclerosis), of which the renal, the cerebral, the hepatic, an the coronary arteries are most often affected.

Before the above changes have taken place the condition is functional and th prognosis good. Radiant heat baths are ordered to improve the cutaneous circula tion, and are very efficacious, especially when combined with massage.

THROMBOSIS

A thrombus is a solid formation or clotting of the constituents of the bloc which may occur in the heart or vessels.

It may be induced by—(1) Retardation of the circulation; (2) changes in th constituents of the blood; (3) alteration of the lining membrane of the heart o vessels, usually due to inflammation. The surface becomes roughened an coagulation is induced. Phlebitis (inflammation of a vein) is frequently associate with thrombosis. Occasionally the changes are set up by trauma.

Thrombosis occurs in infective diseases such as typhoid, pneumonia, an appendicitis, showing that it is frequently due to bacterial action. It may follo an operation upon any part. It is also associated with gout, anæmia, an pregnancy, both before and after parturition.

Peripheral venous thrombosis will be considered here, as massage is a usef agent in removing the œdema which remains after resolution or organisation the thrombus and in improving the circulation and general nutrition of the lim The onset of venous thrombosis may be sudden or gradual. The *symptoms* ar Pain and local tenderness, fever, sweats, tender thickening in the course of th affected vein, œdema, and coldness of the limb.

The course of the complaint is very variable, and depends upon the size of th thrombus and its cause. It may terminate by resolution (return to natural cond tions in the inflamed area) or organisation (a process in which the clot is gradual converted into fibrous or scar tissue, leaving the limb in a more or less œdemato condition with dilatation and frequent varicosity of the collateral veins). A thi termination may be the formation of embolus. A portion of the thrombus detached and carried by the circulation to other parts, where it may cause insta death.

Treatment.—Massage is ordered in from two to three months' time aft resolution or organisation has taken place. It should be given most cautious and should consist at first of gentle effleurage to help the circulation in th collateral veins. No deep movements should be carried out in the region of th thrombus. Passive and active movements of the joints may be introduced later.

PHLEGMASIA ALBA DOLENS (WHITE LEG)

This is a condition which occurs most usually in women after confinement, as the result of thrombo-phlebitis of the iliac and femoral veins due to puerperal sepsis. It may also occur after dysentery, typhoid fever, and other fevers and diseases. The left leg is more frequently affected than the right, and if both legs are involved it is usually affected first. The *symptoms* are: pain in the thigh, fever, and enlargement of the leg due to œdematous swelling, which may be of the pitting or the solid variety. In the latter case there is obstruction in the lymph vessels as well as the veins. The limb presents a white, glossy appearance. The acute stage lasts for about a week and then the pain and swelling diminish, and, in favourable cases, the leg may return to its normal condition in about six weeks' time. In severe cases there is permanent enlargement of the limb.

The sequelæ of phlegmasia alba dolens are aching, œdema,—especially of the ankles,—and muscular weakness.

Treatment.—Massage, consisting of light effleurage, may be commenced about the seventh week. If the thrombosis has extended to the thigh the area of the thrombus must be avoided. Passive movements involving the hip joint, frictions, and kneadings must be postponed for about three months, when all danger of dislodging the thrombus is past.

VARICOSE VEINS

Varicosity is a dilated and weakened condition of the veins, which occurs in the lower extremities and in the hæmorrhoidal plexus (when it occurs here it is known as hæmorrhoids or piles). The valves become incompetent, and are unable to oppose the regurgitation of the blood. In the lower extremities the condition may be caused by some obstruction at a higher point, such as tight garters, congestion of the viscera, etc.

Treatment.—In giving massage for varicose veins the lower extremities should be elevated. The whole limb should be included in the treatment. Effleurage movements only should be employed, and these should be carried out with very gentle pressure on account of the weak condition of the walls of the veins and the tenderness of the parts. In some cases it is well to work at first only over the collateral vessels, and to avoid the more prominent veins. Breathing exercises should be included in the treatment, and passive and careful active movements to help the circulation in the legs.

HÆMORRHOIDS

Internal hæmorrhoids are those caused by dilatation of the hæmorrhoidal plexus inside the sphincter ani, beneath the mucous membrane; external hæmorrhoids are those found under the skin outside the anus. They are the result of bad circulation in the rectum, due to constipation, sedentary habits, liver, heart, and other diseases which affect the general and portal circulations.

The *treatment* consists of general gymnastics to improve the circulation, including those which specially influence the portal circulation, and respiratory exercises. Movements which are depleting from the pelvis should be given, to relieve pressure in the hæmorrhoidal veins. Abdominal massage should be given with, sometimes, anal and internal massage of the rectum.

ANÆMIA

Anæmia is a condition denoting a deficiency in the quality of the blood. The chief constituent of the red corpuscles, *i.e.* the hæmoglobin, is that most at fault. The disease may be either "primary" or "secondary." Pernicious anæmia and chlorosis belong to the first class, as, so far, no definite cause has been discovered for either condition.

Primary Anæmia.—*Pernicious anæmia* usually affects people of middle age, but it may occur in children. The outlook in these cases is serious. There is often only temporary recovery, but in some cases the patient may live for many years after the onset of the disease. *Chlorosis* is a form of anæmia which occurs in young girls and which usually yields easily to treatment.

Secondary Anæmia.—The greater number of cases of anæmia can be classified as simple, chronic, and secondary.

Causes.—Repeated small hæmorrhages, derangements of the digestion, want of proper food, air, or exercise, lead or mercurial poisoning, defective circulation due to heart disease, kidney disease, chronic suppuration, tumours, etc.

Symptoms.—Changes in the blood, sallow skin, weakness of the muscular and nervous systems, impaired digestion, constipation, headache, loss of appetite, irregular menstruation, tendency to œdema, dyspnœa, palpitation, and other symptoms of a weak heart.

Treatment.—Massage of the limbs and trunk, giving special attention to the abdomen. Respiratory exercises. At first passive limb and trunk movements, followed later by active movements. Local heart treatment if necessary. The treatment should be carefully graduated so as not to tire the patient.

Massage and exercises promote the process of blood formation and general metabolism by improving the circulation and the digestion and by increasing respiratory activity.

Tables such as the following, gradually increasing in strength, may be arranged:—

General Strengthening Treatment

Three Tables in order of Strength

No. I

1. Half lying chest lift stroking.
2. Half lying leg kneading.
3. Half lying leg rolling for circulation and leg updrawing and outstretching.
4. Half lying arm kneading.
5. Half lying arm rolling and forearm flexion and extension.
6. Arm lean standing back hacking.
7. Wing high ride sitting circle turning.
8. Wing high ride sitting trunk backward bending.
9. Hook half lying abdominal massage, including stomach and abdominal shakings.
10. Wing high ride sitting backward drawing and raising.
11. Heave grasp standing chest clapping.
12. Yard sitting arm rolling for respiration.

No. II

1. Yard sitting arm rolling for respiration.
2. Half lying arm kneading.
3. Back lean standing double forearm flexion and extension.
4. Half lying leg kneading.
5. Tiptoe marching.
6. Wing stride standing trunk rolling.
7. Heave grasp standing chest clapping.
8. Yard walk standing double plane arm carrying.
9. Wing close sitting trunk twisting.
10. Half lying double leg updrawing.
11. Wing lax stoop stride sitting trunk raising.
12. Hook half lying abdominal massage.
13. Arm lean standing back hacking.
14. Forward lying back massage.
15. Sitting head extension arm rotation and deep breathing.

No. III

1. Standing head extension arm rotation and deep breathing.
2. Heave grasp standing chest clapping.
3. Yard walk standing double plane arm carrying.
4. Cock step.
5. Wing close sitting trunk twisting.
6. Reach grasp sitting head extension.
7. Hook half lying leg abduction and adduction.
8. Arm lean standing back hacking.
9. Neck firm standing trunk falling forwards and raising.
10. Hook half lying abdominal massage.
11. Lying double leg lifting.
12. Stretch sitting double arm flexion and extension.
13. Wing lax stoop sitting trunk raising with head support.
14. Wing high ride sitting plane twisting.
15. Wing high ride sitting circle turning for respiration.
16. Wing standing heel raising and knee bending.
17. Forward lying back massage.

CHAPTER X

MASSAGE AND EXERCISES FOR ABDOMINAL CONDITIONS

Chronic Gastritis—Dilatation of the Stomach—Nervous Dyspepsia—Movable Kidney—Chronic Constipation—Chronic Enteritis—Appendicitis—Massage of the Uterus—Pregnancy—Lying-in Period.

CHRONIC GASTRITIS (CHRONIC GASTRIC CATARRH)

Chronic gastritis is usually due to repeated irritation of the gastric mucous membrane. This may be set up by insufficient mastication; eating coarse, indigestible, or highly flavoured food; eating too much or too late at night; taking alcohol or too much and too strong tea or coffee; and by using certain drugs.

Chronic catarrh may also result from acute gastritis, from congestion of the mucous membrane due to heart, lung, or liver disease, and from septic conditions of the teeth, nose, and pharynx. Predisposing causes are: anæmia, Bright's disease, gout, tuberculosis, or some acute illness such as influenza.

The *symptoms* are: loss of appetite, furred tongue, bad breath, and an unpleasant taste in the mouth. A feeling of distension and sometimes pain and heartburn is experienced after meals, and there is frequently nausea, sometimes followed by vomiting. Constipation is usual, but, when there is atrophy of the mucous membrane, leading to absence of gastric juice and fermentation (achylia gastrica), diarrhœa may be present instead.

The *massage treatment* should consist of abdominal massage, previously described, stomach shaking and stomach pit shaking being particularly useful movements, as they promote increased gastric secretion, and facilitate the passage of the food from the stomach into the intestines.

A table of exercises should be arranged in addition, and should include movements to promote cellular activity in the digestive tract, to help peristalsis, when constipation is present, by influencing the portal circulation and by working the abdominal muscles. In this case, owing to the congestion, it is not wise to bring blood strongly to the abdomen, therefore a movement which is repleting may be followed by one which has the opposite effect, and in this way a good circulation is promoted through the part; for the same reason the stoop position should be chosen when giving some of the exercises involving the abdominal muscles.

A gymastic table like the following may be given:—

1. Standing arms raised forwards, upwards, laterally, and downwards in time with respiration.
2. Half lying leg updrawing and outstretching.
3. Wing high ride sitting circle turning.
4. Wing high ride lax stoop sitting backward drawing to the vertical plane and forward bending.
5. Hook half lying leg abduction and adduction.
6. Wing stoop stride sitting screw twisting.
7. Head extension arm rotation and deep breathing.

When diarrhœa is present, light abdominal vibrations, shakings, and strokings should be employed to promote the absorption of fluids and to diminish peristalsis. Exercises for the extremities of a depleting nature from the pelvis may also be given.

DILATATION OF THE STOMACH

Atony and dilatation of the stomach may arise from chronic gastritis, anæmia, neurasthenia, or after any prolonged illness causing general muscular weakness. It is also often the result of eating or drinking too much or too often, or it may be caused by pyloric obstruction due to a tumour or ulcer.

The chief *symptom* is a feeling of fullness during or directly after meals. Splashing on palpation or shaking can be produced if a small amount of water has been drunk even though the stomach is otherwise empty. In a simple case, without complications, there is no pain, and vomiting is rare.

The *treatment* consists of abdominal massage. Stomach shaking, stomach pit shaking, and stomach kneading are valuable movements. The shakings should be repeated frequently during the treatment.

Active movements involving the abdominal muscles, such as double leg updrawing, double knee updrawing and downpressing, trunk rolling and trunk twisting, etc., should be given, and, in these cases, depleting movements are unnecessary.

In cases of enteroptosis (prolapse of the abdominal viscera) the following method of restoring the contents of the abdomen to their normal position has been recommended by Dr. Kellogg :—

The patient lies in the supine position, with the knees flexed. A pillow is placed under the head only, as the shoulders should not be raised. Several deep preliminary breaths should be taken, and deep breathing should be continued during the movement. The masseuse stands on the left-hand side of the patient, facing towards the feet, and places the ulnar borders of the hand, one in each groin, parallel to the inguinal ligament. They are then pressed down into the pelvis, and the contents of the abdomen are grasped and drawn slowly and forcibly upwards during the act of inspiration. This movement may be repeated several times.

Shaking and rolling movements are recommended to precede the above lifting movement, or they may be used in alternation with it.

NERVOUS DYSPEPSIA

This complaint may be due to general nervous exhaustion caused by mental or physical overstrain, anxiety, or other causes of neurasthenia; or it may be the result of special exhaustion of the gastro-intestinal system. It is also a symptom of hysteria.

The *symptoms* are variable and irregular. There is loss of appetite and more or less wasting. The patient complains of abdominal discomfort, which is generally increased during and after meals. Flatulence is usual, not, as a rule, the result of excessive fermentation, but of aerophagy. The discomforts complained of often disappear entirely if the patient is interested or amused, but they are increased by anxiety or agitation of any kind. Constipation is rarely absent. There is frequently atony and dilatation of the stomach, with either an excess or deficiency of gastric secretion. Other symptoms common to neurasthenia are also present, such as insomnia, depression, and self-absorption.

Treatment.—General massage is given, particular attention being paid to the abdomen. Passive and, later, active movements should be carried out, and arranged with the view of improving the general condition and working the abdominal muscles.

MOVABLE KIDNEY

To ascertain if the kidney is out of place the patient should lie with the head and shoulders slightly raised and the legs flexed. The left hand should be placed behind upon the lumbar region and the right upon the right hypochondrium just below the margin of the liver in the line of the nipple. The patient should be directed to take a deep breath while palpation is made with both hands. In the event of very slight displacement (palpable kidney) the lower part of the organ can be felt. In cases known as "movable kidney" the right hand can be placed above its upper pole. The term "floating kidney" applies to rare cases of congenital origin in which the kidney is almost completely surrounded by peritoneum and is attached to the abdominal wall by a sort of mesentery enclosing the vessels and nerves which pass to the hilum. In this case the kidney is freely movable, and may sometimes be found so low down as to be mistaken for an ovarian cyst.

It is easy to mistake an enlarged gall bladder for a movable kidney, unless it is remembered that the latter can quite easily be moved up and back into position, and that it can be felt behind and to the lateral side of the gall bladder; also that the patient complains of a feeling of sickness when the kidney is pressed between the hands. The right kidney is the one usually affected. Occasionally both are movable.

The *causes* of movable kidney are: tearing, wasting, or stretching of the fascia renalis due to injury; tight lacing; enteroptosis; relaxed abdominal walls due to pregnancy, tumours, or wasting of the fat which surrounds the kidney.

Symptoms.—There may be no symptoms, but usually the patient complains of a dull pain in the lumbar region and sometimes of a sickening, dragging sensation. On unusual exertion there may be acute abdominal pain, vomiting, and faintness. Neurasthenia is frequently associated with movable kidney, and the latter may, by pressure, set up inflammation in the stomach and intestines and so give rise to disturbances of digestion.

Gymnastic treatment aims at—1. Strengthening the relaxed structures which hold the organ in position. This is done by gentle vibrations and hacking in the region of the kidney, after having first replaced the latter, and by the specially valuable movement called "under kidney tremble shaking," which is carried out with upward and medial pressure. 2. Strengthening the abdominal muscles by massage and by active movements, such as lying with the feet crossed and drawing in the abdominal muscles, high ride sitting backward drawing to the vertical, half lying double leg updrawing, lying pelvic lifting, and hook lying double leg abduction and adduction combined with pelvic lifting (in cases of enteroptosis). 3. Improving the general condition by muscle kneadings, respiratory and other exercises.

CHRONIC CONSTIPATION

This is a functional disease of the intestines in which there is either delay in the onward movement of the fæces through the intestines with normal excretion (intestinal constipation), or retention in the rectum with normal passage of the contents as far as the pelvic colon (dyschezia).

Constipation may be caused by some local obstruction, such as tumours, adhesions, or morbid growths; or it may be due to errors of diet, irregularity, sedentary habits, weakness of the abdominal muscles, anæmia, neurasthenia, diabetes, diseases of the stomach, liver, and heart, fevers, and lead poisoning; also deficient stimulation due to insufficiency of waste matter in the rectum and colon —the result of eating too little or of excessive absorption.

The results are either or both of the following conditions: 1, impaired power of the intestine to pass on its contents, due to weakness of the muscular fibres, weak reflex action or inhibitory impulses; 2, the formation of hard, dry masses of fæcal matter in the large intestine, due to excessive absorption of fluid or to deficient secretion. In either, and still more, in both of these conditions there is a disproportion between the work to be done and power to do it.

The *symptoms* are: infrequent or deficient evacuations of a dry, hard nature; abdominal pain caused by irritation in different parts of the intestine, or by pressure; inflammation; hæmorrhoids; obstructions; foul tongue and breath; loss of appetite; headache, and lassitude.

Treatment.—If the patient is active and not confined to bed a general gymnastic table is advisable to improve the general condition; otherwise general massage may be given. In either case deep colon kneadings and frictions, abdominal and lumbar side shakings, and leg rolling should be carried out to stimulate the intestinal musculature. The gymnastic table should include active movements for the abdominal muscles, both to strengthen them and to produce intestinal action reflexly. Movements to influence the portal circulation, such as trunk rolling and circle turning, should also be added. Such a table is the following:—

1. Standing arms raising forwards, upwards, laterally, and downwards in time with respiration.
2. Half lying leg rolling.
3. Wing stride standing trunk rolling.
4. Standing head extension arm rotation and deep breathing.
5. Wing high ride fall turn sitting forward turning.
6. Cock step.
7. Hook half lying abdominal massage.
8. Wing toe support sitting trunk falling backwards and raising.
9. Wing standing heel raising and knee bending.
10. Wing or heave grasp close sitting trunk twisting.
11. Half lying double leg updrawing.
12. Standing arms raising sideways and deep breathing.

CHRONIC ENTERITIS OR CHRONIC CATARRH OF THE INTESTINES

Chronic catarrh of the intestines may follow an acute attack (of which the primary causes are: errors of diet, poisons, chill, changes in the quality or quantity of intestinal secretions, excess or diminution in the amount of bile passed into the intestines, and nervous influences. Secondary causes are: liver, lung, heart, and Bright's disease, infectious diseases, spread of inflammation from neighbouring parts), or it may be due to obstruction in the portal system caused by liver or heart disease, which leads to chronic congestion in the intestinal tract, with either thickening or atrophy of the mucous membrane. The chronic condition is also associated with Bright's disease.

The *symptoms* are diarrhœa, which may or may not be accompanied by pain. This condition may alternate with constipation. When the small intestine is chiefly affected, portions of undigested food substances are passed. In catarrh of the large intestine the evacuations are liquid, or hard if the irritation is due to constipation, and may contain small or large quantities of mucus and some blood (catarrhal colitis). The general nutrition of the system is impaired by the disturbance of the digestive functions, and the patient becomes depressed, irritable, and dull.

Treatment.—For diarrhœa, gentle abdominal vibrations and shakings should be given to reduce peristaltic action and to promote absorption and secretion by stimulating the cells and glands in the mucous membrane of the intestines. Movements such as stoop stride sitting double plane arm carrying, stoop stride sitting trunk raising, back lean standing leg forward drawing, etc., should be given to draw blood from the abdomen.

When constipation is present, abdominal kneadings and frictions, sacral beating, leg rolling, and active movements for the abdominal muscles should be given, and also those influencing the portal circulation.

The gymnastic table should also include movements to improve the general condition.

APPENDICITIS

Appendicitis is an infective inflammatory disease of the vermiform appendix. The *symptoms* are: pain, nausea and vomiting, constipation, rise of temperature, and tenderness and pain on pressure.

Treatment.—Very careful abdominal massage may be given when the attack is over to promote the absorption of exudates, to increase peristalsis, and, after operation, to stretch adhesions.

Gentle vibrations should be given at first over the part. Shakings and frictions should be introduced gradually as the patient can bear them. The temperature should be taken, and, if there is any rise after massage, or pain, the treatment should be suspended and information of the change should be given to the doctor. Later, leg rolling, trunk rolling and twisting, leg abduction and adduction, and other active movements may be given to promote peristalsis.

These are cases in which great care should be exercised, and slow progression made from gentle to stronger passive and active movements.

EXTERNAL MASSAGE OF THE UTERUS AND OVARIES

In certain functional disorders of the uterus and ovaries massage has been found to exercise a beneficial effect. Internal manipulation of these parts is, however, entirely outside the province of the masseuse, and should only be carried out by a gynæcologist.

Except after child-birth, the position of the normal uterus renders it inaccessible to direct external manipulation; something may, however, be done by stroking, rolling, percussion, and vibration in the hypogastric region to stimulate the nerves and circulation of the part, and so to promote nutrition and help to restore function. Before undertaking even external massage of the uterus very careful directions should be obtained from the doctor in charge of the case, as, if there is any displacement or abnormal growth in the region of the ovaries, much harm can be done by undue pressure upon the part. For external massage of the uterus the patient lies at first in the hook half lying position, so as to completely relax the abdominal muscles. The bowels and bladder should be empty. The patient should be directed to breathe deeply and regularly while the manipulations are being carried out. The forward lying position is then taken, and stroking, kneading, percussive, and vibratory movements are employed over the sacrum and in the gluteal region.

Dr. Kellogg, in his book, *The Art of Massage*, says that he has found "inspiratory lifting" a very useful preliminary procedure in masage of the uterus. It is carried out as follows: The patient lies in the supine position, with the legs drawn up, and is directed to exhale completely, and then to make an inspiratory movement, keeping the glottis closed, so as to exclude the air. The effect of this movement is to draw the uterus upwards. As in most cases of this kind there is more or less displacement of the abdominal viscera, the "lifting" movement described on page 347 may also be employed.

The following exercises are useful in certain cases of amenorrhœa (absence of menstruation):—

1. Leg rolling.
2. Lying double leg lifting.
3. Leg adduction with resistance (concentric and excentric).
4. Half lying leg updrawing.
5. Wing arch high knee stride standing screw twisting.

It may be of interest to notice here that massage of the uterus is carried out for the patients at the Rotunda Hospital, Dublin, directly after the placenta has come away, and is continued as a routine process twice daily in order to aid involution. The process is as follows: The ulnar surface of the hand is placed above the fundus of the uterus, and a rotatory movement is made with pressure downwards towards the pubis. This treatment acts most beneficially in hastening involution.

PREGNANCY

General massage may be ordered during the period of pregnancy in cases of weak muscular development. It should be carried out with the following precautions:—

Circumduction, or any movement in which the arm is raised above the horizontal position, should be omitted, also flexion of the thighs upon the abdomen and circumduction of the thighs. The breasts should not be manipulated at all. Massage of the abdomen may be continued during the first three months. Gentle superficial pétrissage (picking up) and stroking movements should be employed for this part; vibration, tapôtement, and all deep kneading movements should be omitted, the object of the masseuse being to improve the tone of the muscles of the abdominal wall without disturbing, or in any way pressing upon, the uterus. Percussion should be avoided on the lower part of the back, which otherwise may be rubbed gently in the usual way during the first three months. After that time all manipulation of either the abdomen or the loins should be omitted, unless directions to the contrary are received, in which case the movements employed should be of the most gentle and superficial nature.

THE LYING-IN PERIOD

In about two days after parturition, in a normal case, gentle massage of the limbs and abdomen—in addition to that of the uterus, described above—may be commenced, together with some simple respiratory exercises and passive movements at the ankles and knees. This is sufficient for the first few days, after which the patient should be able to carry out plantar and dorsi-flexion of the feet and flexion and extension of each knee actively. The back should be masséed when the patient can lie comfortably on her side or face, which will be in about ten days. At about the same time, or earlier, exercises 4 and 5 on the list given below may be carried out. Other active and resistive exercises may be introduced gradually as the patient gets stronger.

Some suitable exercises are:—

1. Lying arm rotation and deep breathing.
2. Lying foot plantar and dorsi-flexion.
3. Lying knee flexion and extension.
4. Lying with the legs extended and the feet crossed, contracting the abdominal muscles several times (Oldevig).
5. Lying trunk raising to the vertical with assistance, and sinking back again against resistance.
6. Lying with the legs extended and the feet crossed, contracting the abdominal muscles, and flexing the lumbar spine so that the latter comes in contact with the bed. The patient breathes in before the exercise and out while it is being performed (Oldevig).
7. Hook lying, leg abduction and adduction combined with pelvic lifting.
8. Lying or half lying, double leg updrawing.
9. Lying, raising the arms forwards, upwards, laterally, and downwards in time with deep breathing.

The treatment aims at helping involution, strengthening the muscles, especially those of the abdomen and pelvic floor, and preventing the general weakness entailed by inactivity.

CHAPTER XI

CONSTITUTIONAL DISEASES

Diabetes—Gout—Obesity—Rickets—Chronic Bright's Disease

DIABETES MELLITUS

Professor Osler's definition of diabetes mellitus is that it is a "disorder of nutrition, in which sugar accumulates in the blood and is excreted in the urine, the daily amount of which is greatly increased."

Causes.—Mental strain, shock, worry, sedentary habits, obesity, over-feeding, alcoholic excess, disease of certain cells (islands of Langerhans) in the pancreas, injury or disease of the brain or spinal cord, pregnancy, and infectious fevers. Gout and malaria may be predisposing causes.

Symptoms.—Thirst, excretion of large quantities of urine, in which sugar, in variable quantities, is present; voracious appetite, and wasting. There is sometimes pain in the lumbar region, the tongue may be coated or become red and glazed, the saliva is reduced in quantity, the skin becomes dry and itchy, and the patient is constipated and depressed.

Complications. — 1. Cutaneous—Boils and carbuncles, eczema, gangrene. 2. Nervous system—Neuralgia, neuritis, sciatica, diabetic coma, insanity, cataract and other eye symptoms, aural symptoms. 3. Respiratory system—Pneumonia and phthisis. 4. Renal system—Albuminuria.

In people over forty the disease is less severe than when the subject is younger; it yields better to treatment, and the patient may live for years. The disease is seldom cured, but very good results from treatment may be gained in cases of intermittent glycosuria.

When the patient is under forty the prognosis is bad and the disease runs a fairly rapid course.

Treatment.—A mild general strengthening gymnastic table should be arranged and should include: 1, muscle kneadings, to promote the oxidation of carbohydrates; 2, abdominal massage and movements to influence the portal circulation, to help the digestive processes, and to increase peristalsis; 3, respiratory movements; 4, active movements carefully introduced.

The treatment should be very carefully gradnated so as not to tire the patient. It is intended to take the place of moderate exercise.

DIABETES INSIPIDUS

This is a chronic affection in which large quantities of normal urine of low specific gravity are passed.

The *gymnastic treatment* consists of a mild general strengthening table.

GOUT

Gout is due to defective metabolism.

Dr. W. Langdon Brown says: "Amid all the confusion that reigns on the subject we can hold to the two definite facts established by Sir Alfred Garrod: in gout there is an excess of uric acid in the blood, and before the paroxysm there is a diminished output of uric acid in the urine. The whole reveals a deficiency in the capacity of the body to katabolise purins. The purin that should be consumed is not really poisonous, but it has the disadvantage of being but sparingly soluble, and is, therefore, apt to be precipitated in outlying parts of the circulation, such as the joints and cartilages of the ear, in the form of fine needle-shaped crystals of biurate of soda, with a considerable degree of accompanying inflammation" (*Practitioner's Encyclopædia of Medicine and Surgery*).

Predisposing Causes.—Heredity, alcohol, overeating combined with want of exercise, poor food, and bad hygienic conditions; also lead poisoning. Exciting causes are mental or physical shock and worry.

Symptoms.—The attack may come on suddenly or there may be premonitory symptoms, such as cramp, depression, irritability, dyspepsia, etc. It usually commences in the early morning with an acute pain in the metatarso-phalangeal joint of the big toe, which swells and becomes red, shiny, and tender. The temperature rises. The attack may last for about a week, and there may not be a recurrence for several months or a year after the first onset of the disease. More joints become involved with repeated attacks, and deposits of urates occur in the articular cartilages and ligaments, and also in tendons, bursæ, the cartilage of the ear, the eyelids, and other parts. The joints usually affected are those of the feet and hands, and in time they become deformed and crippled unless the course of the disease is arrested by treatment.

Irregular or Non-Articular Gout.—The following symptoms, occurring in persons who belong to families showing a hereditary tendency to the disease, are classified under this heading: eczema, biliousness, chronic interstitial nephritis, atheroma, chronic bronchitis, asthma, conjunctivitis, and iritis.

Massage and *gymnastic treatment* is indicated in the intervals between the attacks of gout when the patient cannot take active outdoor exercise. Its object is to improve the circulation, promote the elimination of uric acid, improve metabolism, and so prevent if possible a recurrence of the attack. Massage helps the absorption of œdema and reduces the gouty thickenings round the joints and elsewhere. Radiant heat combined with massage is also useful in the latter condition. Abdominal massage and movements to influence the portal circulation are important, and should be included in the gymnastic table.

OBESITY

These cases are characterised by the excessive development of fat. There is deficient metabolism and oxygenising power, and the body weight is increased.

Obesity may be due to some physiological peculiarities, or it may be a pathological condition.

Causes of Physiological or Simple Obesity.—1, overfeeding, combined with insufficient muscular exercise; 2, beer-drinking; 3, climate; 4, heredity; 5, age; and 6, sex.

Pathological causes are: 1, anæmia; 2, decreased activity of the thyroid gland (myxœdema).

The *symptoms* are: fatigue and perspiration on slight exertion. Decreased muscular power. The heart may be weak and there may be palpitation and dyspnœa on exertion.

Treatment.—Massage of the limbs and trunk should be given, consisting of brisk effleurage, deep kneadings, frictions, and pétrissage. Care should be taken not to work too vigorously at first, as obese patients, as a rule, bruise easily and are quickly tired. The parts which need most attention are usually the joints, neck, abdomen, and loins. Gentle respiratory exercises and passive movements, to promote better circulation, should be given at first. Resistive movements should be introduced as soon as possible, and the table should be made gradually stronger.

RICKETS (RACHITIS)

Rickets is a disease which usually occurs between the seventh month and the fourth year of life. It affects the nutrition of the whole body and there are marked changes in the bones; ossification is delayed, and the bones become soft.

"There is an increase of growth in the cartilaginous and membranous parts, accompanied by a softening of the periosteal deposits and a diminished deposition of lime salts" (Dr. G. A. Sutherland).

Dentition is retarded, and the growth and development of the child is arrested.

Causes.—Bad food and bad hygienic conditions. Acute illnesses, especially those affecting the alimentary tract.

Symptoms.—Muscular weakness, softening of ligaments, night sweats (particularly of the head), delayed dentition, large square head, thickening and softening of the bones of the skull, late closing of the anterior fontanelle, curvature of the spine, alteration in the shape of the thorax, nodules on the sternal extremities of the ribs, enlargement of the epiphyses and softening of the diaphyses of the long bones of the extremities (leading to deformities such as knock-knee and bow-legs), gastro-intestinal catarrh, diarrhœa alternating with constipation, enlarged abdomen, convulsions, spasm of the larynx. There is no pain or tenderness of the bones in uncomplicated cases of rickets. When present it may be due to local inflammation or to scurvy.

Treatment.—General massage should be carried out, giving particular attention to the abdomen, and it is well to use oil to help to nourish the tissues. Respiratory exercises should be taught when the child is old enough, and in the meantime a firmly applied bandage round the abdomen helps costal breathing. The special deformities should also be treated. The child should not be allowed to walk, and should not be lifted by the arms as long as the bones are soft. When the disease is arrested a general strengthening gymnastic treatment is indicated.

CHRONIC BRIGHT'S DISEASE

Chronic parenchymatous nephritis and chronic interstitial nephritis are two types of chronic Bright's disease.

In **chronic parenchymatous nephritis** the inflammation affects the tubules of the kidney.

Causes.—Tuberculosis, chronic alcoholism, and malaria. Cases of acute nephritis—caused by the poisons of scarlet and other fevers, pneumonia, septicæmia, and chill—may become chronic and require massage.

The *symptoms* are: œdema, uræmic symptoms (headache, nausea, foul tongue, insomnia, irritation of the skin), anæmia, increased tension of the pulse, thickening of the arteries, hypertrophy of the left ventricle, muscle wasting, decrease in the amount of urine, which contains abundant albumen.

In **chronic interstitial nephritis** there is degeneration of the substance of the kidney.

Causes.—Alcoholism, gout, and lead-poisoning.

The *symptoms* are: urinary changes; headaches, restlessness, depression, etc., due to high blood pressure and thickness of the arteries; numbness or pain in the legs; breathlessness and palpitation, due to hypertrophy of the heart; uræmic symptoms; cerebral hæmorrhage; partial or complete blindness.

Treatment.—General massage and passive exercises are given in these cases to improve the circulation, relieve œdema, and facilitate the work of the heart. Massage also stimulates the cutaneous nerves, so that excretory activity in the sweat glands is increased.

The treatment should be carried out with very great care. Some authorities consider that gymnastics are contraindicated in these cases unless the kidney trouble is secondary to cardiac insufficiency, the reason given being that in chronic nephritis the equilibrium of the vaso-motor apparatus is in such an unstable condition that the action of the heart is uncertain.

CHAPTER XII

FUNCTIONAL DISORDERS OF THE NERVOUS SYSTEM

Neurasthenia—Neuralgia—Neuritis—Sciatica—Writer's Cramp—Chorea—Insomnia

NEURASTHENIA

This term is used to express a condition of nervous exhaustion, which may be either general, involving the whole nervous system, or local, in which there is derangement of some special function, giving rise to cerebral, gastro-intestinal, cardio-vascular, and other symptoms.

The *causes* may be hereditary, the patient starting in life with what is known as the neurotic introspective temperament, or it may be brought on by overwork of mind and body, and worry and anxiety of all kinds. It also frequently occurs in people who have no interest in life except themselves. It may follow diseases such as influenza and typhoid fever.

The *symptoms* are:—

1. Cerebral or psychic: Depression, self-concentration, morbid fears and worries, loss of will power perhaps, in varying degrees, irresolution in action, lack of concentration in ordinary mental work, etc.

2. Headache, in which the pain is either general or localised. There may be a dull aching sensation in the head, a feeling of pressure or lancinating pain.

3. Spinal symptoms, such as pain in the back, tender spots along the spine, various forms of paræsthesia which may extend to the buttocks and thighs, neuralgiform pains in the intercostal region.

4. Insomnia.

5. Vertigo.

6. Muscular weakness. The patient is very easily fatigued, and the lower extremities feel heavy and weak.

7. Visual and auditory sensory disturbances.

8. Gastro-intestinal disturbances: Indigestion, due to atony and dilatation of the stomach, and constipation. There may be diarrhœa and vomiting, and occasionally muco-membranous enteritis.

9. Cardiac and vaso-motor disturbances: Palpitation and weak and irregular action of the heart, pains in the præcordial region, and flushings.

The *treatment* consists of the removal of the cause if possible. Rest from work and change of air and scene may be sufficient treatment in some cases. In others the Weir Mitchell treatment, or a modified form of it, is necessary, combined with massage. Electrical treatment is sometimes ordered.

These are the most difficult of all the cases with which the masseuse has to deal, and in their successful treatment her personality plays by far the largest part. Experience, a healthy outlook upon life, tact, and good judgment are needed in treating these patients, whose minds and wills need strengthening and help in many cases more than their bodies. The massage indicated is given in the description of the Weir Mitchell treatment.

NEURALGIA

This term denotes a painful condition of the nerves. In the more common forms of the complaint—such as neuralgia of the fifth cranial nerve (tic douloureux) and of the supra-orbital nerve—there is no apparent lesion to account for the pain. On the other hand, definite changes are found in the posterior root ganglion, and sometimes in the posterior horn, in cases of the intercostal neuralgia which follows an attack of shingles. The lightning pains in tabes are also termed neuralgic, and in this case too there are definite changes in the cord and posterior roots. Referred neuralgic pain in the arm, neck, and side is not unusual in lesions of the heart and other organs.

Neuralgia affects adults, rarely children, and women are more prone to it than men. There may be an hereditary predisposition to it. Associated conditions are: general debility, anæmia, rheumatism, rheumatoid arthritis, gout, diabetes, Bright's disease, and toxic poisoning of various kinds. Exposure to cold and carious teeth are common exciting causes.

Symptoms.—These are pain, of a sudden darting character, which comes on in sudden paroxysms and lasts for a variable time. It generally recurs at the same hour every day, or there may be an interval of some days between the attacks. There is also tenderness over certain points along the course of the nerve.

Treatment. — General treatment to improve the whole condition of the patient may be necessary. When ordered in severe or recent cases very gentle massage must be given at first. This should consist of strokings, frictions, and kneadings. Firm pressures over the painful points often relieve the pain. In mild or chronic cases heavy percussion, performed slowly, may have a good effect. If there are indurations along the course of the nerve, deep frictions should be given to disperse them.

NEURITIS

Local Neuritis is an inflamed condition of the trunk and peripheral endings of a spinal nerve. The *symptoms* are pain, tingling, numbness, loss of power, and wasting of the muscles. The *predisposing causes* to neuritis are gout, rheumatism, and alcoholism, while the *exciting causes* are exposure to wet and cold, injuries, chronic poisoning, and muscular strain. It may also result from the extension of inflammation from neighbouring parts. This is common in fibrositis, osteo-arthritis, and rheumatoid-arthritis.

Treatment.—During the acute stage, marked by severe pain, massage is not advisable, as it tends to increase the inflammation. It may, however, be used to prevent the rapid wasting of the muscles that accompanies some forms of neuritis; in these cases very gentle effleurage, friction, and kneading may be applied about the affected part, while the region of the inflamed nerves should be avoided. Once the acute stage has passed, massage is of great use in improving the nutrition of the nerves, causing the absorption of exudates, and in breaking down adhesions. All the different procedures, effleurage, kneading, frictions, pétrissage, and vibration, should then be carried out both locally and also along the spine over the origin of the affected nerve trunk. Joint movements should follow the massage. Care should be taken to keep the parts warm, and not to tire the muscles by prolonged rubbing.

Good results are often obtained in these cases by salicylic ionisation, by applications of galvanism, with the anode as the active electrode, and also by radiant heat. If the pain is set up by thickenings and nodules in the muscles, the results of fibrositis, or from the spread of inflammation in chronic joint affections, the massage must be directed to the removal of the cause and frictions given to reduce the thickenings.

Multiple Neuritis.—In this form a number of nerves are affected equally on both sides of the body. It is due to toxic poisoning, and is set up by infectious diseases such as diphtheria, and also by alcoholism and lead and other poisons. In the acute stage rest and warmth are indicated. Later massage is ordered.

This should be very gentle at first and should be followed by carefully graduatt. movements of the joints. Contractures of the muscles should be guarded againsed

SCIATICA

Sciatica is the term which is applied either to neuralgia of the sciatic nerve or to perineuritis of the trunk of the nerve. Some of the *exciting causes* of sciatica are exposure to wet and cold, excessive walking exercises, a blow upon the nerve trunk, or pressure upon it within the pelvis. It is also frequently due to trouble in the hip joint, which sets up "referred" pain in the nerve, or it may be caused by the extension of fibrositis from the lumbar region to the sheath of the sciatic nerve. Pain, in varying degrees, is felt either all along the course of the nerve and its branches of distribution, or in certain parts of its course. The most tender points are usually found in the buttock, midway between the tuberosity of the ischium and the great trochanter of the femur; in the lower part of the thigh; in the popliteal space; near the head of the fibula, and behind the medial malleolus.

FIG. 171.—KNEADING ALONG THE COURSE OF THE SCIATIC NERVE WITH THE BALL OF THE THUMB.

In severe cases there is loss of power in the affected limb, and wasting of the muscles.

Treatment.—Massage is usually commenced when the acute stage has passed. Its aims are to promote absorption, to relieve pain, to promote the nutrition of the limb, and to stretch the nerve by means of joint movements.

The patient should be placed on the side which is not affected, or in the forward lying position, and the following movements carried out:—

1. Kneading the muscles over the sacrum.
2. Kneading the gluteal muscles with the ball of the thumb, working deeply over the nerve.
3. Vibration over the gluteal region.
4. Picking up the gluteal muscles.
5. Percussion over the course of the nerve in the gluteal region with the ulnar border of the closed fists.
6. Deep frictions in the gluteal fold with the fingers of one hand.
7. The masseuse stands so as to face towards the foot of the bed, places one hand upon the front of the thigh, to steady it, and with the palmar surface of the other strokes rapidly, with upward pressure, over the course of the nerve from the lower margin of the popliteal space to the gluteal fold.

8. Standing as above, the masseuse places one hand upon the front of the thigh, and kneads deeply with the ball of the thumb of the other hand, along the course of the nerve from the lower border of the popliteal space to the gluteal fold.

9. Vibration over the course of the nerve in the thigh.

10. Friction with the pads of the fingers of one hand over the course of the nerve.

11. Pétrissage of the muscles of the thigh over the course of the nerve.

12. Percussion of the muscles of the thigh over the course of the nerve with the ulnar border of the closed fists.

If necessary, the same movements may be employed upon the back of the leg.

In cases where the pain is due to arthritis of the hip, or to fibrositis in the lumbar region (lumbago), the treatment must first be directed to those parts.

Joint Movements

1. Foot rolling.
2. Plantar and dorsi-flexion of the foot.
3. Flexion and extension of the leg.

Fig. 172.—Flexing the Thigh with the Leg extended. (In sciatica, to stretch the nerve more fully, the hand of the masseuse may be placed round the foot so that dorsi-flexion of the latter can be carried out at the same time.)

4. Flexion of the leg, followed by flexion of the thigh obliquely upon the abdomen.
5. Flexion of the thigh, leg extended.
6. Abduction and adduction of the thigh.
7. Leg rolling.

The above treatment should be modified to suit each individual patient. In some cases only very gentle effleurage and friction can be employed at first; in others it may only be possible to work on either side of the nerve. Sometimes firm centrifugal stroking over the course of the nerve in the thigh and leg is found to relieve the pain.

When the patient is up, a good exercise for stretching the nerve is as follows:—

The patient stands on the unaffected leg, with the hands on the hips; the leg on the affected side is extended forward and the heel is placed upon a stool in front.

The patient then bends the trunk over the thigh as far as possible, taking care not to bend the knee in so doing.

WRITER'S CRAMP

Writer's cramp is the most common form of the disease known as "occupation spasm" or "occupation neurosis." It is usually the result of the over-use of the muscles of the thumb and fingers which are employed in the act of writing, namely, the intrinsic muscles of the thumb, opponens pollicis and flexor brevis pollicis, the adductor pollicis, the first dorsal interosseus, also the extensor longus and brevis pollicis and first and second lumbricals. Occasionally this form of cramp occurs in subjects who are not in the habit of writing much. Some people employ only the finger joints when writing, others the wrist as well, and others again the elbow and even the shoulder. The greater the range of joints employed, the less the liability to writer's cramp. The *symptoms* are muscular weakness, tremor, pain, and spasm in varying degrees; but these may not all be present in every case. The intrinsic muscles of the thumb and index-finger are first affected, and become more or less unable to hold or guide the pen. If the disease is not arrested at this stage the superficial and deep muscles on the front of the forearm become involved, and finally, in severe cases, those of the arm and shoulder. Frequently there is great tenderness in places along the course of the radial (O.T. musculo-spiral), median, and ulnar nerves. The cause of writer's cramp and allied forms of spasm—such as pianist's, violinist's, and milker's cramp—is said to be irritation, due to nutritive changes which occur, either somewhere in the course of a motor nerve from its centre to its periphery or in the centre itself.

Treatment.—For massage treatment the patient should be seated. The masseuse should also sit while manipulating the hand and forearm. A pillow should be placed on her knee, upon which the patient's arm can rest comfortably. All the movements given for the hand and arm in "general massage" should be employed; gentle vibrations along the affected nerve trunks may be added, and also tapôtement over the extensor and supinator muscles of the hand. The muscles of the shoulder and pectoral regions should then be manipulated, and, lastly, the cervical and upper dorsal regions of the spine.

The patient should be encouraged to carry out the following exercises several times during the day in order to bring into action the muscles which antagonise those employed when writing:—

1. Extension of the fingers.
2. Abduction of the fingers. In this exercise the fingers are separated from each other. The patient can oppose the movement, and so make it a more vigorous one, by placing the index-finger and thumb of the other hand on either side of the extended fingers, or resistance can be made by another person in the same way. It should be carefully graduated to suit the condition of the muscles.
3. Extension and supination of the forearm.
4. Abduction of the arm.
5. Lateral circumduction of the extended arm.

As the patient's condition improves, short writing exercises may be given to promote co-ordinate movement. The masseuse should be careful to handle the limb very gently at first, and not to tire the muscles by either too vigorous or too prolonged massage. The arm should also be carefully protected from cold during the treatment, and subsequently.

CHOREA

Chorea is a disease of the nervous system which occurs most frequently during the period of childhood. It is much more common in females than males, and in adult life the latter are very rarely affected.

Rheumatic infection is now recognised as the chief exciting cause. Predisposing factors are: an hereditary or acquired nervous disposition, overwork, fright, worry, and pregnancy.

Symptoms.—(1) Involuntary and irregular movements, which generally affect all the muscles in turn, and which interfere with their proper control. (2) Mental restlessness and irritability, etc. (3) Indistinct and hesitating speech.

(4) Muscular weakness and wasting, terminating, in some cases, in actual paralysis.
(5) Rheumatic symptoms, of which the most important is heart disease.

Treatment.—In the acute stage this consists of rests in bed, a plentiful diet, and soothing massage. It will be necessary for the masseuse to work with one hand only, using the other to support and steady the patient, or, in some cases, it may be necessary for an attendant to hold the child while the massage is carried out. Effleurage and soothing strokings only should be given in the early stages. Later, in atonic cases, as the movements subside, pétrissage and kneading may be carefully introduced. Percussion and vibration should be omitted altogether. Exercises form a very important part of the treatment. These should be passive at first, then active, and lastly resistive. Their aim is to re-educate the limbs as well as to strengthen the muscles and improve the general health of the patient. When allowed up, the patient should be directed to carry out free movements of the arms, legs, and trunk. Balance exercises, such as heel raising knee bending, tip-toe walking, etc., are particularly useful. Heart treatment may be necessary, and it is very important in all cases not to tire the patient.

INSOMNIA

Massage for insomnia should be given in the evening, if possible at the patient's usual bedtime. Before commencing, the masseuse should lower the lights and

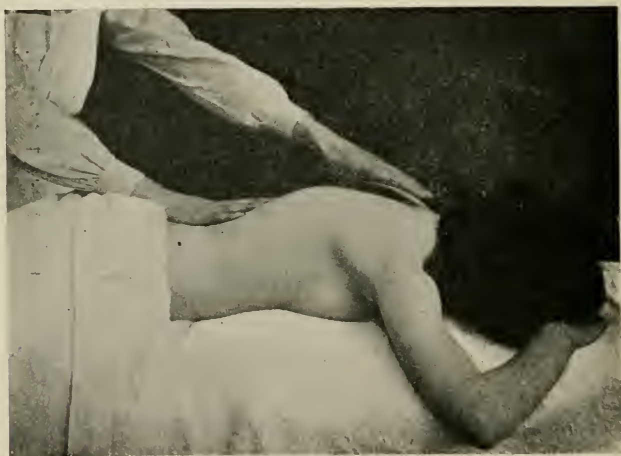


FIG. 173.—STROKING THE SPINE.

attend to the fire if necessary. Most attention in these cases should be given to the back and head, but massage of the limbs, especially of the legs, is usually necessary to improve defective circulation and to allay nervous restlessness.

The limbs should be manipulated first, then the back, and lastly the head and neck. The movements for the back, head, and neck should be carried out slowly and rhythmically. If the insomnia is caused by cerebral congestion, centrifugal effleurage, kneading, and friction should be employed upon the limbs; if by cerebral anæmia, the movements should be directed centripetally. With the exception of percussion, all the movements employed for the back in general massage may be given, and the following added as being particularly soothing:—

Stroking of the Spine.—(*a*) Stroke the spine from the occiput to the sacrum with the palmar surface of each hand alternately (Fig. 173).

(*b*) Place the fingers of the left hand upon those of the right, then apply circular stroking slowly down the whole length of the spine with the pads of the fingers of the right hand.

The back having been manipulated, the patient is placed again in the lying position. If a warm drink or nourishment of any kind has been ordered, it should be given before passing on to massage of the head and neck, so as not to disturb the patient at the conclusion of the treatment.

For massage of the head, see Chapter V., p. 284.

When the head has been manipulated the following movements may be carried out for the neck :—

1. *Efflcurage.*—(*a*) Place the palmar surface of the extended fingers upon the neck below the ears, and stroke firmly in a downward and lateral direction towards the shoulders.

(*b*) Stroke in a downward direction over the jugular veins.

2. *Friction.*—Employ friction upon the posterior and anterior aspects of the neck.

Should sleeplessness be caused by indigestion, abdominal massage should be given in the morning, between the patient's breakfast and luncheon hours, as massage of the abdomen has often an exciting effect when given at night.

CHAPTER XIII

DISEASES OF OBSCURE ORIGIN

Fibrositis—Lumbago—Rheumatism—Volkmann's Ischæmic Contracture

FIBROSITIS

In a paper read at the British Medical Association at Brighton in July 1913, and published in the *British Medical Journal* of 4th October 1913, Dr. A. P. Luff defines fibrositis as follows: "The essential pathological change in fibrositis is an inflammatory hyperplasia[1] of the white fibrous tissue in various parts of the body, associated with exudation and proliferation of the connective tissue elements, leading to swelling and thickening of the affected fibrous tissues. This condition may undergo absorption and so completely disappear, or, if not suitably treated, it may pass on to organisation with the formation of nodules and patches of thickening.

"The articular structures proper—synovial membrane, cartilage, and bone—are not primarily affected, but the parts implicated are the fibrous tissues of the joints, muscles, and bones, especially the aponeurosis and insertions of the muscles, the muscle sheaths in which the muscle spindles lie, the bursæ, fasciæ, the fibrous ligaments and capsules of the joints, and the periosteum. Such affections cause pain and stiffness in the structures, are specially apt to recur, and are commonly referred to as rheumatic or even gouty in their origin. This inflammatory hyperplasia of the fibrous tissues occurs in patches, and is started by exposure to wet or cold, by injury, or by some irritant, microbic or toxic, conveyed in the blood. Sudden movement of the affected muscles generally causes excruciating pain, while the local pain on pressure is one of the most diagnostic features in these cases.

"The indurations may be widespread, but are generally well defined, and vary in size from an eighth of an inch to one inch in diameter. They may be situated in the subcutaneous tissue, the muscles, tendons, aponeurosis, the capsules and ligaments of the joints, the bursæ, the sheaths of the nerves, and periosteum."

Dr. Luff attributes the onset of the condition to exposure to cold and wet; sudden changes in the temperature; local injuries in which tendons and ligaments are strained; absorption of irritating toxins from the alimentary tract, such as occurs in cases of constipation, dyspepsia, and colitis; toxic absorption in tonsillitis and pharyngitis; and the specific microbe or its toxin met with in influenza and feverish cold.

Muscular rheumatism, so called, is one of the most common forms of fibrositis, and gives rise, according to the muscles affected, to stiff neck, stiff shoulder, headache, intercostal rheumatism, and lumbago. The fibrositis in the last-named condition is commonly set up by strain of the muscles attached to the back of the sacrum. The inflammatory process may extend to the sheath of the sciatic nerve, and set up sciatica.

Fibrositis may also occur in the abdominal muscles, and may be mistaken for appendicitis, ovarian or other diseases.

Other forms are: fibrositis of the bursæ, particularly the subacromial bursa;

[1] Hyperplasia = an excessive growth of normal tissue elements.

fibrositis of the plantar fascia; of the joints, those of the knuckles and fingers being most often affected; and chronic fibrositis of the subcutaneous tissue.

The thickenings and nodules which remain after an attack of fibrositis in the neighbourhood of the brachial plexus or of the nerve trunks set up tenderness and pain, sometimes very acute, which may be mistaken for neuritis.

Treatment.—The treatment in the early stages of acute cases consists of rest and external applications in the form of hot fomentations and liniments. Later, and in chronic cases, radiant heat, ionisation, massage, and exercises are indicated. The massage manipulations in many cases must be gentle at first, but as soon as possible vigorous work should be done to disperse the thickenings and nodules. Deep frictions, strong kneadings, and pétrissage should be given over the affected area, even though the manipulations may be painful to the patient. Ionisation of the affected tissues before the massage has usually a very marked effect in lessening this pain and tenderness. It enables the operator to work more deeply than is possible otherwise, with little discomfort to the patient. Passive and graduated active movements for the muscles involved should also be given.

In cases of fibrositis of joints and tendon sheaths, massage should be given about the affected part. The latter should not be directly manipulated until the acute symptoms have completely disappeared.

LUMBAGO

This a form of fibrositis which may be primarily set up in the lumbar muscles by chill, damp, or gastro-intestinal disturbances, such as constipation and dyspepsia; or it may be the result of over-strain of the muscles, usually at their fibrous attachment to the back of the sacrum, the affection extending through the lumbar region and sometimes to the sacro-iliac joint and to the sheath of the sciatic nerve.

The *symptoms* of the acute form are: severe pain which is aggravated on movement, muscular tenderness, and stiffness. The chronic form may come on insidiously or it may follow an acute attack, especially if this has been caused by strain of tendons or ligaments. The symptoms are less severe than in the acute form. There may be residual thickenings in the part.

Treatment.—The treatment of acute lumbago in the early stages consists of rest, hot fomentations, and the application of liniments. Later, radiant heat, ionisation, and massage are given. The latter should be gentle at first, consisting of strokings, frictions, and vibrations. Easy active movements should be gradually introduced.

For chronic cases vigorous massage is necessary. It is often useful to precede the rubbing by radiant heat or ionisation.

ARTHRITIS DEFORMANS, OR CHRONIC RHEUMATISM

This disease, although extremely common and having well-marked characteristics in many cases, is so varied in its manifestations that its real nature and ætiology are still obscure, as may be judged from the many names that have been applied to it, such as chronic rheumatoid arthritis, rheumatic gout, arthritis deformans, arthritis senilis, arthritis sicca, etc. The probable explanation is that there are several separate diseases grouped together, each with a separate cause, and with only one point of definite resemblance, that is, a chronic or subacute inflammation of one or many joints, which tends to progress to more or less complete disorganisation of the joint attacked, and without as a rule evident cause or constitutional symptoms. But as our knowledge increases we are becoming gradually able to distinguish between fairly definite types of the disease, and to assign a cause or group of causes to each of these types.

Pathological Changes.—The changes affect both the articular cartilage, the synovial membrane, and the peri-articular structures. The most definite and common change is in the articular cartilage, which becomes worn away over the surfaces of the bone exposed to friction, so that the ends of the bone finally become smooth and polished, eburnated, or worn into grooves and ridges. The edges of the cartilage become at the same time overgrown so that "lipping" occurs round the joint, and this development of new bone may even involve the synovial membrane and ligaments. The synovial membrane becomes thickened, forming fringes and villi. The peri-articular structures become infiltrated and swollen, the ligaments and tendons in some cases disappearing or becoming partially ossified. Heberden's nodes are nodules of bone which develop in the interphalangeal joints of the fingers. The disease is usually accompanied by marked atrophy of the muscles, also in some cases by contractions, neuritis, and trophic disturbances. In different cases these various changes occur in varying degrees.

An arbitrary classification of the different forms of arthritis deformans is impossible in the present state of our knowledge on the subject, but the following will serve for purposes of description and is probably the simplest of the many proposed :—

1. **Polyarticular Arthritis Deformans.**—In this form of the disease it is usually the smaller joints of the body that are involved, specially those of the hands and feet, the corresponding joints of both sides being generally attacked. In some cases there may be, during some stage of the progress of the disease, an involvement of some of the larger joints as well. This type of the disease may be further subdivided according as to whether it is (*a*) chronic or (*b*) acute.

(*a*) The *chronic* form usually attacks elderly people, women perhaps more than men, and leads to a very typical deformity of the hands, where the fingers are deflected towards the ulnar side. The joints become stiff and swollen ; they are tender, and may develop Heberden's nodes. There is grating and pain on movement. Muscular wasting is usually very marked. Pain is a variable symptom; there may be little or none except when the joint is moved, or it may be very acute, and is worse at night. The patient usually suffers from great depression, the result partly of pain, inability to get about, and muscular weakness. Other symptoms may be : local sweating, glossiness of the skin, pigmentation, and rapid pulse. Anæmia, dyspepsia, constipation, and cardiac weakness may be associated with the arthritic condition.

Though there may be intermissions, the disease tends to progress steadily till the patient may be entirely crippled.

(*b*) The *acute* polyarticular variety is usually seen in younger patients, and frequently seems to be brought about by the absorption of toxins from some definite source, pyorrhœa alveolaris, leucorrhœa, and other septic foci. It is chiefly in such cases as these that the brilliant results of vaccine treatment have been obtained, an antagonous vaccine being prepared from the septic focus. It is on account of these successes that the present tendency has arisen for vaccine treatment in all cases of rheumatism. In some of these cases there may be a definite rise of temperature, and if this is accompanied by involvement of some of the larger joints, the case may easily be mistaken for one of acute rheumatic fever.

The *treatment* consists in the first place of the removal of the cause when possible—this alone may arrest the disease—and of vaccine inoculation in suitable cases. The patient should wear woollen clothing and have plenty of fresh air and good food. A liberal meat diet is indicated, a preponderance of starchy foods, tending to produce disturbances of digestion. Barley water and salutaris water are recommended as being beneficial drinks. Saline aperients are best if required ; cascara and the derivatives of senna should not be given. Hydro-therapeutic measures, such as the Aix douche, are often of value, especially in chronic cases. Radiant heat, ionisation, massage, and passive and active movements are ordered in subacute and chronic cases. The massage and exercises are best given after an application of radiant heat or ionisation, which soften and relax the tissues considerably in many cases, and make movement easier. Frictions round the joints are especially useful in reducing thickenings in the capsules and peri-articular structures. Clapping with cupped hands is also a good movement in chronic cases to promote better circulation through the part, but should not be given if there is any fear of the recurrence of acute symptoms. For the same reason all the movements for the joint should be carefully graduated. The muscles which move it should be manipulated to prevent atrophy. Vibrations and tapôtement should be given over those which are stretched, but omitted for the contracted groups.

Passive and active movements of the joints are given to stretch contractures and adhesions and so improve mobility, and to strengthen the wasted muscles. Anæmia, cardiac weakness, dyspepsia, and constipation should, if present, be suitably treated by gymnastic treatment.

2. **Monarticular Arthritis Deformans.**—This form of the disease usually attacks the larger joints, hip, knee, and shoulder; more than one may be involved at the same or different times. It is frequently started by an injury to the joint in an elderly person. It may begin suddenly, or insidiously, and is very chronic in its course. The osseous changes are usually well marked, leading to lipping of the cartilages, creaking and grating on movement; pain, especially at night and on changes of the weather, is a marked symptom. Movements become more and more impaired, deformity becomes obvious, and the joint may finally become completely crippled from pain and the interlocking of the overgrown edges of cartilage. The patient may enjoy fair general health.

Treatment.—Bier's treatment by passive congestion is sometimes used with success, for the relief of pain, in the stage marked by synovial effusion. Its object is to increase the natural reaction of the tissues by promoting venous hyperæmia in the affected joint. This is effected by means of an elastic bandage, applied over lint above the joint, and with sufficient pressure to cause congestion of the veins without impeding the arterial flow of blood to the part. This is kept on until the pain subsides, and is repeated when necessary. At a later stage, radiant heat, massage, and passive and active movements are usually commenced. The technique of the massage treatment is the same as that indicated for the polyarticular variety, but if there are extensive changes in the bone little can be done and the results are disappointing.

There is another form of arthritis in which the vertebræ are the seat of the disease, and which is known as **spondylitis deformans.** In some cases the spine alone is affected, in others the hip and shoulder joints may also be involved. The cervical region only may be affected. If the lumbar spine is involved, sciatica may result. The intervertebral discs undergo absorption, and there may be complete general ankylosis of the spine, with kyphosis and fixation of the ribs. Pain, paræsthesia, and muscular atrophy ensue from pressure over the nerve roots. This form of arthritis generally affects elderly men of the poorer classes.

ACUTE RHEUMATISM (RHEUMATIC FEVER)

This is an acute infective disease now said to be almost undoubtedly due to a specific micro-organism. The disease occurs most often between the ages of ten and twenty, but little children and also adults between twenty and thirty are commonly affected.

Predisposing factors are: (1) Season; it has been shown that the disease most usually occurs during dry seasons. (2) Heredity. (3) Chills.

Symptoms.—A temperature which may run from 100° to 103°, rapid pulse, sweating, arthritis of the joints with pain and swelling, inflammation of the fibrous tissues. There may be furred tongue and constipation. All the joints of the body may be involved, but chiefly those of the wrist, elbows, ankles, and knees. The disease may subside in some joints and then reappear in others. In children the heart is sometimes mainly affected, the arthritis being latent or altogether absent.

Complications.—Endocarditis is much the most common of these, and the mitral cusps are most usually affected. Other complications are pericarditis, myocarditis, pleurisy, pneumonia, chorea, the formation of fibrous nodules in the subcutaneous tissues of the hands, feet, and other regions, skin eruptions, hyperpyrexia (sudden rise of temperature, generally a fatal condition).

The *treatment* consists, during the acute stage, of confinement to bed. The limbs are wrapped in hot, dry wool, kept in place by bandages. Drugs are given to cut short the disease. Rheumatic fever is not often fatal, but it may recur. It usually lasts for a week or a fortnight, and convalescence is prolonged.

In most cases the inflammation subsides completely, leaving no after-effects. In some, when the joints remain swollen and stiff, massage and passive movements preceded by hot-air treatment are indicated to break down adhesions and promote absorption. The movements should be very gentle at first, and carefully graduated as regards strength for fear of a recurrence. The treatment should be at once suspended if there is increase of swelling or pain, and this should be reported to the doctor. In all cases of rheumatic fever, massage and passive movements might be carried out with benefit for a week or so before the patient is allowed up, in order to strengthen the muscles and render the joints more supple.

When the heart is involved, as it generally is, convalescence is tedious and prolonged. The patient is kept in bed for at least a month, and in some cases longer, after the fever has subsided.

Before being allowed up, massage treatment may be begun, consisting of gentle manipulation of the limbs, passive and, later, active movements, and local heart treatment. The pulse should be taken before and during the treatment. Any irregularity or increase in its rate is an indication that the massage is too strong, and must be modified or suspended until the doctor has been consulted.

VOLKMANN'S ISCHÆMIC CONTRACTURE

This condition is caused by interference with the blood supply of the part by tight bandaging, splints, and sometimes after injury to the brachial artery at the elbow. It occurs most often after fractures in the neighbourhood of the elbow or those of the forearm. There is partial paralysis and contraction of the muscles. The flexors of the wrist and fingers are most often affected; they become tense and contracted. The wrist is slightly flexed, the hand is pronated, the proximal phalanges of the fingers are extended and the two distal ones are flexed.

The *treatment* in the early stage consists of daily massage of the hand and arm, with graduated extension of the fingers and wrist, beginning at the distal phalangeal joints. At first, extension of the fingers can only be carried out when the wrist is fully flexed. In order more easily to replace the splint for keeping the fingers extended, the wrist and metacarpo-phalangeal joints should first be flexed.

CHAPTER XIV

Lubricants—Fomentations—Bandages

LUBRICANTS

In giving massage it is better, as a rule, not to employ lubricants, as dry rubbing has a more stimulating effect upon the tissues, and is usually preferred by the patient. In cases such as the following, however, their use is both necessary and beneficial:—

When the patient is a young child, or a rickety subject, or is very old or emaciated; when masséeing stiff joints, or a limb which has been in splints; in all cases where the skin is very sensitive, dry, or hairy. The following lubricants are recommended:—

Cocoa-nut butter, cocoa-nut, olive and neat's-foot oil, white vaseline, and lanoline. The masseuse should only rub a small amount of the lubricant upon her hands when required, as the application of much oleaginous matter is objectionable from every point of view. Lubricants should not be employed when giving electrical massage, as oil is a bad conductor of electricity.

If the patient perspires much, or if in warm weather the manipulator's hands become moist, a little powder (boric or talcum) may be used.

FOMENTATIONS

Fomentations are ordered to relieve pain, and, in cases of acute inflammation, to hasten suppuration. Their application causes dilatation of the superficial vessels of the part, and increases the flow of blood through them. In this way tension in the more deeply situated vessels, and consequent pressure upon the sensory nerves, is relieved. The method of preparing and applying a fomentation is as follows:—

Place a wringer or thick towel across a bowl or basin, and upon this lay from two to four folds of coarse flannel (a piece of old blanket answers the purpose well). Then pour boiling water over the flannel, wring it dry, and carry it to the bedside in the wringer. Next shake out the folds, apply the flannel to the part, and cover with a piece of mackintosh or jaconet large enough to completely overlap the fomentation. Over this again place a piece of dry flannel. In the case of a limb this covering should be large enough to completely encircle the part, and the ends should be fastened together with safety pins. In this way the necessity for applying a bandage to keep the fomentation in position is obviated, an advantage when it is desirable to keep the parts perfectly quiet. Fomentations should be changed about every fifteen or twenty minutes, and sometimes oftener; they should never be left on until they are cold. Two stupes should be kept in use, one should be drying while the other is on the patient. The patient's skin should be dried before each fresh application.

If a boric fomentation is ordered, two or three thicknesses of boracic lint, or some gangee tissue sprinkled with boracic powder, should be used instead of the flannel, and applied in the same way. When the stuping is stopped it is advisable to keep the parts covered with cotton wool or flannel for two or three days, to prevent cold.

Cold Compresses.—Cold compresses are used to reduce inflammation. They are made and applied in the following way:—

Two or three layers of lint or linen are wrung out of cold water, applied to the inflamed area, and covered with a piece of jaconet. If an iced compress is ordered, a piece of ice, partially covered with flannel to prevent it from dissolving quickly, is placed in the water. A second compress should be kept upon the ice while the other is in use. They should be changed frequently.

Lotions.—Medicated lotions are sometimes ordered for inflamed joints, etc., to promote absorption through the skin. These may be either evaporating or non-evaporating. In applying an evaporating lotion a single layer of lint should be saturated and laid uncovered upon the part. A non-evaporating lotion should be prepared and applied in exactly the same way as an ordinary cold compress.

BANDAGES

All bandages may be divided into two classes,—simple and compound. A simple bandage is made of one piece of material, a compound of two or more. Under each of these heads many varieties are found, both as regards material and shape, to suit the purposes and the different parts of the body for which they are

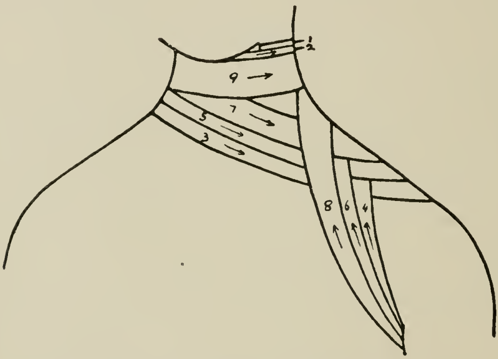


FIG. 174.—FIGURE OF 8 OF THE NECK AND AXILLA.

needed. The materials chiefly used in making them are gauze, linen, flannel, elastic webbing, and rubber. Bandages are used for the following purposes:—

1. To keep dressings and splints in position.
2. To support and protect.
3. To exercise compression.
4. To prevent movement.

In applying a bandage the chief points to be observed are: efficiency, comfort, and neatness, the two first being of paramount importance. Of the different kinds the roller bandage is the one most commonly used. It is made in different lengths and widths; the latter are, approximately, as follows for the different parts:—

For the head	2 inches wide.
„ body	$2\frac{1}{2}$, 3, or 4 inches wide.
„ fingers and toes	$\frac{3}{4}$ inch wide.
„ hand and wrist	$1\frac{1}{4}$ „
„ arm	$1\frac{1}{2}$ or 2 inches wide.
„ leg	2 or $2\frac{1}{2}$ „

These bandages are applied in various ways. There is the spiral pattern for the limbs; the figure of 8 for the ankle, knee, and other parts; the spica for the shoulder and groin; and the recurrent, or capeline, for the head. In applying a roller bandage to a leg or arm, the external surface of the free end should be placed upon the medial side of the limb, and should be overlapped by one or two initial turns so as to fix it firmly. The bandage should then be continued from below upwards towards the trunk, with firm, even pressure. Each turn should overlap the preceding one by one-third of its width, or by more when there is swelling. In order that the bandage may fit the limb smoothly where its diameter varies, reverses should be made. To make a reverse, the top edge of the bandage is fixed by the thumb of one hand and the bandage is turned downwards or reversed so that the upper border of one round becomes the lower border of the next. Reverses should not be made over a bony prominence. Care should be taken to make the bandage sufficiently tight to serve its purpose and keep in position, without impeding the proper circulation of the part. The end of the bandage should be turned neatly in and confined by a safety pin on the lateral side of the limb.

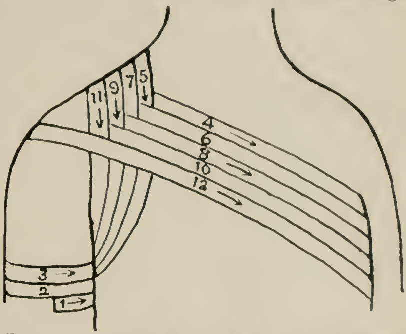
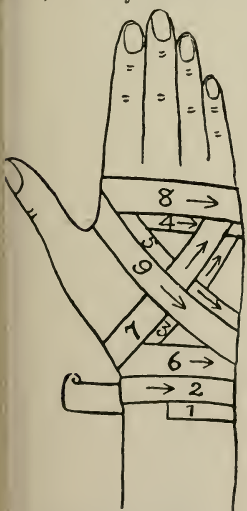


Fig. 175.—Descending Spica of the Shoulder.

Rollers made of flannel are the best for rheumatic joints. They are ılso better than linen and cotton in ·ases of œdema and swelling, on account of their greater elasticity; this enables ·hem to expand and relax, to a certain extent, when further swelling or reduction ·akes place, while continuing to support the part.

Plain rubber bandages are sometimes put on to reduce swelling and for varicose ·veins, but they are not as a rule recommended. They should be perforated, and should never be applied direct to the skin. The part should first be powdered, and a piece of gauze or lint placed round it; otherwise evaporation is hindered, and heat, discomfort, and wasting of the muscles are induced. No reverses should be made in applying this kind of bandage.



ɪɢ. 176.—Figure of 8 of the Hand and Wrist.

Elastic webbing is used chiefly to afford support when the patient begins to use the limb after an injury. It should not be constantly worn, and should always be removed at night, as it impedes the circulation in the part.

Besides the roller, there are T-shaped, many-tail, and triangular bandages for keeping dressings in position, and, in the case of the last-named, for support.

The triangular bandage, when used as a sling for the forearm and hand, should be arranged and applied as follows: A square piece of material is folded in the form of a triangle, having a base of about 48 inches and a height of 20 inches. The forearm is flexed and held across the chest. The hand is placed upon the middle of the base of the triangle, the inner end of which is carried straight up and round the neck, on the side of the injured limb, while the outer end is passed across the chest to the opposite side of the neck to tie with its fellow. The apex of the triangle ·hould be folded in under the elbow. A larger triangular bandage or sling, to ·upport the whole of the upper extremity, is applied as follows: the forearm · flexed and folded across the chest; the hand is placed at the base of the ·riangle, the inner end of which is passed under the axilla of the affected arm ·nd across the back to the opposite shoulder; the other, or external half, is ·rought across the front of the chest to the same point, and the two ends

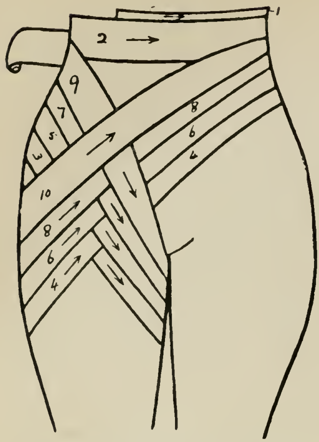


FIG. 177.—ASCENDING SPICA OF THE GROIN.

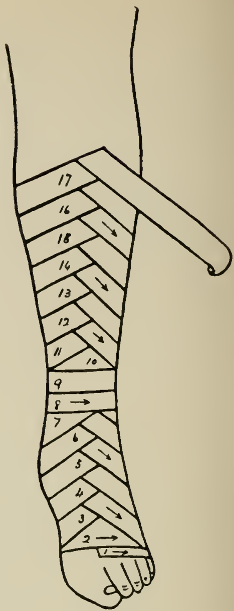


FIG. 180.—REVERSED SPIRAL OF THE FOOT AND LEG.

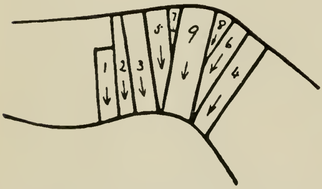


FIG. 178.—ROLLER CAP OF THE KNEE.

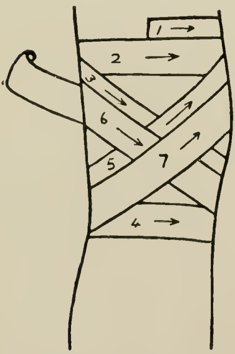


FIG. 179.—FIGURE OF 8 OF THE KNEE.

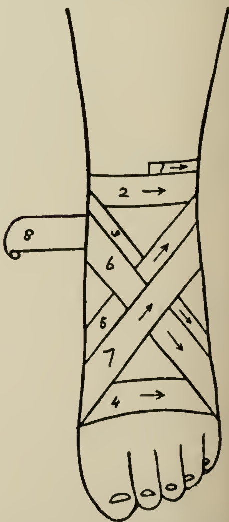


FIG. 181.—FIGURE OF 8 OF THE FOOT AND ANKLE.

are tied together. The apex of the triangle should be brought round the arm to the front, and secured by a pin to the external half.

Permanent or "hard" dressings are sometimes used in cases of sprain, to ensure absolute rest. The part is first covered with layers of cotton wool, and may be bandaged in the usual way; the plaster or starch dressing is then applied. When massage is ordered, an incision is made by the surgeon along the dressing, so that it can be easily removed and put on again by the masseuse.

[FIG.] 182.—TRIANGULAR BANDAGE ARRANGED [A]S A SLING FOR THE FOREARM AND [H]AND.

FIG. 183.—LARGE TRIANGULAR BANDAGE ARRANGED AS A SLING TO SUPPORT THE ARM AND FOREARM.

CHAPTER XV

ELECTRICAL METHODS IN CONJUNCTION WITH MASSAGE

Conductors— Practical Units— Electric Currents— Polarisation— Cells— Galvanic Current Battery and Apparatus—Motor Points—The Reaction of Degeneration —Practical Testing—Effects and Uses of the Galvanic Current—Central Galvanisation—The Faradic Coil—Effects and Uses of the Faradic Current— General Faradisation—Faradisation of the Skin—Galvano-Faradisation— Electric Baths—Infantile Paralysis—Facial Paralysis—Brachial Neuritis— Sciatica—Writer's Cramp—Spasmodic Torticollis—Constipation.

Electricity may be produced by friction, heat, chemical action, contact of metals, induction, and other means, and it may manifest itself when it is either in a state of rest (static electricity), or when in motion.

The phenomena of the X-rays and the transmission of electro-magnetic waves across space come under the heading of electricity in vibration or radiation. Electricity in rotation is termed magnetism, while when it flows along conductors it is known as current electricity.

When any two substances are rubbed together one becomes what is called "positively" and the other "negatively" electrified to the same extent. Franklin's theory is that all bodies contain a uniform amount of electricity, but that when any two of them are rubbed together the existing equilibrium is disturbed, and the electricity then distributes itself unequally between them, one having more and the other less of it than before. The body containing more is said to be "positively" electrified, while the one containing less is said to be "negatively" electrified.

The more modern theory is that there is an essential distinction between positive and negative electricity, each atom of matter being supposed to consist of a nucleus to which is attached a positive charge surrounded by a system of negative electric charges or electrons, which bear a relation to it similar to that which our planetary system bears to the sun. When an electron is removed from such a system by friction, chemical action, or some other disturbing force, it exists either as a free negative charge or as a negative ion if associated with another atom which was previously neutral. The residual system would be a positive ion.

Two bodies charged with different kinds of electricity attract each other, while two bodies charged with the same kind of electricity repel each other. For example: if a glass rod is rubbed with a piece of flannel or silk it becomes positively electrified; if it is then placed in a paper stirrup suspended by a silk thread so that it can move freely, it will repel a similarly rubbed and suspended glass rod when both are brought close together. On the other hand, a rubbed stick of sealing-wax and a rubbed glass rod will be attracted towards each other, because sealing-wax, when rubbed, becomes negatively electrified as compared with glass.

CONDUCTORS

All substances can conduct electricity to some extent. Some offer very little resistance to the passage of a current through them, and these are called good conductors of electricity. Others, again, offer so much resistance that they are termed non-conductors or insulators, while between these two there is a class of substances which are partial conductors of electricity.

Good Conductors.	Partial Conductors.	Non-Conductors or Insulators.
Silver. Copper. Platinum. Other metals. Hard carbon. Water containing acids or salts in solution.	The body. Ordinary tap water. Concrete. Charcoal.	Oils. Wool. Silk. Gutta-percha. Paraffin. Glass. Dry cotton. Dry wood.

In order to transmit a charge of electricity from one point to another, there must be a difference of electric level or potential between the two points, as electricity, like water, always tends to flow from a higher to a lower level. Therefore, when a charged body is connected with a non-electrified body by means of a wire or other good conductor of electricity, a current instantly passes from the former to the latter, the charge is divided between the two bodies, and both are brought to the same electric level, so that there can be no further flow from one to the other. To maintain a continuous current of electricity some force has to be at work to secure a continued difference of potential between two points, and a complete circuit must be provided for the current to flow along.

PRACTICAL UNITS

Electro-motive force, or E.M.F., is the driving force which causes electricity to move, or tend to move, from one place to another. Difference of potential or difference of electric level gives rise to electro-motive force in the same way that difference in the level of two water tanks give rise to a force tending to move the water through a pipe connecting the tanks. The unit of E.M.F. is the volt, which is about two-thirds of the E.M.F. given by a Leclanché cell.

The ohm or unit of resistance is the resistance offered by a column of pure mercury 106·3 centimetres long, and one square millimetre cross section at the temperature of melting ice. Pieces of wire having definite resistances can be prepared by comparing their resistance with that of a standard mercury column.

The resistance offered to the passage of a current inside a cell is called "internal" resistance. It varies according to the size of the plates, their distance from each other, and the nature of the exciting fluid. The larger and closer together the plates are the lower will be the resistance. In a small Leclanché cell it is about ·5 ohm: in the large size about ·7 ohm. Anything that resists the flow of the current outside the battery is called external resistance. The resistance of the human body is computed to be about 3000 ohms. It varies largely according as to whether the skin, which offers far more resistance to a current than all the rest of the tissues put together, is dry or moist, thick or thin. Dry skin acts almost as an insulator, but when moistened its resistance is greatly lessened. The wires which convey the current from the battery to the patient also offer a small resistance to the current. This varies according to their length and thickness. A long wire offers more resistance than a short wire of the same thickness, and a thin wire more than a thick one of the same length.

The ampere or unit of current strength is the amount of current which flows through a conductor having a resistance of one ohm when an E.M.F. of one volt is maintained between its ends; the ampere may, however, be defined by the amount of chemical decomposition it can effect in a given time. When passed through a solution of silver nitrate a current of one ampere causes ·001118 grams of silver to be deposited on the kathode in each second of time. It may also be defined by the force which a wire carrying the current exerts on a magnet in its neighbourhood. The magnetic and chemical effects are strictly proportional to the current; if the latter is doubled the rate of chemical decomposition, and the magnetic force at a given point near the conductor, will both be doubled.

The unit of current used in electro-medical work is the milliampere, or $\frac{1}{1000}$th part of an ampere, as the amount of current needed is never more than a fractional part of the latter. Dr. Ohm, from whom the unit of resistance takes its name, discovered that anything that increases the E.M.F. of a cell makes the current stronger, while anything that increases the resistance in any part of a circuit diminishes the current. Ohm's law, as it is called, is mathematically stated thus: $\frac{\text{E.M.F.}}{\text{Resistance}} = \text{current.}$

This formula gives the current strength in amperes.

ELECTRIC CURRENTS

Electric currents may be continuous, interrupted, or alternating.

A continuous current is one which flows in one direction without stopping.

An interrupted current is one which flows in one direction but which is interrupted or broken at regular intervals.

An alternating current is one which flows at regular intervals, first in one direction and then in the opposite direction.

Towards the end of the eighteenth century Dr. Galvani of Bologna and Professor Volta of Pavia made some important discoveries in regard to electric currents.

Volta found that by placing two strips of metals of different kinds in a glass jar filled with dilute acid or brine, a continuous current of electricity could be obtained when the plates were connected together by means of a wire. It is on this principle that the cells used in medical batteries are constructed.

Certain metals become negatively electrified when placed in an exciting fluid, and others positively so. The former class possess the power of passing into solution in the form of positively charged ions, or atoms carrying a positive electric charge. In doing so they become themselves negatively electrified, positive and negative electricity being always simultaneously developed in the presence of a force which disturbs the existing electrical equilibrium—in this case chemical action. The following is a list of conductors so arranged that those which come first on the list become more electro-negative when immersed in an exciting fluid than each succeeding one: zinc, iron, lead, copper, silver, platinum, carbon. In constructing a cell, zinc and carbon are usually chosen as the positive and negative plates, as the difference of potential between these two materials is greater than between either of them and any intervening metal in the above list; the E.M.F. of the cell is therefore greater than if, for example, zinc and copper plates are used. The exciting fluid in which the plates are immersed should be capable of acting chemically on the oxidisable conductor (the zinc in this case), and it should also be a conductor of electricity. Such fluids are called electrolytes, because they become decomposed when conducting an electric current. This process of the decomposition of a liquid is called electrolysis. The charged atoms which are normally present in an electrolyte are called ions, and the conductivity is due to the presence of these. Those parts of the carbon and zinc plates which are above the level of the exciting fluid are called respectively the positive and negative poles, because the current is said to flow through the external part of the circuit (*i.e.* outside the cell), from the carbon through the conductor and back to the zinc plate.

Directly the circuit is made by joining the positive and negative poles of a battery together chemical action begins, atoms of zinc go into solution in the acid, and the plate gradually consumes away. During the process the zinc becomes electro-negative, and the entrance of the positively charged zinc ions into the liquid causes positively charged hydrogen ions to be precipitated on to the carbon plate. These hydrogen ions give up their electric charge to the carbon, and are liberated as free hydrogen. The positive charge thus acquired by the carbon then flows along the conductor back to the negatively electrified zinc. The consumption of the zinc plate maintains the difference of potential between the two plates, or, in other words, maintains the pressure without which there could be no continuous flow of electricity round the circuit. Chemical action causes a certain condition in cells after a time which weakens, and may almost stop the current; this condition is known as "polarisation."

Polarisation

Polarisation can be best explained by describing the chemical action in a simple voltaic cell with zinc and carbon as the negative and positive plates, and sulphuric acid as the electrolyte. Sulphuric acid is a complex substance composed of molecules, each one of which consists of two atoms of hydrogen, one of sulphur, and four of oxygen = H_2SO_4. A considerable proportion of the sulphuric acid exists in the liquid in a dissociated state, consisting of hydrogen ions having a positive charge, and SO_4 ions having a negative charge. When the circuit is closed, positively charged zinc ions enter the liquid and combine with the negatively charged SO_4 ions to form neutral zinc sulphate. Owing to the increased positive potential of the liquid, the hydrogen ions are precipitated on to the carbon plate, give up their charges to it, and combine together to form neutral molecules of free hydrogen.

After a time the surface of the carbon becomes covered with these hydrogen bubbles, and this weakens the current in two ways:—

Firstly, the film it forms on the carbon practically converts it into a hydrogen plate, and this, being much less electro-negative to zinc than carbon, reduces the effective pressure of the cell.

Secondly, the film of hydrogen bubbles increases the resistance by reducing the contact area of the plate with the liquid. If it were not for polarisation the current would continue at its initial strength until the zinc plate was consumed or the acid exhausted.

As each atom of zinc carries a definite charge as a zinc ion into solution, the amount of zinc consumed is strictly proportional to the amount of electricity passed through the cell, or in other words, to the product of the current multiplied by the time for which it flows.

Remedies for Polarisation

There are various remedies for preventing the formation of hydrogen bubbles on the carbon plate, but the most effectual of these is the addition of an oxidising substance, such as bichromate of potash, chlorine, or nitric acid to the electrolyte, in order that the hydrogen may be consumed as soon as it reaches the carbon plate. Solid depolarisers, such as peroxide of manganese, are also used.

Local Action

Even when the circuit is not closed and the battery is at rest the zinc continues to waste away. This is due to the metallic impurities which zinc contains, which cause local currents to be set up over its surface. Also, parts of the zinc plate are unequally hard, so that some portions of it are more easily attacked by the acid than others; this sets up a difference of potential between one part of the zinc and another, and local currents are established. To prevent this inequality in hardness and consequent local action, the surface of the zinc plate must be amalgamated with mercury.

CELLS

The Leclanché cell is the one most used at present in medical work. It has zinc and carbon for its plates and the electrolyte is a solution of ammonium chloride, commonly known as sal-ammoniac, in the proportion of 6 oz. to a pint of water. The carbon is placed in the centre of the cell. It is surrounded by peroxide of manganese, which acts as a depolariser and oxidises the hydrogen evolved by chemical action. In the small Leclanché cells which are used in portable batteries, the carbon and peroxide of manganese are enclosed together in a canvas sac, outside which a thin, rounded plate of zinc is placed. This type of cell lasts for a variable number of months. The solution can be emptied out and renewed when necessary, but the zinc cannot be taken out and attended to as in other forms of cell.

In the large Leclanché cell the carbon plate and depolariser are packed in a porous pot and the zinc is in the form of a rod. This kind of cell can be very easily kept in order, as the zinc, if blackened, can be taken out and cleaned and amalgamated, and the solution renewed from time to time. To amalgamate zinc it should first be scraped and dipped into diluted sulphuric or hydrochloric acid. Some drops of mercury should then be poured upon it, and rubbed in with a piece of linen tied round a stick, until the whole surface is uniformly bright and even. The cell should be kept filled to two-thirds of its capacity, and the upper part should be smeared with vaseline to prevent creeping of the salts and consequent corrosion of the connections. In charging a cell the sal-ammoniac should be dissolved in warm water in a jug, and poured into the cell when cold. The E.M.F. of a Leclanché cell is 1·5 volt. The internal resistance depends upon the size; it is less in the case of large cells.

Dry Cells

These differ from liquid cells in having a moist, pasty substance as an electrolyte instead of a fluid excitant. They are sealed up, are very portable and convenient, and last for about a year. When run down they cannot be recharged like liquid cells, but must be replaced by new ones.

Chromic Acid Cell

Another form of cell is the chromic acid cell. The plates are zinc and carbon, and the exciting fluid is a solution of potassium or sodium bichromate and sulphuric acid.

The proportions are as follows:—

Potassium bichromate or sodium bichromate	$6\frac{1}{2}$ oz.
Sulphuric acid	6 oz.
Water	35 oz.

In this cell the zinc should be taken out of the solution when the battery is not working, and should be newly amalgamated when necessary. When the liquid becomes discoloured it should be emptied out and the cell recharged. This is not a convenient form of cell for use in a portable battery, as the electrolyte spills easily and is very destructive to clothing, conducting cords, etc.

Arrangement of Cells

Cells may either be arranged in "parallel" or in "series." They are arranged in parallel when there is but a very low resistance to be overcome in the external circuit, as in cautery work. A sufficiently large current can be obtained to heat a cautery by lessening the internal resistance of a battery without increasing its E.M.F. This is done by connecting a zinc of one cell to that of the next, and the carbon of one cell to the carbon of the next. Cells thus arranged are equivalent to one big cell. The zincs act as one large zinc plate, and the carbons as one large carbon plate. Big cells have less internal resistance than small ones, because their plates, being larger, do not polarise so quickly, and offer more available parts for the current to flow through. Their E.M.F. is no greater than that of a small cell, but the output of current is greater owing to the lesser resistance. They also last longer. If four Leclanché cells, each having an E.M.F. of 1·5 volt and the resistance of 0·5 ohm, are joined together in parallel, the total E.M.F. of the four cells will be no greater than that of one, but the total resistance will only be a quarter that of one cell, namely one-eighth of an ohm. *With a very low external resistance* the current yielded by the four cells in parallel will therefore, according to Ohm's law, be greater than if they are arranged in series.

The current obtainable from cells arranged in parallel is, however, not sufficient to overcome a high external resistance such as that offered by the human body. To obtain such a current it is not enough to lessen the internal resistance, which bears but a small proportion to the whole, the E.M.F. of the battery must be increased, and this is accomplished by joining cells together in "series." To arrange cells in "series" the zinc of one cell must be connected with the carbon of the next, and so on. The more cells which are thus connected up in a "series" the greater will be the E.M.F. of the battery, as, according to Volta's law, the total E.M.F. of the cells so arranged is "equal to that of one cell multiplied by the number of cells." With eighteen Leclanché cells arranged in "series," each cell having an E.M.F. of 1·5 volt, the total E.M.F. of the eighteen cells will amount to 27 volts. If the negative pole of the first cell and the positive pole of the eighteenth cell are connected by a conductor with a body whose resistance, added to that of the cells and connecting wires, amounts to 3000 ohms, the battery, according to Ohm's law, should yield a current of 9 milliamperes.

$$\frac{27 \text{ volts}}{3000 \text{ ohms}} = \frac{9}{1000} \text{ or 9 milliamperes.}$$

GALVANIC OR CONTINUOUS CURRENT BATTERY AND APPARATUS

A galvanic, continuous, or constant current medical battery of the finished type is one containing from eighteen to forty cells arranged in series, and hidden by a switchboard upon which is a current collector, a current reverser, a milliampere-meter, and two terminals or binding screws.

Current Collectors

By means of a current collector one or more cells can be brought into the circuit, and the current can be gradually increased or decreased as required. A single current collector is worked on the following plan :—

A number of metal studs, exceeding by one the number of cells in the battery, are arranged in a circle on an ebony plate. A crank is placed on a pivot in the centre, so that it can be brought into contact with each of the studs in turn. Stud No. 1 is connected

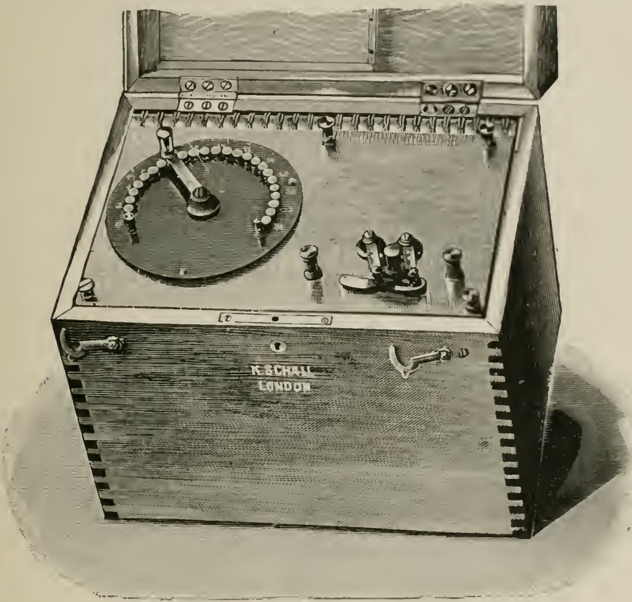


FIG. 184.—GALVANIC BATTERY.

by a wire with the positive pole (carbon plate) of the first cell, stud No. 2 with the positive pole of the second cell, and so on. The pivoted extremity of the crank is connected with the positive terminal on the switchboard, marked on most batteries by the positive sign +. The negative pole (zinc plate) of the first cell is connected by a wire with the negative terminal on the switchboard, marked by the negative sign −. As long as the crank rests upon the stud marked 0 no current can flow, because the circuit is not closed, there is as yet no connection between the zinc and carbon plates of any of the cells; but when a connection is made between the + and − terminals, and the crank is turned on to stud No. 1, one cell is brought into use and a complete circuit is made. A current of electricity then flows inside the first cell from the zinc to the carbon plate, thence through a wire to No. 1 stud of the current collector, and along the crank to the positive terminal. From this point it passes through the provided conducting medium and returns to the cell *via* the negative terminal, which, as mentioned above, is connected with the zinc plate. When the crank is turned on to the stud No. 2 two cells are brought into the circuit, and the current then flows from the zinc to the carbon of the first cell, thence through a wire connection to the zinc of the second cell, and from the carbon of the second cell to stud No. 2. It then passes through the crank and other connections back to the zinc plate of the first cell. The studs are insulated from each other and placed close together, so that when passing from one stud to the next the crank may be in contact with both; this prevents any break in the current and consequent shock to the patient. The crank should never be left in contact with two studs for more than a second, as, if it is, the cell whose positive pole is connected with the second stud will be "short circuited." A cell is said to be short circuited when its two plates are connected together by a very good conductor of electricity, so that there is very little resistance in the external part of the circuit. The cell then soon gets exhausted, owing to rapid chemical action, one of the laws relating to chemical action in a cell being that it is proportionate to the strength of the current flowing through it. Care should be taken also, for the above reason, not to place electrodes in metallic contact with each other or in contact with any two studs if laying them down on the battery.

In batteries fitted with a single current collector the first cells are always being used, and in consequence get run down sooner than the last ones, which may only occasionally be brought into the circuit. To obviate this drawback a current collector with two cranks has been devised, by means of which any one cell or group of cells can be brought into use. It is known as the double current collector.

Current Reversers

A current reverser is a device for reversing the direction of a current in the *external part of a circuit.* The arrangement is as follows: The negative pole of the battery is connected with the two metal plates on the switchboard, marked usually R (reverse) and N (normal). The positive pole is connected with the central metal plate. When the cranks are turned towards the right, so that one of them rests on the plate marked N, the current flows from the + terminal on the switchboard through the conductor to the − terminal; but when they are turned in the opposite direction, so that the left-hand crank rests on the metal plate marked R, the polarity of the terminals, and therefore of the electrodes attached to them, is reversed, and the current then flows from the terminal marked − to that marked +. In medical work it is sometimes necessary to alter the direction of a current, and it is a great advantage to be able to do so by the above simple device, instead of having to change the position of the electrodes on the patient.

Galvanometers

Galvanometers are instruments for measuring the strength of the current in a circuit. When graduated to give reading in amperes they are called ampere-meters or ammeters. For medical use they are constructed to measure the current in milliamperes, and are then

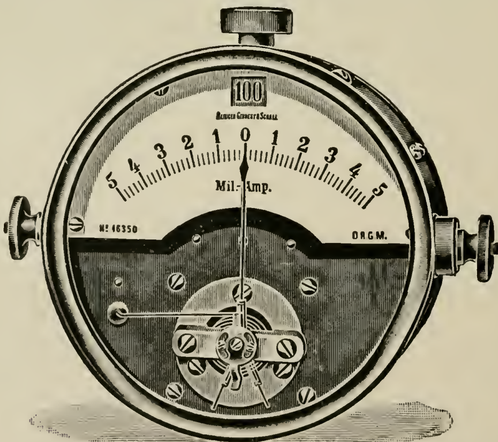


FIG. 185.—MILLIAMPERE-METER (D'Arsonval or Moving Coil Type).

known as milliampere-meters. When graduated to read the voltage of a battery they are known as volt-meters.

In 1819 Oersted discovered that a free magnet tends to place itself at right angles to a wire through which a current is flowing, and that it is deflected to right or left of its usual position (*i.e.* pointing north and south) according to the direction of the current. It is on this principle that galvanometers are constructed. The older type consists of a horseshoe magnet suspended or pivoted in the centre of a fixed coil of wire. When the current flows through the coil the magnet is deflected, and the pointer attached to it indicates on a dial the strength of the current which is passing through the circuit. These galvanometers must be placed perfectly level, and adjusted so that the pointer is at zero before the current is turned on. In the d'Arsonval or moving coil galvanometer, a newer type of instrument and now much used, the magnet is made large and is fixed, and the coil moves. When the current passes through the coil it acts in the same way that a magnet does, and is attracted or repelled according to the direction of a current flowing through it: it moves against the controlling action of a spring to an extent proportional to the current. One of the advantages of the d'Arsonval galvanometers is, that the pointer attached to the frame upon which the "moving coil" is wound indicates the strength of the current immediately, without previous oscillations. Galvanometers graduated to read in milliamperes may be easily put out of order by sending too strong a current through a circuit. If the terminals of a battery are connected together by a conducting cord or the metal part of an electrode, the current yielded with even one cell in the circuit may be too large to be measured in milliamperes, and the instrument may be damaged in consequence. In testing, therefore, to see if a battery is working properly, some resistance should be put in the external circuit. If a rheostat is not available this can be accomplished

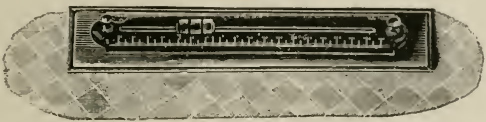


FIG 186.—GRAPHITE RHEOSTAT (with sliding spring, by which the resistance can be varied gradually).

by placing the electrodes in a bowl of water so that they do not touch each other. If the battery is in good working order the milliampere-meter should show a regular increase of current every time an extra cell is brought into the circuit by the current collector.

Rheostats or Adjustable Resistances

Rheostats are appliances for controlling the current by altering the resistance in a circuit. They are made of graphite, German silver wire, and other materials, and are constructed so that their resistance can be easily varied. They are much used for regulating the current in cauteries, but in ordinary medical work they have been almost entirely replaced by current collectors.

Conducting Cords

Conducting cords are used for conveying the current from the battery to the patient. They should be about 5 ft. long. Those usually sold for the purpose are made of strands of flexible copper wire, insulated with silk or cotton, and fitted at either end with a metal pin for the attachment of the cord to the battery terminal and to the electrode.

FIG. 187.—DISC ELECTRODE.

The copper wire is very liable to break after being some time in use. If this happens near either end of the cord, the defect can be remedied by cutting it right across at the broken part, stripping back the covering, and making a new connection with the pin.

Conducting cords made of ordinary electric bell wire are now often used. It is cheap, and it is well insulated by an inner coat of rubber and an outer one of paraffined cotton. When the wire is cut to the required length the covering should be stripped from it for an inch at either end for its direct attachment to the terminal and electrode. Electric light flexible wire can be used in the same way. It is made up of two distinct insulated wires. These can be separated so that two conducting cords can be obtained from a length of $1\frac{1}{2}$ yd.

Electrodes

Electrodes are the conducting media by which the current enters the body. They are of various shapes and sizes, are made of tin, carbon, lead, pewter, zinc, etc., and are covered with an absorbent material such as flannel or chamois leather. The electrode which is connected with the positive pole of a battery is called the anode, that connected with the negative pole the kathode. The body is an electrolytic conductor of electricity, and during the passage of a current through it certain of the atoms of which the tissues are composed are dissociated from each other. Some of these ions or atoms carry a positive charge and move towards the kathode. They are called kations. Others, said to be electro-negative, are attracted towards the anode, and are called anions. Alkalies are kations, and are liberated at the kathode. Acids are anions, and are liberated at the anode.

Uncovered electrodes should never be placed in contact with the skin, or sores will result. This is due to electrolytic action in the body, and the accumulation of irritating products of the process on the surface of the skin under the electrodes. When the metal plates are covered and the coverings are kept moist, the products of electrolysis are absorbed into the material and diluted.

The kathode stimulates and is more painful than the anode, which has a sedative effect. The increased excitability of a nerve in the neighbourhood of the kathode is called katelectrotonus. The diminished excitability near the anode is known as anelectrotonus. The current is said to flow through the body from the anode to the kathode. Sometimes both electrodes are placed upon some affected part, and this is called the *bi-polar method.* More often one, the "active" electrode, is placed on the part to be treated, while the other, the "indifferent" electrode, is placed on the sternum or some convenient part of the body in order to complete the circuit. This is called the *uni-polar method.* When both electrodes are stationary, the application is said to be *stabile*; when one or both are moved over the surface to be treated, the application is called *labile.*

FIG. 188.—HANDLE FOR ELECTRODE.

For ordinary applications of galvanism and faradism the operator should be provided with two disc electrodes, one 1 in. and the other about 2 in. in diameter; three flat flexible electrodes, one about $3\frac{1}{2}$ in. × 6 in., the other two $4\frac{1}{2}$ in. × 8 in. and 8 in. × 12 in., for the application of large currents. A roller and a bracelet electrode may be included in the outfit. Disc electrodes are made to screw on to a terminal which is provided with a binding screw for the attachment of the conducting cord. This terminal is mounted on the end of a wooden handle, which insulates the operator from the current.

The small disc is used when concentration of the current upon one particular spot is desired, as in testing the reaction of muscles. The larger size is used as the active pole in an ordinary application. The roller also makes a convenient active electrode when small currents are being passed. The flat electrode is used as the "indifferent" pole. It is usually made of tin, zinc, or lead, and can be bent to fit the surface to which it is applied. It should be padded with absorbent wool, and encased in a sheath having a leather back and a flannel or chamois leather front.

The bracelet electrode is worn by the operator in giving electrical massage. The manipulations are carried out in the usual way, and during the process the current is conveyed to the patient through the operator's hands.

Wash-leather, flannel, or lint covers for the electrodes should be made and kept for each patient, and should be frequently renewed. A pad of absorbent wool should be put between the cover and the metal plate. Disc electrodes can be obtained now with an arrangement by which the cover is fastened over the electrode by a celluloid ring. This can be slipped on and off, and the cover changed with a minimum amount of trouble.

FIG. 189.—ROLLER ELECTRODE, WITH HANDLE.

Electrodes should be well pressed down so as to make good contact with the surface of the skin. They should also be soaked in warm water, or in well-dissolved salt and water (1 teaspoonful of salt to 1 pint of water), before use, and should be kept moist during the application. This lessens the resistance of the skin, aids conduction, and prevents blistering. In treating a patient with the continuous current, great care should be taken not to cause blisters by leaving the electrodes too long on any one spot. The skin, especially under the kathode, should be examined frequently, and if found to be very red the electrode should be moved immediately to another part.

Large electrodes should be used when deep-lying structures are to be influenced and when large currents are to be administered. What may prove a painfully strong current if applied by means of a small electrode can be easily borne if given through a larger conductor.

In treating the arms by the uni-polar method, either with the galvanic or faradic current, the indifferent electrode should be placed upon the sternum or the lower part of the cervical spine. In treating the legs and abdomen it should be placed in the lumbar or gluteal regions; in treating the back, upon the abdomen. A folded towel or handkerchief should always be placed at the back of the indifferent electrode to keep the patient's clothing and the bedclothes dry.

FIG. 190.—BRACELET ELECTRODE.

Care should be taken to keep the metal parts of a battery and all accessary apparatus free from rust and dirt of any kind. Conducting cords should be frequently examined to see that the wire core is not broken. If it is, the patient may either get unpleasant shocks or else may receive no current at all. Conducting cords should be tightly screwed on to the battery terminals and also to the electrodes. The sudden application and cessation of a current causes an unpleasant and possibly injurious shock, and should be carefully guarded against. For this reason the electrodes should always be placed in position on the patient before the current is turned on, and should not be removed until it is turned off. The current should be gradually increased and diminished for the same reason.

Testing the Polarity of the Electrodes

The positive and negative poles of a galvanic battery should be marked by the signs + and −. If the battery has been repaired, and there is any doubt as to the connection of the carbon plate with the + terminal and the zinc plate with the − terminal, there are two simple tests which can be used to determine the polarity of the electrodes. One is to place the ends of the connecting wires in a bowl of water about 1 inch apart. Bubbles

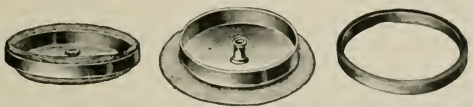


FIG. 191.—DISC ELECTRODE, WITH CELLULOID RING. The illustration on the right shows the ring only, the illustration in the centre shows the electrode with a new cover ready to be slipped over it, and the illustration on the left shows the complete electrode, with cover held in position by the ring.

of hydrogen will appear at the point of the wire which is connected with the zinc plate, *i.e.* the negative pole. The electrode attached to this wire is therefore the kathode. The other test is to place the ends of the wires upon a piece of wet blue litmus paper. It will turn pink under the point of the wire which is attached to the carbon plate. This is due to the liberation of acids at the positive pole, and the electrode attached to this wire is therefore the anode.

MOTOR POINTS AND NORMAL MUSCLE CONTRACTIONS

If a galvanic current is applied to a patient, and the active electrode is placed upon the motor point of a muscle (*i.e.* the point at which the supplying nerve enters the muscle and where it can be most easily stimulated), the latter, if normal, will contract with a short sudden jerk, when a current of from 3 to 5 milliamperes is passed. This contraction only occurs at the moment when the circuit is closed, not as the current continues to flow, or, except with very powerful currents, when it is broken. A healthy muscle will contract more easily, that is, with a weaker current, when the kathode is over the motor point, than when the anode is the active electrode. The closing contraction obtained with the kathode is known as K.C.C., that with the anode as A.C.C., while the abbreviations K.O.C. and A.O.C. stand for kathodal and anodal opening contraction—only obtainable with very strong currents. The contraction of healthy muscles can be obtained, not only by direct stimulation through their motor points, but also indirectly through stimulation of their nerve trunks. There are certain points at which these nerve trunks can be most easily reached, called motor points. Diagrams showing the motor points of the muscles and nerve trunks are appended at the end of the book. The position of the motor points of muscles vary slightly in different individuals; the active electrode should therefore be moved about until the exact spot is reached at which the muscle responds most readily to stimulation.

Muscles can contract through direct stimulation of their fibres, as well as through stimulation of the nerves supplying them. In health, however, the intramuscular nerve fibres respond more quickly to electrical stimulation than the muscle fibres do, and the reaction due to the latter is therefore obscured.

THE REACTION OF DEGENERATION, OR R.D.

When the nerve cells in the anterior horn of the spinal cord, or the nerves proceeding from them, are acutely injured, as in infantile, radial (O.T. musculo-spiral), and other paralyses, certain changes in the nerves and the muscles supplied by them are set up. These changes lead to the diminution, and finally to the complete loss of excitability in both nerves and muscles to the faradic current. The latter continue to respond to stimulation by the continuous current, but their contractions are sluggish, although at the same time they may be greater in extent than that of a healthy muscle. This is the condition known as the *reaction of degeneration*, and it is sometimes also marked by a more easily obtained contraction with the anode instead of the kathode, as the active electrode.

Partial R.D. may precede or follow complete R.D. It is characterised by a slight response to faradism. In the worst cases all reactions cease entirely after a time; this means that not only have the nerves degenerated, but also the muscle fibres, which are replaced by fibrous tissue.

TESTING THE REACTIONS OF MUSCLES

Testing should be carried out first with the interrupted and afterwards with the continuous current. The flat pad and small disc electrode should be used. They should both be thoroughly moistened with warm water or salt and water. In testing the muscles of the arm, the flat, flexible, or "indifferent" electrode may be placed either upon the sternum, where the patient can hold it in position, or else upon the lower part of the cervical spine. In the latter case, if the patient leans back upon a pillow, good contact can be made between the skin and the electrode. The limb should be supported by the operator, and the muscles should be relaxed. The small disc should be the active electrode, and should be placed upon the motor point of the muscle to be tested. If the galvanic current is used, a pressure of about 20 volts will be needed to begin with for the limbs, and 10 volts for the face. The current should then be interrupted and made again. This can be done in three or four ways. If a battery is fitted with a double current collector, the first crank can be moved on and off the dummy stud marked O. Otherwise interruptions can be effected by simply raising the electrode and replacing it. Sometimes the testing electrode is screwed on to a handle which is fitted with a spring for "making" the current. If no closing contraction is obtained the current must be increased, and when it appears its character should be noted—whether it is sluggish or quick, or greater or smaller in extent than the reaction of a healthy muscle. The reading of the galvanometer should be noticed, to know the amount of current needed to produce the contraction, and whether the latter was more easily obtained with the kathode as active electrode, or the anode. If only one arm or leg is affected, the character of the reactions can be compared with those of the healthy limb. In testing the muscles of the leg the indifferent electrode should be secured upon the lumbar or gluteal region.

Sometimes contractions are best obtained by placing both electrodes on the muscle, one at each extremity. The reaction of muscles to stimulation of the nerve trunks should also be ascertained.

EFFECTS AND USES OF THE GALVANIC CURRENT

Owing to the continuous flow of the galvanic current in one direction without interruption, its electrolytic or chemical effects are more marked than those of the faradic current, and it is said to be more concerned in nutritional changes in the tissues than the latter. The galvanic current is employed in cases of paralysis when R.D. is present, to promote the nutrition of the degenerate muscles. In these cases the kathode should be the active electrode, and the current should be interrupted at intervals to obtain contraction of the muscles. It is used in cases of neurasthenia and for the relief of pain in sciatica, in the later stages of neuritis, in neuralgia when the pain is due to local neuritis, and may also be employed in the various forms of occupation neuroses, and spasmodic torticollis. The galvanic current is also used for the destruction of nævi, superfluous hairs, fibroids, etc., and drugs are now administered through the skin and conveyed through the tissues under the attractive influence of the poles. The former process is called electrolysis, the latter ionic medication or ionisation.

For stimulating effects, labile applications with the kathode as active electrode should be used; for sedative effects, stabile applications with the anode as active electrode.

CENTRAL GALVANISATION

Central galvanisation is the stimulation of the whole cerebro-spinal system, and is useful in cases of neurasthenia, insomnia, dyspepsia, etc.

The kathode is made the indifferent pole, and is placed upon the epigastrium. The current may be applied to the patient's head and neck through the hand of the masseuse, who wears a bracelet electrode. She should place her hand upon the patient's forehead, and then gradually turn on the current until the required strength is reached. She should then pass her hand over the top and back of the head, which should be wet, and down the neck on the medial side of the sterno-cleido-mastoid muscle, to influence the pneumogastric nerve. The current should afterwards be applied along the whole length of the spine. In the absence of specific directions as to dosage from the doctor, from 1 to 2 milliamperes may be given to the head for from one to three minutes, 3 to 5 milliamperes to the neck for from three to five minutes, and up to 9 or 10 milliamperes to the back for ten minutes.[1]

THE FARADIC COIL

Faraday discovered that a current flowing through a coil of wire will, if its strength is varying, or if it is "made" and "broken," induce a current in a neighbouring coil of wire. He also found that if a magnet is made to approach towards or recede from a closed circuit, a current will be induced in the latter. Such a current is called an *induced* or *faradic current*. A faradic coil is made on the following principle: A coil of stout insulated wire is wound upon a bobbin having a soft iron core. This is called the primary coil, and is connected with a battery of one or two cells. A vibrating spring, worked by means of a magnet, is inserted in the circuit between the cells and the coil. This spring "makes" and "breaks" the battery current at frequent and regular intervals. At every "make" a momentary reverse pressure is set up in the primary coil which retards the rise of the battery current; at every "break" a momentary direct pressure (*i.e.* in the same direction as that of the battery pressure), which may be much greater than that of the cells, is induced in the coil, and the current due to this pressure is led off by two wires connected to the two ends of the coil for application to the patient. This is called the *primary faradic current*. It is one flowing always in one direction, but interrupted at frequent intervals. It is quite distinct from the battery current, being only obtained at the "break" or cessation of the latter.

FIG. 192.—DR. SPAMER'S COIL.

The *secondary* or *alternating current* is obtained by tapping a coil, usually consisting of many turns of fine wire, wound over the primary coil. Sometimes this secondary coil

[1] In applying electricity to the head the current should always be passed through it from above downwards, or in the antero-posterior direction, never transversely, as this causes vertigo and faintness.

is wound upon a bobbin having a hollow centre large enough to slide on and off the primary coil. Sometimes both coils are wound upon one reel, but quite independently of each other. The rise and fall of the current in the primary coil induces currents in the secondary coil. These currents are alternating in direction. The secondary current obtained at the "break" is always greater than that obtained at the "make" of the battery current. The strength of both depends upon that of the primary or inducing current. The iron core consists of bundles of soft iron wires. When the current flows round the primary coil the iron becomes magnetised, and the rise and fall of the magnetism in the core at every "make" and "break" of the battery current increases the induced current. In some batteries the core is made to slide in and out of the primary coil. When fully pressed home the maximum primary current is obtained, while the more it is withdrawn from its socket the weaker the current becomes. In coils where the core is fixed, a brass tube can be slipped over it to reduce the current. With a "sledge" coil the secondary or alternating current can be regulated not only by means of the iron core but by sliding the secondary coil over the primary. The strongest current is obtained when the former is directly over the latter. Before applying the current to a patient the masseuse should test it by applying the moistened electrodes to her own hand. When the current is definitely felt, and when the hand muscles begin to contract slightly, she may know that a strong enough current has been obtained to begin with. The position

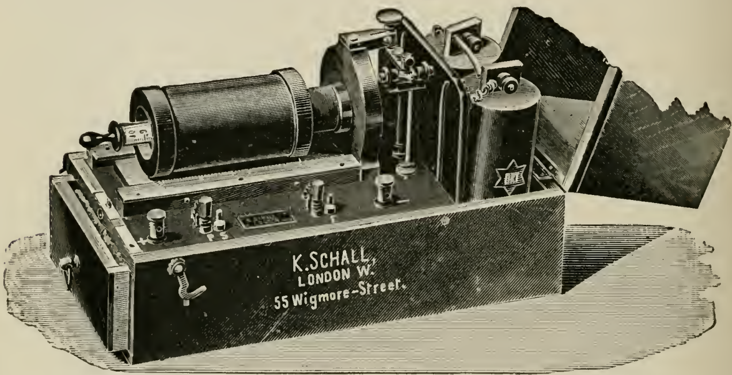


FIG. 193.—DUBOIS-REYMOND'S SLEDGE COIL, with Commutator for Primary and Secondary Current and Adjustable Interrupter.

of the core should then be noted, and also if giving a secondary current with the sledge coil, that of the secondary coil. The core should then be removed or uncovered, and the current turned off. When the electrodes are in position on the patient the current should be turned on and *gradually* increased to the right strength. Currents strong enough to cause actual pain should never be employed in giving an ordinary application. A masseuse should provide herself with a portable faradic coil, preferably one having an adjustable interrupter, so that the frequency of the interruptions can be regulated as required. Some coils have one pair of terminals for leading off either the primary or secondary faradic current, according to the position of the switch marked P and S. A second switch is for turning the battery current on and off. Other coils have two pairs of terminals—one pair for leading off the primary faradic, and the other pair for leading off the secondary faradic current—and one switch for turning the battery current on and off.

EFFECTS AND USES OF THE FARADIC CURRENT

The faradic current is used when general stimulation of the whole nervous system is required, as in neurasthenia and hysteria. It is employed in cases of anæmia and general debility after constitutional illness; in paralysis if R.D. is not present, and it is also used in certain cases as a sedative to pain.

The slowly interrupted primary faradic current (with the hammer set so as to make about two interruptions per second), or the slowly interrupted secondary current from a short coarse wire coil, are recommended by some medical authorities to promote muscle growth and general nutrition of the tissues. They are also recommended for stimulations of deep-lying organs, such as the stomach, liver, and intestines, in cases of dyspepsia and constipation. Others prefer using the fine wire secondary coil current for all purposes of general nerve and visceral stimulation. A rapidly interrupted weak current from the long fine secondary coil should be used when sedative effects are desired, as in cases of neuralgia when the pain is of referred origin. The rapid vibrations have a numbing effect upon the part. The passage of a quickly interrupted faradic current causes tetanus of the muscles, they have no time to relax between each "make" and "break" of the battery current.

GENERAL FARADISATION

General faradisation promotes tissue changes and general nutrition. It is useful in cases of dyspepsia, anæmia, neurasthenia, etc. The indifferent electrode is placed upon the spine in treating the limbs, and upon the abdomen when treating the back. The active electrode is moved in turn over the limbs, abdomen, and back. The secondary current is usually prescribed, and for the promotion of muscle growth it should be slowly interrupted so as to cause the slow, rhythmical contraction of the muscles under treatment. The current should not be so strong as to cause pain or discomfort.

FARADISATION OF THE SKIN

For faradisation of the skin, the secondary current from the long fine wire coil should be applied either by means of a wire brush electrode, or through the operator's own hand. The skin should be quite dry, or else the current will penetrate through it to the underlying muscles. To ensure dryness a little starch powder may be sprinkled over the part to be treated.

GALVANO-FARADISATION

Occasionally the continuous and induced currents are used simultaneously in cases of paralysis, general debility, nervous exhaustion, and for stimulation of the abdominal

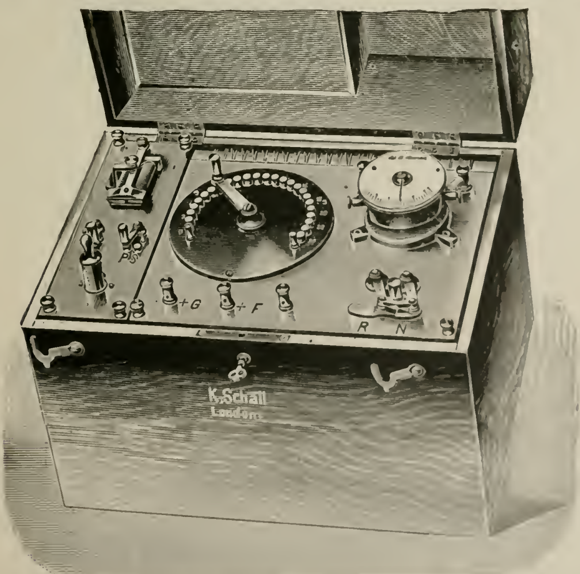


FIG. 194. - COMBINED MEDICAL BATTERY.

viscera. For applications of this kind "combined" batteries are sold. The faradic coil and galvanic battery are fitted into one case, and the currents can either be led off simultaneously through the same conducting cords or may be used separately. A combined current can also be obtained by using a separate galvanic battery and faradic coil, and connecting the negative terminal of the former with the positive terminal of the latter. The current is then led to the patient by attaching the conducting cords to the negative terminal of the coil and to the positive terminal of the galvanic battery.

When portability is a consideration in the choice of a battery, as it usually is for the masseuse, the "combined" make is not recommended. It is very heavy to carry, and combined currents are not often ordered. A separate coil and galvanic battery are far more convenient in massage practice, and when galvano-faradisation is ordered, the combined current can be obtained by coupling the coil and galvanic battery together, as described above.

ELECTRIC BATHS

Baths form a very convenient and comfortable way of applying electricity either generally or locally. For general applications, *i.e.* when it is desired to bring the whole system under the influence of electricity, the full-length bath is used. When the current is taken from the main electric lighting supply, the bath must be made of porcelain, and specially installed for the purpose. No one who has not had special training under an expert should attempt to use the current from this source in giving an electric bath, as there are many risks attendant upon so doing, and in order to avoid them a complete working knowledge of the whole apparatus is necessary. Galvanic electric baths can, however,

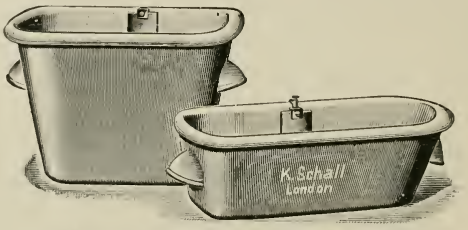


FIG. 195.—PORCELAIN FOOT-BATH AND ARM-BATH.

be manipulated with safety by persons with no very special training by using large Leclanché or accumulator cells as the means of supply. An ordinary full-length porcelain bath can be then used. The patient should be immersed up to the neck in warm water, about 99° Fahr. In a bi-polar bath two electrodes are hung over the edge of the bath, one at either end. These electrodes are made of tin, carbon, or zinc, and are provided with binding screws for the attachment of the conducting wires from the battery. The one at the head of the bath should be about 12 in. × 18 in., and should be attached to the positive pole of the battery. The foot electrode should be about 10 in. × 10 in., and should be attached to the negative pole. A "paddle" electrode may be used if it is necessary to concentrate the current upon any particular part of the patient's body. It can be attached by a conducting cord to either of the other electrodes, and moved about as desired. The patient's head and shoulders should be kept from touching the electrode at the head of the bath. To effect this a neck rest may be improvised by securing a broad band of webbing or other material across the bath for the patient to lean against. A back rest, made in the form of a wooden frame with bands of webbing stretched across it, is also used for this purpose. The feet, if not actually touching the negative electrode, should be kept close to it.

It has been computed that only about one-third of the current in a bi-polar bath passes through the patient. The rest flows through the water from one electrode to the other and is wasted. No salt should be added to the bath or the water will conduct still better than before, and the patient will receive less of the total current. The latter should be turned on very gradually when the patient is in the bath. It should never be strong enough to cause any discomfort, and should be turned gradually off before the patient gets out of the bath. For galvanic current baths, large Leclanché cells are better than small ones. Accumulator cells must be used when large currents are employed, such as from 50 to 100 milliamperes, and the current can be regulated by means of a shunt rheostat (volt regulator) placed in the circuit.

If the faradic current is used it should be obtained either from the primary or from a short coarse secondary coil. Strong, thick conducting wires should be used to convey the current from the battery or coil to the bath.

The duration of the bath should be from ten to twenty minutes. The patient's pulse and temperature should be taken before and after treatment. In order to cool off before going into the open air the patient should dress slowly, and rest for a short time after treatment.

Electric baths should not be given after a full meal. If the patient feels at all faint the current should be immediately reduced.

Small porcelain baths fitted with carbon electrodes can now be obtained for applying electricity to the limbs. Those for the lower extremities are made so that the legs can be immersed in water up to the knees, while the arm-baths are made to take in the hand and forearm. One electrode may be placed in the bath, and the other upon some part of the patient's body, or else in a second bath in which the patient's other arm or leg is immersed. This arrangement is called a mono-polar bath. If it is desired to bring both legs under treatment—as in cases of paraplegia—each should be placed in a foot-bath; the entire current will then traverse both legs. If the whole of one side is to be treated—as in hemiplegia—one arm and one leg should be immersed. If galvanism is applied in this way the current flows from the bath in which the anode is placed through the patient to the kathode bath. If one arm only is to be treated, one electrode should be placed in the bath, and the other upon the upper part of the spine. If the forearm only is to be influenced, both electrodes may be placed in the bath, one at either end (bi-polar method). In a mono-polar bath all the current traverses the patient's tissues between the electrodes—the water in the bath may be looked upon as a large perfectly fitting electrode. In a bi-polar bath only a fractional part of the total current is transmitted by the patient. Larger currents are therefore needed for bi-polar than for mono-polar applications.

The "four-cell" bath apparatus, designed by Dr. Schnee and called by his name, consists of a chair and four small baths each fitted with an electrode, which is connected through the medium of a specially designed switchboard with the battery. The current obtained can be either continuous, interrupted, or alternating, and its direction can be regulated by means of a commutator. The patient sits in the chair, the forearms are immersed in the arm-baths fixed at either side of the chair, and the legs are placed in the deeper tubs provided for them. An arm-bath can be quite easily and cheaply improvised by obtaining an oblong earthenware basin—such as are sold for kitchen use—fitting it with two electrodes, about 5 in. × 3½ in., and attaching these to a coil for faradism or to a battery for galvanisation.

The advantages of using baths as a means of applying electricity are as follows: First, the patient suffers less discomfort, because the water acts as a large electrode, and the current is diffused over a large area. Secondly, the water thoroughly moistens the skin and considerably reduces its resistance. Thirdly, the warm water in the bath keeps the parts under treatment agreeably warm during the application.

TREATMENT FOR DIFFERENT TYPES OF CASE

Infantile Paralysis

In treating with the continuous current the anode should be the indifferent electrode, and should be placed upon the back. The kathode should be moved over the affected muscles. The current should be frequently broken to obtain, if possible, contractions of the muscles. Currents of from 4 to 6 milliamperes may be used. Applications are usually ordered daily for from twenty to thirty minutes.

Facial Paralysis

If R.D. is present the continuous current is usually ordered; if the muscles respond to faradism the coil is used. In applying the former the indifferent electrode should be placed at the back of the neck or held underneath the ear. The active electrode is then moved over the affected muscles. The dosage ordered is usually from 2 to 5 milliamperes. In passing 2 or 3 milliamperes the kathode may be used as the active electrode. When a larger current is ordered the anode must be used over the affected part, as the skin of the face is very sensitive, and a current of 4 or 5 milliamperes is more easily borne with the anode as the active pole. Treatment is usually ordered daily for fifteen minutes.

Brachial Neuritis

In all cases of painful neuritis the galvanic current must be used. As a rule, large currents are ordered, and should be administered through large electrodes. In treating brachial neuritis the anode is placed upon the cervical spine or upon the shoulder above the clavicle, and the kathode, in the form of a flexible flat electrode, is folded round the forearm. A current of from 10 to 12 milliamperes may be ordered, and the application should last for from ten to thirty minutes.

Sciatica

Two large flexible electrodes are used. The anode, about $4\frac{1}{2}$ in. $\times$ 8 in., is placed upon the buttock of the affected side. The kathode should be larger, about 8 in. $\times$ 12 in., and should be closely moulded round the lower part of the leg. Both electrodes must be well padded with absorbent wool, and thoroughly moistened. The current should be turned on and off gradually. From 15 to 30 milliamperes may be ordered. Treatment is generally given daily at first for twenty or thirty minutes.

Writer's Cramp

The indifferent electrode, the kathode, should be placed upon the back of the neck, the anode may be held upon the back of the hand and upon any tender points along the arm. The strength of current ordered varies from 2 to 8 milliamperes. Applications are usually given once or twice daily for fifteen or twenty minutes. The galvanic bath is a good way of administering electricity in a case of this kind.

Spasmodic Torticollis

The galvanic current is used. The kathode is applied to the back of the neck. The anode is held stationary on the sterno-cleido-mastoid muscle of the affected side. A current of from 2 to 5 milliamperes may be ordered for about ten minutes twice a day.

Constipation

For constipation, the slowly interrupted faradic current is usually prescribed. The indifferent electrode should be placed upon the lower part of the back, and the active electrode should be moved slowly along the course of the colon and over the liver.

IONIC MEDICATION

As previously mentioned, the charged atoms which are normally present in an electrolyte are called ions. When a continuous current of electricity is made to pass through an electrolyte these charged atoms, or groups of atoms, are attracted by and move towards the pole of opposite sign to themselves, those positively charged to the kathode and those negatively charged to the anode. On this principle, drugs can be introduced into the body by means of a galvanic current, and the process is called ionic medication or ionisation. It is carried out as follows: The skin of the part to be treated should first be washed to remove any grease and so ensure the better penetration of the ions, and any cut or spot upon the skin should be covered either with collodion or adhesive plaster, otherwise the current would enter very easily at this point and cause a severe burn. The drug to be used is dissolved in water, and a thick pad of lint or gamgee tissue is soaked in the solution, then moderately wrung out and placed over the affected part, under the kathode or anode, according to the sign of the drug to be introduced. A large indifferent electrode, consisting of a pad soaked in a warm salt solution, should be placed upon some convenient part of the patient's body, or an arm or leg bath may be used instead. When the current is turned on, the migration of ions takes place through the tissues of the body.

After an application the lint or gamgee tissue should be thoroughly rinsed out and dried, in preparation for the patient's next treatment.

In carrying out ionic medication it is all-important to know under which pole to place the drug in order that the required ions may penetrate through the tissues. No mistake can be made about the choice of pole if it is remembered that in pharmaceutical nomenclature the positive element or base of a drug comes first and the negative element last.

Example :—

+	−
Potassium	Iodide
Sodium	Chloride
Sodium	Salicylate
Lithium	Sulphate
Cocaine	Hydrochloride
Quinine	Bisulphate
Zinc	Sulphate, etc.

If the positive element of the drug is to be driven into the tissues, the pad which is soaked in the solution must be placed under the anode. The required ions will then be repelled from the anode and migrate through the body towards the kathode. Similarly, if the negative element of the drug is to be introduced into the body it must be driven in from the pad under the kathode.

Apparatus

The continuous current for carrying out the treatment may be obtained—(*A*) From a universal apparatus. This is a machine from which faradic and sinusoidal currents can also be obtained. The currents are generated in this apparatus by a motor dynamo which is driven by the current from the main. They can be smoothly graduated, a very important point in regard to the comfort and well-being of the patient. An amply sufficient amperage for all cases can be obtained from this source of supply. (*B*) A medical battery of twenty-four cells and upwards. This should be fitted with a milliampere-meter and also with a current collector, so that the current can be increased and decreased by one cell at a time. (*C*) From the continuous current main, in which case a shunt switchboard for regulating the current must be used. This source of current is not recommended, as it is attended by risks to the patient. If it is used, a competent electrical engineer should be employed to design and arrange safety fuses in the circuit.

The best kind of conducting cords are those made of flexible copper wire, insulated by indiarubber tubing. The wire is thicker than that of the ordinary cords sold, and does not get corroded by the penetration of the solutions used as it does when only covered by cotton or silk. Great care should be taken to ensure the safe and good contact of all the connections. This is a most important point, as any sudden break in the current will give an unpleasant, and, in the case of large currents, perhaps a dangerous shock. Electrodes with the connecting wires soldered on can now be obtained and are the safest for use when applying large currents.

The electrodes used consist of layers of lint, gamgee tissue, or absorbent wool, over which is placed a metal plate. The layers of lint or wool should be applied evenly over the affected part, and, to ensure its good contact with the skin, and also to hold the two parts of the electrodes together and in position, a bandage should be firmly applied over the whole. The lint or absorbent wool should be folded in not less than sixteen thicknesses, if any strength of current over 20 milliamperes is being passed. The metal part of the electrode should be smaller than the pad, so that it cannot come into contact with the skin; indeed, provided that the pad is large enough, the metal plate may be quite small. An arm or leg bath, filled with a sufficient quantity of the solution to cover the part, may be used as the active electrode when treating the forearm and hand or the foot. This sometimes forms a more convenient and comfortable electrode than the pad. When the ions of metals, such as zinc and copper, are used for treating ulcers, etc., the metal part of the active electrode (the anode) should be of the same material, so that a renewal of the ions may be kept up from it.

In other cases aluminium is said to be perhaps the best kind of metal to use. Tin electrodes are also used, and metal gauze forms a very convenient kind of conductor when treating joints. It can be cut into strips of the required length and width, and placed round the joint over the wrapping of lint. Safety pins with binding screws soldered on can now be obtained for making a connection with the wire when using this kind of electrode.

Distilled water is recommended for ionisation, but tap water, if boiled, can also be used. Dr. Lewis Jones, in his book, *Ionic Medication*, says: "If tap water is used, mineral constituents, usually calcium carbonate, will share in the transport of the current; but there is no evidence to show that their presence complicates the operation to any appreciable extent." The drugs can be procured in soloid form. One soloid dissolved in 1 ounce of water gives a 1 per cent. solution. A more convenient and cheaper method is to have a 10 or 20 per cent. stock solution of the drug made up by a chemist, and then to dilute it with the required amount of hot water when wanted for use. Thus, to make up a 2 per cent. solution, four parts of boiling water should be added to one part of a 10 per cent. stock solution; or nine parts of water to one part of a 20 per cent. stock solution.

Details of Treatment

Stiff Joints.—In cases where the disease or morbid agent has ceased to be active, excellent results have been obtained by ionisation with sodium chloride, the chlorine ions having a softening effect upon the tissues. It has also been used successfully in cases of Dupuytren's and Palmar's contraction and in the contraction of cicatricial tissue.

Professor Leduc's method is to saturate sixteen thicknesses of absorbent cotton-wool in a 1 or 2 per cent. solution of sodium chloride and to wrap it round the affected joint. He recommends that several turns should be made round the limb so that there may be thirty-two or forty-eight thicknesses of tissue between the skin and the plate of tin connected with the negative pole. The whole is then kept in position by a bandage. The indifferent electrode may consist of an arm or leg bath of warm water with a little salt in it, or of a large compress of absorbent cotton-wool folded in sixteen thicknesses and saturated in a warm salt solution; this may be placed round the other limb, and over it is secured another metal electrode which is connected to the positive pole. The current is then very gradually turned on and should not reach its maximum strength for several minutes. Professor Leduc mentions that the discomfort which is complained of by the patient at first is due, not to the intensity of the current, but to the rapidity with which the intensity is raised. The current may be very gradually increased to any strength up to 100 milliamperes, the amount which can be tolerated varying with the individual. Once the current has reached its maximum strength little or no discomfort is experienced. At the end of the treatment the current should be gradually turned off. The application may last for half an hour or longer, according to directions, with the maximum strength of current. Usually three treatments per week are ordered, but after some time these may be reduced to two and later to one, as the skin and tissues become more sensitive after a few applications. Should the patient complain of discomfort in any particular spot under the pad the current should be at once turned off, the bandage undone, and the part examined. Localised pain usually means either that the pad is not applied with uniform pressure over the whole part or that there is some scratch or pimple on the skin. In either case the density of the current is increased at that point, and a severe burn may result unless precautions are taken. If there is a small abrasion of the skin, it should be covered either by collodion or adhesive plaster and the treatment may then be resumed.

Brachial Neuritis.—A 1 or 2 per cent. solution of sodium salicylate or potassium iodide is usually ordered for this condition. A pad of lint of about twenty thicknesses, and measuring about 8 in. × 6 in., is soaked in the solution and then applied over the shoulder, between the root of the neck and the shoulder-joint (the nearest point to the plexus being above the clavicle, lateral to the sterno-mastoid muscle). A metal electrode (aluminium or tin) is placed over the pad and connected with the negative pole of the battery or source of current. The hand and forearm may be placed in an arm bath, which is connected with the positive pole; or another pad, wetted in a warm salt solution, may be wrapped round the arm or hand. If treating with sodium salicylate a current of 50 milliamperes is usually well tolerated; some patients may take more, others less, and the treatment lasts for from twenty or thirty to forty minutes, according to the doctor's instructions.

When using potassium iodide smaller currents and shorter applications are recommended, as the iodide ions are said to have a more caustic action upon the skin than the salicylic ions. Therefore, when driving in the former, unless definite instructions are received as to the strength of the current, it is wiser to employ only about 20 milliamperes and to give an application lasting about twenty minutes.

Sciatica.—The drug usually ordered is sodium salicylate. A thick pad, measuring about 10 in. × 8 in., is saturated with a 2 or 3 per cent. solution of the drug and placed upon the buttock, or wherever along the course of the nerve that the pain is most severe. Over this is placed a metal plate which is attached to the negative pole. Sometimes it may be necessary to apply a pad which will be large enough to cover the whole of the back of the thigh and the buttock, or else two active electrodes attached to the negative pole can be used. The indifferent electrode consists of a large pad applied to the leg and attached to the positive pole. Currents of from 50 to 100 milliamperes may be given, and the treatment may last for forty minutes or longer. Potassium iodide or sodium thiosulphate may be ordered in these cases instead of sodium salicylate.

Intercostal Neuralgia.—If sodium salicylate is ordered, a large pad is soaked in a 1 or 2 per cent. solution of the drug and placed under the kathode upon the painful part. If this is on the left side, the præcordial area must be avoided and extra care must be taken not to make sudden changes in the strength of the current; the pulse should also be taken during the treatment, as the latter may influence the action of the heart. The anode or indifferent electrode may consist of a foot bath of warm salt water. Applications lasting from thirty to sixty minutes may be ordered.

Lumbago.—The active electrode, consisting of a large pad soaked in the solution ordered, should be placed upon the lumbar region; the indifferent electrode should be placed a little higher up the back or round one of the legs. Large currents are usually ordered, in which case any strength of current up to 100 milliamperes, that can be comfortably borne, may be given.

Fibrositis.—In cases of fibrositis a 2 per cent. solution of sodium chloride is often ordered. The chlorine ions are introduced under the kathode. Massage is often much better tolerated when given after the ionisation treatment in these cases.

RADIANT HEAT AND LIGHT

This treatment is often ordered in conjunction with massage in cases of rheumatism, neuritis, and other conditions. Upright or reclining bath cabinets are used for the treatment of the whole body, the head only excluded. These cabinets are fitted with about fifty incandescent lamps of white, blue, or red crystal glass, as required. (The blue light is said by some people to be best for nervous disorders, the red for anæmia and disturbances of the circulation.) The amount of heat and light can be regulated either by means of switches for turning on and off a certain number of lamps at a time, or by a rheostat which alters the strength of the current coming from the electric-lighting mains. The reclining baths are, for most patients, more comfortable than the upright ones; they have also an arrangement of lamps underneath the couch, which is a great advantage in treating cases of sciatica.

Practical Details

If any covering is worn at all while in the bath, it should consist only of some transparent material, such as butter muslin. This absorbs the perspiration and at the same time—a most important point—permits the light to penetrate through it to the body. Any space left between the patient's neck and the edge of the aperture for the head should be filled by a towel. A thermometer should be fixed in the bath and the temperature of the latter must be regulated according to the case under treatment. 160° F. to 170° F. is a usual maximum bath temperature in most cases; but if the patient perspires freely, with a lower degree of heat, there is no need to increase it. It is most important in every case to watch the pulse carefully, as its rate often increases rapidly during an application, or it may become weak and irregular. A pulse rate approaching 120 should be regarded as highly dangerous. It is always well to ask for special instructions on this point before undertaking the treatment. The latter should be suspended immediately should the pulse become weak, irregular, or over rapid, otherwise it may last for from fifteen to thirty minutes, according to directions. The windows of the room should be open while the patient is in the bath, and a towel wrung out in cold water may be placed upon the head. After the application of heat and light the patient should be wrapped up in very hot towels and placed upon a couch between blankets for about half an hour. Massage, rubbing with eau de Cologne, may then be given. Hot water should be drunk during the treatment (except in cases of œdema); it promotes elimination through the sweat glands and at the same time makes up for the loss of moisture incurred. The patient should not be allowed to go out until thoroughly cool and rested. Small baths for the shoulder, the limbs, or the trunk are used for local applications of heat and light. When the bath is in position over the part to be treated a blanket is placed over any aperture, so that the cool air from outside is excluded. An application of radiant heat and light is often given before ionisation, and good results are obtained by the combined treatment.

DIATHERMY

This is a new treatment in which heat, generated by electricity, is the therapeutic agent. A high frequency apparatus, with specially modified interrupters, is employed. The currents are led off to the patient by means of rubber-covered cords, to which the electrodes are attached. The latter should be covered with a pad of moistened lint, and should be secured so as to make good contact with the skin. They should be large enough to prevent blistering, as, with this form of electricity, currents of considerably over 1 ampere may be ordered. The effect of the treatment is to raise the internal temperature of the parts under and between the electrodes, and it has been found useful in (1) acute muscular conditions, such as lumbago; (2) in the pain of neuritis or that associated with chronic joint disease, chiefly osteo- or rheumatoid-arthritis, neuralgia, etc.; (3) in neurasthenia. The applications last for five or ten minutes, and the patient should remain lying down for a few minutes after the treatment. Diathermy is also used for surgical purposes.

BOOKS RECOMMENDED FOR FURTHER STUDY

Medical Electricity, by Lewis Jones.
Ionic Medication, by Lewis Jones.
Electrical Treatment, by Wilfred Harris.

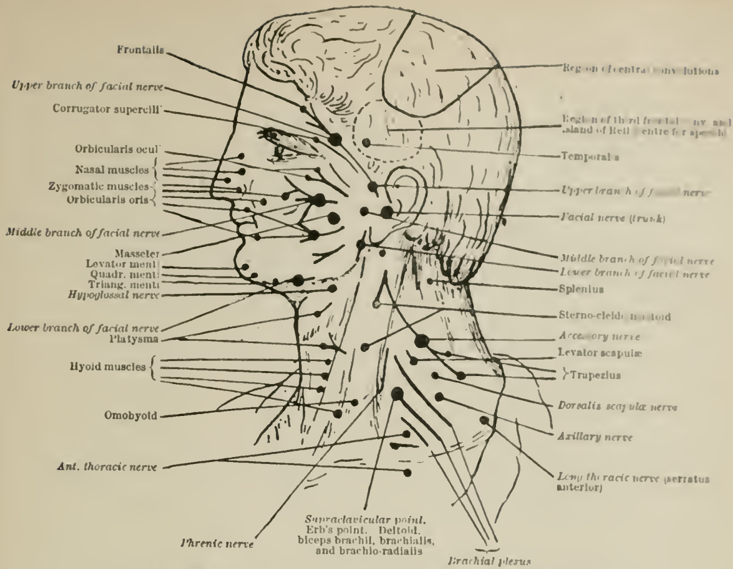


FIG. 196.—MOTOR POINTS OF THE FACE AND NECK (after Erb).

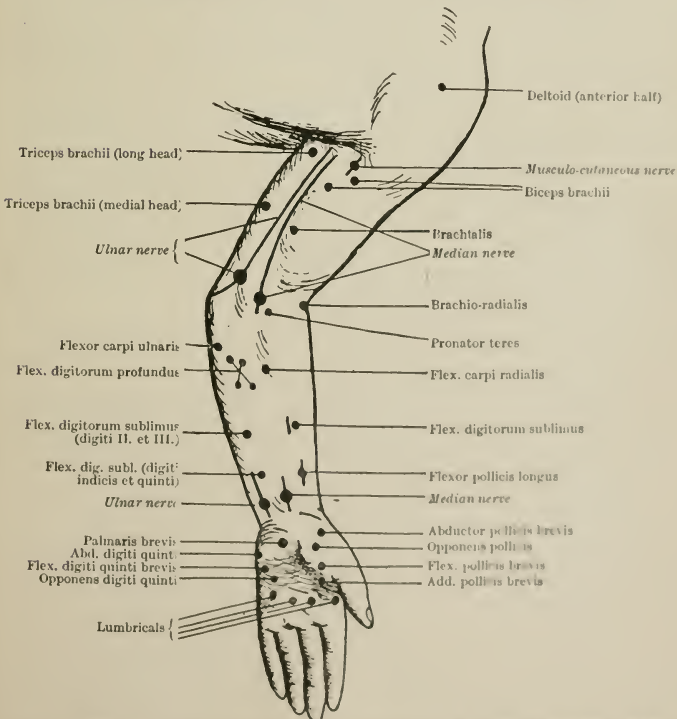


FIG. 197.—MOTOR POINTS OF THE UPPER EXTREMITY—Anterior Aspect (after Erb).

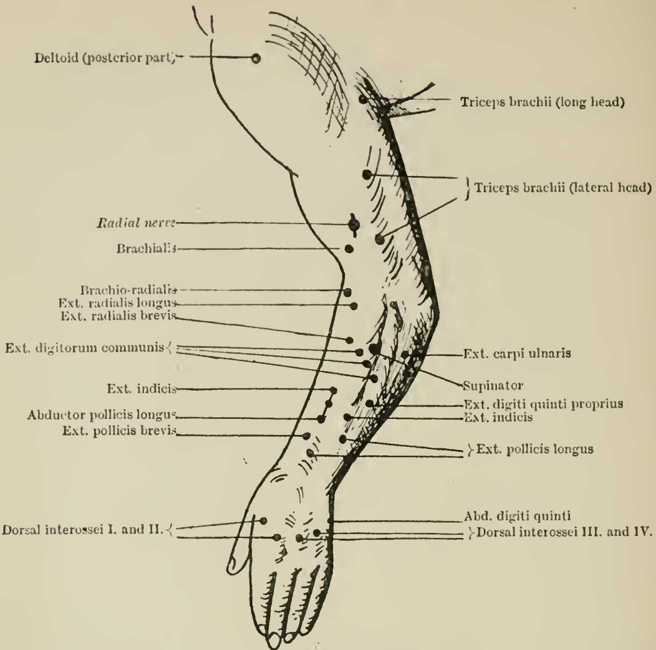


FIG. 198.—MOTOR POINTS OF THE UPPER EXTREMITY—Posterior Aspect (after Erb).

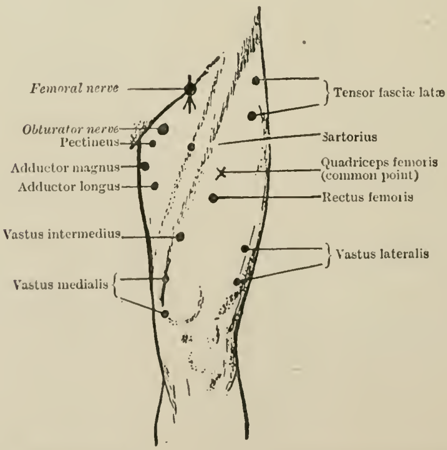


FIG. 199.—MOTOR POINTS OF THE THIGH—Anterior Aspect (after Erb).

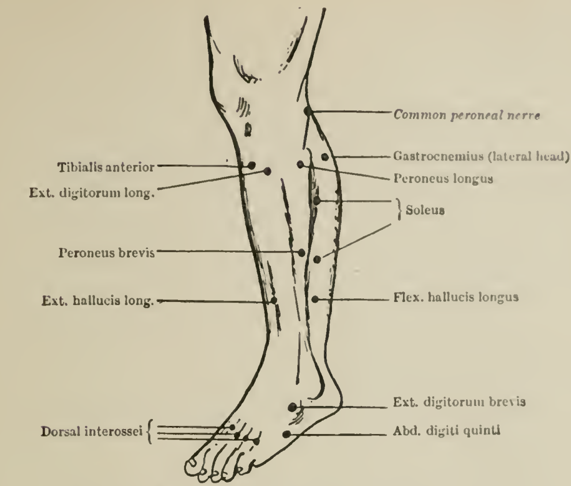


FIG. 200.—MOTOR POINTS OF THE LEG (after Erb).

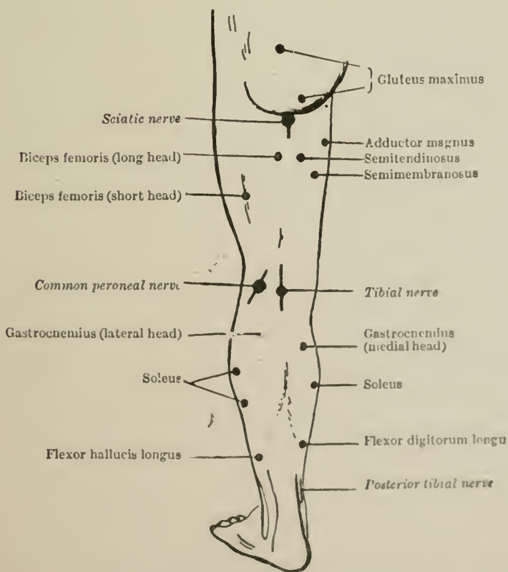


FIG. 201.—MOTOR POINTS OF THE LOWER EXTREMITY—Posterior Aspect (after Erb).

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