

Grant's METHOD of ANATOMY

**by regions
descriptive and deductive**

Tenth Edition

**JOHN V. BASMAJIAN,
M.D., F.A.C.A., F.R.C.P.(C)**

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Preface to the Tenth Edition

Courses in human anatomy continue to change not only from decade to decade but also from year to year and even semester to semester. In medical schools, both students and professors have reawakened to the need for recognizing priorities. Clinical emphasis has been rediscovered; hence, anatomy textbooks that present the subject as "basic facts" are out of favor. Fortunately, this book always relied heavily on clinical significance as the major justification for the inclusion or exclusion of details. Hence, a new edition did not dictate a complete revamping. However, this is not a book on clinical examination; it is a book with a clinical foundation, *i.e.*, an anatomical basis for clinical practice. Fortunately, I have been in the very middle of some of the most innovative changes in the teaching and learning of gross anatomy in North America. First at Emory University and since 1977 at McMaster University, I have dealt first hand with revolutionary modes of studying the subject. At the latter university, students acquire their anatomical knowledge while solving problems of patients in a clinical setting. More than ever, the basic approach of *Grant's Method* seems to be the touchstone of learning all that is important and essential in human gross anatomy, regardless of the educational mode, philosophy, or time allotment. This book is a friend and counselor; it relies on logic, explanation, and rational thought to lead the reader to the learning and retention of principles.

Much shifting of materials has occurred to fit the majority of programs. New material in both text and illustrations has been introduced cautiously so as to prevent "bloating." However, the new radiographic atlas is included in the hope that this important clinical aid enhances student learning.

The order of presentation of sections now

conforms to that found in *Grant's Atlas* and *Grant's Dissector*. As before, however, this particular sequence of chapters is not of critical importance in day-to-day work because each section has been fashioned to stand alone. Hence, any sequence of dissections or lectures in specific programs can be adjusted to easily. As before, students should first read (and then reread, whenever possible) the section "General Considerations," which emphasizes systematic anatomy.

While future clinicians studying anatomy for the first time are the chief users of this book, an effort has been made to make it highly usable for biologists, graduate students, and practicing surgeons and physicians. Every attempt has been made to be up-to-date with new developments without increasing the details. Readers will soon note that clear devices are used to increase and decrease the emphasis on specific materials. Small type sections are not for memorization!

Readers will soon find that this book no longer is designed to fit any particular course of teaching. Whether the student dissects or does not is not important here; the book is planned to stand alone *if necessary*. It should make good reading on a desert island. It is a helper so that students can understand "why" and not just "what." Thus the many line drawings emphasize *concepts* and the text relies heavily on *rational explanation and deduction*. The human body is a logical system and not just a jumble of parts. Intelligent students want to know "why" and they soon find that understanding the embryologic and functional logic used in this book permits them to understand the body, not just memorize facts about it.

This, the tenth edition, is the fourth edition of *Grant's Method* that I have edited since Professor Grant handed this task to

me. Much of the work was done in the Anatomy Department of Emory University in Atlanta, Georgia, where I was a Professor until 1977. It is a pleasure to acknowledge the help and support I received from my colleagues there. Illustrated material by Mike Dismatsek of Chedoke Rehabilitation Centre in Hamilton and secretarial assistance by Mrs. Margaret Szakszon have made my work easier. I am also grateful to Sara Finnegan, Vice President and Editor-in-Chief of Williams & Wilkins, whose help has been freely given.

Professor Grant conceived this book in the 1930's and was its sole spirit and author until the end of the 1950's. Since then I have labored with devotion and pleasure in placing the sixth to this tenth edition at the

disposal of all students. Always I have strived to maintain the essence and most of the "method" of the original—logical deduction—while shaping the size and content of the volume to the current needs. The fact that teachers and students have found the approach useful and perhaps exciting has provided the fuel that has kept this lamp burning bright. Once more, it is an honor to dedicate this volume to the memory of its founder, Professor J. C. Boileau Grant, one of the greatest teachers of human anatomy in the English language since John Hunter.

John V. Basmajian

*McMaster University
Hamilton, Ontario, Canada
1980*

Preface to the First Edition

The study of human anatomy may be attempted in either of two ways. One consists in collecting facts and memorizing them. This demands a memory which is wax to receive impressions and marble to retain them. Even so endowed a student will not master the infinite complexities of the subject. The other way consists in correlating facts, that is studying them in their mutual relationships. This leads inevitably to the apprehending of the underlying principles involved, and the *raison d'être* of such relationships. The student will thus learn to reason anatomically and will find the acquisition of new and related facts an easier task. It is the purpose of this book to lead the student to approach the subject from this viewpoint, and it involves certain departures from tradition.

The human body is here considered by regions. In most regions some feature predominates. It may be a muscle, a vessel, a nerve, a bony landmark, or other palpable structure, or it may be a viscus. The regions are for the most part built up around the dominant or central feature.

The markings, lines and ridges, depressions and excrescences on a bone tell a story, as do the scars and irregularities of the earth's surface. Because they are in the main to be interpreted by reference to the soft parts that surround and find attachment to them, the bones are not described together under the heading "osteology," as though they were things apart. The shafts of the bones are considered with the surrounding soft parts, the ends with the joints into which they enter. The bones of the foot are primarily considered as a single mechanism—so are those of the hand and of the skull. The correct orientation of certain bones is given in cases where, without this information, the actions of certain muscles (e.g., *gluteus medius*, *teres major*) could not be understood.

It is not the mere presence of a ligament or its name that is of interest, but the functions it serves. These depend commonly on the direction of the fibers of the ligament, occasionally on their precise attachments. Many fibrous bands bearing individual names are really members of a community. A challenge thrown at one must be taken up by all. They act in unison, and therefore they are considered together as a unit.

In the consideration of viscera the subject is elucidated by reference to comparative anatomy and to embryology. These are cognate sciences which throw light about the existing structure of man. The positions of the viscera are referred to selected vertebral levels, the vertebral column being an ever present and ever ready measuring rod.

Illustrations, to be of value, must be simple and accurate, and must convey a definite idea. It is for these reasons that they consist entirely of line drawings. Their simplicity encourages the student to reproduce them and, though diagrammatic in nature, they are based on measurements and observations of a great deal of carefully dissected material. Their accuracy, therefore, in those details they are intended to illuminate, has been the object of very considerable work.

The book is meant to be a working instrument designed to make anatomy rational, interesting, and of direct application to the problems of medicine and surgery. The bare, dry, and unrelated facts of anatomy tend rapidly to disappear into forgetfulness. That is largely because its guiding principles are not grasped so as to capture the imagination. Once they are grasped it will be found that details and relationships will remain within certain and easy recall.

J. C. Boileau Grant

University of Toronto
September 1937

Introduction and Descriptive Terms

There are few words with a longer history than the word *Anatomy*. If we write *anatomy*, we use the name that Aristotle gave to the Science of Anatomy 2300 years ago. He made the first approach to accurate knowledge of the subject, although it was derived from dissections of the lower animals only. The word means cutting up—the method by which the study of the structure of living things is made possible.

The boundaries of the subject have widened. Through the use of the microscope and with the aid of stains, the field of Anatomy has come to include microscopical anatomy, or *histology*, and the study of development before birth, or *embryology*. The study of the anatomy of other animals, *comparative anatomy*, has been pursued exhaustively, partly in an endeavor to explain the changes in form, *morphology*, of different animals, including man. *Physical Anthropology*, or the branch of the study of mankind that deals chiefly with the external features and the measurements of different races and groups of people and with the study of prehistoric remains, commands interest of the anatomist. The hereditary, nutritional, chemical, and other factors controlling and modifying the growth of the embryo, of the child, and of animals are within his legitimate field; so also is the growth of tissues in test tubes, *tissue culture*. Feeding and other experiments on animals play leading parts in many investigations.

Individuals differ in outward form and features, for example, how varied are fingerprints and the arrangement of the veins visible through the skin; individuals differ also in their internal makeup. Textbooks, for the most part, describe average conditions where weights and measures are concerned and the commonest conditions where arrangements and patterns are concerned. Owing to the variety of these, the

commonest may have less than a 50% incidence; therefore, it may not be truly representative. As data on variations accumulate, the subject of *Statistical Anatomy* emerges. Some variations are so rare as to be abnormalities or *anomalies*. Among the different races of mankind there are percentage differences in the form and arrangement of structures, just as there are among the different races of the apes and other animals. However, relatively little is known as yet of *Racial Anatomy*, which is a branch of physical anthropology.

The human body is generally dissected by regions, *Regional Anatomy*, and described by systems, *Systematic Anatomy*. The regions of the body comprise (1) the head and neck, (2) the trunk, and (3) the limbs. These can be divided and subdivided indefinitely. The trunk is divisible into thorax, abdomen, and pelvis. The systems of the body comprise the skeleton (the study of which is osteology), the joints (arthrology), the muscles (myology), the nervous system (neurology, which includes the brain, spinal cord, organs of special sense, the nerves, and the autonomic nervous system), and the cardiovascular system, which includes the heart, blood vessels, and lymph vessels. The viscera of the body (exclusive of the heart and parts of the nervous system) comprise four tubular systems—the digestive, respiratory, urinary, and genital—and the ductless or endocrine glands. All these are wrapped up in the skin and subcutaneous tissue.

Anatomy considered with special reference to its medical and surgical bearing is called *Applied Anatomy*. Anatomy can be studied profitably, although to a limited extent, by means of cross-sections, *Cross-Section Anatomy*. In the living subject a great deal can be learned by inspection and palpation of surface parts. This and the relating of deeper parts to the skin surface,

Surface Anatomy, are a necessary part of a medical education. *Radiographic Anatomy* relies on the X-ray to reveal much that cannot be investigated by other means.

Regarding nomenclature, it may be said briefly that over 30,000 anatomical terms were in use in the various textbooks of Anatomy and in the journals when, in the year 1895, the German Anatomical Society, meeting in Basle, approved a list of about 5,000 terms known as the Basle Nomina Anatomica (B.N.A.). Six terse rules, set down by the Commission for its own guidance, are worth recording here. They are as follows: (1) Each part shall have only one name. (2) Each term shall be in Latin. (3) Each term shall be as short and simple as possible. (4) The terms shall be merely memory signs. (They need lay no claim to description or to speculative interpretation.) (5) Related terms shall, as far as possible, be similar, e.g., femoral nerve, femoral artery, and femoral vein. (6) Adjectives, in general, shall be arranged as opposites, e.g., major and minor, superior and inferior.

In the year 1933, The Anatomical Society of Great Britain and Ireland, meeting in Birmingham, adopted a revision of the B.N.A., known as the B.R.; in 1935, the German Anatomical Society, meeting in Jena, likewise adopted a revision, known as the J.N.A. or I.N.A. Despite their many excellent points, these found only local and restricted acceptance. In 1955, the Sixth International Congress of Anatomists, meeting in Paris, gave approval to a somewhat conservative revision of the B.N.A. which was submitted to it, and which contained many B.R. and I.N.A. terms. Subsequently minor revisions and corrections were made at the Seventh, Eighth, and Ninth Congresses held in New York (1960), Wiesbaden, Germany (1965), Leningrad (1970), and Tokyo (1975). It is hoped and believed that this Nomina Anatomica (the Fourth Edition of which was published in 1978 by *Excerpta Medica*) will come to be used exclusively and universally.

DESCRIPTIVE TERMS

In describing the relationship of one structure to another it is obviously necessary to avoid ambiguity and misunderstanding.

For descriptive purposes the human body

is regarded as standing erect, the eyes looking forward to the horizon, the arms by the sides, and the palms of the hands and the toes directed forward; this is the **Anatomical Position**. The cadaver may be placed on the table lying on its back, on its side, or on its face, but for descriptive purposes it is assumed to be standing erect in the anatomical position. The palm of the hand is understood to be the anterior surface of the hand (Figure I.1).

The body is divided into two halves, a right and a left, by the *median or midsagittal plane*. The anterior and posterior borders of this plane reach the skin surface at the front and back of the body at the *median line or midline*.

Terms of Relationship. Three pairs of relative terms suffice to express the relationship of any given structure to another (Figure I.2). They are:

1. Anterior or in front = nearer the front surface of the body.
Posterior or behind = nearer the back surface of the body.
2. Superior or above = nearer the crown of the head.
Inferior or below = nearer the soles of the feet.
3. Medial = nearer the median plane of the body.

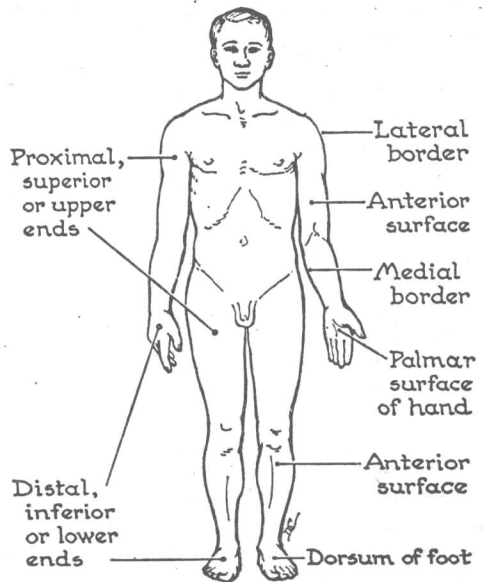


Figure I.1. The subject in the Anatomical Position—except for the right forearm, which is pronated.

Lateral = farther from the median plane of the body.

The foregoing terms are applicable to all regions and all parts of the body—always provided that the body is, or is assumed to be, in the anatomical position.

Terms of Comparison. When it is desired to compare the relationship of some structure in man with the same structure in, for example, a dog, it is necessary to use a different set of terms, terms related not to space but to parts of the body, such as the head, tail, belly, and back. For example, in man standing erect, the heart lies above the diaphragm; in the dog standing on all fours, it lies in front of the diaphragm; however, in both instances its position rel-

ative to other parts of the body is the same; so, *speaking comparatively*, one would say that both in man and in the dog the heart is on the head, cranial, or cephalic side of the diaphragm (Figure I.3).

Hence, the terms *ventral and dorsal*, *cranial and caudal*, as well as *medial and lateral* are applicable to the trunk or torso (thorax, abdomen, and pelvis) irrespective of the position assumed by the body. Moreover, it is desirable to employ these terms in embryology and comparative embryology, and it is quite correct to employ them in human anatomy—for no misunderstanding can arise from their use as synonyms for anterior, posterior, superior, and inferior.

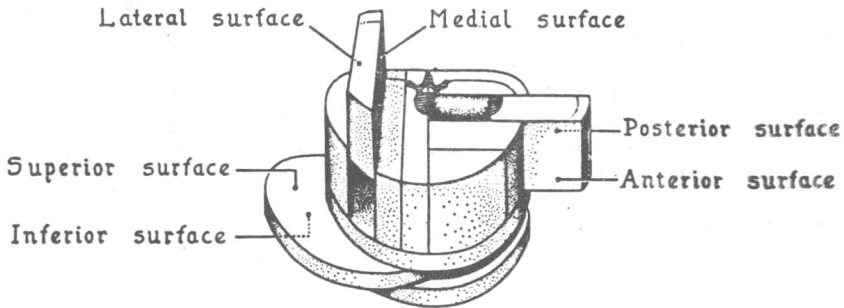


Figure I.2. Three pairs of surfaces involving six essential descriptive terms. They are related to the three fundamental planes in the body.

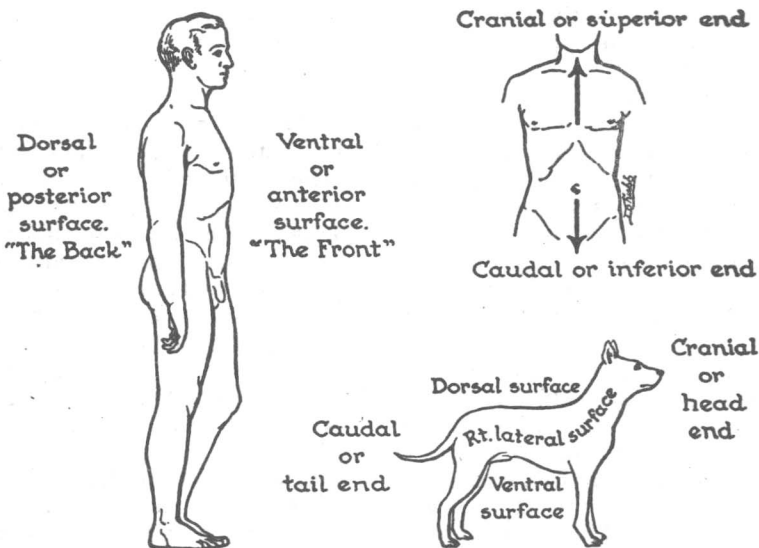
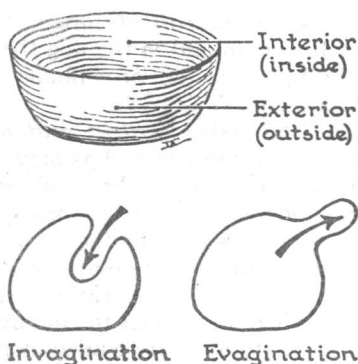
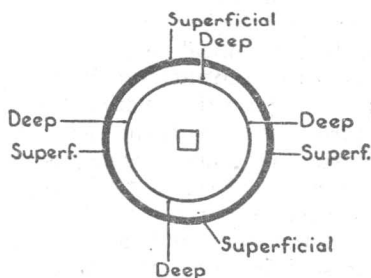


Figure I.3. Three pairs of terms necessary to comparative anatomy and of more general application than those given in Figure I.2.



Figures 1.4, 1.5, and 1.6. Three pairs of contrasting terms.



In the limbs, terms are coupled with reference to (1) the proximity to the trunk, *proximal* = near the trunk and is synonymous with superior; *distal* = farther from the trunk and is synonymous with inferior; (2) the morphological borders, *preaxial* = the lateral or radial border (i.e., thumb side) of the upper limb and the medial or tibial border (i.e., big toe side) of the lower limb; *postaxial* = the medial or ulnar border of the upper limb and the lateral or fibular border of the lower limb; and (3) the functional surface, *flexor* and *extensor*, the flexor surface being anterior in the upper limb and posterior in the lower limb.

The anterior surface of the hand is generally called the *palmar* (or volar) surface, and the inferior surface of the foot is called the *plantar* surface. The opposite surfaces are called the *dorsum* of the hand and foot.

Other Terms. *Inside, interior, or internal* and *outside, exterior, or external*, are reserved (1) for bony cavities, such as the pelvic, thoracic, cranial, and orbital, and (2) for hollow organs, such as the heart, mouth, bladder, and intestine (Figure 1.4).

An *invagination* and an *evagination* (L. *vagina* = a sheath or scabbard) are inward and outward bulgings of the wall of a cavity (Figure 1.5).

Superficial and *deep* denote nearness to and remoteness from the skin surface irrespective of whether at the front, side, or back. These two may be applied to organs, such as the liver and lung (Figure 1.6).

On, over, and under are terms to beware of. They should be used in a general sense and without specific regard to the anatomical position. Carefully avoid using them loosely in place of "superior to" and "inferior to," for such misuse is the cause of much misunderstanding.

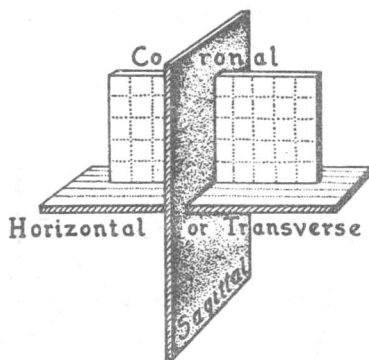


Figure 1.7. The three fundamental planes.

Ipsilateral refers to the same side of the body, e.g., the right arm and the right leg. *Contralateral* refers to opposite sides of the body.

Planes. (1) A *sagittal plane* is any vertical anteroposterior plane parallel to and including the median plane. (2) A *coronal* or *frontal plane* is any vertical side-to-side plane at right angles to the sagittal plane. (3) A *transverse plane* is any plane at right angles to 1 and 2, i.e., at right angles to the long axis of the body or limb. In the case of an organ or other structure, a *transverse* or *cross-section* is a section at right angles to the long axis of that organ or structure. (4) An *oblique plane* may lie at any other angle. (See Figures 1.7-1.9.)

Attachments of Muscles. Muscles are attached at both ends. The proximal attachment of a limb muscle is its *origin*; the distal end is its *insertion*. No function is implied by these terms. When applied to muscles not associated with the limbs, the terms are arbitrarily assigned, historical precedence being the chief determinant.

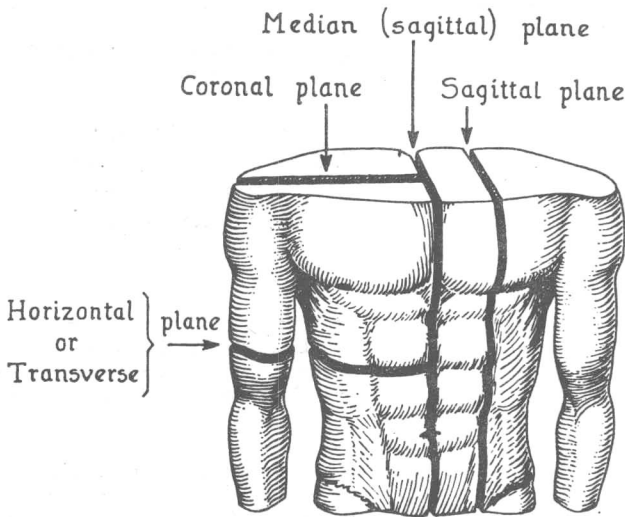


Figure 1.8. Fundamental planes in the body.

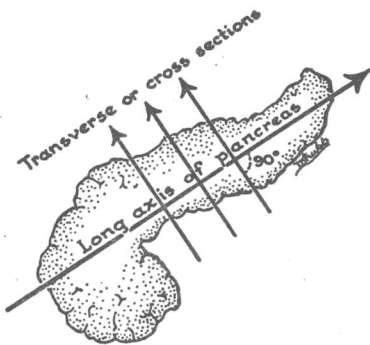


Figure 1.9. A cross-section of an organ or part is a section made at right angles to its long axis.

Vessels. Arteries are likened to trees with *branches*; veins are likened to rivers with *tributaries*.

Movements at Joints. To *flex* is to bend or to make an angle.

To *extend* is to stretch out or to straighten. Movements of flexion and extension take place at the elbow joint.

To *abduct* is to draw away laterally from the median plane of the body.

To *adduct* is the opposite movement in the same plane (L. *ab* = from; *ad* = to; *duco* = I lead). Movements of abduction and adduction, as well as of flexion and extension, take place at the wrist joint.

The middle finger is regarded as lying in the *axial line of the hand*, and the 2nd toe as lying in the *axial line of the foot*. Ab-

duction and adduction of the fingers and toes are movements from and toward these axial lines, although, as discussed elsewhere, movements of the thumb are named differently.

To *circumduct* (L. *circum* = around) is to perform the movements of flexion, abduction, extension, and adduction in sequence, thereby describing a cone, as can be done at the shoulder, hip, wrist, and metacarpophalangeal (knuckle) joints.

To *rotate* is to turn or revolve on a long axis, as the arm at the shoulder joint, the femur at the hip joint, the radius on the ulna, and certain vertebrae on each other.

To *pronate* was originally to bend or flex the body forward, as in obeisance in prayer, that is, to face downward or prone. Applied to the forearm, to *pronate* means to turn it so that the palm of the hand faces downwards on a table, which is the equivalent of facing backward when it hangs by the side.

To *supinate* is to rotate the forearm laterally so that the dorsum of the hand rests on the table or faces backward when the limb hangs by the side. Supine = lying on the back.

To *protract* (L. *pro* = forward; *traho* = I pull) is to move forward.

To *retract* is to move backwards. Protraction and retraction are terms applied to the movements of the lower jaw and shoulder girdle.

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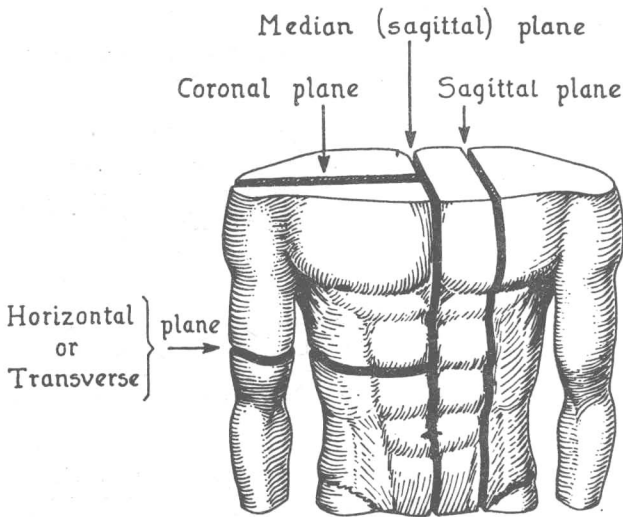


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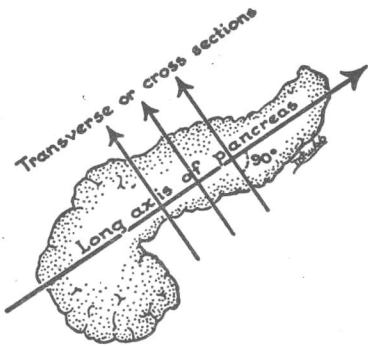


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SECTION ONE

GENERAL CONSIDERATIONS

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chapter 1

Locomotor Systems



BONE

Physical Properties; Functions; Structure; Classification.

Markings on Dried Bones: Terms; A Living Bone; The Part of a Young Bone; Epiphyses; Nutrient Artery and Canal; Ossification; Bone Marrow; Vessels and Nerves; Historical.

CARTILAGE

Hyaline Cartilage; Fibrocartilage; Elastic Cartilage.

VERTEBRAL COLUMN

PARTS OF A TYPICAL VERTEBRA AND THEIR FUNCTIONS—Body; Vertebral Arch; Processes; Ossification.

ARTICULATED VERTEBRAL COLUMN—Intervertebral Discs; Bodies of the Vertebrae; Curvatures; Varying Stature; Line of Gravity; Transverse Processes; Pedicles; Laminae; Vertebral Foramina and Vertebral Canal; Articular Processes; Spinous Process.

ARTICULATIONS OR JOINTS

SKULL TYPE—Suture and Synchondrosis; Synostosis.

VERTEBRAL TYPE—Symphysis; Symphysis between Two Vertebral Bodies; Syndesmosis; Vertebral Syndesmoses.

LIMB TYPE—Synovial Joint; Articular Capsule, Joint Cavity; Synovial Membrane and Folds, Synovia; Fat-Pads, Articular Discs, Ligaments, Articular Cartilage, Lubrication, Labra, Nerves, and Vessels.

Classification of Synovial Joints

MUSCLES

SKELETAL MUSCLES—Fibers; Parts; Insertions; Synovial Bursa; Synovial Sheath.

Internal Structure; Contraction; Investigation; Electromyography; Muscle Action.

Blood Supply; Nerves; Nomenclature; Variations.

ACCESSORY MUSCLES

BONE

In this chapter our main concern is with bone as a tissue and its general characteristics, but the vertebrae are described in detail because an understanding of them is fundamental to several regions. The student should not proceed with a study of regional anatomy until this chapter and the succeeding ones are read and understood.

A bone of a living man is itself a living thing. It has blood vessels, lymph vessels, and nerves. It grows. It is subject to disease. When fractured it heals itself, and if the fracture is so improperly set that the parts have lost their previous alignment, its internal structure undergoes remodeling in order that it may continue to withstand strains and stresses as it did before. Unnecessary bone is resorbed. For example, following the extraction of a tooth, the walls of the socket, thus rendered empty, disappear; also, the bones of a paralyzed limb atrophy (become thinner and

weaker) from disuse. Conversely, when bones have increased weight to support, they hypertrophy (become thicker and stronger).

Bones have an *organic framework* of fibrous tissue and cells, among which *inorganic salts*—notably, phosphate of calcium—are deposited in a characteristic fashion. The fibrous tissue gives the bones resilience and toughness; the salts give them hardness and rigidity and make them opaque to X-rays. One-third is organic; two-thirds are inorganic.

Properties of Bone

Physical Properties. By submerging a bone in a mineral acid the salts are removed, but the organic material remains and still displays in detail the shape of the untreated bone. Such a specimen is flexible. For example, a decalcified fibula can be tied in a knot (*fig. 1.1*); when the knot is untied, the fibula springs back into shape.