Synopsis of Gross Anatomy

Third Edition
revised and enlarged

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Gross Anatomy

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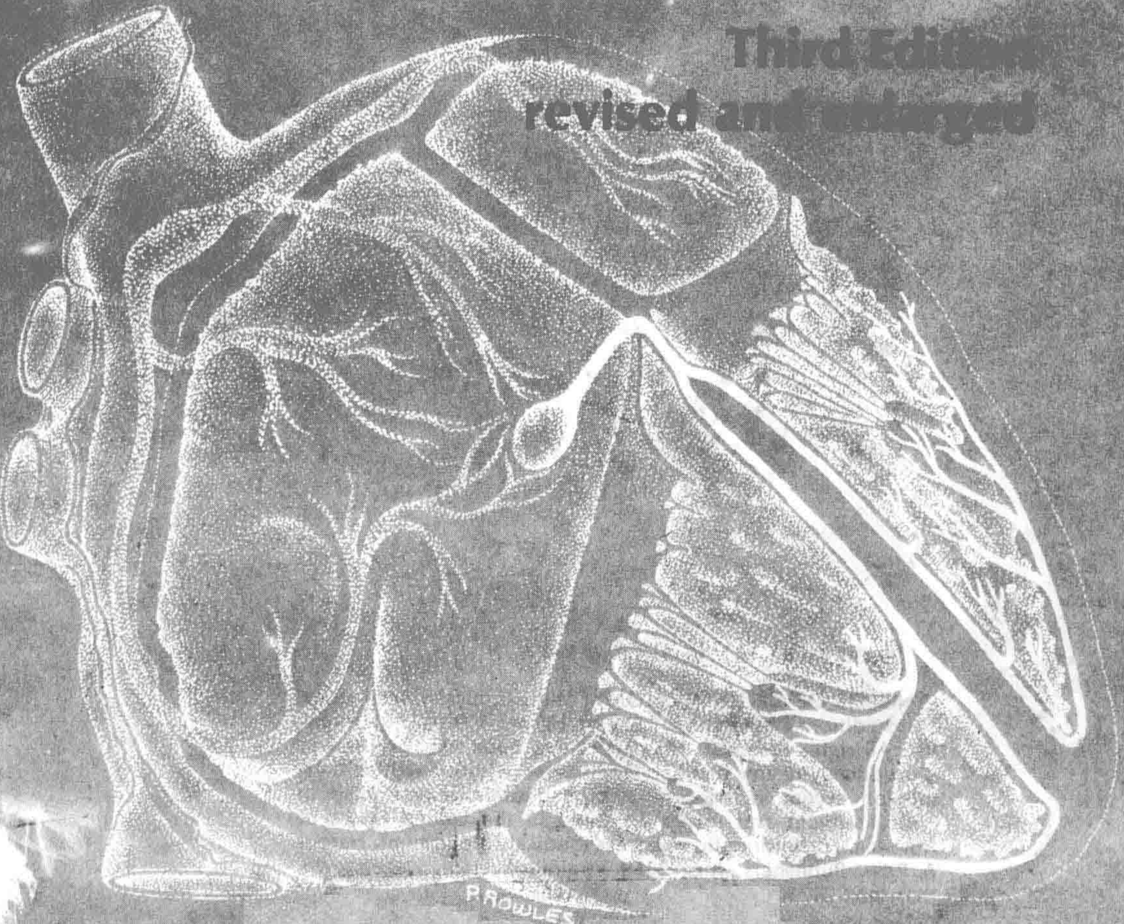

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preface to the third edition

The third edition of our *Synopsis of Gross Anatomy* is a sharp departure from the traditional presentations of previous editions. With the addition of 154 clinical explanations and comments, this edition is highly clinically oriented. All of the clinical correlations have been critically read and verified by interested, competent, practicing physicians and surgeons, and are brief and succinct—never exhaustive. They are designed only to alert the beginning student of the many medical and surgical situations that can be understood and, more important, remembered, from an anatomic point of view.

Another major improvement is the addition of 50 new illustrations by Pamela Rowles. Some are replacements, but most are new and often novel views of regional anatomy.

We publish our new edition confident that we have retained the best of the other editions and have added new, exciting material and concepts. This refreshing approach to gross anatomy will be helpful (especially to the beginning student) by making the study of anatomy more attractive, meaningful, and particularly, more relevant to the practice of medicine and dentistry.

We gratefully acknowledge the kindnesses of our colleagues, Dr. Lawrence H. Miller, Director, Family Practice Residency, St. Joseph Medical Center, Wichita, Kansas; Dr. Ray Snider, Professor and Chairman of the Department of Surgery, Truman Medical Center, Kansas City, Missouri; and Dr. Beaty Pemberton, Associate Professor of Surgery, Truman Medical Center, and Docent, University of Missouri–Kansas City School of Medicine, for reading and offering constructive suggestions as they edited the clinical correlations included in this edition.

We are also indebted to Harper and Row for their constant encouragement and for their assistance in providing the additional artwork for this third edition.

J.B.C.
I.R.T.

preface to the first edition

This synoptic volume of regional anatomy presents the basic facts and concepts in the study of gross anatomy considered essential for students of medicine and associated sciences. It meets the need of the student for a concise, straightforward textbook, uncluttered by minutiae. This synopsis is intended not to replace selective reading in large conventional textbooks, but rather to give the student an initial appreciation of important body structures and relations.

Many original illustrations have been especially prepared to enhance this epitomized approach to the study of anatomy. The line drawings are keyed to the text and can be readily correlated with regional dissections.

For the student who finds gross anatomy difficult, this compact text may provide all that one can or need comprehend of the subject. However, for those who wish to pursue the subject more deeply, it will serve as a framework for the building of a broader and firmer foundation in anatomy.

Because of its regional approach, we suggest that this book could be used as 1) a study guide in conjunction with anatomic atlases and larger textbooks, 2) a companion text in gross dissection, or 3) a review of the fundamentals of gross anatomy.

In brief, we have endeavored to present, in the most succinct form, the essentials of human gross anatomy that we believe every medical student should know.

We gratefully acknowledge the kindness of our colleagues, Dr. Frank D. Allen, Associate Professor of Anatomy, George Washington University, and Dr. W. Montague Cobb, Chairman and Professor of Anatomy, Howard University, in reading and offering constructive suggestions for improvement of our original text.

We are deeply indebted to Mr. David S. Kern and his daughter Bonnie for the excellent rendering of most of the illustrations, to Mr. Michael S. Murtaugh for his splendid diagrammatic sketches and drawings, and to Dr. William A. Rush, Jr., Mrs. Margaret Dupree, and Miss Joan Ruback for their contributions to the artwork.

By the kind permission of various authors and their publishers, we have borrowed a few illustrations from the sources acknowledged in the individual legends.

J.B.C.
I.R.T.

Washington, D.C.

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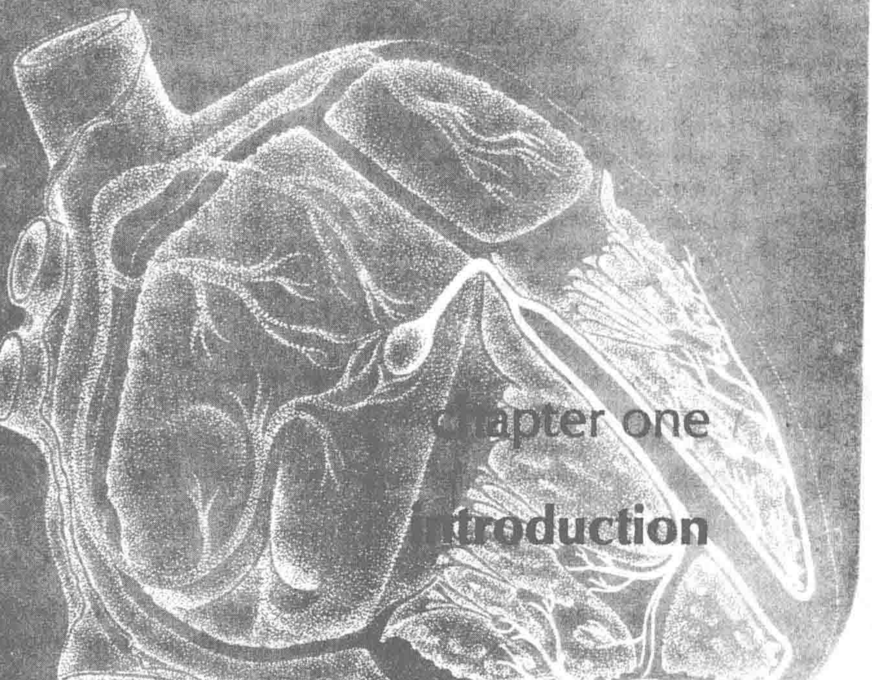


chapter one

Introduction

Man has a natural curiosity about his body. It is first expressed when the infant becomes fascinated by his own hand movements. The study of gross anatomy is the continuation of this innate interest but it goes far beyond bodily movements; it is the formal identification and study of the dissectable structures of the body and their interrelationships. To the degree that this inborn interest is cultivated and developed, anatomy will be a stimulating and rewarding study.

The purpose of gross anatomic dissection and study is to obtain direct exposure to the three-dimensional relationships of the body and to be able to visualize just how we are put together. This does not negate the utilization of oral descriptions or explanations in the form of lectures, written text material, illustrations, or various visual aids such as models and films. These, however, should be considered only as adjunct tools to the firsthand information obtained through dissection as the student moves toward the goal of gross anatomy study—to secure a working knowledge of, and appreciation for, the structure and form of the human body.

In gross anatomy a voluminous amount of factual data must be acquired during a short time. This introductory chapter will present certain basic concepts as a foundation to aid the student to assimilate the deluge of information that will follow. As regional dissection and study of the body proceed, these general concepts of the different systems should become recurrent themes. Understanding them will make the subsequent acquisition of information more meaningful and rewarding.

The brief accounts given here of concepts of the skeletal system and associated joints, muscular system, fasciae, body cavities, lymphatics, cardiovascular system, and the nervous system are in no sense complete, nor are they intended to be. Rather, they constitute an introductory, conceptual approach to your study of anatomy.

ANATOMIC TERMINOLOGY

Anatomy introduces the student to the language of medicine and dentistry. It has been estimated that this language, which the physician must master, comprises about 10,000 terms, three-fourths of which are encountered in anatomy. The word roots or stems, prefixes and suffixes are largely derived from Latin and Greek. Those who have studied these languages are well-equipped to understand and use anatomic terminology. If, however, the student's background in classical languages is deficient, he can overcome this handicap by learning certain fundamentals of vocabulary and linguistic principles. For example, the stem *myo* (Greek μῦς) in the terms myocardium (*cardium* heart), myometrium (*metrium* uterus), myoglobin (*globin* protein), myoblast (*blast* immature cell), myocele (*cele* hernia), myoma (*oma* tumor), all refer to muscle. Thus, the astute student will pay special attention as he encounters new terms to make certain he defines new words and stems as he encounters them.

TERMS OF REFERENCE

Terms of reference to the human body are standardized to refer to a rather arbitrary concept called the **anatomic position,** in which the body is erect, the face forward, the arms at the sides with the palms of the hands turned forward (Fig. 1–1). The terms listed in Table 1–1 are used to indicate the location of structures in the body with reference to this anatomic position irrespective of the position the body of a patient or the cadaver might assume. This does away with the necessity of using words such as over, under, below, above, all of which can indicate two directions in the three-dimensional body and may thereby be confusing.

It is important to keep in mind that the above terms of reference locate a structure in its relationship to other structures of the body. For example, the descend-

Fig. 1–1. Anatomic position. (Langley LL, Telford IR, Christensen JB: Dynamic Anatomy and Physiology, 4th ed. New York, McGraw-Hill, 1974)

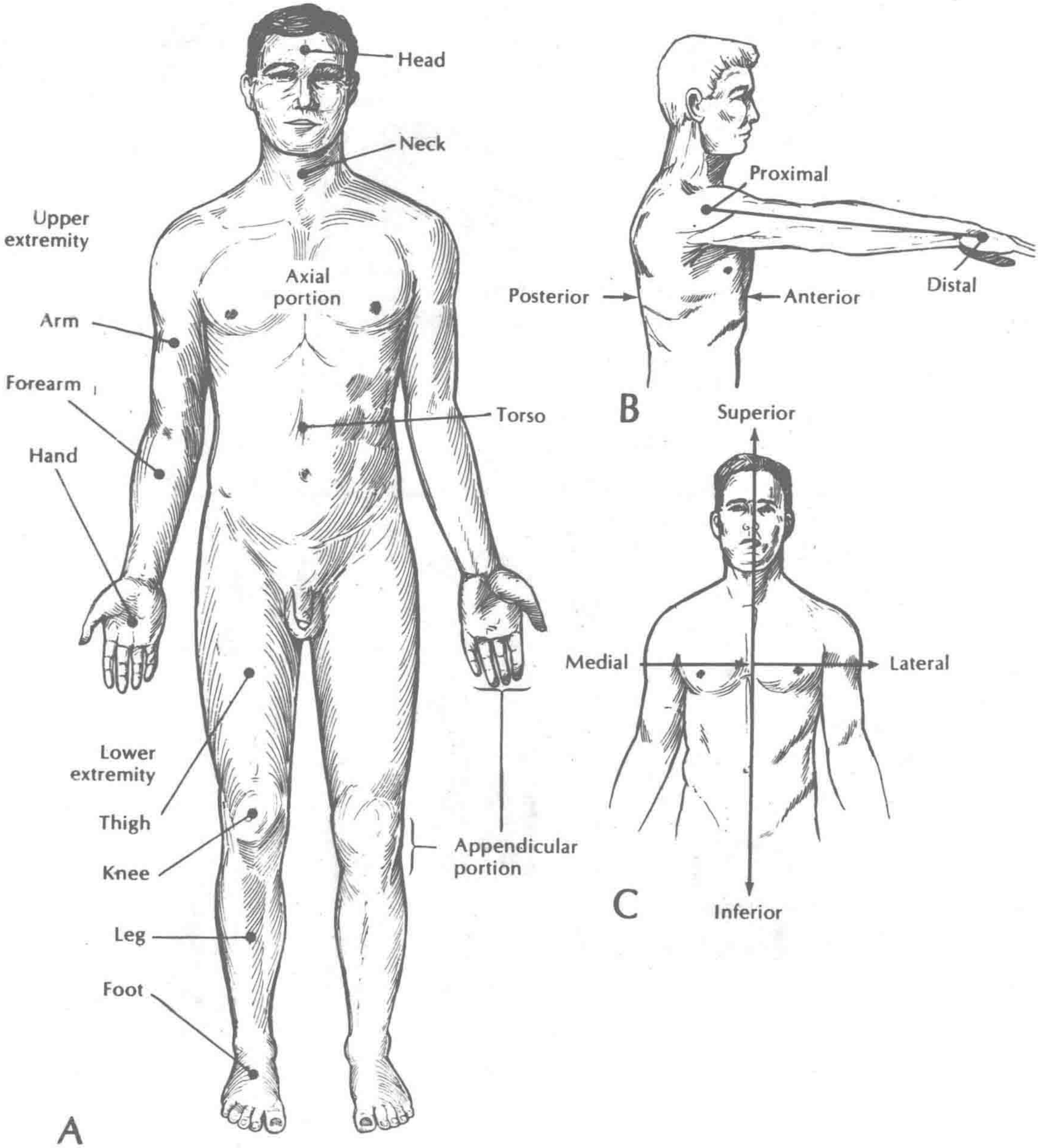
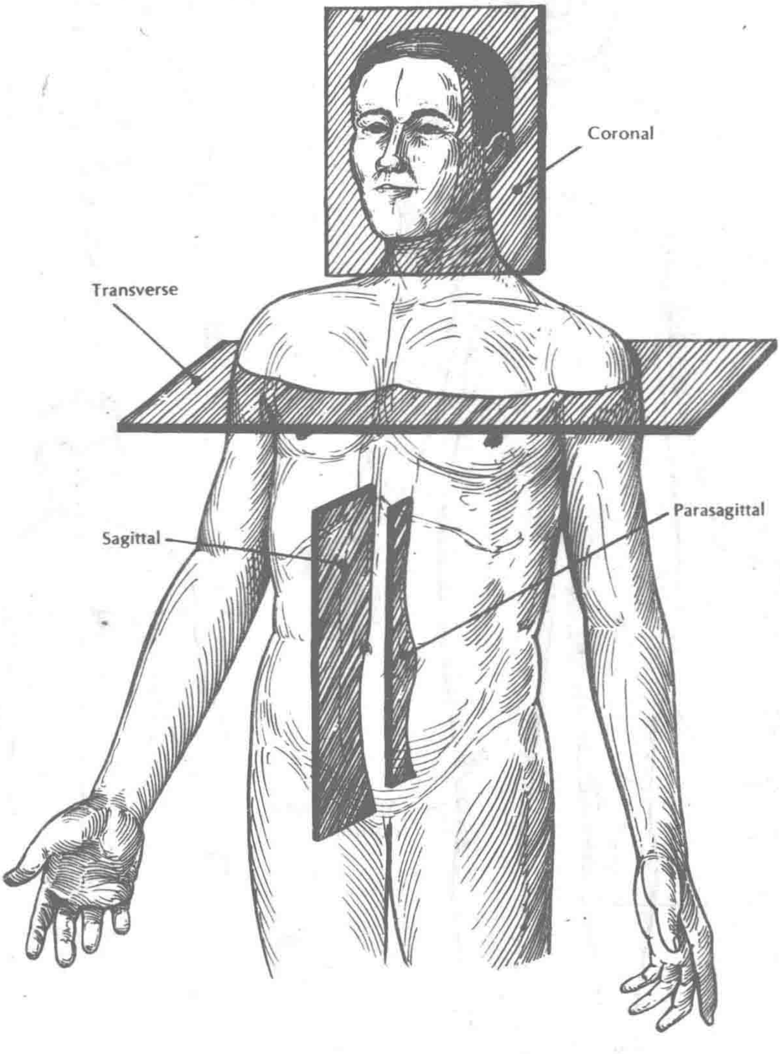


TABLE 1-1. TERMS OF REFERENCE

Term	Synonym	Definition
Superior	Cranial, cephalic	Toward the head
Inferior	Caudal	Toward the feet
Anterior	Ventral, volar, palmar (latter two refer to hand)	Toward the front of the body
Posterior	Dorsal	Toward the back of the body
Medial		Toward the midline of the body
Lateral		Toward the side of the body
External	Superficial	Toward the surface of the body
Internal	Deep	Away from the surface of the body
Proximal		Toward the main mass of the body
Distal		Away from the main mass of the body
Central		Toward the center of the body
Peripheral		Away from the center of the body
Plantar		Sole of the foot

Fig. 1–2. Anatomic planes of reference. (Langley LL, Telford IR, Christensen JB: Dynamic Anatomy and Physiology, 4th ed. New York, McGraw-Hill, 1974)



ing aorta in the chest is located anterior to (in front of) the necks of the ribs and posterior to (behind) the heart; it is inferior to (below) the arch of the aorta and superior to (above) the diaphragm. It lies lateral to the vertebral column but medial to the angle of the ribs.

Terms denoting planes of the body also refer to the anatomic position. Of the three basic planes of the body, the **sagittal** and **coronal** (frontal) **planes** are both vertical along the long axis of the body, while the **transverse** (horizontal or cross-sectional) **plane** is at right angles to the longitudinal axis (Fig. 1–2). These planes are used either in reference to the whole body, to a specific region of the body, or to a separate organ. In the latter case, if the structure has been removed from the body, the terms longitudinal and transverse may be substituted.

The sagittal plane separates the body into right and left segments. If sectioned in the median sagittal plane, the body would be divided into equal halves, except for unpaired organs; if in a parasagittal plane, unequal halves. A coronal section would separate the anterior (front) part of the body from the posterior (back) part. A transverse section would bisect a superior (upper) segment from an inferior (lower) segment.

SKELETAL SYSTEM

The skeletal system comprises approximately 206 bones and a number of cartilaginous components. The total number of bones is an approximation because a variable number of supernumerary or accessory bones may also be present. These additional elements most frequently occur as small (Wormian) bones between the flat bones of the skull, as additional carpal or tarsal bones in the hands and feet, or as sesamoid bones within tendons.

CARTILAGE

Three types of cartilage occur in the body: hyaline, elastic, and fibrous. **Hyaline cartilage** covers the articular surface of bones. **Elastic cartilage,** which has a greater resiliency due to embedded elastic fibers in its ground substance, is present in structures that undergo functional distortion as, *e.g.*, the external ear and epiglottic cartilage. **Fibrocartilage** has an increased strength due to a preponderance of collagen fibers in its ground substance. It is found in structures subjected to excessive stress, such as the weight-bearing intervertebral discs.

BONES

Although the number of bones may vary from individual to individual, the average complement, as tabulated on the following page, may be subdivided into appendicular and axial portions of the skeleton.

Functions of Bones

Bones provide the supportive framework of the body and protect vital organs. Their marrow cavities are the primary site of blood formation in the adult (especially the flat bones of the skull, scapulae, vertebrae, and ilia). They also

Axial skeleton		
Skull	22	
Ear ossicles	6	
Hyoid bone	1	
Vertebral column	26	
Ribs and sternum	25	
		80
Appendicular skeleton		
Upper extremity	64	
Lower extremity	62	
		126
Total		206

afford storage of minerals, principally calcium and phosphorus. The primary interests of bones to the student in gross anatomy are the following:

1. They are sites of muscular attachments and thereby act as levers to provide movement.
2. Their morphologic characteristics and markings including sexual differences.
3. The relationships of other structures to bones, principally vessels and nerves, which become clinically important in trauma.
4. The sequential appearance and fusion of epiphyses during the growth period which are indicative of normal or pathologic development.

Morphologic Characteristics

Bones are classified as to shape, *i.e.*, long, short, flat, or irregular. In **long bones** the length exceeds the width, as in most bones of the extremities. Long bones consist of 1) a **shaft** (diaphysis) having an elongated marrow cavity with little internal trabeculation, 2) two ends or **extremities** (epiphyses) which may or may not be separated from the diaphysis during the growth period by a plate of cartilage, the epiphyseal disc, and, 3) the **metaphysis,** the zone between the diaphysis and the epiphysis which flares out from the shaft of the bone toward the epiphysis. During the growth period the cartilaginous **epiphyseal disc** provides new cells for the increase in length of long bones. When growth ceases, this area ossifies and the epiphysis becomes continuous with the diaphysis. The metaphysis and the epiphysis have extensive internal trabeculation. The trabeculae are usually aligned in the direction of the stress and strain placed on the bone.

Short bones are approximately equal in all three dimensions. Examples of the short bones are the carpal and tarsal bones of the wrist and ankle. Internal trabeculation, similar to that seen in the epiphyses of long bones, is also present in short bones.

Flat bones include the scapulae, ribs, sternum, and bones of the cranium. They are formed by two thin plates of compact bone with a minimal interval of trabecular bone between them that forms the interval of the marrow cavity. In the flat bones of the skull this area is referred to as the diplöe.

Irregular bones, as their name implies, have a complicated configuration with numerous processes. Examples of irregular bones are the individual vertebrae of the vertebral column or the sphenoid and ethmoid bones of the skull.

Sesamoid bones are very small bones (with the exception of the relatively large patella) embedded within certain tendons. They usually occur in a tendon as it passes over an articulation. They can act as fulcrums to increase the mechanical advantage of the muscle action over the joint as well as provide for extra strength to limit trauma to the tendon from pressure or friction. The most constant sesamoid bones are the patella and those associated with the proximal joints of the thumb and great toe.

Bone processes are discrete projections from the main body of the bone. The naming of surface markings indicates their morphologic characteristics. For example, crests or ridges are lineal elevations; sulci and grooves are lineal depressions; tubercles, tuberosities, or trochanters are circumscribed, roughened elevations of increasing size, and styloid processes or spines are spike-like projections. Foramina are holes that may pass either entirely through the bone or only through the cortex. They provide for the passage of nerves and vessels. Fissures are clefts between adjacent bones.

Experimental evidence indicates that the definitive form of a bone is dependent upon both genetic or intrinsic factors, and physical or external factors. Embryologic transplant studies have shown that a given bone, *e.g.*, the femur, will develop its characteristic processes irrespective of chemical, hormonal, or extrinsic factors. Bone markings, however, are modified by mechanical factors. As a response to increased stress of the muscular attachments to bone, well-developed muscular individuals have more prominent processes than do less muscular individuals. Moreover, the orthopedic surgeon is able, by varying stress or tension on a given bone, to compensate to a degree for developmental abnormalities.

Sexual Characteristics

Sexual differences are reflected by 1) the degree of massiveness of the skeleton and 2) by functional modifications. In the first instance although variations occur in races and between individuals, the male skeleton, in general, is more massive, with more pronounced and larger processes, than is the female skeleton.

The most pronounced example of functional adaptation occurs in the female pelvis. The innominate bones are modified to provide minimal osseous impedence in the birth channel to facilitate passage of the fetus through the pelvic cavity in partuition. Features of this adaptation include a greater relative as well as absolute width of the pelvic openings. This results in a circular inlet of the female pelvis, in contrast to an oval configuration in the male, as well as a displacement of the ischial spines and coccyx to increase the dimensions of the pelvic outlet.

Bones as Levers

The physician is also interested in the interplay of bones at articulations. The articular ends of a bone reflect the type of activity at the joint. Thus, the surfaces of bones associated with freely movable articulations are covered with hyaline (articular) cartilage which has a smooth, glassy appearance. In contrast, bones forming nonmovable joints (synarthroses and synchondroses) have rough surfaces.

The disparity in area of smoothness of two bones forming a freely movable joint is also meaningful. For example, the extent of the articular surfaces at the distal end of the femur and the proximal end of the tibia suggests that the knee is not a simple hinge joint, but rather that the surfaces must also slide across one another in movement.

Relationships of Bones to Other Structures

Bone markings frequently provide clues to the relationships of bones to other anatomic structures. If a muscle attaches to a bone over a relatively extensive area, the surface of the bone will appear smooth. Attachment of a muscle to a limited area, *e.g.*, in the attachment of the tendon of the deltoid muscle, results in a definitive elevation, the deltoid tuberosity. Moreover, the size of the elevation will usually indicate the magnitude of stress the muscle produces.

Study of the foramina of the skull should always parallel study of the nerves, arteries, and veins that traverse these foramina.

Sulci or grooves almost invariably reflect the relationship of soft structures to bone. For example, the intertubercular sulcus of the humerous lodges the tendon of the long head of the biceps. The depth of a sulcus that lodges a tendon is, moreover, related to the strength of the pull of the muscle upon that tendon. Grooves may also lodge nerves or vessels. The depression along the posterior aspect in the midshaft of the humerus delineates the path of the radial nerve as it spirals around the bone. The relatively deep channels on the internal surface of the skull reflect the course of the meningeal blood vessels.

Organs also form depressions on bones. The bilateral, shallow concavities on the internal aspect of the occipital bone are due to the convexity of the cerebellar hemispheres situated in this area.

Centers of Ossification

Embryologically, bones may arise either by direct transformation of mesenchyme into bone, as occurs in the flat bones of the skull, or through **endochondral bone formation.** In the latter, a precursor cartilage model of the developing bone is laid down with a subsequent bone replacement of this cartilage model. In long bones such bone transformation from cartilage occurs initially at the midpoint of the diaphysis and is referred to as the **primary center of ossification. Secondary ossification centers** appear later in the epiphyses or in the ends of the long bones. The cartilage between the primary and secondary centers decreases progressively in relative amount, but persists as the epiphyseal disc, a plate-like zone, as long as growth in length is taking place.

SLIPPED EPIPHYSIS

Injury to the extremities of long bones, in a young person, may cause an epiphyseal displacement. Such an injury may be serious since the epiphyseal plate (disc) is the growth center for the bone. If such injuries go untreated, the longitudinal growth of the affected bone may be retarded, or even arrested, resulting in permanent shortening of the limb.

Some basic concepts of bone growth are summarized below:

1. The age of a growing individual may be reliably estimated from an assessment of his ossification centers.
2. Centers normally present at birth include the distal femur, proximal tibia, calcaneus, talus, cuboid, and the proximal end of the humerus.
3. Most epiphyses have fused (*i.e.*, the growth zone cartilage has become ossified) in the male by the age of 20. Both the appearance and fusion of epiphyses of the female precedes those of the male by about 2 years.
4. A given long bone may have epiphyses at both ends of the bone or only at one end. The latter is seen at the metacarpals, metatarsals, and phalanges.
5. If a long bone has a single epiphysis it usually occurs at the end of the bone that undergoes the greatest excursion in movement.
6. In long bones that have two epiphyses, the epiphysis that appears first is usually the last to fuse with the shaft and it contributes most to the growth in length of the bone.
7. The more rapidly growing ends of bones of the extremities are at the knee (for the femur, fibula, and tibia), at the shoulder (for the humerus), and at the wrist (for the radius and ulna).
8. Nutrient arteries entering the diaphyses reflect this disparity in growth rate at the two epiphyses by angling away from the more rapidly growing end (*mnemonic:* From the knee I flee, to the elbow I go).

JOINTS OR ARTICULATIONS

In gross anatomy our primary interest in articulations has to do with the degree of motion occurring at joints. In studying joint movements we are concerned with: 1) The type of joint (hinge, ball and socket, gliding); 2) the accessory structures associated with joints which may act primarily to stablize, or conversely, allow maximal motion; 3) the muscles or their tendons that cross joints, and are the movers of the bones forming the joint; and 4) the blood and nerve supply of joints.

JOINT CLASSIFICATION

An articulation, or joint, is the contact or union between two or more bones or cartilages. They are classified by the degree of motion that occurs at the joint, namely, immovable, slightly movable, and freely movable joints (Fig. 1–3). This classification also reflects, in the same order, the nature of the tissue between the bony surfaces, *i.e.*, fibrous, cartilaginous or synovial.

Synarthrodial or Immovable Joints

These joints are characterized by the bones being united either by cartilage (synchondroses), or by a minimal amount of fibrous tissue (synostoses). Cartilaginous unions are differentiated as primary or secondary cartilaginous