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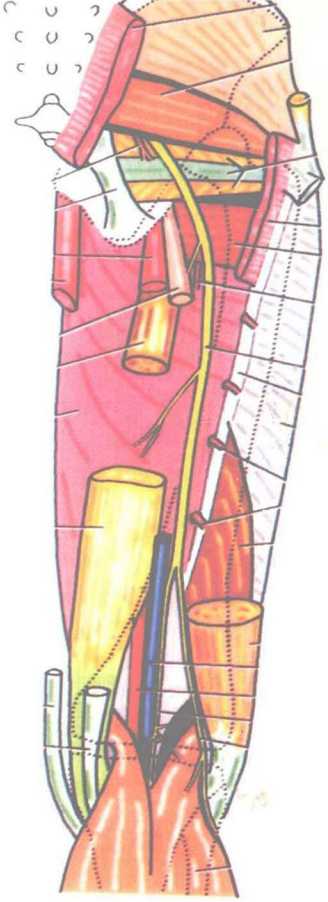


Inderbir Singh

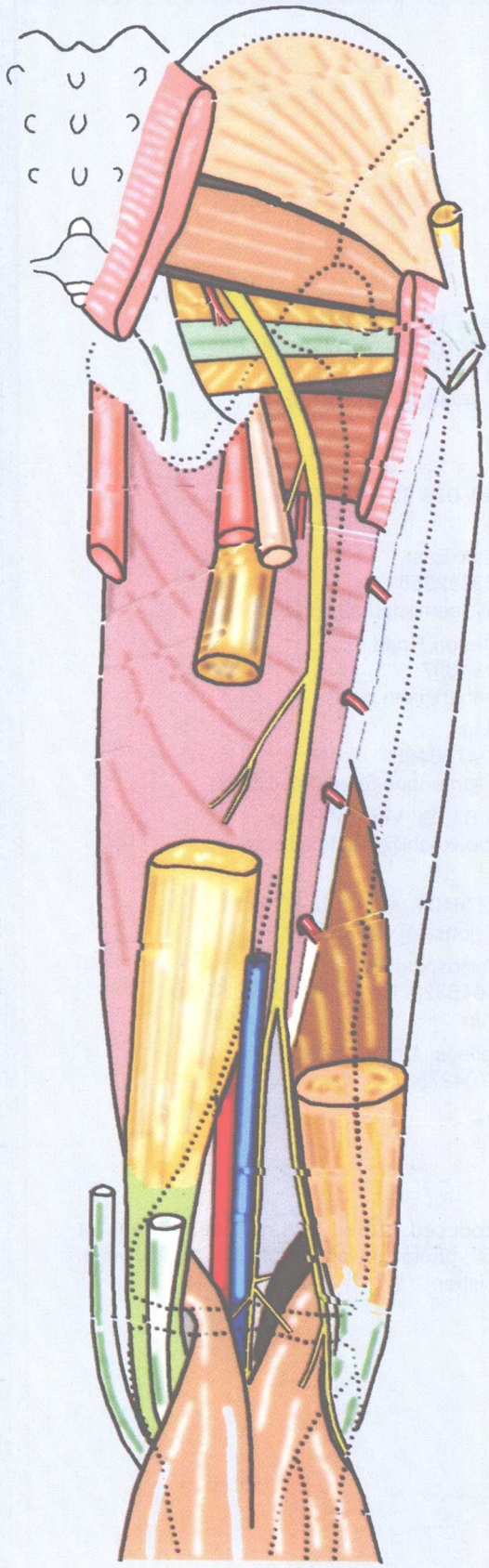
Textbook of ANATOMY

With Colour Atlas

Volume One

Introduction
Osteology
Upper Extremity
Lower Extremity

JAYPEE



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ANATOMY

With Colour Atlas

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Inderbir Singh

Volume One

JAYPEE

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- 282 IIIrd Floor, Khaleel Shirazi Estate, Fountain Plaza, Pantheon Road,
  Chennai 600 008, Phones: +91-44-28193265, +91-44-28194897,
  Rel: +91-44-32972089, Fax: +91-44-28193231, e-mail: jpchen@eth.net
- 4-2-1067/1-3, Ist Floor, Balaji Building, Ramkote Cross Road,
  Hyderabad 500 095, Phones: +91-40-66610020, +91-40-24758498
  Rel:+91-40-32940929 Fax: +91-40-24758499, e-mail: jpmedpub@rediffmail.com
- "KURUVI BUILDING", 1st Floor, Plot/Door No. 41/3098-B & B1, St. Vincent Road,
  Kochi 682 018, Phone: +91-0484-4036109, e-mail: jaypeekochi@rediffmail.com
- 1-A Indian Mirror Street, Wellington Square,
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- 106 Amit Industrial Estate, 61 Dr SS Rao Road, Near MGM Hospital, Parel,
  Mumbai 400 012, Phones: +91-22-24124863, +91-22-24104532, Rel: +91-22-32926896
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  Nagpur 440 009 (MS), Phone: Rel: 3245220, Fax: 0712-2704275
  e-mail: jaypeenagpur@dataone.in

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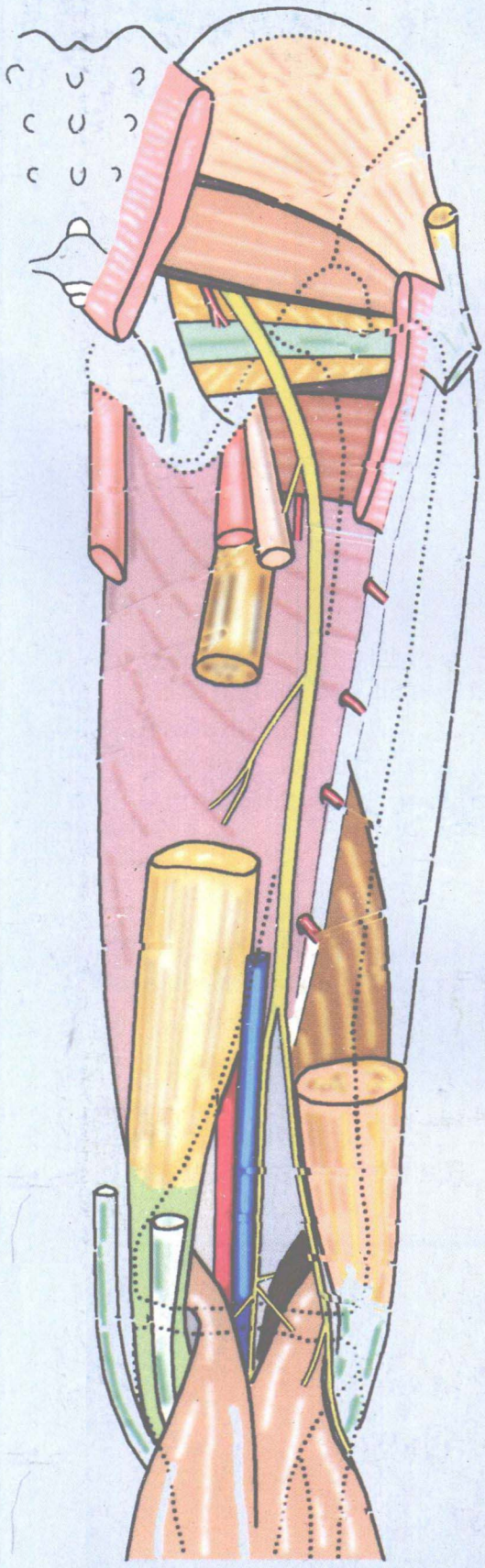

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Preface to the Fourth Edition

The considerations that guided the preparation of the first edition of this book remain unchanged (See preface to that first edition). After the publication of that edition it became known that the Medical Council of India had decided to reduce the duration of the first professional M.B.B.S course from eighteen months to twelve, greatly reducing the time available for the study of Anatomy.

Inevitably, many facts that have traditionally been taught now have to be excluded. It is to be expected that different teachers will have their own ideas of what to teach and what to omit. At the same time, some gifted students will be able to assimilate much more, in a relatively short time, than others will find possible.

It, therefore, becomes imperative for an author to grade information into different levels.

1. The descriptions of essential features, which every student must know, are printed on a white background.

2. Details that a good undergraduate student should know are printed on a light blue background.

3. Further details that will interest bright students and post-graduates are printed on a yellowish background.

However, to preserve continuity of narration, matter belonging to all the three categories is given in appropriate sequence. It is recommended that students reading the text for the first time should confine themselves to the main matter (white background).

It is accepted that any such classification can never be perfect; and teachers will inevitably differ on whether there is any sense in attempting such grading; or on what facts should fall under each category. Individual teachers will, therefore, have to decide this for themselves and guide their students accordingly. All that I have done is to provide a sample classification that teachers may modify as desired. In those institutions where such guidance from teachers is not forthcoming, students will be well advised to follow the grading as presented in this book.

I take this opportunity to thank all teachers and students who have pointed out errors in the third edition, and have given suggestions for improvement. I am specially obliged to Prof. R.N. Bajpai (Kanpur) and to Prof. B. Issac (Vellore) for their highly relevant and constructive suggestions.

Printing technology continues to make rapid advances and taking advantage of these this edition has been made much more attractive. A majority of illustrations have been improved, and errors corrected.

Beginning with this edition the book is now being made available in two formats. The traditional three volume format continues to be available. In addition the complete book is now also presented in a single volume.

I find the enthusiasm of Mr. J. P. Vij, extremely infectious. At my age of 78, he is still able to enthuse me to continue with my writing activities. My gratitude to him is beyond all words.

Rohtak

INDERBIR SINGH

Preface to the First Edition

Textbooks of anatomy (like the subject itself) have the unenviable reputation of being dull and boring. This book makes an attempt to (hopefully) change this image. The emphasis throughout the book is on a picture memory rather than a verbal one; and on understanding of facts rather than their cramming. The author tries to take his young reader (figuratively) by the hand; and lead him, or her, through a journey of discovery that is as interesting as it is informative.

It is with this objective that this book incorporates a colour atlas. The atlas is realistic to the extent that normal contours and relationships are maintained in the illustrations; but it is schematic in that some structures present in the field of dissection are omitted, or are delineated more clearly than is possible to see in actual dissections. In describing any part of the body, the region is first reviewed using the atlas figures as a guide. This is followed by detailed consideration of individual structures.

For the medical student the study of anatomy is not an end in itself. It is a necessary beginning to the study of physiology, pathology, and the signs and symptoms of disease. The subject acquires interest if the student is made aware of the clinical importance of what he studies in the anatomy class room. This is why there has always been emphasis on what has been called 'applied anatomy'. However, many surgeons and physicians feel that much of what goes under the name of traditional applied anatomy is obsolete, and has to be unlearnt. In this book, therefore, the emphasis is on providing students some examples of clinical correlations of anatomical structures. Instead of spreading out this information in small bits throughout the book a separate chapter is devoted to clinical correlations at the end of each major part.

I shall be grateful to students and teachers who point out errors, typographical or factual, and shall welcome suggestions for improvement.

I am grateful to the many students and colleagues who have encouraged me in my book writing endeavours, and this book might never have been written but for their good wishes and encouragement.

INDERBIR SINGH

Rohtak, January 1995

Contents of Volume One

Part One

An Elementary Introduction to The Structure of The Human Body

Chapter 1

Learning the Language of Anatomy

THE SUBJECT OF ANATOMY

Anatomy is the science that deals with the structure of the human body. Many features of structure can be seen by naked eye and such a study is called ***gross anatomy*** or ***morphological anatomy***. Many other features can be observed only under a microscope, and a study of these features constitutes the science of ***microscopic anatomy*** or ***histology***. Histology includes the study of details of the structure of cells (***cytology***), and of related chemical considerations (***histochemistry***). Many recent advances in our knowledge of the structure of the body have been made possible by the use of high magnifications available with an electron microscope, and such details are referred to as ***ultrastructure***. The science of anatomy also includes the study of the development of tissues and organs before birth: this is called ***embryology***. Aspects of anatomy that are of particular relevance to understanding of disease and its treatment are referred to as ***applied anatomy*** or ***clinical anatomy***.

This book deals mainly with gross human anatomy. Brief notes dealing with histology, embryology and clinical anatomy are given where appropriate.

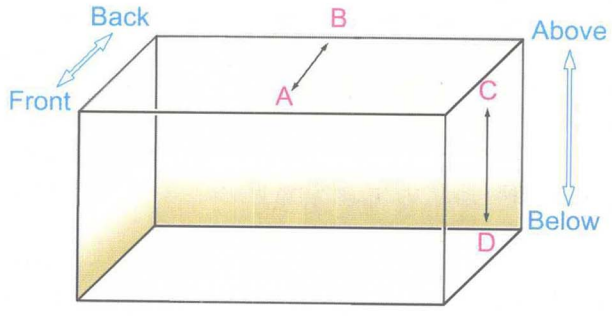

Fig. 1.1. Scheme to explain the terms anterior, posterior, superior, and inferior.

MAIN SUBDIVISIONS OF THE HUMAN BODY

For convenience of description the human body is divided into a number of major parts. Many of the parts bear names with which the student will be already familiar, but even some of these may require more precise definition.

The uppermost part of the body is the head. The ***face*** is part of the ***head*** (and includes the region of the ***forehead***, the ***eyes***, the ***nose***, the ***cheeks*** and the ***chin***). Below the head there is the neck. Note that the junction of the head with the neck is oblique because the neck extends higher up on the back than in front. Below the neck, there is the region that a lay person calls the chest. In anatomical terminology the chest is referred to as the ***thorax***. The thorax is in the form of a bony cage within which the heart and lungs lie. Below the thorax, there is the region commonly referred to as 'stomach' or 'belly'. Its proper name is ***abdomen***. The abdomen contains several organs of vital importance to the body. Traced downwards, the abdomen extends to the hips. A part of the abdomen present in the region of the hips is called the ***pelvis***.

The thorax and abdomen together form the ***trunk***. Attached to the trunk there are the upper and lower ***limbs***, or the upper and lower ***extremities***. In relation to the upper limb the terms ***shoulder***, ***elbow***, ***wrist***, ***hand***, ***palm***, ***fingers*** and ***thumb*** will be familiar. A lay person frequently refers to the entire upper limb as the ***arm***, but in anatomy we use this term only for the region between the shoulder and elbow. The region between the elbow and wrist is the ***forearm***. The fingers and thumb are also called ***digits***.

In the lower limbs the terms ***hip***, ***knee***, ***ankle***, ***foot*** and ***toes*** will be familiar. The region between the hip and the knee is the ***thigh***, and that between the knee and the ankle is the ***leg***. Like the fingers the toes are also called ***digits***. The innermost, and largest toe, is the ***great toe***.

SOME COMMONLY USED DESCRIPTIVE TERMS

The study of anatomy is like the learning of a new language. Hundreds of new words have to be learnt, and an intimate familiarity with them attained. The learning of these terms is the basic foundation on which all subsequent studies in various subjects of the medical curriculum depend. In short, the study of anatomy teaches us the language of medicine.

Of all the terms to be learnt the first, and most fundamental, are those used for precise descriptions of the mutual relationships of various structures within the body. In describing such relationships the lay-person uses terms like 'in front', 'behind', 'above', 'below' etc. However, in a study of anatomy, such terms are found to be inadequate; and the student's first task is to become familiar with the specialized terms used.

A major problem in describing anatomical relationships is that they keep changing with movement. For example, when a person stands upright the head is the uppermost part of the body and the feet the lowermost. However, on lying down the head and feet are at the same level. The problem is overcome by always describing relationships within the body presuming that the person is standing upright, looking directly forwards, with the arms held by the sides of the body, and with the palms facing forwards. This posture is referred to as the ***anatomical position***. We will now consider some descriptive terms one by one.

(**1**) When structure **A** lies nearer the front of the body as compared to structure **B**, **A** is said to be ***anterior*** to **B** (Fig.1.1).

The opposite of anterior is ***posterior***. In the above example, it follows that **B** is posterior to **A**. Using these terms we can say that the nose is anterior to the ears; and the ears are posterior to the nose.

(**2**) When structure **C** lies nearer the upper end of the body as compared to structure **D**, **C** is said to be ***superior*** to **D** (Fig. 1.1). The opposite of superior is ***inferior***. In the above example **D** is inferior to **C**. (No difference in the quality of the structures is implied!). Using these terms we can say that the nose is superior to the mouth, but is inferior to the forehead.

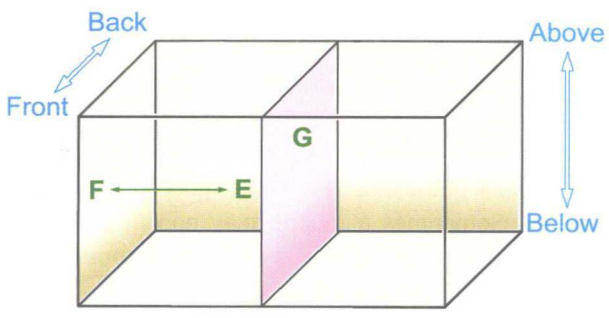

Fig. 1.2. Scheme to explain the terms medial, lateral and median.

(**3**) The body can be divided into two equal halves, right and left, by a plane passing vertically through it. The plane separating the two halves is called the ***median plane*** (Fig. 1.2). When a structure lies in the median plane it is said to be ***median*** in position (e.g., G in Fig. 1.2). When structure **E** lies nearer the median plane than structure **F**, **E** is said to be ***medial*** to **F**. The opposite of medial is ***lateral***. In the above example **F** is lateral to **E**.

In the anatomical position the palm faces forwards and the thumb lies along the outer side of the hand. Starting from the side of the thumb (or first digit) the fingers are named index finger (second digit), middle finger (third digit), ring finger (fourth digit) and little finger (fifth digit). To describe the medial-lateral relationships of the fingers we can say that the thumb lies lateral to the index finger. The index finger is medial to the thumb, but is lateral to the middle finger. The middle finger is medial to the index finger and lateral to the ring finger. From these examples it will be clear that the terms anterior-posterior, superior-inferior, and medial-lateral are relative terms. They are not absolute.

Various combinations of the descriptive terms mentioned above are frequently used. For example, each eye is anterior to the corresponding ear; and is also medial to it. Therefore, the eye can be said to be ***anteromedial*** to the ear. The tip of the nose is inferior and medial to each eye: we can say the nose is ***inferomedial*** to the eye.

We must now consider terms that are sometimes used as equivalent to some of the terms introduced above. The anterior aspect of the body corresponds to the ventral aspect of the body of four-footed animals. Hence the term ***ventral*** is often used as equivalent to anterior. (However, we shall see later that the two terms are not always equivalent, e.g. in the thigh). The opposite of ventral is ***dorsal***. In the hand the palm is on the anterior or ventral aspect. This aspect of the hand is often called the ***palmar*** aspect. The back of the hand is the dorsal aspect, or simply the ***dorsum***, of the hand. In the case of the foot the surface towards the sole is ventral: it is called the ***plantar aspect***. The upper side of the foot is the ***dorsum*** of the foot.

While referring to structures in the trunk the term ***cranial*** (= towards the head) is sometimes used instead of superior; and ***caudal*** (= towards the tail) in place of inferior. In the limbs the term superior is sometimes replaced by ***proximal*** (= nearer) and inferior by ***distal*** (= more distant). Using this convention the phalanges of the hands are designated proximal, middle and distal. In the case of the forearm (or

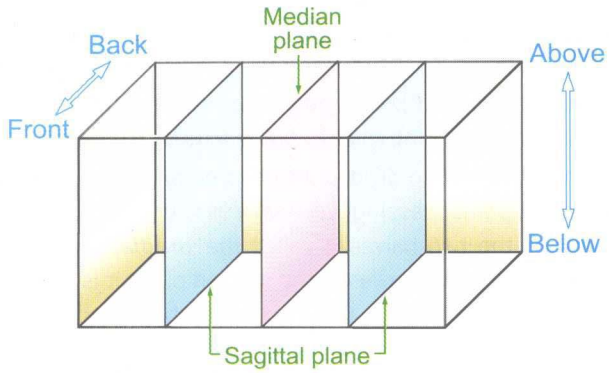

Fig. 1.3. Scheme showing median and paramedian planes.

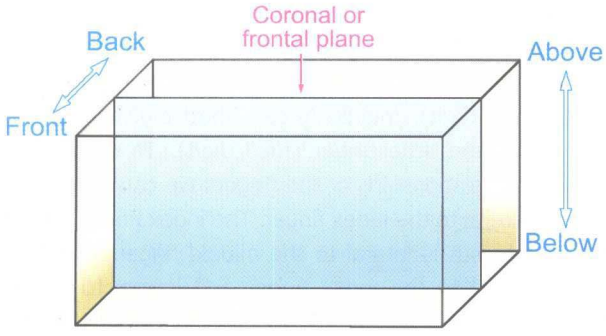

Fig. 1.4. Scheme showing a frontal or coronal plane.

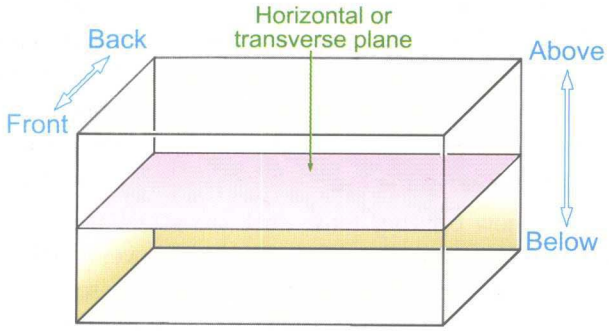

Fig. 1.5. Scheme showing a horizontal or transverse plane.

hand) the medial side is often referred to as the ***ulnar*** side, and the lateral side as the ***radial*** side. Similarly, in the leg (or foot) we can speak of the ***tibial*** (= medial) or ***fibular*** (= lateral) sides.

In addition to the terms described above there are some terms that are used to define planes passing through the body. (The concept of planes can be understood by reference to a cube. The angles of the cube are points: they have no length. The edges of the cube are lines: they have length but no width. The surfaces of the cube have length as well as breadth, but no thickness: these can be regarded as planes. (Remember than any flat surface is also called a plane surface: the essential thing about a plane is that it is absolutely flat).

We have already seen that a plane passing vertically through the midline of the body, so as to divide the body into right and left halves, is called the ***median plane***. It is also called the ***mid-sagittal plane***. Vertical planes to the right or left of the median plane, and parallel to the latter, are called ***paramedian*** or ***sagittal planes*** (Fig. 1.3). A vertical plane placed at right angles to the median plane (dividing the body into anterior and posterior parts) is called a ***coronal plane*** or a ***frontal plane*** (Fig. 1.4). Planes passing horizontally across the body (i.e., at right angles to both the sagittal and coronal planes) and dividing it into upper and lower parts, are called ***transverse*** or ***horizontal planes*** (Fig. 1.5). In addition there are innumerable oblique planes intermediate between those described above.

Sections through any part of the body in any of the planes mentioned above are given corresponding names. Thus we speak of median sections, sagittal sections, coronal or frontal sections, transverse sections and oblique sections.

STRUCTURES CONSTITUTING THE HUMAN BODY

When we dissect up any part of the body we encounter various elements. The basic framework of the body is provided by a large number of ***bones*** that collectively form the ***skeleton***. As bones are hard they not only maintain their own shape, but also provide shape to the part of the body within which they lie. In some situations (e.g., the nose or the ear) part of the skeleton is made up, not of bone but of, a firm but flexible tissue called ***cartilage***. Bones meet each other at ***joints***, many of which allow movements to be performed. At joints, bones are united to each other by fibrous bands called ***ligaments***. Overlying (and usually attached to) bones we see ***muscles***. Muscles are what the layman refers to as flesh. In the limbs, muscles form the main bulk. Muscle tissue has the property of being able to shorten in length. In other words muscles can contract, and by contraction they provide power for movements. A typical muscle has two ends one (traditionally) called the ***origin***, and the other called the ***insertion***. Both ends are attached, typically, to bones. The attachment to bone may be a direct one, but quite often the muscle fibres end in cord like structures called ***tendons*** which convey the pull of the muscle to bone. Tendons are very strong structures. Sometimes a muscle may end in a flat fibrous membrane. Such a membrane is called an ***aponeurosis***.

When we dissect a limb we find that the muscles within it are separated from skin, and from each other, by a tissue in which fibres are prominent. Such tissue is referred to as fascia.

Immediately beneath the skin the fibres of the fascia are arranged loosely and this loose tissue is called ***superficial fascia***. Over some parts of the body the superficial fascia may contain considerable amounts of fat. Deep to the superficial fascia the muscles are covered by a much better formed and stronger membrane. This membrane is the ***deep fascia***. In the limbs, and in the neck, the deep fascia encloses deeper structures like a tight sleeve. Membranes similar to deep fascia may also intervene between adjacent muscles forming ***intermuscular septa***. Such septa often give attachment to muscle fibres.

Running through the intervals between muscles (usually in relation to fascial septa) there are ***blood vessels***, ***lymphatic vessels***, and ***nerves***.

Blood vessels are tubular structures through which blood circulates. The vessels that carry blood from the heart to various tissues are called ***arteries***. Those vessels that return this blood to the heart are called ***veins***. Within tissues arteries and veins are connected by plexuses of microscopic vessels called ***capillaries***.

Lymphatic vessels are delicate, thin walled tubes. They are difficult to see. They often run alongside veins. Along the course of these lymphatic vessels small bean shaped structures are present in certain situations. These are ***lymph nodes***. Lymphatic vessels and lymph nodes are part of a system that plays a prominent role in protecting the body in various ways that you will study later.

Running through tissues, often in the company of blood vessels, we have solid cord like structures called ***nerves***. Each nerve is a bundle of a large number of ***nerve fibres***. Each nerve fibre is a process arising from a ***nerve cell*** (or ***neuron***). Most nerve cells are located in the brain and in the spinal cord. Nerves transmit impulses from the brain and spinal cord to various tissues. They also carry information from tissues to the brain. Impulses passing through nerves are responsible for contraction of muscle, and for secretions by glands. Sensations like touch, pain, sight and hearing are all dependent on nerve impulses travelling through nerve fibres.

Bones, muscles, blood vessels, nerves etc., which we have spoken of in the previous paragraphs are to be seen in all parts of the body. In addition to these many parts of the body have specialized ***organs***, also commonly called ***viscera***. Some of the viscera are solid (e.g., the liver, or the kidney), while others are tubular (e.g., the intestines) or sac like (e.g., the stomach). The viscera are grouped together in accordance with function to form various organ systems. Some examples of organ systems are the respiratory system responsible for providing the body with oxygen; the alimentary or digestive system responsible for the digestion and absorption of food; the urinary system responsible for removal of waste products from the body through urine; and the genital system which contains organs concerned with reproduction.

From the discussions in the previous paragraphs it will be clear that in the study of the anatomy of any part of the body we have to consider the following:

(**1**) The skeletal basis of the part including bones and joints.

(**2**) The muscles and fasciae.

(**3**) The blood vessels and nerves.

(**4**) The lymph nodes and their areas of drainage.

(**5**) Viscera present in the region.

REGIONAL AND SYSTEMIC STUDY OF ANATOMY

The best method for the study of gross anatomy is by dissection of a cadaver. In doing so we naturally study all structures of a region together, and obtain a good idea of their mutual relationships. This kind of study is called ***regional anatomy***.

The major disadvantage of a regional approach to the study of anatomy is that in any given region we often see only small segments of structures that may have a much wider distribution. This is specially true in the case of blood vessels and nerves. It is because of this fact that many text books of anatomy follow what is called the systemic approach. In studying (for example) the arteries in this way we begin with the main artery leaving the heart and trace its branches into all parts of the body.

It will be obvious that both the regional and systemic approaches have some advantages. However, students doing their dissections find it more convenient if all facts relevant to the region of study are available at one place. In this book we will, therefore, follow the regional approach, but will supplement it where necessary by a systemic review of the distribution of blood vessels and nerves within the part.

By its very nature the study of anatomy by dissection is a time consuming process. Because of this a student who enters a medical college may find that at the end of a year of study he or she may know very little about the anatomy of some very important organs that belong to regions not yet dissected. Meanwhile, teachers in other subjects could be making repeated references to such organs. This is an unsatisfactory situation. To help students to cope with this problem, to some extent, this book begins by reviewing elementary features of the anatomy of different parts of the body and of different organ systems. All these will be studied in detail in later sections.

Chapter 2

A Brief Introduction to Bones, Joints and Muscles of the Body

INTRODUCTION TO THE SKELETON

We have seen that the basic foundation of the body is provided by the skeleton. Although details of the features to be seen on individual bones are best studied along with the anatomy of the region concerned, any student embarking on a study of anatomy needs to have a general idea of the skeleton as a whole. The purpose of this section is to provide such information.

The human skeleton may be divided into:

(**a**) the ***axial skeleton*** consisting of the bones of the head, neck and trunk; and

(**b**) the ***appendicular skeleton*** consisting of the bones of the limbs.

A preliminary look at the skull

The skeleton of the head is called the skull. It is seen from the lateral side in Fig. 2.1 and from above in Fig. 2.2. The skull contains a large ***cranial cavity*** in which the brain is lodged. Just below the forehead the skull shows two large depressions, the right and left ***orbits***, in which the eyes are lodged. In the region of the nose and mouth there are apertures that lead into the interior of the skull.

The skull is made up of a large number of bones that are firmly joined together. Some of these are as follows. In the region of the forehead there is the ***frontal bone***. At the back of the head (also called the ***occiput***) there is the ***occipital bone***. The top of the skull, and parts of its side walls, are formed mainly by the right and left ***parietal bones***. The region of the head just above the ears is referred to as the ***temple***, and the bone here is the ***temporal bone*** (right or left). The bone that forms the upper jaw, and bears the upper teeth, is the ***maxilla***. The prominence of the cheek is formed by the ***zygomatic bone***. In the floor of the cranial cavity there is an unpaired bone called the ***sphenoid bone***. The bone of the lower jaw is called the ***mandible***. It is separate from the rest of the skull.

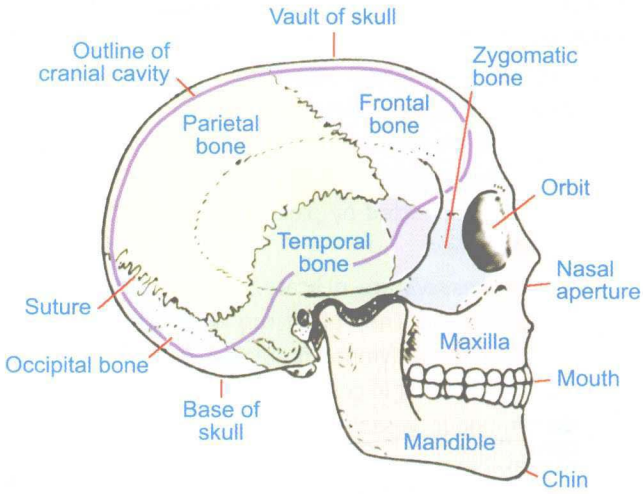

Fig. 2.1. Skull seen from the right side.

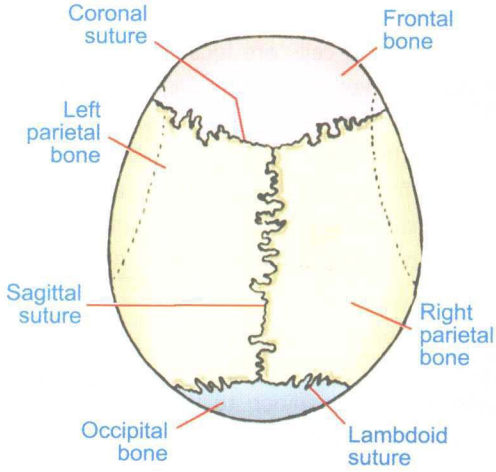

Fig. 2.2. Skull seen from above.

In addition to these large bones there are several smaller ones that will be identified when we take up the study of the skull in detail.

The vertebral column

Below the skull the central axis of the body is formed by the backbone or ***vertebral column*** (Fig. 2.3). The vertebral column is made up of a large number of bones of irregular shape called ***vertebrae***. There are seven ***cervical vertebrae*** in the neck. Below these there are twelve ***thoracic vertebrae*** that take part in forming the skeleton of the thorax. Still lower down there are five ***lumbar vertebrae*** that lie in the posterior wall of the abdomen. The lowest part of the vertebral column is made up of the ***sacrum***, which consists of five sacral vertebrae that are fused together; and of a small bone called the ***coccyx***. The coccyx is made up of four rudimentary vertebrae fused together. There are thus thirty three vertebrae in all. Taking the sacrum and coccyx as single bones the vertebral column has twenty six bones.

Skeleton of the thorax

The skeleton of the thorax forms a bony cage that protects the heart, the lungs, and some other organs (Fig. 2.4). Behind, it is made up of twelve thoracic vertebrae. In front, it is formed by a bone called the ***sternum***. The sternum consists of an upper part, the ***manubrium***; a middle part, the ***body***; and a lower part, the ***xiphoid process***. The side walls of the thorax are formed by twelve ribs on either side.

Each rib is a long curved bone that is attached posteriorly to the vertebral column. It curves round the sides of the thorax. Its anterior end is attached to a bar of cartilage (the ***costal cartilage***) through which it gains attachment to the sternum. This arrangement is seen typically in the upper seven ribs (***true ribs***). The 8th, 9th and 10th costal cartilages do not reach the sternum, but end by getting attached to the next higher cartilage (***false ribs***). The anterior ends of the 11th and 12th ribs are free: they are, therefore, called ***floating ribs***.

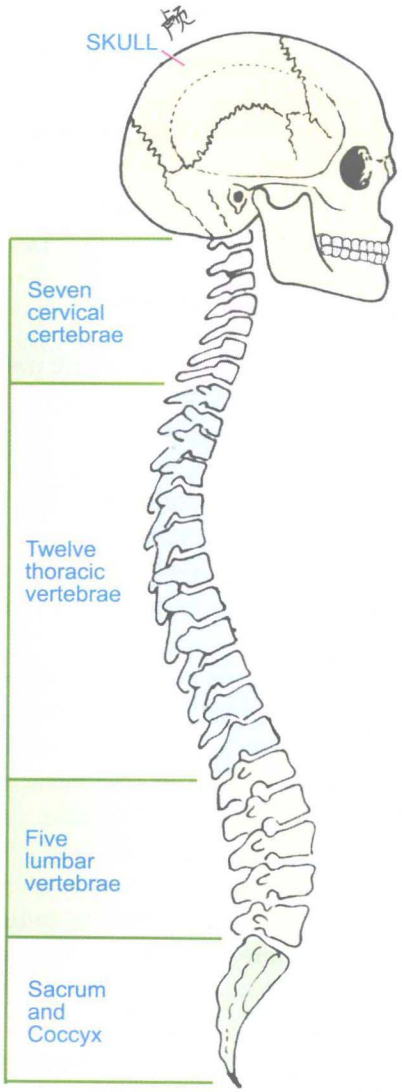

Fig. 2.3. Skull and vertebral column (side view).

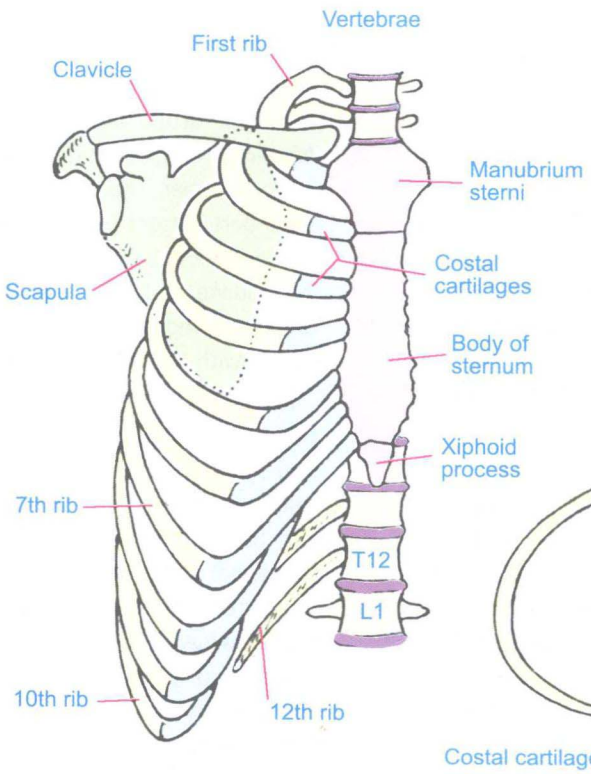

Fig. 2.4 A. Skeleton of the thorax as seen from the front. The bones of the shoulder girdle are also shown.

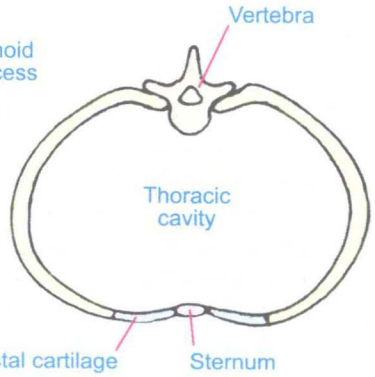

Fig. 2.4B. Section across thorax.

Skeleton of the Upper Limb

The skeleton of each upper limb (Fig. 2.5) consists of the bones of the ***pectoral girdle*** (or ***shoulder girdle***) that lie in close relation to the upper part of the thorax (Fig. 2.4A), and those of the ***free limb***.

The pectoral girdle consists of the collar bone or ***clavicle***, and the ***scapula***. The clavicle is a rod like bone placed in front of the upper part of the thorax. Medially, it is attached to the manubrium of the sternum, and laterally to the scapula. The scapula is a triangular plate of bone placed behind the upper part of the thorax.

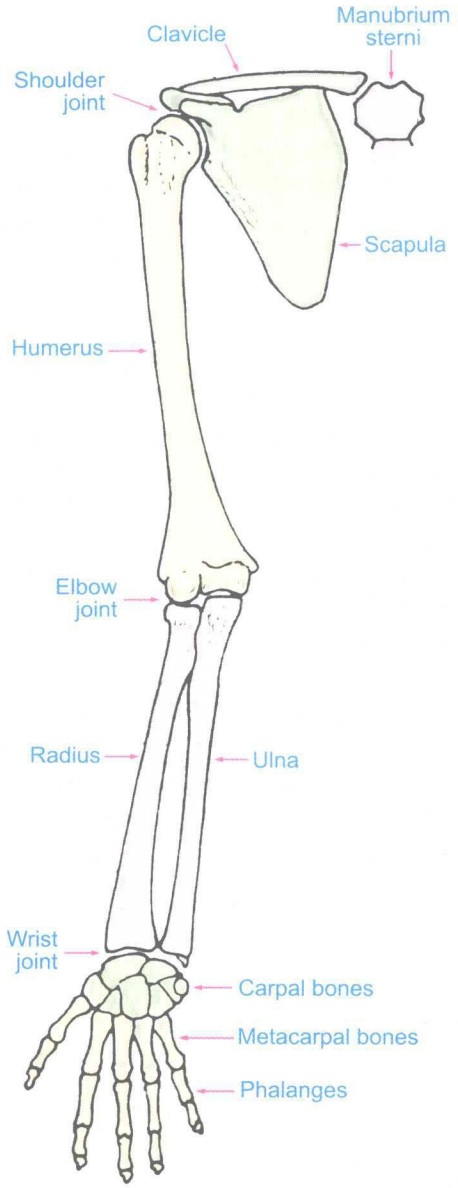

Fig. 2.5. Skeleton of the right upper limb. The manubrium sterni is included for orientation.

The bone of the arm is called the ***humerus***. There are two bones in the forearm: the bone that lies laterally (i.e., towards the thumb) is called the ***radius***; and the bone that lies medially (i.e., towards the little finger) is called the ***ulna***. The humerus, radius and ulna are long bones each having a cylindrical middle part called the ***shaft***, and expanded upper and lower ***ends***.

In the wrist there are eight small, roughly cuboidal, ***carpal bones***. The skeleton of the palm is made up of five rod like ***metacarpal bones***, while the skeleton of the fingers (or digits) is made up of the ***phalanges***. There are three phalanges, ***proximal, middle and distal,*** in each digit except the thumb which has only two phalanges (proximal and distal).

The upper end of the humerus is joined to the scapula at the ***shoulder joint***, and its lower end is joined to the upper ends of the radius and ulna to form the ***elbow joint***. The ***wrist joint*** is formed where the lower ends of the radius and ulna meet the carpal bones. The upper and lower ends of the radius and ulna are united to one another at the ***superior and inferior radioulnar joints***. There are numerous small joints in the hand: the ***intercarpal*** between the carpal bones themselves; the ***carpometacarpal*** between the carpal and metacarpal bones; the ***metacarpo-phalangeal*** between each metacarpal bone and the proximal phalanx; and the ***inter-phalangeal*** joints between the phalanges themselves.

Skeleton of the Lower Limb

The skeleton of the lower limb consists of the bones of the ***pelvic girdle***, and those of the ***free limb*** (Fig. 2.6). The pelvic girdle is made up of one ***hip bone*** on either side. Each hip bone is made up of three parts that are fused together. The upper expanded part of the bone is called the ***ilium***. A small part in front (shaded in the figure) is called the ***pubis***. The lower part of the bone is called the ***ischium***. Anteriorly, the two pubic bones meet in the midline to form a joint called the ***pubic symphysis***. Posteriorly, the sacrum is wedged in between the two hip bones. The hip bones and sacrum (along with the coccyx) form the ***bony pelvis***.

The bones of the free part of the limb are arranged in a pattern similar to that in the upper limb. The bone of the thigh is called the ***femur***. There are two bones in the leg. The medial of the two (lying towards the great toe) is called the ***tibia***, while the outer bone is called the ***fibula***. The femur, tibia and fibula are long bones having cylindrical shafts with expanded upper and lower ends. In the region of the ankle, and the posterior part of the foot, there are seven roughly cuboidal ***tarsal bones***. The largest of these is the ***calcaneus,*** which forms the heel. Next in size we have the ***talus***. In the anterior part of the foot there are five ***metatarsal bones***. Each digit (or toe) has three ***phalanges*** — proximal, middle and distal: however, the great toe has only two phalanges — proximal and distal.

The upper end of the femur fits into a deep socket in the hip bone (called the ***acetabulum***) to form the ***hip joint***. The lower end of the femur meets the tibia to form the ***knee joint***. A small bone, the ***patella***, is placed in front of the knee. The tibia and fibula are joined to each other at their

upper and lower ends to form the superior and inferior ***tibiofibular joints***. The lower ends of the tibia and fibula join the talus to form the ***ankle joint***. Within the foot there are ***intertarsal, tarsometatarsal, metatarsophalangeal and interphalangeal joints*** on a pattern similar to those in the hand.

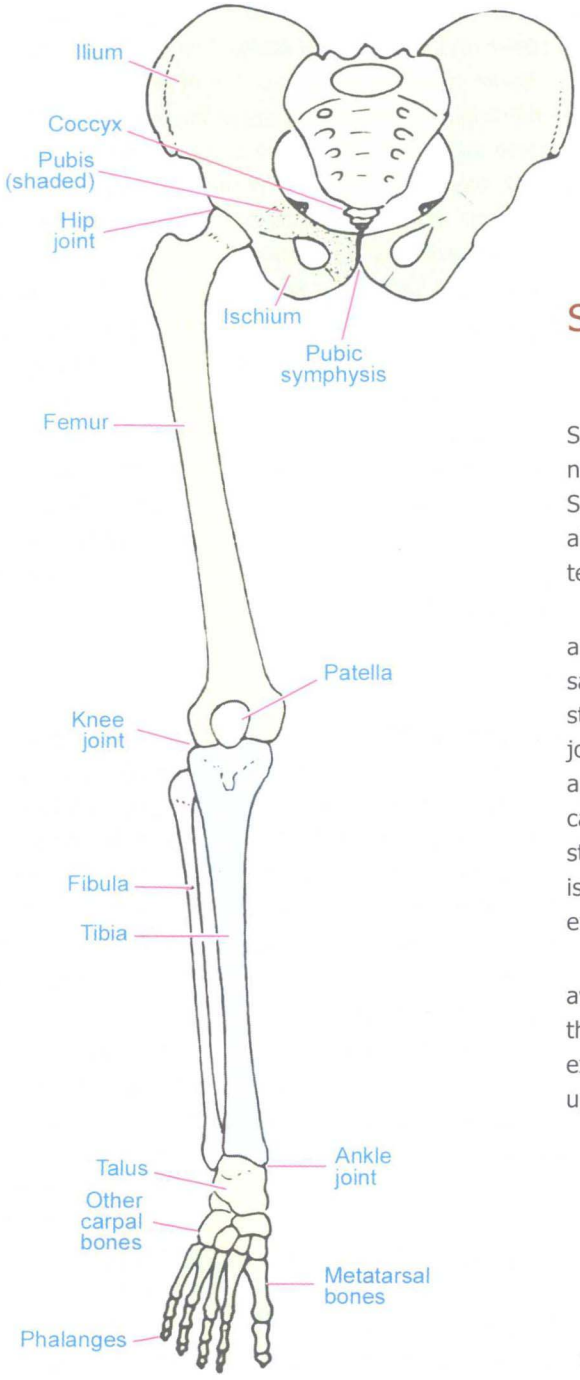

Fig. 2.6. Skeleton of the pelvis and right lower limb.

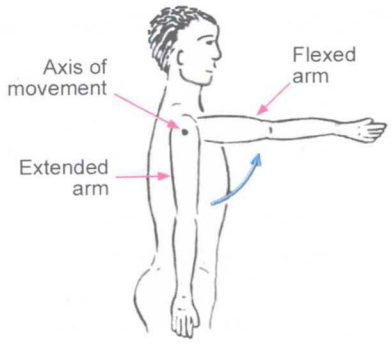

Fig. 2.7. Diagram to explain the movement of flexion of the forearm.

SOME FEATURES OF JOINTS

We have seen that joints are formed where two (or more) bones meet. Some joints are merely bonds of union between different bones and do not allow movement. Joints of the skull (sutures) belong to this category. Some joints allow slight movement, while some (like the shoulder joint) allow great freedom of movement. In describing movements we use certain terms which the student must understand clearly.

In Chapter 1 we have introduced the concept of planes. Movements at any joint can take place in various planes. Movements taking place in a sagittal plane are referred to as ***flexion*** (= bending), and ***extension*** (= straightening). For example when we bend the upper limb at the elbow joint so that the front of the forearm tends to approach the front of the arm this movement is called flexion. Straightening the limb at elbow is called extension. Bending the neck forwards is flexion of the neck, and straightening it is extension. Similarly, when we bow, the vertebral column is being flexed, and when the body is made upright the spine is being extended.

Movements in the coronal plane are referred to as ***abduction*** (= taking away) or ***adduction*** (= bringing near). When a limb is moved laterally so that it moves away from the trunk it is said to undergo abduction. For example, such a movement takes place at the shoulder joint when the upper limb is raised sidewards. A similar movement takes place at the hip

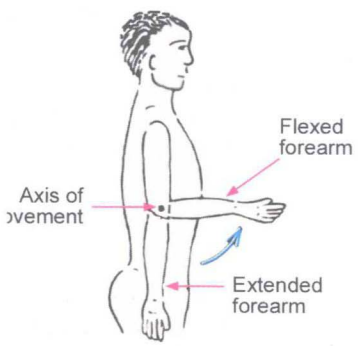

Fig. 2.8. Diagram to explain the movement of flexion of the arm.

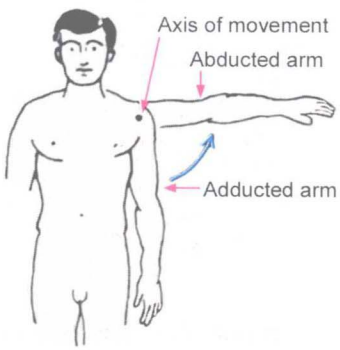

Fig. 2.9. Diagram to explain the movement of abduction of the arm.