



# Introduction to Anatomy and Anatomical Terms

*Competency achievement:* The student should be able to:  
**AN: 1.1**

## Objectives

- To define human anatomy and to document the history of anatomy
- To list the subdivision of the anatomy
- To define the anatomical position and to list the anatomical planes
- To list the anatomical terms used to relating the body parts, related to muscles, vessels, movements and bones
- To list the basic clinical terminologies which are essential in understanding the case scenarios
- To explain the molecular organization of the human body
- To list the human body system and body cavities
- To know the methods of human body (cadaver) preservation for teaching gross anatomy

Human anatomy is the science concerned with the structure of the human body. The term 'anatomy' is derived from the Greek word meaning "to cut up" ("ana," meaning "up," and "tome," meaning "a cutting"). The dissection of cadavers (dead bodies) has served as the basis for understanding the structure and function of the human body. Most of the terms that form the language of anatomy are of Greek or Latin derivations. In the past, human anatomy was an academic, descriptive science primarily concerned with identifying and naming body structures. Although dissection and description form the basis of anatomy, **the importance of human anatomy is in its functional approach and clinical applications.** Human anatomy is a practical, applied science that provides the foundation

for understanding physical performance and body health. Knowledge of the structure of the human body from what can be seen with the naked eye (gross anatomy) down to the molecular level is fundamental to understand the body function and how both structure and function are modified by disease. Anatomy teaching in medical schools has been traditionally based around the use of human cadaveric specimens, either taking the whole-body specimens for complete dissection or as prosected specimens. Of late more emphasis are given to identify the human body structure using radiology technique and looking at the cellular level in microscopic anatomy. We shall explore the human body using all these methods wherever they are applicable.

## HISTORY OF ANATOMY

The study of anatomy goes back over 2,000 years, to the Ancient Greeks. The systematic study of anatomy was started by Greek scientists Alcmaeon and Empedocles. Alcmaeon was said to be the first person to dissect the human body and first to propose that the brain is the center of intelligence. During third century B.C.E, the Greek anatomists, **Erasistratus and Herophilus** started first scientific studies designed to discover the workings of human anatomy. It was said that they were performing the dissection on bodies of convicted criminals. During second century **Galen**, a physician from Rome contributed immense information about human body. His most important discovery was that arteries carry blood although he did not discover circulation. He identified 7 of the

12 cranial nerves and proposed that urine is formed in the kidney, not in the bladder.

During 8th to 14th century the quest for new knowledge became stagnant because of the belief that *God knows best, and so He should—since He created everything*. During 15th century many breakthroughs helped in understanding the human body and function. **Leonardo da Vinci**, Italian Renaissance artist (1452–1519) began a series of anatomical drawings depicting the ideal human form. He also made a picture closely resembling an unborn baby in the womb with the correct attachment of the umbilical cord.

**Andreas Vesalius** was an anatomist and physician, born in 1514 is considered as **father of modern anatomy**. He wrote the “*De humani corporis fabrica*” (on the structure of the human body) which challenged traditional knowledge of human anatomy which are based on Galen’s findings. This book was the first accurate description of the interior of the human body. **William Harvey** (1578–1657), an English physician described the circulation of the blood. During mid-17th century, the study of human anatomy enormously improved with the invention of the compound microscope by **Robert Hooke**. The viewing of cell structures and physiological processes were no longer limited to the naked eye. During 18th century dissection became a recognized punishment for the worst criminals. The dissections performed on hanged bodies were kept for public exhibition. **Sir Henry Gray** was a British anatomist and surgeon most notable for publishing the book *Gray’s Anatomy*. At present, his book is considered as the most authoritative in medical science. During 19th century the study of anatomy of humans and animals further improved with the advancement of histology and developmental biology. In recent past the advances in radiological techniques have permitted researchers to make remarkable connections between anatomy and physiology. This also have allowed them to integrate and relate the study of anatomy with other medical disciplines.

## SUBDIVISION OF HUMAN ANATOMY

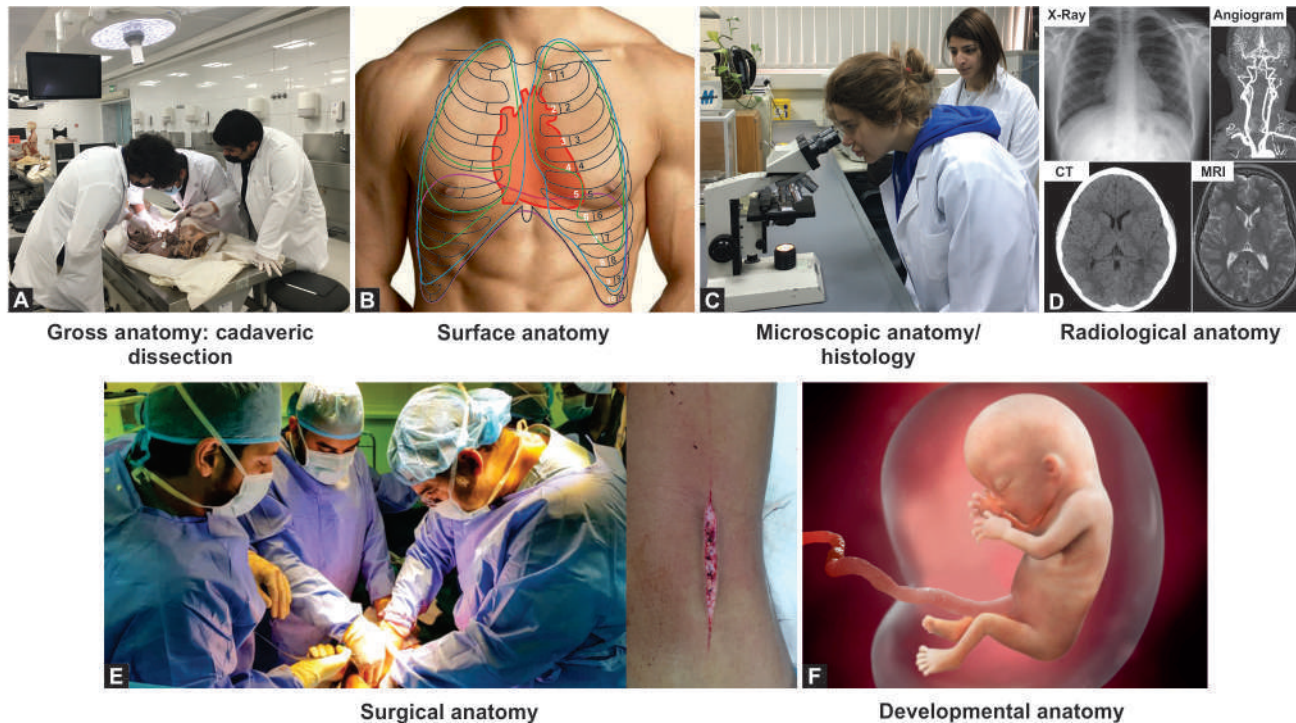
**1. Gross anatomy:** It is the study of structures of a cadaver that can be observed with naked eye (Fig. 1.1A). The study of gross anatomy may involve dissection or noninvasive methods. The aim is to collect data about the larger structures of organs and organ systems. In dissection, the scientist cuts open the human cadaver and examines its organs. Medical and dental students perform dissection as part of their practical work in gross human anatomy during their studies. Of late emphasis are made on living anatomy using techniques like endoscopy,

where an endoscope is inserted through mouth or nasal cavity or anal canal to visualize the gastrointestinal tract.

- 2. Surface anatomy:** It deals with surface features of the body that can be observed or palpated (felt firmly). It is often neglected part of anatomy as we focus more on studying the internal anatomy. A knowledge of surface anatomy is essential to one’s competence in many procedures such as cardio-pulmonary resuscitation, surgery, physical therapy, taking X rays and electrocardiograms, giving injections, drawing blood, listening to heart and respiratory sounds, measuring the pulse and blood pressure, and finding pressure points to stop arterial bleeding, among other procedures (Fig. 1.1B).
- 3. Microscopic anatomy:** It deals with the study of structures with the help of a microscope. The cytology (study of cells) and histology (study of tissues) are specialties of anatomy that have provided additional understanding of the structure and function of the human body. Certain cells/tissues can be stained by certain dyes (vital stains) which colour selectively the elements in the cell. By looking at tissue under the microscope, one can learn about the architecture of the cells (Fig. 1.1C). For example, if a person has cancer, examining the tissue under the microscope will reveal how the cancer cells are acting and how they affect normal human tissue. Histology involves studying tissues and cells using histological techniques such as sectioning and staining, and then looking at them under a light or electron microscope. This will be discussed in a separate section.
- 4. Radiological anatomy:** It involves the study of anatomical structures as they are visualized by X-rays, ultrasound scans or other specialized procedures (CT/MRI scans) performed on living body. In contrast X-ray, radiopaque substances can be ingested or injected for visualizing internal organs. Angiography involves making a radiograph after injecting a dye into the blood stream. Since radiographs compress the body image with an overlap of organs and tissues, diagnosis is often difficult. The computerized axial tomography technique (CT or CAT scans) has greatly enhanced the versatility of X-rays, using a computer to display a cross-sectional image similar to that which could only be obtained in an actual section through the body. Magnetic resonance imaging (MRI) and positron emission tomography (PET) are the other techniques used to observe the organ structures of the body. Most clinicians view internal anatomy with the aid of radiographic images and procedures. Proper interpretation of these images requires a detailed knowledge of anatomy (Fig. 1.1D).

**5. Surgical anatomy:** To the surgeon knowledge of gross anatomy is of paramount and permanent importance. Precise incision on various parts of the body, relations of viscera and their vascularity and endoscopic procedure requires sound knowledge of anatomy (Fig.1.1E). Surgical anatomy studies anatomical landmarks important for surgical procedures. It is the application of anatomy in surgical diagnosis, and treatment.

**6. Developmental anatomy (embryology):** It deals with the study of prenatal stages of human development. The series of dynamic events unfolding from the time of fertilization to the birth of new individual. It is helpful in understanding the adult anatomy and congenital anomalies (birth defects). Understanding of human development resulted in development of new techniques for prenatal diagnosis and treatments (Fig.1.1F).



**Fig. 1.1 A to F:** Branches of human anatomy

## ANATOMICAL TERMS

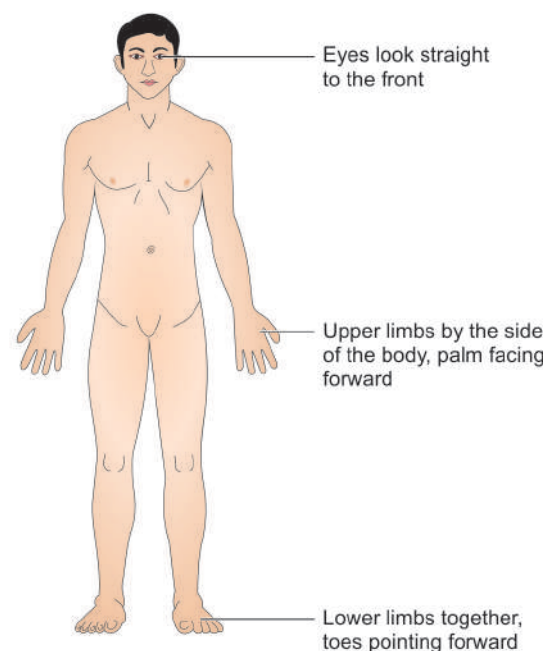
Though we are familiar with the common terms of many parts and regions of our body, it is essential that we use internationally accepted anatomical names/terms.

### Body Positions

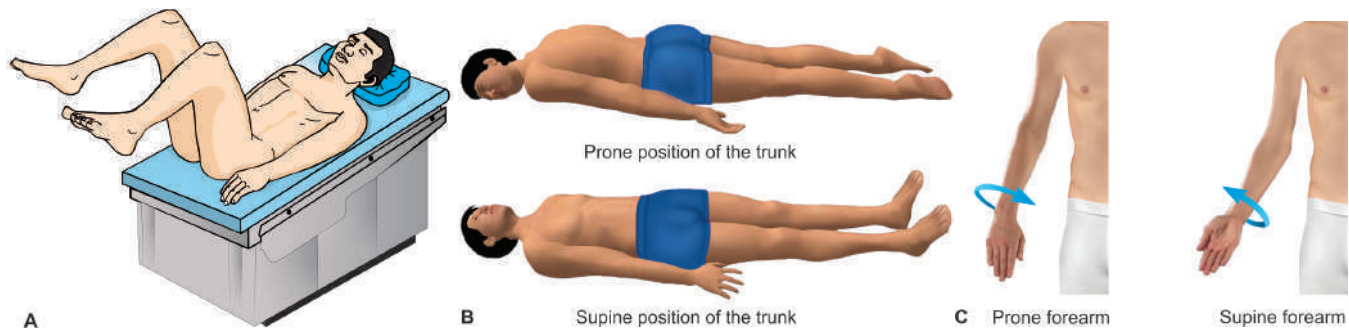
The following are the positions/postures of the human body during clinical examination/cadaver dissection/anatomical description.

**Anatomical position:** All descriptions of the human body are based on the assumption that the person is (Fig.1.2):

- Standing erect
- Eyes look straight to the front
- Upper limbs are by the sides of the body and palms facing forward
- Lower limbs are together and digits (toes) pointing forward



**Fig. 1.2:** Anatomical position



**Fig. 1.3:** Other types of body positions: **A:** Lithotomy position; **B:** Supine and prone position of the trunk; **C:** Supine and prone position of the forearm

**Supine position:** The person is lying down on back with the face directed upwards (Fig.1.3).

**Prone position:** The person is lying down facing the ground (Fig.1.3).

**Lithotomy position:** The person is lying down on his back with fully flexed (knees pointing to the roof) and abducted (widely spread) thighs.

### Anatomical Planes

These are imaginary planes (lines) that cut through the body when it is in anatomical position. They help in identifying and studying the relative position of a structure/organ in relation to one another. They further help us in making precise surgical incisions (Fig. 1.4).

- **Median Plane:** It is an imaginary vertical/sagittal plane passing longitudinally through the middle of the body from front to back, dividing it into two equal halves. It is also called mid-sagittal plane.
- **Sagittal Planes:** These are imaginary vertical planes passing through the body parallel to the median plane.

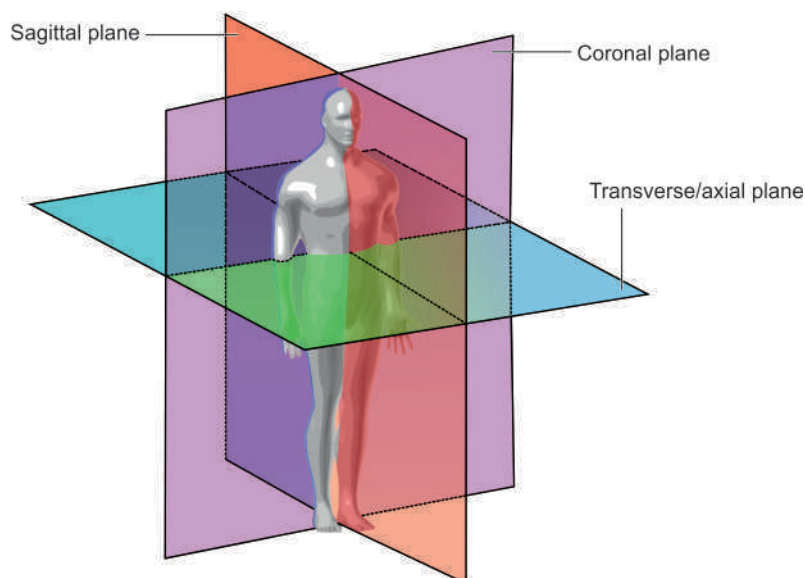
These planes are also referred as lateral planes or parasagittal planes.

- **Coronal Planes:** These are imaginary planes passing through the body at right angle to the median plane, dividing it into anterior (front) and posterior (back) portions. It is also referred as frontal plane.
- **Horizontal Planes:** These are imaginary planes passing through the body at right angles to both the median and coronal planes. This plane is parallel to the ground. This plane divides the body into superior (upper) and inferior (lower) parts. This plane is also referred as transverse or axial plane.
- **Oblique Planes:** Any plane other than those mentioned above, they slant or deviate from the other planes.

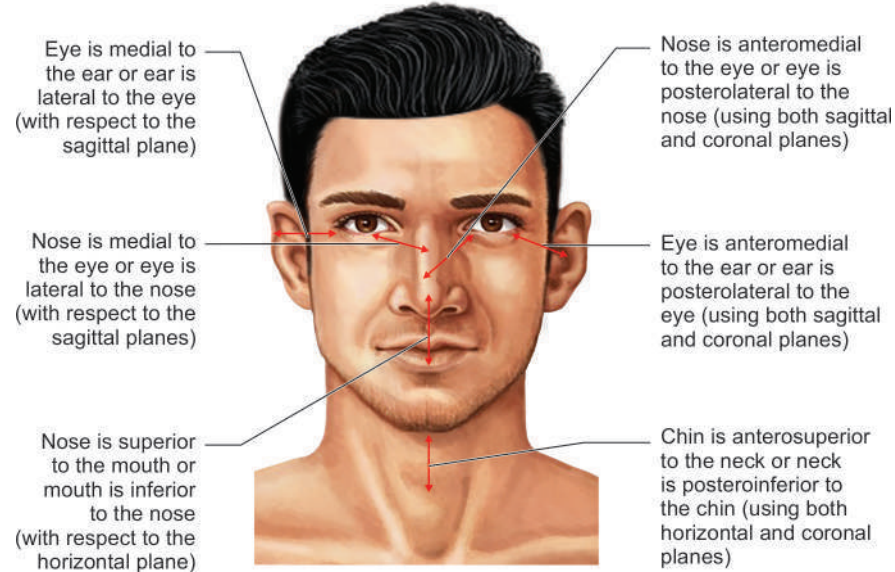
### Terms of Relationship

**Superior (cranial):** Nearer to the head.

**Inferior (caudal):** Nearer to the feet. This relationship uses horizontal plane (Fig. 1.5).



**Fig. 1.4:** Anatomical planes



**Fig. 1.5:** Anatomical terms of relations

*For example*, the head is superior (above) to the neck. The abdomen is inferior (below) to the thorax/chest.

**Anterior (ventral):** Nearer to the front.

**Posterior (dorsal):** Nearer to the back. This relationship uses coronal plane.

*For example*, the nose is anterior to the eyes. The ear is posterior to eyes (when compared through coronal plane).

**Medial:** Nearer to the median plane.

**Lateral:** farther (away) from the median plane. This relationship uses sagittal or parasagittal planes.

*For example*, the nose is medial to the eye. The eye is lateral to the nose (when compared through median or sagittal planes).

Further using these terminologies more precise relationship between the structures can be described using combination of sagittal, coronal and horizontal planes .

*For example*, nose is anteromedial to the eye. The ear is posterolateral to the eye.

**Intermediate**—means between—your heart is intermediate to your lungs.

There are also terms that describe specific body parts. Palmar describes the palm side of the hand. Dorsal describes the back side of the hand. Plantar describes the bottom of the foot.

### Terms of Comparison

Compare the relative positions of two structures with each other.

**Proximal:** Nearer to the trunk/point of origin.

**Distal:** Away from the trunk/point of origin.

*For example*, the elbow is proximal to the hand, while the hand is distal to the forearm (Fig.1.6A).

**Superficial:** Nearer to/on the surface.

**Deep:** Farther from the surface (Fig.1.6B).

*For example*, skin is superficial to fascia, while the muscles are deeper to the fascia.

**External:** Towards/on the exterior.

**Internal:** Towards/in the interior (Fig.1.6C).

*For example*, the heart is externally covered by pericardium and internally covered by endocardium.

**Central:** Nearer to/towards the center.

**Peripheral:** Away from the center.

*For example*, the inferior vena cava passes through central part of the diaphragm. The peripheral part of the diaphragm is mainly attached to the rib cage.

**Parietal:** External wall of a body cavity.

**Visceral:** Pertaining to covering of an organ (Fig.1.6D).

*For example*, the pleura has an outer/external parietal layer and an inner visceral layer with pleural cavity between them.

**Ipsilateral:** On the same side of the body.

**Contralateral:** On the opposite side of the body (Fig.1.6E).

*For example*, the ipsilateral limbs are affected means right (or left) upper limb and right (or left) lower limb are affected. Contralateral refers to when right (left) upper limb and left (right) lower limb are affected.

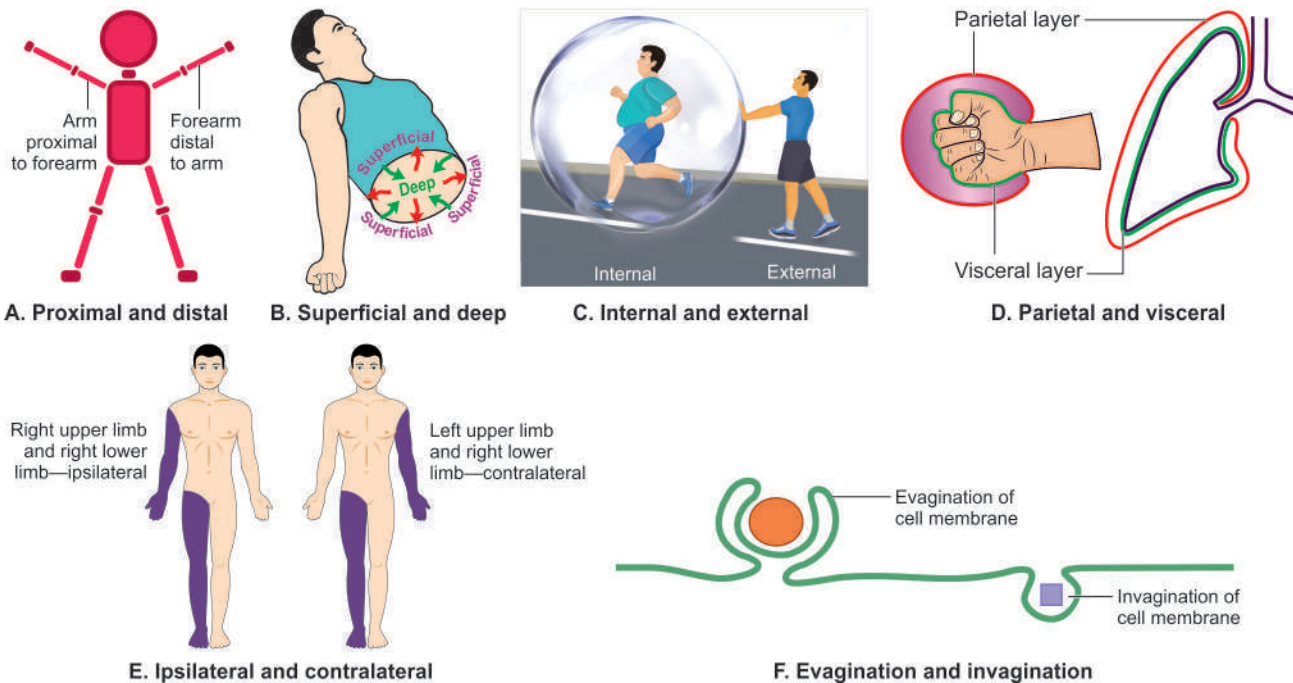


Fig. 1.6: Anatomical terms of comparison

**Evagination:** Outward bulging of the wall of a cavity.

**Invagination:** Inward bulging of the wall of a cavity. This is often referred to the activity of cytoplasmic membrane (Fig. 1.6F).

### Terms Describing Movements at Joints

- **Flexion:** Bending/making a decreasing angle between the bones or parts of the body. In this movement there is an approximation of flexor surfaces (Fig. 1.7A and B).
- **Extension:** Straightening of a bent part or making an increasing the angle between bones of the body. In this movement there is an approximation of extensor surfaces (Fig. 1.7A and B).
- **Abduction:** Moving away from the median plane (Fig. 1.7C and D).
- **Adduction:** Moving toward the median plane (Fig. 1.7C and D).
- **Rotation:** Moving around the long axis.
- **Medial rotation:** Inward rotation (Fig. 1.7E).
- **Lateral rotation:** Outward rotation (Fig. 1.7E).
- **Circumduction:** Circular movement combining flexion, abduction, extension and adduction.
- **Eversion:** Raising the lateral border of the foot.
- **Inversion:** Raising the medial border of the sole of the foot.
- **Pronation:** Rotation of the forearm so that the palm is turned backwards (Fig. 1.7F).
- **Supination:** Rotation of the forearm so that the palm is turned forwards (remember in anatomical position).

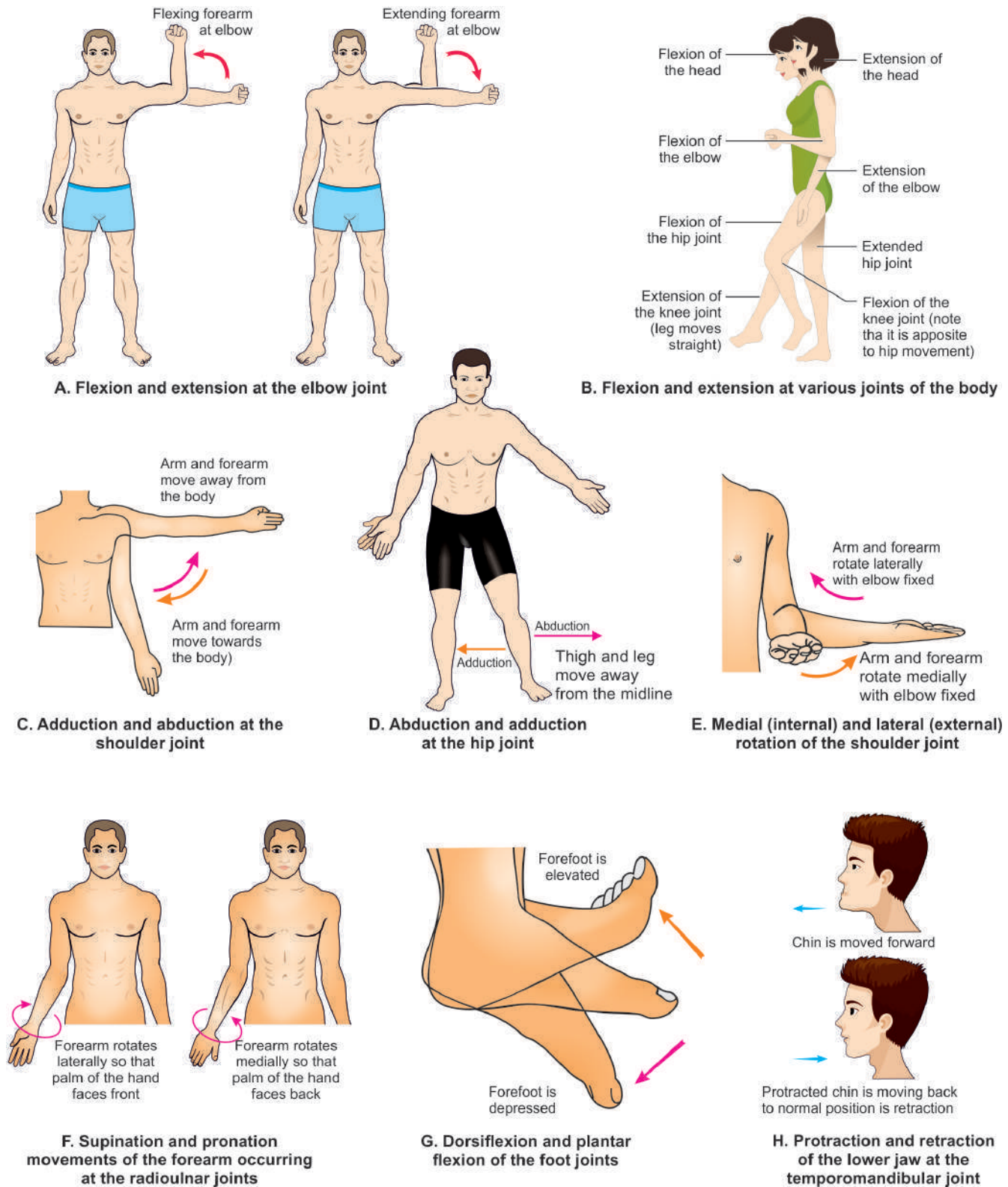
- **Dorsiflexion:** Forefoot is raised and the angle between the front of the leg and dorsum of the foot is reduced (Fig. 1.7G).
- **Plantar flexion:** The forefoot is depressed and the angle between the front of the leg and dorsum of the foot is increased (Fig. 1.7G).
- **Protrusion:** Moving anteriorly (forward) (Fig. 1.7H).
- **Retraction:** Moving posteriorly (backward) (Fig. 1.7H).

### Terms Related to Muscle

- **Origin:** It is the end of the muscle, which is fixed and shows relatively less movement during contraction.
- **Insertion:** It is the end of the muscle, which shows relatively more movement during contraction. The origin of the muscle is considered as proximal attachment and insertion as distal attachment (Fig. 1.8).
- **Belly:** The fleshy and contractile part of a muscle.
- **Tendon:** The fibrous, non-contractile part of the muscle.
- **Aponeurosis:** The flattened, sheet of dense connective tissue, which attaches the muscles to the bone/skin.
- **Raphe:** A fibrous band made up of interdigitating aponeurotic fibers of the muscles.

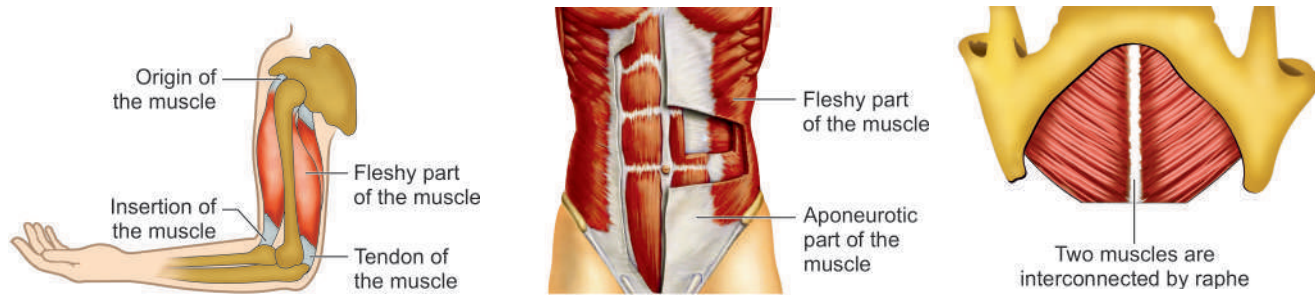
### Terms Related to Blood Vessels

- **Arteries:** They carry oxygenated blood away from the heart. They are thick-walled structure with small lumen (Fig. 1.9A and B).



**Fig. 1.7:** Anatomical terms describing the movements at the joints of the body

- **Veins:** They carry deoxygenated blood towards the heart. They are thin-walled structure with comparatively large lumen (Fig. 1.9A and B). Valves are the structures inside the veins/heart which maintain uni-directional blood flow.
- **Arterioles:** These are the smallest branches of the arteries within the tissue (with diameter 100  $\mu$ m or less).
- **Venules:** These are the minute vessels in the tissue, which join to form vein.



**Fig. 1.8:** Anatomical terms related to the skeletal muscle

- **Capillaries:** These are microscopic vessels connecting arterioles to venules.

The umbilical artery and pulmonary artery are exceptions, which carry the deoxygenated blood. The pulmonary vein and umbilical vein carry oxygenated blood.

The terms related to the joints, lymphatic and nervous systems are discussed in the next chapter (General Anatomy).

### Terms Related to Lymphatic System

**Lymph:** It is also called lymphatic fluid which is a collection of the extracellular fluid derived from blood plasma. The fluid drains from cells and tissues (that is not reabsorbed into the capillaries). The fluid also contains white blood cells (lymphocytes).

**Lymphatic vessels:** These are the network of capillaries (microvessels) and a large network of tubes located throughout your body that transport lymph away from tissues.

**Lymph nodes:** They are bean-shaped glands that monitor and filter the lymph and produce lymphocytes.

### Terms Related to Bones

#### Terms related to articulations

**Condyle:** A rounded knob that articulates with another bone, example occipital condyles of skull or condyles of the femur.

**Facet:** A smooth, flat, slightly concave or convex articular surface, example articular facets of the vertebrae.

**Head:** The prominent expanded end of a bone, sometimes rounded, example head of femur (thigh one) and humerus (bone of the arm).

#### Extensions and projections

**Crest:** A narrow ridge, example iliac crest of pelvis.

**Epicondyle:** A projection superior to a condyle, example medial epicondyle of the femur.

**Line:** A slightly raised, elongated ridge, example nuchal lines of the skull.

**Process:** Any bony prominence, example mastoid process of the skull.

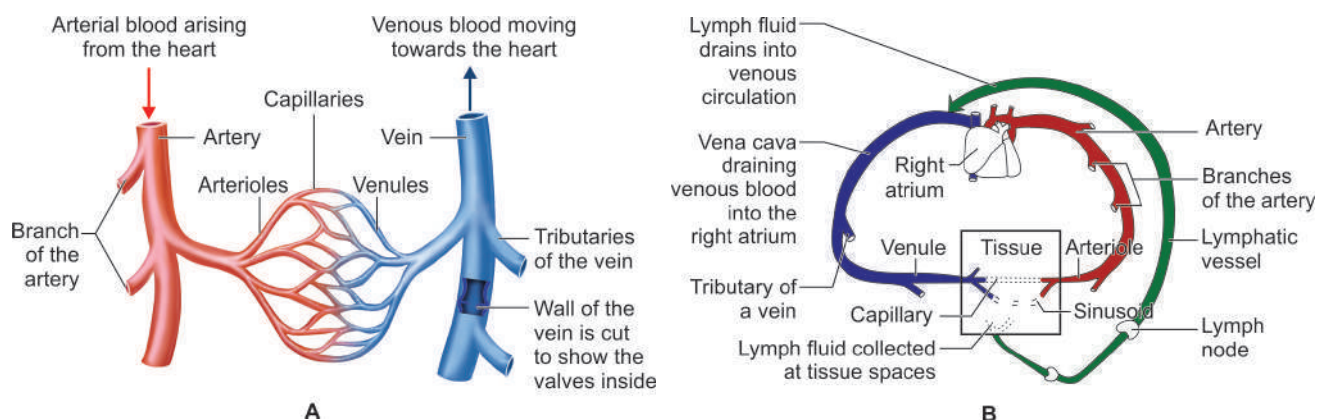
**Protuberance:** A bony outgrowth or protruding part, example mental protuberance of the chin.

**Spine:** A sharp, slender, or narrow process, example spine of the scapula.

**Trochanter:** Two massive processes unique to the femur.

**Tubercle:** A small, rounded process, example greater tubercle of the humerus.

**Tuberosity:** A rough elevated surface, example tibial tuberosity.



**Fig. 1.9:** **A:** Anatomical terms related to the blood vessels; **B:** Anatomical terms related to the blood vessels and lymphatic system

### Depressions

**Alveolus:** A pit or socket, example tooth socket.

**Fossa:** A shallow, broad, or elongated basin, example mandibular fossa.

**Fovea:** A small pit, for example fovea capitis of the femur.

**Sulcus:** A groove for a tendon, nerve, or blood vessel, example intertubercular sulcus of the humerus.

### Passages and cavities

**Canal:** A tubular passage or tunnel in a bone, example condylar canal of the skull, or optic canal.

**Fissure:** A slit through a bone, example orbital fissures behind the eye.

**Foramen:** A hole through a bone, usually round, example foramen magnum of the skull or small nutrient foramen for the passage of the blood vessel.

**Meatus:** An opening into a canal, example acoustic meatus of the ear.

**Sinus:** A space in a bone, example frontal sinus of the forehead.

### Terms Related to Nervous System

**Nerve/nerve fibre:** It is a cable-like structure within the body designed to conduct nerve impulses that relay information from one part of the body to the other. They are mainly collections of axons of the neurons.

**Afferent nerve:** Impulses conveyed from periphery to the CNS (sensory nerve).

**Efferent nerve:** Impulses conveyed from CNS to the periphery (motor nerve).

## BASIC CLINICAL TERMINOLOGIES

Throughout this book, you find number of case scenarios which mimics the actual cases which you face in future. Being first year medical students, you are not expected to know the diagnosis and management/treatment. There are number of questions after each case scenarios which you must attempt to answer. These questions signify importance of learning anatomy and its applicability in future. However, while reading the case scenarios you will come across many clinical terminologies which you might not be familiar with. Hence, some of the commonly used clinical terminologies are listed here and this should help you to grasp the case better. However, it is advised to every student keep their own medical dictionary.

• **Abrasion:** A type of open wound that is caused by the skin rubbing against a rough surface.

- **Abscess:** A local accumulation of pus anywhere in the body.
- **Acute:** Sudden but usually short.
- **Aneurysm:** An enlargement (dilatation) of an artery caused by weakness in its wall.
- **Auscultation:** The act of listening to sounds arising within organs (as the lungs or heart) usually using a stethoscope.
- **Avulsion:** An injury in which a body structure is torn off by either trauma or surgery.
- **Biopsy:** Removal of cells or tissues from the body for examination by a pathologist.
- **Blood pressure:** The blood pressure is the pressure of the blood within the arteries. It is produced primarily by the contraction of the heart muscle which ensures that blood is pumped to all tissues adequately.
- **Bradycardia:** It refers to a slow heart rate, when the heart beats less than 60 beats per minute.
- **Cellulitis:** It refers to inflamed or infected tissue beneath the skin.
- **Cyanosis:** A bluish color of the skin and the mucous membranes due to insufficient oxygen in the blood.
- **Ectopic:** It refers to location of a structure (cells/tissues/organs) in the wrong place or out of place.
- **Edema:** Body parts swell from injury or inflammation
- **Embolism:** The obstruction of a blood vessel by a foreign substance or a blood clot that travels through the bloodstream which plugs the vessel.
- **Erythema:** Redness of the skin or mucous membranes, caused by hyperemia (increased blood flow) in superficial capillaries. It occurs with any skin injury, infection, or inflammation.
- **Febrile:** It refers to feverish condition or having a fever. A fever is an abnormally high body temperature, typically as the result of illness.
- **Fibrosis:** Formation or development of fibrous connective tissue as a reparative response to injury or damage.
- **Gestation:** The period (time) between conception and birth.
- **Haemorrhage:** It refers to bleeding.
- **Heart rate:** The number of heart beats per unit of time, usually per minute.
- **Hematoma:** A localized swelling that is filled with blood caused by a break in the wall of a blood vessel.
- **Herniation:** Abnormal protrusion of tissue/organ through a weak area in the body wall or within the body cavity.
- **Hypertension:** It refers to a repeatedly elevated blood pressure.
- **In remission:** The disease which is not getting worse
- **Ischemia:** Inadequate blood supply to a local area due to blockage of blood vessels supplying that area.

- **IV cannula:** Intravenous (IV) cannulation is a technique in which a cannula is placed inside a vein to provide venous access. This venous access allows sampling of blood, as well as administration of fluids, medications.
- **Laceration:** A wound that is produced by the tearing of soft body tissue, which is often irregular and jagged
- **Lesion:** It refers to a wound, sore, or cut.
- **Lump:** A protuberance or localized area of swelling that can occur anywhere on the body. It may be solid, fluid, or gaseous. Lumps may be described as soft and fluctuant, firm or even 'stony hard'. Fluctuation indicates a fluid swelling.
- **Maneuver:** Any form of management or procedure that acts on a patient to evoke a result or outcome.
- **Melanoma:** A form of skin cancer that begins in the cells (melanocytes) that control the pigment in the skin.
- **Metastasis:** The spread of cancer cells from the place where they first formed to another part of the body.
- **Necrosis:** The death of living cells or tissues.
- **Neonate:** A neonate refers to a newborn and the neonatal period is the first 4 weeks of a child's life.
- **Neuralgia:** An intense burning or stabbing pain caused by irritation of or damage to a nerve.
- **Noninvasive:** It refers to a technique or a procedure which does not require entering the body with instruments.
- **Numbness:** A loss of sensation or feeling in a part of your body.
- **Pallor:** A pale color of the skin that can be caused by many facts but most often because of reduced amount of oxyhaemoglobin.
- **Palpation:** It is a method of feeling with the fingers or hands during a physical examination. The health care provider touches and feels your body to examine the size, consistency, texture, location, and tenderness of an organ or body part.
- **Paralysis:** Loss of power of muscle contraction.
- **Percussion:** It is a method of tapping body parts with fingers, hands, or small instruments as part of a physical examination. It is done to determine, the size, consistency, and borders of body organs or presence or absence of fluid in body areas.
- **Phlebotomist:** A person who draws blood for diagnostic tests.
- **Polyp:** A mass or growth of thin tissue.
- **Pulse:** The rhythmic dilation of an artery that results from beating of the heart.
- **Severed:** It refers to divide one structure into two parts or to remove one part or keep apart.
- **Sprain:** An injury to a ligament (stretch or tear) that results from overuse or trauma.
- **Tachycardia:** It refers to a heart rate over 100 beats per minute.
- **Tachypnea:** It refers to fast, shallow breathing, which can be due to a lack of oxygen or too much carbon dioxide in the body.
- **Tenderness:** It refers to pain or discomfort when an affected area is touched. It should not be confused with the pain that a patient perceives without touching. Pain is patient's perception, while tenderness is a sign that a clinician elicits.
- **Thrombosis:** The formation or presence of a blood clot in a blood vessel.
- **Tourniquet:** A device, such as a strip of cloth or a band of rubber, that is wrapped tightly around a leg or an arm to prevent the flow of blood to the leg or the arm for a period of time.
- **Tumour:** An abnormal mass of tissue that forms when cells grow and divide more than they should or do not die when they should. Tumors may be benign (not cancer) or malignant (cancer).
- **Valgus:** A deformity in which an anatomical part is turned outward (away from the midline) from the body
- **Varus:** A deformity in which an anatomical part is turned inward toward the midline of the body.
- **Venipuncture:** The puncture of a vein with a needle to withdraw blood and is also called phlebotomy.

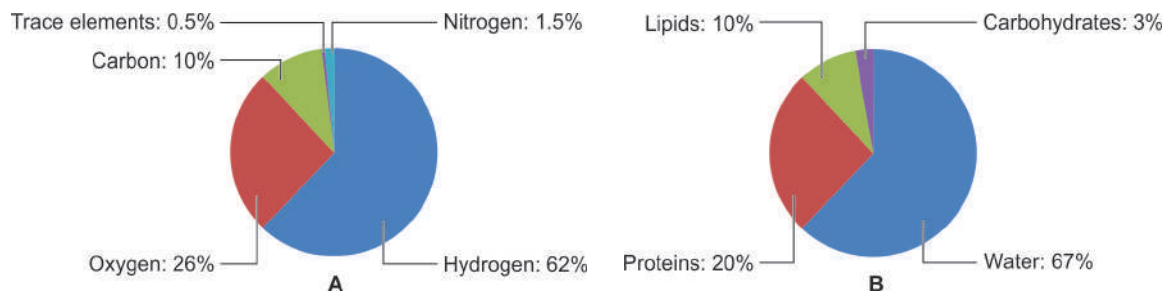
## HUMAN BODY ORGANIZATION

Study of the human body will begin with an overview of microscopic anatomy and then proceed to the gross and macroscopic anatomy of each organ system. When considering events from the microscopic to macroscopic scales we are examining several interdependent levels of organization.

To begin with chemical or molecular level of organization, the human body consists of over a dozen different elements, but four of them (hydrogen, oxygen, carbon and nitrogen) account for more than 99% of the total number of atoms (Fig. 1.10A).

At the chemical level, atoms interact to form compounds with distinctive properties. The major classes of compounds in the human body are illustrated in (Fig. 1.10B).

**1. Cellular level:** The cell is the basic structural and functional component of life. It is at the cellular level that such vital functions of life as metabolism, growth, irritability and adaptability, repair and reproduction are carried out. Cells are composed of minute articles called atoms, which are bound together to form larger particles called molecules. Certain molecules are arranged into small functional sources called organelles. Each organelle carries out a specific function within the cell. The nucleus, mitochondria and endoplasmic reticulum are organelles. The human body contains many distinct kinds of cells; each specialized to perform specific



**Fig. 1.10:** A: Molecular organization; B: Major classes of compound

function, e.g. muscle cells, bone cells, fat cells, blood cells and nerve cells.

- 2. Tissue level:** Tissues are groups of similar cells that perform specific functions. An example of a tissue is the muscle within the heart, which functions to contract and pump the blood through the body.
- 3. Organ level:** An organ is an aggregate of two or more tissues, integrated to perform a particular function. Each organ usually has one or more primary tissues and several secondary tissues. In the stomach, for example, the inside lining epithelium is considered as primary tissue because it performs the basic functions like secretion and absorption. Secondary tissue of the stomach is the supporting connective tissue and vascular, nervous and muscular tissue which are present in its wall.
- 4. System level:** The system of the body constitutes the next level of structural organization. A body system consists of various organs that have similar or related functions. Examples of systems are the circulatory system, endocrine system, etc. Certain organs may serve several systems. It should be kept in mind that these divisions are somewhat arbitrary as to which organs are included and which organs are excluded. Skeletal muscles attached to bones are part of the muscular system, but the smooth muscles around soft tissues are not. Skeletal muscles are attached to bones, and serve to move the bones, but bones are part of the skeletal system, not the muscular system. All the systems of the body are interrelated and function together, constituting the total organism.
- 2. Skeletal system:** It consists of **206 bones** that are connected by tendons, ligaments and cartilage. The skeleton not only helps us move, but it is also involved in the production of blood cells and the storage of calcium.
- 3. Muscular system:** It consists of about **650 muscles** that aid in movement, blood flow and other bodily functions. There are three types of muscle: Skeletal muscle which is connected to bone and helps with voluntary movement, smooth muscle which is found in the walls of the organs and helps to move substances through their lumen, and cardiac muscle which is found in the heart and helps pump the blood.
- 4. Lymphatic system:** The lymphatic system includes lymph nodes, lymph ducts and lymph vessels, and also plays a role in the body's defenses. Its main job is to make and move lymph, a clear fluid that contains white blood cells, which help the body fight infection. The lymphatic system also removes excess lymph fluid from bodily tissues and returns it to the blood.
- 5. Respiratory system:** It allows us to take in vital oxygen and expel carbon dioxide in a process we call breathing. It consists mainly of the trachea, the diaphragm and the lungs.
- 6. Digestive system:** It consists of a series of connected tubular organs that together, allow the body to break down and absorb food, and remove waste. It includes the mouth, esophagus, stomach, small intestine, large intestine, rectum, and anus. The liver and pancreas also play a role in the digestive system because they produce digestive juices.

## HUMAN BODY SYSTEMS

There are 11 organ systems in the human body:

- 1. Integumentary system:** It refers to skin which is body's largest organ. It protects us from the outside world, and is our first defense against bacteria, viruses and other pathogens. Our skin also helps regulate body temperature and eliminate waste through perspiration. In addition to skin, the integumentary system includes hair and nails. It is also site for many sensory receptors.
- 7. Nervous system:** It controls both voluntary action (like conscious movement) and involuntary actions (like breathing) and sends signals to different parts of the body. The central nervous system includes the brain and spinal cord. The peripheral nervous system consists of nerves that connect every other part of the body to the central nervous system.
- 8. Endocrine system:** It consists of eight major glands that secrete hormones into the blood. These

hormones, in turn, travel through the bloodstream to different tissues and regulate various bodily functions such as metabolism, growth and sexual function.

9. **Cardiovascular system:** The cardiovascular system consists of heart and blood vessels. Heart pump the blood to various organs of the body through arteries. Veins bring back blood to the heart from organs. The blood contains nutrients, oxygen, carbon dioxide, and hormones.
10. **Urinary system:** It helps to eliminate waste product called urea from the body, which is produced when certain foods are broken down. The urinary system includes two kidneys, two ureters, the bladder, two sphincter muscles and the urethra. Urine produced by the kidneys travels down the ureters to the bladder and exits the body through the urethra.
11. **Reproductive system:** It allows humans to reproduce. The male reproductive system mainly includes the penis and the testes (which produce sperm). The female reproductive system consists of the vagina, the uterus and the ovaries (which produce eggs/ovum). During conception, a sperm cell fuses with an egg cell, which creates a fertilized egg that implants and grows in the uterus.

Although these systems have different names, they all work interdependently, meaning they work together and depend on each other.

## Vital Organs

Humans have five vital organs that are essential for survival. These are the brain, heart, kidneys, liver and lungs.

The human brain is the body's control center, receiving and sending signals to other organs through the nervous system and through secreted hormones. It is responsible for our thoughts, feelings, memory storage and general perception of the world.

The human heart is a responsible for pumping blood throughout our body.

The job of the kidneys is to remove waste and extra fluid from the blood. The kidneys take urea out of the blood and combine it with water and other substances to make urine.

The liver has many functions, including detoxifying of harmful chemicals, breakdown of drugs, filtering of blood, and secretion of bile and production of blood-clotting proteins.

The lungs are responsible for extracting the oxygen from the air we breathe and transferring it to our blood where it can be sent to our cells. The lungs also remove carbon dioxide, which we exhale.

## Body Regions

The human body is divided into several regions that can be identified on the surface of the body (Fig. 1.11). Learning the terminology used with reference to these regions now will make it easier to learn the names of underlying structures later. The major body regions are the head, neck, trunk, upper extremity and lower extremity. The trunk is frequently divided into the thorax and abdomen.

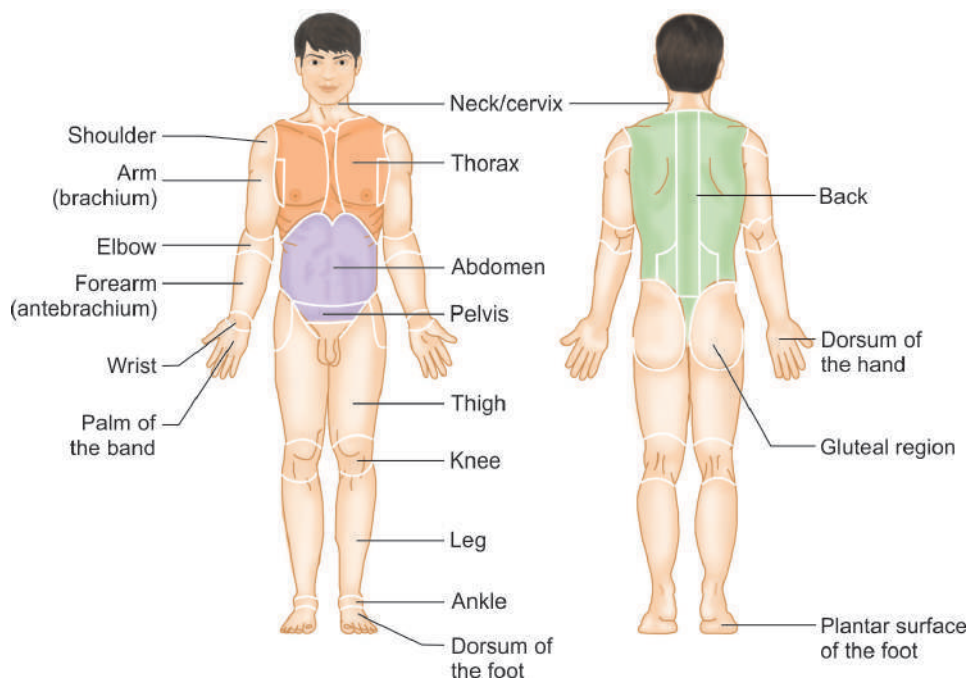


Fig. 1.11: Human body regions

**Head:** The head is divided into a facial region (which includes the eyes, nose and mouth) and a cranial region, which covers and supports the brain.

**Neck:** The neck referred to as the cervix or cervical region, supports the head and permits it to move.

**Thorax:** The thoracic region is commonly referred as chest. The mammary region of the thorax surrounds the nipple and in sexually mature females is enlarged as the breast. Between the mammary regions is the sternal region. The armpit is called axilla. The vertebral region, following the vertebral column extends the length of the back.

**Abdomen:** The abdomen is located below the thorax. The umbilicus is a landmark on the front and center of the abdomen. The abdomen has been divided into nine regions in order to describe the location of internal organs. The abdomen is anatomically divided by two horizontal lines and two vertical lines. These lines when intersect each other, make nine abdominal quadrants, which you shall study in the abdomen.

The **pelvic region** forms the lower portion of the abdomen. The **perineum** is the region containing the external sex organs and the anal opening. The center of the backside of the abdomen is called lumbar region. The sacral region is located further down at the point where the vertebral column terminates. The large hip muscles form the buttock or gluteal region.

**Upper extremity (upper limb):** The upper limb is anatomically divided into the shoulder, brachium (arm), antebrachium (forearm) and hand. The front of the hand

is referred to as the palm and back of the hand is called dorsum. The fingers are referred as digits.

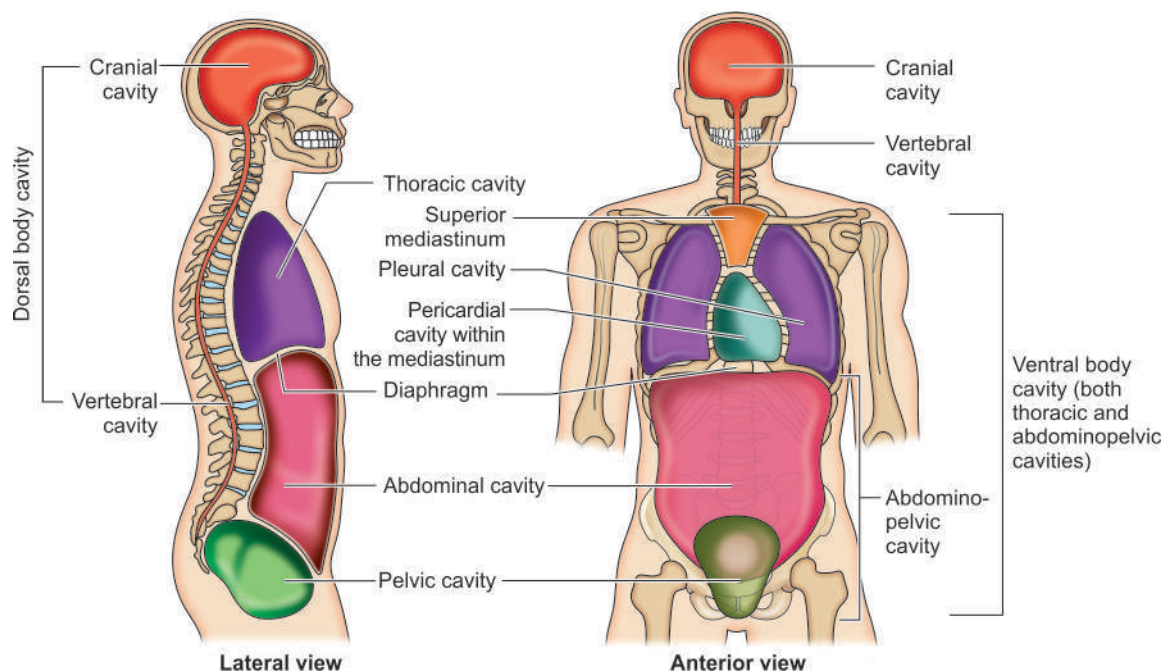
**Lower extremity (lower limb):** The lower limb consists of thigh, knee, leg and foot. The sole of the foot is referred to as the plantar surface. The dorsum of the foot is the top surface.

## Body Cavities

Body cavities are confined spaces within the body. During development, the cavity within the trunk is called coelom, which is lined with a membrane that secretes a lubricating fluid. The coelom is divided by the muscular diaphragm into an upper thoracic cavity, or chest cavity, and a lower abdomino-pelvic cavity (Fig. 1.12). Organs within the coelom are collectively called viscera. The thoracic cavity is further divided into **two pleural cavities** by invagination of lungs on both sides and a **pericardial cavity** in the middle by the heart. Similarly, with invagination of some abdominal organs, the abdominal cavity is referred as **peritoneal cavity**. In addition to these large cavities, there are several small cavities like oral or buccal cavity, middle ear cavities and nasal cavities. The cranial cavity contains brain and its coverings.

## Human Body Preservation for Teaching Gross Anatomy

Gross anatomy has been taught in most of the medical schools using a dead human body (cadaver). These cadavers are therefore used as educational tools. These cadavers are obtained as unclaimed dead bodies from the authorized government



**Fig. 1.12:** Human body cavities

institutions. Of late lot many people are donating their body for medical schools voluntarily after death. As medical students you need to value and respect these cadavers. It is also important for you to know the principles and methods preserving these cadavers. It is important that the dead bodies are fixed and preserved properly keeping in the mind the safety of students as well as teachers.

**Embalming:** It is a procedure of fixing the dead human body with appropriate chemicals and preventing them from destruction and decomposition. This is achieved by treating the cadaver with special chemicals, and one of the most important chemicals used for this purpose is formaldehyde. The selected embalming fluids should ensure that any infection is not transmitted from dead body on contact and prevention of putrefaction. Formaldehyde is bactericidal, fungicidal, and insecticidal. Formaldehyde,  $\text{CH}_2\text{O}$ , is a highly reactive aldehyde gas formed by oxidation or incomplete combustion of hydrocarbons. The embalming fluid is mixture of formalin, alcohols, glutaraldehyde, methanol, ethanol, phenol, water, and dyes. The commercially available formaldehyde is 37% of formalin in water (formalin is formaldehyde dissolved in water). It is diluted with water and now a day's fixative embalming fluid is not just formalin, instead it is mixture of many chemicals. Fixative solutions labelled as 10% buffered formalin are 4%

solutions of formaldehyde (a 10% solution made from a 37–40% solution of formaldehyde).

Before the embalming begins, the body is washed in a disinfectant solution. Limbs are massaged to relieve the stiffening of the joints and muscles. Any necessary shaving would also take place at this time. During the surgical portion of embalming process, the blood is removed from the body through the veins (femoral vein in the thigh and internal jugular vein in the neck) and replaced with embalming fluid through the arteries (femoral artery in the thigh and common carotid artery in the neck). After the arterial embalming, the body's cavities must be embalmed as well. A small incision is made in the lower part of the abdomen and a trocar (a sharp surgical instrument) is inserted into the body cavity. The organs in the chest cavity and the abdomen are then punctured and drained of gas and fluid contents. Once the entire blood flows out and embalming fluid start draining through the veins and the body becomes heavy, the body is fully embalmed. These embalmed cadavers can be refrigerated (cold stored) or in the formalin tank (5 to 10% concentration) for anatomical study and dissection. Students and employees who handle formalin fixed cadavers must have read and understood the safety guidelines of their institution regarding hazards of formaldehyde concentration. Given an opportunity every medical student must observe the process of embalming.



# General Anatomy

## Competencies

**AN: 1.2, 2.1 to 2.6, 3.1 to 3.3, 4.1 to 4.5, 5.1 to 5.8, 6.1 to 6.3, 7.1 to 7.8**

## Objectives

- To list the functions and layers of the skin
- To list the variety of skin lines and their locations in the body
- To define fascia and to discuss its layers, structure and functions briefly
- To name the three types of cartilage and to list their locations in the body
- To list the functions of the bone
- To identify the bones in a human skeleton
- To classify the bone based on the position, shape, gross structure and development giving examples to each variety
- To name the three types of muscles present in the body and to give their locations and functions
- To discuss the arrangement of skeletal muscle fibres, lubricating mechanisms associated with it
- To know the importance of nerve supply to the skeletal muscle
- To discuss the mechanism of action of the skeletal muscle
- To classify the joints giving examples to each variety
- To list the different types of synovial joints and to give examples to each variety
- To describe the structure of a typical synovial joint
- To describe the importance of nerve supply to the joint
- To describe the movements occurring at the synovial joint
- To define artery, arterioles, capillaries, sinusoids, venules and veins
- To list the types of arterial anastomoses and to give their location and significance
- To define lymph, lymph vessels and lymph node
- To list the functions of lymphatic system
- To list the cells forming the nervous tissue with their functions
- To define a nerve, sensory nerve and motor nerve
- To describe the formation of a typical spinal nerve
- To list the twelve cranial nerves

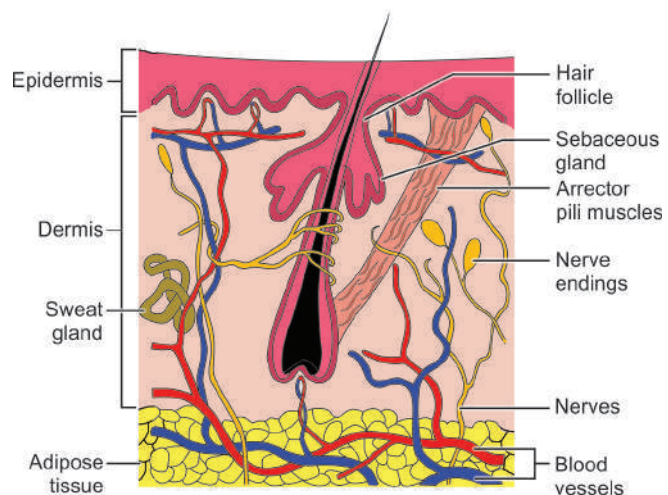
## SKIN

Skin covers the entire external surface of the body including external auditory meatus (outer ear) and lateral aspect of tympanic membrane.

Structurally skin is complex and highly specialized lamina having a surface area between 1.2 and 2.2 m<sup>2</sup>. The thickness ranges from about 1.5 to 4.0 mm. Skin is also called cutis or integument. Skin consists of an outer epidermis (cellular layer) and inner dermis (connective tissue layer). Skin is associated with sweat and sebaceous glands and also hair follicles (Fig. 2.1). These structures will be discussed in Chapter 7.

## Functions

- Skin protects against micro-organisms, toxic substances, ultraviolet radiation and friction.



**Fig. 2.1:** Schematic representation of skin