

Introduction to Anatomical Terms and Organization of the Human Body



Learning Objectives

On completion of the chapter, students will be able to:

- Enumerate various systems of the body.
- Define anatomical and lithotomy positions.
- Enumerate parts of upper limb.
- Enumerate parts of lower limb.

Chapter Outline

- Subdivisions of Anatomy and Physiology
- Parts of the Body
- Terminologies
- Environment
- Homeostasis

Key Terms

Anatomical position: Person standing erect, eyes looking forward, feet together and forearms supinated with palms facing forward.

Coronal plane: Divides the body into anterior and posterior halves.

Midsagittal plane: Divides the body into exactly right and left halves from anterior to posterior sides.

Pronation: When the palm faces backward or downward.

Prone position: Person lies on his/her abdomen with hands on sides and feet together.

Supination: When the palm is facing forward or upward.

Supine position: Person is lying on his/her back with hands on the sides and feet together.

Transverse plane: Divides the body or limb into upper/proximal and lower/distal parts.

Human body is unique, comprising of various organs and systems, which work both independently and interdependently according to its needs. The human body has to be studied from its normal structural and functional point of view. Once the normal structure and functions are understood, it is easy to comprehend the diseased state and necessary treatment to bring the status back to normal.

Anatomy is the science of learning the normal structure of the human. **Physiology** deals with learning and understanding the functions of the body. Thus, anatomy and physiology are the two sides of the same coin. Physiology is the enacting of various scenes in anatomy hall/theatre. The two branches of medical science are intimately related.

SUBDIVISIONS OF ANATOMY AND PHYSIOLOGY

The main subdivisions of anatomy are **gross anatomy** including neuroanatomy, **histology** or microscopic anatomy, **embryology** or developmental anatomy.

Surface anatomy is the projection of deeper structures on the skin.

Clinical anatomy emphasizes certain relations that are important to the physician/surgeon/dentist.

Radiological and imaging anatomy is the study of various components of the body by using X-ray, ultrasound, etc.

Genetics deals with the information contained in the chromosomes.

Systemic anatomy is the study of the structure of various systems of the body.

Similarly, physiology can be subdivided into renal physiology (study of functions of kidney), endocrinology (study of hormones and how they control body functions), **cardiovascular physiology** (study of functions of heart and blood vessels), **respiratory physiology** (study of functions of air passage ways and lungs), **neurophysiology** (study of functional properties of nerve cells), etc.

The study of anatomy and physiology can be divided into the following twelve major body systems. These body systems influence one other and work interdependently and independently to maintain health. These systems are as follows:

- **The integumentary system (dermatology)** consists of the skin with its various appendages, i.e., hair, sweat gland, sebaceous gland and nail (Fig. 1.1). Skin is the outer most protective and sensitive covering of the body.

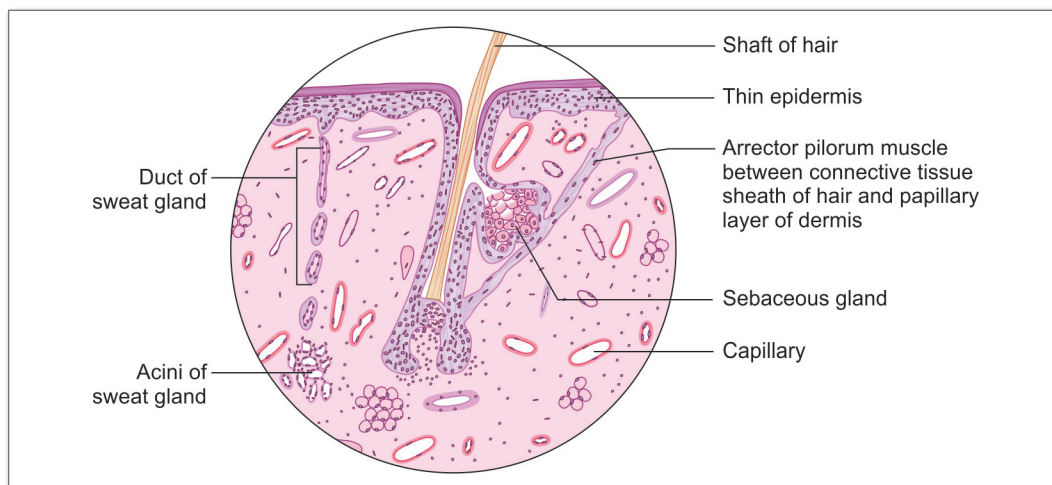


Figure 1.1: Skin

- The **skeletal system (osteology)** consists of numerous cartilages and bones, providing support and symmetry to the body (Fig. 1.2). Cartilage keeps the respiratory pathway patent. Bones being the largest store house of calcium provide attachment to numerous skeletal muscles for locomotion. Bones also make cavities or cages for protection of organs like brain, heart, lungs, and reproductive organs.
- **Muscular system** is the system which moves the body externally from one place to other and is responsible for facial expressions with the help of voluntary muscles (Fig. 1.3). The smooth muscles of the digestive system move the food components from esophagus down to stomach, intestines and eliminate the waste products. The third type of muscle is cardiac muscle which receives and propels the blood to the limbs and to various other parts of the body for providing oxygen.
- The **articular system (arthrology)** comprises various joints with their ligaments (Fig. 1.2). Various types of movements take place at the synovial joints. Cartilaginous joints are for growth of the bones during childhood and for providing stability. The fibrous joints also allow growth of the bones and provide integrity and stability to the adjoining bones.
- **Respiratory system (pulmonology)** consists of nose, nasopharynx, larynx, trachea, bronchi, bronchioles, alveoli (Fig. 1.4). These structures oxygenate the venous blood and help in elimination of carbon dioxide.

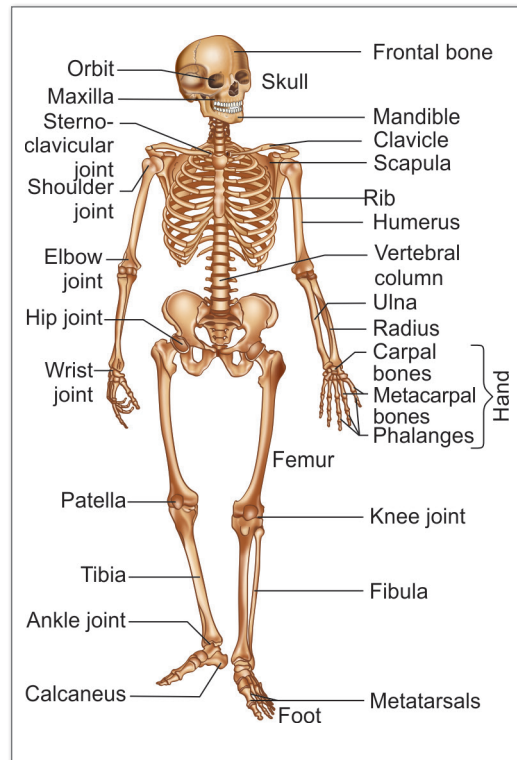


Figure 1.2: Human skeleton

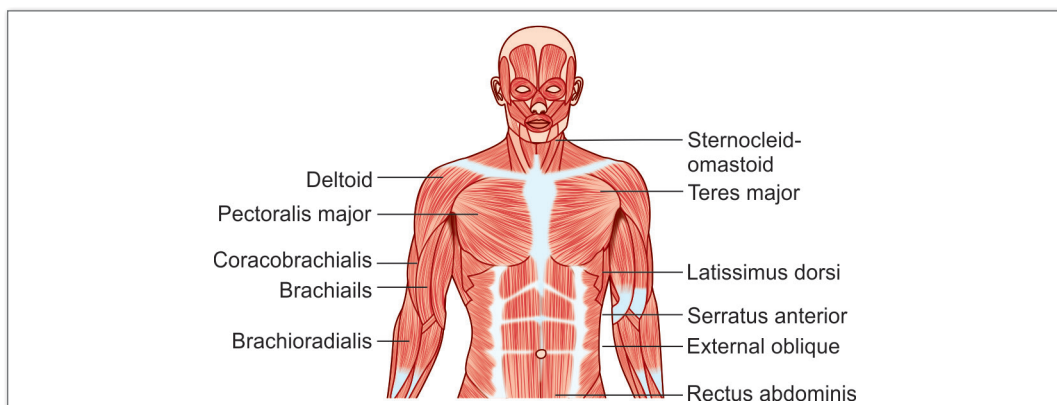


Figure 1.3: Skeletal muscles

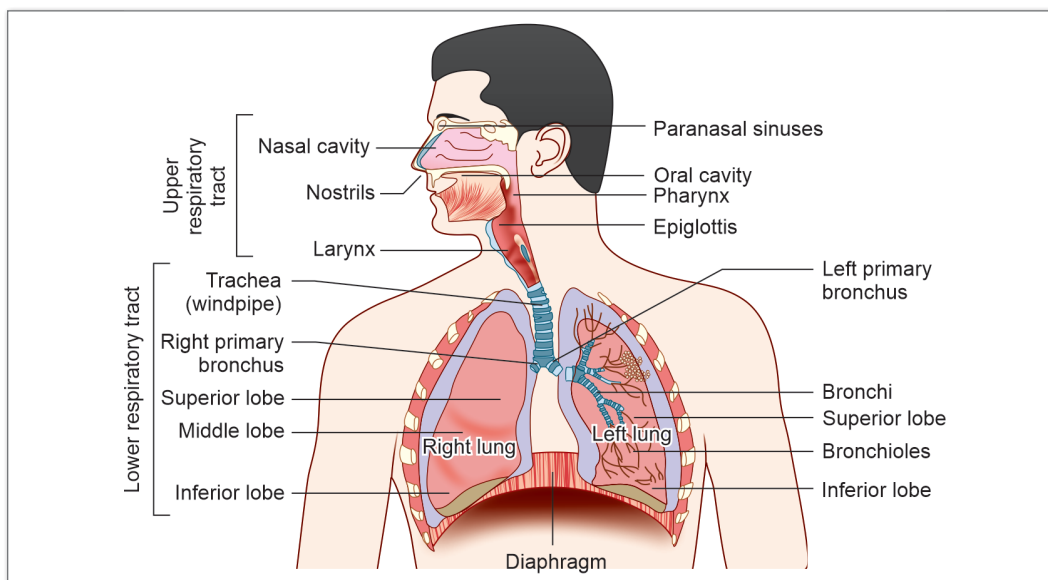


Figure 1.4: Respiratory system

- **Circulatory system (angiology)** comprises cardiovascular system which consists of heart and blood vessels, i.e., arteries, veins and capillaries (Figs 1.5 and 1.6). Blood supplies nutrients and oxygen to cells and takes away carbon dioxide and wastes from cells and help to regulate acid-base balance, temperature and water content of body fluids. Blood components help to defend against diseases and disease causing organisms.

Lymphatic system comprises various lymph vessels which withdraw excess tissue fluid with macromolecules, filters it through lymph nodes and returns it to the venous system (Fig. 1.7).

- **Digestive system (gastroenterology)** comprises various organs associated with ingestion, mastication, deglutition, digestion, absorption of food components. This system also eliminates the solid waste from the body through the anal canal. It is made up of a long tube from mouth to the anus and various associated glands like liver, gallbladder, pancreas, salivary glands, gastric and intestinal glands (Fig. 1.8).
- **Nervous system (neurology)** consists of billions of neurons included in the central nervous system (brain and spinal cord) and peripheral nervous system (cranial and spinal nerves) (Fig. 1.9). This is the system which controls the whole body including its muscles, glands and organs. The nervous system controls both our voluntary and involuntary activities. The personality of the person is dependent on the integrity of the nervous system.
- **Urinary system (nephrology and urology)** helps in excretion of liquid waste from the body. This system comprises kidneys, ureters, urinary bladder and urethra (Fig. 1.10). The kidneys filter the blood and produce, transport, store and expel the urine at frequent intervals.
- **Reproductive system (andrology in males and gynaecology in females)** consists of different organs in males and females. In males, these are testes, epididymes, vas deferens, ejaculatory ducts, urethra, prostate, seminal vesicles and penis (Fig. 1.11).

In females, the organs are ovaries, fallopian tubes, uterus, vagina (Fig. 1.12). These two sets of organs are responsible for the production of ova and spermatozoa which on fertilization,

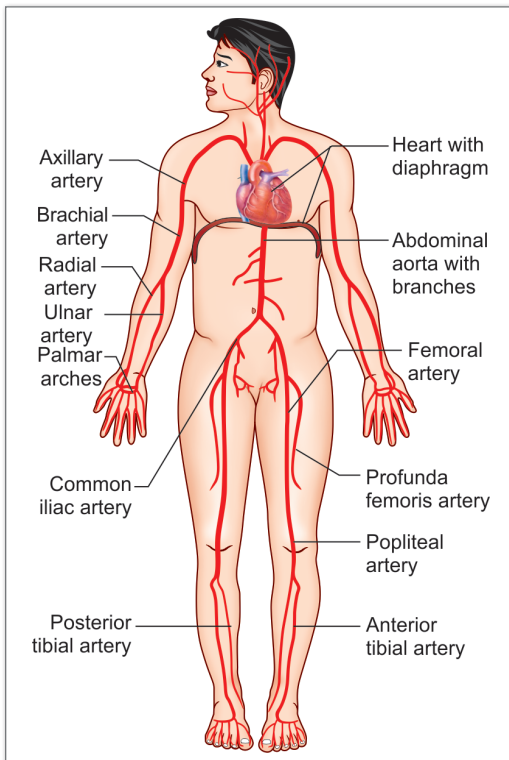


Figure 1.5: Arterial system

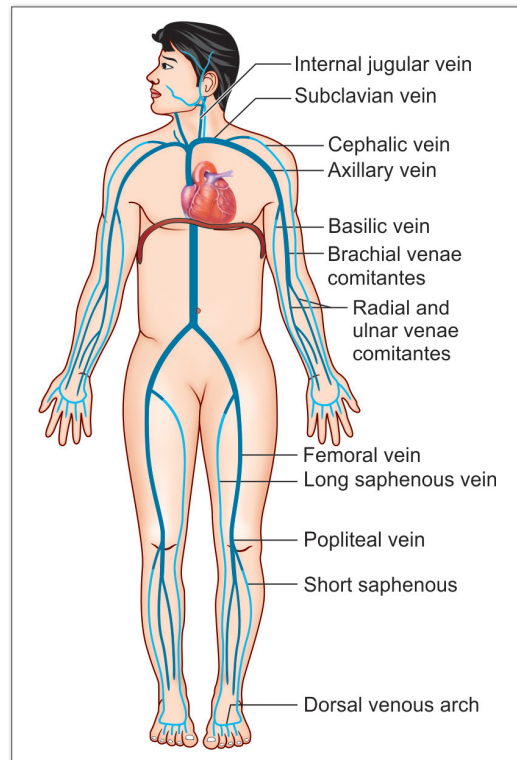


Figure 1.6: Venous system

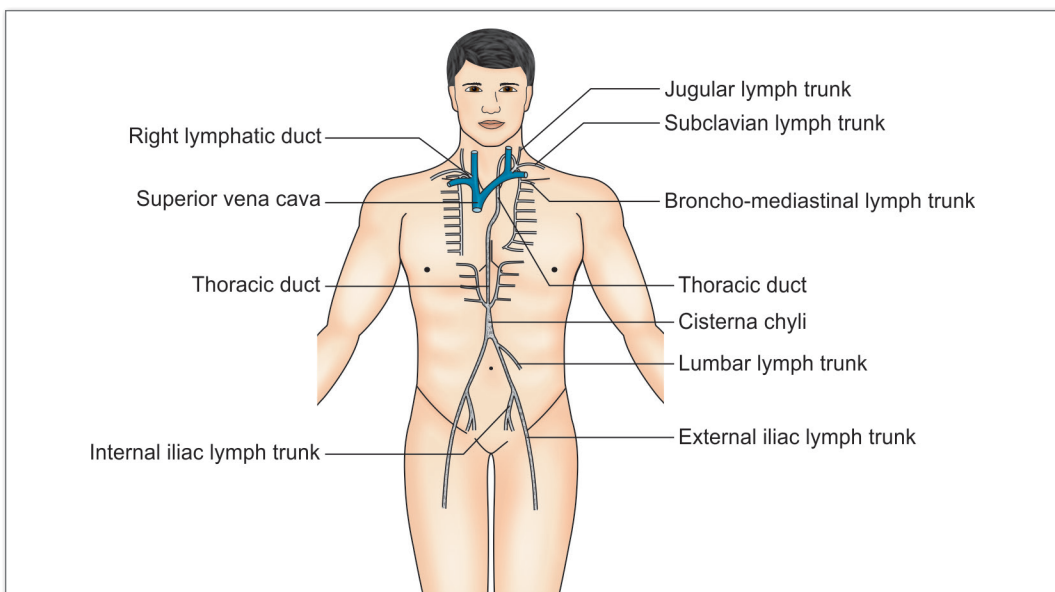


Figure 1.7: Lymphatic system

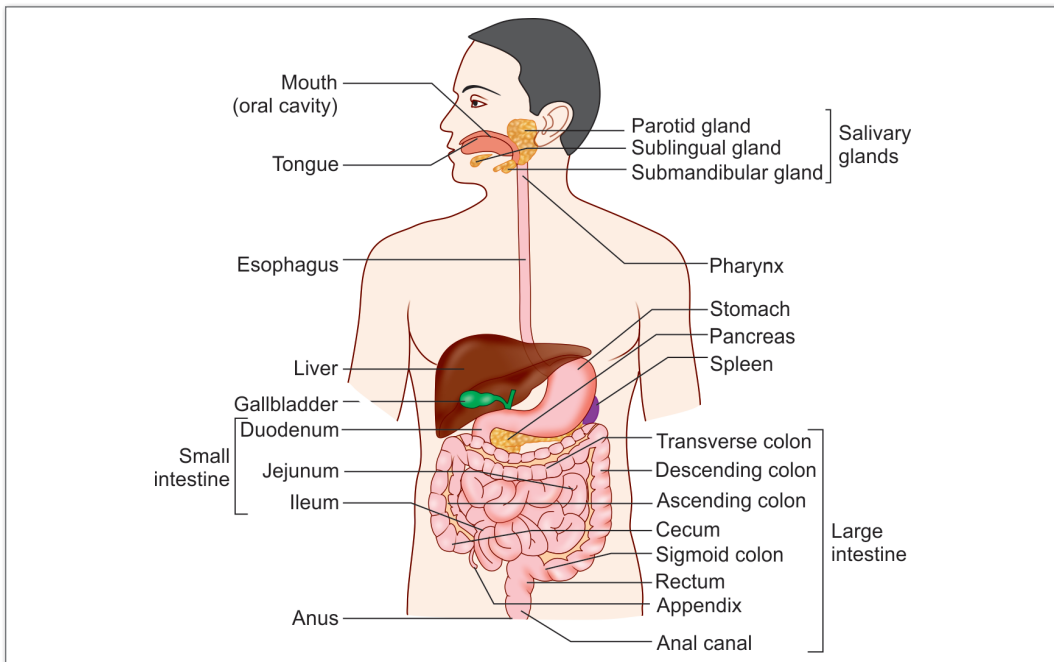


Figure 1.8: Digestive system

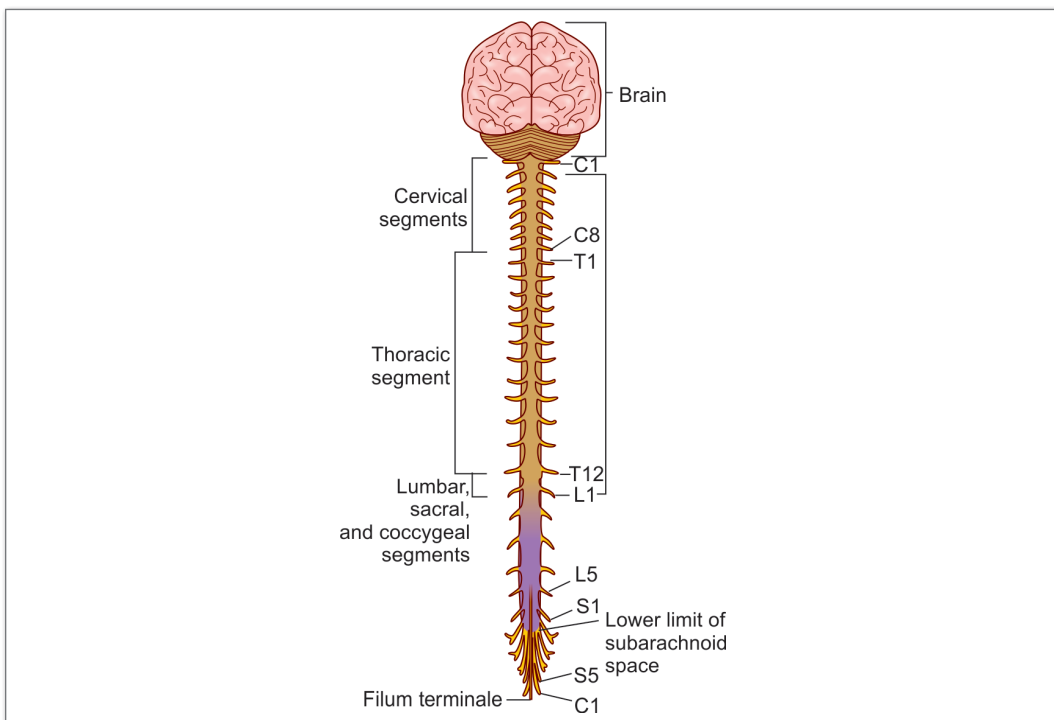


Figure 1.9: Nervous system

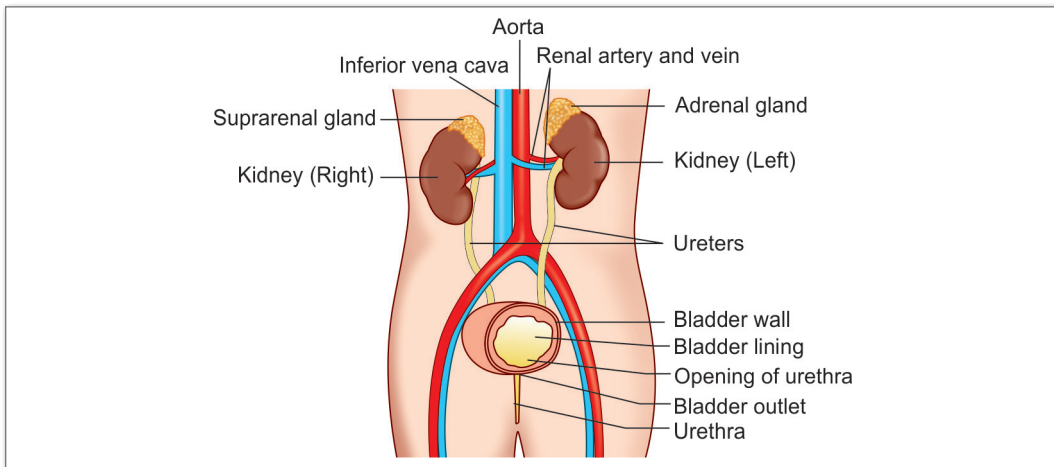


Figure 1.10: Urinary system

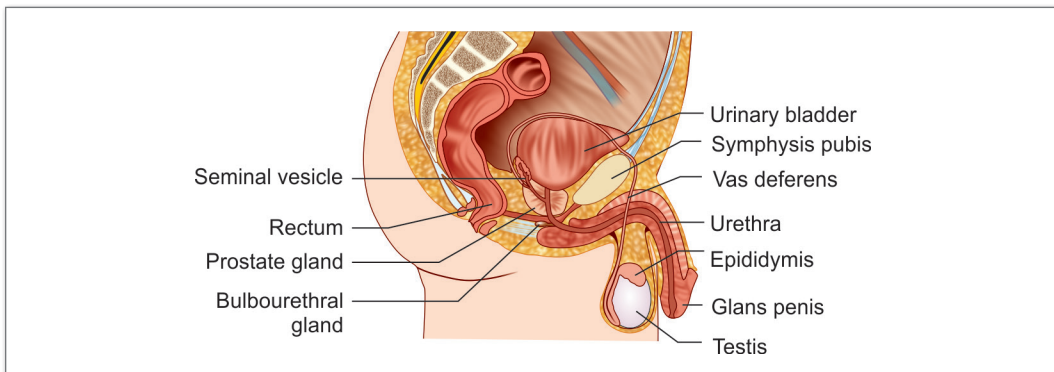


Figure 1.11: Male reproductive system

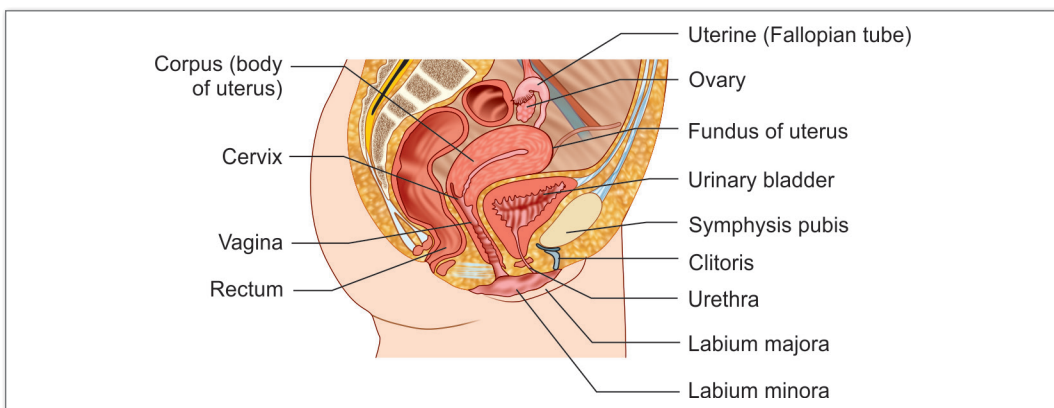


Figure 1.12: Female reproductive system

implantation and proper nourishment in the uterus develops into a foetus. The foetus delivers out after 9 months of pregnancy.

- **The endocrine system (endocrinology)** consists of ductless glands like hypothalamus, hypophysis cerebri, thyroid, parathyroid, suprarenal glands and islets of Langerhans in pancreas. These produce hormones, that are carried to various target organs via blood (Fig. 1.13). These hormones influence metabolism and other processes like production of spermatozoa and the menstrual cycle.
- **Special senses** include senses of taste, sight, smell, hearing, balance and touch (Fig. 1.14). Taste is appreciated by the papillae present in the tongue, epiglottis and soft palate. Sense of sight is appreciated in the nervous layer, the retina of the eyeball. Receptors of smell are only present in the mucous membrane of the uppermost part of the nasal cavity. Hearing and balance are compactly organised in the internal ear. Touch is perceived through the skin.

Body cavities: The organs that make up the systems of the body are contained in three cavities, i.e., cranial, thoracic and abdominopelvic cavity (Fig. 1.15).

PARTS OF THE BODY

The human body consists of the following parts:

- Head, neck and brain
- Trunk divided into upper part or thorax and lower part or abdomen (pelvis).
- Two upper limbs
- Two lower limbs.

Head, Neck and Brain

Head is the upper most or cranial part of the body. Bone of the head is the skull (cranial cavity) which contains brain, and special sense organs like eyes, ears, nose and tongue. Various regions are shown in Figure 1.16.

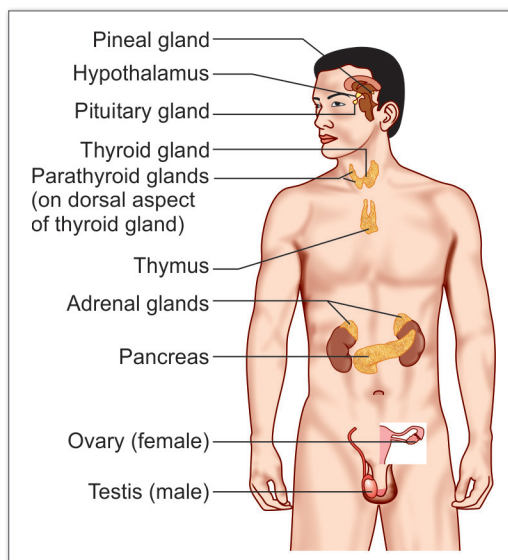


Figure 1.13: Endocrine system

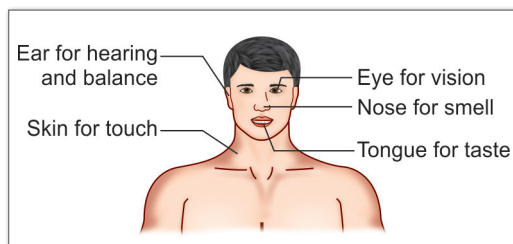


Figure 1.14: Special senses

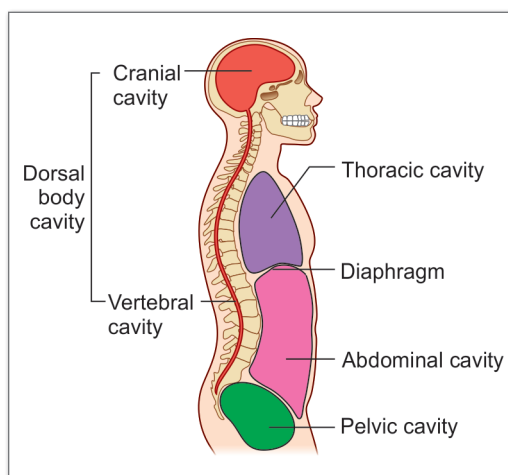


Figure 1.15: Body cavities

Neck follows the head. Bones of neck are 1–7 cervical vertebrae. It contains big blood vessels, nerves and tubes like trachea and esophagus.

Trunk

It is divided into:

- An upper part or thoracic cavity.
- A lower part or abdominopelvic cavity.

Thorax

Thorax/thoracic region lies below the neck. Bones in this part are 1–12 thoracic vertebrae, one sternum and 12 pair of ribs and costal cartilages. All these form the bony **thoracic cavity** which contains single heart, more to the left side of the body, blood vessels, right and left lungs with trachea and bronchi, esophagus, nerves and lymph nodes. **Mediastinum** is the space between the lungs including the structures found there, such as heart, esophagus and blood vessels.

Abdomen

Abdomen/abdominal region is present below the thorax. The thoracoabdominal diaphragm separates the two cavities. Bones here are 1 to 5 lumbar vertebrae. The abdominal cavity contains digestive system and urinary system. It also contains spleen, suprarenal glands, blood vessels, nerves and lymph nodes. Many organs are pushed up in thoracic cavity (Fig. 1.16).

Lower part of abdomen is called the **pelvis**, bounded by the two hip bones and sacrum with coccyx. The **pelvic cavity** so formed contains lower part of urinary and digestive systems. In between it contains the reproductive organs which are different in male and female.

The lowest part of abdomen is the **perineum** which contains the openings of urethra and anal canal in male and openings of urethra, vagina and anal canal in female.

Upper Limbs

They are made of the following parts:

- **Shoulder girdle** is made of two bones, the **clavicle** and **scapula** and includes pectoral region in the front of chest, scapular region in the back of chest and shoulder joint. Axilla lies between the upper aspect of thorax and the medial side of upper limb.
- **Arm or brachium** extends between shoulder joint and the elbow joint. Only one bone, **humerus** forms the skeleton of arm (Fig. 1.16).
- **Forearm or antebrachium** extends between the elbow and the wrist joints. Two bones, the **radius** laterally and **ulna** medially lie in this region. Radius

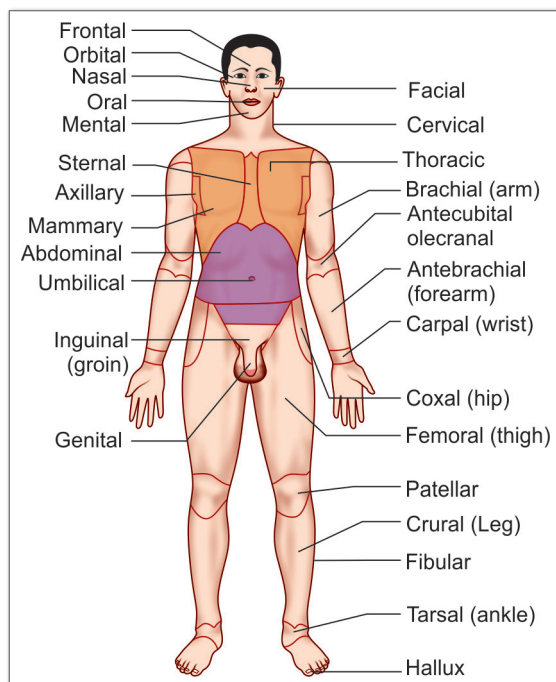


Figure 1.16: Regions of the body

rotates over ulna causing movements of pronation of forearm with the palm facing backward. When the two bones are parallel to each other, the position is called supine, with the palm facing forward.

- **Hand or carpal** region extends from the wrist to the tips of the digits. Bones in this region are 8 small carpal bones, 5 metacarpals and 14 phalanges.

The **palm** is the region over the metacarpals and the phalanges form the skeleton of the digits.

There are five digits from lateral to medial side. These are called 1st digit or thumb, 2nd digit or index finger, 3rd digit or middle finger, 4th digit or ring finger and 5th digit or little finger (see Fig. 1.2).

Lower Limbs

These are two identical limbs. Its various parts are:

- **Pelvic girdle** comprised of two hip bones and a sacrum. Each **hip bone** is made up of three bones: (1) Ilium, (2) Ischium and (3) Pubis. Inguinal region in front is at the junction of abdomen and lower limb and gluteal region on the back of ilium and ischium (Fig. 1.16).
- **Thigh** extends between the hip and knee joints. **Femur** is the only bone lying in this area.
- **Leg** extends between the knee and ankle joints. Two bones, a large **tibia** and slender **fibula** form skeleton of this region.
- **Foot** lies distal to the ankle joint. Bones forming the foot are 7 tarsal bones, 5 metatarsal bones and 14 small phalanges.

Phalanges are very small and form skeleton of the small digits. The digits are named from medial to lateral as 1st digit or big toe, 2nd digit or 2nd toe to 5th digit or 5th toe. The sole of the foot faces plantarwards (see Fig. 1.2).

TERMINOLOGIES

Anatomical Position

When a person is standing straight, with eyes looking forward, both arms by the side of body, palms facing forward, both feet together, the position is anatomical position. All the descriptions of viscera, vessels and nerves are done as if the body is in anatomical position (Fig. 1.17).

Supine Position

When a person is lying on his/her back, arms by the side, palms facing upward and feet together, the position is supine position.

Prone Position

Person lying on his face, chest and abdomen, is said to be in prone position.

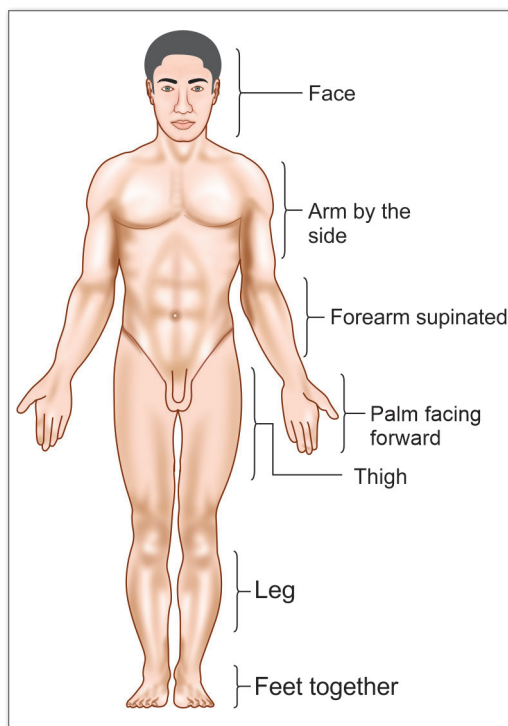


Figure 1.17: Anatomical position

Lithotomy Position

Person lying on her back with legs up and feet supported with straps. In this position, the perineal region is well visualized. This position is mostly used for delivery of the baby (Fig. 1.18).

Planes

A plane passing through the center of the body dividing it into two equal right and left halves is **median** or **midsagittal plane** (Fig. 1.19).

Any plane parallel to median plane is a **sagittal plane**.

A plane at right angles to median/midsagittal plane which divides the body into anterior and posterior halves is called a **coronal plane**.

A plane at right angles to both sagittal and coronal planes which divides the body into upper and lower parts is called a **transverse plane**.

Terms Used in Relation to Trunk

- **Ventral or anterior** is the front of trunk (Figs 1.20A and B).
- **Dorsal or posterior** is the back of trunk.
- **Medial** is a plane close to the median plane.
- **Lateral** is plane away from the median plane.
- **Cranial/superior** is close to the head end of trunk.
- **Caudal/inferior** is close to the lower end of the trunk.
- **Superficial** is close to skin/toward surface of body.
- **Deep** is away from skin/away from surface of body.
- **Ipsilateral**: On the same side of body as another structure.
- **Contralateral**: On opposite side of body from another structure.

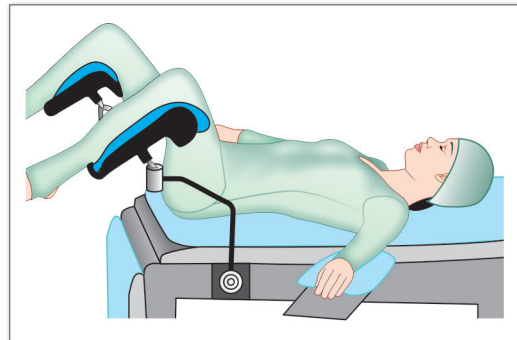


Figure 1.18: Lithotomy position

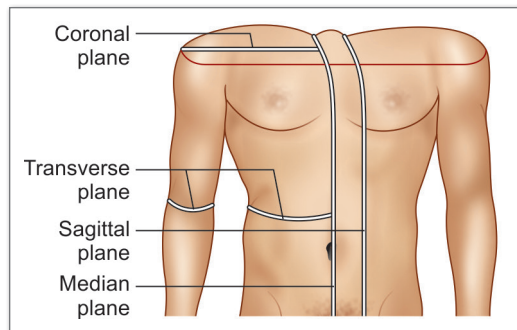


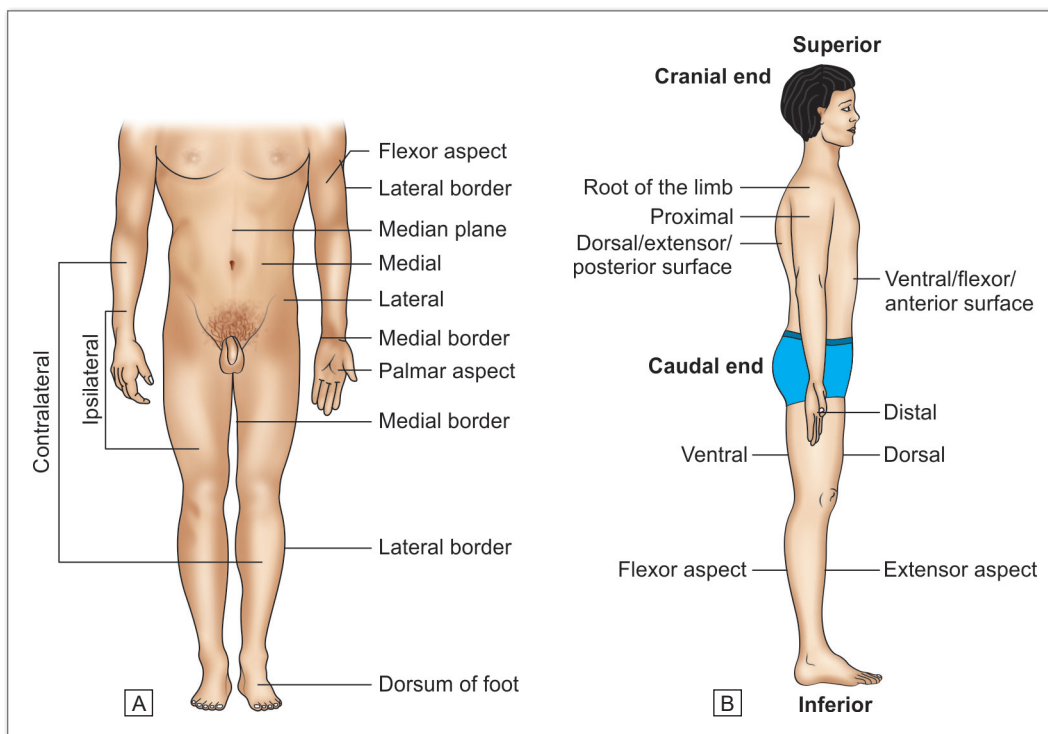
Figure 1.19: Anatomical planes

Terms Used in Relation to Upper Limb

- **Ventral or anterior** is the front or flexor aspect (Fig. 1.20A).
- **Dorsal or posterior** is the back aspect.
- **Medial border** lies along the little finger, medial border of forearm and arm.
- **Lateral border** follows the thumb, lateral border of forearm and arm.
- **Proximal** is close to root of limb, while **distal** is away from the root (Fig. 1.20B).
- **Palmar** aspect is the front of the palm.
- **Dorsal** aspect of hand is on the back of palm.
- **Flexor** aspect is front of upper limb.
- **Extensor** aspect is back of upper limb.

Terms Used in Relation to Lower Limb

- **Ventral** aspect is the back of lower limb (Fig. 1.20B).
- **Dorsal** aspect is the front of lower limb.



Figures 1.20A and B: Anatomical terms

- **Medial border** lies along the big toe or hallux, medial border of leg and thigh.
- **Lateral border** lies along the little toe, lateral border of leg and thigh (Fig. 1.20A).
- **Flexor aspect** is back of lower limb.
- **Extensor aspect** is front of lower limb.
- **Proximal** is close to the root of limb, while **distal** is away from it.

Terms of Position of Body Movements

Movements in general at synovial joints are divided into four main categories.

1. **Gliding movement:** Relatively, flat surfaces move back-and-forth and from side-to-side with respect to one another. The angle between articulating bones does not change significantly.
2. **Angular movements:** Angle between articulating bones decreases or increases. In **flexion** there is decrease in angle between articulating bones (Fig. 1.21) and in **extension** there is increase in angle between articulating bones (Fig. 1.22). **Lateral flexion** is movement of trunk sideways to the right or left at the waist. **Adduction** is movement of bone toward midline whereas **abduction** is movement of bone away from midline (Fig. 1.23).
3. **Rotation:** A bone revolves around its own longitudinal axis. In **medial rotation**, anterior surface of a bone of limb is turned toward the midline. In **lateral rotation**, anterior surface of bone of limb is turned away from midline.
4. **Special movements:** These occur only at certain joints, e.g., pronation, supination in forearm; protraction and retraction at temporomandibular joint.

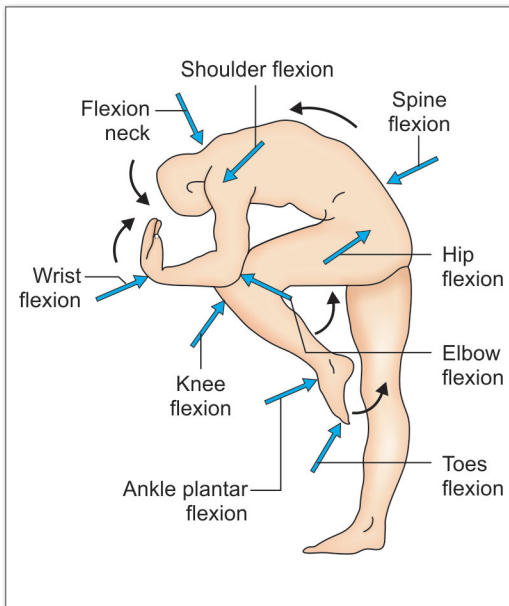


Figure 1.21: Flexion

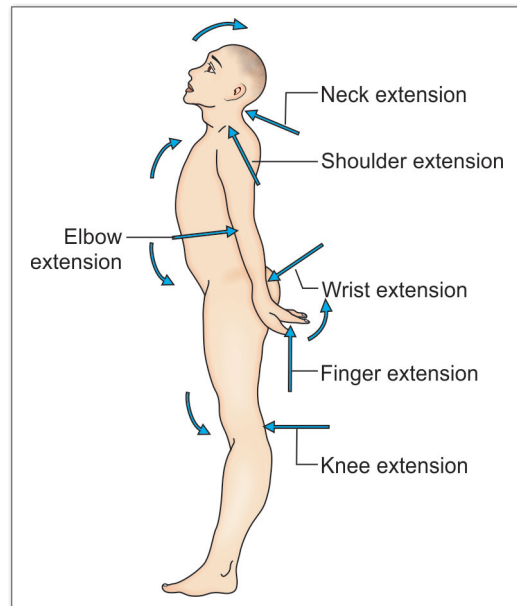


Figure 1.22: Extension

In Upper Limb

- **Flexion:** When two flexor surfaces are brought close to each other, e.g., in elbow joint when front of arm and forearm are opposed to each other (Fig. 1.21).
- **Extension:** When extensor or dorsal surfaces are brought in as much approximation as possible, e.g., straightening the arm and forearm at the elbow joint (Figs 1.22 and 1.24).
- **Abduction:** When limb is taken away from the body.
- **Adduction:** When limb is brought close to the body.
- **Circumduction:** It is movement of distal end of a body part in a circle. A combination of flexion, abduction, extension and adduction in a sequence is called circumduction as in bowling (Fig. 1.23).
- **Medial rotation:** When the arm rotates medially bringing the flexed forearm across the chest.
- **Lateral rotation:** When arm rotates laterally taking the flexed forearm away from the body.
- **Supination:** When the palm is facing forward or upward, as in putting food in the mouth (Fig. 1.24).

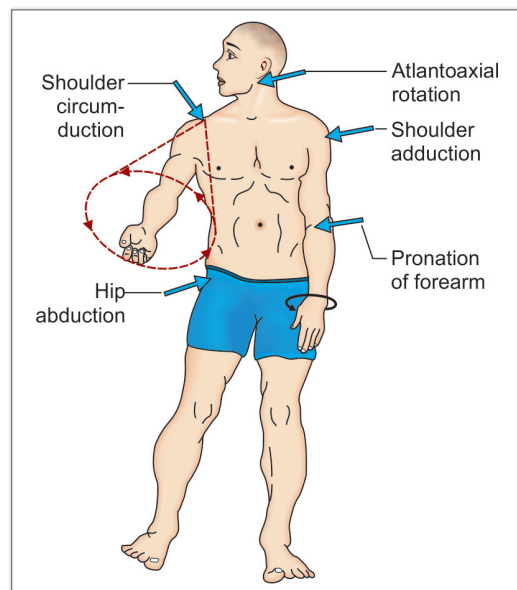


Figure 1.23: Movements of upper limb

- **Pronation:** When the palm faces backward or downward, as in picking food with fingers from the plate (Fig. 1.24).
- **Adduction of digits/fingers:** When all fingers get together.
- **Abduction:** When all fingers separate. The axis of movement of the fingers is the line passing through the center of the middle finger.
- **Opposition of thumb:** When tip of thumb touches the tips of any of the fingers.
- **Circumduction of thumb:** Movement of flexion, abduction, extension and adduction in sequence.

In Lower Limb

- **Flexion of thigh:** When front of thigh comes in contact with front of abdomen (Figs 1.21 and 1.25).
- **Extension of thigh:** When person stands erect (Figs 1.22 and 1.25).
- **Abduction:** When thigh is taken away from the median plane.
- **Adduction:** When thigh is brought close to median plane.
- **Flexion of knee:** When back of thigh and back of leg come in opposition (Fig. 1.25).
- **Extension of knee:** When thigh and leg are in straight line as in standing.
- **Dorsiflexion of foot:** When dorsum of foot is brought close to front of leg and sole faces forward.
- **Plantar flexion of foot:** When sole of foot or plantar aspect of foot faces backward.
- **Inversion of foot:** When medial border of foot is raised from the ground (Fig. 1.25).
- **Eversion of foot:** When lateral border of foot is raised from ground.

In the Neck

- **Flexion:** When face comes closer to chest (Fig. 1.21).
- **Extension:** When face is brought away from the chest (Fig. 1.22).
- **Lateral flexion:** When ear is brought close to shoulder.
- **Opening the mouth:** When lower jaw is lowered to open the mouth.
- **Closure of the mouth:** When lower jaw is opposed to the upper jaw, closing the mouth.

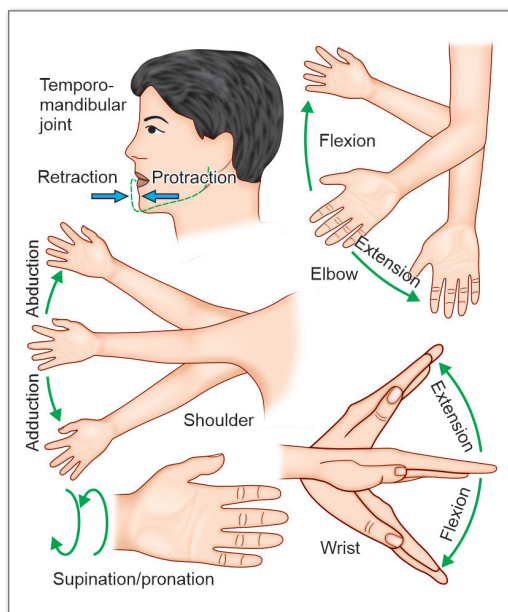


Figure 1.24: Movements of some of the joints

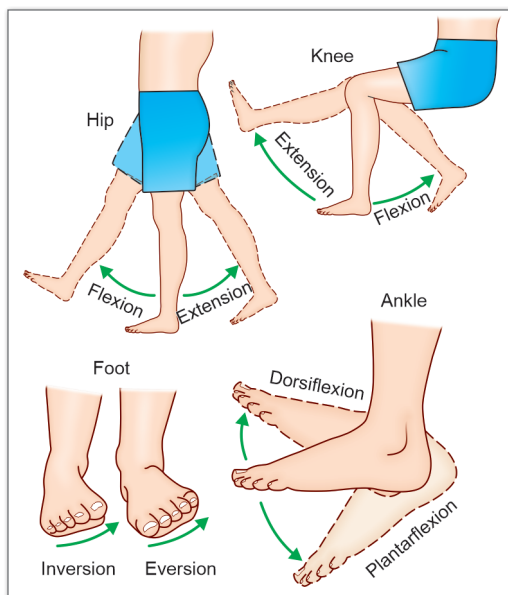


Figure 1.25: Movements of joints of lower limb

- **Protraction:** When lower jaw slides forward in its socket in the temporal bone of skull (Fig. 1.24).
- **Retraction:** When lower jaw slides backward in its socket in the temporal bone of skull.

In the Trunk

- Forward bending is **flexion** (Fig. 1.21).
- Backward bending is called **extension**.
- Sideward movement is **lateral flexion**.
- Sideward rotation is **lateral rotation**.

ENVIRONMENT

The environment around the body which provides oxygen and nutrients required by all the cells of body is called **external environment**. The skin is the barrier between the body cells and the external environment. The cells are surrounded by a variable amount of fluid called **interstitial/tissue fluid**. This constitutes **internal environment**. The nutrients reach the cells from tissue fluid and the metabolic waste products of the cells also reach into the tissue fluid, from where these are transported into lymphatic or venous system.

Cell membrane around each cell acts as a barrier between intracellular components and tissue fluid constituents.

HOMEOSTASIS

Homeostasis actually means **unchanging**. But, the internal environment can change within narrow limits only. The control of homeostasis is done by a control system.

Control center determines the limits within which the variable factor should be maintained. It receives input from **detector or sensor** and integrates the incoming information. When the incoming signal indicates adjustment is needed the output of control center to **effector** (produces a response or effect) is changed to maintain homeostasis. The proper functioning of body cells depends on precise regulation of the composition of their surrounding fluid. The homeostasis maintains the composition and volume of body fluids found inside cells as well as surrounding them.

Negative Feedback Mechanisms

The effector response decreases the effect of original stimulus in negative feedback mechanism thus maintaining the homeostasis.

↑ Thyroxine → Hypothalamus → ↓ Thyrotropin releasing factor → Anterior pituitary
↓
Thyroxine lowered ← ↓ TSH

Positive Feedback Mechanisms

The stimulus increases the response. During labor, oxytocin level is high, causing uterine contractions. These force the baby's head into cervix of uterus stimulating stretch receptors. In response to this, more oxytocin hormone is released, further strengthening the contractions and maintaining labor. After birth of baby stimulation of stretch receptors stops in cervix and the release of oxytocin stops.

ASSESS YOURSELF

Long Answer Questions

1. Name various systems of human body. Enumerate parts of respiratory system.
2. Describe various body planes. What is their importance?

Short Answer Questions

1. Mention the terms of position of body movements.
2. What is the importance of pronation and supination?

Multiple Choice Questions

1. Which of the following planes divides the body into anterior and posterior parts?
 - a. Sagittal plane
 - b. Coronal plane
 - c. Median plane
 - d. Transverse plane
2. In anatomical position, palmar surface of the hands:
 - a. Faces anteriorly
 - b. Faces posteriorly
 - c. Faces superiorly
 - d. Faces inferiorly
3. In which position a person is lying on his back with the hips and knees flexed and thighs apart?
 - a. Supine position
 - b. Prone position
 - c. Anatomical position
 - d. Lithotomy position
4. In which of the following movements, the upper limb will move away from the body in the coronal plane?
 - a. Adduction
 - b. Abduction
 - c. Flexion
 - d. Extension
5. In which of the following movements, the fingers are spread apart away from the neutrally positioned middle finger?
 - a. Abduction
 - b. Adduction
 - c. Flexion
 - d. Extension

Answers to Multiple Choice Questions

1. b 2. a 3. d 4. b 5. a