Chapter
1

Introduction

Life is a book with three chapters. Two are already written by God—birth and death. The chapter in the middle is empty; fill it with smile, love and faith.

Human anatomy is the science which deals with the structure of the human body. The term, 'anatomy', is derived from a Greek word, "anatome", meaning cutting up. The term 'dissection' is a Latin equivalent of the Greek *anatome*. However, the two words, anatomy and dissection, are not synonymous. Dissection is a mere technique, whereas anatomy is a wide field of study.

Anatomy forms firm foundation of the whole art of medicine and introduces the student to the greater part of medical terminology. "Anatomy is to physiology as geography is to history, i.e. it describes the theatre in which the action takes place."

SUBDIVISIONS OF ANATOMY

Initially, anatomy was studied mainly by dissection. But the scope of modern anatomy has become very wide because it is now studied by all possible techniques which can enlarge the boundaries of the anatomical knowledge.

The main subdivisions of anatomy are:

1. ***Cadaveric anatomy*** is studied on dead embalmed (preserved) bodies usually with the naked eye (macroscopic or gross anatomy). This can be done by one of the two approaches:
   a. In *regional anatomy* the body is studied in parts, like the upper limb, lower limb, thorax, abdomen, head and neck, and brain (Fig. 1.1).

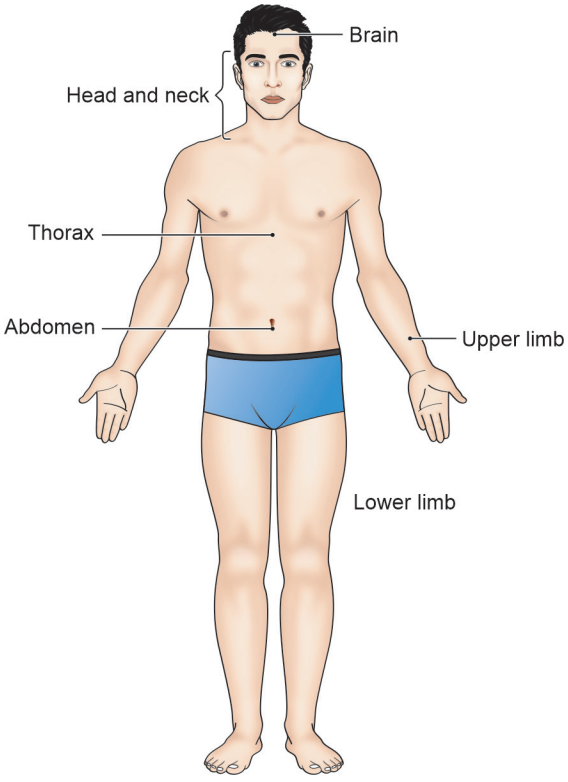


Fig. 1.1: Various regions of the body

b. In *systemic anatomy* the body is studied in systems, like the skeletal system (osteology), muscular system (myology), articulatory system (arthrology or syndesmology), vascular system (angiology), nervous system (neurology), and respiratory, digestive, urogenital and endocrine systems (splanchnology). The locomotor system includes osteology, arthrology and myology. These systems are briefly mentioned close to the end of this chapter.

2. ***Living anatomy*** is studied by inspection (Fig. 1.2a), palpation (Fig. 1.2b), percussion (Fig. 1.2c), auscultation (Fig. 1.2d), endoscopy (bronchoscopy, gastroscopy), radiography, electromyography, etc.
3. ***Embryology (developmental anatomy)*** is the study of the prenatal developmental changes in an individual (Fig. 1.3). The developmental history is called 'ontogeny'. The evolutionary history, on the other hand, is called 'phylogeny'.

Fig. 1.2a: Inspection of the chest

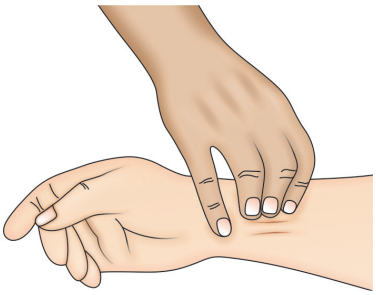


Fig. 1.2b: Palpation

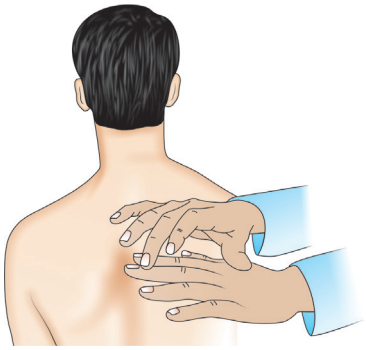


Fig. 1.2c: Percussion

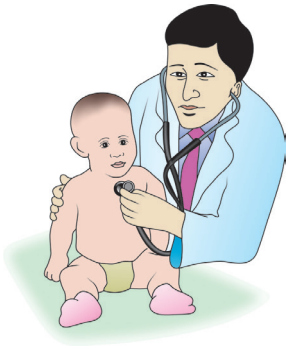


Fig. 1.2d: Auscultation

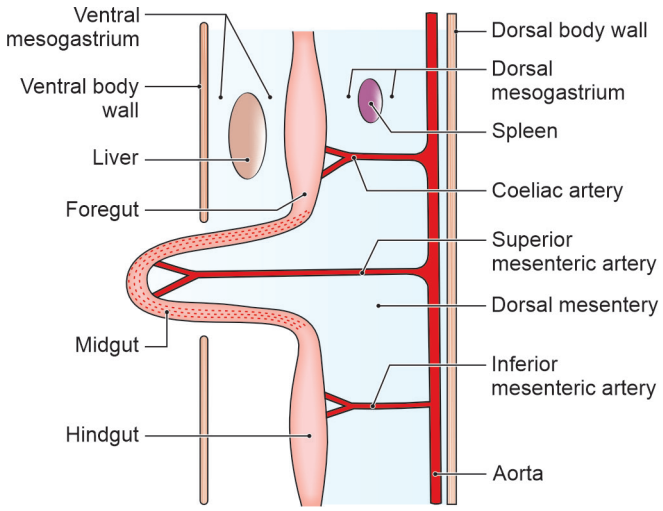
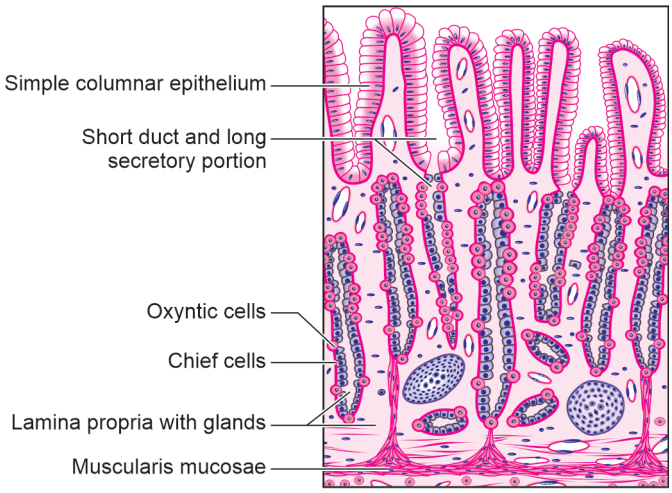


Fig. 1.3: Development of various parts of the gut

4. ***Histology (microscopic anatomy)*** is the study of structures with the aid of a microscope (Fig. 1.4).
5. ***Surface anatomy (topographic anatomy)*** is the study of deeper parts of the body in relation to the skin surface, e.g. palpating the artery. It is most important in clinical practice, physical therapy and surgical operations, e.g. palpating the artery (Fig. 1.5).



- All epithelial cells are simple columnar in type
- Parietal cells are large and pink, chief cells are small and blue
- Duct is 1/3rd, secretory part is 2/3rd

Fig. 1.4: Histology of the fundus of stomach

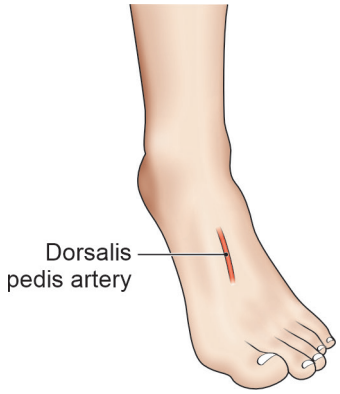


Fig. 1.5: Palpating the dorsalis pedis artery

6. ***Radiographic and imaging anatomy*** is the study of the bones and deeper organs by plain and contrast radiography, by ultrasound and computerised tomographic (CT) scans (Fig. 1.6).
7. ***Comparative anatomy*** is the study of anatomy of the other animals to explain the changes in form, structure and function (morphology) of different parts of the human body.
8. ***Physical anthropology*** deals with the external features and measurements of different races and groups of people, and with the study of the prehistoric remains (Fig. 1.7).
9. ***Applied anatomy (clinical anatomy)*** deals with application of the anatomical knowledge to the medical and surgical practice (Fig. 1.8).

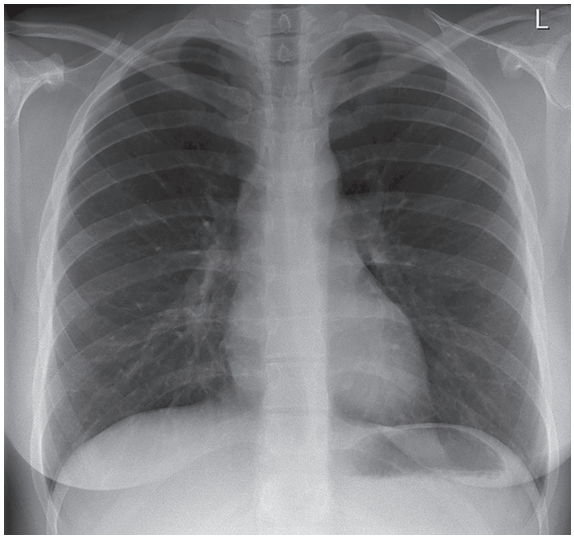


Fig. 1.6: X-ray Chest: Posteroanterior view

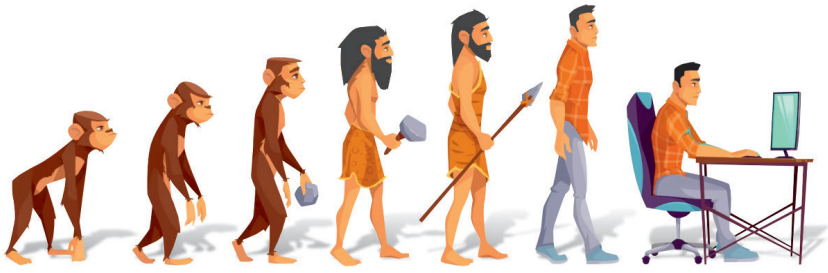


Fig. 1.7: Physical anthropology

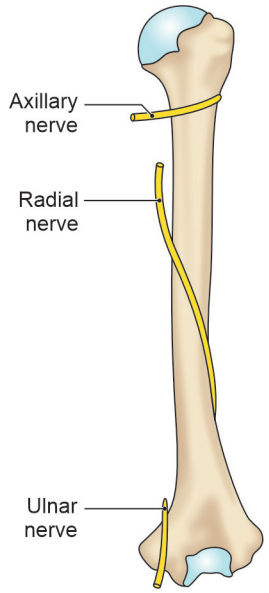


Fig. 1.8: The relation of nerves to the posterior aspect of humerus

10. ***Experimental anatomy*** is the study of the factors which influence and determine the form, structure and function of different parts of the body.
11. ***Genetics*** deals with the study of information present in the chromosomes (*see* Chapter 17).

HISTORY OF ANATOMY

1. Greek Period (BC)

Hippocrates of Cos (circa 400 BC), the 'father of medicine', is regarded as one of the founders of anatomy. Parts of hippocratic collection are the earliest anatomical descriptions.

Herophilus of Chalcedon (circa 300 BC) is called the "father of anatomy". He was a Greek physician, and was one of the first to dissect the human body.

2. Roman Period (AD)

Galen of Pergamum, Asia Minor (circa 130–200 AD), the "prince of physicians", practised medicine at Rome. He was the foremost practitioner of his days and the first experimental physiologist.

3. Fourteenth Century

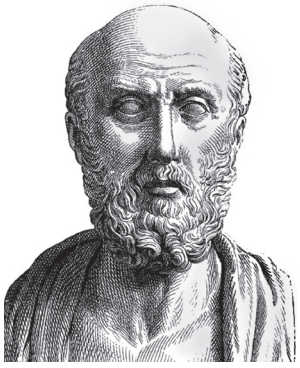
Mundinus or Mondino d'Luzzi (1276–1326), the 'restorer of anatomy', was an Italian anatomist and professor of anatomy at Bologna.

4. Fifteenth Century

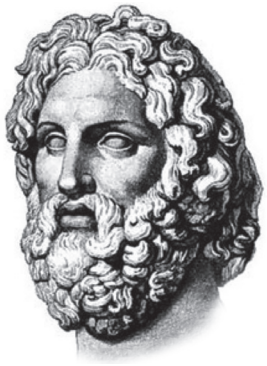
Leonardo da Vinci of Italy (1452–1519), the originator of cross sectional anatomy, was one of the greatest geniuses the world has known. He was the founder of modern anatomy.

5. Sixteenth Century

Vesalius (1514–1564), the 'reformer of anatomy', was German in origin, Belgian (Brussels) by birth, and found an Italian (Padua) university favourable for his work. He was professor of anatomy at Padua.



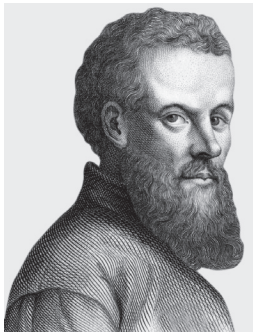
Hippocrates



Herophilus

Galen

Leonardo da Vinci



Vesalius

6. Seventeenth Century

William Harvey (1578–1657) was an English physician who discovered the circulation of blood, and published it as *Anatomical Exercise on the Motion of the Heart* and *Blood* in *Animals*. He also published a book on embryology.

7. Eighteenth Century

William Hunter (1718–1783) was a London anatomist and obstetrician. He introduced the present day embalming with the help of Harvey's discovery, and founded with his younger brother (John Hunter) the famous Hunterian museum.

8. Nineteenth Century

Dissection by medical students was made compulsory in Edinburgh (1826) and Maryland (1833). Burke and Hare scandal of 16 murders took place in Edinburgh in 1828. Warburton Anatomy Act (1832) was passed in England under which the unclaimed bodies were made available for dissection. The 'Act' was passed in America (Massachusetts) in 1831. Formalin was used as a fixative in 1890s.

X-rays were discovered by Roentgen in 1895.

The noted anatomists of this century include Ashley Cooper (1768–1841; British surgeon), Cuvier (1769–1832; French naturalist), Meckel (1724–1774; German anatomist), and Henry Gray (1827–1861; the author of Gray's *Anatomy*).

9. Twentieth Century

The electron microscope was invented in 20th century. It was applied in clinical practice, which made startling changes in the study of normal and diseased conditions.

Besides plain X-rays, in this century, ultrasonography and echocardiography were discovered. These were the non-invasive safe procedure.

Also computer-axial tomography or CT scan, a non-invasive procedure and magnetic resonance imaging were devised.

10. Twenty-first Century

Foetal medicine is emerging as a newer subject. Even treatment *in utero* is being practised in some cases.

Human genome has been prepared.

New research in drugs for many diseases, especially AIDS, is being done very enthusiastically. There is also a strong possibility of gene therapy.

Indian Anatomists

Dr Inderjit Dewan worked chiefly on osteology and anthropology.

Dr DS Choudhry did notable work on carotid body.

Dr H Chaterjee and Dr H Verma researched on embryology.

Dr SS Dayal did good work in cancer biology.

Dr Shamer Singh and his team did pioneering work on teratology.

Dr Chaturvedi's and Dr CD Gupta's prominent work was on corrosion cast.

Dr LV Chako, Dr HN Keswani, Dr Veena Bijlani, Dr Gopinath, Dr Shashi Wadhwa of All India Institute of Medical Sciences, New Delhi, researched on neuroanatomy.

Dr Keswani and his team established museum of history of medicine.

Dr AK Susheela of AIIMS, New Delhi, has done profound work on fluorosis.

Dr MC Vaidya and Dr NK Mehra are well known for their work on leprosy, HLA and immunology.

Dr IB Singh of Rohtak did enlightening studies on histology. He has been author of several books in anatomy.

Dr AK Dutta of West Bengal had authored many books on anatomy. Dr Yogesh Sontakke has been writing many books on anatomy.

Pandit Madhusudan Gupta was the first man who dissected a cadaver in 1836 in Calcutta and created a sensation in orthodox Hindu society. He was honored by a 7 cannon salute.

Dr A Halim is a great teacher of many teachers. He retired from KGMC, Lucknow, UP. His book *Surface* and *Radiological Anatomy* is most popular.

Dr Chandrama Anand retired as Director of Lady Hardinge Medical College and associated hospitals. She was Director Professor and Head, Department of Anatomy, a very passionate, all-rounder lovable teacher.

Amongst the medical educationists are Dr Sita Achaya, Dr Ved Prakash, Dr Basu, Dr M Kaul, Dr Chandrama Anand, Dr Indira Bahl, Dr Swarna Bhardwaj, Dr Rewa Choudhary, Dr Smita Kakar, Dr Anita Tuli, Dr Shashi Raheja, Dr Ram Prakash, Dr Veena


Dr Madhusudan Gupta


Dr A Halim


Dr Chandrama Anand

Bharihoke, Dr Madhur Gupta, Dr Neelam Vasudeva, Dr Sabita Mishra, Dr Raj Mehra, Dr Rani Kumar, Dr Satyam Khare, Dr JM Kaul, Dr Shipra Paul, Dr Dharamnarayan, Dr AC Das, Dr A Halim, Dr DR Singh and many others.

Dr Harish Agarwal, an anatomist, worked in jurisprudence for a number of years.

Dr Cooper of Chennai, Dr M Thomas and Dr Kiran Kucheria did commendable work on genetics.

Dr Mehdi Hasan and Dr Nafis Ahmad Faruqi did pioneering research in neuroanatomy.

Dr Balasubramanyam is a computer anatomist.

ANATOMICAL NOMENCLATURE

Galen (2nd century) wrote his book in Greek and Vesalius (16th century) did it in Latin. Most of the anatomical terms, therefore, are either in Greek or Latin. By 19th century about 30,000 anatomical terms were in use in the books and journals. In 1895, the German Anatomical Society held a meeting in Basle, and approved a list of about 5000 terms known as **Basle Nomina Anatomica** (BNA). The following six rules were laid down to be followed strictly: (1) Each part shall have only one name; (2) each term shall be in Latin; (3) each term shall be as short and simple as possible; (4) the terms shall be merely memory signs; (5) the related terms shall be similar, e.g. femoral artery, femoral vein, and femoral nerve; and (6) the adjectives shall be arranged as opposites, e.g. major and minor, superior and inferior.

BNA was revised in 1933 by a committee of the Anatomical Society of Great Britain and Ireland in a meeting held at **Birmingham**. The revised BNA was named Birmingham **Revision** (*BR*). An independent revision of the BNA was also done by German anatomists in 1935, and was known as **Jena Nomina Anatomica** (*JNA* or *INA*). However, the *BR* and *INA* found only local and restricted acceptance.

In 1950, it was agreed at an International Congress of Anatomists held at Oxford that a further attempt should be made to establish a generally acceptable international nomenclature. In the Sixth International Congress of Anatomists held at Paris (1955), a somewhat conservative revision of BNA with many terms from BR and INA was approved. Minor revisions and corrections were made at the International Congresses held in New York (1960), and Wiesbaden, Germany (1965), and the 3rd edition of **Nomina Anatomica** (Ed. GAG Mitchell, 1968) was published by the Excerpta Medica Foundation.

The drafts on *Nomina Histologica* and *Nomina Embryologica* prepared by the subcommittee of the International Anatomical Nomenclature Committee (IANC) were approved in a plenary session of the Eleventh International Congress of Anatomists held in Leningrad in 1970. After a critical revision, the 4th edition of *Nomina Anatomica* (Ed. Roger Warwick, 1977) containing *Nomina Histologica* and *Nomina Embryologica* was published by the same publisher.

Competency achievement: The student should be able to:
AN 1.1 Demonstrate normal anatomical position, various planes, relation, comparison, laterality and movement in our body

ANATOMICAL TERMINOLOGY

Various positions, planes, terms in relation to various regions and movements are described.

Positions

- ***Anatomical position:*** When a person is standing straight with eyes looking forwards, both arms by the side of body, palms facing forwards, both feet together, the position is anatomical position (Fig. 1.9).

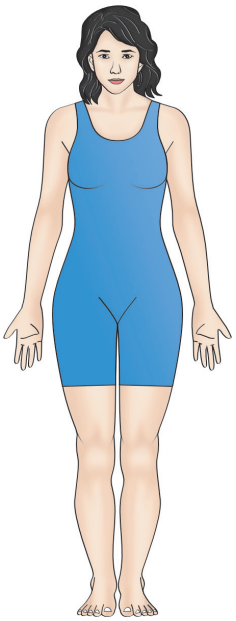


Fig. 1.9: Anatomical position

- ***Supine position:*** When a person is lying on his/her back, arms by the side, palms facing upwards and feet put together, the position is supine position (Fig. 1.10).
- ***Prone position:*** Person lying on his/her face, chest and abdomen is said to be in prone position (Fig. 1.11).
- ***Lithotomy position:*** Person lying on her back with legs up and feet supported in straps. This position is mostly used during delivery of the baby (Fig. 1.12).

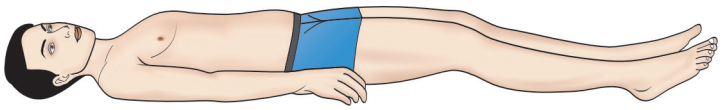


Fig. 1.10: Supine position

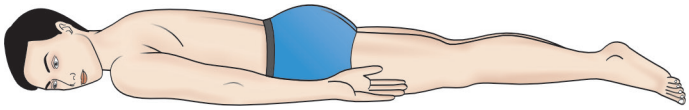


Fig. 1.11: Prone position

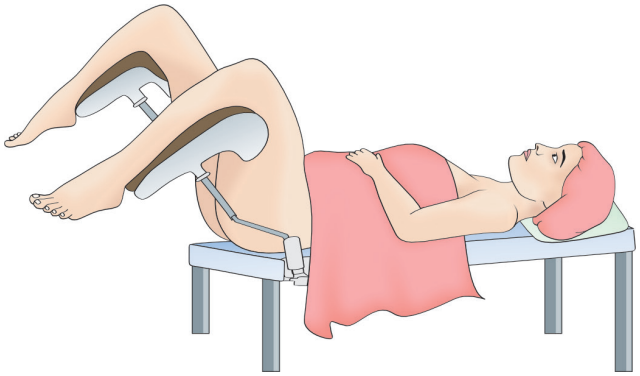


Fig. 1.12: Lithotomy position

Planes

- A plane passing through the centre of the body dividing it into two equal right and left halves, is the median or midsagittal plane (Fig.1.13). Plane parallel to median or midsagittal plane is the sagittal plane.
- A plane at right angles to sagittal or median plane which divides the body into anterior and posterior halves is called a **coronal plane** (Figs 1.14 and 1.15).

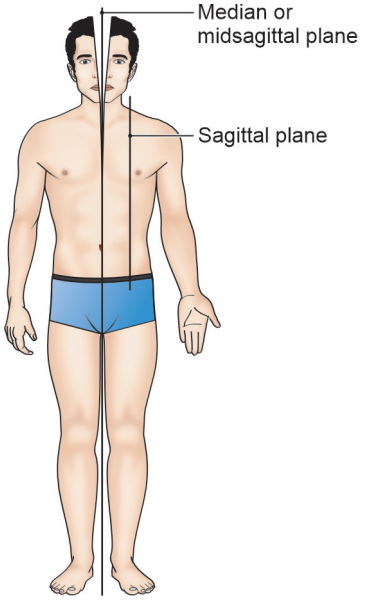


Fig. 1.13: Median and sagittal planes

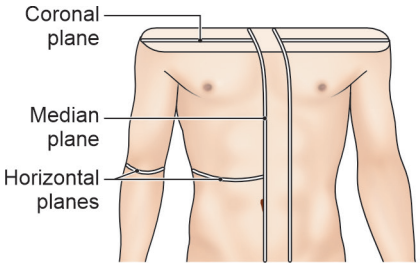


Fig. 1.14: Median, sagittal, coronal and horizontal planes

- A plane at right angles to both sagittal and coronal planes which divides the body into upper and lower parts is called a **transverse horizontal plane** (Fig. 1.15).
- ***Oblique plane:*** Any other plane other than coronal, transverse and midsagittal is called oblique plane.
- ***Cardinal plane:*** If any plane traverses the centre of the body, it is called cardinal plane.

Some other terms:

- ***Fundamental position:*** It is same as anatomical position except that palms are facing the body. It is a comfortable position and is not important from anatomy point of view.
- ***Centre of gravity:*** The point where three cardinal planes intersect in the body is called "centre of gravity".

Terms used in Relation to Trunk, Neck and Face

- ***Ventral*** or ***anterior*** is the front of trunk, neck and face.
- ***Dorsal*** or ***posterior*** is the back of trunk, neck and face (Fig. 1.17).
- ***Medial*** is a plane close to the median plane (Fig. 1.16).
- ***Lateral*** is plane away from the median plane.
- ***Proximal/cranial/superior*** is close to the head end of body.

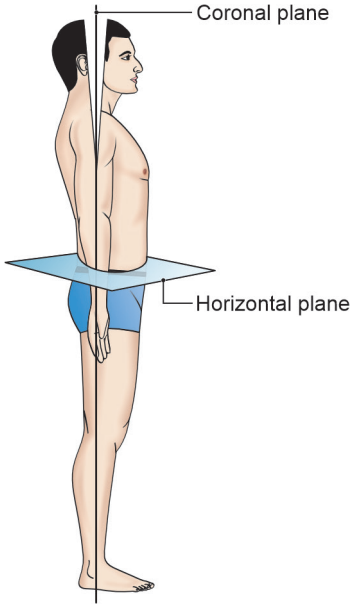


Fig. 1.15: Coronal and horizontal planes

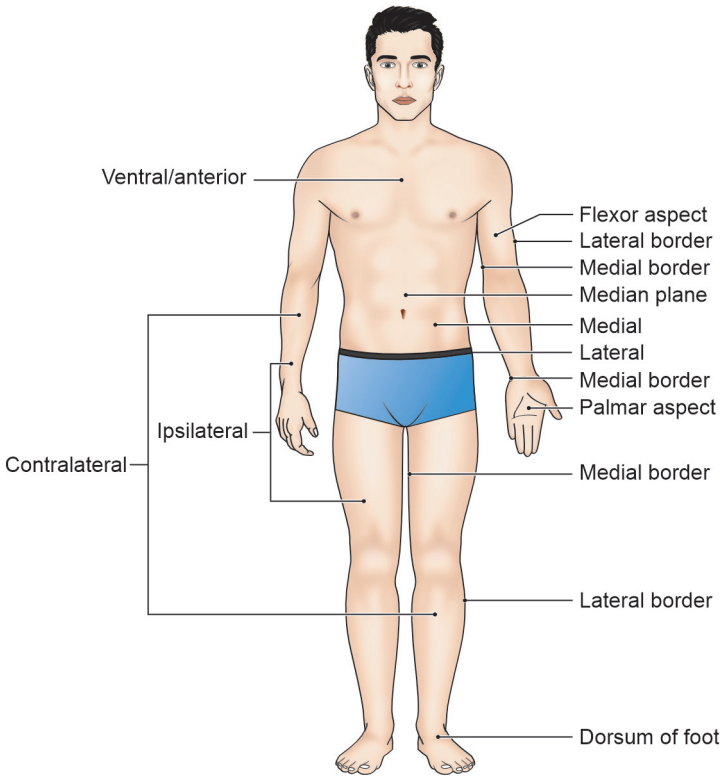


Fig. 1.16: Language of anatomy

- ***Distal/caudal/inferior*** is close to the lower end of the trunk.
- ***Superficial is close to skin/towards*** the surface of body (Fig. 1.18).
- ***Deep*** is away from skin/away from the surface of body.
- ***Ipsilateral*** is on the same side of the body as another structure.
- ***Contralateral*** is on opposite side of body from another structure.
- ***Invagination*** is projection inside.
- ***Evagination*** is projection outside (Fig. 1.19).

Terms Used in Relation to Upper Limb

- ***Ventral*** or ***anterior*** is the front aspect (Fig. 1.17).
- ***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 (Fig. 1.16).

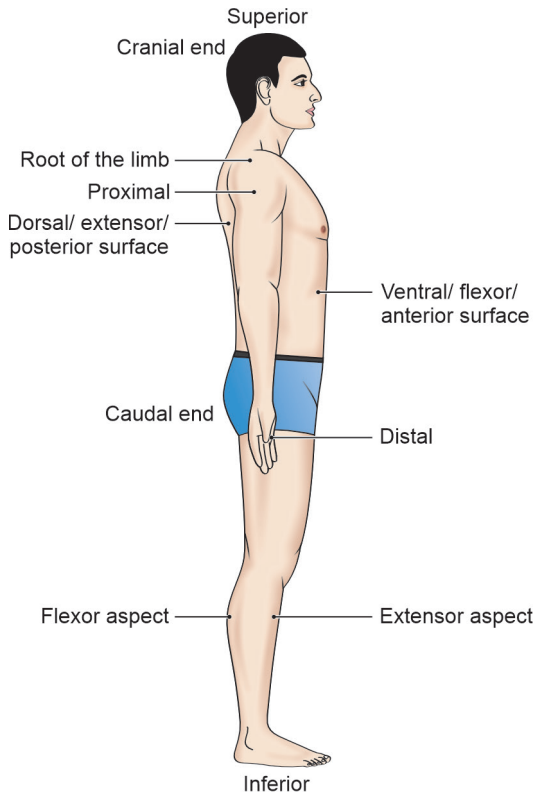


Fig. 1.17: Language of anatomy

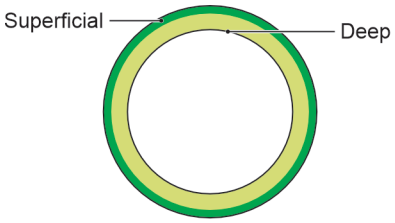


Fig. 1.18: Language of anatomy

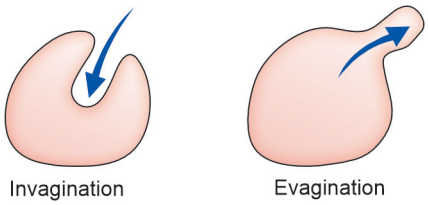


Fig. 1.19: Language of anatomy

- ***Proximal*** is close to root of limb, while ***distal*** is away from the root (Fig. 1.17).
- ***Palmar*** aspect is the front of the palm (Fig. 1.16).
- ***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

- *Posterior* aspect is the back of lower limb.
- *Anterior* aspect is front of lower limb.
- *Medial border* lies along the big toe or hallux, medial border of leg and thigh (Fig. 1.16).
- *Lateral border* lies along the little toe, lateral border of leg and thigh.
- *Flexor* aspect is back of lower limb.
- *Extensor* aspect is front of lower limb (Fig. 1.17).
- *Proximal* is close to the root of limb, while *distal* is away from it.

Terms of Relation Commonly used in Embryology and Comparative Anatomy, but Sometimes in Gross Anatomy

a. *Ventral*—towards the belly (like anterior).
b. *Dorsal*—towards the back (like posterior).
c. *Cranial or rostral*—towards the head (like superior) (Fig. 1.17).
d. *Caudal*—towards the tail (Fig. 1.17).

TERMS RELATED TO 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 and in **extension** there is increase in angle between articulating bones (Fig. 1.20). **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.
3. *Special movements:* These occur only at certain joints, e.g. pronation, supination at radioulnar joints, protraction and retraction at temporomandibular joint, inversion and eversion at subtalar joint.
4. *Rotation:* A bone revolves around its own longitudinal axis. In **medial rotation** anterior surface of a bone of limb is turned towards the midline. In **lateral rotation** anterior surface of a bone of limb is turned away from midline.

In Upper limb

Shoulder Joint

- ***Abduction of shoulder:*** When limb is taken away from the body (Fig. 1.21).
- ***Adduction of shoulder:*** When limb is brought close to the body.
- ***Flexion of shoulder:*** If arm is taken towards the front of the chest wall.
- ***Extension:*** Arm is taken backwards and laterally (Fig. 1.22).
- ***Circumduction:*** It is movement of distal end of a part of the body in a circle. A combination of extension, abduction, flexion and adduction in a sequence is called circumduction as in bowling.
- ***Medial rotation of shoulder:*** When the arm rotates medially bringing the flexed forearm across the chest (elbow in contact with trunk).

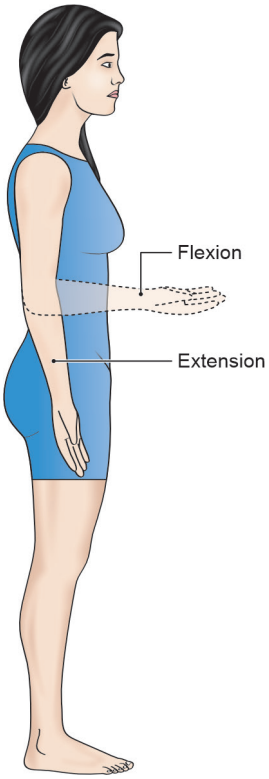


Fig. 1.20: Angular movements

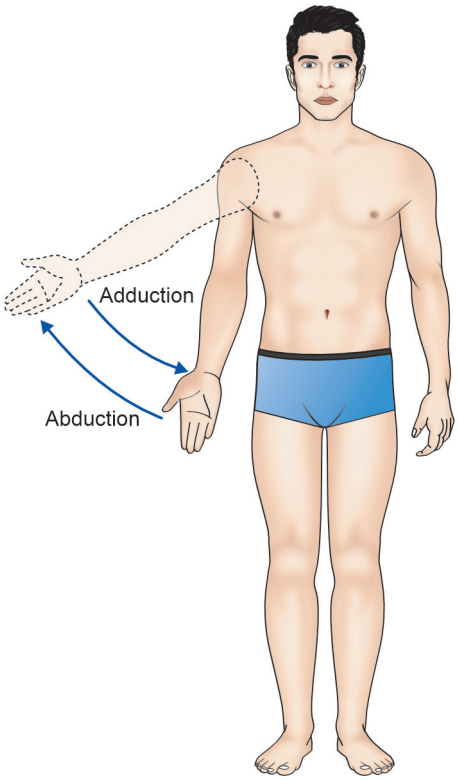


Fig. 1.21: Abduction and adduction of shoulder joint

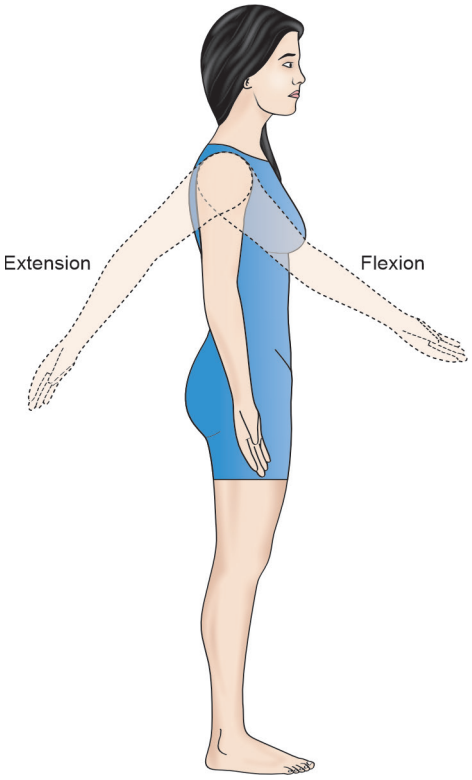


Fig. 1.22: Flexion and extension of shoulder joint

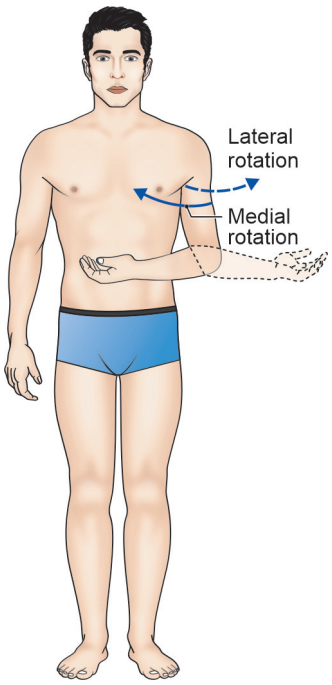


Fig. 1.23: Medial rotation and lateral rotation of shoulder joint

- ***Lateral rotation of shoulder:*** When arm rotates laterally taking the flexed forearm away from the body (Fig. 1.23) (elbow in contact with trunk).

Elbow Joint

- ***Flexion:*** When two flexor surfaces are brought close to each other, e.g. in elbow joint when front of arm and forearm move close to each other (Fig. 1.20).
- ***Extension:*** When extensor or dorsal surfaces are brought in as much approximation as possible, e.g. straighten the forearm at the elbow joint (Fig. 1.20).

Forearm

- ***Supination:*** When the palm is facing forwards or upwards, as in putting food in the mouth (Fig. 1.24).

- ***Pronation:*** When the palm faces backwards or downwards, as in picking food with fingers from the plate.

Wrist Joint

- ***Flexion of wrist:*** When palm comes closer to front of forearm.
- ***Extension of wrist:*** When dorsum of hand comes closer to back of forearm (Fig. 1.25).
- ***Adduction of wrist:*** When medial border of palm is turned medially.
- ***Abduction of wrist:*** When lateral border of palm is turned laterally.

Thumb

- ***Opposition of thumb:*** When tip of thumb touches the tips of any of the fingers (Fig. 1.26).
- ***Circumduction of thumb:*** Movement of extension, abduction, flexion and adduction in sequence.
- ***Flexion of thumb:*** When thumb is taken across the palm (Fig. 1.27).
- ***Extension of thumb:*** When thumb is taken backwards in the plane of the palm (Fig. 1.28).
- ***Abduction of thumb:*** When thumb is put vertically at right angles to plane of the palm (Fig. 1.29).
- ***Adduction of thumb:*** When thumb is in close contact with lateral side of index finger (Fig. 1.30).

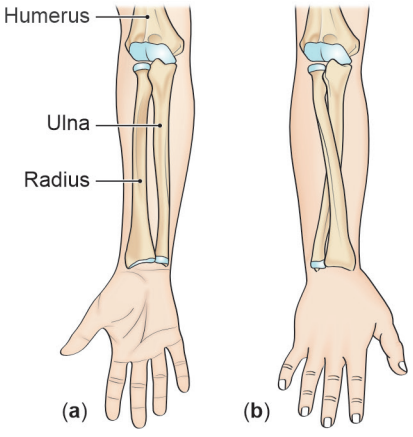


Fig. 1.24: Supinated forearm (a) and pronated forearm (b)

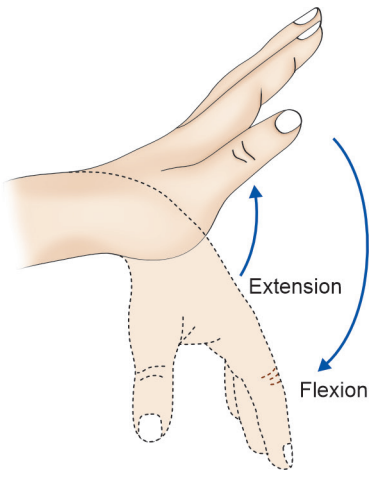


Fig. 1.25: Flexion and extension of wrist joint

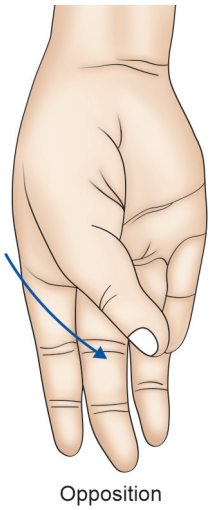


Fig. 1.26: Opposition of thumb

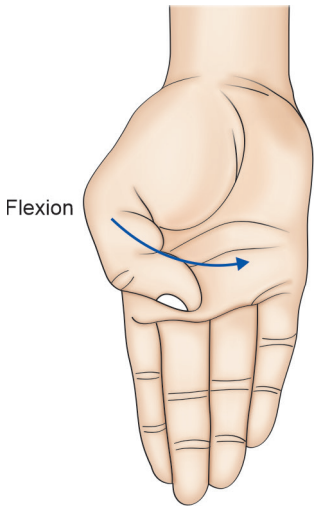


Fig. 1.27: Flexion of thumb

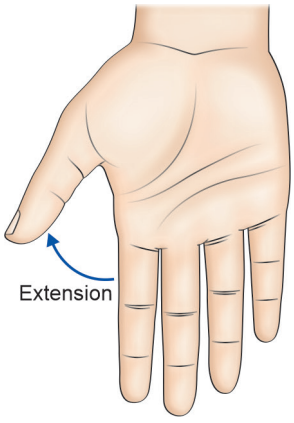


Fig. 1.28: Extension of thumb

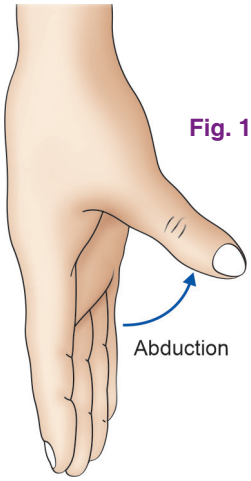


Fig. 1.29: Abduction of thumb

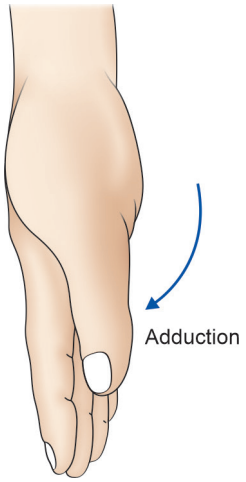


Fig. 1.30: Adduction of thumb

Movement of Fingers

The axis of movement of fingers is the line passing through the centre of the middle finger (Fig. 1.31).

- ***Adduction of digits/fingers:*** When all the fingers get together.
- ***Abduction:*** When all fingers separate (Fig. 1.31).
- ***Flexion of metacarpophalangeal and interphalangeal joints:*** When attempting to make a fist.
- ***Extension of metacarpophalangeal and interphalangeal joints:*** When opening the fist (Fig. 1.32).

In Lower Limb

- ***Flexion of thigh:*** When front of thigh comes close to or in contact with front of abdomen (Fig. 1.33).
- ***Extension of thigh:*** When person stands erect.
- ***Abduction:*** When thigh is taken away from the median plane.
- ***Adduction:*** When thigh is brought close to median plane.
- ***Medial rotation:*** When thigh is turned medially. It is done by pointing the big toe medially.
- ***Lateral rotation:*** When thigh is turned laterally. It is done by pointing the big toe laterally.
- ***Circumduction:*** When flexion, adduction, extension and abduction are done in sequence (Fig. 1.35)

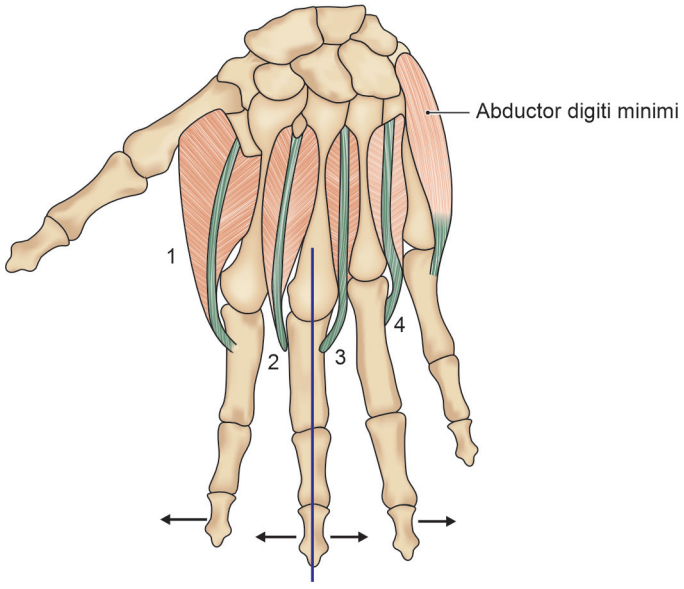


Fig. 1.31: Abduction of 2nd–5th digits

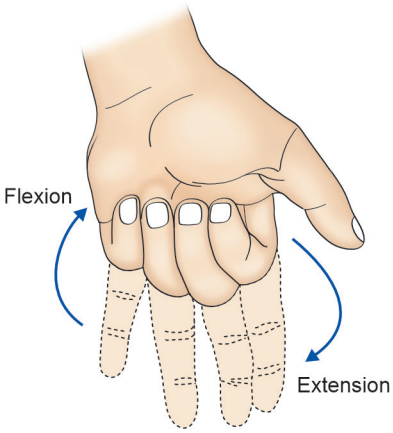


Fig. 1.32: Flexion and extension of metacarpophalangeal and interphalangeal joints

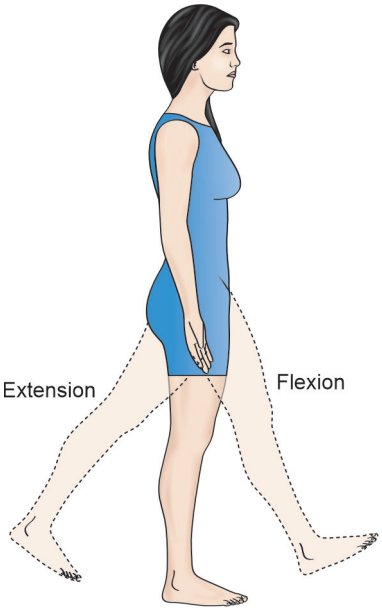


Fig. 1.33: Flexion and extension of thigh

- ***Flexion of knee:*** When back of thigh and back of leg come close to or are in opposition (Fig. 1.34a and b).
- ***Extension of knee:*** When thigh and leg are in straight line as in standing (Fig. 1.36).
- ***Dorsiflexion of foot:*** When dorsum of foot is brought close to front of leg and sole faces forwards (Fig. 1.37).
- ***Plantarflexion of foot:*** When sole of foot or plantar aspect of foot faces backwards.
- ***Inversion of foot:*** When medial border of foot is raised from the ground (Fig. 1.38).

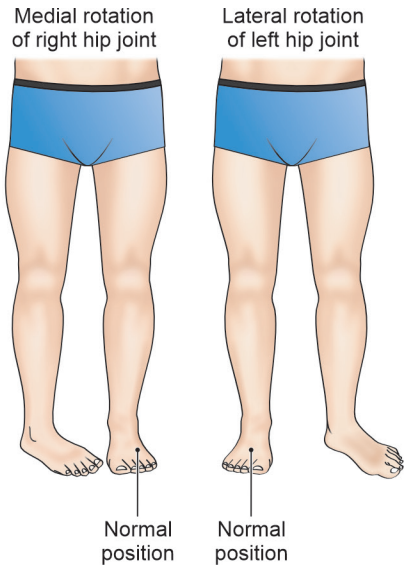


Fig. 1.34: Medial rotation and lateral rotation of thigh

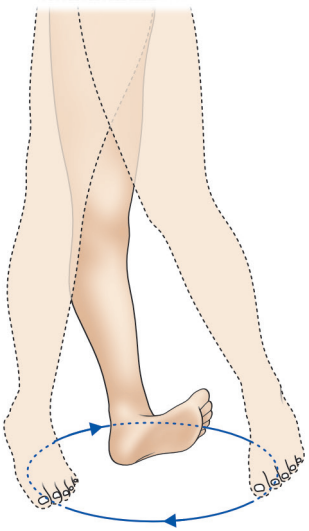


Fig. 1.35: Circumduction of lower limb

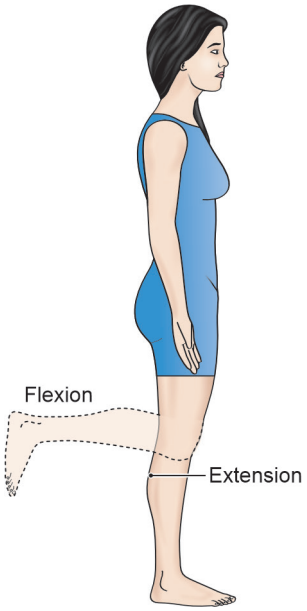


Fig. 1.36: Flexion and extension of knee joint

Fig. 1.37: Dorsiflexion and plantar flexion of foot

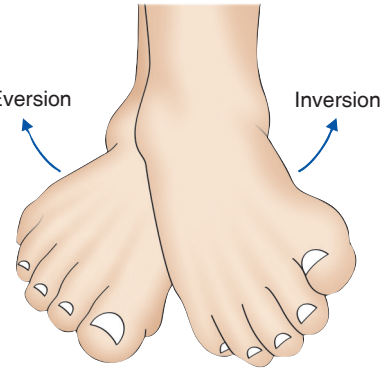


Fig. 1.38: Inversion and eversion of foot

- ***Eversion of foot:*** When lateral border of foot is raised from the ground.

In the Neck

- ***Flexion:*** When face comes closer to chest.
- ***Extension:*** When face is taken away from the chest (Fig. 1.39).
- ***Lateral flexion:*** When ear is brought close to shoulder (Fig. 1.40).
- ***Rotation:*** When neck rotates so that chin goes to opposite side.
- ***Opening the mouth:*** When lower jaw is lowered to open the mouth (Fig. 1.41).
- ***Closure of the mouth:*** When lower jaw is opposed to the upper jaw, closing the mouth (Fig. 1.42).
- ***Protraction:*** When lower jaw slides forwards in its socket in the temporal bone of skull (Fig. 1.43).
- ***Retraction:*** When lower jaw slides backwards in its socket in the temporal bone of skull (Fig. 1.44).

In the Trunk

- Backward bending is called ***extension*** (Fig. 1.39).
- Forward bending is ***flexion***.
- Sideward movement ***is lateral flexion*** (Fig. 1.40)
- Sideward rotation is ***lateral rotation***.

Terms used for Describing Muscles

a. ***Origin:*** The end of a muscle which is relatively fixed during its contraction (Fig. 1.45).

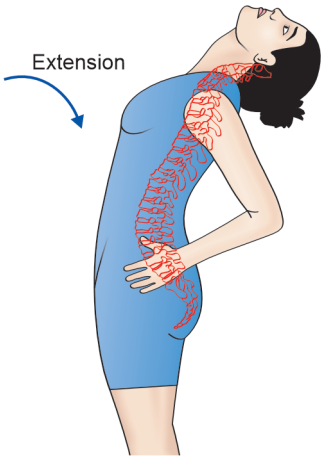


Fig. 1.39: Extension of neck and trunk

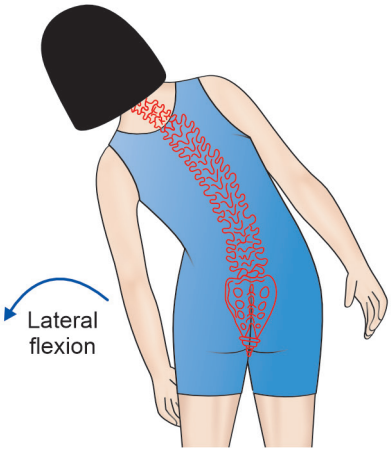


Fig. 1.40: Lateral flexion of neck and trunk

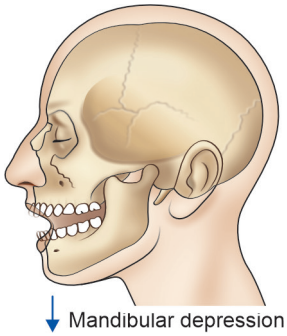


Fig. 1.41: Opening the mouth

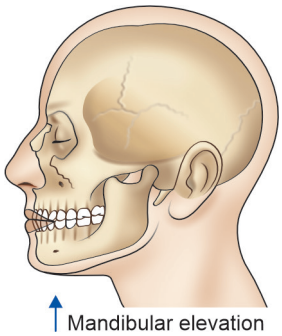


Fig. 1.42: Closing the mouth

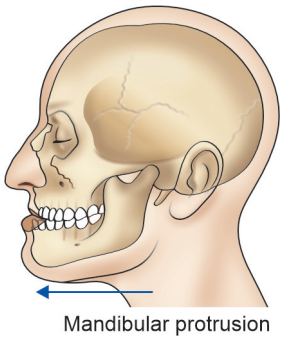


Fig. 1.43: Protraction of lower jaw

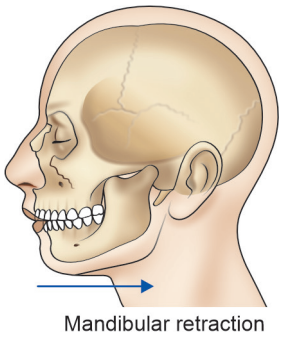


Fig. 1.44: Retraction of lower jaw

b. ***Insertion:*** The end of a muscle which moves during its contraction. The two terms, origin and insertion, are sometimes interchangeable, when the origin moves and the insertion is fixed.
c. ***Belly:*** The fleshy and contractile part of a muscle (Fig. 1.45).
d. ***Tendon:*** The fibrous noncontractile and cord-like part of a muscle.
e. ***Aponeurosis:*** The flattened tendon.
f. ***Raphe:*** A fibrous band made up of interdigitating fibres of the tendons or aponeuroses. Unlike a ligament, it is stretchable.
g. ***Ligaments:*** Fibrous, inelastic bands which connect two segments of a joint.

Terms used for Describing Vessels

a. ***Arteries*** carry oxygenated blood away from the heart. The only exception to this remark are the pulmonary and umbilical arteries which carry deoxygenated blood. Arteries resemble trees because they have branches (arterioles) (Fig. 1.46).

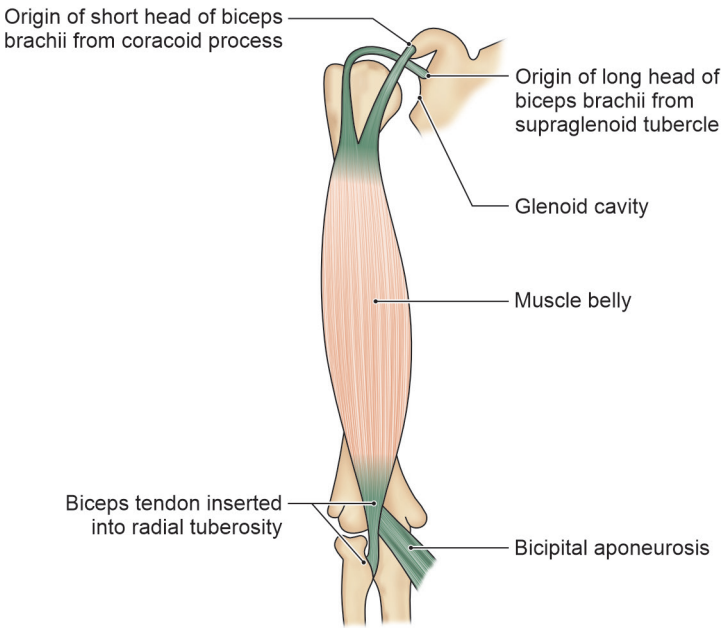


Fig. 1.45: Terms for describing muscles

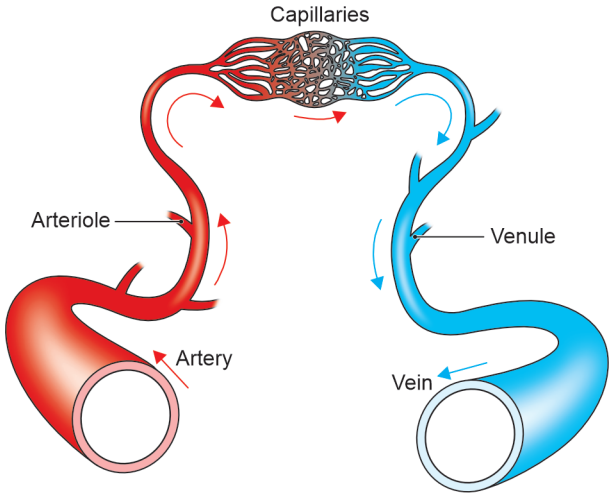


Fig. 1.46: Terms used for describing vessels

b. ***Veins*** carry deoxygenated blood towards the heart. The exception to this remark are the pulmonary and umbilical veins which carry oxygenated blood. Veins resemble rivers because

they have tributaries (venules). Veins have valves to allow unidirectional flow of blood (*see* Fig. 5.8).

c. ***Venae comitantes*** are two veins, one on each side of a medium-sized artery of a limb joined to each other across the artery (*see* Fig. 5.11).

d. ***Capillaries*** are networks of microscopic vessels connecting arterioles to venules (Fig. 1.46).

e. ***Sinusoids*** are large, irregular, vascular spaces which are closely surrounded by the parenchyma of the organ. These are seen in liver, spleen, bone marrow, suprarenal glands, parathyroid glands.

f. ***Anastomoses*** are precapillary or postcapillary communications between the neighbouring vessels (Fig. 1.47).

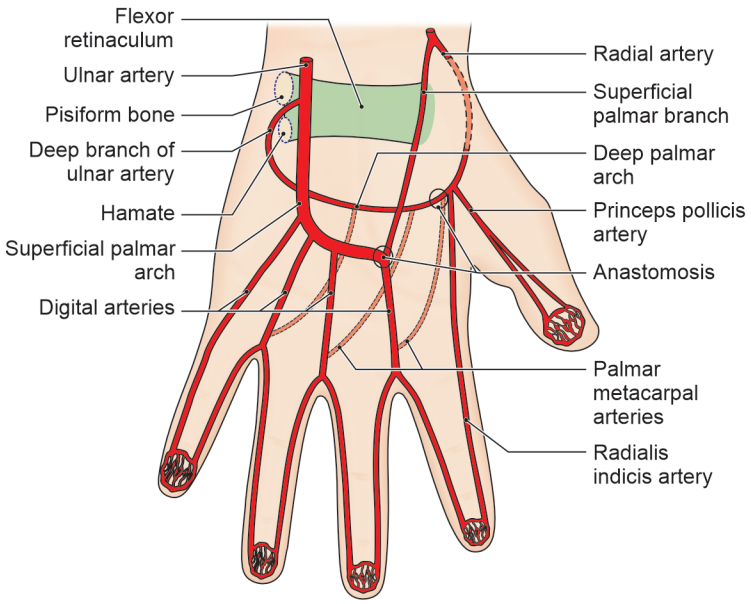


Fig. 1.47: Anastomoses of the arteries

Terms used for Describing Bone Features

Bone marking	*Example*
Linear elevation	
Line	Superior nuchal line and inferior nuchal line of the occipital bone (Fig. 1.48)

(*Contd.*)

Bone marking	*Example (Contd.)*
Crest	The illac crest of the hip bone, of spine of scapula (Fig. 1.49)
Ridge	The medial and lateral supracondylar ridges of the humerus (Fig. 1.50)
Rounded elevation	
Tubercle	Pubic tubercle, lesser and greater tubercles of humerus
Protuberance	External occipital protuberance (Fig. 1.48)
Tuberosity	Ischial tuberosity of the hip bone, deltoid tuberosity (Fig. 1.50)
Malleolus	Medial malleolus of the tibia, lateral malleolus of the fibula
Trochanter	Greater and lesser trochanters of the femur (Fig. 1.51)
Sharp elevation	
Spine or spinous process	Ischial spine, spine of vertebra, anterior superior iliac spine
Styloid process	Styloid process of temporal bone (Fig. 1.48)
Expanded ends for articulation	
Head	Head of humerus, head of femur, head of radius
Condyle	Medial and lateral condyles of femur (knuckle-like process Fig. 1.51)
Epicondyle (a prominence situated just above condyle)	Medial and lateral epicondyles of femur (Fig. 1.52), medial and lateral epicondyles of humerus (Fig. 1.50)
Small flat area for articulation	
Facet	Facet on head of rib for articulation with vertebral body
Depressions	
Notch	Greater sciatic notch and lesser sciatic notch of hip bone
Groove or sulcus	Bicipital groove of humerus (Fig. 1.50)
Fossa	Radial and coronoid fossae (Fig. 1.50) of humerus, acetabular fossa of hip bone
Openings	
Fissure	Superior orbital and inferior orbital fissures (Fig. 1.53)
Foramen	Infraorbital foramen of the maxilla
Canal	Carotid canal of temporal bone
Meatus	External acoustic meatus and internal acoustic meatus of temporal bone

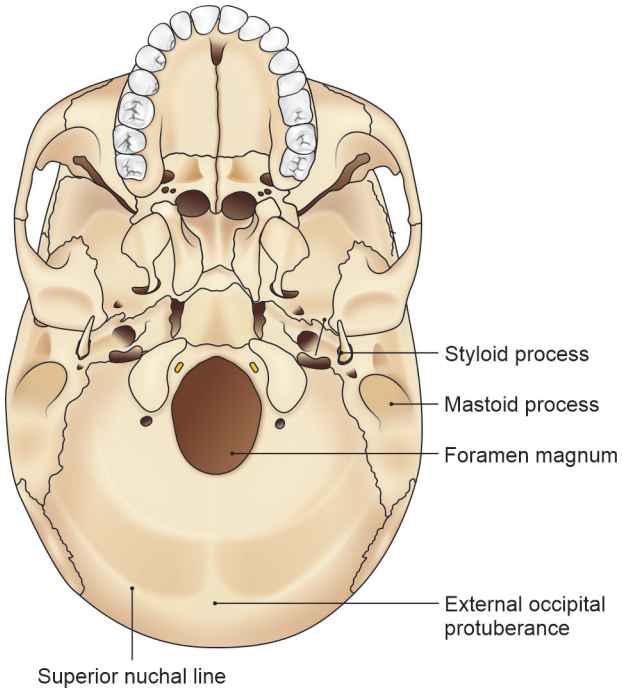


Fig. 1.48: Terms used for describing bone features

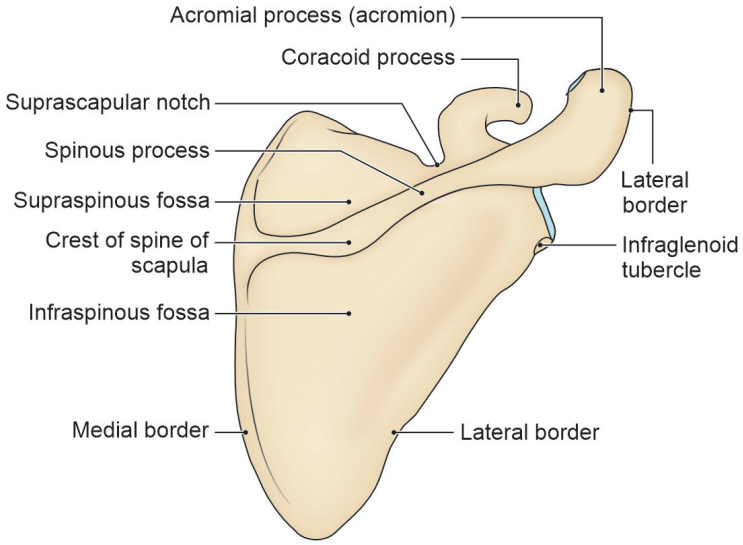


Fig. 1.49: Terms used for describing bone features

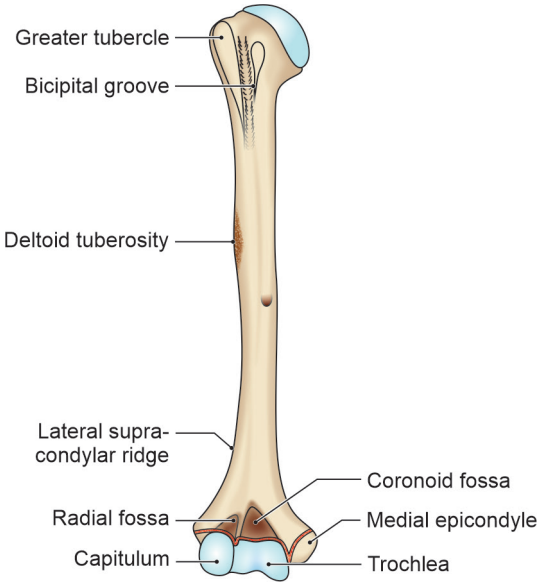


Fig. 1.50: Terms used for describing bone features

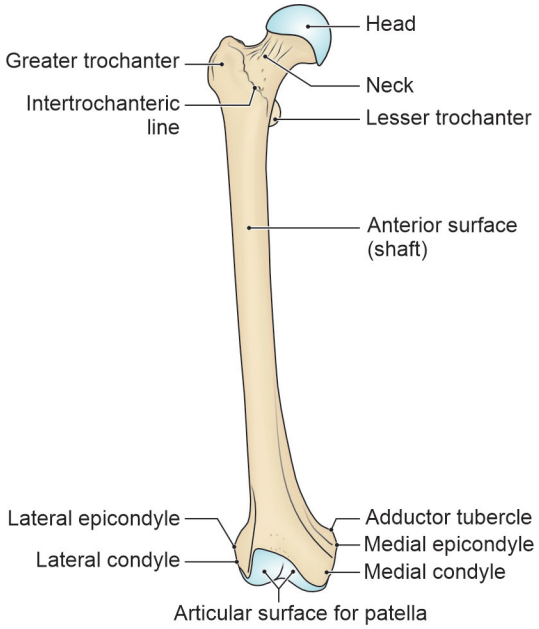


Fig. 1.51: Terms used for describing bone features

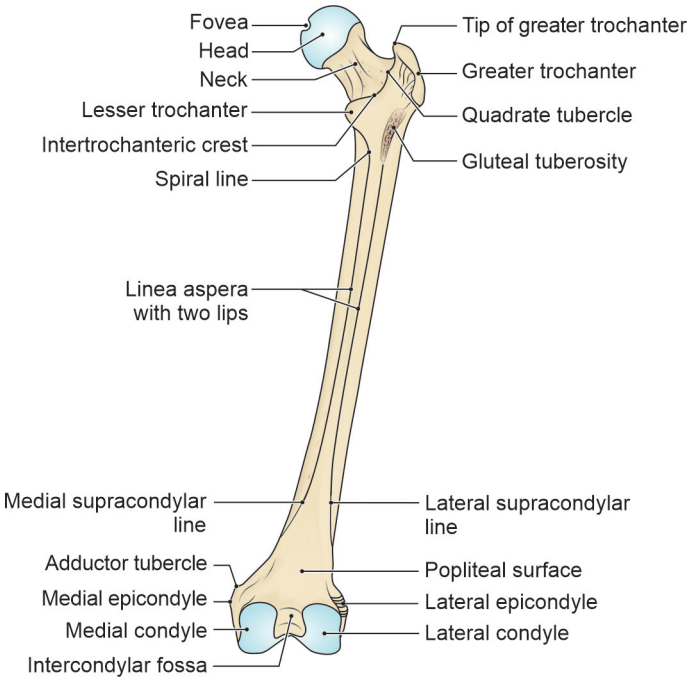


Fig. 1.52: Terms used for describing bone features

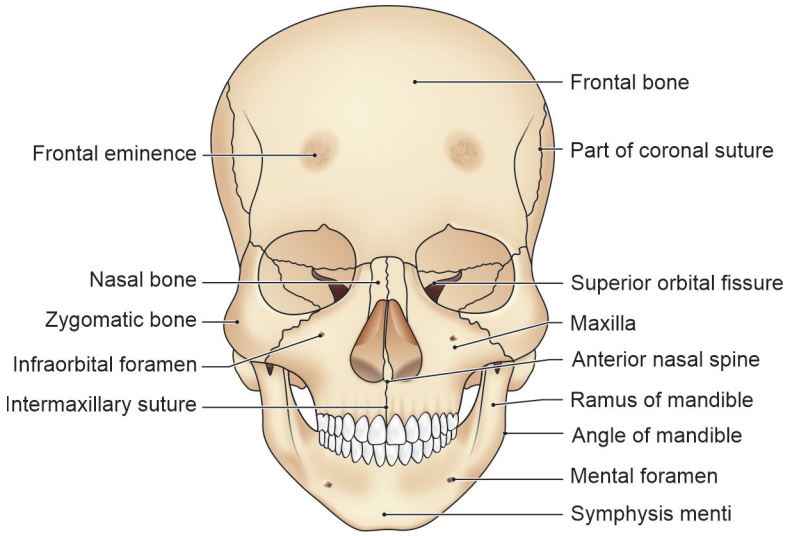


Fig. 1.53: Terms used for describing bone features

Systems of the Body

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

1. ***Respiratory system (pulmonology)*** consists of nose, nasopharynx, larynx, trachea, bronchi, bronchioles, alveoli and the main muscle is the diaphragm. These structures receive oxygen to oxygenate the venous blood and help in elimination of carbon dioxide (Fig. 1.54).
2. ***Articular system (arthrology)*** comprises various joints with their ligaments. Various types of movements take place at the synovial joints. Cartilaginous and fibrous joints are for growth of the bones. The joints provide integrity and stability to the adjoining bones (Fig. 1.55) and some form cavities for protection of organs.

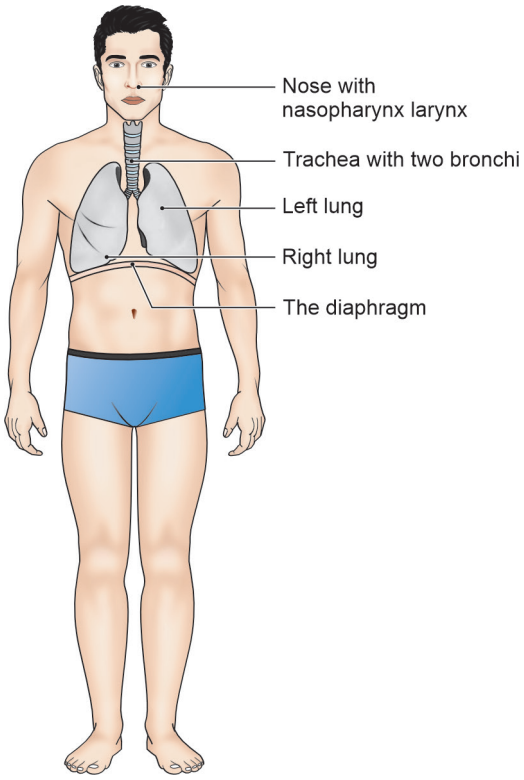


Fig. 1.54: Respiratory system

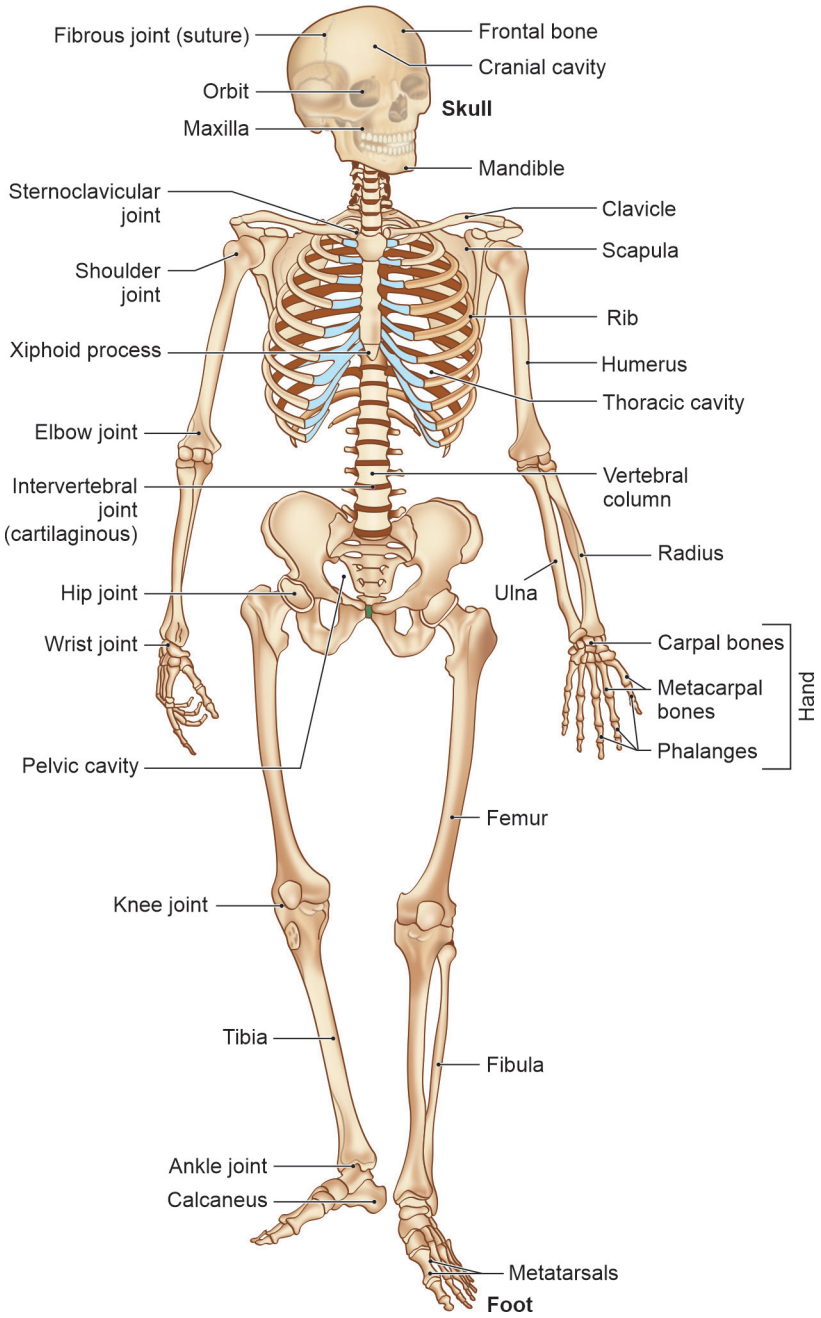


Fig. 1.55: Articular system

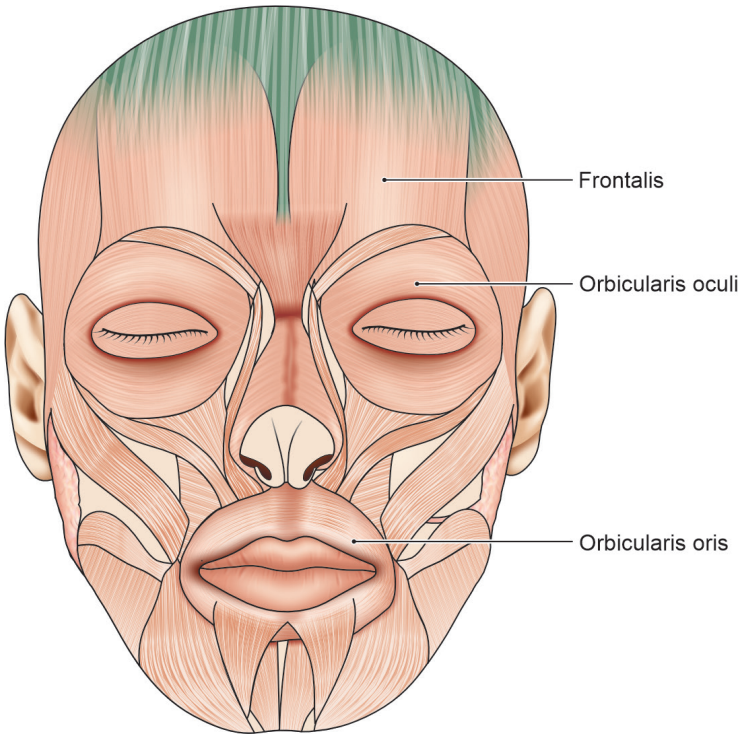


Fig. 1.56: Part of muscular system

3. ***Muscular system*** is the system which moves the various joints of the body and is responsible for activity, locomotion and facial expressions (Fig. 1.56).
4. ***Circulatory system (angiology)*** comprises cardiovascular system which consists of heart and blood vessels, i.e. arteries, veins and capillaries. Blood supplies nutrients and oxygen to cells and takes away carbon dioxide and wastes from cells and helps to regulate acid–base balance, temperature and water content of body fluids. Blood components help to defend against diseases and disease causing organisms (Fig. 1.57).
5. ***Lymphatic system*** comprises of various lymph vessels which withdraw excess tissue fluid with macromolecules, filters it through lymph nodes and returns it to the venous system (*see* Fig. 6.3).
6. ***Skeletal system (osteology)*** consists of numerous cartilages and bones, providing support and symmetry to the body. Cartilage

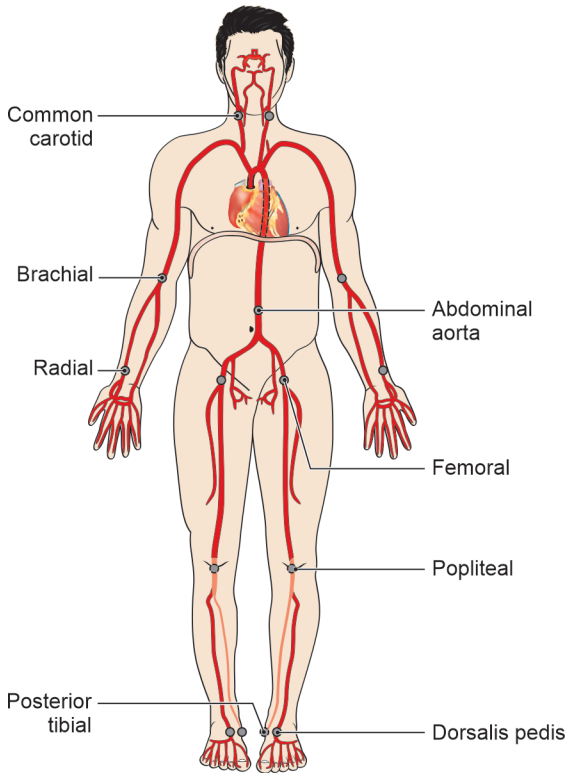


Fig. 1.57: Arterial system

keeps the respiratory pathway patent. Bones being the largest storehouse of calcium provide attachment to numerous skeletal muscles for locomotion. Bones also make cavities or cages for protection of organs like brain, spinal cord, heart, lungs, and reproductive organs (Fig. 1.55).

7. ***Integumentary system (dermatology)*** consists of the skin with its various appendages, i.e. hair, sweat gland, sebaceous gland and nail. Skin is the outermost protective and sensitive covering of the body (*see* Fig. 8.1).
8. ***Digestive system (gastroenterology)*** comprises various organs associated with ingestion, mastication, deglutition, digestion and 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

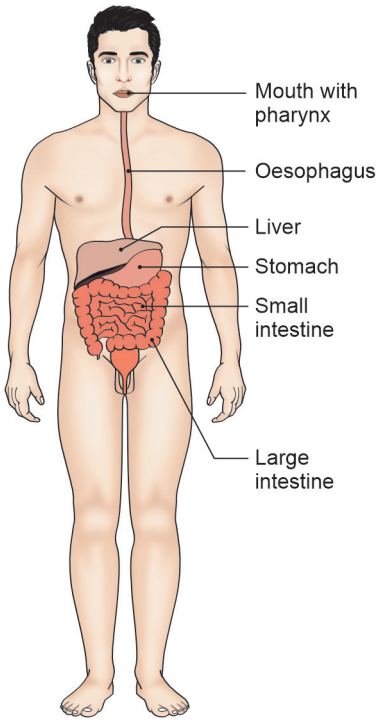


Fig. 1.58: Digestive system

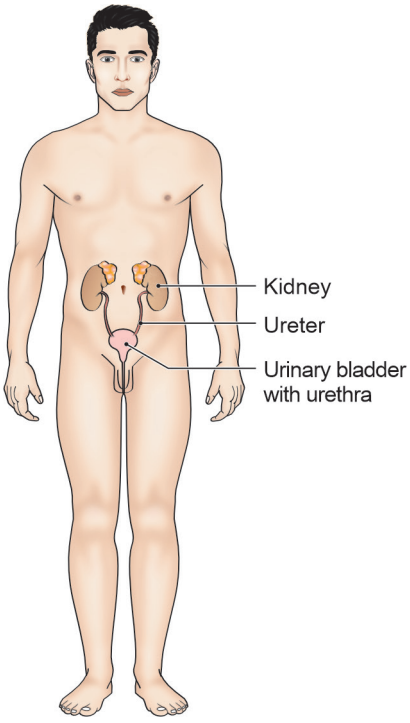


Fig. 1.59: Urinary system

glands like salivary glands, liver, gallbladder, pancreas, gastric and intestinal glands (Fig. 1.58).

9. ***Urinary system (urology)*** helps in excretion of liquid waste from the body. This system comprises kidneys, ureters, urinary bladder and urethra. The kidneys filter the blood and produce, transport, store and expel the urine at frequent intervals (Fig. 1.59). Details can be learnt from 9th edition of *BD Chaurasia's Human Anatomy*, Volume 2, Chapter 24.
10. ***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. 1.60). In females the organs are ovaries, fallopian tubes, uterus and vagina (Fig. 1.61). These two sets of organs are responsible for the production of ova and spermatozoa which on fertilization, implantation and proper nourishment in the uterus develops

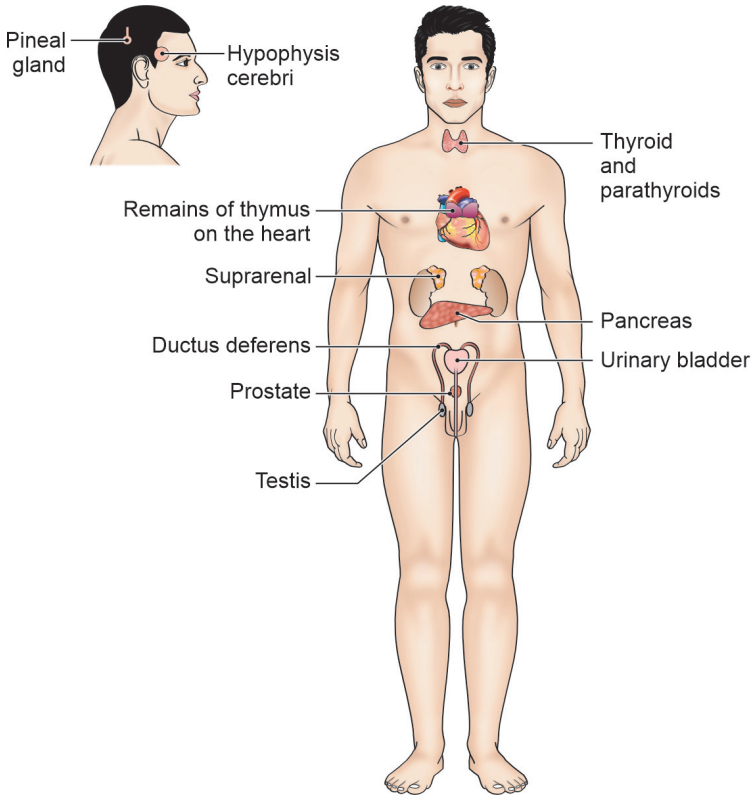


Fig. 1.60: Reproductive and endocrine systems in male

into a foetus. The foetus delivers out after nine months of pregnancy. Details can be seen from 9th edition of *BD Chaurasia's Human Anatomy*, Volume 2, Chapters 31 and 32.

11. ***Endocrine system (endocrinology)*** consists of ductless glands like hypothalamus, hypophysis cerebri, thyroid, parathyroid, suprarenal glands and islets of Langerhans in pancreas which produce hormones, that are carried to various target organs via blood. In male additional endocrine gland is testis, whereas in female it is replaced by ovary (Figs 1.60 and 1.61). These hormones influence metabolism and other processes like production of spermatozoa and the menstrual cycle.
12. ***Special senses*** include senses of taste, sight, smell, hearing, balance and touch. Taste is appreciated by the papillae present in the tongue, epiglottis and soft palate. Sense of sight is

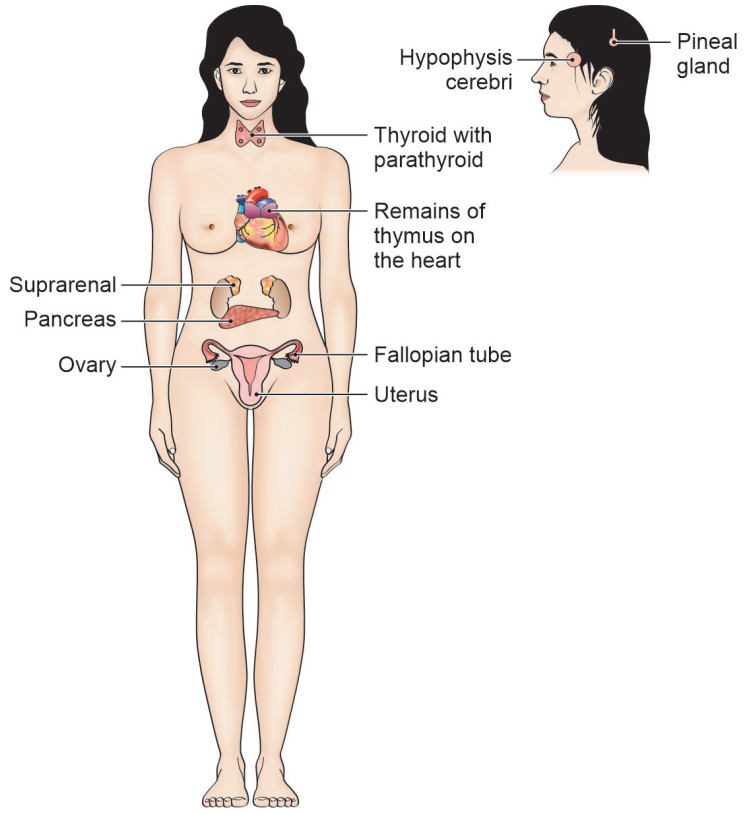


Fig. 1.61: Reproductive and endocrine systems in female

appreciated in the nervous layer, the retina, of the eyeball. Receptors of smell are only present in the mucous membrane of the upper part of the nasal cavity. Hearing and balance are compactly organised in the internal ear. Touch is perceived through the skin (Fig. 1.62).

13. ***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). 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 (Fig. 1.63). The details of the system can be available in 9th edition of *BD Chaurasia's Human Anatomy*, Volume 4.

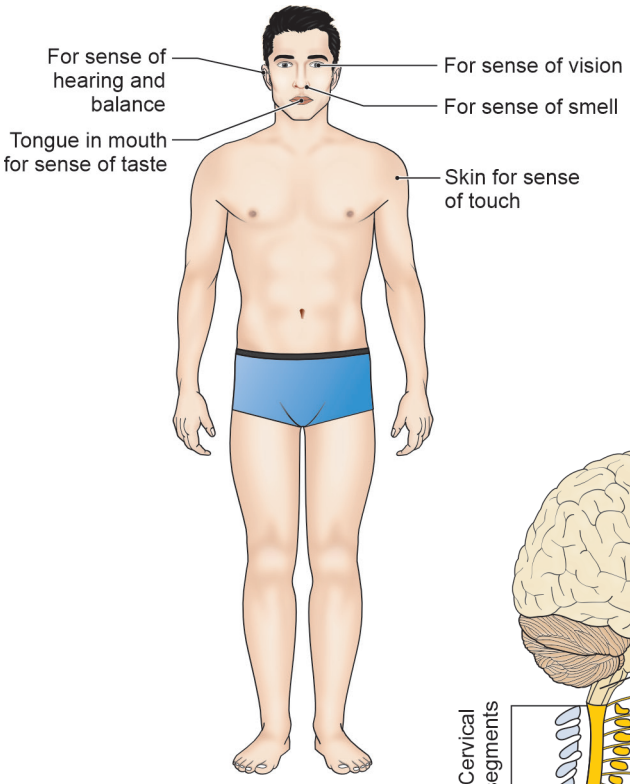


Fig. 1.62: Special senses

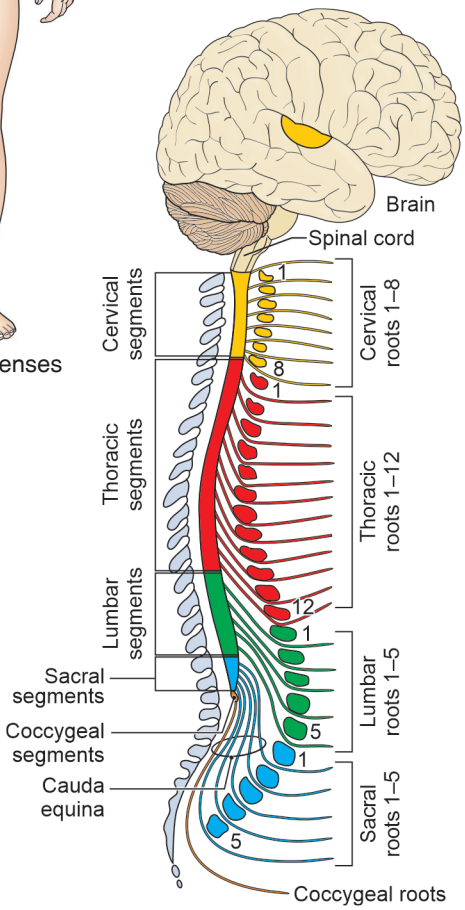


Fig. 1.63: Central nervous system

Clinical Anatomy

1. The ***suffix***, '-itis', means inflammation, e.g. appendicitis, tonsillitis, arthritis, neuritis, dermatitis, etc.
2. The suffix, '***-ectomy***', means removal from the body, e.g. appendicectomy, tonsillectomy, gastrectomy, nephrectomy, etc.
3. The suffix, '***-otomy***', means to open and then close a hollow organ, e.g. laparotomy, hysterotomy, cystotomy, cystolithotomy, etc.
4. The suffix, '***-ostomy***', means to open hollow organ and leave it open, e.g. cystostomy, colostomy, tracheostomy, etc.
5. The suffix, '***-oma'***, means a tumour, e.g. lipoma, osteoma, neurofibroma, haemangioma, carcinoma, etc.
6. ***Puberty:*** The age at which the secondary sexual characters develop, being 12–15 years in girls and 13–16 years in boys.
7. ***Symptoms*** are subjective complaints of the patient about his disease.
8. ***Signs (physical signs)*** are objective findings of the doctor on the patient.
9. ***Diagnosis:*** Identification of a disease, or determination of the nature of a disease.
10. ***Prognosis:*** Forecasting the probable course and ultimate outcome of a disease.
11. ***Pyrexia:*** Fever.
12. ***Lesion:*** Injury, or a circumscribed pathologic change in the tissues.
13. ***Inflammation*** is the local reaction of the tissues to an injury or an abnormal stimulation caused by a physical, chemical, or biologic agent. It is characterized by:
    a. Swelling b. Pain c. Redness
    d. Warmth or heat e. Loss of function.
14. ***Oedema:*** Swelling due to accumulation of fluid in the extracellular space.
15. ***Thrombosis:*** Intravascular coagulation (solidification) of blood.
16. ***Embolism:*** Occlusion of a vessel by a detached and circulating thrombus (embolus).
17. ***Haemorrhage:*** Bleeding which may be external or internal.
18. ***Ulcer:*** A localized breach (gap, erosion) in the surface continuity of the skin or mucous membrane.
19. ***Sinus:*** A blind track (open at one end) lined by epithelium.

20. ***Fistula:*** An abnormal passage usually between two internal organs or organ to surface of the body and lined by epithelium.
21. ***Necrosis:*** Local death of a tissue or organ due to irreversible damage to the nucleus.
22. ***Degeneration:*** A retrogressive change causing deterioration in the structural and functional qualities. It is a reversible process, but may end in necrosis.
23. ***Gangrene:*** A form of necrosis (death) combined with putrefaction.
24. ***Infarction:*** Death (necrosis) of a tissue due to sudden obstruction of its artery of supply (often an end-artery).
25. ***Atrophy:*** Diminution in the size of cells, tissue, organ, or a part due to loss of its nutrition.
26. ***Dystrophy:*** Diminution in the size due to defective nutrition.
27. Hypertrophy: Increase in the size without any increase in the number of cells.
28. ***Hyperplasia:*** Increase in the size due to increase in the number of cells.
29. ***Hypoplasia:*** Incomplete development.
30. ***Aplasia:*** Failure of development.
31. ***Syndrome:*** A group of diverse symptoms and signs constituting together the picture of a disease.
32. ***Paralysis:*** Loss of motor power (movement) of a part of body due to denervation or primary disease of the muscles.
33. ***Hemiplegia:*** Paralysis of one-half of the body.
34. ***Paraplegia:*** Paralysis of both the lower limbs.
35. ***Monoplegia:*** Paralysis of any one limb.
36. ***Quadriplegia:*** Paralysis of all the four limbs.
37. ***Anaesthesia:*** Loss of sensation.
38. ***Analgesia:*** Loss of the pain sensibility.
39. ***Thermanaesthesia:*** Loss of the temperature sensibility.
40. ***Hyperaesthesia:*** Abnormally increased sensibility.
41. ***Paraesthesia:*** Perverted feeling of sensations.
42. ***Coma:*** Deep unconsciousness.
43. ***Tumour (neoplasm):*** A circumscribed, noninflammatory, abnormal growth arising from the body tissues.
44. ***Benign:*** Mild illness or growth which does not endanger life.
45. ***Malignant:*** Severe form of illness or growth, which is resistant to treatment.

46. ***Carcinoma:*** Malignant growth arising from the epithelium (ectoderm or endoderm).
47. ***Sarcoma:*** Malignant growth arising from connective tissue (mesoderm).
48. ***Cancer:*** A general term used to indicate any malignant neoplasm which shows invasiveness and results in death of the patient, if not properly treated.
49. ***Metastasis:*** Spread of a local disease (like the cancer cells) to distant parts of the body.
50. ***Convalescence:*** The recovery period between the end of a disease and restoration to complete health.
51. ***Therapy:*** The treatment of disease.

ARRANGEMENT OF STRUCTURES IN THE BODY FROM WITHIN OUTWARDS

1. Bones form the supporting framework of the body.
2. Muscles are attached to bones.
3. Blood vessels, nerves and lymphatics form neurovascular bundles which course in between the muscles, along the fascial planes.
4. The thoracic and abdominal cavities contain several internal organs called viscera.
5. The whole body has three general coverings, namely (a) skin; (b) superficial fascia; and (c) deep fascia.

Points to Remember

- Hippocrates is the father of medicine.
- Leonardo da Vinci is the founder of modern anatomy.
- Dr Inderjit Dewan researched on osteology and anthropology.
- Anatomical position is the most important position for understanding anatomy.
- Median plane is only one plane in the trunk.
- Pronation and supination of forearm are special movements which permit "picking up of food (pronation)" and "putting it in the mouth (supination)".
- Big toe being in the same plane as rest of the toes is unique to human.

- Inversion and eversion of the foot help in its adjustment to the rough ground.
- There are 12 systems in the body. Medical students learn anatomy as regional anatomy, whereas nursing students learn it as systemic anatomy.
- Median/midsagittal plane divides the body into right and left halves.
- Coronal plane divides the body/any part into anterior and posterior parts.
- Transverse/horizontal plane divides the body/part into upper and lower portions.

Multiple Choice Questions

1. Name the founder of modern anatomy:

a. Vesalius
b. Herophilus
c. Galen
d. Leonardo da Vinci

2. Name the father of medicine:

a. Herophilus
b. Galen
c. Hippocrates
d. Vesalius

3. Name the father of anatomy:

a. Henry Gray
b. Hippocrates
c. Galen
d. Herophilus

4. Phylogeny is the developmental history of a human:

a. Through evolution
b. Through life
c. Before birth
d. From birth to death

5. Ontogeny is the developmental/history of a human:

a. Through evolution
b. Before birth
c. From fertilization till death
d. After birth

6. Anatomical position has following features *except*:

a. Person standing erect
b. Forearms are pronated
c. Feet together
d. Eyes looking forwards

7. Which statement about the coronal plane is incorrect:

a. Divides the body into anterior half and posterior half
b. Lies at right angle to sagittal plane
c. Lies at right angle to transverse plane
d. Divides the body into right half and left half

8. Define abduction:

a. Movement away from central axis
b. Movement towards central axis
c. Approximation of the ventral surfaces
d. Approximation of the dorsal surfaces

9. What is the position of forearms in the anatomical position?

a. Pronated
b. Supinated
c. Midprone
d. None of the above

10. Plane at right angle to the long axis of body/body part is called:

a. Sagittal
b. Coronal
c. Transverse/horizontal
d. Oblique

11. The term cranial means:

a. Towards the head
b. Towards the back
c. Towards the tail
d. Towards the front

12. Preaxial border of upper limb is:

a. Its inner border
b. Its outer border
c. Its anterior median line
d. Its posterior median line

Answers

1. d **2.** c **3.** d **4.** a **5.** c **6.** b **7.** d **8.** a
9. b **10.** c **11.** a **12.** b