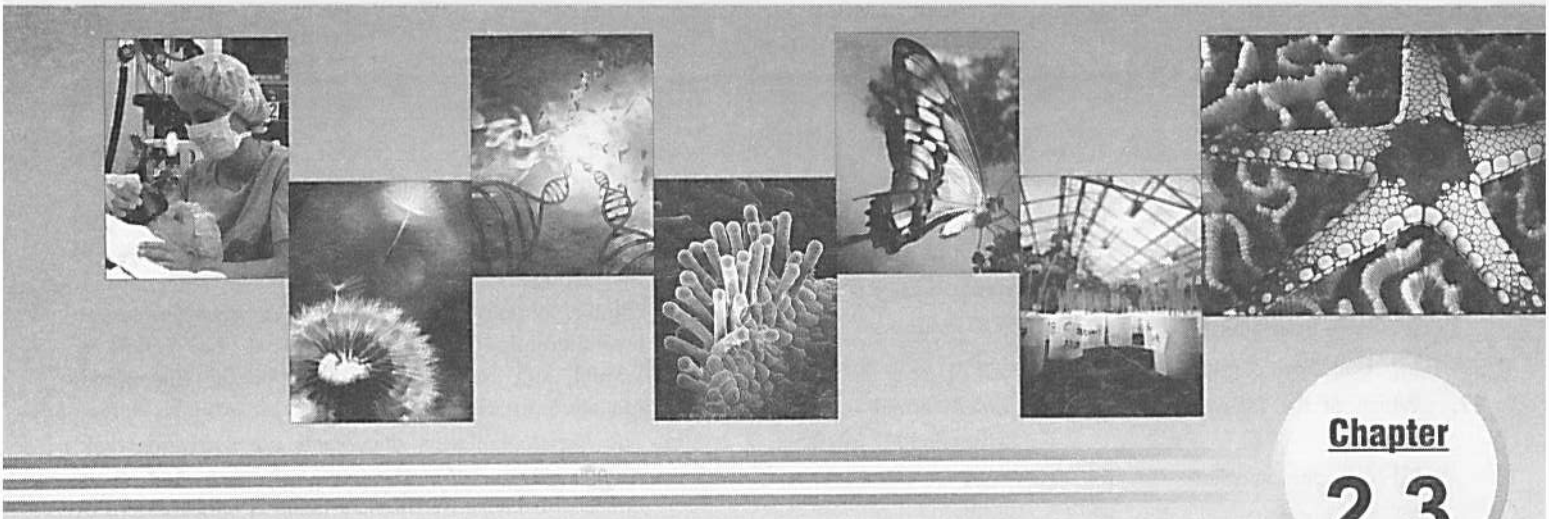


Chapter

2.3

Animal Tissues

A tissue may be defined as a group of one or more types of cells having a similar origin and specialized for a specific function or functions along with the intercellular material.

Branch of biology dealing with the study of tissue is called histology. The term 'tissue' was introduced by *Bichat* and also known as 'Father of histology'. *Mayer* coined the term 'histology' and the founder of histology is *Marcello Malpighi*. Following types of tissues are found in animals :

Epithelial Tissue

An epithelium is a tissue composed of one or more layers of cells that cover the body surface and lines its various cavities. It serves for protection, secretion and excretion. The word 'epithelium' (G. *epi* = upon, *thele* = nipple) was introduced by *Ruysch*. They are located on the outer surfaces of organs, including the skin. They form the linings of tracts, cavities and vessels. Epithelial tissue evolved first in animal kingdom. It originate from all the three primary germ layers.

Structure

Cells are arranged in one or more layers, cells are compactly arranged and there is no inter cellular matrix between them. Neighbouring cells are held together by intercellular junctional complexes like desmosomes, tight junctions, interdigitations etc. The cells of lowermost layers always rest on a non living basement membrane or basal lamina. Basement membrane is made up of no cell product of epithelial tissue. It is formed of mucopolysaccharides, glycoprotein and collagen or reticular fibres. Blood vessels are absent in the epithelial tissues. However, nerve endings may penetrate the epithelium. It possesses very high capacity of renewal (mitotic cell division). The following types of modifications and junctions are found in the plasma membrane of adjacent epithelial cells to keep the cells together.

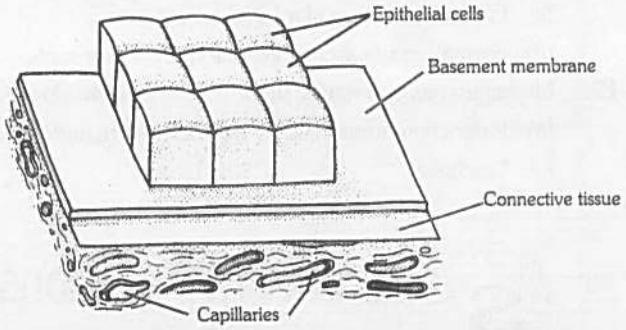


Fig : 2.3-1 Diagram to show an epithelium with its basement membrane resting upon underlying connective tissue

Microvilli : These are simple and minute cytoplasmic processes arising from free exposed surfaces of the cell. They absorb material. e.g. Intestine.

Stereocilia : These are non-motile cytoplasmic processes. e.g. Epididymis, vas deference.

Kinocilia : It is contractile motile fibrous processes arising from basal granules. e.g. Oviduct, Fallopian tube.

Tight junctions (Zona occludens) : At certain places the plasma membranes of adjacent cells are tightly packed or even fused together. e.g. Brain.

Desmosomes : Desmosome is present in epithelial tissue. They consist of thickened area and several fine tonofibrils extending from each plasma membrane into cytoplasm of respective cells. Macula adherens is a kind of desmosome. e.g. Vagina, Urinary bladder.

Gap junction : At place, the adjacent cells form ion-rich gap junctions for intercellular communication and chemical exchange. These junctions probably do not provide physical support.

Interdigitations : These are interwoven finger-like processes of plasma membranes of adjacent cells.

Intercellular bridges : These are minute projections that arise from adjacent cell membranes. The intercellular bridges make contact with one another.

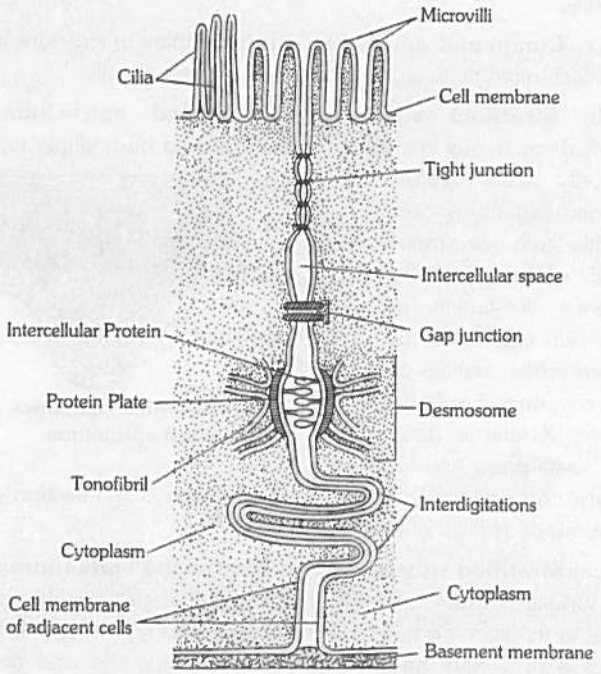


Fig : 2.3-2 Intercellular junctions between two adjacent epithelial cells

Functions

Epithelial tissues have a wide spread distribution throughout the body and serve several important functions –

(1) Generalized protection is the most important function of membranous epithelium. It is the relatively tough and impermeable epithelial covering of the skin that protects the body from mechanical and chemical injury and also from invading bacteria and other disease causing micro-organisms.

(2) Epithelial structures specialized for sensory functions are found in the skin, nose, eye and ear.

(3) Glandular epithelium is specialized for secretory activity, secretory products include hormones, mucous, digestive juices and sweat.

(4) The epithelium lining of the gut and respiratory tracts allows the absorption of nutrients from the gut.

(5) It is the specialized epithelial lining of kidney tubules that makes the excretion and concentration of excretory products in the urine.

(6) Ciliated epithelium moves fluid, mucus and other materials in the organs it lines.

(7) Germinal epithelium of the seminiferous tubules and ovaries produces spermatozoa and ova respectively.

(8) The ability of epithelium to regenerate quickly helps in the healing of wounds.

(9) Pigmented epithelium of retina darkens the cavity of eyeball.

(10) The epithelia check the absorption of harmful or unnecessary materials.

(11) Epithelium of alveoli of the lungs brings about exchange of gases between blood and air.

(12) Epithelium also produce exoskeletal structures such as scales, feathers, hair, nail, claws, horns and hoofs.

Types of epithelial tissue

Mainly based on the location and functions of tissue it is of following types –

(1) **Simple epithelium :** It simple in structure and basically formed by single layer cells.

(i) **Simple squamous epithelium :** It consists of only one layer of flat, scale like cells, usually polygonal cells which are closely fitted together like the tiles of a mosaic. It is also known as pavement epithelium. *e.g.*, It forms lining of blood vessels, lymph vessel, heart, peritoneum, pleura, Bowman's capsule, thin segment of loop of Henle and lung alveoli.

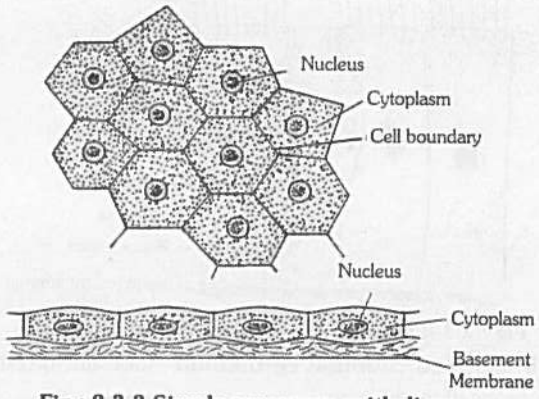


Fig : 2.3-3 Simple squamous epithelium

(ii) **Simple cuboidal epithelium :** The simple cuboidal epithelium is composed of one layer of cuboidal shaped cells resting on a basement membrane. The nuclei are situated centrally. e.g. the cuboidal epithelium is present in the small salivary and pancreatic ducts, thyroid vesicles, parts of membranous labyrinth, PCT, DCT, ovaries, seminiferous tubules of testes, ciliary bodies, choroid, iris of eyes, thin bronchioles and sweat gland of mammalian skin.

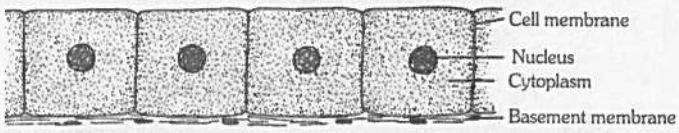


Fig : 2.3-4 Simple cuboidal epithelium

(iii) **Simple columnar epithelium :** It consists of a single layer cells, many of which have modified structure. Three common modifications are goblet, cilia and microvilli. Simple columnar epithelium is present in the stomach and intestine e.g. inner lining of gall bladder and bile duct. It also occurs in the gastric gland, intestinal glands, pancreatic lobules.

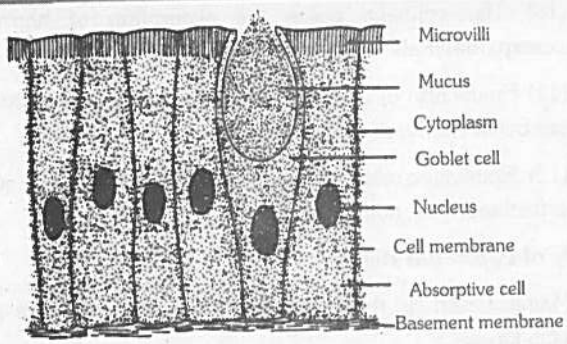


Fig : 2.3-5 Simple columnar epithelium

(iv) **Simple ciliated epithelium :** It bears numerous delicate hair like outgrowths called cilia arising from basal granules which helps to create a current to transport the materials. The ciliated epithelium is of two types :

(a) **Ciliated columnar epithelium :** It lines respiratory tract (Lower end of bronchi), fallopian tubes (oviducts), ventricles of brain (ependyma), central canal of spinal cord, tympanic cavity.

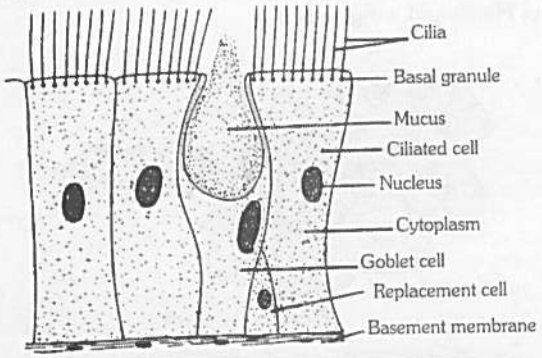


Fig : 2.3-6 Simple columnar ciliated epithelium

(b) **Ciliated cuboidal epithelium :** It occurs in certain parts of nephrons of the kidneys.

(v) **Pseudostratified epithelium :** It always consist of single layer of irregularly shaped columnar cells, touches the basement membrane. The long cells have oval nuclei however,

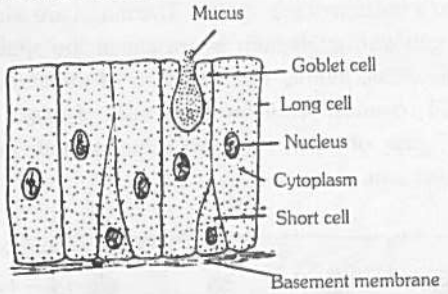


Fig : 2.3-7 Pseudostratified epithelium

Short cells have rounded nuclei although epithelium is one cell thick, but it gives the appearance of a stratified epithelium, hence it is called pseudostratified epithelium. Mucus secreting goblet cells are numerous and cilia are present. It is of two types –

(a) **Pseudostratified columnar ciliated epithelium :** It is found in the lining of trachea and bronchi (Upper).

(b) **Pseudostratified columnar epithelium :** It is found in certain segments of human male urethra and parotid salivary gland, vasa deferentia and epididymis.

(c) **Stratified squamous epithelium :** The cells in the deepest layer are columnar or cuboidal with oval nuclei. It is called germinative layer. The cells of this layer divide by mitosis to form new cells.

(2) **Compound epithelium :** It is complex in structure and basically formed by two or more than two layers of cells.

(i) **Stratified squamous keratinised epithelium :** Stratified squamous epithelium is characterized by multiple layers of cells with typical flattened squamous cells at the free or outer surface of the sheet. The presence of keratin in these cells contributes to the protective qualities of skin covering the body surface. Keratin is dead and waterproof so it protects the underlying tissues from abrasion and infection e.g. epidermis of the skin of land vertebrates.

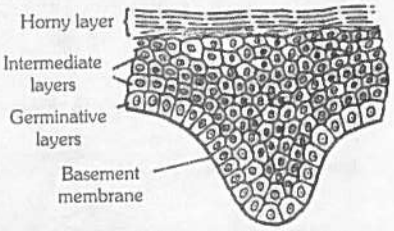


Fig : 2.3-8 Stratified squamous Keratinised epithelium

(ii) **Stratified squamous non keratinised epithelium :** Its free surface is moist, and the outer epithelial cells, unlike those found in the skin, do not contain keratin. This type of epithelium serves a protective function. It is found lining the oral cavity (buccal cavity), pharynx, oesophagus, anal canal, lowerpart of urethra, vocal cords, vagina, cervix (lower part of uterus) and cornea of eyes.

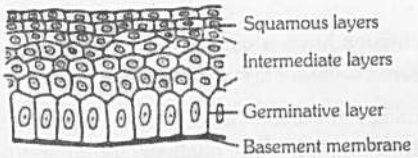


Fig : 2.3-9 Stratified squamous non keratinised epithelium

(iii) **Stratified cuboidal epithelium :** It consists of two or more rows of low cuboidal-shaped cells which are arranged randomly over a basement membrane. It is found in the sweat gland ducts, larger salivary and pancreatic ducts.

(iv) **Stratified columnar epithelium :** It is protective epithelium having multiple layers of columnar cells, only the most superficial cells are truly columnar in appearance. Epithelium of this type is rare. It is found in male urethra and in the mucous layer near the anus. It also lines mammary gland ducts and epiglottis.

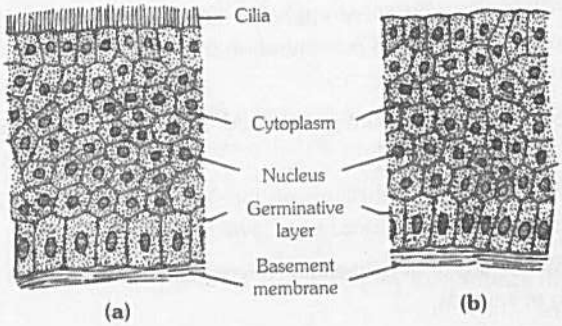


Fig : 2.3-10 (a) Stratified columnar ciliated epithelium
(b) Stratified columnar epithelium

(v) **Stratified columnar ciliated epithelium :** It lines the larynx and upper part of the soft palate.

(3) **Specialized epithelium :** This type of epithelium are specialized to perform specific activity hence, specialized in structure also. They are as follows –

(i) **Transitional epithelium (Urothelium) :** It is often ten or more layers thick. It lacks germinative layer, basement membrane. Stratified transitional epithelium is typically found in the body areas such as the wall of urinary bladder, ureter and renal pelvis. It is located in all the hollow viscera subjected to stress and protects organ wall from tearing.

(ii) **Neurosensory epithelium :** Olfactory mucosa, called Schneiderian membrane, lining of internal nares, retina of eyes and epithelial covering of tongue containing taste buds are examples of neurosensory epithelia. The sensory cells bear, at their free ends, slender "sensory hairs" to receive specific stimuli. Basely, these cells are connected, by means of synapses, with fine fibrils of sensory nerves.

(iii) **Pigmented epithelium :** The epithelial cells of the basal layer of retina contain pigment. Hence, this layer is often referred to as a pigmented epithelium. e.g. – Pigmented layer of retina, iris and skin.

(iv) **Germinal epithelium :** Specialized cuboidal cells capable of producing gametes as found in gonads. Germinal epithelium produces gametes e.g., ova (Female gametes) and sperms (Male gametes)

Glands

Glandular epithelium are specialized for secretory activity. A cell, tissue or organ which secretes a useful chemical material is known as gland. Glands are made up of cuboidal epithelial cells which are more secretory. All glands arise as folding of epithelia. The golgi body in gland cells are larger and more secretory. Most of the glands of body are merocrine types. It originate from all three germinal layers. (ecto, meso and endoderm). Liver is the largest gland of the body and lined by glandular epithelium.

Types of glands

(A) On the basis of number of cells

(1) **Unicellular gland :** It consist of unicellular gland cells which are called as goblet cells or chalice cells. They secrete mucous and found in mucosa of intestine and stomach. Mucous lubricates the food for easy peristalsis. Their life span is about 2–3 days.

(2) **Multicellular gland :** It consist of many cells and are generally located in underlying connective tissue *e.g.* gastric and intestinal glands.

(B) On the basis of presence or absence of ducts

(1) **Exocrine gland :** These are those glands which discharge their secretory products into ducts. It is also called ducted glands or glands of external secretion. e.g. Salivary glands, Mammary glands and Tear glands.

(2) **Endocrine gland :** They are often called ductless gland, because they discharge their secretory products (hormones) directly into the blood. e.g. Pituitary gland, thyroid, parathyroid and adrenal glands.

(3) **Heterocrine gland :** These are those glands which are partly endocrine and partly exocrine in function. e.g. Pancreas.

Structural classification of exocrine glands

Multicellular exocrine glands are classified by structure, using the shape of their ducts and the complexity (branching) of their ducts system as distinguishing characteristics. Shape include tubular and alveolar (Sac like). Simple exocrine glands *e.g.* intestinal glands, mammalian sweat glands, cutaneous glands of frog etc. have only one duct leading to surface. Compound exocrine glands have two or more ducts *e.g.* liver, salivary glands etc.

Table : 2.3-1

Type	Example
Simple tubular	Intestinal glands, crypts of Lieberkuhn in ileum.
Simple coiled tubular	Sweat glands in man
Simple branched tubular	Gastric (stomach) gland, and Uterine gland.
Simple alveolar	Mucous gland in skin of frog, Poison gland of toad and seminal vesicle.
Simple branched alveolar	Sebaceous glands
Compound tubular	Brunner's gland, bulbourethral gland and liver.
Compound alveolar	Sublingual and submandibular salivary gland
Compound tubulo alveolar	Parotid salivary glands, Mammary gland and Pancreas.

Classification of glands on the basis of their mode of secretion

(1) **Apocrine gland :** Apocrine glands collect their secretory products near the apex or tip, of the cell and then release it into a duct by pinching off the distended end. This process results in some loss of cytoplasm and damage to the cell. e.g. Mammary glands. (Modified sweat gland)

(2) **Holocrine gland :** Holocrine glands collect their secretory products inside the cell and then rupture completely to release it. These cells self destruct to complete their functions. e.g. Sebaceous glands. In case of rabbit sebaceous glands are found in dermis of skin. Pineal body and thymus can also be considered as holocrine gland.

(3) **Merocrine gland :** Merocrine glands (Eccrine or Epicrine glands) discharge their secretory product directly through the cell or plasma membrane, without injury to the cell wall and without loss of cytoplasm. *e.g.* Sweat glands, exocrine region of vertebrate pancreas, salivary glands and intestinal glands etc.

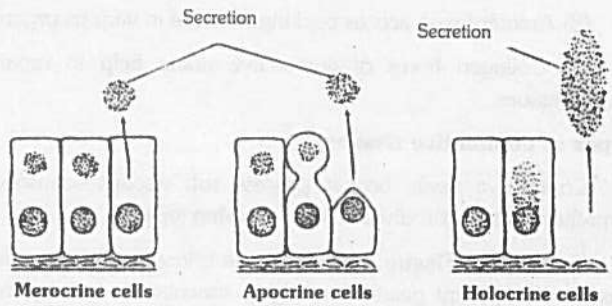


Fig : 2.3-11 Types of glands regarding the mode of secretion

Classification of glands on the basis of nature of product

(1) **Mucous gland :** Secret slimy mucous e.g. goblet cells, palatine gland, gland of uterus, some gastric gland and gland of colon.

(2) **Serous gland :** Produce watery secretion. e.g. pancreas, parotid, salivary gland, sweat gland and intestinal gland.

(3) **Seromucous gland :** Secrete mixed liquid. e.g. Most gastric gland, sublingual, submaxillary salivary gland, pancreas.

(4) **Cytogenic gland :** They produce cells e.g. Testis and ovary.

Connective tissue

It connects and supports all the other tissues, the intercellular element predominating. The cellular element is usually scanty. In function this tissue may be mechanical, nutritive and defensive. It is a tissue made up of matrix (abundant intercellular substance or ground substance) and living cells that connects and support different tissues. All connective tissues in the body are formed by mesoderm.

Structure

There are large intercellular spaces between the cells. Intercellular spaces are filled with large amount of extracellular materials formed of insoluble protein fibres lying in an amorphous, transparent ground substance called matrix. Ageing of an animal body is associated with deterioration in its connective tissues.

Functions

(1) Their chief function is to bind other tissues together in the organs.

(2) Certain connective tissues such as adipose tissues store fat.

(3) Skeletal connective tissues like bones and cartilages provide the body with a supporting skeletal frame work.

(4) Fluid connective tissues such as blood and lymph transport various materials in the body.

(5) Plasma cells synthesize antibodies, viz., macrophages. Lymphocytes ingest cell debris, harmful bacteria and foreign matter. Thus these cells of connective tissues are protective in function.

(6) The jelly-like ground substance of connective tissues acts as shock absorber around some organs such as eye balls and kidneys.

(7) The bone marrow produces blood cells.

(8) Areolar tissue acts as packing material in various organs.

(9) Collagen fibres of connective tissue help in repair of injured tissues.

Types of connective tissues

Connective tissue proper possess soft viscous semisolid or semi-fluid matrix. It is divided into following types :

(1) **Areolar Tissue :** Areolar tissue is loose connective tissue, possess transparent gelatinous, highly vascular and sticky matrix which have variety of cells and fibres. It allows movement of part connected by it (Muscle and their compound). Areolar tissue mainly consist of different types of cells and fibres.

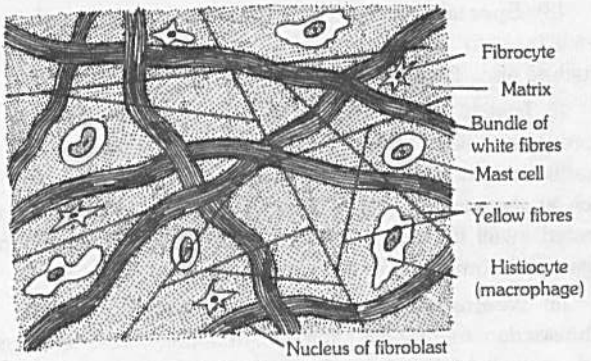
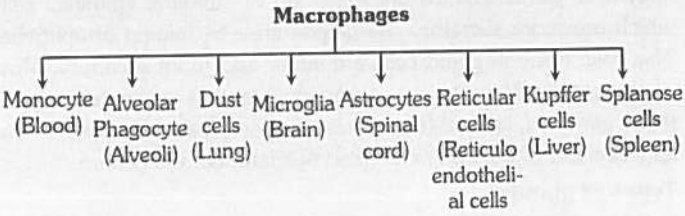


Fig : 2.3-12 Areolar connective tissue

(i) **Cells of areolar tissue :** It has following types –

Fibroblast : These are the most abundant cells, produces fibres, called as fibroblasts in their young active phase and fibrocytes when old and inactive. It synthesize proteins (Collagen, elastin and reticulin). These are undifferentiated mesenchyme stem cells, capable to give rise other cells of connective tissue. Collagen and elastin are formed by fibroblasts.

Histiocytes or Macrophages or Clasmatocytes : These are polymorphic cells. These are amoeboid cells and are main phagocytes of connective tissue. They are having most active lysosomes and phagocytise dead cells and pathogens. Macrophages remove the dead and damaged cells and clean the body so called scavenger cell. All types of macrophages take part in phagocytosis.



Reticular cells : Present only in the reticular tissue and stellate in appearance. Infact they are modified fibroblast producing reticular fibres.

Mast cells : Mast cells were discovered by *Paul Echrlich*. They are large, irregular ovoid cells found in areolar tissue. and their number increases during allergies. It produces or secretes histamine (vasodilator), serotonin (vasoconstrictor) and heparin (anticoagulant). Histamine dilate the blood vessels in allergic and inflammatory conditions. Heparin checks the clotting of blood inside the blood vessels. Serotonin act as vasoconstrictor to arrest bleeding.

Lymphocytes : These are the smallest, less numerous and spherical or ovoid cells resembling lymphocytes of blood and lymph. These actively move about by pseudopodia. Their function is to form and carry antibodies. That is why, they are seen in large numbers at sites of inflammation.

Plasma cells (Plasmacytes) : These are usually small and rounded, superficially resembling lymphocytes but are sluggishly amoeboid and short-lived (only 2 or 3 days). These are the most potential antibody-forming cells of body presumably, mature lymphocytes (B-lymphocytes form antibody) transform into plasma cells or proliferate to form plasma cells. Plasma cells are also known as cart wheel cells.

Fat or Adipose cells (Adipocytes or Lipocytes) : A few, large and spherical cells occur in areolar tissue, singly or in clusters around small blood vessels. Each cell contains a large globule of fat surrounded by a thin peripheral layer of cytoplasm having a nucleus.

Eosinophils : These cells closely resemble the eosinophilic leucocytes of blood. These probably play a phagocytic role in inflammatory and allergic reactions.

Chromatophores : These are pigment cell present in specialised areas such as skin and eye. They are much branched and packed with pigment granules. They are stellate (Star like) cells, which are phagocytic in nature. They phagocytes melanin producing cells and retain melanin hence they provide colour to the skin and other organs. Melanin is black pigment which protects body from ultraviolet rays of sun.

Mesenchyme cells : These are reserve undifferentiated cell which can be transformed into other types of cells when needed.

(ii) **Fibres of areolar tissue :** These are made up with protein and non living structures of protein produced by fibroblasts and present in matrix of connective tissue and are of three types –

Collagenous fibres : These are the most abundant fibrous element of areolar and other connective tissues. These are long, unbranched fibres of a soluble and shining collagen protein (tropo collagen). These fibres are more strengthful and provide maximum tensile strength. These are colourless and hyaline, yet called white fibres to distinguish them from yellow elastin fibres. Collagen protein is the most abundant protein of the body constitutes 25% the total body protein. Collagen fibre can be stained by eosin. When collagen fibres are removed from the areolar tissue they become loose and elastic. e.g. Bone, Cartilage, Ligement and tendon.

Yellow elastin fibres : Formed of elastin protein, these fibres are less numerous, thinner, branched, anastomosing, and of a pale yellow colour. These are very elastic and remain stretched due to tension in the areolar tissue, when broken in teased preparations, these coil and curl like tense wires. Elastin is probably the most resistant of all body proteins to chemical changes. Thousands of years old 'mummies' still have their arteries intact due to well-preserved elastin fibres. They are the orceinophilic i.e. stained by orcein.

Reticulin fibres : These are delicate, freely branching and inelastic fibres of reticulin protein, found interwoven, to form networks. These are very abundant in embryos, new born babies and in healing and regenerating wounds. In areolar tissues of adults, these are mostly replaced by collagen fibres, but remain abundant in lymphoid and blood forming tissues and in the stroma of pancreas, liver etc. They are stained with $AgBr$ and $AgNO_3$ hence are called Argentophillic or Argyrophillic. On boiling collagen and reticular fibres both convert in glue.

(2) **White fibrous tissue (Dense connective tissue):** It is modified form of areolar tissue. Only collagen fibres are present in the matrix and cells are mainly fibroblasts, present at the joints between skull bones and makes them immovable, also found in the dermis of higher mammals. It is of two types –

(i) **Tendons :** A tendon is non-elastic but flexible tissue consisting of parallel bundles of collagenous fibres between which rows of fibroblasts are present. It joins the muscles to bones. It also form chordae tendinae which joins the cusps of atrioventricular valves of heart with the wall of ventricles.

(ii) **Sheath :** In a sheath, the bundles of white fibres lie in a criss-cross manner. The fibroblasts are not in rows but are scattered in the areolae. The sheath form protective covering.

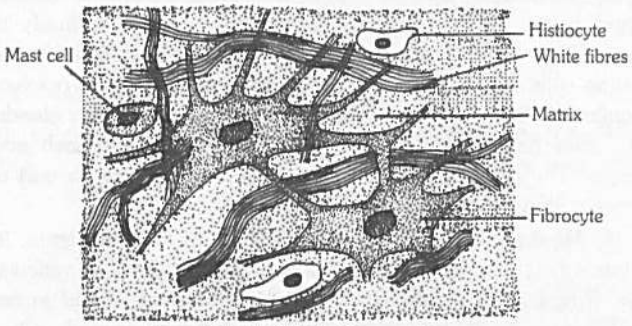


Fig : 2.3-13 White fibrous tissue

(3) **Yellow fibrous tissue (Elastic connective tissue):** The matrix is with numerous and closely packed yellow or elastin fibres which are similar to but thicker than those of areolar connective tissue. It is elastic and flexible. It forms wall of blood vessels, lungs, true vocal chords, trachea, capsule of spleen and bronchioles. It also forms sheet in ligaments. Ligaments is a modified yellow elastic fibrous tissue and connects bone to bone.

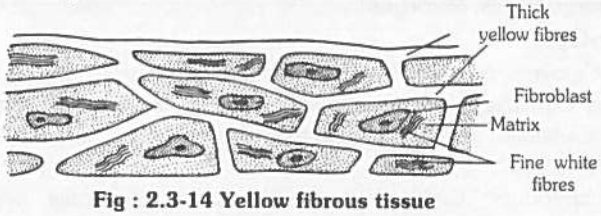


Fig : 2.3-14 Yellow fibrous tissue

(4) **Adipose tissue :** It is modified form of areolar tissue made up of specialized large spherical fat cells (below the skin) or adipocytes. Adipose tissue chiefly act as "Food reserves" or fat depots for storage and metabolism of lipids. Besides this, they also act as heat insulators and pressure, pull and push absorbers. Adipocytes are of two types :

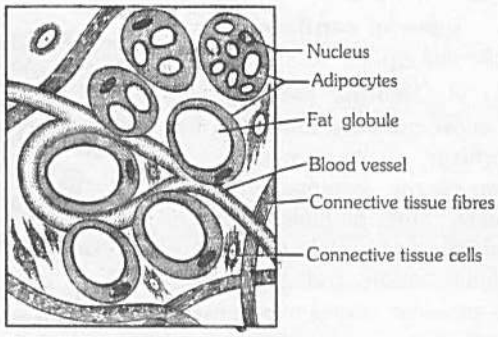


Fig : 2.3-15 Adipose connective tissue

(i) **Unilocular adipocyte (White adipose tissue) :** Common fat of body, having single large fat globule, maintain body temperature, found beneath skin subcutaneous fat panniculus adiposus, blubber of whales and elephants, hump of camel and tail of merino sheep, yellow bone marrow, around kidneys and blood vessels, mesentries, omenta and the fat bodies of frog.

(ii) **Multilocular adipocyte (Brown fat) :** Each multilocular adipocytes have several small fat globules, contain more number of mitochondria, found in rats and other rodents, polar bear, penguins, seal, walrus, in new born human babies and hibernating mammals (rats and other rodents). On oxidation it yields about 20 times more energy than ordinary fat. Brown colour is due to iron containing cytochrome pigment.

(5) **Reticular tissue :** It is a modified form of areolar connective tissue characterized by the matrix which is fluidy in nature. The matrix contains large number of stellate-shaped reticular cells, each with a number of protoplasmic processes. Reticular tissue is found in spleen, thymus, tonsils, lymph glands, liver, bone-marrow, lamina propria of mucosa of stomach and intestine. The reticular cells act as phagocytes and form a part of defence system of the body.

(6) **Myeloid tissue :** It is modification of reticular tissue. Its ground substance is plasma. It posses heavy network of reticular fibres. In active form the cells are myeloblasts. It is found in red bone marrow or haemopoietic tissue and fat reserve of yellow bone marrow.

Skeletal tissue

It provide support and surface for attachment of muscle. Skeletal connective tissue is mesodermal in origin and forms the frame work of body. It provide rigidity to body. These protect the various organ and help in locomotion. It is of three types : Cartilage, Bones, Notochord.

Cartilage

Cartilage is a solid but semi-rigid and flexible connective tissue. Cartilage is a nonvascular connective tissue, consisting of cells embeded in a resilent matrix of chondrin. Chondrin is a protein of cartilage. Regeneration of cartilage can occur from its peri-chondrium. Cartilage is said to be metabolically nearly inactive. In kids the cartilage cells show 2 types of growth.

(1) **Appositional or Perichondral or Secondary or Exogenous growth :** It is due to deposition of matrix and division of chondrogenic cells of periphery. It leads to growth in thickness.

(2) **Endogenous or Interstitial growth :** It is due to deposition of matrix and division in inner cells of cartilage. It leads to growth in size.

Types of cartilage : It is of following types –

(1) **Hyaline cartilage :** It is most primitive and glass like cartilage. Its matrix is transparent homogenous and pearly white or bluish green in colour, contain chondrin. It is slightly elastic and also known as articular cartilage because it forms the articular surface of joints. Hyaline cartilage is found in trachea, larynx and bronchi, limb bones (called hyaline cap), sternum, in the hyoid apparatus nasal septum, ribs (sternal parts) larynx (cricoid, thyroid), nasal cartilage (nasal septum).

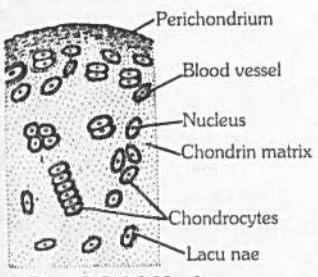


Fig : 2.3-16 Hyaline cartilage (section)

(2) **Fibro cartilage (White fibrous cartilage) :** In this cartilage, the small amount of matrix of cartilage is packed with large number of bundles of thick white (collagen) fibres. So it is toughest and less flexible. It is found in intervertebral discs and acts as shock absorber. It is also found in pubic symphysis and helps in parturition (child birth). The intervertebral discs remain contracted when the body is active, but relaxed when the body is at rest. That is why, our body becomes a bit taller during sleep and after death.

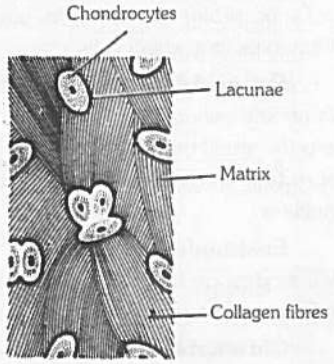


Fig : 2.3-17 Fibrocartilage White

(3) **Elastic cartilage (Yellow elastic cartilage) :** In this cartilage, the matrix is packed with yellow or elastic fibres which run in all directions to form a network. Owing to the presence of yellow fibres, it is very flexible. It gives recoiling power to structures. It is found in mammalian pinna, pharyngotympanic tube, epiglottis, some laryngeal and bronchiolar cartilages.

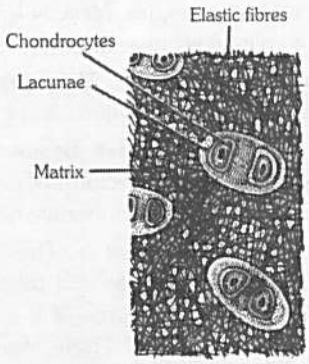


Fig : 2.3-18 Fibrocartilage Elastic

(4) **Calcified cartilage :** It is modified hyaline cartilage, It is hard and non elastic due to deposition of calcium salt-hydroxy appetite in matrix. It is found in pubis of old frog, supra-scapula of frog, quadrate cartilage of frog, shark vertebrae, in man ends of long bone, head of humerus and femur. Calcification may also occur as a regular growth process of bone due to age. It reduces elasticity of the cartilage and makes it more rigid.

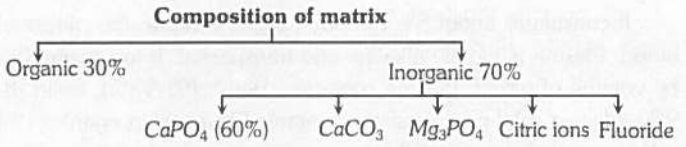
Bone

Bone is a highly calcified (mineralized), hard and rigid connective tissue. It is the major component of adult vertebrate endoskeleton. Besides its mechanical function of supporting the body architecture and internal organs as a frame work, of protecting delicate organ like brain, heart, etc. of forming to muscles to facilitate movement and locomotion, the bone is also a metabolically dynamic tissue which functions as a homeostatic reservoir of ions of calcium, magnesium, phosphorous, etc. About 97% of total calcium of body occurs in the endoskeleton.

Structure of bone

Periosteum : It is a membrane that forms an envelop around the bone. Periosteum comprises of two distinct layers. Outer layer consist of thin white fibrous connective tissue. Inner layer consist of osteoblasts. Osteoblasts are spider like bone cells, also known as bone forming cells, because they produces new bone materials.

Matrix : Matrix is composed of protein called ossein. The matrix forms thin plates called lamellae. Lamellae are of three types. *Haversian lamellae* (occur around Haversian canal) concentric or circumferential lamellae (inner to periosteum and outer to endosteum) and interstitial lamellae (between Haversian system). Between the adjacent lamellae are numerous small cavities called lacunae. A lacunae gives off numerous fine branching tubules called canaliculi. Each lucuna is occupied by bone forming cells called osteocyte.



Endosteum : It is present outer to the bone marrow cavity. Endosteum is a membrane which lines the marrow cavity. It comprises of two distinct layers, one is of fibrous connective tissue and another is osteoblasts.

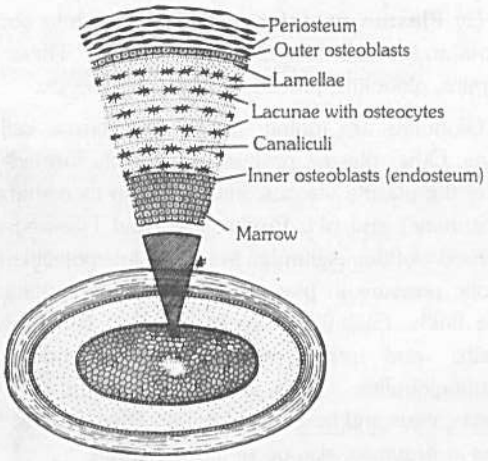


Fig : 2.3-19 T.S. of decalcified bone

Bone marrow : Bone marrow is a specialized type of soft, diffuse connective tissue called "Myeloid tissue". It takes part in production of blood cells hence known as haemopoietic tissue. It is composed of adipose tissue, areolar tissue and blood. It is of two types –

(1) **Red bone marrow :** Red in colour due to presence of lot of blood vessels. In foetal life and at birth present in entire skeleton. After 5th year red bone marrow is replaced by yellow bone marrow, at 20-25 years red bone marrow is present in ribs, sternum, clavicles, vertebrae, scapula, pelvis, epiphysis of humerus and femur. Produces RBCs, WBC, platelets, granular leucocytes like basophils eosinophils and neutrophils.

(2) **Yellow bone marrow :** Yellow in colour and has much fatty tissue (adipose tissue), present in shaft of long bones. Produces blood cells in emergency i.e. at the time of excessive loss of blood, yellow bone marrow may be replaced by red bone marrow in anaemia.

Haversian system : A haversian canal, its lamellae and osteocytes form a haversian system. Haversian canals are found in bone matrix of long bone, like humerus of mammals to provide extra nutrition to living part of matrix. Haversian canals contain artery and veins, osteoblasts in areolar tissue, nerves and lymph. It is also called osteon. Haversian canals are interconnected by transverse canals known as Volkmann's canals.

Types of bone cells : Four types of cells are found in bone :

(1) **Osteoprogenitor cell :** Develops into osteoblast cell due to mitotic cell division.

(2) **Osteoblast :** Bone forming cells found in all bone surfaces. It is small cells which synthesize and secrete osteoid, an important part of ground substance. Process of osteoblast is called canaliculi.

(3) **Osteocyte :** Mature, nondividing osteoblast surrounded by matrix, lying within lacunae.

(4) **Osteoclast :** Bone destroying cells take part in reabsorption of bones, contain large amount of acid phosphatase enzyme.

Types of bone

On the basis of their texture : The bones are divided into two categories spongy or cancellous or tubecular bones and compact or periosteal bones.

Table : 2.3-2 Differences between Spongy bone and Compact bone

Characters	Spongy bone	Compact bone
Arrangement of lamellae	There is no regular Haversian system so have spongy texture.	Have regular Haversian system
Occurrence	In skull bones, ribs, centrum of vertebrae and epiphysis of long bones	In the shaft (diaphysis) of long bones
Marrow cavity	Broad	Narrow
Type of bone marrow	Red marrow in the spaces between lamellae	Yellow marrow in marrow cavity
Function	Marrow forms RBCs and Granular WBCs, Platelets	Marrow stores fats

On the basis of origin of bone : Ossification or osteogenesis is the process of bone formation. A bone is classified into four categories – Cartilaginous, Dermal, Sesamoid and Visceral bones

Table : 2.3-3 Differences between Cartilaginous, Dermal, Sesamoid and Visceral bones

Cartilaginous (Endochondrial) bone	Dermal (Intramembranous) bone	Sesamoid bone	Visceral bone
These are formed by ossification directly on the cartilages and formation involves deposition of body matter by osteoblasts and resorption by osteoclast.	These are formed by ossification in the dermis of the skin.	These are formed by ossification at the joints of the bones or on the tendon and ligament.	They are formed in the soft organs.
These are elongated and hard bones Examples : Vertebrae, humerus, femur and fibula, girdles.	These are membrane-like bones. Examples : skull bones, phalanges, clavicles.	These are small sized disc like bones. Example : patella bone (knee cap).	Examples : oscordis, ospenis, osclitoris.

On the basis of treatment : These are of two types – Dried bone and Decalcified bone

Table : 2.3-4 Differences between Dried bone and Decalcified bone

Characters	Dried bone	Decalcified bone
Type of treatment	Subjected to high temperature.	Subjected to dilute solution of *HCl*.
Nature of matter left	With only mineral matter.	With only organic matter.
Marrow cavity	Empty.	With bone-marrow.
Fate of cells	Periosteum, endosteum, osteoblasts and osteocytes are absent being killed by high temperature.	Periosteum, endosteum, osteoblasts and osteocytes all are present.
Lacunae	Lacunae present.	Lacunae absent.

Functions of bone

(1) **Support :** Bones form the framework of the body and contribute to the shape, alignment and positioning of the body.

(2) **Protection :** Bony "boxes" protect the delicate structures they enclose,

(3) **Movement :** Bones with their joints constitute levers that move as muscle contract.

(4) **Mineral storage :** Bones are the major reservoir for calcium, phosphorus and other minerals.

(5) **Haematopoiesis :** Blood cell formation is carried out by myeloid tissue.

Notochord

It is found in all chordate, It is replaced by vertebral column in vertebrate. Notochord is rod like structure. Notochord is made up of chordal cells.

Vascular tissues

It is a mobile connective tissue derived from mesoderm which consists of fibre-free fluid matrix and specialised living cells that are not formed *in situ*, can neither divide nor secrete matrix. Vascular tissue regularly circulates in the body, takes part in transport of material and performs such activities as scavanging, healing of wounds and defence against pathogens. Vascular tissue is of two types, blood and lymph,

Blood

In chordates, and in annelids amongst the non chordates, the blood is a red and opaque fluid of salty taste and peculiar smell. It is a little heavier than water. The study of blood is called haematology. It is red coloured liquid connective tissue which originates from the mesoderm. It reaches into the various organs through the blood vessels and transports various chemical substances between different tissues. During embryonic state, the blood is mainly formed in the liver but little blood is also formed in the spleen and ribs. In adults, the blood is formed in the red bone marrow. The blood formation is called as haemopoiesis.

Viscosity – 4.7, p^H –7.4

Specific gravity – 1.04 – 1.07

Volume – 5-6 litre/70 Kg or $1/13^{th}$ part of total body weight

Plasma

It constitutes about 5% of body weight. It represents matrix of blood. Plasma is slightly alkaline and transparent. It forms 55-60% by volume of blood. Plasma contains : Water (91-92%), Solid (8-9%). Plasma solid part consists of organic (7%) and inorganic (1%) substances which are as follows :

Organic constituents of plasma : Some are its own constituents, while others are those which are transported by it. All these are divisible into following categories :

(1) **Plasma proteins :** Protein constitute about 7% part of plasma and remain in it as colloid particles. These mainly include albumins, globulins, prothrombin and fibrinogen.

Globulins are mainly formed by plasma cells in lymphoid organs. Other plasma proteins are mainly formed in liver. These render the plasma viscous, and maintain its osmotic pressure (7.5 atmospheric) and pH. Prothrombin and Fibrinogen are essential for blood clotting. Albumins are mainly responsible for maintaining osmotic pressure in plasma and for osmoregulation in cells and tissue fluids. Globulins help in osmoregulation and transport of proteins and other substances, but most globulins are immunoglobulins, which act as antibodies, destroying harmful bacteria, virus and toxins in blood and tissue fluids. Some proteins, acting as enzymes, also occur in the plasma.

(2) **Digested nutrients :** These include glucose, fats, fatty acids, phospholipids, cholesterol, nucleosides, amino acids, vitamins etc. These are supplied by the blood to all cells of body.

(3) **Excretory substances :** These chiefly include ammonia collected by blood from body cells and urea, uric acid, creatine, creatinine etc., collected mainly from the liver and transported to kidneys for excretion.

(4) **Hormones :** These are secreted and released in blood by endocrine glands.

(5) **Dissolved gases :** Each 100 ml. of water of blood plasma contains about 0.29 ml of O_2, 5 ml. of CO_2 and 0.5 ml of nitrogen dissolved in it.

(6) **Defence compounds :** Certain immunoglobulins or antibodies and some other substances, such as lysozyme (a polysaccharide) and properdin (a large protein) always occur in the plasma. These serve to destroy bacteria, viruses and toxic substances that may enter into the blood from outside, or from body tissues.

(7) **Anticoagulant :** Mast cells of connective tissues continuously release, in blood plasma, a conjugated polysaccharide, named heparin. The latter serves to prevent coagulation of blood while it is flowing in intact blood vessels.

Inorganic constituents of plasma : Chloride and bicarbonate salts of sodium are the main inorganic constituents. Traces of other salts, like phosphates, bicarbonates, sulphates and iodides of calcium, magnesium and potassium are also found. All salts constitute about 1% of plasma. These remain as ions (electrolytes) and maintain the alkalinity of plasma. A balanced quantity of salt ions in the plasma is essential for proper functioning of nervous system, muscles and other tissues.

Blood corpuscles

Blood corpuscles form 40-50% of the blood and are of three types *viz.* Red blood corpuscles, white blood corpuscles and platelets.

(1) **Red blood corpuscles (RBCs or Erythrocytes) :** These occur only in vertebrates and are the most abundant (99%) of blood corpuscles, imparting the characteristic red colour to the blood. The shape, size and structure of RBCs vary in different types of vertebrates, but their function is same in all, namely to transport respiratory gases, especially the oxygen (O_2).

RBCs of frog : Amphibian RBCs are largest amongst the vertebrates. Those of Amphiuma and Proteus are largest amongst amphibians about 82 μm. These are flattened and oval, disclike, but slightly biconvex due to a large oval and centrally-placed nucleus.

RBCs of mammals : Mammals have smallest RBCs amongst the vertebrates. Those of Musk deer are smallest amongst the mammals. Whereas the RBCs of other vertebrates are oval and nucleated, those of mammals are roughly circular (except those of the family camellidae – camels, llamas, dromedaries – which are oval in shape) and non-nucleated.

RBCs of human : They are about 7.4μm in diameter and its thickness is 1 to 1.5μm. It is pale yellow in colour but appear to be red in group. Surface area of all RBCs of a person totals about 1500 to 2000 times the surface area of the body itself.

Structure of RBCs : Each RBC is bounded by a dynamic, enzyme-containing plasma membrane. In human RBC, about 26.5 crore molecules of haemoglobin are packed in the intracellular framework. Water constitutes about 60% of RBC. The rest is solid. Haemoglobin forms about 34% of wet and 90% of dry weight of an RBC. Thus, 100 ml of normal human blood contains about 15 gm of haemoglobin on an average. An apparatus named haemoglobinometer is used to determine the haemoglobin contents of blood.

Structure of haemoglobin : Haemoglobin is a purple coloured iron (in the form of Fe^{+2}) containing respiratory pigment of RBCs. It consists of two parts haem (5%) and globin (95%). It is conjugated protein and made up of 4 globin chains with each attached to haem molecule by Co-ordinate bond. Globin is formed of 4 polypeptide chains 2α chain with 141 amino acids and 2β chain with 146 amino acid each. One-gram haemoglobin binds 1.34 ml oxygen. Amount of *Hb* is measured with the help of haemometer. A male has a greater amount of haemoglobin than a female. The amount of haemoglobin in normal man and woman is 14-16 gm/100 ml and 12–14 gm/100 ml respectively, while in children is slightly higher about 16.5 gm/100 ml of blood and foetus with 23 *gm*/ 100 *ml*.

Number of RBC : The number of RBC are counted by instrument haemocytometer. The total number of RBC per cubic mm of blood is called RBC count.

Table : 2.3-5

S.No.	Organism	Number of RBCs
1.	Male	5 – 5.4 million / cubic mm of blood
2.	Female	4.5 – 5 million / cubic mm of blood
3.	Infants	65 – 70 lacs/ cubic mm of blood
4.	Embryo	85 lacs/ cubic mm of blood
5.	Rabbit	70 lacs / cubic mm of blood
6.	Frog	4 lacs / cubic mm of blood

Life span of RBC : The life span of red blood corpuscles circulating in the blood stream varies in different animals. RBC have longest life span in blood.

Table : 2.3-6

S.No.	Organism	Life span of RBCs
1.	Mammals and Human	120 days or 4 months
2.	Rabbit	80 days
3.	Frog	100 days
4.	New born	100 days

Function of RBCs : The major function of erythrocytes is to receive O_2 of respiratory surfaces and then transport and readily deliver it to all cells of body. This important function is performed by haemoglobin which has a great ability to combine loosely and reversibly with O_2 and hence called "respiratory pigment". Haemoglobin, in annelids, is dissolved in the plasma because of absence of red blood corpuscles. In mollusc and some arthropods, etc., a different respiratory pigment, haemocyanin is found dissolved in the plasma. This pigment is bluish due to presence of copper in place of iron.

Haemolysis : Due to bursting of plasma membrane of RBCs. Its haemoglobin comes out. This process is called haemolysis. Some fat solvent and snake venom cause haemolysis. When RBCs are placed in hypotonic solution haemolysis take place. When human RBCs are placed in pure water or distilled water they will swell and burst. Some times in haemolysis, the RBCs lose their contents by diffusion and hence maintain their emptied forms intact. These are then called "shadows" or "ghosts" of RBCs.

Rouleaux formation : If a drop of fresh blood is placed on a slide under coverslip. RBCs adhere together by their concave surfaces like stacks or pile coins. This is called Rouleaux formation. It occurs probably due to forces of surface tension. It may also occur temporarily in blood vessels wherever circulation becomes unduly slow for some time.

ESR : It is called erythrocyte sedimentation rate. This test is measured by "Wintrobe's tube" and "Westergren's tube" method. It is the rate of sinking/settling down of RBC in the plasma to form rouleaux. Man has lower ESR as compared to women and it is lowest in new born. Normal value of ESR in male is about 5 mm and in female 10 mm in first hour. A rise in ESR indicates the presence of infective/ destructive/ inflammatory diseases.

(2) **White blood corpuscles (WBCs) or Leucocytes :** They are nucleated, colourless and complete cells. They are bigger than RBC but their number is less. WBC shown least consistency in shape. The number of WBC is 5,000 to 10,000 per cubic mm. They are formed in red bone marrow, spleen, thymus and lymph nodes from myelocytes and the process is called as myelecoeisis. The life span of WBC is of 15 hours to 2 days. The WBC are destroyed outside the blood vessels and the process by which they come out is called as diapedesis. An increase in they number of white blood corpuscles is called leucocytosis. More than 20,000 per cubic mm. indicates some disease. A decrease below 5000/*Cu.mm* is called leucopenia as in typhoid fever. The leucocytes are divided into two main varieties.

(i) **Granular leucocytes :** These cells develop in the red bone marrow from the same parent cells as the erythroblasts, i.e., myeloblast in the red bone marrow. These are granular leucocytes of roughly spherical shape, 10μ to 15μ in diameter, actively amoeboid and containing a large number of stainable granules. Their nucleus is irregular and divided into 2 to 5 interconnected lobes. Hence, these are also called polymorphonuclear leucocytes.

(a) Neutrophils are the most abundantand, most active type of WBCs. Nucleus has 3-5lobes. They are phagocytic.

(b) Eosinophils are phagocytic with bilobed nucleus. High eosinophil count indicates allergic conditions and parasitic infestations.

(c) Basophils are nonphagocytic with 2-3 lobes of nucleus. They are also involved in allergic reactions.

(ii) **Agranular leucocytes :** They have a few non-specific or no granules in the cytoplasm and the nucleus is spherical to kidney shaped. They comprise about 25–30 % of all leucocyte and have two varieties.

(a) **Lymphocytes** Protect from pathogens and are involved in the production of antibodies.

(b) **Monocytes** are the largest corpuscles and are phagocytic.

Normal DLC (Differential leucocyte count) is :

Neutrophils	60-70%
Eosinophils	2-4%
Basophils	0.5-1%
Lymphocytes	20-25%
Monocytes	3-8%

(3) **Blood platelets :** These are protoplasmic disc that are found in mammalian blood (lower vertebrates have spindle-shaped cells named thrombocytes). Platelets arise as detached tips of protoplasmic processes extending from the cytoplasm of giant cells, megakaryocytes of red bone marrow. The shape is oval to round, often stellate. There are approximately 300,000 platelets in a cubic millimetre of blood. Platelets are non-nucleated. Life span is about 5-9 days.

Coagulation or Clotting of blood

Process of formation of blood clot is also known as blood coagulation. Normal time of blood clotting is 3 to 8 minutes. Blood clotting is checked in blood vessels by the presence of anticoagulant. When an injury is caused to a blood vessel bleeding starts which is stopped by a process called blood coagulation or clotting. This process can be described under four major stages.

I. Damaged platelets or tissue cells release thromboplastin

II. Prothrombin $\xrightarrow[Ca^{2+}]{\downarrow}$ Thrombin

III. Fibrinogen $\xrightarrow{Ca^{2+}}$ Fibrin

IV. Fibrin + cells $\longrightarrow$ Clot

Blood coagulation is helped by thrombocytes.

Stage I is concerned with the formation of thromboplastin released from damaged tissue or platelets. Thromboplastin helps in the formation of the enzyme thrombokinase.

Stage II involves the conversion of prothrombin into thrombin with the help of thrombokinase and calcium ions.

Stage III involves the conversion of a soluble protein fibrinogen in plasma to insoluble network of fibrous material called fibrin by the action of thrombin.

Stage IV is the formation of red solid mass called blood clot by trapping of blood cells particularly RBCs by fibrin network.

Table : 2.3-7 Coagulation factors

Factor	Name	Factor	Name
I	Fibrinogen	VIII	Antihaemophilic factor
II	Prothrombin	IX	Christmas factor or plasma thromboplastin component (PTC)
III	Thromboplastin	X	Stuart factor or Stuart-Prower factor
IV	Calcium- ions	XI	Plasma thromboplastin antecedent (PTA)
V	Proaccelerin (Labile factor)	XII	Hageman factor
VI	Hypothetical factor	XIII	Fibrin stabilizing factor (FSF)
VII	Serum prothrombin conversion accelerator (Stable factor)		

Functions of blood : On basis of the above account, the general functions of blood can be briefly enumerated as follows :

(1) Blood is the fluid medium which transports different materials between various parts.

(2) The leucocytes of blood play the important role of defense by inactivating and destroying harmful toxins and invaders like bacteria, viruses, fungi and animal parasites.

(3) Blood leucocytes phagocytes and destroy cell debris and inert foreign particles in blood and tissues. Thus, these act as "scavangers" to clean the body's internal environment.

(4) Blood maintains the normal temperature of body. It prevents a sharp rise or fall in temperature which may be caused in any tissue due to abnormal rate of metabolism.

(5) By coagulating at an injury, and by stimulating repairing of damaged tissues, the blood helps in rapid healing of wounds and injuries.

(6) Blood helps in the maintenance of a proper internal environment in the body by regulating the amount of salts, acids, bases and water, etc. in the tissue fluids.

Muscular tissues

Contractility and motility (movement) are fundamental properties of protoplasm. That is why, all cells possess potential motility. Contraction for motility in the cells results essentially from the interaction of two contractile proteins, actin and myosin. These tissues are obviously responsible for movements of organs and locomotion of the body in response to stimuli. These develop from embryonic mesoderm except for those of the iris and ciliary body of eyes, which are ectodermal in origin. About 40% to 50% of our body mass is of muscles. The muscle cells are always elongated, slender and spindle-shaped, fibre-like cells, These are, therefore called muscle fibres. These possess large numbers of myofibrils formed of actin and myosin. Muscle cells lose capacity to divide, multiply and regenerate to a great extent. Study of muscle is called myology. Types of muscle are following –

Striated or striped muscles

Most muscles of body are striated. These generally bring about voluntary movements under conscious control of brain and, hence, called voluntary muscles. Most of these are inserted at both ends upon bones in different parts of the body. Hence, these are also called skeletal muscles. Movements of limbs and the body solely depend upon these muscles. Hence these are also called somatic muscles. These are also called phasic type of muscles, because contraction in these is rapid, but brief and fatigue occurs quickly.

Fine structure of striated muscle fibres : Striated muscle fibres shows transverse striation in the form of regular alternate dark A (anisotropic) and light I (isotropic) bands. The 'A' band contains about 120Å thick and 1.8 μ long "myosin filaments". The I band contains about 60Å thick and 1.0 μ long "actin filament" which are twice as many as myosin filaments. Each I band is divided into two equal halves by a thin, fibrous and transverse zig-zag partition, called 'Z' band ('Z' disc) or Krause's membrane. Each segment of a fibril between two adjacent 'Z' bands is called a sarcomere. It is 2.3 μ long in uncontracted mammalian striated fibres. A slender transverse line, the 'M' or Hansen's line is visible in middle of each 'A' band. The major, middle region of 'A' band is comparatively lighter, but its terminal parts appear darker. The middle lighter region is called 'H' zone. Due to the geomatric bonding pattern, the end of each myosin filament is, thus, encircled by the ends of six actin filaments (hexagon), while the end of each actin filaments is encircled by the ends of three myosin filaments (trigon).

Ultrastructure of myofilaments : At the molecular level, each myosin filament is composed of about 500 thread-like myosin molecules. Three different kinds of proteins participate in the composition of actin filaments. The major part of an actin filament is a coiled double helical strand whose each arm is a linear polymer of small and globular molecules (monomers) actin protein. Another coiled double helical, but thiner, strand runs along the whole length of actin strand. Each arm of this strand is a polymer of fibre-like molecules of tropomyosin protein. The third protein is troponin.

Working of striated muscles : H.E. Huxley and A.F. Huxley in 1954 proposed a theory to explain the process of muscular contraction. This theory is known as 'sliding filament theory'. It was observed that when a fibril contracts, its 'A' bands remain intact, while the 'I' bands progressively shorten and eventually disappear when the fibril has shortened to about 65% of its resting length. At this stage. 'H' zones also disappear because the actin filaments of both sides in each sarcomere reach, and may even overlap each other at the "M" line, and the 'Z' lines now touch the ends of myosin filaments. It was further observed that if a fibre is mechanically streched, the zones of overlap between thick and thin filaments are shorter than in resting condition, resulting in wider 'H' zones. These observations led Huxley to propose that shortening of the fibrils in contraction is brought about by sliding movement of actin filaments over myosin filaments towards "M" line by means of rapidly forming and breaking cross bridges or rachets at the spurs of myosin filaments. Thus, the sarcomere were recognised as the 'ultimate units of contraction'.

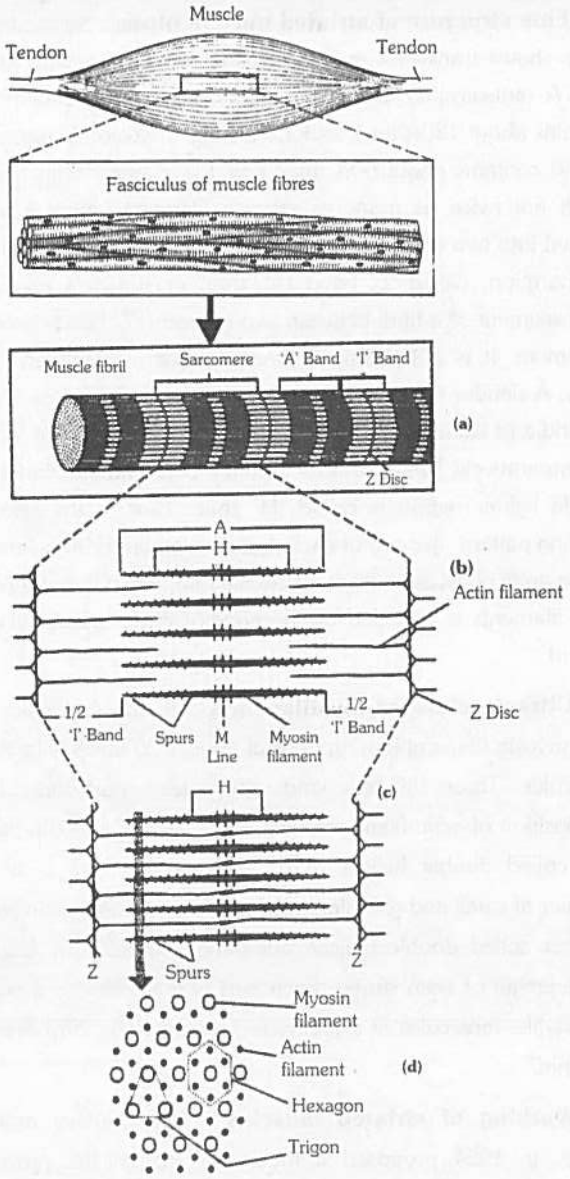


Fig : 2.3-20 Ultrastructure of a relaxed striated myofibril (a) a sarcomere (b) & (c) a contracted sarcomere: (d) T.S. through terminal part of a A band

Smooth muscles

These are called smooth, plain nonstriated involuntary or unstriped muscles due to absence of striations. These occur in the walls of hollow internal organs (alimentary canal, gall bladder, bile ducts, respiratory tracts, uterus, urinogenital ducts, urinary bladder, blood vessels, etc.), in capsules of lymph glands, spleen etc., in iris and ciliary body of eyes, skin dermis, penis and other accessory genitalia, etc. There is no connection of these muscles with bones. Smooth muscles of skin dermis, called arrector pilli muscles, are associated with hair roots, and are responsible for flesh (erection of hairs). Those of penis form a muscular network which helps in its erection and limping.

Structure : Smooth muscle fibre is unbranched goose-spindle shaped, uninucleated and has no sarcolemma. Contraction is slow, involuntary under the control of ANS. Functionally smooth muscles are of two types –

(1) **Single-unit smooth muscle :** Single unit smooth muscle fibres are composed of muscle fibres closely joined together, contract as a single unit. e.g., urinary bladder, gastrointestinal tract, small arteries and small veins.

(2) **Multi-unit smooth muscles :** Are composed of more independent muscle fibres, contract as separate units e.g. – hair root muscle, muscles on the wall of large blood vessels, ciliary muscles, muscles of iris and bronchi.

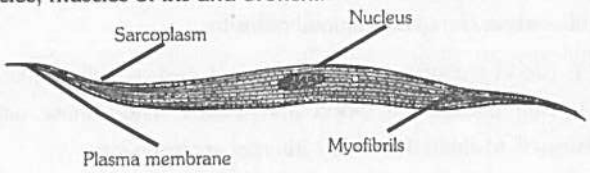


Fig : 2.3-21 Smooth muscle

Cardiac muscles

Heart wall (also the wall of large veins just where these enter into the heart) is made up of cardiac muscles and, hence, called myocardium. Structurally, these muscles resemble striated muscles but, functioning independently of the conscious control of brain, these are involuntary like the smooth muscles. Cardiac muscle cells of fibres are comparatively shorter and thicker, cylindrical, mostly uninucleate with a central nucleus, somewhat branched and covered by a sarcolemma.

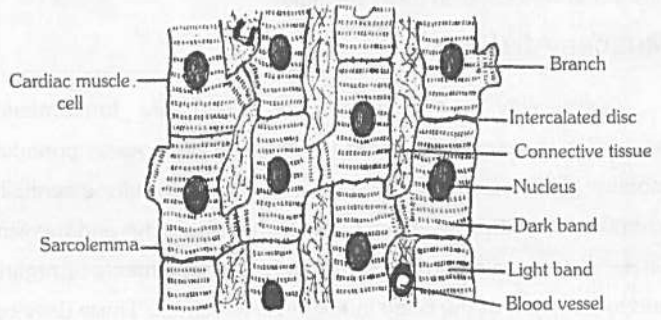


Fig : 2.3-22 Cardiac muscle fibres

Characteristics of a muscle

Antagonistic muscles : The striated muscles occur in antagonistic pairs; one pulls a bone in one direction, while the other pulls it back in reverse direction to its normal position. For example, the biceps muscle, extending from shoulder to radius, bends or flexes the arm at the elbow, whereas the triceps extending from ulna to the shoulder, straightens the arm. Thus, biceps is a flexor and triceps an extensor for bending the arm.

Single twitch : Twitch is a rapid, jerky response to a stimulus. When a muscle receives a single excitation impulse, it respond by a sudden partial contraction (twitch) lasting for about 0.5 second in man. Each twitch is followed by a refractory period during which the muscle does not respond to next stimulus. The refractory period is, however, so short (0.002 second) that the muscle can respond to the second stimulus while still in contraction phase in response to the first stimulus.

Tetanus : Generally, whole muscles contract, not in a single twitch, but in sustained contractions evoked by a series of nerve impulses reaching them in rapid succession. Such a sustained contraction is called tetanus. Described above should not be confused with the disease of "tetanus" (lock jaw) caused by tetanus

bacillus. This disease is characterised by abnormal muscular contractions. Nor it should be confused with "tetany" which is muscular spasm occurring due to deficiency of parathyroid hormone.

Muscle tone or "Tonus" : Even at rest the striated muscles normally remain in a state of mild sustained partial contraction to maintain the body posture. This is called muscle tone. It is a mild state of tetanus.

Paralysis : When supply of motor impulses to a muscle is completely cut off due to destruction, either of the control centres in brain, or of the concerned motor nerves, or due to blocking of myoneural junctions by the use of certain drugs, the muscle function is completely impaired. This is called paralysis of the muscle.

Muscle fatigue : A muscle that has contracted many times at short intervals, exhausts its store of ATP and glycogen and accumulates lactic acid. Hence its contractility gradually decreases and finally stops.

Oxygen debt : During active work or exercise, the rate of oxygen supply by the lungs falls short of the requirement of the muscles. Hence, lactic acid accumulates in the muscles and the breathing gradually becomes hard to enhance O_2 intake by the lungs. This is called oxygen debt.

Involuntary action of skeletal muscles : Muscles are capable of utilizing, in their mechanical work, only about 20% to 40% of energy liberated from glucose. The unutilized energy is lost as "heat" dissipated into the environment. This heat helps in maintenance of body temperature. "Shivering with cold" in winter is caused by a quick involuntary reaction of striated muscles.

Rigor mortis : Rigidity that develops in the muscles after death is known as rigor mortis. It is due to permanent irreversible contraction, establishment of permanent link between actin and myosin and also fall in the concentration of ATP molecules.

Cori's cycle : Lactic acid is transported by blood to liver and there it is converted to glycogen through Cori's cycle.

Contraction period : Time taken in sliding of filament is called contraction time. (10 to 100 milli second).

Relaxation time : It is time taken in relaxation of fibre i.e. active transport of calcium from sarcoplasm to cisternae. (10 to 100 milli second)

Refractory period : It is time in a muscle or nerve fibre when they are non responding to second stimulus. Infact in this period there is temporary loss of excitability. Refractory period for skeletal and cardiac muscle is 5 and 300 milli second respectively.

Hypertrophy and Atrophy of muscles : Muscles which are put to excessive work become thick and strong. This is called their hypertrophy. Conversely, if certain muscles are not used for a long period, those become thin and weak. This is called their atrophy (disuse atrophy). Cardiac muscle have a poor regenerative power.

Nervous tissue

A most complex tissue in the body, composed of densely packed interconnected nerve cells called neurons (as many as 10^{10} in the human brain). It specialized in communication between the various parts of the body and in integration of their activities. Nervous tissue is ectodermal (from neural plate) in origin. It forms the nervous system of the body which controls and coordinates the body functions. There is no intercellular matrix between neurons. These have permanently lost the power of division as have no centriole and have minimum power of regeneration. So these cannot be cultured in vitro. Irritability is the main function of nervous tissue.

Composition of nervous tissue : Nervous tissue is formed of four types of cells :

(1) Neurons (nerve cells) (2) Neuroglia

(3) Ependymal cells (4) Neuro-secretory cells

Neurons

A neuron is a nerve cell with all its branches. Neuron is formed from neuroblast. It is the structural and functional unit of nervous system. It is the longest cell of the body.

(1) **Cyton :** It is also called perikaryon or soma or cell body. Its granular cytoplasm is called neuroplasm which has following structures :

(i) A large, spherical, centrally placed nucleus with a single nucleolus.

(ii) Numerous fine threads called neurofibrils for the conduction of nerve impulses.

(iii) A number of small, basophilic granules called Nissl's granules formed of rough endoplasmic reticulum with ribosomes and are sites of protein synthesis.

(iv) Neuroplasm has large number of mitochondria to provide high energy for impulse conduction.

(v) Neuroplasm may have melanophores with melanin pigment and lipochromes with orange or yellow pigment.

(vi) A mature neuron has no centriole, so it cannot divide.

(vii) A "**Barr body**" is often seen abutting against the inner surface of nuclear membrane of cytons in females. This has been proved to be a transformed 'X' chromosome.

(viii) Certain neurons having flask-shaped cytons and called purkinje cells, occur in the cerebellum of the brain.

(2) **Neuron processes :** The processes of neurons, called neurites, extend varying distances from the cyton and are of two types – dendrites or dendrons and an axon or axis cylinder (neuraxon).

(i) **Dendron :** These are several short, tapering much branched processes. The dendrites contain neurofibrils, neurotubules, Nissl's granules and mitochondria. They conduct nerve impulse towards the cell body.

(ii) **Axon :** This is a single very long, cylindrical process of uniform diameter. It arises from a conical projection, the **axon hillock**, of the cyton. The axon contains neurofibrils and neurotubules but lacks Nissl's granules. Axon is usually branched only terminally into slender branches called telodendria. The latter have knobbed ends called endbulbs or axon terminals or buttons or synaptic knobs or end plates. The synaptic knobs contain mitochondria and secretory vesicles.

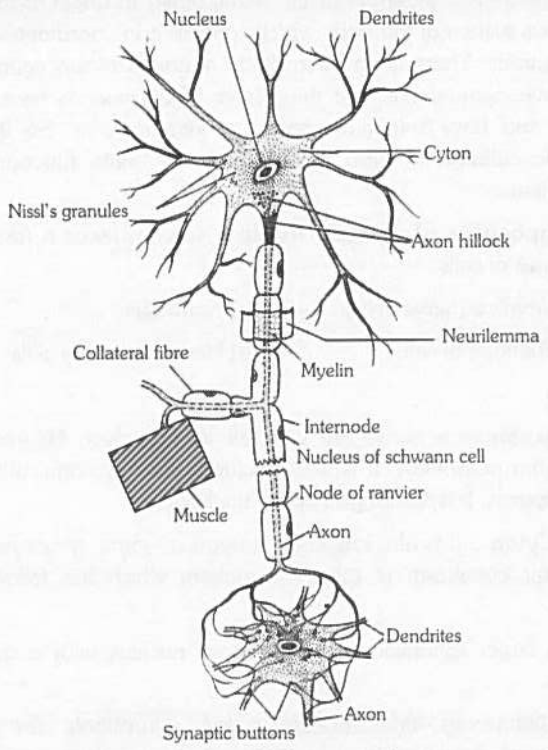


Fig : 2.3-23 An Enlarged Neuron and its synapses with another Neuron

Types of neurons : Neurons are divided into different categories on different basis.

(1) **On the basis of functions :** Neurons are divided into three categories :

Sensory (afferent) neurons : These are found in sense organs. Their dendrons receive the nerve impulse from the nerve process of the receptor cell while their axon forms the synapse with dendron of the next neuron. These may be naked or encapsulated e.g. olfactoreceptors and gustatoreceptors.

Internuncial neurons : These are located in the dorsal horn of the spinal cord. These are called association neurons (when their axon synapses with the dendron of motor neuron of same side) or commissural neuron (when their axon synapses with the dendron of motor neuron of opposite side).

Motor (efferent) neurons : These are always present in the ventral horn of the spinal cord. Their axon ends into the muscle fibres or glands cells. These conduct the nerve impulses to the effector organs which respond to the stimuli.

(2) **On the basis of number of nerve processes :** Neurons are of three types –

Unipolar neurons : In these neurons, only one nerve process arises from the cyton which acts as axon but there is no dendron. These are found only in early embryos. The unipolar neuron of the adult gives rise to a single nerve process, which immediately divides into a dendron and an axon. Such unipolar neurons are called pseudo-unipolar neurons. These are found in the dorsal root ganglia of spinal nerves and in the roots of V, IX and X cranial nerves.

Bipolar neurons : In these neurons, the cyton gives rise to two nerve processes out of which one acts as an axon while other acts as a dendron. These are found in the olfactory epithelium of nasal chamber and retina of eye. These may be isopolar or heteropolar (dendrons being irregularly branched). Ganglia of VIII cranial nerve.

Multipolar neurons : In these neurons, the cyton gives rise to several nerve processes out of which one acts as an axon while remaining nerve processes act as dendrons. These are found in the central nervous system and the ganglia of autonomic nervous system of adult.

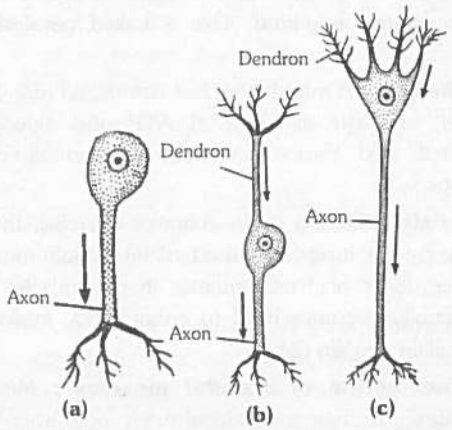


Fig : 2.3-24 Types of Neurons (a) Unipolar; (b) Bipolar; (c) Multipolar

Neuroglia or Glia cells

Neuroglia consists of the supporting and packing cells found in the brain, spinal chord and ganglia. These are non nervous cells. These are ten times more numerous than neurons. In some parts of body the neuroglial cells are called by certain other name such as muller cells in retina, pituicytes in posterior pituitary gland and satellite cells in ganglia.

Types : The neuroglia cells are of three types –

(1) **Astrocytes :** These are large sized and star-shaped cells with numerous processes which form blood brain barrier therefore only located in brain.

(2) **Oligodendrocytes :** These have a few branched processes which resemble the dendrons of the neurons. Forms myelin sheath around CNS Axon, example schwann cells.

(3) **Microglial cells :** These are small sized and spindle-shaped. The microglia cells act as the defensive phagocytes in central nervous system. They arise from the monocytes.

Functions

(1) These are capable of division and help in wear and tear of the central nervous system.

(2) These insulate the adjoining neurons and prevent the lateral transmission of impulses.

(3) These provide nutrition to the neurons.

(4) These act as phagocytes and eat up the microbes.

(5) These help in memory processes.

(6) They acts as Blood brain barrier (BBB) i.e. they inhibit contact between neuron and blood, along with endothelium of capillary. The exchange of material between blood and neuron is always through these neuroglial cells *i.e.*, they are mediator.

Ependymal cells

These are cuboidal and ciliated epithelial cells which lines the cavities of brain (ventricles) and spinal cord (central canal). These form an epithelium called ependyma. Ependymal cell for circulation of CSF.

Neurosecretory cells

These are special type of neurons of the hypothalamus of brain. These are endocrine in function and secrete neurohormones which are carried by the blood of hypophyseal portal system to anterior lobe of pituitary gland and stimulate the secretion of their trophic hormones *e.g.*, TSH, STH, FSH, LH, ACTH, etc.

Nerve fibres

Axon or dendron of a nerve cell covered with one or two sheath is termed as nerve fibre. The nerve fibres are of two types – medullated or myelinated and non medullated or non myelinated regarding their structure.

(1) **Medullated nerve fibres :** A medullated nerve fibre typically consists of a central core, the axis cylinder, or neuraxis, surrounded by two sheaths : inner thick medullary sheath and outer thin neurilemma.

(i) **Axis cylinder :** The axis cylinder is simply the axon or dendron of a nerve cell. It contains longitudinal neurofibrils and mitochondria in its neuroplasm, called axoplasm, limited by cell membrane termed axolemma. It is the axolemma that conducts the nerve impulses.

(ii) **Medullary sheath :** The medullary sheath is composed of a shinning, white, fatty substance called myelin. This sheath perhaps serves as an insulating layer, preventing loss of energy of the nerve impulse during its passage along the fibre. It causes saltatory conduction of impulses. The medullary sheath is continous around the fibres in the central nervous system, but in the fibres of the peripheral nerves it is absent at certain points known as the Node of Ranvier. The part of a nerve fibre between two successive nodes is termed the internode.

(iii) **Neurilemma :** The neurilemma consists of tubular sheath cells (Schwann's cells) placed end to end. The neurilemma is continuous over the Nodes of Ranvier. The function of the Schwann's cells is to produce the myelin sheath around the neuraxis. The medullated nerve fibres within the brain and spinal cord lack neurilemma. Instead, they have an incomplete covering of neuroglia cells, which probably produce the myelin sheath. Neurilemma present around the peripheral nerve fibres enables them to regenerate after injury. Nerve fibres in the brain and spinal cord do not regenrate after injury due to lack of neurilemma. The medullated nerve fibres occur in the white matter of the brain and spinal cord and in the cranial and spinal nerves.

(2) **Non medullated nerve fibres :** A non medullated nerve fibre consists of an axis cylinder enclosed by neurilemma and connective tissue. These fibres appears grey in colour in the fresh state. The non-medullated nerve fibres occur in the autonomic nerves.

Table : 2.3-9 Difference between medullated and non-medullated nerve fibre

S.N	Characters	Medullated nerve fibres	Non-medullated nerve fibres
1.	Occurrence	Found in white matter of brain, spinal cord, cranial and spinal nerves	Found in grey matter of brain and spinal cord, and in autonomic nervous systems.
2.	Sheaths	Neuraxis covered by inner medullary sheath and outer neurilemma	Neuraxis covered by only neurilemma. Medullary sheath is absent
3.	Nodes of Ranvier and internodes	Present	Absent
4.	Diameter	More	Less
5.	Colour	White	Grey
6.	Speed of con duction of nerve impulses.	Faster due to saltatory conduction of nerve impulses	Slower
7.	Collateral branches	Present	Absent

Nerves

The nerves are thread like structures extending between the central nervous system and the receptor or effector organs of the body. These conduct the nerve impulses to and from the central nervous system.

Each nerve is formed of several bundles of nerve fibres, called fasciculi. Each nerve fibre of the bundle is covered by a thin sheath of connective tissue called endoneurium, while each fasciculus is enclosed by another sheath of white fibrous connective tissue called perineurium. All the fasciculi are held together by the connective tissue and are enclosed by a thick coat of white fibrous connective tissue called epineurium. On average, a nerve contains about twice as many unmyelinated fibres as myelinated fibres.

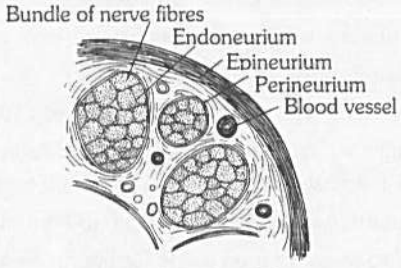


Fig : 2.3-25 T.S. of Nerve

Types of nerves : The nerves are of three types according to the nature of the nerve fibres they are composed of –

(1) **Sensory or afferent nerves :** The nerves with sensory fibres are called sensory nerves. It brings the impulse towards the central nervous system. Example – Olfactory, optic and auditory nerves (I, II, VIII).

(2) **Motor or efferent nerves :** The nerves having efferent fibres are termed motor nerves. It carries the impulses away from central nervous system. Example – Oculomotor, Pathetic and abducens nerves (III, IV, VI).

(3) **Mixed nerves :** Some nerves have both afferent and efferent fibres. These are known as mixed nerves. Example – Trigeminal, facial, glossopharyngeal and vagus nerves (V, VII, IX, X).

Tips & Tricks

- The brown adipose tissue in human is restricted till third month of post natal life.
- Mucoid tissue – An embryoid tissue found in umbilical cord also called wharton's jelly. It is most primitive type of tissue, found in vitreous humour of eye and cock's comb.
- Plasma cells are also called as "Cart wheel cells".
- The term "blubber" refers to subcutaneous deposition of fat in whales.
- Ligamentum flava – connects adjacent vertebrae and the ligaments between the phallanges, fingers and toes.
- Ligamentum nuchae – Found in the neck of quadrapeds to bear the weight of head when grazing.
- Teeth are made up of dentine (bone) and its crown is covered by enamel, which is the hardest substance of the body.
- Astronauts pass out calcium in their urine due to faster breaking down of bones, due to absence of gravitational pull.
- Hardening materials in bones are mainly phosphate of calcium and magnesium.
- Strongest cartilage is fibrocartilage due to collagen fibres.
- Diploic bone – Bone with compact surfaces and cancellous middle e.g., skull bone, vertebrae.
- Calcination – Process of burning of bone till it becomes white.
- Beside calcium phosphate (major constituents) the bones contain potassium, magnesium hydroxide.
- Study of cartilage is called chondrology.
- Study of bone is called osteology.
- Long bones possess pits of Howship.
- Normal blood glucose level is 90 – 120 mg/100 ml.
- Strontium – 90 is the chemical which causes damage to WBC, bone marrow, spleen, lymph nodes and lungs.
- Bone marrow is absent in birds due to Pneumatic bones.
- Granulocyte are formed inside Red bone marrow.
- Haemocytometer is used for red cell counting.
- Phagocytosis was first of all seen by Metchnikoff.
- Blood doping or blood boosting is the transfusion of one's own blood or frozen RBC to increase haemoglobin content to carry more oxygen.
- Spleen also acts as "graveyard" of RBC. If spleen is removed than filtration of dead RBC will stop.
- Polycythemia – Abnormal rise in number of RBC.
- When muscles contract they have squeezing effect on veins running through them. It is termed as muscle pump.
- T-tubules are present in sarcolemma near the junction between A-band and I-band.
- Tongue muscles and muscles of upper part of oesophagus are striated muscles, but without any bone.
- Cholesterol concentration is highest in cardiac muscle.
- Phospholipids concentration is maximum in cardiac muscle.
- The muscles change gradually from voluntary to involunatry in the upper part of oesophagus.
- Lohman Reaction : ADP + Phospho Creatine → ATP + creatine
- Chronaxie is defined as the shortest duration of stimulus required to excite a tissue by a current strength.
- Painful contractions of muscles is called muscle cramp.
- Total number of muscles in human body is 639
- Largest muscle is gluteus maximus (Buttock muscle).
- Smallest muscle is stapedius.
- Longest muscle is sartorius.
- Papillary muscles are associated with heart.
- Gastrocnemius (calf muscle) is the muscle of shank.
- Pectoralis major is flight muscle in bird
- Latissimus dorsi is the muscle of shoulder.
- Ciliary muscle is associated with eye-change focal length of lens.
- Maximum muscles in back region i.e. 180
- Minimum muscles in Neck region i.e. 32
- Muscles in head region are 53
- Masseter – Lower jaw, the strongest muscle in the body.
- Rectus abdominis – Longest visceral muscle found in abdomen.
- Myology – Study of muscles.
- Myogram – Recording of muscular contraction.
- Muscular dystrophy – A hereditary disease of muscle.
- Poliomyelitis – Viral disease that weakens the muscles.
- The value of resting membrane potential is – 60 to – 90 mV.
- Na^+ and K^+ Ions are required for nerve conduction.
- GABA is slow neurotransmitter substance.
- Synapse is a junction between dendrites and axons ends.
- Neuroglial cells differs from neurons in having no Nissls granules.
- Nerve fibres are different from the muscles fibres due to the presence of dendrites.
- Branched ends of nerve cells are called telodendria which establish the functional contact with other nerve cell this connection is called synapse.
- Most of the neurons of our body are multipolar.
- Nissl's bodies are absent in axon and axon hillock.

Ordinary Thinking

Objective Questions

Epithelial tissue

1. Name the type of tissue that form gland **[NCERT; Odisha JEE 2008; MP PMT 2010]**
   (a) Epithelial (b) Muscular
   (c) Squamous (d) Cuboidal
2. In thyroid follicle which type of epithelial tissue is present **[Odisha JEE 2008]**
   (a) Squamous (b) Cuboidal
   (c) Transitional (d) Columnar
3. Stereocilia occur in **[AMU (Med.) 2010]**
   (a) Pseudostratified columnar epithelium of trachea
   (b) Columnar epithelium of stomach
   (c) Stratified columnar epithelium of pharynx
   (d) Pseudostratified columnar epithelium of epididymis
4. Skin is a **[CPMT 2010]**
   (a) Cuboidal epithelium
   (b) Columnar epithelium
   (c) Pseudostratified epithelium
   (d) Stratified epithelium
5. The cell junctions called tight, adhering and gap junctions are found in **[NCERT; CBSE PMT 2009]**
   (a) Muscular tissue (b) Connective tissue
   (c) Epithelial tissue (d) Neural tissue
6. Note the following
   (A) It forms the lining of the cavities of alveoli of the lungs
   (B) It forms the lining of wet surfaces like buccal cavity and oesophagus
   (C) It occurs in the ducts of sweat glands
   (D) It forms the lining of salivary glands and sweat glands
   (E) It is a loose connective tissue
   Which of the above are associated with simple epithelial tissue **[EAMCET 2009]**
   (a) A and D (b) B and C
   (c) C and A (d) D and E
7. Mammary glands are modified **[BHU 2008]**
   (a) Cutaneous glands (b) Sebaceous glands
   (c) Sweat glands (d) Scent glands
8. In which one of the following preparations are you likely to come across cell junctions most frequently **[CBSE PMT 2007]**
   (a) Ciliated epithelium (b) Thromobocytes
   (c) Tendon (d) Hyaline cartilage
9. The function of villi in the intestine is **[NCERT; AIEEE Pharmacy 2003; CBSE PMT 2005; Odisha JEE 2010]**
   (a) Absorption of food
   (b) Increase in the absorptive surface of food
   (c) Control of intestinal movement
   (d) Hinderance in the movement of food
10. Reproductive cells (germinal epithelium) are made up of which of the following epithelial tissue
    (a) Cuboidal (b) Columnar
    (c) Squamous (d) Sensory
11. Schneiderian membrane is found in
    (a) Nasal passage (b) Trachea
    (c) Bowman's capsule (d) Loop of Henle
12. The ciliated epithelium in our body may be found in **[CBSE PMT 1993; MP PMT 1997; RPMT 2005, 06]**
    (a) Ureter (b) Trachea
    (c) Stomach (d) Uterine tube
13. Cells of squamous epithelium are **[MP PMT 1994]**
    (a) Tall with elongated nuclei
    (b) Cube like
    (c) Flat and tile like
    (d) Columnar or cuboidal in shape
14. The cells lining the blood vessels belong to the category of **[NCERT; J & K CET 2008; CBSE PMT (Pre.) 2010; CBSE PMT (Mains) 2011]**
    (a) Columnar epithelium (b) Connective tissue
    (c) Smooth muscle tissue (d) Squamous epithelium
15. Urethra, vagina and oesophagus have a common inner lining of **[CMC Vellore 1993; MP PMT 2003; Odisha JEE 2005]**
    (a) Squamous epithelium
    (b) Ciliated epithelium
    (c) Columnar epithelium
    (d) Stratified squamous epithelium
16. Epithelial tissue performs the following functions **[NCERT; KCET 1994; MP PMT 1995]**
    (a) Protection, secretion, absorption, respiration
    (b) Protection, secretion, sensation, absorption
    (c) Protection, secretion, absorption, digestion
    (d) None of these
17. Simple epithelium is **[DPMT 1993]**
    (a) One cell thick (b) Two cells thick
    (c) Two or three cells thick (d) All are correct
18. The cellular layers in epidermis of skin consists of
    (a) Glandular cells
    (b) Columnar cells
    (c) A squamous stratified cornified epithelium
    (d) A complex stratified epithelium
19. Ciliated epithelium in vertebrates is present in
    (a) Kidney and stomach
    (b) Buccal cavity and oviduct of frog
    (c) Stomach and urinary tubules
    (d) Lymph vessels
20. The secretion of tears, milk, sweat and oil are functions of which of the following tissues **[J & K CET 2012]**
    (a) Epithelial (b) Nervous
    (c) Loose connective (d) Lymphoid
21. Desmosomes are the feature of **[CBSE PMT 1992; AFMC 1993, 99; KCET 2000; BHU 2001]**
    (a) Epithelial tissue (b) Nervous tissue
    (c) Muscular tissue (d) None of these
22. Nature of mammary gland is **[MP PMT 2002]**
    (a) Apocrine (b) Merocrine
    (c) Holocrine (d) None of these
23. An example of merocrine gland is **[MP PMT 2001]**
    (a) Sebaceous gland (b) Pineal gland
    (c) Salivary gland (d) Mammary gland

24. Simple coiled tubular glands are found in **[CPMT 1993]**
(a) Dermis of skin (b) Kidney
(c) Liver (d) Spleen

25. See the following figures

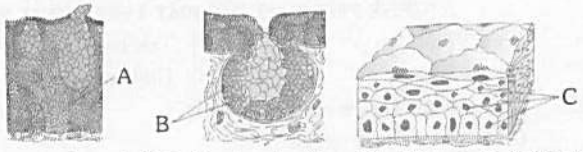


Figure A and B indicate glands while Figure C indicates specific type of tissues. Identify A, B and C **[NCERT]**

	A	B	C
(a)	Unicellular gland	Goblet gland	Pseudostratified epithelium
(b)	Multicellular gland	Unicellular gland	Pseudostratified epithelium
(c)	Unicellular gland	Multicellular gland	Pseudostratified epithelium
(d)	Unicellular gland	Multicellular gland	Compound epithelium

26. In animals, gametes are derived from **[Kerala PMT 2004]**
(a) Epithelial tissue (b) Nervous tissue
(c) Occur singly (d) None of the above

27. Tissue which has power of division and regeneration throughout life
(a) Epithelial tissue (b) Muscular tissue
(c) Connective tissue (d) Nervous tissue

28. The ciliated columnar epithelial cells in humans are known to occur in **[NCERT; MP PMT 2000; AIEEE Pharmacy 2004; Kerala PMT 2007; CBSE PMT (Pre.) 2011; WB JEE 2011]**
(a) Fallopian tubes and urethra
(b) Eustachian tube and stomach lining
(c) Bronchioles and Fallopian tubes
(d) Bile duct and oesophagus

29. Stratified squamous epithelium is found in **[AFMC 1995]**
(a) Trachea (b) Epidermis
(c) Mouth cavity (buccal) (d) Lining of blood vessels

30. Compound squamous epithelium is found in **[BHU 1995]**
(a) Stomach (b) Intestine
(c) Trachea (d) Pharynx

31. Find out the wrongly matched pair **[Kerala PMT 2007]**
(a) Squamous epithelium - Skin of frog
(b) Columnar epithelium - Peritoneum of body cavity
(c) Ciliated epithelium - Bronchioles
(d) Stratified cuboidal epithelium - Oesophagus
(e) Glandular epithelium - Salivary gland

32. The epithelium in the bronchioles is **[MP PMT 1996, 2002]**
(a) Pseudostratified and columnar
(b) Squamous and sensory
(c) Pseudostratified and sensory
(d) Cuboidal and columnar

33. Which type of epithelium is found in oesophagus, buccal cavity, cornea, vagina and cervix **[KCET 2007; Odisha JEE 2011]**
(a) Transitional epithelium
(b) Columnar epithelum
(c) Non–keratinized stratified epithelium
(d) Keratinized stratified epithelium

34. Match the following simple epithelial tissues in column I with their occurrence in column II and choose the correct combination from the options given

Column I	Column II
A. Squamous	1. Intestinal glands
B. Cuboidal	2. Trachea
C. Columnar	3. Ovary
D. Ciliated	4. Blood vessels
E. Pseudo stratified	5. Bronchioles

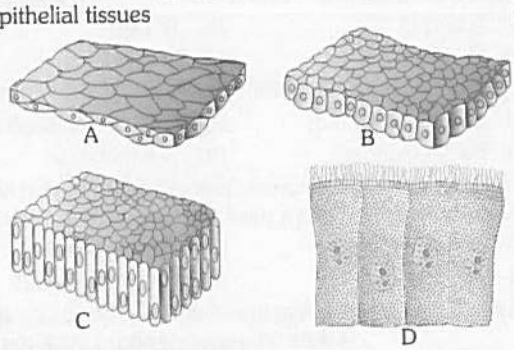
[DPMT 2004; Kerala PMT 2006]
(a) A – 1, B – 2, C – 4, D – 3, E – 5
(b) A – 5, B – 4, C – 2, D – 1, E – 3
(c) A – 4, B – 5, C – 1, D – 2, E – 3
(d) A – 4, B – 3, C – 1, D – 2, E – 5
(e) A – 4, B – 3, C – 1, D – 5, E – 2

35. Which of the following is the characteristic of epithelial tissues **[KCET 2001]**
(a) They are highly vascularised
(b) They never produce glands
(c) They have large intercellular spaces
(d) They have a rapid rate of cell division

36. The type of epithelium found in conjunctiva of eye is **[MP PMT 2001]**
(a) Stratified cuboidal (b) Stratified columnar
(c) Stratified squamous (d) Transitional epithelium

37. Outer layer of skin is made up of keratinised epithelium, this is because **[RPMT 2001]**
(a) It is exposed thus subjected to wear and tear
(b) It covers the whole body
(c) It is thick
(d) It prevents the entry of pathogens

38. See the following figure and identify the following simple epithelial tissues **[NCERT]**



	A	B	C	D
(a)	Squamous	Cuboidal	Columnar	Pseudostratified columnar (ciliated)
(b)	Pseudostratified squamous	Cuboidal	Columnar	Ciliated columnar
(c)	Squamous	Cuboidal	Columnar	Ciliated columnar
(d)	Cuboidal	Squamous	Columnar	Ciliated columnar

39. The intestine and stomach in mammals are lined by **[J & K CET 2002]**

(a) Cuboidal epithelium (b) Columnar epithelium
(c) Squamous epithelium (d) Stratified epithelium

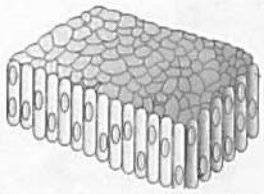
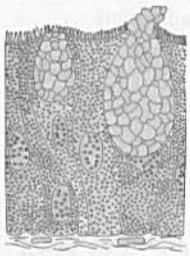
40. Pseudostratified columnar epithelium is found in **[MP PMT 2003]**

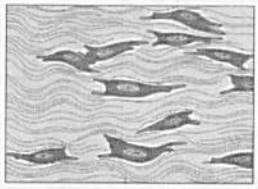
(a) Wall of cloaca (b) Male urethra
(c) Oviduct (d) Oesophagus

41. Epithelial tissues arise from **[MP PMT 1996, 2002]**

(a) Ectoderm (b) Endoderm
(c) Mesoderm (d) All of the above

42. The four sketches (A, B, C and D) given below, represent four different types of animal tissues. Which one of these is correctly identified in the options given, along with its correct location and function **[NCERT; CBSE PMT (Mains) 2012]**

(A)  (B) 

(C)  (D) 

		Tissue	Location	Function
(a)	(B)	Glandular epithelium	Intestine	Secretion
(b)	(C)	Collagen fibres	Cartilage	Attach skeletal muscles to bones
(c)	(D)	Smooth muscle tissue	Heart	Heart contraction
(d)	(A)	Columnar epithelium	Nephron	Secretion and absorption

Connective tissue

1. Glisson's capsule is a delicate connective tissue capsule covering the **[KCET 1994; MP PMT 2002]**

Or

Glisson's capsule is found in **[MP PMT 1998, 2009; CPMT 2001; Kerala PMT 2008]**

(a) Spleen (b) Liver
(c) Kidney (d) Gall bladder

2. The type of connective tissue that is associated with the umbilical cord is **[EAMCET 2009]**

(a) Areolar connective tissue
(b) Jelly-like connective tissue
(c) Adipose connective tissue
(d) Reticular connective tissue

3. Which of the following cells of connective tissue secrete antibodies **[CPMT 2005]**

(a) Mast cells (b) Reticular cells
(c) Adipose cells (d) Plasma cells

4. The mast cells secrete the following substance **[DPMT 1993; CBSE 1998, 2006; CPMT 1998, 2000, 03, 09; AFMC 2002; BHU 2003, 06; MP PMT 2007]**

(a) Heparin (b) Histamine
(c) Serotonin (d) All of the above

5. Originating in bone marrow, circulating in blood for 1–2 days, migrating to connective tissue and forming macrophages is a characteristic of **[AMU (Med.) 2010]**

(a) Eosinophils (b) Basophils
(c) Monocytes (d) Lymphocytes

6. In allergic reaction which is secreted **[Bihar CECE 2006; AIIMS 2009]**

Or

The symptoms of an allergic reaction develop in response to **[WB JEE 2016]**

(a) Histamine (b) Neutrophil
(c) Basophil (d) Acidophil

7. The areolar tissue connects **[CBSE PMT 2006]**

(a) Two bones
(b) Muscle and the bone
(c) Muscle and the fat tissue
(d) Muscles and their compound

8. Ligaments and tendons are **[NCERT; MP PMT 1996; AFMC 1999, 2010; CPMT 2001, 03; BHU 2006]**

(a) Connective tissue (b) Muscular tissue
(c) Fibrous connective tissue (d) Skeletal tissue

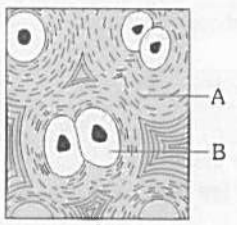
9. Collagen fibres of connective tissue are **[NCERT; CPMT 1999; J & K CET 2012]**

(a) White (b) Yellow
(c) Colourless (d) Red

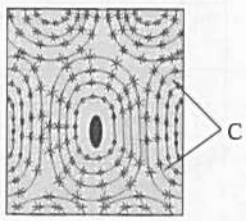
10. Camel's hump is made up of **[DPMT 1993; MHCET 2004]**

(a) Skeletal tissue (b) Muscular tissue
(c) Cartilage (d) Adipose tissue

11. Study the figure I and II carefully and identify the structures A, B and C respectively which are related with specialized connective tissues **[NCERT]**



I



II

	Fig. I	Fig. II	A	B	C
(a)	Bone	Cartilage	Collagen fibres	Osteoblast	Lamella
(b)	Cartilage	Bone	Microtubule	Chondroclast	Lamella
(c)	Cartilage	Bone	Collagen	Chondroclast	Lamella
(d)	Cartilage	Bone	Collagen	Chondrocyte	Lamella

12. Whale is a warm-blooded animal which lives in cold sea. Which organ of its body makes it hot
(a) Blubber (b) Pelage
(c) Muscles (d) Blood vessels

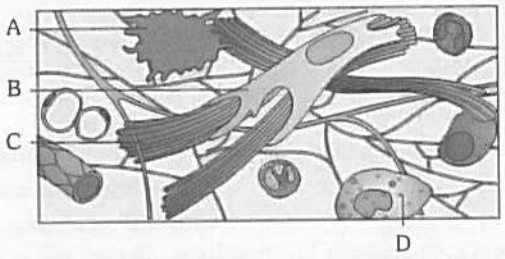
13. Below the skin, the fat is in the form of
Or
Which of the following helps in maintaining body hot
(a) Lipoproteins (b) Adipose tissue
(c) Mucous layer (d) Lymphoid tissue

14. Which statement is incorrect **[AMU (Med.) 2010]**
(a) Mast cells and basophils secrete histamine and heparin
(b) Mast cells are long lived, basophils are short lived
(c) Mast cells are smaller than basophils with a bilobed nucleus
(d) Mast cells are relatively sessile, basophils are mobile

15. The types of fibres found in connective tissues are
(a) Collagan fibres (b) Elastic fibres
(c) Reticular fibres (d) All of the above

16. The intercellular substance found in connective tissue is
(a) Fatty in nature
(b) Muco-polysaccharide
(c) Mainly protein in nature
(d) All are correct

17. Given below is the diagrammatic sketch of a certain type of connective tissue. Identify the parts labelled A, B, C and D, and select the right option about them **[NCERT; CBSE PMT (Mains) 2012]**



	Part-A	Part-B	Part-C	Part-D
(a)	Macro-phage	Fibroblast	Collagen fibres	Mast cells
(b)	Mast cell	Macro-phage	Fibroblast	Collagen, fibres
(c)	Macro-phage	Collagen fibres	Fibroblast	Mast cell
(d)	Mast cell	Collagen fibres	Fibroblast	Macro-phage

18. Most of the cells in areolar tissue are **[NCERT; CBSE PMT 1992; MP PMT 1996; Kerala PMT 2010]**
(a) Fibroblasts (b) Macrophages
(c) Mast cells (d) All the above

19. Histiocyte is a connective tissue cell, the function of which is
(a) Phagocytic (b) Secretion
(c) Substanance (d) Fibre production

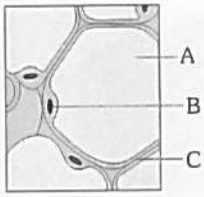
20. Ligament is mainly made up of **[MP PMT 2007]**
(a) Reticulin (b) Elastin
(c) Myosin (d) Collagen

21. A localised inflammatory response appears at the site of infection causes redness, swelling, pain and heat due to certain chemical, they are **[KCET 2007; J & K CET 2012]**
(a) Histamine and prostaglandins
(b) Cerumen and mucus
(c) Histamine and cerumen
(d) Prostaglandins and cerumen

22. Thousand of year old Mummies are still in their condition as they were before due to non-destruction of **[BHU 2005, 12]**
(a) Yellow elastin fibres (b) White elastin fibres
(c) Collagen fibres (d) Veins

23. White adipose tissue contains **[MP PMT 2003]**
(a) Multilocular fat cells (b) Bilocular fat cells
(c) Unilocular fat cells (d) Alocular fat cells

24. The given figure is of adipose tissue, identify marked alphabets



[NCERT]

	A	B	C
(a)	Fat storage area	Nucleus	Cell membrane
(b)	Nucleus	Fat	Cell membrane
(c)	Cytoplasm	Fat	Cell membrane
(d)	Vacuole	Fat	Cell membrane

25. Debove's membrane is a layer of **[BHU 2004]**
(a) Muscular tissue (b) Epithelial tissue
(c) Connective tissue (d) All of these

26. Which among the following is not characteristic of yellow fibres of connective tissue **[Kerala PMT 2004]**
(a) Contain elastin
(b) Fewer in number
(c) Straight and branched
(d) Provide toughness and strength
(e) Occur singly

27. Which one of the following is not a fibrillar protein **[Kerala CET 2003]**
(a) Elastin (b) Collagen
(c) Myosin (d) Albumin

28. Vitreous humor is **[BVP 2003]**
(a) Mucoid connective tissue (b) Solid crystalline
(c) Watery fluid (d) All of these

29. Which of these if not found in connective tissue **[MP PMT 2010]**
(a) Hyaluronic acid (b) Basement membrane
(c) Collagen fibres (d) Fluid

30. The ground substance of connective tissue is basically composed of **[MP PMT 1997]**
(a) Mucopolysaccharides (b) Lipids
(c) Monosaccharides (d) Phospholipids

31. Adipocytes are mainly found in **[NCERT; MP PMT 1997]**
(a) Bones (b) Cartilages
(c) Connective tissue (d) Nerves

32. Arbor vitae is composed of **[AIIMS 1998]**
(a) Grey matter (b) Neurogleal cells
(c) White matter (d) All of these

33. Ligament is **[CBSE PMT 1999; BHU 2000]**
(a) Modifed white fibrous tissue
(b) Modifed yellow elastic fibrous tissue
(c) Inelastic white fibrous tissue
(d) None of these

34. Choose the correctly matched pair **[CPMT 1999; JIPMER 2001; CBSE PMT 2014]**
(a) Areolar tissue – Loose connective tissue
(b) Cartilage – Loose connective tissue
(c) Tendon – Specialized connective tissue
(d) Adipose tissue – Dense connective tissue

35. Which of the following is not a connective tissue **[CPMT 2010]**
(a) Blood (b) Lymph
(c) Nerve (d) Bone

36. Which of the following cells is phagocytic in nature **[AFMC 2000; Odisha JEE 2011]**
(a) Mast cell (b) Podocytes
(c) Macrophages (d) Fibroblast cells

37. Connective tissue is **[Odisha JEE 2002]**
(a) Ectodermal in origin with intercellular spaces
(b) Mesodermal in origin without intercellular spaces
(c) Ectodermal in origin without intercellular spaces
(d) Mesodermal in origin with intercellular spaces

38. Mast cells are found in **[NCERT; MP PMT 1997]**
(a) Connective tissue (b) Muscular tissue
(c) Nervous tissue (d) Blood

39. Collagen is **[CBSE PMT 2002]**
(a) Lipid (b) Carbohydrate
(c) Globular protein (d) Fibrous protein

40. Which one of the following contains the largest quantity of extracellular material **[NCERT; CBSE PMT 2003]**
(a) Myelinated nerve fibres (b) Striated muscle
(c) Areolar tissue (d) Stratified epithelium

41. Fibroblasts, macrophages and mast cells are seen in **[Kerala PMT 2011]**
(a) Epithelial tissue (b) Connective tissue
(c) Skeletal muscle tissue (d) Smooth muscle tissue
(e) Neural tissue

42. Which of the following tissues is most abundant and forms most of the body parts **[NCERT; Odisha JEE 2011]**
(a) Nervous tissue (b) Muscle tissue
(c) Connective tissue (d) Epithelial tissue

43. The falciform ligament in man connects **[NCERT; AMU (Med.) 2012]**
(a) Liver with diaphragm (b) Lungs with diaphragm
(c) Stomach with diaphragm (d) Liver with stomach

44. Select the option having all three correct characteristics **[AIIMS 2012]**

	Structure	Percentage	Function
(a)		0.3 – 0.5	Phagocytic
(b)		0.5 – 1	Secrete histamine and serotonin
(c)		30 – 40	Defence against parasites
(d)		30 – 40	Allergic reactions

45. Identify the following figure – A and B respectively **[NCERT]**

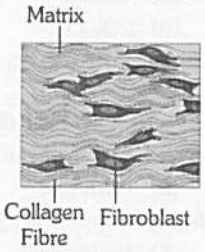


Fig. A

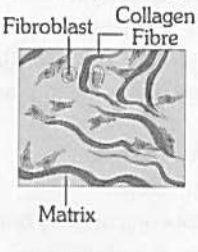


Fig. B

(a) Connective tissue proper, specialized connective tissue
(b) Adipose tissue, specialized connective tissue
(c) Dense irregular connective tissue, dense regular connective tissue
(d) Dense regular connective tissue, dense irregular connective tissue

Skeletal tissue

1. Haversian system is a diagnostic feature of **[KCET 1994; MP PMT 2001; DPMT 2003]**
(a) Avian bones (b) All animals
(c) Mammalian bones only (d) Reptilian bones

2. Which of the following tissue is more elastic
(a) Bone (b) Cartilage
(c) Both are equally elastic (d) Both are not elastic

3. Haversian system are found in the **[BVP 2002]**
(a) Pigeon (b) Panther
(c) Pipe fish (d) Python

4. Which of the following tissue is called as "homeostatic reservoir"
(a) Cartilage (b) Bone
(c) Calcified cartilage (d) All the above

5. During an injury, nasal septum gets damaged and for its recovery which cartilage is prefused **[CBSE PMT 2001]**

Or

Which of the following is a transparent tissue **[CPMT 2001; BHU 2006; MP PMT 2012]**
(a) Hyaline cartilage (b) Elastic cartilage
(c) Calcified cartilage (d) Fibro cartilage

6. Role of bone-marrow in mammals is [MP PMT 1995]
(a) To assist kidneys
(b) To act as haemopoietic tissue
(c) To assist liver
(d) To control blood pressure

7. Pubis in the frog's pelvic girdle is actually a [BVP 2003]
(a) Calcified cartilage (b) Cartilaginous bone
(c) Membrane bone (d) None of these

8. Which among the following is the strongest cartilage [CPMT 2000, 03; BHU 2003]
(a) Hyaline cartilage (b) Elastic cartilage
(c) White fibro cartilage (d) Violet fibro cartilage

9. Protein present in cartilage is [CBSE PMT 1997]
Or
The matrix of hyaline cartilage contains [CPMT 1998]
Or
The skeletal tissue consists of organic matrix called as [CBSE PMT 1993]
(a) Chondrin (b) Oesein
(c) Cartilagin (d) Ossein

10. The supportive skeletal structures in the human external ears and in the nose tip are examples of [CBSE PMT (Mains) 2012]
(a) Ligament (b) Areolar tissue
(c) Bone (d) Cartilage

11. Covering around bone is called [RPMT 2005]
(a) Perichondrion (b) Periosteum
(c) Epiosteum (d) Endosteum

12. Haversian canals of long bones have
(a) One vein and one artery
(b) One nerve and one lymphatic
(c) Some bone cells, fat and areolar tissue
(d) All the above

13. Cartilage is formed by [NCERT; MP PMT 1993, 94; Manipal 1995]
(a) Osteoblast (b) Fibroblast
(c) Chondrocyte (d) Submucosa

14. In mammals Haversian canals are connected with each other by transverse canals, which are called [MP PMT 2001, 03; KCET 2004; AFMC 2008]
(a) Semicircular canals (b) Volkman's canals
(c) Inguinal canals (d) Bidder's canals

15. Major constituent of bone is [NCERT; RPMT 1999; WB JEE 2012; AMU (Med.) 2012]
(a) Calcium phosphate (b) Magnesium phosphate
(c) Calcium carbonate (d) Sodium chloride

16. The tendon are formed of [DPMT 1999; CBSE PMT 1999; JIPMER 2001; CPMT 2003]
(a) White fibrous tissue (connective)
(b) Yellow fibrous tissue (connective)
(c) Areolar tissue
(d) Adipose tissue

17. Intervertebral disc is made up of [AIIMS 1993; MP PMT 2003]
(a) Elastic cartilage (b) Fibrous cartilage
(c) Calcified cartilage (d) Hyaline cartilage

18. Red marrows of the bone produce [AIIMS 1993]
(a) Lymphocytes (b) Eosinophils
(c) Plasma (d) RBC

19. The connective tissue of the vertebrate body is built up from fibres of the protein collagen, embedded in a polysaccharide matrix to form [CBSE PMT 1993]
(a) Cartilage (b) Blood vessel
(c) Heart (d) Lung

20. In the matrix lies the bone cells, called [CBSE PMT 1993]
Or
Cells that maintain marrow cells are called [AFMC 2009]
(a) Chondroclasts (b) Osteoclasts
(c) Osteoblasts (d) Osteocytes

21. A femur is kept in dilute *HCl* for three days, it becomes [CBSE PMT 1993]
(a) Brittle (b) Soft and elastic
(c) Remains as it is (d) Harder

22. A tissue similar to ligament but stretchable is called
(a) Tendon (b) Raphe
(c) Both (a) and (b) (d) None of these

23. Bone-forming cells are known as [NCERT; KCET 1998; PET (Pharmacy) 2013]
(a) Chondroclasts (b) Osteoblasts
(c) Chondroblasts (d) Osteoclasts

24. A polysaccharide constituent found in the matrix of cartilage is [NCERT; AFMC 2012]
(a) Ossein (b) Collagen
(c) Chondroitin (d) Hyaline

Vascular tissue

1. Which is not the cellular element of blood [Odisha JEE 2008]
(a) T-cell (b) B-cell
(c) Plasma (d) Monocyte

2. Average life span of human RBC is [NCERT; MP PMT 2001, 10; CPMT 2003; AFMC 2005; Odisha JEE 2005; BHU 2008]
(a) 100 days (b) 90 days
(c) 120 days (d) None

3. When the count of WBC falls below the optimum number in blood, it is called [Odisha JEE 2005]
(a) Leukopenia (b) Leukemia
(c) Anaemia (d) All of the above

4. Globulins contained in human blood plasma are primarily involved in [CBSE PMT 2009]
(a) Defence mechanisms of body
(b) Osmotic balance of body fluids
(c) Oxygen transport in the blood
(d) Clotting of blood

5. The most active phagocytic white blood cells are [CBSE PMT 2008]
(a) Eosinophils and lymphocytes
(b) Neutrophils and monocytes
(c) Neutrophils and eosinophils
(d) Lymphocytes and macrophages

6. Natural killer lymphocytes are an example for **[KCET 2015]**
(a) Physical barrier (b) Cytokine barrier
(c) Cellular barrier (d) Physiological barrier

7. Both RBC and WBC are formed in the **[CPMT 2003; Odisha JEE 2009]**
(a) Thymus (b) Adrenal
(c) Thyroid (d) Bone marrow

8. Erythrocytes in camel are
(a) Oval and non-nucleated
(b) Oval and nucleated
(c) Circular, biconcave and non-nucleated
(d) Circular, biconvex and nucleated

9. Shape of the nucleus of WBC is usually
(a) Spherical (b) Irregular
(c) Oval (d) Spindle shaped

10. Lymph differs from blood in having
(a) No W.B.C. (b) No protein
(c) Much more of water (d) No R.B.C.

11. A matured mammalian (RBC) is unusual because **[NCERT; Odisha JEE 2009]**
(a) It exhibits diapedesis (b) It is colourless
(c) It has no nucleus (d) It can change its shape

12. Largest single mass of lymphatic tissue in the body is **[DUMET 2009]**
(a) Lung (b) Spleen
(c) Liver (d) Kidney

13. Note the following:
(A) Monocytes (B) Trophocytes
(C) Lymphocytes (D) Mycetocytes
(E) Leucocytes (F) Oenocytes
(G) Urate cells
Which of above are fat cells in *Periplanata* **[EAMCET 2009]**
(a) A, C, E and H (b) B, D, F and G
(c) C, E, F and G (d) A, C, E and F

14. In the clotting mechanism pathway thrombin activates factors **[AMU (Med.) 2010]**
(a) XI, VIII, V (b) XI, IX, X
(c) VIII, X, V (d) IX, VIII, X

15. If kept in 0.8% *NaCl*, R.B.Cs will
(a) Shrink (b) Remain same
(c) Burst (d) None of these

16. *pH* of human blood is **[MP PMT 1999]**
(a) 7.4 (b) 6.2
(c) 9.0 (d) 10.00

17. The largest *RBC's* have been seen in **[KCET 2007]**
(a) Elephant (b) Whale
(c) Amphibia (d) Man

18. Blood clotting can be prevented in a test tube by adding a little
(a) Sodium oxalate (b) Sodium chloride
(c) Sodium hydroxide (d) Ammonium chloride

19. A siderocyte is a RBC containing **[AMU (Med.) 2009]**
(a) Pappenhiemer bodies (b) Russel bodies
(c) Herring's bodies (d) Schuffner's dots

20. What product of the immune system attaches to bacteria, making them easier to be eaten by white blood cells **[J & K CET 2012]**
(a) Antigen (b) Haemoglobin
(c) Antibody (d) MHC I molecule

21. Which of the following cells are associated with immune system of body **[MP PMT 2003]**
(a) Neutrophils (b) Macrophages
(c) Lymphocytes (d) All of these

22. Usually chordates have red blood containing red blood corpuscles. The blood is red due to the presence of the following pigment **[DPMT 1993; AFMC 1993]**
(a) Myoglobin (b) Anthocyanin
(c) β anthocyanin (d) Haemoglobin

23. The chemical which causes damage of WBC, bone marrow, spleen, lymph nodes and lungs is **[AIIMS 1993]**
(a) Iodine –131 (b) Calcium
(c) Strontium –90 (d) Iodine –127

24. Neutrophils promote adhesion of neutrophils to endothelium, attract other neutrophils, monocytes and eosinophils and dilate capillaries by secreting **[AMU (Med.) 2009]**
(a) Cytokines (b) Leucotrienes
(c) Lymphokines (d) Monokines

25. Mineral present in red pigment of vertebrate blood is
(a) Magnesium (b) Iron
(c) Copper (d) Calcium

26. Blood is formed of **[NCERT; MP PMT 1994]**
(a) Plasma and bone marrow cells
(b) Plasma and white and red blood cells
(c) Plasma and white blood cells
(d) Plasma and red blood cells

27. During sleeping the rate of RBC formation
(a) Increases (b) Decreases
(c) Remains constant (d) None of the above

28. In the extrinsic clotting pathway the active factor VII activates factors **[AMU (Med.) 2009]**
(a) X and XI (b) IX and XI
(c) IX and X (d) XI and XII

29. Blood is a kind of **[Bihar CECE 2006; MP PMT 2009; Odisha JEE 2012]**
(a) Areolar tissue (b) Connective tissue
(c) Fluid connective tissue (d) Reticular connective tissue

30. Match the following

Types of leucocytes	Function
A. Neutrophils	1. Heparin and histamine secretion
B. Basophils	2. Antibodies formation
C. Acidophils	3. Scavanger
D. Monocytes	4. Phagocytes
E. Lymphocytes	5. Antiallergic and healing of wounds

The correct pairing sequence is **[NCERT; BHU 2002, 05; Kerala PMT 2006, 08, 2010, 11; CBSE PMT 2008; Odisha JEE 2011]**
(a) 3, 1, 5, 4, 2 (b) 1, 4, 5, 3, 2
(c) 3, 2, 1, 4, 5 (d) 2, 3, 1, 4, 5

31. Match the following

Disease	Cause
A. Diabetes	1. Rise in WBC count
B. Uraemia	2. Deficiency of vitamin B_{12}
C. Anaemia	3. Rise in RBC count
D. Polycythemia	4. Fall of WBC count
E. Pernicious or Megaloblastic anaemia	5. Fall in RBC count
F. Leukemia	6. Increase in blood sugar level
G. Thrombocytopenia	7. Urea is in excess in blood
H. Leucopenia	8. Pathological increase in WBC
I. Leucocytosis	9. Decrease in the number of platelets

The correct matching sequence is

(a) 1, 3, 4, 2, 5, 6, 7, 9, 8 (b) 6, 7, 5, 3, 2, 8, 9, 4, 1
(c) 6, 7, 3, 5, 8, 2, 9, 1, 4 (d) 7, 6, 5, 3, 2, 9, 8, 4, 1

32. The average diameter of red blood corpuscles of man is **[WB JEE 2009]**

(a) 7.2 μm (b) 8.1 μm
(c) 9.2 μm (d) 10.3 μm

33. Which one of the following leucocytes transforms into macrophages **[WB JEE 2009]**

(a) Eosinophil (b) Basophil
(c) Monocyte (d) Lymphocyte

34. Reticulocytes may also be called

(a) Blood platelets (b) Immature erythrocytes
(c) Lymphocytes (d) WBCs

35. Phagocytosis was first of all seen by **[BHU 1995]**

(a) Huxley (b) Haeckal
(c) Metchnikoff (d) Strasburger

36. Highest content of iron is found in **[RPMT 1995]**

(a) WBC (b) Bone cells
(c) RBC (d) Protein

37. Which is the correct sequence of arrangement of types of WBC in decreasing order in terms of number per mm^3 of human blood **[WB JEE 2009]**

(a) Eosinophils > basophils > neutrophils
(b) Basophils > eosinophils > neutrophils
(c) Neutrophils > eosinophils > basophils
(d) Eosinophils > neutrophils > basophils

38. These WBCs makes maximum count amongst leucocyte **[GUJCET 2007]**

(a) Neutrophils (b) Eosinophils
(c) Basophils (d) Lymphocytes

39. The largest corpuscles in mammalian blood are **[MP PMT 1997]**

(a) Basophils (b) Erythrocytes
(c) Monocytes (d) Lymphocytes

40. Blood does not clot inside the blood vessels due to the presence of **[DPMT 1993; JIPMER 1993; AIIMS 1993, 99; CPMT 1994; MP PMT 1997; BHU 2001; AFMC 2003; WB JEE 2010]**

(a) Heparin (b) Fibrinogen
(c) Vitamin K (d) Thrombin

41. Antibody is produced by **[NCERT; BHU 2003; AIEEE Pharmacy 2003; AFMC 2009]**

(a) B-Lymphocyte (b) Heparin
(c) T-Lymphocyte (d) Both (a) and (b)

42. γ – globulins are synthesised inside **[CPMT 1999]**

(a) Liver
(b) Bone marrow
(c) Lymph and lymphoid tissue
(d) Kidney

43. Which of the following is agranulocyte **[CBSE PMT 1997]**

(a) Lymphocyte (b) Eosinophil
(c) Basophil (d) Neutrophil

44. The life span of human WBC is approximately **[CBSE PMT 1997]**

(a) Less than 10 days (b) Between 20 to 30 days
(c) Between 2 to 3 months (d) More than 4 months

45. Which of the following is not a granulocyte **[NCERT; BHU 2000; CPMT 2010]**

(a) Basophils (b) Monocytes
(c) Acidophils (d) Neutrophils

46. In haemoglobin which amino acid acts as blood buffer **[DPMT 2007]**

(a) Histidine (b) Glutamine
(c) Aspartic acid (d) Lysine

47. According to Best and Taylor's theory, which of the following does not play any role in blood clotting **[KCET 2012]**

(a) Prothrombin (b) Fibrinogen
(c) Platelets (d) Calcium ions

48. The chief difference between RBCs of Human and Frog **[NCERT; BVP 2002]**

(a) Only human RBCs have haemoglobin
(b) Human RBCs have more nuclei
(c) Human RBCs are without nucleus
(d) Frog RBCs are without nucleus

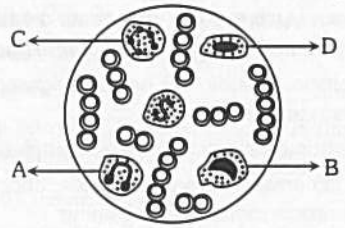
49. Which of the following is enucleate **[NCERT; Kerala CET 2002]**

(a) Squamous epithelial cell
(b) Mature human erythrocyte
(c) Mature frog erythrocyte
(d) Human osteocyte

50. Helper T – Cells : Lymphokines as
Killer T – Cells : _____ **[MHCET 2015]**

(a) Interferons (b) Lysozymes
(c) Perforins (d) Prostaglandins

51. Study the diagram given below and identify the cells labelled as A, B, C and D, and choose the correct option



[KCET 2012]

(a) A = Eosinophil B = Erythrocyte, C = Neutrophil and D = Basophil
(b) A = Eosinophil, B = Lymphocyte, C = Neutrophil and D = Monocyte
(c) A = Erythrocyte, B = Basophil, C = Neutrophil and D = Lymphocyte
(d) A = Eosinophil, B = Monocyte, C = Neutrophil and D = Lymphocyte

52. Which of the following is not phagocytic in nature **[DPMT 2007; WB JEE 2011]**
(a) Monocyte (b) Lymphocyte
(c) Mast cell (d) Neutrophil

53. Which of the following work as phagocytes **[AFMC 2003]**
(a) WBCs (b) RBCs
(c) Enzymes (d) Hormones

54. Serum is **[Odisha JEE 2004]**
(a) Blood without fibrinogen
(b) Lymph without corpuscles
(c) Blood without corpuscles and fibrinogen
(d) Lymph

55. Which is correct **[Odisha JEE 2004]**
(a) Blood has WBC and lymph has RBC
(b) Blood has WBC, RBC and lymph nothing
(c) Blood has RBC, WBC and lymph has WBC
(d) Lymph has WBC, RBC and blood has RBC

56. Which of the following does not play a role in blood coagulation **[CPMT 2004]**
(a) Vitamin *K* (b) Vitamin *D*
(c) Calcium ions (d) Fibrinogen

57. Which is not the function of lymph **[MHCET 2015]**
(a) Transport R.B.C.s
(b) Drain excess tissue fluid
(c) Transport lymphocyte and antibodies
(d) Transport absorbed fat

58. Hematology is the study of **[BVP 2004]**
(a) Bone (b) Blood
(c) Cartilage (d) Nerves

59. Antiserum contains **[MH CET 2002; MP PMT 2012]**
(a) Antigens (b) Antibodies
(c) Leucocytes (d) Heptaus

60. G-6-P dehydrogenase deficiency is associated with haemolysis of **[CBSE PMT 2005]**
(a) Lymphocytes (b) RBCs
(c) Platelets (d) Leucocytes

61. Which of the following substances, if introduced into the blood stream, cause coagulation of blood at the site of its introduction **[CBSE PMT 2005]**
(a) Fibrinogen (b) Prothrombin
(c) Heparin (d) Thromboplastin

62. Which are the phagocytic cells from given diagram **[MHCET 2015]**

(a) I and V (b) I and III
(c) I and IV (d) I and II

63. The process of formation of RBCs is called **[AFMC 2009]**
(a) Poikegenesis (b) Erythropoiesis
(c) Leucogenesis (d) None of these

64. Which of the following is not the main function of lymph glands **[CBSE PMT 1998; AFMC 1999]**
(a) Forming WBC (b) Forming antibodies
(c) Forming RBC (d) Destroying bacteria

65. The process of formation of blood corpuscles is called **[AFMC 2005]**
(a) Haemopoiesis (b) Heamolysis
(c) Heamozoin (d) None of these

66. Mark the odd one **[AFMC 2005]**
(a) Monocytes (b) Lymphocyte
(c) Neutrophils (d) Erythrocytes

67. A drop of each of the following, is placed separately on four slides. Which of them will not coagulate **[CBSE PMT 2007]**
(a) Blood plasma
(b) Blood serum
(c) Sample from the thoracic duct of lymphatic system
(d) Whole blood from pulmonary vein

68. If haemoglobin (Hb) of a normal individual and a sickle-cell patient are run in electrophoretic field, they will show **[AMU (Med.) 2012]**
(a) Same mobilities
(b) Different mobilities
(c) Hb of patient will not move at all
(d) Hbs are immobile

69. Which of the following is a type of white blood cell **[Odisha JEE 2012]**
(a) Reticulocyte (b) Lymphocyte
(c) Erythrocyte (d) Osteocyte

70. Which of the following is absent in blood serum **[Odisha JEE 2012]**
(a) Antigens (b) Fibrinogen
(c) Hormones (d) Antibodies

71. Irregular nuclei is present in **[MP PMT 2007]**

Or

Which white blood cell releases chemical to inhibit blood clotting **[WB JEE 2016]**
(a) Neutrophils (b) Basophils
(c) Eosinophils (d) Monocytes

72. Which option is correct for the formation of 'Intrinsic factor – X activator complex for blood coagulation **[GUJCET 2014]**
(a) Inactivated Christmas factor + AHG + phospholipids + Ca^{2+}
(b) Activated Christmas factor + AHG + phospholipids + Ca^{2+}
(c) Convertin + AHG + Ca^{2+} + FSF
(d) Phospholipid + protein complex + Proconvertin

73. Match the following

A.	Neutrophil	1.	Single large nucleus
B.	Eosinophil	2.	2 to 3 lobed nucleus
C.	Basophil	3.	Kidney shaped nucleus
D.	Lymphocyte	4.	2 to 7 lobed nucleus
E.	Monocyte	5.	Bilobed nucleus

[Kerala PMT 2006]

(a) (A) – (4), (B) – (1), (C) – (3), (D) – (5), (E) – (2)
(b) (A) – (2), (B) – (5), (C) – (1), (D) – (4), (E) – (3)
(c) (A) – (4), (B) – (5), (C) – (2), (D) – (1), (E) – (3)
(d) (A) – (2), (B) – (4), (C) – (5), (D) – (3), (E) – (1)
(e) (A) – (1), (B) – (4), (C) – (3), (D) – (2), (E) – (5)

74. Innate immunity is provided by **[Bihar CECE 2006; J & K CET 2008]**

(a) Neutrophils (b) T- cells
(c) B- cells (d) Antibody

75. Amount of oxygen supplied by 100*ml* arterial blood while passing through the tissues is **[WB JEE 2012]**

(a) 0.4-0.6 *ml* (b) 4-6 ml
(c) 14-15 *ml* (d) 19-20 *ml*

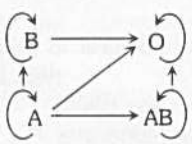
76. People who have migrated from the planes to an area adjoining Rohtang Pass about six months back **[NCERT; CBSE PMT (Pre.) 2012]**

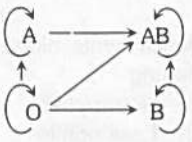
(a) Have more RBCs and their haemoglobin has a lower binding affinity to O_2
(b) Are not physically fit to play games like football
(c) Suffer from altitude sickness with symptoms like nausea fatigue etc
(d) Have the usual RBC count but their haemoglobin has very high binding affinity to O_2

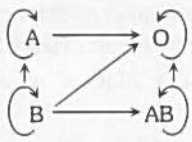
77. Compared to those of humans, the erythrocytes in frog are **[NCERT; CBSE PMT (Pre.) 2012]**

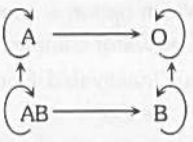
(a) Without nucleus but with haemoglobin
(b) Nucleated and with haemoglobin
(c) Very much smaller and fewer
(d) Nucleated and without haemoglobin

78. See the following representations and identify the correct blood groups and donor compatibility **[NCERT]**

(a) 

(b) 

(c) 

(d) 

79. Heparin is secreted by **[MH CET 2001; WB JEE 2010]**

(a) Blood cells (b) Liver cells
(c) Kidney (d) Nerve cell

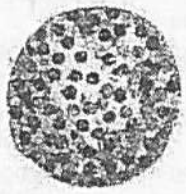
80. If pH of blood is artificially changed to 8, what is most likely to happen **[MP PMT 1992]**

(a) The tissues will not get oxygen as oxyhaemoglobin will not dissociate into oxygen and haemoglobin
(b) The carbon dioxide will not be released from carbonic acid and carbonates
(c) The carbonic anhydrase will be completely inhibited
(d) It will generate carbon monoxide and the animal will die of carbon monoxide poisoning

81. Erythropoesis may be stimulated by the deficiency of **[AIIMS 1992]**

(a) Iron (b) Oxygen
(c) Protein (d) None of the above

82. The figure shows a human blood cell. Identify it and give its characteristics



[NEET (Karnataka) 2013]

	Blood cell	Characteristics
(a)	Basophil	Secrete serotonin, inflammatory response
(b)	B-lymphocyte	Form about 20% of blood cells involved in immune response
(c)	Neutrophil	Most abundant blood cell, phagocytic
(d)	Monocyte	Life span 3 days, produce antibodies

83. Blood cells that increase in number during allergic conditions like asthma are **[AIIMS 2010]**

(a) Neutrophils (b) Basophils
(c) Eosinophils (d) Lymphocytes

84. The ratio of RBC to WBC in man is

(a) 6 : 1 (b) 60 : 1
(c) 600 : 1 (d) 6000 : 1

85. Which of the following cells are round and biconcave in shape **[Kerala PMT 2011]**

(a) White blood cells (b) Red blood cells
(c) Columnar epithelial cells (d) Nerve cells
(e) Mesophyll cells

86. Which one is correct **[KCET 2007; AIPMT (Cancelled) 2015]**

(a) Blood = plasma + *RBC* + *WBC* + blood platelets
(b) Plasma = blood - lymphocytes
(c) Neuron = cyton + dendrite + axon + synapse
(d) Lymph = plasma + *RBC* + *WBC*

87. The sample of a healthy human blood is

(a) Alkaline (b) Acidic
(c) Neutral (d) None of these

88. The iron free compound of haemoglobin is

(a) Globin (b) Haematin
(c) Bilirubin (d) Haemotoxin

89. Haemoglobin contains
(a) 70% globin + 30% haematin
(b) 80% globin + 20% haematin
(c) 95% globin + 05% haematin
(d) 90% globin + 10% haematin

90. The process of blood clot formation within the circulatory system is **[CBSE PMT 1993]**
(a) Thrombosis (b) Thrombocytes
(c) Thrombin (d) Thrombocytopenia

91. If an experiment, animal is made anaemic, production of which hormone will be stepped up **[AIIMS 1993]**
(a) Erythrocytin (b) Erythroblastin
(c) Erythropoietin (d) Enkephalin

92. Lead concentration in blood is considered alarming if it is **[CBSE PMT 2004; CPMT 2005]**
(a) 20 μg/100 ml (b) 30 μg/100 ml
(c) 10 μg/100 ml (d) 4-6 μg/100 ml

93. Mature erythrocytes cannot utilize glucose because they lack **[DUMET 2010]**
(a) Golgi complex (b) Enzymes
(c) Mitochondria (d) Nucleus

94. The medium of plasma is
(a) Acidic (b) Basic
(c) Neutral (d) None of these

95. The *pH* of the blood is maintained balancing the ratio of
(a) Lactic acid and pyruvic acid
(b) $NaHCO_3$ and H_2CO_3
(c) CO_2 and H_2O
(d) Pyruvic acid and H_2CO_3

96. What percent of total blood coming out of heart, goes to kidney **[CPMT 1996]**
(a) 25% (b) 50%
(c) 75% (d) 40%

97. The haemoglobin content per 100 *ml* of blood of a normal healthy human adult is **[NCERT; CBSE PMT (Mains) 2010)]**
(a) 5 to 11 *gms* (b) 25 to 30.0 *gms*
(c) 17 to 20 *gms* (d) 12 to 16.0 *gms*

98. A yellow substance oozing out from wound has
(a) Lymph + RBC + WBC
(b) Lymph + RBC + dead bacteria
(c) Lymph + WBC + dead bacteria
(d) Lymph + dead leucocytes

99. WBC is called true cell because of **[Odisha JEE 2011]**
(a) Presence of nucleus (b) Phagocytosis
(c) Polymorphism (d) None of these

100. The main function of the white blood cell in the human intestine system is to **[AIIMS 2010]**
(a) Combat and destroy antigenic particles
(b) Produce antigens to combat antibodies
(c) Carry oxygen around the body
(d) Transport antigens to *B* memory cells in the lymph nodes

101. A chemical that prevents blood clotting is most useful in the treatment of
(a) Leukemia (b) Anaemia
(c) Coronary thrombosis (d) Haemophilia

102. Which one of the following substances in the blood in man imparts the oxygen carrying capacity to it
(a) Haemocyanin
(b) Haemoglobin
(c) Haemerythrin or haemoerythrin
(d) Sodium ions

103. Oxygen is transported by **[MP PMT 1994, 95]**
(a) Blood plasma (b) RBCs
(c) Leucocytes (d) Thrombocytes

104. Which one of the following in blood absorbs oxygen **[MP PMT 1994]**
(a) WBCs (b) Plasma
(c) RBCs (d) Platelets

105. In mammalian RBC, the precentage of haemoglobin is **[CPMT 1996; MP PMT 2003]**
(a) 40% of biomass (b) 34% of biomass
(c) 90% of biomass (d) 50% of biomass

106. Persons living at high altitude will have **[AFMC 1995]**
(a) Increased alveolar capacity
(b) Increased number of erythrocytes
(c) Haemoglobin curve shifts towards right
(d) All of the above

107. Red cell count is carried out by **[WB JEE 2010]**
(a) Haemocytometer (b) Haemoglobinometer
(c) Sphygmomanometer (d) Electrocardiogram

108. To prevent coagulation blood stored in blood bank contains a small amount of
(a) Calcium sulphate
(b) Prothrombin
(c) Potassium or sodium citrate
(d) None of these

109. Which of the following blood cells help in blood coagulation **[AFMC 2010; Odisha JEE 2010]**
(a) RBCs (b) Lymphocytes
(c) Thrombocytes (d) Basophils

110. In the blood of an adult man the total content of haemoglobin is roughly **[AIIMS 2010]**
(a) Several hundred grams (b) Tens of gram (10-100*g*)
(c) Several grams (d) Several hundred milligram

111. Blood plasma contains – % water **[NCERT; AFMC 2008]**
(a) 60 (b) 80
(c) 90 (d) 98

112. Normal glucose level in blood is **[AFMC 2008]**
(a) 150-180 mg/100ml blood
(b) 80-100 mg/100ml blood
(c) 30-70 mg/100ml blood
(d) 220-250 mg/100ml blood

113. Which of the followings are required for blood clotting **[AFMC 2008, 10; MP PMT 2010]**

(a) K^+, thromboplastin (b) Ca^{++}, thromboplastin

(c) Na^+, Ca^{++} (d) K^+, prothrombin

114. Which one of the following is a matching pair of a certain body feature and its value / count in a normal human adult **[AIIMS 2007, 08]**

(a) Urea – 5–10 mg/100mL of blood

(b) Blood sugar (fasting) –70–100 mg/100mL.

(c) Total blood volume –5–6

(d) ESR in Wintrobe method – 9–15 mm in males and 20–34 mm in females

115. About 97% of O_2 is transported by RBC. The remaining 3% is **[NCERT; Kerala PMT 2008]**

(a) Dissolved in plasma and transported

(b) Remains in lungs

(c) Attached to cell membranes

(d) Inside the mitochondria

(e) In peroxisomes

116. Multi-lobed nucleus and granular cytoplasm are characteristics of which of the following types of WBCs **[Odisha JEE 2010]**

(a) Neutrophils (b) Monocytes

(c) Lymphocytes (d) Eosinophils

117. In normal healthy individuals the percentage of adult and fetal haemoglobin,HbA : HbA2 : HbF is **[AMU (Med.) 2009]**

(a) 96 : 2 : 2 (b) 45 : 45 : 10

(c) 50 : 45 : 5 (d) 80 : 10 :10

118. The majority of CO_2 is transported into blood as **[CPMT 2009]**

(a) Bicarbonate (b) Sulphate

(c) Oxalate (d) Citrate

119. Which of the following prevents the conversion of prothrombin to thrombin in an undamaged blood vessel **[KCET 2009]**

(a) Heparin (b) Calcium ions

(c) Thromboplastin (d) Fibrinogen

120. What is true about RBCs in humans **[CBSE PMT (Pre.) 2010]**

(a) They do not carry CO_2 at all

(b) They carry about 20-25 percent of CO_2

(c) They transport 99.5 percent of O_2

(d) They transport about 80 percent oxygen only and the rest 20 percent of it is transported in dissolved state in blood plasma

121. Which one of the following plasma is involved in the coagulaton of blood **[NCERT; CBSE PMT (Pre.) 2011]**

(a) Fibrinogen (b) An albumin

(c) Serum amylase (d) A globulin

122. Adult human RBCs are enucleate. Which of the following statement (s) is/are not most appropriate explanation for this feature

(A) They do not need to reproduce

(B) They are somatic cells

(C) They do not metabolize

(D) All their internal space is available for oxygen transport

Options **[NEET 2017]**

(a) Only (D) (b) Only (A)

(c) (A), (C) and (D) (d) (B) and (C)

Muscular tissue

1. Which of the following ion is necessary for the contraction of a muscles and nerve impulse transmission **[CPMT 1995; RPMT 1995; BHU 2005]**

(a) Na^+ (b) K^+

(c) Ca^{++} and Mg^{++} ions (d) None of these

2. Which one of the following pairs of chemical substances, is correctly categorised **[NCERT; CBSE PMT (Mains) 2012]**

(a) Calcitonin and thymosin -Thyroid hormones

(b) Pepsin and prolactin-Two digestive enzymes secreted in stomach

(c) Troponin and myosin–Complex proteins in striated muscles

(d) Secretin and rhodopsin –Polypeptide hormones

3. Shivering with cold in winter is caused by **[MP PMT 2001]**

(a) Voluntary action of striated muscles

(b) Voluntary action of unstriated muscles

(c) Involuntary action of striated muscles

(d) Involuntary action of unstriated muscles

4. Unstriped muscles are found in

(a) Neck (b) Urinary bladder

(c) Arms (d) Fingers

5. Cardiac muscles are having characters of

(a) Striped muscle (b) Unstriped muscle

(c) Both (a) and (b) (d) None of these

6. Unstriped smooth muscles are found in

(a) Thigh (b) Eye muscles

(c) Iris (d) Tongue

7. Sarcolemma is the covering of **[MP PMT 2003]**

(a) Nerve fibres (b) Muscle fibres

(c) Bone marrow (d) Liver, kidney and stomach

8. Sliding filament theory can be best explained as **[AIPMT (Cancelled) 2015]**

(a) Actin and Myosin filaments shorten and slide pass each other

(b) Actin and Myosin filaments do not shorten but rather slide pass each other

(c) When myofilaments slide pass other, Myosin filaments shorten while actin filaments do not shorten

(d) When myofilaments slide pass each other actin filaments shorten while myosin filament do not shorten

9. Which of the following makes heart wall more thick **[Odisha JEE 2011]**

(a) Pericardium (b) Epicardium

(c) Myocardium (d) Endocardium

10. Who propounded the "Sliding filament theory" for muscles contraction

(a) Cori

(b) H.E. Huxley

(c) A.F. Huxley

(d) H.E. Huxley and A.F. Huxley

11. In the thin filament of skeletal muscle fibre, a small globular protein, that masks the active sites on the F-actin is **[Kerala PMT 2007, 08]**

(a) G-actin (b) Actin
(c) Tropomyosin (d) Troponin
(e) Myosin

12. During muscular contraction, which of the following events occur

(i) H-zone disappears (ii) A band widens
(iii) I band reduces in width
(iv) Width of A band is unaffected
(v) M line and Z line come closer **[EAMCET 2009; AIIMS 2012]**

(a) (i), (iii), (iv) and (v) (b) (i), (ii) and (v)
(c) (ii), (iv) and (v) (d) (i), (ii) and (iii)

13. Epimysium, perimysium and endomysium are found in **[MP PMT 2009]**

(a) Nerve (b) Blood vessel
(c) Striated muscle (d) Uterus

14. Striped muscles have

(a) One nucleus (b) Many nuclei
(c) Two nuclei (d) No nuclei

15. Oxygen dissociation curve for myoglobin is **[AFMC 2008]**

(a) Sigmoidal (b) Hyperbolic
(c) Linear (d) Parabolic

16. The protein which maintains the muscular storage of oxygen is **[CMC Vellore 1993; WB JEE 2011]**

(a) Myoglobin (b) Actomyosin
(c) Myosin (d) Haemoglobin

17. The interval between the beginning of electrical response and peak of tension recorded is the **[CMC Vellore 1993]**

(a) Latent period (b) Contraction time
(c) Relaxation time (d) None of these

18. Autorhythmicity is a special property of the muscles of the **[KCET 1994]**

Or

Striped and branched muscle are found in **[CPMT 1994]**

(a) Liver (b) Intestine
(c) Heart (d) Kidney

19. Which of the following is the example of structural protein **[RPMT 2006]**

(a) Myosin (b) Collagen
(c) Keratin (d) All of these

20. Smooth muscle fibres are **[JIPMER 1993]**

(a) Cylindrical, unbranched, striated, multinucleate and voluntary
(b) Spindle-shaped, unbranched, non-striated, uninucleate and involuntary
(c) Cylindrical, unbranched, non-striated, multinucleate and involuntary
(d) Spindle-shaped, unbranched, striated, uninucleate and voluntary

21. The most abundant tissue in the body is **[DPMT 1993]**

Or

Which tissue is most widely distributed in the body forming major part

Or

In metazoa one of the following is responsible for locomotion and movement of organs **[MP PMT 2001]**

(a) Nervous (b) Muscular
(c) Vascular (d) Epithelial

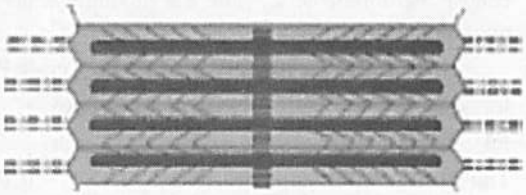
22. All or none law is not applicable for **[WB JEE 2012]**

(a) Whole skeletal muscle
(b) Single skeletal muscle fibre
(c) Whole cardiac muscle
(d) Single smooth muscle fibre

23. The muscles immune to fatigue are

(a) Striped (b) Unstriped
(c) Cardiac (d) None of these

24. State the condition of muscle contraction in following diagram **[GUJCET 2015]**



(a) Resting potential (b) Contraction
(c) Maximally contracted (d) None

25. Striated and voluntary muscle fibres are found in **[MP PMT 1999]**

(a) Lungs (b) Leg muscles
(c) Gall bladder (d) Blood vessels

26. Ciliary muscles are which

Or

Ciliay muscles are contractile structures which

(a) Move cilia of some protozoans
(b) Keep valves of heart intact
(c) Change focal length of human eye and are found at joint of sclera and iris
(d) Cause erection of human hairs in cold and are situated in skin

27. 'Oxygen debt' is amount of oxygen required for

(a) Muscle contraction (b) Muscle relaxation
(c) Muscle recovery (d) All the above

28. In the resting muscle fibre tropomyosin partially covers **[AMU (Med.) 2010]**

(a) *Ca* binding sites on troponin
(b) Actin binding sites on myosin
(c) Myosin binding sites on actin
(d) *Ca* binding sites on actin

29. $Na^+ - K^+$ pump is found in membranes of many cells, like nerve cells. It works against electro chemical gradient and involve an integral protein *ATP*ase. For each molecule of *ATP* used **[AFMC 2006]**

(a) 3 ions of Na^+ are pumped out and two K^+ are taken in

(b) 3 ions of Na^+ are taken in and $2K^+$ are pumped out

(c) 2 ions of Na^+ are thrown out and $3K^+$ are absorbed

(d) 3 ions of K^+ are absorbed and $3Na^+$ are pumped out

30. The 'thick' filament in muscles is polymerised protein of **[Kerala PMT 2012]**

(a) Meromyosins (b) Actins

(c) Troponins (d) Tropomyosins

(e) Keratin

31. Actin filament is made up of **[BHU 2003]**

(a) Actin, troponin and tropomyosin

(b) Actin, troponin

(c) Myosin, troponin

(d) Actin, tropomyosin

32. Krause membrane or Z – line is a myofibril which separates two adjacent **[CBSE PMT 2001; MP PMT 2002; Kerala PMT 2009]**

(a) Sarcomeres (b) H – zones

(c) I – bands (d) A – bands

33. The muscles which can retract are **[CPMT 1998]**

(a) Retractor (b) Protractor

(c) Abductor (d) All of these

34. Read the statements regarding muscle proteins

(A) Actin is a thin filament and is made up of two F-actins

(B) The complex protein, tropomyosin is distributed at regular intervals on the troponin

(C) Myosin is a thick filament which is also a polymerized protein

(D) The globular head of meromyosin consists of light meromyosin (LMM)

Of the above statements **[Kerala PMT 2010]**

(a) (A), (B) and (C) are correct

(b) (A), (B) and (D) are correct

(c) (A) and (C) are correct

(d) (B) and (D) are correct

(e) (B), (C) and (D) are correct

35. Actin and myosin proteins are related with **[BVP 2001]**

(a) Na^+ and K^+ pump

(b) Muscle contraction

(c) Nervous system

(d) Excretion of water products

36. Myoglobin is found in **[MP PMT 1997; AFMC 2000, 12; Pb. PMT 2000]**

(a) Muscles (b) Blood

(c) Liver (d) Spleen

37. Statements

A. A – bands of the muscle is dark and contain myosin

B. I – bands are the light bands and contain actin

C. During muscle contraction the A – band contracts

D. The part between the two Z – lines is called as sarcomere

E. The central part of thin filament, not overlapped by thick filament is called H-zone

Of the above statements **[Kerala PMT 2007]**

(a) A, B and C are correct while D and E are incorrect

(b) A, C, E are correct while B, D are incorrect

(c) A and B are correct while C, D and E are incorrect

(d) A, B, C and E are correct while D is incorrect

(e) A, B and D are correct while C and E are incorrect

38. The structural and functional unit of the striated muscle fibre is called **[CBSE PMT 1998]**

(a) Sarcolemma (b) Sarcomere

(c) Sarcoplasm (d) Myofibril

39. Hypertrophy of muscle is

(a) Muscles become thin and weak due to excessive work

(b) Muscles become thick and strong due to excessive work

(c) Muscles become thin and weak due to no work

(d) Muscles become thick and strong due to no work

40. Action potential is generated by **[MP PMT 2007]**

(a) Na^+ (b) K^+

(c) Ca^+ (d) Cl^-

41. The largest muscle in human body is **[BVP 2000]**

(a) Masseter (b) Sartorius

(c) Stapedius (d) Gluteus

42. The type of muscles present in our **[NCERT; CBSE PMT (Mains) 2011]**

(a) Thigh are striated and voluntary

(b) Upper arm are smooth muscle fibres fusiform in shape

(c) Heart are involuntary and unstriated smooth muscles

(d) Intestine are striated and involuntary

43. The ready source of energy in living cells is **[CPMT 1995]**

(a) Glucose (b) ATP

(c) Glycogen (d) ADP

44. In a muscle, the functional unit of contraction is the **[Kerala PMT 2012]**

(a) Portion of myofibril between two successive 'Z'lines

(b) I band (c) A band

(d) H zone (e) I band with a Z line

45. Unstriated muscles are found in **[RPMT 1995]**

(a) Veins (b) Arteries

(c) Uterus (d) All the above

46. Which set clearly identify striated muscles **[CPMT 2005]**

(a) Cylindrical, syncytial and unbranched

(b) Spindle, unbranched and uninucleated

(c) Cylindrical, striped and nucleated

(d) Cylindrical, striped and branched

47. Muscular tissue is differentiated into **[MP PMT 1995]**
(a) Unstriped, striped
(b) Striped, cardiac
(c) Cardiac muscle, unstriped
(d) Unstriped, striated and cardiac

48. During muscular contraction **[MP PMT 1996]**
(a) ATP is broken down (b) ATP is formed
(c) GTP is broken down (d) None of these

49. The important muscle proteins that help in movement are **[AMU (Med.) 2012]**
(a) Actin and myosin (b) Tropomyosin
(c) Troponin (d) All of these

50. Cardiac muscle fibres differ from skeletal muscles because these are **[AIIMS 2000; MP PMT 2006]**
(a) Striated, involuntary (b) Non-striated-voluntary
(c) Non-striated involuntary (d) Antagonistic

Nervous tissue

1. Most of the neurons of our body are **[AFMC 1994]**
(a) Unipolar (b) Bipolar
(c) Pseudounipolar (d) Multipolar

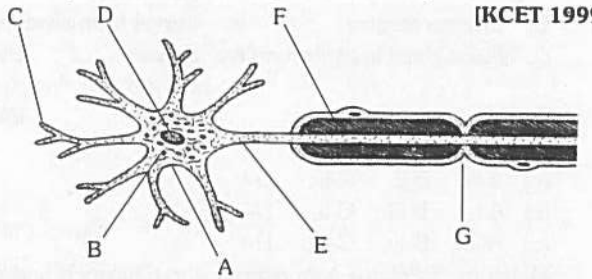
2. Synapses store
(a) Stimulating chemicals (b) Inhibitory chemicals
(c) Conducting chemicals (d) All of these

3. Schwann cells and Node of Ranvier are found in **[DPMT 1993; BHU 2003; Kerala PMT 2009]**
(a) Nervous tissue (b) Osteoblast
(c) Chondrioblast (d) Gland cells

4. Which of the following is regarded as a unit of nervous tissue **[CBSE PMT 1999]**
(a) Axons (b) Dendrites
(c) Neurons (d) Myelin sheath

5. Dark bands are **[NCERT; CPMT 2009]**
(a) A-band (b) B-band
(c) I-band (d) Z-line

6. In the diagram of multipolar myelinated neuron given below, different parts have been indicated by alphabetes; choose the answers in which these alphabetes have been correctly matched with the parts which they indicate **[KCET 1999]**



(a) A=Cell body, B=Nissl bodies, C=Nucleus, D=Dendrites, E=Naked portion of axon, F=Myelin sheath, G=Node of Ranvier
(b) A=Cell body, B=Nissl bodies, C=Naked portion of axon, D=Dendrites, E=Nucleus, F=Myelin sheath, G=Node of Ranvier
(c) A=Cell body, B=Nissl bodies, C=Naked portion of axon, D=Nucleus, E=Dendrites, F=Myelin sheath, G=Node of Ranvier
(d) A=Cell body, B=Nissl bodies, C=Dendrites, D=Nucleus, E=Naked portion of axon, F=Myelin sheath, G=Node of Ranvier

7. Irritability and conductivity are maximum developed in
(a) Muscular tissue (b) Nervous tissue
(c) Connective tissue (d) None of the above

8. Nerve cell originated from embryonic
(a) Ectoderm (b) Mesoderm
(c) Both (a) and (b) (d) Endoderm

9. Longest cell in human body may be **[MP PMT 1998]**
(a) Nerve cell (b) Leg muscle cell
(c) Bone cell (d) Heart muscle cell

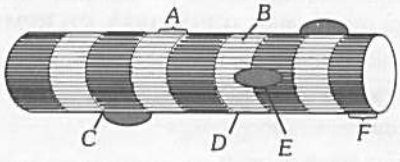
10. Nerve fibre is different from the muscle fibre due to the presence of
(a) Myofibrils (b) Lines
(c) Sarcolemma (d) Dendrites

11. The area where the medullary sheath is absent in the nerve fibre is called **[CPMT 2009]**
(a) Schwann cells (b) Schwann nodes
(c) Nissl Granules (d) Node of Ranvier

12. Nodes of Ranvier are found in **[DPMT 2006; MP PMT 2011]**
(a) Non-myelinated nerve fibres
(b) Myelinated nerve fibres
(c) Both (a) and (b)
(d) None of the above

13. Neurons with long axons are called
(a) Golgi type I (b) Golgi type II
(c) Golgi type III (d) Golgi type IV

14. The diagram given below represents the histology of a stripped muscle. Label the parts A, B, C, D E and F **[KCET 2011]**



(a) A–Sarcoplasm, B–Nucleus, C–Sarcolemma, D–myofibril, E–Dark band, F–Light band
(b) A–Sarcoplasm, B–Light band, C–Myofibril, D–Sarcolemma, E–Nucleus, F–Dark band
(c) A–Light band B–Sarcoplasm, C–Myofibril, D–Sarcolemma, E–Nucleus, F–Dark band
(d) A–Sarcolemma, B–Nucleus, C–Dark band, D–Light band, E–Sarcoplasm, F–Myofibril

15. Which of the damaged cells can not be repaired **[AFMC 2006]**
(a) Liver cells (b) Brain cells
(c) Bone cells (d) Epidermal cells

16. Non-excitable cells, found among the neurons are called **[CPMT 2003]**

Or

Which of the following is not the cell of aerolar tissue **[KCET 2001]**
(a) Dendrite (b) Axon
(c) Schwann's cells (d) Nissl's body

17. Myelin sheath is a layer covering **[CMC Vellore 1993]**
(a) A nerve fibre in an insect
(b) A chick embryo
(c) A muscle fibre in a vertebrate
(d) A nerve fibre in a vertebrate

18. Myelin sheath is covering of
(a) Muscle cells (b) Axon of neurons
(c) Blood vessels (d) Osteocytes

19. The junction between Schwann cells is known as **[MP PMT 1992]**
(a) Plasmalemma (b) Node of Ranvier
(c) Dendrons (d) Synapse

20. Myelin sheath is formed by **[NCERT; CPMT 2010]**
(a) Ranvier cells (b) Muscle cells
(c) Schwann cells (d) Axon

21. The junction between the axon of one neuron and the dendrite of the next is called **[NCERT; CBSE PMT 1999; CPMT 2001; AFMC 2003; MP PMT 2003; Odisha JEE 2011]**

Or

Junction of two nerve fibres is called **[MP PMT 2007]**
(a) A joint (b) A synapse
(c) Constant bridge (d) Junction point

22. Nissl's granules are found in cyton of nerve cells. These have affinity for basic dyes. The granules are made up of **[MP PMT 1992, 97; CBSE PMT 2003; DPMT 2006]**
(a) Mitochondria (b) Cell metabolites
(c) Fat granules (d) Ribosomes

23. The afferent process of neuron is known as
(a) Axon (b) Dendrite
(c) Cyton (d) Neurofibrillae

24. Which of the following tissues in mammals show the least capacity for regeneration **[CPMT 1995, 97; RPMT 2005, 06]**
(a) Epithelial tissue of the skin
(b) Endothelium of blood vessels
(c) Skeletal tissue of long bones
(d) Nervous tissue of brain

25. Schwan cell is found around **[BHU 2003]**
(a) Axon (b) Cyton
(c) Dendrite (d) Dendron

26. The most appropriate definition of Neuroglial cells are that they are **[Kerala CET 2003]**
(a) Nonsensory supporting cells
(b) Secretory cells
(c) Sensory cells
(d) Sensory and supporting cells

27. End plate junction is present between **[CPMT 2010]**
(a) Neuron and striated muscle
(b) Neuron and neuron
(c) Muscle and muscle
(d) Both (b) and (c)

28. Nerve fibres conduct impulses in **[RPMT 1999]**
(a) One direction (b) Two direction
(c) Multidirection (d) None of the above

29. Which one of the following is not essentially a part of nervous system **[CPMT 1998]**
(a) Cyton (b) Axon
(c) Myelinated (d) Intermedin

NCERT Exemplar Questions

1. Which one of the following types of cell in involved in making of the inner walls of large blood vessels **[NCERT]**
(a) Cuboidal epithelium (b) Columnar epithelium
(c) Squamous epithelium (d) Stratified epithelium

2. To which one of the following categories does adipose tissue belong **[NCERT]**
(a) Epithelial (b) Connective
(c) Muscular (d) Neural

3. Which one of the following is not a connective tissue **[NCERT]**
(a) Bone (b) Cartilage
(c) Blood (d) Muscles

4. Which one of the following statements is true for cockroach **[NCERT]**
(a) The number of ovarioles in each ovary are ten
(b) The larval stage is called caterpillar
(c) Anal styles are absent in females
(d) They are ureotelic

5. Match the followings and choose the correct option

A.	Adipose tissue	i.	Nose
B.	Stratified epithelium	ii.	Blood
C.	Hyaline cartilage	iii.	Skin
D.	Fluid connective tissue	iv.	Fat storage

Options **[NCERT]**
(a) A-i, B-ii, C-iii, D-iv
(b) A-iv, B-iii, C-i, D-ii
(c) A-iii, B-i, C-iv, D-ii
(d) A-ii, B-i, C-iv, D-iii

6. Match the followings and choose the correct answer

A.	Hermaphrodite	i.	Produces blood cells and haemoglobin
B.	Direct development	ii.	Testis and ovary in the same animal
C.	Chemoreceptor	iii.	Larval form absent
D.	Blood gland in earthworm	iv.	Sense of chemical substances

Options **[NCERT]**
(a) A-ii, B-iii, C-iv, D-i
(b) A-iii, B-ii, C-iv, D-i
(c) A-i, B-iii, C-ii, D-i
(d) A-ii, B-iv, C-iii, D-i

7. Match the following with reference to Cockroch and choose the correct option

A.	Phallomere	i.	Chain of developing ova
B.	Gonopore	ii.	Bundles of sperm
C.	Spermatophore	iii.	Opening of the ejaculatory duct
D.	Ovarioles	iv.	The external genitalia

Options **[NCERT]**
(a) A-iii, B-iv, C-ii, D-i
(b) A-iv, B-iii, C-ii, D-i
(c) A-iv, B-ii, C-iii, D-i
(d) A-ii, B-iv, C-iii, D-i

8. Match the followings and choose the correct answer

A.	Touch	i.	Nasal epithelium
B.	Smell	ii.	Foramen magnum
C.	Cranial nerves	iii.	Sensory papillae
D.	Medulla oblongata	iv.	Peripheral nervous system

Options **[NCERT]**

(a) A-iii, B-i, C-ii, D-iv
(b) A-ii, B-i, C-iv, D-iii
(c) A-iii, B-iv, C-ii, D-i
(d) A-iii, B-i, C-iv, D-ii

Critical Thinking

Objective Questions

1. Identify the correctly matched pair/pairs of the germ layers and their derivatives

A.	Ectoderm	—	Epidermis
B.	Endoderm	—	Dermis
C.	Mesoderm	—	Muscles
D.	Mesoderm	—	Notochord
E.	Endoderm	—	Enamel of teeth

[KCET 2009]

(a) A, C and D only (b) A, B, C and E only
(c) A and D only (d) A and B only

2. Match list I with list II and find the correct option

List I (Epithelial tissue)		List II (Location)	
(A)	Cuboidal	(1)	Epidermis of skin
(B)	Ciliated	(2)	Inner lining of blood vessels
(C)	Columnar	(3)	Inner surface of gall bladder
(D)	Squamous	(4)	Inner lining of Fallopian tube
(E)	Keratinized squamous	(5)	Lining of pancreatic duct

[Pb PMT 1999, 2009; BHU 2003; Kerala PMT 2009, 11]

(a) (A) — (5), (B) — (4), (C) — (2), (D) — (3), (E) — (1)
(b) (A) — (3), (B) — (4), (C) — (5), (D) — (2), (E) — (1)
(c) (A) — (5), (B) — (4), (C) — (3), (D) — (2), (E) — (1)
(d) (A) — (3), (B) — (4), (C) — (5), (D) — (1), (E) — (2)
(e) (A) — (3), (B) — (5), (C) — (4), (D) — (1), (E) — (2)

3. Which one of the following mammalian cells is not capable of metabolising glucose to carbon-dioxide aerobically **[CBSE PMT 2007]**

(a) White blood cells (b) Unstriated muscle cells
(c) Liver cells (d) Red blood cells

4. An epithelial tissue which has thin and flat cells arranged edge to edge so as to appear like closely packed tiles, is found at the **[CBSE PMT 1994; 2000]**

(a) Inner lining of stomach
(b) Inner lining of cheeks
(c) Outer surface of ovary
(d) Inner lining of fallopian tube

5. In heart cells, which one serves as a second messenger, speeding up muscle cell contraction in response to adrenaline **[Kerala PMT 2006]**

(a) cAMP (b) cGMP
(c) GTP (d) ATP
(e) AMP

6. Stratum germinativum is an example of which kind of epithelium **[CBSE PMT 1997]**

(a) Cuboidal (b) Ciliated
(c) Columnar (d) Squamous

7. Select proper option, by matching column I, II and III

Column I (Common Name)		Column II (Roman Numerical Designation)		Column III (Activation product)	
(P)	Prothrombin	(x)	I	(i)	Convertin
(Q)	Proconvertin	(y)	V	(ii)	Fibrin
(R)	Fibrinogen	(z)	II	(iii)	Thrombin
(S)	Proaccelerin	(w)	VII	(iv)	Accelerin

[GUJCET 2015]

(a) (P - z - iii) (Q - w - i) (R - y - ii) (S - x - iv)
(b) (P - w - ii) (Q - z - iii) (R - y - iv) (S - x - i)
(c) (P - z - iii) (Q - w - ii) (R - x - iv) (S - y - i)
(d) (P - z - iii) (Q - w - i) (R - x - ii) (S - y - iv)

8. Match List – I and List – II and select the correct option

	List – I		List – II
A.	Biological pigments	1.	Sodium chloride
B.	Chemical messengers	2.	Steroids
C.	Important constituent of blood	3.	Prostaglandins
D.	Four carbon rings	4.	Terpenes

[Kerala PMT 2007]

(a) A – 2, B – 4, C – 3, D – 1 (b) A – 2, B – 1, C – 4, D – 3
(c) A – 3, B – 4, C – 2, D – 1 (d) A – 4, B – 3, C – 1, D – 2
(e) A – 3, B – 4, C – 1, D – 2

9. Statements

A. Plasma constitutes 45% of the human blood
B. Albumin is a plasma protein which helps in osmotic balance
C. Factors responsible for the blood clotting process are present in the blood
D. Plasma without clotting factors is called serum
E. Minerals are not generally found in blood

Of the above statements **[Kerala PMT 2007]**

(a) Only E is wrong and all other A to D are correct
(b) A and B are correct and C, D and E are wrong
(c) B and D are correct and A, C and E are wrong
(d) A and E are correct and B, C and D are wrong
(e) B, C and D are correct and A and E are wrong

10. Processes from osteoblasts are called **[MP PMT 2000]**

(a) Dendrites (b) Lamellae
(c) Canaliculi (d) Haversian canals

11. The major protein of the connective tissues is **[DPMT 1993; AIIMS 2001]**

(a) Keratin (b) Collagen
(c) Melanin (d) Myosin

12. The colour in the brown fat is due to

(a) Its larger capacity for generating heat
(b) Large number of mitochondria present
(c) A high concentration of iron containing cytochrome pigments
(d) Presence of chromatophores

13. Choose the correctly matched pair **[CBSE PMT 2014]**
(a) Tubular parts of nephrons-Cuboidal epithelium
(b) Inner surface of bronchioles-Squamous epithelium
(c) Inner lining of salivary ducts-Ciliated epithelium
(d) Moist surface of buccal cavity-Glandular epithelium

14. The protein whose removal enables myosin to bind actin in smooth muscle is **[J & K CET 2012]**
(a) Tropomyosin (b) Caldesmon
(c) Myosin light chain kinase (d) Calmodulin

15. Which pathway is correct for blood clotting **[NCERT]**
(a) Thromboplastin or Thrombokinase → Prothrombin $\xrightarrow{Ca^{+2}}$ Thrombin → Fibrinogen → Fibrin + dead and damaged formed elements → Clot
(b) Thromboplastin or Thrombokinase → Thrombin → Prothrombin $\xrightarrow{Ca^{+2}}$ Fibrin → Fibrinogen + dead and damaged formed elements → Clot
(c) Thromboplastin or Thrombokinase → Fibrinogen → Fibrin → Thrombin $\xrightarrow{Ca^{+2}}$ Prothrombin → Thrombin → Clot + dead and damaged formed elements
(d) Thromboplastin or Thrombokinase (from injured platelets / tissues) → Prothrombin $\xrightarrow{Ca^{+2}}$ Thrombin → Fibrinogen → Fibrin → Clot + dead and damaged formed elements ← Fibrin

16. Match the following

'A'	'B'
A. Barr body	1. Gives a grey colour to the cell body
B. Purkinje cells	2. Conduction muscles of heart
C. Nissl bodies	3. Present in neurilemma
D. Schwann cell	4. Certain neurons having flask shaped cytons
E. Purkinje fibres	5. Found in cytons of female

The correct pairing is
(a) 5, 4, 1, 3, 2 (b) 3, 2, 5, 1, 4
(c) 5, 2, 1, 3, 4 (d) 4, 3, 2, 5, 1

17. Progressive degeneration of skeletal muscle, mostly due to genetic disorder occurs in **[Kerala PMT 2010]**
(a) Myasthenia gravis (b) Muscular dystrophy
(c) Tetany (d) Osteoporosis
(e) Arthritis

18. Polymorphonuclear leucocytes are **[CBSE PMT 1993]**
(a) Monocytes (b) Lymphocytes
(c) Granulocytes (d) Agranulocytes

19. Hyaline cartilage does not have **[DUMET 2010]**
(a) Fibres (b) Lacunae
(c) Cells (d) Blood capillaries

20. In human embryo, main haemopoietic tissue is **[CPMT 1993]**
(a) Spleen (b) Liver
(c) Bone marrow (d) Kidney

21. Platelets release during blood clotting is **[EAMCET 1998]**
(a) Thrombin (b) Prothrombin
(c) Thrombokinase (d) Fibrinogen

22. Lymph contains
(a) Only leucocytes
(b) 99% lymphocytes, no RBCs and other leucocytes
(c) 50% leucocytes and 50% erythrocytes
(d) 99% erythrocytes and 1% small lymphocytes

23. Bundles of striated muscle fibres called fasciculi are enclosed by a sheath called
(a) Epimysium (b) Endomysium
(c) Perimysium (d) Peritoneum

24. The value of resting membrane potential is **[DPMT 1993; Kerala PMT 2006]**
(a) $-90mV$ (b) $-100mV$
(c) $+100mV$ (d) $+90mV$

25. The triceps and biceps muscles are of
(a) Antagonist type (b) Involuntary type
(c) Smooth type (d) Sphincter type

26. Poisons like cyanide inhibit Na^+ efflux and K^+ influx during cellular transport. This inhibitory effect is reversed by an injection of ATP. This demonstrates that **[CBSE PMT 1994]**
(a) ATP is the carrier protein in the transport system
(b) $Na^+ - K^+$ exchange pump operates in the cell
(c) ATP is hydrolysed by ATPase to release energy
(d) Energy for $Na^+ - K^+$ exchange pump comes from ATP

27. Actin binding sites are located on **[Kerala PMT 2011]**
(a) Troponin
(b) Tropomyosin
(c) Meromyosin
(d) Both tropomyosine and meromyosin
(e) Both troponin and tropomyosin

28. Lack of relaxation between successive stimuli in sustained muscle contraction is known as **[NEET (Phase-I) 2016]**
(a) Spasm (b) Fatigue
(c) Tetanus (d) Tonus

29. Which type of tissue correctly matches with its location **[NEET (Phase-I) 2016]**

Tissue	Location
(a) Smooth muscle	Wall of intestine
(b) Areolar tissue	Tendons
(c) Transitional epithelium	Tip nose
(d) Cuboidal epithelium	Lining of Stomach

A R Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
(c) If the assertion is true but the reason is false
(d) If both the assertion and reason are false
(e) If the assertion is false but reason is true

1. Assertion : Total count of RBC comes out to be very low in polycythemia.
Reason : Number of erythrocytes get reduced in the condition of polycythemia.

2. Assertion : Haemoglobin is said to be a conjugated protein.
Reason : It is composed of a protein called haem and a non protein iron porphyrin complex called globin.

3. Assertion : Histamine is involved in allergic and inflammatory reactions.
Reason : Histamine is a vasodilator **[AIIMS 2002]**

4. Assertion : Chilling of blood decreases coagulation time.
Reason : Cold depresses the action of coagulation promoting enzymes.

5. Assertion : Thrombin is necessary to initiate blood coagulation.
Reason : Thrombin helps in the formation of thromboplastins.

6. Assertion : Mast cells in the human body release excessive amounts of inflammatory chemicals which cause allergic reactions.
Reason : Allergens in the environment on reaching human body stimulate mast cells in certain individuals. **[AIIMS 2003, 07]**

7. Assertion : The regulation of RBC production is accomplished by FSH.
Reason : Erythropoietin, hormone circulates to red bone marrow where it increases stem cell mitosis and speed up development of RBCs. **[AIIMS 2002]**

8. Assertion : Muscle cells are also called myofibrils.
Reason : Muscle cells are very thin and elongated.

9. Assertion : Thigh muscles can get tired but not the muscles of ventricle of heart.
Reason : Muscles of thigh are voluntary whereas that of heart are involuntary muscles.

10. Assertion : WBCs accumulate at site of wounds by diapedesis.
Reason : It is squeezing of leucocytes from endothelium. **[AIIMS 2002]**

11. Assertion : Non-striated muscles are said to be voluntary in nature.
Reason : Non-striated muscles can be moved according to will.

12. Assertion : Intercalated discs are important regions of cardiac muscle cells.
Reason : Intercalated discs function as boosters for muscle contraction waves.

13. Assertion : Presence of connective tissue inside the brain is essential for conduction of nerve impulse.
Reason : Connective tissue hold together the nerve cells of brain.

14. Assertion : Histamine is related with allergic and inflammatory reactions.
Reason : Histamine is a vasodilator.

15. Assertion : Non-myelinated nerve fibres do not possess nodes of Ranvier.
Reason : This is due to the absence of nissl's bodies in node of Ranvier.

16. Assertion : Specialization of cells is advantageous for the organism.
Reason : It increase the operational efficiency of an organism. **[AIIMS 2002]**

17. Assertion : Cartilage (protein matrix) and bone (calcium matrix) are rigid connective tissue.
Reason : Blood is connective tissue in which plasma is the matrix. **[AIIMS 2001, 13]**

18. Assertion : Materials can not be exchanged between epithelial cells.
Reason : Blood vessels are absent in epithelial tissue.

19. Assertion : The cells of columnar epithelium in absorptive surfaces often bears microvilli on their free ends.
Reason : Microvilli on their free ends.

20. Assertion : Fatigue is the inability of a muscle to relax.
Reason : It is due to lactic acid accumulation by repeated contraction. **[AIIMS 1998]**

21. Assertion : Fibroblasts help in protection.
Reason : Fibroblasts synthesize two kinds of protein which are protective in nature.

22. Assertion : Bones possess longitudinal canals called lacunae.
Reason : Lacunae carry blood vessels & nerves to the bones.

23. Assertion : Deposits of protein keratin are present in deeper layers of stratified keratinised squamous epithelium.
Reason : Keratin makes this epithelium impervious to water.

24. Assertion : Extracellular materials are important for cells.
Reason : Intercellular materials surround the cells & bind them together.

25. Assertion : Simple epithelium covers surfaces exposed to mechanical or chemical abrasions.
Reason : Protection of underlying tissues is the major function of simple epithelium.

26. Assertion : Tendon is present in all bone joints.
Reason : Tendon connects the bones at the joints & hold them in position.

27. Assertion : Urinary bladder can considerably expand to accommodate urine.
Reason : It is lined by stretchable squamous epithelium.

28. Assertion : Granulocytes are white blood cells.
Reason : They contain lobed nuclei and tiny granules. **[AIIMS 2010]**

29. Assertion : Columnar epithelium lining the intestinal mucosa appears to have a brush like appearance.
Reason : A large number of microvilli are present on brush bordered columnar epithelium.

30. Assertion : The regulation of *RBC* production is accompanied by the kidneys.
Reason : Erythropoietin hormone circulates to the red bone marrow, where it increases stem cell mitosis and speeds up the development of *RBCs*. **[AIIMS 2009]**

Answers

Epithelial tissue

1	a	2	b	3	d	4	d	5	c
6	a	7	c	8	a	9	b	10	a
11	a	12	b	13	c	14	d	15	d
16	b	17	a	18	c	19	b	20	a
21	a	22	a	23	c	24	a	25	d
26	a	27	a	28	c	29	b	30	d
31	b	32	d	33	c	34	e	35	d
36	c	37	a	38	c	39	b	40	b
41	d	42	a						

Connective tissue

1	b	2	b	3	d	4	d	5	c
6	a	7	d	8	c	9	a	10	d
11	d	12	a	13	b	14	c	15	d
16	d	17	a	18	d	19	a	20	d
21	a	22	a	23	c	24	d	25	c
26	d	27	d	28	a	29	b	30	a
31	c	32	c	33	b	34	a	35	c
36	c	37	d	38	a	39	d	40	c
41	b	42	c	43	a	44	b	45	d

Skeletal tissue

1	c	2	b	3	b	4	b	5	a
6	b	7	a	8	c	9	a	10	d
11	b	12	d	13	c	14	b	15	a
16	a	17	b	18	d	19	a	20	d
21	b	22	b	23	b	24	c		

Vascular tissue

1	c	2	c	3	a	4	a	5	b
6	c	7	d	8	b	9	b	10	d
11	c	12	b	13	b	14	a	15	b
16	a	17	c	18	a	19	a	20	c
21	d	22	d	23	c	24	a	25	b
26	b	27	b	28	c	29	c	30	a
31	b	32	a	33	c	34	b	35	c
36	c	37	c	38	a	39	c	40	a
41	a	42	c	43	a	44	a	45	b
46	a	47	c	48	c	49	b	50	c
51	d	52	b	53	a	54	c	55	c
56	b	57	a	58	b	59	b	60	b
61	d	62	a	63	b	64	c	65	a
66	d	67	b	68	b	69	b	70	b
71	b	72	b	73	c	74	a	75	d
76	a	77	b	78	b	79	b	80	c
81	b	82	a	83	c	84	c	85	b
86	a	87	a	88	a	89	c	90	a
91	c	92	b	93	c	94	b	95	b
96	a	97	d	98	c	99	a	100	a
101	c	102	b	103	b	104	c	105	b
106	d	107	a	108	c	109	c	110	a
111	c	112	b	113	b	114	b	115	a
116	a	117	a	118	a	119	a	120	b
121	a	122	c						

Muscular tissue

1	c	2	c	3	c	4	b	5	c
6	c	7	b	8	b	9	c	10	d
11	d	12	a	13	c	14	b	15	b
16	a	17	a	18	c	19	d	20	b
21	b	22	a	23	c	24	c	25	b
26	c	27	c	28	c	29	a	30	a
31	a	32	a	33	d	34	c	35	b

36	a	37	e	38	b	39	b	40	a
41	d	42	a	43	b	44	a	45	d
46	a	47	d	48	a	49	d	50	a

Nervous tissue

1	d	2	d	3	a	4	c	5	a
6	d	7	b	8	a	9	a	10	d
11	d	12	b	13	a	14	c	15	b
16	c	17	d	18	b	19	b	20	c
21	b	22	d	23	b	24	d	25	a
26	a	27	a	28	a	29	d		

NCERT Exemplar Questions

1	c	2	b	3	d	4	c	5	b
6	a	7	b	8	d				

Critical Thinking Question

1	a	2	c	3	d	4	b	5	a
6	c	7	d	8	d	9	e	10	c
11	b	12	c	13	a	14	b	15	d
16	a	17	b	18	c	19	a	20	b
21	c	22	b	23	c	24	a	25	a
26	a	27	c	28	c	29	a		

Assertion and Reason

1	d	2	c	3	a	4	e	5	c
6	a	7	e	8	e	9	b	10	b
11	d	12	a	13	d	14	a	15	c
16	a	17	b	18	e	19	a	20	e
21	a	22	d	23	e	24	a	25	d
26	d	27	c	28	b	29	a	30	a

AS Answers and Solutions

Epithelial tissue

9. (b) Villi of intestine provide a velvety appearance and greatly increase the absorptive surface.

10. (a) Specialized cuboidal cells capable of producing gametes are found in gonads. Germinal epithelium produces gametes e.g., ova (female gamete) and sperm (male gamete).

11. (a) It is the mucous membrane of nasal passage.

12. (b) The ciliated epithelium in trachea, is infact pseudostratified ciliated epithelium having long ciliated columnar cells and short cuboidal cells.

13. (c) Cells of squamous epithelium are flattened scale like and attached to each other like a mosaic.

15. (d) Stratified squamous epithelium occurs at surfaces subject to abrasion but protected from drying. Thus it forms the cornea of eyes, inner surfaces of eye lid, and the lining of buccal cavity, lower part of pharynx, oesophagus, vagina and vestibule of nasal cavities.

16. (b) Epithelial tissues have a widespread distribution throughout the body and serve several important functions such as protection, secretion, sensation and absorption.

17. (a) Cells of simple epithelial tissue are arranged in a single layer.

18. (c) The outer most layer in epidermis of skin consist of keratinized stratified squamous epithelium cells. These cells slowly become dead, non nucleated and water proof.

21. (a) Cells of epithelium are set very close to each other, neighbouring cells are held together by cell junctions or desmosomes.

22. (a) In apocrine glands, secretory products accumulate at the apical margin. It pinches off from rest of the cell. The cell repairs the lost part, e.g., mammary gland.

23. (c) On the basis of mode of secretion pancreas, salivary gland and goblet cells are type of merocrine. In which secretion diffuses out through the cell surface.

26. (a) The cell of Germinal epithelium is cuboidal, which are capable of producing gametes.

27. (a) Epithelial tissue has great regeneration power because when epithelia are injured they regenerate more rapidly than other tissues and thus facilitate rapid healing of wounds.

28. (c) Ciliated columnar epithelium lines bronchioles and fallopian tubes.

29. (b) The skin epidermis of vertebrate animals is consist of keratinizing squamous epithelium in which cells of upper layer are dead with insoluble dead fibrous keratin protein.

35. (d) Epithelia regenerate more rapidly than other tissues when injured.

37. (a) Keratinised epithelium protects the underlying tissues from mechanical injury.

39. (b) Simple columnar epithelium lines the stomach, the small and large intestines, the digestive glands and the gall bladder.

41. (d) Following embryonic layers give rise to

Ectoderm	–	Epidermis
Mesoderm	–	Mesothelium
Endoderm	–	Epithelium of alimentary canal

42. (a) Intestinal epithelium is glandular in nature and secretory in function.

Connective tissue

1. (b) Each liver lobe is formed of hexagonal lobules surrounded by a connective tissue sheath called Glisson's capsule.

4. (d) Mast cells occur in connective tissue proper, these are modified basophils of blood. Mast cells secrete heparin, histamine and serotonin.

7. (d) Areolar tissue fixes skin to underlying muscles or joins integument with muscles.

8. (c) Ligaments are yellow elastic fibrous connective tissue while tendons are white collagen fibrous connective tissue.

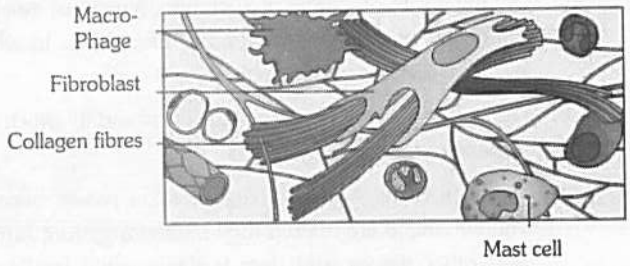
9. (a) Collagen fibres are white formed of a protein, occur in bundles, thick nonelastic with great tensile strength.

10. (d) Adipose tissue is a specialized loose connective tissue in which the fibroblast are modified for fat storage. Prominent adipose tissue sites are subcutaneous fat (panniculus adiposus), blubber of whales and hump of camel.

13. (b) Because adipose tissue takes part in the storage of fat which has the highest calorific value.

15. (d) Three types of fibres collagen, elastic and reticular are found in connective tissue. Each fibre consist of collagen, elastin and reticulin respectively.

17. (a) Correct labelling as follows



18. (d) Areolar tissue contains fibroblast, macrophages mast cells, plasma cells, lymphocytes and adipose cells etc.

19. (a) Histiocyte is a phagocytic cell which is found in loose connective tissue.

23. (c) Adipose tissue may be distinguished into two separate morphological type. White or unilocular fat and brown or multilocular fat.

27. (d) Albumin is a globular protein.

31. (c) Adipocyte are fat cells, which are derived from fibroblast. These adipocyte are found in connective tissue.

33. (b) Ligament is a modified yellow elastic fibrous tissue which occur in the form of cords and binds a bone cartilage with another bone cartilage. It contains white fibres alongwith yellow fibres.

34. (a) Areolar and adipose tissue are loose connective tissue while tendon is dense connective tissue. Cartilage is specialized connective tissue.

36. (c) Macrophages engulf the invading microbes and destroy them.

39. (d) It is albuminous protein which on boiling in water, changes into gelatin.

40. (c) As it has a large matrix with almost all types of cells and fibres.

Skeletal tissue

1. (c) Mammalian bone is characterized by the presence of haversian system or osteon. Osteon is a basic structural unit of mammalian bone consisting of the haversian canal, lamellae and lacunae.

3. (b) The presence of haversian system is a typical character of mammalian bone.

4. (b) Bone is also a metabolically dynamic tissue which functions as a homeostatic reservoir of ions of calcium, magnesium, phosphorous etc. About 97% of total calcium of body occurs in the endoskeleton.

5. (a) Hyaline cartilage forms part of larynx, sternum, tracheal rings and nasal cartilages. Hyaline cartilage is the most abundant kind of cartilage with no fibres and transparent matrix. It is found upon articular surfaces at joints of long bones from articular cartilage, coastal cartilages at the ventral ends of the ribs. It helps to form the nose, larynx, trachea, bronchi and bronchial tubes leading to the lungs.

Fibrocartilage (fibrous cartilage) carries thick dense bundles of white collagen fibres in matrix. They are the strongest cartilage. They occur in joints between vertebrae and also pubic symphysis.

Tendon is a very dense, strong fibrous connective tissue made of collagen fibres. Tendon connects a skeletal muscle to a bone.

7. (a) It is originally hyaline but later become calcified due to deposition of calcium salts in the matrix.

8. (c) It has thick collagen fibres which provide strength, rigidity and firmness.

9. (a) The chondrocytes secrete the flexible matrix called chondrin.

10. (d) Cartilage is a type of connective tissue which is present in human external ears and in the nose tip.

11. (b) Bone is surrounded by dense, white fibrous sheath called periosteum.

13. (c) The cells of mature cartilage called chondrocytes, occurs singly or in groups within spaces called lacunae. The chondrocytes secretes the flexible matrix called chondrin.

14. (b) Haversian canals are interconnected by transverse canals known as volkmann's canals.

15. (a) The major component of vertebrate bone is calcium phosphate. Other components include calcium carbonate, magnesium phosphate and sodium chloride.

16. (a) Tendon is white fibrous connective tissue which attaches muscle to bone.

17. (b) Intervertebral disc is a white fibrous cartilage.

18. (d) In adult, red bone marrow (myleiod tissue) is responsible for producing red blood cells, granular leucocytes and platelets.

21. (b) If a bone is kept in dilute acid (*HCl*) for few days, it becomes soft and flexible. This is called decalcification of the bone.

Vascular tissue

2. (c) The life span of biconcave RBCs in man is 120 days whereas in frog (biconvex RBCs or oval) is 100 days and in rabbit is 80 days.

3. (a) Term leukopenia is applied when, decrease of the number of white blood cells below 5,000 per cubic milimeter.

7. (d) Red bone marrow of long bone produces red blood corpuscles, white blood corpuscles and platelets.

8. (b) Camel has oval and nucleated RBCs.

10. (d) Lymph can be defined as blood minus RBCs but more WBCs.

15. (b) Because R.B.Cs. are isotonic to normal saline solution (0.8%*NaCl*).

17. (c) Amphibian RBCs are largest amongst the vertebrates. Those of Amphiuma and Proteus are largest amongst amphibians about 82μm.
Mammals have smallest RBC's amongst the vertebrates. Those of Musk deer are smallest amongst mammals.

18. (a) Sodium oxalate, sodium citrate and EDTA (Ethylene diamine tetra acetic acid) are used as anticoagulants in blood banks as these bind Ca^{++} so these are called chelating agent.

21. (d) Neutrophils, macrophages and lymphocytes protect the body against foreign microbes by phagocytosis and producing antibodies.

22. (d) Haemoglobin is an iron containing respiratory pigment occuring in vertebrate red blood cells and plasma of some invertebrate.

23. (c) Radioactive strontium–90 is very much similar to calcium in its chemical behaviour, so it gets deposited in the bone in place of calcium and then damage bone, bone marrow and other organs by continuously throwing out radiations and may also cause tumours and lead to bone cancer.

26. (b) Blood is a fluid connective tissue, which consist of blood corpuscles (RBCs, WBCs and Platelets) and plasma.

27. (b) Because of low oxygen demand.

34. (b) Reticulocyte stage is one phase of development of RBCs in which RBCs becomes immature.

35. (c) Phagocytosis, the process of engulfing of object (living or dead) by another organism was first discovered by *Metchnikoff*. He also gave the term phagocytosis.

36. (c) Iron containing pigment haemoglobin is present in *RBC*.

38. (a) Neutrophils are about 62% of the total number of white cells so most abundant sub type.

39. (c) Monocytes are the largest corpuscles and phagocytic.

40. (a) Liver produces an anticoagulant, hetero-polysaccharide called heparin which prevent clotting inside the blood vessels.

41. (a) Antibodies are produced by a sub population of white blood cells in the immune system called lymphocyte.

43. (a) Agranulocytes are leucocytes that lack granules in the cytoplasm. Since lymphocyte does not have granules in their cytoplasm, so it is called agranulocyte.

44. (a) The life span of the granulocytes once released from the bone marrow is normally 4-8 hours circulating in the blood and another 4 to 5 days in the tissue. The monocyte also have a short life span of 10 to 20 hours. The lymphocytes have life spans of few days or months or even years, but this depends on the body's need for these cells.

45. (b) Monocytes and lymphocytes are agranulocytes.

46. (a) Protein buffers in blood include haemoglobin and plasma proteins. Buffering is done by the imidazole group of the histidine residues. Haemoglobin is quantitatively about 6 times more important than the plasma proteins as it is present in about twice the concentration and contains about 3 times the number of histidine residues per molecule.

48. (c) The chief difference between RBCs of human and frog is that the human RBCs are without nucleus and therefore is not a complete cell. However the absence of nucleus in mammals increases respiratory efficiency of RBCs.

52. (b) Lymphocytes are non-phagocytic. They secrete antibodies to destroy microbes & their toxins, reject grafts & kill tumor cells.

54. (c) Serum is watery fluid left after the clotting of blood. Fibrinogen and corpuscles are absent in serum.

59. (b) Antiserum contains antibodies for a specific antigen. This may be of human or animal origin.

61. (d) Because the conversion of prothrombin to thrombin depends on the action of thromboplastin and calcium.

64. (c) We know that lymph glands are also called lymph node. They are composed of lymphatic tissue and give rise to special white blood cells and antibodies. They act as a defence barrier against the spread of infection by engulfing bacteria and other foreign materials from the lymph. They are not concerned with the formation of RBC.

67. (b) Because there is no antibodies found in serum.

72. (b) During blood coagulation, the intrinsic factor – X activator complex is formed by Activated Christmas Factor (IX) + Antihaemophilic Globulin (AHG) + Phospholipid + Ca^{2+}.

76. (a) People going to hilly areas will have polycythemia (more number of RBC in blood) after six months and their Hb has a lower binding affinity to O_2.

79. (b) Heparin is normally secreted by the mast cells of liver.

81. (b) The most important factor controlling the rate of red cell production in the oxygen content of the arterial blood, a decrease in oxygen content stimulates erythropoeisis.

83. (c) Eosinophil is a type of white blood cell that has a granular cytoplasm. Its function involves the regulation of allergic responses and it also produces an enzyme capable of destroying parasites.

84. (c) The total number of WBC in $1ml$ is 8000 and number of RBC is 5 millions in $1ml$

87. (a) pH of blood is 7.4 which is slightly alkaline.

90. (a) Thrombus is a clot formed inside the blood vessels. Thrombus is formed due to slowing of circulation and damage of the vascular endothelium.

91. (c) When air with low oxygen tension (anaemia) is breathed for some length of time, the cell count rises due to liberation of erythropoietin or haemopoietin or erythrocyte stimulating factor (ESF).

94. (b) pH of plasma is 7.4 which is slightly alkaline.

98. (c) Yellow substance oozing out of wound is in fact pus which consists of WBC, lymph and dead cells.

104. (c) RBC absorbs O_2 to form oxyhaemoglobin.

106. (d) Since at high altitudes partial pressure of oxygen in air is less, so to facilitate the rapid gaseous exchange; heart rate, respiratory rate, vital capacity, total lung capacity, RBC count and haemoglobin percentage of persons living there increases.

107. (a) Blood corpuscle counting is done by this instrument.

108. (c) Potassium and sodium citrate remove the calcium ions from blood plasma.

121. (a) Fibrinogen is a plasma protein involved in clotting of blood.

122. (a) Though, except metabolism rest three options are correct. Yet only statement D is related to their function

Muscular tissue

1. (c) Ca^{++} is a essential element for the contraction of muscles because release of Ca^{++} ions from sarcoplasmic reticulum trigger the muscle contraction process.

2. (c) Troponin is a protein which is found on Actin filament and myosin protein is found in myosin filament. Both Actin and Myosin are complex proteins in striated muscles.

3. (c) Involuntary action of striated muscles yield some heat to warm the body.

4. (b) Unstriped muscles are the most widely distributed muscles in the body, e.g., Gastrointestinal tract, uterus, Urinary bladder, iris, ciliary body, blood vesseles etc.

5. (c) Cardiac muscles have a mixture of properties of both striated and unstriated muscles. These muscles continue rhythmic contraction throughout life under the control of ANS.

7. (b) The plasma membrane covering the muscle fibre is called sarcolemma.

8. (b) Sliding filament theory tells that actin slides over myosin during contraction where the length of I-band and sarcomere reduces but no change in length of any filament.

9. (c) Myocardial layer contains cardiac muscles.

10. (d) Sliding filament theory of muscle contraction was given by H.E. Huxley and A.F. Huxley.

14. (b) A striped muscle fibre has many nuclei and it is a syncytium (coenocyte).

16. (a) The sarcoplasm also contains a protein pigment myoglobin, which can take up store or give up oxygen like haemoglobin.

18. (c) Cardiac muscles can contract without the stimulation of nerves and they contract rhythmically.

21. (b) Because there are about 639 muscles which constitutes the bulk of body, 40% of total weight and 50% of soft parts.

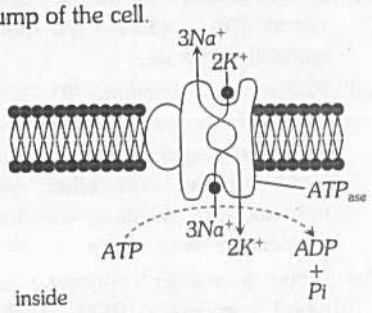
23. (c) Due to long refractory period.

25. (b) Striated muscles (voluntary muscles) are mostly attached to bones through tendons. The muscles are most abundant in limbs.

26. (c) Ciliary muscles by their contraction exerts tension over the zonule, the ligament which suspends the lens and stretch or relax the lens capsule. The lens has elasticity and hence change of tension on it changes the focal length of lens.

27. (c) During active work, the rate of oxygen supply by the lungs falls short of requirement of the muscles. Hence, lactic acid accumulates in the muscles and the breathing gradually becomes hard to enhance O_2 intake by the lungs. This is called oxygen debt.

29. (a) Energy from ATP cause conformational change in the solute carrier complex. From energy of one ATP, 3 Na^+ are pumped outside and two K^+ are taken in. This process of expelling out Na^+ *ions* and drawing in K^+ *ions* against the concentration gradient and electrochemical gradient is called sodium-potassium exchange pump of the cell.



This pump operates by involving the $Na^+ - K^+ -$ ATPase enzyme located in the cell membrane. Such electrogenic pump develops positive charge outside the membrane and negative charge to cell's interior. This difference in charge on either side of the membrane of a resting neuron is the resting membrane potential.

31. (a) One thin filament probably contains 300-400 actin molecules about 50 tropomyosin and 50 troponin. It is said that tropomyosin plays a vital role in sensitizing the contractile proteins (actin and myosin) to calcium ions.

35. (b) Actin and myosin are related with muscle contraction. In muscle contraction, overlapping of actin and myosin molecules interact to form actomyosin complex.

36. (a) Muscles have their own oxygen-carrying iron-protein pigment myoglobin or muscle haemoglobin.

38. (b) The distance between two *Z*-lines is called as sarcomere which is a functional unit of the muscle. Each sarcomere includes one complete A-band and 2 halves I-bands on the sides $(I/2+A+I/2)$.

39. (b) Increase in the size of an organ because of enlarged cells is called hypertrophy.

41. (d) Gluteus maximus is the largest muscle. It is present in the buttock and extends and rotates the thigh laterally.

43. (b) The immediate energy source for muscle contraction is ATP which is present only in small quantities at any given time in the muscle.

48. (a) During muscle contraction, ATP undergoes hydrolysis in the presence of water and myosin ATP are to form ADP + Pi and liberation of energy.

50. (a) Cardiac muscles form the walls of heart. These are intermediate in structure being striated and involuntary. It is meant for automatic and rhythmic contraction. On the other hand skeletal muscles are striated and voluntary, they are most abundant and found attached to skeleton. They are supplied by somatic nerve and hence are under voluntary control.

Nervous tissue

1. (d) Multipolar neurons have several dendrites and one axon. Most neurons in the brain and spinal cord of our body are of this type.

3. (a) Schwann cells are specialised glial cells that form the myelin sheath that coats axons. In peripheral nerve fibre the myelin sheath is interrupted at regular intervals; these interruptions constitute the node of Ranvier.

4. (c) Neurons are structural and functional units of nerve tissue. Their number is quite high, more than 1×10^{12} in brain alone.

7. (b) Nervous tissue consists of cells having a well developed power of irritability and conductivity, forms nervous system.

8. (a) The whole nervous system originates from the ectoderm.

10. (d) Nerve fibres are extended axons or dendrites. Dendrites carry nerve impulses toward the cell body and axon away from it.

13. (a) Neurons are of two types on the basis of axon length, Golgi type-I and Golgi type-II. In Golgi type-I, neuron possess very long axons.

15. (b) Two type of brain cells are found : The neuron and neuroglia. Neurons are functional typical nerve cells which generate and conduct impulses. Due to high degree of specialization the neuron lose their ability to divide. The neuroglia are with ability of division.

16. (c) Non-excitable, supporting components of the nervous tissue include neuroglial cells and schwann's cells.

18. (b) Myelin sheath is a layer covering of vertebrates nerve fibre.

19. (b) Schwann's cell secrete a segment of myelinated fibre called internode.

22. (d) Nissl granules or Nissl bodies are basophilic structure of various shapes-angular, conical or rhomboidal. They are pieces of granular endoplasmic reticulum with or without free polyribosomes. They are found in cytons.

23. (b) Because dendrite receives the impulse for neuron.

28. (a) If a nerve impulse was initiated somewhere in the middle of a nerve fibre, it would proceed to both ends. However, in the synapse, the propagation is strictly one-way from the axon to the dendrite never the reverse.

Critical Thinking Questions

4. (b) Inner lining of cheeks have compound stratified squamous epithelium.

6. (c) Epidermis has several distinct layers of epithelial cells. The innermost layer called stratum germinativum has columnar cells resting upon a common basement membrane.

10. (c) Canaliculi are the protoplasmic processes between osteocytes.

11. (b) Connective tissues function in binding together and constitute the framework of many organs. Collagen is a protein of connective tissue that combine to form the tendons and ligaments.

12. (c) Brown fat contains fat cells with several small fat globules. Brown colour is due to iron-containing cytochrome pigment in fat.

13. (a) Moist surface of buccal cavity – Stratified non-keratinised squamous epithelium

Inner surface of bronchioles – Ciliated epithelium

Inner lining of salivary ducts – Cuboidal epithelium.

18. (c) Nucleus of granulocytes is irregular and divided into 2-5 interconnected lobes. Hence these are also called polymorphonuclear leucocytes.

20. (b) Main haemopoietic organ in embryonic stage is liver. Other haemopoietic organ during foetal life – yolk sac, spleen, lymphnodes, red bone marrow.

21. (c) During blood clotting injured tissue or platelets release a lipoprotein factor called thromboplastin. Thromboplastin helps in the formation of the enzyme thrombokinase.

22. (b) Lymph has no RBCs but about 99% are lymphocytes usually of the small type, the remaining 1% is made up of leucocytes.

23. (c) All fasciculi of a muscle are bound together by a connective tissue termed perimycium which also forms a sheath around each fascicule.

24. (a) Each resting cell is in a polarized across its membrane called resting membrane potential. This potential averages – 70 *mv* (– 60 to – 90 *mv*) on inner side of the membrane in respect to its outer side.

25. (a) Biceps and triceps work as antagonistic muscles at elbow. Contraction of biceps and relaxation of triceps causes flexion of arm. Similarly, contraction of triceps causes extension of arm at elbow.

Assertion and Reason

1. (d) Total count of RBC refers to the total number of red blood corpuscles (erythrocytes) present in one microlitre of the blood. It average 5 million and 4.5 million in adult man and woman respectively. Total count of RBC comes out to be very low in condition of anaemia and after profuse bleeding. On the contrary, polycythemia is the condition which arises due to the abnormal rise in the total count of RBC.

2. (c) Conjugated proteins are the proteins which are formed by the binding of a simple protein with a non-protein prosthetic group. Conjugated chromoproteins are the pigment protein complexes. Haemoglobin is one such conjugated chromoprotein. It is composed of a simple protein called "globin" and non protein iron (Fe^{2+}) porphyrin complex called "heme". 100 ml of blood contains about 15g of haemoglobin. Four Fe^{2+} ions of heme can loosely bound to upto four molecules of oxygen, thus enabling haemoglobin to carry oxygen.

3. (a) Histamine is a derivative of the amino acid histidine produced by damaged cells of vertebrates. When released, it has the effect of dilating capillaries and lowering blood pressure. Histamine is involved in allergic and inflammatory reactions.

4. (e) Treating the blood to low temperatures (chilling) decreases the activity of coagulation promoting enzymes. So, at low temperatures it will take more time for the blood to clot i.e. the coagulation of blood gets delayed. Thus chilling of blood increases the coagulation time (time taken for the blood to coagulate) and not decrease it.

5. (c) Blood coagulation is brought about by the hydrolysis of soluble protein fibrinogen to insoluble fibrin. This reaction is catalysed by the enzyme thrombin. Thrombin occurs in normal blood as an inactive globulin called prothrombin which is activated to thrombin by the action of another enzyme called prothrombinase before blood coagulation starts. Thromboplastins are the coagulation promoting substances released from clumped platelets and damaged tissue, which helps in the formation of the enzyme prothrombinase.

6. (a) The symptoms of an allergic reaction develop in response to histamine. Mast cells release a large amount of histamine into the blood stream and it also act as initiator of the inflammatory response which aids the arival of leucocytes at a site of infection. Histamine stimulates capillary dilation, increased capillary permeability, closure of bronchial tubes, mucus secretion, pain and swelling.

7. (e) Regulation of RBCs production is accomplished by hormone erythropoietin which is secreted by kidney. This hormone increases stem cell mitosis and speed up RBC's development in red bone marrow.

8. (e) Since muscle cells are very thin and elongated, therefore, they are also called as muscle fibres and not myofibril. Myofibril is the unit of a striated muscle fibre. A striated muscle fibre is composed of many myofibirils arranged along the long axis of the fibre. A myofibril is of two types of myofilaments-actin filaments and myosin filaments. Sliding of these myofilaments over one another cause the contraction and relaxation of the muscle fibre.

9. (b) The thigh muscles are the striated muscles which soon get fatigued due to overwork. These muscles show fast contractions and then tire immediately due to accumulation of lactic acid. The muscles of heart wall are the cardiac muscles which are unfatiguable and show rhythmic and automatic contractions. They have specialised regions of the cell membranes which function as boosters for muscle contraction waves. Thigh muscles are called voluntary muscles because they can be moved at the will of organism whereas heart muscles can't be moved at one's will and therefore are involuntary.

10. (b) In wounds, germs are removed by WBCs accumulation at wound site by diapedesis. It is squeezing of leucocytes out from endothelium of capillaries to fight external agent.

11. (d) Non striated or smooth muscles are said to be involuntary in nature because they do not contract or relax according to our will. Those muscles which can be moved according to will of the organism are called voluntary muscles. Striated or skeletal muscles are said to be voluntary in nature as they can be contracted or relaxed voluntarily.

12. (a) Cardiac muscle cells are short cylindrical cells joined end to end and by side branching to form a network. Intercalated discs are the dense junctions formed in between the cardiac muscle cells where they meet each other. Intercalated discs are the specialised regions of the cell membranes. As cardiac muscle possesses considerable rhythmicity and generates its own wave of excitation, these discs function as boosters for muscle contraction wave.

13. (d) Ordinary connective tissue is absent inside the central nervous system. *i.e.* brain and spinal cord and has no function in the conduction of nerve impulse. The neurons of nerve tissue inside the brain and spinal cord are held together by supporting cells called neuroglia cells. Neuroglia cells resemble neurons and have long radiating processes but no nissl granules.

14. (a) Histamines are involved in allergic and inflammatory reactions. Histamines also dilate capillaries.

15. (c) Myelin sheath is a lipid rich insulating layer which covers some nerve fibres of nerve tissue. Such fibres are called myelinated or medullated nerve fibres. Each myelinated nerve fibre shows constrictions at regular intervals called nodes of Ranvier which results from interruption in the myelin sheath at those places. Non myelinated nerve fibres are not covered by any myelin sheath, consequently no nodes of Ranvier are present in them.

16. (a) Specialization of cells into tissue, organ and organ systems is advantageous for the organism. It increase the operational efficiency through division of labour which avoids duplication of work.

17. (b) Cartilage comprises of mucopolysacharide called chondroitin sulphate. Bone is a hard connective tissue. Blood is a fluid connective tissue.

18. (e) Though blood vessels are absent in epithelial tissues, exchanges of materials takes place in them. Materials are exchanged between epithelial cells and vessels of the connective tissues by diffusion across the basement membrane. Also through osmosis and filtration, epithelial tissues exchange materials (e.g. epithelial tissues of pulmonary vein, Bowman's capsule etc).

19. (a) The columnar epithelium bearing microvilli on their free ends give a brush-like appearance to these free border. Villus shaped microvilli greatly increase the area of the free surface of the cell and thereby enhance absorption. Lining of gall bladder, stomach, large intestine are the example of columnar epithelium.

20. (e) Fatigue is the inability of a muscle to contract. It is due to depletion of its chemicals and lactic acid accumulation by repeated contraction.

21. (a) Fibroblasts are the principal cells of areolar tissue. Fibroblasts synthesize two kinds of proteins-collagen and elastin. The tensile strength of collagen fibres and the elasticity fibres prevent displacement and injury of tissues and organs under mechanical stress. Collagen fibres are also laid down at sites of injury and help in tissue repair.

22. (d) Lacunae are actually the flat irregular spaces occurring in the solid matrix of bone. Each lacuna lodges a flat bone cell or osteocyte. Compact bone possesses many parallel, longitudinal column like structures called haversian systems, in which several concentric layers of bony matrix called lamellae encircle a longitudinal central canal called haversian canal. It is the Haversian canal, which carries blood vessels and nerves to the bone. Lacunae containing osteocytes occur in a layer between two lamellae.

23. (e) Keratinised stratified squamous epithelium is a compound epithelium which covers the dry surface of skin. It has many layers of epithelial cells. The deeper layers are formed by living polygonal cells but superficial layers constitute of horny, scale like remains of dead squamous cells. Heavy deposits of the insoluble protein keratin in the dead superficial cells make the epithelium impervious to water and highly resistant to mechanical abrasions.

24. (a) Extracellular materials (also called Intercellular materials) are very important for cells because they surround the individual cells, separate them from each other and bind them together. One or more types of specialized cells are set in specific extracellular materials to constitute a tissue. Nature and amount of extracellular material vary from tissue to tissue. In some tissues, it is limited to very thin layers whereas, in some it is quite vast and separates cells widely apart from one another.

25. (d) Simple epithelium doesn't cover surfaces exposed to mechanical or chemical abrasions, because it is made up of a single layer of cells, hence it is not effective in protecting the underlying tissue. Simple epithelium occurs mainly on secretory and absorptive surfaces. There is another types of epithelial tissue called compound epithelium which being multilayered is effective in providing protection to underlying tissues, hence covers the surfaces exposed to mechanical and chemical abrasions.

26. (d) It is not tendon but another type of connective tissue called ligament which is present in most of the bone joints and connect the bones together. Ligament also helps in holding the bones in position. Tendon, on the other hand, is a dense, strong, fibrous connective tissue which forms strong inextensible attachment of a skeletal muscle to a bone.

27. (c) Urinary bladder is not lined by squamous epithelium but by transitional epithelium which is a stretchable compound epithelium. It has a single layer of cuboidal cells at the base, 2-3 middle layers of large polygonal cells and a superficial layer of large, broad rectangular cells. Stretching considerably flattens and broadens the cells of superficial and middle layers, hence causing expansion of the urinary bladder.

28. (b) On the basis of presence of tiny granules and number of lobes in nucleus of their cytoplasm, white blood cells are divided into two groups

(i) Granulocytes Contain tiny granules and lobed nuclei in their cytoplasm.

(ii) Agranulocytes Have no cytoplasmic granules in their cytoplasm and their nuclei are also undivided.

29. (a) Columnar epithelium is a type of simple epithelium characterised by the presence of tall column like cells. Its major function is absorption or secretion. It covers the inner surface of the intestine, stomach and gall bladder. In the intestine it appears to have a brush like appearance on the free surface, which is due to the presence of large number of microvilli. Function of microvilli is to enhance absorption. Due to the presence of microvilli, the epithelium is also called as brush bordered columnar epithelium.

30. (a) The regulation of RBC production is accompanied by the hormone erythropoietin, which is secreted by the juxtaglomerular cells of kidney. This hormone circulates to the red bone marrow, where it increases stem cell mitosis and speeds the development of RBC.

Animal Tissues

SET Self Evaluation Test

1. Which one of the following is wrongly matched **[Kerala PMT 2009]**

(a) Myosin – Contractile protein
(b) Tendon – Connective tissue
(c) Smooth muscle – Involuntary muscle
(d) Red muscle – Myoglobin
(e) Troponin – Fibrous protein

2. Pseudostratified epithelium is always **[DPMT 1993]**

(a) Single layered (b) Double layered
(c) Multilayered (d) Uncertain

3. Find the wrongly matched pair **[Kerala PMT 2012]**

(a) Unicellular glandular cells – Goblet cell
(b) Saliva – Exocrine secretion
(c) Fusiform fibres – Smooth muscle
(d) Cartilage – Areolar tissue
(e) Intercalated discs – Cardiac tissue

4. The epithelial lining the alveoli of the frog's lungs facing lung cavity is **[BHU 2008]**

(a) Columnar, non-ciliated (b) Columnar, ciliated
(c) Squamous, ciliated (d) Squamous, non-ciliated

5. Epithelial cells adhere to one another with considerable force due to **[BHU 2005]**

(a) Intercellular attraction (b) Presence of desmosomes
(c) Both the above (d) None of the above

6. Basement membrane is made up of **[CBSE PMT 1997]**

(a) Epidermal cell only
(b) Endodermal cell
(c) No cell product of epithelial cell
(d) Both (a) and (b)

7. Transitional epithelium is found in **[AFMC 1997]**

(a) Lungs (b) Liver
(c) Urinary bladder (d) Stomach

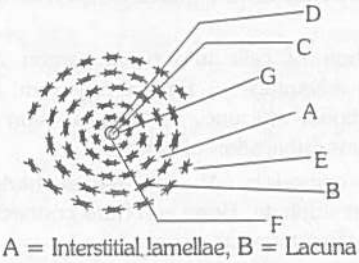
8. The term "blubber" refers to **[KCET 1994]**

(a) A substitute for natural rubber
(b) A subcutaneous deposition of fat in whales
(c) The irregular heart-beat sound
(d) None of these

9. Fats are richly found in **[NCERT; MP PMT 1994, 2003; Pb. PMT 1999]**

(a) Alveolar tissue (b) Lymph glands
(c) Adipose tissue (d) Liver cells

10. In the diagram of the section of bone tissue given below, certain parts have been indicated by alphabets; choose the answer in which these alphabets have been correctly matched with the parts which they indicate **[KCET 2001]**



(a) A = Interstitial lamellae, B = Lacuna with osteocytes, C = Blood vessels, D = Nerve, E = Canaliculi, F = Haversian canal, G = Lamellae
(b) A = Interstitial lamellae, B = Osteocytes in the lacuna C = Blood vessels, D = Nerve, E = Lamellae, F = Haversian system, G = Canaliculi
(c) A = Lamellae, B = Lacuna with osteocytes, C = Artery, D = Lymphatic vessels, E = Canaliculi, F = Vein, G = Haversian canal
(d) A = Interstitial lamellae, B = Osteocytes, C = Nerve, D = Blood vessel, E = Lamellae, F = Haversian canal, G = Canaliculi

11. Vertebrate nails are derivatives of **[MP PMT 2013]**

(a) Stratum lucidum (b) Stratum germinatirum
(c) Stratum granulosum (d) Stratum corneum

12. Shivering in cold is a method for **[MP PMT 2001]**

(a) Prevention of radiation of heat from the body
(b) Production of healthy muscle friction
(c) Production of heat by muscular contractions
(d) Increasing blood supply to skin

13. A tendon gets ossified to form a type of bone called **[MP PMT 2002]**

(a) Sesamoid (b) Membranous
(c) Dermal (d) Cartilage

14. With the help of the given variables, identify the correct sequence, that leads to the formation of blood clot

(A) Blood clot (B) Injury
(C) Factor II (D) Factor III
(E) Factor IV (F) Fibrinogen
(G) Thrombin **[EAMCET 2009]**

(a) $B \rightarrow C \rightarrow D \rightarrow F \rightarrow G \rightarrow A$
(b) $B \rightarrow C \rightarrow G \rightarrow F \rightarrow A$ ($D \uparrow e^+$)
(c) $D \rightarrow B \rightarrow C \rightarrow G \rightarrow F \rightarrow A$ ($\uparrow e^+$)
(d) $B \rightarrow D \rightarrow C \rightarrow F \rightarrow G \rightarrow A$ ($\uparrow e^+$)

15. Which is not true for Red Fibres **[NCERT; MP PMT 2011]**
(a) Muscle contains a red coloured oxygen storing pigment
(b) Muscle contains plenty of Mitochondria
(c) These muscles also called aerobic muscles
(d) Amount of Sarcoplasmic reticulum is high in it

16. Concave surface of mammalian R.B.Cs is helpful in
(a) Formation of more haemoglobin
(b) Increasing surface area of R.B.Cs
(c) Reducing surface tension of plasma membrane
(d) Providing more space for haemoglobin

17. Muscles of alimentary canal are chiefly **[MP PMT 2001]**
(a) Striated and Neurogenic (b) Unstriated and Neurogenic
(c) Striated and Myogenic (d) Unstriated and Myogenic

18. Which is the principal cation in the plasma of the blood **[CBSE PMT 1999]**
(a) Calcium (b) Sodium
(c) Potassium (d) Magnesium

19. What will happen, if the ligaments are cut or broken **[CBSE PMT 2002]**
(a) No movement at joint
(b) Bone will become unfix
(c) Bone will become fixed
(d) Bones will move freely at joints

20. Cardiac muscles are characteristic in that they contract
(a) Slowly and get fatigued
(b) Quickly and get fatigued
(c) Slowly and do not get fatigued
(d) Rhythmically and do not get fatigued

21. The outermost sheath of connective tissue that surrounds a skeletal muscle is **[BHU 2002]**
(a) Epimer (b) Epimere
(c) Epimerite (d) Epimysium

22. Which of the following matches correctly **[AIIMS 2009]**
(a) Factor II – Thromboplastin
(b) Factor III – Prothrombin
(c) Factor VIII – Antihaemophilic globulin
(d) Factor XII – Haemophilic

23. Striped muscles are **[MP PMT 1999]**
(a) Syncytial (b) Uninucleate
(c) Binucleate (d) Anucleate

24. The % similarity in β – chain of Hb in man and rhesus monkey is **[Odisha JEE 2004]**
(a) 2% (b) 4%
(c) 8% (d) 40%

25. Which of the following does not match **[CPMT 2004]**
(a) Muscular movement-ATP
(b) Heart-pace-maker
(c) Monocyte-haemoglobin
(d) Nerve impulse-acetylcholine

26. Difference between bone and cartilage is **[RPMT 2005]**
(a) Haversian canal (b) Blood vessel
(c) Lymph vessel (d) All of these

27. Largest smooth muscle is present in **[AIIMS 1998; CPMT 2002; RPMT 2005]**
(a) Leg (b) Thigh
(c) Uterus of pregnant woman (d) Urethra

28. What percentage of CO_2 is transported by RBC's **[MP PMT 2011]**
(a) 70% (b) 20 - 25%
(c) 97% (d) 7%

Answers and Solutions

1	e	2	a	3	d	4	b	5	b
6	c	7	c	8	b	9	c	10	c
11	d	12	c	13	a	14	b	15	d
16	d	17	d	18	b	19	b	20	d
21	d	22	c	23	a	24	d	25	c
26	d	27	c	28	b				

2. (a) The pseudostratified epithelium without being truly stratified appears to have 2 or 3 layers of cells as nuclei are present at two levels but actually it is single layered.

6. (c) Basement membrane is a delicate intercellular membrane visible in light microscope, which underlies most animal epithelia. Besides this, the basal lamina consists of mucopolysaccharide and very fine fibres.

7. (c) Transitional epithelium is thin flexible and impermeable to water. It forms the inner layer of urinary bladder.

8. (b) Blubber is thick subcutaneous fat insulating body heat in aquatic mammals like whales.

9. (c) The fat storage tissue is called adipose tissue, it is a connective tissue. It also forms shock proof cushions around the kidney, ovaries and eye ball.

12. (c) "Shivering with cold" in winter is caused by a quick involuntary reaction of striated muscles. It yields, not a mechanical work but only some heat just to warm the body.

13. (a) Sesamoid bone is formed by the ossification of tendons e.g. patella.

14. (b) Injury $\longrightarrow$ Prothrombin $\longrightarrow$ Thrombin

Fibrinogen $\longrightarrow$

Thromboplastin $\xleftarrow{Ca^{2+}\text{ ions}}$

$\longrightarrow$ Blood clot.

So, option (b) is correct.

16. (d) Due to the absence of nucleus, mammalian R.B.Cs become biconcave shape which help to accomodate maximum amount of haemoglobin.

17. (d) Muscles of the gut wall are innervated by autonomic nerve fibres and are self-excitatory.

18. (b) Plasma is extracellular fluid. Na^+ is the principal mineral cation in the extracellular fluid.

20. (d) Cardiac muscles have mixture of properties of both striated and unstriated muscles. These muscles continue rhythmic contraction throughout life under the control of A.N.S.

23. (a) A striped muscle fibre has many nuclei and it is a syncytium (coenocyte).

25. (c) Monocyte is the largest white blood cells (WBCs) whereas haemoglobin is found in R.B.Cs. Thus monocyte is not correctly matched with haemoglobin.