

ANIMAL ORGANIZATION

INTRODUCTION

- The largest kingdom with reference to the no. of known species is **Metazoa (multi cellular animal consumers)**
- The most common mode of nutrition in metazoans is **Holozoic**.
- Sedentary animals are **Sponges, sea anemos, coral polyps & sea lilies**.
- Metazoans without nervous system are **Parazoans**.
- Muscle phosphogen in invertebrates is **Phosphoarginine**.
- The animal cell organelle that participates in the formation of **Flagella, cilia & spindle fibres** is **Centrosome**.
- Asexual reproduction in Metazoans is **rare** and occurs in lower **metazoans** only.
- The most common method of reproduction in metazoans is **sexual**.
- The haploid stages in the life cycle of metazoans are **gametes**.
- **Classification** helps in assigning a systemic position to a newly described species.
- The features that form the basis for classification are **symmetry, coelom, and arrangement of cells and patterns of organ systems**.
- The reserve food in most of the metazoans is in the form of **glycogen**.

LEVELS OF ORGANIZATION

- The total no of levels of organization in the kingdom Animalia (including protozoa) is **5**.
- The most primitive level of organization in the kingdom Animalia (protozoa also) is **protoplasmic or acellular**.
- The most primitive level of organization in the kingdom Metazoa is **cellular**.
- The cells are arranged as loose cell aggregates and do not form tissues in the level of organization called **cellular**.
- The cells performing similar function are arranged in to tissues for the first time in the phylum **Cnidaria**.
- The most primitive level of organization in the eumetazoans is **tissue level**.
- Organ and organ system levels of organization appeared for the first time in the members of phylum **Platyhelminthes**.
- The highest level of organization in animals is **organ system**.
- The no of germinal layers in the animals that exhibit only **tissue level** of organization is **2**.
- The no of germinal layers in the animals that possess organ systems is **3**.
- The eumetazoans with **2 germinal layers** namely outer ectoderm and inner endoderm with mesoglea in between them are said to be **diploblastic**.
- The animal phyla with only 2 germinal layers are **Cnidaria and Ctenophora**.
- The stage of embryonic development in which the primary germ layers are formed is **gastrula**.
- The formation of the germinal layer that resulted in structural complexity is **mesoderm**.
- The metazoans with three germinal layers are called **triploblastic or bilaterian animals**.

- The protostomiate animals with open type of circulatory system belong to the phyla **Arthropoda and Mollusca**.
- The deuterostomiate animals with open type of circulatory system belong to **Echinodermata and Urochordata**.
- The **protostomia** animals with closed type of circulatory system belong to the animal groups **Annelida & Cephalopoda**.
- Deuterostomiate animals with closed type of circulatory system belong to **Cephalochordates and Vertebrates**.
- The no of body plans that occur among the metazoans is **3**.
- The body plan in which the cells are loosely aggregated and function independently is **Cell aggregate body plan**.
- If, the body contains a sac like cavity with a single opening which is used for both ingestion and egestion is **Blind sac/Hollow sac**.
- Animals with an incomplete gut belong to the phyla **Coelenterata and Platyhelminthes**.
- A gut with a mouth for ingestion & an anus or cloaca for egestion is said to be **Complete**.
- Tube-within-a-tube-body plan first appeared in the animals of the phylum **Aschelminthes**.
- Protostomiate animals exhibiting tube-within-a-tube-body plan belong to phyla **Aschelminthes to Mollusca**.
- Deuterostomiate animals possessing Tube-within-a-tube-body plan belong to the phyla **Echinodermata and chordata**.

SYMMETRY & COELOM

- If, any plane that passes through the centre does not divide the body of an organism into two antimeres it is said to be **asymmetrical**.
- Asymmetrical protists known to you are **Amoeba, Paramecium and Vorticella**.
- Metazoans showing asymmetry are majority of **sponges and adult gastropods**.
- If, a spherical bodied organism is cut into two equal halves by any plane passing through its focus / Centre, the symmetry is **called Homaxial apolar**.
- A rare type of symmetry which is seen in heliozoans and radiolarians is **spherical**. If, the body of an organism can be cut into two antimeres by any vertical plane passing through its oro-aboral axis, the symmetry is called **radial/Monaxial/ heteropolar**.
- The most common symmetry in sessile and sluggish animals is **radial**.
- The habitat in which radially symmetrical animals are found is **Aquatic**.
- The type of symmetry in the animals having many planes and a single axis is **radial**.
- The triploblastic animals that are secondarily radially symmetrical are **echinoderms**.
- The groups of deuterostomiate animals whose larvae are bilaterally symmetrical but their adults have become **pentaradially** symmetrical are **echinoderms**.
- Protostomiate animals whose larvae are bilaterally symmetrical but their adults have become asymmetrical are **gastropods**.

- The space between the body wall and gut is called **body cavity**.
- The triploblastic animals without body cavity are referred to as **acoelomates**.
- Solid body plan is exhibited by **flat worms**.
- The space between ectoderm and endoderm in flat worms is filled with **parenchyma/mesenchyme**.
- If the body of an organism can be cut into two antimeres by median sagittal plane it is called **bilateral symmetry**.
- The term coelom was coined by **Haeckel**.
- The body cavity which is lined with mesodermal layer is called **coelom**.
- The primary body cavity is called **blastocoelom**
- The secondary body cavity is **true coelom(schizocoelom or enterocoelom)**
- Remnant of embryonic blastocoel or a body cavity which is not lined with mesodermal epithelia is called **pseudocoelom**
- Pseudocoelomates belong to the phylum **Aschelminthes**
- The mesenchyme occupies only a part of the blastocoelom adjoining the ectoderm in the phylum **Aschelminthes/ Nematoda**
- Pseudocoelomic & coelomic fluids act as **hydrostatic skeletons**
- The part of peritoneum which encloses visceral organs is known as **splanchnic or visceral peritoneum**
- The part of peritoneum which underlines the body wall is called **parietal/somatic** peritoneum.
- A double layered peritoneum that connects visceral organs to the body wall is called **mesentery**
- The organs that are covered by somatic peritoneum instead of visceral peritoneum are called **retroperitoneal** organs.
- The retroperitoneal organs in the vertebrate body are **kidneys**
- The coelom which is formed by the splitting of mesoderm during gastrulation is called **schizocoelom**.
- All protostomians are not schizocoelomates, but all schizocoelomates are protostomians.
T/F
- The progenitor of mesoderm in the early embryonic life is **4d blastomere** or **mesentoblast** cell.
- The functional body cavity that is formed by the fusion of blastocoel with coelomic spaces is called **haemocoel**.
- The type of coelom which is formed by the union of mesodermal pouches of **archenteron** is called **enterocoel**
- All enterocoelomates are deuterostomes, but all deuterostomes are not enterocoelomates. **(False)**
- The cleavage in protostomians is **spiral and determinate**.
- The cleavage in deuterostomians is **radial and indeterminate**.
- The type of coelom present in hemichordates is same as that of **echinoderms**.
- The process of regional specialization of gut due to contact between endoderm and mesoderm in it is called **primary induction**.

ANIMAL TISSUES

INTRODUCTION

- The term tissue was coined by **Bichat**.
- Father of modern histology is **Bichat**.
- Microanatomy deals with the study of **tissues**.

EPITHELIA

- **Matrix** varies in composition and quantity in different tissues epithelia.
- The tissue which forms the outer covering of the body and lining of internal organs/ cavities is **epithelium**.
- The structures that provide structural and functional links between the adjacent epithelial cells are **cell junctions**.
- The type of junctions that prevent leakage of water into the surrounding cells in our sweat glands is **tight junction**.
- The type of junction in which the plasma membranes of adjacent cells come in contact at intervals with the help of specific protein is **tight junction**.
- The type of junctions that act as 'rivets' binding cells together into strong sheets is **desmosome / anchoring function**.
- The desmosomes are anchored in cytoplasm through intermediate filaments made of **Keratin**.
- Gap junctions are also called **communicating junctions**.
- The junctions that act as 'hydrophilic' channels formed between adjacent cells through proteins called **connexons** are **gap junctions**.
- The type of junctions that allow rapid transfer of ions from one cell to the other like **plasmodesmata** in plant cells are **gap junctions**.
- The tissue which is derived from any of the three germinal layers is **epithelium**.
- Epithelial tissue is **avascular**.
- The part of basement membrane which lies close to the epithelial cells is called **basal lamina**.
- The part of basement membrane that lies close to underlying connective tissue is called **reticular lamina**.
- The epithelial cells lining the lumen of intestine, gall bladder, parts of renal tubule etc. are provided with minute vibratile cylindrical evaginations called **microvilli**.
- Microvilli increase the surface area of **absorption**.
- Unspecialized contacts between the cells are formed by proteins called **Cadherins**.

- Contact between cells and extracellular matrix is maintained by glycol proteins called **integrins**.
- Elongated and non-motile cilia like structures present in macula, crista and lining cells of epididymis are **stereocilia**.
- An epithelium which is composed of a single layer of cells and forms a lining of body cavities, ducts & tubes is called **simple**.
- An epithelium which consists of two or more layers of cells and has protective function is called **compound / stratified**.
- Simple squamous epithelium is also called **pavement epithelium**.
- Flat and tile-like cells, each with a centrally located ovoid nucleus are present in **simple squamous epithelium**.
- Squamous epithelium with wavy or irregular boundaries is called **tessellated epithelium**.
- The epithelium that usually forms the lining of surfaces specialized for diffusion is **simple squamous**.
- Examples for tessellated epithelium are endothelium of blood vessels and all types of **peritoneum**.
- Smooth squamous epithelium forms the lining of **alveoli of lungs, Bowman's capsule & part of Henle's loop**.
- Main functions of cuboidal epithelium are **secretion & absorption**.
- The cuboidal epithelium forms the lining of **PCT** and some other parts of **nephron**.
- Germinal epithelium is formed by **cuboidal** epithelium.
- The epithelium which is composed of single layer tall and slender cells **with their nuclei located near the base is called columnar**.
- The true surface of cells bears microvilli in certain regions in the case of **columnar** and **cuboidal epithelia**.
- Mucosa of stomach, small intestine lining of gall bladder and epidermis are formed by **columnar epithelium**.
- Ciliated cuboidal epithelium occurs in some parts of **renal tubule**.
- Ciliated columnar epithelium occurs in **fallopian tubes, bronchioles, ependyma** of CNS and **epidermis of planarians**.
- The epithelium that moves particles or mucus in a specific direction is **ciliated**.
- The simple epithelium that appears to be double layered due to differential height of cells and nuclei in different position **is pseudo-stratified**.
- The epithelium with mucus secreting goblet cells is **columnar**
- Dry surfaces subjected to **wear and tear** are covered by **stratified, keratinised squamous**
- The epithelium covering moist surfaces such as BC, pharynx, vagina etc. is known as **non-keratinised, stratified squamous**.
- The epithelium that forms the lining of large ducts of salivary glands, sweat glands and pancreatic ducts is **stratified cuboidal**.
- The epithelial present in the wall of urinary bladder is **transitional**
- Glandular tissues are formed by either **cuboidal** or **columnar**.
- The glandular epithelium with isolated goblet cells as in the mucosa of gut is called **unicellular**.
- If, the glandular tissue is formed by clusters of cells as in salivary glands it is **multicellular**.
- The glands (with ducts) that secrete mucus, milk, ear wax, oil and digestive enzymes are **exocrine**.
- **The ductless glands that release their secretions directly into blood are endocrine**.

- Pancreas is a **merocrine**
- **Epicrine** gland because it releases the secretory granules without the **loss of cellular material**.
- Mammary glands are **apocrine** because the apical part of the cell is pinched off along with the secretory product.
- Sebaceous glands are **holocrine** because the entire cell disintegrates to discharge the secretory products.
- The multicellular glands of stomach and intestine are **tubular**
- The multicellular glands are salivary, mammary and sebaceous are **saecular**

CONNECTIVE TISSUES

- All connective tissues are **mesodermal** in origin.
- The fibres that provide strength, elasticity and flexibility are found in all connective tissues except **vascular**.
- The structural proteins namely collagens & elastin and also the modified polysaccharides that form the matrix / ground substance in a connective tissues is secreted by their **cells**.
- There are three kinds of connective tissues namely **loose, dense and specialized (skeletal and fluid vascular)**
- If the cells and fibres are loosely and distantly placed in a semifluid ground substance, it is called loose CT.
- **Areolar** and adipose tissues are loose connective tissues.
- The tissue that often serves as a support frame work to skin is **areolar**
- The cells of areolar tissue are **fibroblasts, mast cells, macrophages, plasma cells, etc.**
- The cells that secrete fibres and major part of matrix are irregular cells with stellate processes and are called **fibroblasts**.
- Round or oval cells that secrete heparin, histamine are **mast cells**.
- The cells that produce antibodies are **plasma cells**.
- The amoeboid cells that engulf digest microbes, dead cells and foreign particles are **macrophages**.
- **Tissue fixed macrophages are histiocytes**.
- 'Packing' tissue of the body is **areolar**.
- The tissue that is involved in allergic reactions and defence is **areolar**.
- The tissue that also provides materials for repair is **areolar**.
- Fat storing specialized tissue is **adipose**.
- Fat storing cells are called **adipocytes**.
- Adipose tissue is similar to areolar tissue except for abundant **adipocytes**.
- The tissue that forms a shock **absorbing cushion** around eyes, heart and kidneys is **adipose**.
- Yellow bone marrow mainly contains **adipose tissue**.
- Thermal insulation is provided by **subcutaneous fat**.
- **Blubber** of whales and hump of camel is formed by '**WAT**'.

- Adipocyte of WAT is **monolocular** (single lipid droplet) where as that of 'BAT' is **multilocular** (several small lipid drop lets)
- Adipocytes of 'BAT' have more mitochondria than those of WAT and as such they are metabolically more active.
- **WAT** is mostly found in fetuses and infants.
- The supporting frame work of lymphoid organs such as spleen, bone marrow, lymph nodes, etc. is formed by **reticular** tissue.
- If, the fibres and fibroblasts are relatively abundant and compactly packed it is called **dense fibrous** tissue.
- Depending upon the type and **orientation of fibres** it is of two types namely dense irregular, **dense regular** and dense regular and elastic connective tissue.
- If, bundles of collagen fibres are oriented in all directions to provide high degree of mechanical strength and the fibroblasts are less in number, it is **irregular dense fibrous** tissue.
- Examples for dense irregular fibrous tissue are reticular layer of **dermis, pericardium, periosteum, perichondrium, epineurium, epimysium**, etc.
- If bundles of collagen fibres are arranged parallel to one another, it is called **dense regular fibrous tissue**.
- Dense regular fibrous tissues that contains parallel bundles of collagen fibres enclosing rows of fibroblasts and non- elastin fibres **tendons**
- Usually a **tendon** connects a skeletal muscle to a bone.
- **Chordae tendinae** of heart are also **tendons** but not connected to any bone.
- Dense regular fibrous tissue which has both strength and elasticity and also joins bone to bone is called **ligament**.
- Dense regular fibrous tissue with bundles of collagen fibres arranged variously in the same plane, yellow elastin fibres and less number of fibroblasts is called **ligament**.
- Over stretching of **ligament** produces **sprain**.
- The dense fibrous tissue that contains mostly yellow elastic fibres and cable of stretching and recoiling is **elastic fibrous** tissue.
- Elastic fibrous tissue in present in **vocal cords, elastic ligaments, trachea and bronchi**.
- Mucous connective tissue occurs in umbilical cord **skeletal tissue** as **Wharton's jelly**.

SKELETAL TISSUES (CARTILAGE & BONE)

- Specialized connective tissues having solid matrix is called **skeletal**.
- The living cells of skeletal tissue occur in fluid filled spaces called **lacunae**.
- The soft skeletal tissue which is firm, but flexible and can tolerate compression is **cartilage / gristle**
- The matrix of cartilage is called **chondrin** (avascular) which is secreted by **chondrocytes**.
- The dense irregular fibrous sheath usually covering a cartilage is called **perichondrium (vascular)**
- There are **three** types of cartilages.
- Cartilage with a bluish white and translucent matrix is **hyaline**.
- The weakest and the most common type of cartilage **hyaline**.
- Hyaline cartilage without perichondrium is **articular cartilage**.

- Examples of hyaline cartilages are **inter nasal septum**, **costal cartilages**, **epiphyseal plates**, **rings of trachea**, **bronchi** and cartilages of **larynx**.
- The strongest of all cartilages which is also without perichondrium is **fibrous cartilage**.
- Fibrous cartilage is found in **pubic symphysis** and **intervertebral discs**.
- Elastic cartilage is found in **ear pinna**, **epiglottis** and **Eustachian process**

Bone

- Solid, hard and rigid skeletal tissue: **osseous tissue**.
- The tissue with a hard and non-pliable matrix rich in **calcium salts** and **collagen** is osseous tissue.
- Homeostatic reservoir of mineral salts is osseous tissue.
- Immature bone cells are **osteoblasts**.
- Mature bone cells are **osteocytes**.
- Bone eating or bone remodeling cells are **osteoclasts**.
- The matrix of a bone is called **osseine**.
- Osteocytes occur singly inside fluid filled canals called **lacunae**.
- A compact mammalian bone is characterised by the presence of **Haversian systems**.
- Cancellous bones are also called **spongy/trabecular** bones.
- The matrix of a light weight bone (spongy) is formed by **trabeculae**.
- The spaces between trabeculae are filled with **redbone marrow**.
- Cancellous bones are **metaphysis**, **vertebrae**, **flat bones** of skull and **ribs**.
- Osteocytes possess protoplasmic processes called canaliculi which lie which lie inside **lacunae**.
- A Haversian canal, its surrounding lamellae lacunae constitute a **Haversian system/osteon**.
- The transverse/oblique canals that connect Haversian canals are **Volkman's canals**.
- The composition of organic matter and inorganic matter in the dry weight of a **mature** bone, **35%**, **65%** respectively.
- Calcium phosphate in a bone occurs in the form of crystals of **hydroxyapatite**.

Vascular connective tissues

- The study of red river of life is **hematology**.
- The percentage of plasma and formed elements of blood in its total volume respectively is **55%** & **45%**.
- The total volume of blood in adult normal human being is **5-6 litres**.
- The % of total volume of blood occupied by RBCs is called **hematocrit**.
- The composition of plasma is water (**92%.solutes8%**).

- The smallest and the most abundant plasma protein is **albumin**.
- The serum protein responsible for colloidal osmotic pressure is **albumin**.
- The fall in the levels of serum proteins results in **edema**.
- Gamma globulins are antibodies/**immunoglobulins**.
- pH of blood under normal conditions is **7.4**.
- Serum proteins act as blood base **buffers**.
- The tissue that produces RBCs in early **embryonic** life is yolk sac **mesoderm**.
- The **Haemopoietic** tissue in the final stages of development and after birth is **red bone marrow**
- The mammals having elliptical RBC are **camel & llama**.
- Erythrocytes of mammals are **biconcave, circular** and **enucleate**.
- A large area for the exchange of gases is provided by biconcave shape by enhancing **surface area to volume ratio**.
- The RBC count per cubic millimeter of blood in man and woman respectively is **5 millions, 4.5 millions**.
- A fall in total RBC count is called erythrocytopenia/oligocythemia which leads to **anemia**.
- An abnormal rise in RBC count is **polycythemia**.
- The hormone that stimulates the red bone marrow to increase the production of RBC during shortage of oxygen is **erythropoietin**
- The chemical names of vitamins that are required for maturation of RBC are **Cyanocobalamin** and **folic acid**.
- Immature RBC often seen in circulating blood of leukemia patients are **reticulocytes**.
- The no of polypeptide chains in a molecule of haemoglobin(**2alpha and 2 beta**)
- The no of haeme groups in a molecule of haemoglobin is **4**.
- One molecule of hemoglobin carries **4 molecules of oxygen**.
- The life span RBC in human beings is **120 days**.
- The organs in which worn out RBC destroyed are **liver and spleen**.
- Spleen is also the reservoir of RBC and grave yard of worn out **RBC**.
- The WBC are spherical or irregular in shape and **nucleate**.
- The movement of WBC through capillary wall in to extra vascular area is called **diapedesis**.
- The total leucocyte in a cubic millimeter of blood is **6000—10000**.
- An increase in leucocyte count is **leukocytosis**

- Leukocytosis indicates **Leukemia (blood cancer)**.
- The fall in leucocyte count is called **leuco cytopenia**.
- The type of granulocytes that supplement the function of mast cells is **basophils**.
- The granulocytes that possess fewer and irregular granules and an irregular lobed nucleus are **basophils**.
- The granulocytes that secrete **heparin, histamine** and **bradykinin** are **basophils**.
- The granulocytes that possess a **distinctly bilobed nucleus** are **eosinophils/acidophils**.
- The WBC whose number increases during allergic reactions is **esinophils** .
- The granulocytes that remove antigen and antibody complexes are **eosinophils**.
- The granulocytes having small and abundant cytoplasmic granules and **2 to 5 lobed nucleus** are **neutrophils**.
- The granulocytes that are described as '**microscopic policemen**' are **neutrophils**.
- The leucocytes that occur in highest % of all leucocytes are **neutrophils**.
- The somatic cells in female mammals having sex chromatin/drumstick body attached to **nucleus** are **neutrophils**.
- The WBCs that account for **30%** Of the total leucocyte population are **lymphocytes**.
- The WBCs with a large spherical nucleus and scanty cytoplasm are **lymphocytes**.
- The WBCs that perform reverse **diapedesis** are **lymphocytes**.
- The WBCs having the longest life span are **lymphocytes**.
- The largest of all leucocytes in size are **monocytes**.
- The leucocytes having reniform nucleus are **monocytes**.
- The WBCs that are described as '**internal scavengers**' are **monocytes**.
- The WBCs that differentiate into macrophages when they enter connective tissues are **monocytes**.
- The formed elements that occur as enucleate round or oval biconvex discs are **platelets**.
- The number of platelets per cubic millimeter of blood is **21/2 to 41/2 lacks**.
- The cells of bone marrow that form platelets by fragmentation are **megakaryocytes**.
- The clotting factor released by damaged platelets is **thromboplastin**.
- The formed elements that plug minor vascular openings are **platelets**.
- The formation of platelets is known as **thrombopoiesis**.
- Platelets help in preventing loss of blood from injured blood vessels by initiating the process of clotting / **haemostasis**.

- Platelets produce Hageman's factor, fibrin stabilizing factor and **thromboplastin**.
- Life span of platelets is **8 days**
- Decrease in platelet count is called **thrombocytopenia**
- Rise in platelet count above the normal level is **thrombocytosis**.

Lymph

- Lymph is often described as '**white river of life**'.
- Blood minus RBCs platelets and large protein molecules is **lymph**.
- Lymph is derived from interstitial fluid by **lymph capillaries**.
- Lymph is less viscous and almost **transparent**.
- Leucocytes of lymph are derived from lymph nodes and blood capillaries through **diapedesis**.
- Lymph capillaries are more permeable to large proteins and particulate matter than blood capillaries.
- Lymph has **more wastes** and **fewer nutrients** than blood.
- Lymph flows from tissues to **brachiocephalic** veins.
- The composition of lymph varies from **area to area** in the body
- The content of fibrinogen, ca^{2+} & po_4 is less than that of blood.
- The formation of interstitial fluid at the arteriole end is due to **hydrostatic** pressure.
- The return of most of the interstitial fluid to blood capillaries is due to **osmotic pressure** at **venule** end.
- The lymph capillaries of intestinal villi in to digested fats are absorbed are lacteals.
- Lymphatic system represents the accessory route for the interstitial fluid from tissues to blood.

Muscular tissues

- Muscles are **mesodermal** in origin except the muscles of iris and ciliary body which are ectodermal in origin.
- The study of muscles is called **myology**.
- The muscular tissues are without **extra cellular matrix**.
- The three important properties of muscles are **excitability, contractility and elasticity**.
- The elongated myocytes/sarcocytes are called **muscle fibers**.
- The plasma membrane of a muscle fiber is called **sarcolemma**, its cytoplasm is **sarcoplasm**, its ER is sarcoplasmic reticulum and its mitochondria are **sarcosomes**.

- The sarcoplasm of muscle fiber contains several contractile parallel **myofibrils**.
- The myofibrils are made up of **myofilaments, thin actin** and **thick myosin**
- The arrangement of actin and myosin impart **striped nature**.
- The sarcoplasm also contains **myoglobin, CP, ATP, glycogen**, etc.
- There are three kinds of muscles i.e. **skeletal, smooth** and **cardiac**.

SKELETAL MUSCLE

- Striated muscles are called **skeletal** and **voluntary**.
- A striated muscle fiber surrounded by a thin sheath, the **endomysium**.
- A bundle of striated muscle fibers is called a fascicle which is enveloped by **perimysium**.
- A group of **fascicles** form a muscle which is enveloped by **epimysium**.
- These layers of collagenous sheath extend beyond the muscle to form a **chord –like tendon** or a sheet-like **aponeurosis**.
- A skeletal muscle fiber is long, cylindrical, unbranched and **multinucleate (syncytial)**.
- Striated voluntary muscles contract quickly and also **fatigue quickly**.
- Skeletal muscles are innervated by **somatic nervous** system.
- The mononucleate & myogenic satellite cells help in **regeneration**.

SMOOTH MUSCLE

- The smooth muscles are also called non-striated **involuntary** muscles.
- The smooth muscles are located in the walls of **visceral** organs
- Smooth muscles do not show cross bands, hence the name **smooth muscle**.
- Non-visceral smooth muscles are present in iris and ciliary body of eye and also in '**arrector pili**' **dermis** of skin.
- A smooth muscle fibre is fusiform and **uninucleated**.
- Myofibrils of a smooth sarcocytes do not show alternate dark and light bands due to **irregular** arrangement of **actin and myosin**.
- The smooth muscles are innervated by autonomous nervous system, hence perform **involuntary contractions**.
- The smooth muscles perform sustained involuntary contractions called **spasms**.
- Large smooth muscles occur in **pregnant uterus** of women.
- In the wall of hollow organs smooth muscles form layers, **circular** (for narrowing) and **longitudinal** (for shortening).
- The sarcoplasmic reticulum of smooth muscle is **sparsely** developed.
- The smooth muscle fibers are arranged in two ways, **single unit** and **multiunit**.
- Single unit smooth muscles occur in the walls of alimentary canal, fallopian tube, ureters, urinary bladder, etc. The muscle fibers form a single compact unit and contract as a single unit. There is a single innervation.

- Multiple unit smooth muscle fibers occur independently or in small groups. Contract as separate units.
- There is separate innervation for each unit.
- Smooth muscles do not possess troponin-tropomyosin mechanism of controlling contraction.
- The Ca^{++} is bound to the calcium-binding protein calmodulin (acts as a second messenger).
 - Calmodulin- Ca^{++} complex activates myosin kinase, promoting contraction.
 - The smooth muscles do not possess 'T' tubules and triad system. They contract slowly and do not get fatigued.

CARDIAC (HEART) MUSCLE

- Cardiac muscle is a type of **involuntary** and **striated** muscle.
- It occurs in the **myocardium** heart.
- The cardiac myocytes are relatively **short** and **branched** fibers.
- Each cardiac myocyte has a centrally located nucleus.
- The cardiac **myocyte** shows striations like that of a **skeletal sarcocyte**.
- The overlapping arrangement of **myosin filaments**(actin & myosin)
- Cardiac myocytes produce alternate **dark and light bands**.
- Cardiac myocytes have more **mitochondria** than either of **skeletal** or **smooth** muscle myocytes.
- The sarcoplasmic tubules of cardiac sarcocytes have no **cisternae**.
- The **t tubules** are seen along the z lines in a **cardiac** muscle.
- The most distinguished feature of cardiac muscle is the presence of intercalated discs.
- At an intercalated disc, the cell membranes of two adjacent **cardiac myocytes** are **interdigitated** and bound together by **gap junctions** and **desmosomes**.
- These junctions help to stabilize the relative positions of adjacent cells and maintain the three **dimensional** structure.
- The **gap/electrical junctions** contain connexon protein channels through which ions and **small molecules move from cell to cell**.
- Thus the **gap junctions** facilitate the conduction of muscle impulse from **cell to cell at a time**.
- Because the cardiac myocytes are **mechanically, chemically and electrically** connected to one another, the entire myocardium acts as a single cell. For this reason cardiac muscle has been called a **Functional syncytium**.
- The contractions of cardiac muscle are **rapid, rhythmic, myogenic** (through pace maker) and **involuntary**.
- Cardiac muscle has 't' tubules at the level of **z- discs** which form triads with junctional processes of sarcoplasmic reticulum.
- Cardiac muscles are seldom **fatigued**.
- Brownish **lipofuscin** granules accumulate as age advances in **cardiac** myocytes, hepatocytes and **cyton** of neurons.

NERVOUS TISSUE

- The most complex tissue in the vertebrate body is **nervous tissue**.
- Nervous tissue is **ectodermal** in origin.

- Nervous tissue is without **intercellular matrix**.
- The main function of nervous tissue is **irritability**.
- The two properties of nervous tissue are **excitability and conductivity**.
- Nervous tissue is composed of **neuroglia neurons and neuro sensory cells**.
- Neurons are the **structural and functional** units of nervous system.
- Neurons are impulse conducting cells whereas **neuroglia are** non-conducting cells.
- Cells of Packing tissue or supporting cells of nervous tissue are **neuroglia**.
- A neuron usually consists of a cyton, one to many dendrites and a single **axon**.
- The cell body of a neuron is known as a **cyton/soma/perikaryon**.
- The cytoplasm of soma of a neuron contains a spherical nucleus, **Nissl/Tigroid** bodies, **neurofibrils, Lipofuscin** granules (products of cellular **wear and tear**, etc.
- A group of cytons in the central nervous system constitute a **nucleus**.
- A group of cytons in the peripheral nervous system forms a **ganglion**
- The short branched processes that arise from the cell body are called **dendrites**
- Dendrites also contain **Nissl bodies** and **neurofibrils**.
- Dendrites are afferent processes as they conduct impulses towards **cyton**.
- An axon is an **efferent process** as it conducts impulses away from cyton towards **the effector**.
- The part of cyton from which the axon arises is called **axon hillock**.
Axoplasm of an axon contains neurofibrils but no **Nissl bodies**.
- An axon may form **collateral branches**.
- The distal branches of an axon are called **telodendria/axon terminals**.
- The telodendria form terminal boutons or synaptic knobs that contain **synaptic vesicles** storing **neuro transmitters**.
- Bundle axons in CNS are called a tract whereas that of **PNS** is called a **nerve**.
- A neuron having a single process which divides in to two branches is **unipolar or pseudo-unipolar**.
- The soma of pseudo-unipolar neuron is situated in the **dorsal root ganglion** of a spinal nerve.
- A neuron with **one axon** and **one dendrite** that arise directly from the cyton is called a **bipolar neuron**.
- Bipolar neurons are found in retina of an eye, sensory cells of internal ear an olfactory epithelium.
- A neuron having many dendrites and a single axon is called **multipolar**.
- Most abundant neurons in the human body are **multipolar**.
- In a myelinated nerve fibre of PNS, the **plasmalemma** of Schwann cell wraps around an inter node of an axon.
- The concentric layers of the Schwann cell contain **myelin** (with high proportion of lipids).
- In PNS a single axon is myelinated by many **Schwan cells**.
- The outermost layer of Schwann cell which contains cytoplasm and nucleus is **neurilemma**.
- In CNS a single oligodendrocyte can myelinate **many axons**.
- The parts of a myelinated axon without myelin are called **nodes of Ranvier**.
- The part between adjacent nodes is an **internode**.
- Myelinated nerve fibers occur in **white matter** of CNS, **cranial** and **spinal** nerves.
- Schwann cells also envelope Unmyelinated axons, but without dense **membrane wrapping**.
- Unmyelinated axons occur in **grey matter** of **CNS** and **ANS**.

- The neurons that carry impulses from the receptors to CNS are **afferent** neurons.
- The longest axons in human body are those of **sciatic** nerves.
- The **longest** cell in human body is **neuron**
- The neurons that carry impulses from CNS **to effectors i.e. Glands** and muscles are called **motor or efferent** neurons.
- The neurons that connect sensory and motor neurons in CNS are **connector/associated** neurons.
- A nerve is made up of many bundles of nerve fibers, the fascicles which are bound together by a sheath of dense connective tissue sheath, the **epineurium**.
- Epineurium penetrates the nerve to form **perineurium** around each fascicle.
- An individual nerve fibre is enclosed by a thin layer of loose connective tissue, the **endoneurium**
- Cranial nerves are three types I.e. **sensory, motor** and **mixed**
- The most numerous cells in CNS are '**glial**' cells.
- The cells that provide a microenvironment suitable for neuronal activity are **glial** cells.
- The glial cells of CNS include neuroglia **astroglia, oligodendroglia, ependymal** cells and **microglia**.
- Star shaped glial cells that form interconnected network and bind neurons and capillaries are **astroglia**
- The glial cells that form the lining of cavities of brain and spinal cord are **ependymal**.
- The glial cells that become **phagocytic** at injured places of nervous tissue are **microglia**.
- The glial cells of PNS are **satellite and Schwann cells**.
- The support cells in the peripheral ganglia are **satellite cells**.
- Neurons do not show any increase in number because they do not undergo division due to the absence of **centrosome**