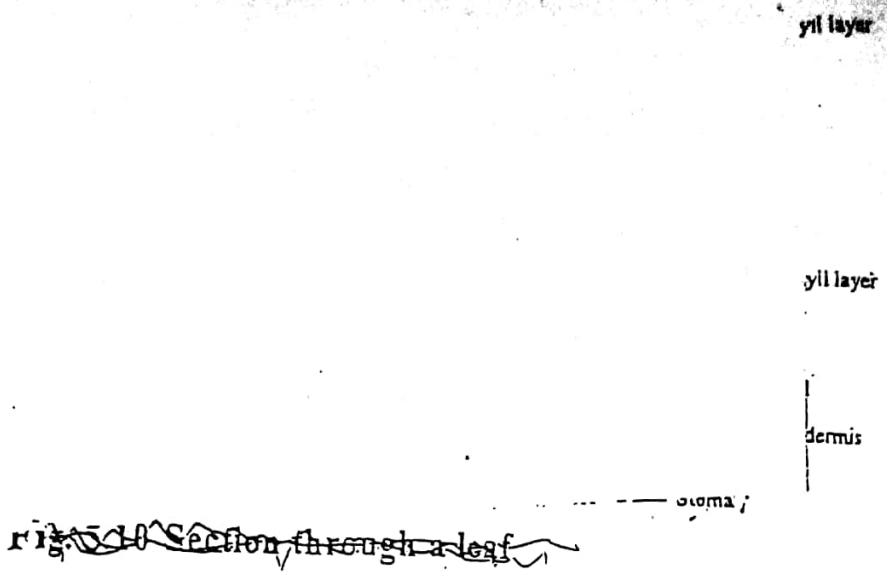

Fig. 2.1: Section through a leaf

B. ANIMAL HISTOLOGY

There are four different types of tissues in Animals namely epithelia, connective, muscular, nervous and tissues.

A. EPITHELIUM:

This forms the outer protecting surface of the body and also of all glands. It furnishes important parts of the sense organs and lines walls of internal cavities. The very important function is the participation in the metabolism of the body through the absorption of substances from the outside medium and the elimination of other substances to the outside. All substances normally received or given off by the body must pass through the epithelium. For secretory function, the epithelia tissues produce special structures called glands.

Types of Epithelia Tissue:

They can be classified in terms of:

(a) Shape of the epithelial cells

(b) The arrangement of the cells in the epithelial sheet.

Shape of epithelial cells vary. This is due to the fact that in a living condition there are changes due.to stretching or contraction. Stretching will flatten the cell, contraction will make the cell tall

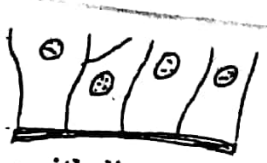

Fig. 5.11 Columnar epithelium

There may be transitional forms to the above three forms. Most of these cells may have on their surface, motile or ciliated structures.

The basement membrane is an extracellular layer lying between the epithelium and the underlying connective tissue. Formally this structure was interpreted as a condensation of ground substance of the connective tissue but there is evidence to show that the basement membrane is a product of the epithelium.

Simple Squamous Epithelium:

This epithelium has thin plate-like cells arranged in one layer and on the surface of the connective tissue. The cells adhere closely to one another by their edges. On the surface, a typical mosaic pattern is observed with tesselated edges.

In the human body this epithelium is found in:

(i) In the inner surface of the wall of the membranous labyrinth.

(ii) Inner surface of the tympanic membrane of the ear

(iii) In the bowman's capsule

(iv) In the descending loop of Henle in the kidney.

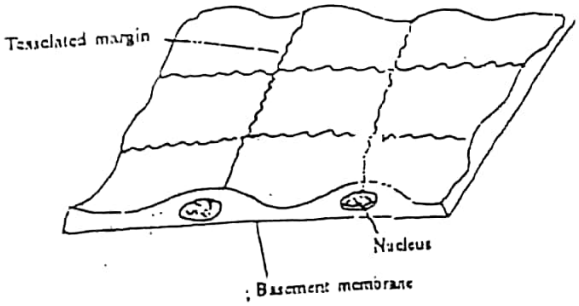

Fig. 5.12 Simple Squamous Epithelium

Simple Cuboidal Epithelium:

The low primastic cell bodies of this epithelium adhere to one another by their lateral surfaces. They are small hexagonal polygons, whereas vertically

they appear as small squares. These cells are found in many glands such as :

(i) Thyroid gland
(ii) The free surface of the ovary
(iii) Secretory ducts of many glands and
(iv) At the pigmented epithelium of the retina.

Simple columnar ciliated epithelium:

Exactly like the simple columnar epithelium except that there are cilia on the free surface of the cells.

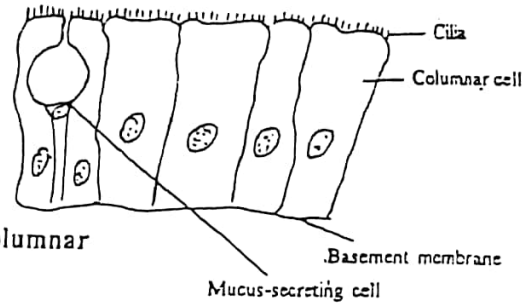

Fig 5.13. Simple columnar ciliated epithelium

These epithelia are found in the small bronchi of the respiratory tract and functions either to remove dirt or mucus; in the nasal sinus, and in the central canal of spinal cord for the movement of the spinal fluid in the uterus and oviduct for movement of the ova and other structures.

Stratified Squamous Epithelium:

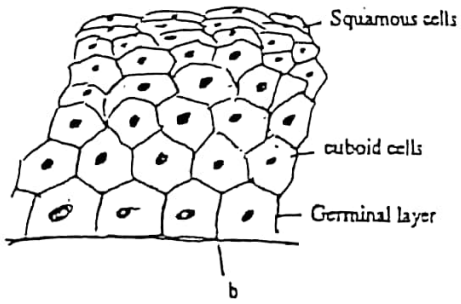

Fig 5.14 Stratified Squamous Epithelium

The epithelial cell is quite thick; in a vertical section the cells vary in shape; and size. The layer overlying the connective tissue is cuboidal in

shape; they may even be columnar. Cell lying towards the outside become squamous and further outwards become flattened out.

These epithelia are found: in the epidermis in parts of the epiglottis; in some parts of the conjuctiva and cornea, in the vagina and some parts of female urethra.

Pseudo-Stratified Columnar Epithelium:

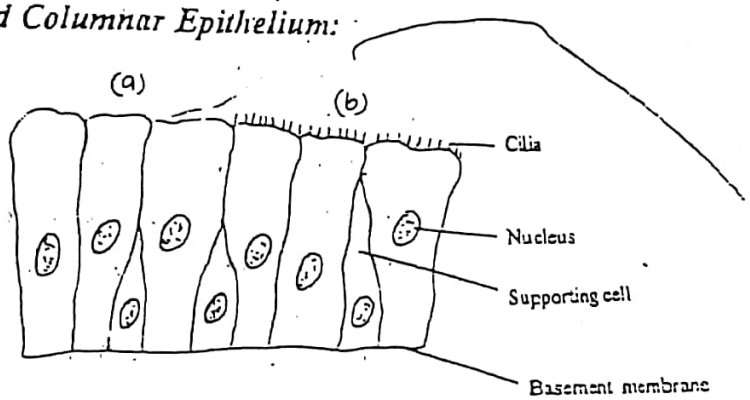

Fig. 5.15 Pseudostratified epithelium (a) columnar (b) ciliated.

The nuclei are at different levels and the cells lack uniformity. While some of the cells connect with the epithelial membrane, they have lost their connection with the surface membrane. They are found in the excretory duct of most glands and in the male urethra.

Transitional Epithelium:

These represent a transition between the stratified, squamous and the columnar epithelia. This epithelium is found in the walls of hollow organs. These organ are subject to great mechanical changes due to contraction and distension and because of these the appearance of the epithelia varies greatly in the contracted condition. The epithelium consists of many cell layers. In the stretched condition, it consists of only two layers, a superficial layer and a basal layer. The superficial layer looks like squamous epithelium and the basal layer looks like irregular cuboidal cells.

Fig. 5.16 Transitional Epithelium

These cells are found in the lining of male urethra, and in the lining of male bladder.

INNER STRUCTURE OF EPITHELIAL CELLS:

The nucleus of most epithelial cells is generally single and has a very simple shape. In the squamous epithelium the nucleus is oval in shape; in cuboidal cell it is spherical; in columnar cell it is elongated along the axis of the cell and has a cylindrical shape.

Sometimes in some epithelial cells there may be many nuclei, e.g. in the liver and mitochondria are abundant in epithelial cells. In squamous epithelium the mitochondria surround the nucleus. In the columnar cell the mitochondria are concentrated below and above the nucleus.

Another structure common in cells is tonofibrills. These give support to the cell body, i.e. they serve as frame–work in the cell body. They are well–developed in squamous epithelia.

B. CONNECTIVE TISSUES:

The connective tissues consist of:

(1) Connective tissue proper
(2) Bones and cartilages
(3) Blood and lymph

CONNECTIVE TISSUE PROPER

This tissue contains a lot of fibres and intercellular substances. This is the commonest connective tissue. They are made up of the following types.

(I) Loose Connective Tissue (Areolar)

This connective tissue is a whitish sticky mass and fills out the spaces between organs. Together with blood vessels they penetrate into interior of most organs. It is more like sponge and has a lot of vacuoles which can easily be filled with air.

The Intercellular Substances

These are: (i) The collagen or white fibres
(ii) Elastic or yellow fibres, and
(iii) The ground substance

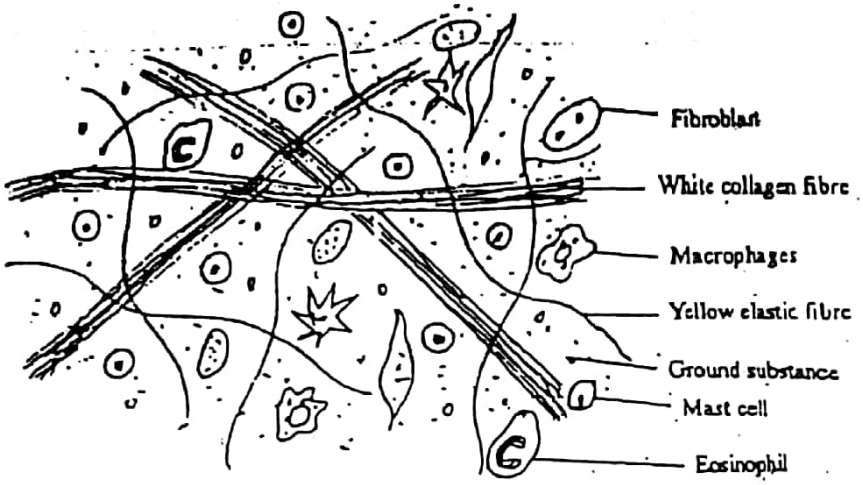

Fig. 5.17 Loose or Areolar Tissue

Collagen Fibres:

These are long wavy threads which measure about 1-12 um in thickness and they run in almost all directions. They are colourless, very flexible and as such they show a great resistance to a pulling force. In boiling water the fibres dissolve and yield what is called animal glue or gelatin. They are easily affected by weak acids and alkali. In an acid medium they are easily digested by pepsin

Elastic Fibres:

These are scarce in the loose connective tissue. They are also very long and run in all directions. They appear brilliant, highly refractive and by far thinner that collagen fibres. They yield easily to stretching and the characteristic constituent of the fibre is elastin. They are highly resistant to boiling H_2O acids and alkali.

Grand Substance:

This is a homogenous material derived from connective tissue cells and it is a complex mixture of proteins, carbohydrates, lipids and water.

Cellular Elements:

These include the following:

Fibroblasts, Microphages, Lymphoid wandering cells, Mast cells, Eosinophils (leucocytes) and Fat cells.

Fibroblasts

These are long flat elements and normally found adjacent to the surface of colleagues fibres. They are believed to be concerned with the secretion of tissue fibres.

(ii) Macrophages:

Normally scattered singly among the fibroblasts. In a normal loose connective tissue the microphage are resting cells, but where there is inflammation they are active and mobile. They may sometimes become phagocytic during which they engulf and destroy foreign bodies.

(iii) Mast cells:

They are smaller in size, oval and flattened. They are said to elaborate anticoagulants in the body. They are also capable of producing ground substance.

(iv) Eosinophils:

Eosinophils are occasionally found in the connective tissue of some glands, e.g. mammary glands and lungs. They are regarded as leucocytes which have migrated from blood cells and have come to settle in the tissue. They have nuclei which are polymorphic.

(v) Fat Cells

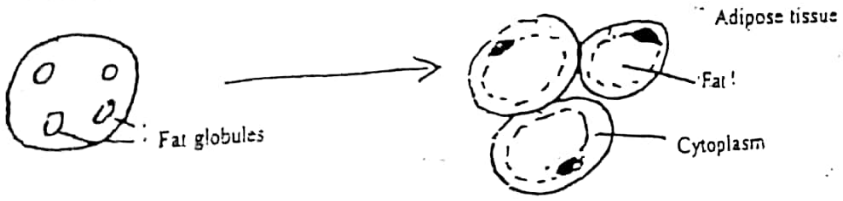

Fig. 5.18 Fat Cells

Certain cells which have fat storing functions are also found in the loose connective tissue especially in blood vessels.

When these fat-storing tissues accumulate in large quantity they are transformed to what is called adipose tissue. A living fat cell is a large spherical body within which the cytoplasm is reduced. This fat tissue may develop in any tissue.

Functions of the loose connective tissue

(i) A medium which supports and surrounds the elements of other tissues and organs.

(ii) It serves as a parking material

(iii) It fills out the spaces between all organs

(iv) The flexible collagenous fibres allow for movement of connected parts in relation to one another

(v) It plays an important role in the nutrition of other tissues which they surround

(vi) The noxious body which may appear between the body are neutralised by the elements of the loose connective tissue.

(vii) Exogenous material, e.g. boils and some of the pathogens which cause them, are dealt with by elements of loose connective tissue.

REGULAR CONNECTIVE TISSUE

The component of regular connective tissue especially collagen bundles are arranged in a regular plan. This arrangement reflects the mechanical requirements of the tissues. These tissues include:

Tendon, Lamellated connective tissue and Fibrillated membrane.

(i) Tendon

The tendons have fibres which are flexible and which offer great resistance to pulling force. The tissues have distinct fibrous structure and characteristic shining white appearance. They are thick, well-packed and the fibres are usually parallel. They show a characteristic longitudinal striation.

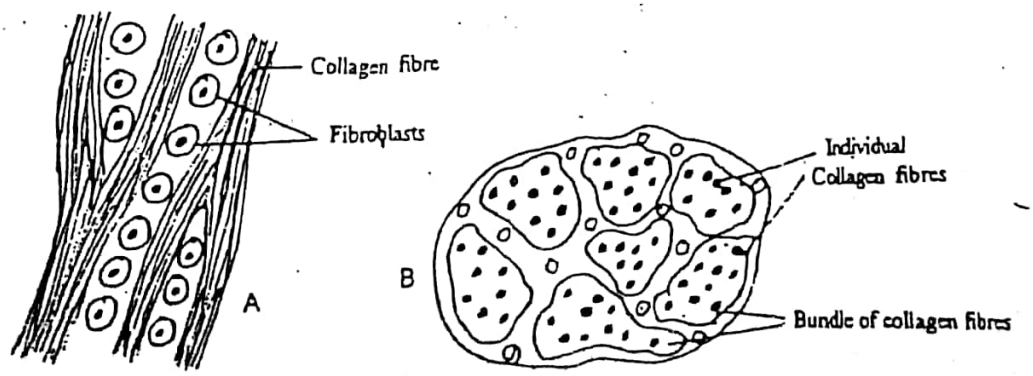

Fig. 5.19 Structure of a Tendon (a) Lateral Section (b) Transverse Section

These fibres appear to join or join at certain areas at acute angles. The elastic network has elastic fibres. The only cell present is the fibroblast which are arranged in long parallel rows in between the rows of the collagen bundles.

Lamellated Connective Tissue.

These are found in small organs or part of organs which are usually cylindrical in shape. They normally form thin but soft resistant protective sheath. They may be looked upon as a condensation of the loose connective tissue found on the surface of the cylindrical structures. They are found: (i) outside the basement membrane in the wall of seminiferous tubule, and (ii) in the perineurium of nerve fibres.

Elastic Tissue:

Some parts of the body have elastic tissue which yield easily to some force. They also regain original length as soon as the force is removed. The elastic fibres dominate and this tissue is usually yellow in colour. This tissue can be found in the following places.

(i) In the vocal cords, where they form parallel fibres,
(ii) In the ligaments of the vertebrates,
(iii) In the ligamentum suspensorium (penis),
(iv) In membranes in the wall of hollow organs upon which a changing pressure acts from within, such as the largest arteries
(v) In the heart, and
(vi) In the trachea and bronchi

Adipose Tissue:

This has predominantly, fat cells which are closely packed. In the narrow spaces between the cells are some compressed fibroblasts, some lymphoid cells and some mast cells. Between these fat cells are collagenous and elastic fibres.

Fat cells usually contain a rich network of blood capillaries. They store neutral fat. The tissue forms soft and elastic pads between the various organs of the body.

Blood

The blood of the adult vertebrate is a red liquid which circulates in a closed system of tubes known as blood vessels. The quantity of blood in man is about 7% of body weight and the liquid matrix is the plasma. The plasma is usually colourless in small quantity but yellow in large quantities. The cells of the blood are:

(1) Erythrocytes (Red blood cells)
(2) Leucocytes (White blood cells)
(3) Blood platelets

Erythrocytes:

In mammals the red blood corpuscles are non-motile and have no nuclei. They have no Golgi apparatus, no mitochondria, and no centriole.

A normal human being has about 35ml of red-blood cells in the body. The normal red blood cell count is about 5.2 million/cubic mm for male and about 4.7 million cubic mm for female.

The size of the erythrocyte ranges from 1.74 - 1.9 μm in diameter. The red blood cells are usually pale or greenish-yellow in colour but in large masses the yellowness gives rise to deep-red colour.

The erythrocytes of mammals are biconcave discs, extremely flexible and soft and can easily be distorted but they can regain their original shape as soon as the force is removed . The red blood cells have marked tendency to adhere to one another by their surfaces so that they form piles known as rouleaux.

Functions:

The red blood cells are carriers of oxygen, In the blood vessels of the lungs, the haemoglobin of red blood cells will combine with oxygen to form oxy-haemoglobin.
Haemoglobin also plays an important part in the elimination of carbon-dioxide.

Leucocytes

These are fewer in number than the red blood cells. They are about 5000 -9,000/mm^3. This figure is higher in children. They are true cells because

e nucleus and cytoplasm and they are amoeboid in shape.

YPES

(1) Lymphocytes

These cells are small and have the same size as red blood cells. They have scanty, clear, homogeneous cytoplasm and a nucleus which almost completely fills the cell.

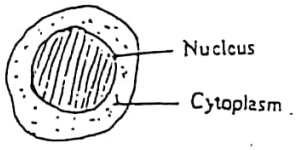

Fig. 5.20 Lymphocyte

(2) Monocytes:

Larger cells than the lymphocytes. They have oval or indented nucleus. They have larger amounts of cytoplasm than the lymphocytes.

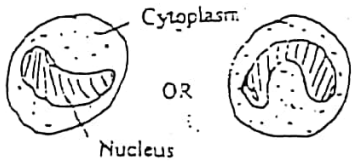

Fig. 5.21 Monocyte

(3) Heterophil Granular Leucocytes (Neutrophil) (Polymorph)

The cytoplasm is filled with fine granules and the nucleus is lobated.

Functions:

They are phagocytic to particulate materials which are harmful to the body. In addition to this, they are sources of antibodies.

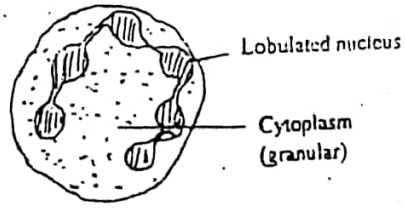

Fig. 5.22 Neutrophil

Blood Platelets (Thrombocytes)

These are small colourless corpuscles. They are round or oval and biconvex in shape. In a blood count they measure about 250,000 to a cubic millimeter. In a fresh blood, the platelets usually agglutinate and stick on to glass. They are very light cells. Since they are very light, if centrifuged, the platelets will stay at the surface of the centrifuged blood.

They are adhesives and this is demonstrated at any point where there is injury. If there is injury, the platelets will agglutinate and adhere to the endothelia lining the injured part. In other words they are very essential in the clotting of blood.

SKELETAL TISSUES

Cartilage

The cartilage is a specialised connective tissue and forms most of the temporary skeleton of the embryo. They also provide a model in which most bones develop. In the adult mammal the cartilage persists as part of joints. It is also found in the respiratory passages and the pinna of the ear. The following types of cartilages exist: (i) Hyaline (glass - like) cartilage, (ii) elastic cartilage, and (iii) fibrous cartilage.

Hyaline cartilage: This is found at (i) the ventral end of the ribs, (ii) on surfaces of bones within the joints, (iii) in parts of respiratory system, and (iv) they are wide-spread in the embryo.

This cartilage is flexible and somewhat elastic, semi - transparent with bluish tint.

Chondrocytes

These cells are mostly spherical; exception are those towards the surface where they become flattened. This flattening out is due to some pressure from outside. Within the lacuna is the cell which completely fills the space.

The Cytoplasm of the cartilage cells (chondrocyte)

This contains long mitochondria, some vacuoles, some fat droplets and some variable amount of glycogen.

Substance (Interstitial Substance)

The cells are usually closely packed and they appear as the framework of cross–beams about the cells. In some, the ground substance looks like a solid mass with cells lining them. Within this mass are some fibres. The cartilage has no blood vessels therefore all nutritive material must have to diffuse through the interstitial substance to the cartilage.

Elastic Cartilage

Elastic cartilage is found in the external ear, in the external auditory and eustachian tube, it is also found in the epiglottis. This cartilage differs from the hyaline cartilage in that it has a yellow colour, it is more flexible and more elastic but the cells are the same as in hyaline cartilage.

The ground substance differs from that of hyaline cartilage in that it is ermeable by elastic fibre.

Fibrocartilage

Fibrocartilage occurs in very few places. It is found at the intervertebral discs (between vertebrae), and in the pubic symphysis.

The tissues contain the same type of cells as other types of cartilage except that the ground substance usually contain thick compact collagenous bundles which usually lie parallel to one another and between these parallel cells are the cartilage cells. The fibrocartilage is said to be a transition between cartilage and connective tissue.

Bone

The bone is a hard specialised connective tissue with a calcified collagenous intercellular substance.

(1) It performs a mechanical function in forming the skeletal support for the body

(2) It protects vital organs of the cranial and thoracic cavity

(3) The bone lodges the bone marrow

(4) The bone serves as a store of calcium. This calcium plays the part of meeting the immediate needs of the animal.

The bone is a plastic tissue and is highly sensitive to alteration of its

normal mechanical function. With use the bone may become fully developed. If not used the bone degenerates.

All bones are covered with a specialised connective tissue called PERIOSTEUM and ENDOSTEUM. The Endosteum covers the bone marrow.

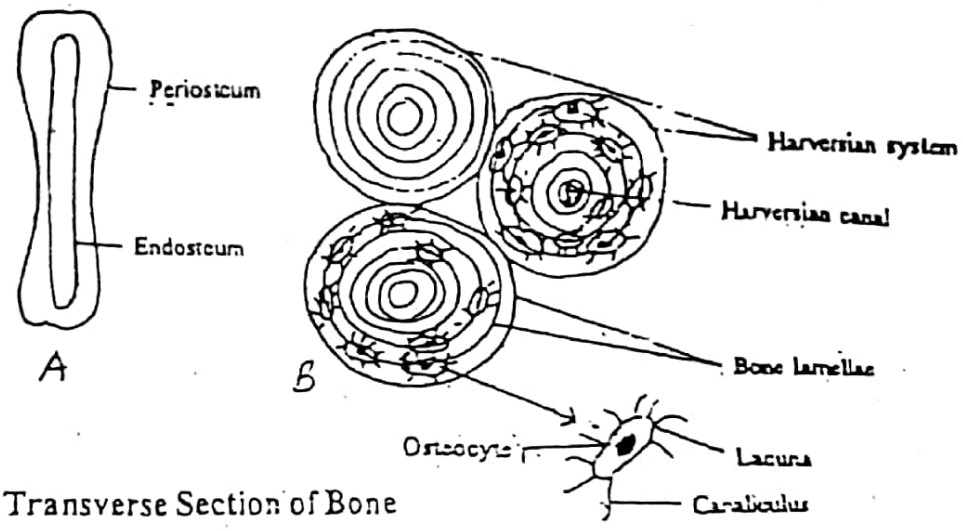

Fig. 5.23 Transverse Section of Bone

The greater part of mass of the bone is made up of layers of ground substance known as lamellae and they are calcified. Embedded in the ground substance are the lacunae and within these are the Osteocytes. From the walls of the lacunae are little apertures running through the whole matrix; these are called canaliculi and they are responsible for the carriage of nutrient substances to the bone. The Harversian canal occupies the centre. It normally carries blood vessels.

Cells of the bone:

These include: osteoblasts, osteocytes and osteoclasts

They are all closely interrelated.

1. Osteoblasts:

Osteoblasts are associated with the formation of bone tissues and are always found on the surface of the bone undergoing development. The body of the osteoblast has a large nucleus and normally contains ribo-nucleic acid and phosphate. The presence of these two substances dictates the function of osteoblast. They are responsible for formation of protein of the bone matrix.

2. Osteocytes:

Osteocytes are osteoblasts which have become-embedded in the bone matrix.

...sts are multinucleate giant cells derived from the cells of the bone ...row as a result of fusion of a number of osteoblasts.

MUSCULAR TISSUES

Smooth Muscles (involuntary)

Smooth muscles contract independently of voluntary control. Striated muscles contract dependently. Cardiac muscle is striated muscle, involuntary and contract automatically and rhythmically.

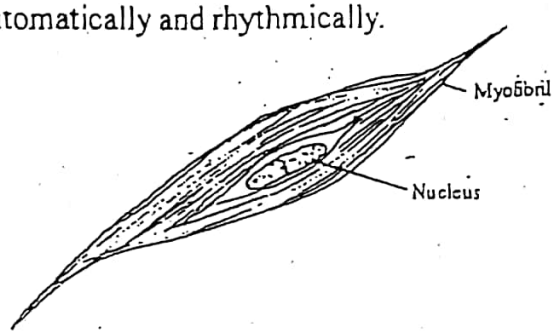

Fig. 5.24 A Smooth Muscle cell

SMOOTH MUSCULAR TISSUE (INVOLUNTARY)

(i) Smooth muscle fibres are present in the contractile portions of the wall of digestive tract from the middle of oesophagus to the anus.
(ii) They are found in the ducts of glands connected with the intestine
(iii) They are also found in the respiratory passages from the trachea to the alveolal ducts
(iv) They are present in the urinary and genital ducts
(v) In the walls of arteries and veins
(vi) In scattered amounts in the connective tissue of the skin and
(vii) In the connective tissue of sensory organs such as the eye.

The muscle fibres appear as long spindle-shaped body which is thickened at the middle and becoming narrow at the apex. The nucleus of this muscle fibre is slightly eccentric and lies about the middle of the muscle fibre and contains a large number of nucleoli. The cytoplasm of the living muscle fibre appears homogeneous but when it is stained, it contains small myofibrils. The liquid contained in the fibres is known as sacroplasm (cytoplasm).

Striated Muscle Fibre (skeletal muscle)

Muscles which are attached to the skeleton consist of striated muscle fibres. When these muscles are teased they are found to consists of long cylindrical fibres. These muscles fibres are large, multinucleate cells. Freshly teased muscle fibre is slightly yellow in colour. The striation is both longitudinally and transversely. These striations (longstriations) depend on the fact that the muscle have striated fibrils. The transverse striation is due to the fact that the myofibril within the muscle fibre consist of cylindrical segments with different refractive index and these segments alternate regularly along the fibre. The bulk of the muscle fibre consists of fibrous proteins and the most important of these proteins are myosin and actin. The muscles also contains glycogen, some lipids and a pigment known as myoglobin.

Sacrolemma: This is a delicate membrane which completely covers the muscle fibre. It is thought to be composed of plasmallema of the cell and the basement membrane of the connective tissue.

Nucleus: The nuclei in the striated muscle are usually elongated in the direction of the long axis of the fibre. They are usually numerous. In the muscles of mammals the nuclei lie directly below the sarcolemma in the sarcroplasm of the cell.

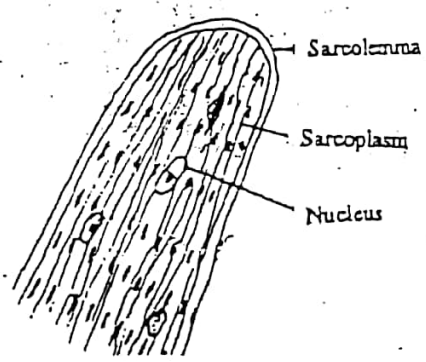

Fig 5.25 One end of a skeletal muscle fibre

Sarcoplasm: This is the cytoplasm of muscle fibre and fills the spaces between the myofibril. It is usually abundant around the nuclei and also immediately below the sarcolemma. This liquid takes part in the nutrition of the myofibrils and in the conduction of excitation through the muscle fibres. The sarcoplasm contains a large number of mitochondria which are known as sarcosomes.

RIL:

e myofibril is composed of cylindrical segments of two main types. The first type of the segments is refractile and this appears dark. It is given the name anisotropic or A-band. Alternating with this is the Isotropic segment or I - band. In the I- band is the Z-band which is about midway of I-band. This I- band seem to have connections with the sarcolemma. The distance between two Z- bands is a sarcomere.

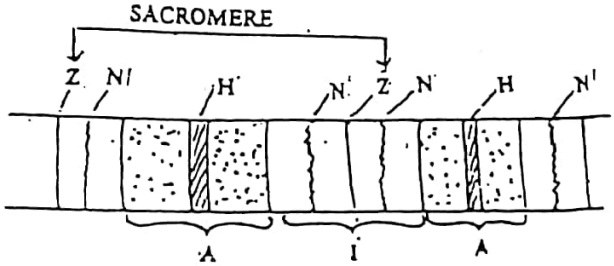

Fig. 5.26 Dark and light zones of myofibrils

CARDIAC MUSCLE TISSUE

The muscles normally contract rhythmically and automatically. The heart of vertebrates is composed of a net-work of peculiar striated muscle fibres which are separate cellular units, joined end-to-end at the intercalated discs.

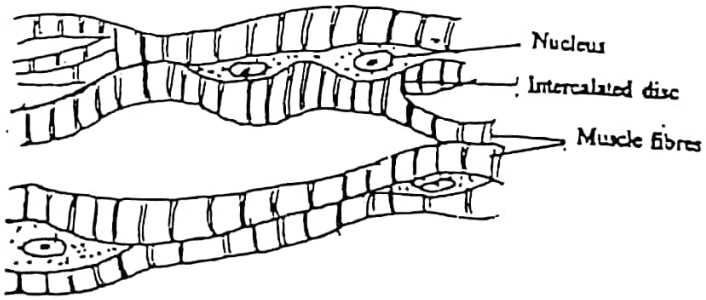

Fig.5.27 Cardiac Muscle

The cardiac muscle fibre consists of nucleus, myofibrils, sarcoplasm and sarcolemma.

Nuclei: In cardiac muscles the nuclei lie inside the myofibril. They are usually surrounded by sarcoplasm. They are oval in shape.

Myofibrils: This is similar to that of the striated muscle fibre and have the similar striations. They have the A, I, Z, N bands.

Sarcoplasm: This is abundant and normally surrounds the nucleus. The MITOCHONDRIA are also numerous - more numerous than in ordinary muscle.

Sarcolemma: This is a thin membrane. It is however not as thick as in ordinary muscle.

Intercalated Discs: Recent studies show that the heart is made up of intercalated discs which are also the sites of attachment of muscle fibres.

THE NERVOUS TISSUE

The entire mass of the nervous tissue in the body forms the nervous system. A central function of this tissue is to receive stimuli from the environment and to transform them into nervous excitations and then to transmit them into higher nerve centres where appropriate responses are carried out.

The Central Nervous System:- This is made up of the brain and the spinal cord. These are the higher nervous centres. It is here that most of the excitations are recognised and appropriate responses are taken.

Peripheral Nervous System:- These nerve tissues are outside the brain and spinal cord. They serve to interconnect all other tissues with the central nervous system.

Basic Unit of the Central Nervous System: The cell within the nervous system which carries out special functions are called nerve cells or neurons.

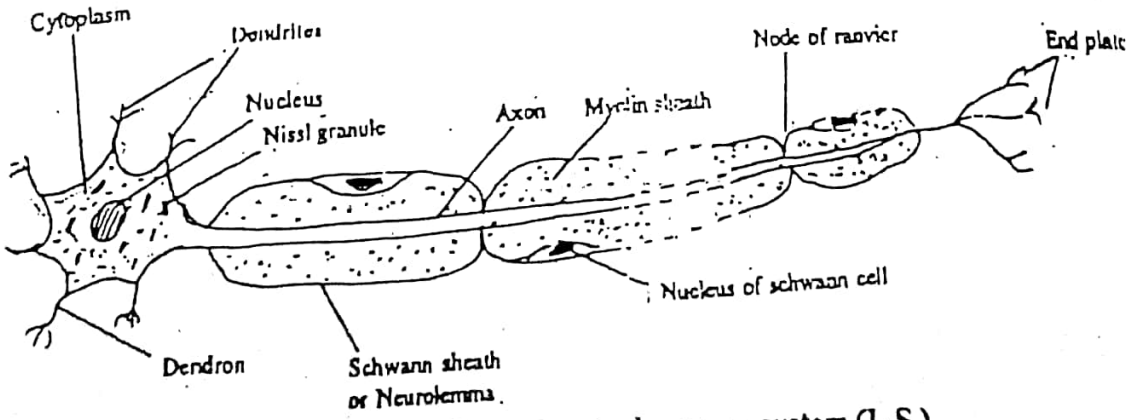

Fig. 5.28 Modulated nerve fibre of central nervous system (L.S.)

The neuron consists of a cell body which is made up of a nucleus and the surrounding cytoplasm. This cytoplasm sends out radiating processes known as dendrites. In addition to this is the nerve fibre or axon (axis). The

...nder is long.

...cleus:- This nucleus is usually large and contains a large nucleus. The chromatin materials within the nucleus is scanty.

Cytoplasm of the cell body: A number of substances are present in the cytoplasm namely neurofibrils, Nissl bodies, mitochondria, Golgi apparatus and centrosome which is present only in embryo

(1) The Neurofibrils are homogeneous threads, which can only be shown by special staining. They are located within the cytoplasm.

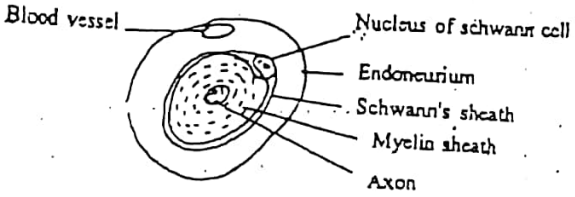

Fig. 5.29 (b) Transverse Section, Modulated nerve fibre

(2) The Nissl Bodies: These are conspicuous and are said to be involved in protein synthesis. The other components present in the cytoplasm are enumerated above. Their functions are similar to what they perform in normal cells.

PROCESSES FROM THE CELL BODY

Dendrites and axon

Dendrites:- These are short processes and are usually restricted to the immediate vicinity of the cell body. They receive nerve, impulses from other neurons. They are divided into primary, secondary and tertiary branches.

Axon: There is usually only one axon to a neuron and this usually arises from the cell body from a small conical elevation known as hillock. It is a very long fibre and does not contain Nisil bodies. Very few of them have branches. At the end, the axon branch to form end–plates.

1: Unipolar neuron: Neurons which have only a single process. Here the axon is usually very large. This type of neurone is found only in the embryo

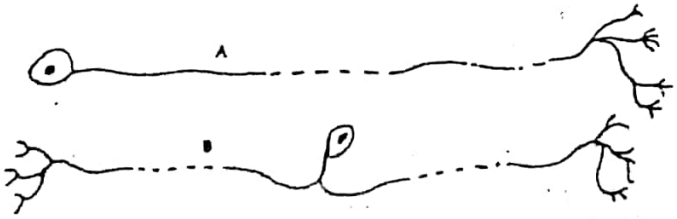

Fig 5.29A Unipolar neuron (B) Pseudo-unipolar neuron

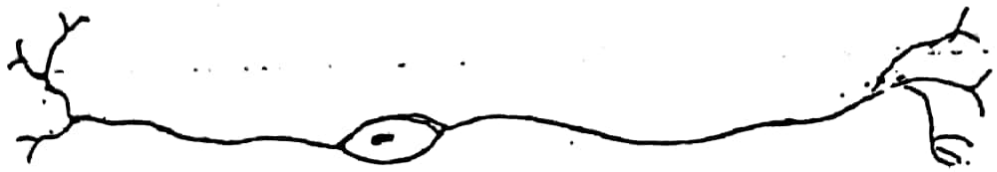

Fig. 5.29(C) Bipolar neuron

2. Bipolar Neuron

The axon and one dendron originate from the cell body. This kind of neurons are found in cells of (i) the retina of the eye (ii) the cochlear of the ear, and (iii) the olfactory epithelia

3. Multipolar Neurons:

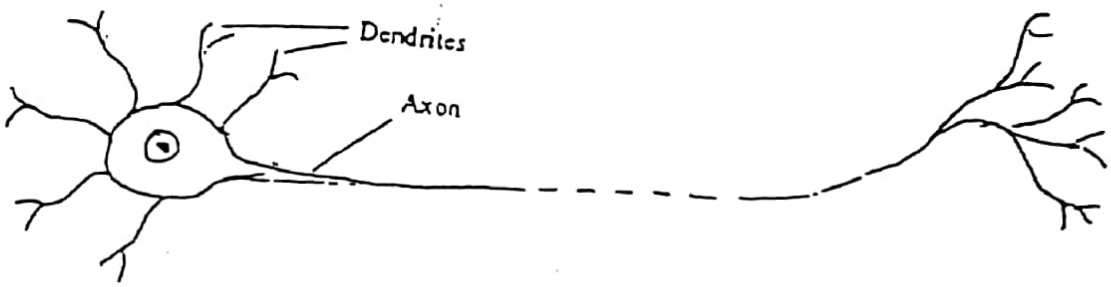

Fig. 5.29(D) Multipolar Neuron

These are found in the Ventral column of grey matter of the spinal cord.

The Nerve fibre

The nerve fibre is composed of axon and its coverings. All axons are associated with a sheath composed of Schwann cells. All axons, except the small ones, are covered with myelin sheath. It is usually common to designate nerve fibres either as myelinated or unmyelinated. The nucleus of the Schwann cells are usually conspicuous.

Axon

This is a thin cylindrical process of uniform size and with smooth appearance. It is somewhat smaller at the node of ranvier. It is made up of neuroplasm, some mitochondria but lacks the Nissl granule.

Schwann Sheath

This is the neurolemma. It envelopes all axons of the peripheral nerves.