

5.5 BIOLOGY NOTES 2020

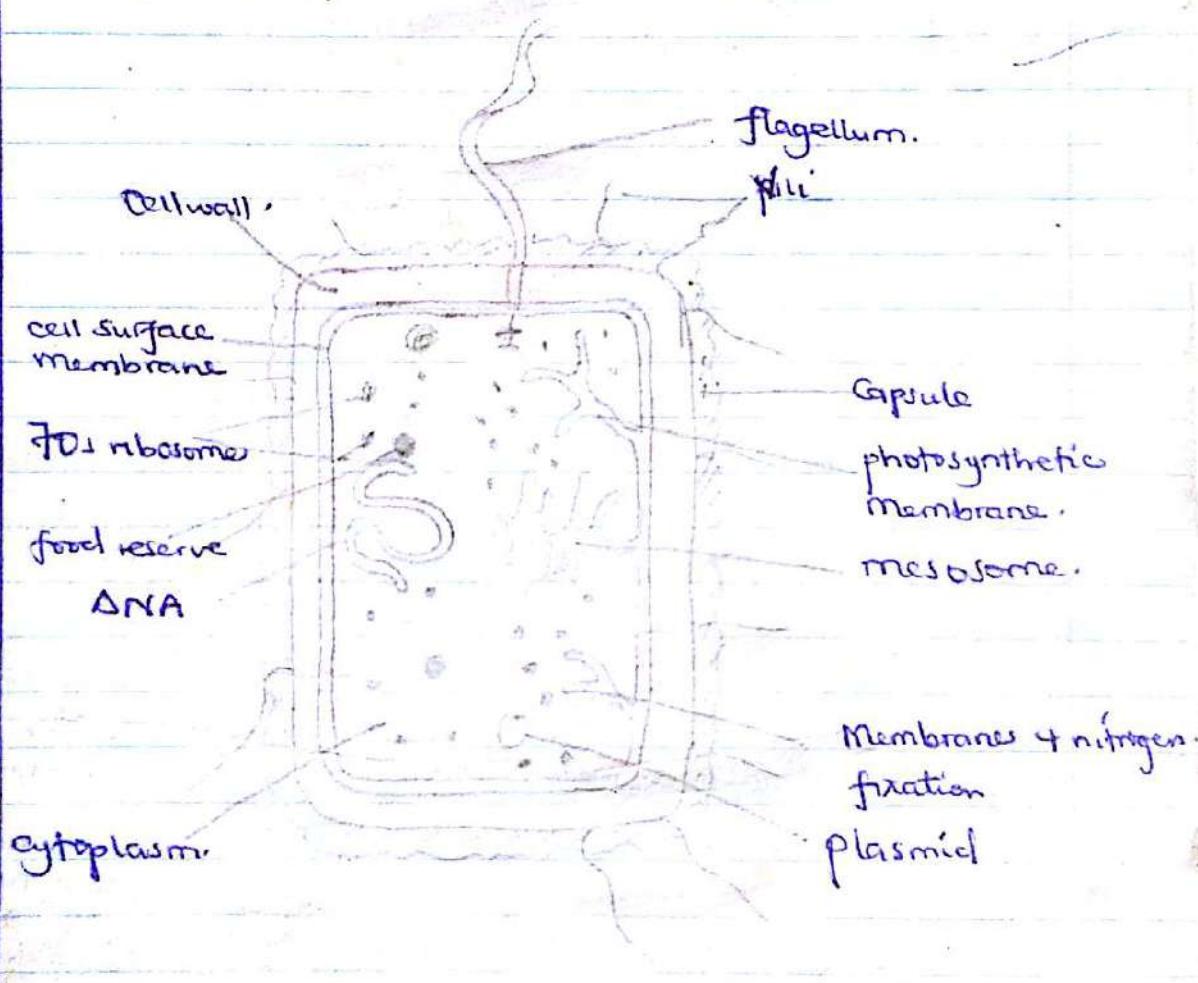
PROKARYOTIC AND EUKARYOTIC CELLS

PROKARYOTIC CELL

prokaryotic cells are cells w/c lack a nuclear Membrane and Membrane bound organelles eg: bacteria cell blue-green algae.

These cells are the most ~~per~~ ancient group of organisms with simpler cell structure lacking an organell nucleus and hence their DNA ~~struc~~ material is not enclosed by a cell Membrane.

A TYPICAL PROKARYOTIC CELL.



EUKARYOTIC CELLS

Are cells which have a nucleus enclosed with a nuclear Membrane and also have Membrane bound Organelles eg Mitochondria, Cytoplasm, chloroplast.

The best examples are cells of high plants and animals.

THE STRUCTURE OF AN ANIMAL CELL

Exocytosis is of secretory product.

Secretory vesicle

Golgi vesicles

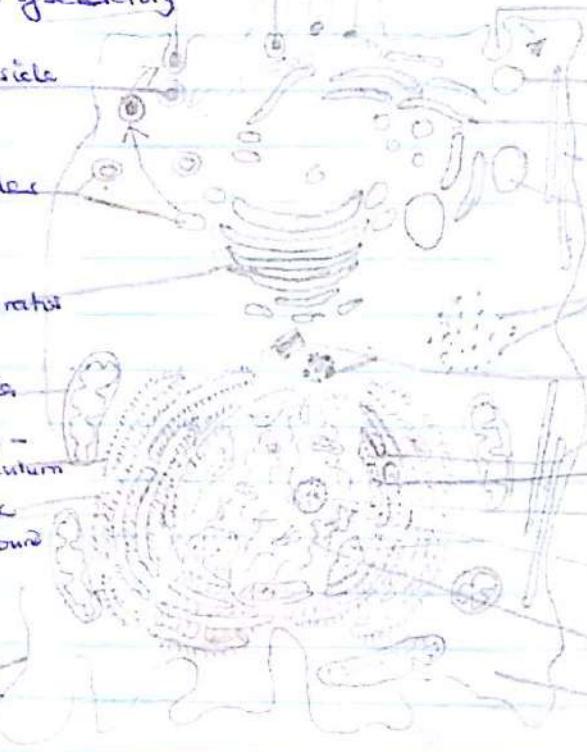
Golgi apparatus

Mitochondria

Rough endoplasmic reticulum

Smooth endoplasmic reticulum bound ribosomes

Cell surface Membrane



pinocytotic vesicle forming pinocytotic vesicle

Smooth endoplasmic reticulum, microtubules often near cell periphery, lysosome.

Free ribosomes scattered throughout cytoplasm, two centrioles at right angles to each other and close to nucleus, nuclear pore.

Nuclear envelope (two membranes).

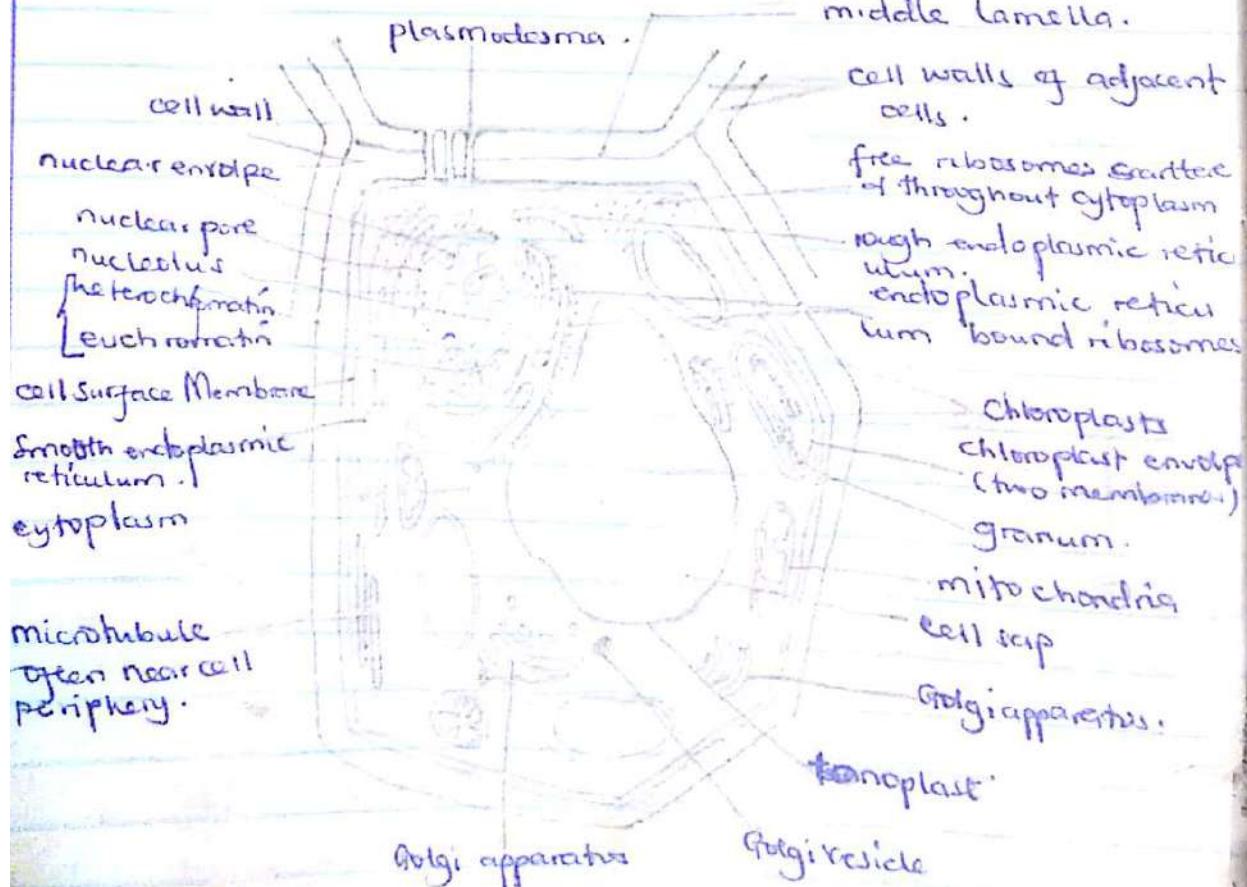
Nucleolus

Heterochromatin

Euchromatin

Cytoplasm

THE STRUCTURE OF A PLANT CELL



Middle lamella.

Cell walls of adjacent cells.

Free ribosomes scattered throughout cytoplasm, rough endoplasmic reticulum, endoplasmic reticulum bound ribosomes.

Chloroplast, chloroplast envelope (two membranes), granum.

Mitochondria, cell sap.

Golgi apparatus.

Tonoplast.

Golgi vesicle

COMPARISON BTW EUKARYOTIC AND PROKARYOTIC CELLS.

Similarities

- In both cells the protoplasm is surrounded with a selectively permeable Membrane.
- The Membrane binding the protoplasm consists of Lipids and proteins.
- Both contain the cytoplasm.
- A cell wall is present in some eukaryotic cell and prokaryotic cells.
- Both contain DNA Material.
- Both cells have the ability to replicate.

Differences

Prokaryotic cells	Eukaryotic cells.
→ Don't have the true nucleus. → And so has no nuclear Membrane.	→ Have a nucleus bound in a nuclear Membrane.
→ Contain single stranded DNA which lies in the cytoplasm.	→ DNA is double stranded.
→ Energy yielding reactions occur in mesosome	→ Energy yielding reactions occur in Mitochondria.
→ Contain small amount of DNA	→ contain large amount of DNA
→ DNA is not associated with protein & RNA to form chromosomes	→ DNA is associated with protein and RNA to form chromosomes.
→ They lack Membrane bound Organells	→ They contain Membrane bound Organells such as protoplasm in mitochondria and nucleus
→ They contain small ribosomes (70S)	→ have large ribosomes (80S)
→ flagella if present lacks "9+2" of microtubules arrangement	→ flagella if present has "9+2" tubules arrangement.
→ They do not have a system of interconnected channels	→ They have an Intercellular system of connected Membrane channel.

- The cell walls contains polysaccharides with amino acid and is strengthened by murein (polysaccharides).
- photosynthesis occurs on the photosynthetic Membrane
- The cell wall (in plants) contain polysaccharide cellulose which is the strengthening material.
- It takes place in chloroplasts.

DIFFERENCES BTW PLANTS AND ANIMAL CELLS.

Plant cell	Animal cell
→ contain a tough rigid cellulose in the cell wall.	→ They lack a cell wall
→ pits and plasmodesmata are present.	→ No pits and plasmodesmata.
→ Have a middle lamella joining the cell wall and adjacent cells.	→ Do not have a middle lamella.
→ Plastids (chloroplasts and leucoplasts) are present in large numbers.	→ plastids are absent
→ contain a nucleus at the edge of the cell.	→ The nucleus occupies the central position of the cytoplasm.
→ Chloroplast is present around the Vacuole.	→ Tonoplast is absent.
→ Lysosomes not normally present.	→ Lysosome normally present.
→ Centrioles absent in other plants.	→ Centrioles present.
→ Cili and flagella are absent in higher plants.	→ Cili and flagella are present.
→ Starch grains present as storage materials.	→ Glycogen grains present as storage materials.

~~Hypothesis~~

Daniel & Davison model
The protein molecules are not static
protein molecule feed off the whole membrane

Engle & Nicolson
protein molecules are static
protein molecules are attached on the layers of the phospholipid

~~Start~~ THE PLASMA MEMBRANE.

The plasma Membrane acts as a boundary between the cell and the environment. It permits different substances to pass through them, different nutrients ~~were~~ other substances ~~are~~ but not able to pass through it hence ~~it is~~ described as a partially permeable Membrane or semi-permeable membrane.

The cell Membrane is also known as the ~~plasma~~ Membrane since it binds the protoplasm which is ~~the living~~ ~~other~~ part of the cell. All cell Membranes have ~~basic~~ cell structures!

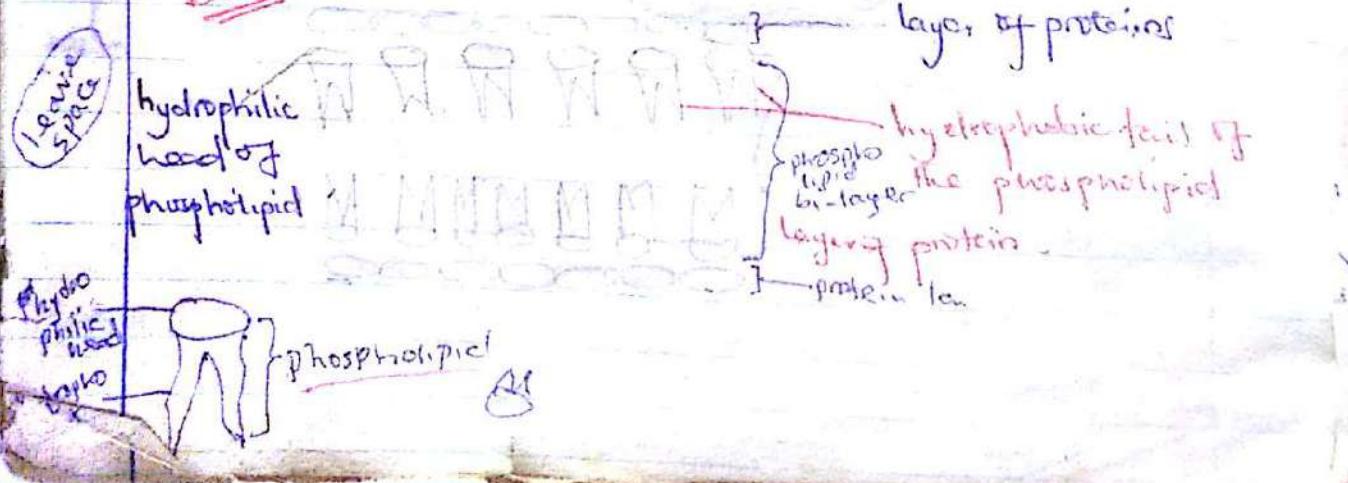
The Molecular structure of the cell Membrane was first studied by Daniel and Davison. The ~~first~~ scientist who put the theory to explain the structure of the cell Membrane.

The Daniel-Davison Model of plasma Membrane

According to this model, the plasma Membrane consists of a double layer of phospholipids, sandwiched between two layers of protein Molecules.

The lipid Molecules are positioned at right angles so that their hydrophilic heads of phospholipid Molecule face on the opposite side of the Membrane while the hydrophobic tails are directed towards the centre.

Draw



~~THE FLUID MOSAIC STRUCTURE & MODEL OF PLASMA MEMBRANE~~

Singer and Nicolson studied the ultra-structure of cell membrane and put out the fluid mosaic Model.

According to this Model the plasma Membrane consist of a bi-layer of phospholipids with hydrophilic heads of phospholipid molecules facing outwards into ~~outwards~~ environment, and ~~inwards~~ and outside the cell, while the hydrophobic tails face each other towards the centre of the Membrane.

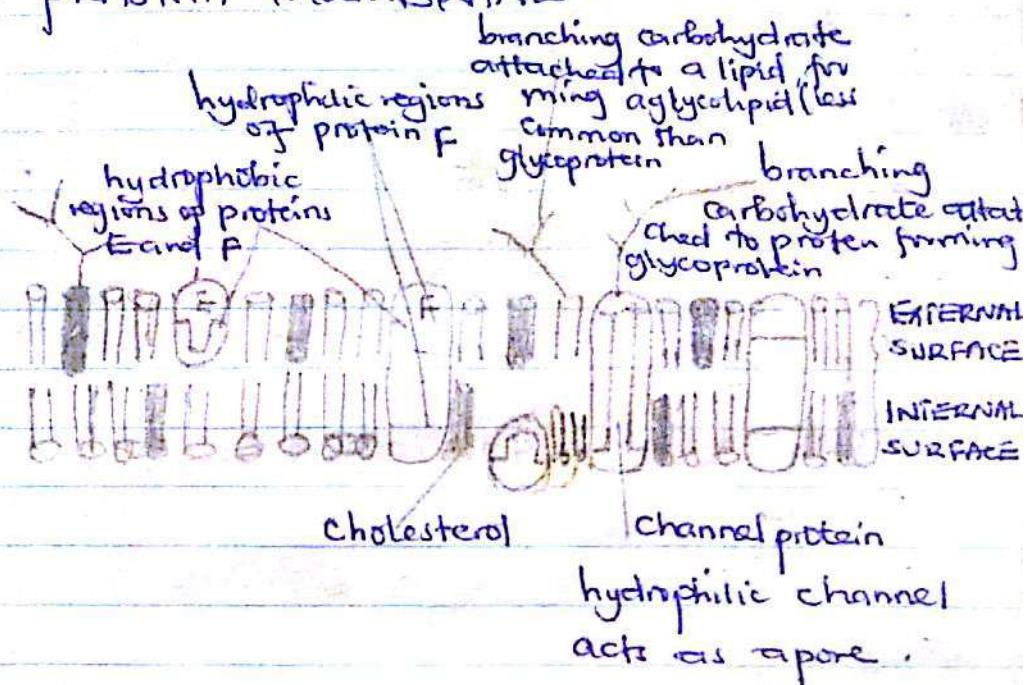
The protein Molecules are scattered with in the phospholipid layer and the phospholipid Molecules move about them selves in a fluid layer. The ~~affid~~ proteins interact with the fluid phospholipid bi layer to form a fluid mosaic pattern. Some protein Molecules penetrate into the phospholipid ~~layer~~ and these are known as Intrinsic proteins while some protein Molecules attach on the surface of the phospholipid Molecules and these are called extrinsic proteins. Some Intrinsic proteins penetrate through both layer of phospholipids and these are called transmembrane proteins. Some protein and lipid Molecules interact with carbohydrate forming glycoprotein and glycolipid respectively. The plasma ^{membrane} also contains cholesterol which increases flexibility and stability of plasma Membrane.

Cholesterol

THE DIAGRAM SHOWING THE FLUID MOSAIC MODEL OF PLASMA MEMBRANE.

DRAW
BE

Leave space



TRANSPORT ACROSS THE PLASMA MEMBRANE.

Ions and larger polar molecules, sugars, amino acids, fatty acids and glycerol are rejected by the hydrophobic region of the cell membrane.

These substances majority diffuse through the protein channels and carrier protein into or out of the cell.

Mineral ions enter through ion gated channels in the out of the cell. Water Molecules are and hence would be rejected by phospholipids. water Molecules are smaller and hence to the enter the cell through phospholipid bilayers. Non polar substances are transported across the phospholipid layer.

cell
polar
However
mole
across

- functions of proteins in the plasma membrane
- Some proteins are carrier proteins which are involved in selective transport of polar Molecules and ions through the cell Membrane. the process facilitated by diffusion or active transport.
 - Some protein Molecules act as enzymes which catalyses various chemical reactions.
 - Some proteins in the Membrane act as receptor Molecules eg hormonal receptors, receptor for neural transmitters and hence these proteins are involved in chemical signalling between cells.
 - Some proteins act as Identity Markers (antigens) so that they can be recognized by the body's immune system.
 - This property is very important in the body's defence against diseases
 - Some proteins in the plasma Membrane form protein channels, through which ions and polar Molecules diffuse in and out of the cell.

Cell ORGANELLES

The nucleus:

Nucleus is found in the eukaryotic cells except Mature phloem, Haeme tube elements and Mature red blood cells.

The nucleus is the largest of cell organelles. It is a double Membrane organelle (ie it is enclosed by an envelope ie (nuclear envelope)).

The outer Membrane of an envelope is continuous with endoplasmic reticulum which may be covering ribosomes (rough endoplasmic reticulum or) May be a smooth endoplasmic reticulum (lacking ribosomes)

The nuclear envelope is perforated with nuclear pores which provide passage for material in and out of the nuclear plasma hence facilitates the exchange of materials b/w the cytoplasm and the nuclear plasma.

The nuclear plasma also contains chromatin which extend into chromosomes during cell division.

The nucleus also contains DNA (genetic material) and a nucleolus where ribosomes are synthesised. In the nucleolus also ribosomal RNA is manufactured.

In the nucleolus also ribosomal RNA is manufactured

FUNCTIONS OF THE CELLS NUCLEUS.

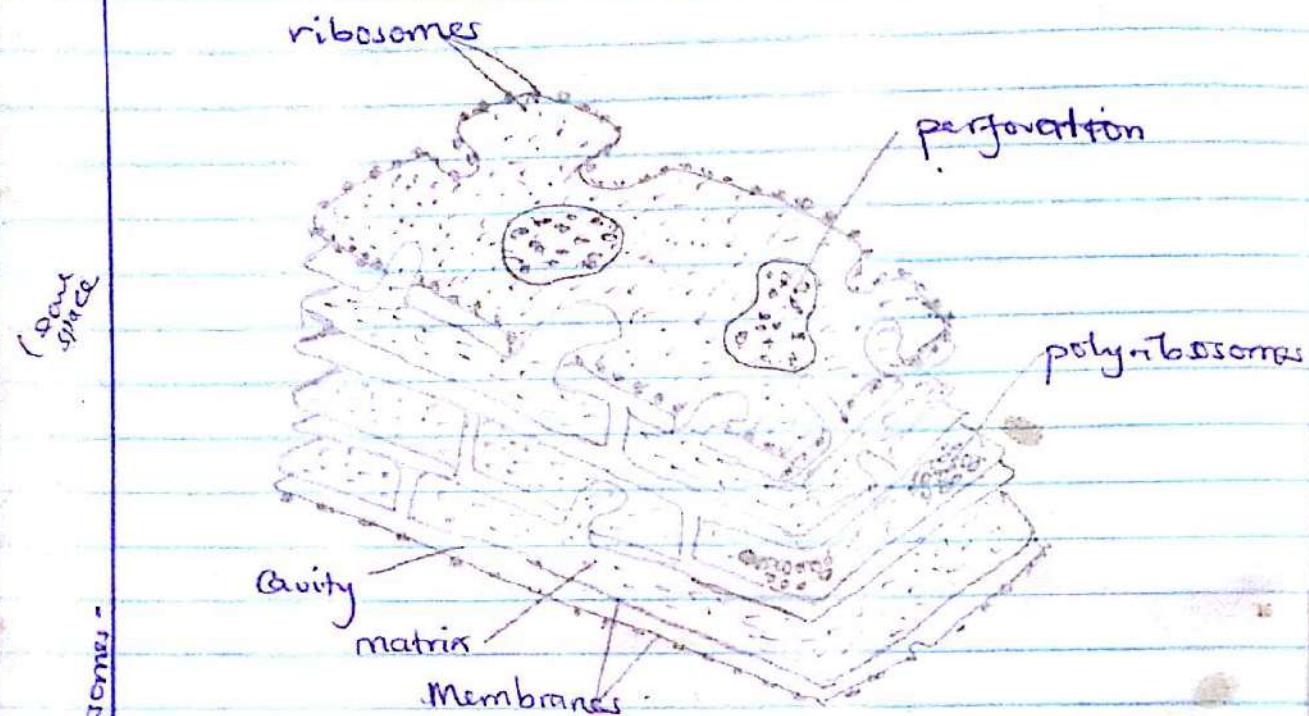
- It controls the activities of the cell.
- It is the site for protein synthesis of messenger RNA.
- Ribosomes are manufactured in the nucleolus.
- It contains DNA.
- It controls cell division in the cell.

ENDO PLASMIC RETICULUM

This is a network of system of flattened membrane channels called cisternae. It is continuous to the outer Membrane of the nucleus to form a series of sheets to which its ribosomes are attached. Then it forms rough endoplasmic reticulum and if no ribosomes then it is smooth endoplasmic reticulum.

(responsible for transportation of materials in a cell)

A DIAGRAM SHOWING FLATTENED MEMBRANES OF ROUGH ENDOPHASIC RETICULUM:



Functions of rough endoplasmic reticulum.

- Having extensive system of Membranes. It provides large surface area for transportation of materials in the cell.
- It isolates and transports proteins after manufacture. cyto
- It provides the structure skeleton to the cell which enables a cell to maintain its shell.
- It's responsible for collection and storage of Manufactured Materials in the cell bcz they are shade out of the cell.

Functions of smooth endoplasmic reticulum.

- Responsible for synthesis of lipid and Steroids and their transport to be the same.
- It synthesizes polysaccharides
- It is responsible for formation of lysosomes.
- provides vesicles which lead to formation of Golgi body.

- Provides surface area for detoxification
- It also synthesises cellulose
- It contributes on the structural skeleton of the cell.

GOLGI

GOLGI BODY

→ This structure is similar to smooth endoplasmic reticulum. It consists of membrane bound channel known as Cisternae. The golgi apparatus is well developed in secretory cells where it is essential for processing and transportation of substances that are yet to be transported across the cell membrane for secretion.

The Golgi apparatus modified synthesised carbohydrates and proteins in the cells whereby it forms glycoproteins and glycolipids which are hormone cell secretions.

Proteins from the endoplasmic reticulum form vesicles of materials being transported which are budded off and fuse with the membranes of the golgi apparatus from which vesicles pitch off and fuse with the cell membrane to discharge secretions.

How is the golgi apparatus formed?
 Vesicles ^{cut} pitch off from the smooth or rough endoplasmic reticulum and fuse to form a system of Membrane sacs (Cisternae). The membranes formed become extensive to form a system of interconnected - Membranes. We are now at their stage of maturation called Golgi body.

~~processing~~ and transportation of substances for secretion by the Golgi body.

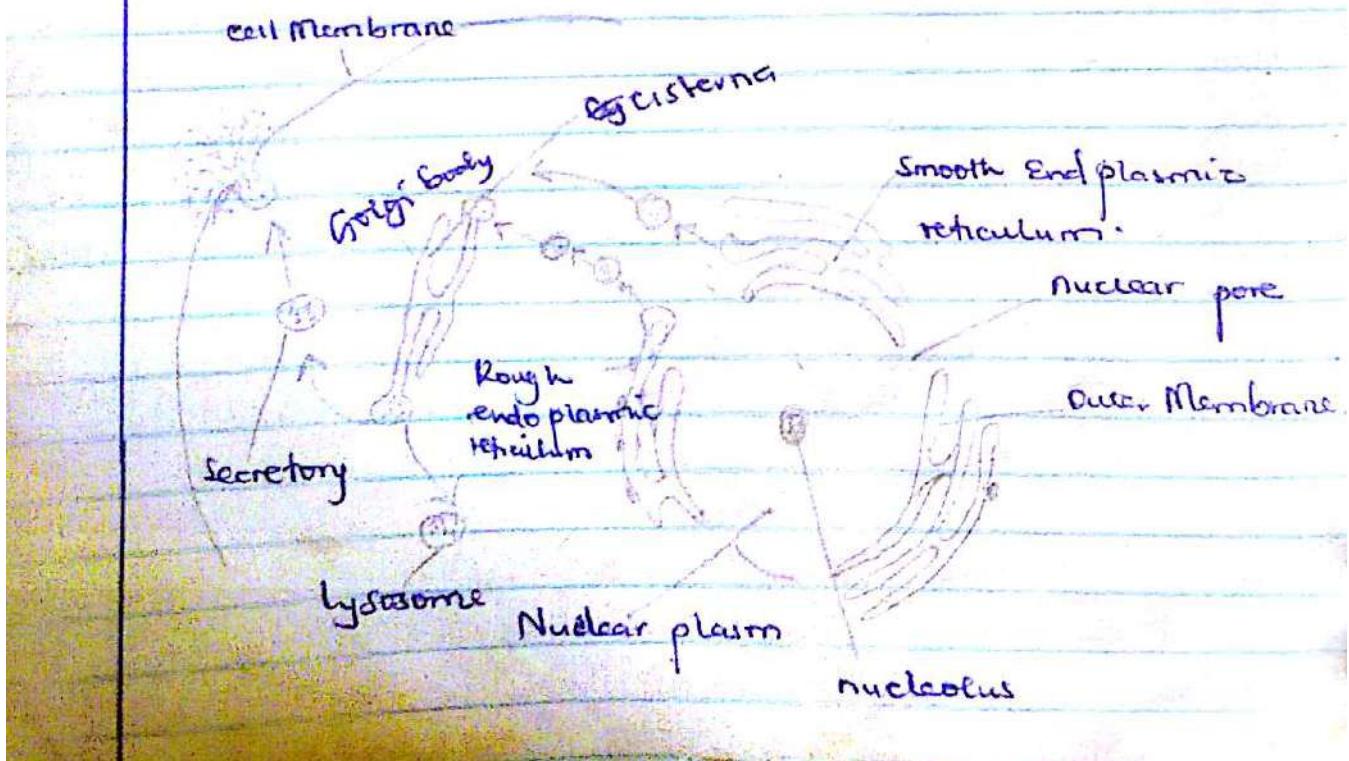
The proteins formed from ribosomes of rough endoplasmic reticulum and the lipids and steroids formed from the smooth endoplasmic reticulum are not at their final stage of being secreted from the cell.

These substances have to be channeled through the golgi apparatus in which they are modified and processed into useful secretory materials.

Vesicle

Vesicles containing carbohydrates, lipid, proteins from the endo plasma reticulum pinch off from the flattened Membranes to form Vesicles which move towards the golgi body and fuse with the system of Membrane to empty their content into

The Membrane, while inside the golgi body ^{substances} are sorted, modified and processed into useful secretory substances. Later alone the processed substances are transported through the Membrane channels of the golgi apparatus and form vesicle which bud off to form secretory vesicles ^{to release their content} fuse with the cell Membrane and discharge the content outside the cell.



GENERAL FUNCTIONS OF GOLGI BODY

- processing and transportation of secretory substances eg glycolipids, glycoprotein and enzymes.
- Responsible for formation of lysosome.
- Involved in prodn of secretory enzymes like digestive enzymes found in pancreatic juice.
- Responsible for formation of cell wall in plant cells by synthesis of cellulose.

Chloroplasts

belongs to a large group of organelles known as plastids. Chloroplasts have ~~an~~ ^{or chloroplast} envelope (double Membrane) ie the inner and outer Membrane. They are oval in shape. Inside the ~~envelope~~ ^{chloroplast} There are two distinct regions ie a matrix known as Stroma and stacked Membranes called grana.

Each granum consist of 2-100 closed flattened stacks called thylakoids in which photosynthetic pigments such as chlorophyll are situated.

Within the stroma are also series of starch grains which act as temporary stores of carbohydrates and there are small amounts of DNA. Oil droplets also occur in stroma and ribosomes (polyribosomes) which may be in groups or they may be individually scattered in the stroma.

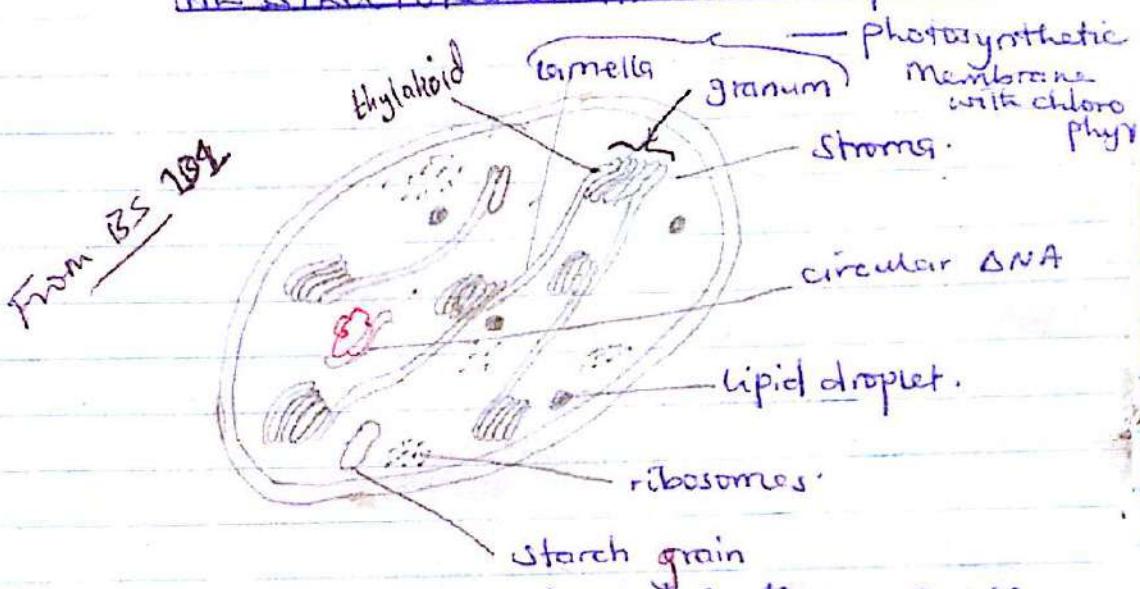
The stroma contains a variety of enzymes involved in the light independent stage of photosynthesis.

The chloroplast is a photosynthetic organellie where photosynthesis take place producing sugars from water and CO_2 using sunlight.

~~Chloroplast~~
is a photosynthetic
organelle.

~~energy~~. In fact the light dependent stage (light stage) occurs in the Thylakoid Membrane while the light independent stage (dark stage) takes place in the Stroma.

THE STRUCTURE OF THE CHLOROPLAST.



How chloroplasts are adapted to their function

- They are bounded by double Membrane (envelope) to isolate photosynthetic reactions from other cellular activities.
- They contain numerous thylakoids to hold chlorophyll in suitable position of trapping maximum light.
- Thylakoids are stacked on top of each other to form grana to provide a large surface area for light dependent reactions to take place with in the little space.
- Also contain enzymes in the stroma, for photosynthetic reaction.

PLASTIDS

They are small bodies of various shapes found in the ~~cytoplasm~~ ^{chloroplast} of plant cells but absent in fungi.

They contain their DNA and good reserve materials. Some plastids are pigmented whereas some lack pigments.

- Both of them have DNA
- Both of them have an envelope (double membrane organelle)
- Both of them have ribosome

Both of them have a matrix

~~Those that are pigmented are called chromoplasts.~~

wlc include chloroplasts, and those wlc are non pigmented are called Leukoplasts.

All plastids contain a fluid matrix called stroma.

CHROMOPLASTS

The most common ^{Chromoplast} ~~plasto~~ in cells in green plants are the chloroplasts wlc give the leaf a green colour.

Other chromoplasts in plants occur in variety of colours like orange, yellow, red etc due to presence of pigments in them such as carotenes and Xanthophylls. Xanthophylls.

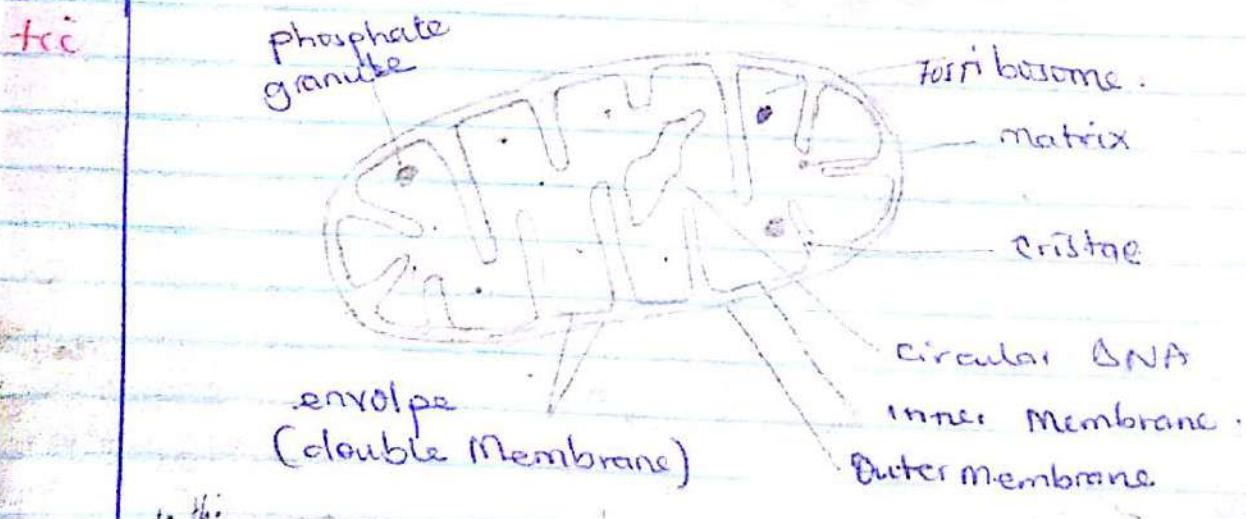
Some other chromoplasts also occur in pericarps of fruits and petals of flowers. ^{Pericarp}

LEUKOPLASTS

These plastids lack pigments. They are found in cells of those plant tissues wlc are not normally exposed to light eg roots and underground stems. Majority ~~they~~ are responsible for food storage in the cells.

MITOCHONDRIA

THE STRUCTURE OF A MITOCHONDRIA.



to this

Krebs

It is a rod shaped double Membrane bound -
Organelle in which energy is produced in cells in
Eukaryotic cells.

The inner Membrane is highly folded to give
rise to partitions known as Cristae which are
sites of energy production through ~~H₂O~~ Oxidative
phosphorylation and electron transport. Also -
contain a matrix which is a site of Krebs cycle
leading to energy production. In the matrix also are
ribosomes and coiled strand of DNA.

The presence of ribosomes in the matrix suggests
that Mitochondria carries out its own protein -
Synthesis enzymes while the presence of DNA
suggests that the Mitochondria is capable of
self replication (division).

~~which~~
~~life~~
Cells ~~rate~~ require a lot of energy e.g. cells of
epithelial lining where materials are absorbed
by active transport contain numerous mitochondria

Comparison b/w chloroplast and Mitochondria

Similarities

- They both contain their own nucleic acids (DNA & RNA).
- Both have a fluid matrix.
- Both are bound by a double Membrane (envelope).
- Both contain their own ribosomes.
- Their Membranes consist of lipoproteins.
- Both contain inter Membranal spaces.

Differences

Mitochondria

- The Inner Membrane is highly folded to form cristae.

chloroplast

- The Inner Membrane when folded form lamella.
↓
Unfolded

→ Lacks Internal Membrane
strom system

→ lacks pigments.

→ Rod shaped

+ functioning releases energy
in cell

ribs are absent

Lysosomes

are found in most eukaryotic cells, and are simple
of by a single membrane to form sacs
contain digestive enzymes such as lipases
proteases.

enzymes are normally collectively referred

Lysozymes

Lysosomes are produced by budding off
body and some times the endoplasmic

enzymes contained in the lysosomes are
from attacking the content of the
m of the cell) by their binding Memb

When lysosomes lyse / rupture, they release
w/c carry out self digestion of the cell
ie they are found in the process known
catalysis and for this reason lysosomes are
as suicide bags in the cell.

FUNCTIONS OF THE LYSOSOMES,

are responsible for digestion of worn out
w/in the cell. Any resulting
nutrients are then absorbed back into the
sm while the indigestive material form
vesicle w/c full with cell Membrane to

The lone Membrane when

Contain Internal Membrane stm
eg lamella and thylakoid.

Contains pigments eg chlorophyll.

oval shaped.

functionally release they
out photosynthetic rgn.

starch grains are scattered
with in matrix.

Starched

They o

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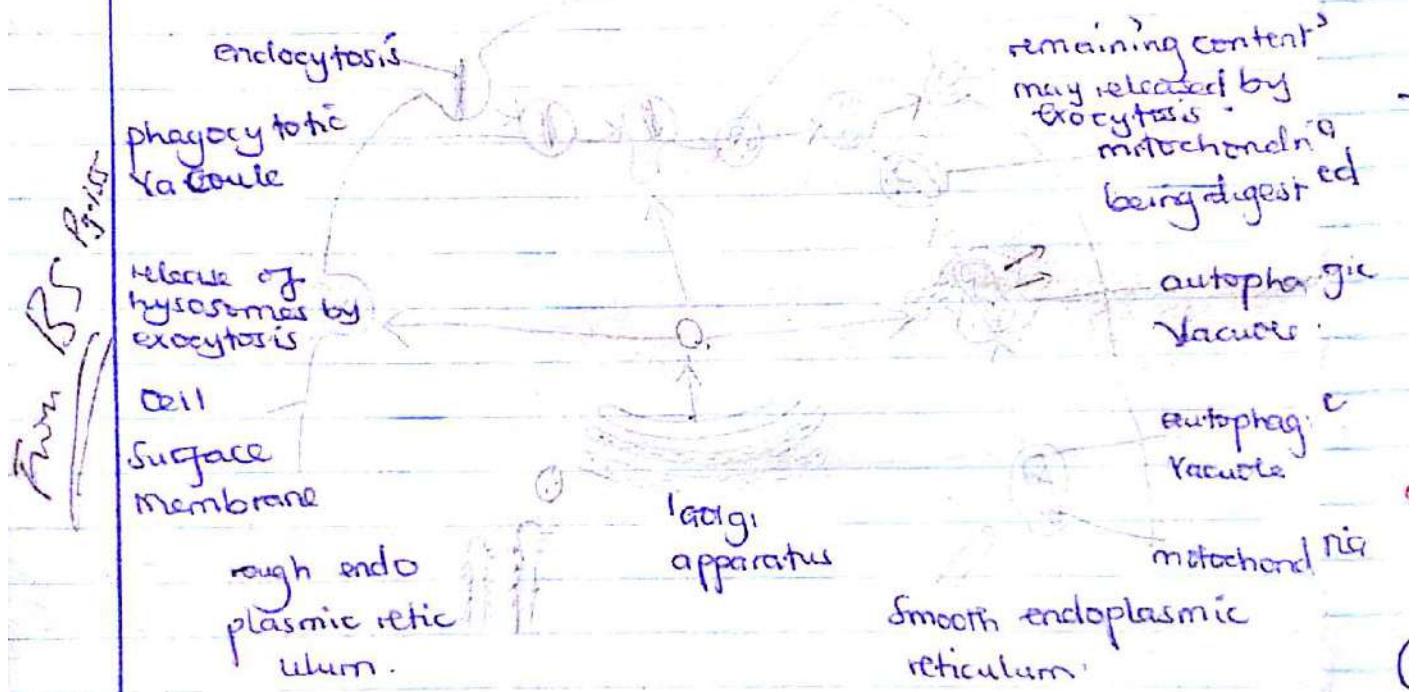


Phagocytic

eliminate its content outside the cell.

2. Digestion of food materials taken into the cell by phagocytosis. Lysosomes usually secrete their enzymes ~~in~~ ^{into} their phagocytic vesicle after w/c the useful products of digestion are observed into the cytoplasm.

digestion



3. Autolysis: It is a process by w/c cells that are old, dead, worn out or damaged ^{are} destroyed by lysosomal enzymes. For this reasons this process is also known as self digestion.

Autolysis is also important in the developmental stages of animals like Tadpoles for resorption of the tail; Autolysis clears cells for new cell growth.

CELL VACUOLE

This is a fluid filled sac bounded by a single membrane called the Tonoplast.

Mature plant cells have a large centralised vacuole, contains a solution of sugars, mineral salts, organic acids, pigment like anthocyanin and organic acids plus some hydrolytic enzymes called cathepsins.

Volute??

Major functions of the vacuole.

- The sugars and amino acids act as temporarily food - stored in the cell hence a vacuole is a storage organelle.
- The anthocyanin contained in the vacuole is a storage pigment of various colours in leaves and petals ~~of~~ for flowers for attracting pollinators and in fruits to attract animals for dispersal.
- Contains hydrolytic enzymes which perform functions similar to those of lysosomes.
- The vacuole enhances turgidity in non. woody plants and leaves by contributing to the osmotic properties of the cell attributed to the solute volute accumulated in it.

Step

NON MEMBRANE BOUND STRUCTURE

IN THE CELL.

- ① ribosomes (function is manufacturing protein) granules
- Are small cytoplasmic granule found inside the cell. They may be free in the cytoplasm or bind to membrane system like endoplasmic reticulum.

In eukaryotic cells, they are bigger and ~~so as~~ 80's type while in the prokaryotic cells, ~~are~~ 70's type.

A group of ribosomes may occur in the cytoplasm making a chain and this is called polysomes / polyribosomes.

Function of ribosomes

STORAGE GRANULES.

Every cell contains a limited store of food ~~which~~ may be in form of soluble materials such as sugar found in vacuoles of plant cells or insoluble material in form of glycogen, in cell

granules

sugars in animal cells, starch grains in plant cell, fat droplets in animal cells and oil droplets in plant cells.

Major functions of the vacuole:

The

FUNCTIONS OF RIBOSOMES

They are responsible for protein synthesis in the cell.

③ MICROTUBULES

These occur widely throughout the Eukaryotic cells but absent in prokaryotic cells.

They are composed of two similar proteins ie alpha (α) and Beta(β) tubulin.

They are distributed within the cytoplasm but also may occur in bundles.

FUNCTION OF MICROTUBULES

- They form a framework on w/c cellulose wall is built for the case of plant cell.
- They are used in transportation of Materials especially in plant cell for instance, translocation by cytoplasmic streaming
- They form spindle fibres w/c are important in Cell division.
- They are involved in formation of centrioles, flagella and cilia.

MICRO ~~ELEMENT~~ FILAMENTS

Long thin solid fibres smaller than microtubule

They are made up of proteins of different types and themselves are of two types.

Thin filament - contain a protein called actin.

Thick filament - contain a protein called Myosin

Myosin

FILAMENTS FUNCTIONS OF THE MICRO ELEMENT

- ① They are used for cell Mov'ts
~~Involved in the formation of vesicles ie the contractility~~
- ② enable the cell Membrane to form in foldings w/c lead to formation of vesicles.
- ③ Together with Microtubule, they contribute to ^{Cytoskeleton} ~~cytoskeleton~~ of the cell.

CILLIA AND FLAGELLA.

Cilia and flagella are found in some cells w/c are usually mobile or concerned with absorption of substances.

Cilia and flagella are almost similar ~~except~~ ^{except} cilia flagella:

- | | |
|---------------------|----------------------|
| 1. Are usually many | - one in most cases |
| 2. shorter | - longer than cilia. |

In eukaryotic cells they both consist of pairs of peripheral microtubules surrounding central pair of microtubule and this arrangement is referred to as the "9+2" pattern.

THE CROSS SECTION OF FLAGELLA SHOWING "9+2" PATTERN OF MICROTUBULES.



one of the two central microtubules.

One of the 9 pairs of peripheral microtubule

The "9+2" pattern of microtubules, is lacking in the cilia and flagella of prokaryotic cells.

The arm like structure on one microtubule of one of the 9 pairs are ^{site of} ATP hydrolysis to release energy required for motility of cilia or flagella since they contain the necessary enzyme ^{ATPase} ~~ATPase~~ for ATP hydrolysis.

Functions of cilia to an organism.

Important for locomotion of low organism particularly protzoa such as paramecium.

In some invertebrates like Molluscs, cilia maintain circulation of body's fluid in the body spaces.

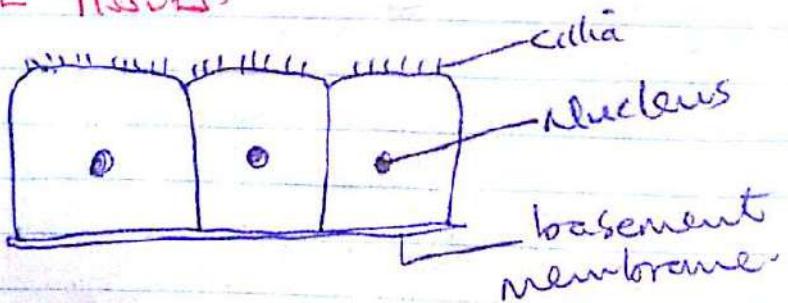
Cilia are used for immobilising food eg in paramecium, cilia bring food to the site of ingestion by creating a wave of H_2O current.

They are important in clearing debris like dust particles from the air in air passages.

Responsible for motility of ova in the oviduct in the mammalian female reproductive system.

In some parts of the body, cilia are associated with cells that form ciliated tissues which perform the role of increasing surface area for absorption eg. In human small intestine and in the kidney tubule.

DIAGRAM SHOWING THE CILIATED CELLS OF CILIATED EPITHELIAL TISSUE.



Prolifera.

functions of the flagella.

- They are also related to motility or locomotion to some cell organisms
- Important for motility of whole organism e.g. in protists like Euglena, Trypanosoma etc.
- In higher animals like ^{mammals} they are responsible for motility of sperm cells within the reproductive tract.
- Important in feeding mechanisms of some organisms like sponges of phylum ~~Porifera~~^{Periphere} by creating water current we aid motility of food particles.

CENTRIOLES

In the cell, the centrioles are located in specialised areas especially ^{near} the nucleus. Centrioles are found only in animal cells ^{but} they are generally absent in higher plant cells.

Centrioles are hollow cylindrical structures whose walls consist of parallel groups of microtubules arranged in rings, each ring consisting of three microtubules.

Centrioles are important in cell division, where they assemble and organise the spindle fibres.

CELL WALL

Cell walls are found in plant cells of higher plants and fungi. It consists of a rigid wall of cellulose which is secreted by protoplast of the cell.

Cell walls also occur in prokaryotic cells however plant cells walls differ in chemical composition from those of prokaryotic cell wall and fungi.

Briefly,

The primary wall of the plant cell consisting of cellulose fibres running through a matrix of other polysaccharides like pectin. ^{consists}

Cellulose fibres consists of cross-linkages making some fluid filled spaces which makes the cell

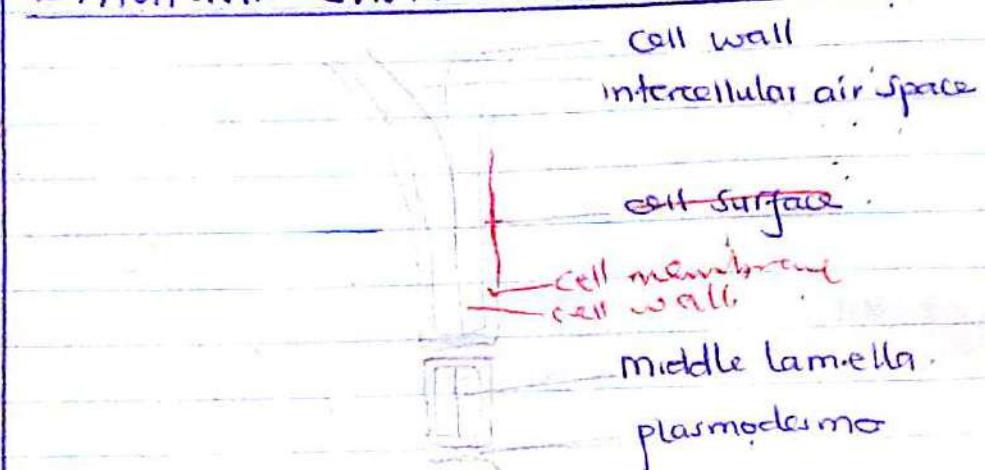
unthickened

wall permeable to H_2O and dissolved solutes.

During the deposition of the cell wall, some areas of the cell wall remain unthickened to form pits; through which thin cytoplasmic strands pass to the neighbouring cells and offering means of mov't of materials.

These areas of perforations are called plasmodesma.

DIAGRAM SHOWING THE STRUCTURE OF A CELL WALL



B/w adjacent cells of plants is a thin layer of pectic substances such as calcium and Magnesium pectates called the middle lamella. w/c joins the cell walls of the two neighbouring cells.

This offers extra strength to the cell wall.

Extra strength of the cell wall is achieved by:

(i) Lignification: Here the cell wall undergoes extensive addition of lignin which is a complex polymer of non-carbohydrate substances deposited in the cellulose.

Lignin anchors cellulose fibres together rendering the cellulose wall rigid but impermeable to water and dissolve solutes. This is necessary in cells of conducting tissues such as Xylem where the protoplasmic content dies to form hollow conducting vessels.

(ii) Addition of Suberin: Also a tough substance especially in cork cells w/c renders the cell impermeable to H_2O .

- When not lignified allows entry of water into cell by osmosis.
- Increases surface area for active transport in some cells.
- Maintains & determines shape of plant cell due to big rigid.
- It controls turgidity when water enters the cell.
- provides mechanical support.

Functions of the cell wall

- The cell walls of the root endodermal cells are impregnated with suberin that forms a barrier to water movement.
- Some cell walls are modified as food reserves as in storage of hemicelluloses in some seeds.
- The cell walls of ~~transfer cells~~ ^{Some plant cells develop} can increase surface area of the cell surface ~~area of the cell and the membrane~~. Consequent increase in surface area of the cell. Surface membrane increases the efficiency of transfer by active transports.
- The walls of xylem vessels and sieve tubes ~~by~~ are adapted for long distance translocation of materials through the cells.
- Cell walls develop a coating of waxy cutin on exposed epidermal surfaces reducing water loss and risks of infection.
- Cell walls undergo impregnation with suberin which serves a supportive function after secondary growth.
- Mechanical support is produced by the cell wall. Extensive lignification increases ^{the} ~~some~~ cell walls in some plants and is particularly important in trees and shrubs.
- Orientation of cellulose microfibrils limits ability and helps to control cell growth and shape since the cell's ability to stretch is determined by their arrangement.
- Cell walls are fairly rigid and resistant to expansion and thereby ^{controls} ~~allow~~ of turgidity when the water enters the cell by osmosis. This contributes to support - mostly in non woody or herbaceous plants, and organs.
- The system of interconnected cell walls ~~the apoplast~~ is a major pathway of movement of H_2O and mineral salts ~~within~~ in the plant roots.

mechanical support

control turgidity

pathway

impregnation

deposited with

Size

DIVERSITY OF CELLS

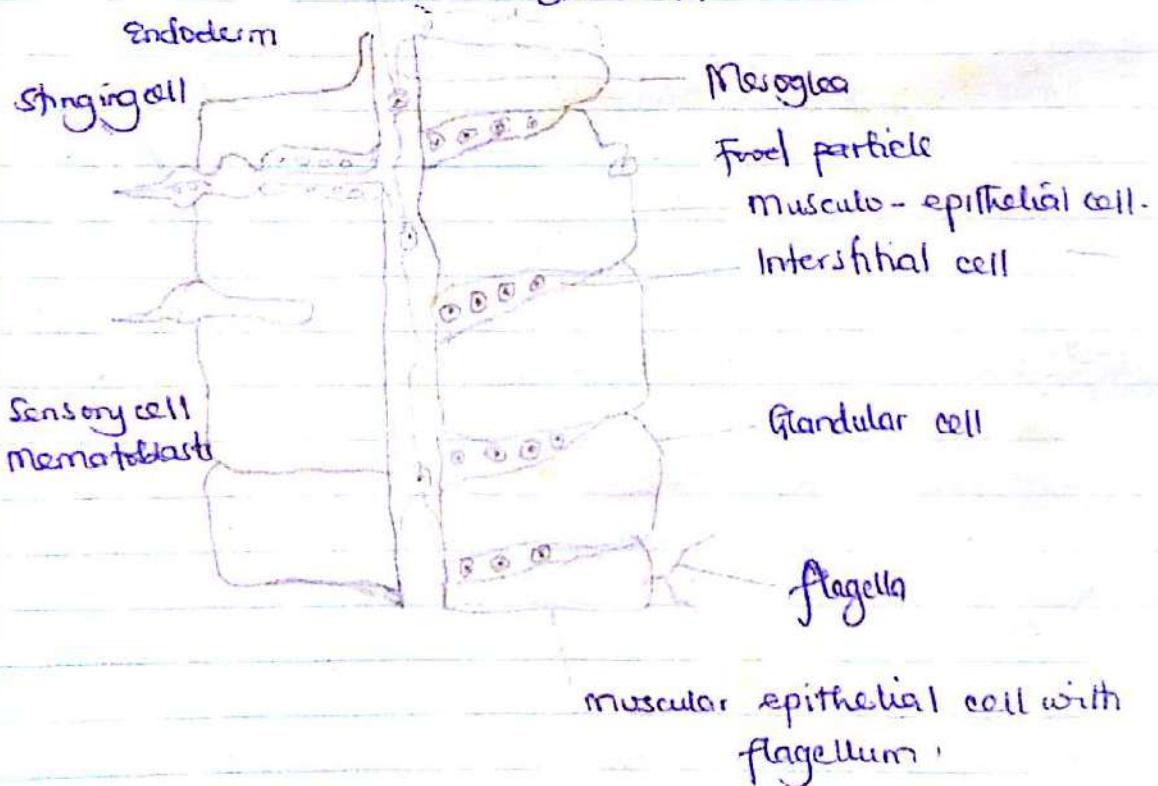
Cells that serve the same functions are identical in shape and composition e.g. they contain the same type and number of cell organelles. However in multicellular organisms, there are different levels of cell organisation.

There is cell specialisation to form tissues and organs for instance some organisms like the hydra and sponges.

They are a tissue level of organisation where cells are specialised to perform specific functions.

THE DIAGRAM SHOWING THE LONGITUDINAL SECTION THROUGH THE BODY WALL OF THE HYDRA

Nerve cell Endoderm

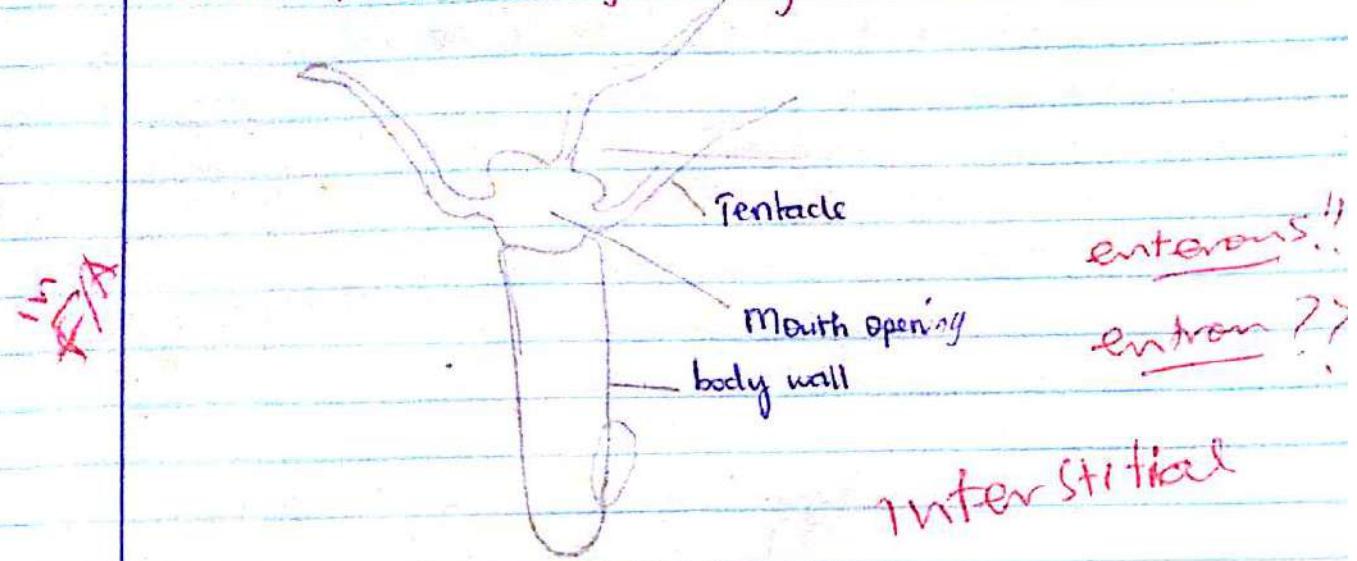


muscular epithelial cell with flagellum.

Cells show cell specialisation that is:-

- (i) Stinging cells: These immobilise food from external environment e.g. water towards the tentacles and then the tentacles push food into the mouth opening.

External structure of the hydra



- (i) **Granular cells:** These secrete the digestive enzyme to the enteron where digestion takes place.
- (ii) **Musculo-epithelial cells:** These also are involved in feeding where by they take up food particles by **phagocytosis**.
Some ~~musculo~~ epithelial cells have flagella w/c circulate the semi-fluid content of the enteron.
- (iii) **Nerve cells:** These are of sensitizing sensitivity of the cell.
- (iv) **Interstitial cells:** They bridge the gap b/w the cells. They actually act as packing cells.
- (v) **Sensory cells:** They are for sensitizing (detecting change) in environment.

ADVANTAGES OF A MULTI CELLULAR STATE

- Insures increase in size of the organism.
- There is cell specialisation (division of labour) w/c permits greater efficiency of the organism to exploit its environment.

DISADVANTAGES OF A MULTI CELLULAR STATE

- Increases in cells.
- ④ Increase in size ^{and it leads to a small surface area} to volume ratio, which decreases diffusion rate of substances into cells.

Multicellular ~~Organisms~~ ^{Organelles} experience difficult in finding food and air by simple diffusion. This can be over come by ~~development~~ ^{development} of transport systems e.g. Blood circulatory system.

Division of labour thereby requires diversification ^{ed} cells in multicellular organisms. Specialised cells exist in different organisms for example.

Epithelial cells:

These make up epithelial tissues. They are of several types depending on the types of epithelial tissue where they are found.

Glandular cells:

These secrete useful substances in the body eg digestive juice, hormones etc.

Fibroblasts:

Are found in ~~higher~~ animals. They secrete protein fibres like collagen fibres found in connecting tissues as their function.

Chondroblasts:

They are found in the cartilage where they secrete the matrix of cartilage.

Osteoblasts: Osteoblast

found in bones ^{and} secrete matrix of bones.

Red blood cells which are useful in transportation of O_2 & C_0_2 within the body and white blood cells which defend the body against diseases.

Spermatogonia: There are male gametes involved in reproduction.

Chromatophores: found in amphibians and reptiles and are pigmented cells. Stinging cells ~~are~~ These immobilise ~~stabilise~~ food and also release toxic substances for killing prey.

Epidermal cells:

Form from epidermis of stems & roots of plants.

Root hair cells. For absorption of H_2O and mineral salts from soil.

Palisade

photosynthetic cells present in palisade layer of leaves, it's where photosynthesis takes place.

How are challenges of multicellular state overcome?

- By developing a transport system by which gases and nutrients are transported from one part of the body to the other.
- Developing flattened body eg in flat worms. This increases on the surface area by which nutrients are absorbed by the body.
- By developing thin layer of the body wall. This reduces on the diffusion distance over which molecules eg gases diffuse into or out of the cell.
- Some organisms have their body external organs highly folded eg external gills ~~of tad~~ tail poles to increase on the surface area for gaseous exchange.
- By bringing the external medium of exchange, close to the body tissues. eg tracheoles systems in insects where oxygen is brought near to the body tissues by a system of tubes called tracheoles.
- They have folded membranes to provide a large short surface area for diffusion of gases.
- Some organisms have moist respiratory surfaces to facilitate easy diffusion of gases in solution form.
- Some organisms have pigments in their blood that have high affinity for oxygen and these aid oxygen transportation in the body.

LEVELS OF ORGANISATION

In the course of evolution there are three-four levels of organisation of cells.

- Unicellular level of Organisation This is where an organism exists as a single cell which plays all the functions of life at this level of organisation the organelles in the cell are so specialized to perform specific functions equivalent to those functions performed by different tissues and organs in higher organisms (multicellular organisms.) The best example of this is the amoeba, paramecium etc.

Multicellular: Tissue level of organisation: Here the functions of life are not so readily played by a single cell but rather by a group of cells that are coordinated to perform a specific function; such organisms include coelenterates e.g. the hydra.

The organisation of cells to form tissues exist in the hydra. This organism has its body divided into i.e ectoderm (outside layer of cells) and endoderm (inside layer of cells) which face the body cavity called the enteron. In the middle of the two layers of cells there is a mesoglea which consists of the nerve tissues. The animal has specialised cells which are coordinated to perform specific functions as follows:

Glandular cells: These are found in the endoderm where they play a role of secreting proteolytic enzymes into the enteron which begin intracellular digestion.

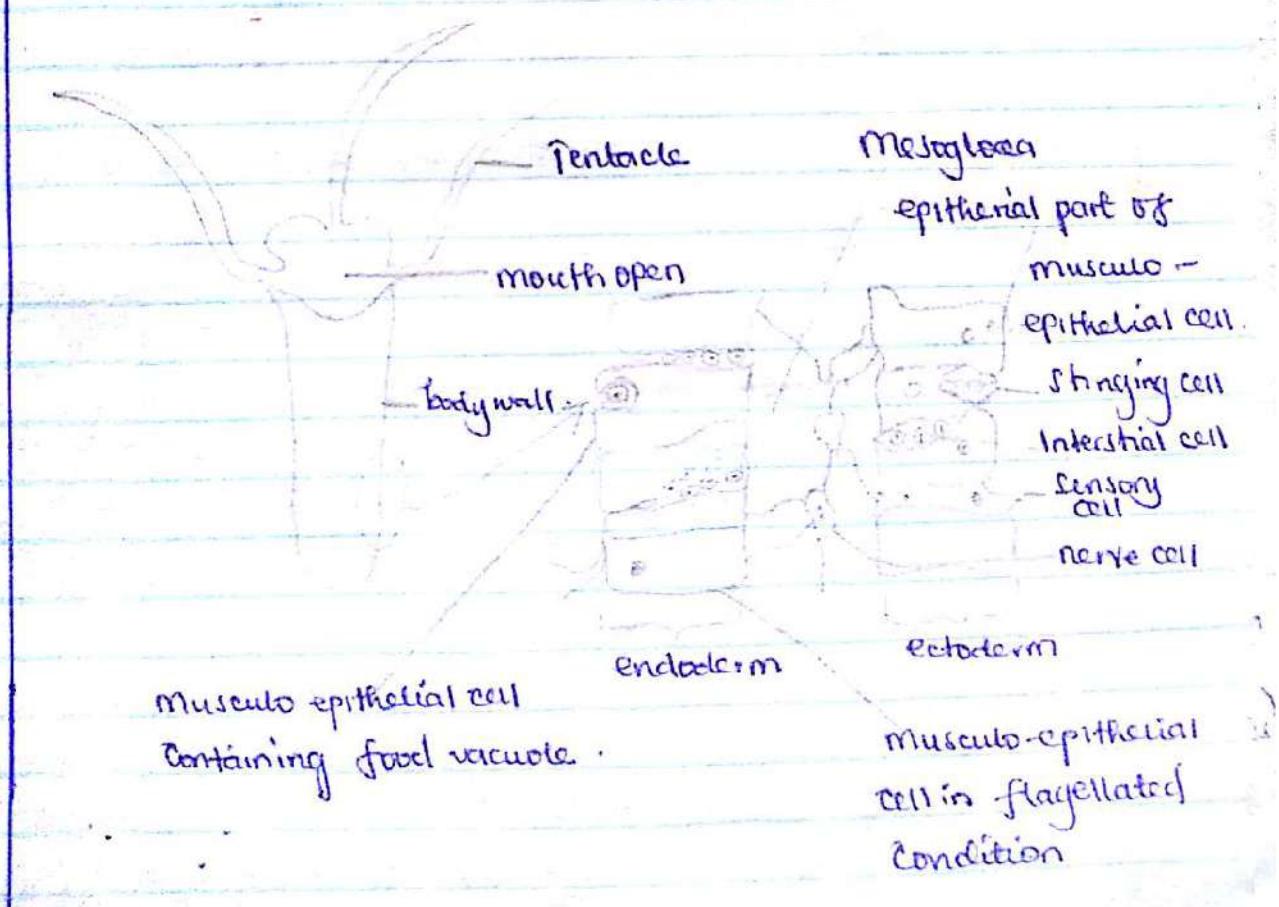
Stinging cells (nematoblasts): These are found in the ectoderm and these immobilise food from the external environment it water and the foot (prey) is pulled towards the mouth opening by tentacles. These cells immobilise the prey by injecting poisonous chemicals which paralyse the prey.

Musculo epithelial cells : found both in the endo-derm and ecto-derm. In the endoderm musculo epithelial cells take up particles from the enteron that are partially digested and form food vacuoles in which digestion of food is completed. These cells take up food materials by phagocytosis. Some musculo epithelial cells are flagellated and those found in the endoderm circulated food particles and the fluid within the enteron for easy digestion of food.

Sensory cells : These are mainly found in the ectoderm and they play role of sensitivity whereby they enable the animal to detect changes within the environment

Nerve cells : These are also for sensitivity. The nerve cells, sensory cells and musculo epithelial cells are integrated to form a tissue.

Interstitial cells : These bridge the gaps b/w the other cells within the endoderm and the ectoderm.



ORGAN LEVEL OF ORGANISATION.

In this level of organisation the tissues are co-ordinated to perform a specific function. In doing so tissues form organs for example a mammalian kidney is an organ consisting of tissues such as blood, smooth muscle whose sole function is to eliminate unwanted substances from the body.

COLONIAL LEVEL OF ORGANISATION

At this level of organisations cells are functionally much more isolated from one another, unlike in the hydra where cells are integrated to some degree. In colonial organisation the organisms exists as colonies of single cells which are functionally independent of one another unlike in multicellular state where there is a degree of dependency. The best examples where these organisms are the spongey.

- Advantages of multicellular state of life;
- Insures increase in the size of an organism
 - There is cell specialisation of cell (division of labour) which permits greater efficiency of the organism to exploit its environment.

Disadvantages of multicellular state of life

- Increases in cells.
- There is cell specialisation
- Increase in size it leads to a small surface area to volume ratio which decreases diffusion rate of substance into cells.

STOP

HISTOLOGY.

Although in some organisms the functions of life are played by a single cell, in multicellular organisms group up to form tissues which play specific functions. The tissues then form organs which result in formation of organ systems.

Histology is the study of tissues

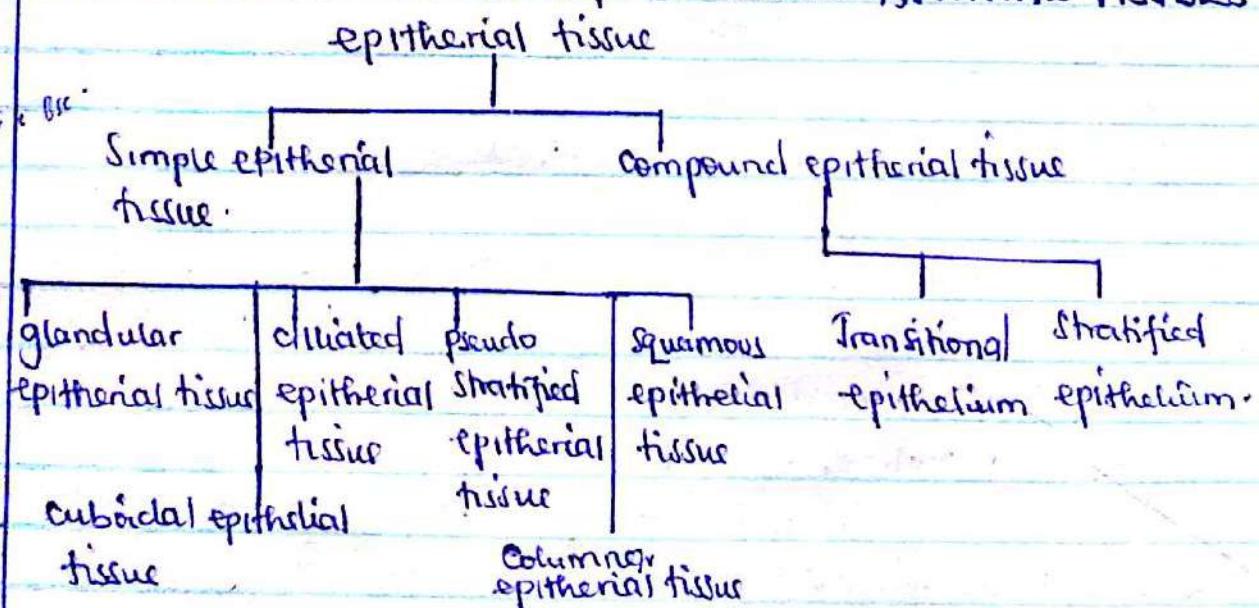
ANIMAL TISSUES.

Animal tissues can be categorised into: epithelial tissues, glandular tissues, connective tissues, Nervous tissues.

EPITHERIAL TISSUES

An epithelium is a lining covering the body surface or a body cavity. Epithelial tissues therefore form the epithelia and cover either the external surface or the internal surface of a body part.

CLASSIFICATION OF EPITHERIAL ANIMAL TISSUES



CLASSIFICATION

Classification of epithelium tissue consist of -

- (1) Number of cell layers : It is a simple epithelium if it is made up of a single layer of cells and it is a compound if it is made up many layers of cells.

* Selective absorption occurs in kidney tubules.

- (ii) Shape of cells: e.g. cuboidal, columnar.
- (iii) Cell surface specialisation e.g. presence of cilia on cell surface hence ciliated epithelial.

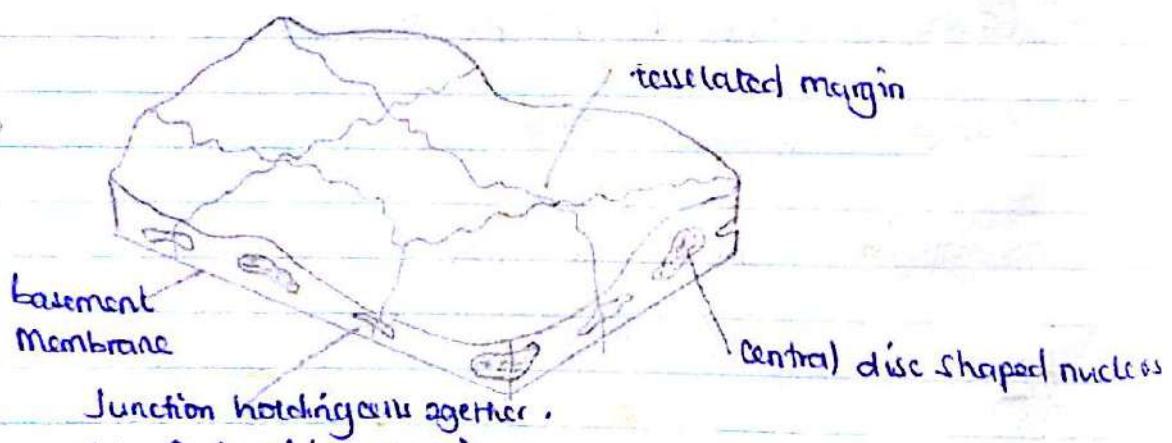
SIMPLE EPITHELIUM

The are always one cell thick (single layers each). They

SQUAMOUS (PARCHMENT) EPITHELIUM.

This consists of flat scale like cell with ridges on the surface making the boundary b/w cells. Cells rest on a base membrane. The cells have a thin nucleus and irregular surface. They are found in areas where permeability is the property of epithelium e.g. in the kidney tubules where selectively absorption occurs, epithelium of blood vessels especially capillaries, the alveolar surface in the lungs.

It also provides smooth lining of hollow structures such as chambers of the heart, where it allows the relatively friction free passage of fluid through them.



Junction holding cells together.

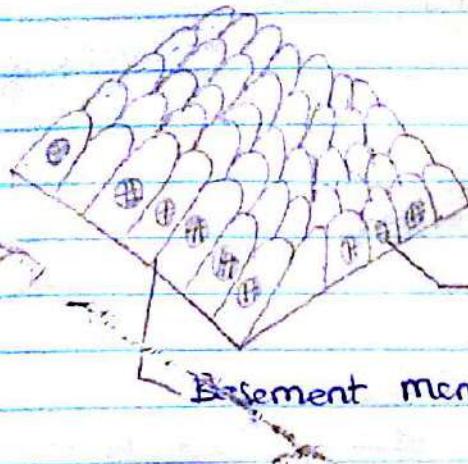
(b) CUBOIDAL EPITHELIUM

This consists of cells which are cube shaped possessing a central spherical nucleus. It is found in lining of ducts and tubules which may have secretory and absorptive function e.g. lining of salivary and pancreatic ducts, lining of proximal and distal convoluted tubules of the kidney, collecting duct and in many glands with secretory functions like salivary glands, pancreas, mucus glands in the stomach and thyroid glands.

* Globule cells
secrete mucus.

3. S

84



central spherical nucleus

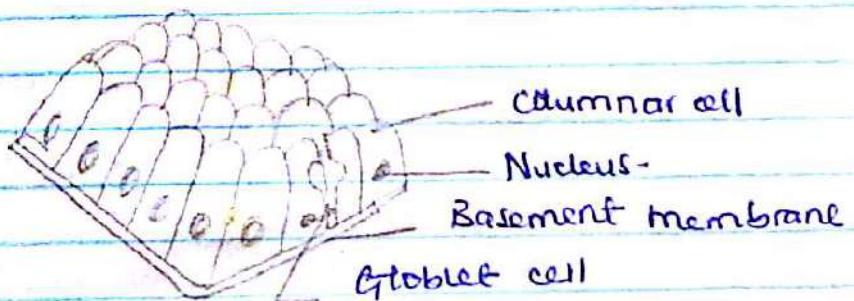
Basement membrane.

Irregular
cells.
Goblet cells
are present.
found in
lining of
intestines
walls.

(C) Columnar epithelium

This consists of rectangular cells resting on a basement membrane. They are relatively tall and narrow compared to those of cuboidal epithelium. Each cell consists of the nucleus situated at its basal end and goblet cells which secrete mucus are interspersed among the epithelial cells and the epithelia may be secretory or absorptive in function.

In the intestines
mucus secreted by
goblet cells protects
the lining of intestine
from self digestion
and lubricates food.



B
P
D
E

It is also found in the lining of intestinal where mucus secreted by goblet cells protects the lining of intestine from self digestion and also lubricates food.

(D) Ciliated epithelium:

Cells of this tissue are usually columnar in shape & bear numerous cilia at the free surface hence it is simple columnar ciliated epithelium. They are always associated with Mucus secreting cells (goblet cells) producing fluid in which the cilia set up currents.

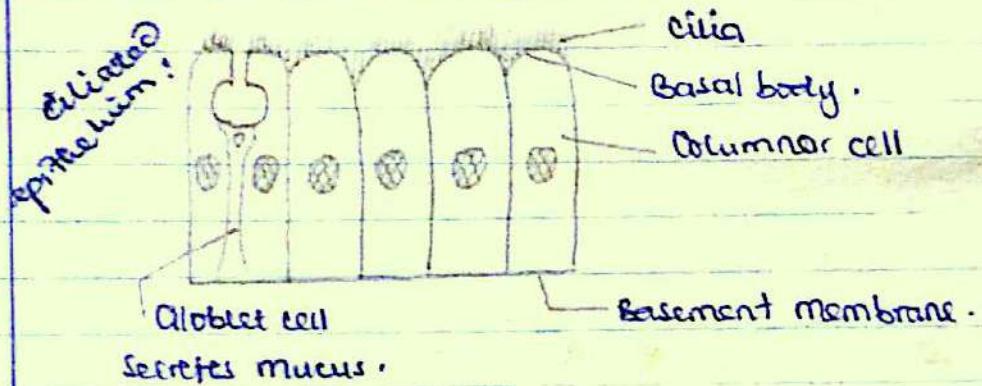
It is found in tube structures and cavities where it helps to move substances over the body. The cilia move the ~~ovule~~ (female egg cells). Respiratory passages e.g. trachea, bronchi and bronchioles where cilia move

clust so that the delicate gaseous tracts aren't damaged. Also found in mucous of nasal passages ventricle of the brain and the spinal canal.

Pseudostratified epithelium

This is a simple epithelium consisting of cell resting on the surface basement of cell membrane but some times don't reach after surface thus giving numerous that the epithelium consist of more than ~~than~~ one layer of cells it may be ciliated in this case pseudostratified ciliated.

It is commonly found in large ducts of excretory system such as urinary tract and respiratory passages like the trachea & bronchi where it is ciliated and columnar.



COMPOUND EPITHELIUM.

① Stratified epithelium:

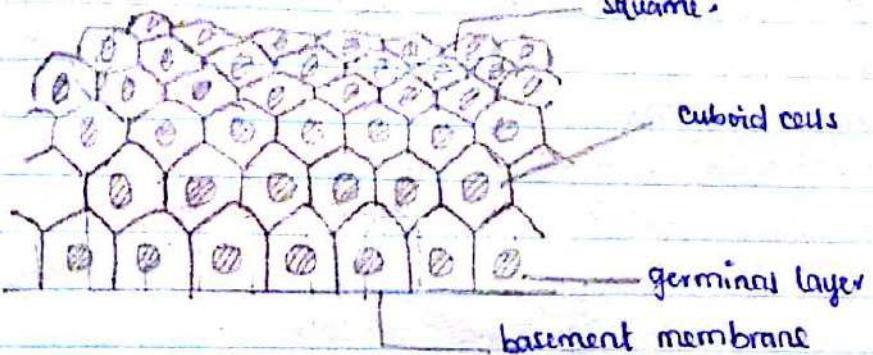
This has more than one layer of cells with only one layer resting on the basement membrane, cells at the base beneath the others continue to divide by mitosis and are pushed outwards towards the free surface of the tissue where they become flattened. There it may be squamous stratified epithelium, or stratified epithelium cuboidal epithelium. The cells may remain unkeratinized e.g. in the lining of the oesophagus where the epithelium protects the underlying tissue against mechanical damage by friction with food being swallowed. In other areas of the body, the epithelium may be transformed into dead horny layer of keratin e.g. the upper layer of the skin will keeps peeling and is replaced by new cells.

location of lining
lining of organs

stratified epithelium is also found in areas where lining is reliable abrasion eg in the lining of the mouth and the vagina where it protects the surface against abrasion.

Squamous.

protection
injury
abrasion



Transitional epithelia

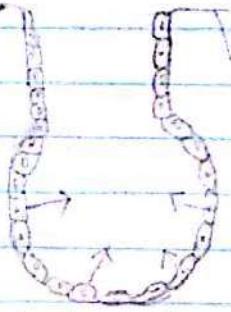
This is the form of stratified epithelia named so because it has same cells that are intermediate b/w stratified cuboidal (when relaxed) and stratified squamous (when compressed). It consists of $3 \frac{1}{2}$ to 4 layers of cells of similar shape and size except at the free surface where the cells appear more flattened. Cells near the surface don't peel off but are able to modify their shape when subjected to different conditions. This property is important ^{for e.g. body} in ~~locations~~ where structures are subjected to considerable stretching ^{e.g.} lining of the bladder, ureter, kidney and pelvis of the kidney.

Glandular epithelium \rightarrow F/A page 35.

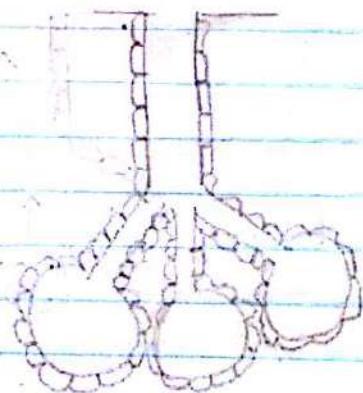
This consists of cells with secretory functions such as goblet cells or it can be an aggregate of glandular cells containing many many cells to form multicellular glands. Glandular epithelium is a component of many types of glands of different shapes as follows

(i) Simple saccular glands: eg mucus glands in the skin of frogs. It consists of round shaped cavity in sole glandular cells forming ~~a triangle of cells~~ to produce their secretion.

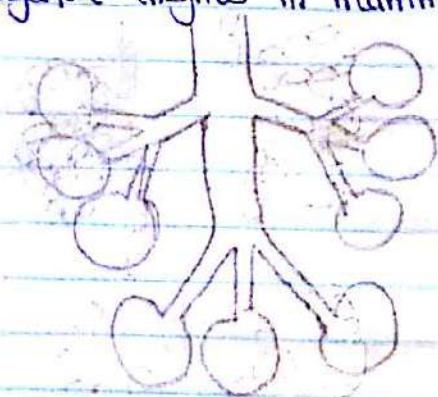
function of glands



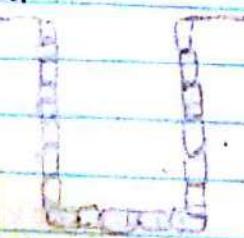
(i) Simple branched and saccular glands : eg sebaceous -
glands in mammalian ~~gland~~ skin



(ii) Compound saccular glands : eg exocrine part of the pancreas
which secretes digestive enzymes in mammalian ~~gland~~ digestive
system



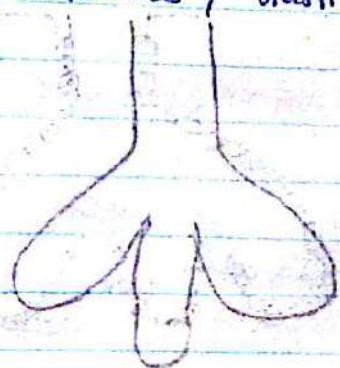
(iii) Simple tubular glands : eg crypts of Lieberkühn in the mamma
lian intestinal wall



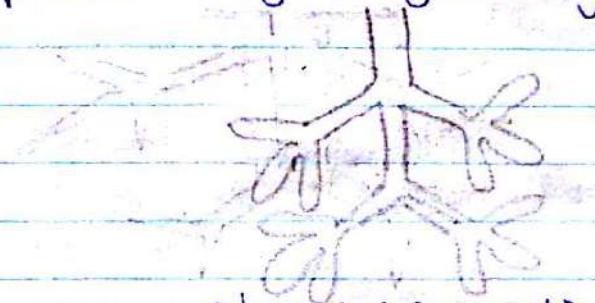
(iv) Simple coiled tubular gland : eg sweat gland



(i) Simple branched tubular gland; eg Brunner's gland found in the wall of mammalian small intestines, Gastric gland in the stomach walls.



(ii) Compound tubular gland; eg salivary glands.



Glands are classified according to the mode of secretion into two.

(a) Exocrine glands:

These are glands which produce their secretion into a duct through which the secretion is taken away. All the above examples of glands are the exocrine glands.

(b) Endocrine glands (ductless)

These are glands whose secretion is passed out directly into the blood stream. Such glands form close connections with blood capillaries.

Endocrine glands are further classified according to the mode of secretion by their cells. i.e.

(i) Merocrine gland; In these glands, the secretion produced by the cells are discharged without losing any part of its cytoplasm i.e. the cell remains intact.

(ii) Apocrine gland; Here secretion from the cells occur in such away that part of the cell cytoplasm is released along with the secretion.

(iii) Holocrine gland; In this gland the whole cell breaks down to release secretory parts.

merocrine
apocrine

holocrine

out of body
cavities leave

Q Explain how the epithelial tissues adapted to its functions

~~cavities~~ Epithelial tissue is the lining covering the body surface or surface of the duct or surface of the cavity. It is classified into simple (one cell thick) or compound (more than one cell thick) each having adaptations for its functions as follows:

- ① **Squamous epithelium** is thin and this enables it to permit diffusion of materials through it. It also provides a smooth lining to hollow structures such as blood vessels and chambers of the heart where it allows relatively friction ^{free} passage of fluids through them.
- ② **Cuboidal epithelium**: consists of numerous microvilli projecting from ~~the~~ free surface of cells w/c increase surface area for reabsorption of materials from the fluid in the tubules.
- ③ **Columnar epithelium** consist of tall and quite narrow cells which provide more cytoplasm per unit area of the epithelium; for ^{chemical reactions}
- ④ There is also frequently a conspicuous striated border of microvilli at the surface end of each cell w/c increases surface area for absorption and secretion.
- ⑤ It also lines the stomach where mucus secreted by the goblet cell protects the stomach lining from the acidic contents of the stomach. mucus also lubricates the passage of food in the intestines.
- ⑥ Columnar epithelium lining the intestines also plays an important part in supporting other types of cells.
- ⑦ **Ciliated epithelium** bears numerous cilia at their free surfaces eg in the respiratory passages like in trachea where it serves to move materials from one location to another. Cilia waft mucus in the respiratory tract up to the throat for swallowing.

The mucus traps bacteria, dust and other small particles penetrating them from reaching the lungs. In some organisms like flattened worm, cilia on the body outside play an important role in locomotion. The thickness of transitional epithelial tissue prevents urine from escaping into the surrounding.

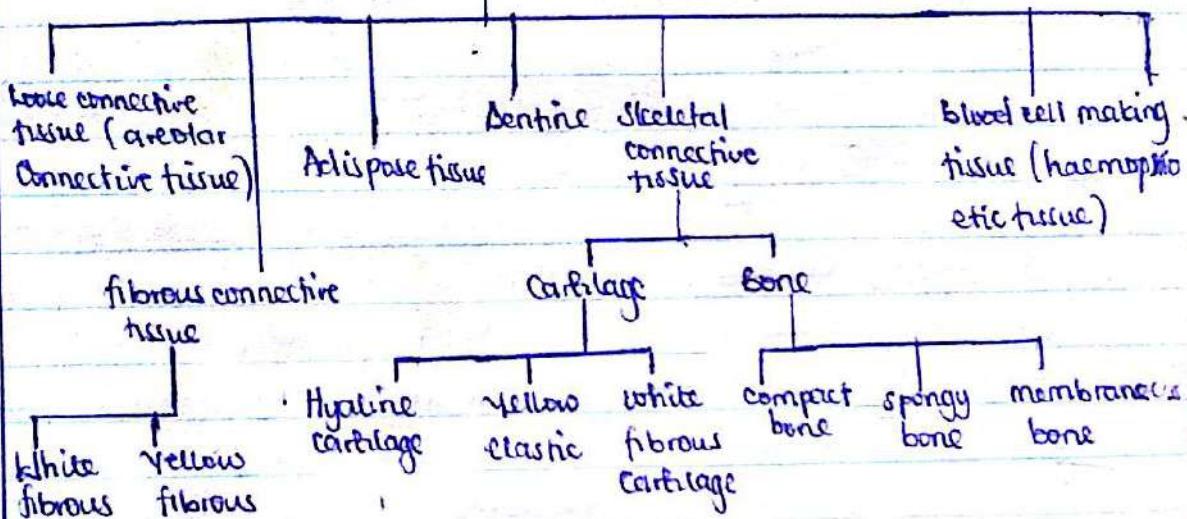
- ⑧ squamous stratified in the parts of oesophagus protects the underlying tissues against mechanical damages by friction with food just swallowed.

Start

CONNECTIVE TISSUES

connective tissues serves the purpose of binding other tissues or organs of the body together. A typical connective tissue consists of cells embedded in a ground substance (matrix). In some cases, the tissues may consist of fibres. Connective tissues are classified according to composition and strength as follows.

connective tissue.



Loose connective tissue (areolar connective tissue).

This is a simple form of connective tissue consisting of thin fibres and thick bundles of collagen fibres embedded in a matrix. The fibres form a net work and improve on the strength of the tissue. It consists of a fluid matrix in which several types of cells are embedded. These cells include:

(i) **Macrophages:** These are phagocytic cells i.e. they engulf bacteria and foreign particles and hence they are defensive cells (defend the body) against pathogens.

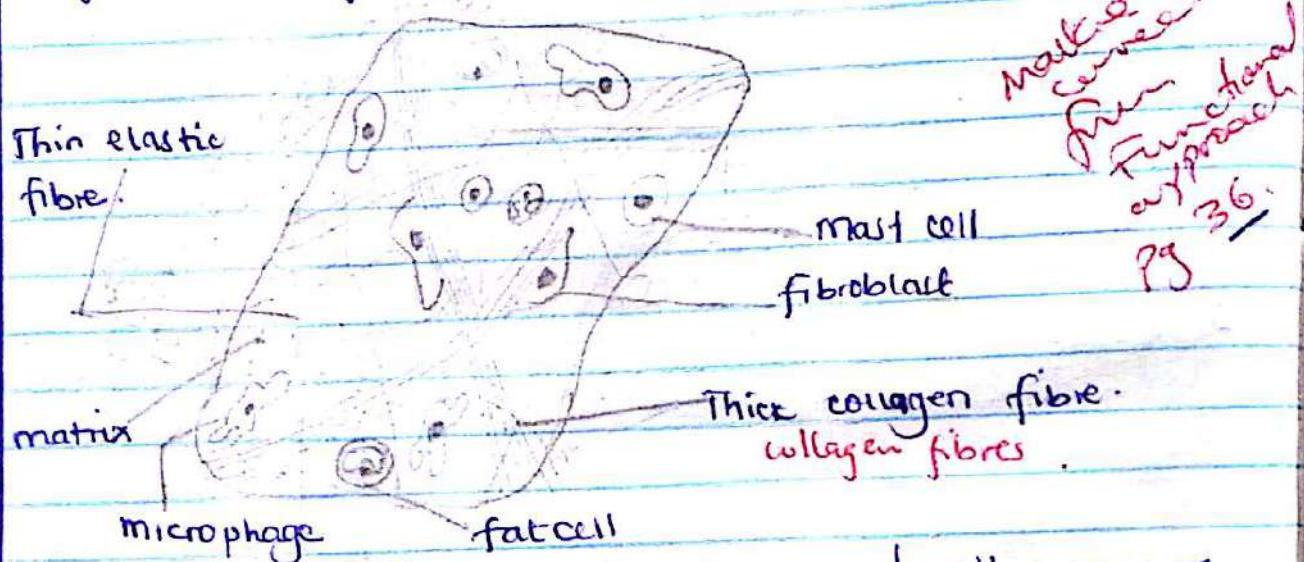
(ii) **Mast cells:** These secrete an anti-coagulant substance - into the matrix which maintains the fluid nature of the matrix.

(vii) **fibroblasts**: These play a role of ^{producing} ~~produced~~ fibres.

(viii) **fat cells**: These store fats.

The thick collagen fibres are flexible but Inelastic which provides strength to the tissue while the thin fibres made of the protein known as elastin are elastic in nature and this ensures elasticity of the tissues.

Diagram showing a regular connective tissue.



Areolar connective tissue is found around all organs of the body where it performs an important role of ^{separating} ~~supporting~~ ^{so that they don't interfere with each other's activities} ~~activities~~. However, ^{other than acting as} ~~acting and binding~~ structures in the body, it also protects against invasion of harmful bacteria in the body. It also protects against ^{invasion} ~~inversion~~ a function performed by macrophages.

Fibrous connective tissues:

This contains more fibres randomly scattered into the matrix. ^{If there are} More fibres than cells etc. makes it more stronger than the loose connective tissue.

Fibrous connective tissues are found around delicate organs of the body such as the kidneys and the heart where they provide strength and support to the organs.

Fibrous connective tissue are divided into two.

White fibrous connective tissue: This is composed of mainly parallel bundles of collagen fibres strong and flexible but inelastic e.g. Tendons are most pure white fibrous.

tissues we exert a pull on. Other examples are muscles connected to the bone. Other examples are-

- Ligaments
- Sclerotic coat of the eye and the cornea.

(1) Yellow elastic tissue:

This contains mainly a network of fibres made up of a protein known as elastin which is more elastic. It is commonly found in elastic structures of the body such as walls of the arteries and alveoli of the lungs.

* (2) Skeletal Connective tissues :

These are responsible for support and body framework. They include the bones and cartilage.

(a) **Cartilage:** This is a connective tissue consisting of cells called Chondroblasts embedded in a matrix known as Condrin. The Matrix is produced by the chondroblasts themselves.

In some form of simple cartilage, no fibres in the matrix whereas in others forms the matrix contains fibres mainly collagenous fibres. The cells eventually become enclosed by a membrane in space called Lacunae and in this condition the cells are now termed as chondrocytes.

The margin (periphery of the cartilage) consists of a dense layer of cells embedded in fibrils and this layer is called the perichondrium from which new cells are formed and are constantly added to the internal matrix.

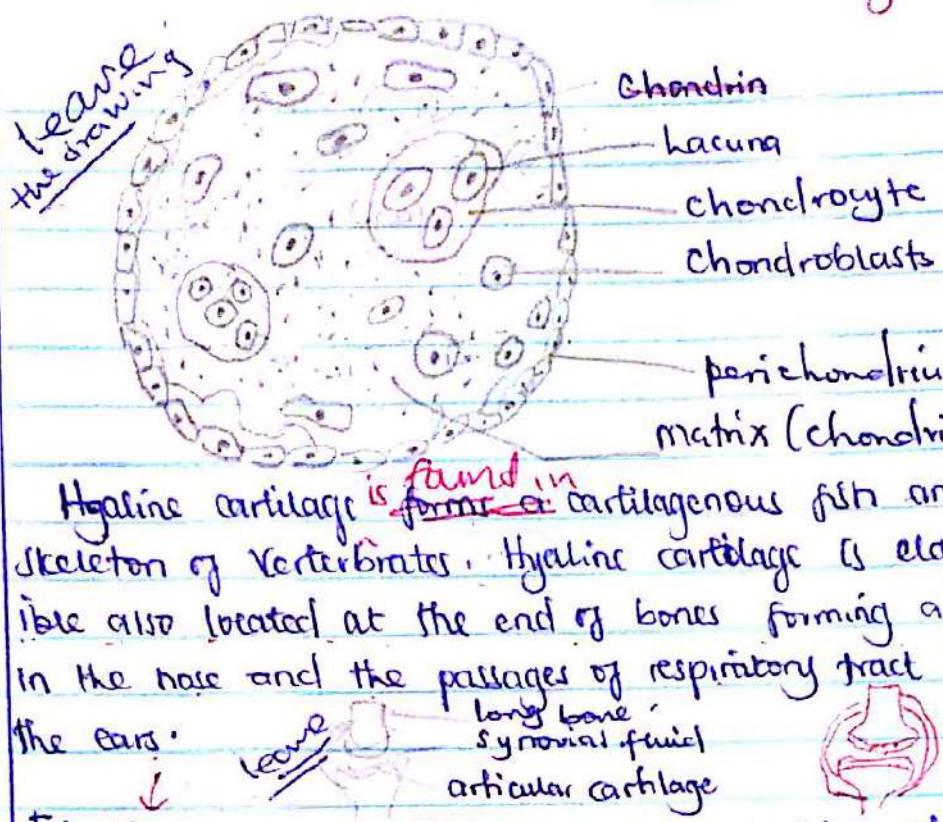
Type of cartilage

1 Hyaline cartilage.

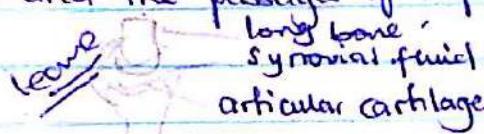
Chondroblast ✓
Chondroblast X

This is a simple form of cartilage consisting of a semi-transparent matrix in which cells are embedded but with no fibres. Some chondroblasts are freely scattered in the matrix, while others are enclosed in Lacunae ~~as chondrocytes~~. The concrete chondrocytes near the periphery are ~~flat~~ flattened in shape whereas those in the centre are angular in shape.

Cartilaginous fish



Hyaline cartilage ~~is found in~~ or cartilaginous fish and ~~in~~ ⁱⁿ embryonic skeleton of vertebrates. Hyaline cartilage is elastic compressed ^{compressible} also located at the end of bones forming a joint and also in the nose and the passages of respiratory tract and also in the ears.



Elastic Cartilage: This consists of a matrix whc is semi-transparent. It contains a net work of elastic fibres whc gives it a greater elasticity and flexibility and permit the tissues to quickly retain their shape after distortion.

~~state~~ Fibrous cartilage: This consists of a large no of bundles of paired collagen fibres that run parallel to each other. These fibres provide greater tensile strength as well as a small degree of flexibility but inelastic.

It is located between the adjacent vertebra (intervertebral discs) where it provides a cushioning effect. This type of cartilage is also found in the symphysis pubis (region b/w two pubic bones of the pelvis) and in the ligamentous capsules of joints.

Functions of cartilages

- cushions both bones where it acts as a shock absorber eg in the intervertebral discs.
- It reduces friction at the ~~and~~ ^{between} articular surfaces of bones, and thereby it acts as a lubricant.
- cartilage is a precursor of bones and therefore responsible for growth and dev't of bones.

BONES

Structure: A bone consists of a solid matrix containing amino-polysaccharide. The matrix of bone is deposited with calcium and phosphate salts which makes it harder compared to that of cartilage. Some times, Calcium Carbonate and Calcium chloride may be part of the bone matrix.

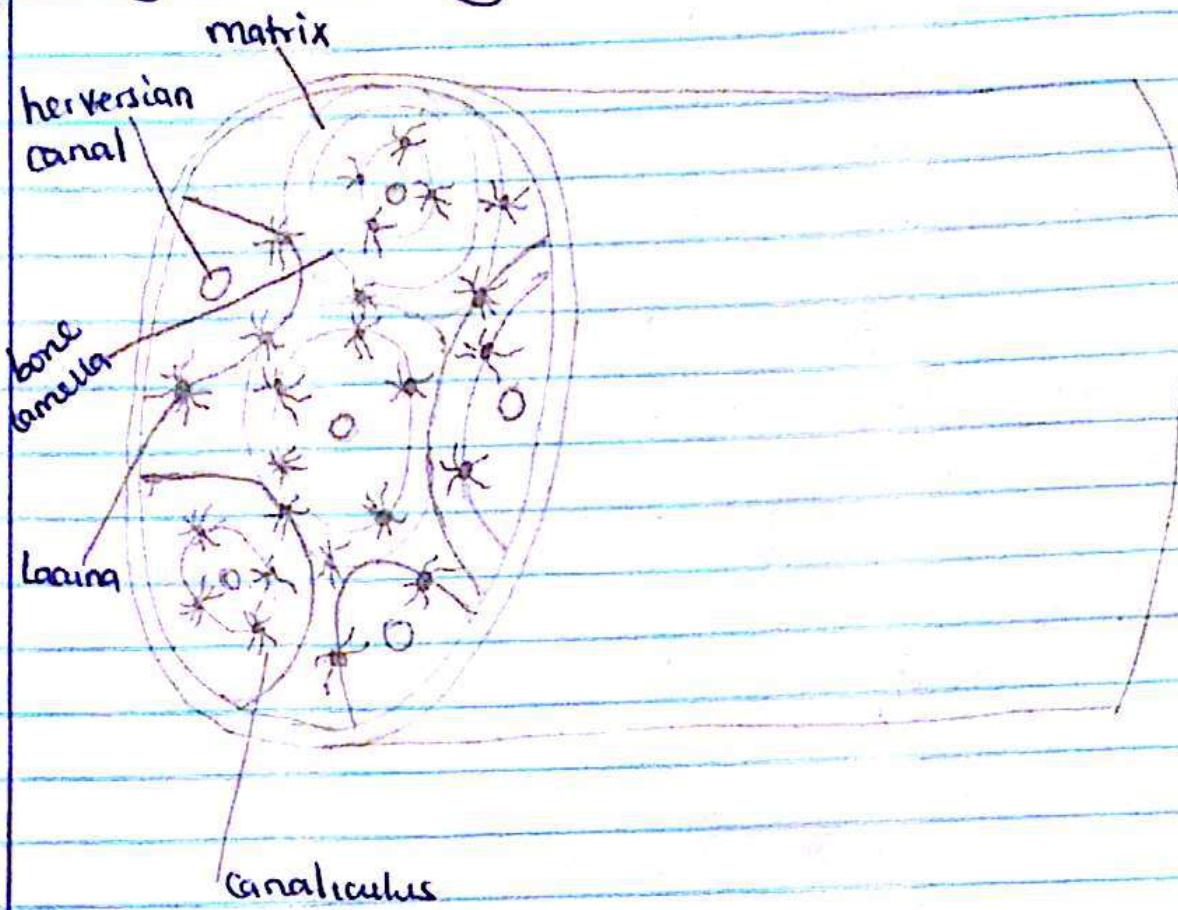
The matrix of a bone is produced by bone cells called Osteoblasts which are enclosed in specific spaces called lacunae.

The bone matrix is laid in layers called bone lamellae which are concentric and in the centre of the lamella is a haversian canal which provide passage of nerve fibres and blood vessels. Apexostem.

Usually, the osteoblasts move about the bone matrix, as they utilize nutrients in it, forming fibrous channels called canalliculi in the matrix.

As the bone matures, the osteoblasts become less active and contain less organelles. ~~At this stage, they are called~~ Osteocytes; When structural changes in the bone are required, depending on the function the bone is to serve, the osteocytes are activated and quickly ^{again} regain the original structure of osteoblasts. The bone cell which actively ~~feed~~ ^{calcified} the matrix in the effort of obtaining nutrients are Osteoclasts.

~~part 9~~ Diagram showing a transverse section of a bone.



Types of bones.

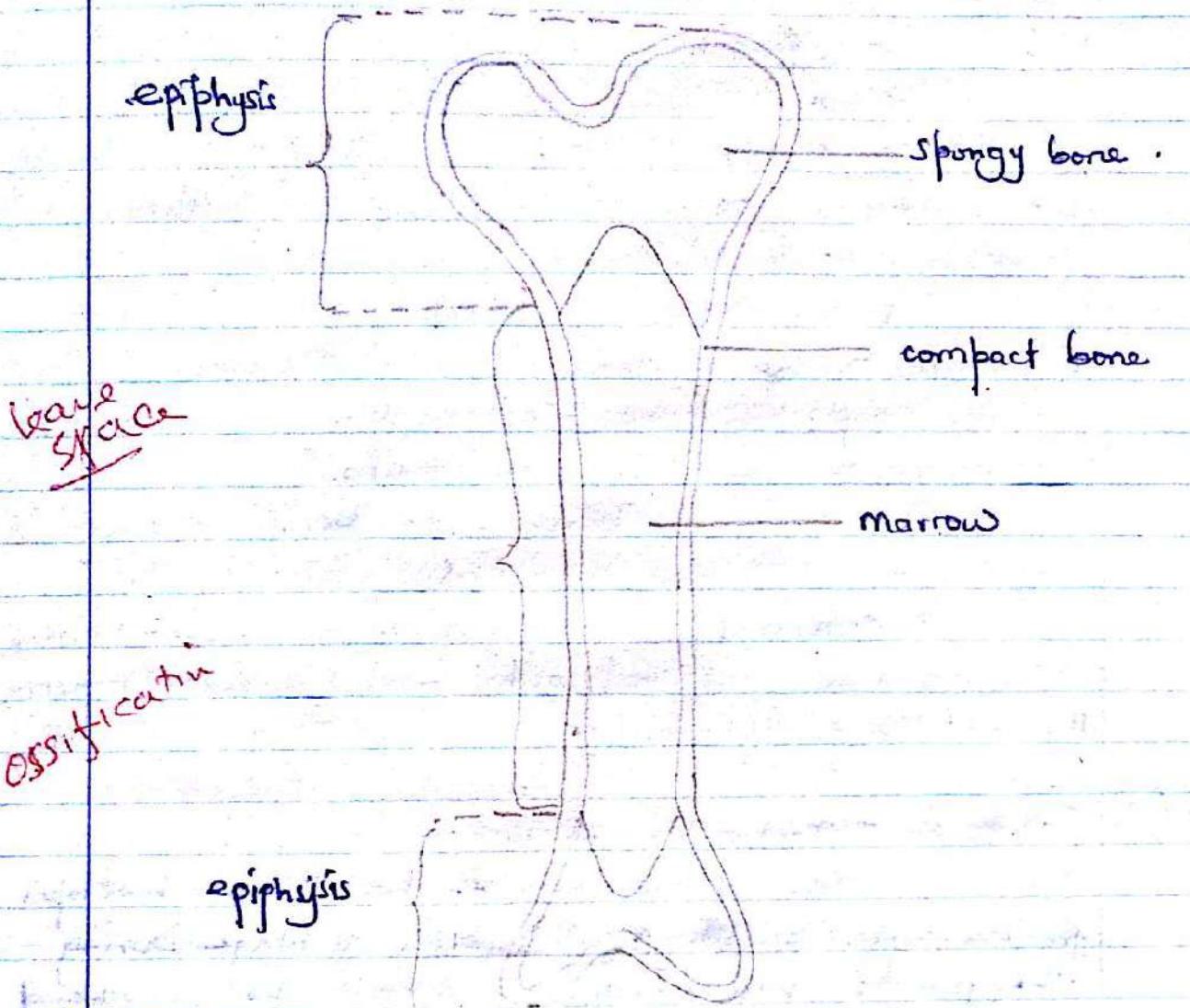
① compact bones. (hard bone)

Compact bones is harder and is responsible for offering strength to the body part where it is found. Compact bones are long bones of skeleton e.g. femur, tibia, radius etc. but also bones like those of vertebral column, and skull are also compact bones.

The matrix of a compact bone is laid in concentric rings of lamellae with a series of ~~haversian canals~~ Canals.

The osteoblasts, lamellae and the canals together form what is called the Haversian System.

Fracture structure of long bone of femur.



ossification

process of bone formation

The process by which a bone is formed is called ossification. There are two processes of ossification.

a) Intramembranous Ossification

In this process of ossification, the cells of connective tissue proliferate to form the osteoblasts which forms clusters in the central plane of a connective tissue from which a bone is to be formed.

The clusters of osteoblasts arise as a result of rapid cell division by mitosis.

The osteoblasts then secrete the bone matrix and they arrange themselves in the longitudinal axis of the future bone.

As development continues, the matrix becomes arranged in concentric rings of bone lamellae whose centre is perforated by haversian canals, which allow passage of blood vessels supplying nutrients to the matrix.

A dense layer of connective tissue forms around the bone to form the periosteum.

When a spongy bone is to be formed, fibrous stripes are ^{formed} in the matrix, making the matrix less compact, but in case of a compact bone, the matrix is deposited with inorganic salts especially calcium phosphates to make it compact and harder.

(b) Endochondral ossification.

This is a process where the bone develops from simple cartilage (i.e. hyaline cartilage). During the process, blood vessels penetrate the perichondrium of the cartilage along its longitudinal axis (Shaft). This stimulates some cells of the perichondrium (chondroblasts) to undergo ^{go} active cell division and proliferate to form osteoblasts.

A primary ossification centre forms inside the shaft and this is progressive, very invaded by blood vessels and this is progressively invaded by blood vessels and osteoblasts.

The osteoblasts now secrete the bone matrix which replaces chondroitin sulphate of cartilage.

The matrix now becomes calcified by deposition of calcium salts.

The osteoblasts are arranged to form concentric rings with in the bone lamella with series of haversian

Canalici

canals in the centre.

The bone cells erode the matrix to form a series of canalici. The periphery of the cartilage proliferate to form the periosteum.

Functions of bones in body

- They act as a frame work on which the body is supported.
- provide attachment to muscles.
- protect vital and delicate body organs eg the skull. Protects the brain.
- They act as store for calcium and other inorganic salts.
- They are a site of blood cell formation.

Bones differ from cartilage in the following ways.

<u>Bone</u>	<u>Cartilage</u>
- consist of solid matrix (Cortex)	- Has a soft matrix
- matrix is secreted by osteoblasts.	- matrix is secreted by chondroblasts.
- Highly supplied with blood vessels.	- lacks blood vessels.
- contain blood nerve fibres	- No nerve fibres.
- cells are arranged in concentric rings	- Cells are randomly distributed in the matrix
- Has a marrow cavity	- lacks a cavity.

S&P

Muscle tissue

Muscle tissues makes about 40% of the ~~mass~~ Mammalian body weight.
Muscles are classified as follow:

(a) Smooth muscles.

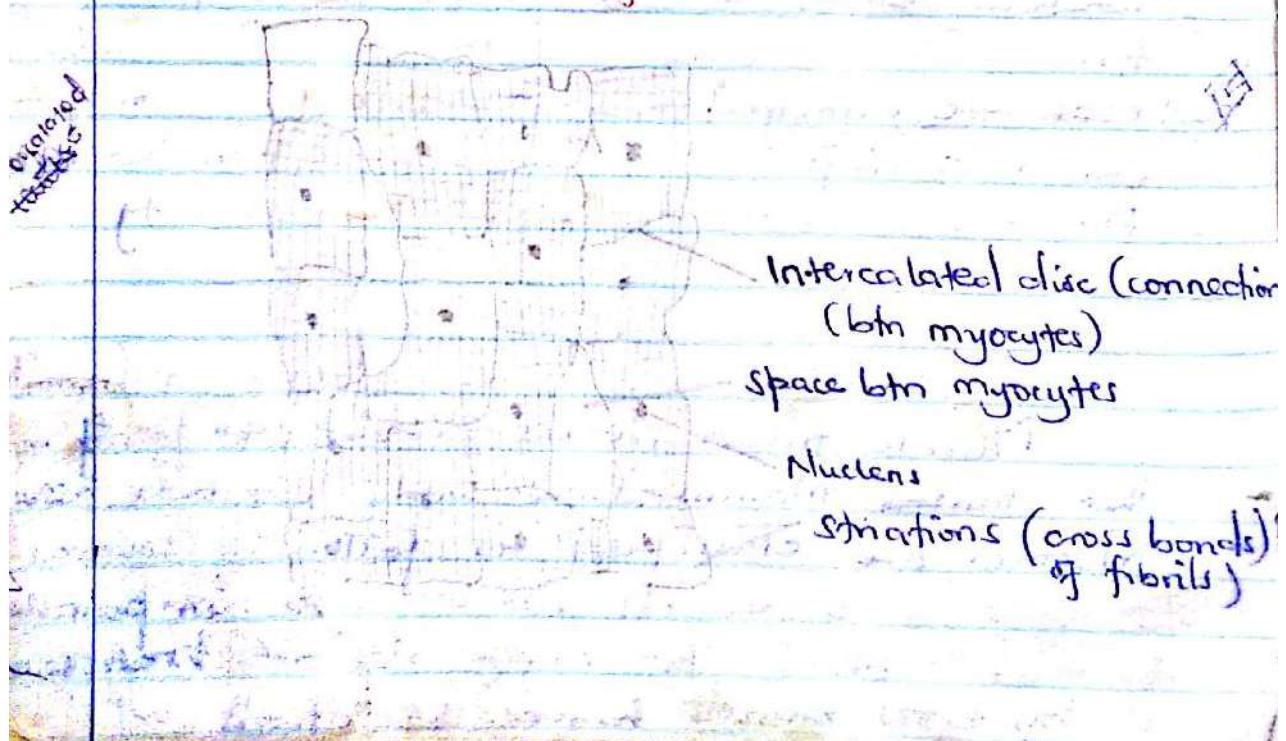
These muscles do not contain strips of fibres ie they are not striated. Smooth muscles are controlled by automatic nervous system. For this reason, they are also called **Involuntary muscle**. Examples are the muscle in the abdominal wall, intestinal wall and urinary bladder. These muscles contract slowly and fatigue slowly (slow twitch muscles).

(b) Cardiac muscles.

These make up the wall of the heart. This muscle tissue consists of muscle cells (myocytes) interconnected by intercalated discs, which offer them ability to conduct a wave of contraction (action potential) continuously.

Cardiac muscles are striated (ie have cross bands of fibrils). This muscle tissue has a unique property in that it is **myogenic** (ie contraction begins within the muscle itself) and they contract without fatigue, for the whole of life.

Diagram showing structure of cardiac muscle



How are cardiac muscle tissue adapted to its function?

- Myocytes are joined to form intercalated discs, for continuous excitation and rapid transmission of a wave of contraction from cell to cell.
- Each myocyte has a net work of striations which also enhance rapid transmission of a wave of excitation throughout the heart.
- The tissues has a rich blood supply to deliver oxygen to myocytes to meet the high demand for oxygen which ensures rapid contraction.
- The muscles contain a pigment myoglobin - which has a high affinity for oxygen which ensures that oxygen is not easily depleted in the muscles.

(c) Skeletal muscles

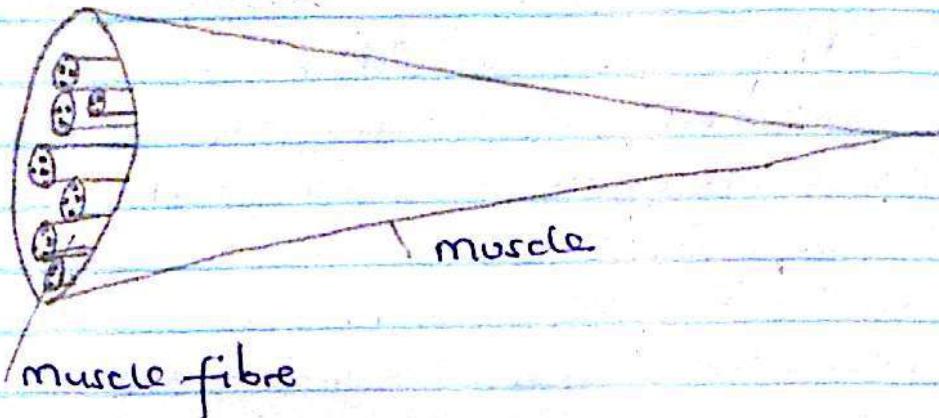
This type of muscle is responsible for skeletal movement in the body, and its contraction is controlled by the voluntary part of the nervous system, for which reason it is also called voluntary muscle.

This skeletal muscle is striated hence they are also called striped muscle.

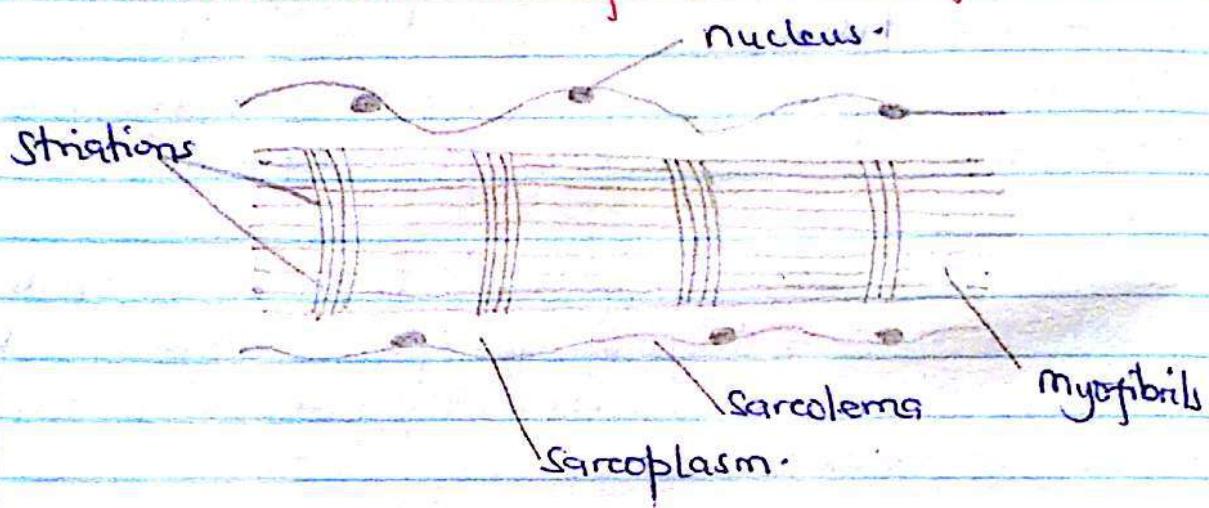
Structure

A skeletal muscle tissue consists of bundles of muscle fibres that run parallel to each other, the whole length of the muscle tissue. Each muscle fibre again consists of several strands of myofibrils which also run parallel to each other. The myofibrils are transverse d by cross bands known as thin filaments.

Diagram showing a skeletal muscle tissue.



Internal structure of a muscle fibre



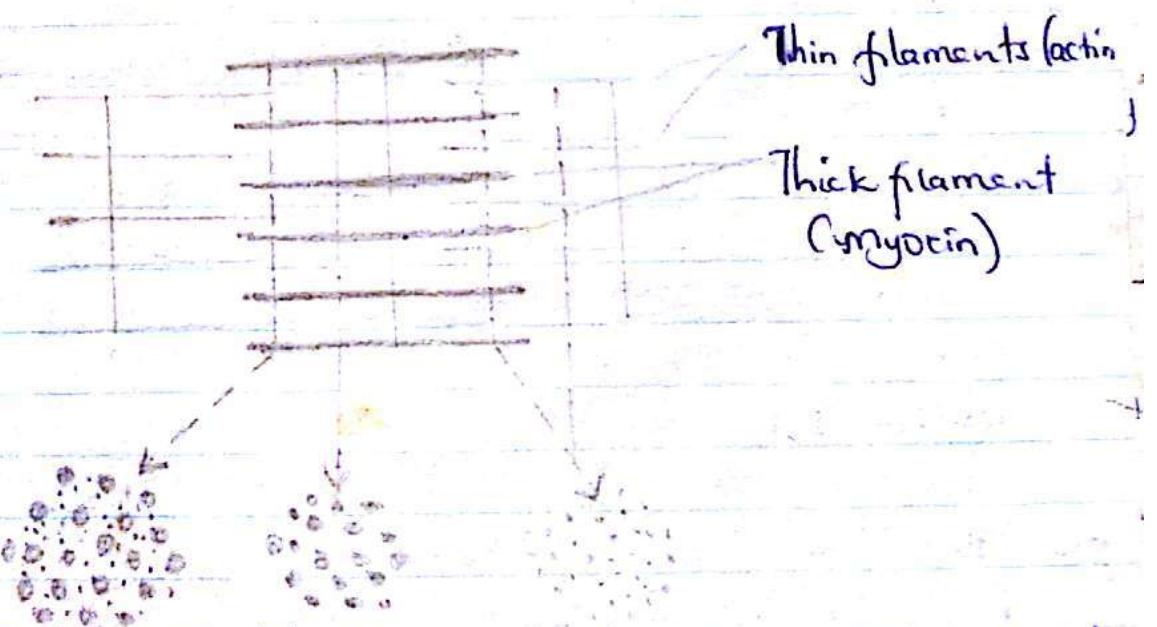
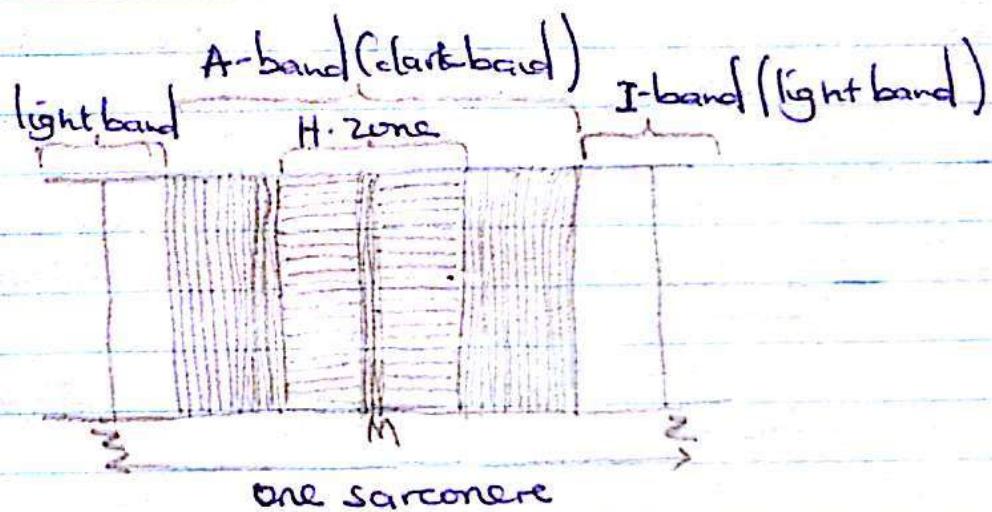
Each myofibril consists of two protein filament:-

- Thin filament made up of a protein called actin.
- Thick filament made up of a protein called myosin.

In some parts of the myofibril, myosin and actin overlap just like interlocking fingers. When observed under electrons microscope, the whole length of the myofibril has light and dark bands. The myosin filaments form the dark band, also called A-band and actin forms the lighter band also called the I-band.

In the region where the myosin and actin overlap, it appears more darker, forming a more darker part of the dark band (A-bands/I) while the centre of the dark band (where there is myosin only) appears lighter, forming the H-zone.

The I-band (light band) consist of actin filaments only and these are joined by a Z-line. The distance from one Z-line to another, is a **sarcomere**, which is a fundamental functional unit of the myofibril. The myosin filaments are joined by an M-line. The band pattern and the corresponding arrangement of actin and myosin filaments in a myofibril is shown in the diagram below.



Section through section thru section through light band
and of dark H-zone thick filament (thin filament only)
band (thick only)
and thin filaments
together)

During contraction, the actin filaments extend further into myosin. This causes the I-band (light band) to shorten and the H-zone also to become small while the more darker part of the A-band becomes bigger.

Eventually the whole Sarcomere (distance b/w the Z-lines) becomes ~~shorter~~ shorter

In a relaxed muscle, the actin filament are slightly interlocked with myosin, hence the darker part of the A-band is small while the light band (I-band) is bigger. The sarcomere becomes longer as a result.

stretched

Thin filament Thick filament

Light band H-zone Light band

Contracted

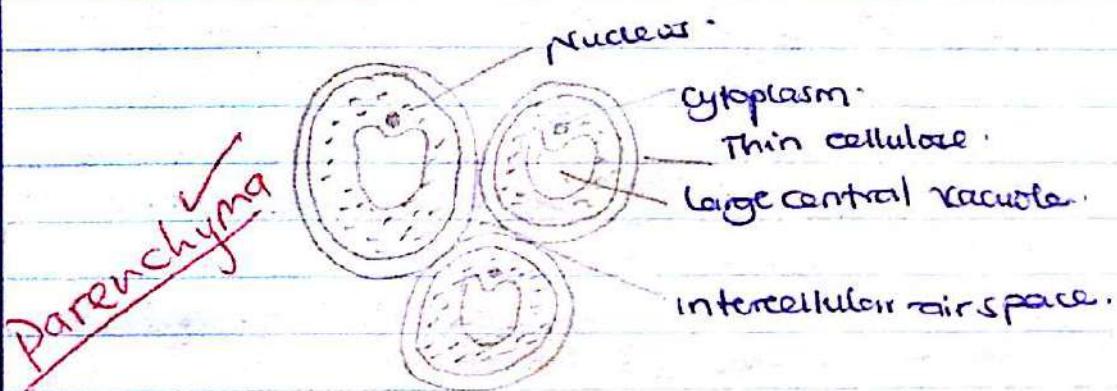
PLANT TISSUES

plant tissues are divided into ^{Ground tissue} Ground tissues, mechanical tissues, vascular tissues, meristematic tissues and photolytic tissues.

PARENCHYMA TISSUE (Ground packing tissue)

^{It is} ~~tissue~~ ^{packing} found in the cortex ^{It consists} This tissue serves a function as packing tissue. It fills spaces in between other tissues of the plant. It consists of cells which are spherical with ~~in~~ thin cellulose walls, ^{and} large intercellular spaces b/w them.

PQ 162
Br. P. 6.7



Parenchyma tissues are distributed in the cortex, the pith, ^{fill in space} ~~modulatory rays~~ and ^{as} packing tissue in the xylem and phloem. The main functions of parenchyma are:-

- (1) To fill spaces b/w other tissues and hence they provide support to the plant.
- They ^{Maintain} ~~support~~ shapes and ^{offer support} to plants parts especially leaves, when ^{the cells} ~~they~~ are turgid.
- They allow gaseous exchange to take place due to intercellular air spaces.
- They are storage tissues for the plant i.e. they store water, lipids and a carbohydrate in form of starch in their cytoplasm.

Parenchyma doesn't ^{only form} part of the cortex of roots and stems but also it is found in the mesophyll of leaves where they maintain the normal shape of the leaves enabling it to absorb

maximum sun light

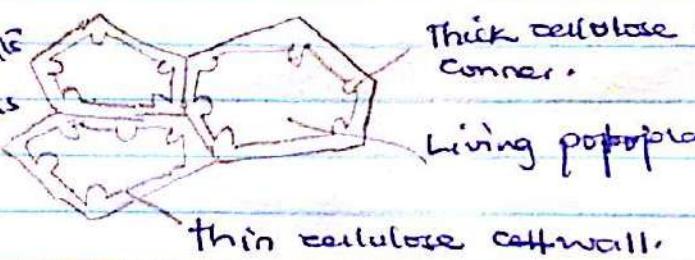
Made of living cells.
Have walls with additional cellulose.
They have walls with additional cellulose in their corners.
These features provide them with extra mechanical strength.
Mechanical strength is provided by thick cellulose at the corners.

COLLENCHYMA TISSUE

Collenchyma tissue are made of living cells and they have walls with additional cellulose in their corners deposited in their corners which provides them with extra mechanical strength. Cells in these tissues are elongated with polygonal - tapering ends. They are distributed in the outer regions of the cortex of the stems and the root but also found in the midrib of leaves.

Transverse section of collenchyma tissue

- Made of living cells
- Have walls with additional cellulose.
- Deposited in 5 corners.
- Provides mechanical strength.
- Cells are elongated & pointed.
- Cells are polygonal & tapering at ends.
- Distributed in outer regions of cortex of stem & root.
- Also found in midrib's of leaves.



Longitudinal section of collenchyma tissue



Q.N: How is the collenchyma tissue adapted to its function
+ Cell walls have additional cellulose deposited around their corners for extra-mechanical support.

~~- cells have uniformly lignified cell walls~~

Lignified ✓

SCLERENCHYMA TISSUES

This tissue consists of cells with uniformly lignified cell walls. In the cellulose cell wall, there is a strengthening substance called lignin, pectin and sometimes hemicellulose. Because lignin is a tough and impermeable substance, the protoplasm of the cell die leaving an open lumen - and hence the sclerenchyma are conducting tissues in plants.

The main functions of sclerenchyma are;

- They provide mechanical support for plants due to lignified walls.
- permit movement of materials e.g. water & mineral salts between the adjacent cells.

* Sclerenchyma tissue is of 2 types

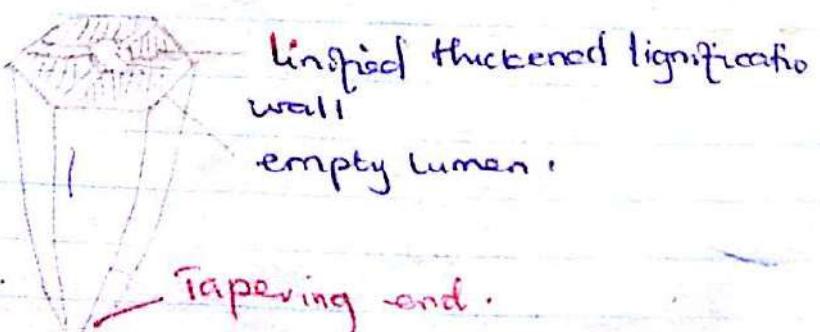
- (I) fibres
- (II) sclereid

The fibres are long and narrow cells with tapering ends while sclereids are short and branched cells.

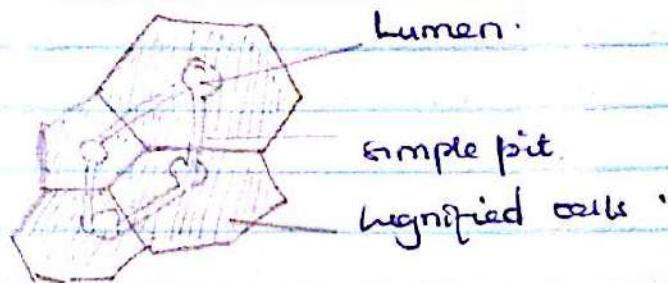
Distribution in the plant.

Fibres are found in the outer regions of the cortex, pericycle of stems and in phloem and xylem conducting tissues. Sclereids are found in the cortex, pericarp of fruits and in seed testa.

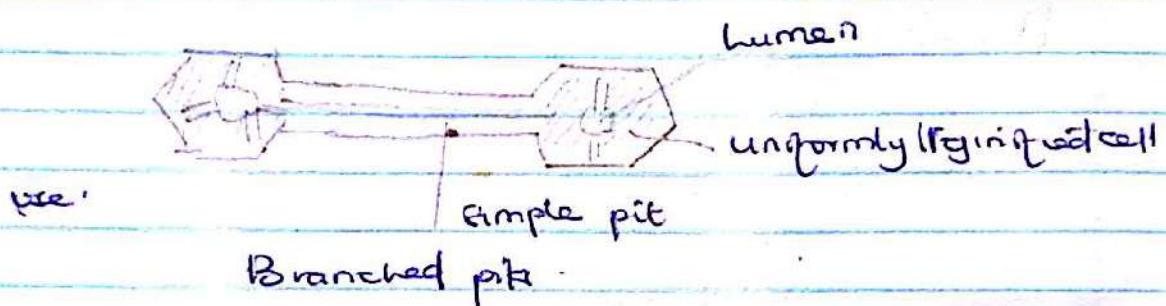
Diagram showing a longitudinal section of a fibre cell.



Cross section of fibre tissue



Transverse section of sclerocell



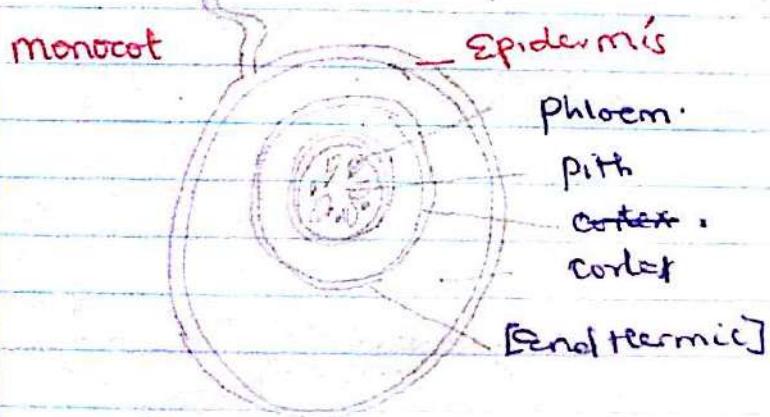
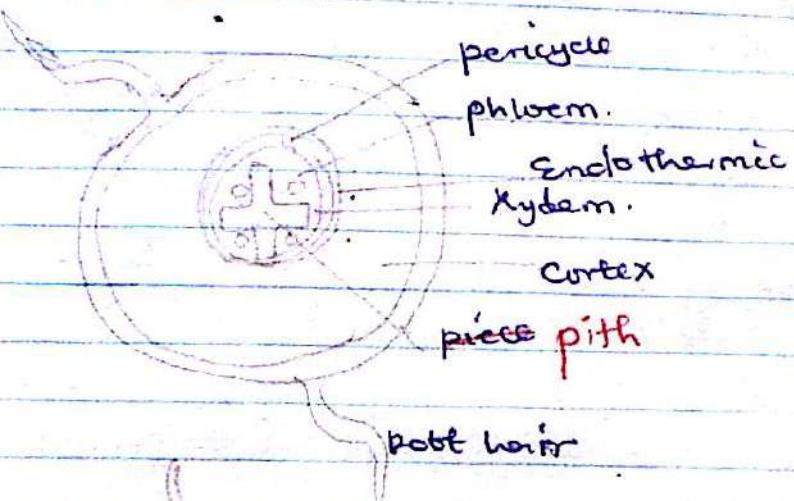
How is sclerenchyma tissue adapted to its function

- The cell wall of sclerenchyma fibres and the sclereids are uniformly heavily thickened with lignin, a ~~hard~~ substance which provides tensile strength.
- The ends of sclerenchyma fibres interlock with one another which increases their combined strength.
- The fibres are arranged into sheets of tissues that extend for a long distance in a longitudinal direction which also provide strength for the tissue.
- In between the cells the sclerenchyma have simple pits which aid distribution or transport of substances such as nutrients and water from cell to cell.

VASCULAR TISSUES

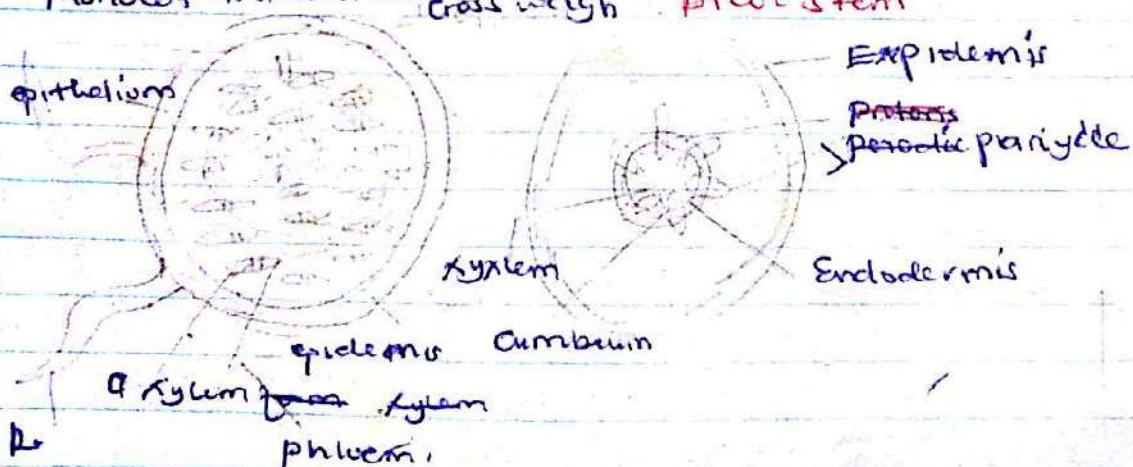
These are conducting tissues in plants consisting of xylem and phloem in roots and stems. These tissues form the vascular cylinder of higher plants together with the pericycle.

Cross section
Dicot root



Control, cross section
Dicot root.

Monocot and control stem cross section. Dicot stem



The pericycle is the outer most layer of the vascular cylinder consisting of a single layer of parenchyma cells which retain the power of cell division to enlarge the vascular cylinder.

The xylem:

Xylem consists of various types of cells which are non-living and some are living cells. The cell wall material is usually deposited with lignin, cellulose, pectins and hemicellulose.

The major function of xylem is to conduct water and mineral salts in plants. However it also provides mechanical support to plants.

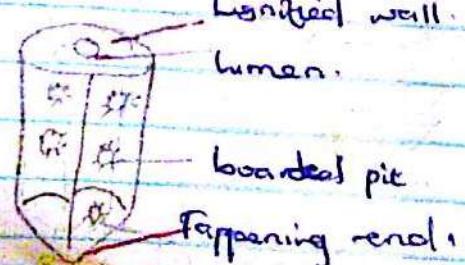
Xylem consists of 4 types of cells namely:

- Tracheids
- Vessel Elements.
- ~~Parenchyma~~ Xylem Parenchyma
- Xylem fibres.

Tracheids

A tracheid is an elongated cell with tapering ends and with thick lignified walls. Tracheids are non-living cells because when lignin is laid into the cellulose wall, the protoplasm dies living in an empty lumen that runs along the axis of the plant organ in which they are found.

Tracheids overlap and communicate with adjacent tracheids by means of bordered pits through which substances such as water are distributed.



Vessel Elements.

A xylem vessel element is cylindrical, opening ended non-living, tubular with lignified cell wall. A vessel is formed when cells (vessel elements) arrange end to end so that their end wall touch wlc after lignification disintegrate to form a continuous lumen thru wlc H_2O is conducted.

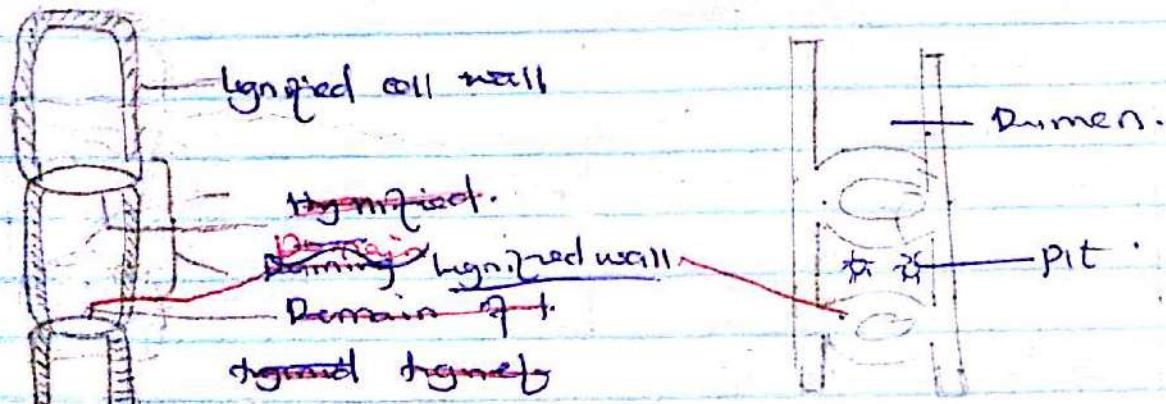
In mature vessel, lignin is not deposited over the entire cellulose wall but only in rings or in spirals hence several patterns of lignification include, pitted, Reticulate, spiral, Annular, scalariform and scalariform

In spiral and annular patterns of lignification lignin is deposited in rings with cellulose wall around the whole length of xylem vessel.

In pitted lignification the whole wall of xylem is uniformly lignified except in certain areas where pits are formed as rims of lignin is deposited in form of interconnecting bars. This pattern can be modified into scalariform lignification where the bars elongate to form rings.

Diagram showing fusion of vessel elements into xylem vessel.

eg.



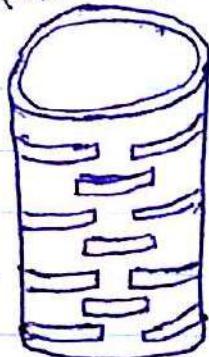
Forms of Lignification

Annotate.

(c)

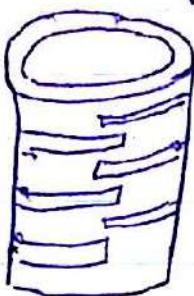
Anular

Reticulate.

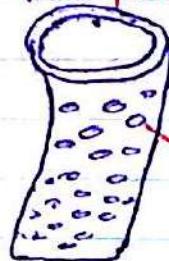


Lattice

Scalariform.



pit pitted



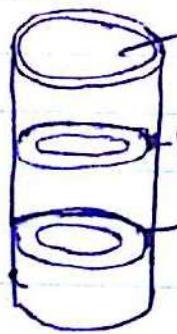
bordered pit.

4 forms of Lignification

(d)

Anular;

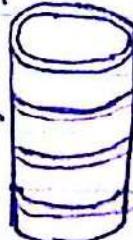
(e)



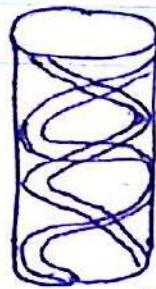
lumen or

Ring of lignin

(b). spiral



Simple
spiral



multiple
spiral

Xylem fibres

Xylem fibre like xylem vessel are associated by tracheids. They are mainly supporting tissues in junction and they have much thicker walls than those of tracheids but also with bordered pits like those of vessels.

However they have narrower lumen compared to the xylem vessels and they stronger and offer additional mechanical strength to the xylem.

Xylem parenchyma

These consist of piles of elongated cells which are of parenchyma origin. They are living cells which serve the function of storing food.

Adaptations of xylem tissue to its functions

- Mature cells in both vessels and tracheids lack living protoplasm to form an empty lumen which removes resistance to water flow through them.
- The vessel elements are placed end to end with their end walls degenerated to form a continuous lumen for distribution of water up the plant.
- The walls of tracheids and vessels are lignified which offer greater strength to withstand pressure during transportation of water.
- Vessels and tracheids have a narrow / fine lumen which maintain high capillarity for water transport within the plant.
- The lignin in the cellulose wall increases adhesion of water molecules which enable water to rise / move through the Xylem vessels by capillarity.
- Vessels and tracheids have bordered pits for lateral distribution of water to other neighbouring cells.
- Has spiral and annular thickening which gives rise to high tensile strength and prevents the vessel from collapsing.

The phloem:

A phloem is completely a living tissue i.e. it performs a role of translocation (translocation) of organic substances e.g. sugars, amino acids etc. in plants. It consists of sieve tube elements, companion cells, phloem fibres, parenchyma and the sclereids.

The sieve tubes:

Sieve tubes are formed by end to end fusion of cells known as sieve tube elements whose end walls are made of cellulose and pectin substance is just like parenchyma cells. Their nuclei degenerate and get lost as the sieve elements mature and the cytoplasm becomes confined to the thin layer around the periphery layer of the cell.

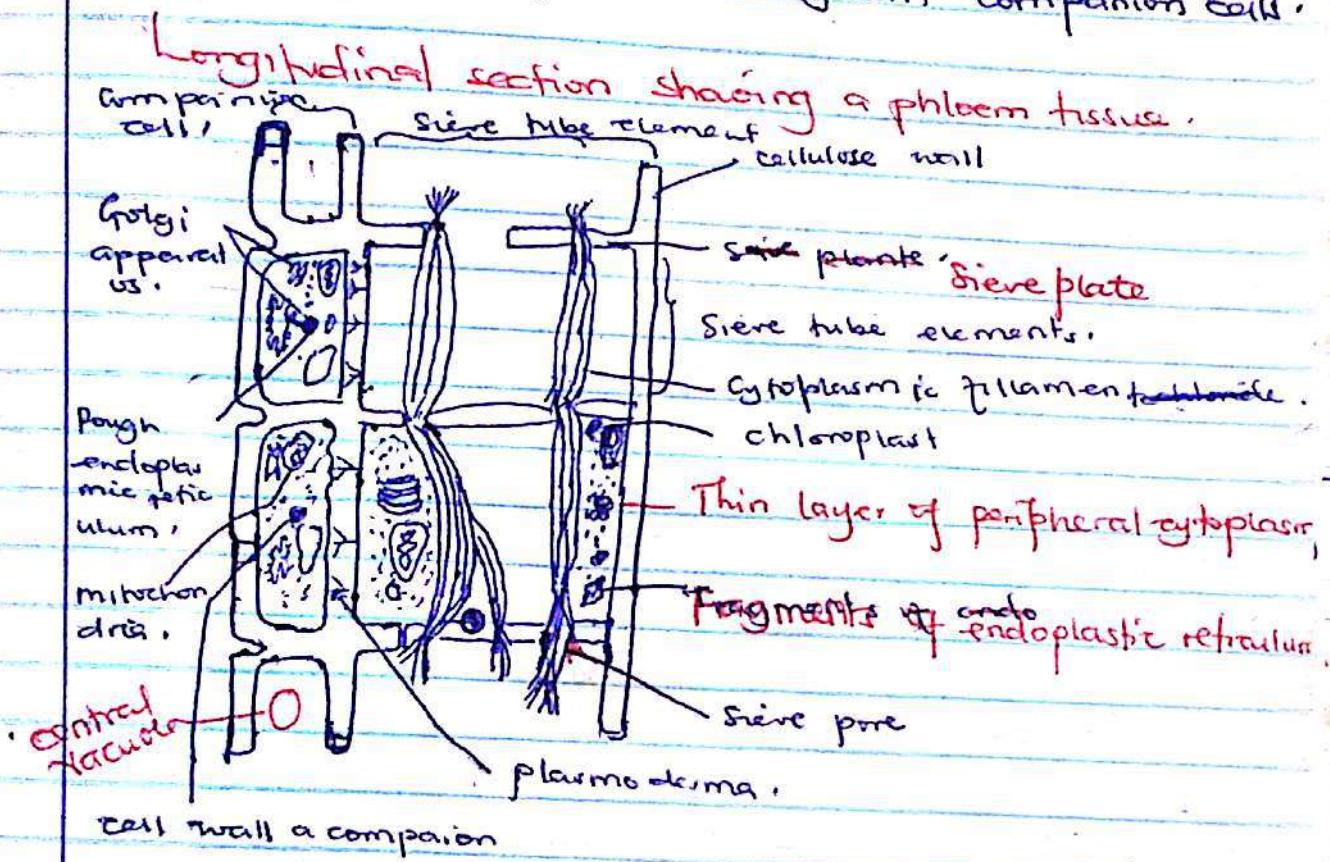
The end walls of the sieve elements become perforated to form sieve pores in the sieve plates through which cytoplasmic filaments run from one sieve element to another and these aid translocation of organic substances through the phloem.

Although they lack nucleus the sieve elements remain living but are dependant on adjacent companion cells for energy required during translocation of organic substances.

The Companion cells

Each companion cell is in close association with a sieve element. It contains active cytoplasm containing numerous organelles including mitochondria, ribosomes, a prominent nucleus and endoplasmic reticulum. Companion don't play a direct role in translocation of organic materials but are metabolically active and supply the phloem with enough energy for translocation.

The two, companion cells and sieve elements are in direct communication through small cytoplasmic strands known as **Plasmodesmata** plural **plasmodesma singular**. that runs through the end walls of the sieve tube from the adjacent companion cells.



~~Cell structure fitting function~~ is the distribution of organelles of a cell in an organ or tissue in intensities that suit their function.
(Starch as good store)

Starch can easily be hydrolysed by hydrolytic enzymes like amylase in times of need.

Starch is insoluble in water hence exerting a low osmotic pressure in solution.

PHLOEM PARENCHYMA:

These are elongated and sometimes tapering. They are also living cells and their main function is to store organic food materials. They are absent in the phloem of monocot.

Phloem fibres

These are also found in Dicots plants but not monocots. They are exactly similar to sclerenchyma fibres. They occasionally occur in primary phloem but more frequently in secondary phloem of dicots. In secondary phloem, they form vertically running bars of cells where they strengthen the phloem and enable it to withstand pressure.

Adaptations of phloem to its function

possess sieve elements which are elongated and unconnected end to end to form a continuous hollow structure for continuous flow of organic substances.

The end walls of the sieve elements are perforated to form sieve pores which allow passage of organic materials.

The phloem consist of cytoplasmic filaments - that run from one sieve element to the other for continuous translocation of organic substances within the plant by cytoplasmic streaming.

Each sieve element is associated with companion cells which provide the necessary energy & active transport of materials through the phloem.

The sieve contains a small amount of phloem fibres which provides mechanical support and lignicity to plant organs.

found in
dicot but not
monocot

sieve

like element

cells are perforated

end walls

cytoplasmic

filaments

companion

cells

phloem

fibres

small
amount

lignin

organic

material

— The phloem parenchyma aids in storage and controlling cytoplasmic components on the periphery of each sieve element and this provides free space for passage of organic substances.

Compare the structure of xylem and phloem.

Xylem

- Has bordered pits
- Has no nucleus
- No ~~manufacturing~~ production of energy
- It has a hollow lumen which permits water and other substances
- Companion cells absent
- Cells are dead

phloem

- No bordered pits except it has sieve pores.
- consist of a prominent nucleus in the companion cells
- It can manufacture the energy through the mitochondria in the companion cells
- It is sealed with a sieve plate.
- Companion cells present.
- Cells are living

Other tissues in plants.

Epidermal tissues.

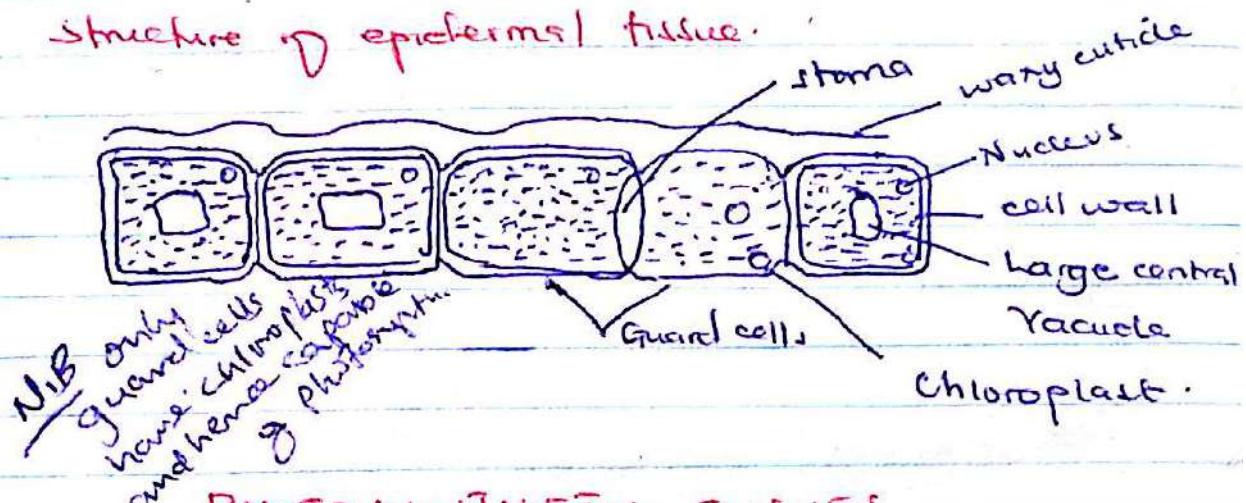
The epidermis arise from the outer most layer of the apical meristematic cells known as the protoderm. The epidermis consist of a single layer of closely packed cells usually lacking intercellular air spaces. It consists of living cells. Some specialised e.g. Guard cells which contain chloroplasts for photosynthesis unlike the rest of the epidermal cells of the leaf.

Functions of epidermal tissues.

- They offer protection of internal tissues against mechanical injury, excess heat, water loss and the infection by micro-organisms like the Bacteria and fungi.

- Epidermal tissue offers passage for light to the internal photosynthetic tissues of the leaves.
- In leaves the specialised epidermal cells (Guard cells) control the opening and closure of stomata.

Structure of epidermal tissue.



PHOTOSYNTHETIC TISSUES

These are tissues responsible for synthesizing of organic compounds in the plant. They contain chloroplasts where photosynthesis takes place and are more abundant in leaves.

MERISTEMATIC TISSUES

These are the simplest plant tissue located at the growing point of the plant i.e. the apex of the root, at the apex of the shoot.

Meristematic tissues are small, thin walled and lack sap vacuoles and chloroplasts. Their important feature is that they have ability to divide and subsequently differentiate into specialised cells.

Adaptations of voluntary muscles to their functions:

Consists of numerous fibres containing numerous long, cylindrical, unbranched and elastic myofibrils which allows the muscle to extend a wide range. The elasticity allows it to regain its original length after stretching.

The myofibrils are arranged parallel to one another which allows sliding over one another during contraction and relaxation.

- Each muscle fibre has connection with motor portions of the voluntary nervous system. This enables to respond to actions of this section of the nervous system in response to changes in the env't.
- The muscle has a dense network of blood capillaries. This ensures efficient supply of oxygen and materials and removal of wastes.
- The muscles contain myoglobin instead of haemoglobin in blood. Myoglobin has a higher affinity for O_2 than haemoglobin.
- The fluid bathing the myofibrils contains numerous glycogen granules and mitochondria. This ensures that enough energy is in form of ATP is available to the muscle for use in contraction.

END