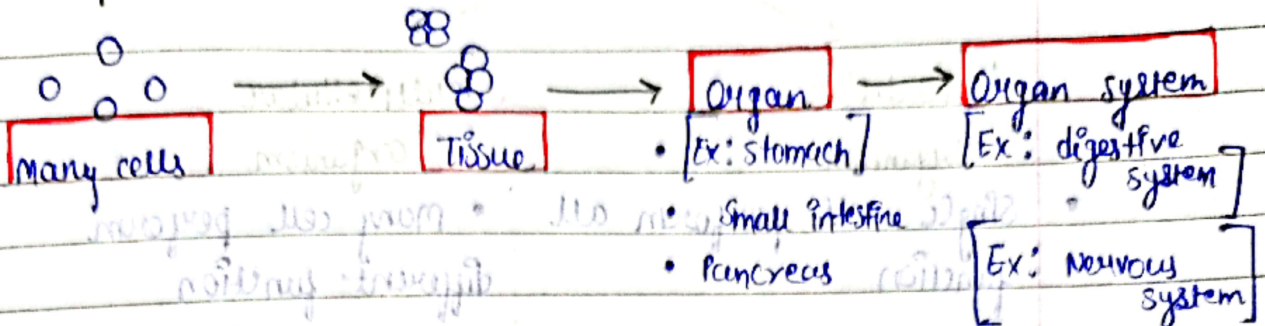


Cell - The unit of life

* What is cell?

a) Concept



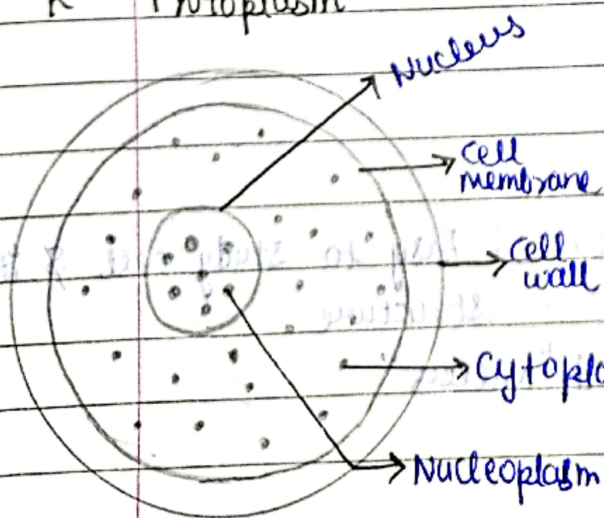
Human

b) Definition: Cell is the fundamental [basic], structural & functional unit of living organism.

* Difference Between

	Inanimate	Animate
	Non-living	living
cell	absent	Present

* Protoplasm



- ^(living) Protoplasm = Nucleus [nucleoplasm] + cytoplasm
- Protoplasm + cell membrane = Protoplast
- Cell without cell wall = protoplast

* Unicellular and multicellular organisms :

- All living organism composed of cell.

Unicellular organism

- Single cell perform all function

eg: Amoeba, Euglena, Paramecium

Multicellular organism

- Many cell perform different function

eg: Plants, Animals [Human]

- Unicellular organism: It can perform all essential function of life so independent existence occur.

* Discovery of cell :

1st time :

- Cell discovered by Robert Hook.
- Cork: Dead, Plant cell

Cell derived from:

'cellula' word meaning
⇒ Compartment / Box

1st time living cell :

- Cell [living] discovered by Anton Van Leeuwenhoek [Bacteria]

NOTE: Discovery of electron microscope: Easy to study cell & its structure
in 1950s

NOTE: Robert Brown discovered "Nucleus" (1831)

* Cell Theory :

- Cell Theory formulated by MATTHIAS SCHLEIDEN & THEODORE SCHWANN

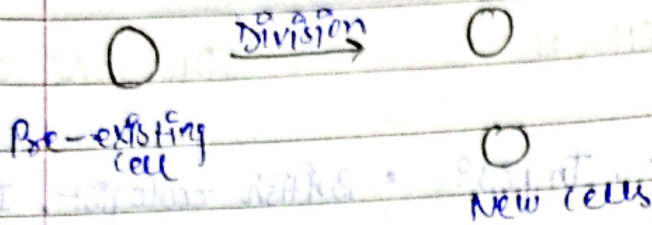
MATTHIAS SCHLEIDEN	THEODORE SCHWANN
- German Botanist, In 1838 - He studied different type of plants - All plants composed of cells & cell forms tissue.	- British zoologist, In 1839 - He studied different animal cell. a) Animal cell covered by thin layer Plasma membrane or cell membrane b) Presence of cell wall : unique character of plants c) Plants & animals composed of cells & its product [Tissue]

Drawback of cell Theory: How new cells were formed not explained by both the scientist.

Exception: virus is exception to cell Theory.

* Rudolf Virchow, 1855:

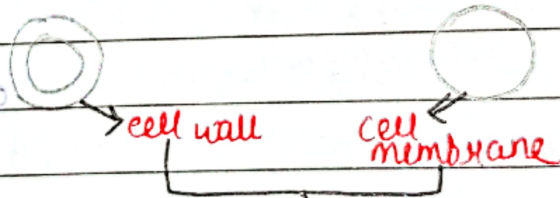
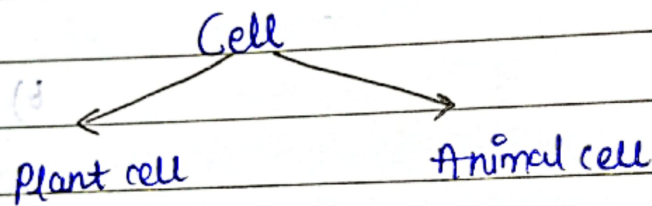
- Omnis cellula e cellula
"cell arise from division of pre-existing cell"



- All living organisms composed of cell & its product [Tissue]

- Final shape to cell theory was given by Rudolf Virchow

* Delimiting layer

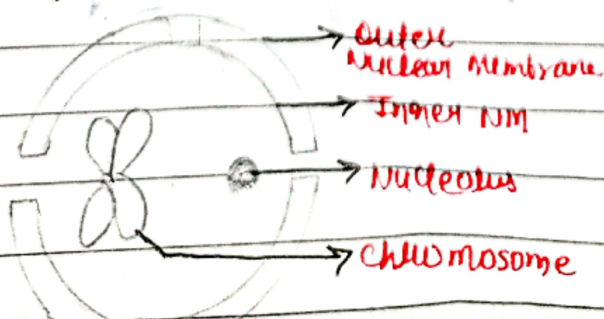


Delimiting layer [which make boundary of cell]

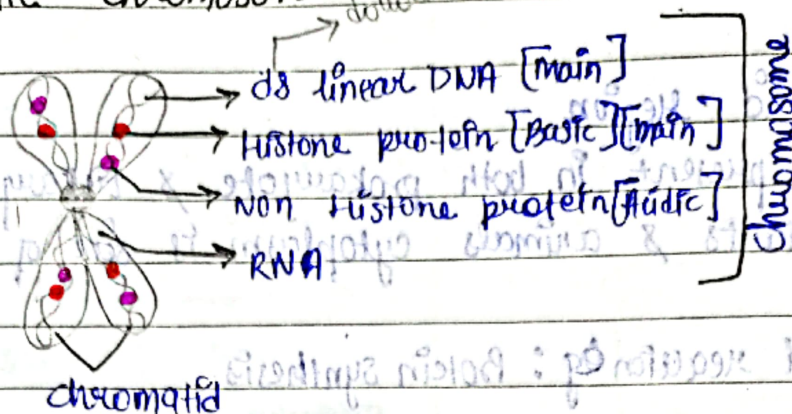
eg: Onion peel cell

eg: human cheek cell

* Eukaryotic Nucleus

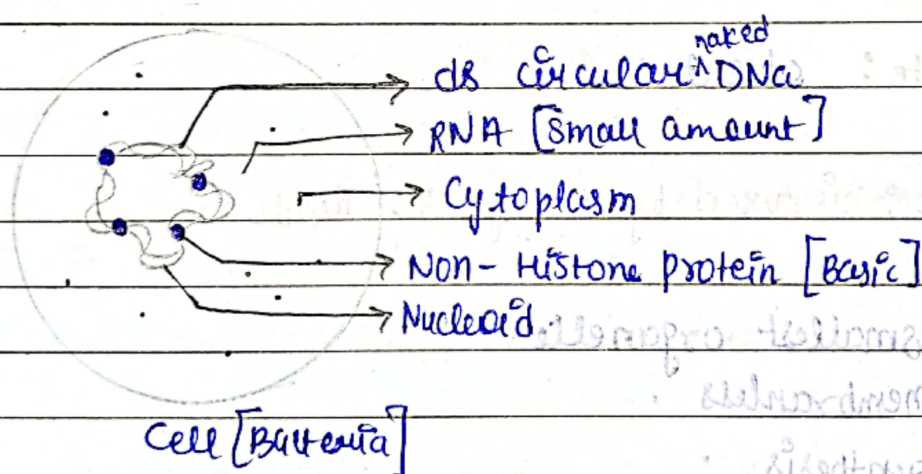


* Euchromatic chromosome



- DNA length : $2 \cdot 2m$
- Nucleus length : $10^{-6}m$
- Nucleus : chromosome : DNA [genetic material]
- chromatid : V shaped [2 chromatid]

* Prokaryotic nucleus



- Nuclear membrane & nucleolus is absent
- Nucleus not well defined.
- True nucleus absent.
- Its DNA is naked [not covered by nuclear membrane]
- Histone protein : absent
- False chromosome : present
- True chromosome : absent

* Cytoplasm

- Semifluid region
- It is present in both prokaryote & Eukaryote.
- In plants & animals cytoplasm is site of cellular activities
chemical reactions
It keeps cell in living state
- Chemical reaction eg: Protein synthesis

* Cell organelle

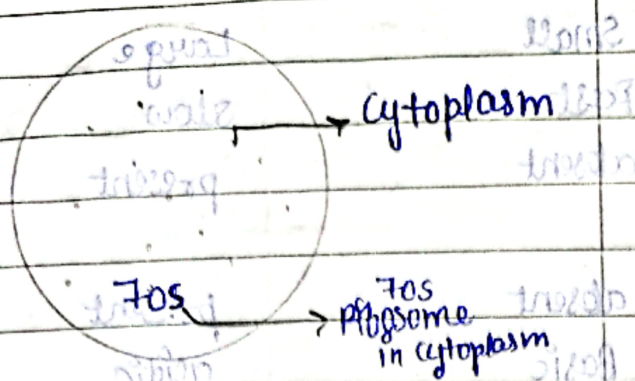
Eukaryote: Membrane bound cell organelle present
: mitochondria, Golgi, Body, ER, Lysosome, vacuole, microbodies.

Prokaryote: absent (only Ribosome)

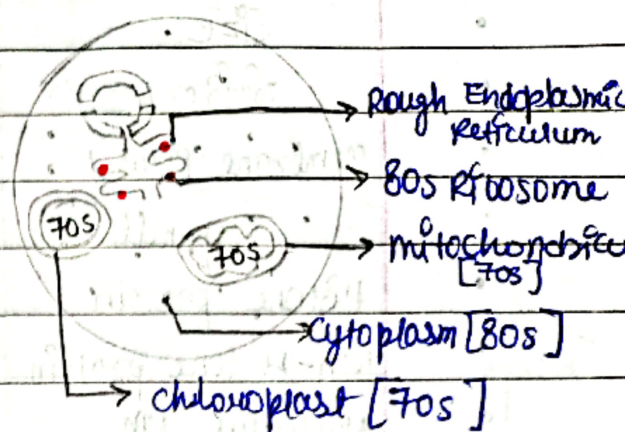
* Ribosome: Discovered by George E. Palade

- It is smallest organelle.
- It is membranless.
- Protein synthesis.
- Called as "Palade particle".
- Found in both prokaryote as well as eukaryote.

Prokaryote



Eukaryote



Both 70S & 80S Ribosome are found in Eukaryotic cell.

* Centrosome

- It is absent in prokaryote.
- It is present in Eukaryote [animal cell] → helps in cell division.
- It is absent in higher plant.
- Centrosome consists of 2 centriole.
- It is membranless.

* Shape & size of cell

- shape, size of cell: vary
- Shape of cell vary with function
- mycoplasma [prokaryote]: smallest cell: 0.3 μm in length.
- Bacteria: 3-5 μm in diameter
- Ostrich egg: largest cell
- RBC: 7 μm
- nerve cell: long

• Shape of cell
 ⇒ disc, cuboidal, columnar, irregular etc.

Character	Prokaryote	Eukaryote
-----------	------------	-----------

Size	Small	Large
Divide	Fast	slow
membrane Bound organelle	absent	present

Histone protein	absent	present
Non-Histone protein	Basic	acidic

Nucleolus, NM	absent	present
well defined Nucleus	absent	present

Chromosome	False Chromosome	True
------------	------------------	------

DNA	Double strand, Circular, naked (Not covered by NM)	ds, linear, covered by NM
-----	--	---------------------------

Ribosome	70s	70s, 80s
----------	-----	----------

Centriosome	absent	present [animal cell]
-------------	--------	-----------------------

* Shape of different cells

① RBC = Round and biconcave

② WBC = amoeboid

③ Columnar epithelial cells = long & narrow

④ Nerve cell = Branched & long

⑤ Atracheid = elongated

⑥ mesophyll cells = round & oval

[Mycoplasma & PPLO are same]

*

Prokaryotic cell

Bacteria

Blue-green
algae

Mycoplasma

PPLO

(Pneumonia like organism)

cell wall
absent

cattle

Lungs

pleural
fluid

organism

Infection
[pneumonia]

* Shape of Bacteria [4 types]

Coccus

[Spherical]



Bacillus

[Rod]



common
shape

Vibrio

[comma]



Spirillum

[Spiral]



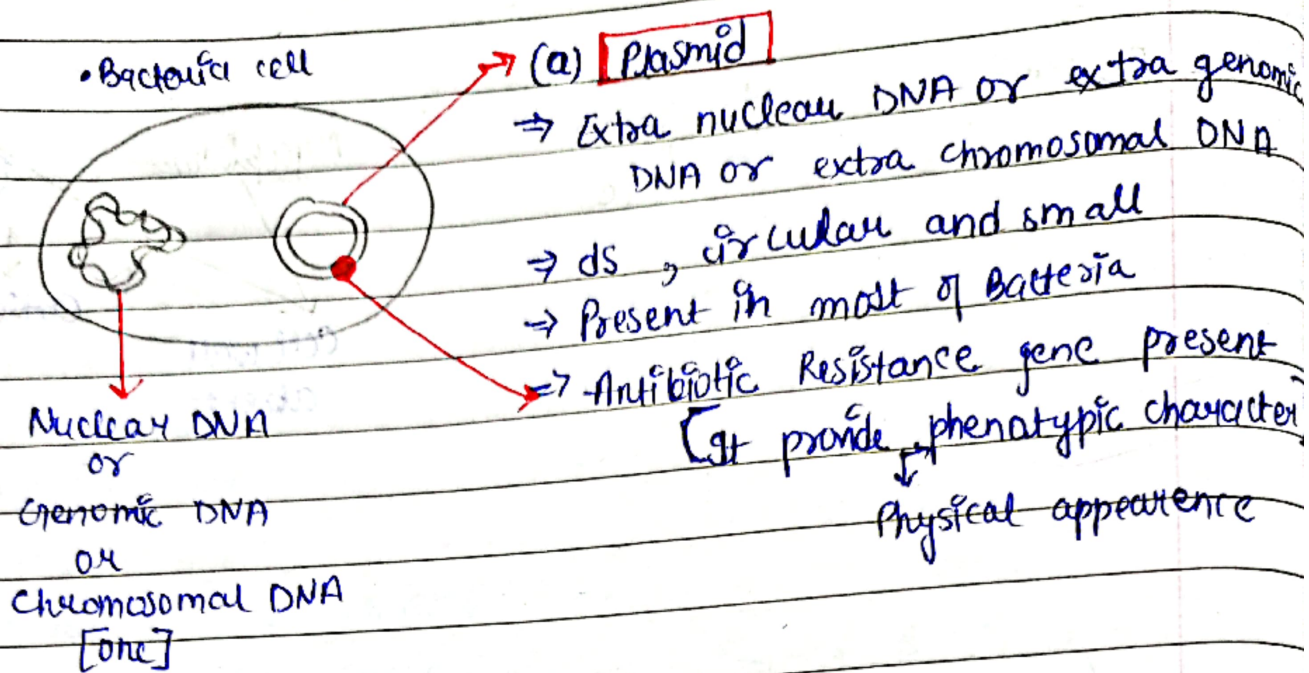
Note:

Organisation of prokaryote

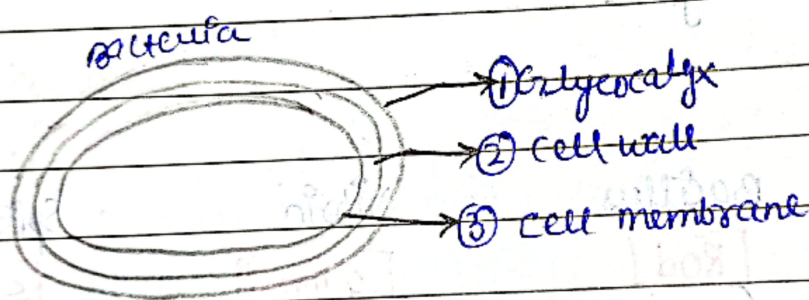
Fundamentally similar
But

exhibit different
shape & function

Structure of Prokaryotic cell



NOTE: Plasmid helps in Transformation of foreign DNA



• ① + ② + ③ ⇒ **cell envelope**

⇒ 3 layer, tightly attach

⇒ Chemically complex

⇒ Function of 3 layers: different

⇒ All 3 Behave as a protective unit.

⇒ most of Prokaryote

①

Glycocalyx [outer layer]

Hard, Thick,
Tough
[capsule]Soft, loose,
Thin
[slime layer]

- In most of bacteria capsule is present

- In some bacteria slime is present

- Glycocalyx is made of mainly polysaccharide [carbohydrate]
- Thickness & composition of glycocalyx vary in different bacteria.
- Glycocalyx provide sticky character to bacteria.

②

Cell wall

- cell wall is made up of peptidoglycan / murein
 - Sugar
 - amino acid
- Provide shape to cell & prevent bursting / collapsing of cell.

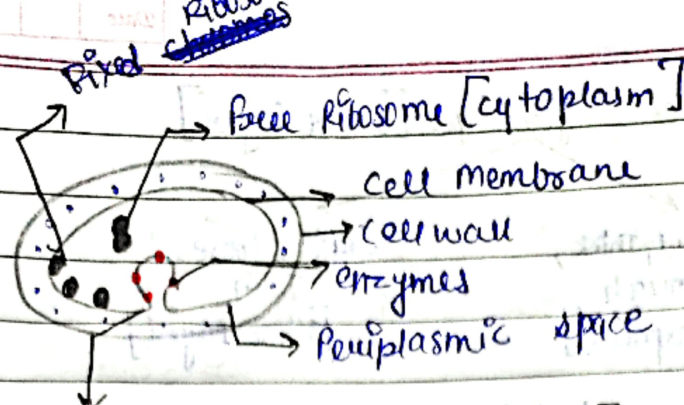
③

Cell membrane

- cell wall is made up of lipid + protein.
- Its structure is almost similar in prokaryotes & eukaryotes
- cell membrane is selectively permeable
 - • • [solute]
 - ← H₂O [solvent]

cell memb.

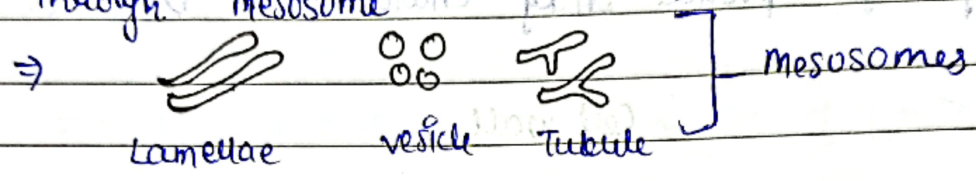
- cell membrane interact with outer environment



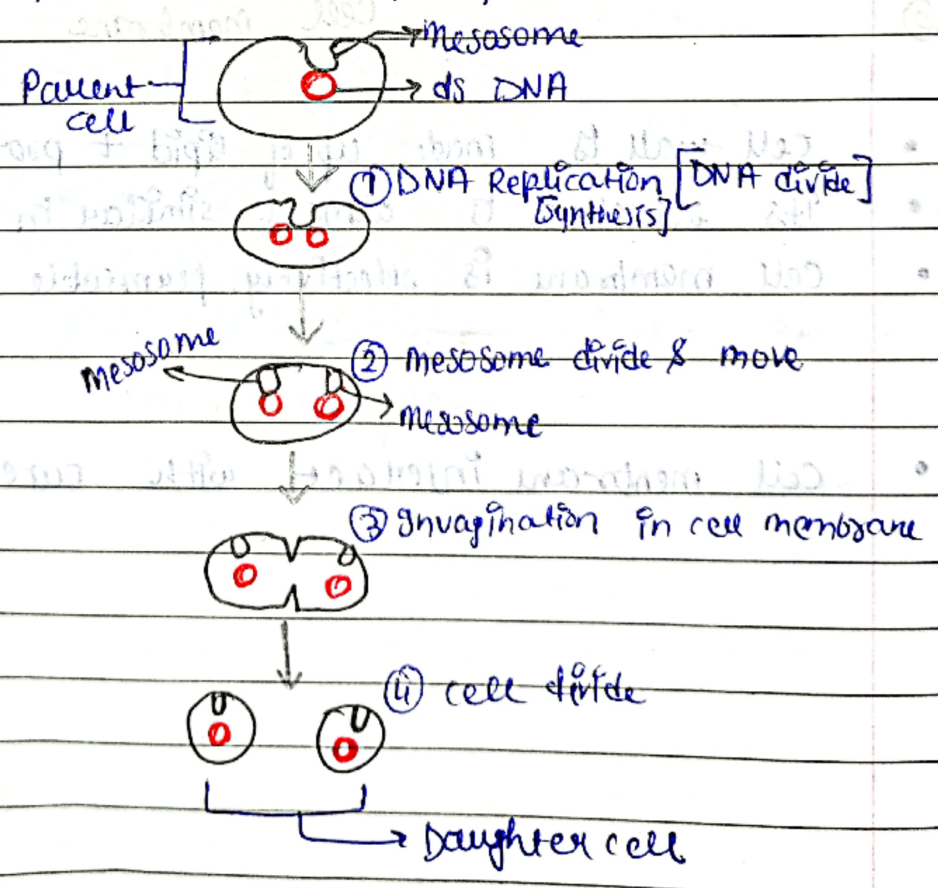
[mesosome release] Secrete protein from cytoplasm into periplasmic space. Secretion & This protein enzymes helps in digestion of food]

(c) **Mesosome** [only in prokaryote]

- ⇒ It is extension / invagination of cell membrane
- ⇒ Eukaryote respire through mitochondria
- ⇒ In Prokaryote mitochondria is absent, so they respire through "mesosome"



- ⇒ Mesosome increase surface area & enzyme content
- ⇒ Secretion : Transportation
- ⇒ Mesosome discharge outside the cell
- ⇒ DNA Replication & its equally distribution in daughter cell



⇒ mesosome helps in cell wall synthesis.

d) Inclusion Body

- ⇒ It is found in prokaryotes cytoplasm
- ⇒ It is membranless
- ⇒ Inclusion Body store reserve material

eg: ① Phosphate granule

↓
[stores phosphorus]

② Glycogen granule

↓
[stores glycogen]

③ ~~Cyano~~ Cyanophycean granule

↓
[stores protein]

↓
[Found in Blue green algae]

④ Gas vacuole

↓
[store air]

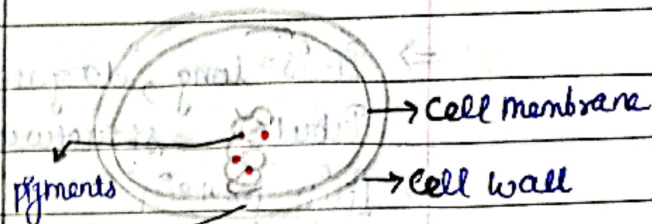
↓
[Provide Buoyancy]

↓
• Found in Blue green algae

Photosynthetic Bacteria

- Purple Sulphur Bacteria
- Green sulphur Bacteria

e) Chromatophore



- It is extension of membrane,
- present in cytoplasm
- It contain pigments.
- It helps in photosynthesis
- It is present in some prokaryote [eg: Blue green algae, cyanobacteria]

- Both are present in bacteria
- No role in 'Locomotion' [motility]

Pili & Fimbriae

⇒ It is long, elongated, Tubular structure

⇒ Pilin protein

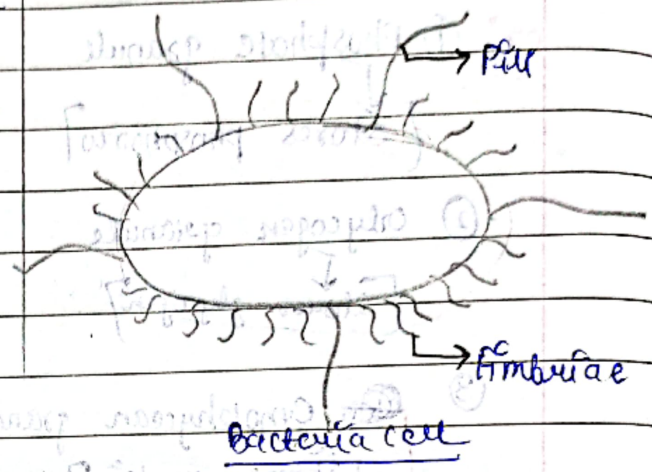
↳ Pili is made of

⇒ It is less in number

⇒ It is short, narrow

⇒ It is more in number

⇒ It is Bristle like & helps in attachment to Rock, Host.

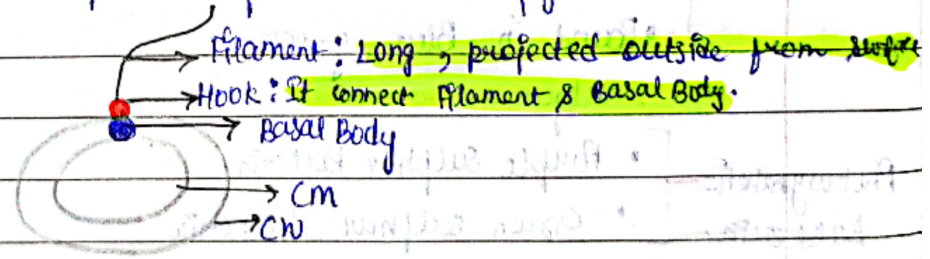


* Bacterial Flagella

- Number & distribution vary in different bacteria.



- There are 3 parts of bacterial flagella.



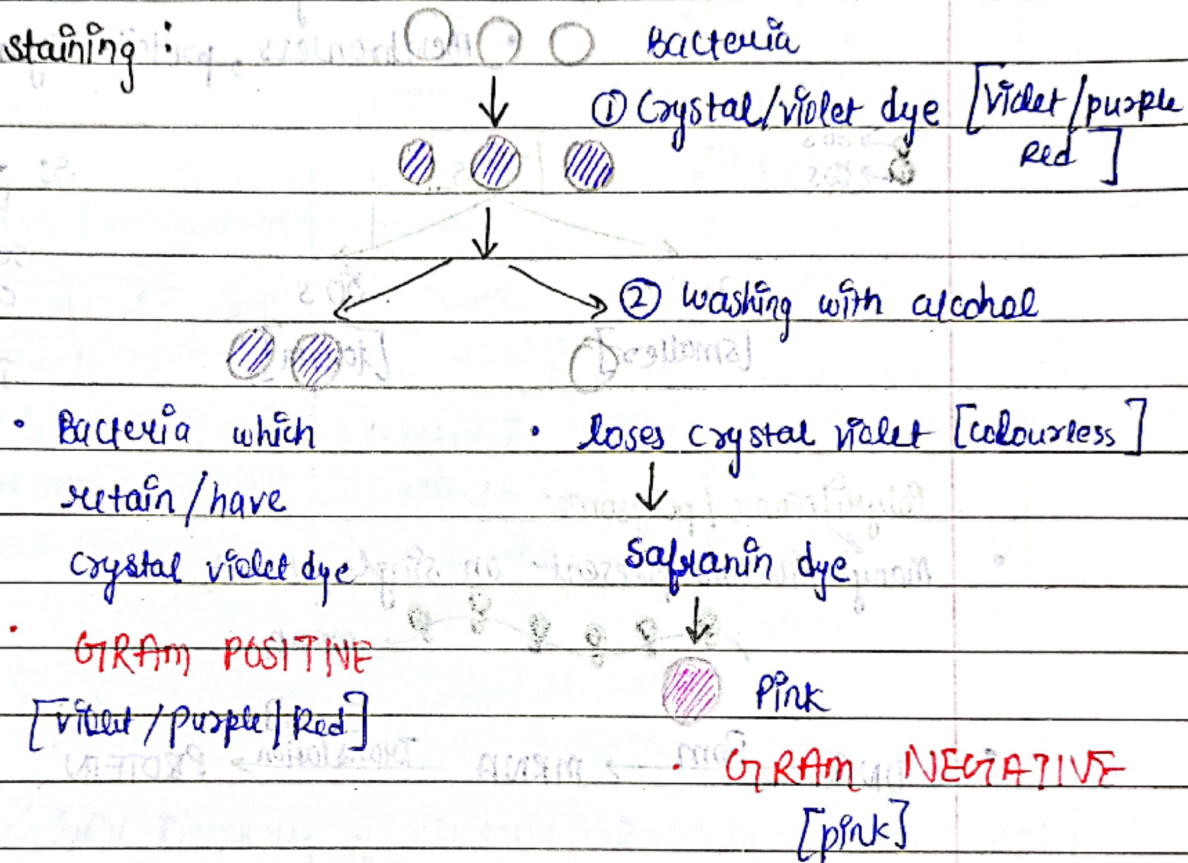
- If flagella is present on bacteria, then bacteria will be motile [movable].

- If flagella is absent on bacteria, then bacteria will be non-motile [no movement]

- **Flagellin protein** is present in flagella
- Flagella is thin, filamentous extension of cell wall.

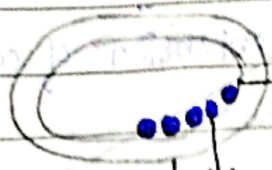
* Classification of bacteria

Gram staining:



* On the basis of staining procedure composition of cell envelope bacteria is classified.

* Prokaryotic Ribosome



- Attached to cell membrane
- 15nm by 20nm in size
- membranless, protein synthesis (help)

30s
50s

70s

30s

[smaller]

50s

[larger]

S: svedberg unit

sedimentation coefficient [velocity]

Indirect measure of size & density.

Polyribosome / polysome

- Many Ribosome present on single mRNA



DNA $\xrightarrow{\text{Transcription}}$ mRNA $\xrightarrow{\text{Translation}}$ PROTEIN

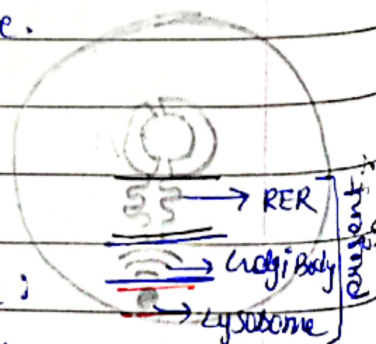
* Eukaryotic cell

- It includes: Protista, plants, animal, Fungi
- Compartmentalisation is present in eukaryote. because memb. bound organelle is present.
- memb. bound organelle is absent in prokaryotes.

Complex locomotory & cytoskeleton structure:

Present: eukaryote
absent: prokaryote.

- Double envelope: cell memb. nuclear memb.] present in eukaryote



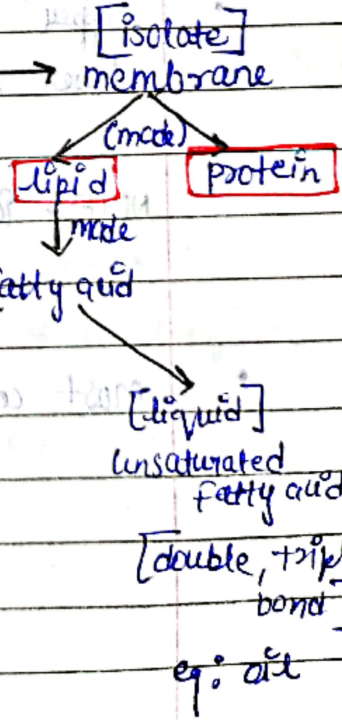
Single envelope: cell memb.
 nuclear membX } prokaryote: present.

* All eukaryotic cell are not identical:

	Plant cell	Animal cell
Cell wall	✓	X
chloroplast [plastid]	✓	X
Large central vacuole	✓	X
centriole [centrosome]	absent in almost all plants.	✓

* Cell membrane

- ~~Discovery of electron microscope~~ Discovery of electron microscope makes easy the study of cell membrane in 1950.
- Chemical studies → RBC of Human → membrane
- Cell membrane is mosaic pattern.



Cell membrane

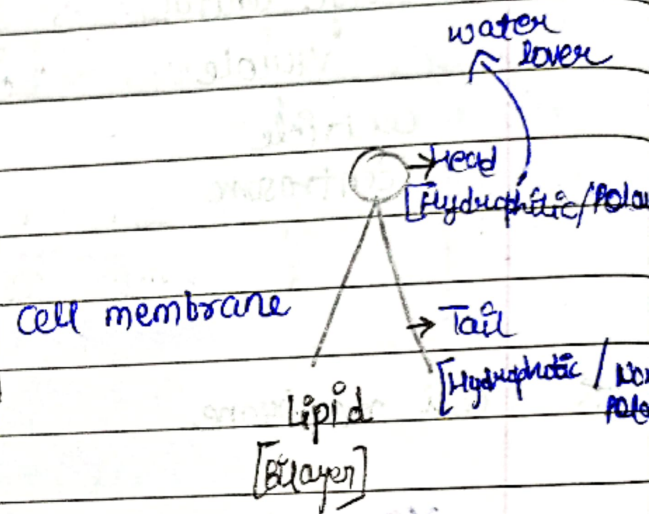
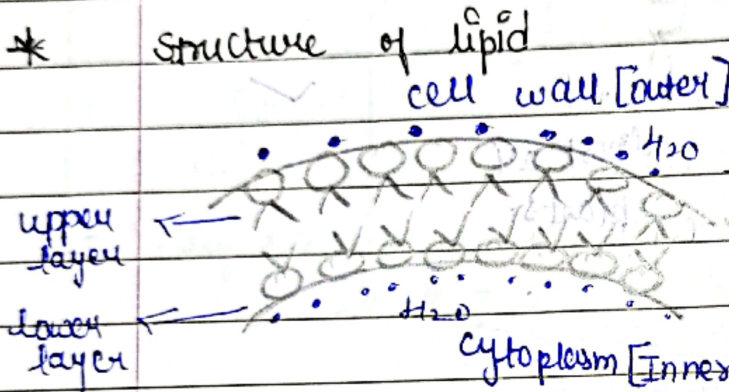
Oulab Jamun model

Protein iceberg in sea of lipid
→ solid
→ liquid



पदार्थ
[Lipid]
[Liquid]

गुणित
[protein]
[solid]



- upper layer is towards cell wall
- lower layer is towards cytoplasm

NOTE: Tail of saturated hydrocarbon directed inwards to protect from aqueous environment.

most common lipid: Phospholipid [eg: phosphoglyceride]

movement of lipid



If lipid move within monolayer
[lateral movement]
[Mostly]



If lipid move b/w two layers
[Flip Flop movement]
[Rarely]

Cell membrane

Biochemical study

RBC

also contain protein & carbohydrates

[52% protein]
[40% lipid]

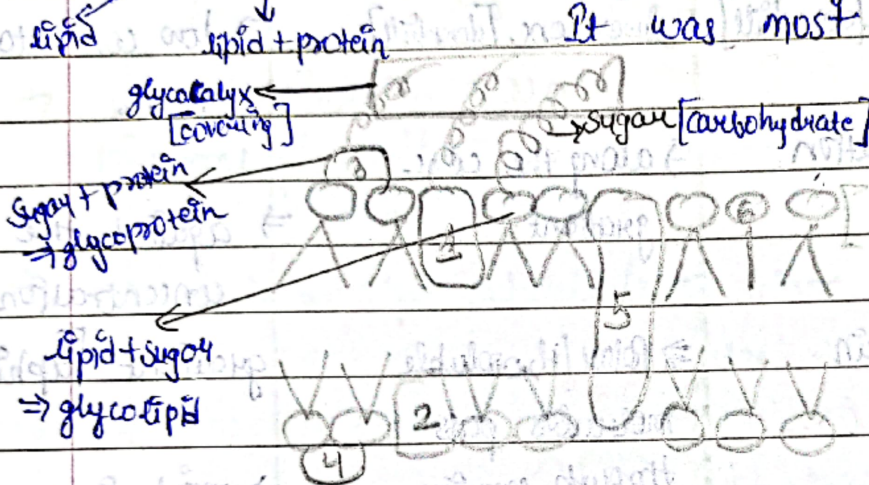
composition of protein & lipid vary in different cell type

* Fluid mosaic model

given by

Singer & Nicolson, in 1972

It was most accepted model



Types of protein [2]

(on basis of ease of extraction)

①②: Integral protein: 70%

[Partially buried] [difficult to remove]

③④: Peripheral protein: 30%

[easy to remove]

⑤: Integral protein

[completely buried]

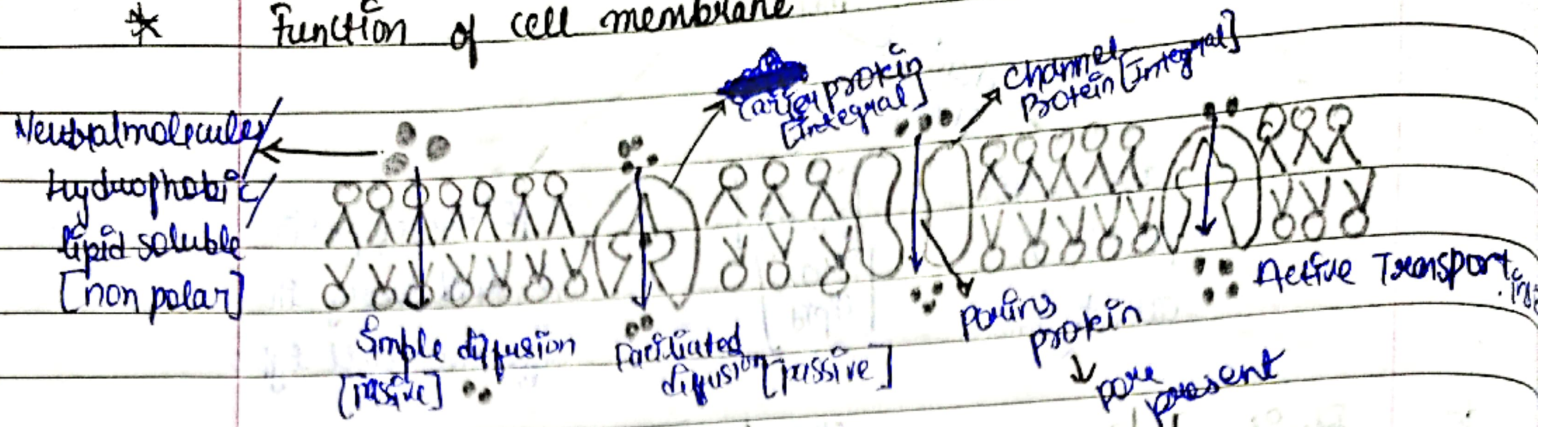
[Transmembrane protein]

⑥: cholesterol

• Lateral movement of protein due to lipid & it confirms the fluid nature of cell membrane

• Protein can't do flip flop movement.

* Function of cell membrane



⇒ Higher concentration to lower conc. [downhill]

⇒ along the concentration gradient [downhill]

⇒ No carrier protein

⇒ No energy involved

⇒ Higher conc. to lower conc. [downhill]

⇒ along the conc. gradient

⇒ Polar / H₂O soluble molecules pass through carrier protein

⇒ No energy involve

⇒ low conc. to high conc.

⇒ against the concentration gradient [uphill]

⇒ mainly ions move through it

⇒ ATP energy involved

⇒ e.g.: Na⁺/K⁺ pump

⇒ main function of cell membrane is transport.

⇒ Other function of cell membrane

a) secretion

b) endocytosis

c) cell growth

d) cell division

e) formation of Intercellular junction

f) communication

Main function of cell membrane

* Transport

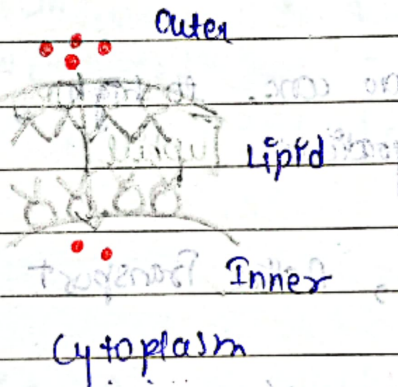
a) Simple diffusion

⇒ Movement: movement of molecules from high conc. to low conc. along conc. gradient [difference] [downhill]

⇒ Energy: No energy involved, Passive Transport

⇒ Carrier protein: NO
[Integral protein]

⇒ Molecule: Lipid soluble / Non polar / Neutral molecule



b) Facilitated diffusion

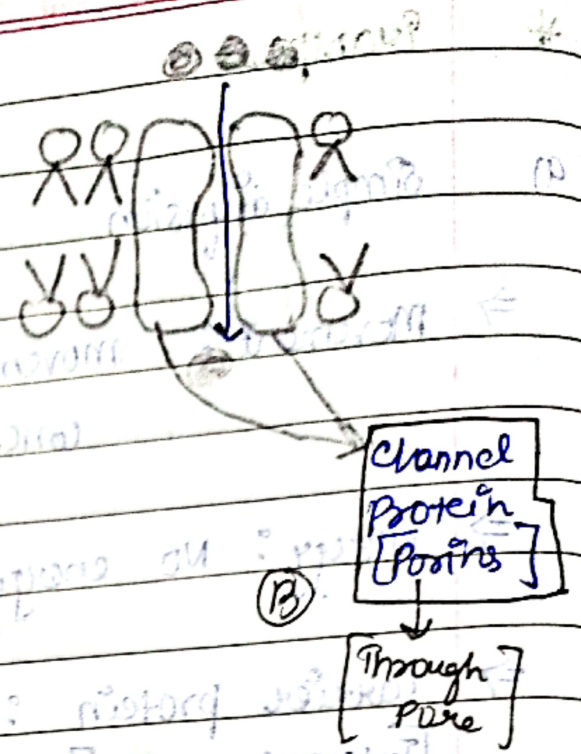
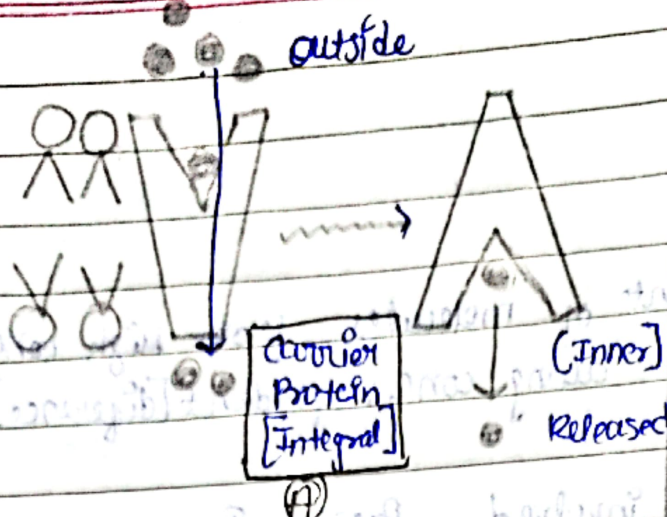
⇒ Movement: high to low concentration, along conc. gradient [downhill]

⇒ Energy: No, Passive Transport

⇒ Carrier protein: Yes
channel protein: Yes

⇒ Molecule: H_2O soluble / Polar move with the help of carrier / channel protein.

glucose is also facilitated diffusion.



(A), (B) : transport protein
[Integral]

c) Active Transport

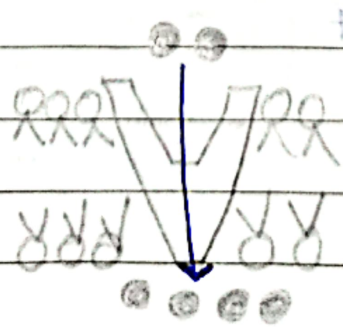
⇒ movement : low conc. to high, against the concentration gradient : [uphill]

⇒ Energy : Yes, Active Transport

⇒ carrier Protein : Yes

⇒ molecules : mainly ions move with help of carrier protein.

eg : $\text{Na}^+ - \text{K}^+$ pump



d)

Osmosis

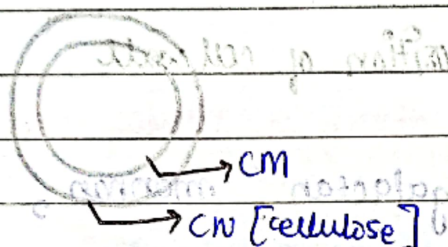
⇒ Movement of water [solvent] from higher concentration to lower concentration through selectively permeable membrane [cell membrane]

⇒ Osmosis is special type of diffusion.

★ Other Function of cell membrane

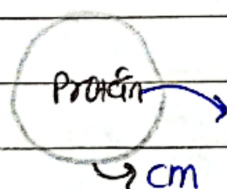
* Cell growth

• cell wall is made up of cellulose



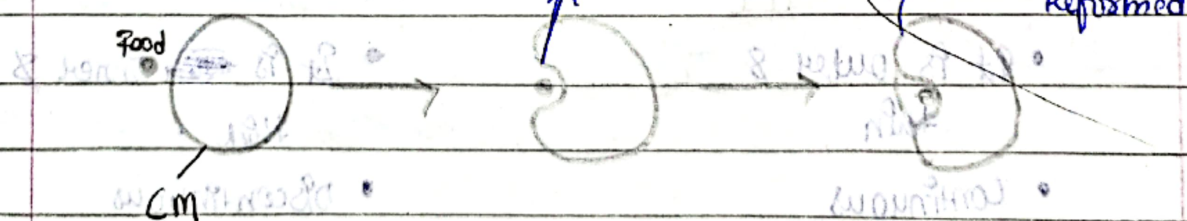
• Synthesis of cellulose is done by cell membrane [CM] made cellulose for CW

* Secretion



• Protein move outside the cell through CM where it is needed : Secretion.

* Endocytosis



Endocytosis

Pinocytosis
[liquid]
food

Phagocytosis
[solid]
food

* Cell division → [Explain in chapter cell cycle & cell division]

* Intercellular Junction [zoology]

* Cell wall

- ⇒ It is a dead structure
- ⇒ It is permeable
- ⇒ It is outer to cell membrane
- ⇒ It is present in Fungi, Plants, Bacteria

Composition of cell wall

⇒ Algae : cellulose, galactan, mannan, CaCO_3 [mineral]

⇒ Plant : cellulose [main], Hemicellulose, pectin protein

⇒ Fungi : chitin

Plant cell wall

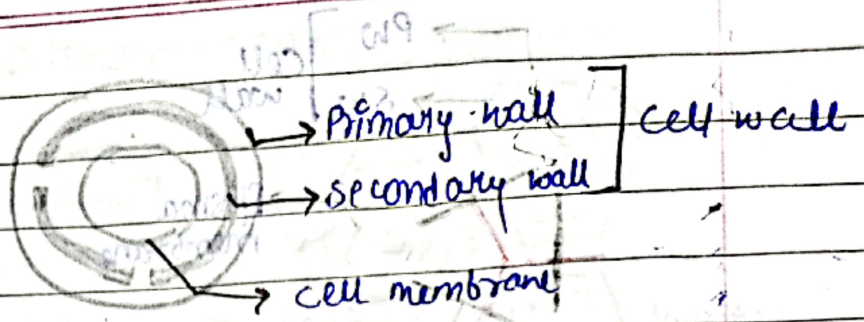
- Plant's cell wall is double layered

PW [Primary wall]

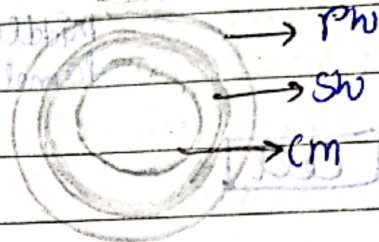
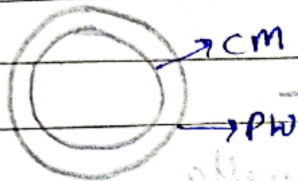
SW [Secondary wall]

- It is outer & thin
- Continuous
- Young / growing cell
- Composition : cellulose, Hemicell, Pectin etc.

- It is ~~thin~~ inner & thick
- Discontinuous
- Once cell becomes old/mature then SW formed inner to primary wall
- Composition : cellulose, Pectin, Lignin



Note:

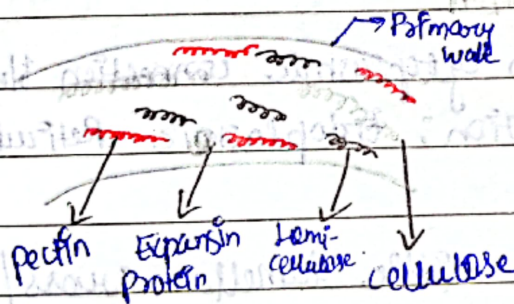


Young cell $\rightarrow$ $\Rightarrow$ PW: Reduced/diminished

Mature cell

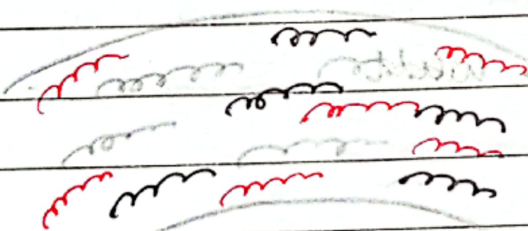
$\Rightarrow$ PW: Reduced/diminished

Primary wall capable of growth



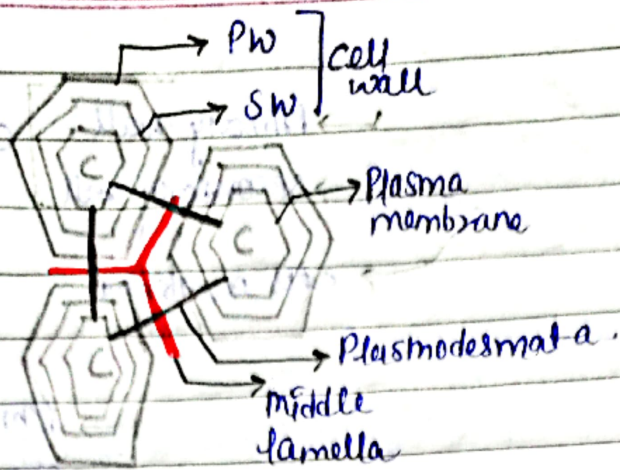
• Expansion protein break bonds b/w Cellulose, Hemicellulose, Pectin

• In Primary wall C, H, P are in bonds



• After breaking of bonds $\rightarrow$ Primary wall will be loosened, then addition of new cell wall material in primary wall

It is called growth



Cell

* middle lamella

⇒ common layer b/w two cell

⇒ composition: Ca pectate [mainly]
Mg pectate.

Plasmodesmata

* ~~composition~~

⇒ It is cytoplasmic connection b/w two cell

⇒ composition: Endoplasmic Reticulum

NOTE: $SW + PW = CW$ & middle lamella cross / Traversed by Plasmodesmata

Function of cell wall

⇒ It provide shape to cell.

⇒ It prevent from infection / mechanical damage [protein]

⇒ large size molecule $\rightsquigarrow$ entry $\rightarrow$ prevent into the cell.
[macromolecule]
[undissolvable]

⇒ cell to cell interaction. [middle lamella].

ENDOMEMBRANE SYSTEM.

• Endo $\Rightarrow$ Inside cell [cytoplasm]

• Membrane system $\Rightarrow$ ER

GIB

Lysosome

vacuole

• These all work together in coordination so they are part of Endomembrane system

• They all have membrane [membrane present]

mitochondria

chloroplast

Peroxisome

These all don't work

in co-ordination, so these are not part of endomembrane system

• NOTE: Each organelle has its distinct / different structure & function

ENDOPLASMIC RETICULUM

(inside the cytoplasm)

Net like structure is formed of MEMBRANE

What is ER?

Ribosome



Cisternae

$\Rightarrow$ • Ribosome [80s]



Tubules

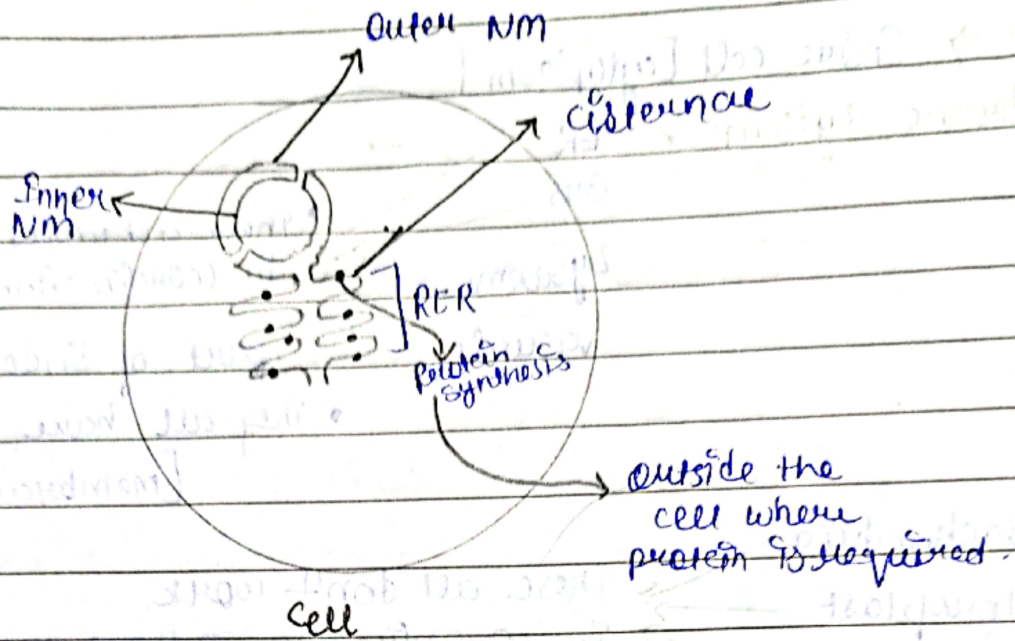
$\Rightarrow$ Ribosome absent



Vesicle

$\Rightarrow$ Ribosome absent

TYPES OF ER

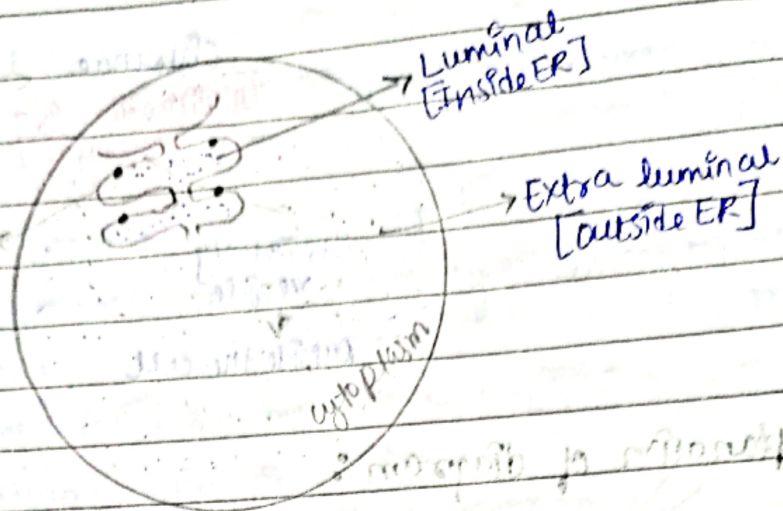


RER [Rough]

SER [Smooth]

- | | |
|--|---|
| <ul style="list-style-type: none"> • Mainly cisternae is present • It arise from or continuous with outer nuclear membrane • Ribosomes ^[80S] are present • Function: Protein synthesis & Secretion [Release protein outside the cell] | <ul style="list-style-type: none"> • Mainly vesicle, Tubules are present • It arise from RER • Ribosome are absent • Function: lipid synthesis or steroid hormone hormone in animal. |
|--|---|

Compartment

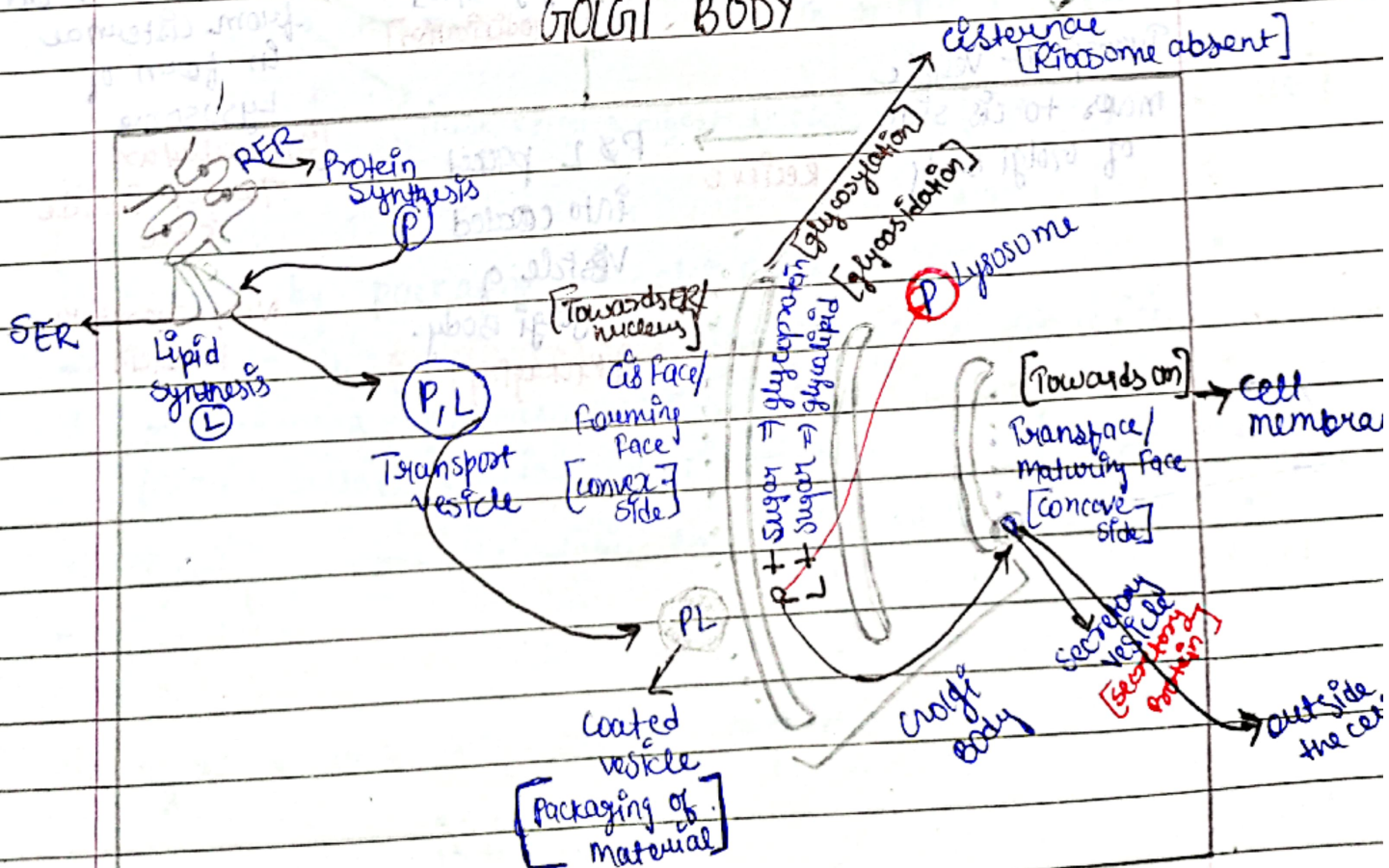


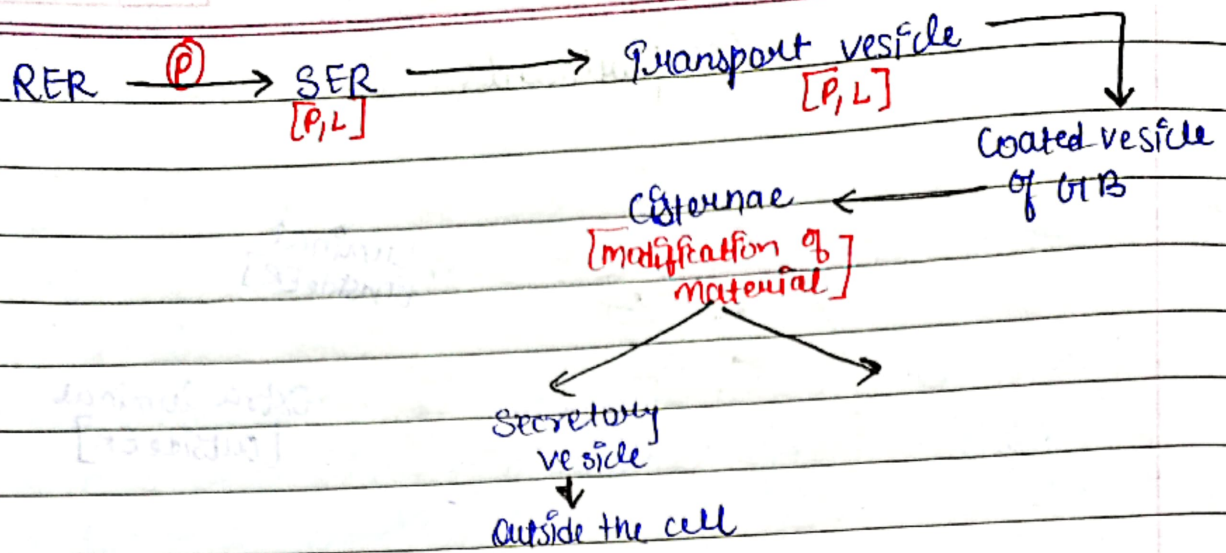
⇒ Network / Reticulum of membrane in cytoplasm

⇒ ER divides the intracellular space into two parts

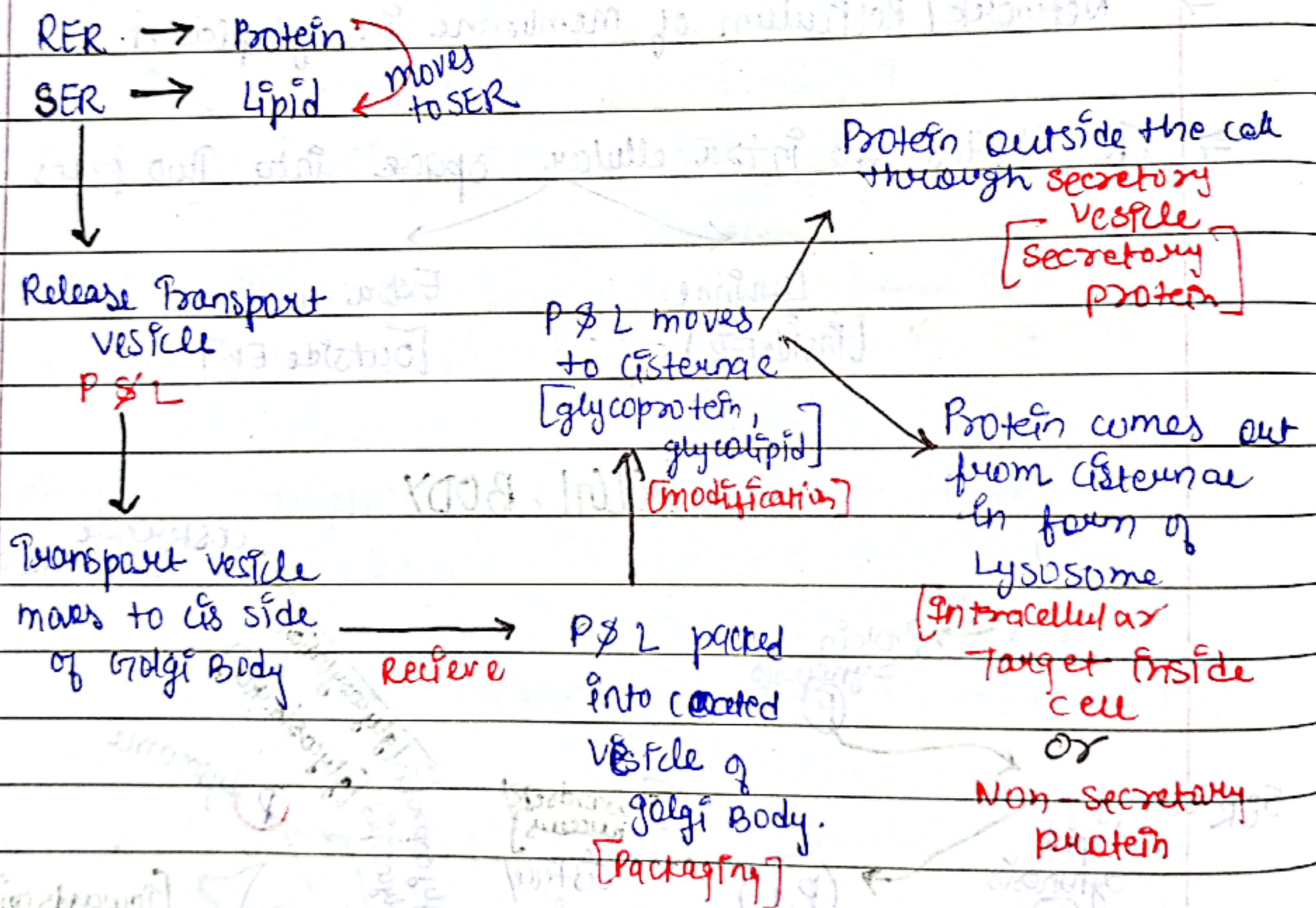
Luminal [Inside ER] Extra luminal [Outside ER]

GOLGI BODY

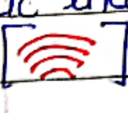


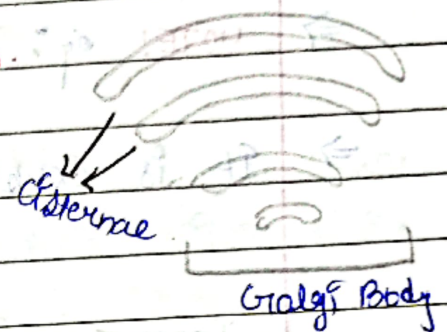


• Explanation of diagram:

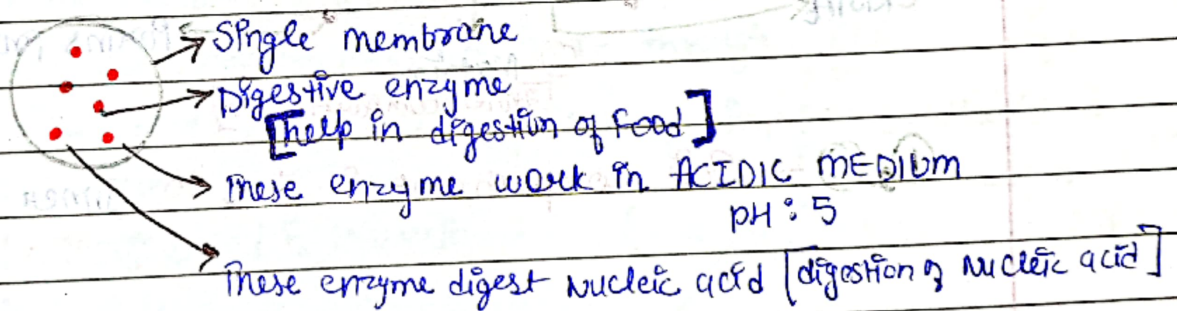


• Structure of Golgi Body

- ⇒ Camillo golgi, 1898
- ⇒ He observed a densely stained structure near nucleus which is **GOLGI BODY**
- ⇒ Golgi Body consist of cisternae. [Flat, disc like, sac like, parallel to each other, arrange concentrically] 
- ⇒ Diametre of cisternae is 0.5 to 1 μm .
- ⇒ No. of cisternae vary in golgi body.



LYSOSOME



- ⇒ Formed by packaging in golgi Body.
- ⇒ RER provide **protein / Enzymes** for lysosome formation.
- ⇒ Carbohydrases, proteases, lipases } Digestive enzymes.
[Carbohydrate] [Protein] [Lipid]
- ⇒ Digestive enzymes / Hydrolytic enzyme [need H_2O]

Acid Hydrolases

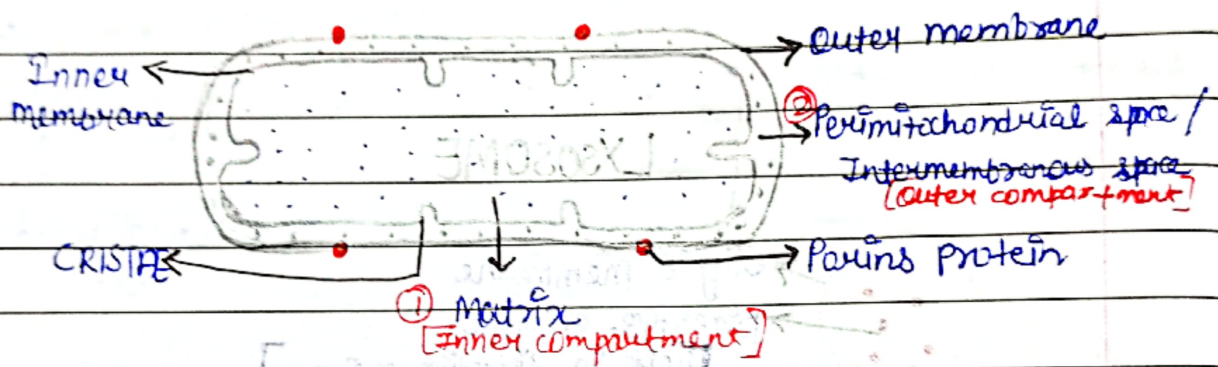
- ⇒ Lysosome are **polymorphic** organelle.

more than one form.

MITOCHONDRIA

→ 70S Ribosome.

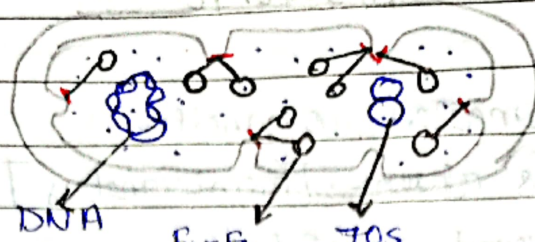
- ⇒ It is a large organelle.
- ⇒ This organelle is not visible in microscope unless stain with dye.
- ⇒ Mitochondria's shape, size & number vary in different cell.
- ⇒ Number of mitochondria depends upon physiology of cell.
- ⇒ **NOTE!** eg: germinating seed ⇒ Number more
non-germ. seed. ⇒ " less
- ⇒ It is double membranous organelle.



①, ② → This compartment is due to inner membrane.

Character	Outer membrane	Inner membrane
• Defining layer	✓	✗
• Porins proteins	✓	✗
• Permeable	more	less
• CRISTAE	✗	✓ [Infolding of inner membrane] [Surface area increases]
	continuous	discontinuous

Note: Both membrane have different enzyme.

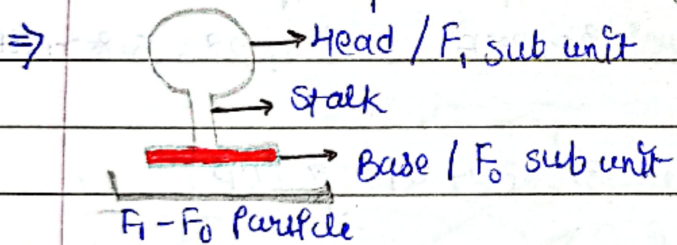


F_1-F_0 Particle / Oxyosome / elementary particle / ATP synthase enzyme.

- ⇒ It is sausage / cylindrical shape.
- ⇒ It divide by fission
- ⇒ **MATRIX**: Homogenous substance covered by inner membrane.
- ⇒ Single, ds circular DNA & some RNA & 70S Ribosome are found in MATRIX.

DNA $\longrightarrow$ RNA $\xrightarrow[\text{70S}]{\text{Ribosome}}$ Protein

- ⇒ mitochondria is called semiautonomous organelle because it can make protein with own DNA through RNA.



It helps in ATP synthesis
[Aerobic Respiration]

- ⇒ Mitochondria is the site of Respiration. [Eukaryotes]

⇒ Matrix: KREB cycle

⇒ Inner membrane: ETC [electron Transport chain] $\longrightarrow$ ATP synthesis

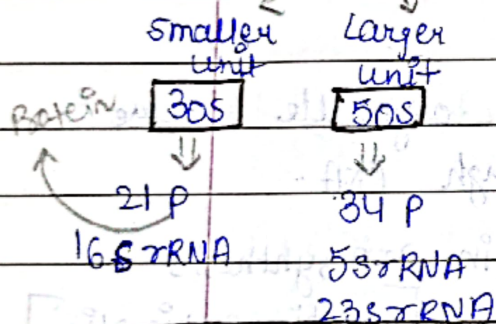
RIBOSOME

- It is the smallest organelle.
- Membrane is absent. [membraneless]
- It is discovered by Palade.
- Its function is "protein synthesis".

Types of Ribosome

Prokaryote

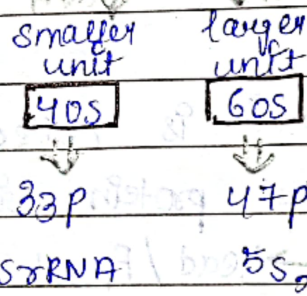
- 70S ribosome is found in prokaryote



rRNA: ribosomal Ribonucleic Acid

Eukaryote

- 80S



$$33P + 47P \Rightarrow 80P$$

- Ribosome consist of RNA + PROTEIN [Ribonucleoprotein]

- S: Svedberg unit [sedimentation coefficient]

velocity

- In Eukaryotes
 - mitochondria: 70S [smaller]
 - Chloroplast: 70S
 - Cytoplasm: 80S [larger]

PLASTID

- Plastid is found in all plant cell & Euglenoids
- Two membrane is found in Plastid.
- It is large, so visible in microscope
- Pigments are found in Plastid.
- It imparts / produce different colours in plant

Types of Plastid [on the basis of pigments]

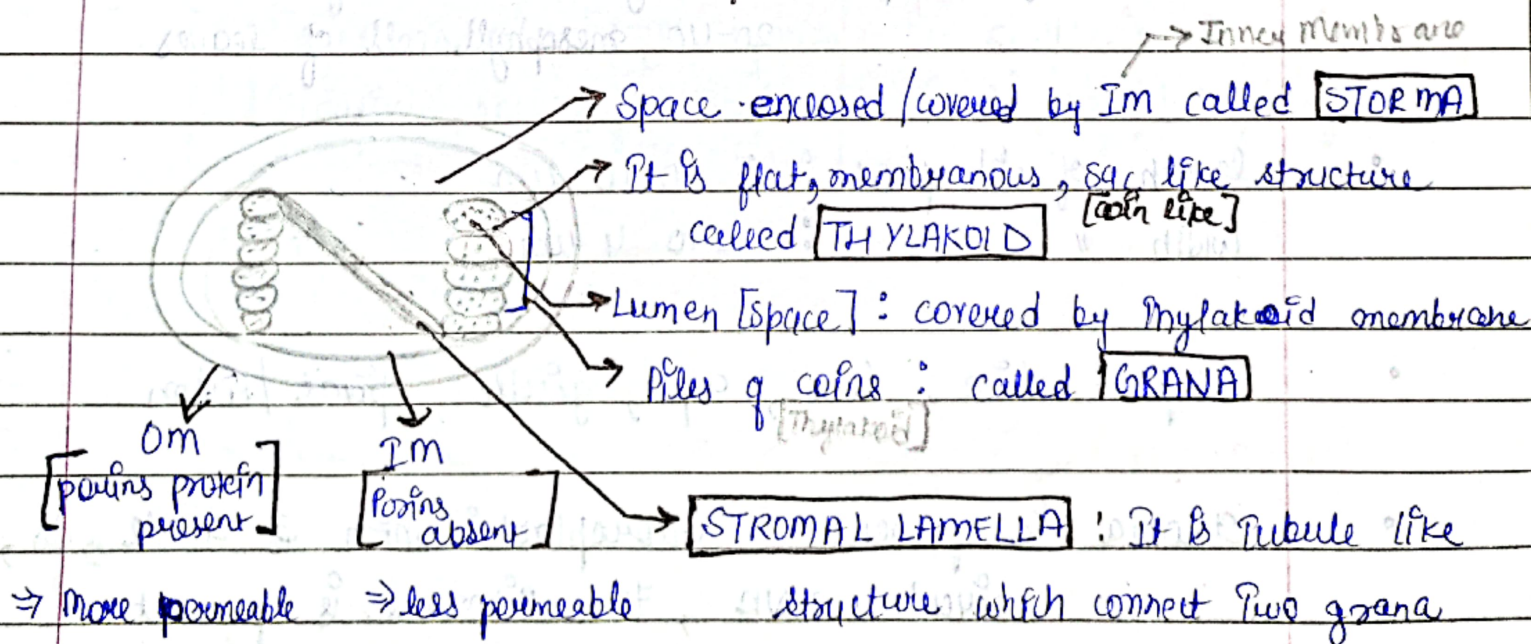
Chromoplast

Chloroplast

Leucoplast

a)

Chloroplast [Green colour]



⇒ more permeable ⇒ less permeable

Photosynthesis

There are two types of reactions in photosynthesis

Light Reaction

+

Dark Reaction

- Site of light reaction:

Grana $\rightarrow$ Thylakoid $\rightarrow$ Membrane

Energy perform $\leftarrow$ absorb light $\leftarrow$ Pigments present [Chlorophyll]

Light Reaction $\rightarrow$ In light ~~energy~~ reaction
energy formed [ATP]

$\rightarrow$ This energy is utilised in dark reaction for synthesis of food / glucose [Carbohydrates]

- Site of Dark reaction:

Stroma

Chloroplast

- Number of chloroplast: single, in Chlamydomonas, green algae 20-40, mesophyll cell of leaves.

length of chloroplast: 5 to 10 μm
width " " " 2 to 4 μm

- Shape: disc, lens, cup, gristle, spiral / Ribbon

- Stroma is present in chloroplast in which small, ds, circular DNA, 70S Ribosome is present.

$\Rightarrow$ Ribosome is present in stroma, $\therefore$ protein synthesis
Carbohydrate synthesis
[dark reaction]

- [Fat soluble] Pigments are found in chloroplast

Chlorophyll
[main pigment]

Carotenoids

Carotene

Xanthophyll

[accessory pigment]

Mitochondria

Chloroplast

Points [on]

✓

✓

Fission [खंडन]

Self duplicating

Self duplicating

Semiautonomous

DNA → RNA → Protein [Pro] [70S]

DNA → RNA → Protein [Pro] [70S]

Function

• Respiration [Breakdown of glucose]

Photosynthesis [Synthesis of Carbohydrate]

ATP synthesis

E-TC → site : inner membrane
electron transport chain

E-TC [Thylakoid membrane] : site

ATP synthesis process is known as
[Oxidative phosphorylation]

ATP synthesis in xla
Photo phosphorylation

b)

Leucoplast [no colour]

- Pigments are absent.
- It is colourless

3 Types of Leucoplast [on basis of shape, size & stored food]

Amyloplast

⇒ store starch
[Potato]

Aleuroplast

⇒ store protein

⇒ store fat & oil

c)

Chromoplast

- Colour → Red, orange, yellow
- Mainly carotenoid pigment is found, Fat soluble carotenoid [carotene + xanthophyll]

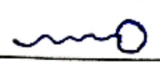
Chillies & Tomato
[green]
Chloroplast

change

Red colour
[Chromoplast]

And orange colour of carrot

CILIA & FLAGELLA

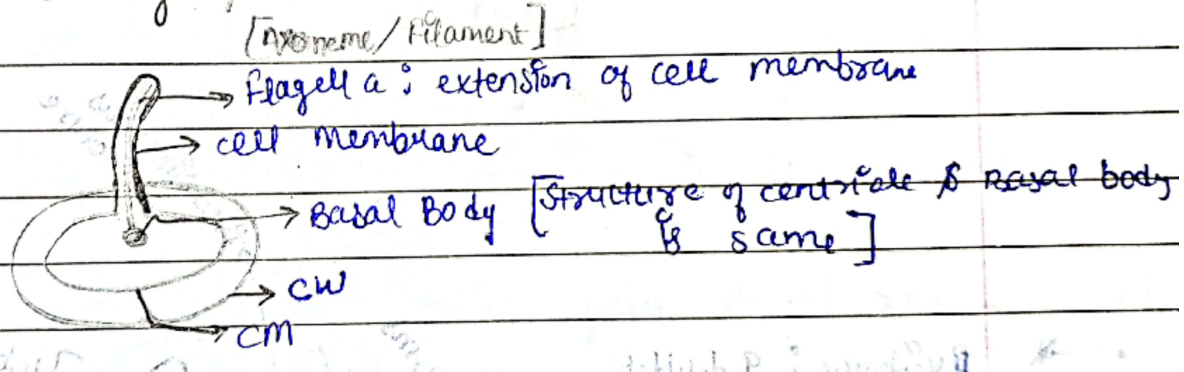
- | | |
|---|---|
| <ul style="list-style-type: none"> • Only in eukaryotes • More in number • Short • They ^(work) beat like oar like [oscillatory movement] | <ul style="list-style-type: none"> • In both eukaryote & prokaryote • Less in number • Long • Snake like movement  |
|---|---|

different structure

- Prokaryotic flagella are made of flagellin protein.
- Eukaryotic flagella are made of tubulin protein

The structure of flagella & cilia are same

Eukaryotic Flagella/cilia [Structure]



Flagella

Made up of microtubule

Made up of tubulin protein

β -Tubulin α -Tubulin

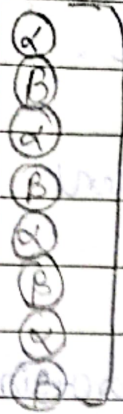
- (β)
- (α)
- (β)
- (α)
- (β)
- (α)
- (β)
- (α)

many α & β tubulin

made one protofilament

α Tubulin protein

β Tubulin protein

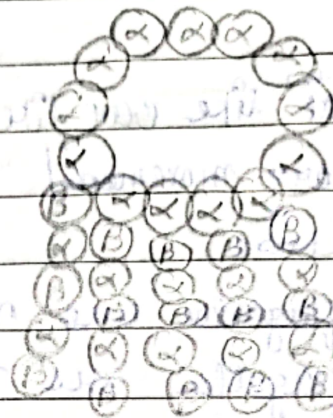


1 chain

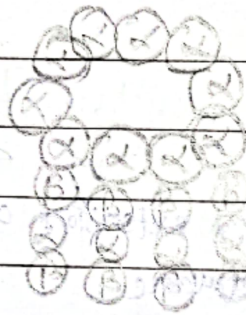
1 Protofilament

13 Protofilament : 1 microtubule :

A microtubule



10 Protofilament : 1 microtubule : B microtubule

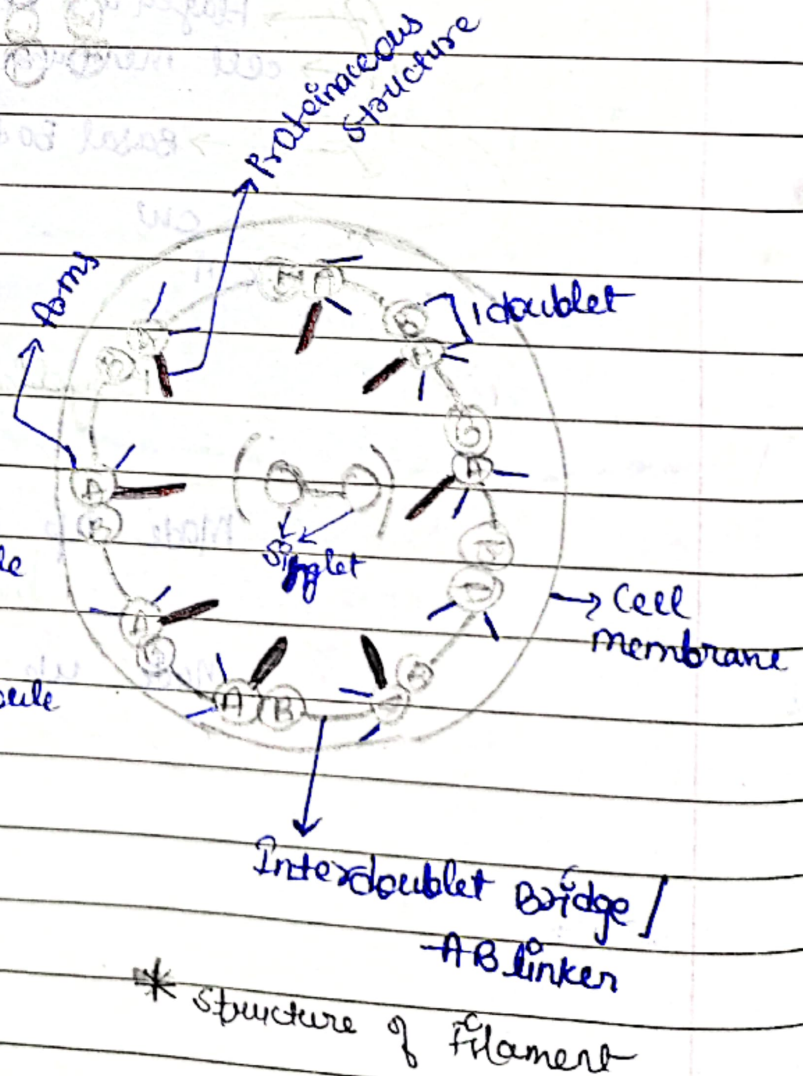


* Periphery : 9 doublet
[वर्तनीय]

* 1 doublet : 2 microtubule

* 9 doublet : $9 \times 2 = 18$ Microtubule

* 9 [doublet] = $9 \times 2 = 18$ Microtubule



* Structure of Filament

- * Total peripheral microtubule : 18
- * Total central microtubule : 2
- * Each central microtubule : Singlet
- * Arrangement of microtubule in axoneme part of cilia & flagella :

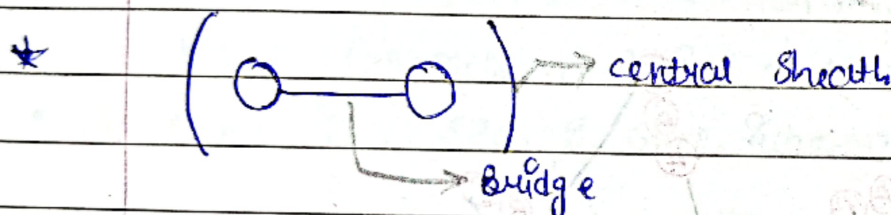
9 [double] + 12 [singlet]
[Peripheral] [Central]

$$9 \times 2 = 18$$

$$2 \times 1 = 2$$

$$18 + 2$$

$$= 20$$

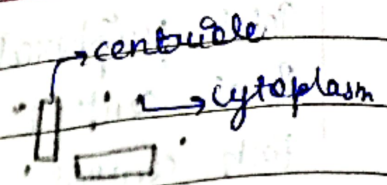


- * central microtubule surrounded by sheath.

- * Proteinaceous structure [Rod-like] arise from a microtubule called Radial spoke [9]

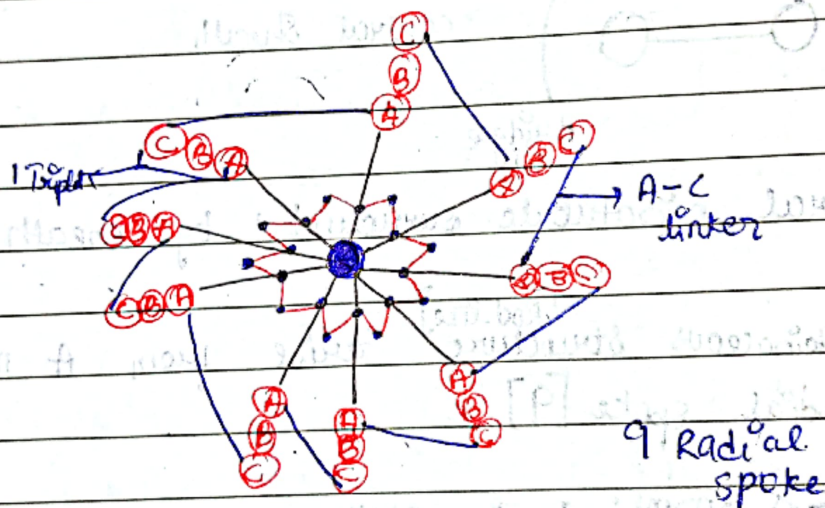
- * (A) → Arms : dynein protein
[ATPase activity]
↓
ATP synthesis

CENTRIOLE



- Present in pairs : 90° to each other
- Centriole surrounded by cytoplasm called centrosphere / pericentriolar satellite.
- Centriole + Centrosphere $\Rightarrow$ Centrosome.
- Centriole absent in higher plant & prokaryote
- Centriole present in algae, fungus, animal cell
- Its structure similar to Basal Body.
- Centriole membranous.

CART WHEEL STRUCTURE



* Total peripheral triplets = 9

* Each Triplet = 3 microtubule

① : 13 Protofilament

② : 10 "

③ : 10 "

* Total microtubule on peripheral side : $9 [\text{Triplet}] = 9 \times 3 = 27$

* $\bullet$: Proteomaceous structure in centre : Central hub

* central microtubule : absent

* $9 [\text{Triplet}] + 0_{\text{centre}}$

$9 \times 3 = 27$

Peripheral

- * Each Radial spoke becomes thick called 'X' thickening (9)
- * B/w two X thickening : one Y thick present [9]
- * 1 centrosome : 2 centriole
- * 1 centriole : 27 microtubule
- * 1 centrosome : 54 microtubule.
- * centriole helps in formation of spindle fibre in animal cell.

NUCLEUS

- Present in eukaryotes
- Large organelle, discovered by Robert Brown
- Cell: generally single nucleus present

NOTE: Paramecium $\Rightarrow$ Two nucleus

- mammalian RBC & sieve tube element [phloem]

$\downarrow$
 nucleus
 absent

[Eukaryote]

- Structure of nucleus [parts]

$\Rightarrow$ Nuclear membrane / Nuclear envelope

$\Rightarrow$ Nucleoplasm / matrix

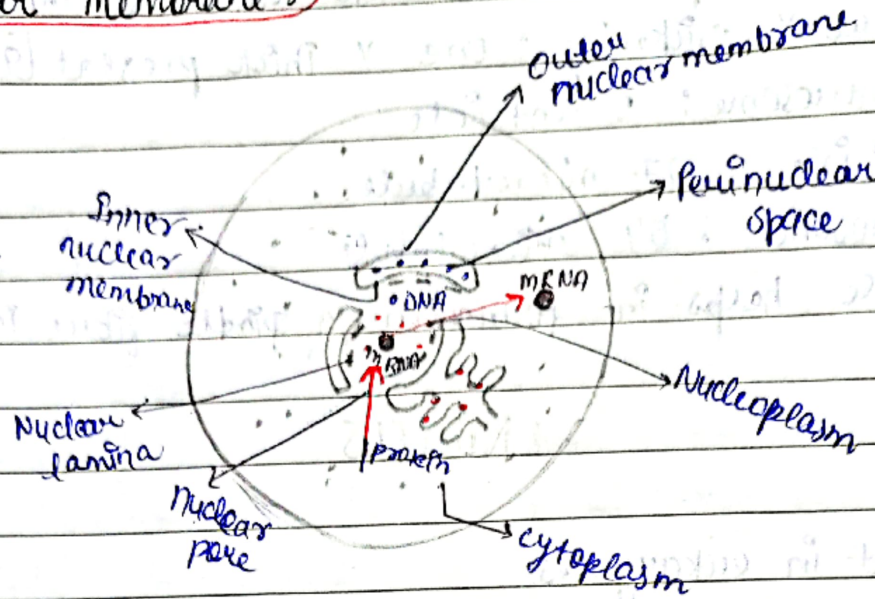
$\Rightarrow$ Nucleolus

$\Rightarrow$ Chromatin.

PARTS OF NUCLEUS

①

Nuclear membrane:



- * Double membranous
- * Outer nuclear memb continuous with RER
- * Outer memb. : Ribosome may be present
- * Outer & inner membrane separated by perinuclear space, 10-50nm width
- * Both end of nuclear membrane fused so space or nuclear pore formed
- * Nucleoplasm & cytoplasm separated by Nuclear membrane
- * Inner nuclear membrane covered by nuclear lamina : made up of lamin protein : acidic protein
- * Intermediate filament / Nuclear lamina
- * Nuclear pore maintain the bidirectional movement of RNA & protein

② Nucleoplasm / Nuclear matrix

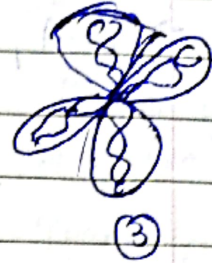
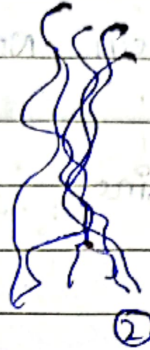
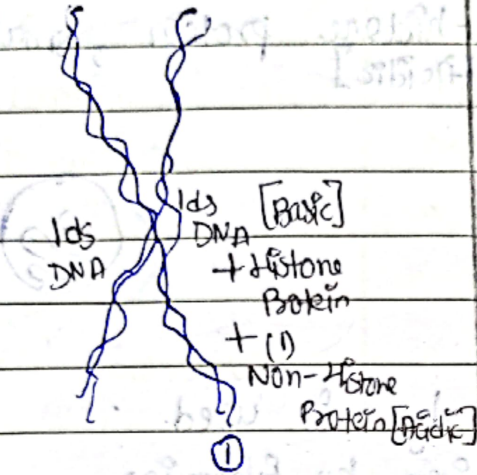
- : semi fluid region
- : contain ① Nucleolus
- ② chromatin

③ Chromatin / Chromosome

DNA

Chromatin

Chromosome



DNA length = Very long
No. of coiling = minimum
visibility = minimum

Intermediate
Intermediate
Intermediate

Short
max-coiling
maximum

- ① Length of DNA
- ② Thin / Thick
- ③ coiling [DNA]
[less / more]

Long
Thin
less

Short
Thick
more

- ④ visibility
- ⑤ Uncandensed or candensed
Form of DNA
- ⑥ Phase

less
uncandensed
Interphase

more
candensed
Late prophase /
metaphase

Histone & Non Histone protein helps in
"DNA packaging"

Chromatin / Chromosome

composition:

⇒ DNA, Histone protein [Basic], Non-histone protein [Acidic], small amount of RNA

Arginine Lysine



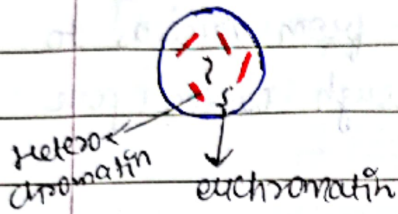
- To stain chromosome, basic dye is used.
- The term chromatin was given by Flemming.
- Definition ⇒ Interphasic nucleus
- Loose ⇒ Thickness reduced
- Extended ⇒ Distributed throughout the nucleus
- Elaborate ⇒ Complexity more.
- Nucleoprotein fibre ⇒ Nucleic acid + protein
[DNA, RNA] [Histone P, Non histone P]

Q Erythrocyte of mammals & sieve tube of vascular plant have no nucleus so tell, these are living or non-living?

→ The Living.

Two types of chromatin

	Euchromatin	Heterochromatin
How DNA packed	Loosely arrange	Tightly arrange
Stain	light	dark Region
Location	Centre	Periphery
Transcription	DNA $\rightarrow$ mRNA Transcription active	NO synthesis of rRNA Transcriptionally inactive

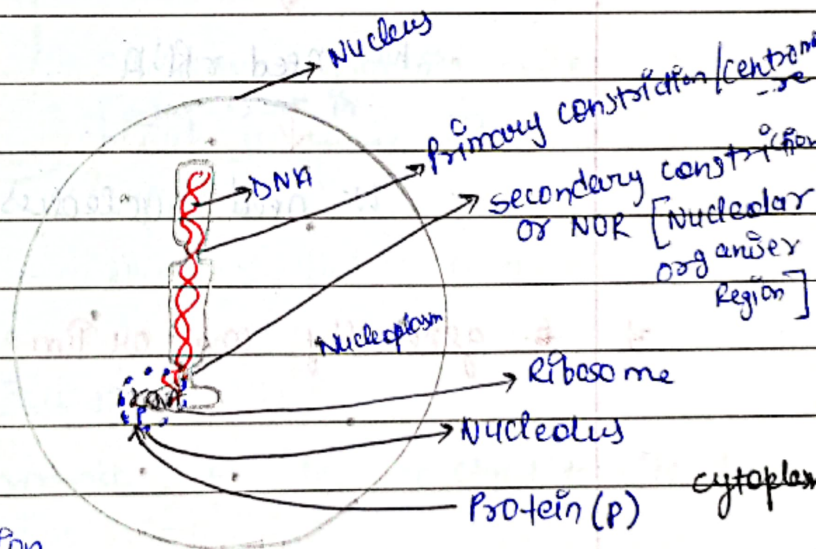


Nucleosome : Histone protein + DNA

Octamer of
Histone protein

④ Nucleus Nucleoplasm
Nucleolus

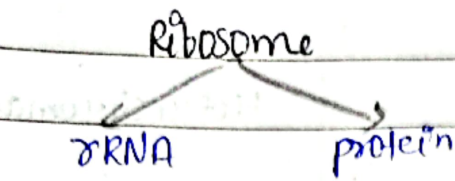
- Structure : spherical
- Location : nucleoplasm
- Membrane : absent, so no boundary / NO separation b/w content of nucleolus & Nucleoplasm.



=> DNA of secondary construction present in Nucleolus form r-RNA [Ribosomal RNA]

=> Site of rRNA synthesis : In nucleolus

=> Nucleolus arise from secondary construction.



↑
Provided by
Nucleolus

⇒ Protein moves from cytoplasm to nucleolus through Nuclear pore

⇒ Protein + rRNA ⇒ Ribosome synthesis
[Nucleolus part of Nucleus]

⇒ Ribosome move from nucleus to cytoplasm through nuclear pore.

* Number of Nucleolus & size :

Cell involved in protein synthesis : Nucleolus no. : maximum large

↓
we need Ribosome

↓
we need rRNA

↓
we need nucleolus

⇒ generally one or two nucleolus present in one nucleus

* Structure of chromosome

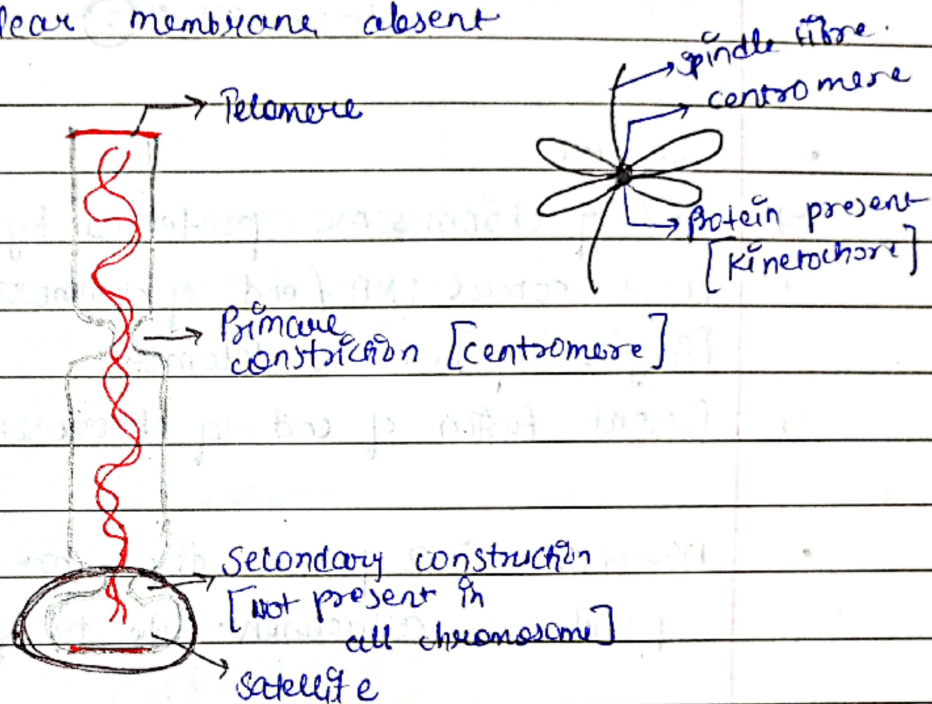
During different stages of cell division:

=> 2m long thread of DNA distributed in 46 chromosome in one cell.

=> chromosome visible in place of nucleus in dividing cell.

[Prophase, metaphase, anaphase]

Nucleolus & nuclear membrane absent



=> Primary constriction / centromere

* chromosome becomes thin [first time]

* Kinetochore present on centromere, provide attachment site to spindle fibre / microtubule.

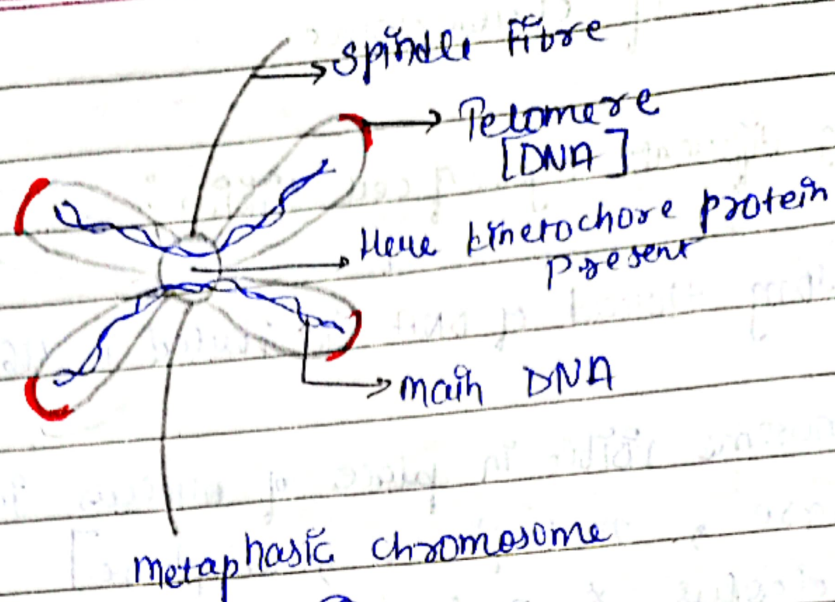
=> Secondary constriction / NDR

* chromosome consists again

* Nucleolus arise from this region [NDR]

* 13, 14, 15, 21, 22 pairs

* Total 10 chromosome



=> chromatid : ②

- Telomere.

- => End of chromosome protected by DNA called Telomere.
- => chromosomal DNA (end of chromosome protected by extra DNA [finger cap] called Telomere.
- => Prevent fusion of end of chromosome.

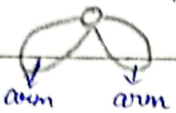
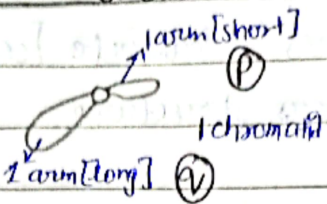
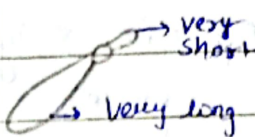
- Kinetochore : 2 protein disc, present on centromere provide an attachment site to spindle fibre / microtubule.

- Satellite : Part of chromosome beyond the secondary constriction.

Date / /

Types of chromosome

[On the basis of position of centromere]

	Metacentric	Submetacentric	Acentric	Telocentric
Diagram				
Location of centromere	centre	centromere slightly away from centre	centromere shifted to one end [sub terminal centromere]	Terminal
Length of arm	Both arms are equal	Both arms unequal 1 arm long & 1 arm short	Both unequal 1 arm very long & 1 arm very short	
Shape	V - shape	L - shape	I shape	I shape

MICROBODIES

- => many structure appear as vesicle covered by membrane.
- => Location : animals & plants
- => Enzymes : present
- => No. of membrane : Single.

=> Example :

- ① Peroxisome : [Photosynthesis chapter]
- ② Sphaerosome
- ③ Glyoxysome.

CYTOSKELETON

- ⇒ Location: Eukaryotes
 ⇒ Definition & types: elaborate [complex] network of filamentous proteinaceous structure.

Microtubule (Tubulin protein)	Microfilament (Actin & myosin)	Intermediate filament
⇒ A hollow, unbranched, cylindrical	⇒ Solid, unbranched, indefinite length	⇒ Lamins protein [Nuclear lamina] ↓
⇒ Location: Present in cilia & flagella, centriole, basal body, spindle fibre.	⇒ made up of Actin & myosin protein	⇒ Acidic protein / scaffold p ↓
⇒ Helps in motility	⇒ Support to cell membrane & helps in animal cytokinesis	⇒ Helps in packaging of [non-histone protein]
⇒ maintain shape of cell		
⇒ Help in Anaphasic movement & Plant cytokinesis.		