- Biology is the science of living organisms. It's a very broad field which deals with various aspects of living beings.
- Present day living forms are not as they had been originated several hundred years back. This is due to the modifications adapted by their ancestral forms. which is called as the "concept of evolution".
- These concepts had been developed by Lamarck (1801) and later modified by Darwin (1859).
- The organized and systematic study of living world could have been possible after the classification system. The classification was based on morphology and chronology.
- Biologists have been able to classify the living organisms by investigating their characteristic features. This was accomplished by adopting scientific methods developed by Francis Bacon (1561-1626).
- All living organisms are classified into five major Kingdoms :

5 Major Kingdoms

Monera	Protista	Fungi	Plantae	Animalia
- Prokaryotic	- Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
- Single celled	- Single celled	Multicellular	Uni or multicellular	Multicellular
- double membranous organelles - absent	- double memb. org. + nt	double memb. org. + nt	double mem + nt	double mem + nt
Incipient nucleus	- well defined nucleus	well def. nucleus	well def. nucleus	well def. nu.
Ex - Bacteria	- Protozoans	Yeasts & molds	All plants, (Trees)	All animals (Fish, cat, humans)
- 70s ribosomes are present	- 80s (Ribosomes are + nt) Ex Amoeba	- 80s Ribosomes + nt	- 80s Ribosomes + nt	- 80s Ribosomes + nt
			Auto trophs	

Cell: Basic Unit of life:

(1665)

- The term cell was coined by Robert hooke!. He examined thin slices of cork and found hexagonal empty chambers. He saw dead cell.
- Antony van Leeuwenhoek (1674) observed living cell under lenses and microscopes.
- Schleiden (1838) stated that all plants are made up of smaller cellular units.

- In 1839, Schwann observed that all animals ~~cells~~ are made up of cells.

Later Schleiden and Schwann proposed the cell theory. The theory states:

① All living organisms are made up of cells.

② Cell is the fundamental structural and functional unit of life. The single cell is capable to survive on its own.

③ New cells arise from the pre-existing cells only. (Omnis cellula-e-cellula by Rudolph Virchow)

- In unicellular organisms, single cell is capable to survive on its own.

- In multicellular organisms, cells work as a unit. ex -

cells → Tissues → Organs → organ system → Multicellular Organism

(product of development from simpler to complex)

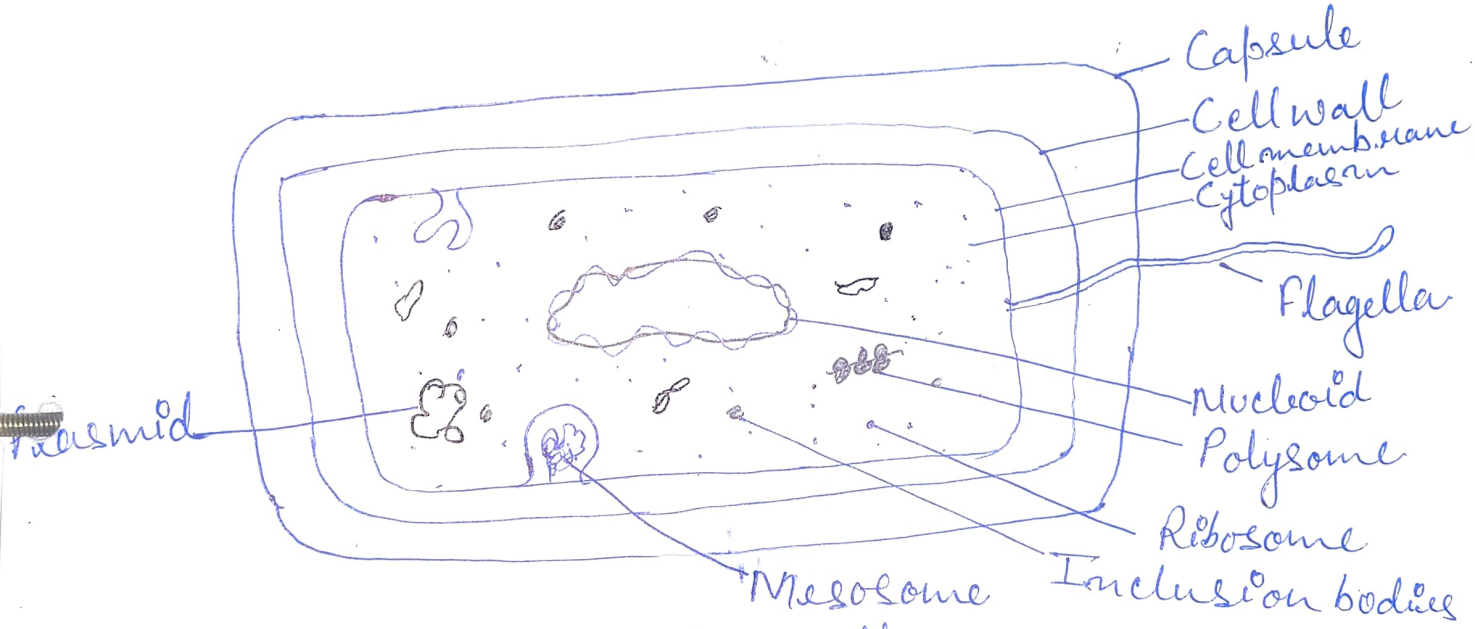
Cell Types : There are two basic cell types -

Prokaryotic Cell : - (Pro = Primitive, Karyon = nucleus)

It is simple in structure.

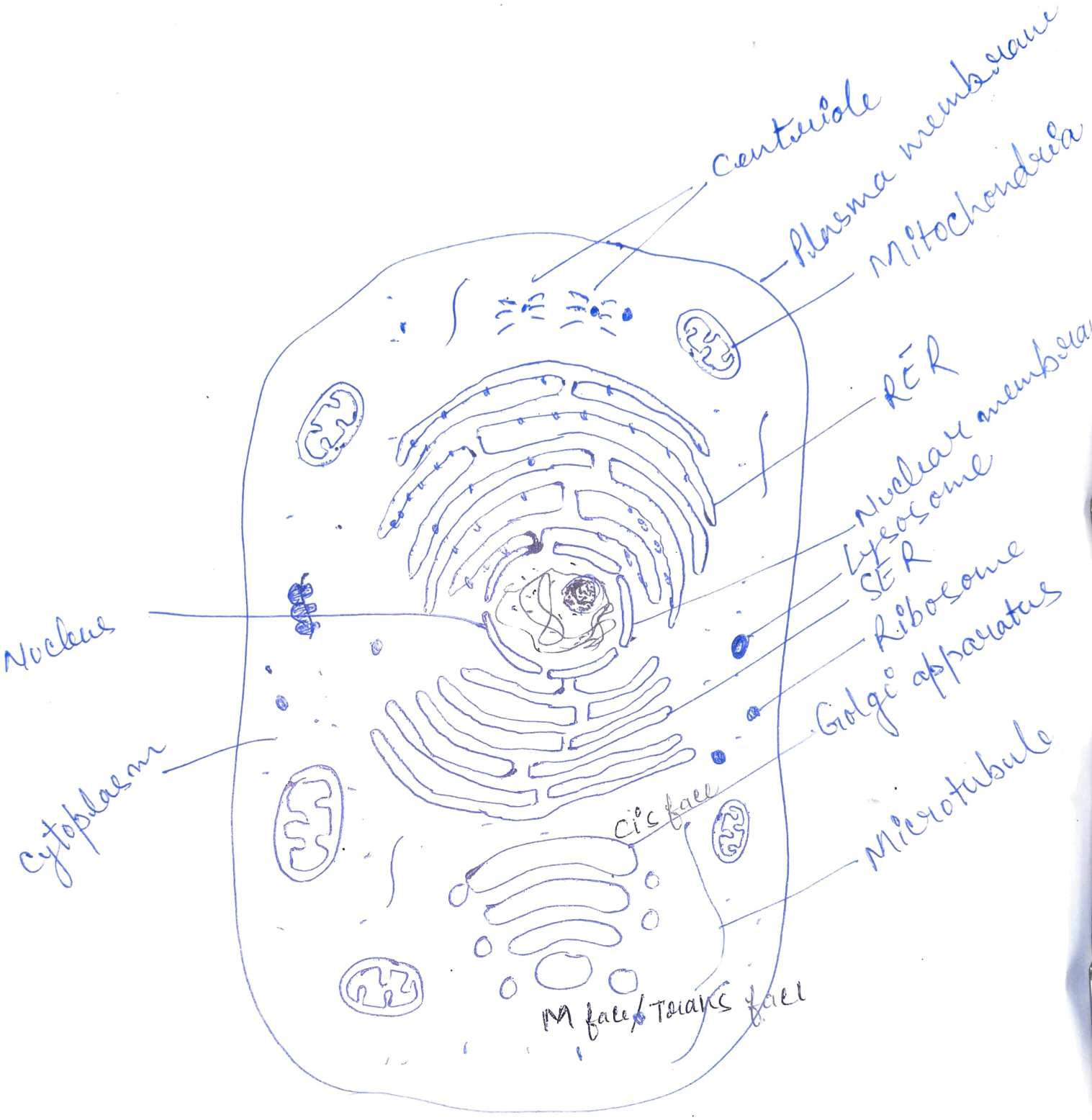
These cells have primitive type of nucleus. That is called as incipient nucleus. These cells lack all the double membranous organelles. It is smaller than Eukaryotes.

ex :- Bacteria and Archea.



—: Prokaryotic Cell :—

- The outermost membrane is called cell wall, followed by cell membrane / plasma membrane.
- In some bacteria outermost slimy layer is present, known as Capsule.



- Eukaryotic Cell -

It gives protection to the cell.

- From the cell surface, flagella and pili emerge out. Flagella helps in locomotion while pili are used to communicate between the cells.

- In the cytoplasm, nucleoid (incipient nucleus) 70s ribosomes, polysomes, inclusion bodies, etc are found.

- Mesosome is present.
- Plasmid (extra chromosomal circular DNA) is present. It helps in Antibiotic resistan
- Mitochondria, Golgi complex, Endo. reti. are absent.

Eukaryotic Cell (Eu = True, Karyon = Nucleus)

- Excluding monera (bacteria), all the four groups are eukaryotes.
- Organisms, having well defined nucleus are called as Eukaryotes. (ex- All animals, plants etc
- Outermost membrane is cell wall in plants and cell membrane in animal cell.
- Cytoplasm contains all the double membranous organelles ex- mitochondria, Golgi complex, endoplasmic reticulum, chloroplast et

- DNA is located in chromosomes and the nucleus has distinct nuclear envelope.
- Many eukaryotes are ciliated with primary cilia, which are helpful in chemo-sensation, mechano-sensation and thermosensation.
- Complex type of flagella tut.

Differences between Prokaryotes and Eukaryotes

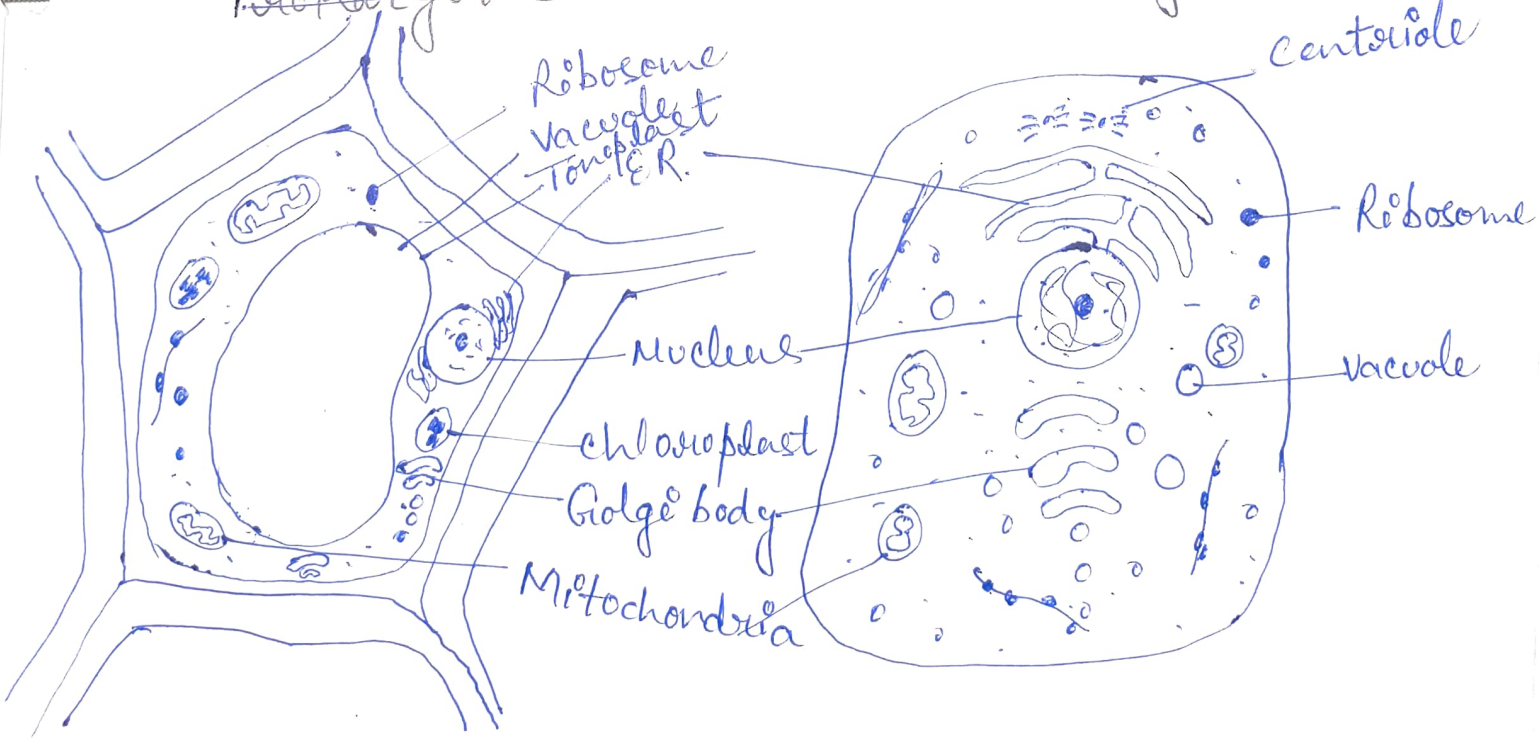
	Prokaryote cell	Eukaryote cell
Cell wall	Present made up of peptidoglycan	Absent in animal cell. Present in plant cell. made up of cellulose
Cell size	1-2 × 1-4 μm or less	more than 5 μm in diameter.
Nucleus	ds circular DNA lying in the cytoplasm.	Linear DNA enclosed in chromosomes within true nucleus.
Cell organelles	ER, -nt Mitochondria -nt Golgi Comp. -nt Plastids -nt 70S Ribosomes tnt	ER tnt Mitochondria tnt Golgi Complex tnt plastids tnt 80S Ribosomes tnt (70S present in mitoch., chloroplast)
Flagella	Simple, Extracellular 20nm diameter	Complex, Intra-cellular, 200nm in diameter

Plant Cell and Animal cell :-

Plant cell	Animal Cell
outermost membrane is cell wall, made up of cellulose.	No cell wall, only Plasma membrane but.
Nucleus is usually peripheral	Nucleus may be anywhere in cytoplasm, but often central.
Large vacuole in centre, filled with cell sap	Vacuoles are usually smaller and numerous.
Plastids (chloroplast) but Centriole absent	- but centriole present

~~Difference b/w Prokaryotic and Eukaryotic cell~~ :-

~~Prokaryotic cell~~ ~~Eukaryotic Cell~~



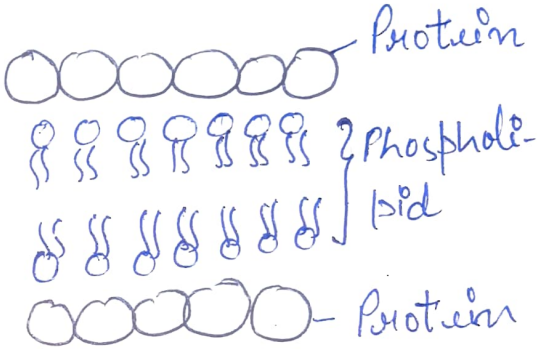
- Plant cell -

- Animal Cell -

Cell structure and function

Cell / Plasma membrane :

- Every cell (living) is externally covered by a thin, transparent, semipermeable membrane called cell membrane / Plasma membrane.
- It consists of inner and outer dense protein layer enclosing a phospholipid bilayer.



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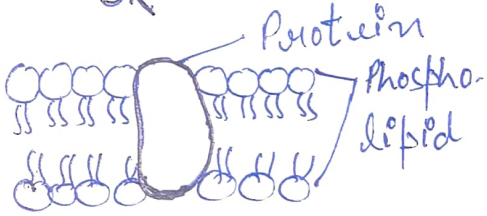


—: Fluid mosaic model :—

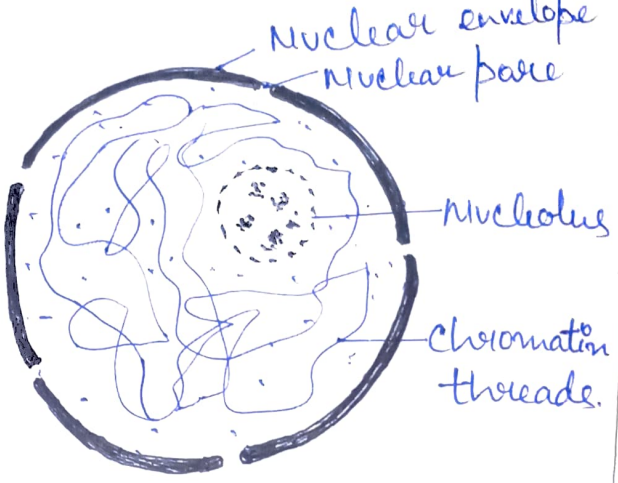
- Fluid mosaic model of Singer and Nicholson demonstrates that proteins are embedded in the sea of phospholipids.
- The chief function is to regulate the passage of materials.

Nucleus and Nucleolus :

- Nucleus was first described by Robert Brown.
- The nucleus is round or oval body lying in the center of the cell. It is delimited by

a double membrane called nuclear membrane.

- Pores are tant in the membrane and provide a passage.

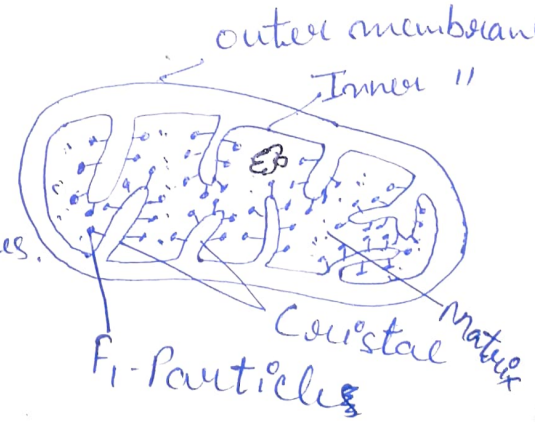


—: Nucleus and Nucleolus:-

- The nucleus is called as "brain of cell".
- It's the storehouse of chromatin threads. which are the genetic material.
- The nucleolus (pl. nucleoli) is a dense body, found in the nucleus.
- The nucleolus is the site of ribosome production.
- The nucleus contains all the genetic informations, and pass on to the progenies.

Mitochondria ("Powerhouse of the cell")

- The term mitochondrion was given by C. Benda.
- It may be rounded, long rod-shaped, spherical, oval etc.
- It consists of two membranes.
  outer - smooth
  inner - extensively folded



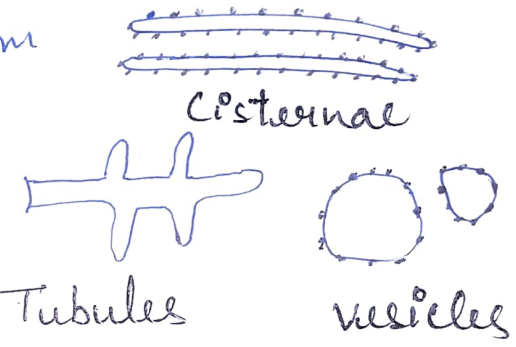
—: Mitochondria :—

- Folds are known as "cristae" and have variety of enzymes.

- ~~Ea~~ F_1 - Particles (oxysomes) are present on inner membrane.
- Mitochondria are the sites of ATP formation, hence called as power house.
- Circular DNA and 70s ribosomes are present in the mitochondria.

Endoplasmic Reticulum ER :-

- The term endoplasmic reticulum was given by Porter.

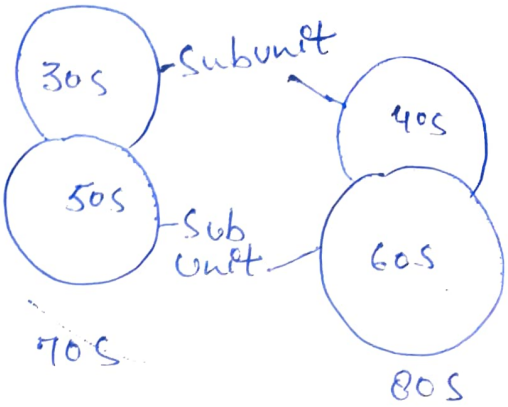


- It is a well developed network of interconnected cisternal, tubules and vesicles.
- On the basis of presence or absence of ribosomes, ER is of two types :
  - Smooth ER (ribosomes -nt) SER
  - Rough ER (ribosomes +nt) RER
- Protein synthesis takes place on RER.
- RER forms transport vesicles, which carry the proteins to Golgi body for processing. It helps in the transportation of material in a directional flow.
- SER is involved in lipid synthesis and detoxification of harmful drugs.

lipid synthesis & Steroid hormones

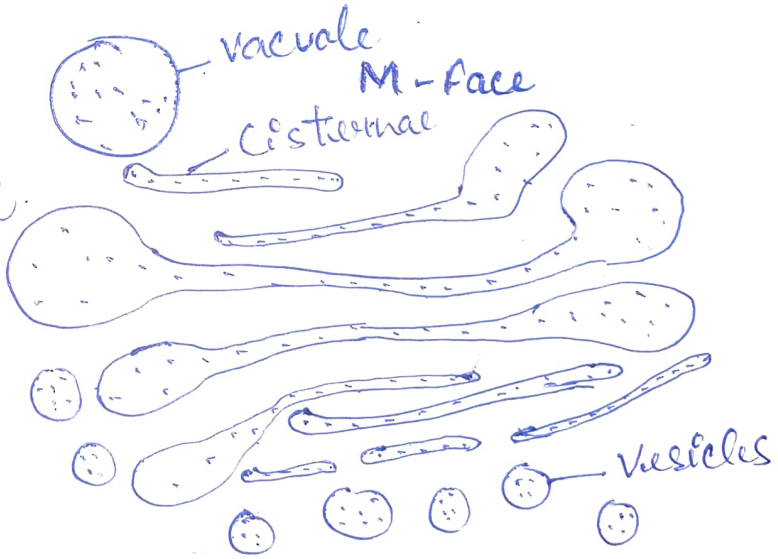
Ribosomes :-

- The ribosomes are ribonucleo-protein particles, made up of two sub-units.



- Ribosomes -

- These were called 'ribosomes' by Palade.
- Each ribosome is formed of two subunits which join only at the time of protein synthesis. ex -
  70S :- 50S and 30S (Found in prokaryotes)
  80S: 60S and 40S (Found in Eukaryotes)
- Ribosomes are called protein-factories.

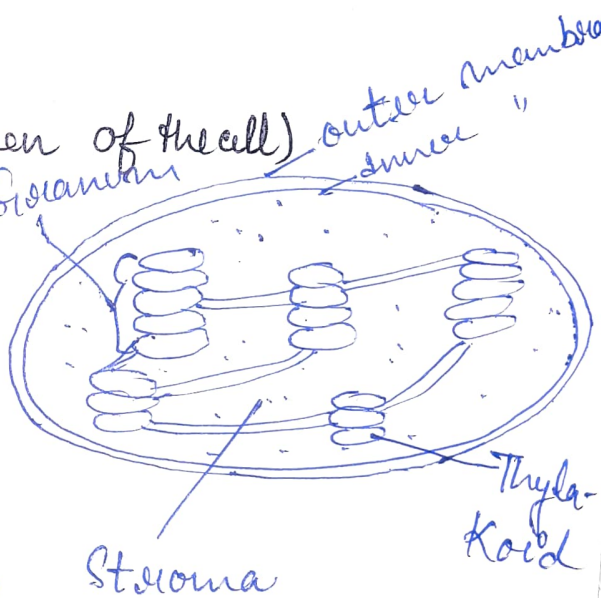


- Golgi Complex

olgi Complex, also called
pochondria, Idiosome or
olgi apparatus, its morpho-
gical details were given
y Camilo Golgi.
t is formed of three types
f elements
) Cisternae (b) Vacuoles (c) Vesicles

- Cisternae / flattened sacs are elongated double layered, flat and curved components with swollen ends.
- Vacuoles are spherical components.
- Vesicles are small sized components.
- It is involved in cell secretion.
- It helps in the formation of hormones, cell plate formation during cytokinesis, biosynthesis of glycoproteins and glycolipids.
- In plants it is called as Dictyosome.

Chloroplast (Plastid) (Kitchen of the cell)



— Chloroplast —

- Term 'chloroplast' was given by Schimper.
- These are found in plant cell only.
- Shape may be ribbon-like, oval, spherical etc.
- There are two membranes. Inside the inner membrane dense, colourless and granular substance present, called stroma or matrix.
- Inner membrane form a number of oval-shaped closed sacs, called thylakoids.
- Thylakoids are structural and functional elements of chloroplasts.

- Many thylakoids form a granum.
- Grana are interconnected by branched tubules, called stroma lamellae.
- These are the sites of photosynthesis, resulting in to evolution of O_2.
- It converts CO_2 into organic food.

Lysosomes (Suicidal Bags of the cell):

- These were first discovered by Christian de Duve.
- Lysosomes are electron microscopic, vesicular structures.
- The main function is intracellular digestion.
- Lysosomes contain various types of enzymes.

DR. KAMAKSHI SAXENA

Cell ~~Signaling~~ Metabolism

- The complex physical and chemical processes occuring within a living cell or organism that are necessary for the maintenance of life.

- In metabolism some substances are broken down to yield energy for vital processes while other substances, necessary for life, are synthesized.

- Metabolism overall is a term that is used for all the chemical transformations that takes place within a living organisms. It includes obtaining energy by feeding (either through eating or through photosynthesis) and releasing energy through respiration.

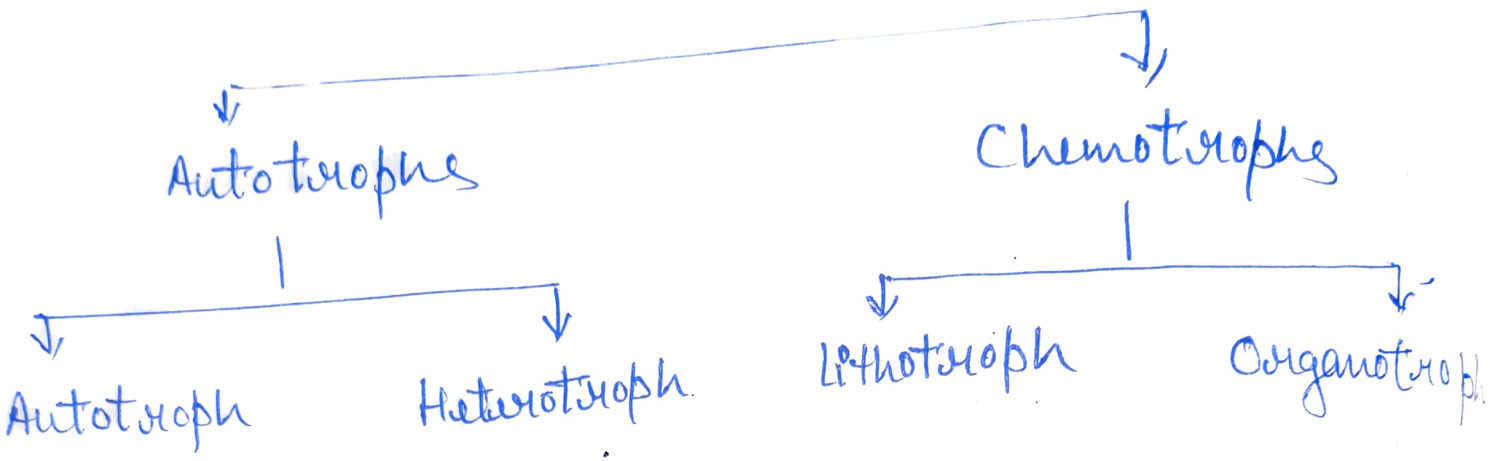
Metabolism helps in body maintenance, body repair and growth.

Types of Cell metabolism -

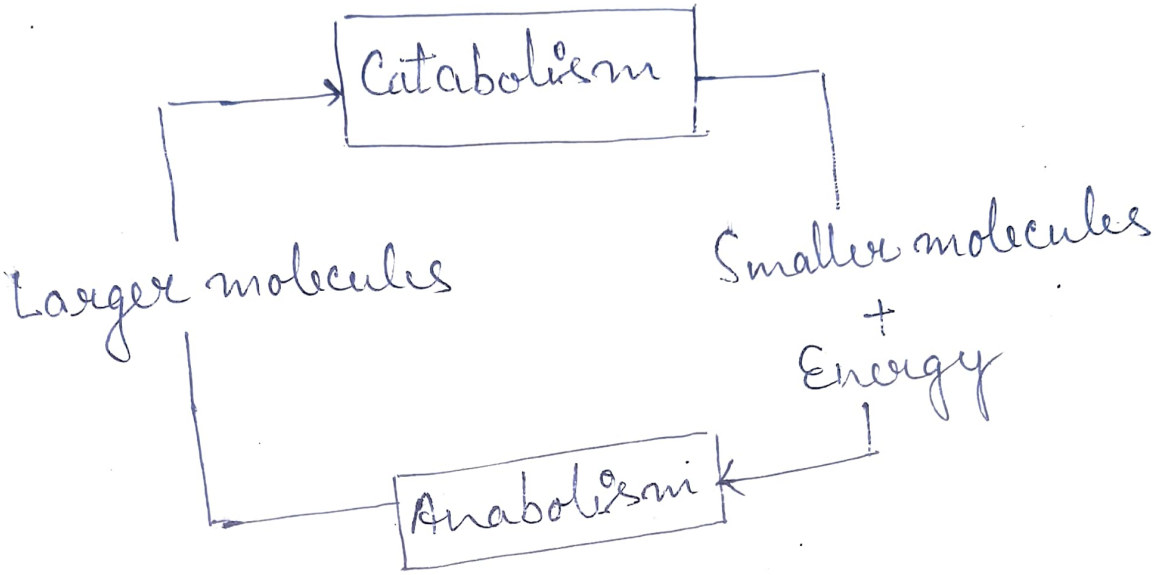
Cell metabolism

- Catabolism
- Anabolism

Catabolism In this reaction, energy is obtained by the breakdown of large molecules in to smaller ones.


Autotrophs
Chemotrophs
Autotroph
Heterotroph
Lithotroph
Organotroph

- In this process energy is released
  eg. Hydrolysis - catabolic reactions.



eg of catabolism :-

Sucrose $\xrightarrow{\text{sucrase}}$ Glucose + Fructose

Anabolism - In this reaction of metabolism cell synthesizes all necessary compounds, which are required for cellular growth and repair.

- These necessary compounds include DNA, RNA & proteins.
- This process requires energy to build larger molecules.
  eg. Dehydration synthesis, ~~[illegible]~~ Protein synthesis.
  etc.

Monosaccharides + Monosaccharides $\underset{\text{hydrolysis}}{\overset{\text{dehydration}}{\rightleftharpoons}}$ Disaccharides + H_2O

Cell metabolism is thousands of enzyme catalysed chemical reaction in cell.
ATP plays an important role in cellular metabolism.
ATP is the energy currency. It links catabolism &

Carbohydrate Metabolism - It involves several metabolic pathways for the generation of energy for cellular respiration. The main steps are:

1) Glycolysis
2) Krebs Cycle / Citric Acid cycle / TCA cycle
3) Electron transport chain

Glycolysis: The breakdown of glucose to provide energy. It takes place in the cytoplasm.

- Glucose is converted into (2) three-carbon molecules of pyruvate through ten different reactions.
- Specific enzyme catalyses each reaction.
- It is a sole source of energy in some mammalian tissues & cell types such as erythrocytes, Brain etc.

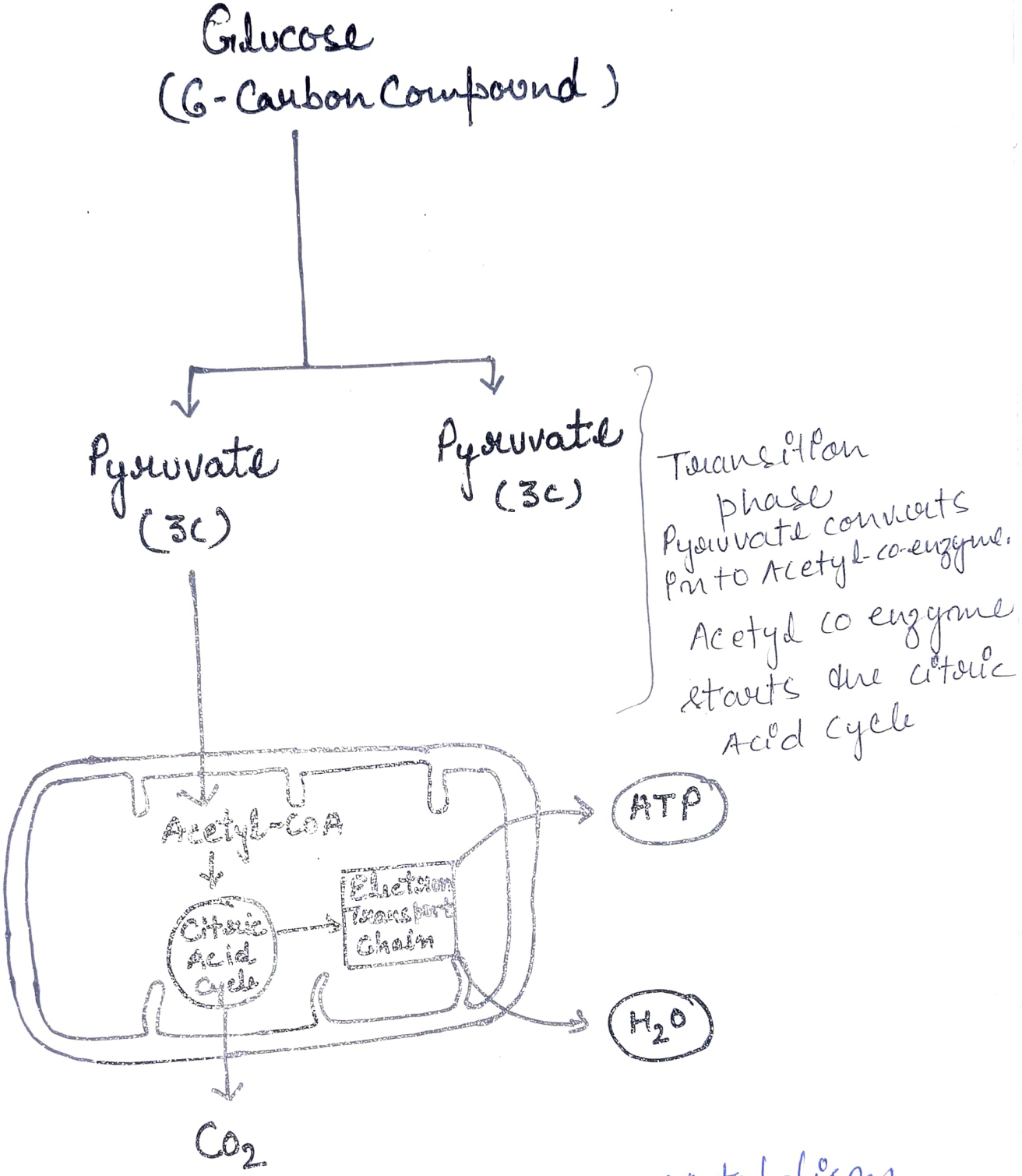
Citric Acid cycle: It occurs in mitochondria (matrix)

- It generates a pool of chemical energy (ATP, NADH)
- It's a part of cellular respiration.
- It is initiated by Acetyl CO enzyme.

Electron Transport chain: It is a series of compounds that transfer electrons from electron donors to electron acceptors.

It occurs in the inner membrane of mitochondria.

In ETC, oxidation of NADH with phosphorylation of ADP to form ATP is supported by ATP synthase.



The events in Carbohydrate Metabolism

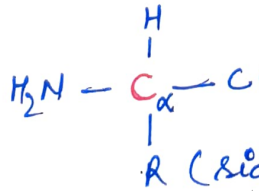
&

ATP Production from Glucose.

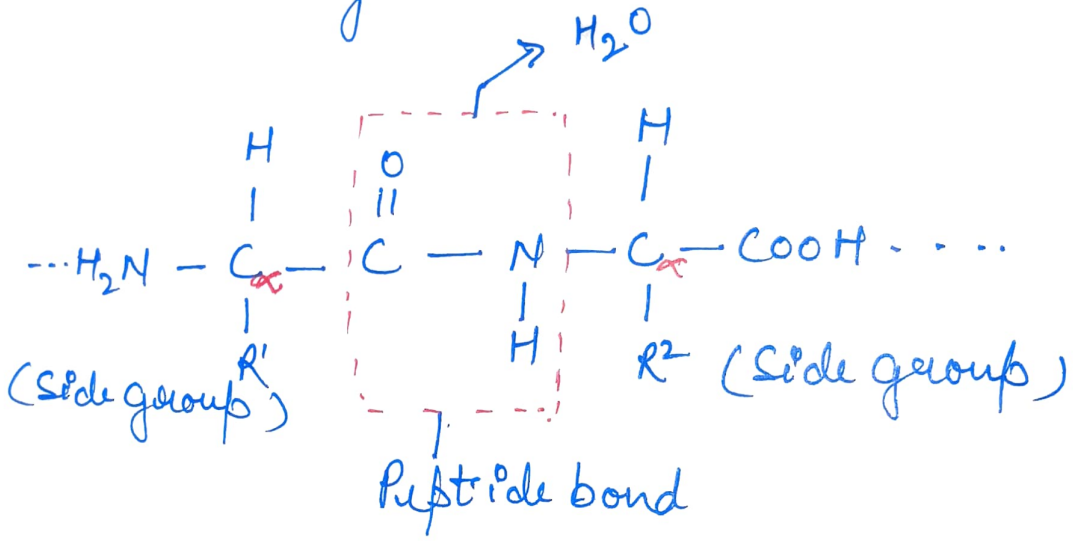
(K.A. KAMAKSHI SAXENA)

Structure of Proteins UNIT I

- G.J. Mulder (1838), gave the name "Protein", which is derived from a Greek word Proteions.
- Proteins are complex organic compounds with higher molecular weights.
- These are made up of Carbon, H_2, O_2, Phosphorous, Nitrogen and small amount of Sulphur.
- Proteins are the most abundant ~~of~~ organic molecule in the living system and constitute about 50% of cellular dry weight.
- Proteins are made up of a number of amino acids. (Amino acids are fundamental structural units of proteins).
- Only 20 amino acids constitute all types of Proteins.
- These amino acids are linked together by peptide bond.
- Each amino acid contains acidic carboxyl groups and basic amino groups.
- The central Carbon atom of amino acid is known as alpha Carbon (C_α) to which all the 4 groups (an amino gep NH_2, a carboxyl group, a hydrogen atom and a side group) are attached.



The peptide bond is formed when the carb
group of one amino acid is joined/li
with the amino group of next amino a
eliminating a water molecule.



• Besides the peptide bonds proteins have several other bonds :-

Hydrogen bond : This bond is formed when a hydrogen atom is bound to an oxygen or nitrogen atom by unshared electron pair. These bonds are found in secondary and tertiary proteins.

$-O-H :> N-H$

Hydrophobic interactions : This is considered to be the major driving force for the folding of globular proteins. It results in the burial of the hydrophobic residues in the core of the protein. Thus the hydrophobic amino acids are grouped together.

Electrostatic interactions : Electrostatic or ionic interactions arise either as attractions between opposite charges or repulsions between like charges.

Van der Waals interactions : Both attractive and repulsive forces are included in Van der Waals interactions.

Individual Van der Waals interactions are weak ones (with stabilization energies of 4.0 to 1.2 KJ/mol)

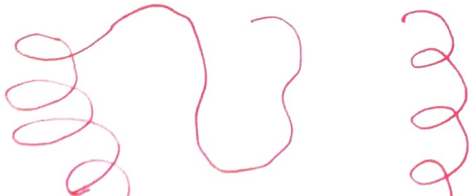
Structure of Proteins: - There can be four basic structural level of proteins as:

Primary Structure - Amino acids are joined end to end by the formation of peptide bonds. It is a linear arrangement of various amino acids forming the polypeptide chain. ex - Insulin, Ribonuclease.
The amino group of first amino acid and carboxyl group of last amino acid of the chain remain intact and called as chain extends from its amino terminus to carboxy terminus.

Secondary Structure - The secondary structure of proteins shows the spirally coiled structure. Hydrogen bonds, salt links and van der waals forces are found.
Ex:- Silk fibre

α-helix or β-extended chains)

Tertiary Structure - To compress the very long spiral chain into globular form, extensive coiling or folding or bending occurs.



These proteins have disulphide bonds along with hydrogen, ionic and hydrophobic bonds.

Quartenary Structure – The polymerization of protein takes place by the aggregation of highly folded subunits. These proteins have many polypeptide chains which remain bound together by weak non-covalent bond.

Ex - Haemoglobin

Functions

(1) Structural :- Certain proteins are responsible for structure and strength of body.

ex - collagen and elastin in bone matrix
vascular system
∧- Keratin

(2) Dynamic :- Proteins function as enzymes, hormones, blood clotting factors, immunoglobins, membrane receptors, storage proteins, muscle contraction etc.

DR. KAMAKSHI SAXENA

Homeostasis

- The processes by which the body regulates its internal environment are referred to as homeostasis.

- The concept of homeostasis was first articulated ~~given~~ by Claude Bernard.

- The term homeostasis was coined by Walter cannon.

- Homoios (same) and stasis (to stand)

- Humans are made up of trillions of cells, these cells perform different functions but they are similar in metabolic requirements such as -

  - obtaining nutrients and O_2 from surrounding environment
  - Nutrients and O_2 to provide energy.
  - Protein synthesis for cell structure.
  - Elimination of CO_2 and waste products
  - Regulation of exchange of materials between the cell and its surrounding environment.

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There are three types of homeostasis -

① Primary ② Secondary ③ Tertiary

Example - After cut or abrasion

↓

Blood comes out

↓ Primary homeostasis

Formation of Platelets plug

↓ Secondary homeostasis

Formation of fibrin through coagulation

↓ Tertiary homeostasis

Formation of Plasma for the breakdown of clot

↓ Homeostasis maintained

↓

Survival of the organism

Homeostatic regulation - Constant monitoring and adjustments of body's internal environment according to the climate change is known as homeostatic regulation.

It involves three parts -

Receptor → Control center → Effector

Receptor: receives information of any change

Control center: receives and processes informations

Effector: it responds to the commands of the control center.

Regulation of body temp :-

Temp. receptors (skin) → Brain (C.C.) → Blood vessels, Sweat glands (Effectors)

Conc. of nutrients :-

Constant supply of nutrients → energy production → Cell activities.

- Conc. of O_2 and CO_2 :-

O_2 used in chemical reactions → CO_2 produced →

CO_2 removed to minimize the acid formation

- Conc. of waste products :-

Chemical reactions → waste produced → waste removed

- Conc. of water, salt and other electrolytes :-

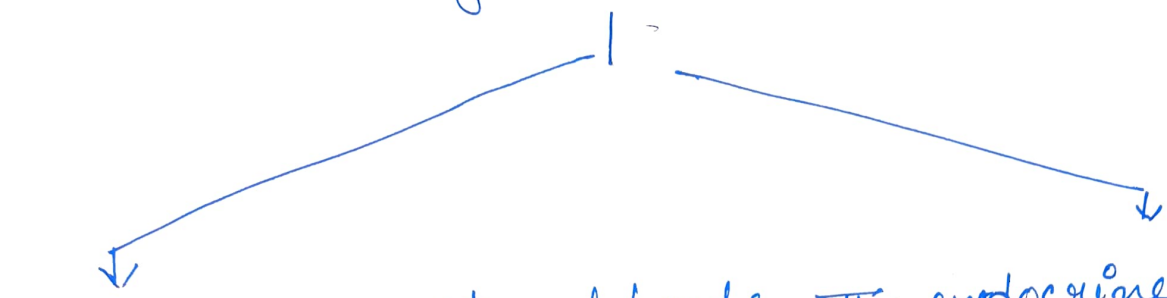
Extracellular fluid with NaCl, other electrolytes → water enters Cell → Proper volume of the cell.

(water leaves)

Pathways to alter homeostasis : The homeostatic balance becomes disrupted in two basic ways -

- either deficiency (cells not getting all they need)
- or toxicity (cells being poisoned by things they do not need)

Extrinsic homeostatic System - Most homeostatic systems are extrinsic and regulated by nervous system and endocrine system in higher animals.



The nervous system depends on sensory organs to receive stimuli and transmit a message to the spinal cord or brain. The spinal cord or brain process the input and send a signal to the effector (muscle or gland).

The endocrine system involves a chemical to the reflex. Sensors detect a change and send a message to effector (parathyroid) which makes PTH (parathyroid hormone)

Some reflex actions have a combination of nervous and endocrine responses.

Intrinsic homeostatic System - This control system involves only one organ or tissue. Ex - when muscles use more O_2 and produce more CO_2, intrinsic controls cause dialation of the blood vessels.

Nervous System - Nervous system plays an important role in maintaining homeostasis by controlling and regulating the body.

The receptors receive the stimuli and send it to the central centre in brain as nerve impulses. Now brain takes the decision and directs the effector for response. Ex -

Abnormal lowering of body temp → Effector → acts to increase body temp.

The nervous system has two major portions -

① The central nervous system

② The peripheral nervous system

Central Nervous System: It consists of brain and spinal cord. The hypothalamus is located in the brain which influences the action of medulla oblongata and pituitary gland. It is concerned with the homeostasis.

Peripheral Nervous System: It consists of the spinal nerves. It contains motor neurons that control internal organs. It has two divisions -

① Sympathetic

② Parasympathetic

Sympathatic system is associated with

reactions.

Parasympathetic system is associated with daily reactions.

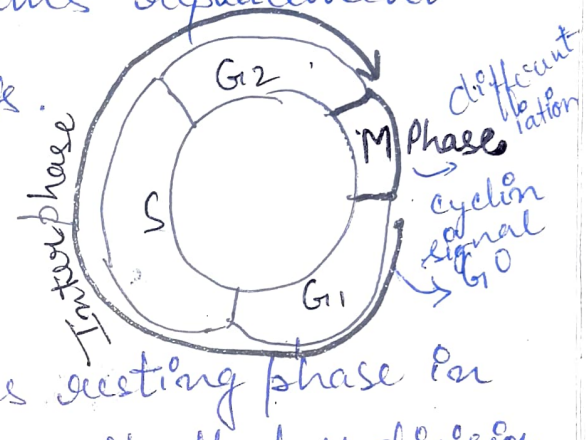
Peripheral nervous system is a part of autonomic nervous system.

Endocrine System - Endocrine system consists of glands which secrete special compounds called hormones. Endocrine system regulates the metabolism and body development. It secretes sex hormones, which regulate the development of repro-ductive organs.

- It helps in the mobilization of minerals like Ca for bone growth.
- It also helps in muscle growth by regulating muscle metabolism.
- Hormones regulate CNS by influencing fluid / electrolyte balance.
- Hormones regulate heart rate and blood pressure as well as lymphatic system.

Cell Growth and Reproduction

- "Continuity of life" is an important characteristic of living organisms which involves division and replication of cells.
- Growth and development of organism depend on the division and multiplication of cells.
- Cell division also ~~but~~ performs replacement and repair of worn out cells.



Two parts of cell division:

① Interphase ② M-phase

① Interphase: is also called as resting phase in which cell prepares itself for division.

This phase consists of three phases -

G_1 Phase, S phase, G_2 Phase

② M-phase or Mitotic Phase: Interphase is followed by the M-phase. It involves the separation of sister chromatids and their distribution in to daughter cells.

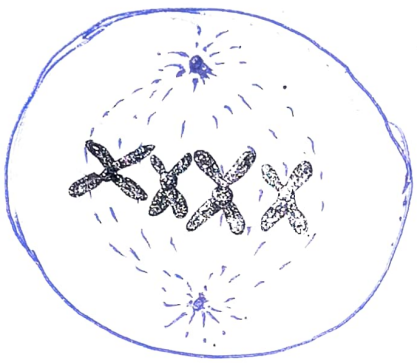
It consists of two phases:

① Karyokinesis (ii) Cytokinesis

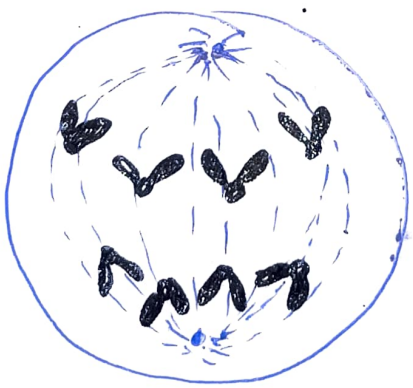
Types of Cell Division:

① Mitosis ② Meiosis

Prophase



Metaphase



Anaphase

division)
discovered by Strasburger.
term was coined by Flemming.

It occurs mainly in somatic cells as well as germ cells. It has two phases
(A) Karyokinesis (B) cytokinesis

(A) Karyokinesis : It comprises four stages.

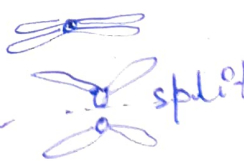
(1) Prophase - centriole pairs start moving towards opposite poles.

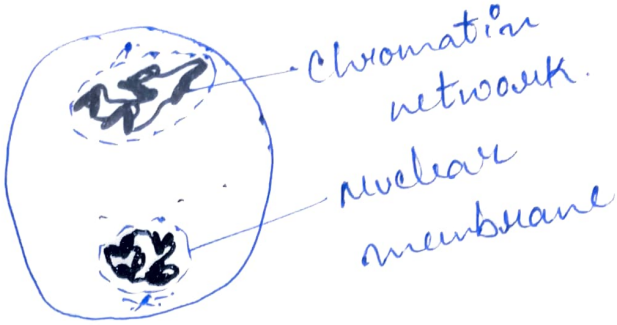
- Disappearance of Golgi body, ER, nuclear membrane and nucleolus
- Condensation of chromosomes.
- Spindle apparatus is formed.

(2) Metaphase - chromosomes arrange at metaphase plate or equatorial plate.

- Each centromere is joined by two chromosomal fibres

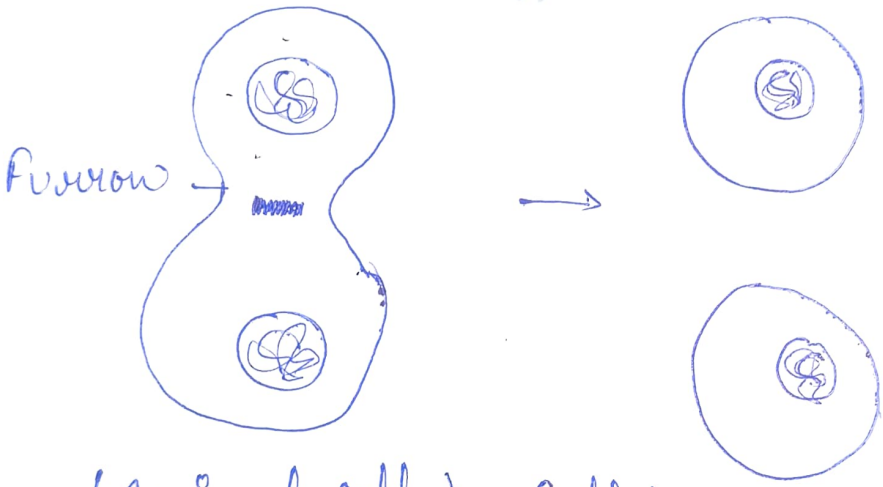
(3) Anaphase - Each centromere splits.
- Two daughter chromosomes are formed



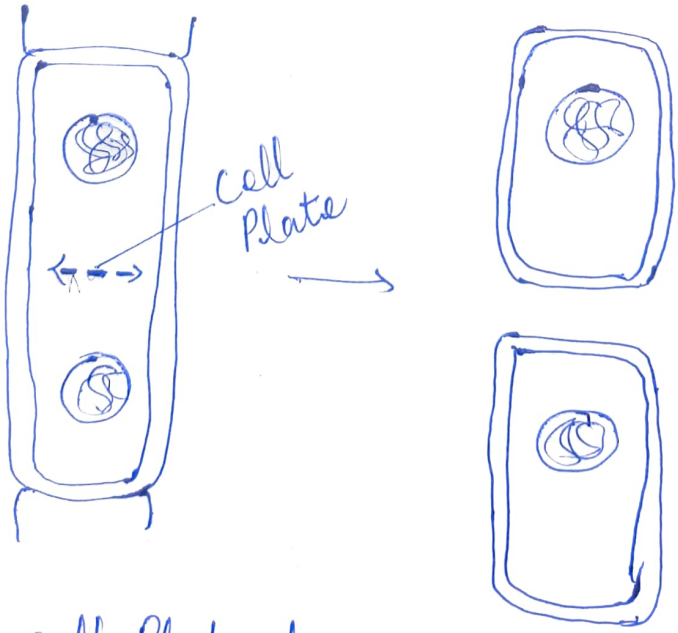


Telophase

Cytokinesis



(Animal cell) Cell furrow method



Cell Plate formation

Daughter chromosomes move towards opposite poles moving
Chromosomes appear V-shaped, J-shaped or rod-shaped

Telophase - At each pole, a new nuclear membrane reappears around the chromosomes.

- Nucleolus, Golgi body, Endoplasmic reticulum are reformed.
- chromosomes form chromatin network.

Cytokinesis - It involves division of cytoplasm.

- In animal cells, a constriction develops in the cell membrane which deepens and finally divides the cell into two daughter cells. This is called cell furrow method.
- In plant cells, cytokinesis occurs by cell plate formation.

Significance of Mitosis -

- It keeps the chromosome number constant in daughter cells, so that the genetic stability is maintained.
- It helps in growth and development.
- It provides new cells for repair and regeneration.
- It helps in asexual reproduction.
- It maintains surface area/volume ratio which increases the exchange power of the cell.

- Meiosis is a cell division which occurs at the time of gamete formation.
- This division consists of two nuclear divisions that reduces the total no. of chromosomes, resulting in to four daughter cells.
- The no. of chromosomes remain just half as compared to ~~daus~~ parent cell.

(46) chromosomes $\xrightarrow{\text{meiosis div.}}$ (23) chr.
2n (diploid) n (haploid)

- During meiosis, nucleus divides twice but the DNA is replicated once.
- I nuclear division in meiosis is called as reductional division because chromosome no remains/becomes just half to its parent cell. (Meiosis I)
- II nuclear div. is called as equational division because no. of chromosomes remain equal to its parent cell. (Meiosis II)

Meiosis division

Meiosis I

Prophase I
- Leptotene
- Zygotene
- Pachytene
- Diplotene
- Diakinesis

Metaphase I

Anaphase I

Telophase I

Meiosis II

Prophase II

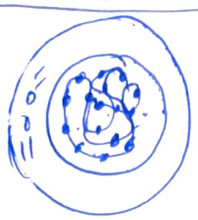
Metaphase II

Ana. II

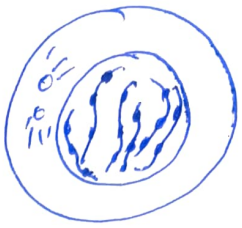
Telo. II

Meiosis - I

Prophase I

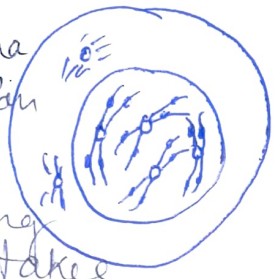


Leptotene



Pairing of homologous chromosome starts

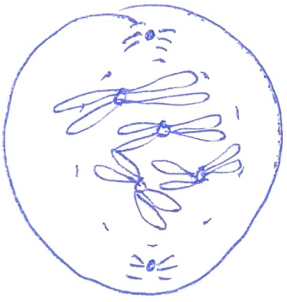
Zygotene



Chiasma formation & Crossing over takes place. Pachytene

After crossing over Separation of homologous chromosome starts.

Diplotene



Diakinesis

Meiosis I :

Meiosis occurs at the time of gamete formation in the diploid germ cell.

The nucleus division is called as Karyokinesis, followed by cytoplasm division known as cytokinesis.

Karyokinesis I is divided into four phases.

① Prophase I ② Anaphase I ③ Metaphase I

④ Telophase I

Prophase I : This is the longest phase in meiosis. It is divided into five stages.

① Leptotene ② Zygotene ③ Pachytene ④ Diplotene

⑤ Diakinesis.

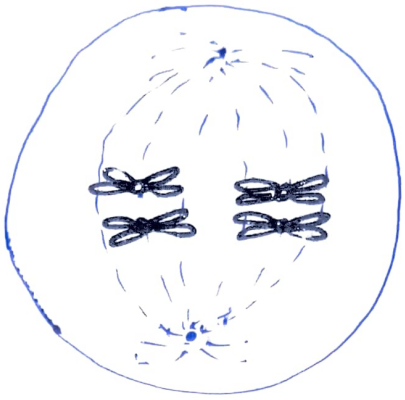
① Leptotene stage :

- Chromatin network becomes condensed to form chromosomes.
- Homologous chromosomes (identical in structure but one from maternal side and one from paternal side) start to form a pair.

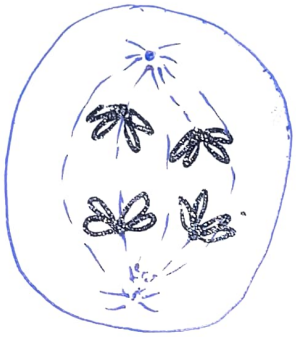
② Zygotene stage :

- The homologous chromosomes pair along their entire length, called as synapsis.
- Each pair of the homologous chromosomes constitutes a bivalent/diad.

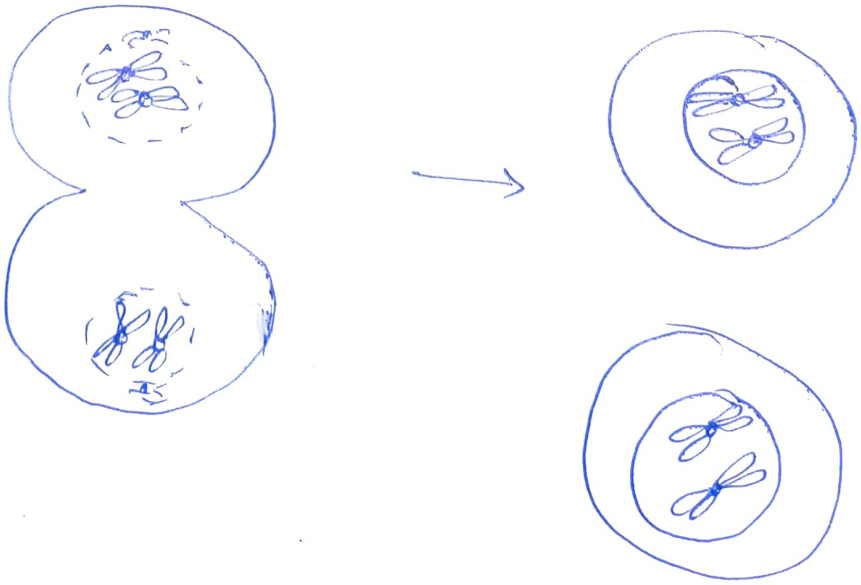
Metaphase I



Anaphase I



Telophase I



achytene stage:

The synaptic chromosomes form tetrad.

At some points non-sister chromatides join each other and exchange their segments. These points are termed as chiasmata.

- The exchange of segments is called as crossing over.

Diplotene stage:

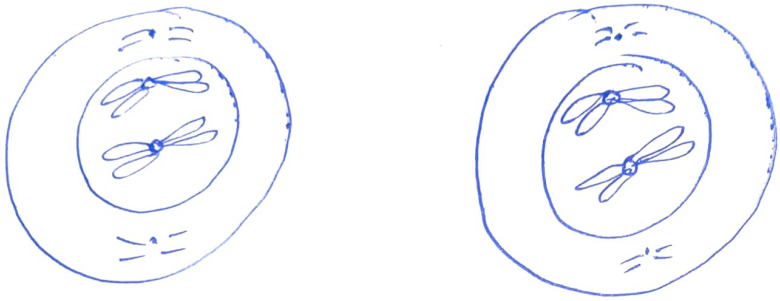
- Crossing over gets completed, chromosomes start to separate.
- Nucleoli & nuclear membrane disappears.
- Aster rays and spindle apparatus appear.
- Synaptonemal complex breaks.

Diakinesis: Bivalent separates, nuclear membrane & nucleolus disappears. Spindle apparatus appears.

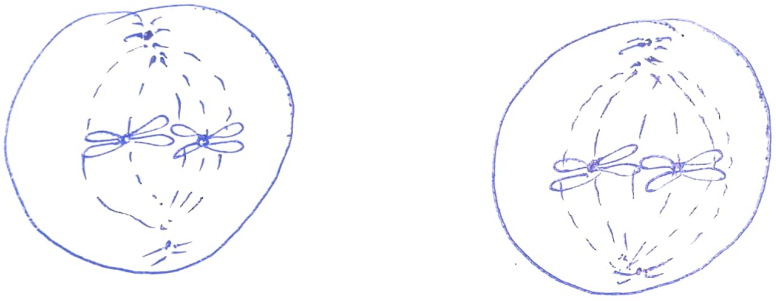
Metaphase I: Paired homologous chromosomes arrange themselves on the equitorial line of the spindle also known as metaphase plate.

Meiosis - II

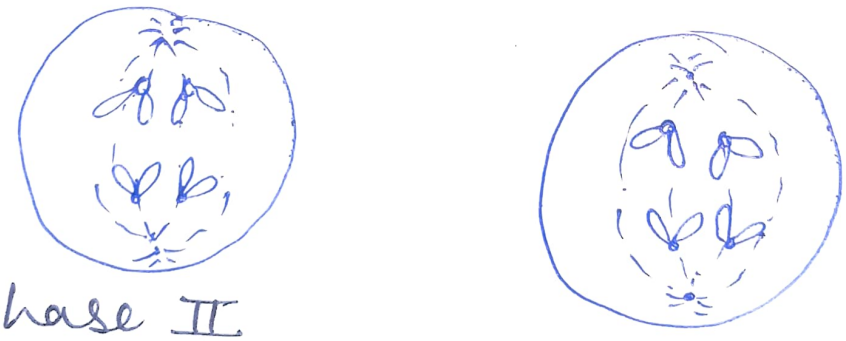
Prophase II



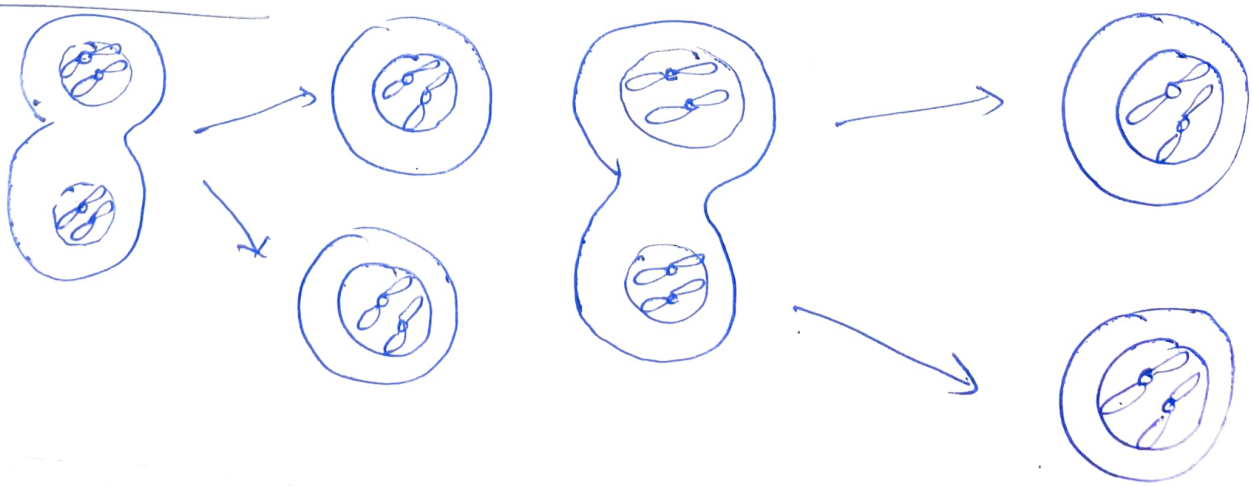
Metaphase II



Anaphase II



Telophase II



Anaphase I – In this stage, homologous chromosomes move towards the opposite poles & each chromosome still consists of two sister chromatids.

Telophase I – The chromosomes reach at the two poles and start to elongate ~~and~~ to form chromatin network.
Nuclear membrane and nucleolus reappear.

Cytokinesis I – It may or may not occur.

Meiosis II : Meiosis II resembles to mitosis in many ways. It occurs immediatly after meiosis I.
It consists of i) Karyokinesis II ii) cytokinesis II
Karyokinesis II is divided into
① Prophase II ② Metaphase II ③ Anaphase II ④ Telophase II

Prophase II – Centriole divides and form two.
- Aster rays appear and nuclear membrane disappear.
- Nucleolus disappears.
- Spindle apparatus appears.
- Each chromosome consists of two chromatids.

Metaphase II - The chromosomes arrange on the equatorial plate at metaphase II.

Anaphase II chromosomes get separated from the centromere and each chromosome with two chromatids moves towards the opposite poles. At this stage chromosomes appear V/J shaped.

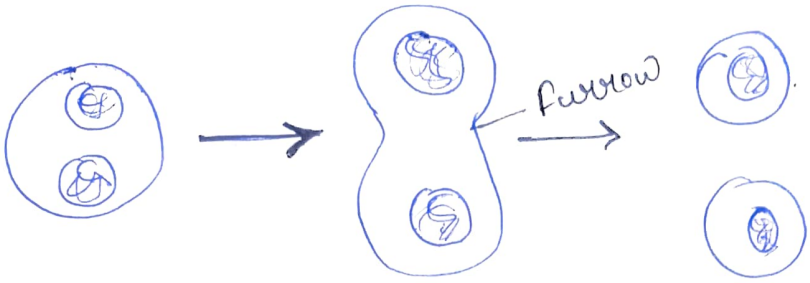
Telophase II - chromosomes elongate to form chromatin network.

- Nucleolus and nuclear membrane reappear.
- Spindle apparatus degenerates.

Cytokinesis II cytoplasm divides by two methods.
i) Cell furrow method (in animal cell)
ii) Cell plate method (in plant cell)
It divides each cell in to two daughter cell, each cell is haploid.

After meiosis I and meiosis II, there are total four daughter cells formed.

i) Cell furrow method - Animal cell divides by this method. In the middle of cell, a constriction appears on both sides. which gradually deepens and finally separates the two daughter cells.



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Cell plate method - In plants, cell divides by cell plate method.

- Plate formation starts from the centre and proceed towards periphery.

- It finally results in to two daughter cells.

Significance of Meiosis -

- Meiosis is a very significant process which maintains the uniformity of chromosome ~~no~~ set. Due to meiosis I the no. of chromosomes remain constant in offsprings.

- Due to crossing over genes combine and variations appear in progenies.

DR. KAMAKSHI SAXENA

Cell differentiation

- It is a biological process whereby an unspecialized cell becomes more specialized.

- Regulation of cell differentiation starts from the embryo level in an organism, differentiation occurs numerous times during the development of multicellular organisms, as the organism changes from a simple zygote to a complex system of tissues or cell types.

- Embryo contains various cells and each cell has the capability to develop in to many different ways.

- Cells after differentiation have different structure and function but they are genetically identical.

- Differentiated cells are different from one another.

- Fertilized egg or early zygote has the ability to give rise to every type of cell in the adult body and hence referred as totipotent.

- As the development of zygote takes place, it looses its totipotency and becomes ~~determined~~ specialized and differentiated in to specific cell type.

- Cell division begins in zygote (mitotically).

Zygote → 8 celled stage

Totipotent

16 celled stage → 64 celled (Blastula) stage

Pluripotent

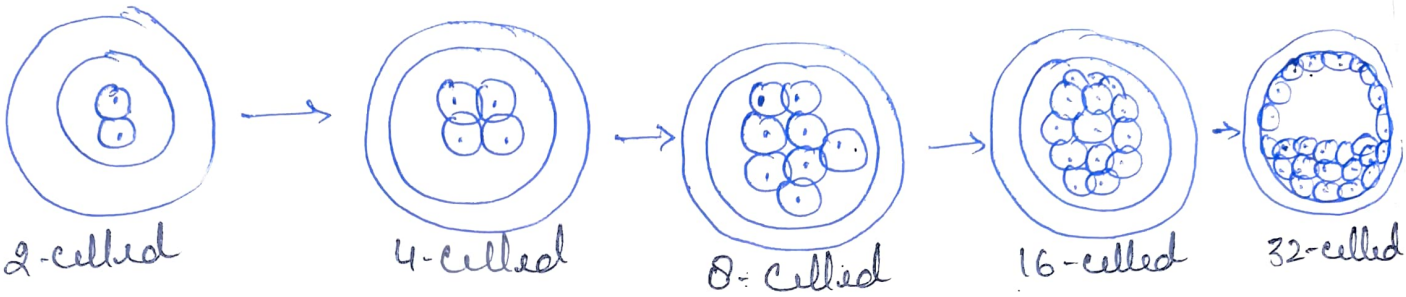
Germ layers — Ectoderm, Mesoderm, Endoderm

Multipotent

Epidermis / organ specific

Unipotent

- The divided zygotic cell is termed as blastula and blastula is called as pluripotent.



- Cells of blastula can generate all types of cell except trophoectoderm.
- Upon further division, cells become more restricted and give rise to multipotent cell. ex-haematopoitic cell that can give rise to different type of blood cells.
- Blastula further divides and redivides to form embryo.
- Embryo is further differentiated into 3 different layers:

Mesoderm (middle layer)
Cardiac muscles
Skeletal muscles
RBC
Smooth muscles
Cells of Kidney

Ectoderm (External layer)
Epidermis (skin cells)
Neuron of Brain
Pigment cells

Endoderm (external layer)
Lung cells.
Thyroid cells
Pancreatic cells