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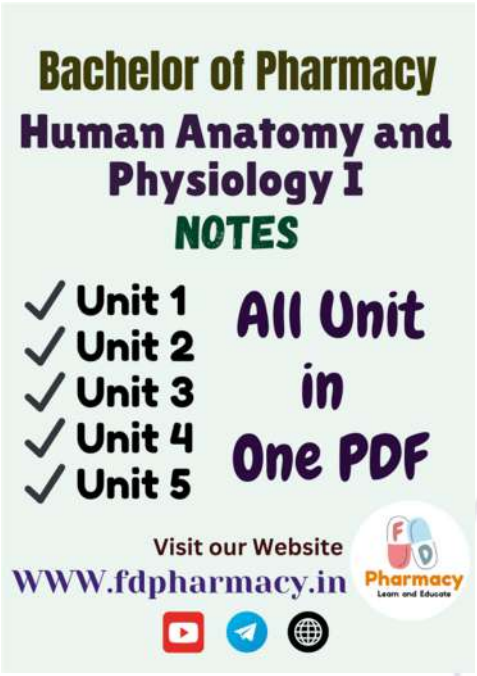
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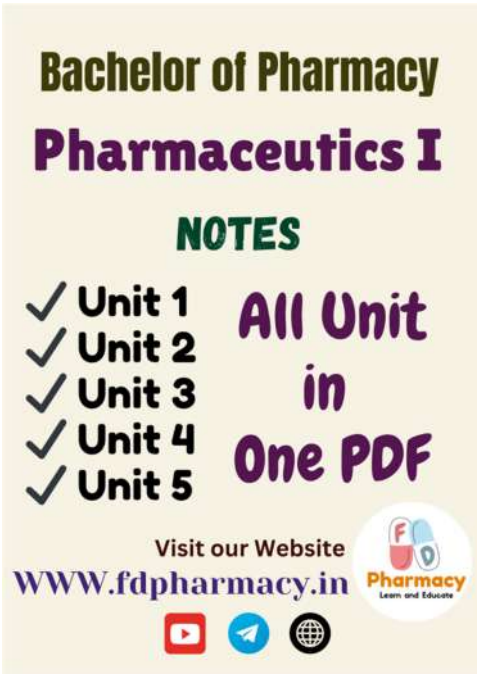
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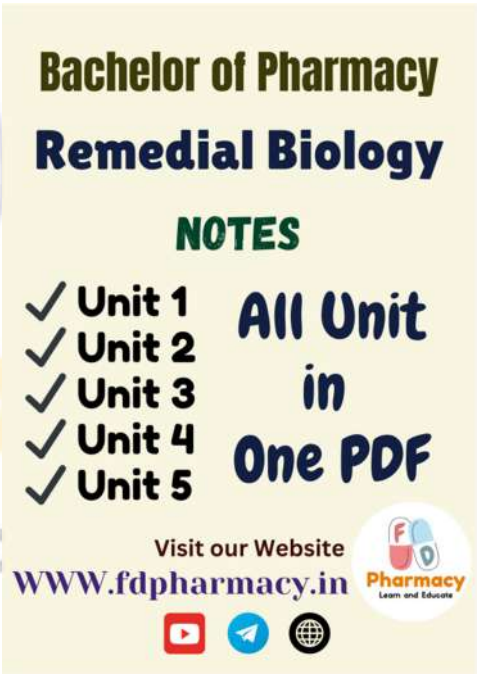
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HUMAN ANATOMY AND PHYSIOLOGY – I

UNIT 1

TOPIC :

- **Cellular level of organization**

  Structure and functions of cell, transport across cell membrane, cell division, cell junctions. General principles of cell communication, intracellular signaling pathway activation by extracellular signal molecule, Forms of intracellular signaling: a) Contact-dependent b) Paracrine c) Synaptic d) Endocrine

Cell

Cell is the basic structural & functional unit of all living organism. All the living organisms can be categorised into

I. Unicellular organisms eg. Protozoa, yeast, and bacteria
II. Multicellular organisms eg. Plants & humans.
III. A human cell consist 100 trillon of cells
    - Size of the cell is 10 µm
    - Mass of the cell is 1 nano gram

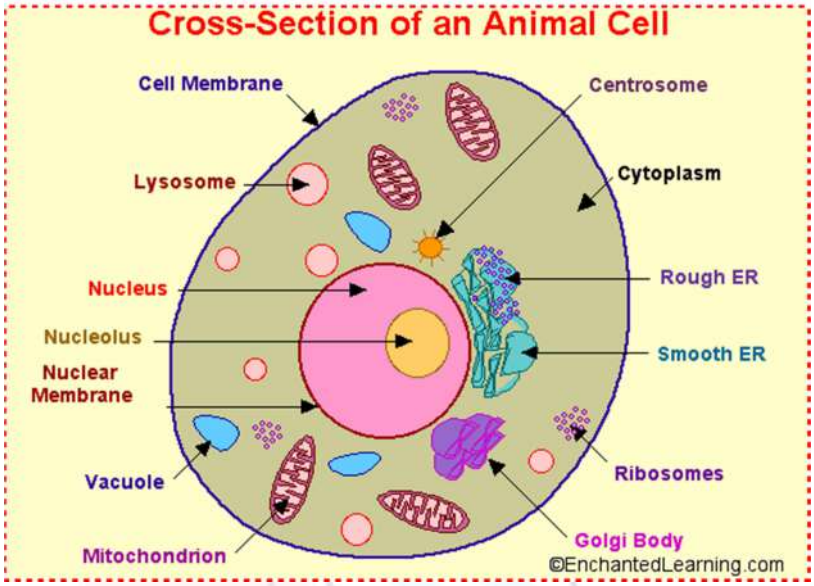
Cell are two Types

- **Prokaryotic Cells :** These cells do not have well developed nucleus,but organells are present. Eg. Archaebacteria,
- **Eukaryotic Cells :** These cells have well developed nucleus & other organells. Eg, plants, animals

Structure of cell

A cell Comprises of the following three basic components

- Cell membrane (or Plasma membrane)
- Cytoplasm
- Nucleus



1. Cell Membrane (or Plasma membrane)

→ The cell membrane is a selectively permeable biological membrane which allow only certain substance to pass through it.

→ It acts as a barrier between the inner and outer surface of the cell.

→ It also known as Plasma lemma.

Properties of cell membrane

- It guards the cell against the external environment.
- It allows cellular transport between cells.
- It helps in recognising a cell.
- It divides the cell into smaller section having different structure & function.
- It allows the fussion of cell membrane with other membrane of cell organellsthrough special point of attachment.
- It regulates the transfer of certain specific molecules through the cell membraneeg. Gap junction
- It enables motility of the cellular organells.

Structure (Fluid mosaic model)

- The fluid mosaic model is the most accepted one
- The fluid mosaic model of the plasma membrane was given by S.J Singer & G.L Nicholson

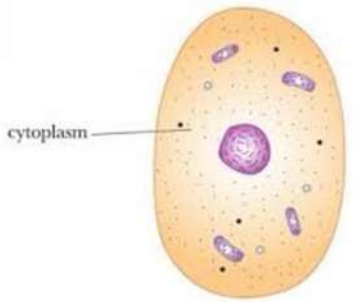
Function of cell membrane

- ✓ **Protection of cells :** The receptors present on the cell membrane all chemical messages to pass between the cell and the system, and thus provides protection to cells.
- ✓ **Separation from surrounding :** In an animal cell, it separates the internal environment from that of the external.
- ✓ **Tissue formation :** Groups of similar cells togetheer form tissues.
- ✓ **Contribution to enzyme acting :** It control the activity of enzyme Which further participate in metabolism and immune system.
- ✓ **Particle Transportation :** This occurs by various Mechanism like ,carries proteins And ion pumps.

2. Cytoplasm

- The cell consists of cytoplasm enclosed with in the plasma membrane
- The cytoplasm includes various organells present inside a cell and therefore these organells are also referred as a cytoplasmic organells
- Bassically The cytoplasm is the fluid in which cell organells remain suspended (mitochondria ' Golgi body, nucleus,etc

Structure of cytoplasm



The cytoplasm is divided into three parts Namely

1. Cytosol
2. Cytoplasmic organelles
3. Cytoplasmic Inclusion

- **Cytosol :** It is the fluid present inside the cell. The fluid bathes the cytoplasmic organelles

  Characterstic features of cytosol include.
  - Majority of the cell metabolism takes placem within the cytosol.
  - They also act as ribosomes and intracellular receptors.

- **Cytoplasmic organelles :** Cell consists the organelles (via Golgi body, mitochondra, etc) have some specific characteristics that help in the maintenance of life.

- **Cytoplasmic Inclusion :** certain bodies are present within a cell but are unable to perform their own metabolic process. These Structure also lac membrane binding them.

Function of cytoplasm

- It provide the site for cell growth and expansion
- It provide space for organelles tp remain suspended in the medium
- It also helps in the movement of several elements within the cell
- Various biochemical reactions, importance for the maintenance of life, occur in the cytoplasm
- It has enzymes which help in the breaking the large macromolecule into smaller ones so that other organelles can use them easily

3. Nucleus

- Mucleus is the spherical organelle that consists of a double layer membrane build up ofphosopholipids & protein.
- It also known as the contro cell.
- It consist genetic material of cell.

Structure of Nucleus

The Nucleus structure is comparised of following compound.

- **Nuclear Envelop :** A large number of small circular or octagonal nuclear pores are present of specific point on the nuclear envelop. This nuclear pores regulated movement of the macromolecules from the nucleus to the cytoplasm and vice-versa.

- **Nucleoplasm :** The nuclear cavity of the nucleus is filled up by one of the specalised forms ofprotoplasm, Known as nucleoplasm.

- **Chromatin material :** The chromatic material saturated with DNA , transmits the coded structural and functional information between the cell and organism.

- **Interphase chromatin :** During the interphase (the period of the cell cycle where the cell is not dividing) Two type of chromatin can br formed
  - **Euchromatin :** It includes the active DNA.
  - **Heterochromatin :** It mostly include the inactive DNA.
- **Nucleolus :** The nucleus of the cell has a nucleolus also known as nucleoi. It is a non-membrane bound structure containing protein and nucleic acids.

- **Chromosome :** The word Chromosome has been derived from the Greek word

  Chroma means ***colour*** ***Soma*** means ***body***

  A chromosome can be defined as DNA-bound protein (histone protein) that carry genetic information from generation to other

Function of Nucleus

- It consists most of the physiological activities of the cell
- It functions to encode all the genetic information that carries the hereditary characteristics in living organisms
- It has direct Involvement in reproduction (cell division)

Other Organelles

- **Mitochondria**
  - Most of the eukaryotic cells contain a membrane-bound cell organells called mitochondria.
  - Diameter ranging from 0.5µm – 10.µm.
  - Mitochondria are also know as the power house of the cell.
  - Because they generate Adenosine Triphosphate (ATP) used as a source of chemical.
  - Mitochondria are the chief source of energy in the cell.

Structure of mitochondria

Mitochondria are double membranous cell organelle having the following parts

1. **Outer membrane :** This membrane contain transport protein.
   - which are helpful in transporting ions and atoms across the organelle.

2. **Inner Menbrane :** This membrane is involved in the formation of cristae . Cristae are finger like projection in the matrix bearing small particle called F1 particle or oxysomes. Enzymes of the respiratory chain are present in cristae.

3. **Mitichonderial matrix :** matrix of the mitochondria is formed by fluid present within it
    - This fluid contains enzymes involved in kebe's cycle.
    - To oxidise fatty acids and pyruvic acid.

Function of mitochondria

- Regulates plasma membrane potential and cellular anabolism &catabolism.
- Synthesis of steroids.
- Aerobic Respiration to create energy for the functioning of cell.
- And The Main function of mitochondria , which are organelles also known as the power house of the cell because it is produce energy.

➢ **Golgi bodies**

→ The golgi body comprises of folded and compresed membranous sacs piled up each other. All the cell contain golgi body however it is large in those cells facilitate the systhesis and export of protein via, endoplasmic reticulum to the golgi complex.

Structure of golgi body

→ The golgi body consists of membrane bounded stacks called cisternae each cisterna contist of flattened membrane disks that carry golgi enzymes.

Function of Golgi bodies

Golgi body is involved in the synthesis of a different number of macromolecule

- **Modifying, sorting, and packing :** The golgi complex plays

an important role in sorting, mordifying and packing of substance for use with in the cell secretion.

- **Modification of protein :** proteins delivered by the endoplasmic recticulum are modified by the golgi body.
- **Transportation of substance :** enzymes present in the cisternae bond to the carbohydrates and phosphate group by the process of glycosylation and phosphorylation in order to modify substance by the transport of substance.
- **Formation of spindle :** The golgi body is involved in the formulation nof meiotic and mitotic spindles.
- **Excretion of water :** These organelles help in the excretion excess amount of water.

➢ **Lysosomes**

→ In 1949 a bwlgian cytoligist Christan de duve had discovered the cell organelle ' lysosomes 'The word lysosome derived from greek word

- ***Lysis*** means to ***separate***
- ***Some*** means ***body***

→ They are generally known as suicide-sacs or suicide bags.

Structure of lysosome

- Some non-green plant cells possess lysosomes.
- They are also called suicide bags as they cause intracellular digestion (destruct the carbohydrates ,protein, DNA ,RNA etc) and thus destory the cell.

Characteristic feature of lysosome

➲ They are present in high number n a single cell.

➲ They possess nearly 40 different enzymes.

➲ They are referred as suicidal bags since the enzymes present in them can digest the whole cell in case of damage or death of the cell.

Function of lysosome

- Provide defence against invading micraorganisms via circulatating macrophages.
- Helps dissolve blood clots.
- Cause the sperm to penetrate the ovum.
- Decompose the mature RBC and dead cells.
- Help in reabsorption of water and small molecule in kidney and urinary bladder.

➢ **Microsomes / Endoplasmic reticulum**

- Microsome are a heterogeneous set of vesicles having diameter 20- 200 nm 7consisting of endoplasmic reticulum.
- This vesicles are isolated by differential centrifugation and formed threestructural features.
  i.e, rough vesicles smooth vesicles ribosomes.

Structure of microsomes / endoplasmic reticulum

➲ **Rough endoplasmic reticulum (RER) :** Small particles of RNA known as ribosomes are found inclose association with the membrane of the endoplasmic reticulum which gives a rough apperance to the membrane.

➲ **Smooth endoplasmic reticulum (SER) :** The membrane of SER do not contain ribosomes and help in the metabolism of carbohydrates and lipid they are involved in the synthesis of steroidhormones in adernals and tests.

➲ **Sarcoplasmic reticulum (SR) :** Most of the muscles condidts of a unique type of smooth er called sacroplasmic reticulum.

Function of Microsome / endoplasmic reticulum

- It acts as a structural framework of the cytoplasm.
- It exchanges material with the cytosol by active transport, osmosis, and diffusion.

- Protein synthesised by its surface- bound ribosomes are collected and stored by RER.
- It has different metabolic enzymes which helps in the synthesis of phospholipid,cholestrol

➢ **Ribosomes**

→ Ribosomes are cell organelles where protein synthesis takes place. They are abundant in livingcells They are either found as free particles (in prokaryotic and eukaryotic cells or particle attached to membrane as in eukaryotic cells).

Structure of Ribosomes

- Ribosomes are ribonucleoproteins I,e. made from RNA Complex and proteinIt is divided into smaller parts called subunits.
- Which are made up of both protein and ribonucleic acid componentsSmaller sub unit & Larger sub unit.s

Function of Ribosomes

- The primary Function of ribosomes is protein synthesis.
- The information carried in the genetic code is converted into protein moleculewithin the ribosomes.

Function of Cell

1. **cell growth & Metabolism :**
   - Cell grow either by increasing its number or in size
   - Metabolism is the chemical reaction that occurs in our body cell its change food in energy
   - During metabolism, various anabolic & catabolic process occur
     - **Catabolic process :** Breakdown of complex molecule occurs within the cells to produce energy
     - **Anabolic process :** Cells utilise energy to synthesis complex biomolecule and perfrom other biological function
2. **Cell Division :** It involve the splitting of a single cell. Mother cell splits into two daughter Cells this result in the growth of multicellular organisms.During the cell division, DNA also synthesised and the process is known as replication.
3. **Protein Synthesis :** It occurs within the cell, by two major steps Transcription & Translation
4. **Molecule Transport :** The cell must be able to acquire nutrients and other molecule to survive

Transport across cell membranes

- The structure of the plasma membrane pro ides it with the property of selective permeability, meaning that not all substances can cross it. Those that can, do so in different ways depending on their size and characteristics
- Membrane is a biological membrane, which is made up with phospholipeds bilayer and allow substance to move through it,
- It is known as membrane transport.

Substances are transported across the cell membrane through :-

1. Passive transport

→ The movement of substances across cell membranes without the cell needing to expend energy.

→ It relies on the concentration gradient, moving substances from areas of high concentration to areas of low concentration

Passive Diffusion

- It is the transport of substance across the concentration gradient from the region of higher concentration to lower concentration without use of energy.
- Eg: diffusion of Lipid soluble molecules like O_2 & Co2 across the cell membrane.

Facilitated diffusion

- In this, substance transport across the concentration gradient, but with the help of any carrier bodies (that's why it is also called Carrier mediated transport).
- It is suitable for poorly diffusible substance.
- Carrier used such as SLC (Solute carrier Transporter)

- Eg : Entry of glucose into RBC, Intestinal absorption of Vit. B1 & B2.

2. Active transport

→ In this, Substance transport opposite the concentration gradient with the help of energy.
→ In this, ATP is used.
→ There is two types of Active transport

Primary Active Transport : In this, ATP is used as a energy

Eg : Absorption og Glucose.

Secondary Active Transport : In this, electrochemical gradient are used instead of energy.

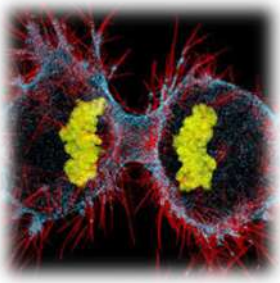
Eg : sodium-glucose cotransporter (SGLT), where sodium ions moving down their gradient into the cell are coupled with the movement of glucose against its gradient into the cell.

3. Endocytosis

→ In this transport, drugs of very large size molecules get transported via engulfment by cell membrane.
→ Eg : Cellular uptake of macromolecular like fat, starch, oil-soluble vitamines like A, D,E,K and drug like Insulin.

Cell Division

- **Cell Division** is the process by which a parent cell divides into two or more daughter cells.
- It is essential for growth, repair, reproduction, and development in living organisms.
- There are two main types of cell division
  - Mitosis
  - Meiosis



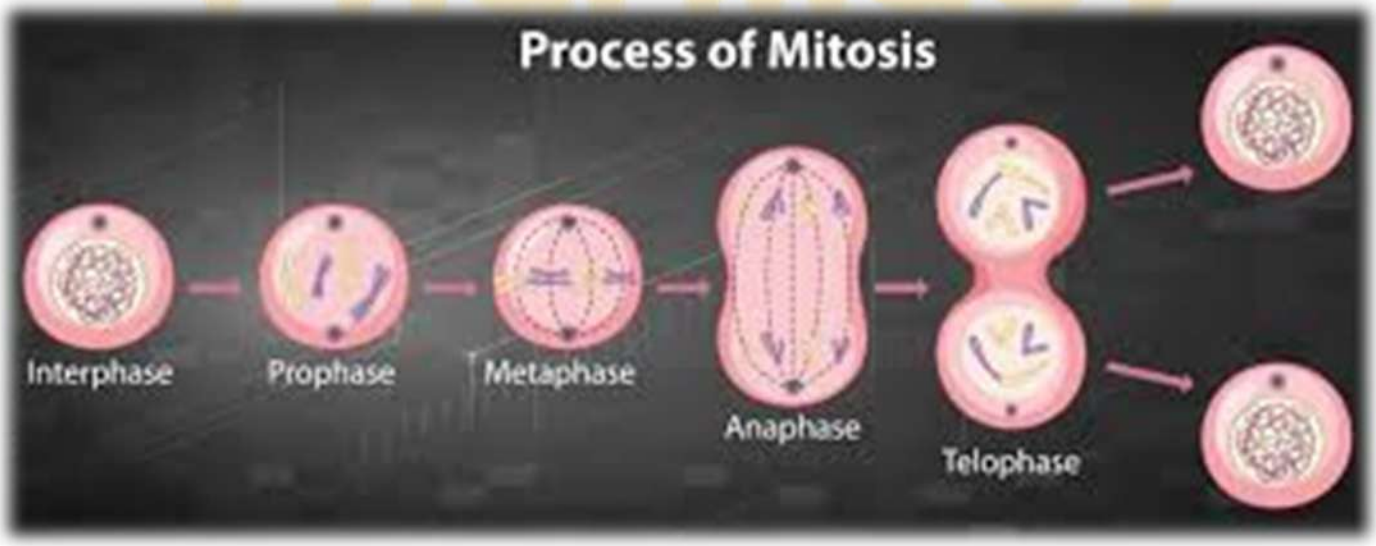
Mitosis

→ **Mitosis** is the process by which a **single cell divides to form two identical daughter cells**. It is used for **growth**, **healing**, and **replacing old cells** in the body.

→ Also known as (M-phase or mitotic phase (Equational division).

→ It is occurs in somatic cell in which already existing parent cell divides into two identical daughter cells.

→ In this, the no. of chromose in daughter cell is same as the no. of chromosome in parent cell



→ It is occurs into two parts

1. **Karyokinesis :** It ia a process by which the cell nucleus divides into two daughter nuclei.

Prophase :

- This phase begins with initiation of condensation of the chromosal material ie. chromatin
- Centrioles (centrosome) move towards the opposite poles of the cell.
- Organelles like golgi complex, ER, Nucleolus, and Nuclear envelope disappear at the end of prophase

Metaphase

- This phase begins with complete disintegration of nuclear envelope.
- chromosomal condensation completed and two sister chromatids are holds together by centromere
- Kinetochores (small disc shaped) at the surface of centron.
- Spindle fible attache to kinetochores and chromosor are moved to spindle equator and get alligned.

Anaphase

- Begins with splitting of each chromosomes.
- Separation of chromatids and move towards Opposite poles.

Telophase

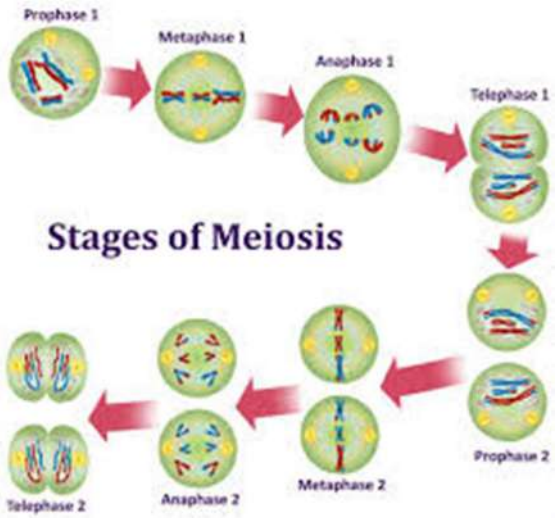
- last stage of mitosis and in this, chromosomes loose individualitry (decondensation) and chromatin material is collected as a mass at two poles.
- Nuclear membrane reappear and two nuclear formed
- other organelles reappears.

2. **Cytokinesis :** It is the division of parent cell cytoplasm after nucleus division to form two daughter cells

Meiosis

It occurs in gamete celle (reproductive cells).

In this, offsprings are produced by the fusion of a Female gamete and a male gamete



It occurs in two stages :-

i) Meiosis-I : It is disceded into four phases.

Prophase-I : It is longer and more complex,

It is further sub-divided into five phases-

a) **luptotine phase** → Condensation of chromosoms starts.
b) **Zygotene phase** → pairing of chromosomes, and the paired chromosome refered as Homologous chromosomes process is known as Synapsis) and formed synaptonemal complex
c) **Pachytene phase** → exchange of genetic material b/w two homologous chromosomes l,e. crossing over
d) **Diplotene phase** → dissolution of synaptonemal complex and formed x-shaped structure termed as chiasmata)

e) **Diakinesis phase** → Terminalisation of chiasmata, chromosome condensation completed, mitotic spindes is assembled, Nucleolus and nuclear envelop disappear.

Metaphase - I : chromosomes allign at the equatorial plate, microtubules are Seen attaching to the pair.

Anaphase – I : Homologous chromosomes separated.

Telophase – I : Nuclear membrans and nucleoulus reappear. this telophase followed by cytokinesis and formed two haploid (gametes) cells.

ii) Meiosis – II : It is similar as normal mitosis. It also comprises of four stages

Prophase-II : condensation of chromosomes, formation of Spindles and disappearance of nucleus.

Metaphase-II : equatorial alignment of Chromosomes.

Anaphase-II : separation of chromatides and move towards opposite Poles

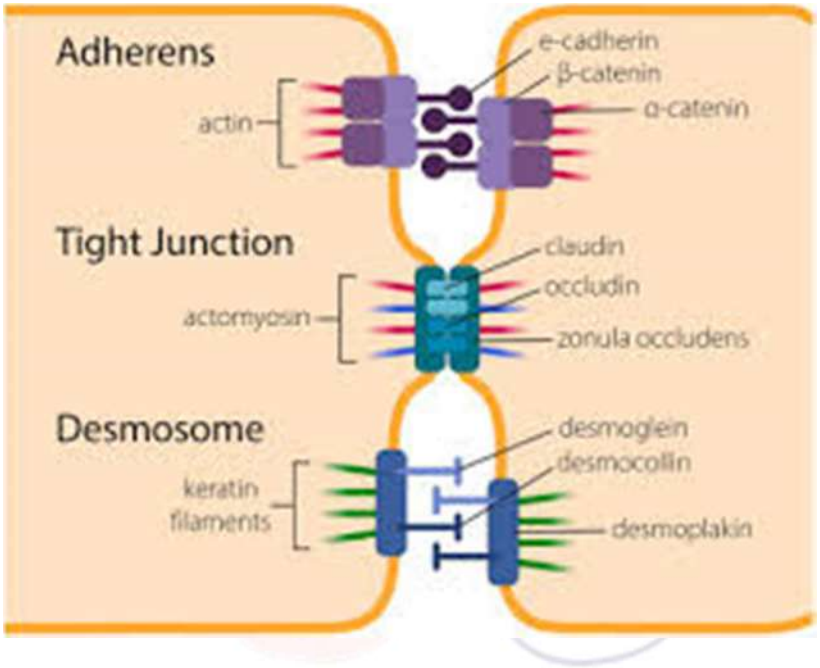
Telophase-II : chromesomes loose indivusualy and chromatin material is called as mass of two poles. Nuclear menbrans reappear f organelles

Cell Junction

→ It is the contact/connection) between the neighboring cells of between a cell and the extracellular matrix.

→ These are made up with multiprotein complex.

→ They are present in various cells, but their number is more in epithelial tissue



functions

- They creates the communications between the cells.
- They maintain the paracellular barrier and prevent the movement of unwanted water solutes and other substances.
- helps in attachement of cells and also responsible for transfer of substances and ions
- also provide (stregnth to the cells.

They are divided into :

1. Tight junction:

- Adjacent plasma membranes are joined tightly together
- This help to stop substances from leaking.
- It is permeable in for many ions
- Pass the ion through diffusion or active transport.

2. Adhering junction:

- It performs cementing keep neighbouring cells.
- Adhering junction is defined as a cell junction whose cytoplasmic face is linked to the actin cytoskeleton.
- Protein forms the encircling bands and attach to the extracellular material
- It stabilizes the surface of epithelia.

3. Gap junction:

- Gap junctions facilitate the cells to communicate with each other, share nutrients & transfer chemical / electrical signals
- Proteins form holes between adjacent animal cells allows various ions and molecules to pass freely between cells. Abundant in cardiac muscle and smooth muscle where they transmit electrical activity
- Assembly of six proteins that create gap between two plasma membranes called Conn exons.
- Regulation of gap junction communication
    - Intra Cellular Calcium
    - pH
    - Voltage
    - Extracellular signals.

Genearal Principal of Cell Communication

- Also known as "Cell Signalling".
- It is the communication b/w the cells.
- In this,the cell transmit (send), receive and process the signal from one cell to another cell or with itself.
- It is important to maintain (homiostasis. for growth and development of cells.
- They communicate with each other to help in transport substances, generate electrical potential across cell membrane and responed to change occuring in internal & external environment.

General principle

- In cell communication, one cell send it signals (ie ligands) which received by the receptor of another cell, then receptor activates and give response target cell through secondary messengers (eg. cAMP, IP_3].

Intracellular signalling pathway activation by extracellular signal molecule

Cell communication is of two types:-

1. Intercellular signalling (extracellular] : it refers to the communication between the cells.
2. Intracellular signalling : It refers to the pathway which Involves various (chain within the cell)
    - Intracellular signalling primarily uses external signal in the form of messenger or hormones,
    - these signal are produced by 'signal-producing cells' and recognised by target cells (receptors).

- these signals then transduced into an intracellular signalling chain.

It is completed in three steps: -

- Reception
- Transduction
- Response

Forms of Intracellular signalling

They are Four Forms of Intracellular Signalling

a) Contact-dependent
b) Paracrine
c) Synaptic
d) Endocrine

a) Contact-dependent : In this, one cell is directly in contact with another cell through membrane-membrane contact. Eg : between immune cells - initiation of immune response

b) Paracrine signalling : In this, target cell is very close signaling cell and communication occured between nearby cells.

c) Synaptic signalling : It is occurs between neurons and target cells, which is one type of juxtacrine (electrical) and parocrine (chemica signalling)

d) Endocrine Signalling : In this, signalling molecules i.e. hormones reached into its target cells through blood. eq. Estrogen etc....