HUMAN ANATOMY AND PHYSIOLOGY-I, BP-101(T)

UNIT-I (Introduction to human body)

CLASS:4

TOPIC –Transport across cell membrane, Cell Divisions, and Cell Junctions

A gradient is just a gradual difference in a variable across space.

In cells, the semipermeable membrane is the plasma membrane with its lipid bilayer, and the two solutions can be:

- The cytoplasm of the cell and the interstitial fluid when the exchange happens between the cell and its exterior environment.
- The cytoplasm of the cell and the lumen of a membranous organelle when the exchange happens between the cell and one of its organelles.

There are two types of gradients that condition the direction in which molecules will try to move across a semipermeable membrane like the plasma membrane: chemical and electrical gradients.

- Chemical gradients, also known as concentration gradients, are spatial differences in the concentration of a substance. When talking about chemical gradients in the context of the cell membrane, we are referring to a different concentration of certain molecules on either side of the membrane (inside and outside of the cell or organelle).
- Electrical gradients are generated by differences in the amount of charge on either side of the membrane. The resting membrane potential (usually around -70 mV) indicates that, even without a stimulus, there is a difference in charge on the inside and outside of the cell. The resting membrane potential is negative because there are more positively charged ions *outside* of the cell than inside, i.e. the inside of the cell is more negative.

When the molecules that cross the cell membrane are not charged, the only gradient we need to consider when working out the direction of movement during passive transport (in the absence of energy) is the chemical gradient. For example, neutral gases like oxygen will travel across the membrane and into the cells of the lung because usually there is more oxygen in the air than within the cells. The opposite is true of CO_2, which has higher concentration within the lungs and travels towards the air without needing extra mediation.

When the molecules are charged, however, there are two things to take into account: the concentration and the electrical gradients. Electrical gradients are only about charge: if there are more positive charges outside the cell, in theory, it doesn't matter if it is sodium or potassium ions (Na^+ and K^+, respectively) that travel into the cell to neutralise the charge. However, Na^+ ions are more abundant outside the cell and K^+ ions are more abundant inside the cell, so if the appropriate channels open to allow charged molecules to cross the cell membrane, it would be Na^+ ions that flow more easily into the cell, as they would be travelling in favour of their concentration and electrical gradient.

Types of transport across the cell membrane:

Definition: Transport across the cell membrane refers to the movement of substances such as ions, molecules, and even viruses into and out of a cell or membrane-bound organelle. This process is highly regulated because it is critical for maintaining cellular homeostasis and facilitating cellular communication and function.

There are three main ways in which molecules are transported across the cell membrane: passive, active and secondary active transport. We will have a closer look at each type of transport in the article but first let's look at the main difference between them.

- Passive transport
  - Osmosis
  - Simple Diffusion
  - Facilitated Diffusion
- Active transport
  - Bulk transport
- Secondary active transport (co-transport)

The main difference between these modes of transport is that active transport requires energy in the form of ATP, but passive transport does not. Secondary active transport does not directly require energy but uses the gradients generated by other processes of active transport to move the molecules involved (it indirectly uses cellular energy).

Passive transport refers to transport across the cell membrane that does not require energy from metabolic processes. Instead, this form of transport relies on the natural kinetic energy of molecules and their random movement, plus the natural gradients that form on different sides of the cell membrane.

All molecules in a solution are in constant movement, so just by chance, molecules that can move across the lipid bilayer will do so at one time or another. However, the net movement of molecules depends on the gradient: even though molecules are in constant movement, more molecules will cross the membrane to the side of less concentration if there is a gradient.

There are three modes of passive transport:

- Simple diffusion
- Facilitated diffusion
- Osmosis

Simple diffusion: Simple diffusion is the movement of molecules from a region of high concentration to a region of low concentration until an equilibrium is reached without the mediation of proteins.
Ex: Oxygen can freely diffuse through the cell membrane using this form of passive transport because it is a small and neutral molecule.

Facilitated diffusion: Facilitated diffusion is the movement of molecules from a region of high concentration to a region of low concentration until an equilibrium is reached with the help of membrane proteins, such as channel proteins and carrier proteins. In other words, facilitated diffusion is simple diffusion with the addition of membrane proteins.
Ex: Glucose is an example of a molecule that is transported across the cell membrane through facilitated diffusion.

Osmosis: Osmosis is the movement of water molecules from a region of high water potential to a region of lower water potential through a semipermeable membrane.

CELL JUNCTIONS

Cell junction is the connection between neighbouring cells or the contact between the cell and the extracellular matrix.

Connection between two cells is called **Intercellular junction** like tight junction, gap junction, adherence junction and desmosome.

- Intracellular space in closely packed tissue is about 20nm. The cells are bound together by the specific adhesive glycoprotein.
- Epithelial cells adhere to each other through glycoproteins called Cadherins.

Cell junctions are classified into 3 types:

Occulding junction	Communicating junction	Anchoring junction
• Which prevenet intracellular exchange of substance. i.e movement of ion, molecules. • All tight junction belongs to this category, as the cell membrane of adjacent cell fuse together firmly they are known Zona occuldens. • Hold neighbour cells and tissue firmly. • Form selective barrier for small molecule and total barrier for large molecule. • Prevent lateral movement of proteins and lipids act like fence. • BBB Made up by this tight junction to prevent entry of frequent substances.	• Permit the intercellular exchange of substance i.e ion, molecule. • Gap junction is one of the communicating junction, also known as nexus, present in heart. • Diameter of the channel gap is 1.5 to 3 nm, permit transport of glucose, amino acid, ions and other having molecule weight below 1000. • Rapid Propagation of action potentials and chemical exchange.	• They are strength providing junction. • They provide firm structural attachment between two cells or between a cell and extracellular matrix. • Present in heart muscle, epidermis of skin, which are subject to severemechanical stress.

IMPORTANT QUESTIONS:

2M QUESTIONS:
1. Define Anatomy and Physiology along with its scope.
2. Define Homeostasis.
3. What is feedback system.
4. Define cell. Write the functions of mitochondria.
5. Differentiate mitosis and meiosis.
6. Differentiate Phagocytosis and Pinocytosis.
7. Define: 1. Facilitated transport 2. Osmosis transport.
8. Differentiate exocrine and endocrine signaling.
9. Define Autocrine and Juxtacrine signaling.
10. Define tissue and its types with examples.

5M QUESTIONS
1) Draw a labelled diagram cell showing its cell organelles and their function.
2) Define tissue and its types in detail.
3) What is cell cycle and explain in detail.
4) What is cell division and explain its types.
5) What are different cell junctions.
6) Explain cell signaling and cell communication.
7) What is homeostasis and explain its feedback mechanism

10 M QUESTIONS

1. Define tissue and its types in detail.
2. What are different cell junctions.
3. Explain cell signaling and cell communication.