UNIVERSITY OF MEDICAL SCIENCES, ONDO

DEPARTMENT OF PHYSIOLOGY

PHS 211

TRANSPORT MECHANISM

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➤Introduction

- ➤Basic mechanisms
- Passive transport
- Active transport

INTRODUCTION

➢Body cells need essential substances (nutrients, water, electrolytes etc) and must get rid of unwanted substances (waste materials, carbon dioxide etc) to function optimally.

≻Transport mechanisms across cell membrane will help to achieve these.

➤Cell membranes either allow all substances to pass (permeable membrane) or may be restrictive allowing only small solvent molecules to pass (semipermeable membrane).

≻Lipids and proteins of cell membrane play important role for substances to be transported between ECF and ICF.

BASIC MECHANISMS

► Passive transport mechanism

► Active transport mechanism

PASSIVE TRANSPORT MECHANISM

- Transport of substances along concentration gradient or electrical gradient or both.
- ➢It is also known as diffusion or downhill movement. It requires no energy.
- ➤The energy involved is the energy of the normal kinetic motion of matter.
- ➤Substances move from region of higher concentration to region of lower concentration through a permeable membrane.

TYPES OF DIFFUSION

≻Diffusion is of two types

- Simple diffusion
- Facilitated (carrier mediated) diffusion

SIMPLE DIFFUSION

≻Occurs either through lipid layer or protein layer of cell membrane.

- ➤Through lipid layer: the lipid layer is permeable to lipid soluble substances alone e.g. oxygen, carbon dioxide and alcohol.
- ➢Diffusion through this lipid layer is directly proportional to the solubility of the substances in lipids.
- ➤Through protein layer: The protein layer is permeable to water soluble substances e.g. many electrolytes diffuse through the protein layer.

FACILITATED OR CARRIER MEDIATED DIFFUSION

>Occurs with the aid of carrier proteins of the cell membrane.

➤Water soluble substances with larger molecules are transported through the cell membrane with the help of a carrier protein.

≻Transport of substances are faster than in simple diffusion.

➤Glucose and amino acids are examples of substances transported by this means.

FACTORS AFFECTING RATE OF DIFFUSION

- ≻Permeability of the cell membrane.
- \succ Temperature of the body.
- ➢Concentration or electrical gradient of the substance across the cell membrane.
- Solubility of the substance. e.g. oxygen is highly soluble in lipid and diffuses rapidly through lipid layer.
- ≻Thickness of the cell membrane.
- \succ Size of the molecules.
- ≻Size of ions.
- ≻Charge on the ions

SPECIAL TYPES OF PASSIVE TRANSPORT

\succ Bulk flow

➢Filtration

≻Osmosis

- ➢Bulk flow: diffusion of large amount of substances from a region of high pressure to region of low pressure.
- ➢E.g. The exchange of gases across the respiratory membrane in the lungs.
- ➢Partial pressure of oxygen is greater in the alveolar air than in the alveolar capillary blood.
- ➢Oxygen moves from alveolar air into the blood through the respiratory membrane.

≻Reverse is the case for carbon dioxide.

- ➢Filtration: movement of water or solute from an area of high hydrostatic pressure to an area of low hydrostatic pressure.
- ≻Hydrostatic pressure is developed by the weight of the fluid.
- ➢Example is seen at the arterial end of the capillaries where movement of fluid occurs along with dissolved substances from blood into the interstitial fluid.

≻Osmosis: A special type of diffusion.

- ➢Defined as the movement of water or solvent from an area of lower concentration to an area of higher concentration of a solute through a semi-permeable membrane.
- ➤The semi-permeable membrane permits the passage of only water or other solvents but not the solutes.
- ➢ It occurs when there is a difference in the solute concentration on both sides of the membrane.
- ≻Osmosis depends upon osmotic pressure.
- ≻Osmosis across the cell membrane is of two types
- Endosmosis: movement of water into the cell.
- Exosmosis: movement of water out of the cell.

ACTIVE TRANSPORT

➢Movement of substances against the chemical, electrical or electrochemical gradient.

 \succ It is also called uphill transport.

➢It requires energy which is obtained majorly from the breakdown of high energy compounds e.g. ATP.

CARRIER PROTEINS OF ACTIVE TRANSPORT

Carrier proteins involved in active transport are two types.

Uniport

• Symport or antiport.

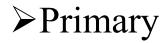
➤Uniport: carrier protein that carries a single substance in one direction. It is also called uniport pump.

Symport or antiport: carrier protein that transport two substances at a time.

Symport transports two different substances in the same direction, it is also known as symport pump.

➤Antiport transports two substances in opposite direction, it is also called antiport pump.

TYPES OF ACTIVE TRANSPORT





➢Primary active transport: energy is directly liberated from the breakdown of ATP.

Substances like sodium, potassium, calcium, hydrogen and chloride are transported across the cell membrane.

Secondary active transport: This is the transport of a substance with sodium ion by the help of a common carrier protein.

➤The movement is either in the same direction or in the opposite direction.

- Secondary active transport may be co-transport or counter-transport.
- Sodium co-transport: Sodium is transported along side another substance by the same carrier protein called symport.
- Energy needed for transport of sodium is derived from the breakdown of ATP.
- Energy released by the transport of sodiun is used to transport the other substance.
- Glucose and amino acids are transported by this process.
- Sodium counter-transport: Substances are transported across cell membrane in exchange for sodium ion by carrier protein called antiport. E.g. sodium-hydrogen counter transport

SPECIAL TYPES OF ACTIVE TRANSPORT

➤Endocytosis

➢Exocytosis

➤Transcytosis

➢Endocytosis: Macromolecules (substances with larger molecules) enter the cell.

➤Macromolecules cannot pass through the cell membrane by both passive and active transport, hence they are transported by endocytosis.

➢It is an energy-dependent movement of molecules across cell membrane.

➢Portion of the membrane protrudes, surrounds the substance and engulfs it, then bring it into the cell.

- >Endocytosis is divided into three
- Pinocytosis
- Phagocytosis
- Receptor-mediated endocytosis.

- Pinocytosis: Macromolecules in form of fluid droplets, bacteria and antigen are taken into the cell. It is also called cell drinking.
- Phagocytosis: Particles larger than macromolecules like larger bacteria and larger antigen are engulfed into the cells. It is also called cell eating.
- Receptor-mediated endocytosis: Macromolecules are transported with the help of a receptor protein. The surface of cell membrane has some pits which contain receptor proteins called clathrin. Chemical or ligand binds to a receptor in the membrane and is enclosed in a vesicle to be graded.

- Exocytosis: Process by which substances are expelled or removed from the cell.
- Substances are extruded from cell without passing through the cell membrane e.g. the release of peptide hormones from endocrine glands or transfer of fats from intestinal cell into the lacteal.
- ➤Transcytosis: This is a transport mechanism in which an extracellular macromolecule enter through one side of the cell, migrate across the cytoplasm of the cell and exits through the other side of the cell.