Transport through The cell membrane

Code: CBF-103

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Learning Objectives:

At the end of the lecture the students should be able to:

- Describe the importance of active transport as primary active transport; and secondary active transport (co-transport and counter – transport) and give examples.
- Define vesicular transport and its types.
- Basic principles of transport across epithelial membrane

II- Active Transport

Characters

1. use a ***protein carrier***.
2. Occur against the concentration gradient ***(uphill)***
3. It *requires energy* in the form of **ATP**.

Active transport is divided into two types according to the source of the energy used to cause the transport:

1. Primary active transport
2. Secondary active transport

1- Primary active transport

The the carrier derived the energy ***directly from ATP.***

Examples of primary active transport:

I- Na -K pump:

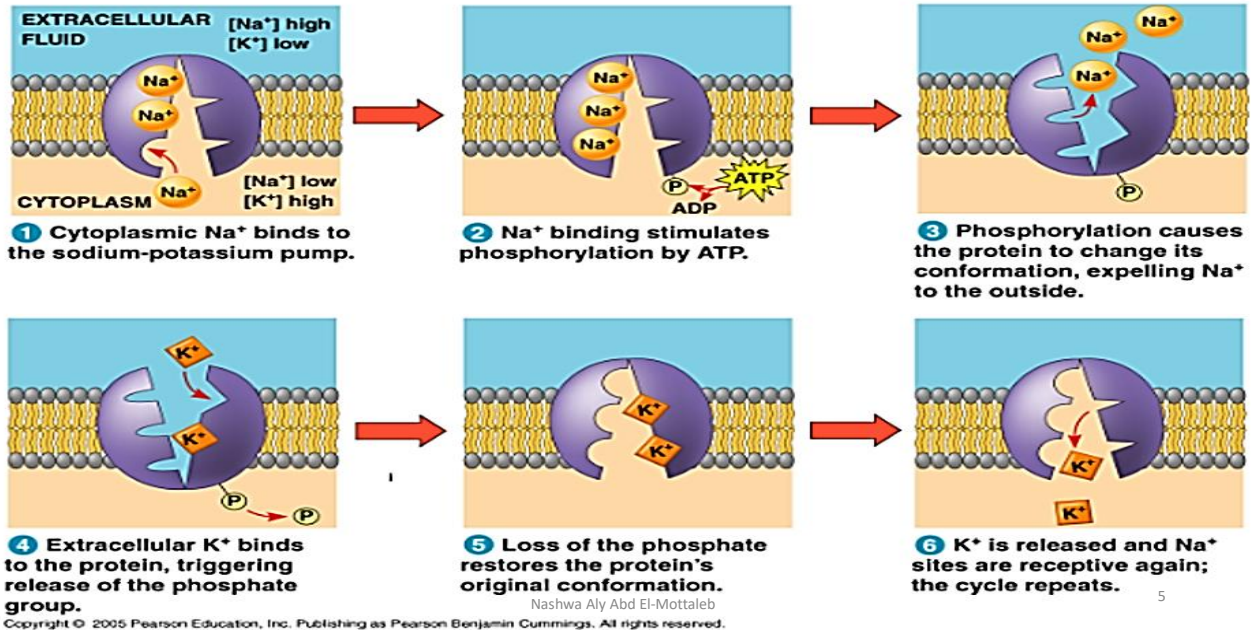
Characteristics

- three receptor sites for binding Na^+
- Two receptor sites for K^+
- Binding sites for ***ATPase activity (pump)*** near the sodium**.**
- Present in all cell membranes.

II- The Ca^{++} pump helps in muscle contraction.

III- The H^+ pump form HCl in the stomach and kidney

Mechanism of Na+ - K+ pump:



1 Cytoplasmic Na^+ binds to the sodium-potassium pump.

2 Na^+ binding stimulates phosphorylation by ATP.

3 Phosphorylation causes the protein to change its conformation, expelling Na^+ to the outside.

4 Extracellular K^+ binds to the protein, triggering release of the phosphate group.

5 Loss of the phosphate restores the protein's original conformation.

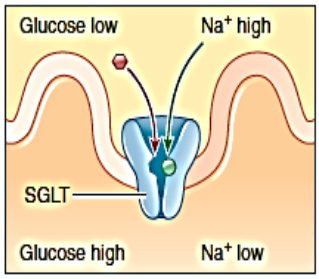
6 K^+ is released and Na^+ sites are receptive again; the cycle repeats.

2- Secondary active transport

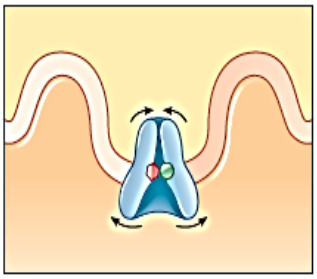
Characters: The energy required derived ***indirectly*** from the ion gradient.

Mechanism

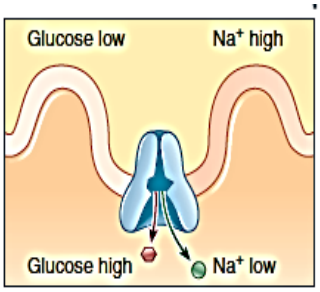
1- Na^+ co-transport:



2a Binding of Na^+ on luminal side, where Na^+ concentration is higher, increases affinity of SGLT for glucose. Therefore, glucose also binds to SGLT on luminal side, where glucose concentration is lower.



2b When both Na^+ and glucose are bound, SGLT changes shape, opening to cell interior.

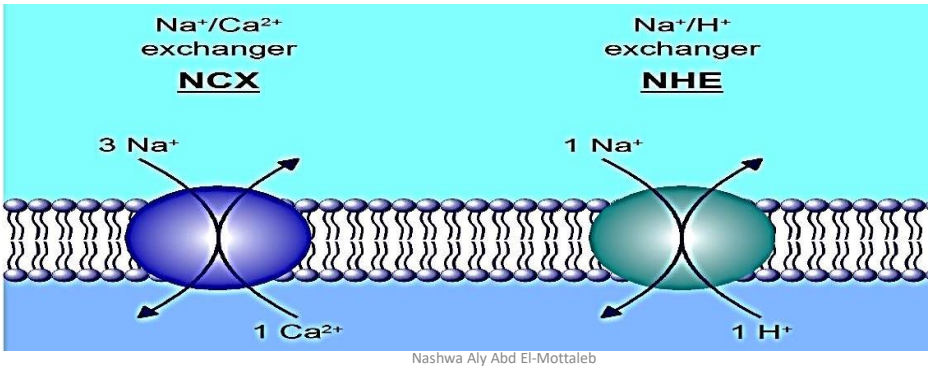


2c SGLT releases Na^+ to cell interior, where Na^+ concentration is lower. Because affinity of SGLT for glucose decreases on release of Na^+, SGLT also releases glucose to cell interior, where glucose concentration is higher.

2- Na+ counter-transport:

1. Na^+-Ca^{++} **counter-transport** is very important for the contraction of cardiac muscles.

2. Na^+-H^+ **counter-transport** occurs in the kidney.

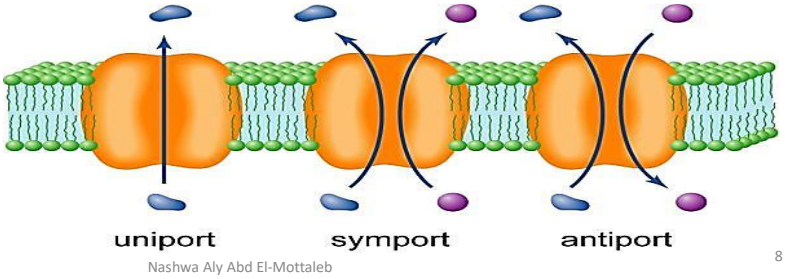


Carrier types

1-Uniporters are carriers that transport a single particle in one direction, such as the facilitated diffusion of glucose.

2- Symporters transport two particles in the same direction, such as the Na^+ co-transport of glucose and amino acid.

3-Antiporters transport molecules in opposite direction, such as the Na^+-Ca^{++} and Na^+-H^+ exchangers.



Vesicular Transport or Bulk Transport

Large particle as protein hormones and bacteria are transported by ***vesicular transport***

Endocytosis: transport into the cell.

Exocytosis: transport out of the cell.

Endocytosis

I-Pinocytosis:

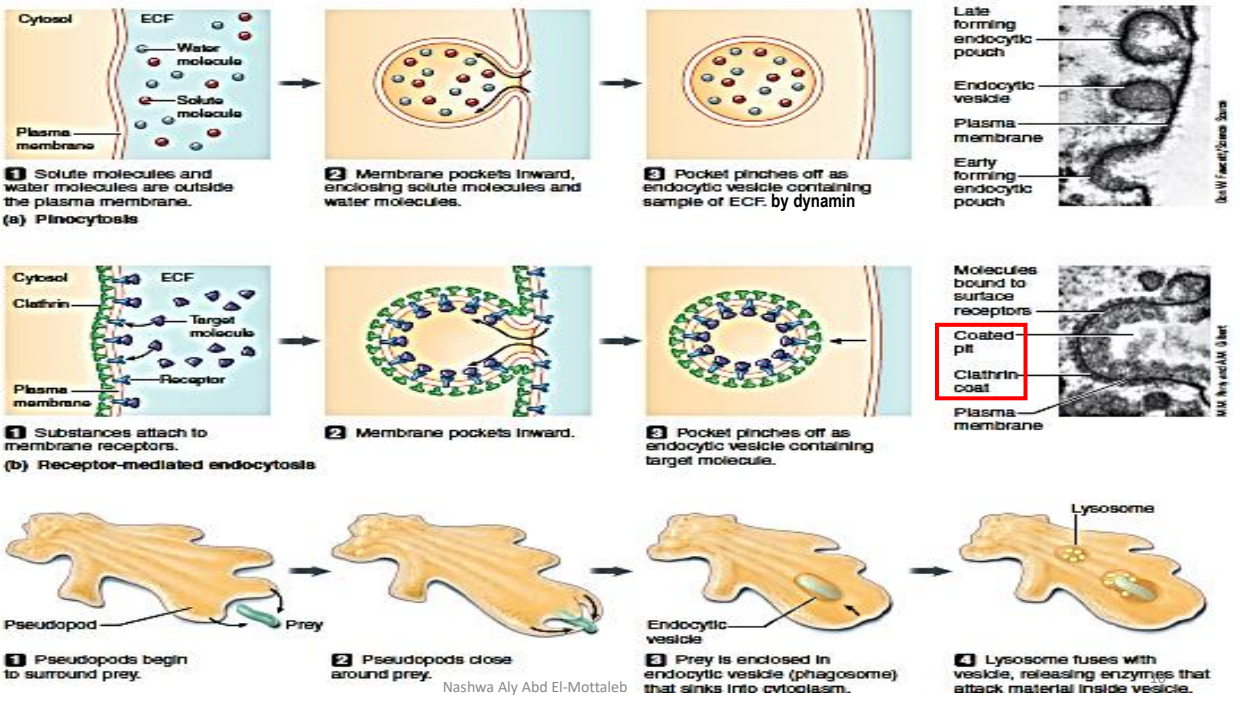
The vesicles traps some of the ***extracellular fluid***. The process is also known as ***"cell drinking".***

II- Receptor-mediated endocytosis:

1. It is a highly selective process.
2. It is triggered by the binding of a specific molecule to a surface membrane receptor specific for that molecule.

III-Phagocytosis

It means engulf of large molecules such as food and bacteria into vesicles and called ***"cell eating".***

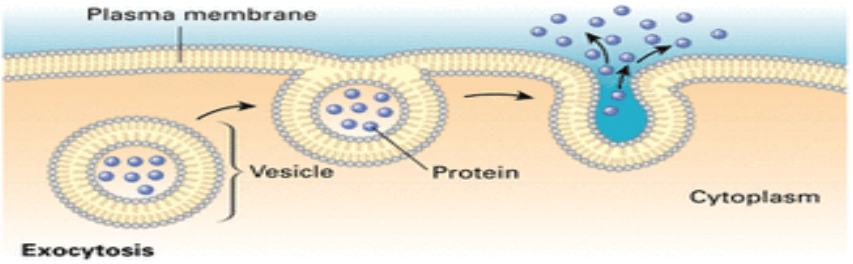


Exocytosis

1. Almost the reverse of endocytosis occurs. It is an active process (requiring energy and Ca^{++}).

- The membrane of the vesicle fuses with the plasma membrane.

- Then, the area of fusion breaks down, the vesicle opens up and release its contents to extracellular space.



Transport Across Epithelial membrane

Transcellular Transport : transport ***through*** the cytoplasm of the epithelial cells.

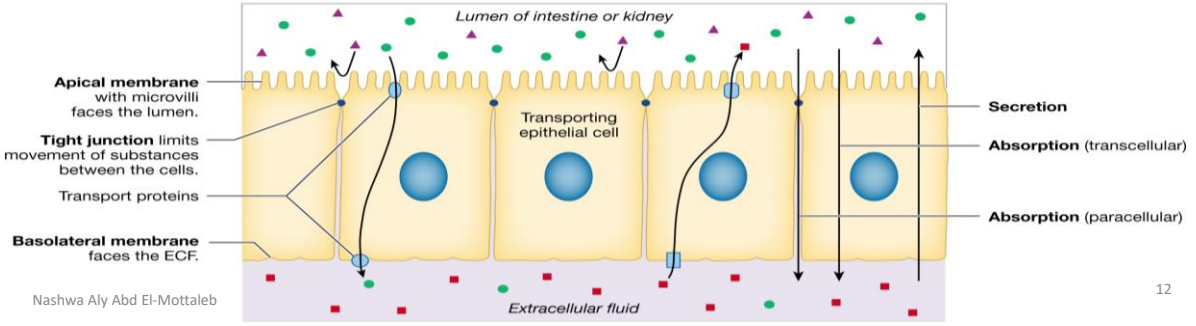
Paracellular transport means transport through the spaces ***between*** epithelial cells.

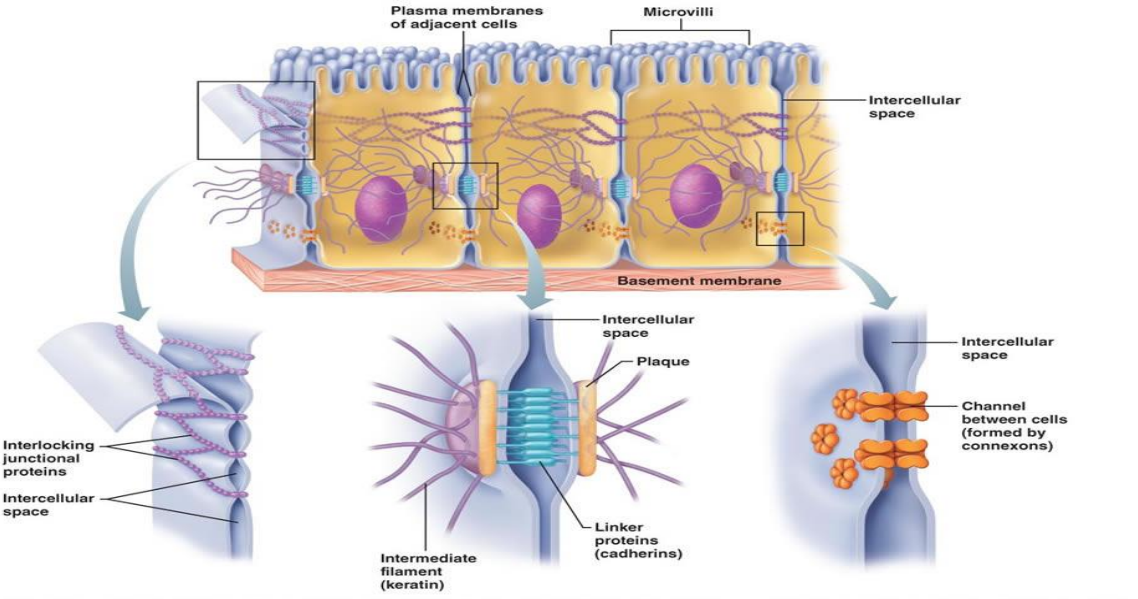
It is limited by the junctional complexes that consist of three structures:

1- Tight junction (impermeable junction).

2- Gap junctions (communicating junction).

1. Desmosomes (adhering junction).





References:

- Lippincott' integrated systems book
- Human body in health and diseases
- Elsevier's integrated physiology