# TRANSPORT

# OF

# NUTRIENTS, IONS AND

# MACROMOLECULES ACROSS MEMBRANE

**SUBMITTED BY-**

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# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

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# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

INTRODUCTION

- The plasma membrane functions as a selectively permeable membrane with exquisite selectively regarding with nucleus cross and which direction they are allowed to travel.
- The plasma membrane act as a barrier.
- The substances transported may include a variety of macromolecules like nutrients molecules, metabolites and a verity of ions.
- Transport of molecules across the membrane may be active or passive.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

OVERVIEW

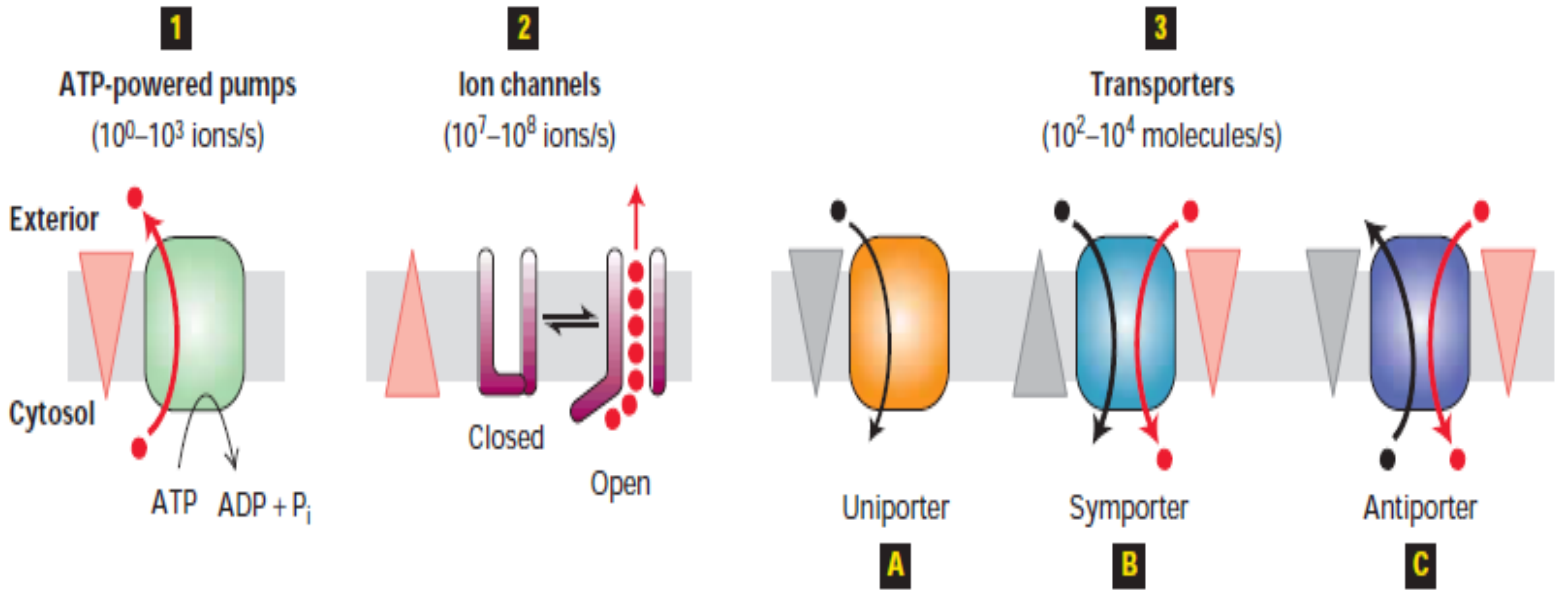


**Fig 1: Overview of membrane transport**

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

TRANSPORT OF IONS

A large number of molecules must constantly transit between the inside and out side of the cell, must frequently one at a time, but also in large packages.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

## ACTIVE TRANSPORT

Is the movement of a substance against its concentration gradient (from low to high concentration).

In all cells, this is usually concerned with accumulating high concentrations of molecules that the cell needs, such as ions, glucose, and amino acids.

If the process uses chemical energy, such as from adenosine triphosphate (ATP), it is termed primary active transport.

Secondary active transport involves the use of an electrochemical gradient. Active transport uses energy, unlike passive transport, which does not use any type of energy.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

ACTIVE TRANSPORT

## EXAMPLE OF ACTIVE TRANSPORT
## SODIUM – POTASSIUM PUMP

The process of moving sodium and potassium ions across the cell membrane is an active transport process involving the hydrolysis of ATP to provide the necessary energy.

It involves an enzyme referred to as $Na^+/K^+$-ATPase.

This process is responsible for maintaining the large excess of $Na^+$ outside the cell and the large excess of $K^+$ ions on the inside.

It accomplishes the transport of three $Na^+$ to the outside of the cell and the transport of two $K^+$ ions to the inside.

This unbalanced charge transfer contributes to the separation of charge across the membrane. The sodium-potassium pump is an important contributor to action potential produced by nerve cells.

This pump is called a P-type ion pump because the ATP interactions phosphorylates the transport protein and causes a change in its conformity.

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ACTIVE TRANSPORT

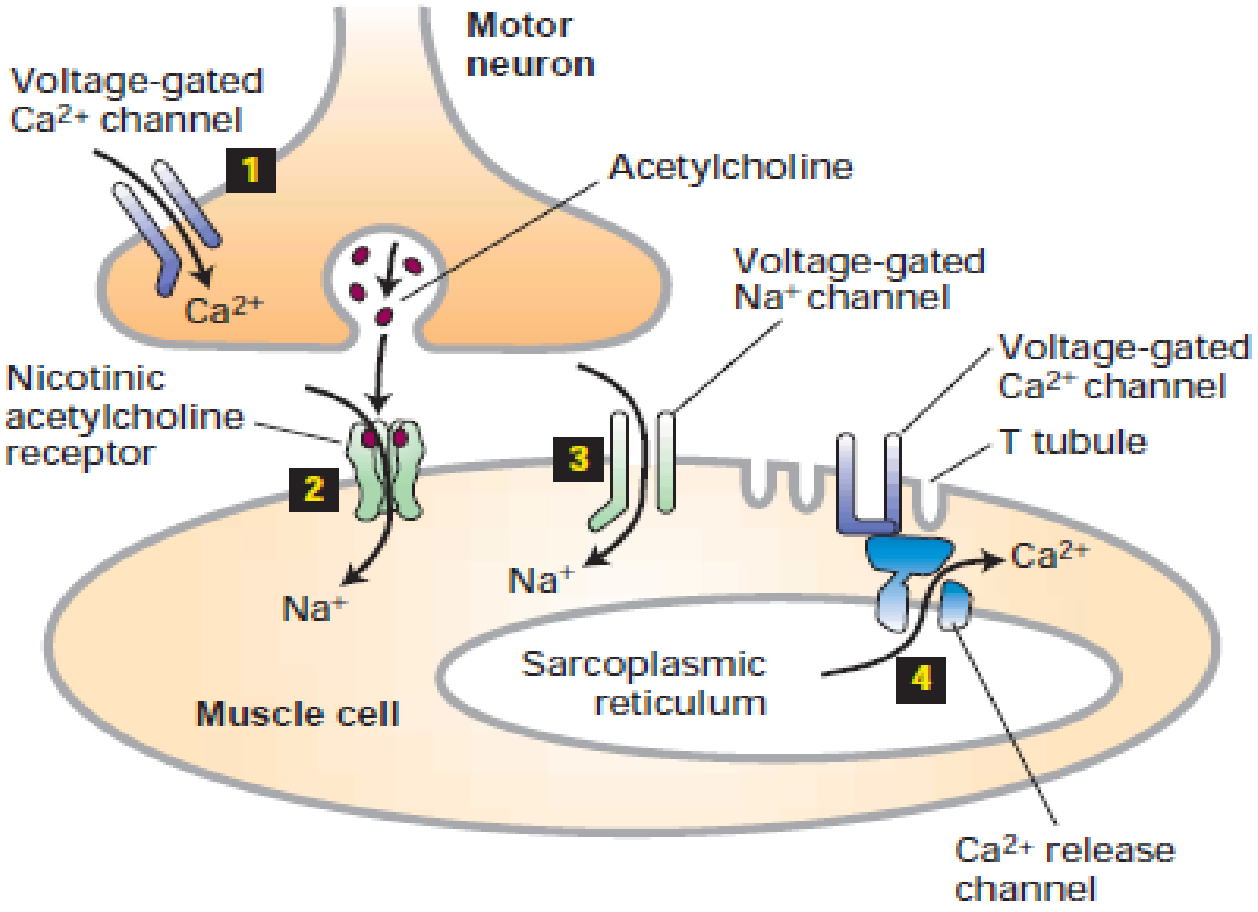




**Fig: 2. Opening of acetylcholine ion channels leads to muscle contraction**

## ATP-powered pumps and the intracellular ionic envirnment

ATP-powered pumps are transmembrane proteins with one or more binding sites for ATP located on the cytosolic face of the membrane.

Although these proteins commonly are called *ATPases*, *they* normally do not hydrolyze ATP into ADP and Pi unless ions or other molecules are simultaneously transported.

This tight coupling between ATP hydrolysis and transport, the energy stored in the phosphoanhydride bond is not dissipated but rather used to move ions or other molecules uphill against an electrochemical gradient.

The four classes of ATP powered pumps:-

P-Class pump
V-Class pump
F-Class proton pump
ABC super family pump

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

ACTIVE TRANSPORT

**P-class pumps**

P-class ion pumps contain a transmembrane catalytic α-subunit, which contains an ATP -binding site and usually a smaller β-subunit, which may have regulatory functions.

**V-class proton pumps**

V – class pump contain at least three kinds of transmembrane proteins and five kinds of extrinsic polypeptides that form the cytosolic domain.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

ACTIVE TRANSPORT

**F-class proton pumps**

F – class pumps are generally found in bacterial plasma membranes and in mitochondria and chloroplast.

**A B C Transporter**

Referred to as the ABC ( ATP- binding cassette) super family, this class includes more than 100 different transport proteins found in organisms ranging from bacteria to humans.
Each ABC protein is specific for single substrate or group of related substrate including ions, sugars peptides, polysaccharide and even proteins

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ACTIVE TRANSPORT

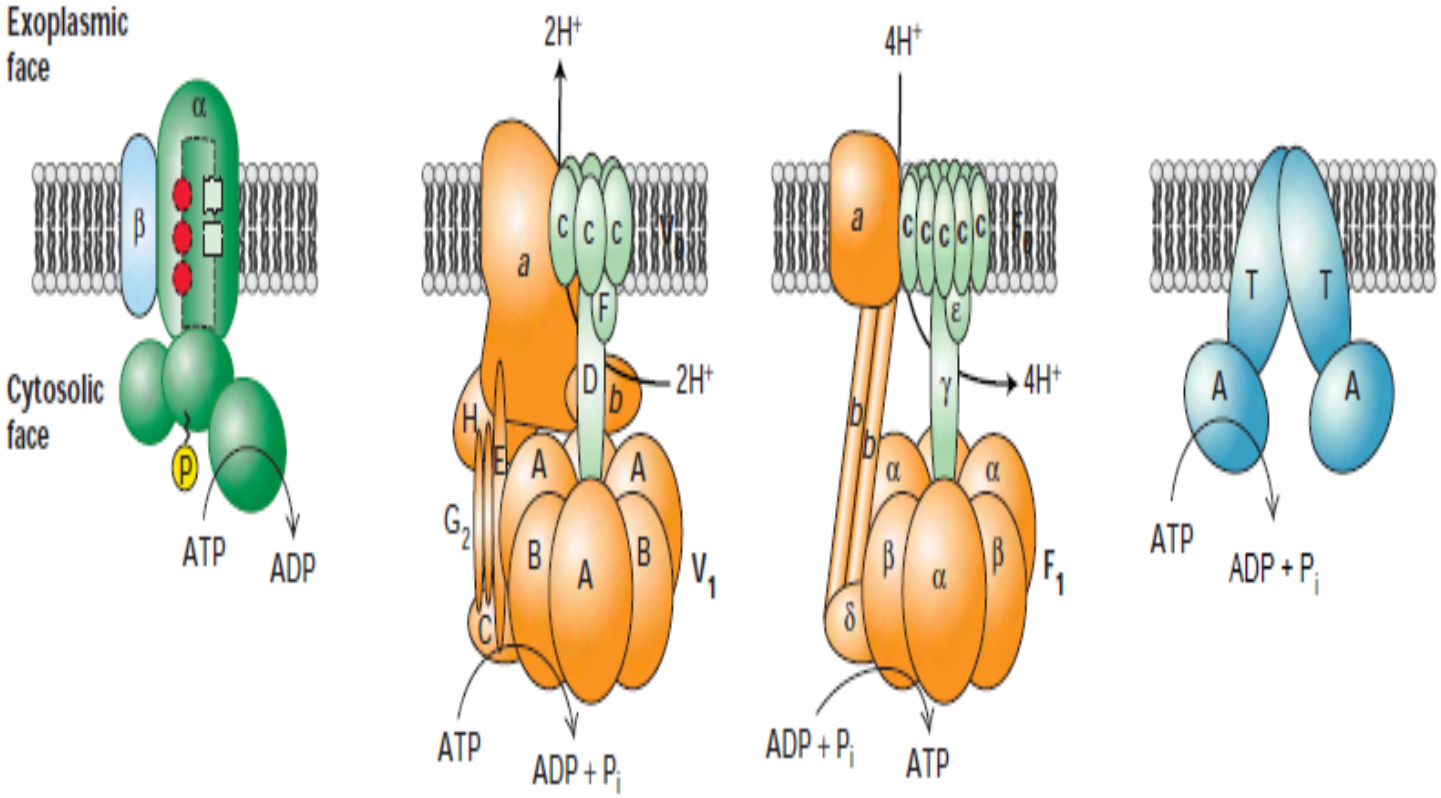


**Fig:3. The four classes of ATP powered pumps**

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

## PASSIVE TRANSPORT

Passive transport is the moving of biochemical across membranes of cells without the use of chemical energy

Diffusion is the process by which molecules migrate over the cell membrane from areas of higher concentration to areas of lower concentration. When the amounts of molecules become stabilized, this state is called equilibrium. This occurs through random molecular motion.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE



## SECONDARY ACTIVE TRANSPORT

Secondary active transport depends upon chemiosmotic energy(Membrane potential and /ion gradients).

Example:- secondary active transport are the glucose transport system of the intestinal epithelium of mammals and the lactose permease system in Ecoli.

Beside ATP powered pumps, cell have a second, discrete class of proteins that transport ions and small molecule, such as glucose and amino acids against the energy stored in the electrochemical gradient of one substance to drive the uphill movement of another substances, therefore called secondary active transport.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE



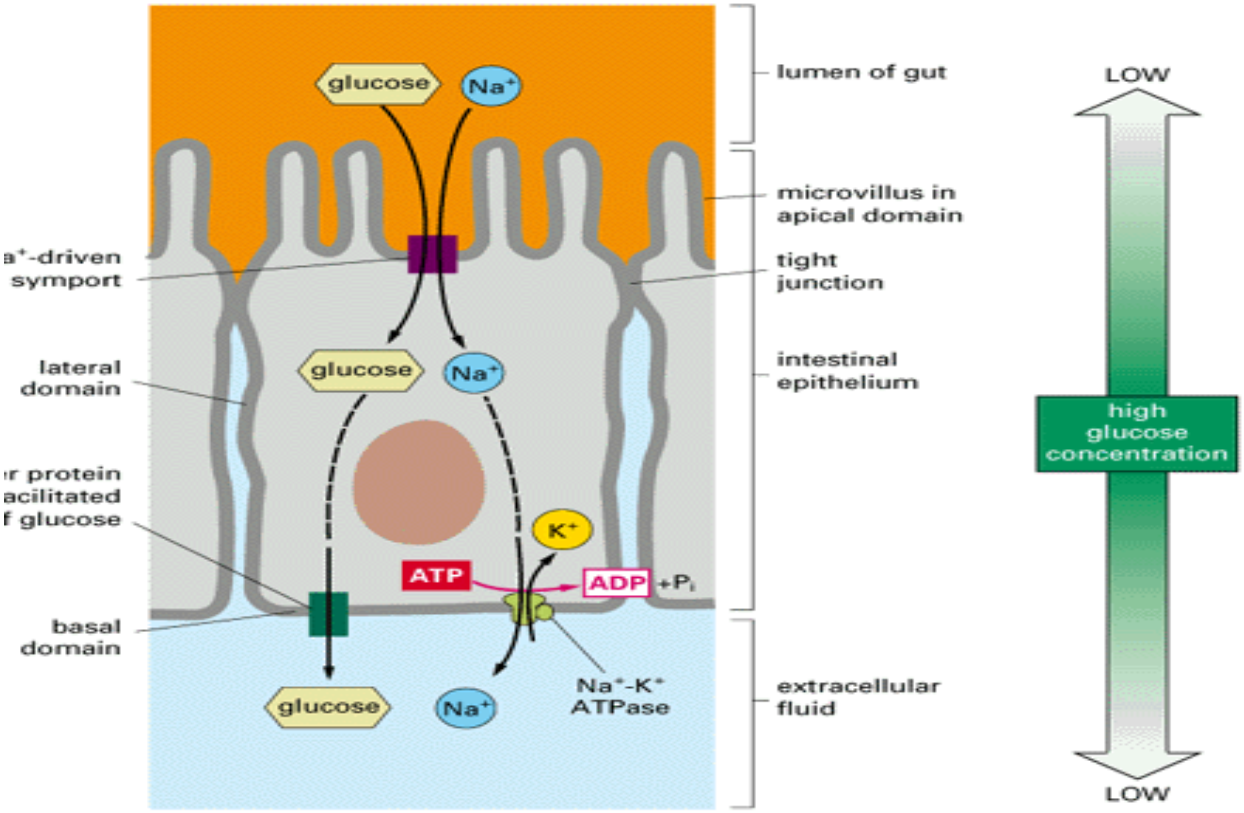


**Fig:4. The trancellular transport of glucose**

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

TRANSPORT OF NUTRIENTS

## ACTIVE TRANSPORT

### Co transport by Symporters and Antiporters

Besides ATP-powered pumps, cells have a second, discrete class of proteins that transport ions and small molecules,such as glucose and amino acids, against a concentration gradient.

Co transporters use the energy stored in the electrochemical gradient of Na or H ions to power the uphill movement of another substance, which may be a small organic molecule or a different ion.

An important feature of such **co transport** is that neither molecule can move alone; movement of both molecules together is obligatory, or *coupled.*

When the transported molecule and co transported ion move in the same direction, the process is called **symport.**

When they move in opposite directions, the process is called **antiport.**

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE



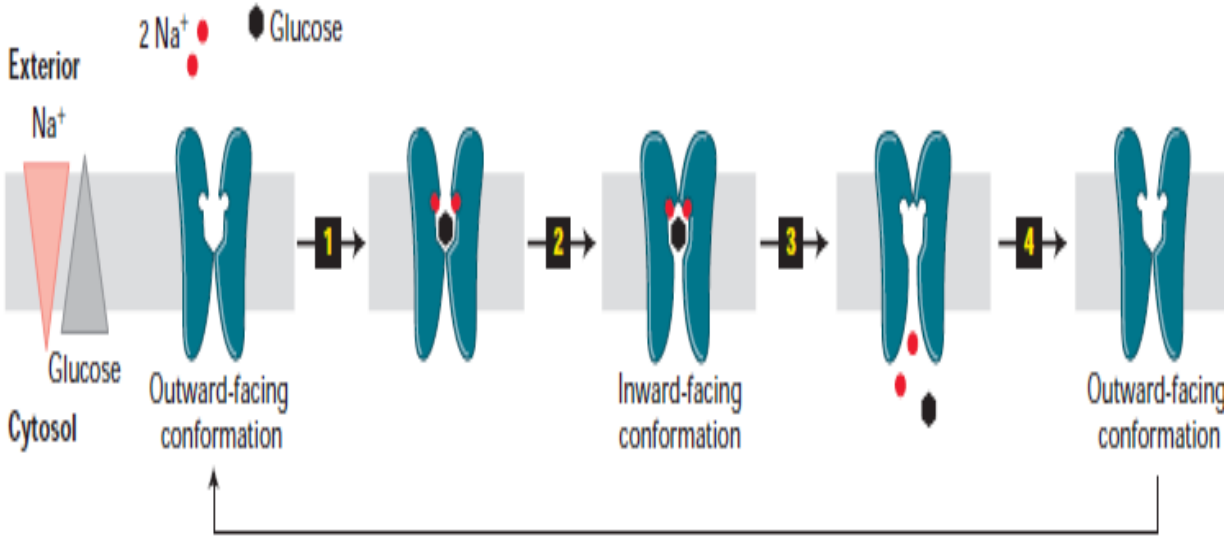


**Fig:5. Co transport by Symporters and Antiporters**

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

TRANSPORT OF NUTRIENTS

## Multiple Transport Proteins Are Needed to Move Glucose and Amino Acids Across Epithelia

In the first stage of this process, a two-Na/one-glucose symporter ocated in microvillus membranes imports glucose, against its concentration gradient, from the intestinal lumen across the apical surface of the epithelial cells.

In the second stage, glucose and amino acids concentrated inside intestinal cells by symporters are exported down their concentration gradients into the blood via uniport proteins in the basolateral membrane.

In the case of glucose, this movement is mediated by GLUT2.

This GLUT isoform has a relatively low affinity for glucose but increases its rate of transport substantially when the glucose gradient across the membrane rises.

This two-stage process is movement of Na ions, glucose, and amino acids from the intestinal lumen across the intestinal epithelium into the extracellular medium that surrounds the basolateral surface of intestinal epithelial cells.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE



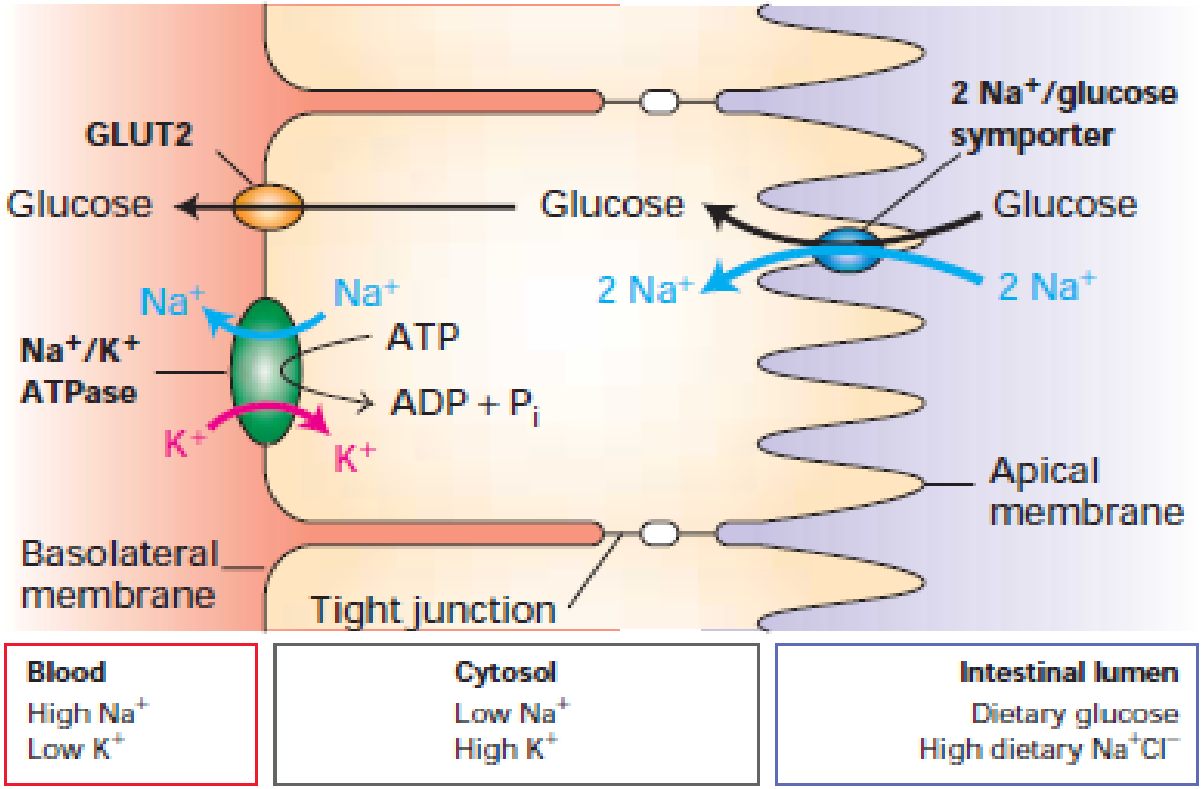


**Fig: 6. Glucose transport**

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE



**NUCLIC ACID TRANSPORT**

**Nucleocytoplasmic transport**

Nuclear pore complexes are the site of exchange of macromolecules between the cytoplasm and the nucleus.

❖**Signal for transport across the pores**

▪**Import of nuclear protein.**

In protein α,β heterodimer facilitate import of nuclear proteins.

▪**Export from nucleus.**

RNA export from the nucleus across NPC is also mediated by some signal sequences in the proteins that associate with RNA to form RNPs.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE



## ❖Active Transport

This form of transport is assumed when molecules larger than the pore diameter (10 nm) get into the nucleus.

. The active process is facilitated by:-

- Energy
- Signal sequence and

### Energy

Transport of mRNA can be inhibited by cooling the cells (placing them at 4 C).

ATP Hydrolysis is required to import a protein into the nucleus.

When ATP is added, the proteins are allowed to enter.

The ATP is needed for entry, but not for binding to specific receptors.

### Signal sequence

The signal is in the peptide sequences. These are recognition sequences rich in lysine, arginine, and proline.

Signal may control direction of transport.

Also, transport of RNA is inhibited by alteration of the 3' end or the 5' cap structure.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

SUMMARY

- The plasma membrane act as a semipermeable barrier between the cell and the extracellular environment.
- Plasma membrane act as physical boundaries between organelles and cytoplasm and between the cell and it's surrounding environment.
- The substances transported may include a variety of macromolecules l like nutrients molecules, metabolites and verity of ions.
- Charged molecules is facilitated by regulated pores/channels and by the transport proteins or pumps found in the membrane.
- Transport of molecules across the membrane may be active or passive.

# TRANSPORT OF NUTRIENTS, IONS AND MACROMOLECULES ACROSS MEMBRANE

## CONCLUSION

In all living organisms, it is vitally important that cells and cell organelles should allow transport of a variety of substances into and outside of these structures.

Transport is important so that the cell may respond rapidly to stimuli (e.g., sights , sounds , smells).

The substances transported may include a variety of micro molecules like nutrient molecules , metabolites and variety of ions (Na, K, Ca, Cl,H)

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