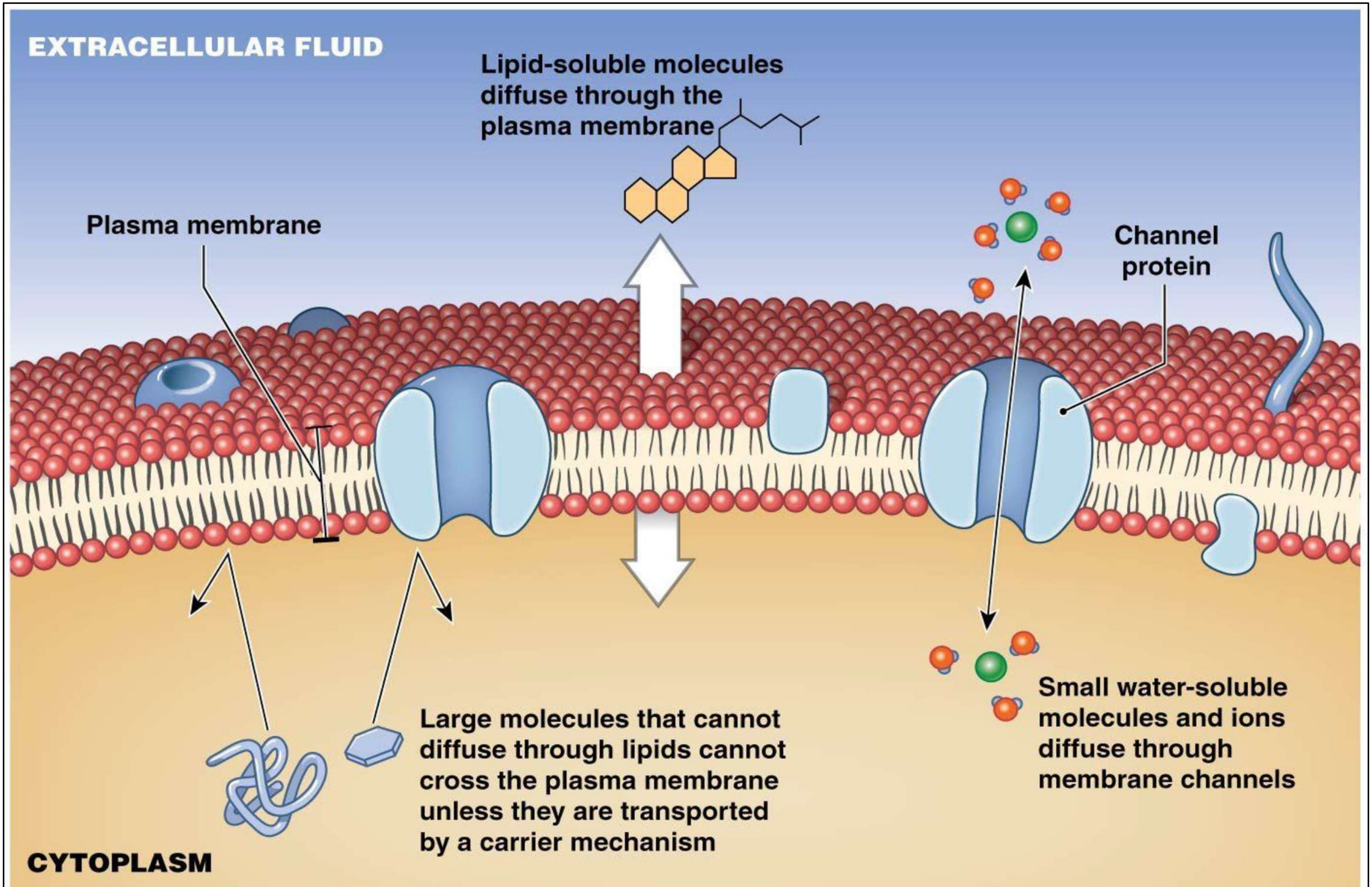
Transport Across Plasma Membrane

- The plasma membrane is a selectively permeable barrier between the cell and the extracellular environment.
- In other words, plasma membranes are **selectively permeable**-they allow some substances through but not others.
- Selectively permeable or semi-permeable means that only certain substances which are able to pass through the membrane.
- If the membrane were to lose this selectivity, the cell would no longer be able to maintain **homeostasis**, or to sustain itself, and it would be destroyed.

Selective permeability of Plasma Membrane



Types of transport:

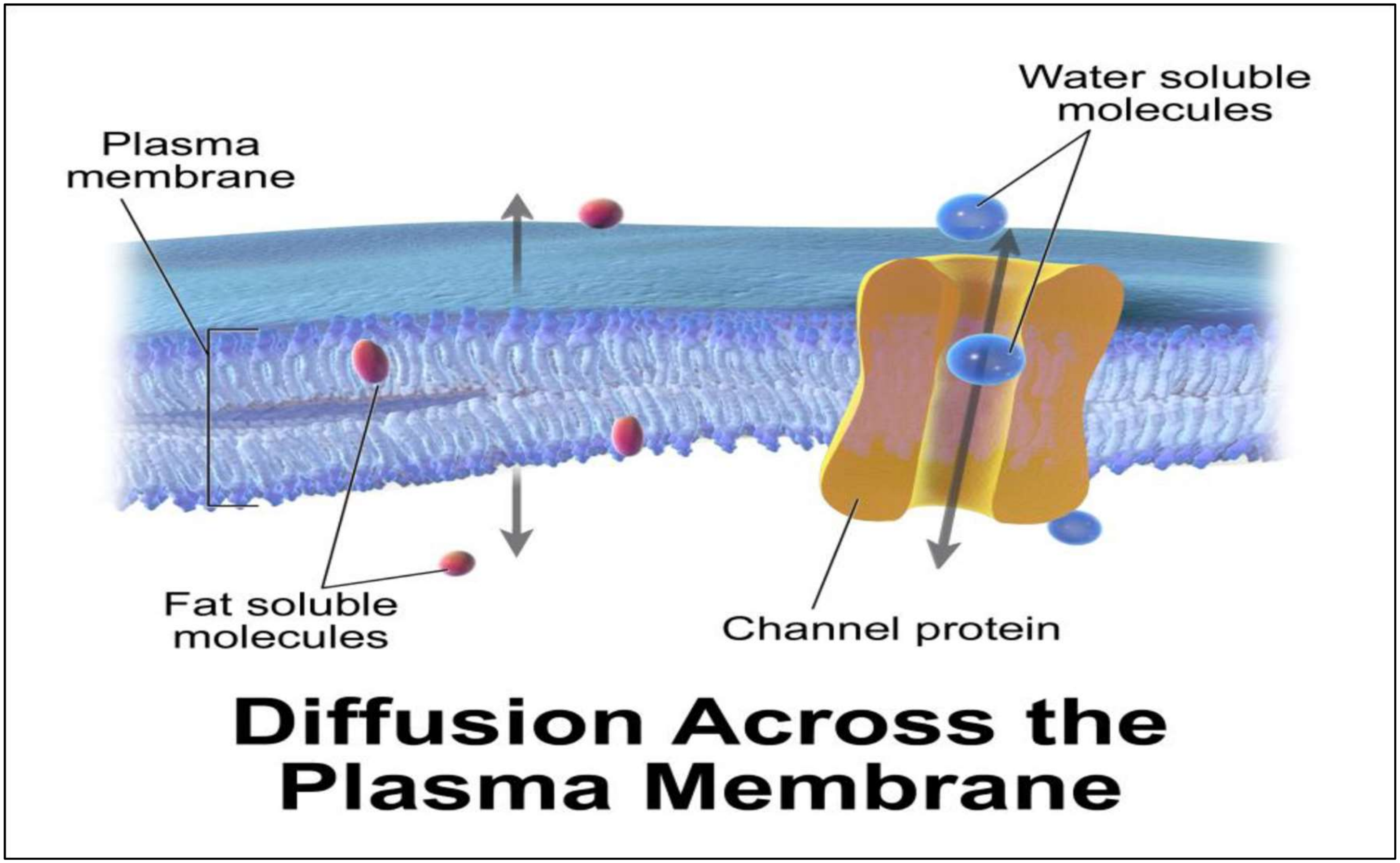
- Transporting substances across the plasma membrane can require that the cell use some of its energy. If energy is used, the transport is called ***active***.
- If molecules can pass through the plasma membrane without using energy, the molecules are using ***passive*** transport.

Passive transport

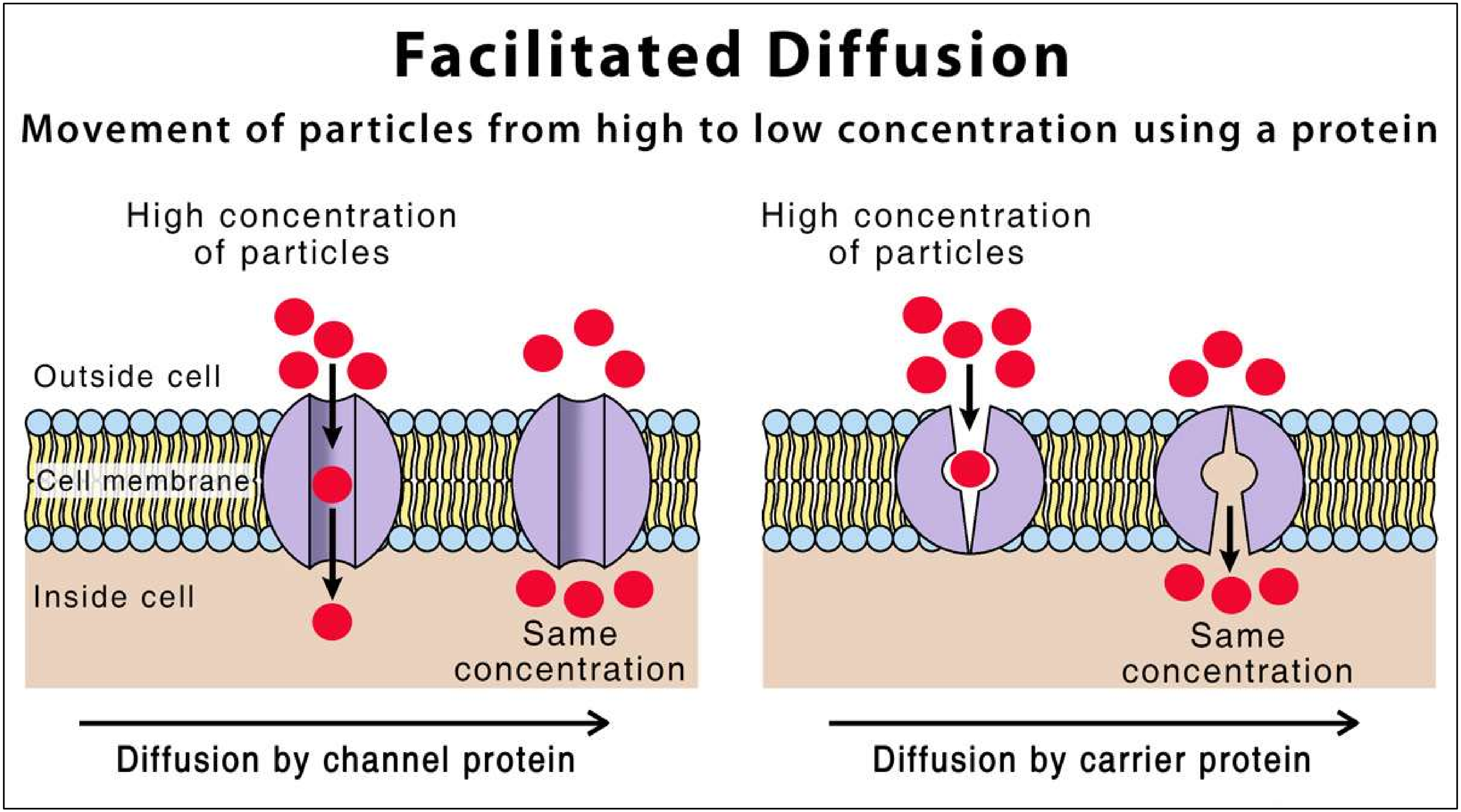
- Substances move down its concentration or electrical gradient to cross the membrane using its own kinetic energy.
- Kinetic energy is intrinsic to the particles that are moving.
- No input of energy from the cell.

A membrane can allow molecules to be passively transported through it in three ways: **diffusion**, **osmosis**, and **filtration**.

Diffusion



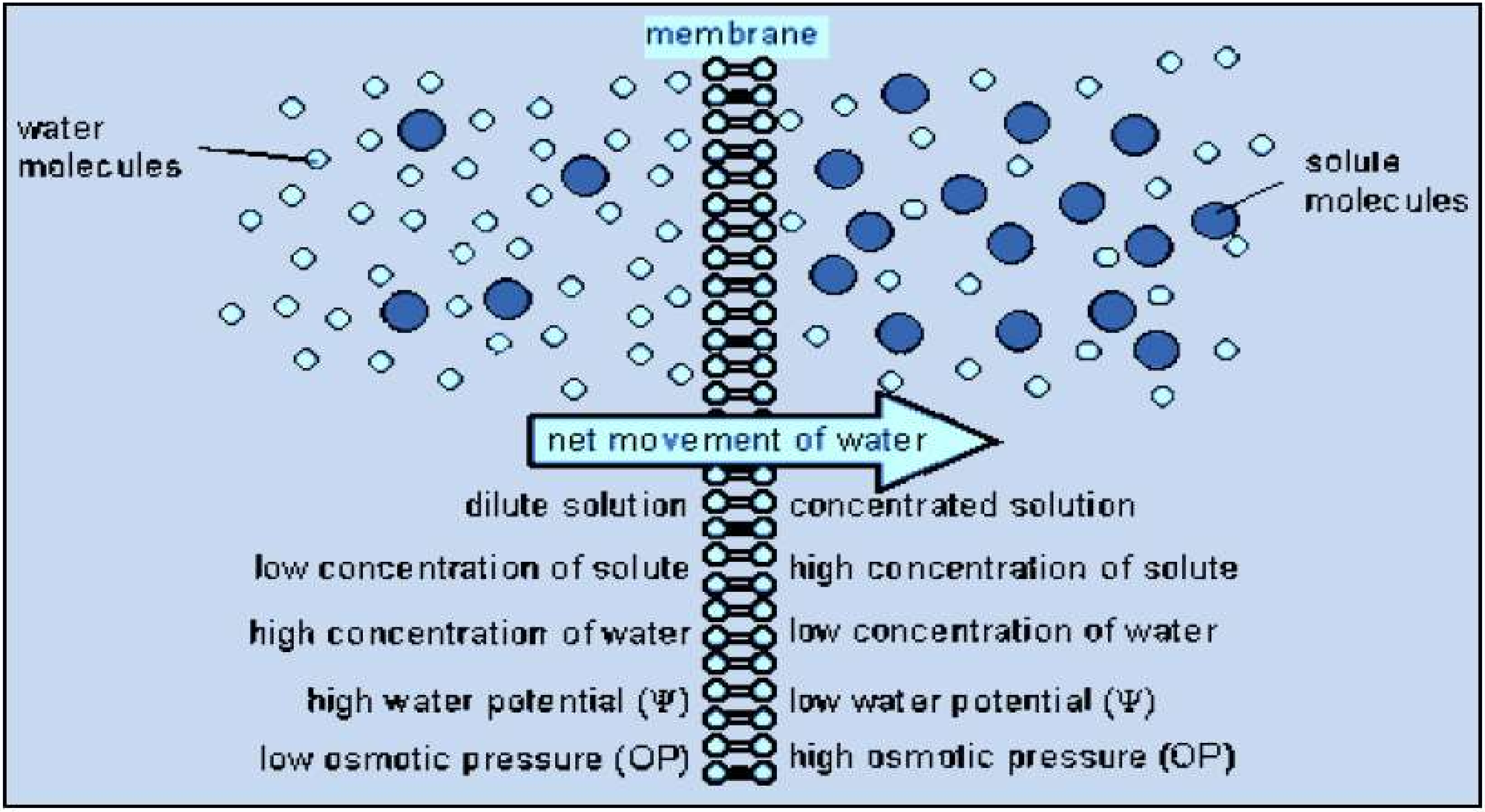
- A single substance tends to move from an area of high concentration to an area of low concentration until the concentration is equal across a space.
- Diffusion expends no energy.



- **Facilitated transport involving the passive movement of molecules along their concentration gradient, guided by an integral membrane protein forming a pore or channel.**

- **Facilitated diffusion does not need energy (ATP).**

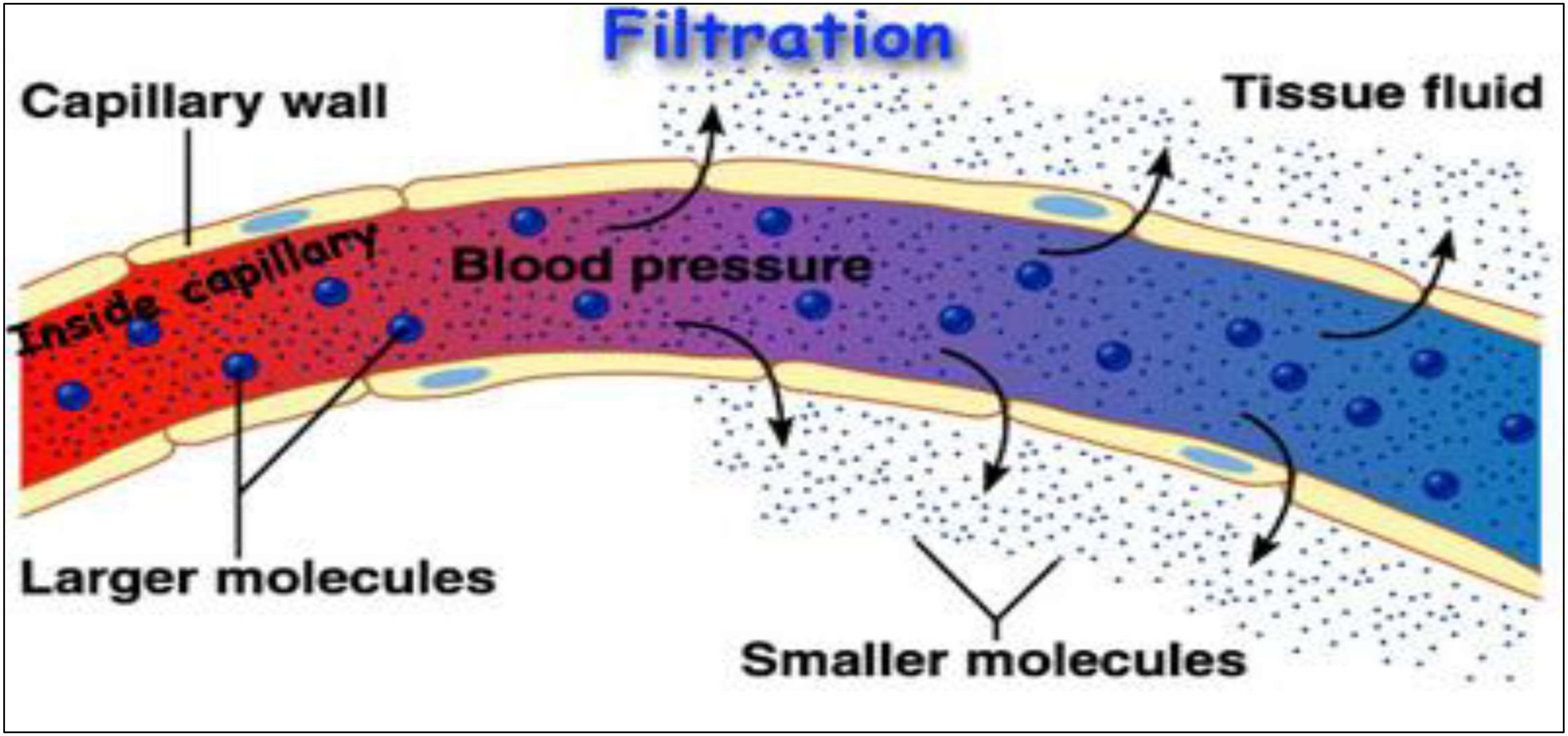
Osmosis



- **In living systems, the solvent is water, which moves by osmosis across plasma membranes from an area of higher water concentration to lower concentration.**

- **Water molecules pass by moving through the lipid bilayer and through aquaporins (integral membrane proteins that function as water channels).**

Filtration

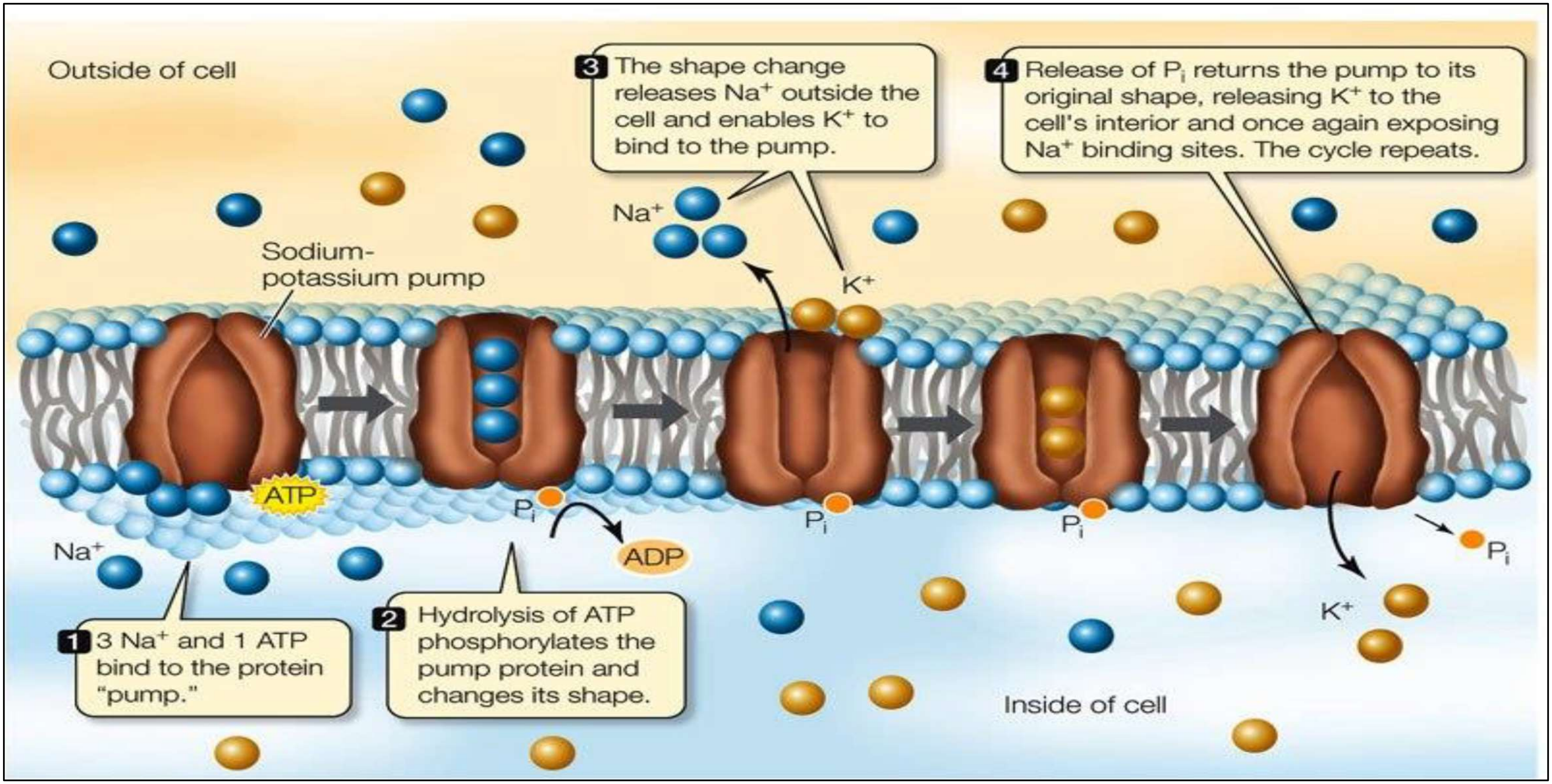


The capillary membrane acts as filter paper, allowing fluid to surround the body's cells and keeping large molecules from getting into the tissue fluid.

Key Points of Passive Transport

- Plasma membranes are selectively permeable; if they were to lose this selectivity, the cell would no longer be able to sustain itself.
- In passive transport, substances simply move from an area of higher concentration to an area of lower concentration, which does not require the input of energy.
- Concentration gradient, size of the particles that are diffusing, and temperature of the system affect the rate of diffusion.
- Some materials diffuse readily through the membrane, but others require specialized proteins, such as channels and transporters, to carry them into or out of the cell.

ACTIVE TRANSPORT

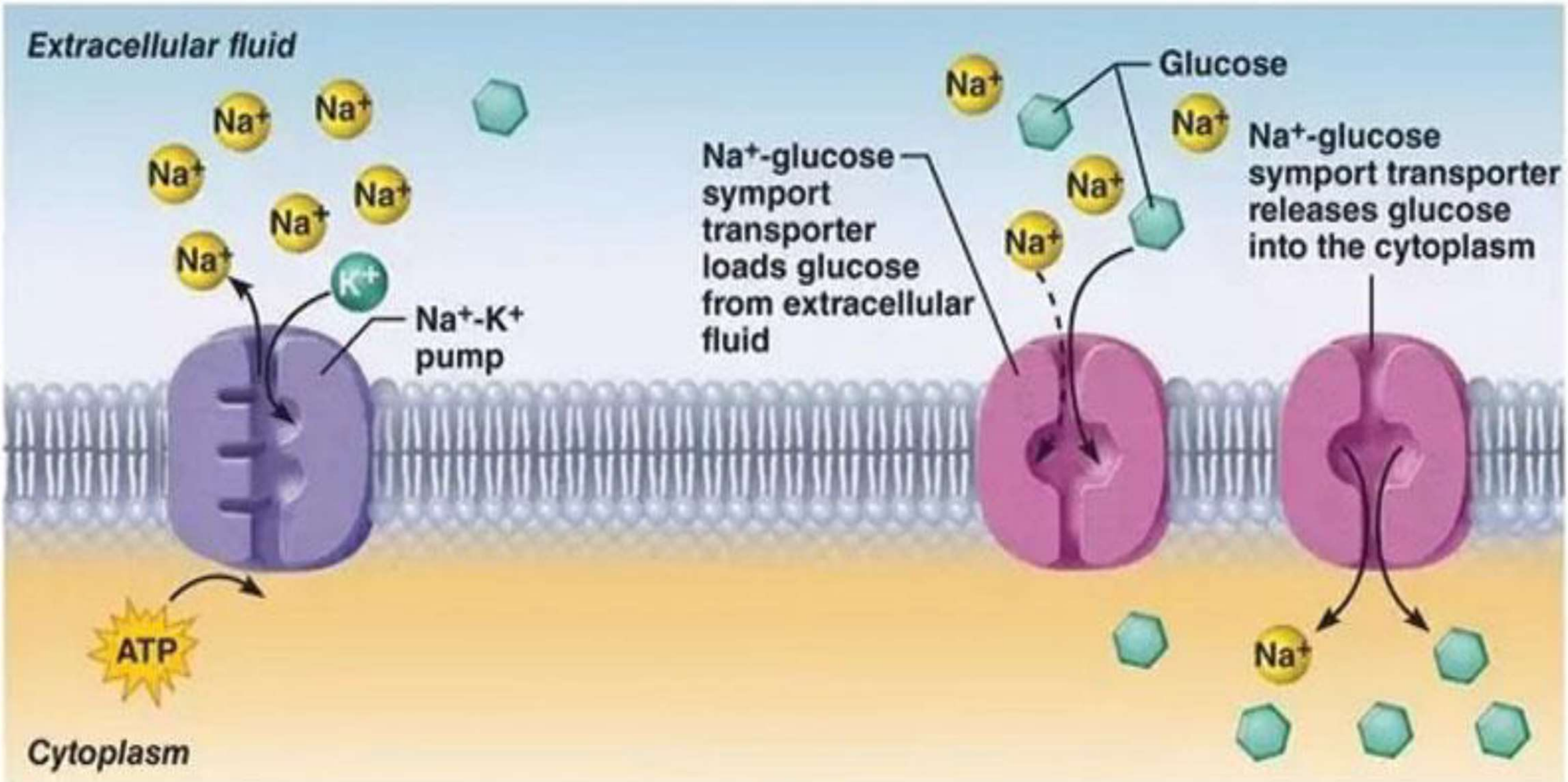


Active transport is the movement of dissolved molecules into or out of a cell through the cell membrane, from a region of lower concentration to a region of higher concentration. The particles move against the concentration gradient, using energy released during respiration.

Two types of active transport

- **Primary active transport**, also called ***direct active transport***, directly uses chemical energy (such as ATP) to transport all species of solutes across a membrane against their concentration gradient.
- **Secondary active transport**, allows one solute to move downhill (along its electrochemical potential gradient) in order to yield enough entropic energy to drive the transport of the other solute uphill (from a low concentration region to a high one). This is also known as ***coupled transport***.

Fig: Primary and Secondary active transport



① Primary active transport
The ATP-driven Na^+-K^+ pump stores energy by creating a steep concentration gradient for Na^+ entry into the cell.

② Secondary active transport
As Na^+ diffuses back across the membrane through a membrane cotransporter protein, it drives glucose against its concentration gradient into the cell.

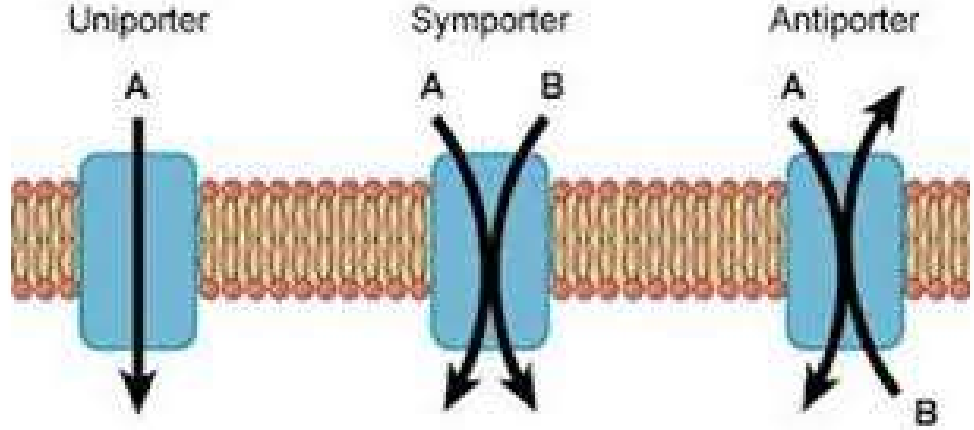
Key Points for Primary active transport:

- The sodium-potassium pump moves K+ into the cell while moving Na+ at a ratio of three Na+ for every two K+ ions.
- When the sodium-potassium- ATPase enzyme points into the cell, it has a high affinity for sodium ions and binds three of them, hydrolyzing ATP and changing shape.
- As the enzyme changes shape, it reorients itself towards the outside of the cell, and the three sodium ions are released.
- The enzyme's new shape allows two potassium to bind and the phosphate group to detach, and the carrier protein repositions itself towards the interior of the cell.
- The enzyme changes shape again, releasing the potassium ions into the cell.
- After potassium is released into the cell, the enzyme binds three sodium ions, which starts the process over again.

Key Points for Secondary active transport

- The electrical and concentration gradients of a membrane tend to drive sodium into and potassium out of the cell, and active transport works against these gradients.
- To move substances against a concentration or electrochemical gradient, the cell must utilize energy in the form of ATP during active transport.
- Primary active transport, which is directly dependent on ATP, moves ions across a membrane and creates a difference in charge across that membrane.
- Secondary active transport, created by primary active transport, is the transport of a solute in the direction of its electrochemical gradient and does not directly require ATP.
- Carrier proteins such as uniporters, symporters, and antiporters perform primary active transport and facilitate the movement of solutes across the cell's membrane.

Carrier Proteins of Active Transport



- **Two types:**
  - **Uniport**
  - **Symport or antiport**

1. Uniport/ Uniport pump:

- Carrier protein that carries only one substance in a single direction

2. Symport/Antiport pump:

- The carrier protein carries two substances at a time
- Same direction: symport
- Opposite direction: antiport