Physiology

Physiology is how living organisms work, from cell to tissue to organ to system
and how living organisms as a whole accomplishes particular tasks essential for life.

The the goal of physiology is to explain the physical and chemical factors that are responsible for the origin, development, and progression of life from the very simple virus up to the largest tree to the complicated human being

About 60% of human body is fluid. Most of this fluid is inside the cells and called ***intracellular fluid***. About 1/3 is in the spaces outside the cell and called ***extra cellular fluid***. This extra cellular fluid is in constant motion throughout the body. It is rapidly transported in the circulating blood and then mixed between the blood and tissues fluid by ***diffusion*** through the capillary walls. In the extra cellular fluid are ions and nutrients needed by the cells for maintenance of cellular life. Therefore, all cells live in essentially the same environment, for which reason the extracellular fluid is called (***internal environment of the body***)

Homeostasis: Homeostasis is maintenance of static or constant conditions in internal environment. Whenever there is disturbance of homeostasis, the regulating systems bring the internal environment back into balance. This is mainly achieved by nervous system and endocrine system by *negative feedback mechanisms*.

Feedback system can produce either ***negative feedback*** or ***positive feedback***. *If the response reverses the original disturbance to normal, then the system is negative feedback system. If the response reinforces or intensifies the initial changes or disturbance, then the system operating by positive feedback.*

The cell membrane structure and function

CM is a semi permeable membrane allowing some substances to pass through it excluding others.

- It is made up of protein & lipid.

Structure of plasma membrane

Protein	55 %
Phospholipids	25 %
Cholesterol	13 %
Other lipids	4 %
CHO	3 %

Phospholipids consists of two parts:

1. Phosphate head: water soluble (hydrophilic)

2. Lipid tail: lipid soluble (hydrophobic)

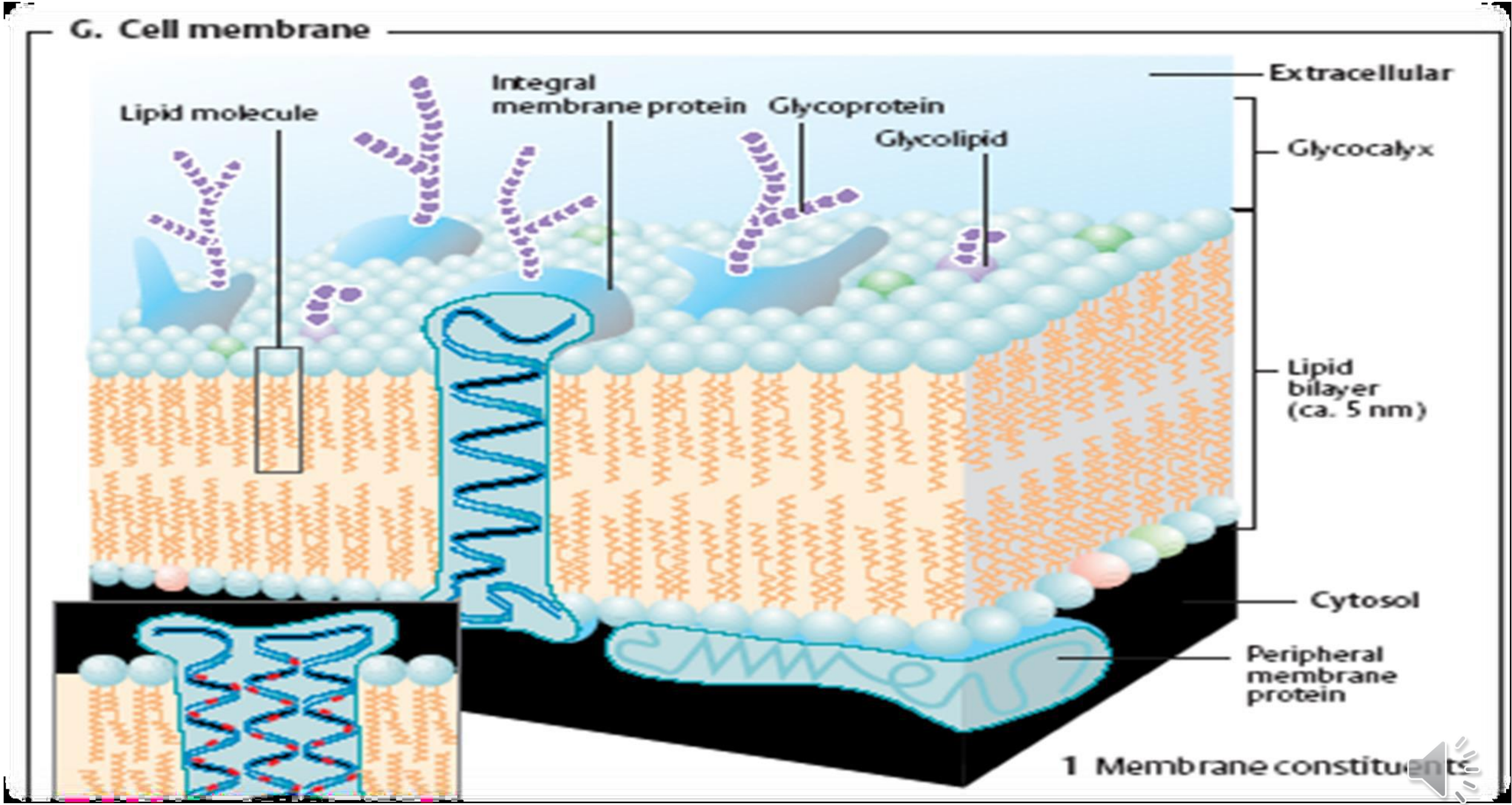
Lipid bilayer is the major barrier impermeable usually to usual water soluble substances such as ions, glucose, urea.

Proteins on the cell membrane

There are two kinds of proteins:

1.Integral proteins: located extracellularly.

2.Peripheral proteins: located inside the cell and are usually attached to integral proteins.


G. Cell membrane
Extracellular
Lipid molecule
Integral membrane protein
Glycoprotein
Glycolipid
Glycocalyx
Lipid bilayer (ca. 5 nm)
Cytosol
Peripheral membrane protein
1 Membrane constituents

Functions of proteins on the cell membrane

1. They are structural proteins.

2. Act as pumps, actively transporting ions across the membrane.

3.Carriers, transporting substances down their electrochemical gradient by facilitated diffusion.

4. Ion channels, when activated they permit the passage of ions into or out of the cell.

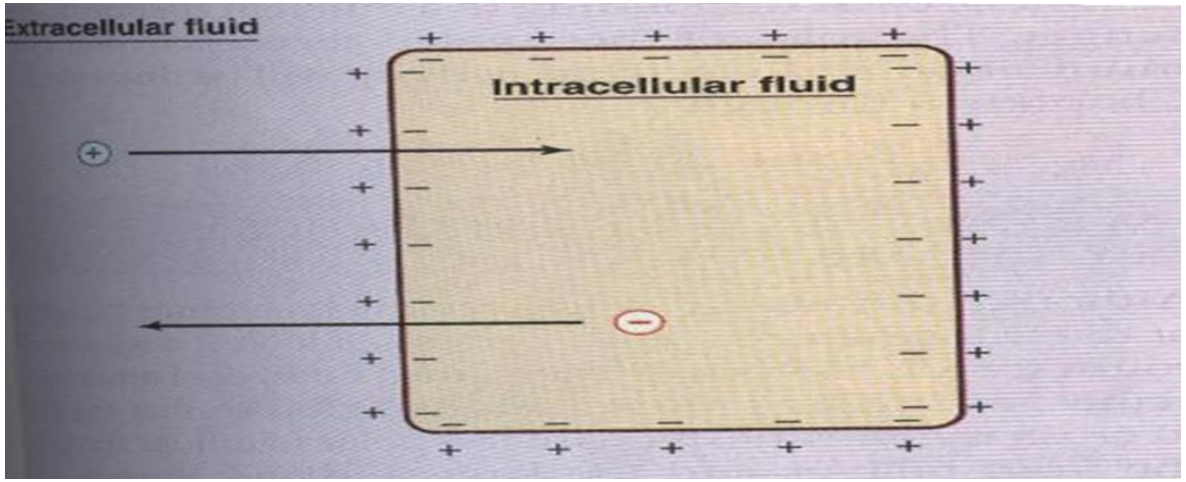
5. Enzymes, catalyzing reactions at the surface of the membrane.

6. Receptors, that binds neurotransmitters & hormones initiating physiological changes inside the cell.

Membrane potential

* **Resting membrane potential (RMP):** is a potential difference across the CM of most cells with the inside negative relative to the exterior.

* **Action Potential (AP) :**Is the process which involves rapid change (increase and decrease) of the electrical membrane potential of the cell.



Na+ K+ Exchange Pump

It is present in all cells of the body, it extrudes 3 Na+ out and at the same time pump 2 K+ into the inside.

1. Maintaining Na+ and K+ concentration difference across the cell membrane (controlling cell volume).

2. Establishing a negative electrical potential inside the cells, which form the basis of nerves and muscles functions.

The energy is provided by hydrolysis of ATP which is now extensively linked to the effect of Na+ -K+ ATPase enzyme.

Forces that regulate movement between intracellular and extracellular compartments are :

Osmosis

-Diffusion

-Active transport

-Endocytosis and Exocytosis

Osmosis

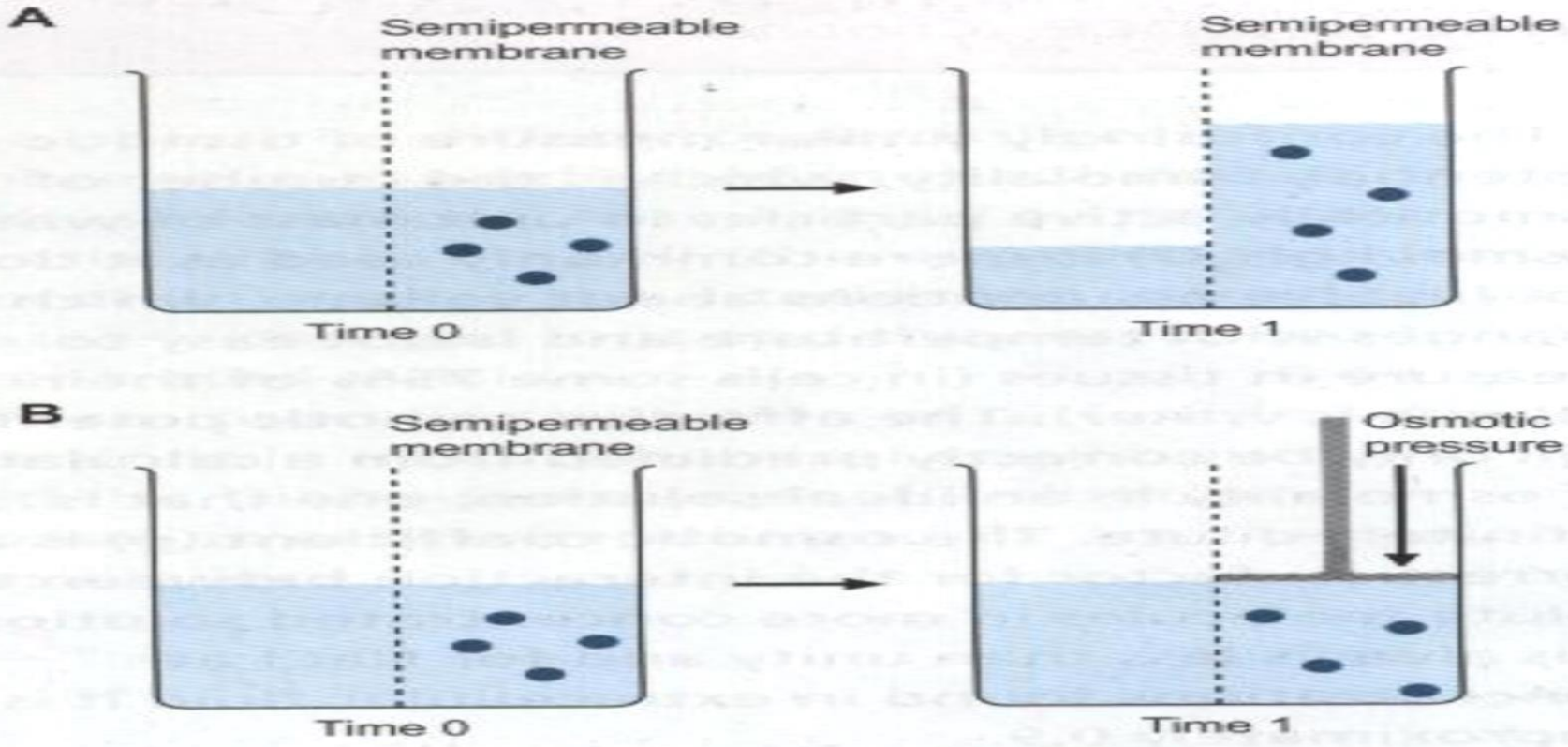


Fig. 1.2.4 Osmosis. A. Water moves from a dilute to a concentrated solution through a semipermeable membrane. B. This movement can be stopped by applying pressure to the concentrated solution. The pressure required to just stop the movement from pure water into a solution is called the osmotic pressure of that solution.

Diffusion

It is the kinetic movement of molecules or ions from areas of high concentration to areas of low concentration.

Diffusion type

1.Simple diffusion

2.Facilitated diffusion

Simple diffusion

A-Simple diffusion through the lipid bilayer.

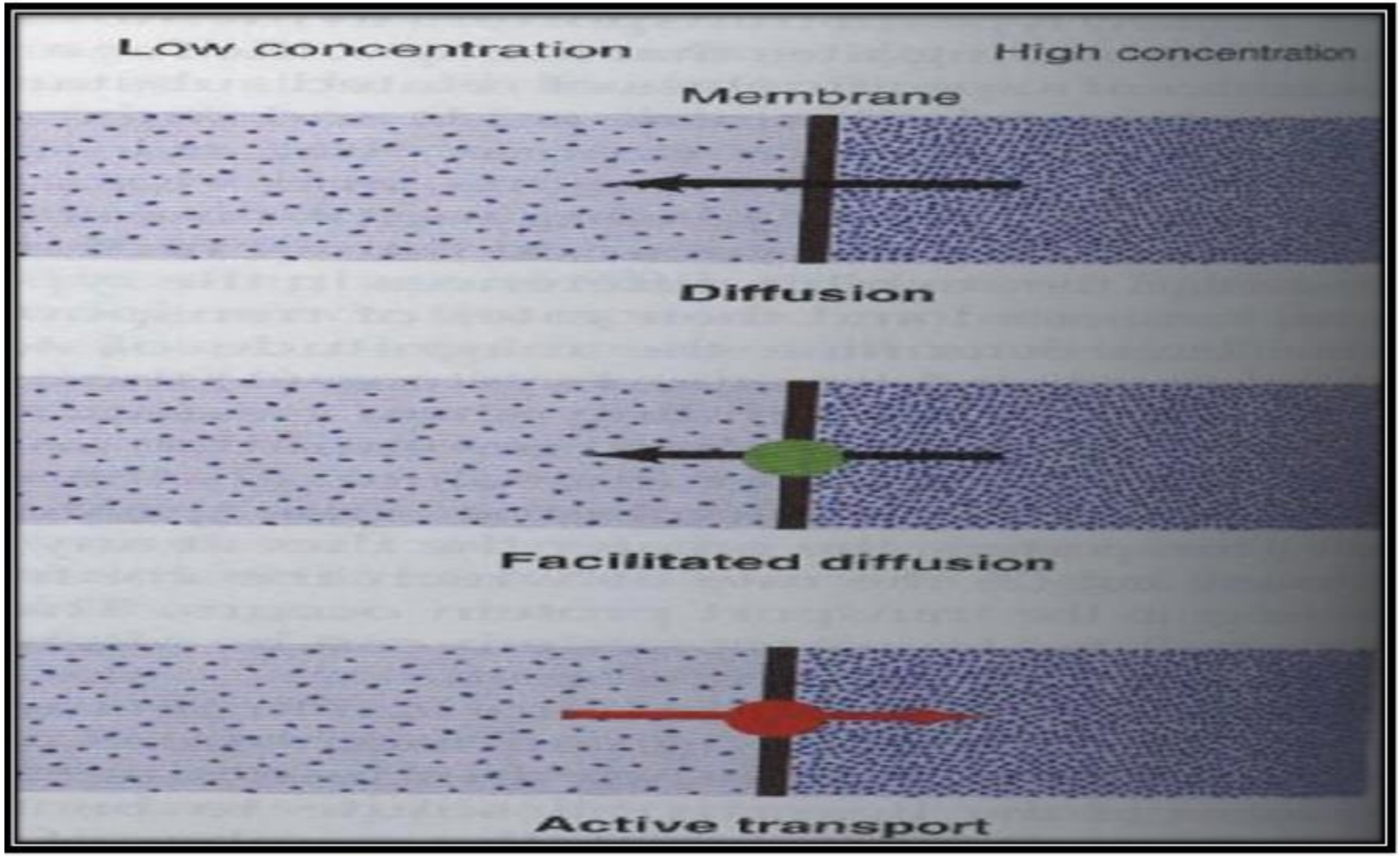
B-Simple diffusion through protein channels.

High lipid soluble substances like CO_2, O_2, N_2 & alcohol pass with great easy.

Facilitated diffusion

Also termed carrier mediated transport, because transport of substances occurs by binding to carrier proteins, which facilitate diffusion of molecules, e.g. transport of glucose & amino acids.

- **The carrier proteins transport substances in the direction of their chemical or electrical gradient, *no energy* is required.**


Low concentration
High concentration
Membrane
Diffusion
Facilitated diffusion
Active transport

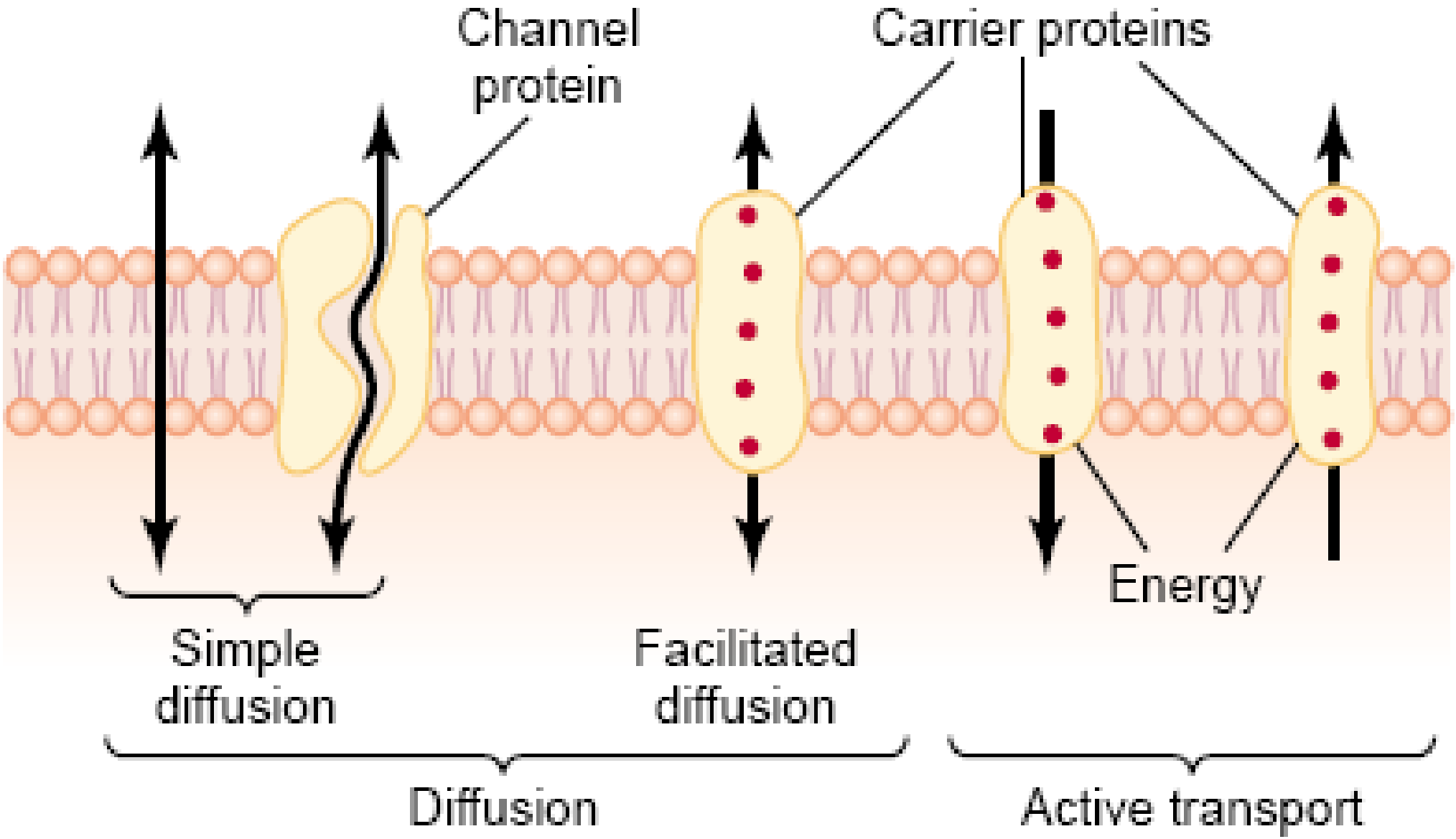
Active transport

Carrier proteins transport substances against their electrical and chemical gradient, this form of transport *requires energy.*

It is divided in to 2 types according to the source of energy:

1.Primary Active Transport : The energy is directly derived from ATP. e.g. Na+ K+ pump.

2.Secondary Active transport: The energy is derived indirectly from ionic concentration gradients that are created in the primary Active Transport.


Channel protein
Carrier proteins
Energy
Simple diffusion
Facilitated diffusion
Diffusion
Active transport

Exocytosis

Proteins that are secreted by cells move from the endoplasmic reticulum to the Golgi apparatus, then they are extruded into secretary granules or vesicles, move to the CM, fusing their membrane with the CM , the area of fusion breaks down, leaving the content of the vesicle outside the cell & the CM intact.

Endocytosis

Is the reverse of Exocytosis.

There are two kinds of Endocytosis:

- Pinocytosis (cell drinking).
- Phagocytosis(cell eating).

- It is the process by which bacteria or dead tissues are engulfed by cells.
- The material makes contact with the CM which then invaginates, leaving the engulfed material in a membrane-enclosed vacuole and the CM remains intact.

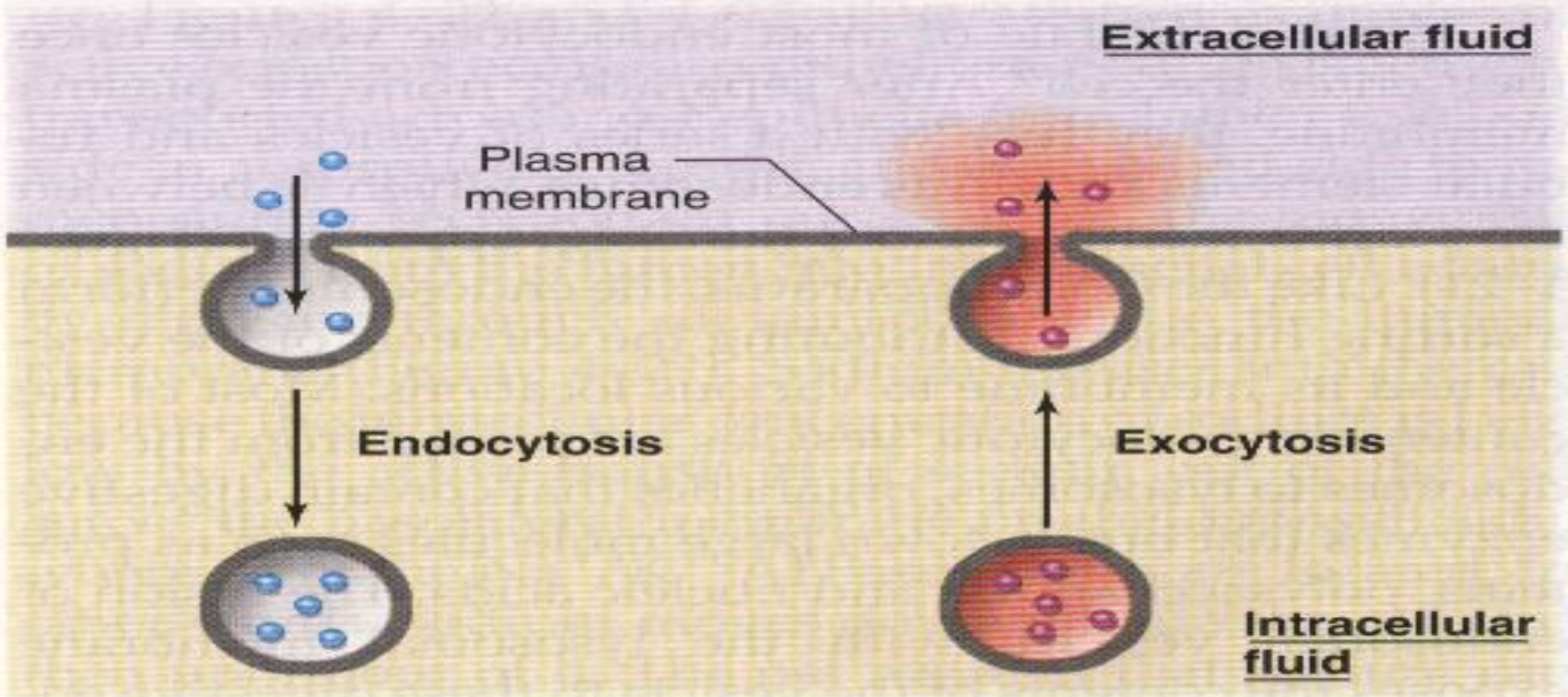


FIGURE 4–20
Endocytosis and exocytosis.