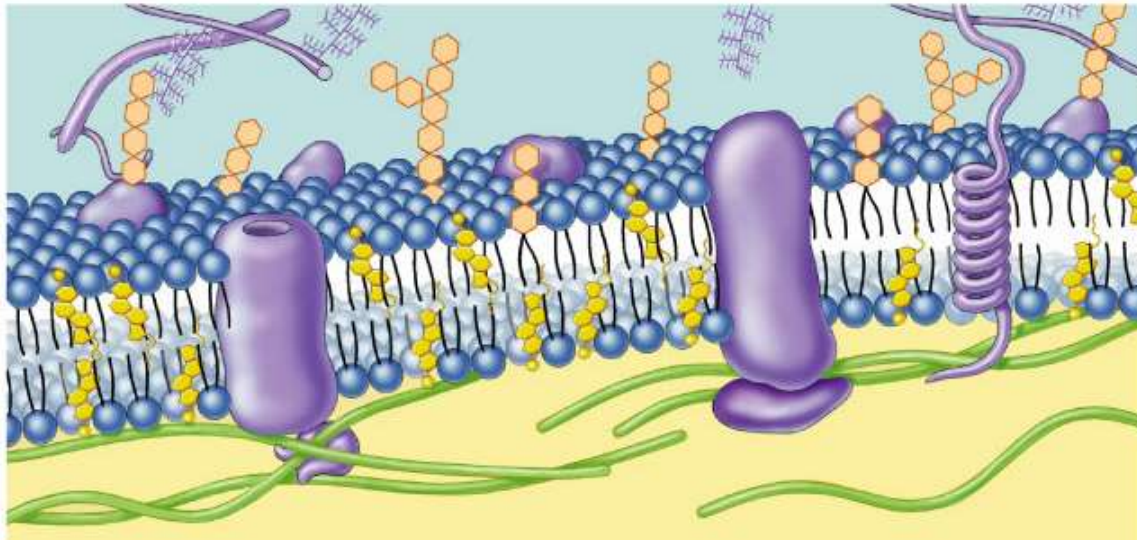


Cell membrane



what

Function of the cell membrane ?

- Separation of the cell components from the nonliving surroundings (8 nm thick)
- It controls traffic into and out of the cell.
- Like other membranes, the plasma membrane is **selectively permeable**, allowing some substances to cross more easily than others (hydrophilic vs hydrophobic)

Composition of cell membrane



The basic structural unit of biological membranes is a lipid bilayer



Phospholipids are the primary bilayer forming lipids



ما هو Phospholipid؟
هو جزيء دهني مكوّن من:

- Hydrophilic head**
phosphate group. رأس محب للماء، قطبي، يحتوي
- Hydrophobic tails**
fatty acid chains. ذيول كارهة للماء، غالباً

الفكرة الذهبية:
Phospholipid هو amphipathic molecule.

Amphipathic = مزدوج الطبيعة
يعني عنده جزء يحب الماء وجزء يكره الماء.

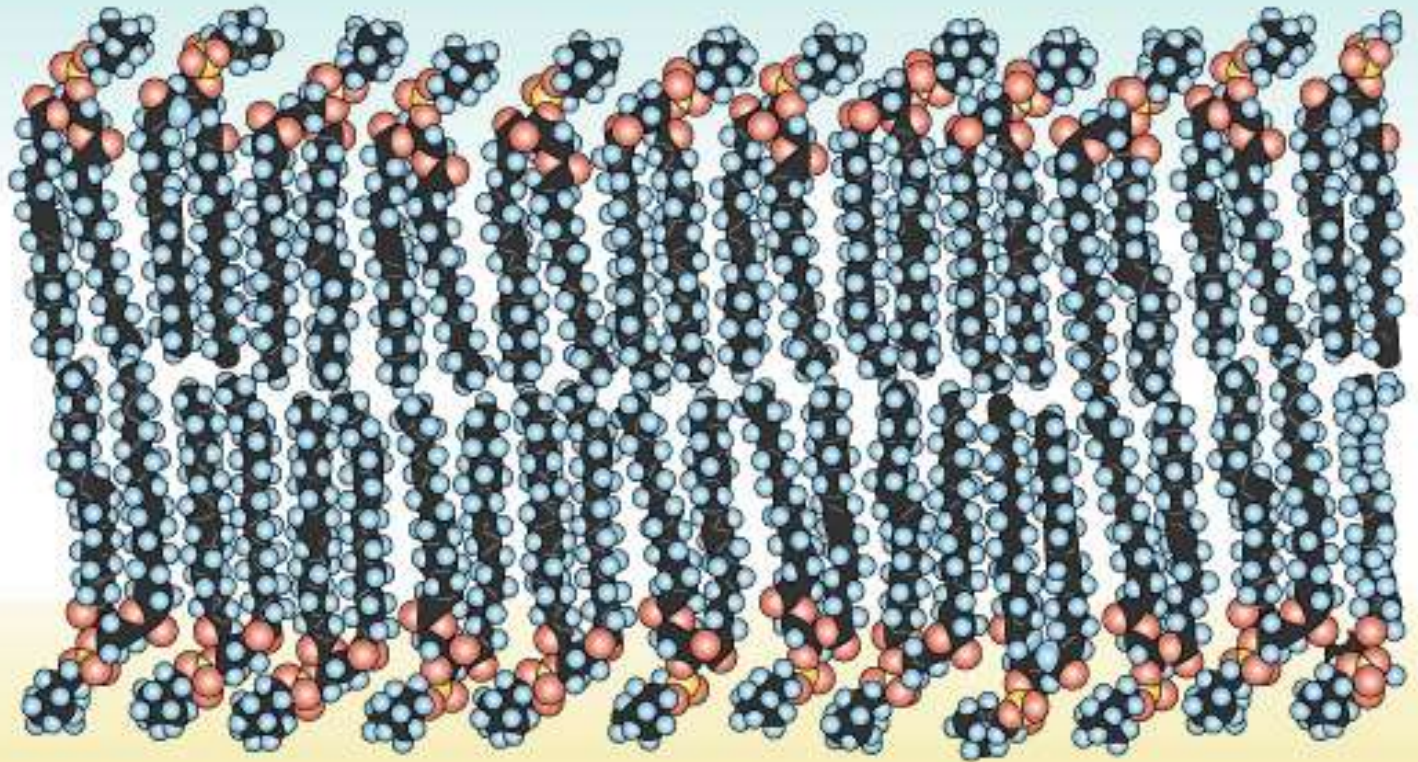
Part	English	Arabic	يحب أو يكره الماء؟
Head	Hydrophilic head	رأس محب للماء	يحب الماء
Tails	Hydrophobic tails	ذيول كارهة للماء	تكره الماء

General membrane structures

polar
hydrophilic
heads

nonpolar
hydrophobic
tails

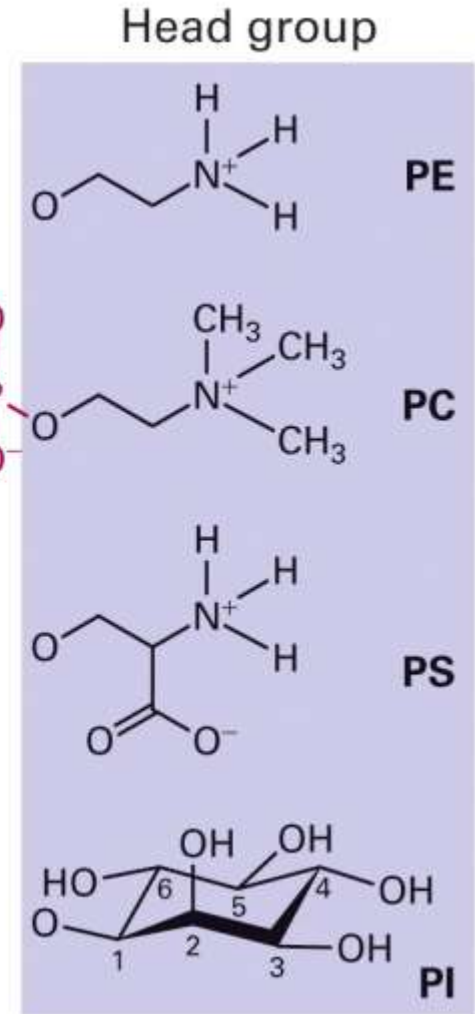
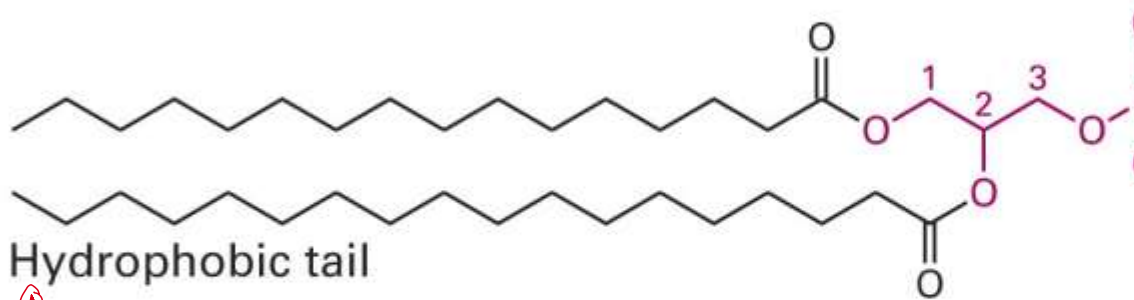
polar
hydrophilic
heads



what

Different types of phospholipids?

(a) Phosphoglycerides



➤ Choline, ethanolamine are the most abundant PL classes. Head group has no net charge

➤ Serine and inositol head groups have net negative charges

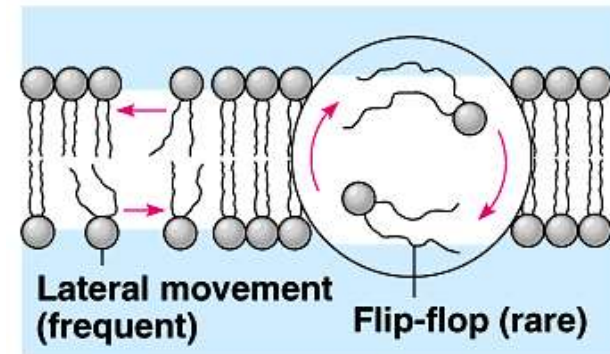
What are

Characteristics of membrane?

- The main macromolecules in membranes are lipids and proteins, but include some carbohydrates
- Membranes are fluid
- Membranes are mosaics of structure and function
- Membrane carbohydrates are important for cell-cell recognition

Membranes are fluid

- A membrane is held in together by **weak hydrophobic interactions**
- Most membrane lipids and some proteins **can drift laterally** within the membrane (2 microns per second)
- Molecules **rarely flip transversely** (flip-flop) across the membrane, because hydrophilic parts would have to cross the membrane's hydrophobic core.



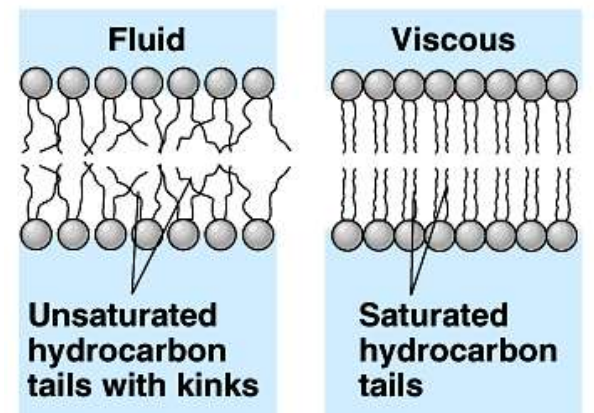
(a) Movement of phospholipids

السبب	الحدث	Movement
داخل نفس الطبقة، سهل	شائع	Lateral movement
يتجاوز عمود hydrophilic head	نادر	Flip-flop
يتجاوز عمود hydrophobic core		

سؤال دكتور سابق:
Why is flip-flop rare?
Because the hydrophilic head must cross the hydrophobic core of the bilayer

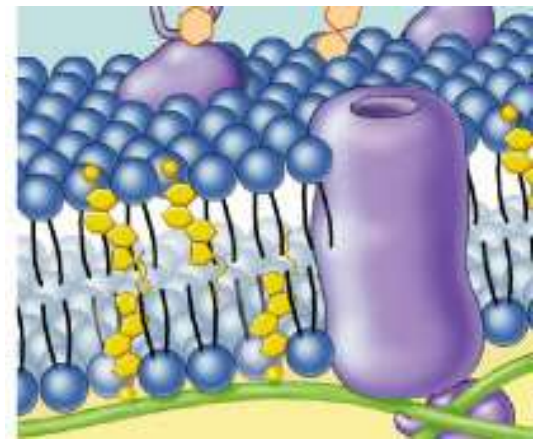
Membranes are fluid

- Membrane fluidity is influenced by temperature and by its constituents.
- As temperatures cool, membranes switch from a fluid state to a solid state as the phospholipids are more closely packed.
- Membranes rich in unsaturated fatty acids are more fluid than those dominated by saturated fatty acids because the kinks in the unsaturated fatty acid tails prevent tight packing



Membranes are fluid

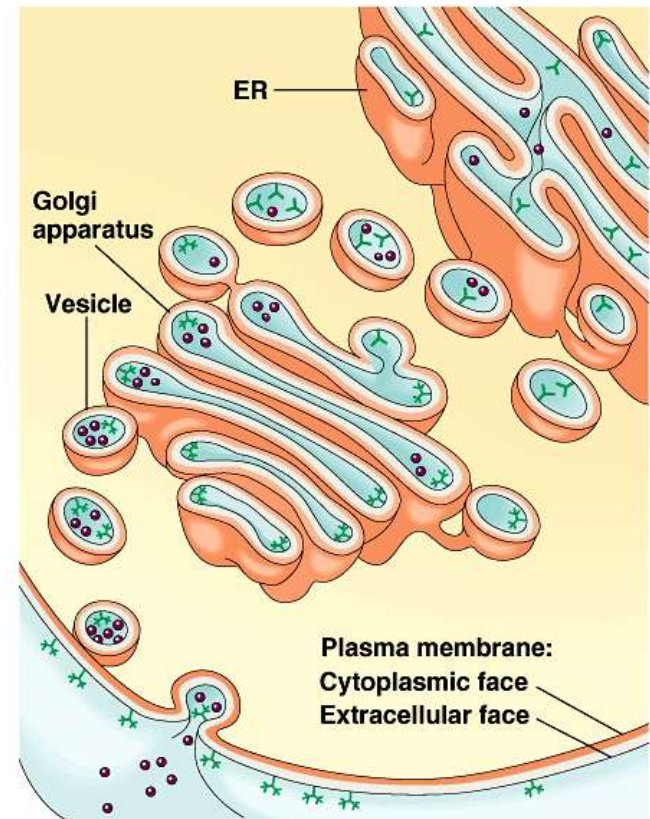
- Short chain fatty acyl groups tend to increase lateral mobility
- cholesterol in membrane of eukaryotes, modulates **membrane fluidity** by making the membrane:
 - Less fluid at warm temperatures (e.g. 37 °C body temperature) by restraining the phospholipid movement.
 - More fluid at lower (cool) temperatures by preventing close packing of phospholipids.
 - Cells may **alter** membrane lipid concentration in response to changes in temperature



Membranes are mosaics of structure and function

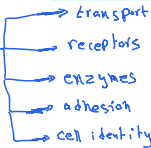
- Membranes have **asymmetric** inside and outside faces. The membrane's **synthesis and modification by the ER** determines this asymmetric distribution of lipids, proteins and carbohydrates.
- The **two lipid layers may differ in lipid composition.**
- Membrane proteins **have a clear direction.**
- **When present, carbohydrates are restricted to the membrane's exterior**

on the extracellular surface of the plasma membrane



Membrane Proteins

- Proteins determine **most of the membrane's specific functions**



- Membrane proteins:

- **peripheral proteins**

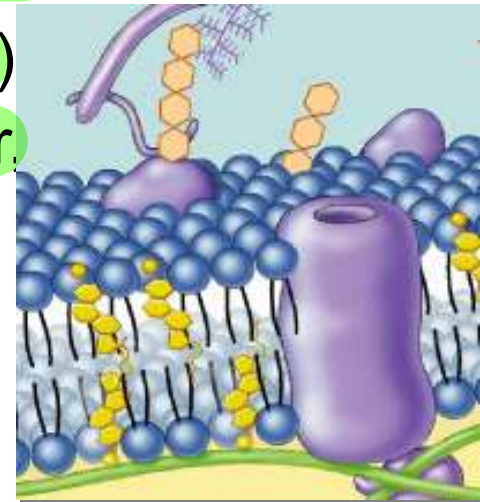
- loosely bound to surface of membrane
 - cell surface identity marker (antigens)

- **integral proteins:** penetrate lipid bilayer, usually across whole membrane

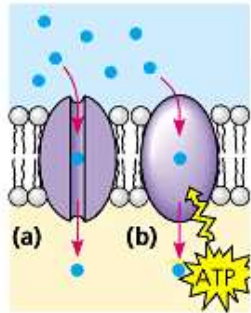
- transmembrane protein:
 - transport proteins (channels, permeases (pumps))

سؤال مهم: What is the difference between peripheral and integral proteins

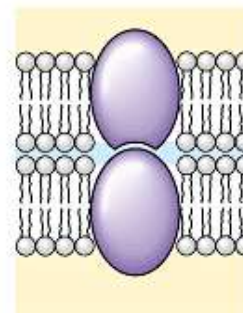
Integral protein	Peripheral protein	Feature
Embedded in bilayer	Surface	Location
Yes	No	Penetrates bilayer?
Strong	Loose	Binding
Transport, receptor	Marker, support	Example function



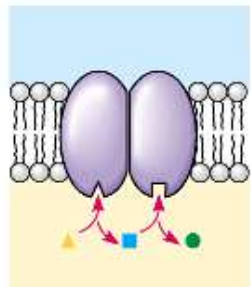
Many Functions of Membrane Proteins



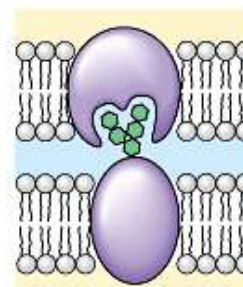
Transport



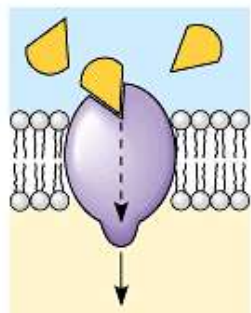
Intercellular joining



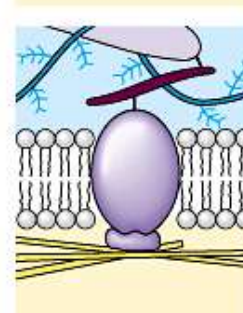
Enzymatic activity



Cell-cell recognition



Signal transduction



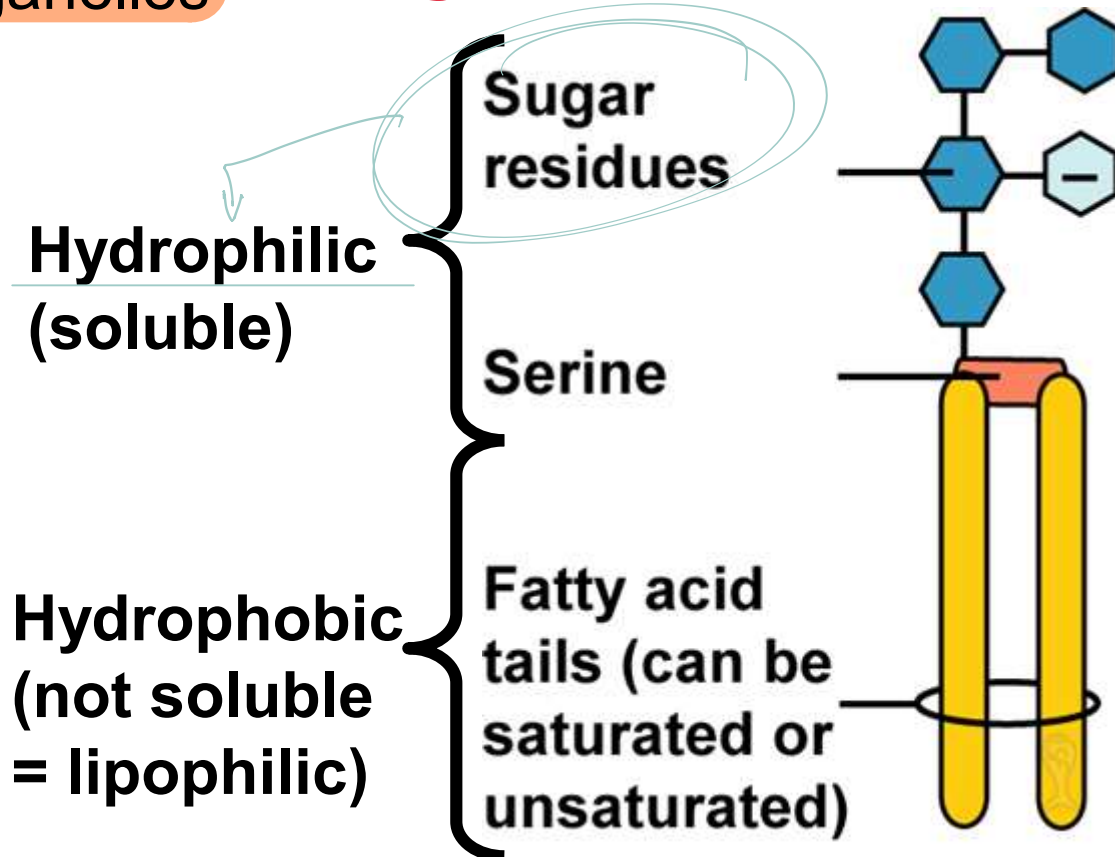
Attachment to the cytoskeleton and extracellular matrix (ECM)

Lipids with carbohydrate ← Glycolipids

هذه الإنشادات يعطي خلايا هوية مختلفة identity

ويعرفون Glycolipids

- Pattern of **sugar residues is variable**
- Always in **outer leaflet of cell membrane, & inner leaflet of organelles**



Membrane carbohydrates are important for cell-cell recognition

- Cell-cell recognition: The ability of a cell to distinguish one type of neighboring cell from another.
- Cell-cell recognition is crucial in the functioning of an organism. It is the basis for:
 - **Sorting** of cells into tissues and organs in an animal embryo's cell.
 - **Rejection** of foreign cells by the immune system.
- The way cells recognize other cells is probably by keying on surface molecules (**markers**)

- markers
- antigens
- glycoproteins/glycolipids

الخلايا تتعرف على بعضها من خلال molecules موجودة على السطح وتسمى بـ

الفكرة الامتحانية:

Cell recognition depends heavily on membrane carbohydrates on the extracellular surface

Membrane carbohydrates are important for cell-cell recognition

➤ Membrane carbohydrates are ^{oligosaccharides} usually branched oligosaccharides with fewer than 15 sugar units.

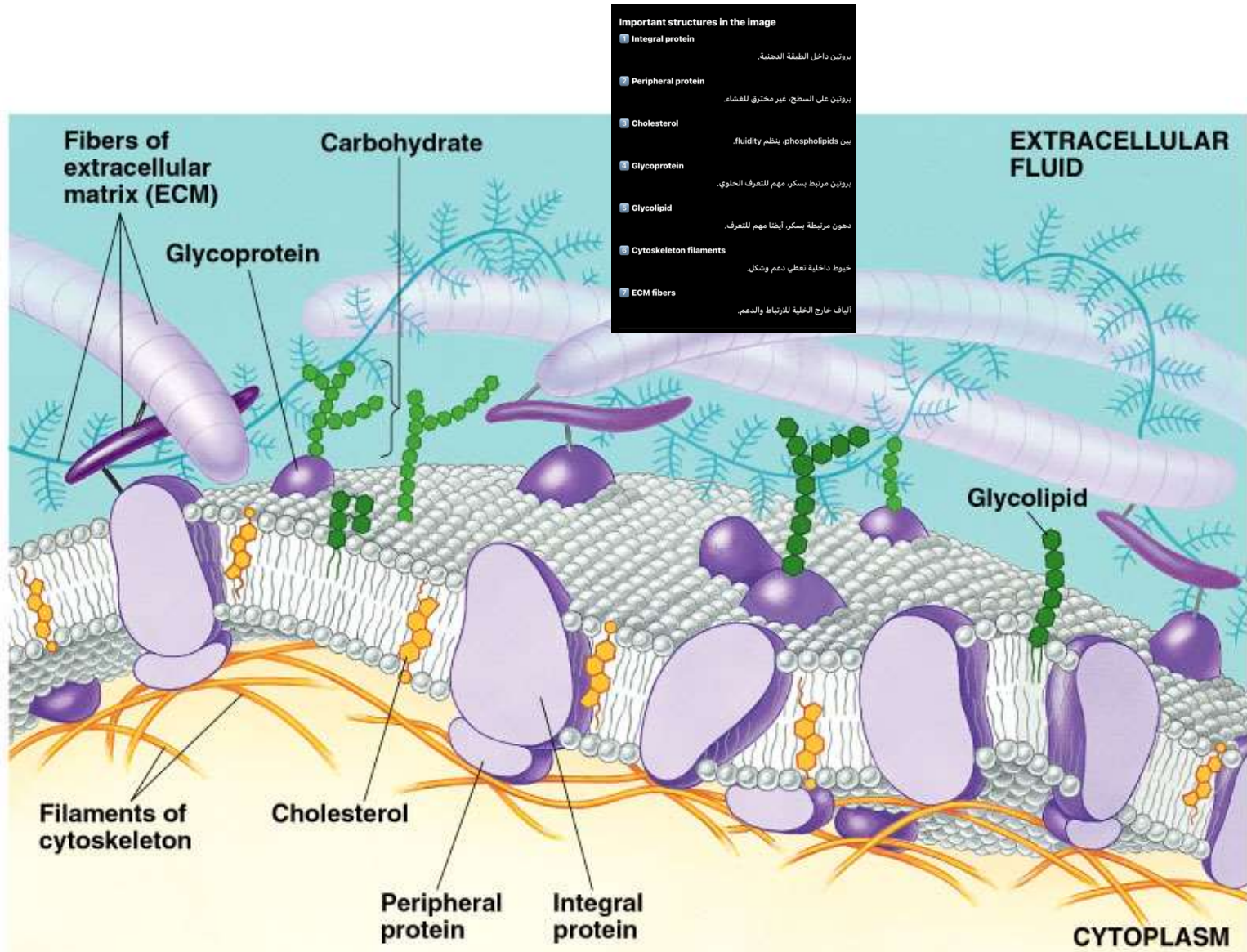
➤ They may be covalently bonded either to lipids, forming glycolipids, or, more commonly, to proteins, forming glycoproteins.

① carbohydrates + Lipids → Glycolipids ← Covalent (علاقة)

② Carbohydrates + proteins → Glycoproteins → more common

How
➤ The oligosaccharides on the external side of the plasma membrane vary from species to species, individual to individual, and even from cell type to cell type within the same individual

Movement across cell membrane



what are

Movement across cell membrane?

1

➤ Passive Transport

without ATP

➤ Simple diffusion

➤ diffusion of nonpolar, hydrophobic molecules

→ O₂
→ CO₂
→ Lipid-soluble molecules
→ steroid hormones

➤ lipids

➤ high → low concentration gradient

➤ Facilitated transport

➤ diffusion of polar, hydrophilic molecules

➤ through a protein channel

➤ high → low concentration gradient

2

➤ Active transport

➤ diffusion *against* concentration gradient

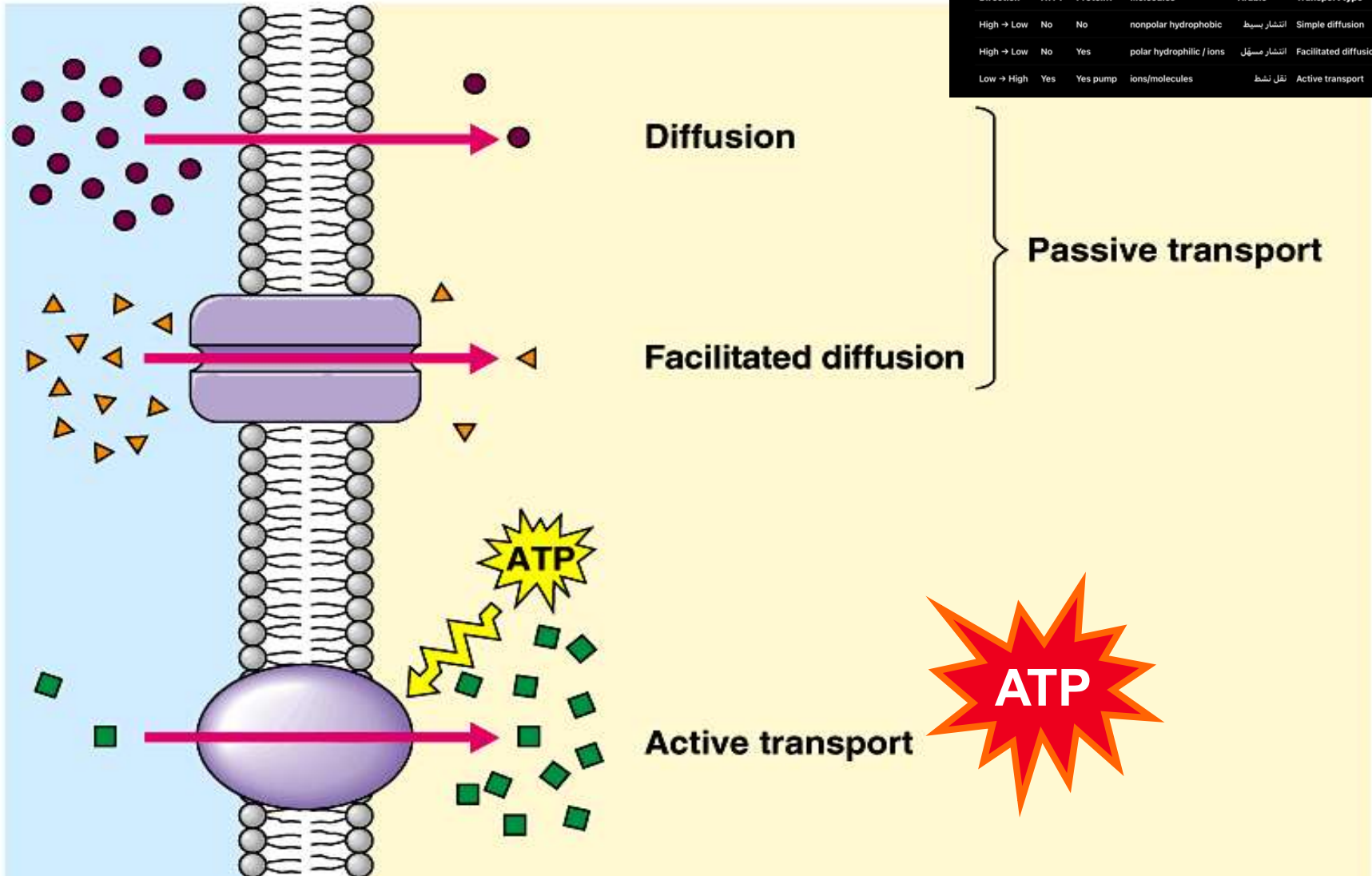
➤ low → high

➤ uses a protein pump

➤ requires ATP

Direction	Needs ATP?	Needs protein?	Type
High → Low	No	No	Simple diffusion
High → Low	No	Yes	Facilitated diffusion
Low → High	Yes	Yes	Active transport

Movement across cell membrane



أهم جدول في التشابتر:

Direction	ATP?	Protein?	Molecules	Arabic	Transport type
High → Low	No	No	nonpolar hydrophobic	انتشار بسيط	Simple diffusion
High → Low	No	Yes	polar hydrophilic / ions	انتشار مسهل	Facilitated diffusion
Low → High	Yes	Yes pump	ions/molecules	نقل نشط	Active transport

Transport of large molecules

➤ Moving large molecules into & out of cell

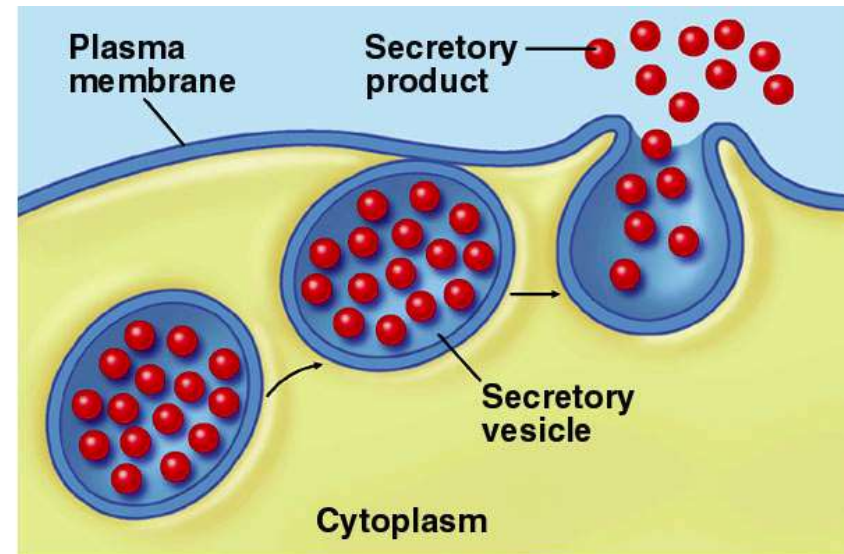
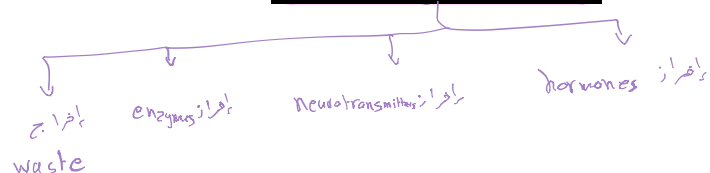
➤ through vesicles & vacuoles

➤ **endocytosis**

➤ **phagocytosis** = “cellular eating”

➤ **pinocytosis** = “cellular drinking”

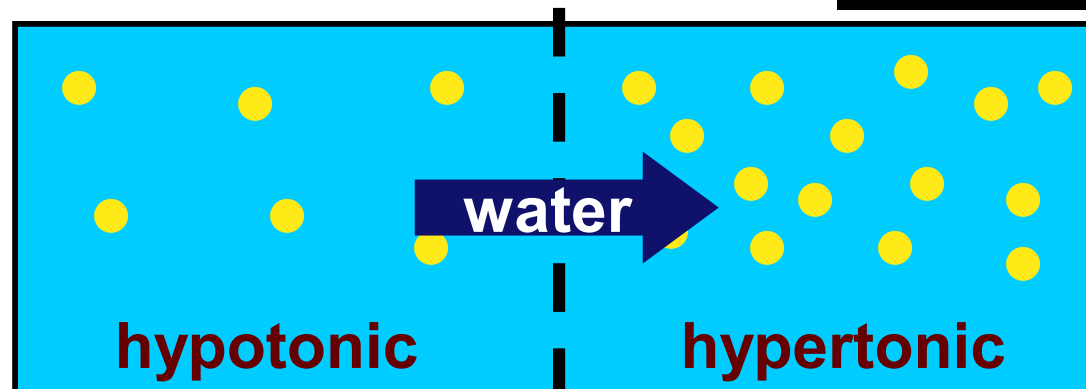
➤ **exocytosis**



Diffusion of water

- Diffusion of water from **high concentration** of water to **low concentration** of water
- Direction of osmosis is determined by comparing total solute concentrations الماء يتحرك نحو الجهة التي فيها سolute أكثر
- Hypertonic - more solute, less water
- Hypotonic - less solute, more water
- Isotonic - equal solute, equal water

Cell result	Water movement	Solute outside	Solution outside
Cell shrinks	Water leaves cell	More solute	Hypertonic
Cell swells	Water enters cell	Less solute	Hypotonic
Cell unchanged	No net movement	Equal solute	Isotonic



net movement of water

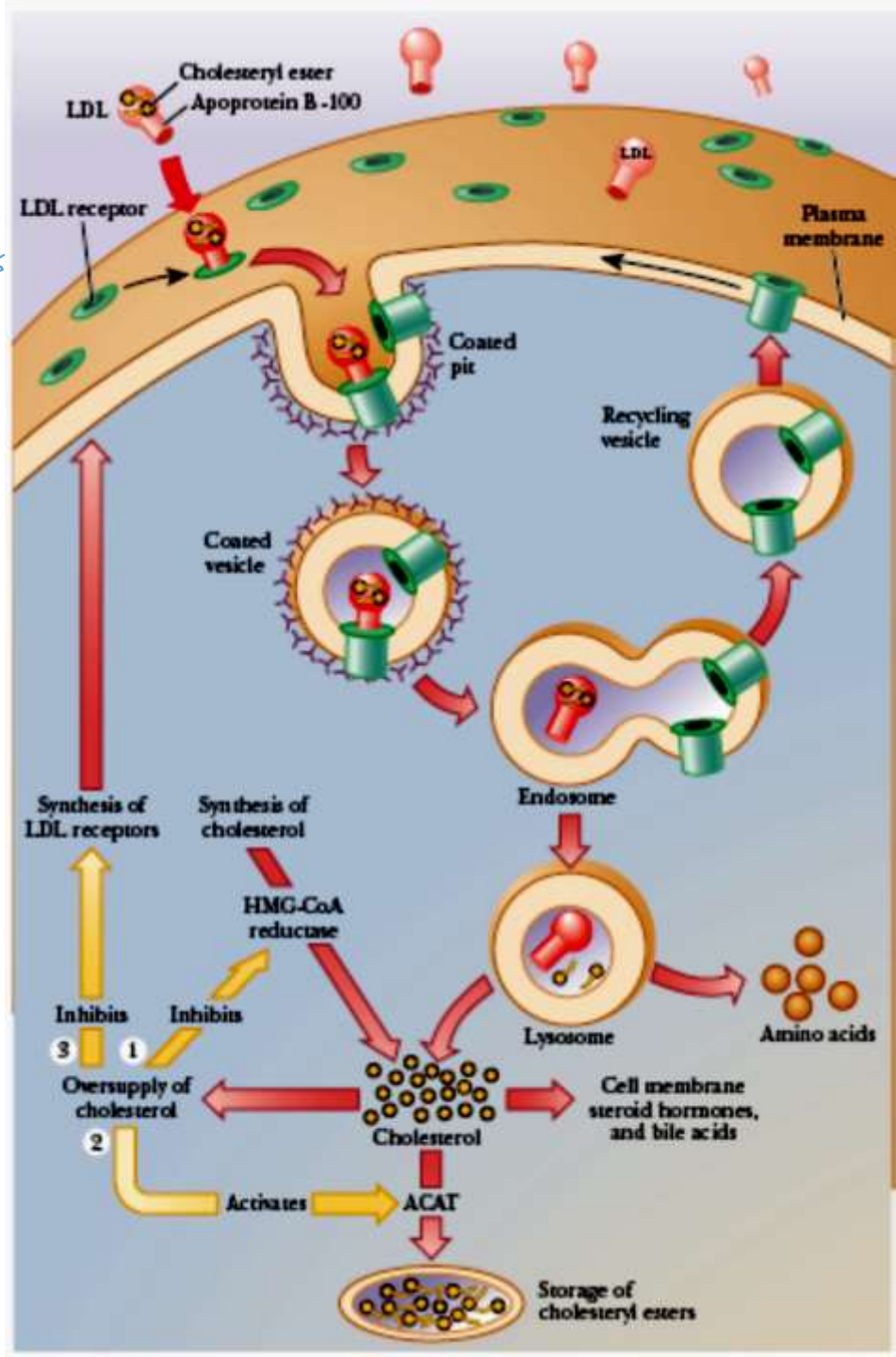
- طريقة حفظ:
- Hyper = high solute outside → water exits → cell shrinks
 - Hypo = low solute outside → water enters → cell swells
 - Iso = equal → stable

LDL = Low-density lipoprotein
(bad cholesterol)

بمعدل الخلية عن طريق

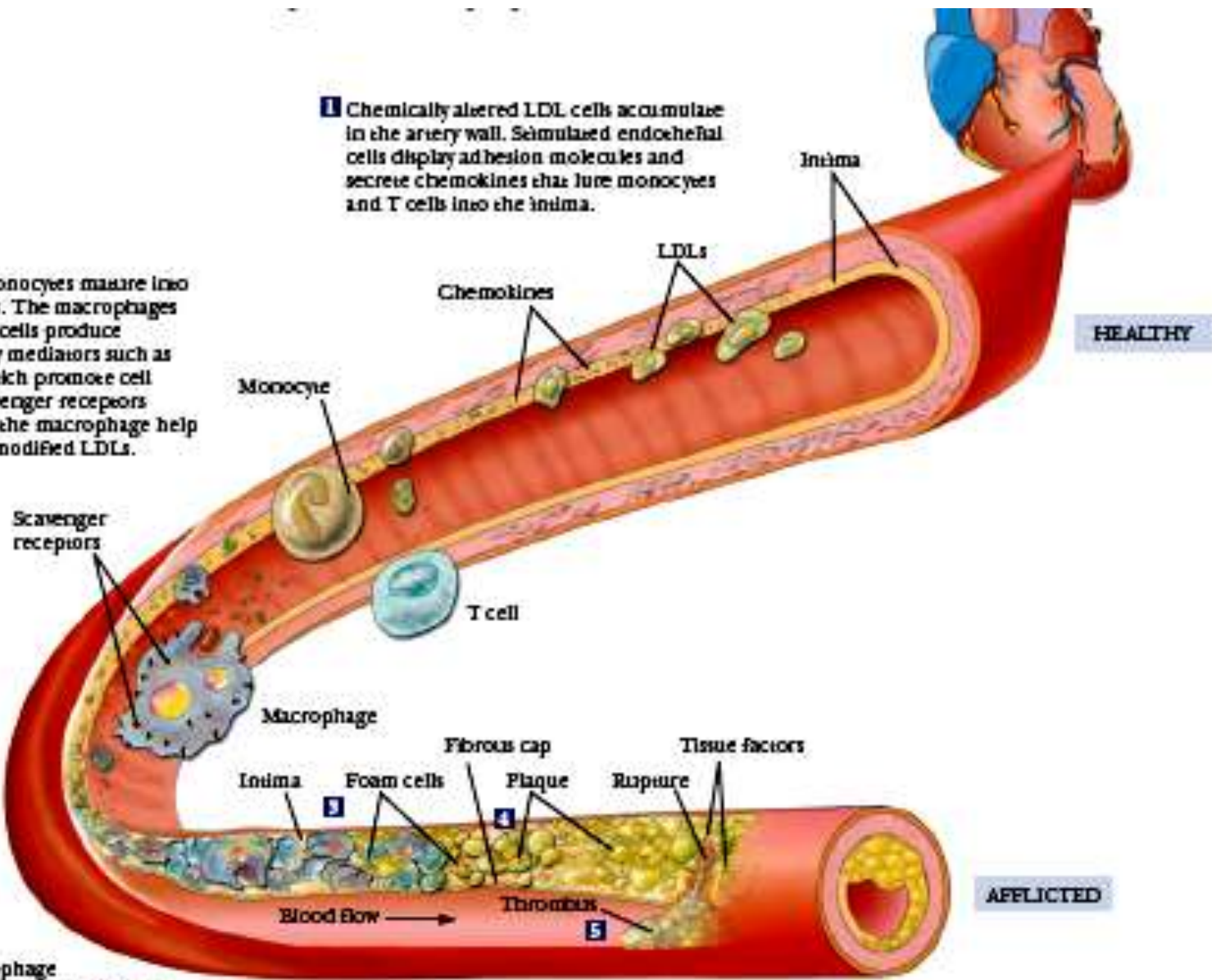
Receptor-mediated endocytosis

Simple diffusion
ولييس



1 Chemically altered LDL cells accumulate in the artery wall. Stimulated endothelial cells display adhesion molecules and secrete chemokines that lure monocytes and T cells into the intima.

2 The lured monocytes mature into macrophages. The macrophages along with T cells produce inflammatory mediators such as cytokines, which promote cell division. Scavenger receptors help them digest modified LDLs.



3 As the macrophage feed on the LDLs they become filled with fatty droplets. These fat-filled macrophages (called foam cells), along with T cells are the earliest form of atherosclerotic plaque.

4 Inflammatory molecules promote further growth of plaque and form a fibrous cap over the lipid core. The fibrous cap seals off the fatty core from the blood.

5 Foam cells weaken the cap by secreting digesting matrix molecules. If the weakened cap ruptures, tissue factors, which display on the foam cell, interact with clot-promoting elements in the blood causing a clot (thrombus).