Chapter 8 The plasma membrane

the plasma membrane

- Cellular membranes are "fluid mosaic" of lipids and proteins.
  - It is boundary separates the living cell from the surrounding
  - the ingredients of membranes-
    - Lipids (phospholipids, Cholestrol)
    - proteins
    - Charbohydrates.
    - proteins

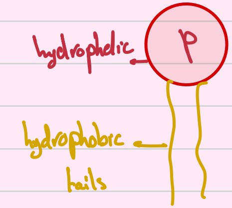
function → "Selective permeability" نفاذية إختارية

- allows to certain substances to cross it more easily them others.

1

Lipids

The phospholipids → the most abundant component (أكثر عنصر متوفر)



- The ability of forming a membrane → is inherited from it's structure.
  - we describe phospholipids with a "amphipthatic molecule"
    - That mean it has both → hydrophilic regions
      → hydrophobic regions

phospholipids could be

- saturated — more solid
- unsaturated. — more liquid

Note:- Some proteins are amphipthatic

← بواسطة phospholipid ← قدرتنا على جدار بين وسطين مائيين ← وذلك بفضل خاصية "amphipathic" الطبيعة المزدوجة لها محبة وكارهة للماء بنفس الوقت

most of plasma membrane's phospholipid are saturated, but we have a minority of unsaturated phospholipids

⇓ that's make the membrane semi fluid.
not too much fluid or too much rigid.

الغشاء البلازمي تحتوي على النوعين من phospholipid
ولكن الأغلب مشبع لجعل طبيعته شبه صلبة ← بين السائلة والصلبة

The movement of membrane components :-

Side way movement

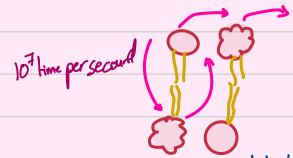
It move freely along side the membrane

very rapid movement it happen 10^7 time per second.

Flip - flop movement

" rarly "

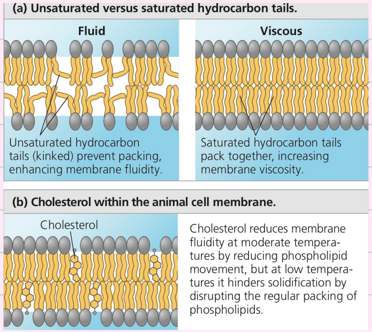
many lipids and proteins are move across the membrane and switching from one to phospholipid layer to other



دليل ع الحركة ← حطوا خليتين متقاربتين بجانب بعض ودامجتوهم ← مع الزمن لاحظوا انتقال البروتينات بين الخليتين .

يستطيعوا التحرك بشكل جانبي على طول الجدار

the membrane must be fluid to work



Controlling the Solubility and temprature.

unsaturated phospholipids.

↳ As the temperature decrease
→ the phospholipids settle into a closely arrangment
→ and the membrane will solidify

But because of the unsaturated phospholipids type and the kink on the tails ⟶ this phospholipids can't pack together and make the membrane more fluid.

Cholesterol

يعمل ع تنظيم سيولة الغشاء البلازمي

It work as "fluid bufer"

not too cold. at low temperature → preventing the close packing.

not too fluid at hight temperature → restrains movement of phospholipids

Because it's position on the cell membrane

في حالة البرد الشديد The phospholipids رح تقترب من بعضها ولكن بوجود الكوليسترول يمنع تجمعهم وتصلبهم ← بالتالي منع تكسر الخلية

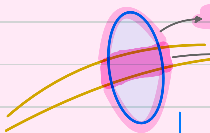
في حالة الحر ← The phospholipids رح يتباعدوا ولكن الكوليسترول يعمل كلاصق يمنع تمزق الغشاء البلازمي

2 Proteins

- Proteins carry out unlimited functions on the membrane.
- They Can move freely side ways
- They not founded randomly on the membrane

* lipid raft تكارب بروتينات
لما ينتقل مجموعة بروتينات معًا حتى ما يصير لخبطة أو تغيير

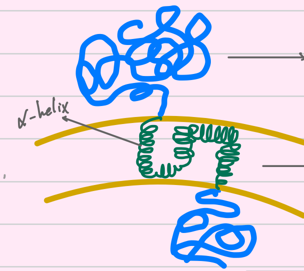
types of proteins:-



water soluble part → It could connect to integrens.

water insoluble part → Consist non polar stranches amino acids
(20-30) amino acid.
→ α helix

↳ Integral protein
"transmembrane"
→ Some have a hydrophilic channels that allow the passage through the membrane of hydrophilic sub.



→ بروتين بشكله الـ hydrophobic
nonpolar = insoluble

→ لكي يعبر من خلال الغشاء البلازمي يعمل مع تغيير شكله إلى α-helixes
polar = hydrophilic

→ عندما يدخل إلى الخلية (وسط مائي) يعود إلى شكله الأصلي

↳ Peripheral protein
water soluble ← لأنه أصلاً في وسط مائي
- ↳ Not embedded into the cell membrane
- ↳ loosely bonded to the surface of membrane to exposed parts of integral proteins.
- ↳ Some others are held in place by attachment to the cytoskeleton.

There are two types of Integrals
- Single side penetration ↓ no name
- double side penetration ↓ Called transmembrane protein

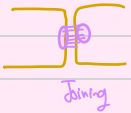
functions-

① transport molecules

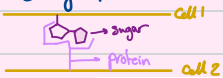
② Enzymes

④ receptors

⑤ Junctions

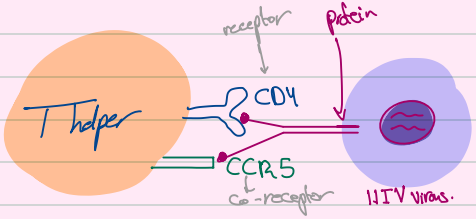


⑤ recognition



⑥ attachment to ECM

HIV:-



the major component of immune system.

CD4 → البروتين المستقبل الذي يرتبط به الفيروس

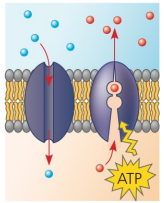
CCR5 → المركب

يعمل على تدمير Th وضعف الجهاز المناعي

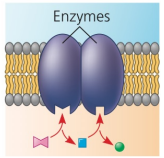
HIV can't enter the cells of resistant individuals who lack CCR5

▼ **Figure 8.7 Some functions of membrane proteins.** In many cases, a single protein performs multiple tasks.

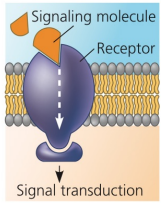
(a) Transport. *Left:* A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute (see Figures 7.32a and 8.15a). *Right:* Other transport proteins shuttle a substance from one side to the other by changing shape (see Figure 8.15b). Some of these proteins hydrolyze ATP as an energy source to actively pump substances across the membrane.



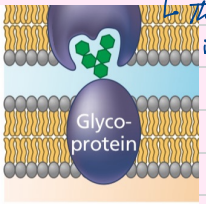
(b) Enzymatic activity. A protein built into the membrane may be an enzyme with its active site (where the reactant binds) exposed to substances in the adjacent solution. In some cases, several enzymes in a membrane are organized as a team that carries out sequential steps of a metabolic pathway.



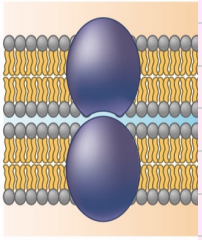
(c) Signal transduction. A membrane protein (receptor) may have a binding site with a specific shape that fits the shape of a chemical messenger, such as a hormone. The external messenger (signaling molecule) may cause the protein to change shape, allowing it to relay the message to the inside of the cell, usually by binding to a cytoplasmic protein (see Figures 7.32a and 9.6).



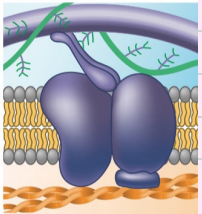
(d) Cell-cell recognition. Some glycoproteins serve as identification tags that are specifically recognized by membrane proteins of other cells. This type of cell-cell binding is usually short-lived compared with that shown in (e).



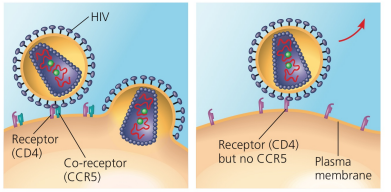
(e) Intercellular joining. Membrane proteins of adjacent cells may hook together in various kinds of junctions, such as gap junctions or tight junctions (see Figure 7.30). This type of binding is more long-lasting than that shown in (d).



(f) Attachment to the cytoskeleton and extracellular matrix (ECM). Microfilaments or other elements of the cytoskeleton may be noncovalently bound to membrane proteins, a function that helps maintain cell shape and stabilizes the location of certain membrane proteins. Proteins that can bind to ECM molecules can coordinate extracellular and intracellular changes



▼ **Figure 8.8 The genetic basis for HIV resistance.**



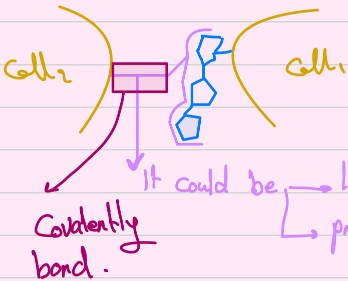
(a) HIV can infect a cell with CCR5 on its surface, as in most people.

(b) HIV cannot infect a cell lacking CCR5 on its surface, as in resistant individuals.

③ Carbohydrates.

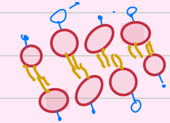
↳ short, unbranched chains → fewer than 15 sugar unit.

It function on the plasma membrane → It have role in cell recognition



what is cell recognition ?

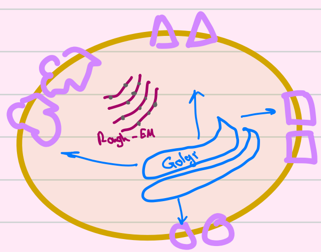
cells recognise each other by binding to molecules containing carbohydrates on the extracellular surface of P.M.



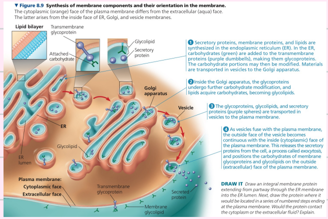
⟹ Synthesis and Sidedness of Membranes.

↳ Membranes have distinct inside and outside faces. → The two lipids layers may differ in lipid composition.

↳ The proteins each one has directional orientation in membrane



يتم تصنيع البروتينات في Rough-ER
ثم بعد ذلك تذهب إلى Golgi والتي بدورها تحدد
لكل بروتين أين يذهب و موقعه.

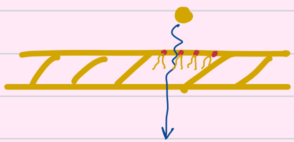


▼ Figure 8.9 Synthesis of membrane components and their orientation in the membrane. The cytoplasmic (orange) face of the plasma membrane differs from the extracellular (aqua) face. The latter arises from the inside face of ER, Golgi, and vesicle membranes.

The Membrane structure results in selective permeability

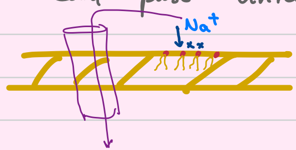
* Hydrophobic (small)

↳ Can pass freely through the membrane.

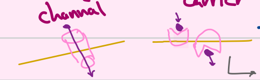


* Hydrophilic (ions, Polar...)

↳ Cant pass unless transport proteins.



transport proteins → channel, carrier



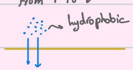
carrier → from ↑ to ↓ → without ATP

* Molecules tend to move from ↑ to ↓ من التركيز الأعلى للأقل.
 but from ↓ to ↑ → PuMP → ATP

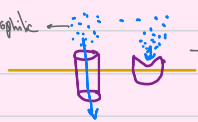
* transport: "مقدمة"

Passive → = diffusion تلقائي
↳ from ↑ to ↓
↳ No ATP needed

Simple diffusion
from ↑ to ↓



Facilitated diffusion



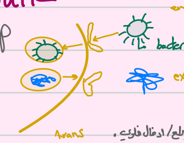
from ↑ to ↓
→ No ATP needed.

Active عكس إرادة العادة ، النقل النشط
from ↓ to ↑
✓ ATP — Bumb is needed

1 directly ↓ ATP
تستخدم ATP بشكل مباشر

2° directly
تستخدم ATP بشكل غير مباشر.

Bulk
ATP



كبيرة ولا تستطيع الدخول للخلية عبر ال passive أو ال active

يتم إدخالها من خلال بلع / إدخال فارغ.

Passive transport :-

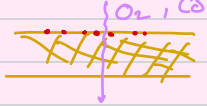
- Diffusion
- Transport molecules from ↑ high concentration to ↓ low concentration (with down concentration gradient)

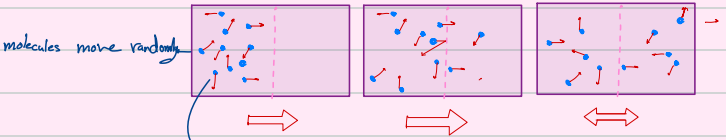
diffusion is a spontaneous process

① Simple diffusion

- for hydrophobic (polar) molecules to pass through lipids.

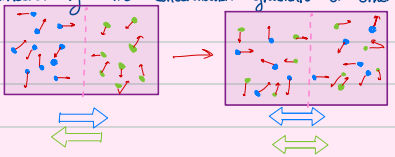
O_2 , CO_2 , some small lipids





There are a transportation of molecules from left to right and from right to left
⇒ But no net diffusion

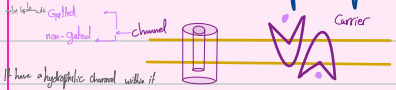
* Each substance diffuses down it's own concentration gradient unaffected by the concentration gradients of other substances.



② Facilitated Diffusion :-

- for hydrophilic molecules (polar)

* we need transport proteins that cross the membrane



It have a hydrophilic channel within it that certain molecules and ions use it as tunnels through the membrane.

It holds on their passengers and change its shape to shuttle them across membrane.

(ions , water ,)

Example :- → aquaporain for water.
- ion channels (gated and non-gated)

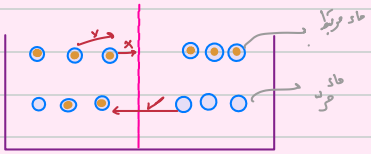
Osmosis :-

↳ Diffusion of water in a semipermeable membrane

شبه منتشر

From [..] to [...]

↳ from ↑ free water to ↓ free water



" الماء يباحث الملح "

أملاح 6 ⟵ 3

ماء مر. ∅ ⟵ 3

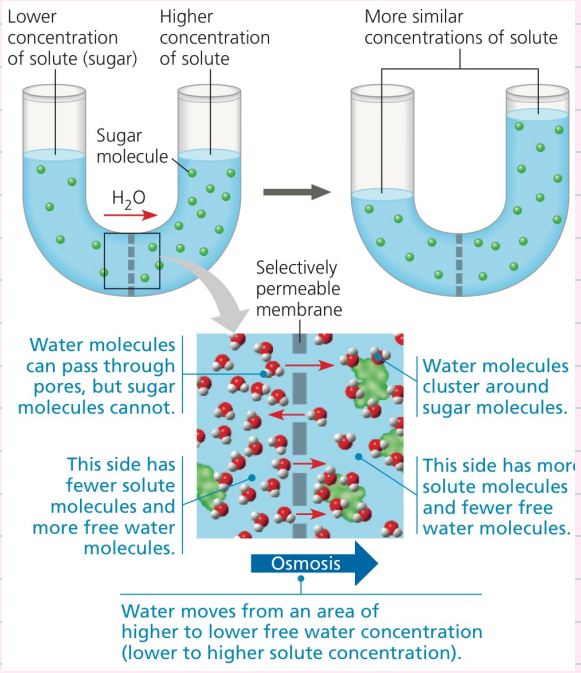
* تركيز أملاح عالي ⟵ يعني تركيز جزيئات ماء قليلة

تركيز الجرح منخفض ⟵ يعني تركيز جزيئات ماء كثيرة عالي .

* الأملاح لا تستطيع العبور من خلال الغشاء

بعض الأيونات بالخاصية الاسموزية ⟵ تستقبل جزيئات الماء الحرة

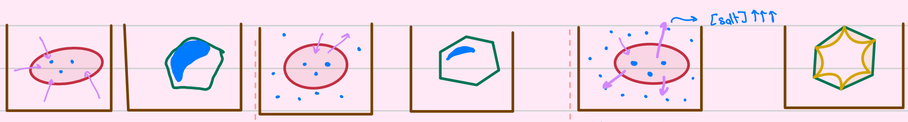
والتي تعمل على تحقيق التوازن في تركيز الأملاح (نسبة الملح للماء)



Water balance of cells. **Tonicity**

When you want to explain the behavior of cell in solution
↳ you must consider both → solute concentration
→ membrane permeability.

Tonicity is the ability of a surrounding solution to cause a cell to gain or lose water.
↳ depends on the concentration of solutes that can't cross the membrane



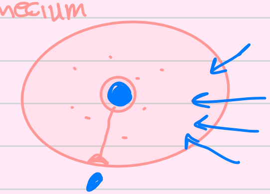
Hypotonic
net movement of water inside the cell.
higher inside diffusion ratio than outside
animal cell "Swell, Burst, lysis"
منفوخة
plant cell "Turgid Normal"

Isotonic "sea water"
No net movement of water across the Plasma M.
the same diffusion rate in the two directions.
"Normal"
طرية
"Flaccid"

hypertonic
Net movement of water outside the cell
out side diffusion rate higher than inside
"Shrink or die"
تكسر البلازما
"Plasmolysis"
↳ In plants as well as in fungi and bacteria

Contractile vacuoles

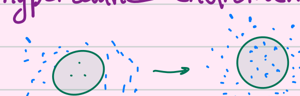
Paramecium



Pure water hypotonic
too much uptake water

why paramecium don't burst?
↳ Paramecium have much less pemarable membrane
↓
that's slow down the uptake of water only.
↳ It have contractile vacuole
↳ an organelle that function as a bilge bump force the water to out.

Prokaryotes that live in hypersaline enviroment



بعض أنواع البكتيريا عشان تتعامل مع hypotonic تأخذ من أملاح الوسط وبتصير متساوية معاه .

Active transport

against Concentration gradient from ↓[ ] to ↑[ ]

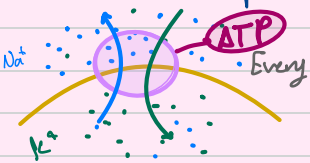
- It needs energy ATP

It require a proteins suttle on the membrane

Carrier - "Pump"

- Primary active transport
  - ↳ use the ATP directly.

Ex- Na^+/k^+ Pump → It is electrogenic pump (mainly in animal cells.)

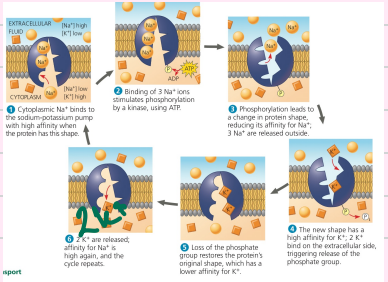


Every 1 ATP → 2 k^+ in, 3 Na^+ out

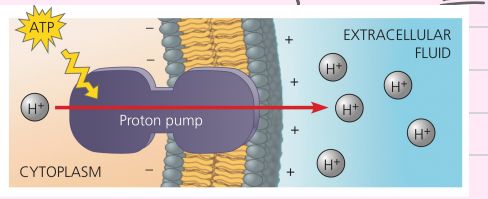
[Membraine Potential]
because the unequal distribution of anions and cations on the two sides of membraine.
50 - 200 millivolt.

Electrochemical gradient

Example 2 : Protons (H^+) Pump. "ATP synthais"
- ↳ electrogenic pump mainly in Plants

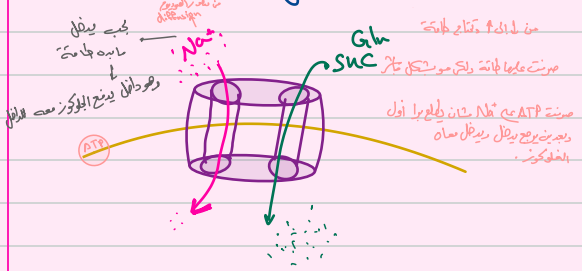


This electrogenetic pumps generate voltage that help to store energy that can be tapped for cellular work



Secondary Cotransport

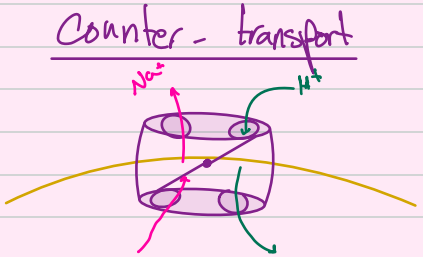
↳ use ATP indirectly

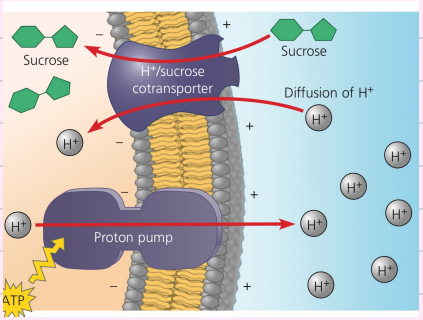


a transport protein (a cotransporter) can couple the "down- hill" diffusion of the solute to the "uphill" transport of a second substance against its own concentration gradient.

In the example
a cotransporter couples the return of H+ to the transport of sucrose into the cell. This protein can translocate sucrose into the cell against its concentration gradient, but only if the sucrose molecule travels in the company of an H+.
The ATP is used on proton pump to transfer H+ out the cell

Counter - transport





Bulk transport

↳ transporting large number of large molecules.

ATP → يعرف جزيئات طاقة بكثرة.

1] Exocytosis

↳ transporting vesicles that are budded from Golgi apparatus

↳ then, it moves along a microtubule of the cytoskeleton to the plasma membrane.

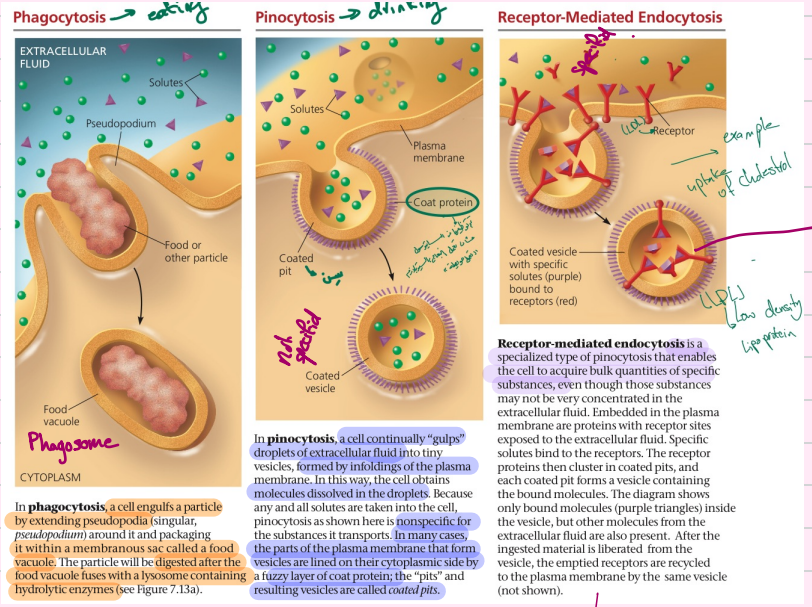
When the vesicle contact with the plasma membrane → specific proteins in both membranes rearrange the lipid molecules of bilayers → so the two membrane fuse

the contents of the vesicle spill out the cell.

Examples:-

- Cells in pancreas that make insulin Secrete it into the extracellular fluid.
- Nerve cells use exocytosis to release neurotransmitters.
- When plant cells are making cell wall deliviers some of necessary proteins and Carbohydrates from Golgi vesicles to the outside of the cell.

2 Endocytosis :-



In **phagocytosis**, a cell engulfs a particle by extending pseudopodia (singular, *pseudopodium*) around it and packaging it within a membranous sac called a food vacuole. The particle will be digested after the food vacuole fuses with a lysosome containing hydrolytic enzymes (see Figure 7.13a).

In **pinocytosis**, a cell continually "gulps" droplets of extracellular fluid into tiny vesicles, formed by infoldings of the plasma membrane. In this way, the cell obtains molecules dissolved in the droplets. Because any and all solutes are taken into the cell, pinocytosis as shown here is nonspecific for the substances it transports. In many cases, the parts of the plasma membrane that form vesicles are lined on their cytoplasmic side by a fuzzy layer of coat protein; the "pits" and resulting vesicles are called *coated pits*.

Receptor-mediated endocytosis is a specialized type of pinocytosis that enables the cell to acquire bulk quantities of specific substances, even though those substances may not be very concentrated in the extracellular fluid. Embedded in the plasma membrane are proteins with receptor sites exposed to the extracellular fluid. Specific solutes bind to the receptors. The receptor proteins then cluster in coated pits, and each coated pit forms a vesicle containing the bound molecules. The diagram shows only bound molecules (purple triangles) inside the vesicle, but other molecules from the extracellular fluid are also present. After the ingested material is liberated from the vesicle, the emptied receptors are recycled to the plasma membrane by the same vesicle (not shown).

type of cholesterol

Ex :- LPL receptor → cholesterol

human cells use receptor-Mediated endocytosis to take in cholesterol for membrane synthesis

low density LPL: → it bind to LDL receptor → then inter the cell.

Contain Cholesterol

Disease :- Familial Hypercholesterolemia → no LDL receptor

the end

By Tala Alali

دعوة حلوة من الناس الحلوة ^^