UNIT 2:

CELLS, MEMBRANES AND SIGNALING …

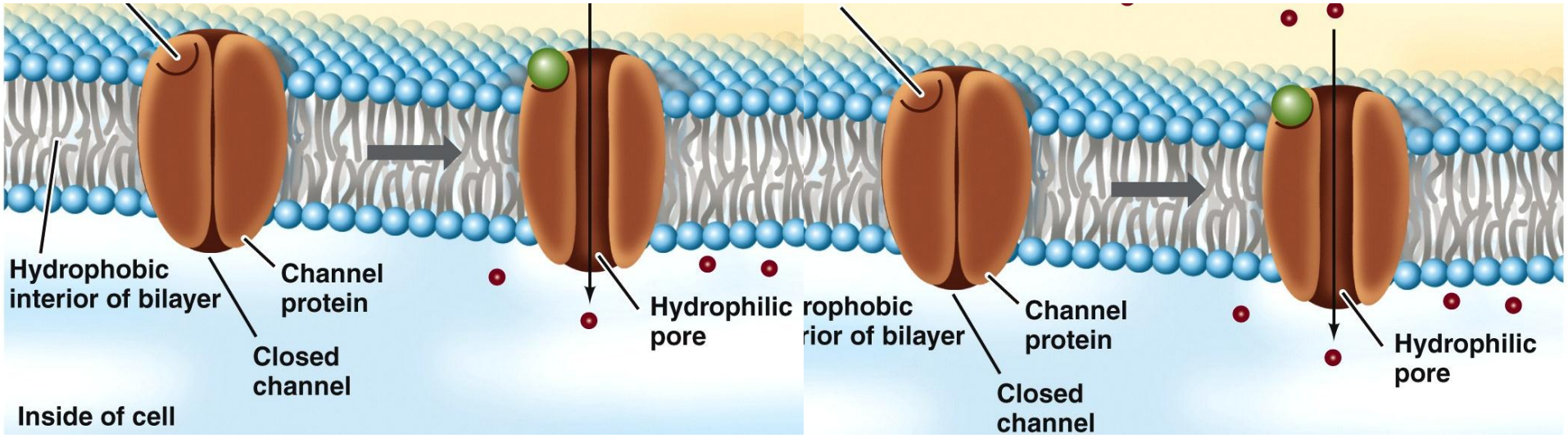
TRANSPORT ACROSS MEMBRANES

Chapter 5 Hillis Textbook

TYPES OF TRANSPORT ACROSS THE CELL (PLASMA) MEMBRANE:

What do you remember?

Complete the chart with what you recall.

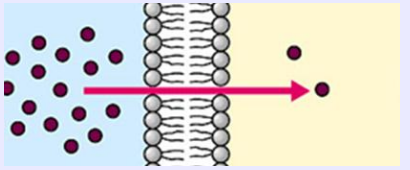


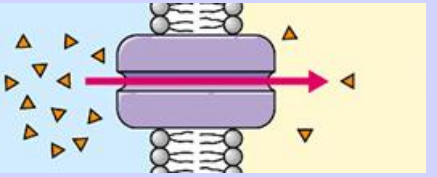
PASSIVE TRANSPORT

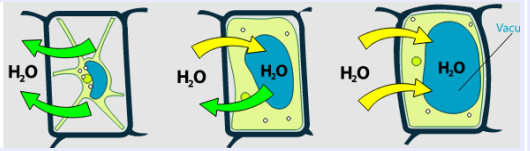
_____ ENERGY

_____ to _____
CONCENTRATION

TYPES:

1. 

2. 

3. 

Hyper:

_____

Iso:

_____

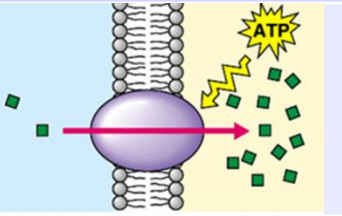
Hypo:_____

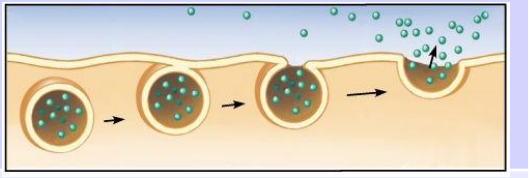
ACTIVE TRANSPORT

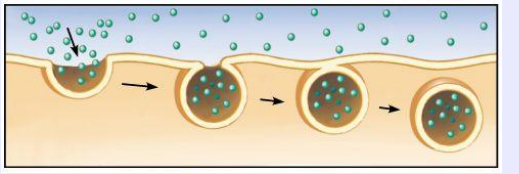
_____ ENERGY

_____ to _____
CONCENTRATION

TYPES:

1. 

2. 

3. 

Phagocytosis:

_____

Pinocytosis:

_____

THINK ABOUT IT...

CELL MEMBRANE COMPONENTS AND CHARACTERISTICS:

Components:	Characteristics:

SELECTIVELY PERMEABLE CHARACTERISTIC (SEMI-PERMEABLE):

Biological membranes are selectively permeable, they allow some substances, and not others, to pass.

SO, HOW DO THINGS GET IN AND OUT?!!!

Two processes of transport:

- **Passive transport** does not require metabolic energy.
- **Active transport** requires input of metabolic energy.

PASSIVE TRANSPORT:
no energy

Diffusion is the process of random movement toward *equilibrium*.

Speed of diffusion depends on three factors:

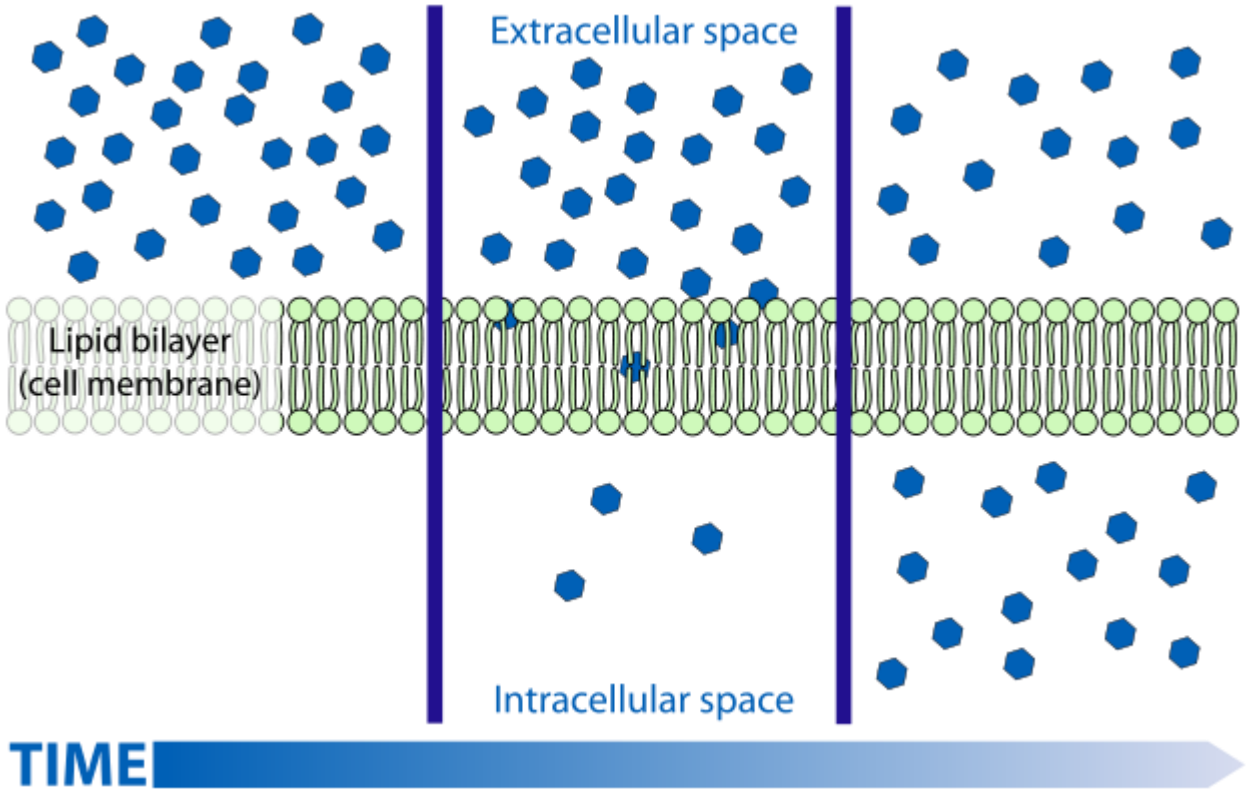
- *Diameter* of the molecules—smaller molecules diffuse faster
- *Temperature* of the solution—higher temperatures lead to faster diffusion
- The *concentration gradient* in the system—the greater the concentration gradient in a system, the faster a substance will diffuse

A higher concentration inside the cell causes the solute to diffuse out, and a higher concentration outside causes the solute to diffuse in, for many molecules.

Simple diffusion takes place through the phospholipid bilayer.

A molecule that is hydrophobic and soluble in lipids can pass through the membrane.

Polar molecules do not pass through—they are not soluble in the hydrophilic interior and form bonds instead in the aqueous environment near the membrane.

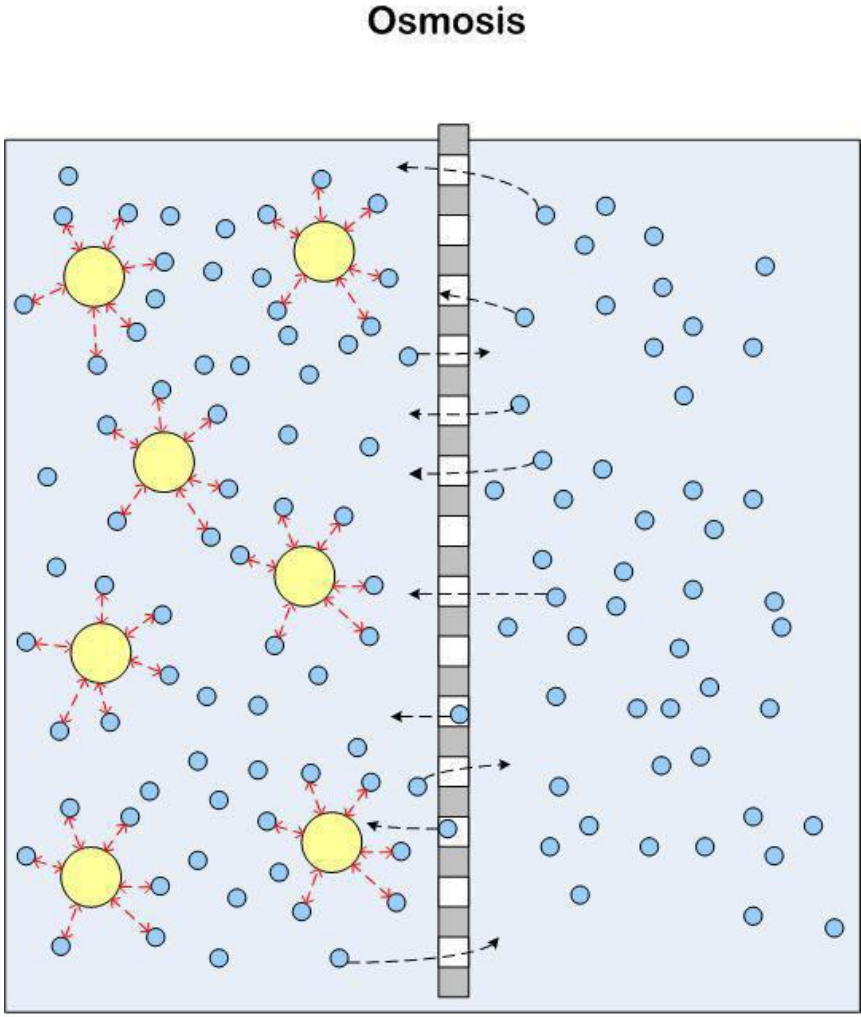


Osmosis is the diffusion of **<u>water</u>** across membranes.

It depends on the concentration of solute molecules on either side of the membrane.

Water passes through special membrane channels called

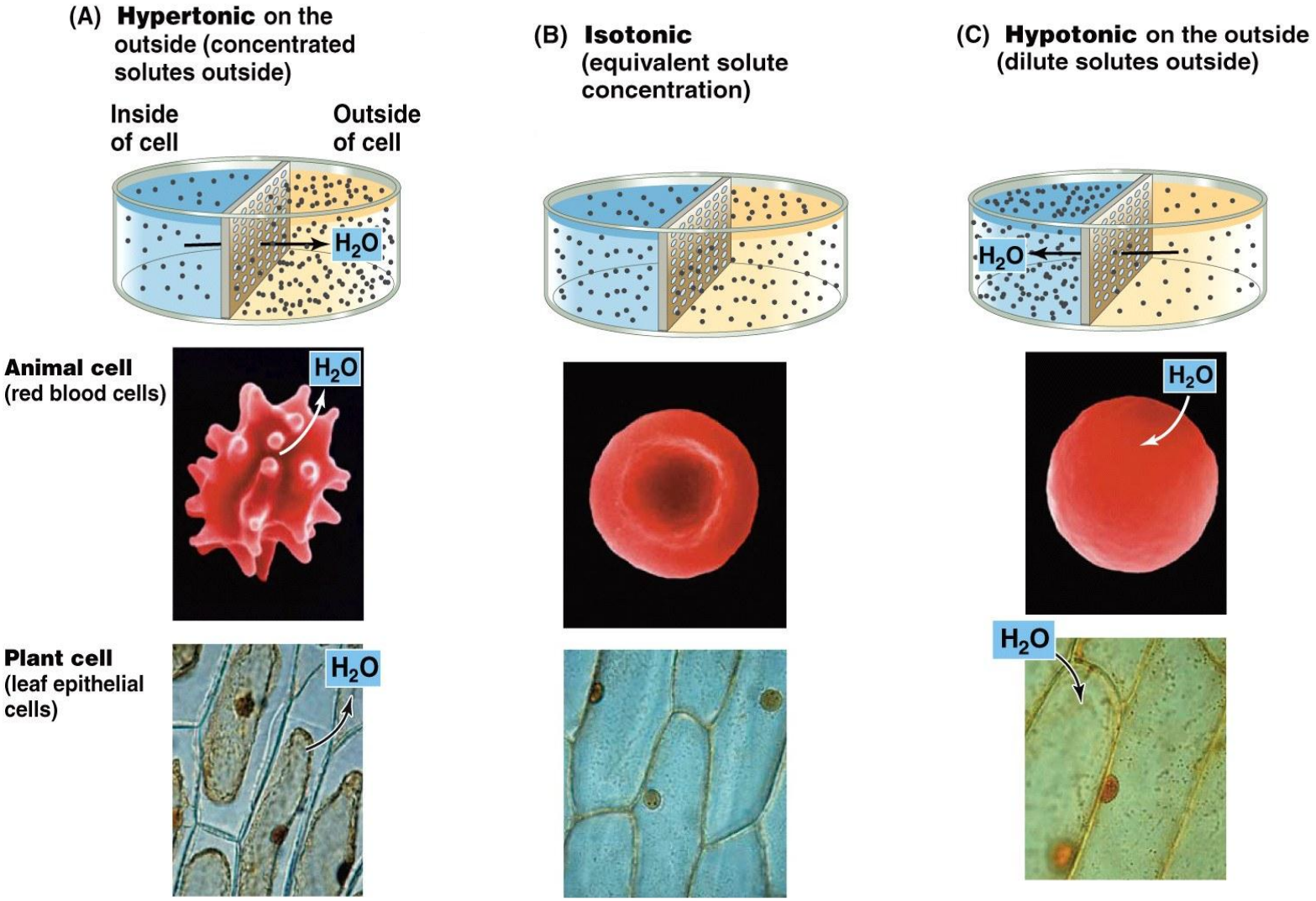
AQUAPORINS



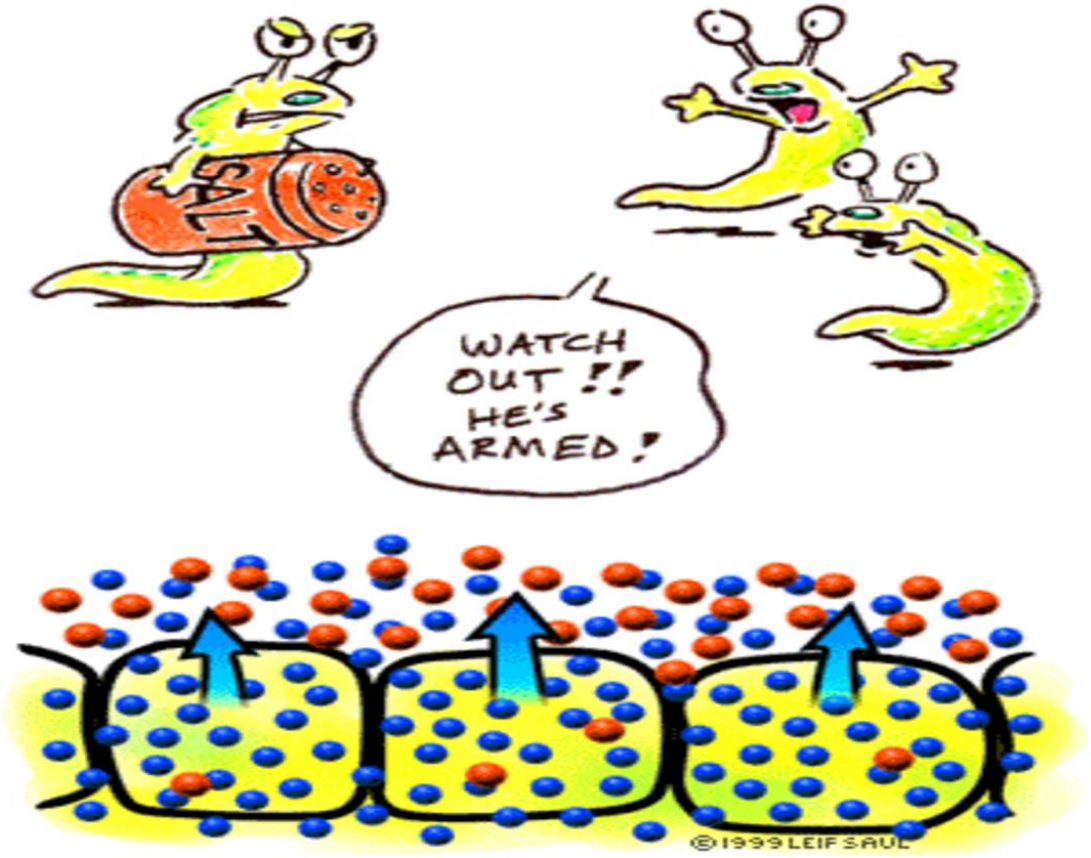
Net flow of small molecules is toward the higher concentration of large molecules (left) because the solute hinders passage toward the lower concentration (right).

When comparing two solutions separated by a membrane:

- A **hypertonic** solution has a higher solute concentration.
- **Isotonic** solutions have equal solute concentrations.
- A **hypotonic** solution has a lower solute concentration.



Diffusion and Osmosis



Solute: materials that are dissolved in the water environment. Ex. Salt!

The concentration of solutes in the environment determines the direction of osmosis in all animal cells.

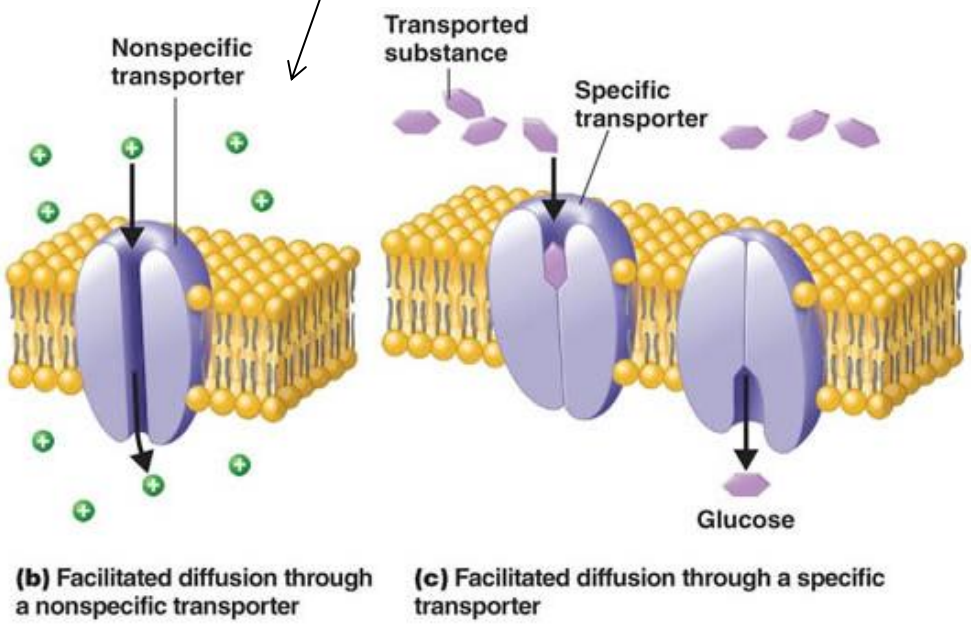
In other organisms, cell walls limit the volume that can be taken up.

Turgor pressure is the internal pressure against the cell wall—as it builds up, it prevents more water from entering.

Facilitated Diffusion is different from Simple Diffusion:

Diffusion may be aided by <u>channel proteins!</u> Still driven by a concentration gradient

Channel proteins are integral membrane proteins that form channels across the membrane.



(b) Facilitated diffusion through a nonspecific transporter

(c) Facilitated diffusion through a specific transporter

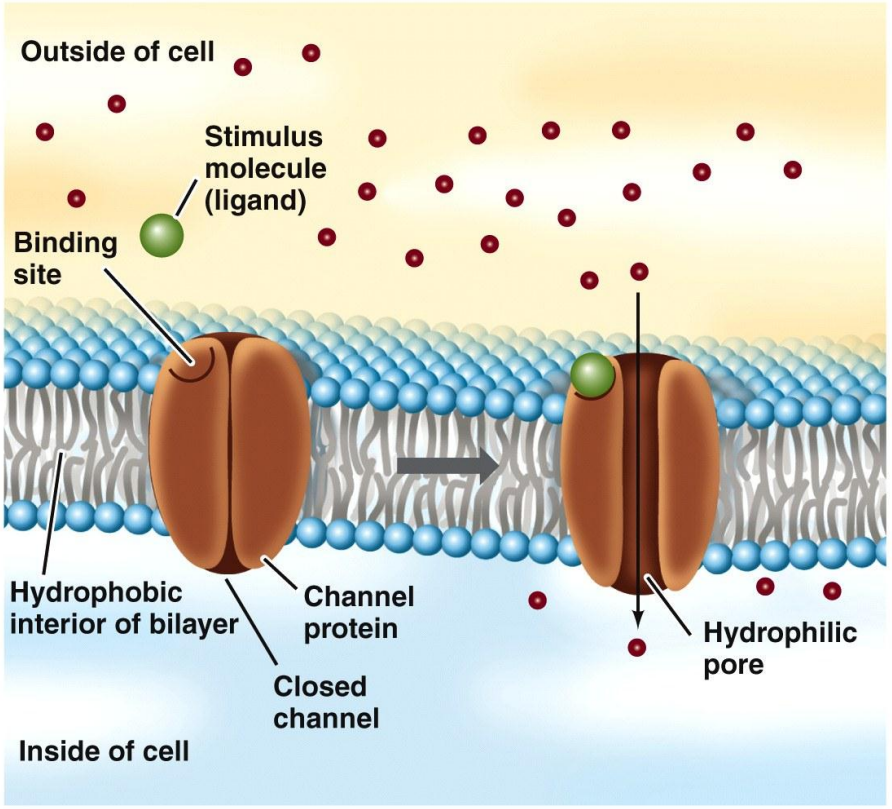
Substances can also bind to **carrier proteins** to speed up diffusion.

Facilitated Diffusion
Channel proteins:

Ion channels are a type of channel protein—most are gated, and can be opened or closed to ion passage.

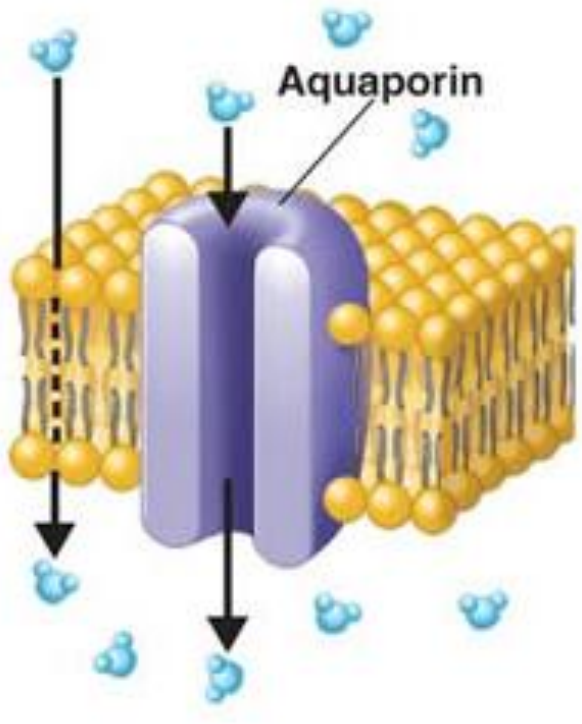
A **gated channel** opens when a stimulus causes the channel to change shape.

The stimulus may be a **ligand**, a chemical signal.
A ligand-gated channel responds to its ligand.



PRINCIPLES OF LIFE, Figure 5.4

Facilitated Diffusion
Channel Proteins:



(d) Osmosis through the lipid bilayer (left) and an aquaporin (right)

Water crosses membranes at a faster rate than simple diffusion.

It may “hitchhike” with ions such as Na^+ as they pass through channels.

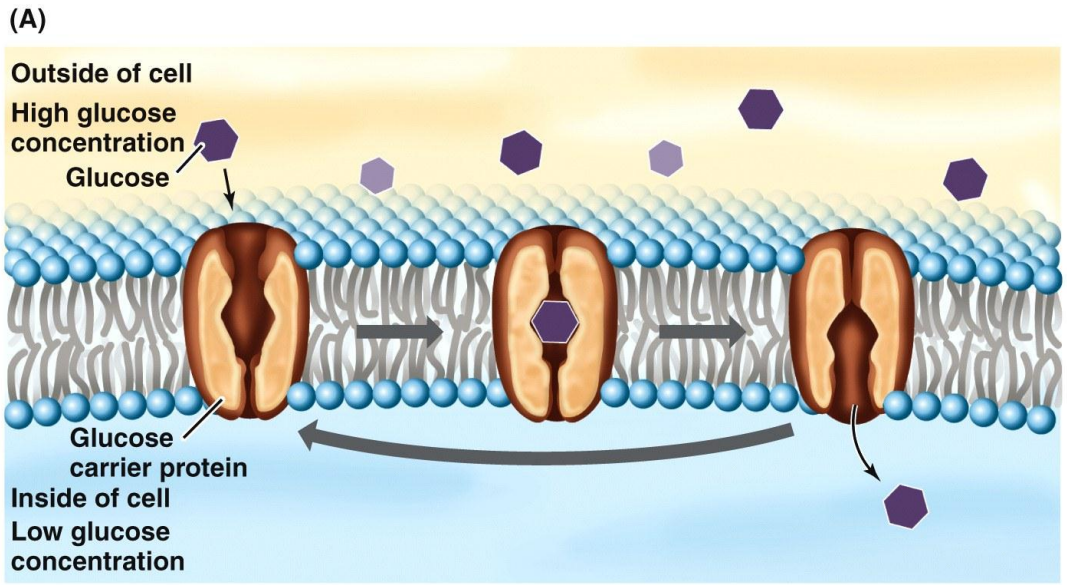
Aquaporins are specific channels that allow large amounts of water to move along its concentration gradient.

Facilitated Diffusion
Carrier Proteins:

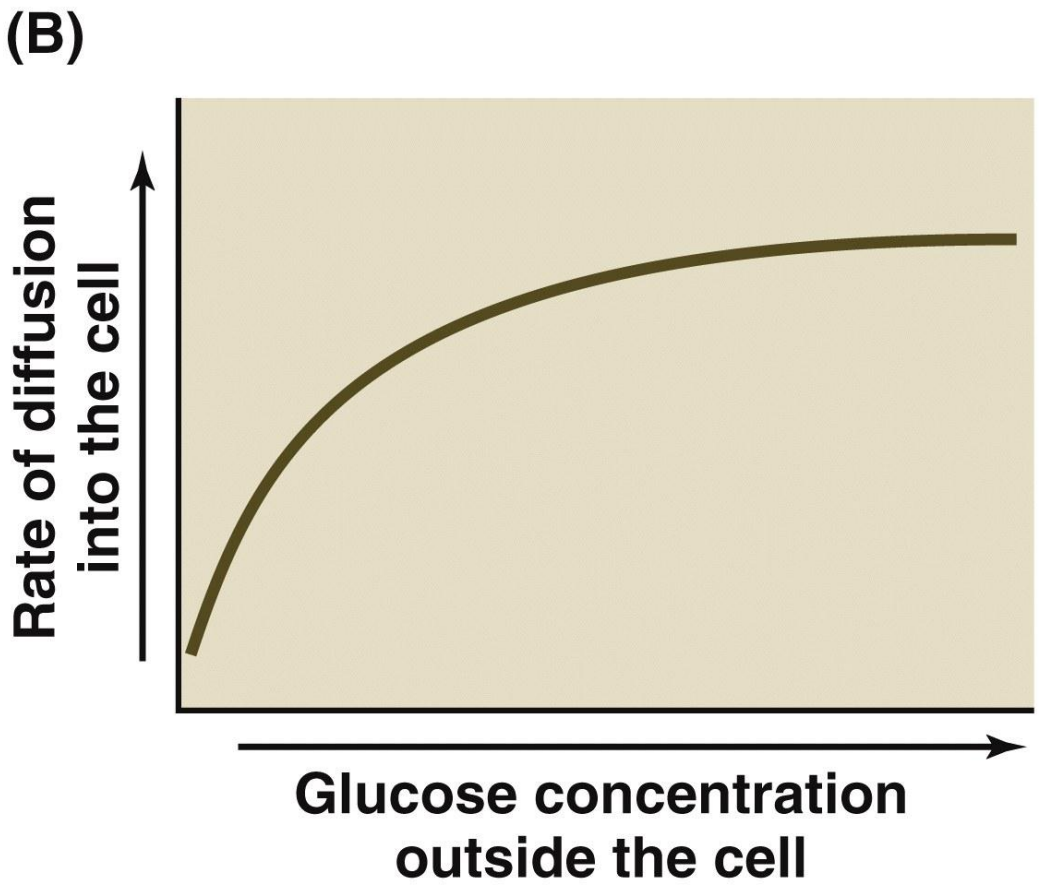
Carrier proteins in the membrane facilitate diffusion by binding substances.

Glucose transporters are carrier proteins in mammalian cells.

Glucose molecules bind to the carrier protein and cause the protein to change shape—it releases glucose on the other side of the membrane.



PRINCIPLES OF LIFE, Figure 5.6 (Part 1)



What can you infer from the graph?

PRINCIPLES OF LIFE, Figure 5.6 (Part 2)

As glucose increases outside the cell, protein carriers needed are used up (SATURATED) and the rate will level off. The rate of diffusion has reached it's max.

ACTIVE TRANSPORT:

energy is needed to happen

Active transport requires the input of energy to move substances *against their concentration gradients*.

Active transport is used to overcome concentration imbalances that are maintained by proteins in the membrane.

Active Transport:

The energy source for active transport is often ATP.

Active transport is *directional* and moves a substance against its concentration gradient.

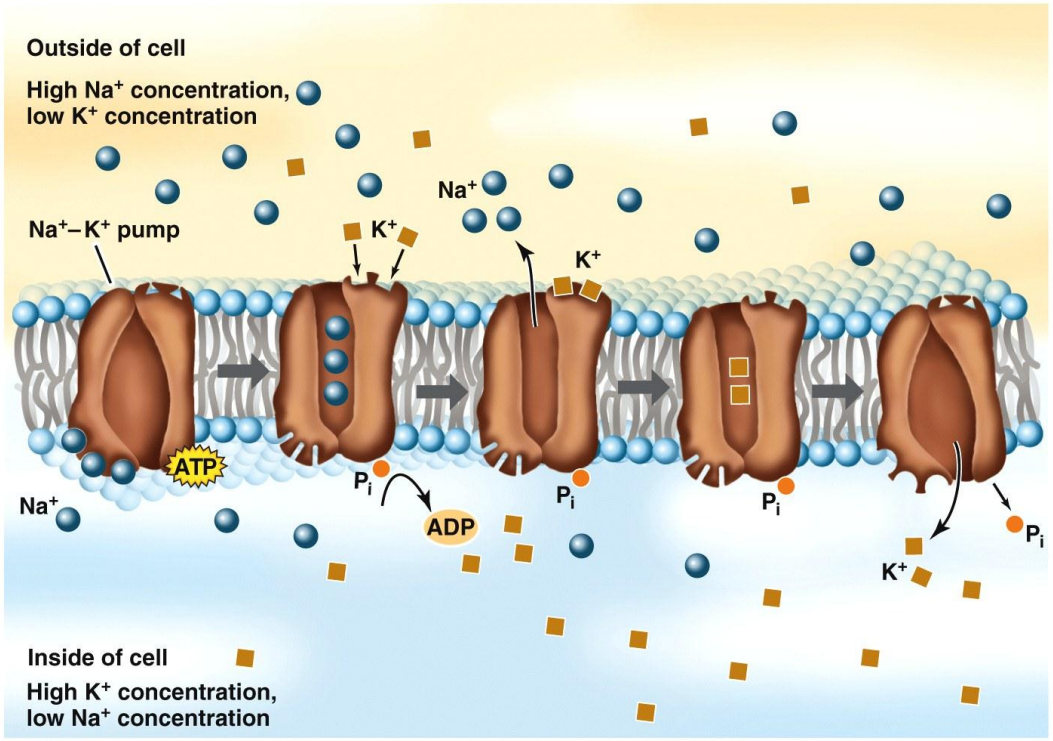
A substance moves in the direction of the cell's needs, usually by means of a specific carrier protein.

Two types of active transport:

- **Primary active transport** involves hydrolysis of ATP for energy.
- **Secondary active transport** uses the energy from an ion concentration gradient, or an electrical gradient.

The **sodium–potassium (Na^+–K^+) pump** is an integral membrane protein that pumps Na^+ out of a cell and K^+ in.

One molecule of ATP moves two K^+ and three Na^+ ions.

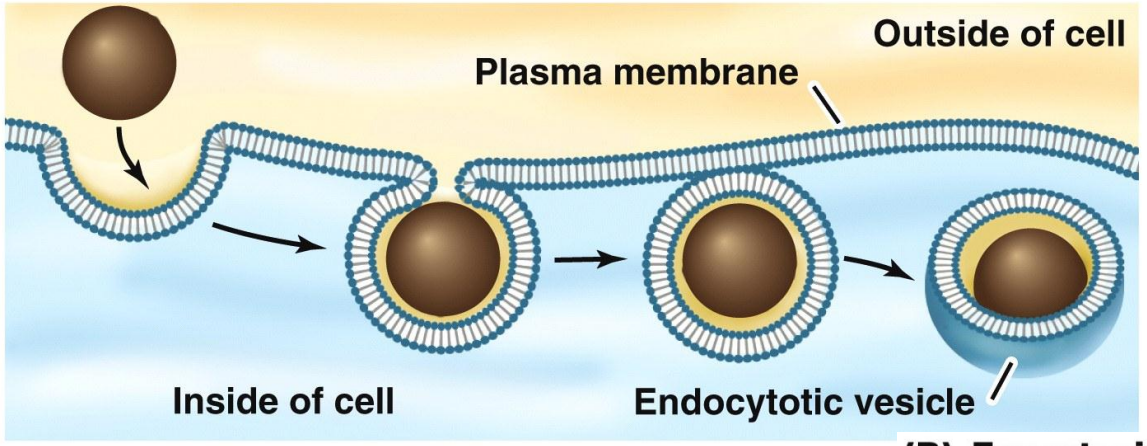


PRINCIPLES OF LIFE, Figure 5.7

Macromolecules are too large or too charged to pass through biological membranes and instead pass through vesicles.

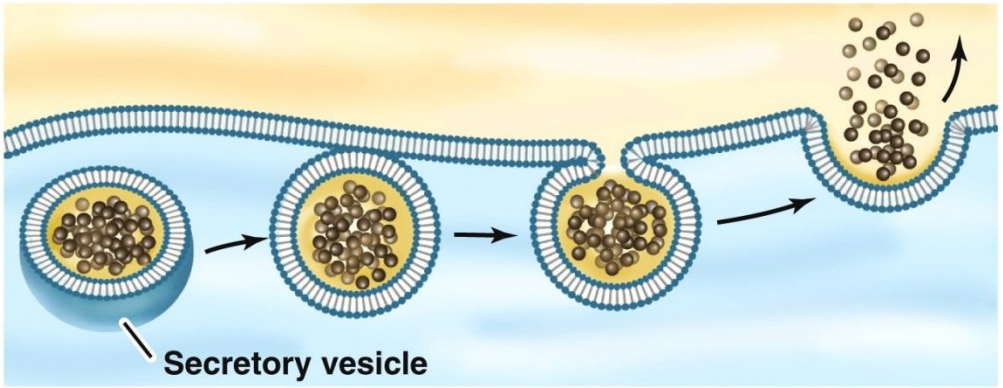
To take up or to secrete macromolecules, cells must use ***endocytosis* or *exocytosis*.**

(A) Endocytosis



***PRINCIPLES OF LIFE*, Figure 5.8 (Part 1)**

(B) Exocytosis



***PRINCIPLES OF LIFE*, Figure 5.8 (Part 2)**

Three types of **endocytosis** brings molecules into the cell: **phagocytosis, pinocytosis, and receptor–mediated endocytosis.**

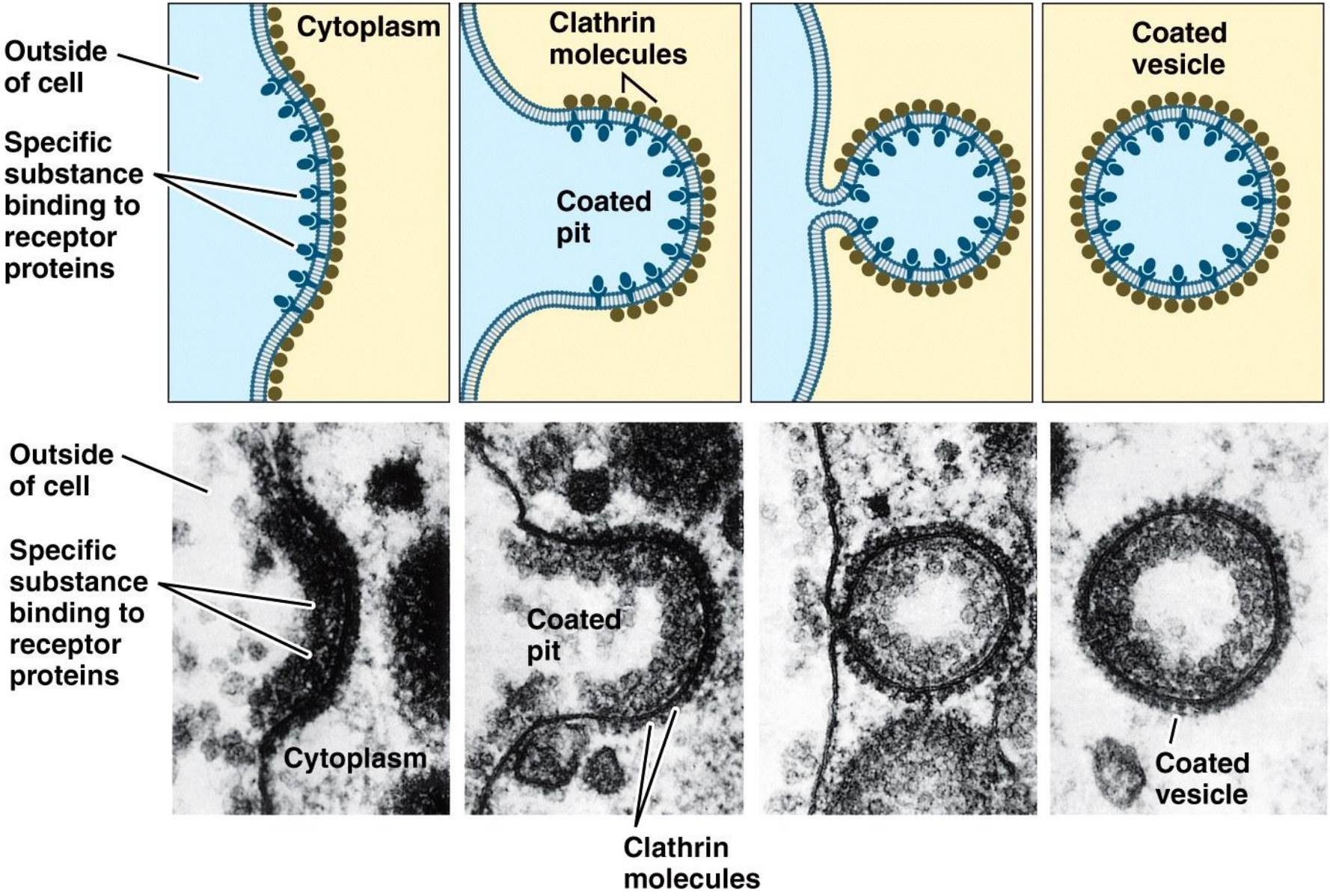
In all three, the membrane folds around the molecules and forms a vesicle.The vesicle then separates from the membrane.

In **phagocytosis** (“cellular eating”), part of the membrane engulfs a large particle or cell. A food vacuole (phagosome) forms and usually fuses with a lysosome, where contents are digested.

In **pinocytosis** (“cellular drinking”), vesicles also form. The vesicles are smaller and bring in fluids and dissolved substances, as in the endothelium near blood vessels.

Receptor–mediated endocytosis depends on **receptors** to bind to specific molecules (their *ligands*). The receptors are integral membrane proteins

Receptor-Mediated Endocytosis

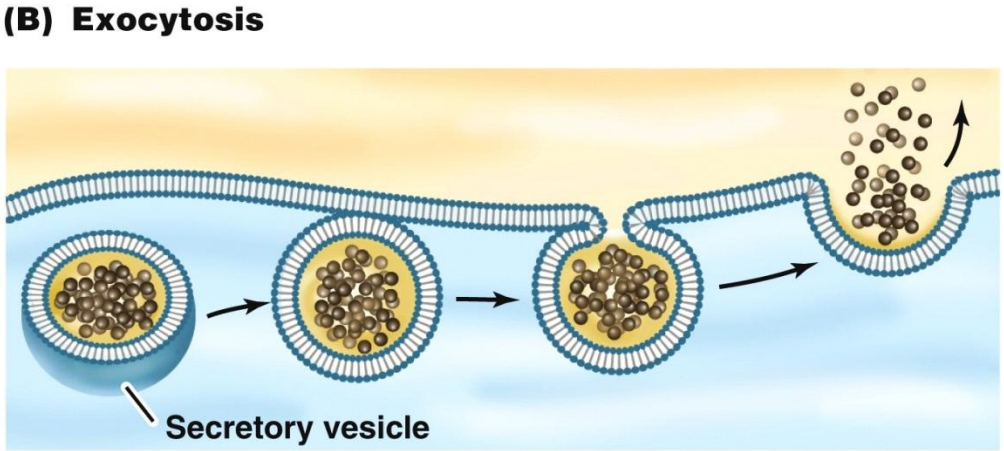


***PRINCIPLES OF LIFE,* Figure 5.9 (Part 2)**

Exocytosis moves materials out of the cell in vesicles.

The vesicle membrane fuses with the plasma membrane and the contents are released into the cellular environment.

Exocytosis is important in the secretion of substances made in the cell.



PRINCIPLES OF LIFE, Figure 5.8 (Part 2)

WHAT IS MISSING?

TABLE 5.1 Membrane Transport Mechanisms

	SIMPLE DIFFUSION	FACILITATED DIFFUSION (CHANNEL OR CARRIER PROTEIN)	ACTIVE TRANSPORT
Cellular energy required?	No		
Driving force	Concentration gradient		
Membrane protein required?	No		
Specificity	No		

PRINCIPLES OF LIFE, Table 5.1

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PRINCIPLES OF LIFE, Table 5.1

WHAT IS MISSING?

TABLE 5.1 Membrane Transport Mechanisms

	SIMPLE DIFFUSION	FACILITATED DIFFUSION (CHANNEL OR CARRIER PROTEIN)	ACTIVE TRANSPORT
Cellular energy required?	No	No	Yes
Driving force	Concentration gradient	Concentration gradient	ATP hydrolysis (against concentration gradient)
Membrane protein required?	No	Yes	Yes
Specificity	No	Yes	Yes

***PRINCIPLES OF LIFE,* Table 5.1**