BIOLOGY 12 **NAME: ____________________________**

CELL MEMBRANES

INTRODUCTION

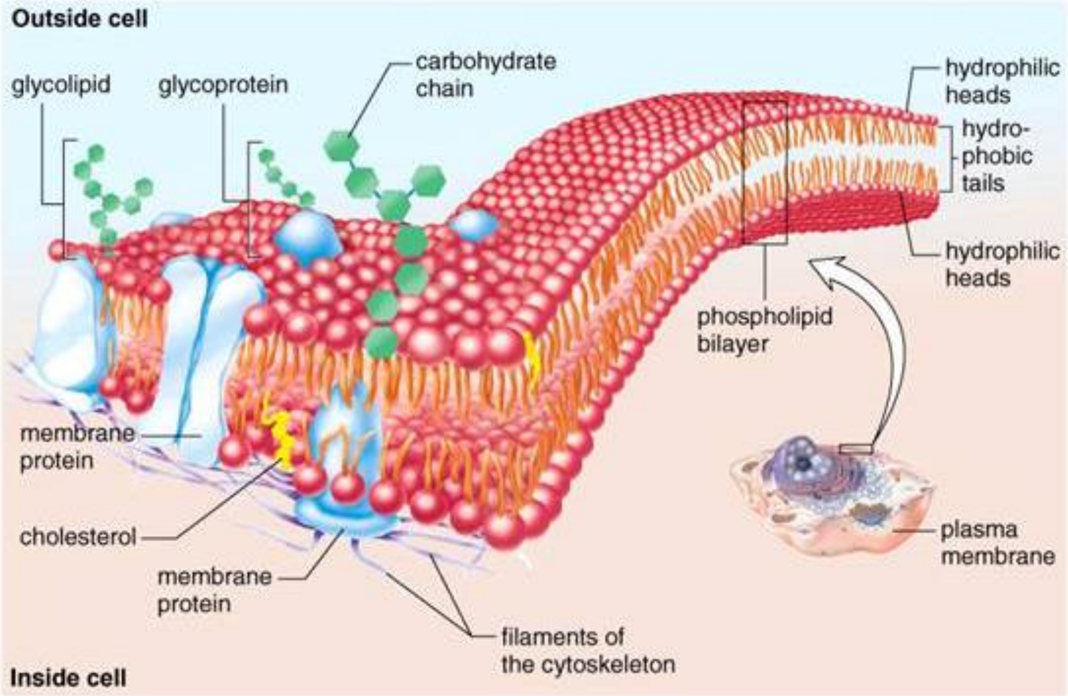
1. The cell membrane ___regulates___ the passage of molecules into and out of the cell.
2. Some types of molecules, particularly ___small___ molecules, pass freely across the cell membrane while others do not.
3. ___Water___ passes freely across the cell membrane, and this can affect cell size and shape.
4. ___Carrier proteins___ assist the transport of some ions and molecules across the cell membrane.
5. Vesicle ___formation___ takes substances into the cell, and vesicle ___fusion___ with the cell membrane discharges substances from the cell.

CELL MEMBRANE- Structure and Function

The "cell surface membrane" is the outer living boundary of the cell that both defines the contents of the cell and regulates the passage of molecules into and out of the cell.

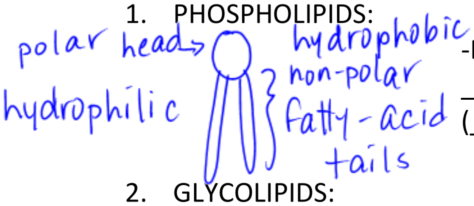
The cell membrane is a ___phospholipid bilayer___ in which protein molecules are either partially or wholly embedded.

- The phospholipid bilayer has a ___fluid___ consistency, comparable to that of light oil.
- The proteins are scattered throughout the membrane, forming a ___mosaic___ pattern.
    - This description of the cell membrane is called the:
      ___FLUID- MOSAIC MODEL___



PHOSPHOLIPID BILAYER (Structural Elements)

1. PHOSPHOLIPIDS:

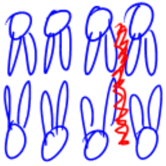


-Each phospholipid has a polar (___hydrophilic___) head that is ___attracted___ to polar water molecules and 2 nonpolar (___hydrophobic___) tails that face ___away___ from the water.

2. GLYCOLIPIDS:

-Similar to phospholipids except that the polar hydrophilic head is a variety of sugars joined to form a straight or branching ___carbohydrate chain___

3. CHOLESTEROL:



-Cholesterol is a lipid that is found in animal cell membranes only (related steroids are found in the cell membrane of plants).

-Cholesterol lends stability to the lipid bilayer and prevents a drastic decrease in fluidity at low temperatures.

CELL MEMBRANE PROTEINS (Functional Elements)

The lipid bilayer determines the basic structure of cell membrane, but the various functions of the membrane are carried out by the cell membrane proteins.

The fluid mosaic model recognizes TWO categories of membrane proteins, that differ in their attraction to the hydrophobic interior of the lipid bilayer and therefore the degree to which they penetrate into the membrane.

1. INTEGRAL (or intrinsic) MEMBRANE PROTEINS

= embedded partially or completely in bilayer

- Integral proteins that pass entirely through the membrane have two hydrophilic ends and a hydrophobic middle region. The hydrophobic middle regions are held in association with the membrane interior, and the hydrophilic ends extend into the watery medium at the membrane surface
- Integral proteins that extend only partly through the membrane have a hydrophobic end suspended in the membrane interior, and the hydrophilic ends facing the surrounding watery medium.
- The integral proteins are free to displace phospholipid molecules and move laterally through the fluid bilayer

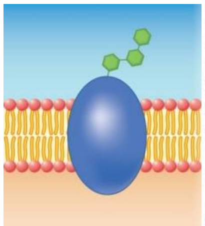
The integral proteins largely determine a cell membrane's specific function

EXAMPLES OF INTEGRAL MEMBRANE PROTEINS:

i. Cell Recognition Protein

= cellular fingerprint (cells recognize each other)

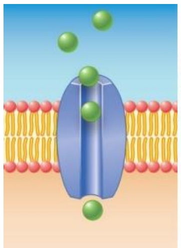
- Many integral proteins are glycoproteins, which have an attached carbohydrate chain that projects externally



Cell Recognition Protein
The MHC (major histocompatibility complex) glycoproteins are different for each person, so organ transplants are difficult to achieve. Cells with foreign MHC glycoproteins are attacked by white blood cells responsible for immunity.

ii. Channel Protein - form tunnels

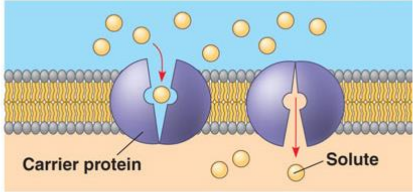
= allow molecules or ions (charged) to move across membrane



Channel Protein
Allows a particular molecule or ion to cross the plasma membrane freely. Cystic fibrosis, an inherited disorder, is caused by a faulty chloride (Cl^-) channel; a thick mucus collects in airways and in pancreatic and liver ducts.

iii. Carrier Proteins ~ gates

(Na^+/K^+ pump) = combine with a specific molecule to move it across the membrane

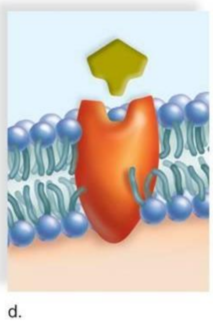


Carrier Protein
Selectively interacts with a specific molecule or ion so that it can cross the plasma membrane. The family of GLUT carriers transfers glucose in and out of the various cell types of the body. Different carriers respond differently to blood levels of glucose.

iv. Receptor Protein

= bind to a specific molecule due to its shape (e.g. hormones)

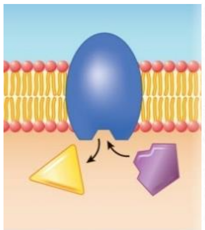
→ binding effects metabolism of a cell



Receptor Protein
Shaped in such a way that a specific molecule can bind to it. Some types of dwarfism result not because the body does not produce enough growth hormone, but because the plasma membrane growth hormone receptors are faulty and cannot interact with growth hormone.

v. Enzymatic Protein

= carries out a specific metabolic reaction (e.g. catalyst)



Enzymatic Protein
Catalyzes a specific reaction. The membrane protein, adenylate cyclase, is involved in ATP metabolism. Cholera bacteria release a toxin that interferes with the proper functioning of adenylate cyclase, which eventually leads to severe diarrhea.

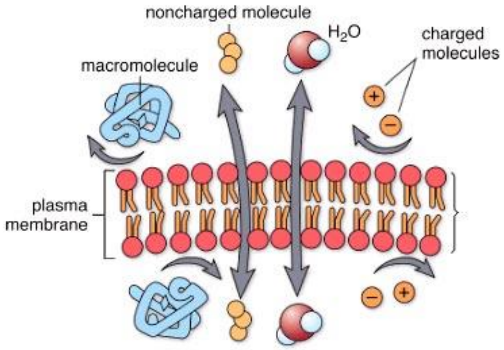
2. **PERIPHERAL (or extrinsic) MEMBRANE PROTEINS**

= attached to the surface of the cell membrane

- Either on the cytoplasmic side (inside) or the outer surface side
    - Peripheral membrane proteins are sufficiently hydrophilic that they are located on the membrane surface
    - Attached to the cell membrane by weak hydrophilic bonds to either the hydrophilic portions of integral proteins that protrude from the membrane or to the hydrophilic heads of membrane phospholipids.
- The peripheral proteins on the inside of the cell membrane largely serve as links to cytoskeletal filaments, and on the outside, serve as links to an extracellular matrix.

THE TYPES OF MOLECULES THAT CROSS THE CELL MEMBRANE:

In order for molecules to enter or exit the cell, they must cross the cell membrane. The structure of the cell membrane affects what types of molecules can freely pass through it.



- Small **noncharged** lipid soluble molecules pass freely (easily) across the phospholipid bilayer.

Examples: Vitamins A, D, K; gases (oxygen and carbon dioxide); alcohol

(**Water** passes into and out of the cell with relative ease. It probably moves through protein channels with a pore size large enough to allow the passage of water and prevent the passage of other molecules.)

- Macromolecules cannot cross the membrane because they are too large.

=Therefore they can only cross the cell membrane when they are taken in or out by vesicle formation

Examples: carbohydrates, lipids, proteins, nucleic acids

- Ions and charged molecules like sugars and amino acids, cannot cross the cell membrane because they are unable to enter the hydrophobic interior of the phospholipid bilayer.

  =Therefore, they are assisted across by one of two classes of integral transport proteins:

  1) **CARRIER PROTIENS** combine with an ion or charged molecules before transporting it across the membrane
  2) **CHANNEL PROTEINS** form a channel that allows an ion or charged molecules to pass through.

NOTE: The cell membrane is usually positively charged **outside** and negatively charged **inside**.

- Negative ions tend to move across carrier proteins or through channel proteins from **inside the cell to outside the cell.**

Example: Chloride ion (Cl^-); Hydroxide ion (OH^-)

- Positive ions tend to move across carrier proteins or through channel proteins from **outside the cell to the inside**

Example: Hydrogen ion (H^+); Magnesium ion (Mg^{+2})

Because the passage of molecules through the membrane is restricted, the CELL MEMBRANE is said to be:

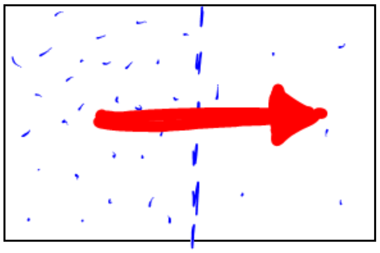
SELECTIVELY (DIFFERENTIALLY) PERMEABLE

TRANSPORT ACROSS THE CELL MEMBRANE:

There are two basic mechanisms by which materials are transported across cell membranes:

1. PASSIVE WAYS and 2. ACTIVE WAYS

I. **PASSIVE WAYS:** do not require energy (ATP)



- Depends on the differences in concentration of molecules inside and outside of the cell, and the random motion energy (Kinetic energy) of these molecules.
    - *If the molecules are more highly concentrated outside, the direction of movement will be from outside to inside. If the concentration is higher inside, the movement will be in the opposite direction.*

This difference in concentration inside and outside of the cell is known as the:
concentration ([ ]) gradient

a) **Simple Diffusion ("Diffusion")**

= movement of molecules from an area of high concentration to an area of lower concentration DOWN the [ ] gradient until equilibrium is reached

- Diffusion is a physical process that applies to any type of molecule, but the chemical and physical properties of the SELECTIVELY PERMEABLE cell membrane only allow just a few types of molecules to enter and exit.

Example: Lipid-soluble molecules (ie: alcohols); Gases (ie O_2 and CO_2)

Factors Affecting the Rate of Diffusion

- temperature = higher → particles move faster → more collisions → more rapid diffusion
- concentration gradient = higher [ ] of particles on one side → more rapid diffusion
- pressure (more crowded on one side of membrane) = ↑ pressure moves particles closer → ↑ concentration → more collisions, more rapid diffusion.

(Aided) b) **Facilitated Diffusion (movement with the concentration gradient)**

= diffusion of materials across a cell membrane assisted by a specific protein carrier

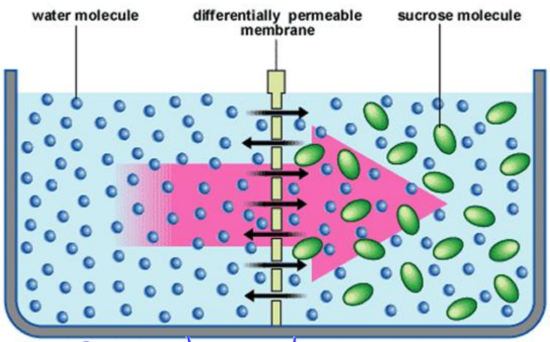
- Driven by a concentration gradient, therefore does not require ATP energy
- Occurs at a faster rate than simple diffusion

Example: certain sugar molecules (ie. glucose); amino acids

c) **Osmosis ("a special sort of diffusion dealing with water crossing the membrane")**

= passive transport (no ATP) of H_2O molecules across a selectively permeable membrane from an area of high water concentration (HWC) to an area of low water concentration (LWC)

- Water makes up about 70-95% of a living cell. Since water is the most abundant substance in cells, its movement into and out of cells is of vital importance. The cell has no control over osmosis. Water will flow into or out of the cell depending on the concentration of water molecules on either side of the membrane. The concentration of water on each side of the membrane, in turn, is determined by the concentration of solutes in that water solution.



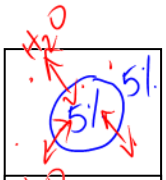
DEFINITIONS:

A **SOLUTION** contains both a SOLUTE and a SOLVENT

i) Solute = a substance dissolved in a solvent

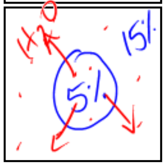
ii) Solvent = a fluid that dissolves solutes (water)

iii) Tonicity = solute strength (concentration)



ISOTONIC SOLUTION: iso = same; solute concentration is the same on both sides of the membrane.

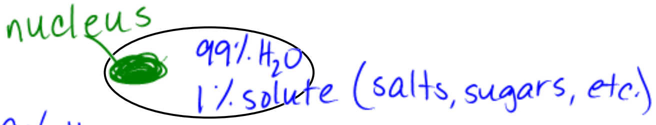
HYPOTONIC SOLUTION: hypo = less than (lower); solute concentration is lower outside than inside the cell



HYPERTONIC SOLUTION: hyper = more than (higher); solute concentration is higher outside than inside the cell

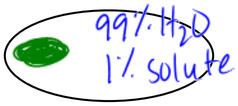
RESPONSE OF AN **ANIMAL CELL** IMMERSED IN SOLUTIONS OF DIFFERENT **OSMOTIC** CHARACTERISTICS:

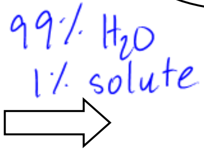
TYPICAL ANIMAL CELL



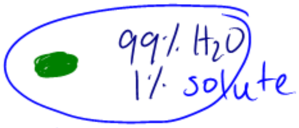
1. Placed in an **ISOTONIC** solution:

Before:





After:

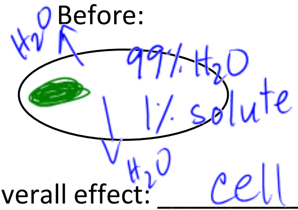


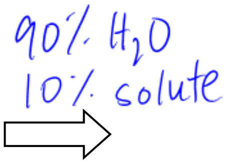
NO NET MOVEMENT OF H_2O

= Overall effect: no net change, solute concentration is the same on both sides of membrane

2. Placed in a **HYPERTONIC** solution:

Before:





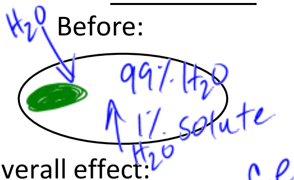
After:

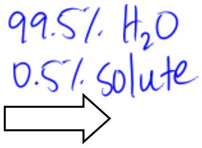
NET MOVEMENT OF H_2O OUT OF CELL

= Overall effect: cell loses water → shrinks
process is call crenation

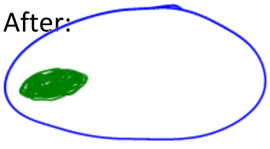
3. Placed in an **HYPOTONIC** solution:

Before:





After:



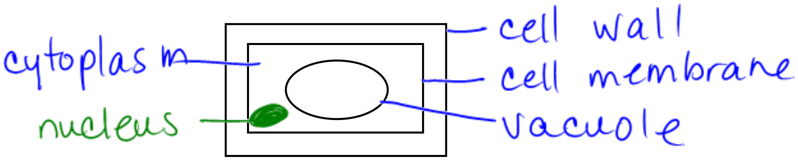
CELL BURSTS = LYSIS

= Overall effect: cell gains water = swells up and bursts due to water pressure

Red blood cell bursts = hemolysis

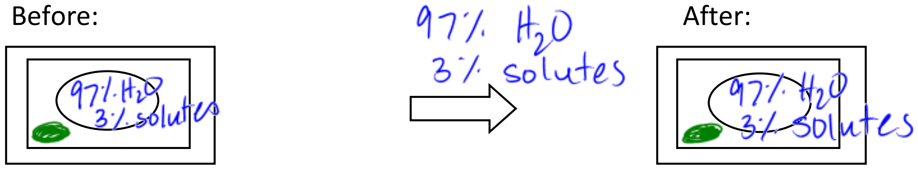
RESPONSES OF A **PLANT CELL** IMMERSED IN SOLUTIONS OF DIFFERENT **OSMOTIC** CHARACTERISTICS:

TYPICAL PLANT CELL:



1. Placed in an **ISOTONIC** solution:

Before: After:

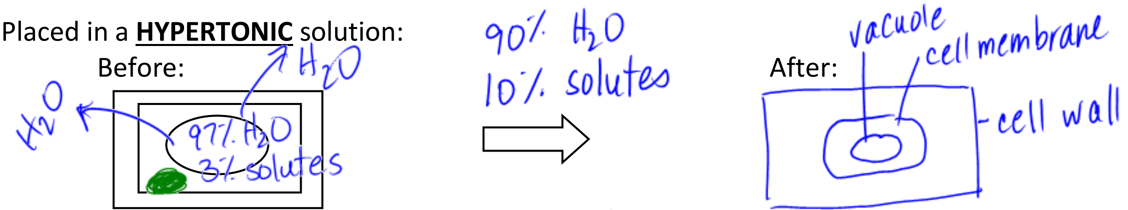


NO NET MOVEMENT OF H_2O

= Overall effect: no overall change solute concentration is the same on both sides of membrane

2. Placed in a **HYPERTONIC** solution:

Before: After:

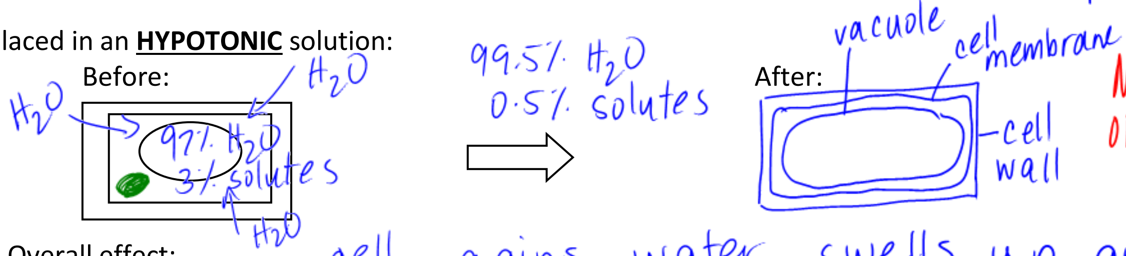


NET MOVEMENT OF WATER OUT OF CELL

= Overall effect: cell loses water → remains the same size but cytoplasm and vacuole shrink = plasmolysis

3. Placed in an **HYPOTONIC** solution:

Before: After:



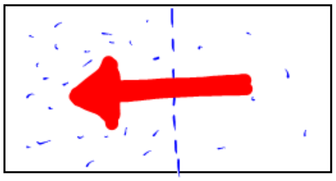
NET MOVEMENT OF H_2O INTO CELL.

= Overall effect: cell gains water, swells up and becomes turgid (does not burst due to cell wall)

II. **ACTIVE WAYS:** requires energy (ATP)

a) Active Transport

Both a **carrier protein** and an expenditure of **energy** are needed to transport molecules against their **concentration gradient.**

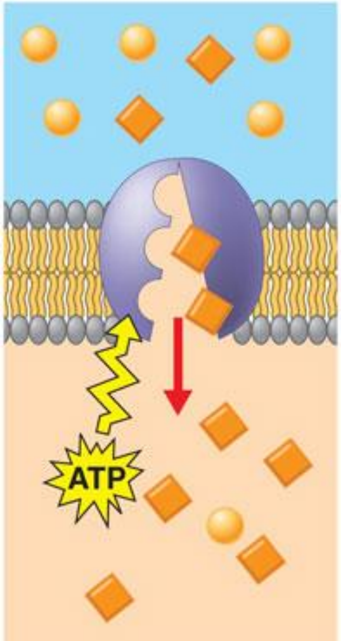


= the transfer of a substance into or out of a cell from a region of lower concentration to an area of higher concentration

Four characteristics provide the major criteria identifying ACTIVE TRANSPORT:

1. It goes against the concentration gradient.
    - That is, molecules move from a region of low concentration of that molecule to a region of high concentration of that molecule.
2. It requires cellular energy.
    - This energy comes from a special energy-carrying molecule = ATP (adenosine triphosphate). Splitting of one of the three phosphate groups converts ATP into ADP (adenosine diphosphate), which releases free energy. Therefore, it is not surprising that cells involved primarily in active transport, such as kidney cells, have a large number of mitochondria near the membrane through which the active transport is occurring.
3. It depends on the presence and activity of carrier proteins.
    - Carrier proteins involved in active transport often are called pumps, because just as a water pump uses energy to move water against the force of gravity, carrier proteins use energy to move a molecule against its concentration gradient.

Active transport



4. It is specific for certain molecules.
    - Each molecule type is transported by a separate, specific carrier protein that “recognizes” and moves it across the membrane.

Active Transport serves three major functions in cells and organelles:

1. It makes possible the uptake of fuel molecules and other essential nutrients from the environment or surrounding fluid, even when their concentrations are very low.

2. It allows various substances, such as secretory products, waste materials, and sodium ions, to be removed from the cell or organelle, even when the concentration outside is greater than inside.

3. It enables the cell to maintain constant optimal internal concentrations of inorganic electrolytes, particularly potassium, calcium and hydrogen ions.

Examples of Active Transport:

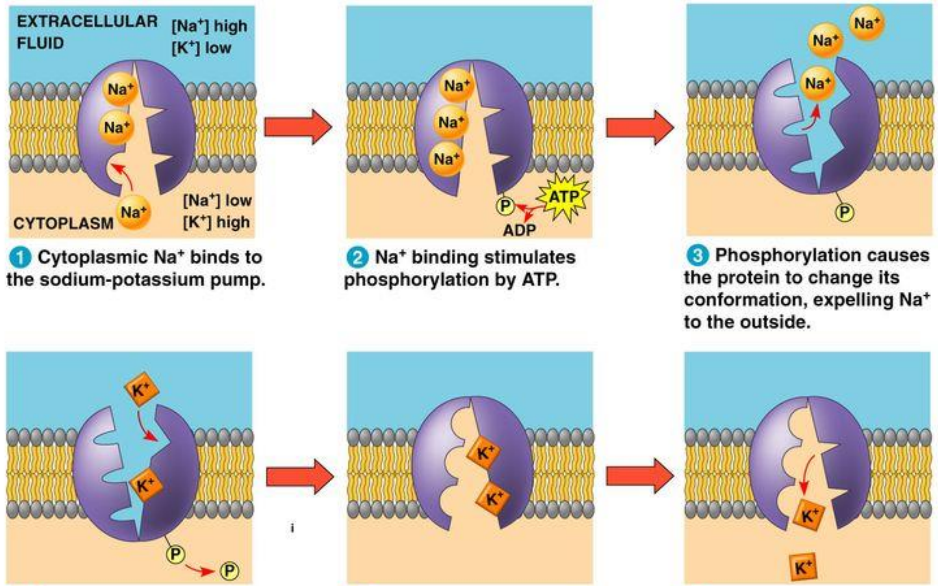
- Absorption of sugar from the intestine; sodium in the kidney tubules; iodine in the cells of the thyroid gland; Sodium-Potassium pumps in nerve and muscle cells.

The **SODIUM-POTASSIUM PUMP:**

One type of active transport present in all cells, but especially important in nerve and muscle cells, is the active accumulation of sodium ions (Na^+) outside the cell and the corresponding accumulation of potassium ions (K^+) within the cell. These two events are presumed to be linked, and the carrier protein is called a **sodium-potassium pump.**

A change in carrier protein shape after the attachment and again the detachment of a phosphate group allows it to alternately combine with sodium ions and potassium ions.

The phosphate group is donated by ATP, which is broken down enzymatically by the carrier.



① Cytoplasmic Na^+ binds to the sodium-potassium pump.

② Na^+ binding stimulates phosphorylation by ATP.

③ Phosphorylation causes the protein to change its conformation, expelling Na^+ to the outside.

④ Extracellular K^+ binds to the protein, triggering release of the phosphate group.

⑤ Loss of the phosphate restores the protein's original conformation.

⑥ K^+ is released and Na^+ sites are receptive again; the cycle repeats.

b) Endocytosis ("Entering by a sac") ("endo" = within; "cyte" = cell; "osis" = action

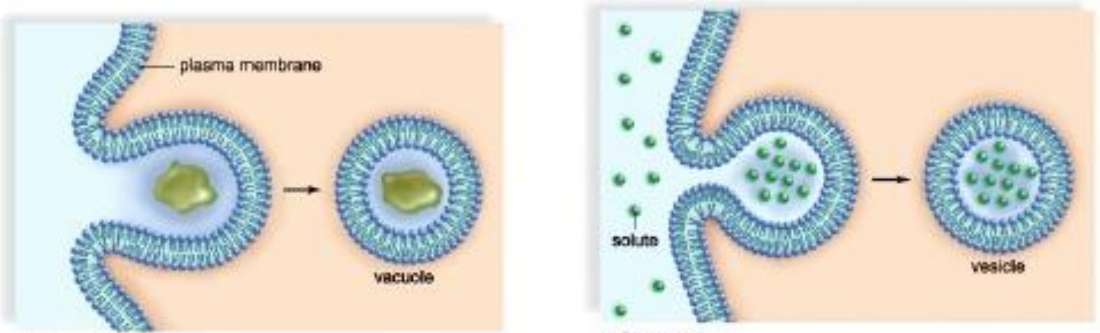
= process in which a vesicle is formed at the cell membrane to bring a substance into a cell

- Macromolecules, such as polypeptides, polysaccharides, or polynucleotides are too large to be transported by protein carriers. Instead macromolecules are transported into the cell by vesicle formation, and this keeps the macromolecules contained so that they do not mix with those in the cytoplasm.
- A portion of the cell membrane invaginates to envelop the substance, and then the membrane pinches off to form an intracellular vesicle.
- Once formed, vesicles contain a substance enclosed by a membrane. In order that these substances might be broken down and incorporated into the cytoplasm, digestion is required. Therefore, it is believed that lysosomes probably fuse with these bodies in order that digestive enzymes may begin to break down the molecules they contain.
- Endocytosis, even when not moving substances against a concentration gradient, **requires energy.**

ENDOCYTOSIS includes:

- Phagocytosis (cell eating) = large sized material, such as a food particle or another cell, is taken into the cell by forming a vesicle.

Example: macrophages remove bacteria and worn-out red blood cells.



a. Phagocytosis

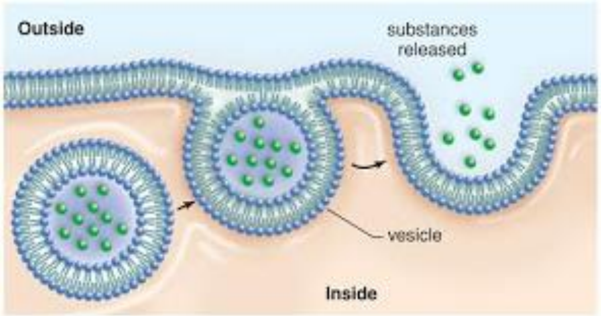
b. Pinocytosis

- Pinocytosis (cell drinking) = liquid or small molecules that are in solution are taken into the cell by forming a vesicle. Whereas phagocytosis can be seen with the light microscope, the electron microscope is required to observe pinocytotic vesicles.

Example: blood cells, cells that line the kidney tubules or intestinal wall and plant root cells, all use this method of ingesting substances.

c) **Exocytosis ("leaving by a sac") ("exo" = without; "cyte" = cell; "osis" = action)**
= process in which a secreted vesicle fuses with the inner cell membrane → vesicle contents are released to the outside of the cell

- Exocytosis is the reverse of endocytosis
- Exocytosis is required for secretion.
  - Substances enclosed in membrane-bound vesicles are carried through the cytoplasm to the inner surface of the membrane. The vesicle then fuses with cell membrane and then releases the vesicle contents to the cell exterior.
- Exocytosis, even when not moving substances against a concentration gradient, **requires energy**.



b. Exocytosis

- cell membrane enlarges

Examples of EXOCYTOSIS:

- Protein secretion to the outside of the cell
- Removal of residues remaining after digestion by lysosome enzymes.

PROTEIN SECRETION
= the dynamic relationship between the nucleus, rough endoplasmic reticulum (rER), Golgi Apparatus and cell surface membrane.

Several cytoplasmic structures function in the synthesis and modification of proteins.

Nucleus:

- One of the functions of the nucleus is to control protein synthesis. Genes contain DNA (found only in the nucleus) which works with RNA (found in both nucleus and cytoplasm) to bring about the synthesis of proteins. The proteins of a cell determine its structure and how it functions.
- The nucleus is separated from the cytoplasm by a double membrane known as the **nuclear envelope**

Ribosomes:

- The site of protein synthesis in the cytoplasm.
- They can be attached to the endoplasmic reticulum (proteins to be exported from the cell) or lie free within the cytoplasm (proteins to be used within the cell)

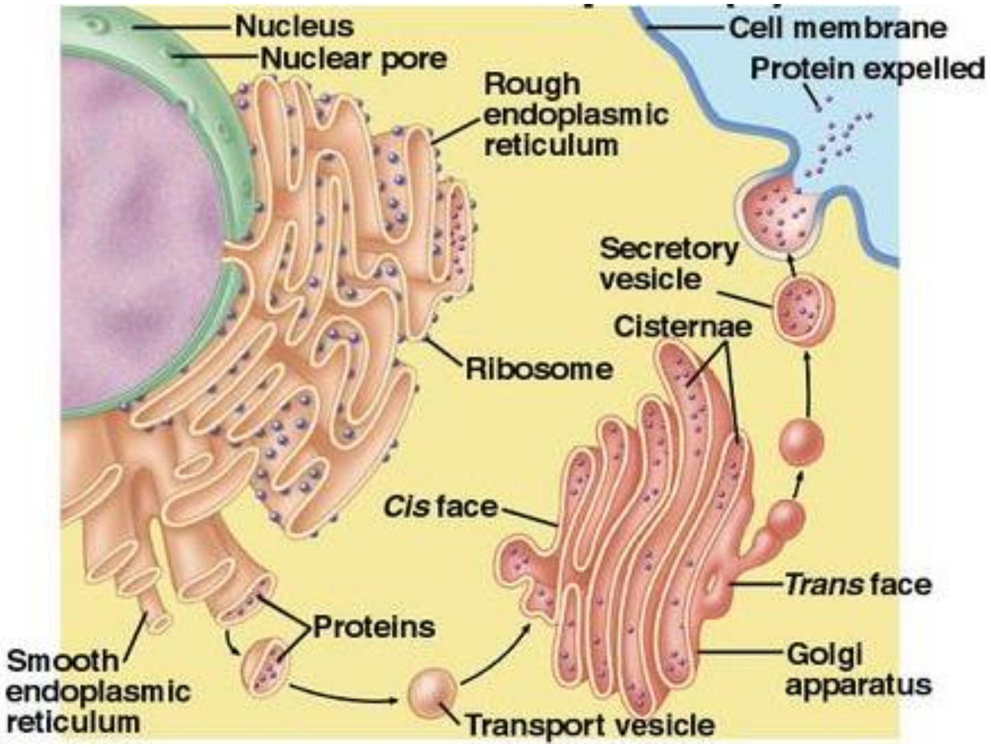
Endoplasmic Reticulum (ER):

- Forms a membranous system of tubular canals (cisternae), which are continuous with the nuclear envelope and branches throughout the cytoplasm.
- If ribosomes are not present, it is called **smooth ER.**
  - Rough ER specializes in protein synthesis

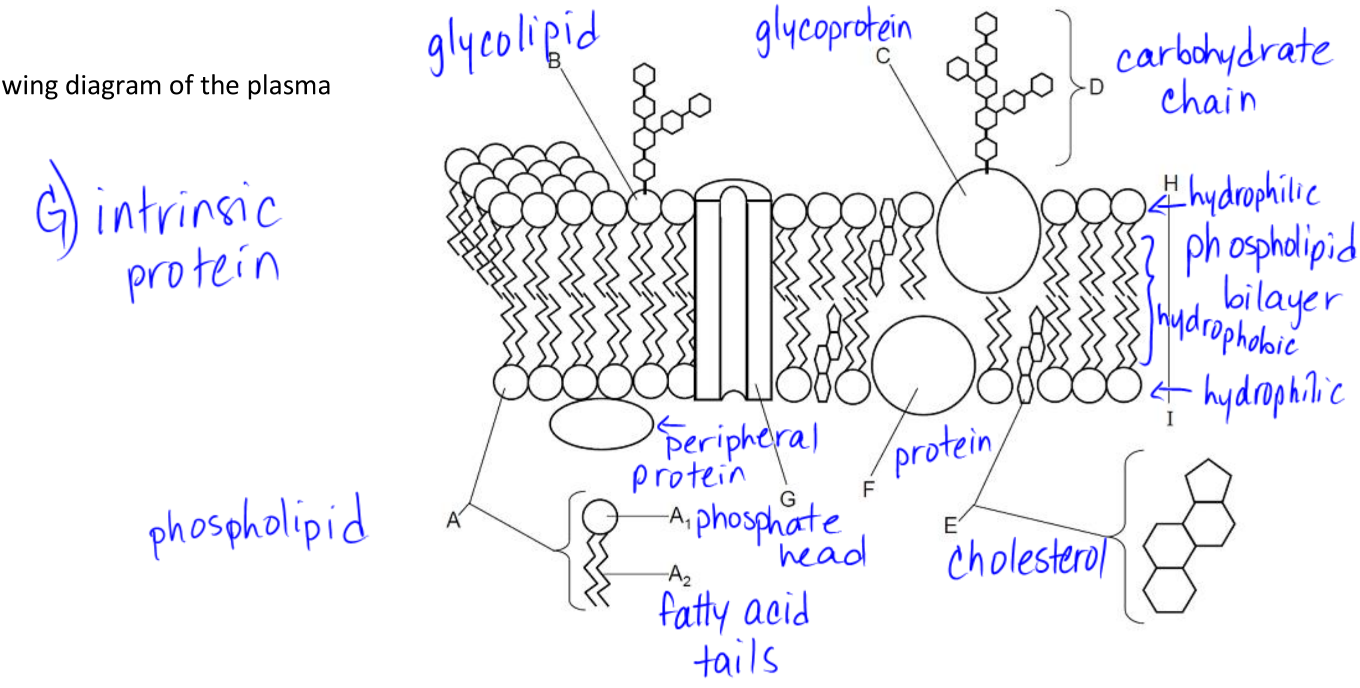
- The ribosomes attached to rough ER make proteins for export from the cell. As the proteins are being made by the ribosomes, they enter the lumen (cisternal space) of the rough ER, where they are modified.
- After arriving at the lumen of the smooth ER, a vesicle (transport vesicle) pinches off and then carries the protein to the Golgi Apparatus, where it is further processed.
    - This is how the Endoplasmic Reticulum serves as a transport system.

Golgi Apparatus:

- Composed of a stack of flattened saccules, which look like hollow pancakes. One side of the stack, called the **inner face,** directed toward the nucleus and the ER. The other side of the stack, called the **outer face,** is directed toward the cell membrane. **Vesicles** occur at the edges of the saccules.
- Functions in modifying, packaging and storing, and distributing proteins produced by the ER.
- After the protein-containing vesicles from the smooth ER are received by its inner face, they are modified as they move through the Golgi apparatus and are then repackaged into **secretory vesicles** that move to the cell membrane, where their contents are discharged by EXOCYTOSIS.
- The Golgi apparatus also produces LYSOSOMES.

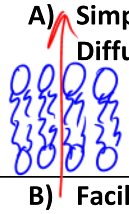


LABEL the following diagram of the plasma membrane:



TRANSPORT ACROSS THE CELL MEMBRANE: SUMMARY TABLE

1. PASSIVE WAYS (No energy/ATP required)

NAME OF PROCESS	DIRECTION	REQUIREMENTS	EXAMPLES
A) Simple Diffusion 	[high] to [low]	- concentration gradient	- small, non-charged lipid soluble molecules - CO_2, O_2 - alcohol - hormones
B) Facilitated Diffusion (faster)	[high] to [low]	- concentration gradient - carrier protein	- charged molecules - amino acids - ions - glucose
C) Osmosis - aqua pore channel	high [water] to low [water]	- concentration gradient (water)	- water

2. ACTIVE WAYS (Requires energy/ATP)

NAME OF PROCESS	DIRECTION	REQUIREMENTS	EXAMPLES
A) Active Transport * mitochondria	[low] to [high]	ATP + carrier protein	- Na^+/K^+ pump in nerve cells - iodine (thyroid)
B) Endocytosis i. Phagocytosis → solids (large molecules) ii. Pinocytosis → liquids (small molecules)	from outside to inside the cell	- ATP - vesicle	- white Blood Cell (WBC) engulfing bacteria - enzymes taken into a cell
C) Exocytosis	from inside to outside of cell	- ATP - vesicle	any secretory protein

Name: ____________________
Date: __________ Blk: _____

Plasma Membrane Structure and Function Worksheet
BC BIOLOGY 12 p. 81- 82

1. According to the _______________-_______________ model for the plasma membrane, there is a phospholipid _________________ in which proteins are scattered throughout the membrane. The _____________________ (water loving) polar heads of the phospholipids face the intracellular and extracellular fluid. The hydrophobic (water hating) nonpolar ________________ of the phospholipid molecules face each other.

2. Why is the cell membrane called the fluid-mosaic model?

3. Phospholipids have their hydrophilic polar heads facing the _____________________ and extracellular fluid. The _____________________ nonpolar tails face each other. The other two types of lipids present in the plasma membrane are the ____________________ and ___________________________. Lipid molecules that have carbohydrate chains attached are called __________________________ while protein molecules with attached carbohydrate chains are called ____________________________. These molecules play an important role in cellular ____________________________.

4. Where are integral and peripheral proteins found in the plasma membrane?

5. Can the phospholipid molecules move sideways and flip-flop? Why or why not?

6. In general, can the proteins in the plasma membrane migrate? Why or why not?

7. The proteins found in the plasma membrane may be _______________________ proteins, which are found within the membrane, or __________________________ proteins, which occur either on the cytoplasmic side or the outer surface side of the membrane.

8. Proteins form different patterns in particular membranes and also within the same membrane at different times. (True or False?) __________. The ___________________ proteins associated with a membrane often have a structural role to stabilize and shape the plasma membrane.

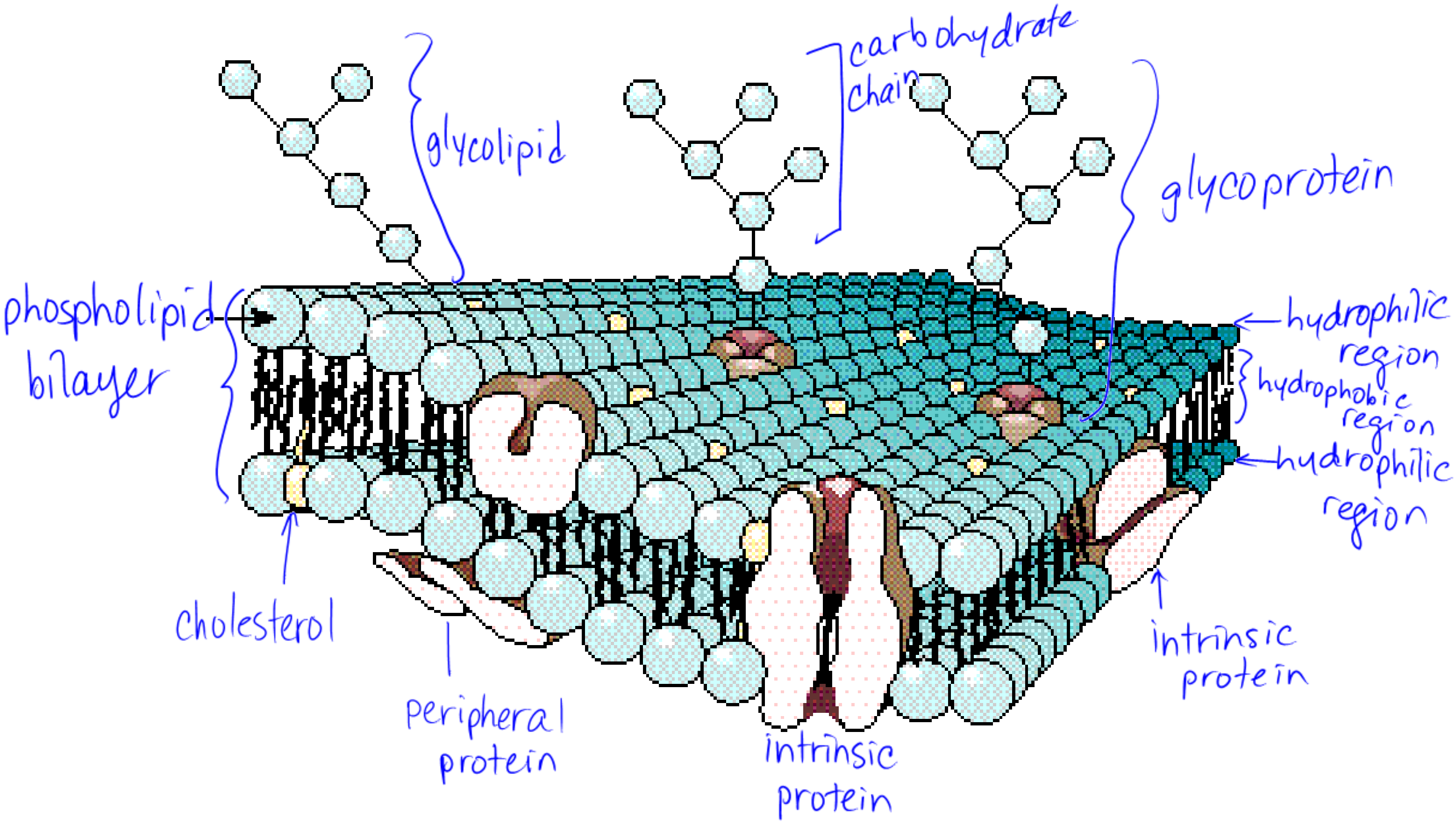
9. Place an "X" next to any of the statements below that are true about the plasma membrane.
_____ The greater the concentration of unsaturated fatty acids, the more fluid is the bilayer
_____ Phospholipid molecules flip-flop from one layer to the other.
_____ Most proteins can drift laterally in the fluid lipid bilayer.
_____ The carbohydrate portions of glycoproteins and glycolipids project internally.

10. Draw and label a phospholipid. Show the hydrophobic and hydrophilic regions.

11. Complete the following table to understand the functions of each component in a plasma membrane.

Chemical Component	**Function**
Lipids:	
Phospholipid bilayer	
Cholesterol	
Proteins:	
Channel protein	
Carrier protein	
Receptor protein	
Enzymatic protein	
Carbohydrates:	
Glycolipids - glycoproteins	

12. Label this diagram of the plasma membrane with the following terms: glycoprotein, glycolipid, cholesterol, hydrophilic region, hydrophobic region. Phospholipid bilayer, protein molecules: Integral (intrinsic) membrane protein, peripheral (extrinsic) protein.



Name: ____________________
Date: __________ Blk: _____

Transport Across the Cell Membrane
BC Biology 12 p. 83-91

How Molecules Cross the Plasma Membrane

1. What type of molecules can pass through the plasma membrane?

2. What type of molecules cannot pass through the plasma membrane?

3. Since some molecules and not others can cross a membrane, it is said to be ___________________________ or selectively permeable.

4. Passive transport ways do not use _____________________ and involve _______________________ or facilitated transport. ______________________________ transport ways do use cellular energy and include active transport, ______________________________, and exocytosis.

Diffusion and Osmosis

1. What happens during diffusion?

2. If dye molecules are placed in water, the _____________ is the dye and the __________ is the water molecules.

3. Define osmosis.

4. In __________ solutions, the solute concentration is the same on both sides of the membrane, and there is no net gain or loss of water. If a cell is placed in a __________ solution, water enters the cell and may cause the cell to burst. __________ refers to disrupted red blood cells.

5. __________ pressure occurs when a plant cell is placed in hypotonic solution and the cytoplasm expands because the large _________________ gains water. The plant cell does not burst due to the _____________________ of the plant.

6. In a ___________________ solution, water leaves the cell and the cell shrinks. If red blood cells are placed in a solution greater than __________ sodium chloride, they shrink and the process is called ________________________. __________ occurs when the plasma membrane pulls away from the cell wall and the cytoplasm shrinks in a hypertonic solution.

7. Define the following terms:

a. turgor pressure:

b. crenation

c. plasmolysis:

8. Red blood cells will not gain or lose water if they are put into 0.9% NaCl. such a solution is said to be ______________________. If the red blood cells were placed in 0.75% NaCl, such a solution would be considered ____________________ and water would ________________ (enter/leave) the cell and cause the cells to undergo ________________________. On the other hand, if the red blood cells were placed in 1.5% NaCl, such a solution would be considered ________________________. In this case, water would ___________________ (enter/leave) the cell and the red blood cells would ______________ (swell/shrink). Such a condition is termed ________________________.

Transport by Carrier Proteins

1. What accounts for the ability of useful molecules to enter and exit the cell at a rapid rate?
2. Are carrier proteins specific for a particular molecule?
3. In ___________________________ transport, glucose and amino acids bind to specific carrier proteins transport the molecules to the other side of the membrane down their __________________________ gradient without the expenditure of ________________________.
4. In ________________________ transport, carrier proteins and an expenditure of __________________ are needed to transport molecules ________________________ their concentration gradient. If the carrier protein transports sodium and potassium, it is called a sodium-potassium ________________.

Endocytosis and Exocytosis

1. Define endocytosis:

2. Define exocytosis:

3. ________________________ occurs when the material taken in by endocytosis is large, such as a food particle.
_________________________ occurs when vesicles form around a liquid or very small particles.

Summary

1. Label each of the situations listed below as to whether diffusion (D), osmosis (O), facilitated transport (F), active transport (A), exocytosis (E), phagocytosis (P) or pinocytosis (Pi) has taken place.

__F__Glucose enters liver cells very quickly by binding to a receptor in the plasma membrane.
__D__An onion is detected by smell at the end of the kitchen table.
__O__A red blood cell shrinks in a solution containing 1% salt.
__D__Red dye crystals are equally distributed in a beaker of water.
__Pi__Fluid, containing minerals, enters a cell by forming a vesicle at the plasma membrane.
__E__Thyroid hormone exits the cell after the Golgi vesicle containing it fused with the plasma membrane.
__P__A bacterial cell is engulfed by a white blood cell.
__A__Sodium ions are pumped out of a cell against a concentration gradient.

2. Complete the table below to distinguish how molecules pass into and out of cell by writing Yes or No.

Process	Uses Energy	Uses Carrier Protein	Goes with Conc. Gradient	Goes against Conc. Gradient	Plasma Membrane Forms Vesicles	Molecules Enter Cell	Molecules Leave Cell	Fluid Uptake in Vesicle	Solid uptake in Vesicle
Diffusion			✓			✓	✓		
Osmosis			✓			✓	✓		
Facilitate transport		✓	✓			✓	✓		
Active Transport	✓	✓		✓		✓	✓		
Exocytosis	✓		both	both			✓		
Pinocytosis	✓		both	both	✓	✓		✓	
Phagocytosis	✓		both	both	✓	✓			✓

3. How does each of the following molecules enter a cell?

a. oxygen SIMPLE DIFFUSION
b. glucose FACILITATED DIFFUSION
c. potassium ions ACTIVE TRANSPORT
d. water OSMOSIS.