GENERAL BIOLOGY 1

MODULE 1

CELL – TRANSPORT MECHANISMS

AUTHORS

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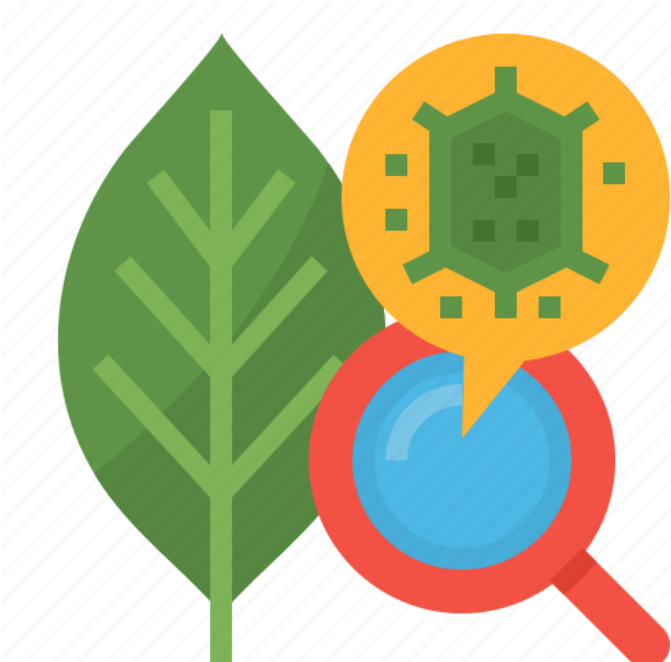


Module 1
Transport Mechanisms

Learning Competencies

- Describe the structural components of the cell membrane;
- Relate the structure and composition of the cell membrane to its function;
- Explain Transport Mechanisms in cells (diffusion, osmosis, facilitated transport, active transport); and
- Differentiate exocytosis and endocytosis.

What you are expected to learn from this module?

After studying this module, you are expected to:

- Identify and describe the different structural components of the cell membrane;
- Connect the structural components of the cell membrane to its function;
- Explain the various Cell Transport Mechanisms namely: diffusion, osmosis, facilitated transport, and active transport; and
- Distinguish the differences between exocytosis and endocytosis.

What is this module all about?

In the preceding discussion, you were able to comprehend the various structures of cells as well as their functions, distinguish between prokaryotic and eukaryotic cells based on their distinguishing characteristics, and characterize the stages of the cell cycle while also comprehending its significance in our lives.

This module will teach you how cells regulate the movement of materials across the cell membrane. Recognize the significance of these materials moving in and out of the cell membrane to meet the demands of maintenance and construction, as well as other cell activities. Furthermore, going through this module will assist you in thoroughly describing and understanding the various cell transport mechanisms.

This module contains the following lessons:

- **Lesson 1 - The Structural Components of the Cell Membrane**
- **Lesson 2 - The Relationship of the Structural Components of the Cell Membrane to its Function**
- **Lesson 3 - Transport Mechanisms in Cells**

How to learn from this module?

I'm sure you're absolutely thrilled to begin your adventure and learn new things. To successfully complete the objectives in this module, keep the following learning tips in mind:

1. Read and follow the instructions carefully.
2. Take your time in reading the lessons.
3. Take note all the essential concepts and terminologies.
4. Answer all the given tests and learning activities honestly and diligently.

What to do before this module?

Directions: Read and understand each item carefully and choose the letter of the correct answer. Each item is worth 1 point. Write your answers on a separate sheet of paper. Good luck!

1. What is the primary function of carbohydrates attached to the exterior of the cell membranes?

A. identification of the cell
B. flexibility of the membrane
C. strengthening the membrane
D. channels through membrane

2. Which of the following plasma membrane component can be either found on its surface or embedded in the membrane structure?

A. protein
B. cholesterol
C. carbohydrate
D. phospholipid

3. Which of the following plasma membrane component where carbohydrates is found outside the surface of the cell and bounded with?

A. lipid or protein
B. phospholipid
C. glycoprotein
D. glycolipid

4. Which interacts to hydrophilic and hydrophobic environments?

A. protein
B. cholesterol
C. phospholipid
D. carbohydrate

5. Which characteristic of a phospholipid contributes to the fluidity of the membrane?
A. its head
B. cholesterol
C. a saturated fatty acid tail
D. double bonds in the fatty acid tail

6. What is the primary function of the plasma membrane?
A. to protect the cell from its surroundings.
B. to provide shape and integrity to the cell.
C. to maintain the cell potential.
D. to be a fluid mosaic model.

7. A vital for cellular signaling processes that influence tissue and organ formation is called _____.
A. membrane markers
B. membrane receptors
C. glycoprotein
D. glycolipid

8. What is the relationship of Cellular Transport Mechanisms to the Plasma Membrane?
A. to protect intracellular components from the extracellular environment.
B. to transport materials into or out of the cell
C. to enclose and define the borders of the cell
D. to transmit signals via complex proteins

9. What is the relationship of Cellular Signaling to the Plasma Membrane?
A. to protect intracellular components from the extracellular environment.
B. to enclose and define the borders of the cell
C. to transmit signals via complex proteins
D. to transport materials into or out of the cell

10. Which of the following hydrocarbons does not dissolve in the lipid bilayer?
A. hydrophilic
B. hydrophobic
C. non polar
D. polar

11. Which of the following is not a part of the cellular transport mechanisms?
A. facilitated
B. active
C. osmosis
D. exocytosis

12. Which of these is the most direct form of cellular transport mechanisms?
A. passive
B. active
C. osmosis
D. exocytosis

13. It is when water molecules move from a region of high concentration to a region of low concentration.
A. facilitated
B. active
C. osmosis
D. diffusion

14. Which of the following is not an attributes of exocytosis?
A. involved with up taking nutrients into the cell

B. secretory vesicles are formed
C. involved in removing waste from the cell
D. uninvolved in cell Wall Formation

15. Water inside the cell equals the water outside the cell and equal amounts of water move in and out of the cell.
A. osmotic
B. hypertonic
C. hypotonic
D. isotonic

16. Which of these mechanisms uses ATP?
A. facilitated
B. active

C. osmosis
D. exocytosis

17. It is the process where the cell engulfs extracellular fluid including material dissolved or suspended in it.
A. passive
B. active
C. endocytosis
D. exocytosis
18. It is otherwise known as cell drinking—a process where small droplets of extracellular fluid is being taken by the cell.
A. pinocytosis
B. phagocytosis
C. endocytosis
D. exocytosis

19. Which type of solution causes a cell to swell?

A. osmotic
B. hypotonic

C. hypertonic
D. isotonic

20. Which of the following terms means water-loving?

A. hypotonic
B. hypertonic

C. hydrophobic
D. hydrophilic

Lesson 1 - The Structural Components of the Cell Membrane

In the current pandemic situation in the Philippines, I know you have observed our law enforcers and frontlines at the checkpoints of different city or security guards at the mall entrances. You can just imagine them as a ***plasma membrane (also known as the cell membrane or cytoplasmic membrane)*** which have a crucial work to do such as permitting or prohibiting who will enter the establishment or the particular city ***(represents the cell)*** or not and even exiting is being checked as well. Carrying goods in a truck or individuals on motorcycles towards a specific cordoned area that shows various methods or ways on how materials are transported in and out of the cell; thus, the ***transport mechanisms***.

Figure 1.A. Image Credit: Philippine News Agency (2021).

Figure 1.B. Image Credit: Rappler (2020).

Membrane transport is a term used in cellular biology to describe a group of mechanisms that control the passage of solutes including such small molecules and ions through biological membranes, which are lipid bilayers with proteins embedded in them.

For all cells, the **plasma membrane (cell membrane)** plays an essential role in the transport mechanisms because it forms a boundary between living cells and their surroundings (in the form of lipids) and controls the traffic molecules/materials that go in and out of the cell. It also needs proteins, which are involved in cross-membrane transport and cell communication, and carbohydrates (sugars and sugar chains), which decorate both the proteins and lipids and help cells recognize each other. The primary function of the plasma membrane is to protect the cell from its surroundings. The plasma membrane, like all other membranes in a cell, exhibits selective permeability, which means that it only allows certain substances to cross more easily than others and completely blocks passage of some substances altogether. Substances such as

water, carbon dioxide, oxygen, and other smaller particles or molecules can pass through the cell's pores; however, larger molecules such as proteins and fats require a lot of energy to pass through or otherwise they won't pass through at all. The plasma membrane takes up substances that the cell requires to meet the demands of maintenance and building, as well as other cell activities, and it also disposes of the cell's wastes.

The illustration below shows the structure of the plasma membrane. The plasma membrane (cell membrane), like other cellular membranes, is referred to as a ***fluid mosaic*** or ***fluid mosaics of lipids and proteins*** in modern terminology. The term mosaic refers to a surface composed of small fragments, such as colored tile cemented together in a mosaic floor or picture. It is primarily made up of a bilayer of phospholipids with their hydrophobic, fatty acid tails in contact with one another. The membrane's landscape is littered with proteins, some of which span the membrane. Some of these proteins are involved in the transport of materials into and out of the cell. Carbohydrates are connected to some of the proteins and lipids on the membrane's outward-facing surface, forming complexes that serve to identify the cell to other cells. Cell membranes enclose and define the boundaries of cells, but they are dynamic and constantly in flux, rather than a static bag. Some of the proteins are linked to the cytoskeleton as well as fibers of the adjacent extracellular material, which aids in the stabilization of the delicate membrane, (as shown in Figure 1.C.).

Structural Components of the Cell Membrane

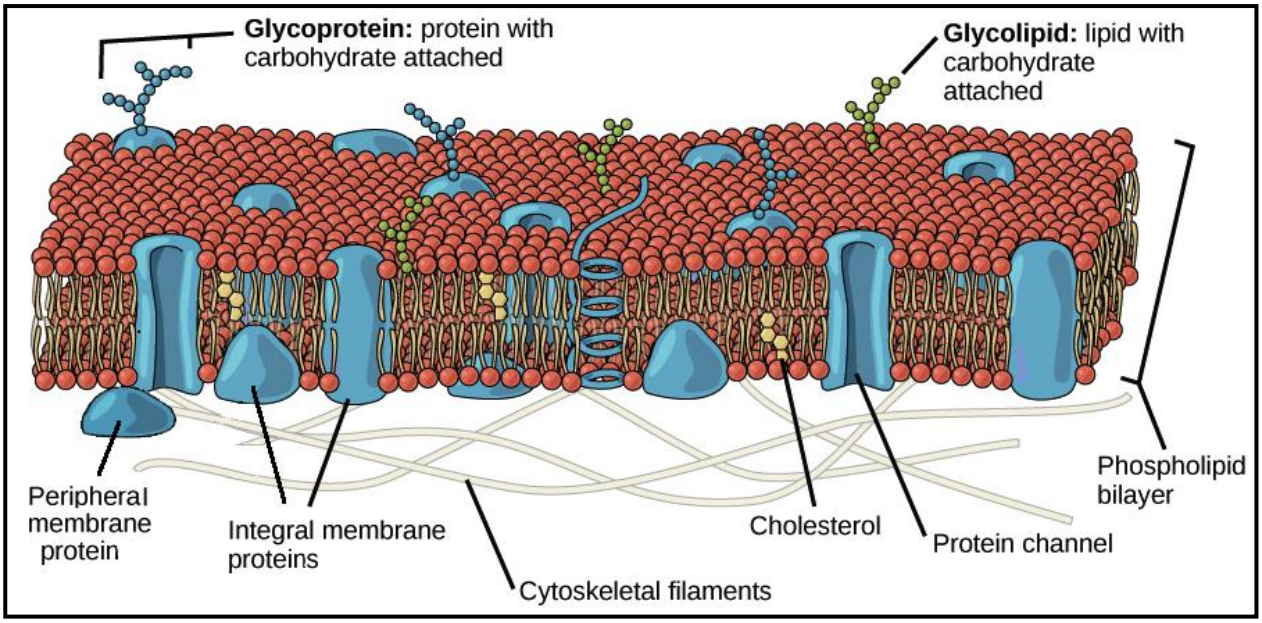


Figure 1.C. Image Credit: Khan Academy Article, originally OpenStax Biology.

In 1935, **Davson-Danielli**, the sandwich model of membrane structure stated that the membrane was made up of a **phospholipid bilayer sandwiched between two protein layers**. Meanwhile, in 1972, a new model was proposed by **Seymour Singer and Garth Nicolson**. According to this model, **proteins were embedded within the lipid bilayer rather than existing as separate layers**. This model, known as the **fluid-mosaic model**, remains the model preferred by scientists today (with refinements).

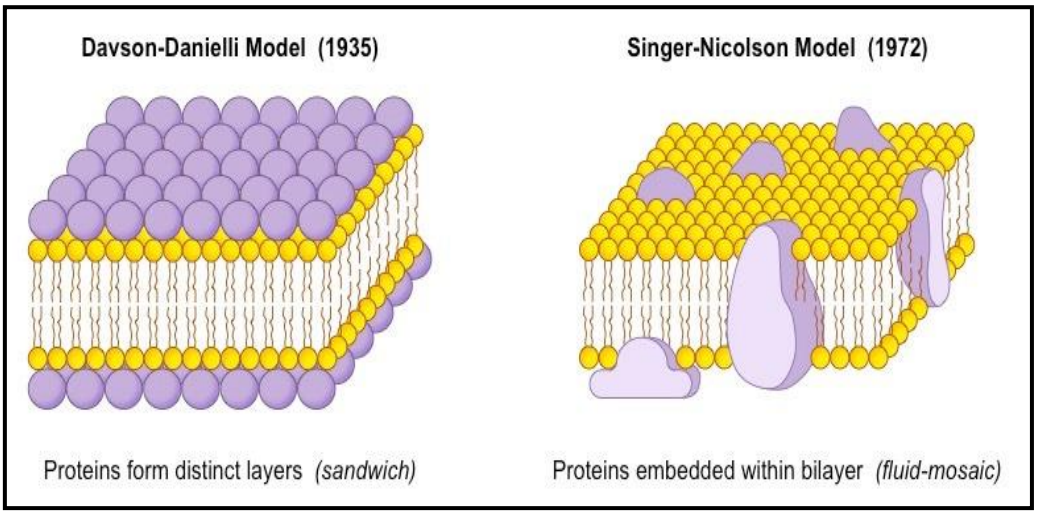


Figure 1.D. Image Credit: BioNinja.

S. Singer and G. Nicolson proposed that the membrane is a mosaic of proteins dispersed within the bilayer, with only the hydrophilic regions exposed to water.

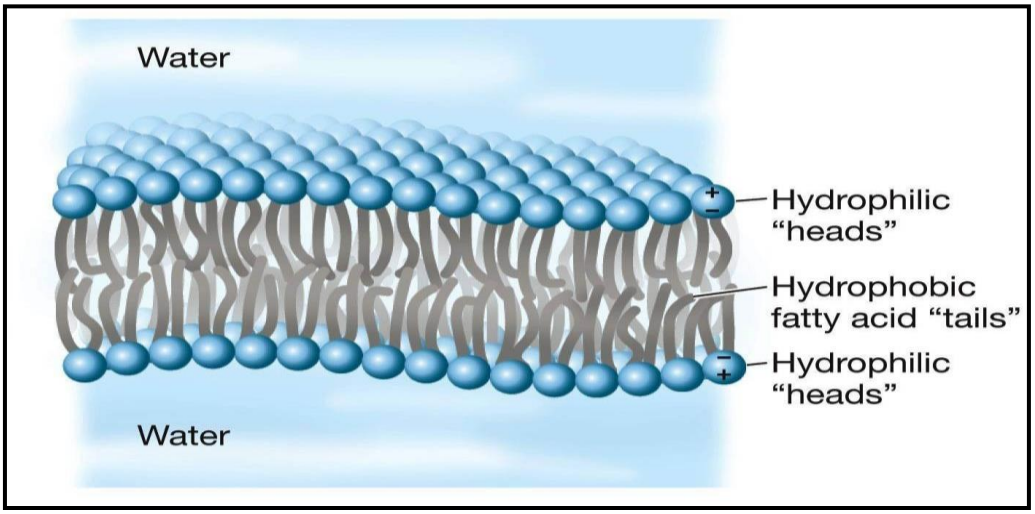


Figure 1.E. Image Credit: LIFE: The Science of Biology, Eight Edition (2007).

The Fluidity of the Membrane

Membranes' fluidity is caused by **temperature**, the configuration of the unsaturated fatty acid tails (some kinked or form a sharp twist by double bonds), the presence of cholesterol embedded in the membrane, and the mosaic nature of the proteins and protein-carbohydrate combinations, which are not firmly fixed in place.

Key Takes of the Fluid Nature of the Cell Membrane:

- Phospholipids in the plasma membrane have the ability to move within the bilayer.
- The majority of lipids and some proteins **drift laterally**.
- It is uncommon for a molecule to **flip-flop transversely** across the membrane.

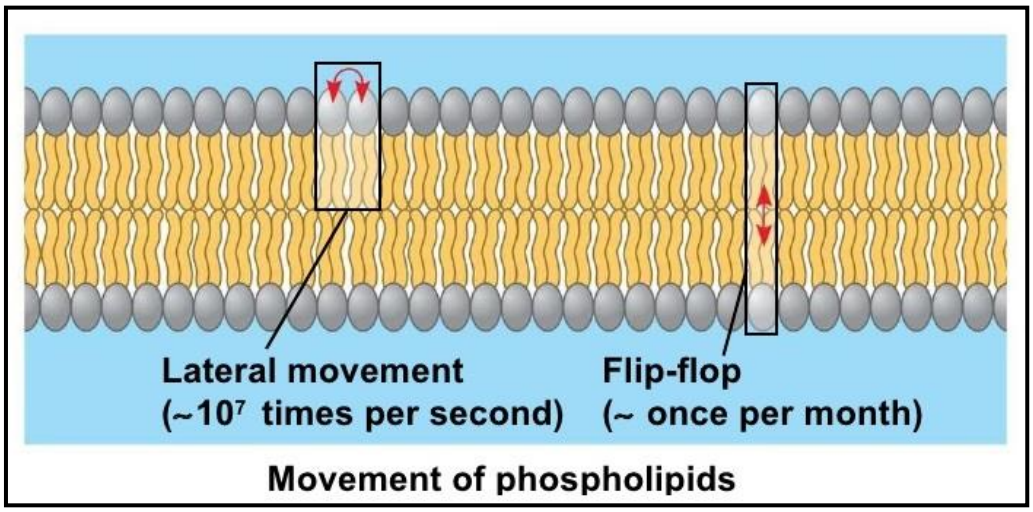


Figure 1.F. Image Credit: Slideplayer.com (2021).

Factors Affecting the Fluidity of the Cell Membrane

Several factors influence the fluidity of the cell membrane, as illustrated in figure 1.G.

- As temperatures fall, membranes transition from a fluid to a solid state.
- The temperature at which a membrane solidifies is determined by the lipids used.
- Unsaturated fatty acid-rich membranes are more fluid than saturated fatty acid-rich membranes.

- Membranes must be fluid in order to function properly; they are typically about as fluid as salad oil.
- At different temperatures, the steroid cholesterol has different effects on membrane fluidity.
- Cholesterol inhibits the movement of phospholipids at high temperatures (such as 37°C).
- It maintains fluidity at low temperatures by preventing tight packing.

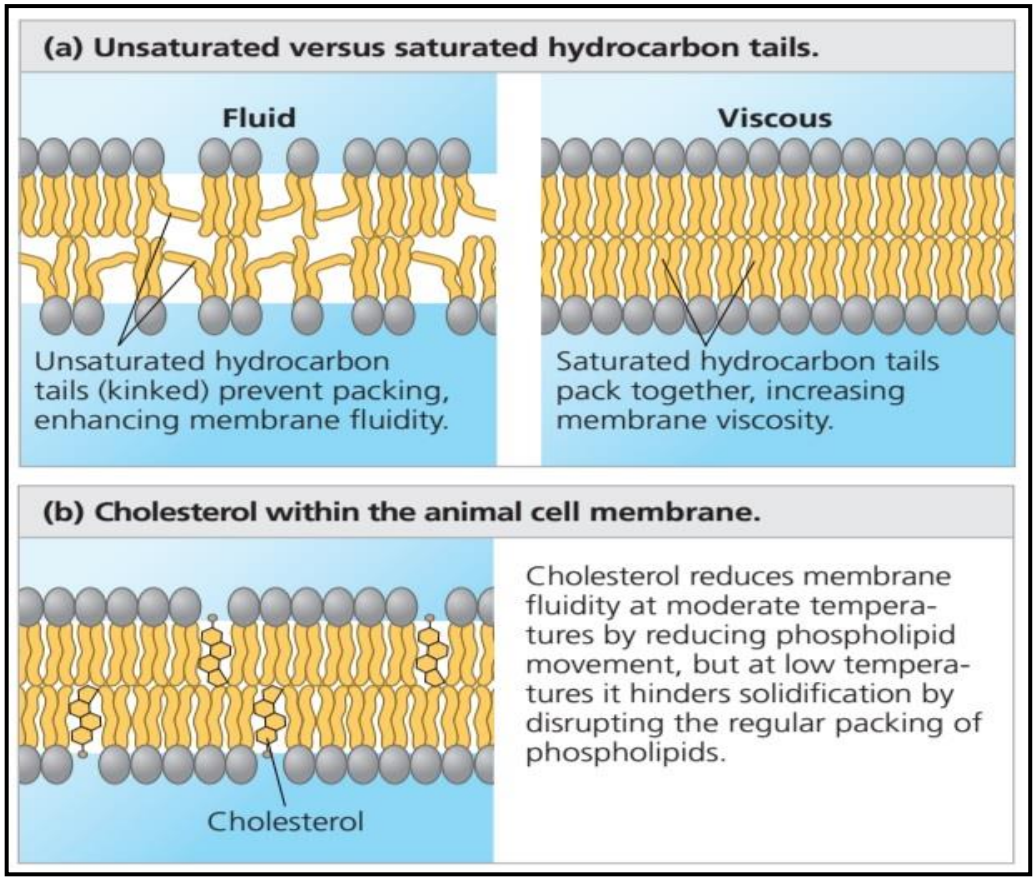


Figure 1.F. Image Credit: Urry, Lisa A. Campbell Biology. Pearson Education. Kindle Edition.

Structural Components of the Cell Membrane (*Plasma Membrane*)

COMPONENT	LOCATION	FUNCTION
Phospholipids	Main fabric of the membrane	• the most abundant lipid in the plasma membrane • are amphipathic

		molecules
Cholesterol	Tucked between the hydrophobic tails of the membrane phospholipids	Dampen effects of temperature
Integral Proteins	Embedded in the phospholipid bilayer; may or may not extend through both layers	Transport of substance through membrane
Peripheral Proteins	On the inner or outer surface of the phospholipid bilayer, but not embedded in its hydrophobic core	Cell recognition
Carbohydrate Chains	Attached to proteins or lipids on the extracellular side of the membrane (forming glycoproteins and glycolipids)	• Cell recognition • Effective interaction with the aqueous environment

Essential Terminologies:

Amphiphilic or Amphipathic

- A molecule with a polar or charged area and a nonpolar or uncharged area capable of interacting with both hydrophilic and hydrophobic environments.

Fluid Mosaic Model

- Describes the plasma membrane's structure as a mosaic of components that includes phospholipids, cholesterol, proteins, glycoproteins, and glycolipids (sugar chains attached to proteins or lipids, respectively), resulting in a fluid character (fluidity).

Glycolipid

- A carbohydrate-lipid combination.

Glycoprotein

- A carbohydrate-protein combination.

Hydrophilic

- A molecule that can form bonds with water; a water-loving molecule.

Hydrophobic

- A molecule that cannot form a bond with water; a water-hating molecule.

Integral protein

- A protein that is integrated into the membrane structure and interacts extensively with the hydrocarbon chains of membrane lipids; these proteins can only be removed by disrupting the membrane with detergents.

Peripheral protein

- Protein found on the surface of a plasma membrane, either on the exterior or interior side; these proteins can be removed (washed off the membrane) by a high-salt wash.

What will you do?

Learning Activity 1.1 - Fill me up!

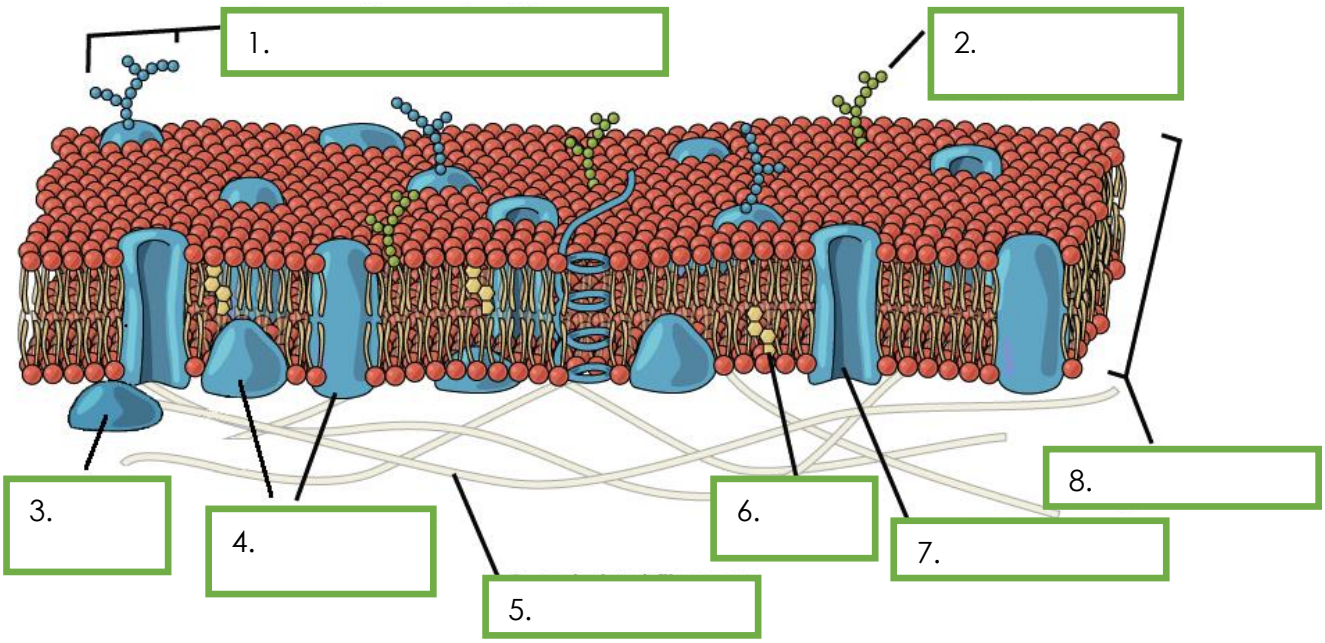
Directions: Provide the best answer by filling the blanks. Write your answers in a 1/2 sheet of paper. Each blank is worth of 1 point.

1. The modern terminology of the cellular or plasma membrane is referred to as the _____ or _____.
2. A membrane is mainly composed of a bilayer of _____.
3. A molecule that are attached to some of the proteins and lipids on the outward-facing surface of the membrane called as _____.
4. The main function of Carbohydrates is _____.
5. The fluid nature of the membrane is due to _____.
6. A type of protein found on the surface of a plasma membrane, either on the exterior or interior side; these proteins can be removed (washed off the membrane) by a high-salt wash is called as _____.
7. A _____ refers to the collection of mechanisms that regulate the passage of solutes.
8. An _____ is a type of protein that are integrated into the membrane structure that interacts extensively with the hydrocarbon chains of membrane lipids.

Key to Answers on pages 36-38.

Learning Activity 1.2 - Identify Me!

Directions: Identify the structural components of the cell membrane by providing the boxes with the correct answer. Write your answers in a 1/4 sheet of paper. Each box is worth of 1 point.



Key to Answers on pages 36-38.

Learning Activity 1.3 - Let's write a reflection!

Instructions:

1. Access and watch the video link provided; — "***Fluid mosaic model of cell membranes***" | Biology | by Khan Academy (2015), https://youtu.be/cP8iQu57dQo

2. Pay close attention to the video and be able to pinpoint and relate to each attribute of the membrane's structural components.

3. Reflect on your life experiences and connect them to the video lesson so that you can write a story similar to the structural components of the cell membrane.

4. Write your reflection neatly on a long piece of bond paper.

5. Your reflection paper will be evaluated using the scoring rubric below.

Reflective Writing Rubric

Skills	5	4	3	2	1
Depth of reflection	Demonstrate a conscious and thorough understanding of the subject matter. This reflection can be used as an example for other students.	Demonstrate a thoughtful understanding of the subject matter.	Demonstrate a basic understanding of the subject matter.	Demonstrate a limited understanding of the subject matter. This reflection needs revision.	Demonstrate little or no understanding of the subject matter. This reflection needs revision.
Use of textual evidence	Use specific and convincing examples from the texts studied to support claims in your own writing, making insightful and applicable connections between texts.	Use relevant examples from the texts studied to support claims in your own writing, making applicable connections between texts.	Use examples from the text to support most claims in your writing with some connections made between texts.	Use incomplete or vaguely developed examples to only partially support claims with no connections made between texts.	No examples from the text are used and claims made in your own writing are unsupported and irrelevant to the topic at hand.
Language use	Use language that is precise and engaging, with notable sense of voice, awareness of audience and purpose, and varied sentence structure.	Use language that is fluent and original, with a sense of voice, awareness of audience and purpose, and the ability to vary sentence structure.	Use basic but appropriate language, with a basic sense of voice, some awareness of audience and purpose and some attempt to vary sentence structure.	Use language that is vague or imprecise for the audience or purpose, with little sense of voice, and a limited awareness of how to vary sentence structure.	Use language that is unsuitable for the audience and purpose, with little or no awareness of sentence structure.
Conventions	Demonstrate control of the conventions with essentially no errors, even with sophisticated language.	Demonstrate control of the conventions, exhibiting occasional errors only when using sophisticated	Demonstrate partial control of the conventions, exhibiting occasional errors that do not hinder comprehension.	Demonstrate limited control of the conventions, exhibiting frequent errors that make comprehension difficult.	Demonstrate little or no control of the conventions, making comprehension almost

Lesson 2 - The Relationship of the Structural Components of the Cell Membrane to its Function

REVIEW

Before we proceed to our next lesson, let's have first a recap on the previous lesson—The Structural Components of the Cell Membrane.

- The plasma membrane serves to protect the cell from its surroundings, facilitates cellular transport, and transmits cellular signals.
- Lipids (phospholipids and cholesterol), proteins, and carbohydrates are the primary components of the plasma membrane.
- The plasma membrane helps to protect intracellular components against the extracellular environment.
- The plasma membrane's structural components are often describes to as the fluid mosaic that includes phospholipids, cholesterol, proteins,

glycoproteins, and glycolipids (sugar chains attached to proteins or lipids, respectively), resulting in a fluid character (fluidity).

- The plasma membrane regulates the materials that enter and exit the cell, thereby mediating cellular processes.
- The plasma membrane contains markers that allow cells to recognize one another and communicate with one another via receptors.

Detailed Illustration of the Structural Components of the Cell Membrane

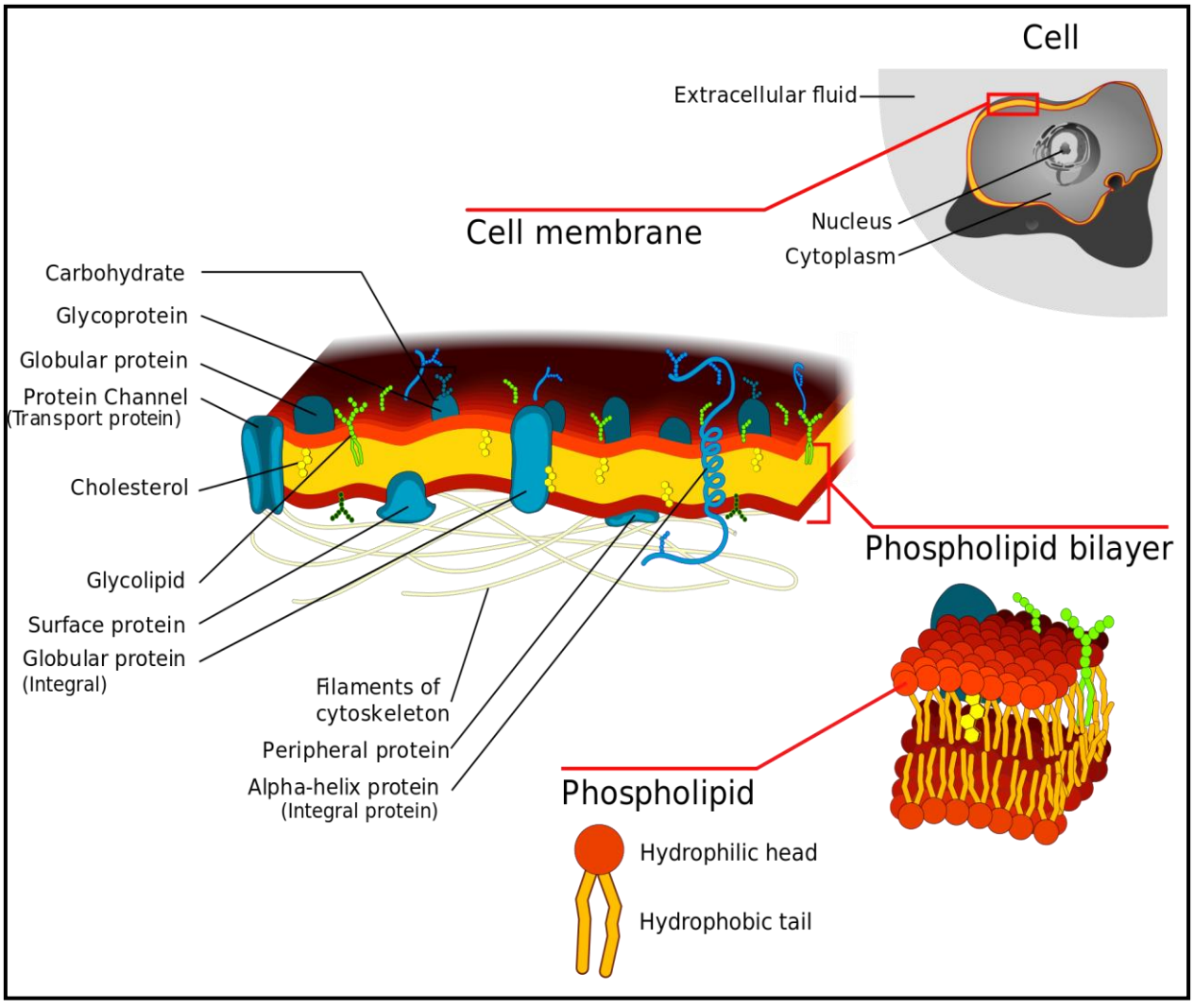


Figure 2.A. Image Credit: Wikimedia Commons, (2008)

Cellular Signaling/Recognition's relation to the Plasma Membrane

The ability of the plasma membrane to transmit signals through complex proteins is one of its most sophisticated functions. These proteins can be receptors, which act as both receivers of extracellular inputs and activators of intracellular processes, or markers, which allow cells to recognize one another.

Membrane proteins perform a variety of functions such as attaching the membrane to the cytoskeleton (provides shape and integrity to the cell) and external fibers, providing identification tags, and forming junctions between adjacent cells. Furthermore, many membrane proteins function as enzymes, which can form catalytic teams for molecular assembly lines. Other proteins act as receptors for chemical messengers released by other cells. On the cell wall, a receptor protein binds to specific molecules, allowing them to be absorbed into the cell. Binding of the messenger to the receptor frequently initiates a chain reaction involving other proteins, which relay the message to a molecule that performs a specific activity within the cell. This is commonly referred to as signal transduction. Some membrane proteins help moves substances across the membrane. This is commonly referred to as membrane transport.

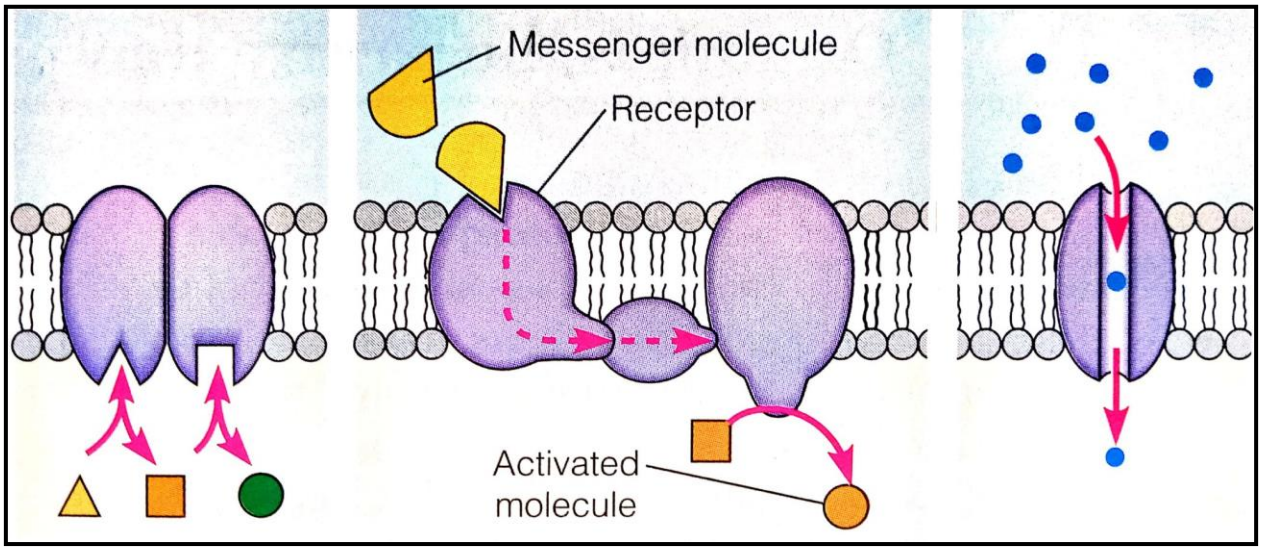


Figure 2.B. Image Credit: Campbell et al. Biology Concepts and Connections (4th Edition) – Chapter 5: The Working Cell. Pp. 81.

Membrane receptors serve as extracellular attachment points for effectors such as hormones and growth factors, which then initiate intracellular responses. Some viruses, such as the Human Immunodeficiency Virus (HIV), can use these receptors to gain access to cells and cause infections.

Membrane markers enable cells to recognize one another, which is important for cellular signaling processes that influence tissue and organ formation during early development. This marking function is also important later in the immune response's self-versus-non-self-distinction. Blood type is determined by marker proteins on human red blood cells, for example (A, B, AB, or O).

Cellular Transport Mechanisms' relation to the Plasma Membrane

The movement of a substance across the selectively permeable plasma membrane can be **passive**—it occurs without the use of cellular energy—or ***active***—it requires the cell to expend energy.

A variety of transport mechanisms involving biological membranes are used by the cell:

1. Passive osmosis and diffusion: transports gases (like O2 and CO2) as well as other small molecules and ions.

2. Transmembrane protein channels and transporters: transport small organic molecules like sugars or amino acids across membranes.

3. Endocytosis is the process by which large molecules (or even whole cells) are transported by engulfing them.

4. Exocytosis is the process by which substances such as hormones or enzymes are removed or secreted.

What will you do?

Learning Activity 2.1 - Give me my function!

Directions: Provide the Functions related to the Structures and Compositions of the Cell Membrane inside the empty blanks. Write your answers in a 1/2 sheet of paper. Each item is worth of 2 points.

Structural Components	Function
Phospholipid Bilayer	1. _____
Membrane Markers	2. _____
Transmembrane protein	3. _____

Membrane Receptors	4. _____
Cytoskeleton	5. _____

Key to Answers on pages 36-38.

Learning Activity 2.2 - Let's Enumerate!

Directions: Answer the following questions. Write your answers in 1/2 sheet of paper. Each item is worth 1 point.

1. List at least four (4) functions of the cell membrane

2. List at least ten (10) structure and composition of the cell membrane along with their function/s.

Key to Answers on pages 36-38.

Learning Activity 2.3 - Let's write a reflection!

Instructions:

1. Access and watch the video link provided; — "Inside the Cell Membrane" by Amoeba Sisters (Feb 28, 2018), https://www.youtube.com/watch?v=qBCVVszQQNs

2. Pay close attention to the video and be able to associate the components and structures of the cell membrane to your household.

3. Make an analogous reflection paper of your household to the structures and components of the cell membrane. Prioritize on the function aspect.

4. Write your reflection neatly on a long piece of bond paper.

5. Your reflection paper will be evaluated using the scoring rubric below.

Reflective Writing Rubric

Skills	5	4	3	2	1
Depth of reflection	Demonstrate a conscious and thorough understanding of the subject matter. This reflection can be used as an example for other students.	Demonstrate a thoughtful understanding of the subject matter.	Demonstrate a basic understanding of the subject matter.	Demonstrate a limited understanding of the subject matter. This reflection needs revision.	Demonstrate little or no understanding of the subject matter. This reflection needs revision.
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Lesson 3 - Transport Mechanisms in Cells

REVIEW

Plasma membranes must allow certain substances to enter and exit a cell while preventing some harmful and essential materials from entering and leaving. In other words, plasma membranes are selectively permeable, allowing some substances but not others to pass through. If they lost this selectivity, the cell would be unable to sustain itself and would be destroyed. Certain substances are required in greater quantities by some cells. These materials must be obtained from extracellular fluids. This may occur passively as certain materials move back and forth, or the cell may have special mechanisms that facilitate transport. Some materials are so vital to a cell that it expends energy hydrolyzing adenosine triphosphate (ATP) to obtain them. Red blood cells expend some of their energy doing so. The majority of cells expend the majority of their energy on maintaining an equilibrium of sodium and potassium ions between the cell's interior and exterior, as well as on protein synthesis.

Selective Permeability of the Plasma Membrane

Plasma membranes lack symmetry, which means that the exterior and interior of the membrane are not the same. The arrangement of proteins and phospholipids, as well as the two leaflets that make up a membrane, differ significantly. Some proteins on the membrane's interior serve as anchors for the membrane to the cytoskeleton's fibers. Peripheral proteins on the membrane's surface bind extracellular matrix elements. Carbohydrates bound to lipids or proteins can also be found on the plasma membrane's outer surface. These carbohydrate complexes aid the cell in binding necessary extracellular fluid substances. This contributes significantly to the plasma membrane's selectivity.

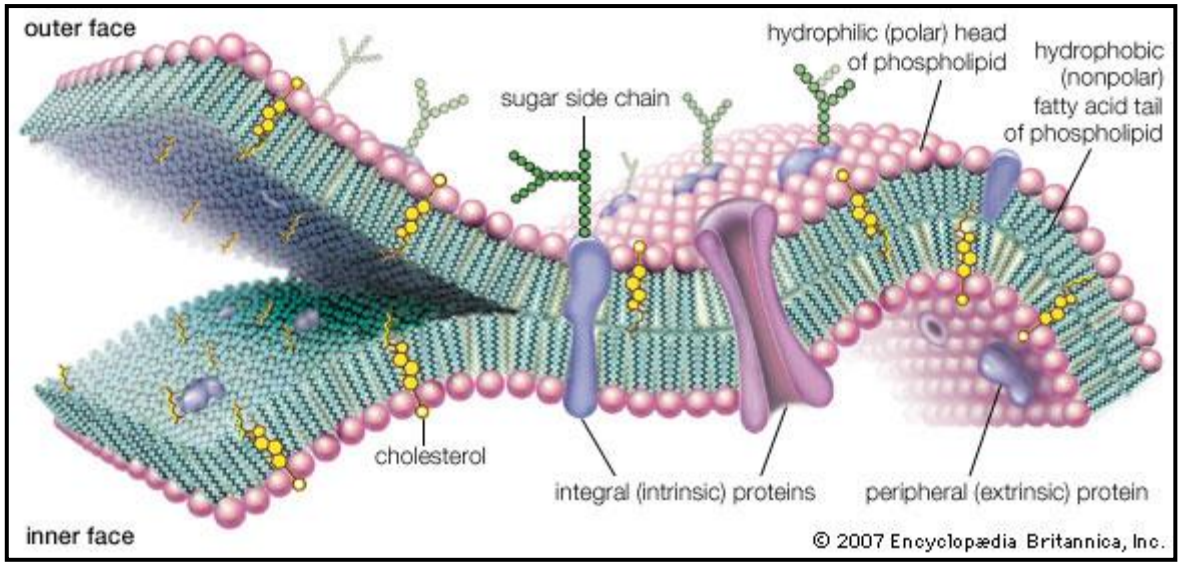


Figure 3.A. Image Credit: Encyclopedia Britannica, Inc., (2007).

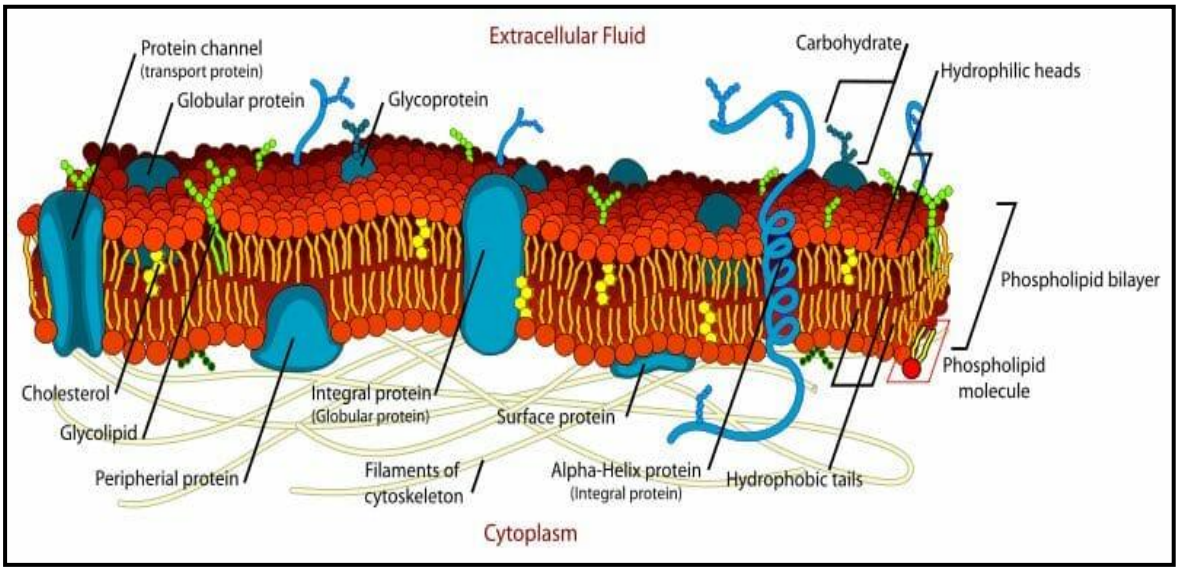


Figure 3.B. Image Credit: BiologyDictionary.Net (2019).

The exterior surface of the plasma membrane is not the same as its interior surface. Remember that plasma membranes are amphiphilic, with hydrophilic and hydrophobic regions. This property facilitates the movement of some materials through the membrane while impeding the movement of others. Material with a low molecular weight that is non-polar and lipid-soluble can easily pass through the hydrophobic lipid core of the membrane. Fat-soluble vitamins A, D, E, and K, for example, easily pass through plasma membranes in the digestive tract and other tissues. Drugs and hormones that are fat-soluble can easily enter cells and transport to tissues and organs throughout the body. Because oxygen and carbon dioxide molecules are chargeless, they pass through membranes via simple diffusion.

Polar substances cause membrane issues. While some polar molecules can easily connect with the outside of the cell, they cannot easily pass through the lipid core of the plasma membrane. Furthermore, while small ions could easily pass through the mosaic of the membrane's spaces, their charge prevents them from doing so. Ions like sodium, potassium, calcium, and chloride must have a unique method of penetrating plasma membranes. To cross plasma membranes, simple sugars and amino acids require the assistance of various transmembrane proteins (channels).

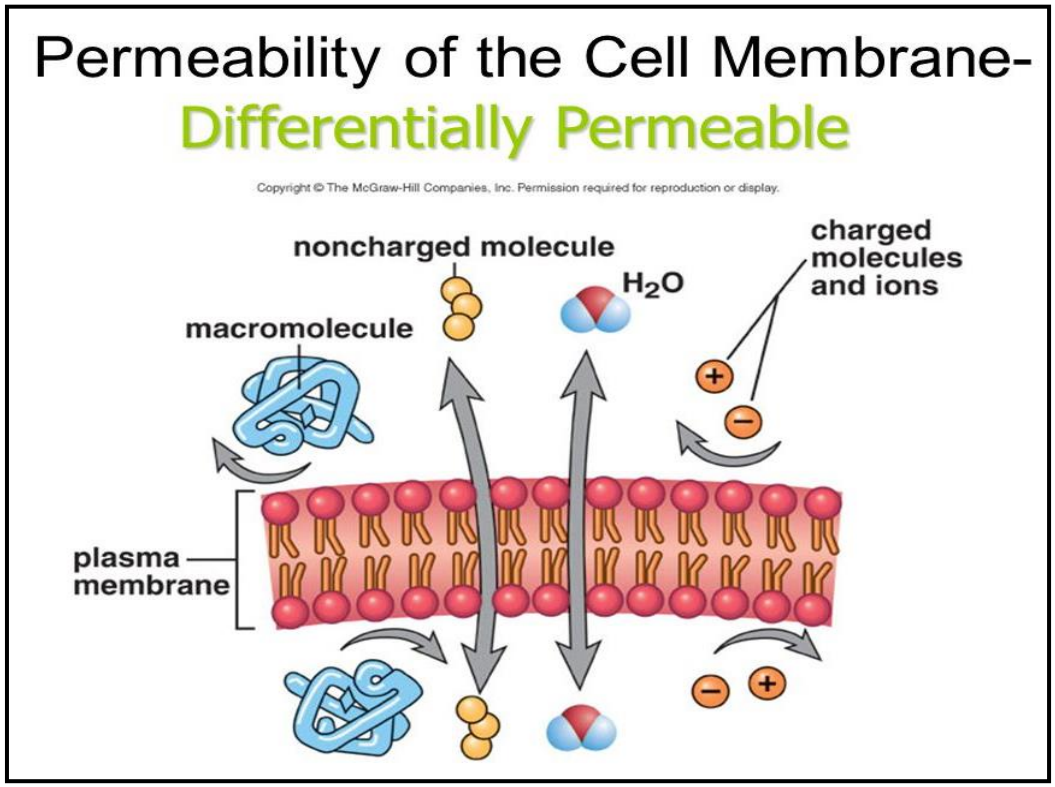


Figure 3.C. Image Credit: The McGraw-Hill Companies, Inc.

Key Takes of the Permeability of the Lipid Bilayer:

- **Hydrophobic** - nonpolar molecules, such as hydrocarbons, can dissolve in the lipid bilayer and rapidly pass through the membrane.
- **Hydrophilic** - polar molecules, such as sugars, do not easily cross the membrane.

The Transport Mechanisms

1. Passive Transport

This process does not necessitate the use of chemical energy. Passive transport may or may not require the assistance of a membrane protein in moving substances across a biological membrane.

Classification of Passive Transport

a. Simple Diffusion

Materials have a tendency to move randomly from areas of high concentration to areas of low concentration until they are evenly distributed in a state of dynamic equilibrium.

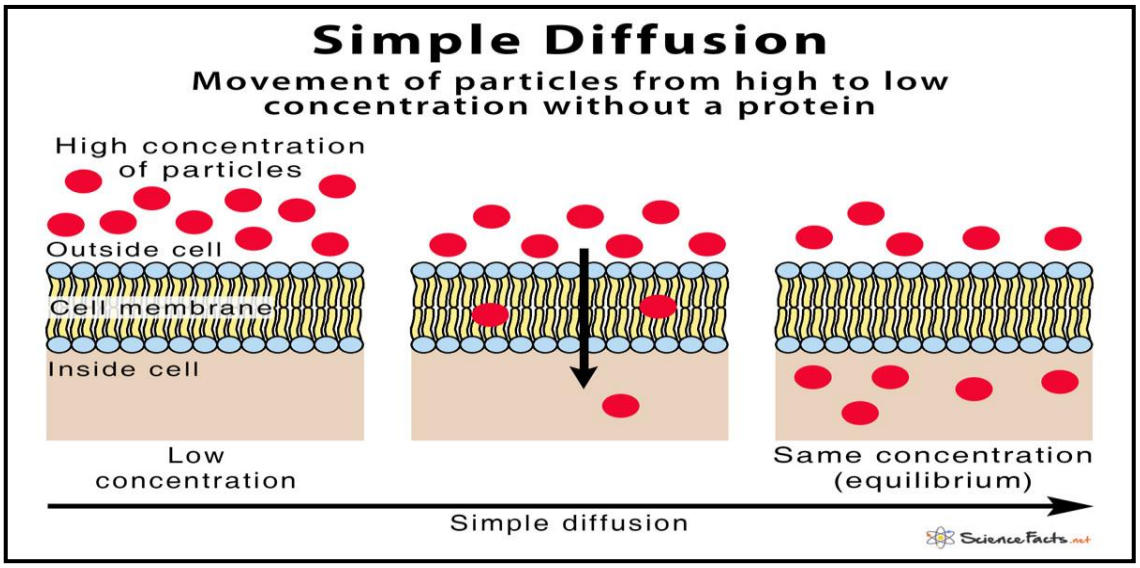


Figure 3.D. Image Credit: ScienceFacts.Net (2020).

b. Facilitated Diffusion (also known as Facilitates Transport or Passive-Mediated Transport)

It is a method of transporting molecules and ions from one location to another using an intermediary such as a protein. This is accomplished by

molecules binding with a carrier protein in the plasma membrane and being transported from a high concentration area to a low concentration area.

- Carrier proteins: Transports noncharged molecules with a specific shape.
- Channel proteins: Tunnel shape that transports small charged molecules.

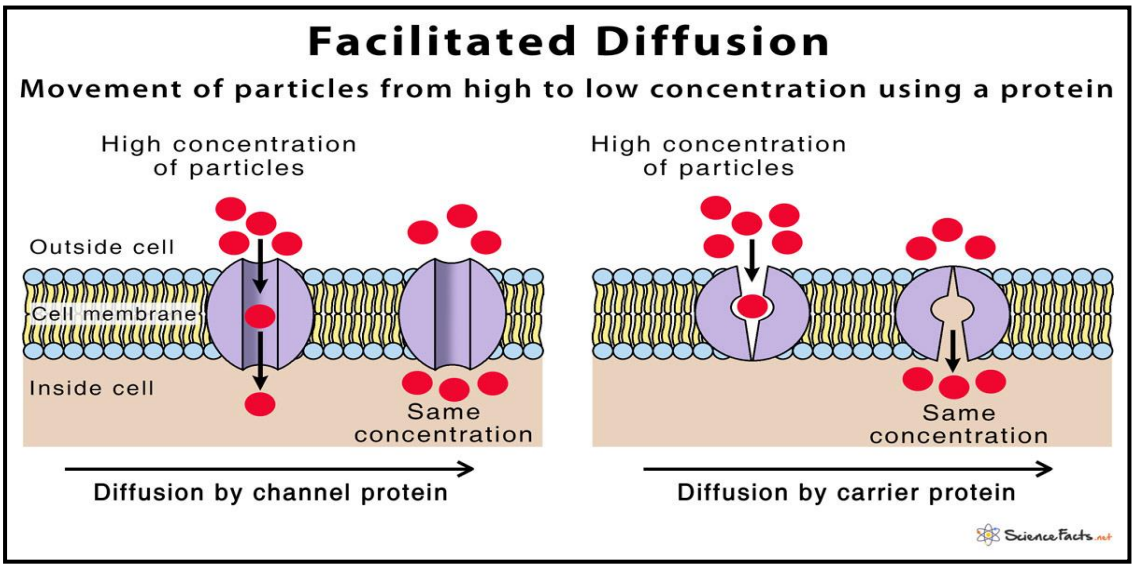


Figure 3.E. Image Credit: ScienceFacts.Net (2020).

c. Osmosis

It is the movement or diffusion of water from a higher concentration region to a lower concentration region via a selectively permeable membrane. The term tonicity in osmosis refers to a property of a solution that is affected by the osmotic force exerted across the membrane as a result of the different concentrations of solutes in and out of the cell.

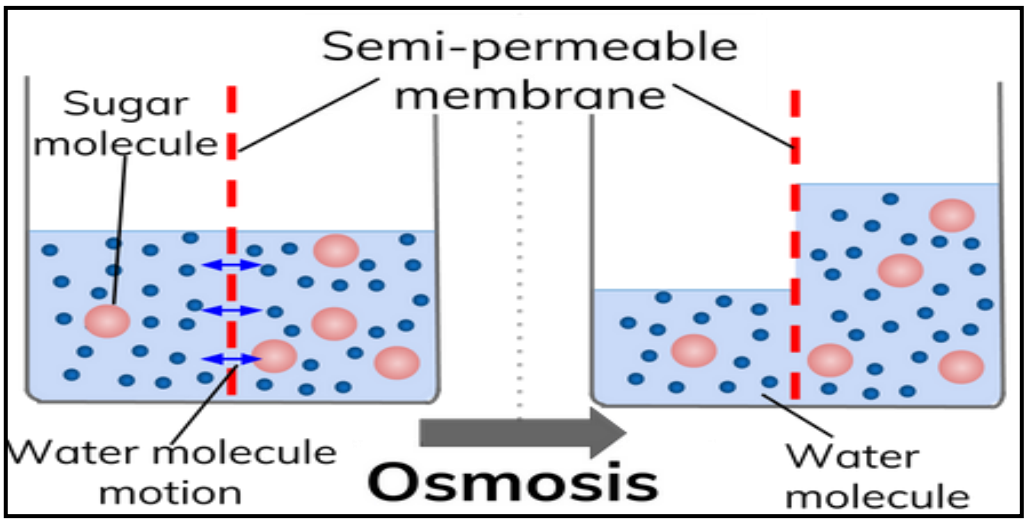


Figure 3.F. Image Credit: Seneca Learning.

Types of Tonicity:

a. Isotonic solution

The concentration of water inside and outside the cell is the same.

b. Hypertonic solution

Water molecules are more concentrated inside the cell than outside.

c. Hypotonic solution

Water molecules are more concentrated outside the cell than inside.

Behavior of Cells in Different Tonicity

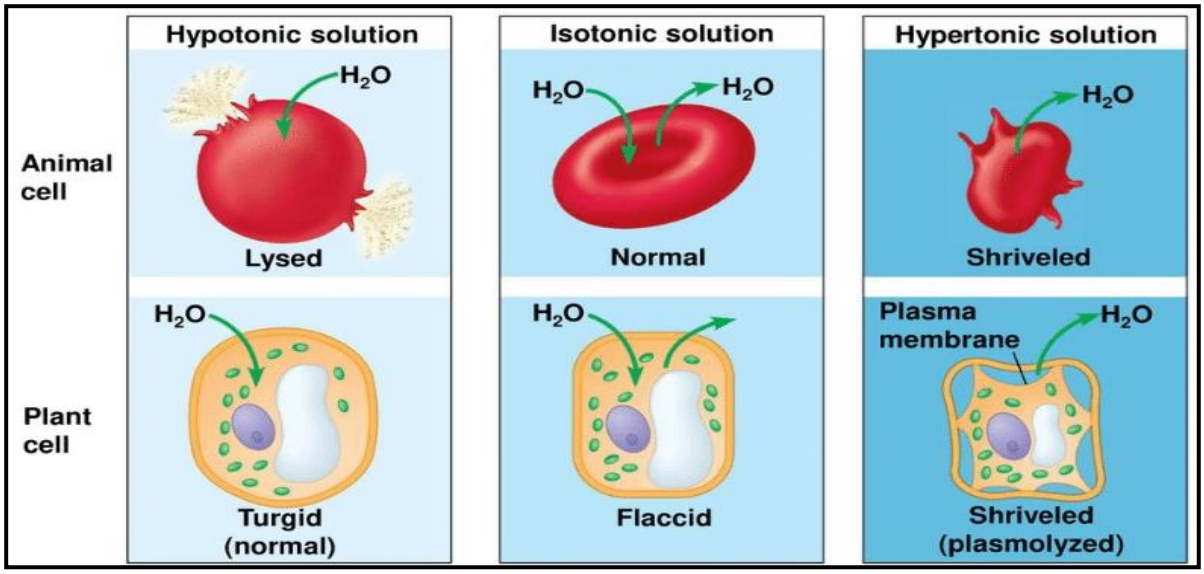


Figure 3.G. Image Credit: Pearson Education, (2012).

2. Active Transport

The movement of a substance across a cell membrane concentration gradient from concentration to higher concentration is referred to as active transport. The cell requires energy to transport molecules into and out of the cell during this transport.

Listed are some examples of Active Transport:

- Kidney cells pump glucose and amino acids out of the urine and back into the blood.

- Intestinal cells pump in nutrients from the gut.
- Root cells pump in nutrients from the soil.
- Gill cells in fish pump out sodium ions.

Active transport entails using chemical energy to move substances across a membrane against a concentration gradient. Uniports, symports, and antiports are all types of active transport proteins.

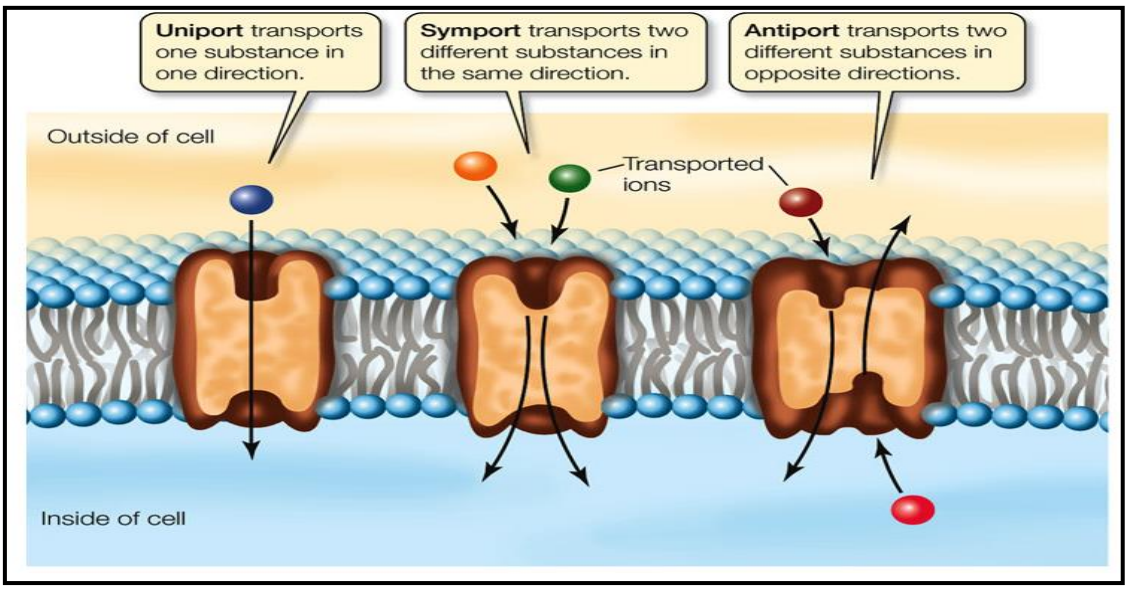


Figure 3.H. Image Credit: LIFE: The Science of Biology, Eight Edition (2007).

Active Transport Pump:

- Sodium-potassium pump
- 3 sodium ions inside the cell and 2 potassium ions outside the cell bind to the pump.
- This allows the release of energy from ATP and causes the protein complex to change shape.
- The change in shape allow the Na+ and K+ ions to move across and be released.

Primary active transport uses ATP hydrolysis energy to move ions into and out of cells against concentration gradients. The sodium-potassium pump is a good example.

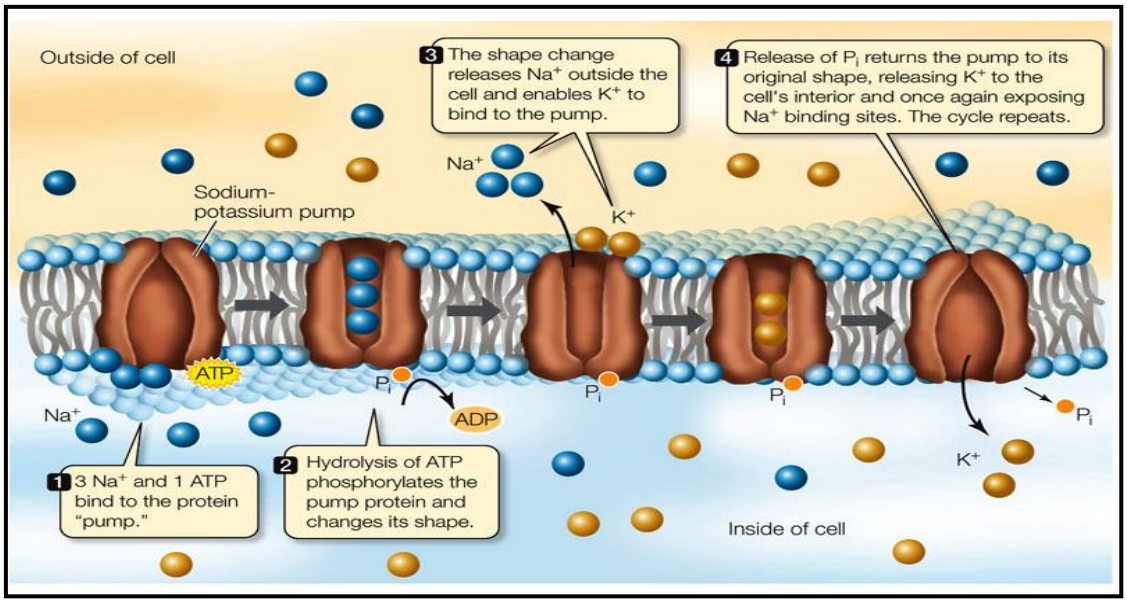


Figure 3.I. Image Credit: LIFE: The Science of Biology, Eight Edition (2007).

Secondary active transport connects the passive movement of one substance along with its concentration gradient to the active movement of another substance against its concentration gradient. The energy from ATP is indirectly used to create the concentration gradient that causes the first substance to move.

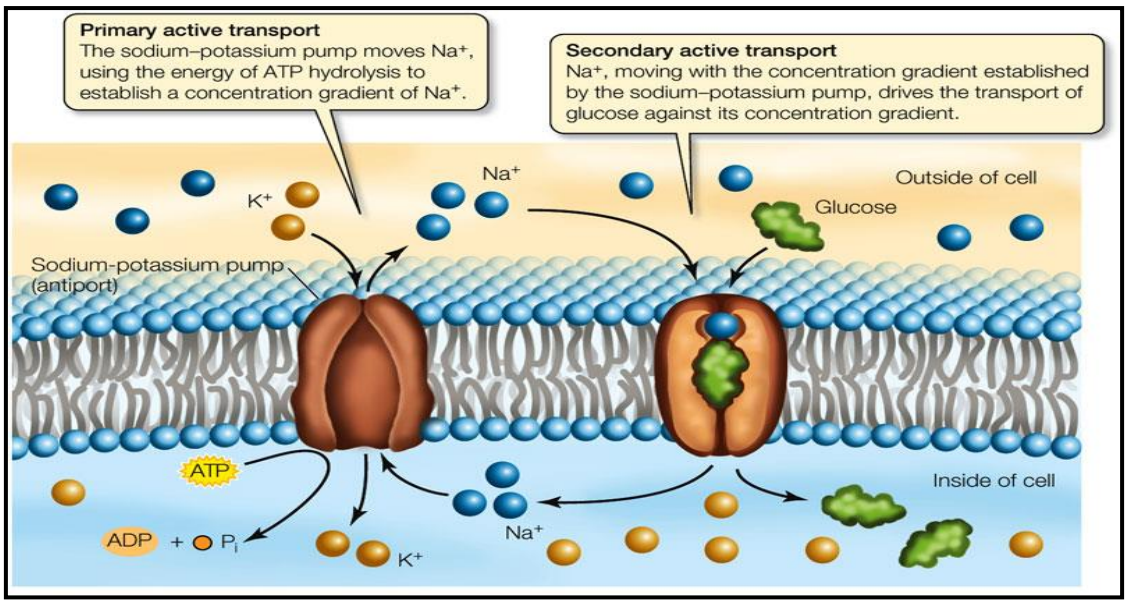


Figure 3.J. Image Credit: LIFE: The Science of Biology, Eight Edition (2007).

Forms of Active Transport (also known as Bulk Transport)

1. Endocytosis

Occurs when the cell membrane folds inward, trapping and enclosing a small amount of extracellular fluid matter.

2. Exocytosis

The opposite of endocytosis in that a vesicle from within the cell moves to the cell membrane. The vesicle fuses to the membrane, secreting its contents.

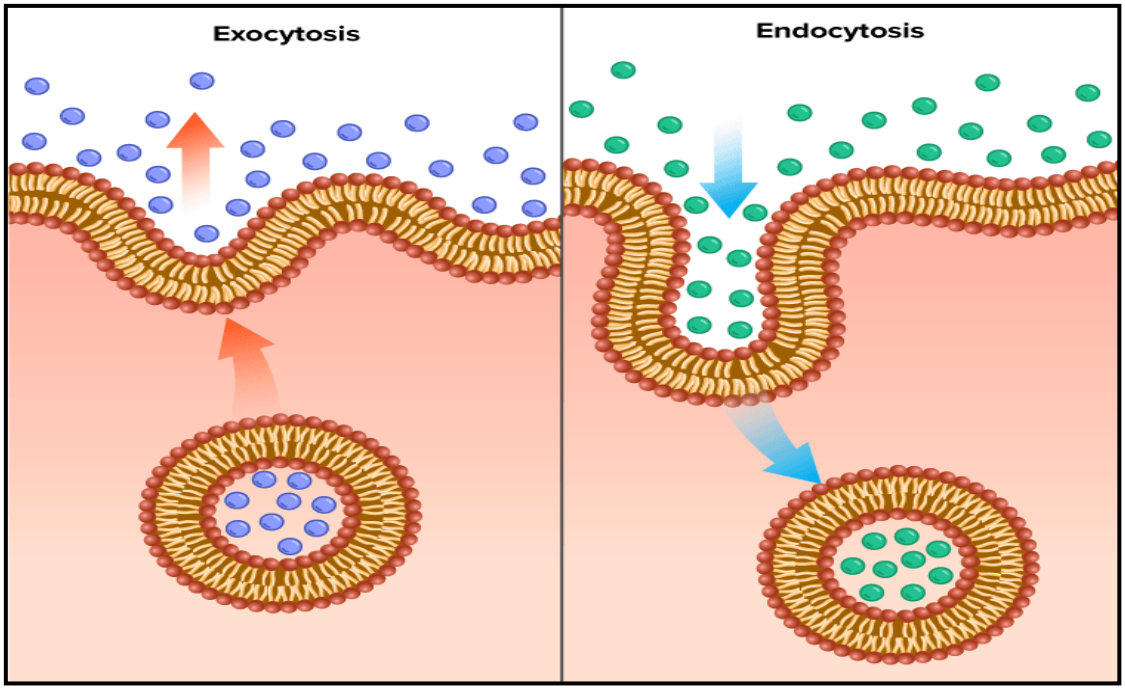


Figure 3.K. Image Credit: CK-12 Foundation, (2021).

Difference between Endocytosis and Exocytosis

	Endocytosis	Exocytosis
Definition	Endocytosis is the movement of macromolecules, large particles, and polar substances into the cell from the outside environment.	Exocytosis is the movement of molecules or particles from inside the cell to the outside.
Process	Involved in nutrient uptake into the cell.	Involved in waste removal from the cell.
Type	Occurs as a result of both phagocytosis and pinocytosis.	Occurs via a constitutive and regulated secretory pathway.
Vesicle	Internal vesicles similar to phagosomes form.	Secretory vesicles are formed
Cell Wall Formation	Not involved	Involved
Example	Phagocytes engulfing bacteria is one example.	One example is hormone release from the cell.

3 Types of Endocytosis

a. Pinocytosis

The absorption of a small droplet of extracellular fluid, otherwise known as cell drinking. This happens in almost all cell types.

b. Phagocytosis

The ingestion of a large droplet of extracellular fluid, otherwise known as cell eating. This takes place in specialized cells.

c. Receptor-mediated endocytosis

The intake of specific molecules that bind to specific proteins in the cell membrane. These proteins are specially designed to fit the shape of a particular molecule.

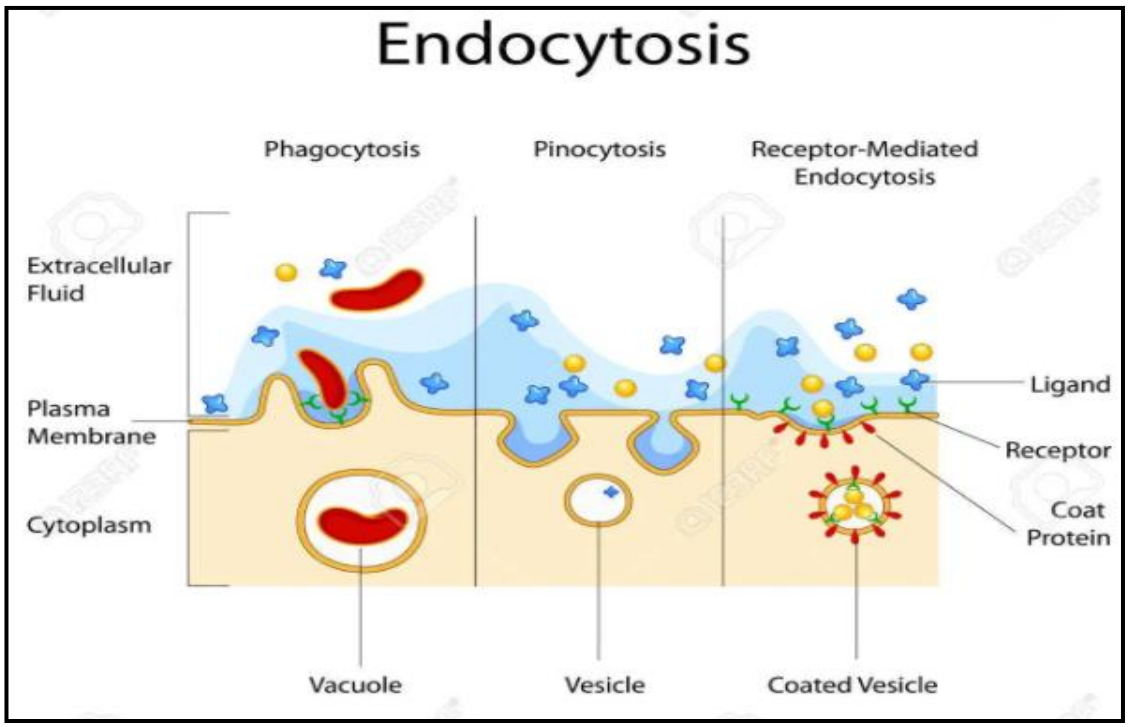


Figure 3.L. Image Credit: 123F Education Chart of Biology.

What will you do?

Learning Activity 3.1 - Write ups!

Directions: Answer the following questions briefly. Write your answers in a 1 whole sheet of paper. Each item is worth of 5 points.

1. Provide the different Transport Mechanisms in a cell with at least 2-3 attributes each.
2. How are things transported through the membrane?
3. How will a person know if the transport mechanism in the cell throughout our body is starting not to work/not working?
4. What will you compare to the transport mechanism to what we have today? Explain.

5. If you are to choose what transport mechanism you prefer, what will it be and why?

Learning Activity 3.2 - Time to construct!

Directions: Construct a concept map showing the differences of Endocytosis and Exocytosis. You can use any materials of your choice. Keep your output in a safe place and submit it on the exact date of submission to be announced by your teacher.

- Your concept map will be evaluated using the rubric below.

	Criteria			Points
	3	2	1	
Relationships between concepts	Clear relationship between concepts. Hierarchical organization from components to sub-components.	Relationship between concepts evident. Components and sub-components present.	Unclear relationship between concepts. Components and sub-components unorganized.	
Cross-linkages	Logical linkages. Clear and thorough explanation of links. Information is clear, accurate and precise.	Logical linkages. Explanation of links unclear. Information is accurate.	Linkages do not make sense and are not explained. Information is inaccurate.	
Presentation	Presentation is orderly and visually appealing. Demonstrates effective use of the elements of graphic design.	Presentation is orderly and effective	Presentation is not orderly.	
			Total	

Learning Activity 3.3 - Complete the box!

Directions: Provide the right answers after the number in the boxes below for the difference between Endocytosis and Exocytosis. Write your answers in a 1/2 sheet of paper. Each item is worth 2 points.

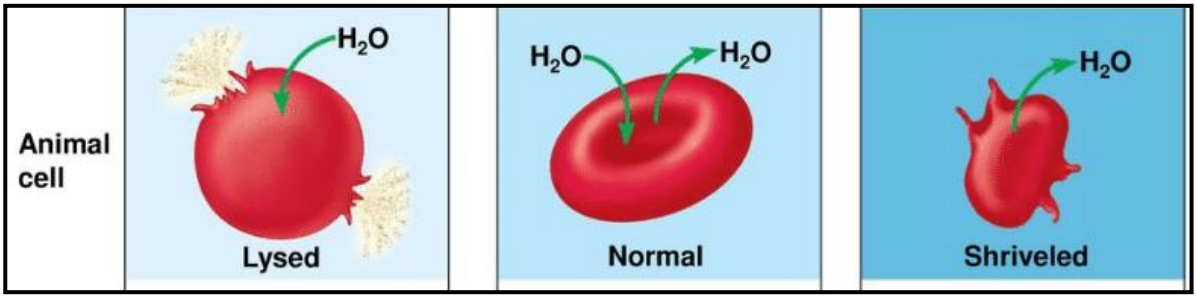
	Endocytosis	**Exocytosis**
Definition	Endocytosis is the movement of macromolecules, large particles, and polar substances into the cell from the outside environment.	1. Exocytosis is the movement of _____
Process	2. Involved in _____.	Involved in waste removal from the cell.
Type	3. Occurs as a result of both _____.	Occurs via a constitutive and regulated secretory pathway.

Vesicle	Internal vesicles similar to phagosomes form.	4. _____ are formed
Cell Wall Formation	5. _____	Involved
Example	Phagocytes engulfing bacteria is one example.	6. One example is _____.

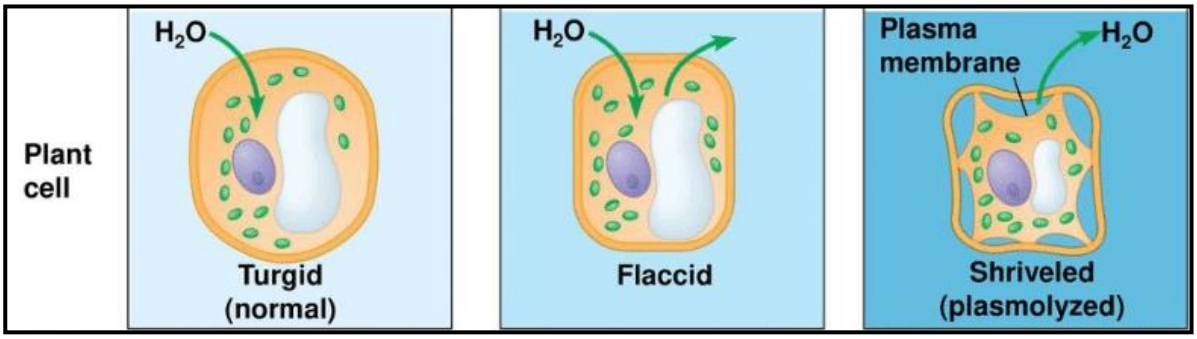
Key to Answers on pages 36-38.

Learning Activity 3.4 - Label and define me!

Part I. Directions: Label the tonicity for each solution. Write **isotonic**, **hypotonic**, or **hypertonic**. Write your answers in 1/2 sheet of paper. Each item is worth 1 point.



1. 2. 3.



4. 5. 6.

Key to Answers on pages 36-38.

Part II. Directions: Define the following terms. Write your answers in a 1/2 sheet of paper. Each item is worth of 2 points.

A. Isotonic - _____.

B. Hypertonic - _____.

C. Hypotonic - _____.

Key to Answers on pages 36-38.

Learning Activity 3.5 - Let's write a reflection!

Instructions:

1. A video link is provided; — "Cell Transport" by Amoeba Sisters (2016), https://www.youtube.com/watch?v=Ptmlvtei8hw

2. Listen carefully for you to be able to determine and differentiate the types of transport mechanism in a cell.

3. Make a reaction paper of the video clip.

4. Write it on a long bond paper.

5. Your reaction paper will be evaluated using the rubric below.

Reflective Writing Rubric

Skills	5	4	3	2	1
Depth of reflection	Demonstrate a conscious and thorough understanding of the subject matter. This reflection can be used as an example for other students.	Demonstrate a thoughtful understanding of the subject matter.	Demonstrate a basic understanding of the subject matter.	Demonstrate a limited understanding of the subject matter. This reflection needs revision.	Demonstrate little or no understanding of the subject matter. This reflection needs revision.
Use of textual evidence	Use specific and convincing examples from the texts studied to support claims in your own writing, making insightful and applicable connections between texts.	Use relevant examples from the texts studied to support claims in your own writing, making applicable connections between texts.	Use examples from the text to support most claims in your writing with some connections made between texts.	Use incomplete or vaguely developed examples to only partially support claims with no connections made between texts.	No examples from the text are used and claims made in your own writing are unsupported and irrelevant to the topic at hand.
Language use	Use language that is precise and engaging, with notable sense of voice, awareness of audience and purpose, and varied sentence structure.	Use language that is fluent and original, with a sense of voice, awareness of audience and purpose, and the ability to vary sentence structure.	Use basic but appropriate language, with a basic sense of voice, some awareness of audience and purpose and some attempt to vary sentence structure.	Use language that is vague or imprecise for the audience or purpose, with little sense of voice, and a limited awareness of how to vary sentence structure.	Use language that is unsuitable for the audience and purpose, with little or no awareness of sentence structure.
Conventions	Demonstrate control of the conventions with essentially no errors, even with sophisticated language.	Demonstrate control of the conventions, exhibiting occasional errors only when using sophisticated	Demonstrate partial control of the conventions, exhibiting occasional errors that do not hinder comprehension.	Demonstrate limited control of the conventions, exhibiting frequent errors that make comprehension difficult.	Demonstrate little or no control of the conventions, making comprehension almost

Let's Summarize!

- **Membrane transport** is a term used in cellular biology to describe a group of mechanisms that control the passage of solutes including such small molecules and ions through biological membranes, which are lipid bilayers with proteins embedded in them.
- The **plasma membrane (cell membrane)** plays an essential role in the transport mechanisms because it forms a boundary between living cells and their surroundings (in the form of lipids) and controls the traffic molecules/materials that go in and out of the cell.
- The plasma membrane (cell membrane), like other cellular membranes, is referred to as a ***fluid mosaic*** or ***fluid mosaics of lipids and proteins*** in modern terminology.
- Plasma Membranes' structural components: **Phospholipids, Cholesterol, Integral Protein, Peripheral Protein, and Carbohydrates Chains**
- Fluid Mosaic Model describes the plasma membrane's structure as a mosaic of components that includes phospholipids, cholesterol, proteins, glycoproteins, and glycolipids (sugar chains attached to proteins or lipids, respectively), resulting in a fluid character (fluidity).

- **Hydrophilic** a molecule that can form bonds with water; a water-loving molecule; meanwhile, **hydrophobic** a molecule that cannot form a bond with water; a water-hating molecule.

- **Transport Mechanisms in cells:**
  - **Passive Transport (**process does not necessitate the use of chemical energy.) – Classification of Passive Transport: (**Simple Diffusion, Facilitated Diffusion,** and **Osmosis**).
  - **Active Transport** (requires energy to transport molecules into and out of the cell during this transport.) – Forms of Active Transport (**Exocytosis** and **Endocytosis**) – Types of Endocytosis (**Phagocytosis**, **Pinocytosis**, and **Receptor-mediated Endocytosis**).

Whew! That was a tough job. Finally, you have finished studying this module. But before you completely end this module, let's find out how much you learned from this learning material by answering the assessment in the next page.

What to do after this module?

Directions: Read and understand each item carefully and choose the letter of the correct answer. Each item is worth 1 point. Write your answers on a separate sheet of paper. Otherwise, if you are using the application, answer the assessment in the application. Good luck!

1. What is the primary function of carbohydrates attached to the exterior of the cell membranes?

A. identification of the cell
B. flexibility of the membrane
C. strengthening the membrane
D. channels through membrane

2. Which of the following plasma membrane component can be either found on its surface or embedded in the membrane structure?

A. protein
B. cholesterol
C. carbohydrate
D. phospholipid

3. Which of the following plasma membrane component where carbohydrates is found outside the surface of the cell and bounded with?

A. lipid or protein
B. phospholipid
C. glycoprotein
D. glycolipid

4. Which interacts to hydrophilic and hydrophobic environments?
A. protein
B. cholesterol
C. phospholipid
D. carbohydrate

5. Which characteristic of a phospholipid contributes to the fluidity of the membrane?
A. its head
B. cholesterol
C. a saturated fatty acid tail
D. double bonds in the fatty acid tail

6. What is the primary function of the plasma membrane?
A. to protect the cell from its surroundings.
B. to provide shape and integrity to the cell.
C. to maintain the cell potential.
D. to be a fluid mosaic model.

7. A vital for cellular signaling processes that influence tissue and organ formation is called _____.
A. membrane markers
B. membrane receptors
C. glycoprotein
D. glycolipid

8. What is the relationship of Cellular Transport Mechanisms to the Plasma Membrane?
A. to protect intracellular components from the extracellular environment.
B. to transport materials into or out of the cell
C. to enclose and define the borders of the cell
D. to transmit signals via complex proteins

9. What is the relationship of Cellular Signaling to the Plasma Membrane?
A. to protect intracellular components from the extracellular environment.
B. to enclose and define the borders of the cell
C. to transmit signals via complex proteins
D. to transport materials into or out of the cell

10. Which of the following hydrocarbons does not dissolve in the lipid bilayer?
A. hydrophilic
B. hydrophobic
C. non polar
D. polar

11. Which of the following is not a part of the cellular transport mechanisms?
A. facilitated
B. active
C. osmosis
D. exocytosis

12. Which of these is the most direct form of cellular transport mechanisms?
A. passive
B. active
C. osmosis
D. exocytosis

13. It is when water molecules move from a region of high concentration to a region of low concentration.
A. facilitated
B. active
C. osmosis
D. diffusion

14. Which of the following is not an attributes of exocytosis?
A. involved with up taking nutrients into the cell

B. secretory vesicles are formed
C. involved in removing waste from the cell
D. uninvolved in cell Wall Formation

15. Water inside the cell equals the water outside the cell and equal amounts of water move in and out of the cell.
A. osmotic
B. hypertonic
C. hypotonic
D. isotonic

16. Which of these mechanisms uses ATP?

A. facilitated
B. active
C. osmosis
D. exocytosis

17. It is the process where the cell engulfs extracellular fluid including material dissolved or suspended in it.

A. passive
B. active
C. endocytosis
D. exocytosis

18. It is otherwise known as cell drinking—a process where small droplets of extracellular fluid is being taken by the cell.

A. pinocytosis
B. phagocytosis
C. endocytosis
D. exocytosis

19. Which type of solution causes a cell to swell?

A. osmotic
B. hypotonic
C. hypertonic
D. isotonic

20. Which of the following terms means water-loving?

A. hypotonic
B. hypertonic
C. hydrophobic
D. hydrophilic

Key to Answers

Lesson 1 – The Structural Components of the Cell Membrane

Learning Activity 1.1 - Fill me up!

1. Fluid mosaic or fluid mosaics of lipids and proteins
2. Phospholipids
3. Carbohydrates
4. To identify the cells to other cells / cell recognition
5. Temperature
6. Peripheral protein
7. Membrane transport
8. Integral protein

Learning Activity 1.2 - Identify Me!

1. Glycoprotein
2. Glycolipid
3. Peripheral Protein
4. Integral Membrane
5. Cytoskeletal filaments
6. Cholesterol
7. Protein Channel
8. Phospholipid bilayer

Lesson 2 - The Relationship of the Structural Components of the Cell Membrane to its Function

Learning Activity 2.1 - Give me my function!

1. Protect the cell from its surroundings
2. Allow cells to recognize one another
3. Transports small organic molecules
4. Provides extracellular attachment sites
5. Provide shape and integrity to the cell

Learning Activity 2.2 - Let's Enumerate!

1.

- Cell Signaling
- Selective Transport
- Excretion of Wastes
- Structural Support

Lesson 3 - Transport Mechanisms in Cells

Learning Activity 3.3 - Complete the box!

1. Molecules or particles from inside the cell to the outside.
2. Nutrient uptake into the cell.
3. Phagocytosis and pinocytosis.
4. Secretory vesicles
5. Not involved
6. Hormone release from the cell.

Learning Activity 3.4 - Label and define me!

Part I.

1. Hypotonic Solution
2. Isotonic Solution
3. Hypertonic Solution
4. Hypotonic Solution
5. Isotonic Solution
6. Hypertonic Solution

Part II.

A. The concentration of water inside and outside the cell is the same.

B. Water molecules are more concentrated inside the cell than outside.

C. Water molecules are more concentrated outside the cell than inside.

Assessment

1. A
2. A
3. A
4. C
5. C
6. A
7. A
8. B
9. C
10. D
11. D
12. A
13. C
14. A
15. D
16. B
17. B
18. A
19. B
20. D

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