

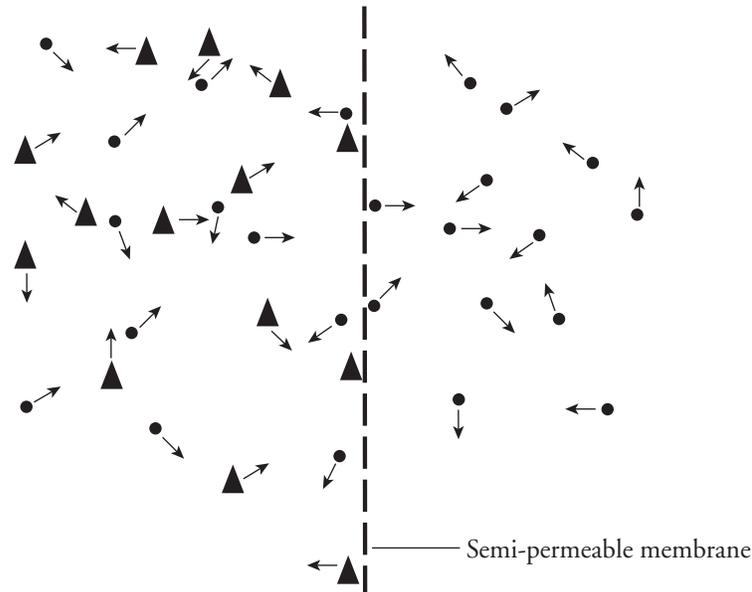
# Membrane Structure and Function

How do substances move in and out of cells?

## Why?

Advertisements for sports drinks, such as Gatorade®, PowerAde®, and Vitaminwater™, etc. seem to be everywhere. All of these drinks are supposed to help your body recover and replenish lost electrolytes, fluids, and vitamins after exercise. But how do the essential molecules contained in these drinks get into your cells quickly to help you recover after exercise?

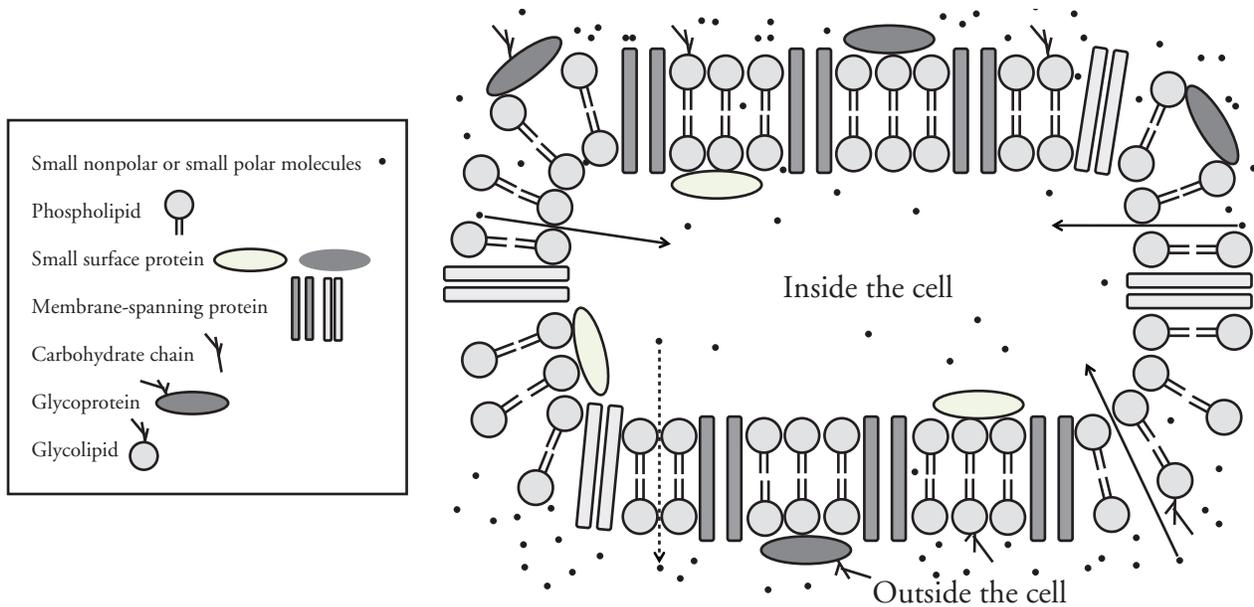
## Model 1 – Simple Diffusion



1. How many different types of molecules are shown in Model 1?
2. Count and record the number of triangles and circles found on each side of the membrane.
3. Which shape is larger?
4. Describe the direction of the movement of the molecules in Model 1?
5. Which molecules are able to pass through the semi-permeable membrane? Justify your answer.
6. If you left this “system” for an extended period of time and then viewed it again, would you expect to find any changes in the concentrations of the molecules on either side of the membrane? Justify your answer.



## Model 2 – The Selectively Permeable Cell Membrane



7. What two major types of biological molecules compose the majority of the cell membrane in Model 2?
8. How many different protein molecules are found in Model 2?
9. What is the difference between the position of the surface proteins and the membrane-spanning proteins?
10. When a carbohydrate chain is attached to a protein, what is the structure called?
11. When a carbohydrate is attached to a phospholipid, what is the structure called?
12. What types of molecules are shown moving across the membrane?
13. Where exactly in the membrane do these molecules pass through?
14. How does the concentration of the small molecules inside the cell compare to that outside the cell?

15. Because particles move randomly, molecules tend to move across the membrane in both directions. Does the model indicate that the molecules are moving in equal amounts in both directions? Justify your answer using complete sentences.

## Read This!

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When there is a difference in concentration of a particular particle on either side of a membrane, a **concentration gradient** exists. Particles move along the concentration gradient from high to low concentration until a state of **equilibrium** is reached. At that point, there is no more net movement in one direction, although the particles continue to move randomly across the membrane, often called **dynamic equilibrium**. The net movement of particles along the concentration gradient is called **diffusion**.

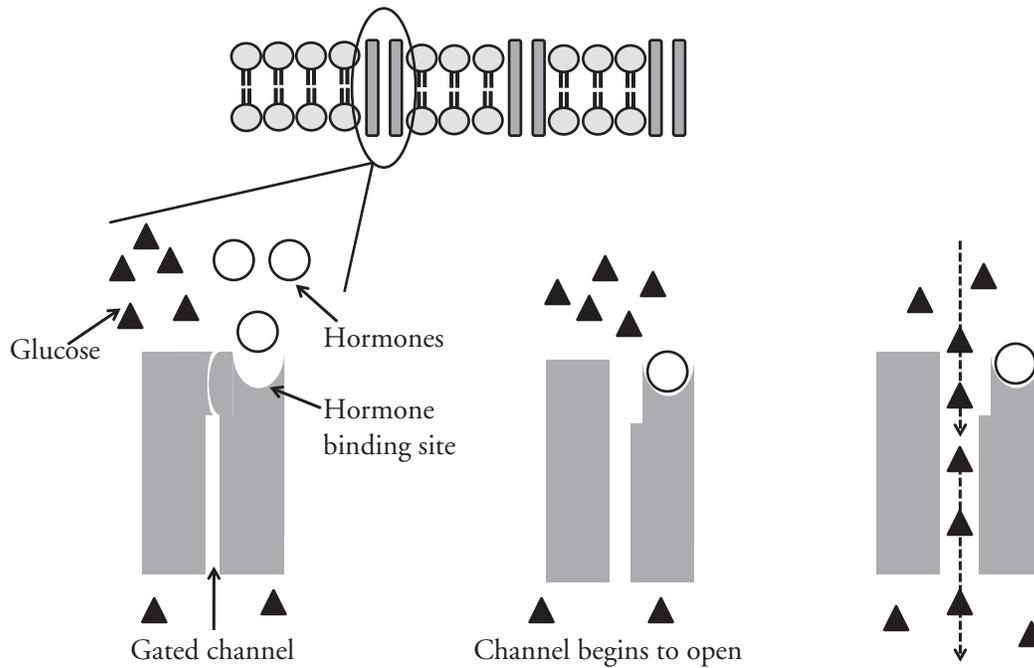
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16. Look back at Models 1 and 2. Which particles are moving by diffusion across the membranes shown?
17. Using all the information from the previous models and questions circle the correct response to correctly fill in each blank.
- Diffusion is the net movement of molecules from an area of (low/high) concentration to an area of (low/high) concentration.
  - The molecules will continue to move along this (semi-permeable membrane/ concentration gradient) until they reach (diffusion/equilibrium).
  - Once equilibrium is reached, molecules will continue to move across a membrane (randomly/in one direction).



### Model 3 – Facilitated Diffusion



18. Which part of the cell membrane is shown in more detail in Model 3?
19. What is the gap between the proteins called?
20. What type of molecules attach to the protein?
21. Explain in detail what happened that allowed the glucose molecules to pass through.

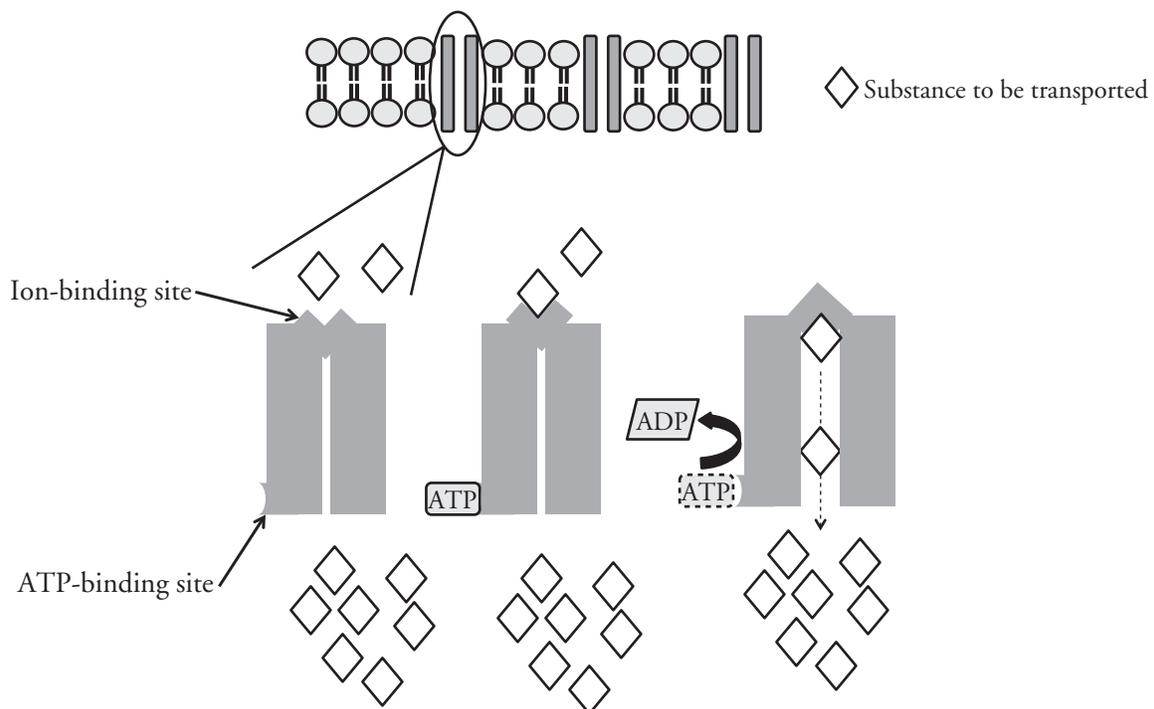
## Read This!

Some molecules, such as glucose, use gated channels as shown in Model 3; however, not all channels are gated. Some channels remain permanently open and are used to transport ions and water across the cell membrane.

22. Discuss with your group why the type of protein channel in Model 3 is called a gated channel. Write your group's responses below.
  
23. To **facilitate** means to help. Explain why this type of diffusion is called facilitated diffusion.
  
24. The “tails” of phospholipids are nonpolar; therefore, they do not readily interact with charged particles such as ions. How can this explain why facilitated diffusion is necessary for the transport of ions such as  $\text{Na}^+$  and  $\text{K}^+$  across the cell membrane? In other words, why would these ions not cross by simple diffusion?



## Model 4 – Active Transport



25. Which part of the cell membrane is shown in more detail in Model 4? Look back at Model 2 if needed.
26. What shape represents the substance being transported across the membrane in Model 4?
27. List two binding sites found on the protein.
28. In which direction is the transported substance moving—from an area of high concentration to low or from an area of low concentration to high? Support your answer.
29. Is the substance being moved along (down) a concentration gradient? Justify your answer.
30. ATP is a type of molecule that can provide energy for biological processes. Explain how the energy is being used in Model 4.
31. What happens to the ATP after it binds to the protein?



32. The type of transport shown in Model 4 is called **active transport**, while diffusion and facilitated diffusion are called **passive transport**. Given the direction of the concentration gradient in active and passive transport examples, explain why active transport requires energy input by the cell.

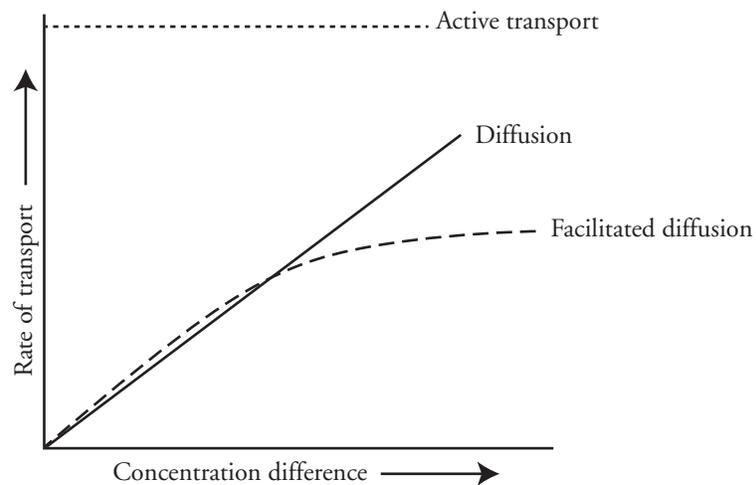


33. With your group, complete the table below to show the difference between active and passive transport.

	Active Transport	Passive Transport	
		Diffusion	Facilitated Diffusion
Requires energy input by the cell			
Molecules move along (down) a concentration gradient			
Moves molecules against (up) a concentration gradient			
Always involves channel (membrane-spanning) proteins			
Molecules pass between the phospholipids			
Moves ions like Na <sup>+</sup> and K <sup>+</sup>			
Moves large molecules			
Moves small nonpolar and polar molecules			

34. With your group develop a definition for active transport.

## Extension Questions



35. Given the information in the graph, which type of cell transport would be best to move substances into or out of the cell quickly?
36. Which type of transport would be the best if the cell needs to respond to a sudden concentration gradient difference?
37. Why would the line representing facilitated diffusion level off as the concentration gets higher, while the line representing diffusion continues to go up at a steady rate?
38. Why does active transport, on the same graph, start off with such a high initial rate compared to diffusion and facilitated diffusion?