√+

AP Reading Guide
Fred and Theresa Holtzclaw

Chapter 7: Membrane Structure and Function

Name Leonie Hoeher **Period** _____

Chapter 7: Membrane Structure and Function

Concept 7.1 Cellular membranes are fluid mosaics of lipids and proteins

1. The large molecules of all living things fall into just four main classes. Name them.
   Lipids, proteins, carbohydrates, and nucleic acids
2. Explain what is meant when we say a molecule is amphipathic.
   An amphipathic molecule has both hydrophilic and hydrophobic regions.
3. In the 1960s, the *Davson-Danielli model* of membrane structure was widely accepted. Describe this model and then cite two lines of evidence that were inconsistent with it. This model proposed that the phospholipid bilayer was sandwiched between two layers of hydrophilic proteins. Problems with this were that different membranes with differing functions don't have the same structure and composition and that membrane proteins are not actually very soluble in water, because they are amphipathic.
4. Who proposed the *fluid mosaic model* of membrane structure? When? Describe this model. S. J. Singer and G. Nicolson proposed the fluid mosaic model in 1972. They said that membrane proteins were dotted in a mosaic-like pattern throughout the membrane, with their hydrophobic regions inside the layer and their hydrophilic regions protruding.
5. What is meant by *membrane fluidity*? Describe the movements seen in the fluid membrane. Membranes are as fluid as salad oil, meaning they are quite fluid. Phospholipids can move laterally within the phospholipid bilayer and may even flip with the opposing phospholipid at times. Some membrane proteins drift, also contributing to fluidity of membrane.
6. Describe how each of the following can affect membrane fluidity:

   a. decreasing temperature
      this can cause membrane to became more solid
   b. phospholipids with unsaturated hydrocarbon chains
      make membrane more fluid at lower temp. due to kinks in tails, which don't allow for close packing
   c. cholesterol
      similarly, cholesterol hinders close packing of phospholipids at low temperature, however also hinders excessive phospholipid movement at higher temperature.

7. Membrane proteins are the *mosaic* part of the model. Describe each of the two main categories:

integral proteins: these proteins ~~span~~ penetrate the hydrophobic interior of the phospholipid bilayer
peripheral proteins: these proteins are not embedded and can be loosely bound to the surface of the membrane and may be held in place by cytoskeleton or extracellular matrix

8. Use Figure 7.9 to briefly describe major functions of membrane proteins.

Function	Description
Transport	Pump or guide substances across membranes
Enzymatic activity	membrane proteins can work together to carry out steps of a metabolic pathway
Signal transduction	messenger binds to protein & changes its shape, giving the message to the inside of the cell
Cell-cell recognition	glycoproteins act as ID tags and can be recognized by other cells
Intercellular joining	membrane proteins of adjacent cells can hook together
Attachment to cytoskeleton and ECM	membrane proteins can bind to cytoskeleton or ECM to coordinate changes within or outside cell

9. Membrane carbohydrates are important in cell-cell recognition. What are two examples of this?

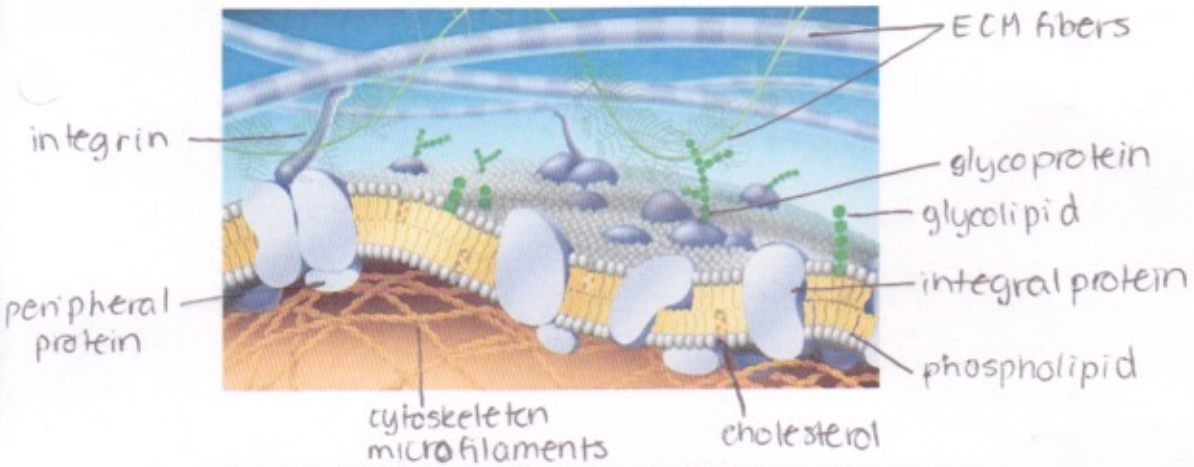
Glycolipids and glycoproteins

10. Distinguish between *glycolipids* and *glycoproteins*.

Glycolipids are short, branched membrane carbohydrates that are covalently banded to lipids, while glycoproteins are carbohydrates covalently bonded to proteins instead. Also, glycoproteins distinguish one cell from another by functioning as "ID tags".

11. Label the following structures:

√**glycolipid**
√**glycoprotein**
√**integral protein**
√**peripheral protein**
√**cholesterol**
√**phospholipid**
√**ECM fibers**
√**cytoskeleton microfilaments**
√**integrins (go back to Chapter 6)**



Concept 7.2 Membrane structure results in selective permeability

12. Distinguish between *channel proteins* and *carrier proteins*.
Channel proteins have a hydrophilic channel, which ions and molecules can pass through, while carrier proteins bind to molecule and change shape to move it across the membrane.

13. Are transport proteins specific? Cite an example that supports your response.
Transport proteins are specific to the molecules or ions that may cross the membrane. For example, in red blood cells a specific carrier protein only transports glucose and even rejects fructose.

14. Peter Agre received the Nobel Prize in 2003 for the discovery of *aquaporins*. What are they?
Aquaporins are channel proteins that greatly speed up the passage of water molecules through the membrane.

15. Consider the following materials that must cross the membrane. For each, tell how it is accomplished.

Material	Method
CO_2	CO_2 may pass thrugh the membrane through simple diffusion
glucose	A carrier protein specific to glucose would help the molecule cross the membrane
H+	H+ ions also need the aid of a ~~channel~~ proten pump to cross the membrane
O_2	small molecules, like O_2 can freely diffuse through the membrane
H_2O	Aquaporins, which are channel proteins, allow water molecules to pass much faster (3 bil. per second)

Concept 7.3 Passive transport is diffusion of a substance across a membrane with no energy investment

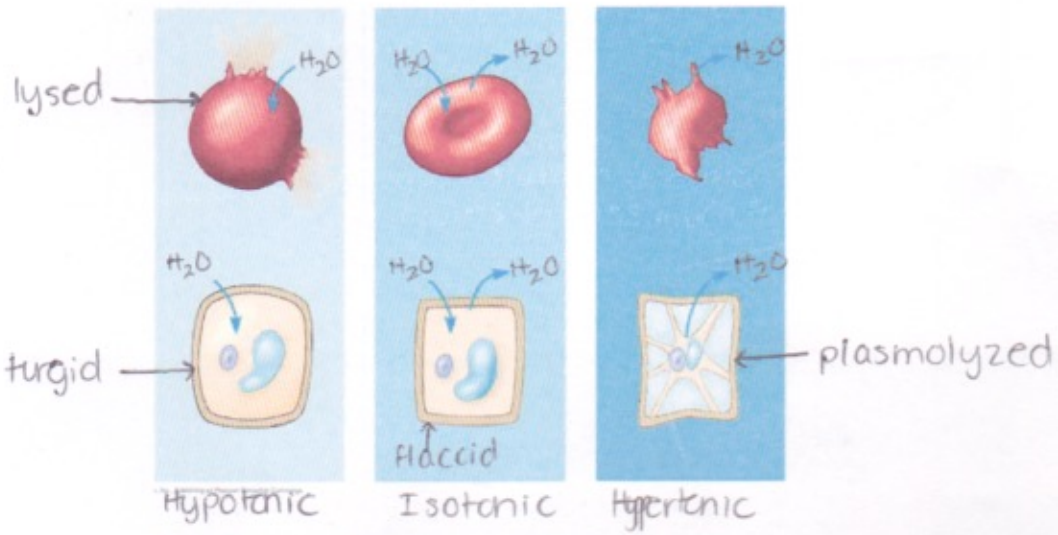
16. Define the following terms:

diffusion – movement of molecules of any substance so that they spread evenly to the space that is available (no energy input)
concentration gradient – region along which the density of a chemical substance increases or decreases
passive transport
diffusion of a substance across a biological membrane (no energy)
osmosis
diffusion of water across a selectively permeable membrane
isotonic
same rate of diffusion across membrane, no net movement
hypertonic
solution w/ higher solute concentration, water moves to the hypertonic area
hypotonic
solution w/ lower solute concentration, water moves out of hypotonic region
turgid
firm, healthy state of plant cell (water coming in)
flaccid
limp state with no tendency for water to enter
plasmolysis
plasma membrane pulls away from cell wall, causing plant cell to wilt and die

17. Use as many words from the list above to describe why a carrot left on the counter overnight would become limp. Underline each word you use.
If a carrot was left out overnight, it would become limp because water would diffuse down its concentration gradient out of the more turgid plant cells. After being left out, the carrot's cells would become flaccid and plasmolysis would occur. The water molecules would be transported passively out of the carrot. This means that the environment could not be isotonic to the cell.

18. What is *facilitated diffusion*? Is it active or passive? Cite two examples.
Facilitated diffusion is passive transport with the help of transport proteins. Two examples could be ion channels and the glucose transport protein.

19. Label the *hypotonic solution*, *isotonic solution*, and *hypertonic solution*. What is indicated by the *blue arrows*? Label them. Which cell is *lysed*? *Turgid*? *Flaccid*? *Plasmolyzed*? Apply all these labels.

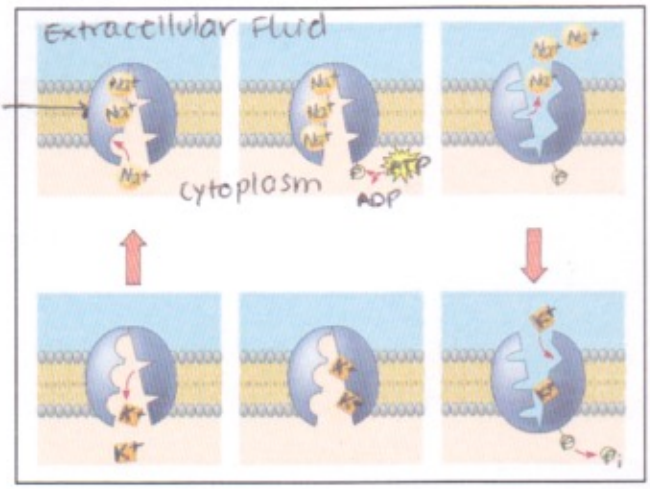


20. Why doesn't the plant cell burst?
The plant cell does not burst due to the cell wall that creates turgor pressure when a large amount of water flows in.

Concept 7.4 Active transport uses energy to move solutes against their gradients

21. Describe *active transport*. What type of transport proteins are involved, and what is the role of ATP in the process?
Active transport pumps solute across a membrane against its gradient with the help of ATP. In this process, only carrier proteins act as the transport proteins. ATP transfers a phosphate grap directly to the transport protein, which can induce a change in protein's shape in a way that it can move the solute across the membrane. For active transport, ATP supplies the required energy.

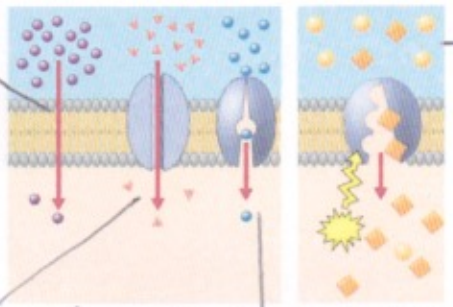
22. The *sodium-potassium pump* is an important system for you to know. Use the following diagram to understand how it works. Use the following terms to label these figures, and briefly summarize what is occurring in each figure: ~~*extracellular fluid, cytoplasm*~~, ~~*Na+*~~, ~~*K+*~~, ~~*ATP*~~, ~~*ADP*~~, ~~*P*~~, ~~*transport protein.*~~



Summary

1. Na+ binds to the sodium-potassium pump
2. Na+ bond triggers phosphorylation by ATP
3. P-group leads to shape change, reducing affinity for Na+, which is released
4. K+ binds to extracellular side and triggers release of P-group
5. Loss of P-group restores original shape, which has lower affinity for K+
6. K+ is released, protein has more affinity for Na+ again and cycle repeats

23. On the diagram below, add these labels: *facilitated diffusion with a carrier protein*, *facilitated diffusion with a channel protein*, ~~*active transport with a carrier protein*~~, ~~*simple diffusion*~~. For each type of transport, give an example of a material that is moved in this manner.



24. What is *membrane potential*? Which side of the membrane is positive?

Membrane potential is the voltage ~~of~~ across a membrane. It acts like a battery that affects the traffic of all charged substances across the membrane. The extracellular side is more positive than the negative cytoplasmic side.

25. What are the two forces that drive the diffusion of ions across the membrane? What is the combination of these forces called? The two forces are the chemical force (ion's gradient) and the electrical force (effect of membrane potential on ion movement). This is called the electrochemical gradient.

26. What is *cotransport*? Explain how understanding it is used in our treatment of diarrhea. Cotransport is the transport of a specific solute by a single ATP-powered pump and can indirectly drive active transport of other solutes. This can be seen when a salt & glucose solution is given to patients w/ diarrhea. The solutes are taken up with Na-glucose cotransporters to maintain Na levels.

Concept 7.5 Bulk transport across the plasma membrane occurs by exocytosis and endocytosis

27. Define each of the following, and give a specific cellular example.

endocytosis – cell takes in molecules by forming new vesicles from plasma membrane (receptor-mediated endocytosis allows for acquiring bulk quantities)
phagocytosis – cell engulfs particle and packages it in membrane sac (cellular eating)
pinocytosis – cell engulfs droplets of extracellular fluid into tiny vesicles (cellular eating)
exocytosis – cell secretes molecules by fusion of vesicles with plasma membrane (used to export products)
receptor-mediated endocytosis – allows for more quantity of specific substances to enter cell. Embedded proteins with receptor sites are activated and form coated pits to transfer certain substances into the cell.

28. What is a *ligand*? What do ligands have to do with receptor-mediated endocytosis? A ligand is a molecule that binds specifically to a receptor site on another molecule. Ligands activate the receptor proteins in receptor-mediated endocytosis.

29. Are the processes you described in question 23 active or passive transport? Explain your response.
Simple diffusion, facilitated diffusion with carrier and channel proteins are all passive transport because they don't require energy to diffuse a substance. Active transport with a carrier protein requires energy from ATP to work, hence the name "active transport".

Testing Your Knowledge: Self-Quiz Answers

Now you should be ready to test your knowledge. Place your answers here:

1._____ 2._____ 3._____ 4._____ 5._____

Reproduce the diagram for question 6, and draw arrows as instructed.

6b._____ 6c._____ 6d._____ 6e._____