AP Biology **Name:** **P:**

Chapter 5 Reading Guide: Membrane Structure and Function

How to use this reading guide: Look over the entire reading guide—read each question to prepare yourself for reading the chapter. Read the chapter carefully and thoroughly. Make sure to look at all of the figures and pictures and read their captions. Then…answer the questions posed below.

Life at the Edge

1. What is selective permeability?

Cellular membranes are fluid mosaics of lipids and proteins

2. What are the "staple" ingredients of membranes? What other molecules might you also find involved?

3. A phospholipid is an amphipathic molecule. What does this mean? How does this affect its chemistry (what it does)?

4. Describe the "fluid mosaic model" of membranes.

5. In what ways are membranes fluid?

    a. Explain what influence each of the following will have on the fluidity of the molecule.
        i. Decreasing temperature

        ii. saturated v. unsaturated fatty acid tails

        iii. cholesterol

6. Why is this fluidity important? How does the changing of membrane fluidity protect plants such as winter wheat?

7. Distinguish between integral proteins and peripheral proteins.

8. List and describe the 6 major functions of membrane proteins.

9. What is cell-cell recognition and how are membrane carbohydrates involved?
    a. To what systems in the body does this cell-cell recognition contribute?
    b. Distinguish between glycolipids and glycoproteins.

10. Draw and label a plasma membrane. Include phospholipids, an integral protein, a peripheral protein, cholesterol, glycoproteins and glycolipids. Label the “inside” face and the “outside” face of the membrane. Show a vesicle fusing with the membrane and describe the “sidedness.”
    a. Describe how and where this membrane is made.

Membrane structure results in selective permeability

11. Selective permeability means that some molecules will pass through the membrane while others won't. Molecules that can pass through will also do so a different rates.
    a. Describe what will pass EASILY through the membrane. Explain why.
    b. What will pass through the membrane with difficulty? Why do these molecules have a harder time?

12. What are transport proteins? What does specificity mean in relation to these proteins? Give an example.
    a. Compare channel proteins with carrier proteins.

13. What is an aquaporin? Why are they necessary for the transport of water across a membrane (think about water's chemical bonding and chemical properties)?

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

14. Define diffusion.
    a. How is dynamic equilibrium related to diffusion?

15. What is the "simple rule" of diffusion?
    a. How is a molecule's diffusion affected by the concentration gradients of other molecules?

    b. Explain how the uptake of oxygen in an active muscle cell is an example of the "simple rule."

16. Why is diffusion considered "passive" transport? What is the energy that fuels diffusion?

17. Study figure 5.10. Explain what the water does and why it does it. This is called_____.
    a. Why doesn't the sugar move?

18. What is tonicity? What factors contribute to this property?

19. In relation to tonicity, one important factor is the concentration of molecules in the solution and whether they can pass across the membrane. For each of the following types of solutions, explain how the solution compares to a cell's internal solution and describe what would happen to a cell if it was placed in this type of solution. Draw a picture.
    a. Isotonic

    b. Hypertonic

    c. Hypotonic

20. Why is it necessary to distinguish between cells without and with cell walls? What problems does a cell without cell walls face?

    a. How does a single-celled organism without a cell wall, such as a paramecium, survive?

21. Plant cells have cell walls. Explain what happens to them in each of the following solutions.
    a. Hypotonic solution (why is this important, especially to houseplants?)

b. Hypertonic solution

22. What is facilitated diffusion?
    a. Contrast ion channels with gated channels.

Active transport uses energy to move solutes against their gradients

23. How does active transport compare to passive transport?
    a. Why might active transport be necessary for a cell? Give an example.

    b. What supplies the energy for active transport?

    c. The sodium-potassium pump is an example of active transport. You need to know this one VERY WELL! Study figure 5.14 and explain how the ATP functions to operate the membrane proteins and what ions are moved against their gradients.

        i. When the pump is on, what happens to the balance of charges across the membrane?

24. What is voltage? How is it related to membrane potential?

25. How is membrane potential like a battery? Describe which direction ions will move because of the membrane potential.

26. What is a proton pump? Explain why they are called electrogenic pumps.

27. Cotransport is when an electrogenic pump, which is actively transporting a solute across a membrane also indirectly transport other molecules across the membrane. Describe the cotransport of sucrose in plant cells.

Bulk transport across the plasma membrane occurs by exocytosis and endocytosis

28. How do exocytosis and endocytosis differ from each other?

    a. Both of these processes might be associated with what organelles?

    b. Which process would result in the expansion of the plasma membrane? Which one will cause the membrane to become smaller? Explain.

29. There are three types of endocytosis: phagocytosis, pinocytosis, and receptor-mediated endocytosis. Study figure 5.18 and describe each one below.
    a. Phagocytosis (give an example from the human body)

    b. Pinocytosis (give an example from the human body)

    c. Receptor-mediated endocytosis (give an example from the human body)

1. Explain how cells can communicate through direct contact. What must be present for this to happen?
    a. In what processes is this type of cell-cell communication important?

2. For each of the following types of local regulators describe how it occurs, what type of molecule is involved and any advantage this type of signaling has.
    a. Paracrine signaling

    b. Synaptic signaling

3. How does long distance signaling compare to short distance communication? What molecules are involved?
    a. Give an example of how this might work.

4. Why is signaling through the nervous system also considered long distance signaling? Describe how this type of signaling works.

5. How did Sutherland's Nobel Prize winning research assist in the understanding of cell communication? What did his research show was happening?

6. When a cell encounters a "signal," the signal is recognized by a receptor and the information that it carries must be changed into another form before the cell can respond. What are the three stages? Briefly, what happens in each stage?

Reception: A signal molecule binds to a receptor protein, causing it to change shape

7. Describe how the structure of a cell's membrane and it's composition of embedded molecules ensures that there is no (or very little) "overheard" conversations in cell communication.
    a. How are ligands involved?
    b. What does the ligand normally do to the "receptor'?

8. Describe the structure of a G-protein receptor.

    a. Describe what processes they are involved in. Give an example.

    b. Describe the link between G-protein receptors and disease.

    c. From reception to activation to response-describe how it works.

9. Ligand-Gated Ion Channel Receptors
    a. From reception to activation to response-describe how it works.

    b. In what system/processes are ion-gated channels important? Give an example.

10. Contrast a ligand which binds to a membrane receptor to a ligand which binds to an intracellular receptor. What would their differences be?

11. There are intracellular receptors for certain steroids (such as testosterone) and for NO (nitric oxide). Using testosterone as an example, explain how the intracellular receptor works. Study figure 5.23.

Transduction: Cascades of molecular interactions relay signals from receptors to target molecules in the cell

12. Transduction pathways are usually multi-step. What is a benefit of having multistep transduction pathways? What does this mean in relation to the cell?

13. How can transduction pathways be compared to falling dominos?

14. At each step, how is the message "transduced?" Meaning what is likely changing at each step?
    a. What molecule is probably causing the changes?

15. Contrast the roles of protein kinases and protein phosphatases in signal transduction.
    a. What type of macromolecule are they?
    b. What the job of each of them?
    c. How does this help transmit at message? Talk about "turning-on" and "turning off" molecules. Study figure 11.8 for assistance.

16. Not all molecules involved in signal transduction pathways are proteins. What is a secondary messenger? What role do they play in transduction?

17. Describe what cAMP is and how it functions in the epinephrine pathway.
    a. How does the microbe *Vibrio cholerae* affect cAMP function?
    b. How does Viagra affect cGMP function?

18. Ca^{2+} is even more widely used as a secondary messenger in the body. What responses are triggered by Ca^{2+}?
    a. How does is act as a secondary messenger?
    b. How are IP_3 and DAG involved in Ca^{2+} secretion?

Response: Cell signaling leads to regulation of cytoplasmic activities or transcription

19. What is the ultimate response to a signal transduction pathways?

20. Study figure 5.25 and figure 5.26. What does each pathway do to the enzyme involved?

    a. In figure 5.26, what could the product of the pathways be? What does this do to DNA?

21. What are the two benefits of a signal transduction pathway involving so many steps?

22. The process by which a signal which is received at the surface of a cell is changed into a specific cellular response is called a "signal transduction pathway." How do the similarities of signal transduction pathways in different organisms suggest there is a common history?