STUDY GUIDE *- Ch. 7.2 - Membrane Structure Results in Selective Permeability* **NAME:** _____

- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.*

1. a. Before we start this Section 2 of the Chapter 7, let's return to the last parts of Section 1, starting with **"Some Function of Membrane Proteins"** to review a little about membrane proteins, the focus of Section 2 and 3. While the phospholipids determine the "fluid" part of the Fluid Mosaic Model of Cell Membranes, membrane proteins make up the "mosaic" part of the model. **While phospholipids determine the fluidity of the membrane, what do proteins determine then**?

   b. If membranes all are made up of phospholipids and proteins, what makes one membrane different from the next in its function?

2. Describe the **two main categories of membrane proteins**.

   1. _____ =

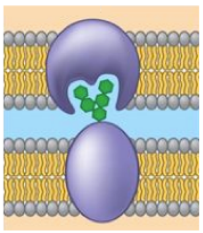
   2. _____ =

3. a. What kind of amino acids do you expect to find on the outer surface of the region of an integral protein that spans the hydrophobic region (interior) of the phospholipid bilayer *(the portion of the integral protein that sits facing the phospholipid tails)*?

   b. What kind of amino acids do you expect to find on the outer surface of the region of an integral protein that faces the aqueous solution on the inside or outside of a membrane *(the portion of the integral protein that sits facing water)*?

4. List and describe the six main **functions of membrane proteins**.

a.



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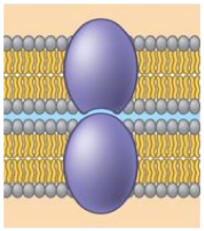

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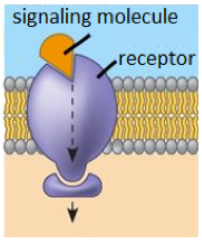

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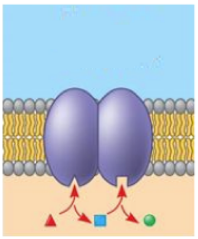

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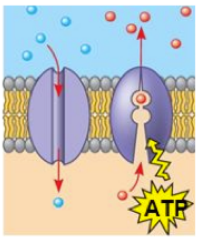

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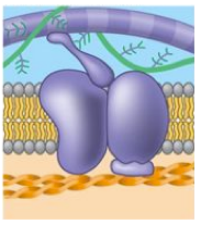

5. a. Study Figure 7.3. Now, draw your own simple animal phospholipid bilayer, showcasing the **Fluid Mosaic Model** of membrane organization. Make your drawing large. This bilayer should contain at least 20 phospholipids, a peripheral membrane protein, two integral membrane proteins *(one of which should be a transmembrane protein and the other a glycoprotein)*, a glycolipid, and a molecule of cholesterol (since it is an animal membrane). **Label each type of molecule**

   b. Based on your understanding of molecular interactions (Ch.2), also highlight on your drawing above the **hydrophobic and the hydrophilic regions of the phospholipid, of the peripheral protein** *(**hint:** unlike integral membrane proteins the peripheral protein is a globular protein almost fully immersed in an aqueous solution)***, of the transmembrane protein and glycoprotein, glycolipid, and of the cholesterol molecule.** *(Review Ch.5 again if you don't remember the exact structure of cholesterol and its functional groups)*

Now, let's delve into Chapter 7, Section 2.

6. Membranes are _____ _____ since they only allow some substances to cross them and others not to.

7. On any given day, cells are moving small **molecules and ions** across their plasma membranes in both directions. Let's consider some **types of substances that are moved in AND moved out of typical animal cells**.

   a. Examples of polar molecules that must enter cells =

   b. Example of a nonpolar molecule that must enter cells =

   c. Category of polar molecules moved out of cells =

   d. Example of a nonpolar molecule moved out of cells =

   e. Examples of a charged ions that must either enter or leave cells =

8. a. List the **category and some examples of substances that CAN cross through the phospholipid bilayer UNAIDED by proteins**?

   Type of Substance =

   Examples of these types of Substances =

b. Why can the substances you listed above in 3.b. and 3.d. **readily cross the phospholipid bilayer** on their own?

c. List the **two categories and some examples of substances that CANNOT cross through the phospholipid bilayer UNAIDED by proteins** and, therefore, need the help of transport proteins?

1. First type of Substance =

   Examples of these types of Substances =

2. Second type of Substance =

   Examples of these types of Substances =

d. Why can the substances you listed above in 3.a., 3.c., and 3.e. **NOT readily cross the phospholipid bilayer**?

9. Polar molecules, with their partial charges, cross the membrane with difficulty on their own. Ions with their full charges, have an even harder time getting through. For this reason, when cells want to ensure that these types of hydrophilic substances can cross into or out of a cell at a productive rate, they rely on **membrane transport proteins** to assist them in getting through. What are the **two categories of transport proteins found in cell membranes**?

   1. _____ 2. _____

   Membranes are thus selectively permeable due to **1.** **the hydrophobic barrier created by the phospholipids**, but also due to **2.** **the types of transport proteins present or not present in a particular membrane** *(which depends on which transport protein genes an organism inherits and which of these genes are expressed or not inside a specific cell)*

10. How does a **Channel Protein** function?

11. How does a **Carrier Protein** function?

12. What is meant when it is said that **transport proteins exhibit specificity for the substance they translocate**?

13. Peter Agre received the Nobel Prize in 2003 for the discovery of **Aquaporins**. Describe their structure and function?

The Discovery of Aquaporins

When Dr. Agre first identified what he would call an "aquaporin" in the plasma membranes of red blood cells he was studying, he didn't know what they were or even if they were a new protein that nobody had identified before. **Certain vertebrate animal immune system cells, white blood cells known as B cells, produce and secrete proteins called antibodies. Different B cells produce different antibodies, each variety able to attract and bind to other proteins and molecules with specificity, due to the antibody and the target protein or other molecule having complimentary shapes. If a researcher tags a specific antibody** *(labels it with fluorescent dye or has a B cell in a culture build it using radioactive amino acids)* **that antibody can be tracked and identified when it is exposed to other cell cytoplasms or tissues. Once a particular labeled antibody binds to the particular protein or other molecule of interest, the location of that protein or other molecule of interest can be identified. Antibodies can thus be used to identify the location of other proteins and molecules in a cell or in tissue as long as an antibody is used that will bind to a portion of that target protein or other molecule.** Using antibodies Dr. Agre made that would bind to this newly discovered protein, he showed his new protein to be one of the most abundant proteins in red cell membranes (200,000 copies per cell!) and even more abundant in certain renal (kidney) cells. Although many people study red cells, no one had ever seen this protein before because it doesn't stain with the usual protein stains often used. It was John Parker, a hematologist and superb red–cell physiologist, who finally said, "Maybe this protein is involved in water transport."

To test this hypothesis, Dr. Agre and his research team performed a simple experiment using frog egg cells: They injected the cells with mRNA that the cells translated into aquaporin proteins. As a consequence, they found that they could turn the cells from being almost watertight (without aquaporins) into highly water–permeable (with aquaporins). The cells with aquaporin would swell and explode when placed in pure, distilled water as a result of **osmosis** *(the diffusion of water)*. With aquaporins, the cell membrane became permeable to water, but **not** to things dissolved in it (solutes), water molecules crossing the membrane from the side with less solute (distilled water) to the side with more (the cell interior).

Aquaporins work equally well for the uptake or release of water. The driving force is not some kind of a pump action, but simply, passive osmosis. **An aquaporin allows osmosis to occur extremely rapidly.**

Aquaporin evolution

Several hundred aquaporins are known so far. Plants have the most, but animals do too. **The presence of aquaporins in almost all organisms and similarities among the molecules suggest that aquaporins arose very early in evolution**.

What happens when DNA mutations disrupt aquaporin function?

Mutations in aquaporin genes can cause health problems since aquaporin proteins either won't be produced, will be overproduced, or won't function properly. People whose kidney cells have defective aquaporin–2 molecules need to drink 20 liters of water a day to prevent dehydration. They can't concentrate their urine enough since their kidney filters the blood, removing water, ions, and waste molecules, but is unable to return the water to the blood thereafter, and so cannot prevent dehydration the way a healthy kidney would. In addition, some patients make too much aquaporin, causing them to retain too much fluid (water) in their blood instead of filtering out enough of it. Fluid retention in pregnant women is caused by the synthesis of too much aquaporin–2. Knowledge of aquaporins may in the future contribute to the solution of medical problems. Specific aquaporins, such as those of the protist parasite that causes malaria, a deadly illness might be useful targets for new drugs. Blocking the aquaporins in the parasite may help kill the parasite and thus treat malaria.

14. Many versions of aquaporins have been identified. Aquaporins exclude passage of hydronium ions (H_3O^+). Recent research reveals a role for some aquaporins even in fat metabolism, in which they allow passage of glycerol, a three-carbon alcohol, in addition to H_2O through membranes. Since H_3O^+ is much closer in size to water than is glycerol *(See figure Ch.5.9 if you need to refresh your mind on the shape of glycerol molecules)*, what do **YOU** suppose is the basis of the selectivity exhibited by this one type of special aquaporin? **Think!**

*(Once you have come up with a good hypothesis, check your answer by going to the **Ch.7.2 Concept Check Question #3** answer in Appendix A)*

15. Study Tip: **The Study Guides you make for class are essentially chapter outlines that highlight the most important facts and ideas you read about.** Feel free to add extra notes onto them if wish and then use these Study Guides to begin studying the material as **soon as you finish an assignment**! Read over them frequently, daily whenever possible, interacting with your Study Guides actively, highlighting and underlining as you study the material you added in them until you start mastering it all. **Then, for any upcoming assessment, all you should have left to do is to study the course slides covered in class and posted in Archie until you are able to teach their contents OUT LOUD, you already having studies well the corresponding sections of your textbook by studying your homework frequently.**

Let's review. Can you **identify these membrane protein functions** now without looking back at your Study Guide or textbook?