STUDY GUIDE - *Ch. 36.2 - Different Mechanisms Transport Substances in Plants Over Short or Long Distances in Plants* **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. These terms are a review, but also very critical to remember in order to understand the transportation of nutrients in vascular plants. Return to Chapter 7 define these terms to refresh your memory of the specifics.

   a. **Passive Transport**

   b. **Active Transport**

   c. **Transport Proteins**

   d. Among Passive and Active Transport, **which process requires the input of energy** in order to occur *(energy either extracted from ATP directly or a from a concentration gradient of an alternate solute than the one you are trying to move - pump - across a membrane)?*

   e. Based on your answer to d. above, which process involves molecules or ions (solutes) **diffusing across a membrane but down their concentration gradients** *(from an area of high concentration to an area of low concentration of the solute)* ***AND*** *which process involves solutes being **pumped across membranes** (pumping implying that the solutes are moving against their concentration gradients (from an area of low concentration to an area of increasing higher concentration of the solute).*

2. Remember, plants have porous, yet mechanically-supportive cell walls surrounding each individual cell's plasma membrane. There are two major compartments where aqueous solutions are found and three major pathways of solute transport between plant cells.

Let's look at the **two main locations of water-based solutions in the plant**. Define each term:

1. **Apoplast =**

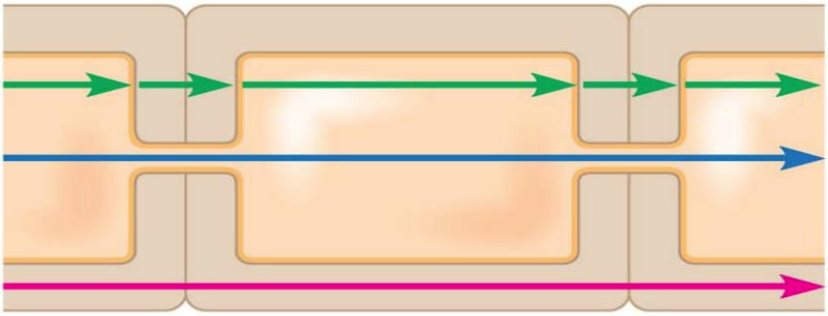
2. **Symplast =**

Now, let's look at the three routes water (and solutes dissolved in water) move between cells within plant tissue. First explain what each term means below. Then, add the term to the correct arrow on the illustration below.

1. **Apoplast Route =**

2. **Symplast Route =**

3. **Transmembrane Route =**



3. As is the case with any organism, **what controls which substances can move into or out of the cell**?

4. a. Let's review again a key concept in cell biology that you learned about in Ch.7. *(Review the Ch.7 slides on the subject again if you do not remember it well).* What is a cell's **membrane potential**?

b. Refer back to Ch.7 for review. Describe how **membrane potential is established in animal cells**? Be specific.
Make sure you describe not just what is moved and where, but also the protein and molecules involved.

c. Review Figure 36.6.a.. Describe how **membrane potential is established in plant cells**? Be specific.
Make sure you describe not just what is moved and where, but also the protein and molecules involved.

d. Review Figure 36.6.b, c, & d. **DESCRIBE** the **steps plant cells engage in while using protons to actively transport into the cell solutes that have to be moved either against their concentration and/or against their electrical gradients (= using protons for cotransport)?**

5. What is **osmosis**?

6. a. Unlike animal cells, **plant cells (like bacterial and fungal cells) have a rigid cell wall, which adds another factor that affects osmosis in addition to the concentration gradient of a solute and the electrical gradient of the solute: physical pressure.**

Define the term **water potential**.

b. **In what direction does free water diffuse (a passive process) when considering the water potential of two neighboring solutions**?

c. Based on this knowledge, **when would water NOT diffuse (when would NO osmosis occur) in terms of the water potential of two neighboring solutions**? ***Think!*** *The answer is **not** when the water potentials of the two solutions are 0 bars or 0 Mpa!*

7. The equation for water potential is $\psi = \psi_s + \psi_p$, where ψ is **water potential**, ψ_s is **solute potential (also known as osmotic potential)**, and ψ_p is the **pressure potential**. Water potential is measured in units of pressure such as **megapascal** (MPa) or **bars.**

   a. What is the ψ_s of pure water?

   b. How does **adding solutes** to pure water affect water potential? And **WHY**?

   c. The **solute potential** of a solution is, therefore, **always zero or**_____**.** (negative or positive?)

8. The equation for water potential is $\psi = \psi_s + \psi_p$, where ψ is **water potential**, ψ_s is **solute potential (also known as osmotic potential)**, and ψ_p is the **pressure potential**. Water potential is measured in units of pressure such as **megapascal** (MPa) or **bars.**

   a. What is **pressure potential**?

   b. Can pressure potential only have a negative value, only have a positive value, or be either positive or negative?

   c. When would **pressure potential decrease** in value?

   d. When would **pressure potential increase** in value?

   e. What is the **turgor pressure** witnessed in cells with cell walls like plants, bacteria, and fungi?

   f. Why is **turgor pressure important for the plant cell**?

9. a. Study Figure 36.7 a. & b.. When **a cell is flaccid (limp), what is its pressure potential**?

   b. When **a cell is turgid (firm) because water has diffused via osmosis into the cell and the protoplast (the plasma membrane and the cytoplasm inside) is pushing against the cell wall, would the cell have a positive or negative pressure potential**?

TWO IMPORTANT ITEMS TO REMEMBER WITH REGARD TO THE DIFFUSION OF WATER:

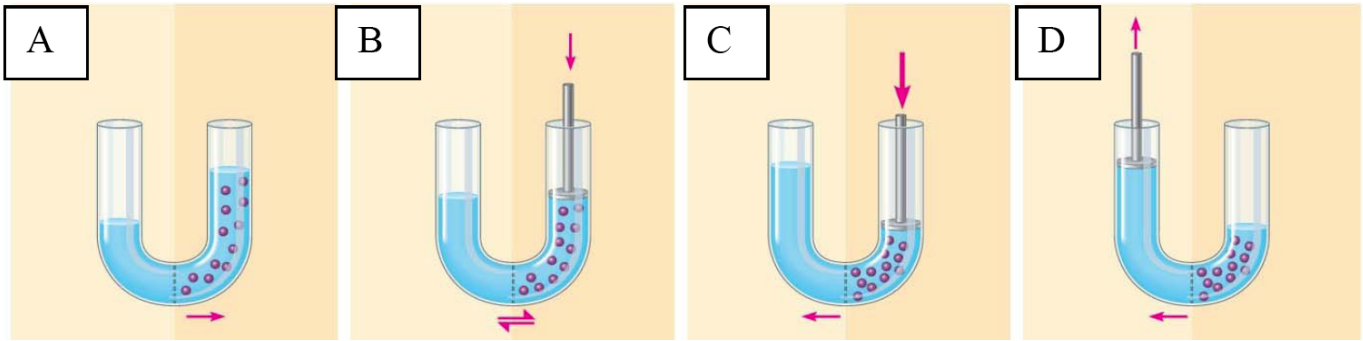
1. Water diffuses from an area of **HIGHER** water potential to an area of **LOWER** water potential, always. *(Osmosis is, thus, **NOT** dependent solely on solute concentrations in solutions)*

2. Osmosis stops when two solutions are in **equilibrium**, meaning that the water potentials of two neighboring solutions are **EQUAL**.

Before you continue, watch the following three videos to review more about the concept of Water Potential:

1. https://www.youtube.com/watch?v=nDZud2g1RVY&t=512s
2. https://www.youtube.com/watch?v=O_eFNOz5WtY&t=204s
3. https://www.youtube.com/watch?v=L-osEc07vMs&t=526s

10. Use the figure below and answer the following questions. Once you have answered the questions, then you can check if you are right by comparing your thinking to the hypothetical example in your text.



a. What is the water potential on the left side of tube A and why?

b. Is the water potential on the right side of tube A positive or negative?

c. Explain, by comparing **water potentials**, why the level of the liquid is higher on the right side of tube A. *(So, compare the water potential ψ of the solution on the left to the water potential ψ of the solution on the right.)*

d. Remember, $\psi = \psi_s + \psi_p$ so **why** is the water potential in the liquid on the left higher than that on the liquid to the right in Tube A? *Discuss specifically the solute and pressure potentials of the two solutions.*

d. In tube B, pressure is being applied on the right side. This is much like the pressure exerted by the cell wall when a plant cell takes up water [when the cell is **turgid** = review chapter 7]. How do the water potentials of the two solutions in tube B **compare**?

e. Explain, **in terms of water potential**, why is the level of liquid the same on both sides even though the two solutions are **not** isotonic to each other, one having a higher solute concentration, being hypertonic, and the other having a lower solute concentration, being hypotonic? ***[Remember, two solutions are isotonic in relation to each other when they have equal CONCENTRATIONS – not numbers – of solutes!].*** Remember, $\psi = \psi_s + \psi_p$

f. How do the water potentials of the two solutions in tube C **compare** resulting in water moving from right to left?

g. Remember, $\psi = \psi_s + \psi_p$, so **why** is the water potential on the right higher than the water potential on the left in tube C?

h. How do the water potentials of the two solutions in tube D **compare** resulting in water moving from left to right?

i. Remember, $\psi = \psi_s + \psi_p$, so **why** is the water potential on the right lower than the water potential on the left in tube D?

11. a. What are **aquaporins**?

b. Which changes inside the cell decrease the rate at which water can diffuse through aquaporins?

1.

2.

12. a. If a plant cell immersed in distilled water has a ψ_s of -0.7 MPa and a ψ of 0 MPa, what is the cell's ψ_p ? Show your work. *(Check your answers by going to the **Ch.36.2 Concept Check Question #1** answers in Appendix A)*

b. If you put the plant cell in an open beaker of solution that has a ψ of -0.4 MPa, what would be its ψ_p at equilibrium? Show your work. *(Check your answers by going to the **Ch.36.2 Concept Check Question #1** answers in Appendix A)*

13. How would a reduction in the number of aquaporin channels affect a plant cell's ability to adjust to new osmotic conditions? *(Check your answers by going to the **Ch.36.2 Concept Check Question #2** answers in Appendix A)*

14. What would happen if you put plant protoplasts in pure water? *Explain in terms of water potential.* *(Check your answers by going to the **Ch.36.2 Concept Check Question #4** answers in Appendix A)*