

AP Biology 2017-2018

Mrs. Spencer

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Welcome to AP Biology! This class is a lot of work, but a lot of fun at the same time! I will be communicating with you via email throughout the summer. We will not be meeting, but you will have summer assignments. They are as follows:

- 1. Send me an email with your name in the subject line so I have your email address before the last day of school.**
2. Read chapters 2-4. Complete study guides. Email me with any questions about the material. There will be a test on those chapters on the second day of class.
3. Complete the packets on protein structure and cell membrane structure and function.

*****ALL WORK IS DUE ON THE FIRST DAY OF SCHOOL!*****

Name _____ Date _____ Blk _____

Chapter 2 Life Chemistry and energy

Answer all questions in your own words. Do not write anything in "textbookese" (copying word from word from textbook and not understanding it).

1. Draw a model of an atom. Label its parts.
2. Compare and contrast ionic and covalent bonds. Discuss polar and nonpolar covalent bonds and hydrogen bonds.
3. What is a functional group and what is its importance?
4. Compare and contrast condensation reactions with hydrolysis reactions. When would they take place?

5. Describe carbohydrates:

a. What are they made up of?

b. Why are they important?

c. Describe the structure.

d. Give examples.

6. Describe lipids:

a. What are they made up of?

b. Why are they important?

c. Describe the structure.

d. Give examples.

7. Compare and contrast anabolic and catabolic reactions. Give examples of each.

Name _____ Date _____ Blk _____

Chapter 3 Nucleic Acids, Proteins and Enzymes

Answer all questions in your own words. Do not write anything in "textbookese" (copying word from word from textbook and not understanding it).

1. Compare and contrast RNA and DNA.
2. Describe the processes of DNA replication, transcription and translation.
3. What is an enzyme? How do they work and why are they important?
4. What is inhibition? Compare and contrast irreversible and reversible inhibition.
5. Name and describe factors that will affect enzyme activity.

Name _____ Date _____ Blk _____

Chapter 4 Cells

Answer all questions in your own words. Do not write anything in “textbookese” (copying word from word from textbook and not understanding it).

1. What is the importance of the ratio of surface area to volume in a cell?
2. Compare and contrast prokaryotes and eukaryotes.
3. Name and describe the major organelles found in eukaryotes.

4. Describe the structures of the cytoskeleton that contribute to the strength and movement of the cell.

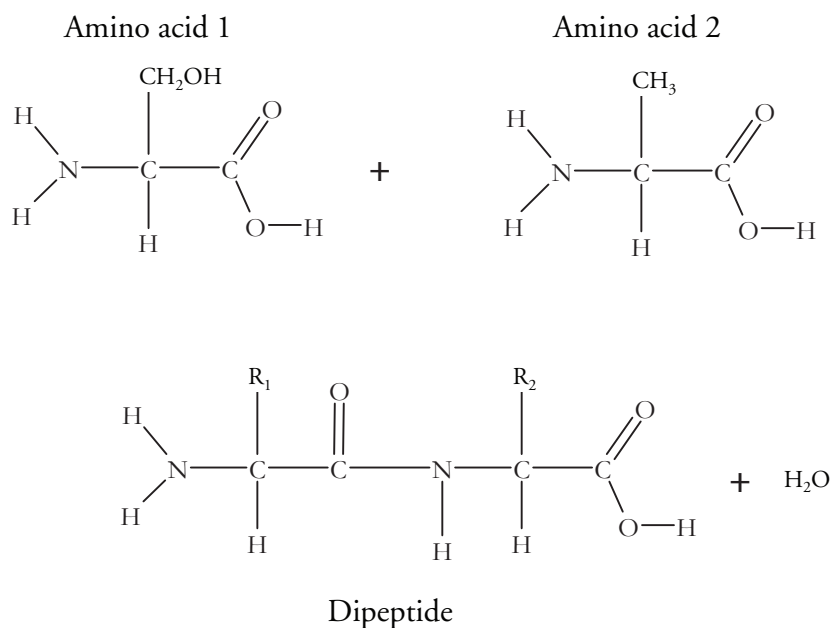
Protein Structure

What are the levels of protein structure and what role do functional groups play?

Why?

Proteins accomplish many cellular tasks such as facilitating chemical reactions, providing structure, and carrying information from one cell to another. How a protein chain coils up and folds determines its three-dimensional shape. Its shape will, in turn, determine how it interacts with other molecules and thus performs its function in the cell.

Model 1 – Formation of a Peptide Bond



1. Examine the amino acids in Model 1.
 - a. Circle an amine group in the diagram.
 - b. Draw a triangle around a carboxylic acid (carboxyl) group.
2. How are the amino acids similar to one another?
3. How are the amino acids different from one another?

4. How many amino acids are involved in the reaction to make a dipeptide?

5. In Model 1 the original amino acids are combined through a **condensation reaction** to make the dipeptide.
 - a. What does R_1 represent in the dipeptide?

 - b. What does R_2 represent in the dipeptide?

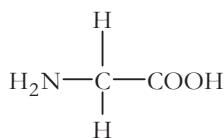
6. Put a box around the atoms in the amino acids that become the H_2O molecule produced by the reaction in Model 1.

7. A peptide bond is a covalent bond linking two amino acids together in a peptide.
 - a. Circle the peptide bond in Model 1.

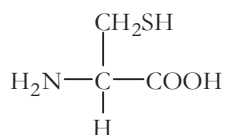
 - b. Between which two atoms in the dipeptide is the peptide bond located?

 - c. Between what two functional groups is the peptide bond located?

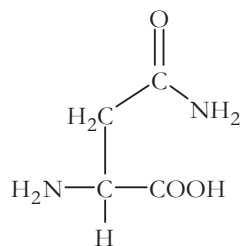
8. There are 22 different amino acids found in nature. Two were shown in Model 1. Additional examples are shown below. With your group, write one or two grammatically correct sentences to describe how these amino acids are similar and how they are different. Use the terms R-group, amine group, and carboxyl group in your description.



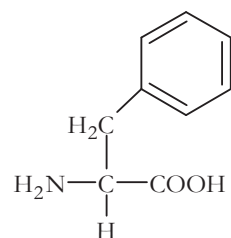
Glycine
(Gly)



Cysteine
(Cys)



Asparagine
(Asn)



Phenylalanine
(Phe)

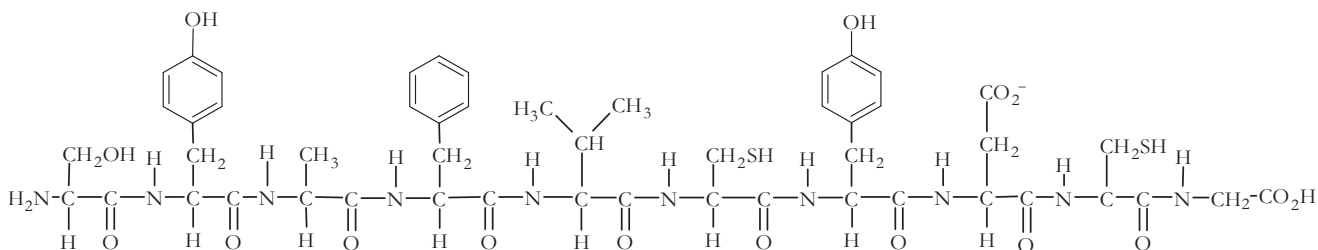


Model 2 – Protein Structure (Part A)

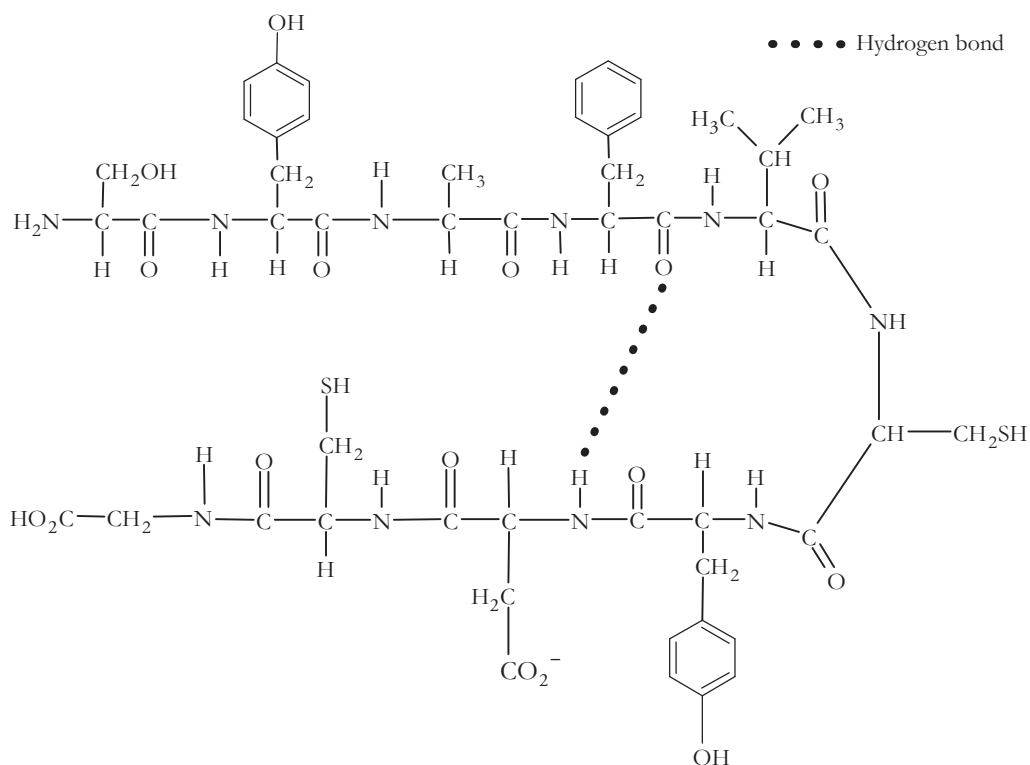
Primary Structure

Amino acid sequence: Ser – Tyr – Ala – Phe – Val – Cys – Tyr – Asp – Cys – Gly

Peptide structure:

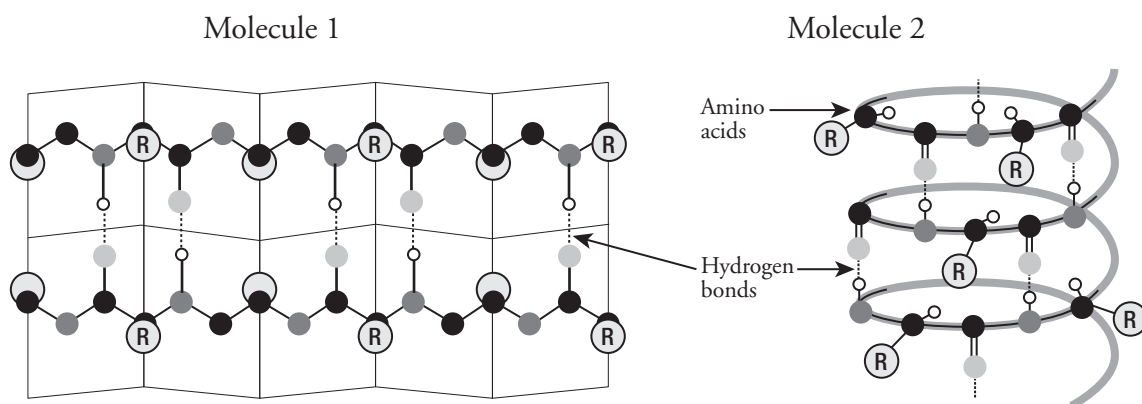



Secondary Structure



9. Locate the **primary structure** of the polypeptide in Model 2.
- Draw an arrow to two different peptide bonds in the diagram.
 - Circle three separate amino acids that were joined together to make the polypeptide.

10. The first five amino acids in this **polypeptide** are serine, tyrosine, alanine, phenylalanine, and valine, in that order (Ser-Tyr-Ala-Phe-Val). If the amino acids were changed or rearranged (i.e., to Val-Phe-Ala-Ser-Tyr), the polypeptide would have a different name and identity. With your group, use this information to write a definition of the primary structure of a protein.
11. Locate the **secondary protein structure** in Model 2.
- What types of bonds are holding the secondary structure in place?
 - What groups on the amino acids are always involved in these bonds?
12. Draw a rectangle around two different R groups on the amino acids in the secondary structure in Model 2.
13. Is there any interaction between R groups in the secondary structure in Model 2?
14. Secondary protein structure can take the form of an alpha(α)-helix or a beta(β)-pleated sheet, as illustrated below.
- Which drawing represents an α -helix, Molecule 1 or Molecule 2? Explain your reasoning.
 - Which drawing represents a β -pleated sheet? Explain your reasoning.

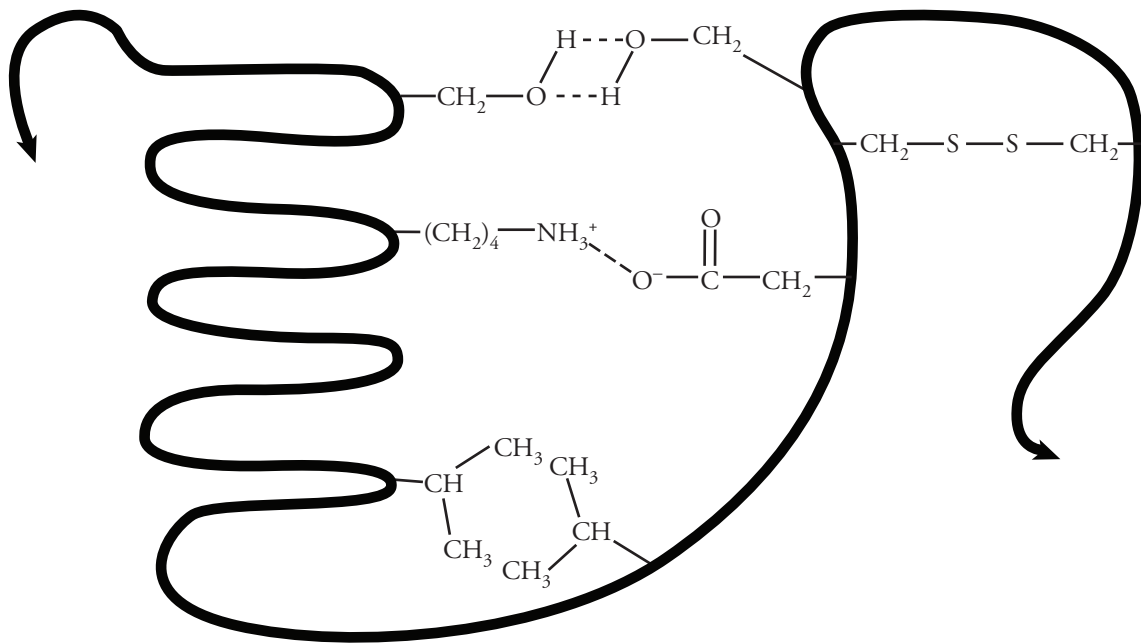


-  15. With your group, write a grammatically correct sentence that summarizes how the secondary protein structure is formed from the primary structure.

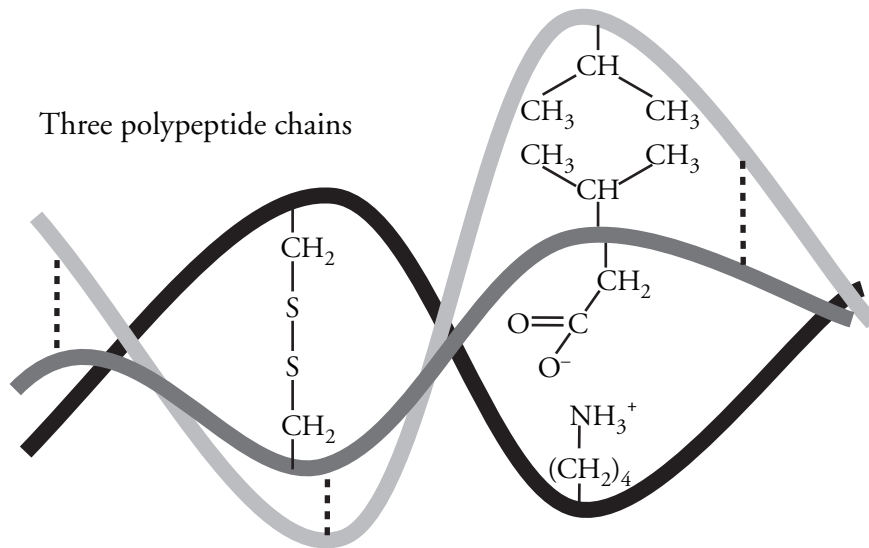


Model 3 – Protein Structure (Part B)

Tertiary Structure



Quaternary Structure



16. Examine the **tertiary structure** in Model 3 and note the interactions that hold this level of structure in place.
- a. Four types of bonds or interactions are shown. Label them with the following terms.
Disulfide bridge Hydrogen bond
Hydrophobic interactions Ionic bond
 - b. Describe the part of the amino acid that participates in these interactions.
 - c. How does your answer in part *b* differ from the bonds that stabilize the secondary structure?
17. What type of functional groups or atoms would need to be present in the R-groups for hydrogen bonding to occur between two amino acids in a protein chain?
18. What type of functional groups or atoms would need to be present in the R-groups for hydrophobic interactions to occur between two amino acids in a protein chain?
19. How many polypeptide chains are shown in the tertiary protein structure in Model 3?
20. Many proteins, but not all, have a fourth level of structure termed **quaternary structure**.
- a. How many polypeptide chains are shown in the quaternary structure of the protein in Model 3?
 - b. What types of bonds and interactions hold the quaternary structure in place?

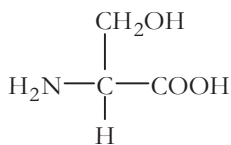


21. With your group, using grammatically correct sentences, define the following.

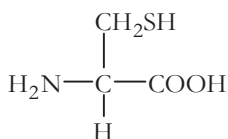
- a. Tertiary protein structure.

- b. Quaternary protein structure.

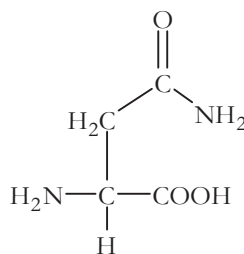
22. Imagine a protein chain that includes the following amino acids among several others.



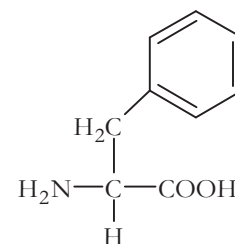
Serine



Cysteine



Asparagine



Phenylalanine

- a. Which of the amino acids could form a hydrogen bond with another amino acid in the chain to stabilize the secondary structure of a β -pleated sheet?

- b. Which of the amino acids could form disulfide bonds with another amino acid in the chain to stabilize the tertiary structure of the protein?

- c. Which of the amino acids could participate in hydrophobic interactions with another amino acid in the chain to stabilize the tertiary structure of the protein?

- d. What types of bonds or interactions could asparagine form with another amino acid in the chain in order to form a quaternary structure with another protein chain?

23. Fill in the following chart using what you've learned from Models 1–3.

Structure	Bond(s) or interactions holding the structure together	Short description	Number of polypeptide chains involved
Primary			1
Secondary			1
Tertiary			1
Quaternary			2 or more



Read This!

Heating and changing pH levels are two ways to disrupt the shape of a protein. High temperatures or pH levels that vary from the natural environment of the protein will break hydrogen bonds, ionic bonds, disulfide bridges, and hydrophobic interactions. Covalent bonds will usually remain undisturbed. This process of destroying the shape of a protein is called **denaturing**.

24. Which of the four levels of protein structure is maintained after denaturing? Explain your answer.



25. Proteins carry out a variety of functions, and their function is critically dependent upon their structure and shape. Enzymes are proteins. What would happen to the structure and function of an enzyme that was exposed to heat or a drastic change in pH?
26. When people get their hair chemically straightened, one chemical is put on the hair to break the disulfide bonds that give the hair strands their shape (curled) and a second chemical is used to reform the disulfide bonds to hold the hair in a new position (straight).
- What level(s) of protein structure is/are affected by these processes?
 - Why doesn't the hair stay straight forever after this treatment?

Extension Questions

27. If a mutation in the DNA of an organism results in the replacement of an amino acid containing a polar R-group with another amino acid containing a nonpolar R-group, how might the structure of the protein be affected? Address the impact on all levels of the protein structure in your answer.
28. Egg whites are primarily composed of the protein albumin. One familiar example of the denaturing of proteins is the difference between the albumin structure in a raw egg versus a cooked egg. Using what you know about the levels of structure in proteins, propose an explanation of changes in albumin (and other proteins) that occur during cooking.
29. Predict what would happen to the egg white if a raw egg were placed in vinegar. Explain your thinking.

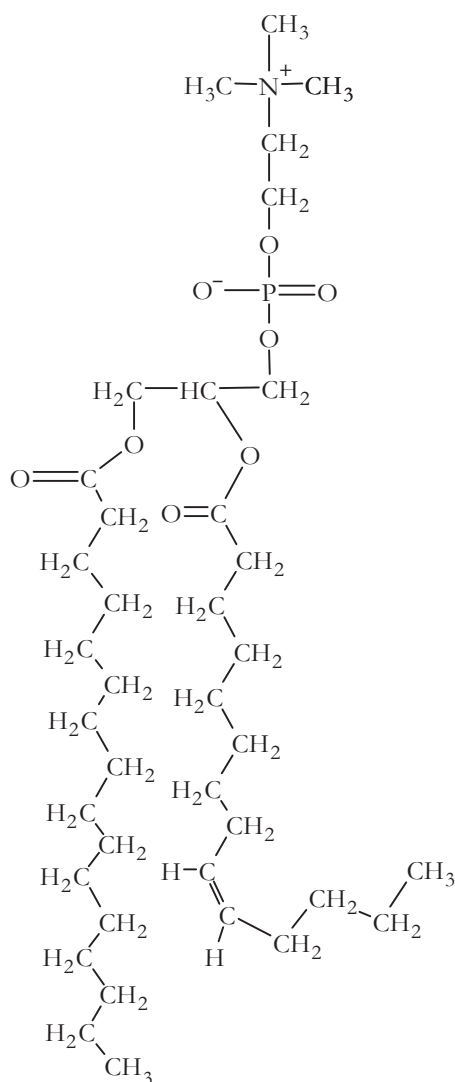
Membrane Structure

What molecules make up a membrane?

Why?

Imagine your bedroom without closets, drawers, shelves, bags or boxes—just a room with a bed. Where would your stuff be? Would you be able to find the things you needed? How efficiently could you get ready for school in the morning? Would all of your school items be together when you sat down to study? The compartments you use in your room—the closet, drawers, etc.—help you organize items by category so that all the items you need to get dressed are in one place. All the items you need for studying are in another place. This **compartmentalization** improves efficiency. Cells also need organization to improve efficiency. The compartmentalization of cells is achieved by dividing up areas in the cell with membranes. A plasma membrane compartmentalizes internal structures while the cell membrane acts as a boundary between the cell and the external environment.

Model 1 – Phospholipids



1. Refer to Model 1. Identify at least two organic functional groups in a phospholipid molecule.

2. Consider the term phospholipid.
 - a. What portion of the molecule in Model 1 is responsible for the “phospho-” part of the name?

 - b. What portion of the molecule in Model 1 is responsible for the “-lipid” part of the name?

3. Part of a phospholipid is polar.
 - a. Circle the portion of the molecule in Model 1 that is polar.
 - b. Would this portion of the phospholipid mix well with water? Explain your reasoning.

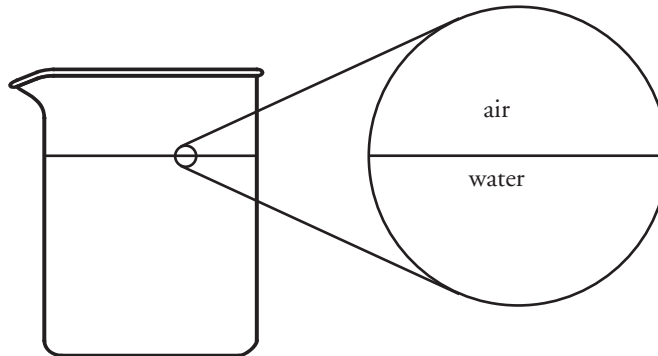
4. Part of a phospholipid is nonpolar.
 - a. Draw a square around the portion of the molecule in Model 1 that is nonpolar.
 - b. Would this portion of the phospholipid mix well with water? Explain your reasoning.

5. Label the regions of the molecule in Model 1 with the phrases “hydrophilic head” and “hydrophobic tail.”

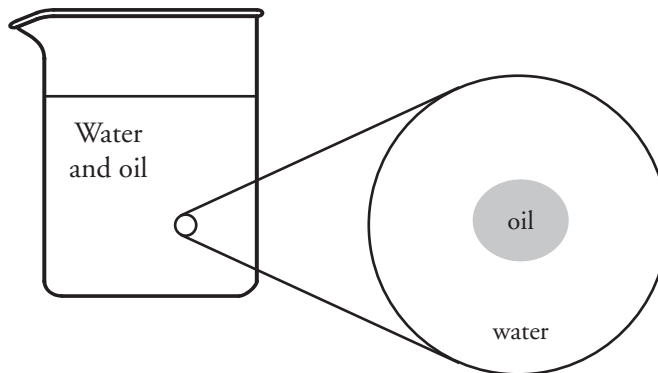
6. Scientists often use a cartoon representation like the one shown below to represent a phospholipid. Which portion of the cartoon represents the hydrophilic head of the phospholipid?



7. When phospholipids are placed on the surface of water they form a thin layer. Consider carefully which portion of the phospholipid will be in the water and which will be in the air in order to obtain the most stable (lowest potential energy—maximum attractions) system. Draw a cartoon-like representation below to show the proper orientation of three phospholipid molecules on the surface of water.



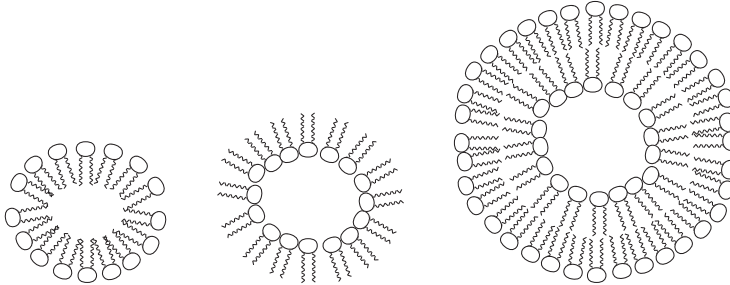
8. When a small amount of oil is added to a beaker of water containing phospholipids, the phospholipids will surround the oil droplets forming **micelles**. Use several cartoon representations of phospholipid molecules to show the arrangement or orientation of phospholipids in a micelle.



9. Recalling that a beaker of water is three-dimensional, what is the three-dimensional shape of the micelle?



10. Phospholipids assemble in layers to make membranes for cells and organelles. Circle the drawing below that represents the most stable (lowest potential energy) assembly of phospholipids where water is both inside and outside of the membrane. (This might be the membrane on a vacuole for instance.) Explain your reasoning.



11. How do phospholipid molecules lead to compartmentalization of a cell?

Read This!

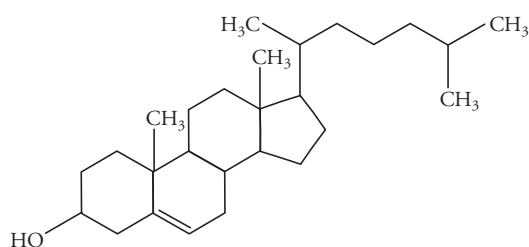
When phospholipids are added to an aqueous environment (consisting mostly of water) the phospholipid molecules will spontaneously assemble into a **phospholipid bilayer** where the layers are held together by weak attractive forces between molecules. These structures are often seen in nature as cell and organelle membranes.

12. Consider animal cells, which are only bound by a cell membrane and plant cells which are bound by both a cell membrane and a cell wall. Are cell membranes flexible (fluid)? Provide specific examples to support your answer.
13. Explain why a phospholipid bilayer is flexible in terms of the strength of the forces that hold it together.

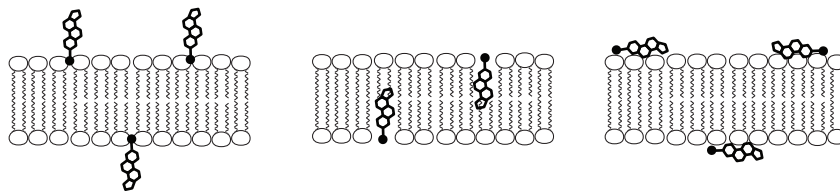
14. Refer to Model 1.

- a. What happens to the shape of the hydrophobic tail in a phospholipid when a double bond is present in the carbon chain?
- b. Explain why the flexibility (fluidity) of a membrane increases when more of the phospholipids in the layers contain double bonds.

15. The diagram below shows the chemical structure of cholesterol, which is a key component of membrane structure.



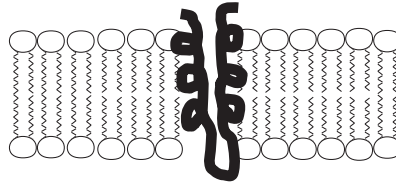
- a. Is the cholesterol molecule mostly polar or mostly nonpolar? Explain.
- b. Circle the drawing below which illustrates the most likely placement of cholesterol in a phospholipid bilayer.



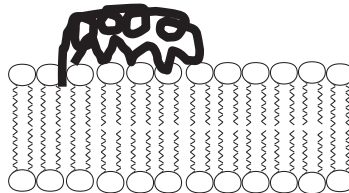
- c. The cholesterol forms weak attractive forces with multiple phospholipids in the bilayer. Would this increase or decrease flexibility of the membrane? Explain your reasoning.

Extension Questions

16. **Embedded proteins** are often found spanning the membrane of a cell or organelle. These proteins serve as channels for specific molecules to travel through the membrane, either into or out of the cell.



- a. What sections of the embedded protein chain are most likely to contain amino acids with hydrophobic R-groups? Explain your reasoning.
- b. What sections of the embedded protein chain are most likely to contain amino acids with hydrophilic R-groups? Explain your reasoning.
17. Some membranes have **surface proteins** on them. These proteins often serve a signaling function between cells. Propose a mechanism by which these surface proteins are able to attach to the membrane.



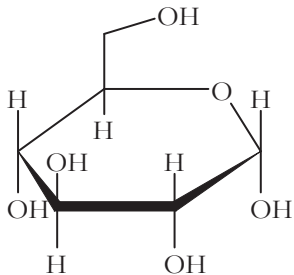
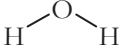
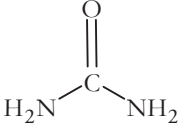
Membrane Function

How does the cell membrane control movement of materials?

Why?

The membrane is critical to the maintenance of homeostasis in living organisms. The cell membrane separates the cell from the external environment and plays a critical role in regulating movement of material in and out of the cell. Additionally, eukaryotic cells are made complex by the presence of internal membranes that form organelles, so the cells may become specialized. These organelle membranes create compartments within the cell that can do specific functions.

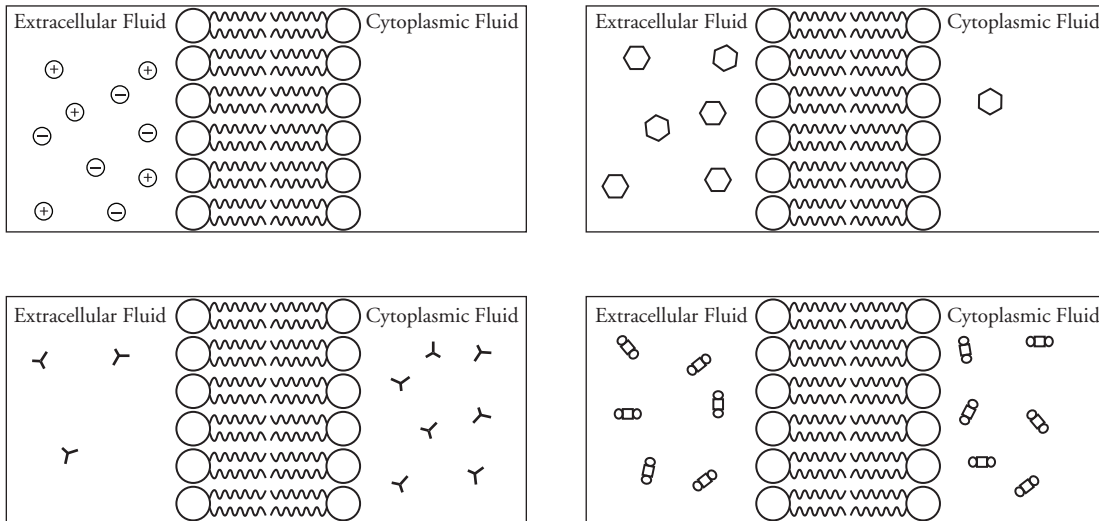
Model 1 – Types of Ions and Molecules in a Cell

Type 1 Ions	Type 2 Molecules	Type 3 Molecules	Type 4 Molecules
Potassium: K^+	Glucose: 	Water: 	Molecular oxygen (O_2): $O=O$
Sodium: Na^+		Urea: 	Carbon dioxide (CO_2): $O=C=O$
Calcium: Ca^{2+}			
Chloride: Cl^-			
	polar		nonpolar
small	large		

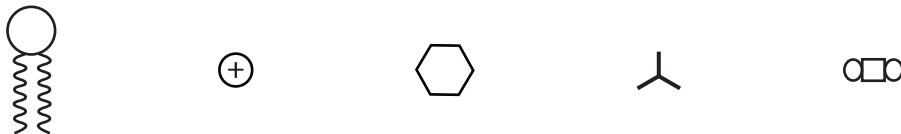
- Consider the ions and molecules in Model 1.
 - Identify at least two substances that would need to move into a cell to maintain homeostasis.
 - Briefly explain why the cell needs each of the substances you identified in part *a*.
- Consider the ions and molecules in Model 1.
 - Identify at least two substances that would need to move out of a cell to maintain homeostasis.
 - Briefly explain the source of the molecules you identified in part *a*.
- Complete the table by labeling the types of substances as polar or nonpolar and large or small.



Model 2 – Selectively Permeable Cell Membrane



4. The four diagrams in Model 2 illustrate movement of four types of substances (see the table in Model 1) across a phospholipid bilayer.
- Use your knowledge of membrane structure and the chemical structures in Model 1 to identify the shapes used in Model 2.



- Label each diagram in Model 2 with the ion or molecule type (i.e., Type 1 Ions or Type 2 Molecules) based on the information in Model 1.
5. For each diagram in Model 2, circle the side of the membrane where the ion or molecule would have originated in the normal function of a cell.

6. Assume the substances in Model 2 were on only one side of the membrane to start. The diagrams illustrate what would happen after some time has passed.
- Which substances in Model 2 appear to be completely blocked by the membrane?
 - Which substances in Model 2 appear to be able to pass freely through the membrane?
 - Which substances in Model 2 appear to pass through the membrane with some difficulty?
 - Urea appears to pass through the membrane more easily than glucose. What characteristic of urea might help explain this observation?



7. The majority of the membrane is made of nonpolar hydrocarbon chains. Use the diagrams in Model 2 and the table in Model 1 to explain the permeability of the membrane for each of the four types of substances in Model 1. *Hint:* Like dissolves like.

Type 1 Ions:

Type 2 Molecules (Large, polar biomolecules):

Type 3 Molecules (Small, polar molecules):

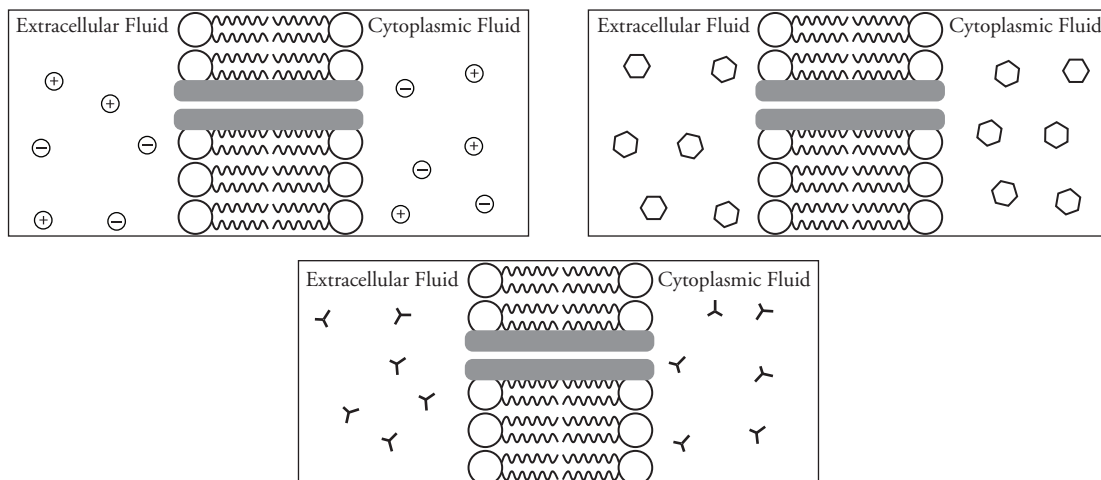
Type 4 Molecules (Small, nonpolar molecules):




Read This!

Diffusion is the process of molecules traveling through a membrane barrier from a location of high concentration to a location of low concentration. The driving force for this process is simply the natural movement of the molecules in random directions. Whether the molecules are allowed to cross or not is only due to the polarity of the molecules themselves and their size. No energy is needed, which is why diffusion is considered a type of **passive transport**. This process is illustrated in Model 2 for several types of molecules.

Model 3 – Embedded Proteins



8. Label the embedded proteins in the membrane diagrams of Model 3.
 9. What appears to be the effect of inserting a protein channel into the membrane on the movement of molecules across the membrane?
-  10. Is the inner surface of the embedded protein likely to be polar or nonpolar in the examples shown in Model 3? Explain your reasoning.

Read This!

When an embedded protein assists in the **passive transport** of molecules across a barrier in the direction of the concentration gradient (from high concentration to low concentration) it is called **facilitated diffusion**. Embedded proteins may also be involved in **active transport** where the cell uses energy from ATP to move molecules across a membrane against the concentration gradient.

11. Summarize the two types of passive transport discussed above. In your answer consider the types of molecules that are transported, the direction of transport, and any external energy or special structures that are needed in the process.
12. Summarize active transport. In your answer consider the direction of transport and any external energy or special structures that are needed in the process.



Extension Questions

13. Some embedded proteins are called **aquaporins**. What molecule do you think aquaporins assist in transporting across a membrane?
14. The molecules below are often moved into or out of cells during biological processes. Categorize each molecule into one of the four types (from Model 1). Using that classification decide whether or not they would be able to cross the cell membrane freely without the help of a membrane protein.

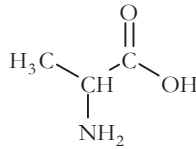
Nitrogen gas



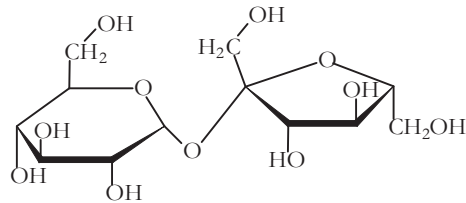
Hydronium



Alanine
(amino acid)



Sucrose



Bicarbonate

