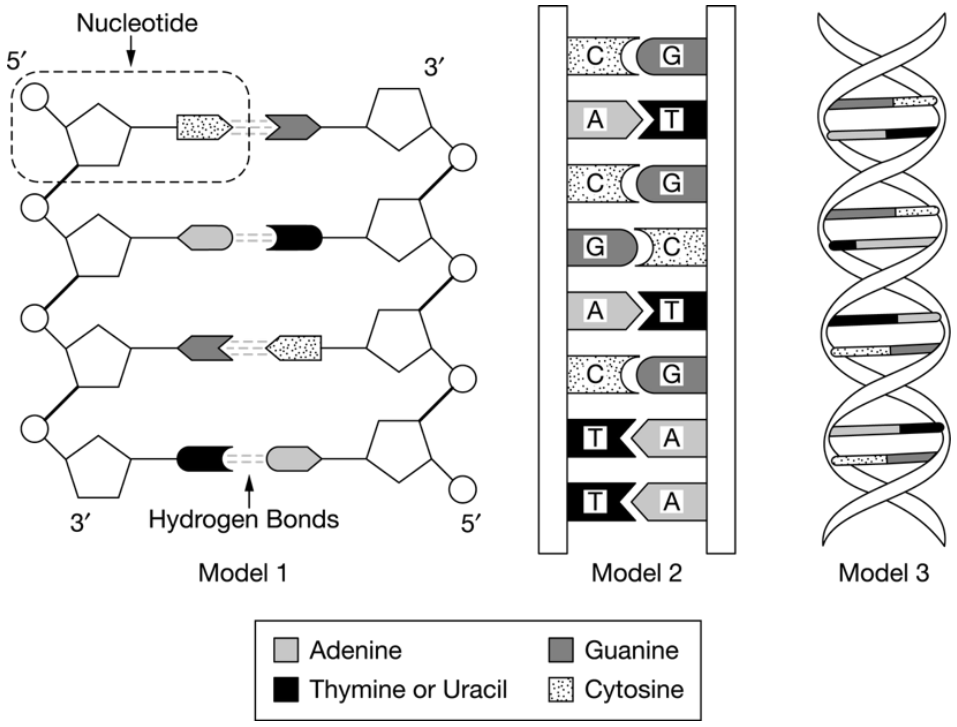
Unit 1: Chemistry of Life Progress Check (MCQ)

[Question 1 through 3 refer to the following]



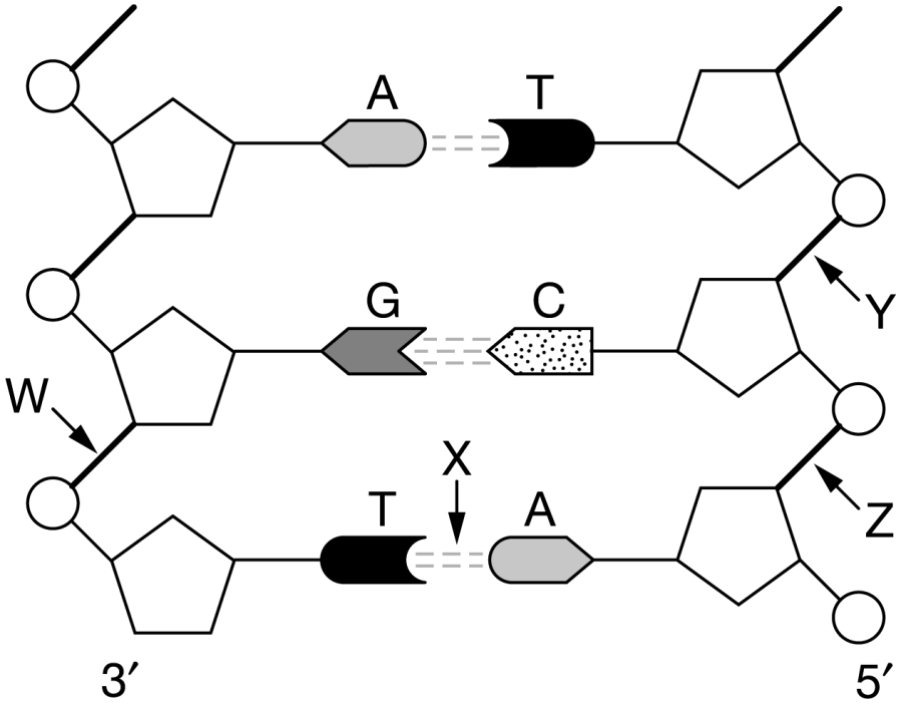


Figure 1. Four different bonds (W, X, Y, and Z) in a DNA molecule

1. Which feature of Model 1 best illustrates how biological information is coded in a DNA molecule?

A. The 5' and 3' labels at the ends of each strand

B. The labeling of the hydrogen bonds between base pairs

C. The lines connecting sugars and phosphate groups that represent covalent bonds

D. The linear sequence of the base pairs

2. Figure 1 represents a segment of DNA. Radiation can damage the nucleotides in a DNA molecule. To repair some types of damage, a single nucleotide can be removed from a DNA molecule and replaced with an undamaged nucleotide. Which of the four labeled bonds in Figure 1 could be broken to remove and replace the cytosine nucleotide without affecting the biological information coded in the DNA molecule?

A. Bond X only

B. Bond W only

C. Bonds Y and Z at the same time

D. Bonds W and Z at the same time

3. A student wants to modify model 1 so that it represents an RNA double helix instead of a DNA double helix. Of the following possible changes, which would be most effective in making model 1 look more like RNA than DNA?

A. Changing the sequence of the base pairs

B. Changing the deoxyriboses to riboses by adding -OH groups

C. Changing the shapes of the nitrogenous bases to match those shown in model 2

D. Changing the sugar-phosphate backbone to a ribbon, as shown in model 3

[Question 4 through 7 refer to the following]

Different polysaccharides are used by plants for energy storage and structural support. The molecular structures for two common polysaccharides are shown in Figure 1. Starch is used by plants for energy storage, and cellulose provides structural support for cell walls. The monomer used to construct both molecules is glucose.

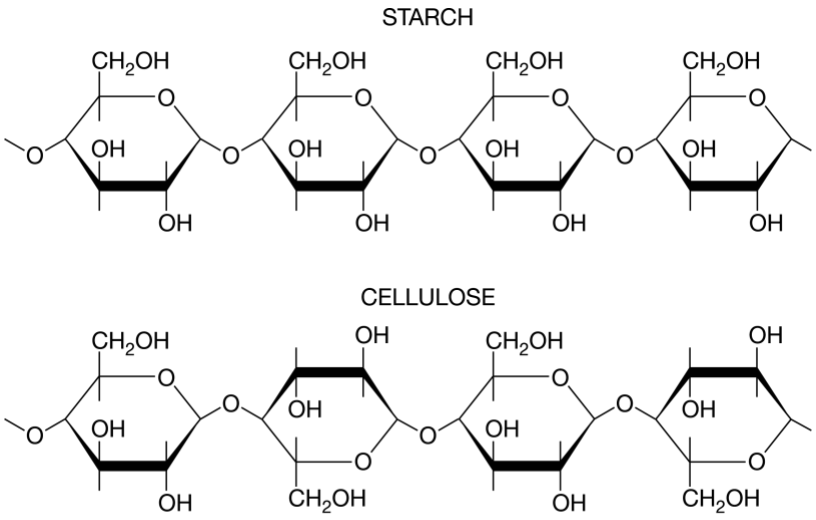


Figure 1. Comparison of segments of starch and cellulose

A study determined the effect of two different digestive enzymes, A and B, on these two polysaccharides. Table 1 presents the data from the study.

Table 1. Effect of Enzymes A and B on Cellulose and Starch

Test Tube	Polysaccharide Added	Enzyme Added	Glucose Detected after 5 minutes at 37°C
1	Cellulose	A	No
2	Cellulose	B	Yes
3	Starch	A	Yes
4	Starch	B	No

Mammals do not produce digestive enzyme B. However, sheep and cattle are two types of mammals that contain microorganisms in their digestive tract that produce enzyme B.

4. Based on Figure 1, which of the following best compares the atomic structures of starch and cellulose?

A. Starch is composed of carbon, hydrogen, and oxygen, while cellulose also contains nitrogen.

B. Starch and cellulose are composed of repeating glucose monomers; however, in cellulose, every other glucose monomer is rotated 180 degrees.

C. Starch is composed of monomers that each have a CH_2OH group, while cellulose only has a CH_2OH group on every other monomer.

D. Starch and cellulose are composed of identical monomers and therefore have identical structures.

5. Which of the following statements best describes the different functions of starch and cellulose in plants?

A. The differences in the assembly and organization of the monomers of these two polymers result in different chemical properties.

B. Since starch and cellulose are composed of identical monomers, the cellular environment where they are located controls their function.

C. The monomers of cellulose are connected by covalent bonds, making it idea for structural support.

D. The monomers of starch are connected by ionic bonds, making it ideal for energy storage for plants.

6. Which of the following best describes the process that adds a monosaccharide to an existing polysaccharide?

A. The monosaccharide is completely broken down by a specific enzyme and then the atoms are reorganized and made into a polysaccharide.

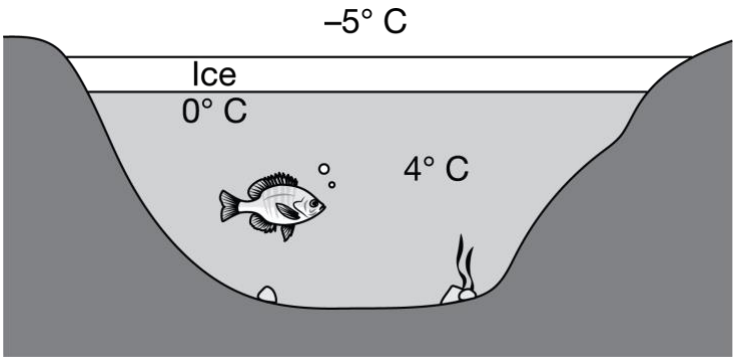
B. Ionic bonds are formed between adjacent carbon atoms of the monosaccharide and the polysaccharide by adding water (H_2O) and a specific enzyme.

C. A specific enzyme removes the hydrogen (H) from the monosaccharide and the hydroxide (OH) from the polysaccharide, creating a bond between the two and creating a water (H_2O) molecule.

D. A specific enzyme removes two hydroxides (OH), one from the monosaccharide, and one from the polysaccharide, creating a bond between the two monosaccharides and creating a hydrogen peroxide (H_2O_2) molecule.

7. Which of the following would most likely occur if cattle lost the ability to maintain a colony of microorganisms in their digestive tract?

A. Cattle would no longer be able to synthesize cellulose.
B. Cattle would have to convert cellulose to starch before digesting it.
C. Cattle would have to start producing enzyme B without the help of the bacteria.
D. Cattle would no longer be able to use cellulose as a primary source of glucose.



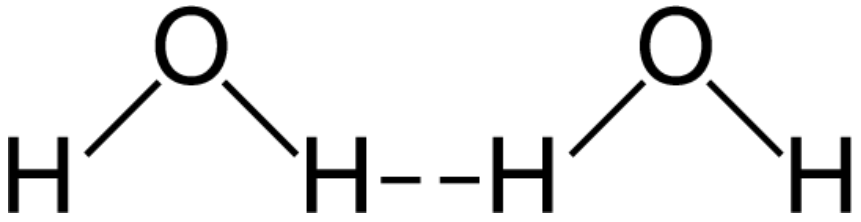
As shown in the diagram, when environmental temperatures drop below freezing, a layer of ice typically forms on the surface of bodies of freshwater such as lakes and rivers.

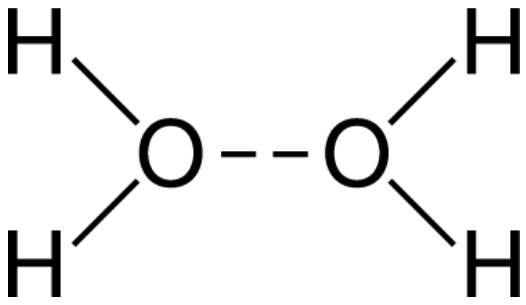
8. Which of the following best describes how the structure of ice benefits the organisms that live in the water below?

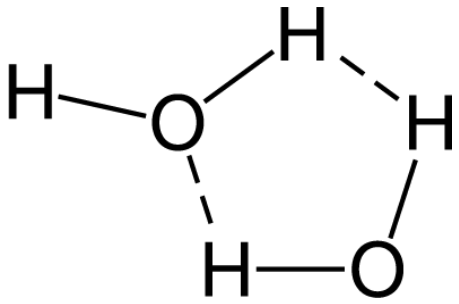
A. The water molecules in ice are closer together than those in liquid water, so the ice prevents the passage of air to the water, maintaining a constant gas mixture in the water.
B. The water molecules in ice are closer together than those in liquid water, so the ice forms a barrier that protects the organisms in the water from the freezing air temperatures.
C. The water molecules in ice are farther apart than those in liquid water, so the ice floats, maintaining the warmer, denser water at the lake bottom.
D. The water molecules in ice are farther apart than those in liquid water, so the ice floats, preventing the escape of gases from the liquid water.

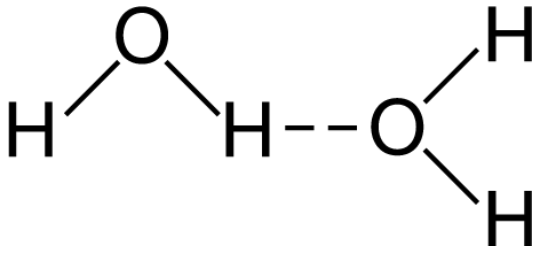
Water molecules are polar covalent molecules. There is a partial negative charge near the oxygen atom and partial positive charges near the hydrogen atoms due to the uneven distribution of electrons between the atoms, which results in the formation of hydrogen bonds between water molecules. The polarity of water molecules contributes to many properties of water that are important for biological processes.

9. Which of the following models best demonstrates the arrangement of hydrogen bonds between adjacent water molecules?

A. 

B. 

C. 

D. 

In vascular plants, water flows from root to leaf via specialized cells called xylem. Xylem cells are hollow cells stacked together like a straw. A student explains that evaporation of water from the leaf pulls water up from the roots through the xylem, as shown in Figure 1.

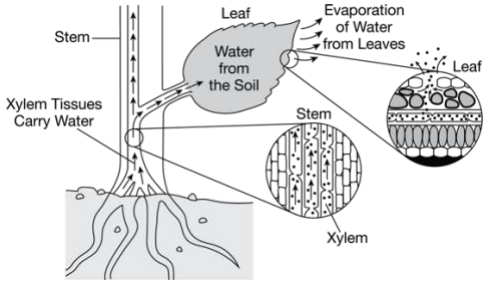


Figure 1. Model of water movement through the xylem, with magnified models of water movement in the stem and leaf.

10. Which statement describes how water is pulled up through the xylem to the leaves of the plant?

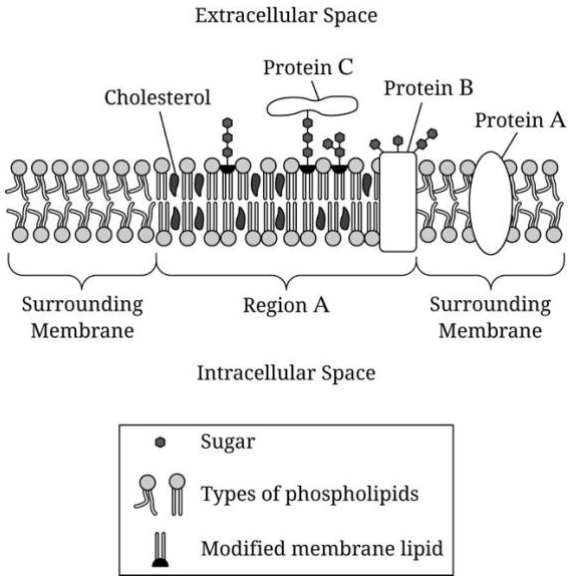
A. As water exits the leaf, hydrogen bonding between water molecules pulls more water up from below.

B. As water exits the leaf, signals are sent to the roots to pump more water up to the leaves through the xylem by adhesion.

C. Evaporation from the leaf decreases the hydrogen bonds that form between the water molecules in the xylem, which helps the water molecules to be pulled up the xylem.

D. Evaporation of water from the leaf increases the hydrogen bonds that form between water molecules in the air, providing the energy for transport.

Researchers have identified regions, including region A in Figure 1, of the cell membrane that have a different density and composition than the surrounding membrane.



11. Which of the following best describes the chemical composition of the different types of macromolecules that make up the membrane represented in Figure 1?

A. All the molecules contain carbon and oxygen, but only some contain nitrogen.
B. All the molecules contain carbon and hydrogen, but only some contain oxygen.
C. All the molecules contain carbon and oxygen, but only some contain hydrogen.
D. All the molecules contain carbon and nitrogen, but only some contain oxygen.

Phosphorous (P) is an important nutrient for plant growth. Figure 1 shows *Arabidopsis thanliana* plants grown under phosphorus-sufficient (left) and phosphorus-starved (right) conditions for six weeks.

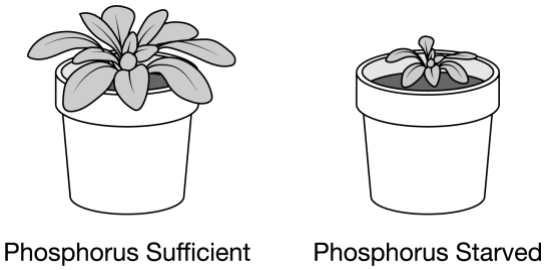


Figure 1. *Arabidopsis thaliana* plants grown for six weeks.

12. Which of the following is the most likely reason for the difference in leaf growth?

A. The phosphorus-starved plant was unable to synthesize both the required proteins and lipids, limiting growth.
B. The phosphorus-starved plant was unable to synthesize both the required proteins and carbohydrates, limiting growth.
C. The phosphorus-starved plant was unable to synthesize both the required nucleic acids and lipids, limiting growth.
D. The phosphorus-starved plant was unable to synthesize both the required carbohydrates and nucleic acids, limiting growth.

A polypeptide is polymer of amino acids held together by peptide bonds. The process of dehydration synthesis creates these peptide bonds, as shown in Figure 1.

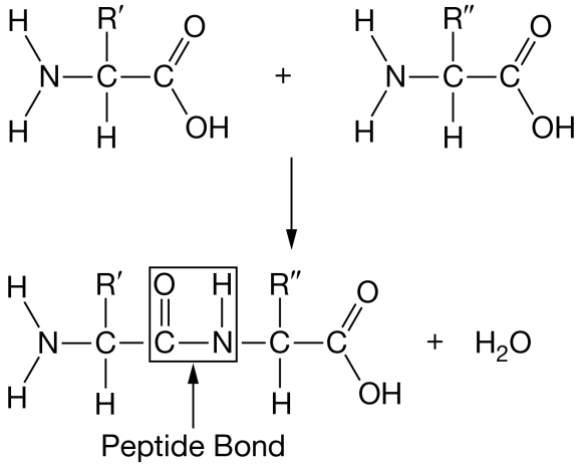
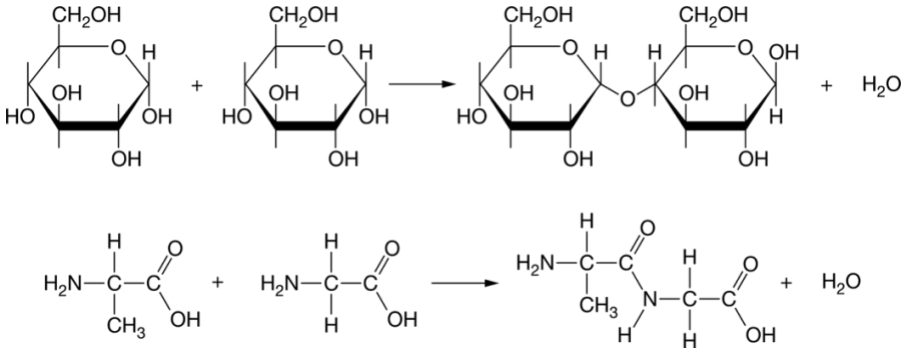


Figure 1. Amino acids are linked through the formation of peptide bonds.

13. As shown in Figure 1, an amino acid must have which of the following properties in order to be incorporated into a polypeptide?

A. The ability to remain stable in the presence of water molecules.
B. An R-group that is compatible with the R-group of the last amino acid incorporated
C. A central carbon atom that reacts with a nitrogen atom to form the peptide bond
D. The ability to form a covalent bond with both its NH_2 group and its COOH group



14. Which of the following is common feature of the illustrated reactions showing the linking of monomers to form macromolecules?

A. Two identical monomers are joined by a covalent bond.
B. Two different monomers are joined by a covalent bond.
C. Monomers are joined by a covalent bond, and a water molecule is produced.
D. Monomers are joined by ionic bonds, and a water molecule is produced.

15. Which of the following describes a key difference among the 20 amino acids that are used to make proteins?

A. Only some amino acids have an R-group.
B. Only some amino acids have a carboxyl group (COOH).
C. Some amino acids are hydrophobic.
D. Some amino acids contain the element phosphorus.

Figure 1 shows three amino acids that are part of a polypeptide chain. Figure 2 shows the same section of the chain after a mutation has occurred.

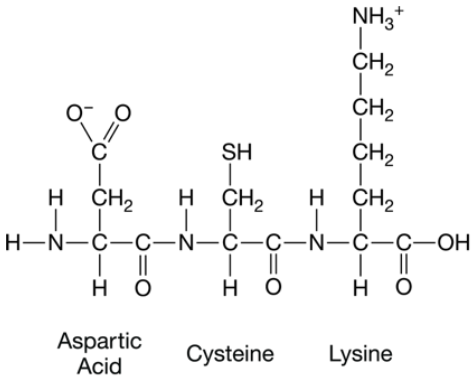


Figure 1: Original Amino Acid Chain

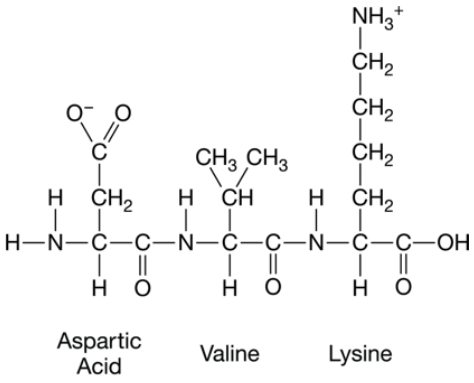


Figure 2: Mutated Amino Acid Chain

16. How might this change affect the structure and function of the protein?

A. The R-group of the new amino acid, valine, has different chemical properties than the R-group of cysteine. This will cause the protein to misfold and not function properly in the cell.
B. The new amino acid, valine, has replaced cysteine in the new protein. Since the number of amino acids has remained the same, there will be no change in the three-dimensional folding, or function, of the protein.
C. Since this is a linear section, it does not influence protein folding. Thus, there will be no change in protein structure or function.
D. Since the new amino acid is bounded on one side by an amino acid with a negatively charged R-group and by an amino acid on the other side with a positively charged R-group, the charges will balance and the protein will fold as usual.

Figure 1 shows a short segment of a double-stranded nucleic acid molecule.

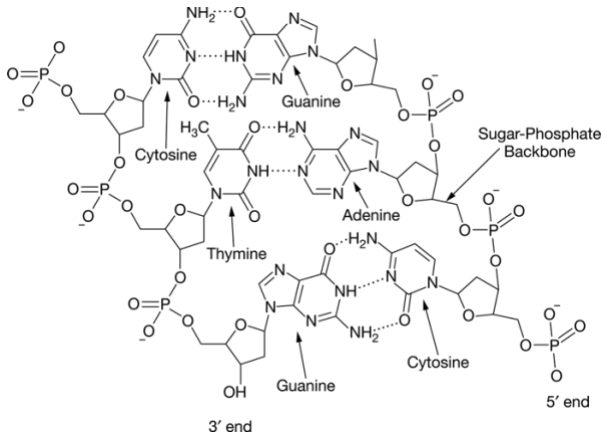


Figure 1. A short segment of double-stranded nucleic acid molecule

17. Which of the following statements is correct about the molecule shown in Figure 1?

A. It is RNA because of the relative direction of the two strands.

B. It is RNA because of the number of different nucleotides found in the molecule.

C. It is DNA because of the nature of the hydrogen bonds between guanine and cytosine.

D. It is DNA because of the nucleotides present.

Figure 1. Molecule 1 represents RNA, and molecule 2 represents DNA.

18. Which of the following best describes a structural similarity between the two molecules shown in Figure 1 that is relevant to their function?

A. Both molecules are composed of the same four nucleotides, which allows each molecule to be produced from the same pool of available nucleotides.

B. Both molecules are composed of the same type of five-carbon sugar, which allows each molecule to act as a building block for the production of polysaccharides.

C. Both molecules contain nucleotides that form base pairs with other nucleotides, which allows each molecule to act as a template in the synthesis of other nucleic acid molecules.

D. Both molecules contain nitrogenous bases and phosphate groups, which allows each molecule to be used as a monomer in the synthesis of proteins and lipids.

19. Which of the following statements best describes a difference between proteins and nucleic acids?

A. Proteins contain sulfur, while nucleic acids do not.

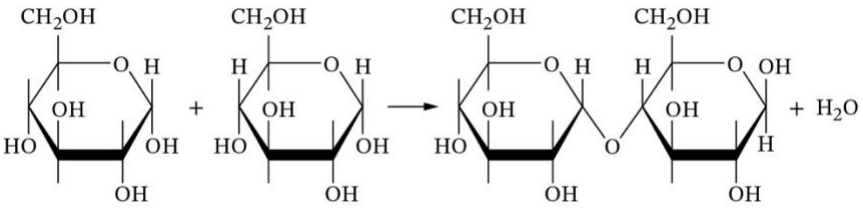
B. Proteins contain phosphorus, while nucleic acids contain sulfur.

C. Both proteins and nucleic acids contain sulfur as a key element.

D. Both proteins and nucleic acids contain nitrogen and sulfur.

Figure 1 shows the formation of maltose (a disaccharide) from two glucose molecules.

Figure 1. Diagram of the formation of maltose



20. Which of the following statements best describes the molecular changes that occur during the reaction shown in Figure 1?

A. Two hydroxyl groups are removed from each glucose molecule, and one water molecule is formed.

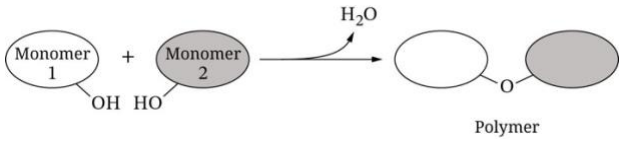
B. A water molecule is added to the hydroxyl groups to form the covalent bond between the two glucose molecules.

C. A hydroxyl group from one glucose molecule and a hydrogen atom from the other glucose molecule are removed, and one water molecule is formed.

D. A hydrogen atom in one glucose molecule and a hydroxyl group in the other glucose molecule form a hydrogen bond.

Figure 1 shows the formation of a carbohydrate polymer.

Figure 1. Formation of a carbohydrate polymer



21. Which of the following best describes how the carbohydrate polymer is being built in Figure 1?

A. A water molecule is added to form a hydrogen bond between two monomers.
B. A water molecule is added to form a covalent bond between two monomers.
C. A water molecule is removed to form a hydrogen bond between two monomers.
D. A water molecule is removed to form a covalent bond between two monomers.

22. Which of the following best describes a characteristic of saturated fatty acids?

A. They contain at least one double bond between carbon atoms.
B. They have a kinked carbon chain structure.
C. They contain only single bonds between carbon atoms.
D. They are more liquid at room temperature than unsaturated fatty acids.

23. Which of the following best describes the role of phospholipids?

A. Phospholipids provide structural stability to animal cell membranes.
B. Phospholipids support physiological functions, including growth.
C. Phospholipids provide energy storage and support cell function.
D. Phospholipids form the lipid bilayer found in cell membranes.

One form of the genetic disorder lipodystrophy involves the lack of an enzyme that is required for the synthesis of triglycerides, a type of lipid. Triglycerides serve as an energy reserve in fat cells.

24. Which of the following best describes the most likely effect of lipodystrophy on cell function?

A. There will be a decrease in phospholipids in cell membranes.
B. There will be a decrease in cholesterol in cell membranes.
C. There will be a decrease in fat storage in cells.
D. There will be a decrease in fatty acid synthesis in cells.

<Answer Key>

1. D
2. C
3. B
4. B
5. A
6. C
7. D
8. C
9. D
10. A
11. A
12. C
13. D
14. C
15. C
16. A
17. D
18. C
19. A
20. C
21. D
22. C
23. D
24. C