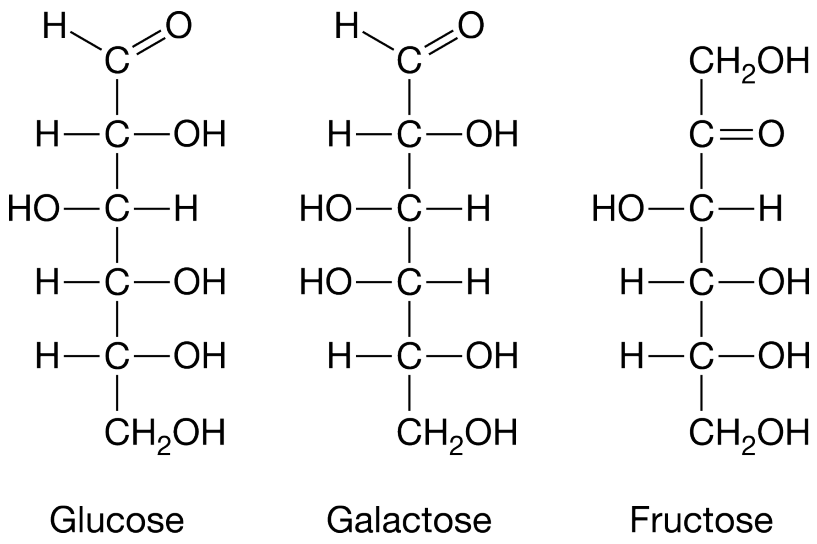
Unit 1 Exam

1. The carbohydrates glucose, galactose, and fructose have the same chemical formula $(C_6H_{12}O_6)$ but different structural formulas, as represented in the figure.



Which of the following statements about glucose, galactose, and fructose is most likely true?

(A) The carbohydrates have the same properties because they have the same number of carbon, hydrogen, and oxygen atoms.

(B) The carbohydrates have the same properties because they each have a single carbon-oxygen double bond.

(C) The carbohydrates have different properties because they have different arrangements of carbon, hydrogen, and oxygen atoms. ✓

(D) The carbohydrates have different properties because they have different numbers of carbon-carbon bonds.

Answer C

Correct. Compounds that have the same chemical formula but different structural formulas usually have different properties.

2. Which of the following is responsible for the cohesive property of water?

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(A) Hydrogen bonds between the oxygen atoms of two adjacent water molecules

(B) Covalent bonds between the hydrogen atoms of two adjacent water molecules

(C) Hydrogen bonds between the oxygen atom of one water molecule and a hydrogen atom of another water molecule ✓

(D) Covalent bonds between the oxygen atom of one water molecule and a hydrogen atom of another water molecule

(E) Hydrogen bonds between water molecules and other types of molecules

3. Bacteriophages are viruses that infect bacteria. In an experiment, bacteriophages were labeled with either radioactive phosphorus or radioactive sulfur. The labeled bacteriophages were incubated with bacteria for a brief amount of time and then removed. The infected bacteria cells were found to contain significant amounts of radioactive phosphorus but not radioactive sulfur.

Based on the results of the experiment, which of the following types of molecules did the bacteriophages most likely inject into the bacteria cells?

(A) Simple carbohydrate

(B) Amino acid

(C) DNA ✓

(D) Polypeptide

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Students investigated the effect of light on the carbon cycle in aquatic ecosystems by performing the controlled experiment summarized below. The students placed equal amounts of water (pH 7.0) from a large aquarium in glass beakers. The students transferred aquatic plants from the aquarium to several of the beakers, and then they placed equal numbers of the beakers in the light or the dark (Figure 1: groups I and II). Similarly, the students transferred goldfish from the same aquarium to other beakers, and then they placed equal numbers of those beakers in the light or dark (Figure 1: groups III and IV). Finally, the students placed an equal number of beakers containing water only in the light or dark (Figure 1: groups V and VI).

After exposing the samples to light or dark for one hour, the students recorded the pH of the water in each beaker. Carbon dioxide dissolved in water will lower the pH of an aqueous solution. In the experiment, the students used changes in pH to monitor changes in the amount of carbon dioxide in the water. For each treatment group, the students calculated the mean pH and standard error, as documented in the table below.

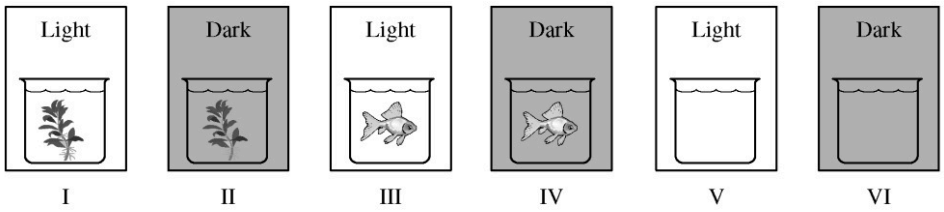

Figure 1. Treatment groups

MEAN pH OF TREATMENT GROUPS AFTER 1 HOUR

Treatment group (n = 10)	I	II	III	IV	V	VI
Mean pH	8.2	6.4	5.9	5.6	7.3	6.8
Standard error of the mean	0.3	0.3	0.2	0.3	0.5	0.4

4. Which of the following graphs is the most appropriate representation of the experimental results documented in the table?

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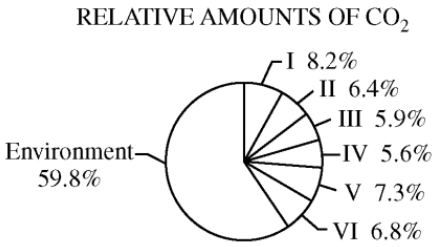
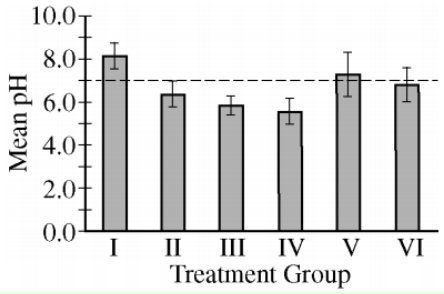
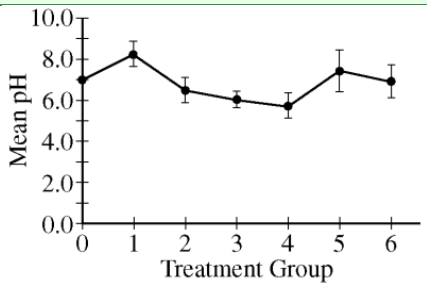
(A)



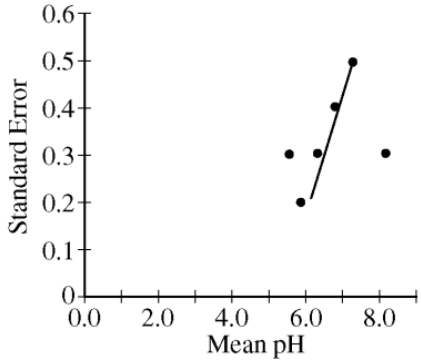
(B)



(C)



(D)



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5. Cholinesterase is an enzyme that catalyzes the hydrolysis of the signaling molecule acetylcholine. Which of the following best explains how cholinesterase carries out its function?

(A) Cholinesterase breaks covalent bonds within acetylcholine by the addition of a water molecule.

(B) Cholinesterase breaks covalent bonds within acetylcholine by removing a water molecule.

(C) Cholinesterase forms covalent bonds between acetylcholine and another molecule by the addition of a water molecule.

(D) Cholinesterase forms covalent bonds between acetylcholine and another molecule by removing a water molecule.

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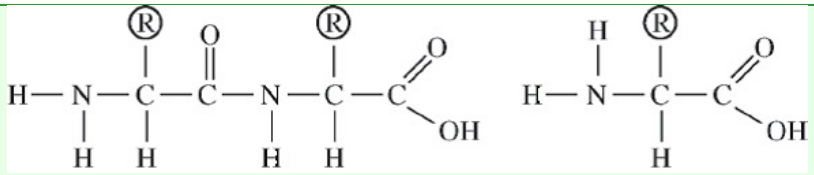
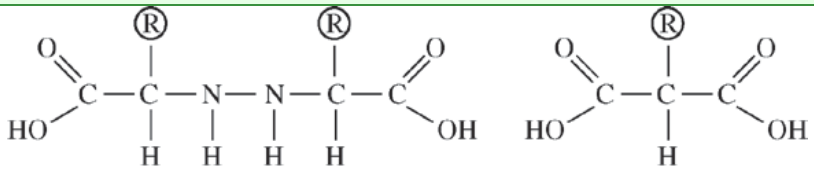
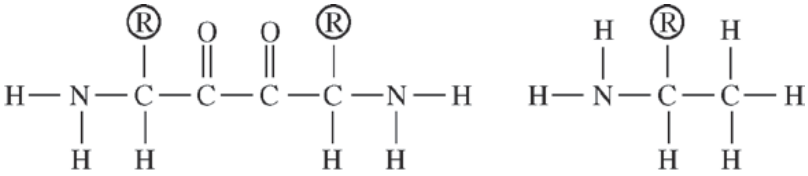
Answer A

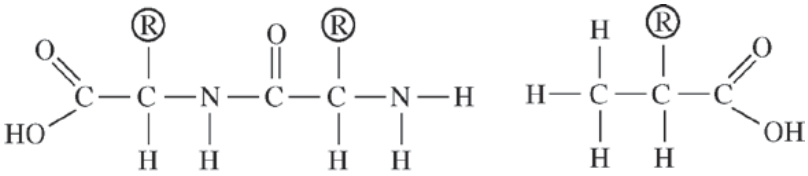
Correct. Hydrolase enzymes catalyze the cleavage of covalent bonds by adding a water molecule to the bond.

6. Which of the following correctly illustrates a dipeptide and an amino acid in the optimal position to form a tripeptide?

(A) 

(B) 

(C) 

(D) 

Answer A

This option is correct. It demonstrates an ability to refine and/or interpret a representation to explain the synthesis of a biological polymer. Peptides or proteins are polymers of amino acid monomers arranged in a unique linear sequence. Each of the 20 amino acids consists of a carbon atom surrounded by an amine

group (NH_2), a carboxyl group (COOH), a hydrogen, and an R (variable) group. When two amino acids are positioned so that the carboxyl group of one amino acid backbone is adjacent to the amine group of another amino acid backbone, they can join by a dehydration reaction.

7. Researchers compared similar proteins from related organisms in different habitats. They found that the proteins from organisms living in harsh environments had a greater number of cysteine amino acids than did proteins from organisms not living in harsh environments. The structure of cysteine is shown. Bonds can form between the sulfur atom of different cysteine amino acids (S-S bonds).

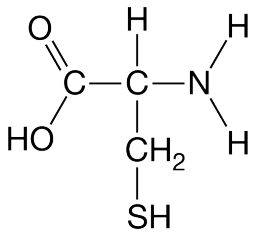


Figure 1. Chemical structure of cysteine

Which of the following best describes the effect of a greater number of cysteine amino acids on the stability of the proteins?

(A) The change has no effect on the stability of the protein because only one type of amino acid is involved.

(B) The change leads to increased protein stability because of an increased number of S-S bonds in the tertiary structure of the proteins. ✓

(C) The change leads to decreased protein stability because of an increased number of S-S bonds in the tertiary structure of the proteins.

(D) The change leads to increased protein stability only when the added cysteine amino acids are next to other cysteine amino acids in the primary structure.

Answer B

Correct. An increased number of S-S bonds are possible with the addition of more cysteine in the proteins. The S-S covalent bonds should add more structural stability to the proteins.

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8.

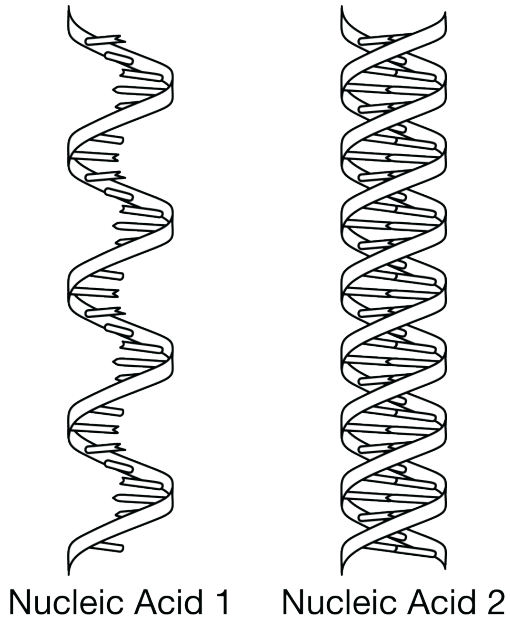

Figure 1. Nucleic acid segments

DNA and RNA are nucleic acids that can store biological information based on the sequence of their nucleotide monomers. Figure 1 shows a short segment of each of the two types of nucleic acids.

Which of the following best describes a structural difference between DNA and RNA?

(A) DNA contains four types of nitrogenous bases, whereas RNA contains only two types of nitrogenous bases.

(B) The backbone of DNA contains deoxyribose, whereas the backbone of RNA contains ribose. ✓

(C) A DNA molecule is composed of two parallel strands with the same $5'$ to $3'$ directionality, whereas an RNA molecule is composed of only one $5'$ to $3'$ strand.

(D) Phosphate groups provide rigidity to DNA, but RNA is flexible and contains no phosphate groups.

Answer B

Correct. The backbones of DNA and RNA are composed of an alternating sugar and base. In DNA, the sugar is deoxyribose, whereas the sugar in RNA is ribose.

9. A chemical binds to a protein composed of a single polypeptide chain and prevents the formation of an alpha helix that is typically formed in the absence of the chemical. Which of the following best describes the effect the chemical has on the structure of the protein?

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(A) The primary structure held together by covalent bonds is affected.

(B) The secondary structure held together by hydrogen bonds is affected. ✓

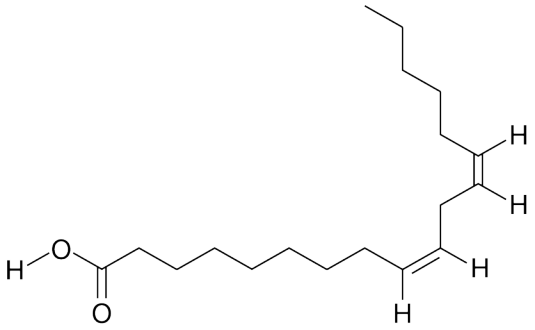
(C) The secondary, tertiary, and quaternary structures are affected.

(D) All levels of protein structure are affected.

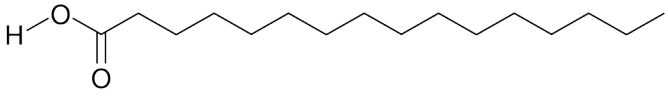
Answer B

Correct. Alpha helices are a form of secondary protein structure and are held together by hydrogen bonds. This chemical prevents alpha helices from forming, and therefore, it is most likely that the chemical affects hydrogen bonding within the local region of amino acids.

10. The molecular structures of linoleic acid and palmitic acid, two naturally occurring substances, are shown in the figure.



Linoleic Acid



Palmitic Acid

Based on the molecular structures shown in the figure, which molecule is likely to be solid at room temperature?

(A) Linoleic acid, because the absence of carbon-carbon double bonds allows the molecules to pack closely together.

(B) Linoleic acid, because the presence of carbon-carbon double bonds prevents the molecules from packing closely together.

(C) Palmitic acid, because the absence of carbon-carbon double bonds allows the molecules to pack closely together. ✓

(D) Palmitic acid, because the presence of carbon-carbon double bonds prevents the molecules from packing closely together.

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Answer C

Correct. Palmitic acid is a saturated fatty acid. The absence of carbon-carbon double bonds in palmitic acid allows the molecules to pack closely together and form a solid at room temperature.

Figure 1. Chemical structure of cyanide

The secondary compound cyanide (Figure 1) is a toxic, bitter-tasting chemical that is found in apple seeds. Cyanide in seeds is only released and tasted if the seed is crushed. When animals eat apples, they typically eat the sweet fleshy part of the fruit and spit out the seeds or swallow them whole.

11. Based on the chemical structure of cyanide, **identify** ONE type of biological macromolecule that could serve as a chemical precursor for the production of cyanide in a plant. **Justify** your choice.

Part A

2 point(s) maximum

Identification (1 point)

• Amino acids OR proteins/polypeptides

• Nucleotides OR nucleic acids

Justification (1 point)

• Macromolecule contains nitrogen

0	1	2 ✓

Student response earns 2 of the following 2 points

2 point(s) maximum

Identification (1 point)

• Amino acids OR proteins/polypeptides

• Nucleotides OR nucleic acids

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Justification (1 point)

• Macromolecule contains nitrogen

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12. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

The stems and fruits of pineapple plants contain a group of protein-digesting enzymes collectively called bromelain and often used as an antibrowning agent for fruits and vegetables. Fruits and vegetables brown when they are bruised during transport or sliced and exposed to air. This browning is controlled by enzymatic pathways that produce brown pigments. The browning of fruits and vegetables reduces the nutritional value of the food, so antibrowning agents such as bromelain are used.

(a) **Identify** the type of monomer of which this enzyme is composed.

(b) Bromelain works by breaking the enzymes that cause browning into smaller molecules. **Explain** how the reaction that breaks up the enzymes occurs.

(c) The pH of a solution determines the charge of certain R groups. The pH of pineapple fruit ranges from 3.5 to 5.2. **Predict** the effect on the activity of bromelain if it is used in a product with a pH of 11.

(d) **Provide reasoning** to justify your prediction.

Part A

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that amino acids are the monomers of which this enzyme is composed.

Part B

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that bromelain acts by enabling the hydrolysis of the protein/polypeptide/amino acid chain, breaking apart the peptide bonds holding the amino acids together OR that bromelain breaks the bond between amino

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acids by using water as a reactant.

Part C

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the activity of bromelain will decrease.

Part D

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that changes in pH will affect the interactions between amino acid R-groups in the enzyme, which will change the folding of the enzyme and thus change its shape and ultimately its function.