3 | BIOLOGICAL MACROMOLECULES

TEST PREP FOR AP® COURSES

58 Urey and Miller constructed an experiment to illustrate the early atmosphere of Earth and possible development of organic molecules in the absence of living cells. Which assumption did Urey and Miller make regarding conditions on Earth?

A Electric sparks occurred to catalyze the reaction.

B The composition of the gases in the atmosphere

C There was sufficient oxygen for creating life.

D It produced water-soluble organic molecules.

Solution The solution is (B). They assumed the composition of gases in the atmosphere included methane, ammonia, and hydrogen gases.

59 Urey and Miller proposed that a series of reactions occurred that ultimately resulted in amino acid formation. What is true based on their theory?

A Hydrogen, methane, water, and ammonia combined to create amino acids.

B Hydrogen, methane, and oxygen combined to create macromolecules.

C Nitrogenous bases combined to form monomers, then RNA.

D Periodic elements combined to create molecules, then DNA.

Solution The solution is (A). Their experiment resulted in the spontaneous formation of amino acids, which form from hydrogen, nitrogen, and other compounds.

60 How does Urey and Miller's model support the claim that simple precursors present on early Earth could have assembled into the complex molecules necessary for life?

A The simple molecules assembled to form amino acids and nucleic acids.

B The organic molecules assembled to form large complexes, such as water and methane.

C The inorganic molecules assembled to form amino acids and nucleic acids.

D The inorganic molecules assembled to form large complexes, such as water and methane.

Solution The solution is (A). Miller and Urey’s experiment resulted in the production of organic molecules, such as amino acids and nucleic acids, from the building blocks of water, methane, ammonia, and hydrogen gas. This was done in the absence of living organisms, but could be used for the development of them.

61 Which statement most accurately describes the importance of the condensation stage during Urey and Miller’s experiment?

A Condensed water enabled the formation of monomers.

B Condensation and evaporation simulated lightning storms.

C Condensation and evaporation simulated the water cycle.

D Condensed water enabled the formation of polymers.

Solution The solution is (C). Condensation and evaporation are main components of the water cycle.

62 According to the findings of the Urey and Miller experiment, the primitive atmosphere consisted of water in the form of steam, methane, ammonia, and hydrogen gases. If there was so much hydrogen gas in the early atmosphere, why is there so little now?

A Hydrogen gas is so light with a molecular weight of 1 that the excess diffused into space over time and is now absent from the atmosphere.

B Hydrogen combined with ammonia to make ammonium.

C It was all used up in the production of organic molecules.

D The excess hydrogen gas was dissolved in the early oceans.

Solution The solution is (A). Hydrogen gas is so light (molecular weight of 1) that the excess diffused into space over time and is now absent from the atmosphere.

63 Could the primitive atmosphere illustrated by the Urey and Miller experiment be reproduced on today's Earth? Why or why not?

A The primitive atmosphere cannot be created due to the oxidizing atmosphere and lack of hydrogen.

B The primitive atmosphere can be created because the atmosphere is reducing and Earth has sufficient hydrogen to reproduce the conditions.

C The primitive atmosphere cannot be created due to the presence of abundant water and hydrogen in the atmosphere.

D The primitive atmosphere can be created because the atmosphere is oxidizing and has less hydrogen.

Solution The solution is (A). The atmosphere reproduced in the Urey and Miller experiment could not exist on present-day Earth. Most of the hydrogen gas has been used or diffused into space. The presence of large amounts of oxygen has created an oxidizing atmosphere that would break down any organic molecules that might be produced.

64 What is structurally different between starch and cellulose that gives them different physical properties?

A Cellulose is formed by β- 1-4 glycosidic linkages and crosslinks, making it rigid, while starch has α- 1-4 and α- 1-6 glycosidic linkages without the tight crosslinks of cellulose.

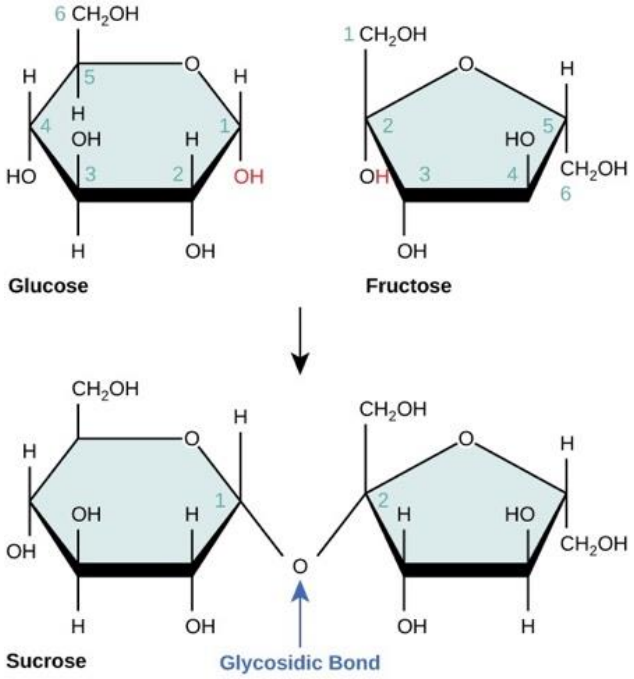
B Cellulose has rigid α- 1-4 glycosidic linkages, while starch has less rigid β- 1-4 glycosidic linkages.

C Cellulose has amylose and amylopectin, making it more rigid than starch.

D Starch has amylose and amylopectin that make it more rigid than cellulose.

Solution The solution is (B). Starch is made up of glucose monomers that are joined by α- 1-4 or α- 1-6 glycosidic bonds. Cellulose is made up of glucose monomers that are linked by β- 1-4 glycosidic bonds.

65 Complex polymers are built from combinations of smaller monomers. What type of reaction is illustrated in the figure, and what is the product of the reaction?



A A synthesis reaction producing glucose

B A hydrolysis reaction producing fructose

C A condensation reaction producing lactose

D A dehydration reaction producing water

Solution The solution is (D). Two six-carbon rings with hydroxyl groups are shown. The hydroxyl group on one is highlighted red, and the hydrogen of a hydroxyl group of the other is highlighted red. An arrow points to two five carbon rings connected by an oxygen. The molecule is sucrose and is formed by the condensation of glucose and fructose.

66 The fatty acids of triglycerides are classified as saturated, unsaturated, or trans fat. What about the structure of these compounds gives them their physical characteristics?

A Saturated fats and trans fats contain the greatest possible number of hydrogen atoms, while unsaturated fats do not.

B Saturated and unsaturated fats have stable configurations, while trans fats are transient.

C Unsaturated fats and trans fats have some double-bonded carbon atoms, while saturated fats do not.

D Unsaturated and trans fats are the same; fatty acids are only found on opposite sides of a trans fat.

Solution The solution is (C). Unsaturated fats and trans fats have some double-bonded carbon atoms, while saturated fats do not.

67 Carbohydrates serve various functions in different animals. Arthropods, like insects, crustaceans, and others, have an outer layer, called the exoskeleton, which protects their internal body parts. This exoskeleton is made mostly of chitin. Chitin is also a major component of the cell walls of fungi, the kingdom that includes molds and mushrooms. Chitin is a polysaccharide.

What is the major difference between chitin and other types of polysaccharides?

A Chitin is a nitrogen-containing polysaccharide, with repeating units of N-acetyl-β-D-glucosamine, a modified sugar.

B Chitin is similar to amylase, but with sulfur linkages between the monomers.

C Chitin is similar to inulin, a polysaccharide with fructose plus additional glucose monomers.

D Chitin contains phosphate groups that give it a stiffness not found in other polysaccharides.

Solution The solution is (A). Chitin is a nitrogen-containing polysaccharide, with repeating units of N-acetyl-β-D-glucosamine, a modified sugar.

68 Which categories of amino acids would you expect to find on the surface of a soluble protein, and which would you expect to find in the interior?

A Nonpolar and charged amino acids will be present on the surface and polar in the interior of the membrane, whereas nonpolar will be found in the membrane-embedded proteins.

B Nonpolar and uncharged proteins will be found on the surface with nonpolar in the interior, while only nonpolar will be found in the embedded proteins.

C Polar and charged amino acids will be found on the surface, whereas nonpolar will be found in the interior.

D Polar and charged amino acids will be found on the surface of a membrane protein, whereas nonpolar will be found in the interior. The membrane protein will be polar and hydrophobic.

Solution The solution is (C). Polar amino acids—such as proline, asparagine, and glutamine—would be found at the surface of a soluble protein, while nonpolar amino acids—such as leucine, methionine, and glycine—would be oriented toward the interior.

69 You have been identifying the sequence of a segment of a protein. The sequence to date is: leucine-methionine-tyrosine-alanine-glutamine-lysine-glutamate. You insert arginine between the leucine and methionine.

What effect would this insertion have on the segment?

A Arginine is a negatively charged amino acid and could attach to the glutamate at the end of the segment.

B Inserting arginine places a positively charged amino acid in a portion that is nonpolar, creating the possibility of a hydrogen bond in this area.

C There would be no effect other than an additional amino acid.

D The arginine could attach to the lysine and bend the protein chain at this point.

Solution The solution is (B). Inserting arginine places a positively charged amino acid in a portion that is nonpolar, creating the possibility of a hydrogen bond in this area.

70 What happens if even one amino acid is substituted for another in a polypeptide? Provide a specific example.

A The change will definitely not be sufficient to have any effect on the function and structure of the protein.

B The amino acid may not show any significant effect on the protein structure and function, or it may have a significant effect, as in the case of hemoglobin in individuals with sickle cell trait.

C These changes would increase the possibility of having extra bends and loops in the proteins, as seen in Leber congenital disease.

D These changes would modify the structures of proteins, making them nonfunctional.

Solution The solution is (B). There are two possibilities when one amino acid is substituted for another: there may be no effect on the protein if the amino acid's position was not critical to the tertiary structure of the protein, or it may cause an extra bond to be made or not made that would significantly alter the functional structure. A classic example of a single amino acid change that significantly modifies the function of a protein is in the case of sickle cell hemoglobin in which a valine replaces a glutamic acid.

71 HIV is an RNA virus that affects CD4 cells, also known as T helper cells, in the human body. Which mechanism is most likely responsible for the fast rate at which HIV can spread?

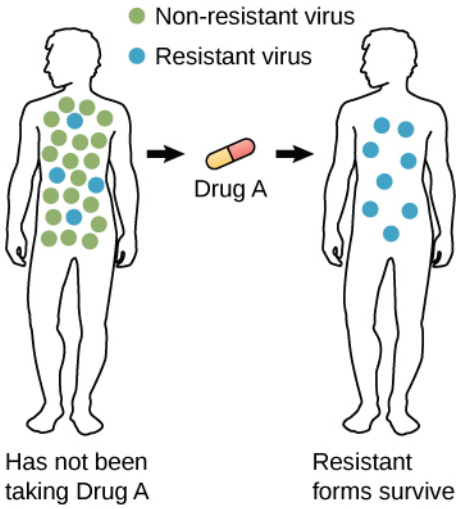
A Recombination

B Mutation

C Reassortment

D Replication errors

Solution The solution is (B). The high rate of mutations allows HIV to develop resistance to antiviral drugs. Furthermore, as the virus mutates, it is not recognized any longer by existing antibodies and is not tagged for destruction.



72 For many years, scientist believed that proteins were the source of heritable information. There are many thousands of different proteins in a cell, and they mediate the cell's metabolism, producing the traits and characteristics of a species. Researchers working with DNA viruses proved that it is DNA that stores and passes on genes. They worked with viruses that have an outer coat of protein and a DNA strand inside.

How did scientists prove that it was DNA, not protein, that is the primary source of heritable information?

A The DNA and protein of the virus were tagged with different isotopes and exposed to the host cell whereas only the DNA was transferred to the host.

B The DNA was tagged with an isotope, which was retained in the virus, proving it to be the genetic material.

C The viral protein was tagged with an isotope, and the host cell was infected by it. This protein was transferred to the host.

D The viral DNA, when sequenced, was found to be present in the host cell, proving it to be the hereditary material instead of protein.

Solution The solution is (A). Researchers tagged the DNA and protein coat of the virus with different isotopes. Then, they exposed host cells to the virus and determined the

tagged proteins did not enter the cell, but the tagged viral DNA did. The virus was replicated in the host cells, showing that the DNA was responsible for the passing of genetic information.

73 The genetic code is based on each amino acid being coded for by a distinctive series of three nucleic acid bases called a codon. The following is a short segment of DNA, using the slash symbol (/) to separate the codons for easy viewing:

ATC/GTT/GAA/CTG/TAG/GAT/AAA

A change has occurred in the segment resulting in the following:

ATC/GTT/GTA/CTG/TAG/GAT/AAA

What kind of change has occurred?

A A substitution of T for A, resulting in a coding change for the third codon

B An addition of C for G, lengthening the strand and changing every codon past the addition

C A deletion of an A, resulting in a shortening and changing every codon past the deletion

D No change has occurred; the same base was replaced with the same base.

Solution The solution is (A). In the third codon, A has been substituted by T, which may or may not change the amino acid.

74 A change in DNA on a chromosome affects all proteins made from that gene for the life of the cell. A change in the RNA involved in protein production is short lived.

What is the difference between the effects of the changes in the two types of nucleic acids?

A DNA is the genetic material that is passed from parent cells to daughter cells and to future generations.

B DNA would not affect the individuals as the proteins made are finally altered and modified. RNA would cause harm to the person as the RNA encoded by the DNA and is not altered.

C DNA is the genetic material and is transferred from one generation to another, making use of repair mechanisms for every mutation. The RNA does not use a repair mechanism.

D DNA, when mutated, makes use of the repair mechanisms and can be repaired, whereas RNA is not repaired and is transferred in generations.

Solution The solution is (A). The DNA in the chromosome will last the life of the cell, and possibly beyond, as shown in the DNA harvested from archeological research. Any protein made from the information on the chromosome will reflect the change in DNA. The effect is permanent and will possibly cause the expression of a genetic disease. If the change happened in a gamete, the change may be transmitted to an

offspring. Any change in the type of RNA lasts only as long as that strand of RNA is intact. All RNA is eventually degraded and replaced with new strands, depending on the needs of the cell. Any change in the RNA will only have an effect until it disappears with the degradation of that RNA. RNA changes alone are not permanent.