3 | BIOLOGICAL MACROMOLECULES

CRITICAL THINKING QUESTIONS

39 The word *hydrolysis* is defined as the lysis of water. How does this apply to polymers?

A Polymers break apart by separating water into hydrogen and a hydroxyl group that are added to the monomers.

B Polymers are synthesized by using the energy released by the breaking of water molecules into hydrogen and a hydroxyl group.

C Polymers are separated into monomers, producing energy and water molecules.

D Polymers are hydrolyzed into monomers using water in a process called dehydration synthesis.

Solution The solution is (A). In the process of hydrolysis, water is separated into a hydrogen atom and a hydroxyl group. These are added to the separated monomers to complete their structures.

40 What role do electrons play in dehydration synthesis and hydrolysis?

A Electrons are added to OH and H ions in dehydration synthesis. They are removed from OH and H in hydrolysis.

B Electrons are transferred from OH and H ions to monomers in dehydration synthesis. They are taken up by the H and OH ions from monomers in hydrolysis.

C Electrons are removed from OH and H in dehydration synthesis. They are added to OH and H in hydrolysis.

D Electrons are transferred from monomers to H and OH ions in hydrolysis. They are transferred from OH and H to monomers in dehydration synthesis.

Solution The solution is (A). Electrons are added to the hydroxyl group and the hydrogen ion during dehydration synthesis to constitute water. During hydrolysis, they are removed from the OH and H of water to create ions to reconstitute monomers.

41 Which bodily process would most likely be hindered by a lack of water in the body?

A Digestion

B Protein synthesis

C DNA copying

D Breathing

Solution The solution is (A). Digestion would be negatively affected by an inability to perform hydrolysis. Digestion requires hydrolysis to break larger polymers within food molecules into monomers.

42 Why is it impossible for humans to digest food that contains cellulose?

A There is no energy available in fiber.

B An inactive form of cellulase in the human digestive tract renders it undigested and removes it as waste.

C The acidic environment in the human stomach makes it impossible to break the bonds in cellulose.

D Human digestive enzymes cannot break down the β-1,4 glycosidic linkage in cellulose, which requires a special enzyme absent in humans.

Solution The solution is (D). Human digestive enzymes cannot break down the β-1-4 linkage. It requires a special enzyme, cellulase, which is secreted by bacteria and protists in the digestive tract of herbivores.

43 Which statement describes some of the differences between cellulose and starch?

A Cellulose is unbranched and starch is branched. Both molecules are found in animals.

B Starch is unbranched and cellulose is branched. Both molecules are found in plants.

C Starch is branched and cellulose is unbranched. Both molecules are found in plants.

D Cellulose is branched and starch is unbranched. Both molecules are found in animals.

Solution The solution is (C). Starch contains branches and cellulose does not. Both molecules are made by plants but neither is made by animals.

44 Which statement best describes the production of sucrose, maltose, and lactose?

A Glucose and fructose combine to form sucrose. Glucose and galactose combine to form lactose. Two glucose monomers combine to form maltose.

B Glucose and fructose combine to form sucrose. Glucose and galactose combine to form maltose. Two glucose combine to form lactose.

C Two glucose combine to form lactose. Glucose and galactose combine to form sucrose. Glucose and fructose combine to form maltose.

D Two galactose combine to form sucrose. Fructose and glucose combine to form lactose. Two glucose combine to form maltose.

Solution The solution is (A). Glucose and fructose are combined to form sucrose. Glucose and galactose are combined to form lactose. Two glucose monomers are combined to form maltose.

45 What are the four classes of lipids? Provide a common example for each one.

A Lipids like margarine, waxes like the coating on feathers, phospholipids like cell membrane constituents, steroids like cholesterol

B Lipids like phosphatidylserine, waxes like phosphatidic acid, phospholipids like oleic acid, steroids like epinephrine

C Lipids like phosphatidic acid, waxes like margarine, phospholipids like phosphatidylcholine, steroids like testosterone

D Lipids like cholesterol, waxes like the coating on feathers, phospholipids like phosphatidylserine, steroids like margarine

Solution The solution is (A). Margarine is a fat with higher trans fatty acid content, wax is present as a feather-coating material, cell membranes are made of phospholipids, and cholesterol is a steroid.

46 What are three functions that lipids serve in plants and/or animals?

A Lipids serve in the storage of energy, as a structural component of hormones, and as signaling molecules.

B Lipids serve in the storage of energy, as carriers for the transport of proteins across the membrane, and as signaling molecules.

C Lipids serve in the breakdown of stored energy molecules, as signaling molecules, and as structural components of hormones.

D Lipids serve in the breakdown of stored energy molecules, as signaling molecules, and as channels for protein transport.

Solution The solution is (A). Lipids serve as a source of long-term energy storage, and as a structural component of some hormones in animals. Hormones are signaling molecules. A class of lipids, the phospholipids, is a major constituent of cell membranes in both plants and animals.

47 How are trans fats created? Why have they been banned from some restaurants?

A Trans fat is produced by the hydrogenation of oil that makes it more saturated and isomerized. It increases LDL in the body.

B The dehydrogenation of oil forms trans fat, which contains single bonds in its structure. It increases HDL in the body.

C Trans fat is produced by the dehydrogenation of oils, which makes it unsaturated. It increases LDL in the body.

D The hydrogenation of oil makes the trans fat, which contains double bonds in its structure. It decreases the HDL in the body.

Solution The solution is (A). Trans fats resemble saturated fats in their chemical and physical characteristics, and they increase LDL. They are produced by bubbling hydrogen gas through unsaturated lipids under pressure, adding hydrogen atoms to the fatty acids in the lipids.

48 How do phospholipids contribute to cell membrane structure?

A Phospholipids orient their heads toward the polar molecules and tails in the interior of the membrane, forming a bilayer.

B Phospholipids orient their tails toward the polar molecules of water solutions and their heads toward in the interior of the membrane, forming a bilayer.

C Phospholipids orient their heads toward the nonpolar molecules and their tails toward the interior of the membrane, forming a bilayer.

D Phospholipids orient their tails toward the polar molecules and their heads toward the nonpolar side of the membrane, forming a bilayer.

Solution The solution is (A). The hydrophilic head orients toward polar molecules such as water or the cytoplasm of the cell, whereas the hydrophobic tails of the molecules orient toward other nonpolar molecules. This forms the middle of the membrane, with heads on the outermost and innermost surfaces of the cell membrane.

49 What type of compound functions in hormone production, contributes to membrane flexibility, and is the starting molecule for bile salts?

A All steroid molecules help in the mentioned functions.

B Cholesterol, which is a lipid and also a steroid, functions here.

C Glycogen, which is a multi-branched polysaccharide of glucose, is the compound.

D Phosphatidylcholine, which is a phospholipid with a choline head group, serves these functions.

Solution The solution is (B). Cholesterol is a steroid and is involved in hormone production, membrane flexibility, and production of bile salts.

50 What part of the cell membrane gives flexibility to the structure?

A Carbohydrates

B Cytoskeleton filaments

C Lipids

D Proteins

Solution The solution is (C). Lipids add flexibility to the membrane, allowing it to bend and twist as necessary.

51 How do the differences in amino acid sequences lead to different protein functions?

A Different amino acids produce different proteins because of the secondary bonds they form.

B Differences in amino acids lead to the recycling of proteins, which produces other functional proteins.

C Different amino acids cause rearrangements of amino acids to produce a functional protein.

D Differences in amino acids cause post-translational modification of the protein, which reassembles to produce a functional protein.

Solution The solution is (A). Differences in amino acid sequences result in different configurations of the finished protein. This allows different protein shapes to bind with different chemicals, giving each protein its function.

52 What causes the changes in protein structure through its three or four levels of structure?

A The primary chain forms secondary α- helix and β- pleated sheets that fold onto each other forming the tertiary structure.

B The primary structure undergoes alternative splicing to form secondary structures that fold on other protein chains to form tertiary structures.

C The primary structure forms secondary α- helix and β- pleated sheets. These further undergo phosphorylation and acetylation to form the tertiary structure.

D The primary structure undergoes alternative splicing to form a secondary structure, and then disulfide bonds give way to tertiary structures.

Solution The solution is (A). The primary structure is based on the bonds between individual amino acids while the secondary structure is based on the formation of alpha and beta pleated sheets. The tertiary structure describes the folding of the secondary structure.

53 What structural level of proteins is functional? Why?

A The secondary structure is functional as it attains its two-dimensional shape, which has the necessary bonds.

B The tertiary structure is functional, as it possesses the geometric shape showing the necessary loops and bends.

C The tertiary structure is functional as it has the non-covalent and covalent bonds along with the subunits attached at the right places, which help it function properly.

D The quaternary structure is functional, as it has the essential set of subunits.

Solution The solution is (B). The folding pattern is what creates the shape of the protein, which determines its use as well as, in the case of enzymes, what substrates it can bind to.

54 How does a chaperone work with proteins?

A Chaperones assist proteins in folding.

B Chaperones cause the aggregation of polypeptides.

C Chaperones associate with proteins once the target protein is folded.

D Chaperones escort proteins during translation.

Solution The solution is (A). Chaperones (or chaperonins) associate with the target protein during the folding process. They act by preventing aggregation of polypeptides that make up the complete protein structure, and they disassociate from the protein once the target protein is folded.

55 What is a difference between DNA and RNA?

A DNA is made from nucleotides, while RNA is not.

B DNA contains deoxyribose and thymine, while RNA contains ribose and uracil.

C DNA contains adenine, while RNA contains guanine.

D DNA is double stranded, while RNA may be double stranded in animals.

Solution The solution is (B). Both DNA and RNA are made of nucleotides containing a sugar (deoxyribose in DNA, ribose in RNA), a nitrogenous base (DNA has thymine, RNA has uracil). Both also have adenine, cytosine, guanine, and a phosphate group.

56 Which molecule carries information in a form that is inherited from one generation to another?

A DNA

B mRNA

C Proteins

D tRNA

Solution The solution is (A). Hereditary information is stored in the sequence of nucleotides found in DNA.

57 What are the four types and functions of RNA?

A mRNA is a single-stranded transcript of DNA. rRNA is found in ribosomes. tRNA transfers specific amino acids to a growing protein strand. miRNA regulates the expression of mRNA strands.

B mRNA is a single-stranded transcript of rRNA. rRNA is translated in ribosomes to make proteins. tRNA transfers specific amino acids to a growing protein strand. miRNA regulates the expression of the mRNA strand.

C mRNA regulates the expression of the miRNA strand. rRNA is found in ribosomes. tRNA transfers specific amino acids to a growing protein strand. miRNA is a single-stranded transcript of DNA.

D mRNA is a single-stranded transcript of DNA. rRNA transfers specific amino acids to a growing protein strand. tRNA is found in ribosomes. miRNA regulates the expression of the mRNA strand.

Solution The solution is (A). Messenger RNA (mRNA) is a single-stranded copy of the sequencing in DNA. It leaves the nucleus and attaches to ribosomes for protein synthesis. Ribosomal RNA (rRNA) plus protein make up the ribosomes, which are used as points of protein synthesis. Transfer RNA (tRNA) is a single-stranded RNA that carries or transfers specific amino acids to the growing protein chain. MicroRNA (miRNA) is a single-stranded RNA that has been folded back on itself. This is trimmed into a short strand of about 20 nucleotide pairs. One of the strands is degraded, while the other binds onto protein. The miRNA-protein complex can attach to mRNA with complementary sequences and functions to regulate the expression of that mRNA strand.