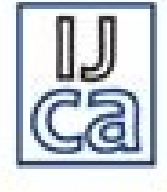
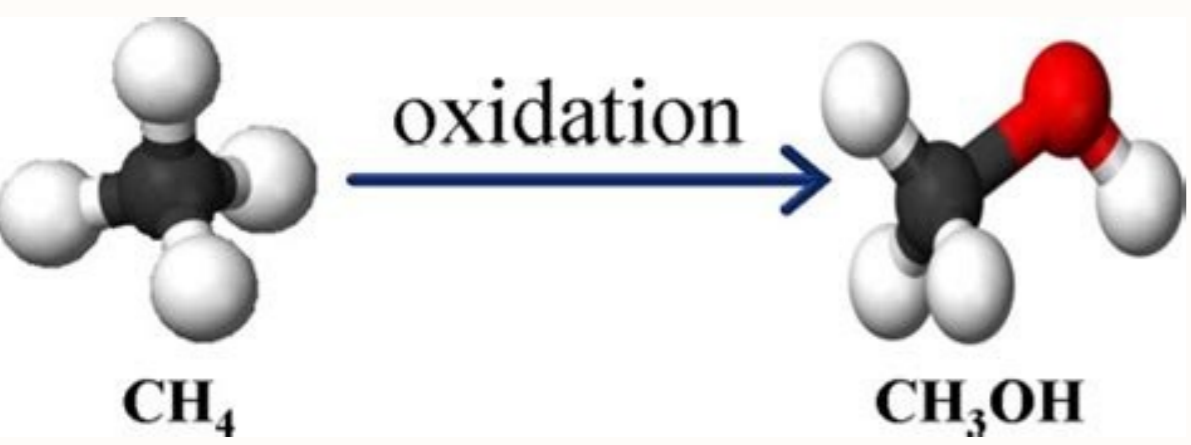


Continue

Biological Macromolecule	Elemental Ratio	Function	Monomer	Examples	Functional Group(s)
Carbohydrate	CHO 1:2:1	- Short term energy storage - structure (cell walls & cellulose)	Monosaccharide	- Glycogen - Starch - Sucrose - Fructose - Lactose - Maltose	-OH (hydroxyl)
Lipids	CHO 1:2:very few	- long term energy storage - insulation body - cushion body organs - transport O ₂	Triglyceride (Glycerol + 3 fatty acids)	Fats, Waxes, Oils, Steroids	-CH ₃ (methyl) -OH
Proteins	CHON No ratio	- structural support - enzymes - receptors (cell membranes) - defense	Amino Acids (20)	- Hemoglobin - Collagen - Antibodies - Keratin (hair, nails) - Actin/Myosin (muscles)	-NH ₂ (amine) -COOH (carboxyl)
Nucleic Acids	CHONP No ratio	- instructions for making proteins - genetic information passed from parent to offspring	Nucleotide (S-C sugar + phosphate + nitrogen base)	DNA RNA	-PO ₄

HYDROLYSIS - adding water to split polymers CONDENSATION - removing water to join monomers together

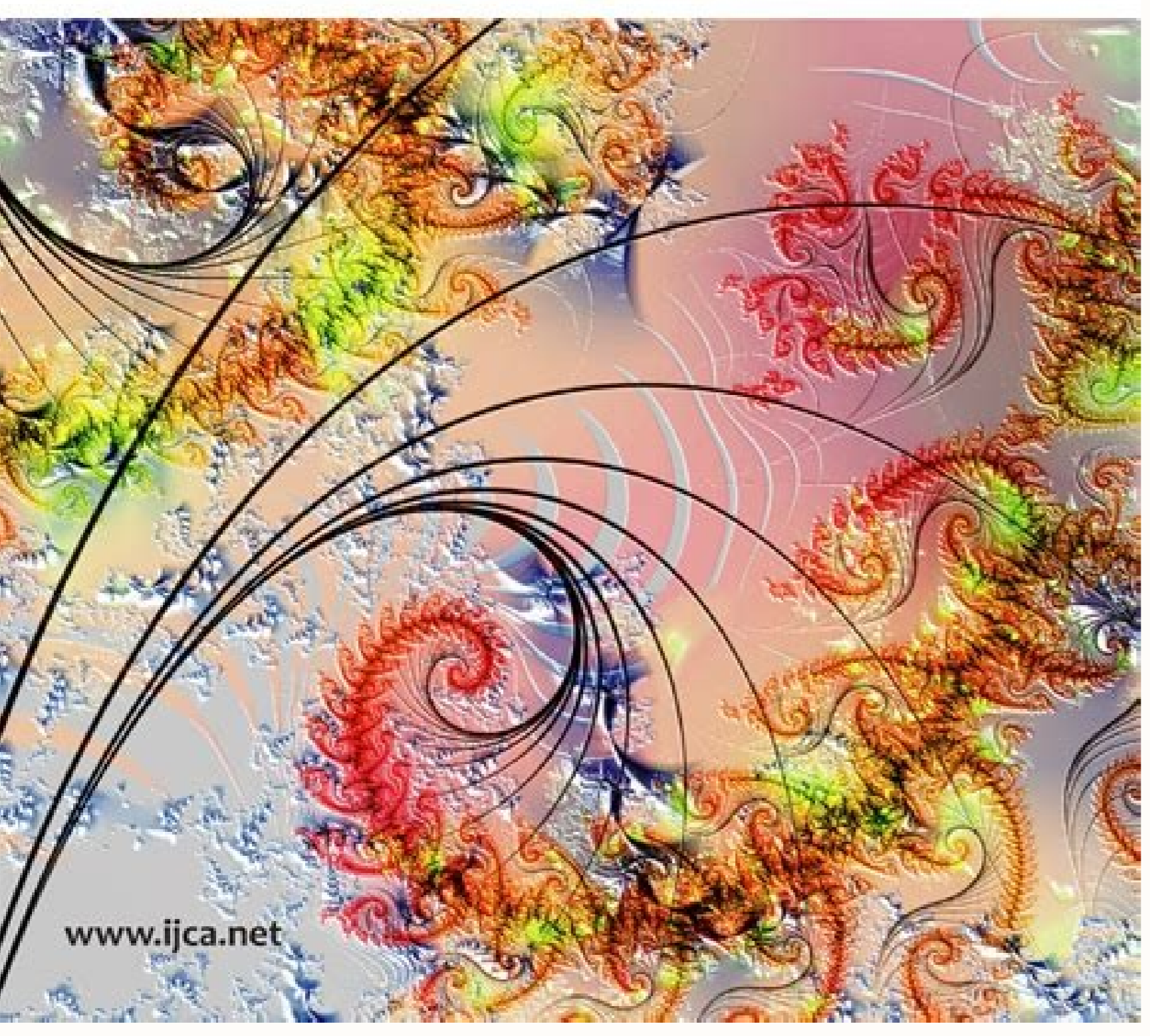


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Editor: Rhiannon Lewis • Associate Editor: Gabriel Mojay

A unique resource for enhancing clinical practice
Written by practitioners for practitioners



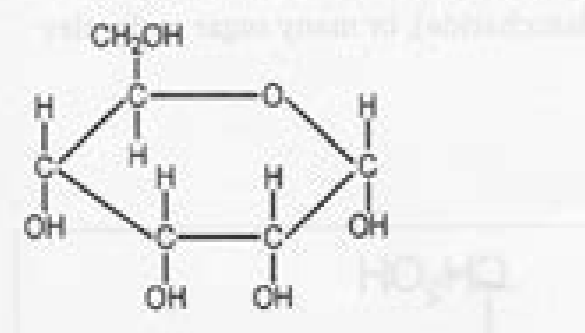
During the formation of the polysaccharide you just drew, how many water molecules were lost?

1 less water molecule than monosaccharides

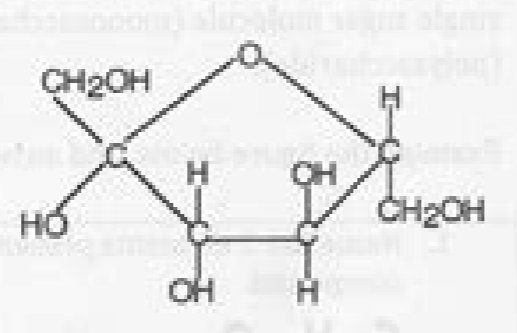
What is the process of putting monomers together to form polymers called?

polymerization

Let's say that the following monosaccharides are going to form a bond. Below each individual monosaccharide, write its chemical formula. Then, in the center blank, write the formula for the resulting disaccharide.



Chemical Formula: C₆H₁₂O₆



Chemical Formula: C₆H₁₂O₆

Resulting disaccharide chemical formula: C₁₂H₂₂O₁₁

Testing for Carbohydrates

When conducting the following tests, what color would the indicator turn?

Benedict's Test

Monosaccharide: orange

Disaccharide:

Polysaccharide:

Iodine Test

Monosaccharide:

Disaccharide:

Polysaccharide: purple

Check the foods you think would test positive for a high carbohydrate content:

Food	Check	Food	Check
Breads	<input checked="" type="checkbox"/>	Jello	<input type="checkbox"/>
Fruits	<input checked="" type="checkbox"/>	Pasta	<input checked="" type="checkbox"/>
Celery	<input type="checkbox"/>	Rice	<input checked="" type="checkbox"/>

Evidence from Molecular Biology

- In 1959, scientists at Cambridge University in the United Kingdom discovered that myoglobin receives oxygen from hemoglobin and stores it in the tissues until needed.
- Myoglobin has a single chain of 153 amino acids wrapped around a group of iron and other atoms (called heme) to which oxygen binds.
- Observed in early 1960s that the structure of myoglobin was similar in all organisms.
- Predict that organisms that are more closely related should have more similar AA sequence in their myoglobin.



Myoglobin, which stores oxygen, is a protein with a single chain of 153 amino acids wrapped around a group of iron and other atoms (called heme) to which oxygen binds. Observed in early 1960s that the structure of myoglobin was similar in all organisms. Predict that organisms that are more closely related should have more similar AA sequence in their myoglobin.

Thank you for your participation! Self-marking What is an element? Give three examples. An element is a pure substance that cannot be broken down into other types of substances. Examples may vary. Sample answer: Three examples of elements are iron, hydrogen, and carbon. Define compound. Explain how compounds form. A compound is a unique substance that consists of two or more elements combined in fixed proportions. Compounds form in chemical reactions. New chemical bonds form when substances react with one another. Compare and contrast atoms and molecules. Atoms are the smallest particles of elements that still have the properties of the elements. Molecules are the smallest particles of compounds that still have the properties of the compounds. Atoms are extremely small and consist of subatomic particles including electrons, protons, and usually neutrons. The subatomic particles are held together by electromagnetic and nuclear forces. Molecules consist of two or more atoms so they are generally larger than individual atoms. The atoms in molecules are held together by chemical bonds in which different atoms share electrons. The compound called water can be broken down into its constituent elements by applying an electric current to it. What ratio of elements is produced in this process? The ratio of elements produced when water breaks down into its constituent elements is two parts hydrogen to one part oxygen. Relate ions and isotopes to elements and atoms. Ions are atoms that have more or fewer electrons than protons so they have a negative or positive charge. Isotopes are atoms that have the same number of protons, so they represent the same element, but that have different numbers of neutrons. What is the most important element to life? Carbon. Iron oxide is often known as rust — the reddish substance you might find on corroded metal. The chemical formula for this type of iron oxide is Fe2O3. Answer the following questions about iron oxide and briefly explain each answer. Is iron oxide an element or a compound? It is a compound because it consists of atoms (Fe and O) of different elements. Would one particle of iron oxide be considered a molecule or an atom? Since iron oxide is a compound, one particle would be called a molecule. Describe the relative proportion of atoms in iron oxide. Iron oxide contains two atoms of iron (Fe) and three atoms of oxygen (O). What causes the Fe and O to stick together in iron oxide? Since iron oxide is a compound, the atoms (Fe and O) are held together by chemical bonds. This is due to the sharing of electrons. Is iron oxide made of metal atoms, metalloid atoms, nonmetal atoms, or a combination of any of these? Iron oxide is made of both metal (Fe) and nonmetal (O) atoms. 14C is an isotope of carbon used in the radiocarbon dating of organic material. The most common isotope of carbon is 12C. Do you think 14C and 12C have different numbers of neutrons or protons? Explain your answer. They have different numbers of neutrons because they are both isotopes of carbon. Isotopes have the same number of protons but different numbers of neutrons. Explain why ions have a positive or negative charge. Ions have a positive or negative charge because they have unequal numbers of electrons and protons. Electrons have a negative charge and protons have a positive charge. If there are equal numbers of electrons and protons, the atom will have no net charge because they cancel each other out. If there are more electrons, it will have a net negative charge and if there are more protons, it will have a net positive charge. Name the three subatomic particles described in this section. Protons, neutrons, and electrons Why is carbon so important to life on Earth? Carbon is so important to life on Earth because it is the basis of biochemical compounds. Carbon can form stable bonds with many elements, including itself, so it can create a huge variety of very large and complex molecules. What are biochemical compounds? Biochemical compounds are carbon-based compounds that are found in living things. They make up the cells and other structures of organisms and carry out life processes. Describe the diversity of biochemical compounds and explain how they are classified. There are nearly ten million biochemical compounds in living things. All of them can be classified into one of four major classes: carbohydrates, lipids, proteins, and nucleic acids. Identify two types of carbohydrates. What are the main functions of this class of biochemical compounds? Types of carbohydrates include sugars and starches. The main functions of this class of biochemical compounds include providing cells with energy, storing energy, and forming certain structures in living things, such as the cell walls of plants. What roles are played by lipids in living things? In living things, lipids store energy, form cell membranes, and carry messages. The enzyme amylase is found in saliva. It helps break down starches in foods into simpler sugar molecules. What type of biochemical compound do you think amylase is? Sample answer: Amylase is an enzyme, so I think it is a protein. Acting as an enzyme is one of the main functions of proteins in living things. Explain how DNA and RNA contain the genetic code. DNA and RNA are nucleic acids, which are polymers made up of monomers called nucleotides. All nucleotides are similar except for a component called a nitrogen base. There are four different nitrogen bases and each nucleotide contains one of these four bases. The sequence of nitrogen bases in the chains of nucleotides in DNA and RNA molecules makes up the code for protein synthesis, called the genetic code. What are the three elements present in every class of biochemical compound? Carbon, hydrogen, and oxygen Classify each of the following terms as a monomer or a polymer: Nucleic acid – Polymer Amino acid – Monomer Monosaccharide – Monomer Protein – Polymer Nucleotide – Monomer Polysaccharide – Polymer Match each of the above monomers with its correct polymer and identify which class of biochemical compound is represented by each monomer/polymer pair. Monomer/polymer pairs: amino acid and protein; monosaccharide and polysaccharide; nucleotide and nucleic acid. Is glucose a monomer or a polymer? Explain your answer. Glucose is a monomer because it is a monosaccharide and many glucose molecules together make up a polysaccharide (the polymer). What is one element contained in proteins and nucleic acids, but not in carbohydrates? Nitrogen. Describe the relationship between proteins and nucleic acids. Answers will vary. Sample answer: Nucleic acids and proteins are both biochemical compounds. Nucleic acids carry the instructions for making proteins and also directly assist in making proteins. Why do you think it is important to eat a diet that contains a balance of carbohydrates, proteins, and fats? Answers will vary. Sample answer: I think it is important to eat a diet that has a balance of carbohydrates, proteins, and fats because each class of biochemical compound has different functions. We need these different compounds to carry out the variety of functions our bodies need to survive. Examine the picture of the meal in Figure 3.3.6. What types of biochemical compounds can you identify? Answers will vary. Sample answer: Lime has carbohydrates, simple sugars; Noodles had complex carbohydrates, starch; Spinach has carbohydrates, cellulose; Fish has protein, made of amino acids. What are carbohydrates? Describe their structure. Carbohydrates are the most common class of biochemical compounds. The monomers of carbohydrates are monosaccharides, such as glucose, which contain just six carbon atoms. Larger carbohydrates are polysaccharides and may contain hundreds or even thousands of monosaccharides. Compare and contrast sugars and complex carbohydrates. Sugars are simple carbohydrates composed of just one or two monosaccharides. They taste sweet and provide the body with energy. Complex carbohydrates are polysaccharides such as starch. They consist of many monosaccharides and generally either store energy or make up structures in living things. Self-marking If you chew on a starchy food (such as a saltine cracker) for several minutes, it may start to taste sweet. Explain why. A starchy food may start to taste sweet after you chew it for several minutes because the enzyme amylase in saliva is breaking down the starch to its component monosaccharides, or sugars, which taste sweet. True or False: Glucose is mainly stored in the human body. False. Self-marking Name three carbohydrates that contain glucose as a monomer. Answers will vary, but may include: sucrose, maltose, lactose, starches, glycogen, and cellulose. Jeans are made of tough, durable cotton. Based on what you know about the structure of carbohydrates, explain how you think this fabric gets its tough qualities. Answers will vary. Sample answer: Cotton is mostly cellulose, which is a polysaccharide chain of several hundred to many thousands of linked glucose units. These long chains probably give cotton its strength and toughness. Which do you think is faster to digest — simple sugars or complex carbohydrates? Explain your answer. Answers will vary. Sample answer: Simple sugars, such as glucose, are probably faster to digest because they are already broken down into a small unit that can be used as energy by the body. Complex carbohydrates need to be broken down to their component monosaccharides, such as glucose, before they can be used by the body. True or False: Cellulose is broken down in the human digestive system into glucose molecules. False. Soluble fibre dissolves in water, insoluble fibre does not dissolve in water. What are the similarities and differences between muscle glycogen and liver glycogen? Muscle glycogen and liver glycogen are both polysaccharides of glucose and are used by the human body to store glucose. However, muscle glycogen is converted to glucose only for use by muscle cells, while liver glycogen is converted to glucose for use by the rest of the body. Which carbohydrate is used directly by the cells of living things for energy? Glucose. Which of the following is not a complex carbohydrate? Disaccharide. What are lipids? Lipids are a major class of biochemical compounds that includes oils and fats. Lipid molecules consist mainly of repeating units called fatty acids. Self-marking Compare and contrast saturated and unsaturated fatty acids. The carbon atoms of saturated fatty acids are bonded to as many hydrogen atoms as possible, forming straight chains. Unsaturated fatty acids have lower melting points and are liquids at room temperature. Plants use unsaturated fatty acids to store energy. Identify three major types of lipids. Describe differences in their structures. Three major types of lipids are triglycerides, phospholipids, and steroids. Triglycerides contain glycerol as well as fatty acids, phospholipids contain phosphates and glycerol in addition to fatty acids, and steroids contain a core of four 5- or 6-carbon rings with other components attached to this four-ring core. How do triglycerides play an important role in human metabolism? Triglycerides play a major role in human metabolism as energy sources and transporters of dietary fat. When you eat, your body converts any calories it doesn't need right away into triglycerides, which are stored in your fat cells. When you need energy between meals, hormones trigger the release of some of these stored triglycerides back into the bloodstream. Explain how phospholipids form cell membranes. Cell membranes are basically phospholipid bilayers. A bilayer forms when many phospholipid molecules line up hydrophobic tail to hydrophobic tail. This creates an inner and outer surface of hydrophilic heads that point toward the watery extracellular space or the watery cell lumen. What is cholesterol? What is its major function? Cholesterol is a steroid compound. Its main function is being an important component of the cell membrane. Give three examples of steroid hormones in humans. Three examples of steroid hormones in humans include cortisone, which is a fight-or-flight hormone, and estrogen and testosterone, which are sex hormones. Which type of fatty acid do you think is predominant in the cheeseburger and fries shown above? Explain your answer. Answers will vary. Sample answer: I think saturated fatty acids will predominate, because steak (red meat) and cheese both come from cows, and animals such as cows typically use saturated fatty acids to store energy. Which type of fat would be the most likely to stay liquid in colder temperatures: bacon fat, olive oil, or soybean oil? Explain your answer. Soybean oil, because it is a good source of polyunsaturated fatty acids, which remain liquid at lower temperatures than monounsaturated fatty acids (olive oil) or saturated fatty acids (bacon fat). Why do you think that the shape of the different types of fatty acid molecules affects how easily they solidify? Can you think of an analogy for this? Answers will vary. Sample answer: Saturated fatty acid molecules are straight chains and therefore can be packed easily and tightly together, so they solidify easily. The bent chains of the unsaturated fatty acid molecules make it harder for them to stack together tightly and solidify. High cholesterol levels in the bloodstream can cause negative health effects. Explain why we wouldn't want to get rid of all of the cholesterol in our bodies. Answers will vary. Sample answer: Cholesterol is an important component of the cell membrane, which surrounds all of our cells. Therefore, it is very important to have some cholesterol in order for our bodies to be maintained and function properly. What are proteins? Proteins are a major class of biochemical compounds made up of small molecules called amino acids. Outline the four levels of protein structure. A protein's primary structure is the sequence of amino acids in its polypeptide chain(s). A protein's secondary structure refers to configurations such as helices and sheets within polypeptides. A protein's tertiary structure refers to the overall shape of the protein molecule and determines its function. A quaternary structure occurs if multiple proteins form, and work together as, a single protein complex. Identify four functions of proteins. Answers may vary. Sample answer: Four functions of proteins are making up muscles, acting as enzymes to speed up chemical reactions in cells, acting as antibodies to bind to specific foreign substances and target them for destruction, and carrying materials. Explain why proteins can take on so many different functions in living things. Proteins can take on so many different functions in living things because of their amazing diversity of structures and their ability to bind with other molecules specifically and tightly. What is the role of proteins in the human diet? The role of proteins in the human diet is to supply amino acids that our cells need to synthesize human proteins. We cannot make all the different amino acids we need for this purpose, so we break down proteins in the foods we eat for their constituent amino acids. Can you have a protein with both an alpha helix and a pleated sheet? Why or why not? Yes, because alpha helices and beta sheets are both types of secondary structures. Since some secondary structures are local, there can be different types in different areas of the protein. If there is a mutation in a gene that causes a different amino acid to be encoded than the one usually encoded in that position within the protein, would that affect the primary structure of the protein? Explain your answer Yes, because the primary structure is the sequence of amino acids encoded by the gene, so if that changes, the primary structure changes directly. The higher structures (secondary, tertiary, quaternary) of the protein? Explain your answer. Probably, because the primary structure determines the higher structures of the protein, and the primary structure is altered by this mutation. The function of the protein? Explain your answer. Probably, because the tertiary structure generally gives the protein its function, and if the change in the amino acid changes the tertiary structure (which is likely) it would change the function of the protein. What is the region of a protein responsible for binding to another molecule? Which level or levels of protein structure creates this region? The binding site. What is the region of a protein responsible for binding to another molecule? Which level or levels of protein structure creates this region? The tertiary structure largely determines the binding site, but that in turn is determined by the primary and secondary structures. Self-marking True or False: You can tell the function of all proteins based on their quaternary structure. False. Explain what the reading means when it says that amino acids are "recycled." Amino acids are recycled in the body because when proteins are broken down, their amino acids can be used again to make new proteins. What are nucleic acids? Nucleic acids are the class of biochemical compounds that includes DNA and RNA. How does RNA differ structurally from DNA? Draw a picture of each. DNA consists of two polynucleotide chains. Each nucleotide contains the sugar deoxyribose. The four nitrogen bases found in DNA are adenine, thymine, guanine, and cytosine. RNA, in contrast, consists of just one polynucleotide chain, and each nucleotide contains the sugar ribose. Instead of the base thymine, RNA contains the base uracil. Describe a nucleotide. Explain how nucleotides bind together to form a polynucleotide. A nucleotide is a small molecule consisting of a phosphate group, a five-carbon sugar, and a nitrogenous base. The sugar molecule of one nucleotide binds with the phosphate group of another nucleotide. Alternating sugars and phosphate groups form the "backbone" of a polynucleotide. What role do nitrogen bases in nucleotides play in the structure and function of DNA? Bonds form between complementary nitrogen bases in the two polynucleotides of DNA, holding the two chains together and causing the molecule to take on its characteristic double helix shape. The sequence of nitrogen bases in DNA make up the genetic code, which contains the instructions for synthesizing proteins in cells. What is a function of RNA? A role of RNA is helping synthesize proteins in cells. Using what you learned in this article about nucleic acids, explain why twins look so similar. Twins look so similar because they inherited identical DNA from their parents as identical twins, and DNA contains genes that determine many of our traits. Self-marking What are the nucleotides on the complementary strand of DNA below? Self-marking Arrange the following in order from the smallest to the largest level of organization: DNA, nucleotide, polynucleotide. Nucleotide, polynucleotide, DNA. As part of the DNA replication process, the two polynucleotide chains are separated from each other, but each individual chain remains intact. What type of bonds are broken in this process? Hydrogen bonds. Adenine, guanine, cytosine, and thymine are nitrogenous bases. Some diseases and disorders are caused by genes. Explain why these genetic disorders can be passed down from parents to their children. DNA is passed down from parents to their offspring, so if there is a gene that causes a disease or a disorder, the parents can pass that down to their children. In animals that reproduce sexually, such as humans, the offspring do not always get the disorder because they contain DNA from both parents. Are there any genetic disorders that run in your family? Answers will vary. What is a chemical reaction? A chemical reaction is a process that changes some chemical substances into others. Define the reactants and products in a chemical reaction. Reactants are the substances that start a chemical reaction, and products are the substances that form as a result of a chemical reaction. In a chemical reaction, bonds break in reactants and new bonds form in products. List three examples of common changes that involve chemical reactions. Examples may vary. Sample answer: Three examples of common changes that involve chemical reactions are a candle burning, iron rusting, and organic matter rotting. Define a chemical bond. A chemical bond is a force holding together atoms in a molecule. What is a chemical equation? Give an example. A chemical equation is a symbolic way of representing what happens during a chemical reaction. An example of a chemical equation is the equation for the burning of methane: CH4 + 2O2 → CO2 + 2H2O. What does it mean for a chemical equation to be balanced? Why must a chemical equation be balanced? A chemical equation is balanced when the same number of atoms of each element appears on each side of the arrow. A chemical equation must be balanced because, according to the law of conservation of mass, mass can neither created nor destroyed. Therefore, during a chemical reaction, the total mass of products must be equal to the total mass of reactants. Our cells use glucose (C6H12O6) to obtain energy in a chemical reaction called cellular respiration. In this reaction, six oxygen molecules (O2) react with one glucose molecule. Answer the following questions about this reaction: How many oxygen atoms are in one molecule of glucose? Six Write out what the reactant side of this equation would look like. C6H12O6 + 6O2 In total, how many oxygen atoms are in the reactants? Explain how you calculated your answer. 18. Six come from the one glucose molecule and 12 come from the six O2 molecules (6 x 2 per molecule), for a total of 18. In total, how many oxygen atoms are in the products? Is it possible to answer this question without knowing what the products are? Why or why not? 18. Yes, you can answer the question without knowing the specific products, because there is conservation of mass. If you know how many oxygen atoms are in the reactants, there will be the same number in the products. Answer the following questions about the following equation: CH4 + 2O2 → CO2 + 2H2O Can carbon dioxide (CO2) transform into methane (CH4) and oxygen (O2) in this reaction? Why or why not? No, because carbon dioxide is a product and the arrow only goes from the reactants to the products in this reaction. How many molecules of carbon dioxide (CO2) are produced in this reaction? One. If there is no number, one molecule is represented. Is the evaporation of liquid water into water vapor a chemical reaction? Why or why not? No, because liquid water and water vapor consist of the same molecules (water, i.e., H2O), so there is no chemical change of one substance into another occurring. This is simply a physical change of state. Why do bonds break in the reactants during a chemical reaction? By definition, a chemical reaction is a process that changes some chemical substances into others. In order to do this, the original chemicals (the reactants) have some of their bonds broken in order to rearrange their atoms into new molecules. Compare endothermic and exothermic chemical reactions. Give an example of a process that involves each type of reaction. Endothermic chemical reactions absorb energy, whereas exothermic chemical reactions release energy. An example of an endothermic process is photosynthesis. An example of an exothermic process is cellular respiration. Define activation energy. Activation energy is the energy needed to start a chemical reaction. Explain why chemical reactions require activation energy. All chemical reactions require activation energy to start molecules moving and bumping together so they can react. Heat is a form of energy. In which type of reaction is heat added to the reactants? Endothermic. In which type of reaction is heat produced? Exothermic. If there was no energy added to an endothermic reaction, would that reaction occur? Why or why not? No, because in an endothermic reaction, an input of energy is needed for the reaction to occur. If there was no energy added to an exothermic reaction, would that reaction occur? Why or why not? No, because even in an exothermic reaction, some energy is needed to start the reaction (activation energy). Explain why a chemical cold pack feels cool when activated. When a tube inside the pack is broken, it releases a chemical that reacts with water inside the pack. This reaction absorbs heat energy because it is endothermic. This quickly cools down the contents of the pack. Explain why cellular respiration and photosynthesis are "opposites" of each other. Answers may vary. Sample answer: Cellular respiration is exothermic and uses glucose to release energy. Photosynthesis is endothermic and uses energy to create glucose. Explain how the sun gives our cells energy indirectly. Answers may vary. Sample answer: Plants use energy from the sun to create sugars through photosynthesis. When humans eat plants, they release that energy through the process of cellular respiration. Also, humans may eat animals that eat plants (or animals that eat other animals that eat plants!) so ultimately the energy our bodies use comes from the sun. What are biochemical reactions? Biochemical reactions are chemical reactions that take place inside living things. Define metabolism. Metabolism refers to the sum of all the biochemical reactions in an organism. Compare and contrast catabolic and anabolic reactions. The biochemical reactions of metabolism include both catabolic and anabolic reactions. Catabolic reactions are exothermic biochemical reactions that release energy, whereas anabolic reactions are endothermic biochemical reactions that absorb energy. Explain the role of enzymes in biochemical reactions. Most biochemical reactions require an enzyme, which is a protein that acts as a biological catalyst. They are needed to speed up biochemical reactions, generally by lowering the activation energy needed for the reactions to begin. Each enzyme has a specific substrate, or substance that it acts upon and reaction that it catalyzes. What are enzyme-deficiency disorders? Enzyme-deficiency disorders are inherited metabolic disorders in which a particular enzyme is defective or missing due to the inheritance of gene mutations. Explain why the relatively low temperature of living things, along with the low concentration of reactants, would cause biochemical reactions to occur very slowly in the body without enzymes. Biochemical reactions require energy to get started, in order to bring the reactant molecules together. At higher temperatures, there is more heat energy, and this causes the molecules to move around and bump into each other. If the temperature is relatively low, as in the human body, the molecules are not moving around as much and there may not be sufficient energy for the reactions to occur quickly. Also, if the concentration of reactant molecules is low, there is less of a chance they will bump into each other and be able to react. Answer the following questions about what happens after you eat a sandwich. Pieces of the sandwich go into your stomach, where there are digestive that break down the food. Which type of metabolic reaction is this? Explain your answer. This is a catabolic reaction because larger molecules in the sandwich are broken down into smaller parts. During the process of digestion, some of the sandwich is broken down into glucose, which is then further broken down to release energy that your cells can use. Is this an or ? Explain your answer. Exothermic, because energy is released. The proteins in the cheese, meat, and bread in the sandwich are broken down into their component amino acids. Then your body uses those amino acids to build new proteins. Which kind of metabolic reaction is represented by the building of these new proteins? Explain your answer. Anabolic, because it is the building up of bigger molecules from smaller ones. Explain why your body doesn't just use one or two enzymes for all of its biochemical reactions. Answers will vary. Sample answer: Your body does not just use one or two enzymes for all of its biochemical reactions because enzymes are substrate-specific, so different enzymes are required for different substrates. Also, different enzymes often require specific environmental conditions (i.e. temperature or pH) so one or two enzymes would not necessarily work in all the different environments of the body. A substrate is the specific substance that an enzyme affects in a biochemical reaction. An enzyme is a biological catalyst. Where is most of Earth's fresh water found? Most of Earth's fresh water is found frozen in ice caps and glaciers (about 69 per cent) or stored under the surface as ground water (about 30 per cent). Identify properties of water. Pure water is odorless, tasteless, and transparent. Water molecules tend to stick together, so water forms drops rather than individual molecules as it drips out of a leaky faucet or off a melting icicle. Water also has a relatively high boiling point and a lower density as a solid (ice) than as a liquid. What is polarity? Explain why water molecules are polar. Polarity is a difference in electrical charge between different parts of the same molecule. Water molecules are polar because the oxygen atom in a water molecule attracts electrons more strongly than the hydrogen atoms do. As a result, the oxygen atom has a slightly negative charge, and the hydrogen atoms have a slightly positive charge. Why do water molecules tend to "stick" together? Water molecules tend to "stick" together because the positive (hydrogen) end of one water molecule is attracted to the negative (oxygen) end of a nearby water molecule. Because of this attraction, weak hydrogen bonds form between adjacent water molecules. What role does water play in photosynthesis and cellular respiration? In photosynthesis, water is a reactant. It reacts with carbon dioxide to form glucose and oxygen. In cellular respiration, water is a product. It forms along with carbon dioxide when glucose and oxygen react. Which do you think is stronger: the bonds between the hydrogen and oxygen atoms within a water molecule, or the bonds between the hydrogen and oxygen atoms between water molecules? Explain your answer. The bonds between the hydrogen and oxygen atoms within a water molecule are stronger because the bonds between molecules are not usually as strong as the bonds within molecules. Given what you've learned about water intoxication (or hyponatremia), explain why you think drinking salt water would be bad for your cells. Answers may vary. Sample answer: Drinking salt water would be bad for your cells because it could cause a higher concentration of salt outside your cells than inside, which would cause water to flow out of the cells due to osmosis. That would cause the cells to shrink — the opposite of what occurs in hyponatremia. This causes dehydration and is dangerous. What is the name for the bonds that form between water molecules? Hydrogen bonds. Explain why water can dissolve other polar molecules. Water can dissolve other polar molecules because the slightly positive hydrogen atoms in water are attracted to the slightly negative atoms in the other polar molecules, and the slightly negative oxygen atoms in water are attracted to the slightly positive atoms in the other polar molecules. This causes the other polar molecules to become dispersed among the water molecules — i.e., dissolved. If there is pollution in the ocean that causes the water to become more cloudy or opaque, how do you think the ocean's photosynthetic organisms will be affected? Explain your answer. Answers may vary. Sample answer: If there is pollution in the ocean that causes the water to become more cloudy or opaque, it will limit the amount of sunlight that photosynthetic organisms in the ocean can receive. This will limit the amount of glucose and oxygen the photosynthetic organisms can produce, because sunlight is required for photosynthesis. This would affect the health of the photosynthetic organisms (and the rest of the food chain!) Describe one way in which your body gets rid of excess water. Urination, perspiration. True or False: Ice floats on top of water because it is denser than water. False. Self-marking What is a solution? A solution is a mixture of two or more substances that has the same composition throughout. Define acidity. Acidity refers to the concentration of hydronium ions in a solution. Explain how acidity is measured. Acidity is measured on the pH scale relative to pure water, which has a pH value of 7. Pure water has a very lower hydronium ion concentration and is essentially neutral. This means that the point of neutrality on the pH scale is 7. Compare and contrast acids and bases. Acids are sour-tasting solutions with a hydronium ion concentration greater than that of pure water and a pH lower than 7. Bases are bitter-tasting solutions with a hydronium ion concentration less than that of pure water and a pH higher than 7. Hydrochloric acid is secreted by the stomach to provide an acidic environment for the enzyme pepsin. What is the pH of this acid? How strong of an acid is it compared with other acids? The pH of hydrochloric acid is zero, making it among the strongest of acids. Define an ion. Identify the ions in the equation below, and explain what makes them ions: 2 H2O → H3O+ + OH- H3O+ and OH- are the ions because they have a positive (+) or negative (-) charge. Explain why the pancreas secretes bicarbonate into the small intestine. The pancreas secretes bicarbonate into the small intestine to neutralize the acid coming from the stomach. This is because the enzymes in the small intestine need a basic environment in which to work. Do you think pepsin would work in the small intestine? Why or why not? No, because pepsin needs an acidic environment to work and the small intestine is more basic. You may have mixed vinegar and baking soda and noticed that they bubble and react with each other. Explain why this happens. Explain also what happens to the pH of this solution after you mix the vinegar and baking soda. Vinegar is an acid and baking soda has a base. The acid and base neutralize each other, causing the observed reaction. The solution becomes closer to neutral (pH = 7) because the acid (vinegar) and base (baking soda) neutralize each other. Pregnancy hormones can cause the lower esophageal sphincter to relax. What effect do you think this has on pregnant women? Explain your answer. Relaxation of the lower esophageal sphincter in pregnant women could cause the women to experience heartburn or GERD, because the stomach acids can back up into the esophagus through the relaxed sphincter. Self-marking The chemical formula for the complex carbohydrate glycogen is C24H42O21. What are the elements in glycogen? Carbon, hydrogen, and oxygen. How many atoms are in one molecule of glycogen? 87 Is glycogen an ion? Why or why not? No, glycogen is not an ion because it does not have a charge. Is glycogen a monosaccharide or a polysaccharide? Besides memorizing this fact, how would you know this based on the information in the question? It is a polysaccharide. You can tell this because the question mentions that glycogen is a complex carbohydrate. Complex carbohydrates are polysaccharides and are made up of many monosaccharides. What is the function of glycogen in the human body? Glycogen is used to store glucose in the human body and acts as an energy reserve. What is the difference between an ion and a polar molecule? Give an example of each in your explanation. Ions are atoms or molecules with a positive or negative charge, for example Na+ or OH-. They have different numbers of electrons and protons, which leads to this overall net charge. Polar molecules, such as water (H2O), have a slight electrical charge in different parts of the molecule, but they are electrically neutral overall. Define monomer and polymer. A monomer is a small molecule that can bond in repeating units to form a larger molecule, called a polymer. Self-marking What is the difference between a protein and a polypeptide? A protein consists of one or more polypeptides. Self-marking People with diabetes have trouble controlling the level of glucose in their bloodstream. Knowing this, why do you think it is often recommended that people with diabetes limit their consumption of carbohydrates? Glucose is a form of carbohydrate, and other carbohydrates are easily broken down into glucose molecules. Therefore, people with diabetes are typically told to limit and/or monitor their intake of carbohydrates, because eating carbohydrates can dramatically affect their blood glucose levels. Identify each of the following reactions as endothermic or exothermic. Cellular respiration – exothermic Photosynthesis – endothermic Catabolic reactions – exothermic Anabolic reactions – endothermic Pepsin is an enzyme in the stomach that helps us digest protein. Answer the following questions about pepsin: What is the substrate for pepsin? The substrate for pepsin is the protein that it breaks down. How does pepsin work to speed up protein digestion? Pepsin, like all enzymes, lowers the activation energy needed for the reaction to occur. Given what you know about the structure of proteins, what do you think are some of the products of the reaction that pepsin catalyzes? Answers will vary. Sample answer: The products of protein digestion are probably smaller parts of the proteins, possibly even down to the individual amino acid level. The stomach is normally acidic. What do you think would happen to the activity of pepsin and protein digestion if the pH is raised significantly? Pepsin requires an acidic environment to function properly. If the pH of the stomach is raised, it would become more basic. Therefore pepsin wouldn't function properly and the digestion of proteins would be impaired. Biological molecules that lower amount of the energy required for a reaction to occur. A chemical reaction that releases energy through light or heat. Any reaction which requires or absorbs energy from its surroundings, usually in the form of heat.

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