Name:_____Date:_____

Ms. Randall LE

<u>Unit 2 The Chemistry of Life</u>

Unit Objectives:

- Identify and describe the four major groups of organic compounds.
- Describe the role of water in building and breaking down organic compounds.
- Recognize and set up the parts of a chemical reaction.
- Describe how do enzymes (catalysts) influence the rate of chemical reactions.
- Describe and analyze the factors that influence the rate of enzyme (catalyst) action.

Focus Questions for the Unit:

- What is makes up matter?
- What does all matter have in common?
- What are some important substances that make up living things?
- Where do living things get energy?
- What happens to chemical bonds during chemical reactions?

Define the following vocabulary:

Carbohydrate
Glucose
Disaccharide
Monosaccharide
Lipid/Fat
Fatty Acids
Glycerol
Amino Acids
Protein
Enzyme

Biological Catalyst
Denature
Indicator
Base
pH
Neutralization
Monomer
Polymer
Nutrients

Lesson 1: Matter **Date:_____**

Objective: To relate the basic building blocks of matter to living things

Watch this! Bill Nye -Atoms

The chemicals that make up living things are more complex than those in nonliving things. Learning the chemical basis of biology can help you understand how processes occur and how living things respond to the environment. Chemical reactions allow living things to grow, develop and reproduce

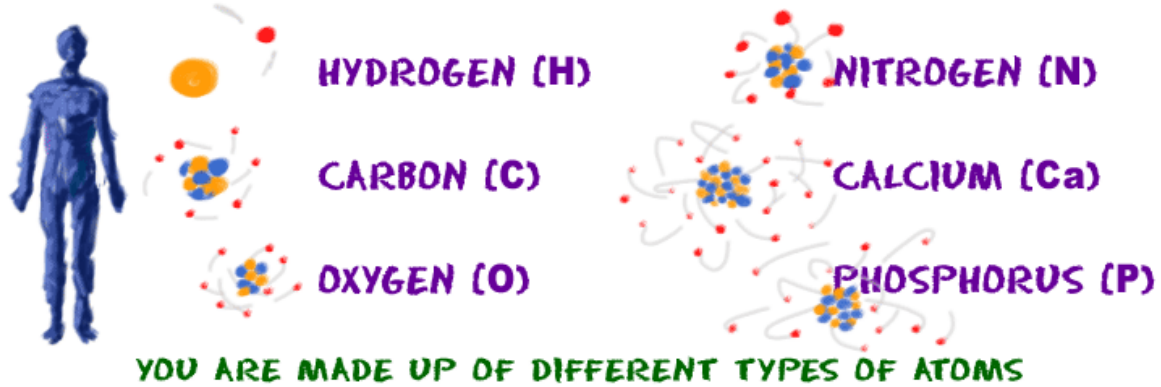
What makes up matter?
All matter is made up of atoms. An atom has a positively charged core surrounded by a negatively charged region.

What are some important interactions between substances in living things?
Hydrogen bonding plays an important role in many of the molecules that make up living things.

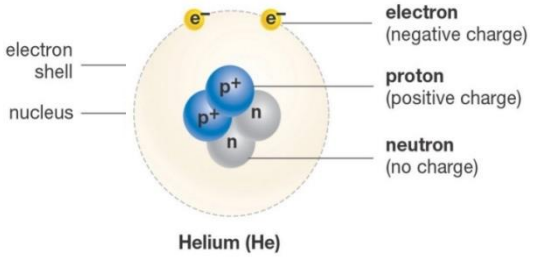
Every living and nonliving thing is made of matter. Matter is anything that has mass and takes up space. To understand how living things work and interact, you must first understand the structure of matter.

ATOMS

Atoms are the building blocks of matter. Atoms are so small that you cannot even see them with a regular compound light microscope.



Structure of an atom:



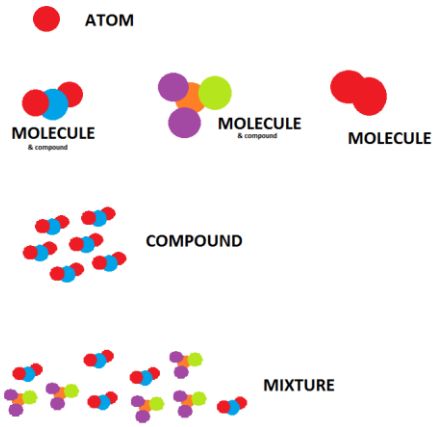
Nucleus - center of an atom that contains protons and neutrons

- **Neutron** - particles with no charge that are located in the nucleus
- **Proton** - positively (+) charged particles that are located in the nucleus
- **Electron** - negatively (-) charged particles that are located outside the nucleus

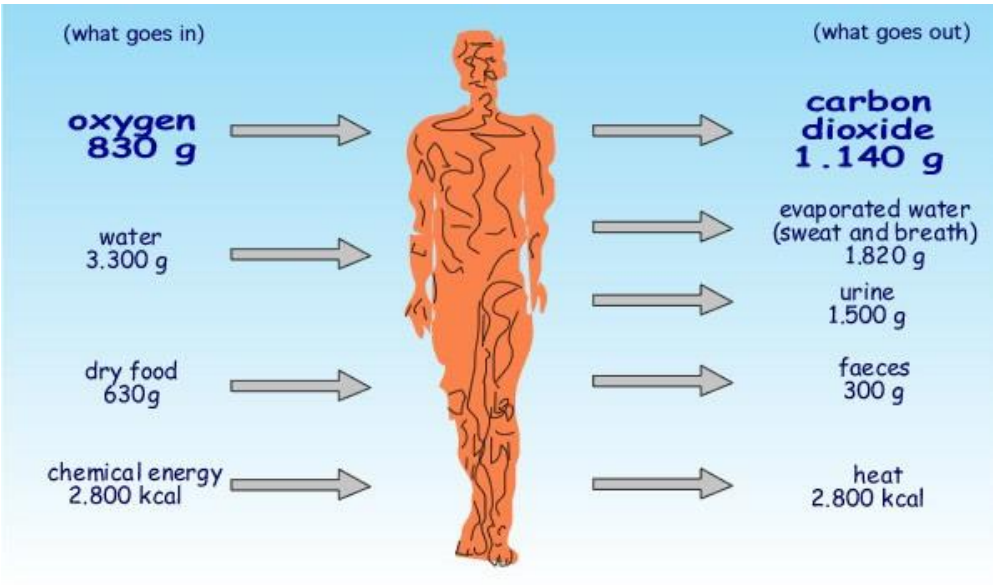
An **element** is a substance that can't be broken down into simpler chemical substances. The smallest particle of an element that has the characteristics of that element is called an **atom**. The **nucleus** is the positively charged center of an atom composed of neutrons and positively charged protons, and surrounded by negatively charged electrons.

A **compound** forms when two or more elements combine. The chemical bond that holds the elements together is a **bond** when electrons are shared. A substance with this kind of bond is called a **molecule.**

An atom that has lost or gained one or more electrons becomes an **ion**, which carries an electric charge.

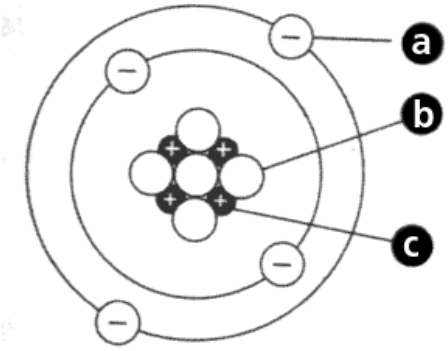


Metabolism is a collection of chemical reactions that takes place in the body's cells. Metabolism converts the fuel in the food we eat into the energy needed to power everything we do, from moving to thinking to growing. Specific proteins in the body control the chemical reactions of metabolism, and each chemical reaction is coordinated with other body functions. In fact, thousands of metabolic reactions happen at the same time — all regulated by the body — to keep our cells healthy and working. Metabolism is a constant process that begins when we're conceived and ends when we die. It is a vital process for all life forms — not just humans. If metabolism stops, living things die.



Check Your Understanding:

Label the parts of an atom on the diagram below.



1. What type of charge does a proton have?

2. What type of charge does a neutron have?

3. What type of charge does an electron have?

3. Which two subatomic particles are located in the nucleus of an atom?

4. Describe an example of metabolism in your body

Practice: Read the following passage carefully and then answer the questions below.

Why Does Matter Matter?
by Kelly Hashway

What do trees, air, and water have in common? They all have **matter**. That means they take up space. You might be wondering why these things look so different if they all have matter. Everything found on Earth can be grouped into one of three states of **matter**: **solid, liquid, or gas**. In order to figure out which state of matter an object fits in, we have to examine its properties. The properties we look at are **shape**, mass, and volume. **Mass** is the amount of matter an object has, and **volume** is the amount of space the matter takes up. Solids are easy to recognize. They have definite shape, mass, and volume. Trees are solids. They are made up of tiny particles called **atoms**. These atoms are packed closely together, and they hold the solid in a definite shape that does not change. If you look around your house, you will see lots of solids. Televisions, beds, tables, chairs, and even the food you eat. Liquids do not have definite shape, but they do have definite mass and volume. Liquids are similar to solids because their atoms are close together, but what makes a liquid different is that those atoms can move around. Liquids can change shape by flowing. If you've ever spilled a glass of milk, then you know it spreads out across the floor. It does this because the milk is taking the shape of the floor. Since liquids do not have a definite shape of their own, they will take the shape of their containers. This is why the same amount of milk can look different in a tall glass, a wide mug, or spread out on your kitchen floor. Gases do not have definite shape or volume. Like liquids, gasses will take the shape of their containers. If a gas is not in a container, it will spread out indefinitely. This is because the atoms in a gas are spaced farther apart than in a solid or a liquid. Being spread out like this allows them to move around freely. Think about the air you breathe every day. That air is spread across the empty space around the earth. You've probably also noticed that you usually cannot see the air. This is another property of gases. Even though we cannot see them, you come in contact with them every day. There's air in the tires of your family car and your bicycle. The sun is made up of gases, and the clouds in the sky are mostly made from water vapor.

When trying to remember the three states of matter, think about water. If it freezes into a solid, it becomes ice. Its atoms are packed together keeping its shape. Of course, we know water can also be a liquid. It flows in rivers or it can be poured from a glass. When water evaporates it becomes water vapor, a type of gas in the air. Try a little experiment of your own by placing an ice cube in a covered glass or container. You will be able to observe the ice first in its solid form and then watch as it melts into a liquid to become water. Eventually the water will turn to water vapor and your glass or container will be filled with this gas.

Directions: Choose a word from the box to complete each sentence.

Solids	Container	Ice
Gases	Atoms	Air
Liquids	Space	Clouds
Volume	Matter	Juice
Mass	Chair	Melting
Shape	Milk	

1. The three basic properties of matter are _____, _____, and _____.

2. All matter is made up of tiny particles called _____.

3. Volume is the amount of _____ that matter takes up.

4. Mass is the amount of _____ an object has.

5. Liquids take the shape of their _____.

6. _____ do not have a definite shape or volume.

7. _____ do not have a definite shape, but they do have a definite volume.

8. _____ have a definite shape and volume.

9. A _____ and _____ are examples of solids.

10. _____ and _____ are examples of liquids.

11. _____ and _____ are examples of gas.

12. Solid ice is _____ when it is changing into a liquid.

Lesson 2: Chemical Bonds and Molecules Date:_____

Objective: To relate chemical bonds in organic and inorganic molecules to the energy and structure of life.

Chemical Bonds are formed when atoms share electrons form **molecules**. The oxygen you breathe consists of molecules made up of two oxygen atoms sharing electrons.

Ex: O_2

Why are bonds important? Strong bonds provide energy for life processes! **Bonds store ENERGY!!!!**

The Importance of Water

Water is one of the most unique molecules known to man and also one of the most important to biological systems. Not only does water exist in nature in all three states of matter (solid, liquid, gas), it also covers 75 percent of the earth and composes roughly 78 percent of the human body.

The uniqueness of water comes from its molecular structure. It has a slight positive and slight negative charge on opposite ends and is a bent molecule.

Because water is a bent, it possesses biologically important characteristics. They are critical to the creation and support of life on Earth.

Hydrogen Bonding

When water molecules align with each other, a weak bond is established between the negatively charged oxygen atom of one water molecule and the positively charged hydrogen atoms of a neighboring water molecule. The weak bond that often forms between hydrogen atoms and neighboring atoms is the *hydrogen bond*. Hydrogen bonds are very common in living organisms; for example, hydrogen bonds form between the bases of DNA to help hold the DNA chain together. Hydrogen bonds give water molecules two additional characteristics: cohesion and surface tension.

PROPERTIES OF WATER

- All life occurs in water
- Neutral molecule
- Oxygen (-) and hydrogen (+) molecules are connected by hydrogen bonds (opposites attract)
- Great solvent
- High surface tension
- Can form hydrogen ions (H+) and hydroxide ions (OH-)

Organic vs. Inorganic

The primary difference between organic compounds and inorganic compounds is that **organic compounds** always contain **carbon** while most inorganic compounds do not contain carbon. Also, almost all organic compounds contain carbon-hydrogen or C-H bonds.

Molecules associated with living organisms are **organic**. These include nucleic acids, fats, sugars, proteins, enzymes and many fuels.

- DNA
- Glucose or sugar, $C_6H_{12}O_6$

Inorganics include salts, metals, substances made from single elements and any other compounds that don't contain carbon bonded to hydrogen.

- table salt or sodium chloride, NaCl
- carbon dioxide, CO_2
- oxygen, O_2
- water ,H_2O

Why do we eat? We eat to take in more of these chemicals

Food for building materials
To make more of us (cells)
For growth
For repair

Food to make energy
Calories
To make ATP

What do we need to eat?

Foods to give you more building blocks & more energy for building & running bodies
Carbohydrates, proteins, fats, nucleic acids, vitamins, minerals, salts, water

Remember- 65% of your body is H_2O. Water is inorganic and doesn't contain carbon.
Rest of you is made of carbon molecules!

Check your understanding

1. What is stored in a chemical bond?

2. What is the difference between an inorganic and organic molecule?

3. Determine if the following compounds are organic or inorganic

   - Water (H_2O) - _____
   - Glucose ($C_6H_{12}O_6$) - _____
   - Carbon Dioxide (CO2) - _____
   - Oxygen (O2) - _____
   - Urea (CH_4N_2O) - _____
   - Salt (NaCl) - _____

4. What do all organic molecules have in common?

Practice:

1. Water is classified as an inorganic compound because it

   A) does not contain carbon
   B) does not contain nitrogen
   C) contains hydrogen
   D) contains oxygen

2. Most organisms contain

   A) organic compounds, only
   B) inorganic compounds, only
   C) both organic and inorganic compounds
   D) neither organic nor inorganic compounds

3. The chart below indicates the elements contained in four different molecules and the number of atoms of each element in those molecules.

	Number of Atoms			
Element	**Molecule *A***	**Molecule *B***	**Molecule *C***	**Molecule *D***
Hydrogen	12	0	3	0
Carbon	6	1	0	1
Nitrogen	0	0	1	0
Oxygen	6	2	0	3
Calcium	0	0	0	1

   Which molecule can be classified as organic?

   A) *A* B) *B* C) *C* D) *D*

4. In a living cell, which compound serves primarily as a substance in which most molecules and ions are dissolved?

   A) glycerol B) glucose
   C) water D) cellulose

5. Which compound is inorganic?

   A) glucose ($C_6H_{12}O_6$)
   B) carbon dioxide (CO_2)
   C) ethane (C_2H_6)
   D) stearic acid ($C_{18}H_{36}O_2$)

6. Which elements are present in all organic compounds?

   A) hydrogen and oxygen
   B) nitrogen and oxygen
   C) nitrogen and carbon
   D) hydrogen and carbon

7. Which substance plays a major role in most of the chemical reactions that occur in a living cell?

   A) water B) glycogen
   C) glycerol D) maltose

8. Which formula represents an organic compound?

   A) $Mg(OH)_2$ B) NaCl
   C) $C_{12}H_{22}O_{11}$ D) NH_3

9. Most of the chemical reactions occurring in a living cell depend on the presence of an inorganic compound known as

   A) glycerol B) glycogen
   C) maltose D) water

Lesson 3: Acids, Bases & pH **Date:_____**

Objective: To compare and contrast properties and uses of acids and bases

Every liquid you see will probably have either **acidic** or **basic** traits. Water (H_2O) can be both an acid and a base, depending on how you look at it. It can be considered an acid in some reactions and a base in others. Water can even react with itself to form acids and bases. It happens in really small amounts, so it won't change your experiments at all. It goes like this:

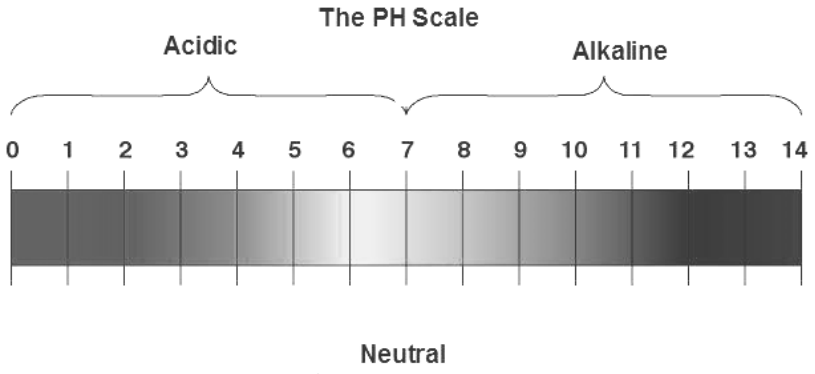
$2H_2O \rightarrow H_3O^+ + OH^-$

An **acid** is a substance that donates (gives up) hydrogen **ions** (ions are atoms with extra electrons or missing electrons). Because of this, when an acid is dissolved in water, the balance between hydrogen ions and hydroxyl ions is shifted. When a hydrogen ion is released, the solution becomes acidic.

A **base** is a substance that accepts (gains) hydrogen ions. When a base is dissolved in water, the balance between hydrogen ions and hydroxyl ions shifts the opposite way. When a hydroxide ion is released, the solution becomes basic. This kind of solution is alkaline.

Acidity and alkalinity are measured with a logarithmic scale called **pH**. Here's why: a strongly acidic solution can have one hundred million million (100,000,000,000,000) times more hydrogen ions than a strongly basic solution! The flip side, of course, is that a strongly basic solution can have 100,000,000,000,000 times more hydroxide ions than a strongly acidic solution.

Scientists use something called the **pH scale** to measure how acidic or basic a liquid is. Although there may be many types of ions in a solution, pH focuses on concentrations of hydrogen ions (H+) and hydroxide ions (OH-). The scale measures values from 0 all the way up to 14. Distilled water is 7 (right in the middle). Acids are found between 0 and 7. Bases are from 7 to 14. Most of the liquids you find every day have a pH near 7 which is considered neutral.



pH scale - indicates the concentration of H+ ions in a solution

Buffer - weak acids or bases that react with strong acids or bases to prevent sharp, sudden changes in pH.

Blood pH:
The bloodstream is the most critically buffered system of the entire body, far more sensitive than any other. Arterial and venous blood must maintain a slightly alkaline pH: arterial blood pH = 7.41 and venous blood pH = 7.36. Because the normal pH of arterial blood is 7.41, a person is considered to have acidosis when the pH of blood falls below this value and to have alkalosis when the pH rises above 7.41.

Check your understanding

1. Evaluate the household substances in the chart below and list them as acids, bases or neutral.

pH Value	H^+ Concentration Compared to Pure Water	Example	pH Value	H^+ Concentration Compared to Pure Water	Example
0	10 000 000	battery acid	7	1	pure water
1	1 000 000	concentrated sulfuric acid	8	0.1	sea water, eggs
2	100 000	lemon juice, vinegar	9	0.01	baking soda
3	10 000	orange juice, soda	10	0.001	Great Salt Lake, milk of magnesia
4	1 000	tomato juice, acid rain	11	0.000 1	ammonia solution
5	100	black coffee, bananas	12	0.000 01	soapy water
6	10	urine, milk	13	0.000 001	bleach, oven cleaner

Acids:

_____

_____

_____

_____

_____

Bases:

_____

_____

_____

_____

_____

Practice:

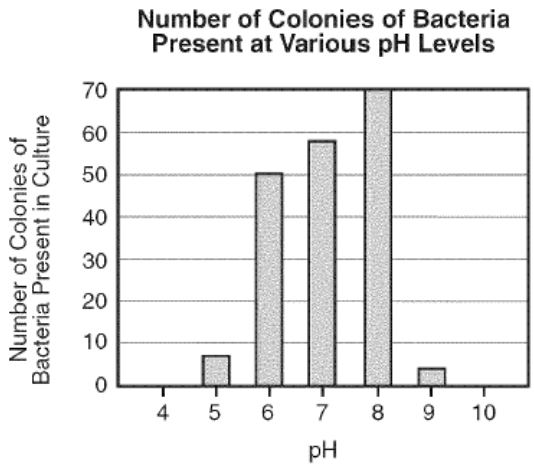
1. In many investigations, both in the laboratory and in natural environments, the pH of substances is measured. Explain why pH is important to living things. In your explanation be sure to:
   • identify *one example of a life process of an organism that could be affected by a pH change*
   • *state one environmental problem that is directly related to pH*
   • *identify one possible cause of this environmental problem*

2. Which substance should be used to determine if a solution is basic?

   A) methylene blue B) Benedict's solution
   C) Lugol's iodine D) pH paper

3. Base your answer to the following question on the graph below and on your knowledge of biology.

   The graph illustrates a single species of bacteria grown at various pH levels.



   The most likely reason there are no colonies in cultures of this species at pH 4 and at pH 10 is that

   A) these bacteria could successfully compete with other species of bacteria at these pH values
   B) there are more predators feeding on these bacteria at pH 4 and pH 10 than at other pH levels
   C) at pH 4 and pH 10 the environment is too acidic or too basic for the bacteria to grow
   D) fertilization cannot occur in these bacteria at pH 4 or pH 10

4. In lakes that are exposed to acid rain, fish populations are declining. This is primarily due to changes in which lake condition?

   A) size B) temperature
   C) pH D) location

5. Which substance could best be used to determine the relative acidity of a solution?

   A) Fehling's solution B) Benedict's solution
   C) pH paper D) methylene blue

6. Tomato plants in a garden are not growing well. The gardener hypothesizes that the soil is too acidic. To test this hypothesis accurately, the gardener could

   A) plant seeds of a different kind of plant
   B) move the tomato plants to an area with less sunlight
   C) change the pH of the soil
   D) reduce the amount of water available to the plant

7. A neutral solution has a pH of

   A) 1 B) 7 C) 9 D) 14

8. Since salivary enzymes normally operate best at a pH close to neutral, the optimum pH range for the hydrolysis of carbohydrates in the human mouth would be

   A) 3-5 B) 4-6 C) 6-8 D) 8-10

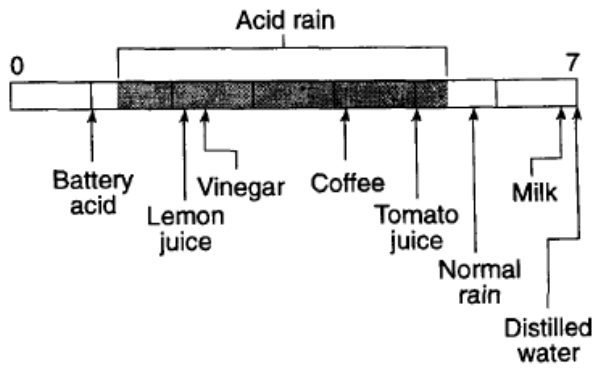
9. An enzyme that works best in an acidic environment would function best at a pH of

   A) 11 B) 9 C) 3 D) 7

10. Maintenance of the pH of human blood within a certain range is an example of

   A) digestion B) synthesis
   C) respiration D) homeostasis

11. A portion of a pH scale is shown below.

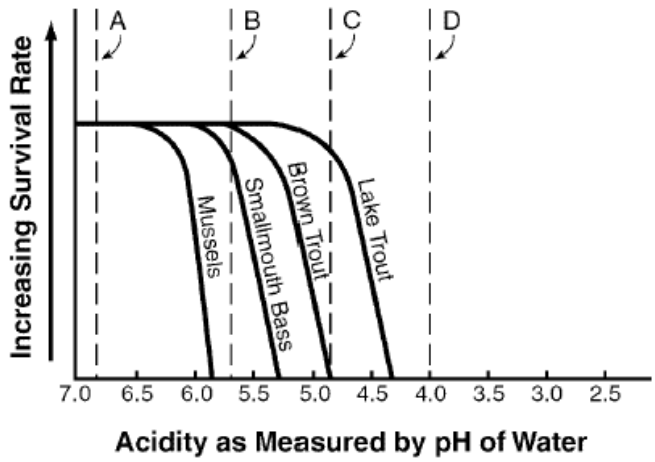


Which substance identified on the scale has a pH closest to the pH of the most acidic acid rain?

A) Battery acid B) Lemon juice
C) Tomato juice D) Normal rain

12. Base your answer to the following question on the information and graph below and on your knowledge of biology.

The Effect of pH on Survival Rates of Selected Species in Certain Adirondack Lakes



KEY:
A – pH of a certain group of Adirondack lakes, 1880
B – pH of rainfall, 1880
C – pH of the same group of Adirondack lakes, 1980
D – pH of rainfall, 1980

State how the pH of these Adirondack lakes changed between 1880 and 1980.

---

13. Which term best describes a solution with a pH of 5?

A) acidic B) neutral
C) basic D) colorless

14. The ocular of a compound light microscope has a magnification of 10×, and the low-power objective and high-power objective lenses have magnifications of 10× and 30×, respectively. If the diameter of the low-power field measures 1,500 micrometers, the diameter of the high-power field will measure

A) 100 μm B) 300 μm
C) 500 μm D) 4,500 μm

Lesson 4: Carbohydrates Date: _____

Objective: To describe the structure and function of carbohydrates

Watch this! You are what you eat!

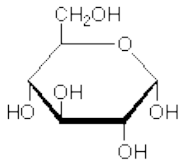
There are four main classes of Organic Compounds are essential to the life processes of all living things: **Carbohydrates, Lipids** (fats), **Proteins** and **Nucleic Acids**. These compounds are built mainly from Carbon, Hydrogen, and Oxygen, the atoms occur in different ratios in each class of compound. Despite their similarities, the different classes of compounds have different properties. The first of these compounds that we will learn about will be Carbohydrates.

Carbohydrate is a fancy way of saying "sugar." They are compounds made up of long chains of simple sugars made of carbon, oxygen and hydrogen. Carbohydrates can be very small or very large molecules, but they are still considered sugars. Organisms can create long chains of glucose molecules for food storage or structural reasons. These carbohydrates provide living things with energy and act as substances used for structure in plants.

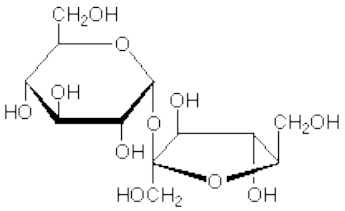
Scientists also use the word saccharide to describe sugars. If there is only one sugar molecule, it is called a **monosaccharide**. If there are two, it is a **disaccharide**. If there are three, it is a trisaccharide. When several carbohydrates combine, it is called a **polysaccharide** ("poly" means many). Hundreds of sugars can be combined in a branched chain. These long chains of glucose molecules are also known as **starches.** You can find starches in foods such as pasta, bread and potatoes. They are very good sources of quick energy for your body and are used to carry out cell processes.

An important structural polysaccharide (carbohydrate) is cellulose, which is found in plants. **Cellulose** is in wood and the cell walls of plants. You know that shirt you're wearing? If it is made of cotton, that's cellulose, too! There can be thousands of glucose subunits in one large molecule of cellulose. If we were like some herbivores or insects, such as termites, we could eat cellulose for food. Those animals don't actually digest the polysaccharides. They have small microorganisms in their bellies that break down the molecules and release smaller sugars.

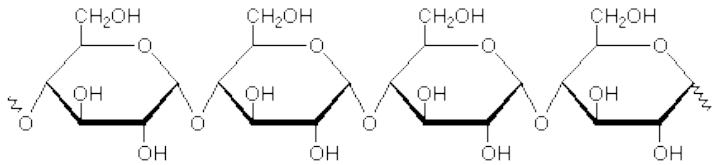
Animals store Glucose in the form of a polysaccharide called **glycogen** in the Liver and Muscles . It is used for quick energy. Glycogen consists of hundreds of Glucose molecules strung together in a highly branched chain. Animals do not digest cellulose; it provides fiber/roughage in their diet.



monosaccharide (glucose)



disaccharide (sucrose)



polysaccharide (amylose starch)

Check your understanding:

1. What are the four compounds essential to all life processes? _____

   _____

2. What is another word for a carbohydrate? _____

Practice:

1. A specific organic compound contains only the elements carbon, hydrogen, and oxygen in the ratio of 1:2:1. This compound is most probably a

   A) nucleic acid B) carbohydrate
   C) protein D) lipid

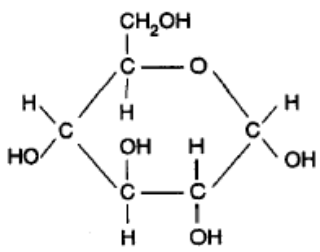
2. If a specific carbohydrate molecule contains ten hydrogen atoms, that same molecule would most probably contain

   A) one nitrogen atom
   B) ten nitrogen atoms
   C) five oxygen atoms
   D) twenty oxygen atoms

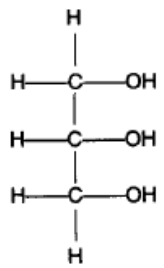
3. Which chemical formula represents a carbohydrate?

   A) CH_4 B) $C_3H_7O_2N$
   C) $C_{12}H_{22}O_{11}$ D) CO_2

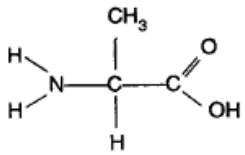
4. Some structural formulas of organic molecules are shown below.



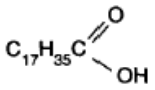
(1)



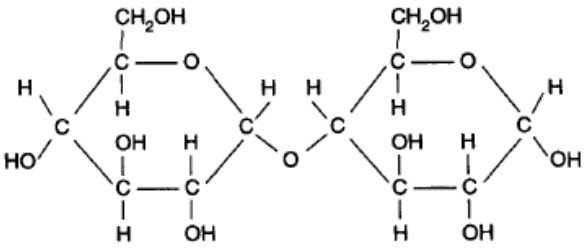
(2)



(3)



(4)

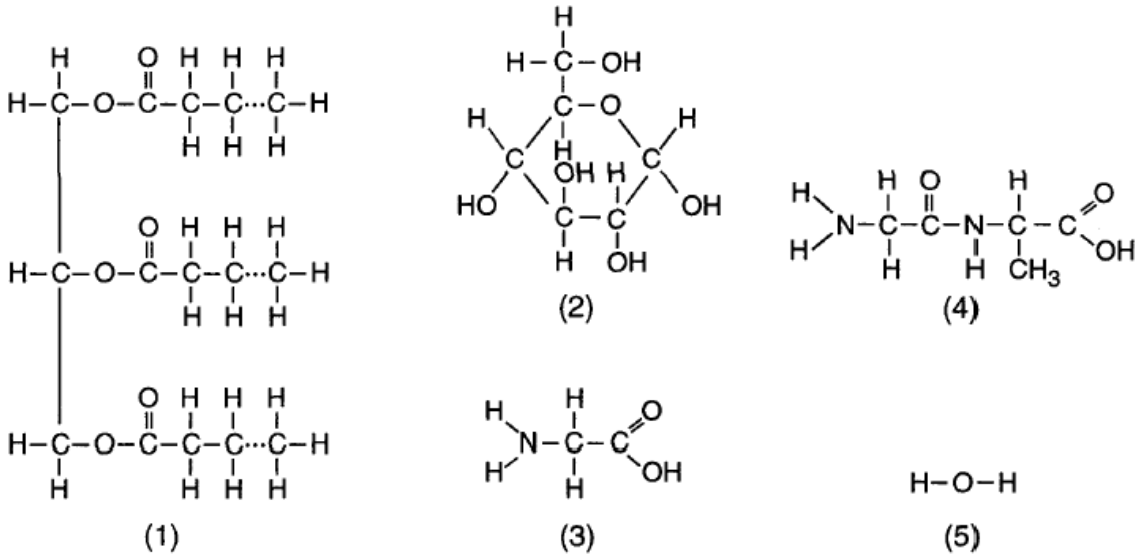


(5)

Which structural formulas represent carbohydrate molecules?

A) 1 and 5 B) 2 and 4 C) 3 and 2 D) 4 and 3

5. Base your answer to the following question on the diagram below. For each of the following phrases, select the molecule, chosen from those shown below, which is best described by that phrase.



An example of a carbohydrate

A) 1 B) 2 C) 3 D) 4 E) 5

6. Which would be considered an inorganic molecule?

A) carbohydrate B) lipids
C) protein D) water

7. If no carbohydrate ingestion occurs in the body during a 24-hour period, liver activity provides for the body's needs by

A) emulsification
B) manufacturing more bile
C) converting glycogen into glucose
D) releasing iron

8. Which compound is a polysaccharide?

A) glucose B) maltase
C) ribose D) starch

9. In humans, excess glucose is stored as the polysaccharide known as

A) glycogen B) glycerol
C) maltose D) cellulose

10. Glycogen is best described as a

A) complex carbohydrate that is often stored in red blood cells
B) complete protein necessary for the synthesis of cell membranes
C) polysaccharide that is synthesized and stored within the human liver
D) by-product of sucrose digestion within the pancreas

11. What are the end products of the hydrolysis of a polysaccharide?

A) simple sugars B) amino acids
C) fatty acids D) nucleotides

12. Base your answer to the following question on the types of molecules in the list below and on your knowledge of biology.

Types of Molecules
(*A*) Amino acid
(*B*) Fatty acid
(*C*) Monosaccharide
(*D*) Glycerol

Which types of molecules are used for the synthesis of a lipid?

A) *A* and *B* B) *B* and *D*
C) *A* and *C* D) *C* and *D*

13. Which procedure would be part of a laboratory investigation designed to determine if a specific nutrient is present in a food?

A) test a moist sample of the food with pH paper
B) add Lugol's iodine solution to a sample of the food
C) place a sample of the food in a test tube containing methylene blue
D) add bromthymol blue to a sample of the food

Lesson 5: Lipids **Date:_____**

Objective: To describe the function and structure of lipids

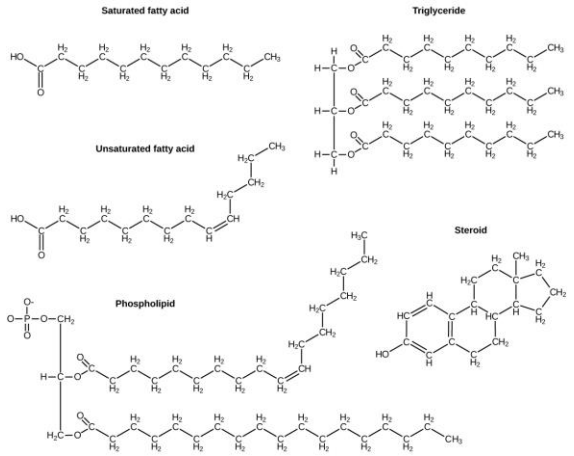
Lipids are another type of organic molecule essential to the life processes of all living things. Remember that organic means they contain carbon (C) and hydrogen (H) atoms. A lipid molecule consists of 1 glycol molecule bonded to 3 fatty acids. These large molecules are repeated over and over to form very long chains. When you think of **fats**, you should know that they are lipids. **Lipids** are also used by organisms to make steroids and waxes. Cell membranes are made out of **phospholipids.**

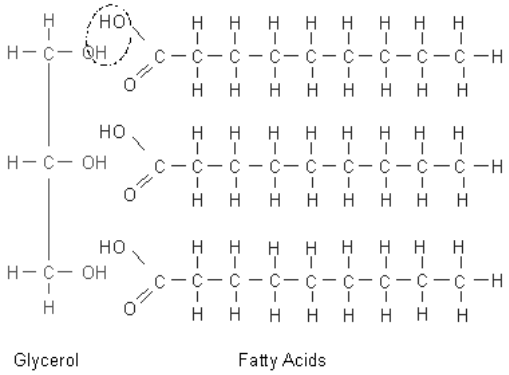
There are two kinds of fats (lipid), saturated and unsaturated. **Unsaturated fats** have at least one double bond in one of the fatty acids. They are much stronger than single bonds with only two electrons. Olive oil, nuts and avocado's contain unsaturated fats. **Saturated** fats have no double bonds and are solids at room temperature. Saturated fats are found mostly in animal products (meat cheese and milk) and foods fried in some plant oils. Saturated fats can raise blood cholesterol levels, and ultimately increase the risk of both heart disease and stroke.

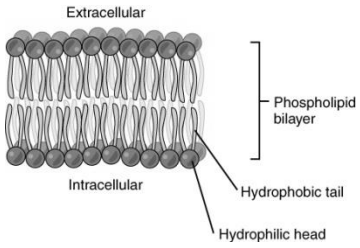
Fats have a lot of energy stored up in their molecular bonds. That's why the human body stores fat as an energy source. When you have extra sugars in your system, your body converts them into fats. When it needs extra fuel, your body breaks down the fat and uses the energy. Where one molecule of sugar only gives a small amount of energy, a fat molecule gives off many times more energy.

Steroids are found in animals within something called hormones. The basis of a steroid molecule is a lipid. You may have heard of steroids in the news. Many bodybuilders and athletes have used anabolic steroids to build muscle mass. Steroids are also used in necessary medicines. Some help people with acne, while others are used as muscle relaxers for injuries.

Waxes are used to coat and protect things in nature. Bees make wax. It can be used for structures, such as the bees' honeycombs. Your ears make wax. It is used to protect the inside of your ear. Plants use wax to stop evaporation of water from their leaves. There is a compound called **cutin** that you can find in the plant cuticle covering the surface of leaves. It helps to seal and protect plant structures.







Check your Understanding:

1. List 3 foods that contain mostly lipids.

2. What structure in living organisms is made of a phospholipid?

.

Practice:

1. Which organic compound is produced when three fatty acid molecules bond to one glycerol molecule?

   A) glycogen B) ATP
   C) PGAL D) a lipid

2. Base your answer to the following question on the types of molecules in the list below and on your knowledge of biology.

   Types of Molecules
   (*A*) Amino acid
   (*B*) Fatty acid
   (*C*) Monosaccharide
   (*D*) Glycerol

   Which types of molecules are used for the synthesis of a lipid?

   A) *A* and *B* B) *B* and *D*
   C) *A* and *C* D) *C* and *D*

3. In a lipid synthesis reaction, the greatest number of fatty acid molecules that could combine into one glycerol molecule is

   A) 1 B) 2 C) 3 D) 6

4. In living organisms, lipids function *mainly* as

   A) sources of stored energy and transmitters of genetic information
   B) transmitters of genetic information and catalysts of chemical reactions
   C) sources of stored energy and components of cellular membranes
   D) catalysts of chemical reactions and components of cellular membranes

5. Vegetable oils, such as corn oil, belong to which general class of organic substances?

   A) lipids B) proteins
   C) carbohydrates D) salts

6. In living organisms, lipids function mainly as

   A) sources of stored energy and transmitters of genetic information
   B) sources of stored energy and components of cellular membranes
   C) transmitters of genetic information and catalysts of chemical reactions
   D) catalysts of chemical reactions and components of cellular membranes

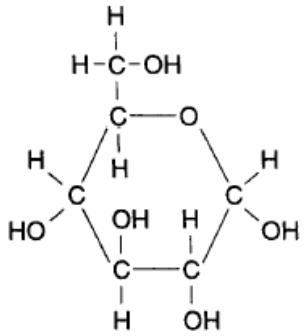
7. Saturated molecules of this nutrient, which may predispose humans to cardiovascular disease, are solid a room temperature.

   A) Lipids B) Carbohydrates
   C) Minerals D) Proteins
   E) Vitamins

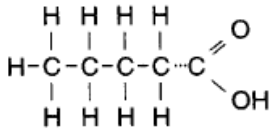
8. The brown paper test for lipids is positive when food is placed on the paper and a spot forms which will allow light to pass through it. Which food would give the strongest positive test for lipids?

   A) flour B) lima beans
   C) peanut butter D) rice

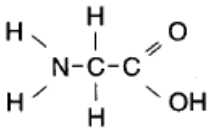
9. The diagrams below represent four different molecules.



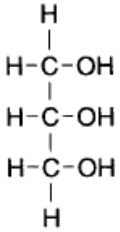
A



B



C



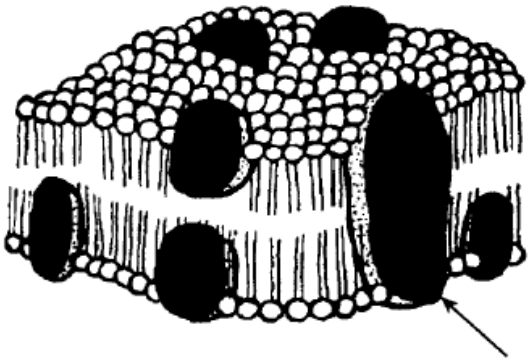
D

Which two diagrams represent the building blocks of lipids?

A) *A* and *B* B) *B* and *D* C) *C* and *D* D) *A* and *C*

---

10. The diagram below represents the fluid-mosaic model of a cell membrane.



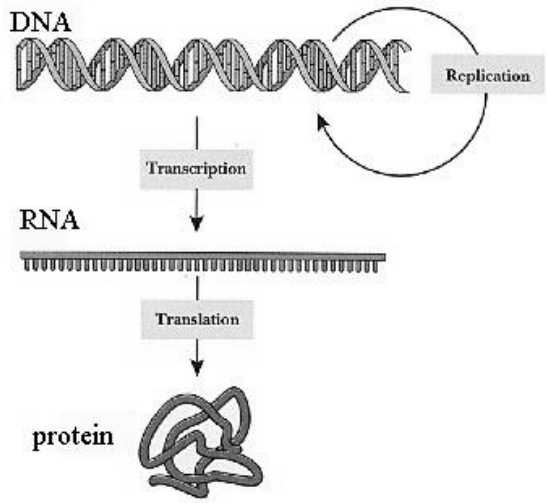
The arrow points to a component of the membrane that is best described as a

A) sugar floating in lipids
B) protein floating in lipids
C) lipid floating in proteins
D) lipid floating in sugars

11. Which substances are produced by the hydrolysis of an oil?

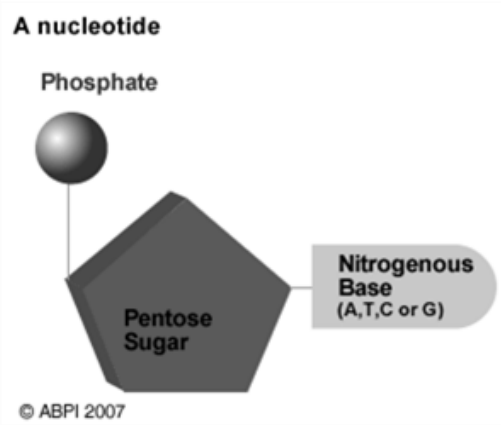
A) water and nucleic acids
B) amino acids and dipeptides
C) fatty acids and glycerol
D) glucose and water

Lesson 6: Nucleic Acids **Date:_____**



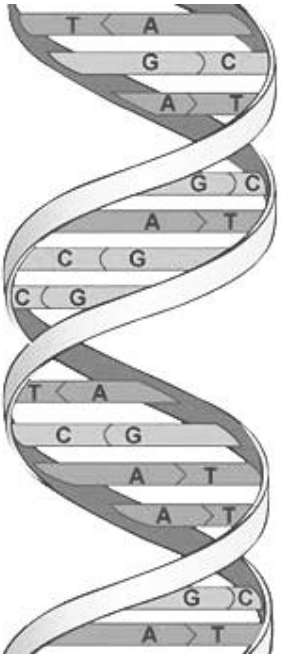
Living organisms are complex systems. Hundreds of thousands of proteins exist inside each one of us to help carry out our daily functions. These proteins are produced within cells and assembled piece-by-piece to exact specifications. The information detailing the specific structure of the proteins inside of our bodies is stored in a set of molecules called **nucleic acids.**

There are two types of nucleic acids, DNA and RNA. Both control protein synthesis and are stored in the nucleus of every cell. This diagram shows how DNA is used to make RNA which is then used to make protein.



Both DNA and RNA are composed of repeating units called nucleic acids or nucleotides. A **nucleotide** has three parts; a sugar molecule, a phosphate molecule and a nitrogenous base. Though the building block of DNA and RNA is the same, the sugar and bases of their nucleotides differ.

DNA is the "master copy" of instructions in a cell for protein synthesis. If the DNA in a cell were changed, protein synthesis in the cell would be affected. This is why DNA is stored in the nucleus and never leaves.



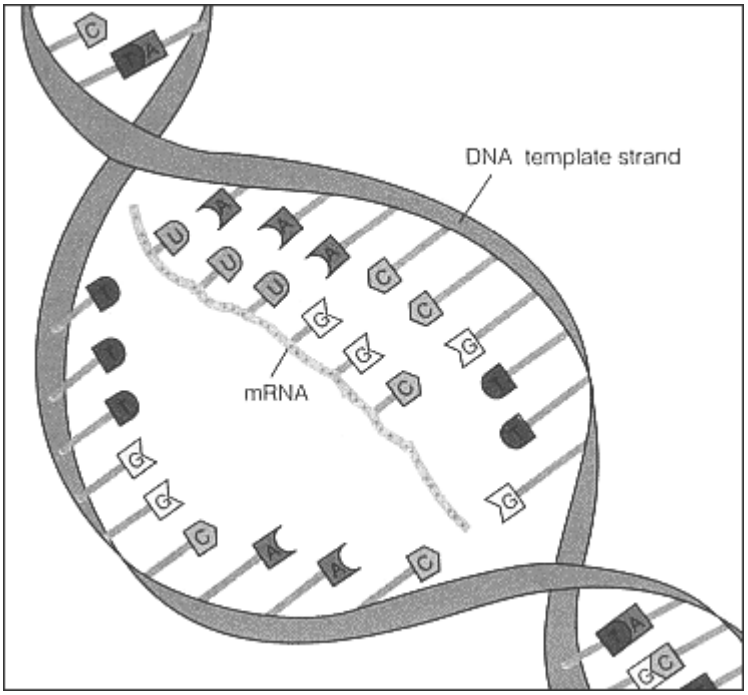
DNA is referred to as a "double helix" because it is a double stranded chain of nucleotides that is twisted like a spiral staircase. Each nucleotide contains the sugar deoxyribose, hence why DNA is named ***deoxyribonucleic acid***. Each DNA nucleotide contains one of four nitrogenous bases (adenine, thymine, cytosine or guanine).

The shape of DNA resembles the shape of a ladder- two sides connected to each other by rungs. The side consists of alternating sugar and phosphate molecules. The rungs of the ladder consist of two bases bonded together. Adenine always bonds with thymine. Guanine always bonds with cytosine. This is called **the law of base pairing.**

The structure of DNA was discovered **by James Watson and Francis Crick** in the 1950's. Interestingly, no two people have the same sequence of bases, except identical twins. Humans have 46 chromosomes in the nucleus of every cell in their body. Each chromosome is a tightly coiled strand of DNA. If the entire DNA in a cell were stretched out end to end, it would be about 4 centimeters long and billions of base pairs long.

RNA is a “blueprint” copy of DNA. It job is to leave the nucleus and take the instructions for protein synthesis to an organelle called the ribosome that manufacture the protein. This diagram shows how DNA untwists to make a type of RNA called mRNA.

RNA is a single strand of nucleotides. Each nucleotide contains the sugar ribose, hence why is called *ribonucleic acid*. Each RNA nucleotide contains one of four nitrogenous bases (adenine, uracil, cytosine or guanine). There are two types of RNA;mRNA and tRNA. These molecules have the ability to bond together during protein synthesis following the law of base pairing. Since RNA does contain thymine, adenine bonds with uracil.



Check your understanding:

1. What is the chemical composition of nucleic acids?

2. What is the function of nucleic acids?

3. Please state which nitrogenous bases bonds with which in DNA

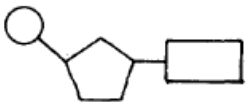
4. Please state which nitrogenous bases bonds with which in RNA?

Practice:

1. Which substances are produced by the hydrolysis of an oil?

   A) water and nucleic acids
   B) amino acids and dipeptides
   C) fatty acids and glycerol
   D) glucose and water

2. The diagram below represents the building block of a large molecule known as a



   A) protein B) fatty acid
   C) carbohydrate D) nucleic acid

3. Plants store carbohydrates in the form of

   A) amino acids B) fatty acids
   C) starch D) nucleic acids

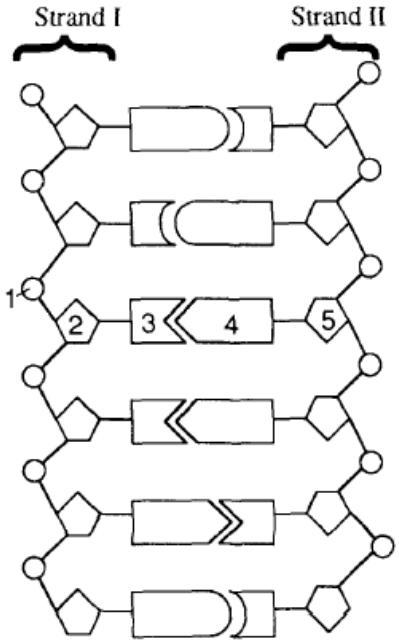
4. All enzymes are examples of organic molecules known as

   A) proteins B) carbohydrates
   C) lipids D) nucleic acids

5. Which organic molecule is correctly paired with an end product of its digestion?

   A) nucleic acid-glycerol
   B) carbohydrate-fatty acid
   C) protein-amino acid
   D) lipid-nucleotide

6. Base your answer to the following question on the diagram below and on your knowledge of biology.



   Structures 1, 2, and 3 make up a

   A) nucleic acid B) ribosome
   C) nucleolus D) nucleotide

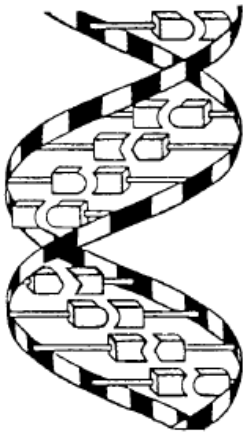
7. What are the end products of the hydrolysis of a polysaccharide?

   A) simple sugars B) amino acids
   C) fatty acids D) nucleotides

8. What are the basic structural units of a DNA molecule?

   A) glucose molecules B) amino acids
   C) lipids D) nucleotides

9.



In the diagram of a polymer above, the repeating subunits are known as

A) amino acids
B) polysaccharides
C) nucleotides
D) fatty acids

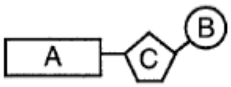
10. The basic unit of the DNA molecule is

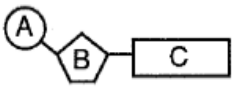
A) a nucleotide
B) an amino acid
C) a phosphate group
D) a nitrogen base

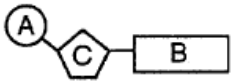
11. The parts of a DNA nucleotide are indicated in the chart below by letters *A*, *B*, and *C*, An X indicates which chemical elements are present in each part.

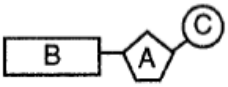
DNA Nucleotide Parts	Elements				
	C	O	H	N	P
A		X	X		X
B	X	X	X		
C	X	X	X	X	

Which diagram best represents a DNA nucleotide.

A)


B)


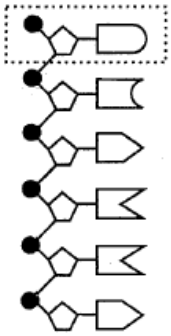
C)


D)


12. A DNA nucleotide may contain

A) deoxyribose, cytosine, and a lipid
B) deoxyribose, thymine, and a phosphate group
C) ribose, uracil, and a polypeptide
D) ribose, adenine, and thymine

13. Base your answer to the following question on the diagram below and on your knowledge of biology. The diagram represents a portion of a strand of a DNA molecule.



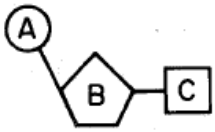
The entire structure enclosed within the dotted line represents a

A) deoxyribose molecule
B) nitrogenous base
C) phosphate
D) nucleotide

14. A DNA nucleotide is composed of

A) carbon, hydrogen, oxygen, nitrogen, and phosphorus
B) carbon, hydrogen, nitrogen, sulfur, and calcium
C) calcium, hydrogen, oxygen, phosphorus, and iron
D) oxygen, hydrogen, phosphorus, sulfur, and iron

15. Which is the correct identification of the parts of the DNA nucleotide in the diagram below?



A) *A* = uracil, *B* = deoxyribose, *C* = thymine
B) *A* = phosphate, *B* = ribose, *C* = uracil
C) *A* = thymine, *B* = ribose, *C* = uracil
D) *A* = phosphate, *B* = deoxyribose, *C* = thymine

16. Which is the sugar component of a DNA nucleotide?

A) adenine
B) deoxyribose
C) glucose
D) phosphate

Lesson 7: Proteins **Date:_____**

Objective: To describe the structure and function of proteins

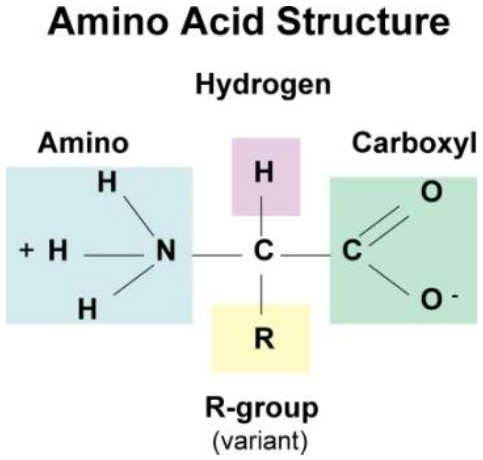
Amino acids are used in every cell of your body to build the proteins you need to survive. All organisms need some proteins, whether they are used in muscles or in simple structures in the cell membrane. Amino acids have a two-carbon bonds; one of the carbons is part of a group called the **carboxyl group** (COO^-). A **carboxyl group** is made up of one carbon (C) and two oxygen (O) atoms. The second carbon is connected to the **amino group** or the **R group**. The main difference among the different amino acids is in their R groups. The difference among the amino acid R groups gives different proteins different shapes and function.

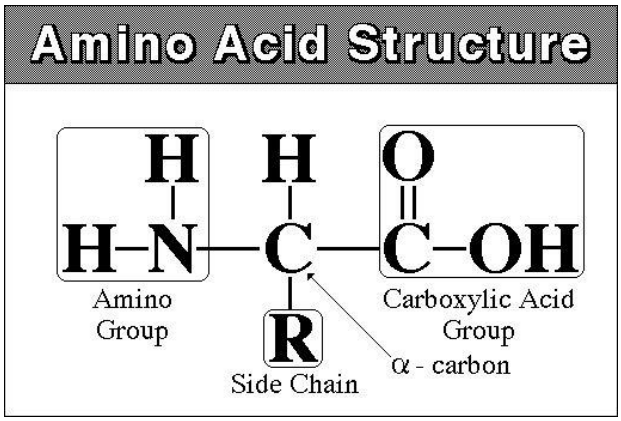
Even though scientists have discovered over 50 amino acids, only 20 are used to make proteins in your body. Of those twenty, nine are defined as **essential amino acids**. This means that your body cannot make them, you must ingest them. The other eleven can be synthesized by an adult body. Amino acids bond together to make long chains, these long chains of amino acids are also called proteins. Thousands of combinations of those twenty amino acids are used to make all of the proteins in your body.

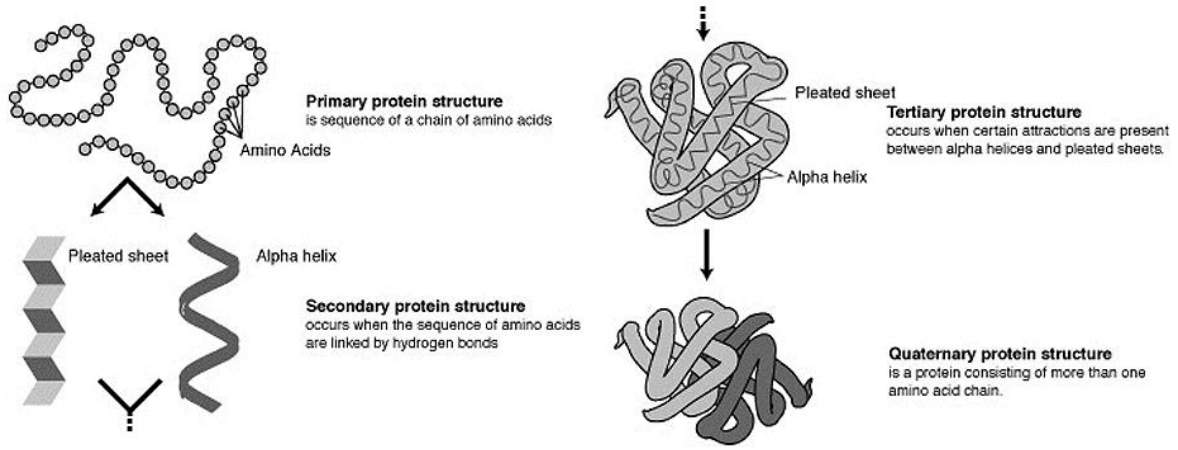
Proteins are organic compounds composed mainly of carbon, hydrogen, oxygen, and nitrogen. They are formed from the bonding of amino acids into long chains. These chains then fold over and over again until they are a certain shape. The shape of a protein determines its function. Depending on their shape, proteins have many functions including making bones, cell repair and growth, regulating cell processes, cell structures, and movement. **Enzymes** are made out of protein and they regulate the bodies' life functions. Red blood cells, muscles, enzymes, skin and hair are all made out of protein.

There are two basic groups of proteins are either; **hydrophobic**, they repel water or **hydrophilic** meaning water loving. These characteristics play a role in protein folding. Even though a protein can be very complex, it is basically a long chain of amino acid subunits all twisted around like a knot or "folded" into shape. When a protein unfolds, it is called denaturing and the protein is no longer able to do its job. Denaturing of proteins occurs with changes in pH and temperature.

Protein, containing essential amino acids can be found in foods like meat, cheese, fish, nuts and soy products.







Check your understanding:

1. List 3 foods that contain mostly proteins.

2. List 3 ways that living creatures use proteins.

3. Give 3 examples of proteins in living organisms.

4. Proteins are chains of what smaller organic molecule?

5. How many different amino acids are there?

Practice:

1. Fatty acids and amino acids both contain

   A) alcohol B) glycerol
   C) simple sugars D) carboxyl groups

2. In some regions of the world, children suffer from a protein deficiency known as kwashiorkor. This deficiency occurs when a child's diet is changed from high-protein breast milk to watery cereal. Even though the child is receiving calories, the child becomes sick and less active, and growth ceases. These symptoms are probably due to

   A) too many nucleic acids in the diet
   B) an overconsumption of complete protein foods
   C) not enough carbohydrates in the diet
   D) a lack of essential amino acids in the diet

3. Two proteins in the same cell perform different functions. This is because the two proteins are composed of which of the following?

   A) chains folded the same way and the same sequence of simple sugars
   B) chains folded the same way and the same sequence of amino acids
   C) chains folded differently and a different sequence of simple sugars
   D) chains folded differently and a different sequence of amino acids

4. What is the shape of a protein molecule influenced by?

   A) whether it is organic or inorganic
   B) changes in temperature or pH
   C) the number of genes found in the nucleus
   D) the number of chromosomes in the cell

5. Base your answer to the following question on the information below and on your knowledge of biology.

   A solution of an enzyme normally found in the human body was added to a flask containing a solution of proteins in distilled water, and then the flask was stoppered. This mixture was then maintained at a temperature of 27°C and a pH of 7 for 48 hours. When the mixture was analyzed, the presence of amino acids was noted.

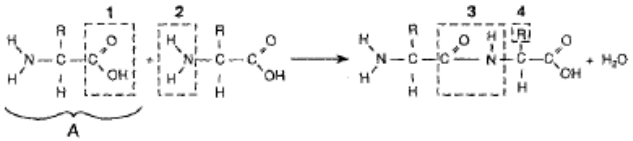
   Which substances would most likely be present in the solution in the flask after 48 hours?

   A) amino acids, only
   B) amino acids and polypeptides, only
   C) polypeptides, amino acids, and enzyme molecules
   D) polysaccharides, amino acids, and enzyme molecules

6. What are proteins ingested by animals immediate sources of?

   A) glucose B) cellulose
   C) fatty acids D) amino acids

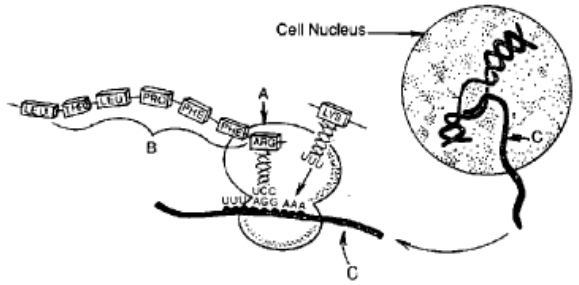
7. Base your answer to the following question on the chemical reaction represented below and on your knowledge of biology.



   Molecule *A* is classified as

   A) a fatty acid B) a monosaccharide
   C) an amino acid D) a nucleotide

8. Base your answer to the following question on the diagram below and on your knowledge of biology. The diagram illustrates some of the steps in the synthesis of proteins.



The chain of molecules at letter *B* is

A) a polysaccharide B) a polypeptide
C) an amino acid D) a nucleic acid

9. The function of most proteins depends primarily on the

A) type and order of amino acids
B) environment of the organism
C) availability of starch molecules
D) nutritional habits of the organism

10. The bond that joins two amino acids together is known as

A) a double bond B) a hydrogen bond
C) an ionic bond D) a peptide bond

11. What occurs during the digestion of proteins?

A) Specific enzymes break down proteins into amino acids.
B) Specific hormones break down proteins into simple sugars.
C) Specific hormones break down proteins into complex starches.
D) Specific enzymes break down proteins into simple sugars.

12. What is the name of the bond linking amino acids together?

A) Ionic bond
B) Phosphodiester bond
C) Glycosidic bond
D) Peptide bond

Lesson 8: Chemical Reactions Date:_____

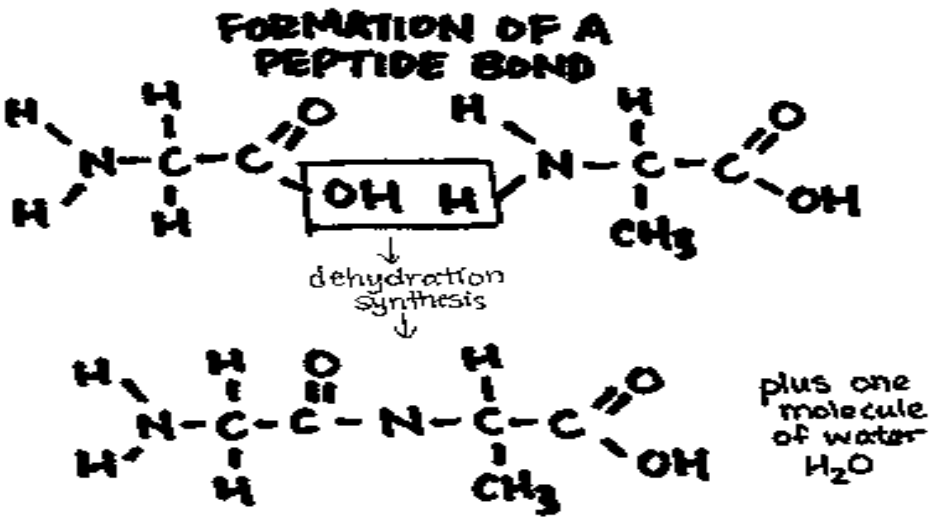
Objective: To compare and contrast the making and breaking of chemical bonds

Watch this! Dehydration synthesis and hydrolysis

When you hear the word Dehydration what do you think of?

- ***Synthesis means "to make"***
- ***Dehydrate means "to remove water"***

Dehydration Synthesis- A larger molecule is made from smaller ones and water (H20) is removed.



In the picture to the left please describe what is happening?

_____

_____

_____

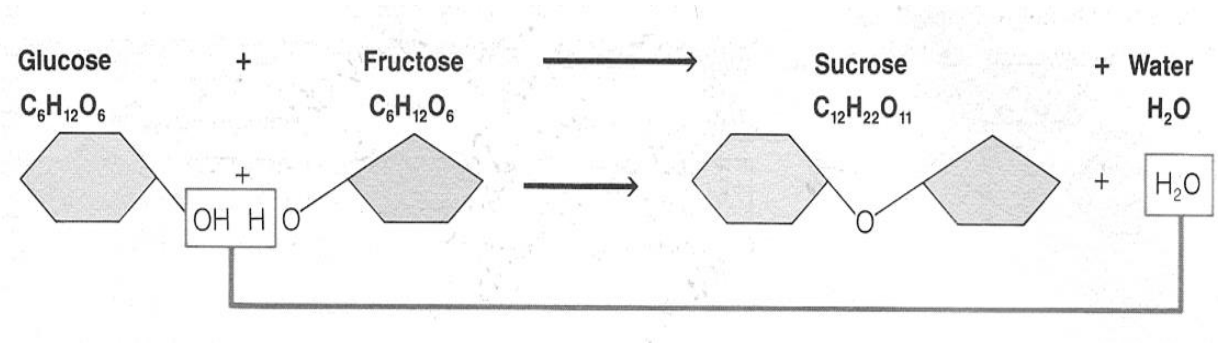
_____

_____

In the picture below how are you making a disaccharide?

_____

_____



Hydrolysis

When you hear the word hydrolysis what do you think of?

- ***Hydro means "water"***
- ***Lysis means "to split"***

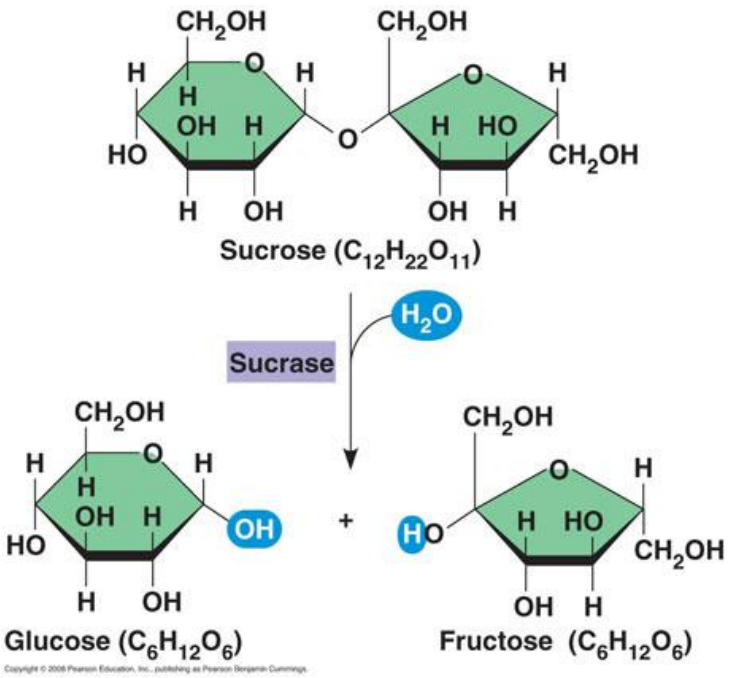
***<u>Hydrolysis</u>*- The opposite of dehydration synthesis**. Water is added to break apart a large molecule into smaller ones.

Describe how a monosaccharide is made in the picture below.

_____

_____

_____



<u>Check your understanding:</u> Fill in the blanks using proper vocabulary.

During _____bonds are created by the removal of a _____molecule. To break a bond water must be_____. This is the process of _____.

Practice:

1. A disaccharide combines with water to produce two monosaccharides in the process known as

   A) hydrolysis
   B) dehydration synthesis
   C) aerobic respiration
   D) photosynthesis

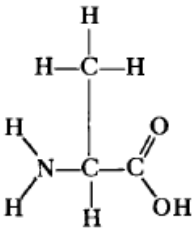
2. A by-product of dehydration synthesis is

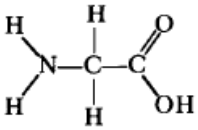
   A) urea B) water
   C) carbon dioxide D) mineral salt

3. The hydrolysis of maltose is catalyzed by

   A) glucose B) water
   C) maltase D) protease

4. Base your answer to the following question on the two compounds whose formulas are shown below.





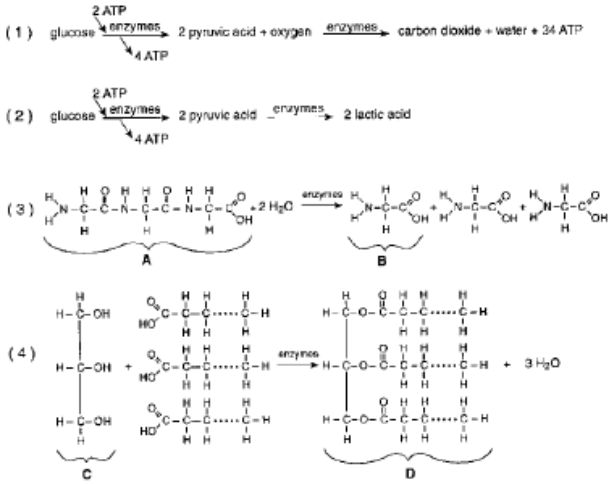
When the two molecules are joined together chemically, a molecule of water is released. This process is known as

   A) dehydration synthesis
   B) hydrolysis
   C) absorption
   D) transpiration pull

5. What are the end products of the hydrolysis of a polysaccharide?

   A) simple sugars B) amino acids
   C) fatty acids D) nucleotides

6. Base your answer to the following question on the reactions below and on your knowledge of biology.



Which reaction represents the process of dehydration synthesis?

   A) 1 B) 2 C) 3 D) 4

7. In plants, a storage product that results from the dehydration synthesis of many glucose molecules is

   A) protein B) a phosphate
   C) an oil D) starch

8. Which factor does not alter the rate of hydrolysis of maltose?

   A) temperature of the environment of the reaction
   B) pH of the environment of the reaction
   C) size of the substrate molecule
   D) number of enzyme molecules present

9. Which process is indicated by the equation below?

$$C_6H_{12}O_6 + C_6H_{12}O_6 \xrightarrow{\text{Enzymes}} C_{12}H_{22}O_{11} + H_2O$$

   A) hydrolysis
   B) osmosis
   C) decomposition
   D) dehydration synthesis

10. Enzymes which speed up the hydrolysis of fats are known as

   A) amylases B) lipases
   C) maltases D) proteases

Objective: To define an enzyme and relate its structure to function

Each chemical reaction that occurs in a living thing is controlled by an enzyme. **Enzymes** are large, complex protein molecules that control the rate of chemical reactions. Enzymes are the organic catalysts in cellular chemical reactions. In chemistry a **catalyst** is something that speeds up or slows down a chemical reaction. Catalysts are neither permanently changed nor used up by the reaction they catalyze. In organisms, enzymes allow the chemical reactions of metabolism to take place more efficiently than they otherwise would at body temperature. For example, amino acids are produced from protein digestion. The enzymes needed for this reaction are not changed but must be present for the reaction to occur.

Some enzymes have a non-protein part called a **coenzyme**. Many coenzymes are vitamins. If a vitamin is missing from the human body, a certain enzyme cannot function. If an enzyme doesn't function, one or more metabolic reactions cannot occur. This is one of the reasons why it is important that you eat a well-balanced diet every day. Without the coenzymes (vitamins) needed by the body, the chemical processes necessary for proper metabolism cannot take place.

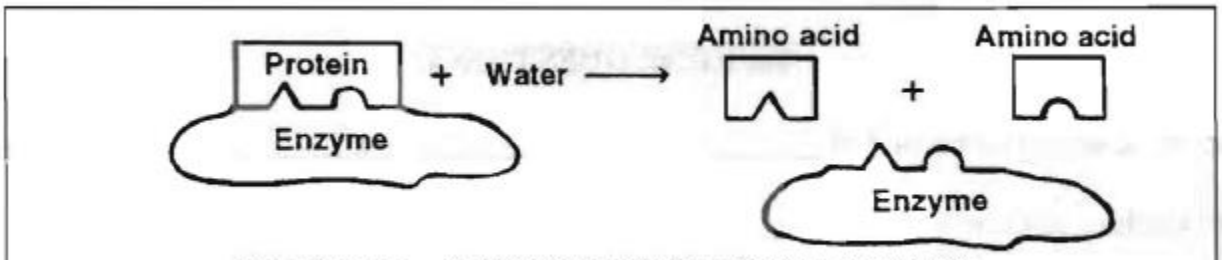
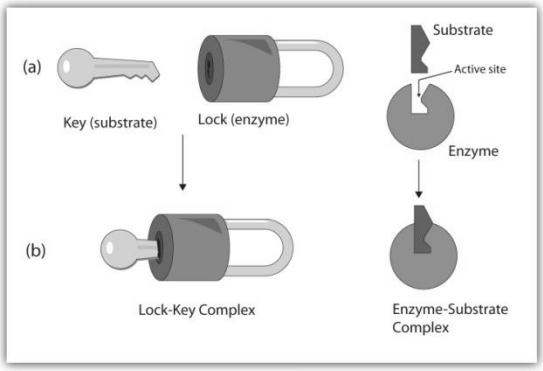


FIGURE 6-11. AN ENZYME-CATALYZED REACTION.

Enzymes are highly specific in their catalytic activity. The specificity of enzyme action is the result of a **"lock-and-key"** arrangement in which the enzyme and the substance it reacts with (the substrate) join together to form an **enzyme-substrate complex**.

When a reaction is completed, the enzyme and the newly formed reaction products separate, leaving the enzyme unchanged. Enzymes are highly efficient catalysts. Only small quantities are needed to catalyze the reaction of relatively large amounts of materials. They are always reused by the cell. Each enzyme has an optimum range of temperature and pH at which it operates most efficiently. Any change in pH or temperature reduces the speed at which the enzyme works and functions of the enzyme. Too great a change in pH and/or temperature and the enzyme wills top working. It is then considered to be **denatured,** meaning that its shape has been changed. If it does not have the proper shape, it cannot function!



Check your understanding:

1. Why does the body need enzymes?

2. What organic molecule are enzymes made of?

3. What does the term “lock and key” refer to?

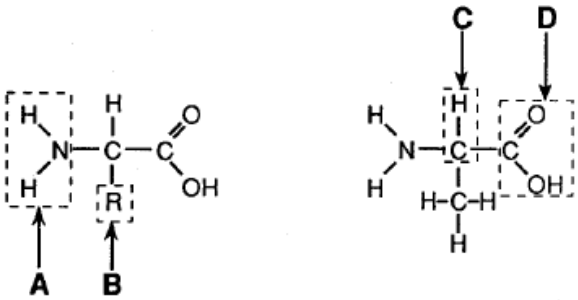
4. How can an enzyme be denatured?

Practice:

1. Which group contains only molecules that are each assembled from smaller organic compounds?

   A) proteins, water, DNA, fats
   B) proteins, starch, carbon dioxide, water
   C) proteins, DNA, fats, starch
   D) proteins, carbon dioxide, DNA, starch

2. Base your answer to the following question on the structural formulas below of two molecules with chemical groups labeled *A*, *B*, *C*, *D* and on your knowledge of biology.



   The structural formulas represent the type of molecules that are building blocks of all

   A) carbohydrates B) nucleic acids
   C) lipids D) proteins

3. All enzymes are examples of organic molecules known as

   A) proteins B) carbohydrates
   C) lipids D) nucleic acids

4. Which statement concerning proteins is not correct?

   A) Proteins are long, usually folded, chains.
   B) The shape of a protein molecule determines its function.
   C) Proteins can be broken down and used for energy.
   D) Proteins are bonded together, resulting in simple sugars.

5. What are proteins ingested by animals immediate sources of?

   A) glucose B) cellulose
   C) fatty acids D) amino acids

6. An element found in all proteins but not found in carbohydrates and lipids is

   A) carbon B) hydrogen
   C) oxygen D) nitrogen

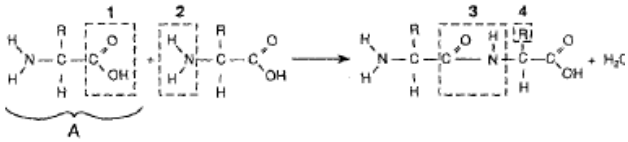
7. What occurs during the digestion of proteins?

   A) Specific enzymes break down proteins into amin acids.
   B) Specific hormones break down proteins into simp sugars.
   C) Specific hormones break down proteins into complex starches.
   D) Specific enzymes break down proteins into simpl sugars.

8. The electron microscope has revealed that the cell membrane is composed of layers of

   A) starch and sugar B) starch and protein
   C) sugar and lipid D) protein and lipid

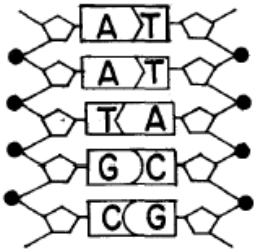
9. Base your answer to the following question on the chemical reaction represented below and on your knowledge of biology.



   Which kind of compound can be produced using mar the types of organic molecules represented in the dia

   A) disaccharide
   B) protein
   C) ribonucleic acid
   D) deoxyribonucleic acid

10. Base your answer to the following question on the diagram below which represents a segment of a DN molecule and on your knowledge of biology.



   This DNA molecule acts as a template for RNA construction in the process of

   A) gene replication B) protein synthesis
   C) osmosis D) synapsis

11. Every living cell contains molecules of

   A) cellulose B) chlorophyll
   C) protein D) hemoglobin

12. Which organic molecule is correctly paired with an end product of its digestion?

    A) nucleic acid-glycerol
    B) carbohydrate-fatty acid
    C) protein-amino acid
    D) lipid-nucleotide

13. The correct order of molecules involved in protein synthesis is

    A) messenger RNA, transfer RNA, DNA, polypeptide
    B) DNA, messenger RNA, polypeptide, transfer RNA
    C) transfer RNA, polypeptide, DNA, messenger RNA, DNA
    D) DNA, messenger RNA, transfer RNA, polypeptide

14. The instructions for the synthesis of a particular protein are carried from the nucleus of a cell to the cytoplasm by

    A) DNA molecules B) ribosomes
    C) polypeptides D) messenger RNA

15. What is the relationship between an organism's DNA and protein specificity?

    A) DNA becomes a specific part of the protein structure.
    B) DNA determines the ribosomal RNA sequence that becomes part of the protein structure.
    C) DNA determines which RNA molecules are incorporated into protein molecules.
    D) DNA determines the amino acid sequence of each protein.

16. Enzymes are a type of

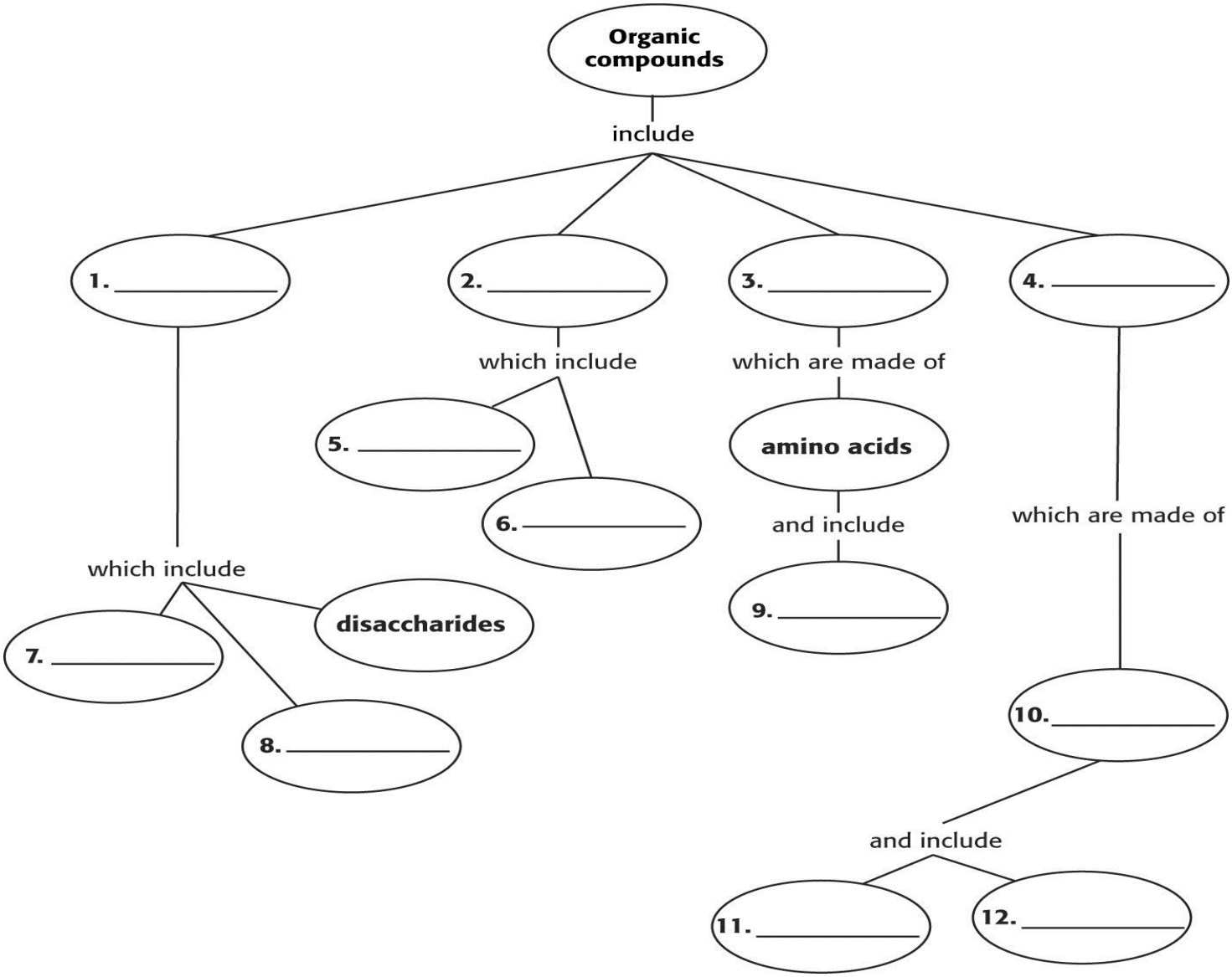
    A) Carbohydrate B) Protein
    C) Nucleotide D) Fatty acid

17. The function of most proteins depends primarily on the

    A) type and order of amino acids
    B) environment of the organism
    C) availability of starch molecules
    D) nutritional habits of the organism

Sum it up! Using the terms provided below, complete the concept map showing the characteristics of organic compounds.

carbohydrates	lipids	oils
DNA	monosaccharides	polysaccharides
enzymes	nucleic acids	proteins
fats	nucleotides	RNA



Key Concept Synthesis

Directions: Use the following graphic organizer to identify the five most important concepts (in the form of single words or phrases) from your notes. Think about identifying the five most important concepts this way: If you had to explain your notes to someone who had not read them, what are the five most important concepts you would want them to understand? Complete the graphic organizer below.

Five Key Concepts (with page numbers)	Write the concept in your own words.	Explain why the concept is important and make connections to other concepts.
1.		
2.		
3.		
4.		
5.		

Unit Project: Molecules of Life **Due Date:_____**

Organic polymers must be broken down and reassembled as they are cycled through the food chain. As you are part of this dynamic, your task is to closely examine some of the polymers in your food.

1. Select two food items (not liquids/beverages) which have nutrition labels attached. You will need to turn in these labels along with your assessment of them, so be sure that you can cut them out and keep them.

2. Design a table which compares the values for the carbohydrates, lipids, and proteins contained within the food items. Identify which polymer has the most energy available and describe why it does. Be sure to consider molecular structure in your answer.

3. Use a textbook or other resources; describe one enzymatic reaction that will happen when you eat one of the food items.
   - Be sure to name the enzyme, substrate, and products.
   - Describe what would happen if the enzyme was unavailable. In your description, be sure to consider the role of water in the digestion of polymers.

4. After digestion, your bloodstream will carry the monomers produced to your cells, where new carbohydrates, proteins, and lipids will be built.
   - Describe what will happen during these condensation reactions.
   - For each polymer, describe at least one function it will have within your body.

Turn in both nutrition labels as well as the answers to the above questions.

Scoring Guide:

4	• Student goes beyond the requirements of a "3" to make relevant connections to additional learning.
3	• Student accurately and appropriately uses relevant scientific vocabulary. • Student accurately explains concepts, providing original examples with added details to illustrate his/her understanding.
2	• Not all parts of the answer are present and/or accurate. Some vocabulary is incorrectly used. • Student does not show independent learning; all examples and descriptions are taken from the text or other resource **or** not enough detail is provided to show understanding.
1	• Little or no understanding of concepts demonstrated. Relevant scientific vocabulary is not used or is misused. • Multiple parts of the assessment are incomplete.