

MCAS Biology

Review Packet

Answer Key

THE CHEMISTRY OF LIFE

1. Define organic. **Compounds that contain carbon atoms that are covalently bonded to other elements, typically hydrogen, oxygen, and other carbon atoms.**
2. All living things are made up of **6 essential elements: SPONCH**. Name the six elements of life.
S – sulfur
P – phosphorus
O – oxygen
N – nitrogen
C – carbon
H – hydrogen
3. Elements join together by chemical bonds to form compounds. Name the 3 types of chemical bonds. **Hydrogen bonds, Covalent bonds, Ionic bonds**
4. There are **4 major categories of organic molecules** that are made up of the SPONCH elements. Complete the following chart on the macromolecules of life.

<u>LIPIDS</u>	<u>CARBOHYDRATES</u>
<i>Elements:</i> carbon, hydrogen, oxygen	<i>Elements:</i> carbon, hydrogen, oxygen
<i>Structure:</i> 3 fatty acid chains linked by a glycerol backbone	<i>Structure:</i> monosaccharides (glucose molecules) bonded together in long chains called polysaccharides (starch)
<i>Function:</i> building blocks of the cell membrane and energy storing molecules	<i>Function:</i> key source of energy
<i>Examples:</i> steroids like cholesterol & fats	<i>Examples:</i> sugar and starch
<u>PROTEINS</u>	<u>NUCLEIC ACIDS</u>
<i>Elements:</i> carbon, hydrogen, oxygen, nitrogen	<i>Elements:</i> carbon, hydrogen, oxygen, nitrogen, phosphorus
<i>Structure:</i> amino acids are bonded in long chains that coil around each other into specific shapes called proteins	<i>Structure:</i> long chain of nucleotides bonded together
<i>Function:</i> some proteins are enzymes (speed up reactions) some are structural (hair, muscle, skin, tendons, etc) and some are antibodies (protect body from infection)	<i>Function:</i> some nucleic acids are DNA (store hereditary information) and some are RNA (aid in building proteins)
<i>Examples:</i> enzymes, collagen, antibodies	<i>Examples:</i> DNA, RNA

5. Define chemical reaction. **The process during which chemical bonds between atoms are broken and new ones are formed, producing one or more different substances.**

6. Write an example of a chemical reaction and label the reactants and products.



7. Define activation energy. **The energy needed to start a chemical reaction**

8. Define enzyme. **Proteins that increase the speed of a chemical reaction**

9. How does an **enzyme affect the activation energy** for a chemical reaction? **Enzymes are catalysts; they reduce the activation energy needed for a chemical reaction to take place.**

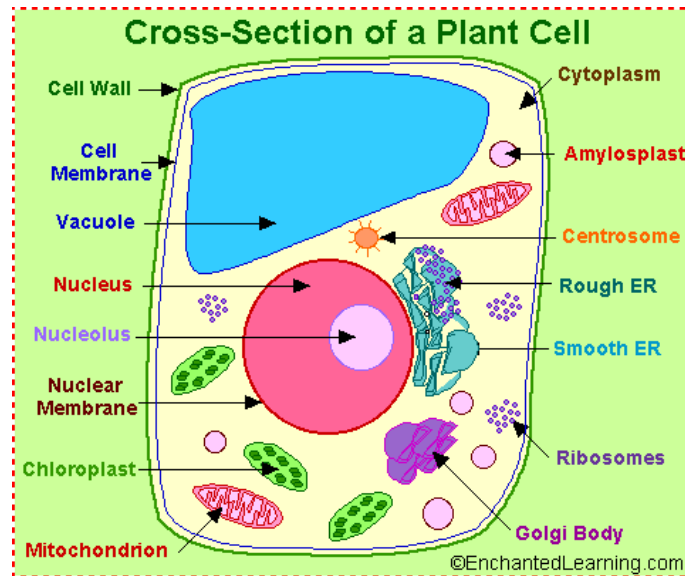
10. **Any factors that affect the shape of an enzyme affect the enzyme's activity.** What effect does pH and temperature have on an enzymes ability to catalyze (speed up) a reaction? **Enzymes work well within very specific ranges of pH and temperature. If the pH or temperature changes to outside of the range, the enzyme shape changes and thus no longer works to speed up the reaction.**

CELL BIOLOGY

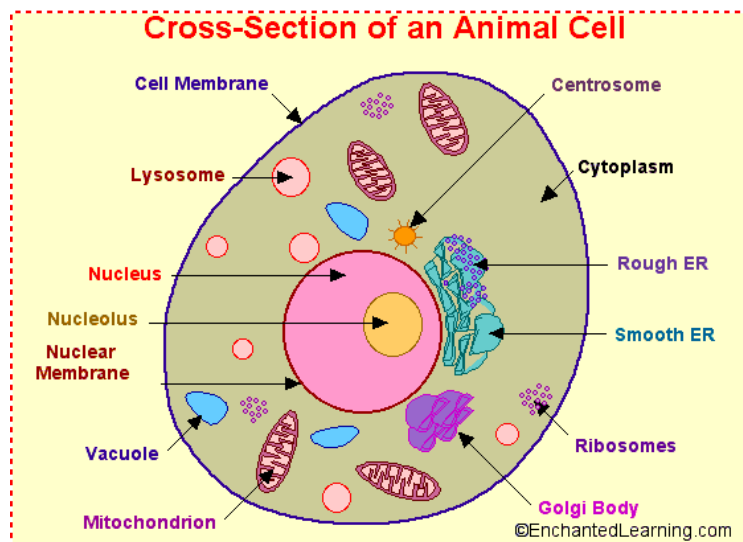
1. Draw a plant and animal cell and label the following parts:

- Cell (plasma) membrane
- nuclear envelope
- nucleus
- nucleolus
- cytoplasm
- mitochondria
- endoplasmic reticulum
- golgi apparatus
- lysosome
- ribosome
- vacuole
- cell wall
- chloroplast
- cytoskeleton
- centriole

Plant Cell



Animal Cell



2. Complete the table below

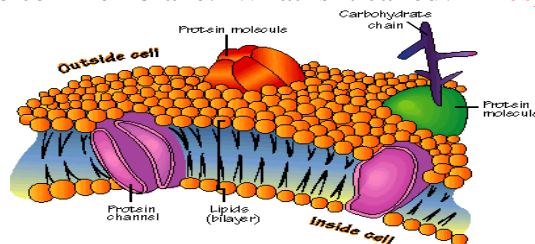
Cell Part	Function (job)	Plant, Animal or Both
Plasma Membrane	Encloses the cell & separates the cytoplasm from its surrounding; regulates what enters & leaves the cell	Both
Nuclear envelope	Separates the nucleus from the cytoplasm	Both
Nucleus	Is the control center of the cell; stores DNA & makes mRNA	Both
Nucleolus	Located inside the nucleus, mRNA are made here	Both
Cytoplasm	Interior part of the cell made up of fluid that cushions all the organelles	Both
Mitochondria	Provides energy to the cell	Both
Endoplasmic reticulum	Processes & modifies proteins that were made in the nucleolus	Both
Golgi apparatus	Packages proteins into vesicles for export throughout the cell	Both
Lysosome	Contain digestive enzymes to clean up the cell	Both
Ribosome	Aid in protein synthesis	Both
Vacuole	Help digestion of materials	Both
	Store nutrients & keeps cell pressure	Plant
Cell wall	Supports & maintains shape, protects cell from damage, connects nearby cells	Plant
Chloroplast	Use light energy to make food (carbohydrates) through photosynthesis	Plant
Cytoskeleton	Helps to maintain cell shape & aids in movement of materials in the cell	Both
Centriole	Helps the formation of the spindle to move chromosomes during mitosis	Animal

3. Explain the differences between a prokaryote and a eukaryote. Give examples of each.

Prokaryotes are cells with no true nucleus, no organelles, reproduce asexually, and are very small. An example is bacteria.

Eukaryotes are cells with a true nucleus, organelles, can reproduce either asexually or sexually, and are fairly large. Examples are plants, animals, protists, fungi.

4. Draw the structure of the cell membrane. What is it called? **Phospholipid bilayer**

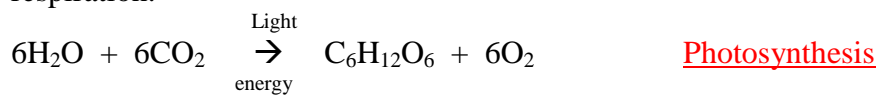


5. Explain how diffusion, osmosis, and facilitated diffusion work. Be sure to know which way water flows across a membrane.

- Diffusion – a type of passive transport across membranes that does not require energy; particles move from areas of high concentration to areas of low concentration
- Osmosis – a type of passive transport across membranes that does not require energy; WATER molecules move from areas of high concentration to areas of low concentration
- Facilitated Diffusion – a type of passive transport across membranes that does not require energy; with the help of a carrier protein particles move from high to low concentration

6. What are the 6 kingdoms of life? Eubacteria, Archaeobacteria, Protista, Fungi, Plants, Animals

7. Identify which formula represents photosynthesis and which formula represents cellular respiration.



8. Define photosynthesis. The process that captures the sunlight's energy in the chloroplast of plant cells and converts it to glucose (sugar), the food for life

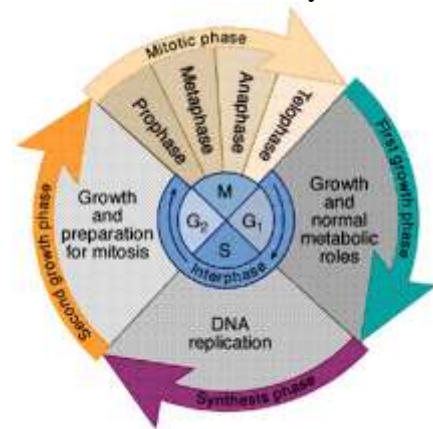
9. Define cellular respiration. The process that breaks down glucose to make energy for the cells to use.

10. How are photosynthesis and cellular respiration related? Cellular respiration is the exact opposite process of photosynthesis.

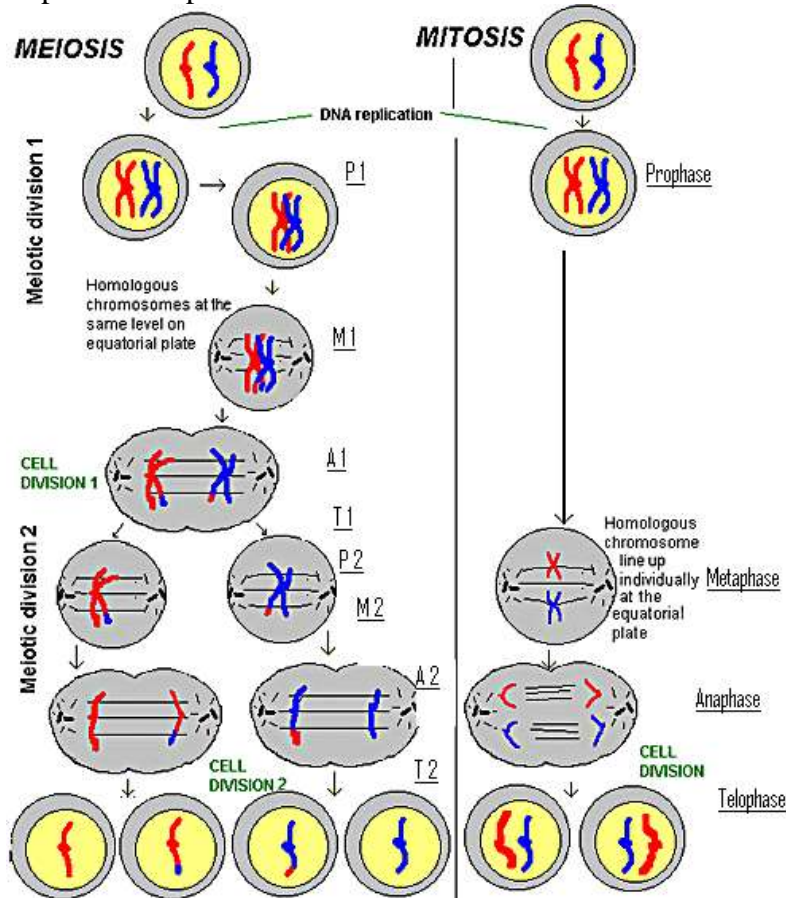
11. Humans need oxygen to be able to perform cellular respiration and gain ATP energy for our cells. What would happen to the oxygen levels on Earth if photosynthesis stopped? Since photosynthesis releases oxygen as a waste product (which is a good thing for us because we need oxygen to perform cellular respiration and gain ATP energy) if photosynthesis stopped the oxygen levels would drop on Earth...eventually killing most consumers that use the oxygen to respire. Cellular respiration releases carbon dioxide as waste, which is important because producers cannot do photosynthesis without carbon dioxide. So if respiration stops no carbon dioxide is release and therefore all producers will die too.

12. What happens when a phosphate group is removed from ATP? Is energy released or gained? Compare the energy levels of ATP, ADP, and AMP to the energy levels of a battery. When a phosphate is removed from ATP energy is released for the cell to use. ATP is like a fully charged battery with 3 phosphates, ADP is a partially charged battery with 2 phosphates, and AMP is a dead battery with only 1 phosphate.

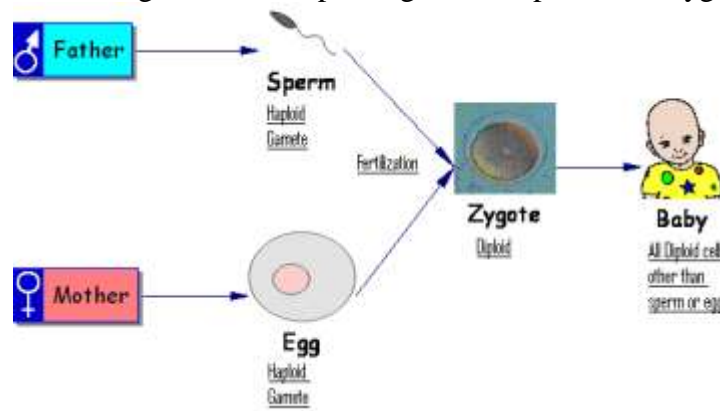
13. Draw and label the five phases of the cell cycle. What is the function of the cell cycle?
 The function of the cell cycle is to successfully make new cells for growth of the organisms or replacement of dead or damaged cells.



14. Compare and contrast mitosis and meiosis in terms of the steps and end products.

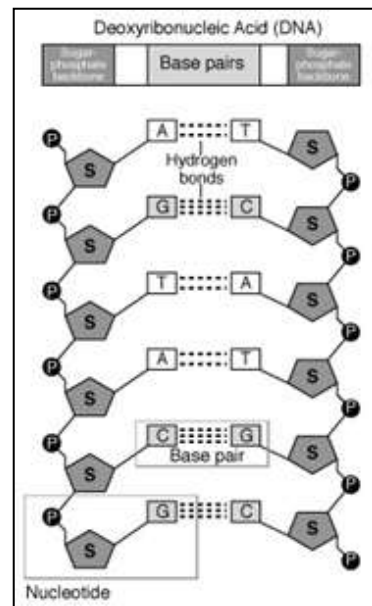


15. Describe fertilization using the terms haploid, gamete, diploid, and zygote.



GENETICS

1. What is **DNA**? **Deoxyribonucleic acid**, the material that stores the information that determines an organism's characteristics
2. Draw and label the 3 parts of a **nucleotide**. How do nucleotides form the structure of DNA?
Nucleotides are the building blocks of DNA. Nucleotides link together to form a chain. Then corresponding nucleotides match-up according to the base-pairing rule to form the second chain. What you end up with is the double helix molecule of DNA.



3. Draw a **molecule of DNA**. Label the following parts:
 - sugar/phosphate backbone
 - nucleotides
 - nitrogen bases
 - hydrogen bonds
4. What does the expression “**double helix**” mean?
Double helix means 2 strands of nucleotides attached by hydrogen bonds in the middle and twisted together.

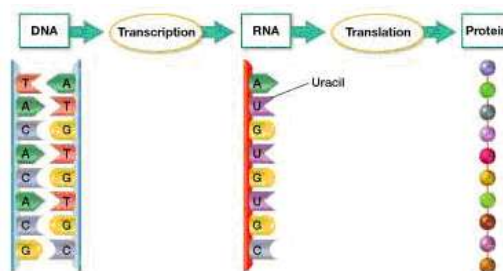
5. What is the **base-pairing rule**?
Adenine hydrogen bonds with Thymine
Guanine hydrogen bonds with Cytosine

6. What is the relationship between **gene and DNA**?
Genes are sections of DNA that code for proteins. The rest of the DNA codes for nothing.

7. List the **3 steps of DNA replication** using the following terms: dna helicase, replication fork, dna polymerase, base-pairing rule
 1. DNA helicase unwinds the double helix by breaking the hydrogen bonds. This forms the replication fork
 2. DNA polymerase adds complementary nucleotides to the separated DNA strands
 3. DNA polymerase continues until it reaches the end of the molecule, thus forming 2 identical DNA molecules.

8. **Gene expression is the process of how genes in the DNA are turned into a phenotype that can be seen.** Draw and label the 2 phases of gene expression. Describe where each happens in the cell.

Transcription starts with DNA and turns it into RNA. This happens in the nucleus.
Translation starts with RNA and turns it into Protein. This happens in the cytoplasm at the ribosomes.



9. Distinguish the **end products of replication, transcription, and translation.**

	Replication	Transcription	Translation
<i>Start</i>	DNA	DNA	RNA
<i>End</i>	DNA	RNA	Protein

10. List 4 types of **DNA mutations**. Do all mutations result in a change in phenotype? Explain using the terms introns, exons, and codon. **No, not all mutations result in a change in phenotype (appearance). Only mutations to parts of the DNA that code for proteins (the exons) will change the phenotype by affecting the codon then the resulting protein.**

4 types of mutations: point mutation, insertion, deletion, transposition, chromosomal rearrangement.

11. What will happen if there is a **mutation to the gametes**? **The gametes are the sex cells, sperm & egg. If the sperm or egg with a mutation gets fertilized the result will be a baby that has a genetic disorder.**

12. Complete the following monohybrid cross. Two parents that are heterozygous for brown eyes. Be sure to identify the **genotypes of the parents, complete the punnett square, identify the phenotypes with genotypes and the ratio of the phenotypes**. What percent of the offspring have blue eyes? **1/4 or 25%**

<u>Bb</u> X <u>Bb</u>		B	b	Phenotype	Genotype	Ratio:
B	BB	Bb		Brown eyes	BB, Bb	3 : 1
b	Bb	bb		Blue eyes	bb	

13. Why do men experience male-pattern baldness more than women? **Men only have one X chromosome, so whatever allele they get for hair, whether it is the dominant normal or the recessive allele that cause baldness, it will show. Men have XY and female have XX**

14. Using Mendel's laws of **segregation and independent assortment**, explain why not all tall people have brown hair. **The law of segregation says that during meiosis the alleles separate independently during Metaphase II of meiosis and the law of independent assortment says that homologous chromosomes separate independently during Metaphase I of meiosis.**

15. Describe an example for each of the following:

Codominance – both forms of the trait are displayed – dalmation dog with black spots	Polygenic Traits – several genes control one trait – skin color or hair color
Incomplete Dominance – neither allele for the trait is dominant – white flower X red flower = pink flower	Multiple Alleles – more than 2 alleles for one trait – Blood types A, B, AB, O

ANATOMY & PHYSIOLOGY

1. Describe the 4 **levels of structural organization** in the human body.

Cells → Tissues → Organs → Organ Systems

2. Complete the following chart for the **major organ systems** of the human body.

Digestive System		
<i>Function</i>	<i>Path of Food (all major organs)</i>	<i>Important Digestive Enzymes</i>
Breaks down and absorbs nutrients from food; removes waste; maintains water balance	Mouth – Pharynx – Epiglottis – Esophagus – Stomach – Small Intestine – Large Intestine – Rectum - Anus	Amylase – in saliva breaks down sugar Pepsin – in stomach breaks down protein Lipase – in pancreas breaks down fat

Circulatory System	
<i>Function</i>	<i>Path of Blood (all major organs)</i>
Transports nutrients, wastes, hormones, and gases	Capillary drops off nutrients to cell & picks up waste – venule – vein – right atrium – right ventricle – pulmonary artery – capillaries (lungs) – pulmonary vein – left atrium – right atrium – aorta – artery – arteriole - capillary

Excretory System	
<i>Function of Kidneys</i>	<i>Function of Liver</i>
Regulate the amount of water and salts in the blood	Secretes bile which helps break down fats and absorb vitamins; regulates sugar levels in blood

Respiratory System	
<i>Function</i>	<i>Path of Oxygen/Carbon Dioxide (all major organs)</i>
Move air into and out of lungs; controls gas exchange between blood and lungs	Mouth/nose – Pharynx – Epiglottis – Larynx – Trachea – Bronchi – Bronchioles – Alveoli – Bronchioles – Bronchi – Trachea – Larynx – Epiglottis – Pharynx – Mouth/nose

Nervous System		
<i>Function</i>	<i>Basic Unit – The Neuron How it works?</i>	<i>Major Components</i>
Regulates behavior; maintains homeostasis; regulates other organ systems; controls sensory and motor functions	Neuron is made up of dendrites that receive an electrical signal which is then carried to the cell body which is then carried through the axon and is then passed on to the next neurons dendrites	Peripheral NS – sensory & motor neurons Central NS – brain & spinal chord

Muscular/Skeletal System	
<i>Function of Muscles</i>	<i>2 Functions of Bones</i>
Help in movement of: bones; contraction of heart and other organs	1. Provides shape and support to the body 2. Produce blood cells and platelets in the marrow of the bone
<i>3 Types of Muscle Tissue & their Functions</i>	<i>2 Types of Connective Tissue & How They Attach Muscle to Bone and Bone to Bone</i>
Skeletal – muscles that move bones Smooth – involuntarily controlled; the muscles that cause the stomach to contract Cardiac – involuntarily controlled; is the muscle that makes up the heart	Ligament – attaches bone to bone Tendon – attaches muscle to bone

3. Define **homeostasis**. The process of maintaining internal stability within an organism

4. The organ systems of the human body work closely together to maintain the health of the entire body. **An organism who cannot maintain homeostasis within all its systems will not live very long.** Problem – It is cold out and you begin to shiver. Explain how the nervous system, muscular system, skeletal system, and circulatory system all work together to help you keep a constant body temperature.

When it is cold out, the sensory neurons (nervous system) send a signal to the spinal cord then the brain. The brain interprets the signal and sends a message to the motor neurons. The motor neurons trigger the muscles (muscular system) in your body to contract/relax over and over again, which also causes the bones to move (skeletal system). This increases warmth in the body. The heart (circulatory system) also beats faster sending warm blood more quickly throughout the body to increase warmth.

EVOLUTION & BIODIVERSITY

1. What is **evolution by natural selection**? Evolution is change of species overtime. This happens due to some kind of change in the environment of an organism. In order to survive the organism has to adapt or die. If there is a mutation that becomes advantageous, it will be selected for (natural selection). Organisms with the advantageous trait are picked as mates and reproduce more successfully, thus passing on the good genes. Over time, the build-up of differences is called evolution.

2. Give an **example** of evolution by natural selection. Finch birds are known to have different beak styles. During rainy seasons many insects are available to eat which are high in protein. Thus birds select mates that have small beaks that eat insects easily. During dry seasons there aren't many insects and only hard seeds. Thus birds select mates that have large, thick beaks that easily break open seeds. Over time more and more adaptations existed and developed into different species of finches.

3. Describe **evidence for evolution** by filling in the chart below.

Fossil Record	Comparative Anatomy		Genetic & Molecular Similarities
	<i>Homologous Structures</i>	<i>Vestigial Structures</i>	
Bones from Lucy show a relationship between apes and humans	The forearm of penguin, human, lizard, and bats all have the same bones	Whale used to be a 4-legged animal on land then moved into the sea and evolved so that the pelvis and legs have lost their function	Gorilla and human have an almost identical hemoglobin protein in our blood

4. Use an example to explain the **steps of speciation** (the formation of a new species).

- 1.) Mutation – elephant with NO tusks
- 2.) Reproductive Isolation – does not get hunted by poachers and can live freely on the savannas
- 3.) Natural Selection – elephants with no tusks live longer since they are not hunted and so they get selected for by other elephants
- 4.) Divergence – over time if populations stay separated they may continually adapt and develop more and more genetic differences
- 5.) New Species – if the 2 populations become so genetically different that they can no longer breed successfully, they are considered 2 different species

5. Define **species**. The basic classification of living things

6. What **characteristics are organisms classified (grouped) by**? Form and structure, behavior, and molecular similarities.

7. List the **8 levels of classification** for all living things.

Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species

8. Binomial nomenclature is the system for scientifically naming organisms. Using an example, describe the **rules for naming an organism**.

Humans scientific name is Homo sapien. The first word is the genus name and is capitalized. The second word in the species name and is lowercase.

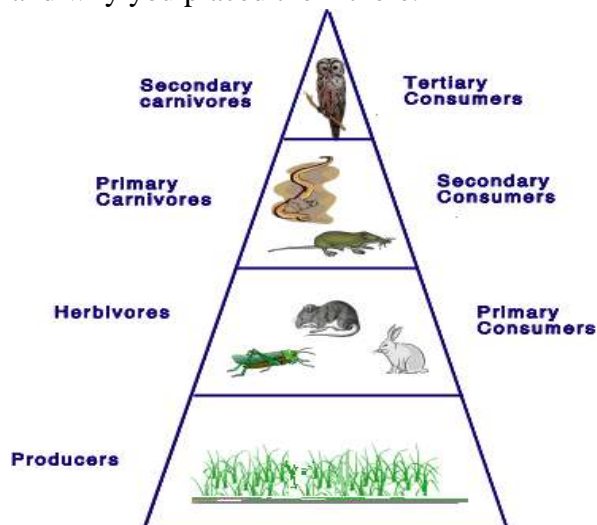
9. Define **biodiversity**. The variety of organisms, their genetic differences, and the communities and ecosystems in which they occur is termed biodiversity.

10. How does **evolution by natural selection affect the biodiversity** of life on earth?

Evolution by natural selection offers a means by which organisms can become more and more different over time to a point where they become new species. Every living thing experiences evolution at some speed. The rate at which new species evolves is exponential. Thus the large biodiversity of life on Earth can be attributed to the process of evolution by natural selection.

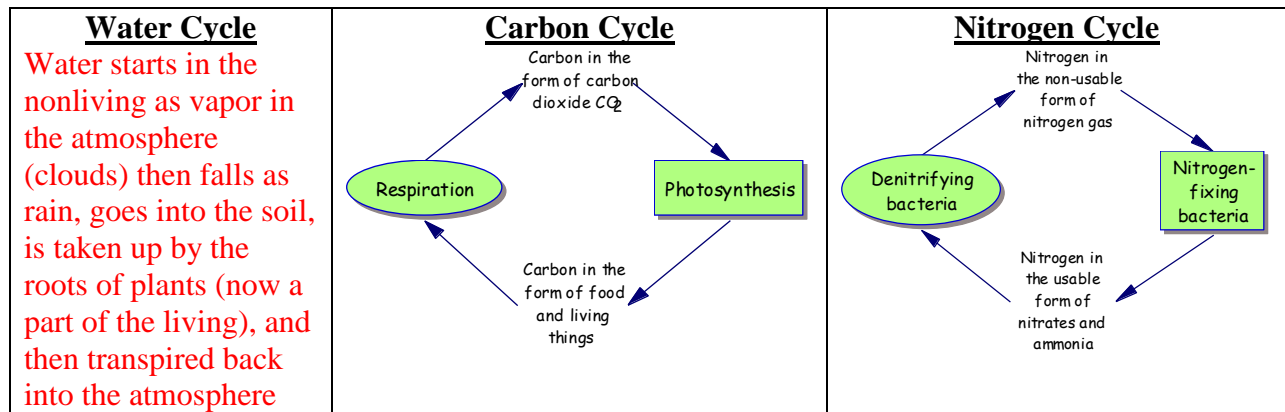
ECOLOGY

1. What is **ecology**? The study of the interactions of living organisms with one another and with their physical environment.
2. What are the **components of an ecosystem**? Ecosystems are made up of living (biotic factors such as plants, animals, bacteria, fungi) and nonliving things (abiotic factors such as soil, water, weather, climate).
3. Define **community**. All the living things in one ecosystem.
4. Trace the **flow of energy** through the members of a community.
Energy begins with the producers who take the sun's energy and turn it into food. The primary consumers or herbivores then obtain their energy by eating the producers. The energy then moves to the secondary consumers or omnivores/carnivores, who obtain their energy by eating the herbivores. Lastly when all the organisms die, the decomposers obtain their energy from them and recycle the nutrients back into the ecosystem.
5. What does a **food chain** show? Give an example.
Food chains show the path energy takes in a specific ecosystem.
Grass → Rabbit → Fox → Wolf
6. How do **food chains relate to food webs**?
A food web is made up of many interconnected food chains.
7. Why are **energy pyramids** usually no more than 4 trophic levels?
As you go up the trophic levels in an energy pyramid, energy is lost as heat from the organisms that are not eaten (die). Once you reach the top there is very little energy available.
8. Identify where the **decomposers** belong in the energy pyramid below. Explain their niche and why you placed them there.



The decomposers belong anywhere outside the pyramid. This is because of their niche. Decomposers niche in an ecosystem is to obtain energy from any dead organism and then to recycle the nutrients back into the ecosystem.

9. **Biogeochemical cycles are important to all ecosystems because they recycle all the important nutrients necessary for living things.** Water, carbon, and nitrogen are essential for life. Describe how these materials are recycled in an ecosystem.



10. **Biological communities are very complex due to the many interactions (symbiotic relationships) that happen between all organisms.** Describe each of the following:

<p><u>Commensalism</u> An interaction between 2 organisms where one receives a benefit and the other isn't helped or harmed.</p>	<p><u>Competition</u> When 2 organisms use the same resources, there is a struggle to obtain the resources. This results in an interaction called competition.</p>
<p><u>Parasitism</u> An interaction between 2 organisms where one receives a benefit and the other is harmed.</p>	<p><u>Mutualism</u> An interaction between 2 organisms where both receives benefits as a result of their interactions.</p>
<p><u>Predator/Prey</u> An interaction between 2 organisms where the predator needs to hunt and kill the prey for food/energy in order to survive.</p>	

11. Define **population**. A group of organisms of the same species living in one area at one time

12. Describe what **factors can affect population size and biodiversity**. Climate change, loss of resources, changes in symbiotic relationships, and pollution due to human activity can all affect population size negatively and thus decrease biodiversity in an ecosystem.