

Biology Keystone Review Packet

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This packet contains helpful information for you to prepare for the upcoming Biology Keystone Test. As you will see, this packet is broken down into several major themes that the Keystone Test will cover. Please take the time to complete each section with your best possible efforts.

Major themes covered in this packet:

- Themes of Life
- Organic Chemistry
- Cells and Cell Transport
- Energy
- Cell Reproduction & Genetics
- Protein Synthesis
- Evolution/Phylogeny
- Ecology

Each section will have major vocabulary words that you should be familiar with, the major content anchors that you should be able to answer questions about, some questions that will refresh your memory and then some practice test questions.

A wikispace has been set up to help you be successful in relearning the material. The address of the wikispace is www.udkeystone.wikispaces.com – use this to your advantage. Your teachers have worked very hard to help you – now it is your turn.

Themes of Life

Vocabulary

Biology
Biotechnology
Forensics
Homeostasis
Homeostatic mechanism
Scientific law
Scientific mechanism

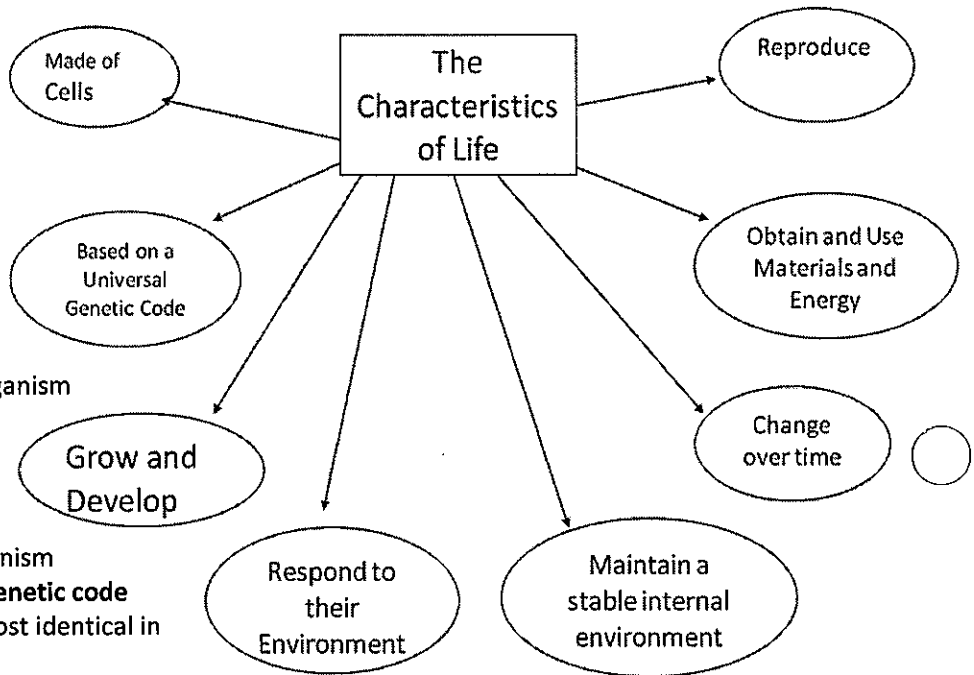
Organ
Organ system
Organism
Scientific principle
Science
System
Temperature

theory
hypothesis
eukaryote
prokaryote

Concepts to Know

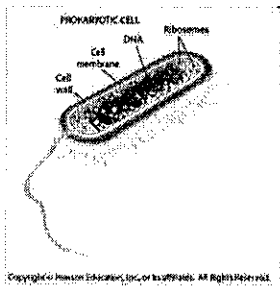
Characteristics of Life:

- **Living things are made of cells**
 - Smallest unit of an organism that is considered alive
 - Can be unicellular (bacteria) or multicellular (humans)
- **Living things reproduce**
 - Asexual: formation of a new organism from one parent. Offspring is a clone
 - Sexual: two cells from different parents unite to produce the 1st cell of new organism
- **Living things are based on a universal genetic code**
 - Based on 1 molecule that is almost identical in every organism on earth: DNA (Deoxyribonucleic Acid)
- **Living things grow and develop**
 - Growth: an increase in size of an organism
 - Development: progression through a life cycle
- **Living things obtain materials and use energy**
 - Autotroph: obtains energy from the sun
 - Heterotroph: obtains energy from consuming other organisms.
- **Living things respond to environment**
 - ex. Find shelter from rain
 - ex. Hibernating to survive the winter
 - ex. Produce toxins to ward off predators
- **Living things maintain a stable internal environment**
 - Homeostasis: keeping internal condition stable relative to the external environment
- **Living things change over time (evolve)**
 - Populations evolve over time

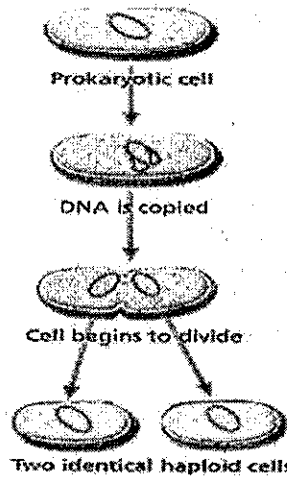


1. Read through the characteristics of life on this page. These 8 characteristics are what tell biologists if something is living or non-living. Remember, biology literally means "Study of life".

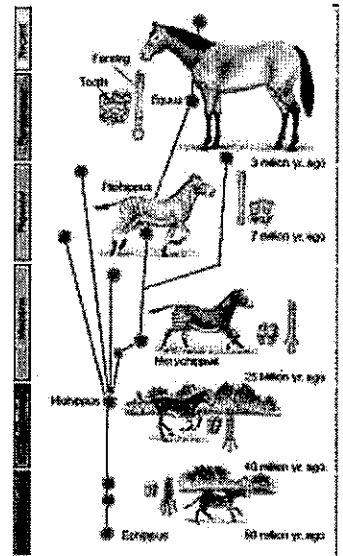
2. Look at the images below. Each one is related to a characteristic of life. Some images may be related to more than one characteristic of life. See if you can match at least one characteristic of life to each image:



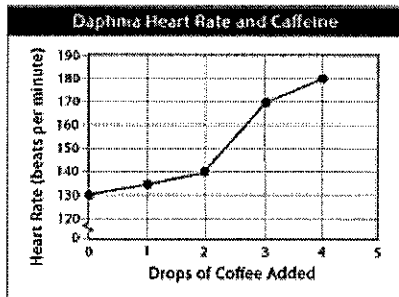
A. _____



C. _____



D. _____



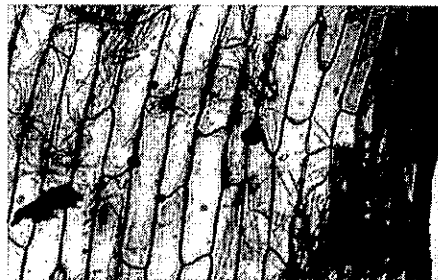
B. _____



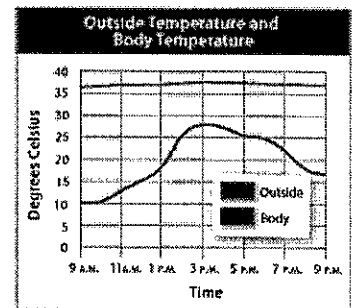
E. _____



F. _____



G. _____



H. _____

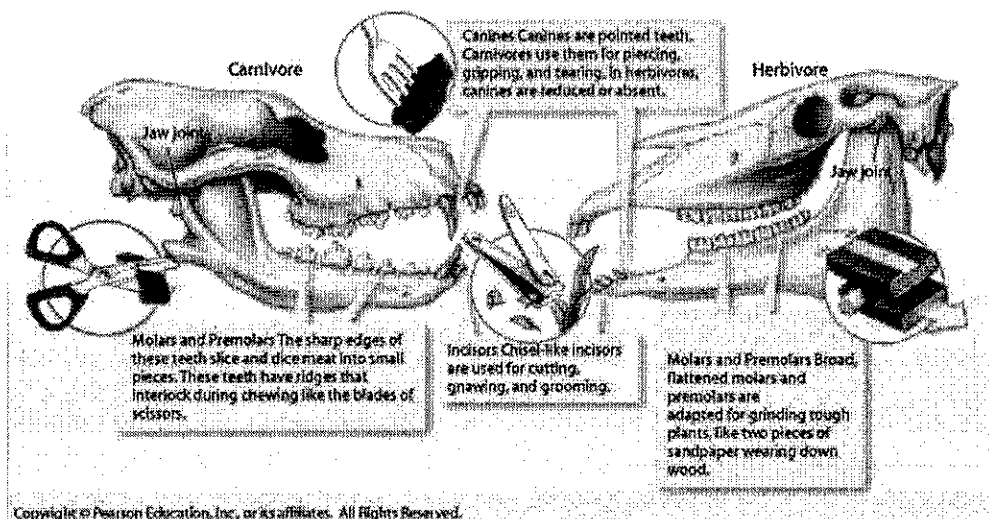


I. _____

Structure and Function:

Structure and function is a central theme to the study of biology. Each major group of organisms has evolved its own particular body part "tool kit" – a collection of structures that have evolved in ways that make particular functions possible. From capturing food to digesting it, and from reproducing to breathing, organisms use structures that have evolved into different forms as species have adapted to life in different environments. The structure of wings, for example enable birds and insects to fly. The structures of legs enable horses to gallop and kangaroos to hop.

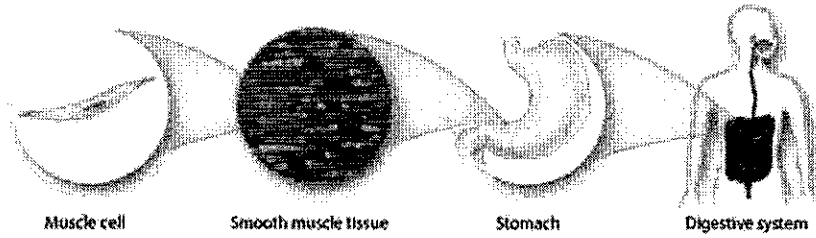
→ Examine the figure below that shows carnivore and herbivore skulls. Don't forget to read the captions!



Now, since you've got some specific ideas about what structure and function are all about answer the questions below:

1. Think about your own teeth. What kinds of foods do you think human teeth are suited for?
2. List at least **three** ways the structure of human teeth serve the function of eating meat and plant material.
 - a. _____
 - b. _____
 - c. _____
3. Now, last but not least apply the theme of structure and function to something you're very familiar with - your hands. List out all the ways you can think of that the structure of your hands serve the function of your hands. Hint – you are a primate!

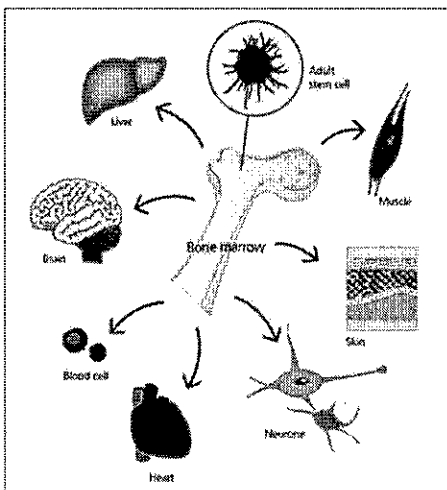
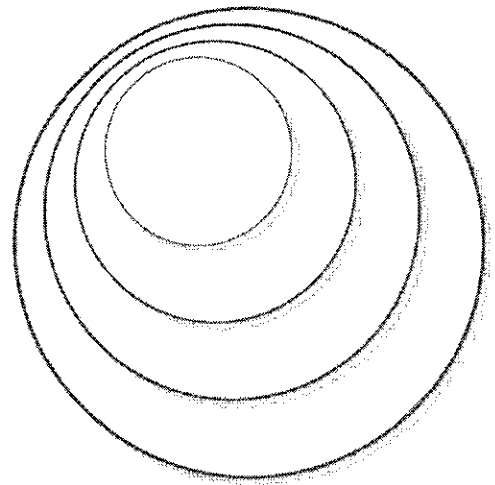
Levels of Organization



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The specialized cells of multicellular organisms are organized into an organ system, as shown above. A tissue is a group of similar cells that perform a particular function. Many tissues work together as an organ to complete complicated tasks. A group of organs that work together to perform a specific function is called an organ system.

- The Venn diagram to the right consists of four concentric circles. Complete the diagram to show the relationships among four levels of organization of life. Use the terms *cells*, *organ*, *organ system*, and *tissue*.
- See if you can include the level of organization called "organism" in the Venn diagram. Show where it would be added.



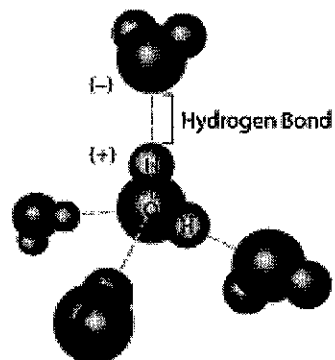
The diagram to the left shows a few of the different types of cells found in your body. Luckily, the cells in our body are specialized. Some cells are specialized to move, to react to the environment; still others to produce substance that the organism needs. Each of these specialized cells contributes to homeostasis in the organism.

Describe how cells of a multicellular organism are like a baseball team, or choose any type of team you like.

Chemistry of water:

Life is connected to water. Nearly 75% of our earth is covered in water. Why is it so special and vital to living things? Let's look at the chemistry of water. Notice in the diagram to the right that water is composed of two hydrogen atoms and one oxygen (H_2O).

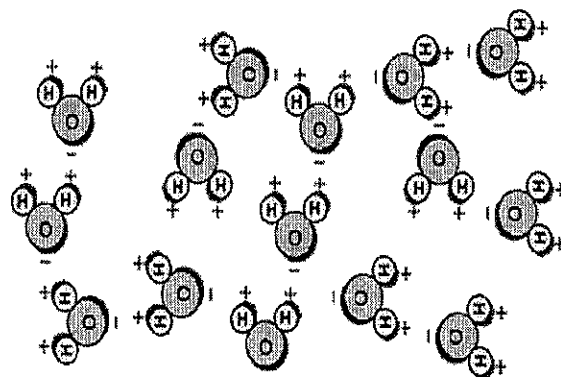
The diagram shows that one side of the water molecule is **positively charged** and the other is **negatively charged**. These opposite charges make water a **polar molecule**.



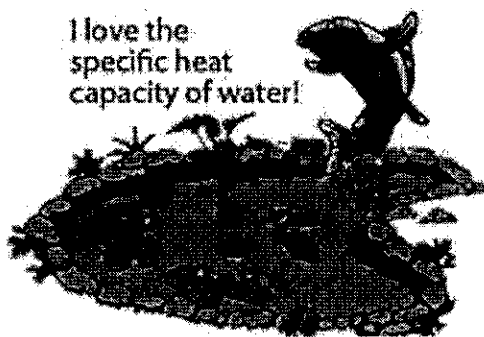
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The **negative oxygen** of one water molecule is attracted to the **positive hydrogen** of another molecule forming a **hydrogen bond**. In other words water likes to stick to itself. Water sticking to water is called **cohesion**. Water sticking to something else is called **adhesion**.

- In the diagram to the right use dotted lines to draw in the bonds that form between water molecules.
- What is the name of this type of bond?
- What special property do the bonds give to water.



It turns out that hydrogen bonds are important for a few more reasons. Hydrogen bonds give water a **high specific heat** and also cause water to **expand upon freezing**.



Specific heat is the amount of energy required to raise one gram of water 1 degree Celsius.

- Can you think of a reason why water can absorb so much heat? Hint – think bonds

It turns out that water expands when frozen and actually becomes **less dense** than when in the liquid state. We call this frozen water ice, which we know floats.

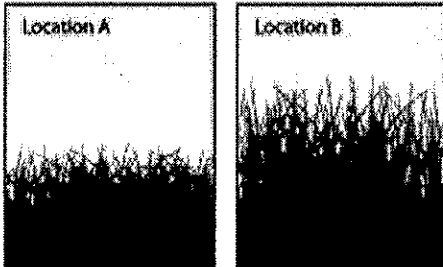


- Challenge yourself to think of two ways that specific heat and the freezing point of water help support life on earth.

Scientific Method/Scientific Terms:

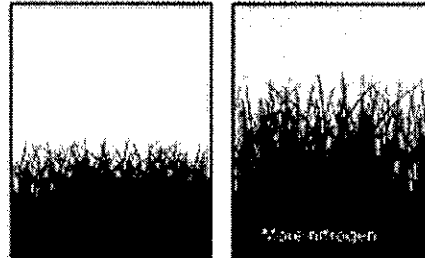
The scenes below show the steps involved in the scientific method read through the experimental scenario and answer the questions below.

OBSERVING AND ASKING QUESTIONS



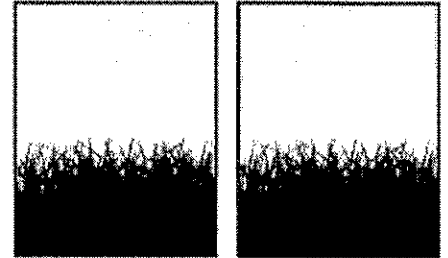
Researchers observed that marsh grass grows taller in some places than others. This observation led to a question: *Why do marsh grasses grow to different heights in different places?*

INFERRING AND HYPOTHESIZING



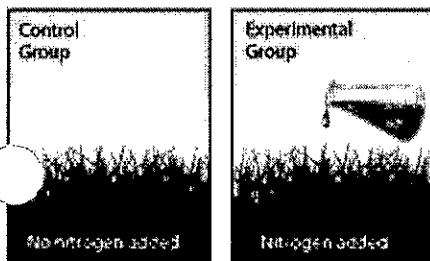
The researchers inferred that something limits grass growth in some places. It could be any environmental factor—temperature, sunlight, water, or nutrients. Based on their knowledge of salt marshes, they proposed a hypothesis: *Marsh grass growth is limited by available nitrogen.*

DESIGNING CONTROLLED EXPERIMENTS



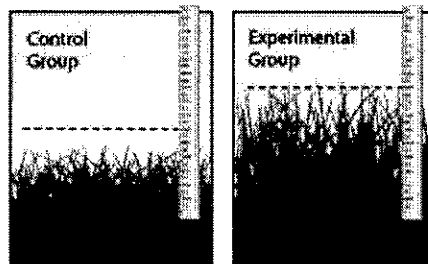
The researchers selected similar plots of marsh grass. All plots had similar plant density, soil type, input of freshwater, and height above average tide level. The plots were divided into control and experimental groups.

DESIGNING CONTROLLED EXPERIMENTS cont.



The researchers added nitrogen fertilizer (the independent variable) to the experimental plots. They then observed the growth of marsh grass (the dependent variable) in both experimental and control plots.

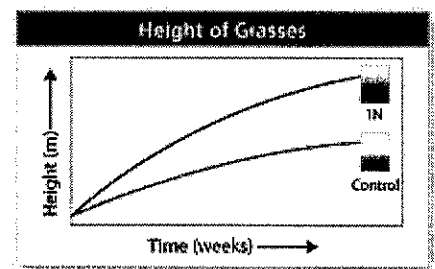
COLLECTING AND ANALYZING DATA



The researchers sampled all the plots throughout the growing season. They measured growth rates and plant sizes, and analyzed the chemical composition of living leaves.

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DRAWING CONCLUSIONS



Data from all plots were compared and evaluated by statistical tests. Data analysis confirmed that marsh grasses in experimental plots with additional nitrogen did, in fact, grow taller and larger than controls. The hypothesis and its predictions were supported.

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10. Based on the scenario what is the difference between a hypothesis and an inference?

11. How did the control group differ from the experimental group?

12. What were the dependent and independent variables?

13. What was the observation that started the research?

In science the word **theory** applies to a well-tested explanation that unifies a broad range of observations and hypotheses and that enables scientists to make accurate predictions about new situations

A **hypothesis** is a scientific explanation for a set of observations that can be tested in ways that support or reject it.

Identify whether each statement is a hypothesis or a theory. For a hypothesis, write an "H" on the line. For a theory, write a "T."

- _____ 14. The rate that grass grows is related to the amount of light it receives.
- _____ 15. All life is related and descended from a common ancestor.
- _____ 16. The universe began about 15 billion years ago.
- _____ 17. New tennis balls bounce higher than old tennis balls.
- _____ 18. Caffeine raises blood pressure.

19. Someone might argue against evolution and say that its "just a theory". Why is this not a very good argument?

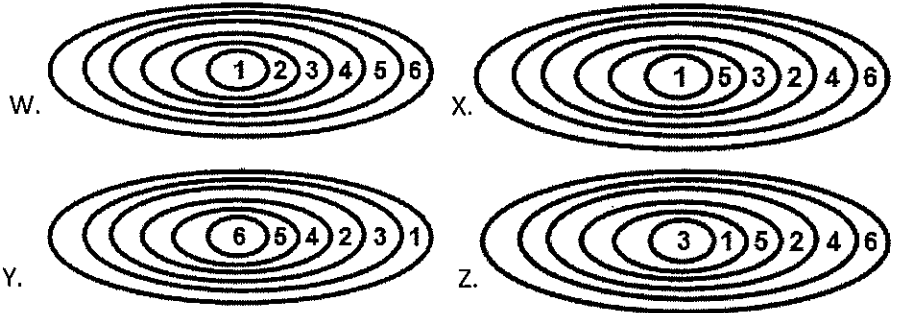
Practice Questions:

1. Which characteristic is shared by **all** prokaryotes and eukaryotes?
 - a. ability to store hereditary information
 - b. use of organelles to control cell processes
 - c. use of cellular respiration for energy release
 - d. ability to move in response to environmental stimuli
2. Living organisms can be classified as prokaryotes or eukaryotes. Which two structures are common to both prokaryotic and eukaryotic cells?
 - a. cell wall and nucleus
 - b. cell wall and chloroplast
 - c. plasma membrane and nucleus
 - d. plasma membrane and cytoplasm
3. Alveoli are microscopic air sacs in the lungs of mammals. Which statement **best** describes how the structure of the alveoli allows the lungs to function properly?
 - a. They increase the amount of energy transferred from the lungs to the blood.
 - b. They increase the flexibility of the lungs as they expand during inhalation.
 - c. They increase the volume of the lungs, allowing more oxygen to be inhaled.
 - d. They increase the surface area of the lungs, allowing efficient gas exchange.
4. Which example is an activity that a fish **most likely** uses to maintain homeostasis within its body?
 - a. using camouflage to avoid predators
 - b. feeding at night to regulate body temperature
 - c. moving to deeper water to regulate metabolic wastes
 - d. exchanging gases through its gills to regulate oxygen levels

5. Which statement best describes an effect of the low density of frozen water in a lake?
- When water freezes, it contracts, decreasing the water level in a lake.
 - Water in a lake freezes from the bottom up, killing most aquatic organisms.
 - When water in a lake freezes, it floats, providing insulation for organisms below.
 - Water removes thermal energy from the land around a lake, causing the lake to freeze.

6. Which diagram best represents the relationship of the items in the list below?

- cell
- organ
- organelle
- organ system
- tissue
- whole organism



- X
- Y
- Z
- W

Open-ended question:

7. Prokaryotic cells are generally much smaller than eukaryotic cells.

Part A: Identify a structural difference between prokaryotic cells and eukaryotic cells that is directly related to their difference in size.

Part B: Based on the structural difference, explain why prokaryotic cells can be much smaller than eukaryotic cells.

Part C: Describe one similarity between prokaryotic cells and eukaryotic cells that is independent of size.

Organic Chemistry

Vocabulary

Adhesion	carbohydrate	catalyst
Cohesion	amino acid	pH
Atom	protein	molecule
Concentration	Macromolecule	specific heat
Biological macromolecules	lipid	organic molecule
monomer	nucleic acid	
Freezing point	enzyme	

Concepts to Know

1st Idea: Due to its properties, carbon is uniquely suited to form biological macromolecules.

→ Use the diagrams below to fill in the blanks and describe why carbon is so important to life.

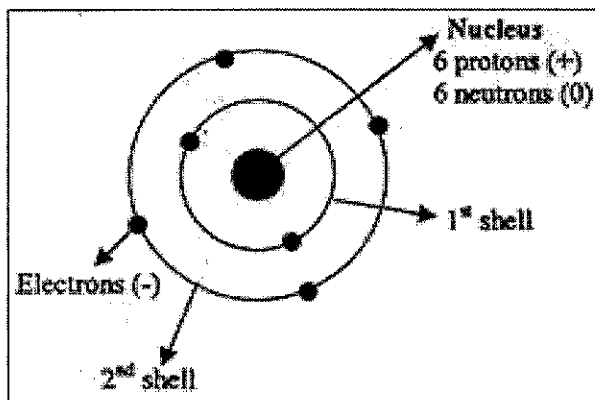


Figure 1: Carbon Atom

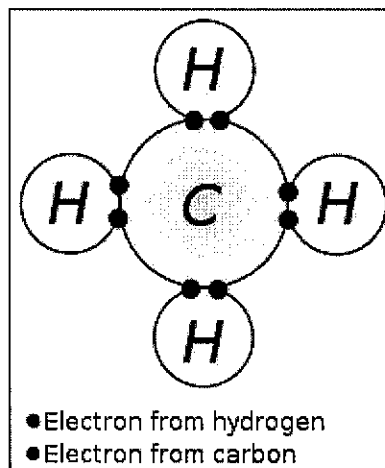


Figure 2: Covalent Bonding between Carbon and Hydrogen

- Carbon has _____ in the outer (valence) shell
 - Valence shell enables easy formation of four covalent bonds
 - Covalent bonds involve _____ of _____ between two atoms

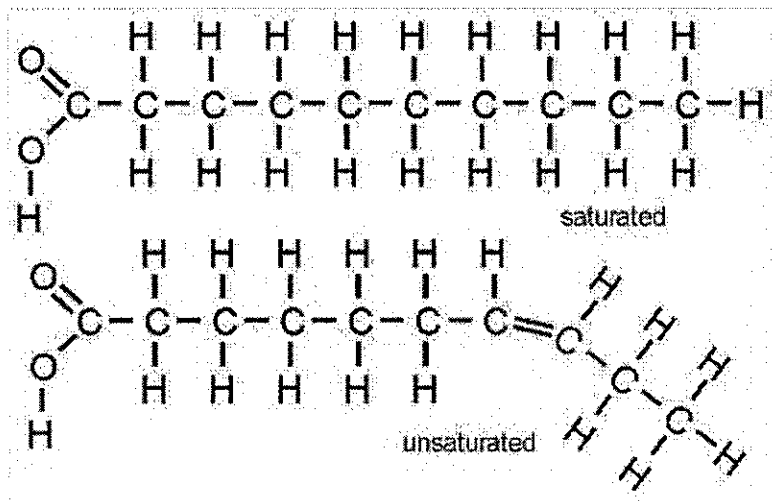
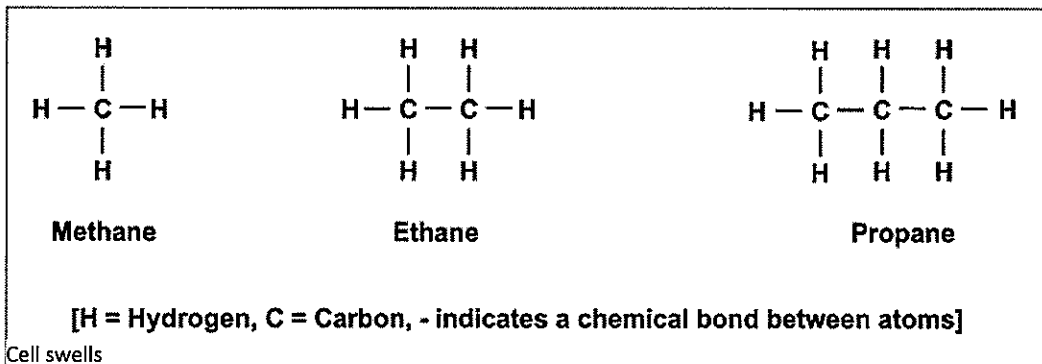


Figure 3: Long Chain Carbon Compounds

- Carbon has the ability to form _____ by forming several bonds in a row

→ Use the diagrams to fill in the blanks and describe how the variety of organic compounds can be explained by carbon's properties.



Cell swells

• **Organic compounds** – Contain _____

• **Variety** is created by the many partners that carbon can bond with

- **Organic compounds** – Contain _____
- **Variety** is created by the many partners that carbon can bond with
- **Properties** include polarity of molecule
- **Polarity** is a description of the balance of charges in a molecule

- _____ means the charges are not balanced
- **Nonpolar** means _____ balance of charges

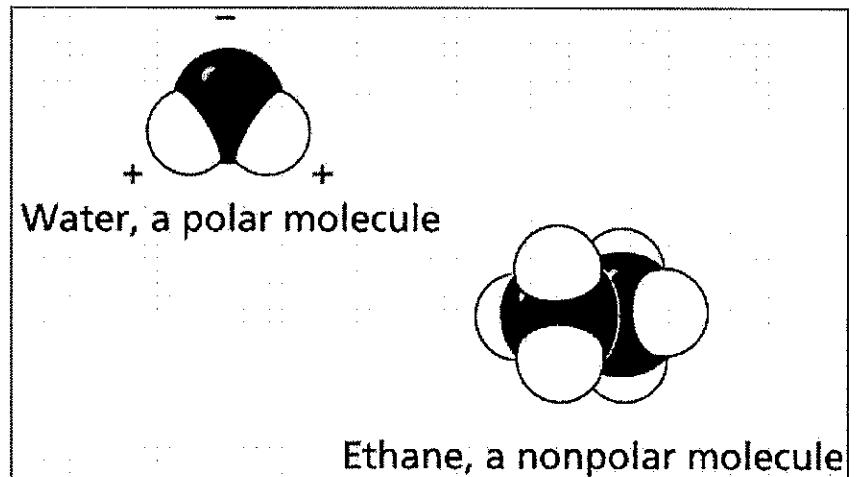
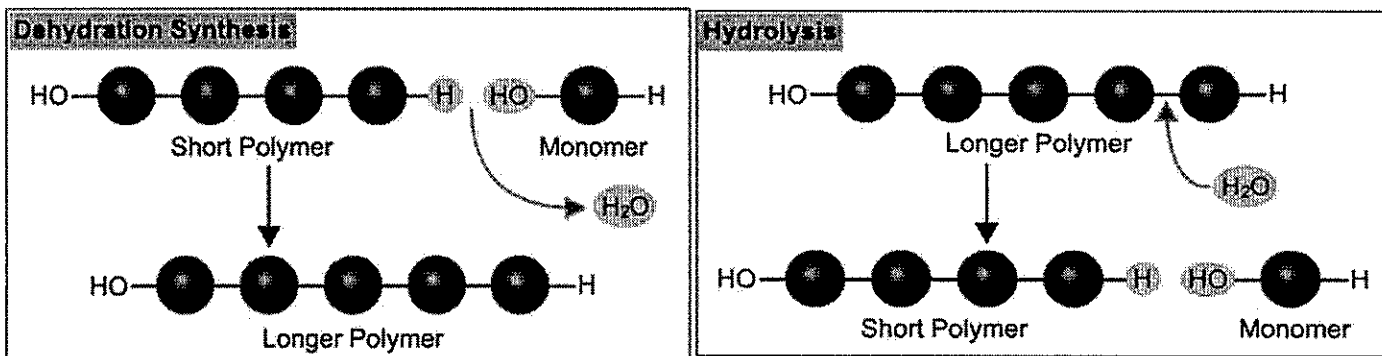


Figure 2: Polar and Nonpolar Compounds

2nd Idea: Biological macromolecules form from monomers.

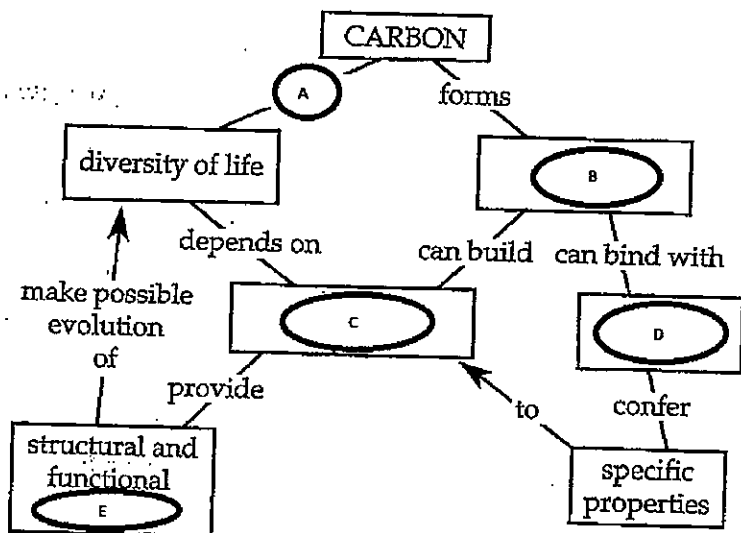
→ Use the diagrams to fill in the blanks and describe how carbon allows for the formation of macromolecules.

- **Macromolecules** are very large molecules
- Most **macromolecules** are polymers
- _____ are long chains of bonded groups
- _____ are the molecules that link to form polymers



- **Dehydration Synthesis** generates _____ and is a common way for polymers to form
- **Hydrolysis** is the process of breaking apart _____

➔ Use the outline above and video called "The Molecules of Life" (<https://udkeystone.wikispaces.com/Organic+Chemistry>) to complete the following concept map and answer the review questions at the end of this section.



A _____

B _____

C _____

D _____

E _____

MACROMOLECULES: STRUCTURE AND FUNCTION

Macromolecules and Their Function		
Class	Monomers	Functions
Carbohydrates	Monosaccharides	Energy, raw materials, energy storage, structural compounds
Lipids	Glycerol, fatty acids, steroids	Energy storage, membranes, steroids, hormones
Proteins	Amino acids	Enzymes, transport, movement, receptors, defense, structure
Nucleic acids	Nucleotides	Heredity, code for amino acid sequence

Carbohydrates are broken down through hydrolysis to serve as fuel for the body or a source of carbon

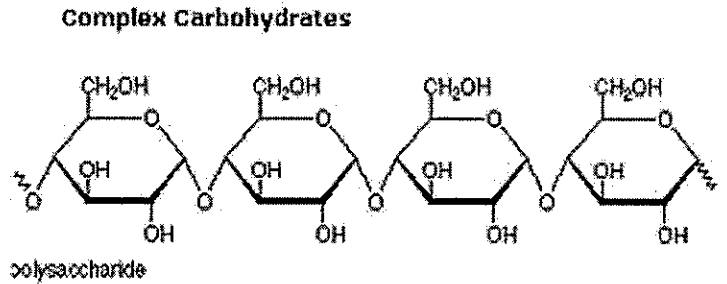
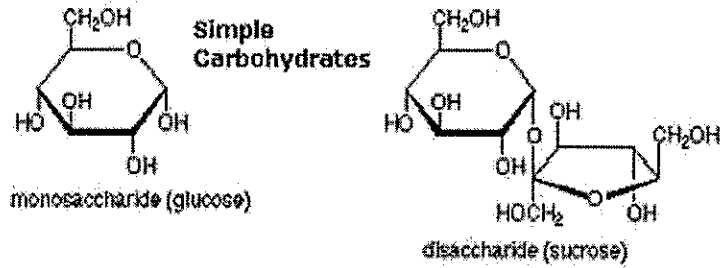
- **Saccharide** means sugar

Carbohydrates can be

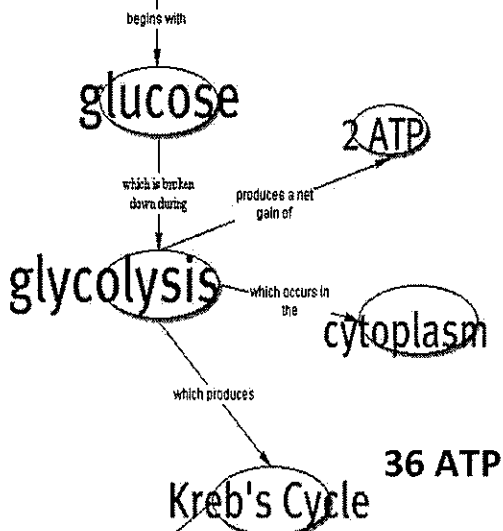
_____ (1 sugar)

_____ (2 sugars), or

_____ (more than 2 sugars)



Cellular Respiration



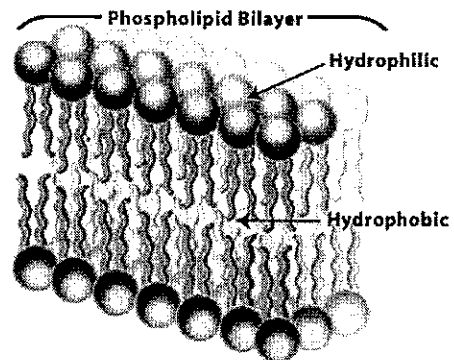
- _____ breaks down carbohydrates like glucose for use in cellular respiration

- **Cellular respiration** is the process through which the body generates energy, or _____

Lipids are nonpolar macromolecules made from long carbon chains

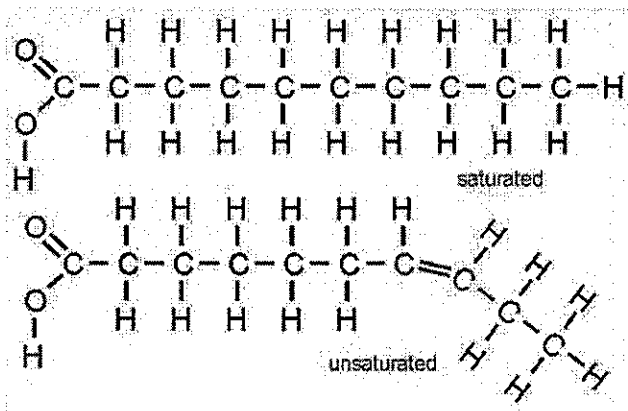
- Lipids can be **fats, phospholipids, or steroids**
- **Fats** store large amounts of energy

- _____ compose cell membranes
- **Steroids** are made of four connected carbon rings with functional groups attached



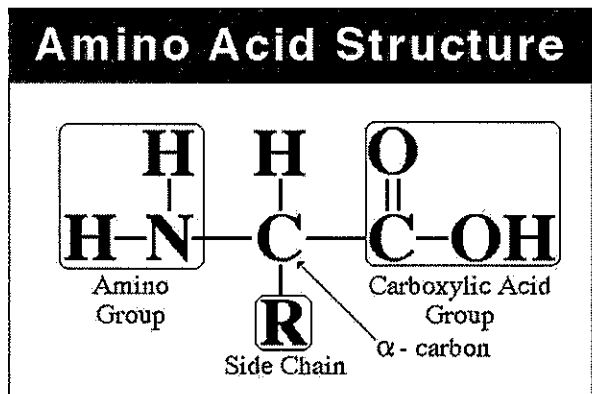
with

- **Lipids** can be saturated or _____
- **Saturated** lipids have a _____ shape and only single bonds between carbons, while **unsaturated** lipids have a nonlinear shape and _____ or triple bonds



Proteins are amino acid polymers that are essential

- **Amino acids** have _____ and _____ groups. They are unique by the "R" group that is attached to
- "R" is like a variable in algebra class. It can have many values (structures).
- **Function** of the amino acid is determined by structure and conformation of the "R" group



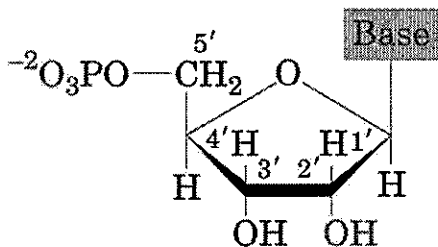
to life

made
carbon
have
the

Nucleic acids are polymers of nucleotides

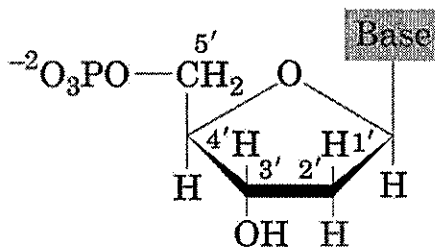
- **Nucleotides** are monomers that consist of pentose (the hexagon shape in the diagram) attached to a phosphate group (in red on diagram) and nitrogen base (in blue on diagram)
- **Pentose** can be deoxyribose (as in DNA or deoxyribose nucleic acid) or ribose (as in RNA or _____ nucleic acid)
- **DNA and RNA** are central to heredity and are made unique by the nitrogenous _____ that is attached
- **Nitrogenous bases** can be cytosine (C), thymine (T), uracil (U), adenine (A), or guanine (G)

(a)



Ribonucleotides

(b)

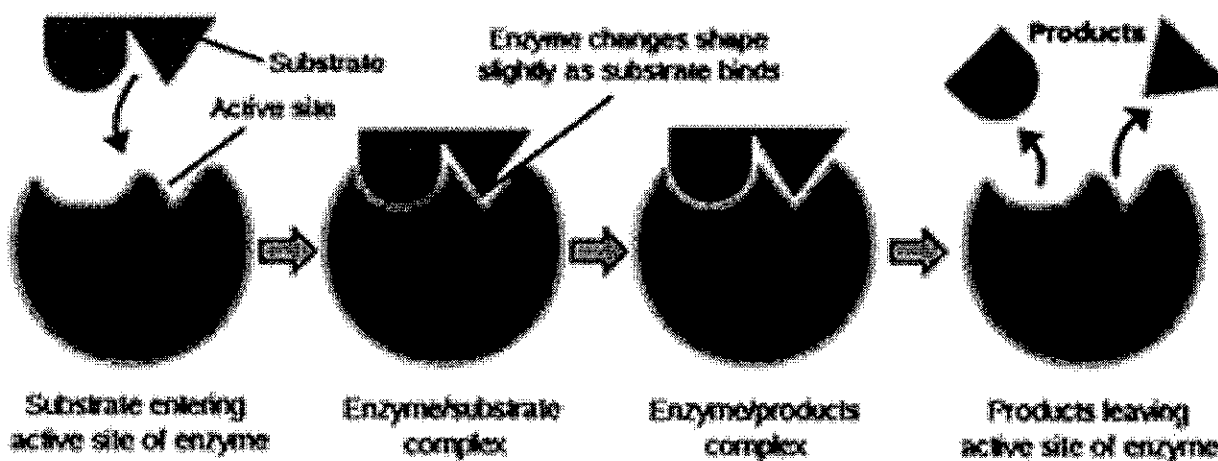


Deoxyribonucleotides

→ Use the outline above and video called "Biological Molecules" (<https://udkeystone.wikispaces.com/Organic+Chemistry>) to answer the review questions at the end of this section.

3rd Idea: Enzymes are mostly macromolecule proteins that act as biological catalysts

- **Catalysts** increase the rate of a reaction without being changed by the reaction
- **Substrates** are the reactants on which enzymes (catalysts) work
- **Rate of reaction** in both directions is increased by the presence of specific enzymes.
- _____ refers to the part of an enzyme that interacts with a substrate

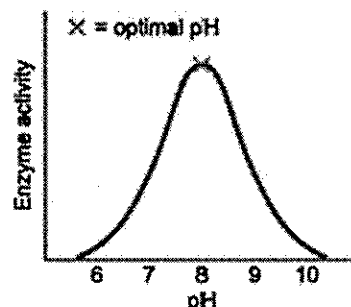
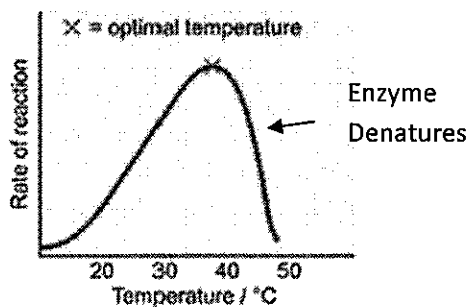
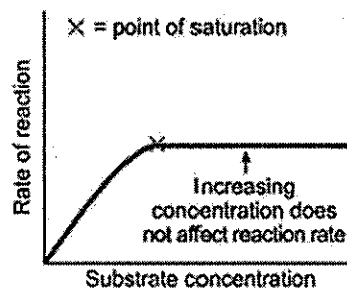
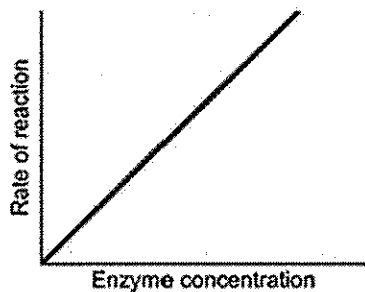


The rate of a reaction involving enzymes has to speed up at times and slow down at other times based on the needs of the organism.

→ Use the video called "Enzymes" (<https://udkeystone.wikispaces.com/Organic+Chemistry>) to answer the questions

- The process of turning enzymes on occurs through _____ or _____
 - _____ means the body only produces the enzyme when it is needed
- **Deactivation** of enzymes occurs through _____ or _____ inhibition
 - **Competitive inhibition** means another chemical bonds with and _____ the active site of the enzyme
 - _____ **inhibition** means another chemical bonds to the enzyme in a position away from the active site, but blocks or alters the active site as a result

4th Idea: Enzyme reaction rates are impacted by temperature, pH & substrate concentration



- **Temperature** is a measure of kinetic energy
 - **Kinetic energy** is the energy of motion. Higher temperature means _____ moving particles.
 - The **number of collisions** between enzymes and substrates is increased if the particles move around _____ (higher temperature)
 - Enzymes do not function well above or below the _____ temperature
 - The enzyme denatures, or breaks down, if the enzyme gets too _____
- **pH** measures acidity
 - Enzymes function best at the _____ pH level
 - If the conditions are too acidic (low pH) or too basic (high pH), the enzyme may denature
- **Concentration** is a measure of how many substrate molecules are present in a given volume.
 - _____ is the concentration where the reaction rate is maximized, the active sites of the enzymes are all used adding more substrate does not increase the rate of reaction.

→ Use the outline above and video called "Enzymes"

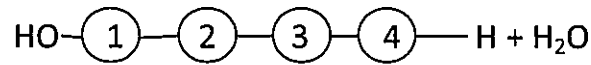
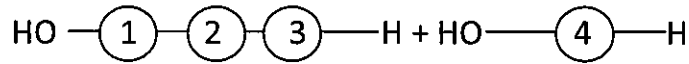
(<https://udkeystone.wikispaces.com/Organic+Chemistry>) to answer the questions on the next page.

Practice Questions:

1. Which statement correctly describes how carbon's ability to form four bonds makes it uniquely suited to form macromolecules?
 - A. It forms short, simple carbon chains.
 - B. It forms large, complex, diverse molecules.
 - C. It forms covalent bonds with other carbon atoms.
 - D. It forms covalent bonds that can exist in a single plane.

Use the diagram below to answer the question.

Chemical Reaction



2. The diagram shows a reaction that forms a polymer from two monomers. What is this type of reaction called?
 - A. glycolysis
 - B. hydrolysis
 - C. photosynthesis
 - D. dehydration synthesis

3. Carbohydrates and proteins are two types of macromolecules. Which functional characteristic of proteins distinguishes them from carbohydrates?
 - A. large amount of stored information
 - B. ability to catalyze biochemical reactions
 - C. efficient storage of usable chemical energy
 - D. tendency to make cell membranes hydrophobic

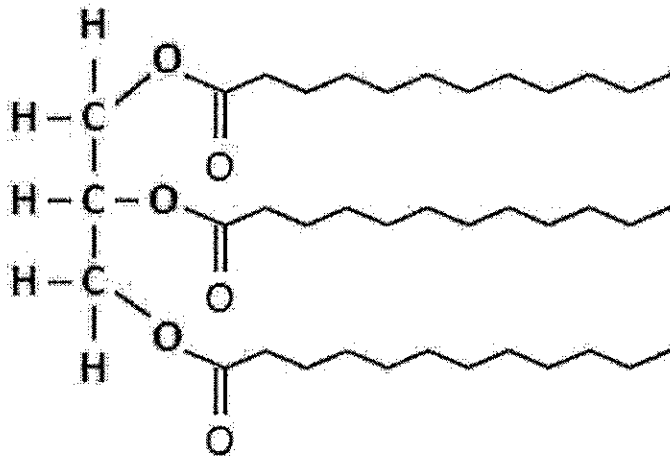
4. Substance A is converted to substance B in a metabolic reaction. Which statement **best** describes the role of an enzyme during this reaction?
 - A. It adjusts the pH of the reaction medium.
 - B. It provides energy to carry out the reaction.
 - C. It dissolves substance A in the reaction medium.
 - D. It speeds up the reaction without being consumed.

5. A scientist observes that, when the pH of the environment surrounding an enzyme is changed, the rate the enzyme catalyzes a reaction greatly decreases. Which statement **best** describes how a change in pH can affect an enzyme?
 - A. A pH change can cause the enzyme to change its shape.
 - B. A pH change can remove energy necessary to activate an enzyme.
 - C. A pH change can add new molecules to the structure of the enzyme.
 - D. A pH change can cause an enzyme to react with a different substrate.

6. Whenever biological organic compounds, such as proteins and carbohydrates, are broken down or synthesized...
 - a. a phase change of matter results.
 - b. thermal expansion occurs.
 - c. sunlight is required.
 - d. energy is absorbed or released.

7. Why does an enzyme function as a catalyst in a reaction?
 - a. It creates the right pH needed for the reaction.
 - b. It decreases the amount of energy needed for the reaction.
 - c. It provides the extra energy needed for the reaction.
 - d. It maintains the proper temperature needed for the reaction.

Examine the structural formula below.



8. Which of the following biomolecules is best represented by this formula?
- nucleic acid
 - protein
 - carbohydrate
 - lipid

Open-ended Question:

9. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

Part A: Describe the general composition of a protein molecule.

Part B: Describe how the structures of proteins differ from the structures of carbohydrates.

Part C: Describe how the functions of proteins differ from the functions of carbohydrates

Cells and Cell Transport

Vocabulary

cell
tissue
cell membrane (plasma membrane)
nucleus
ribosome
mitochondrion
chloroplast
protein synthesis
active transport
carrier (transport) proteins

concentration gradient
diffusion
endocytosis
endoplasmic reticulum
endosymbiosis
exocytosis
facilitated diffusion
extracellular
golgi apparatus
impermeable

intracellular
organelle
osmosis
passive transport
plastids

pumps (ion or molecular)
unicellular
multicellular

Concepts to Know

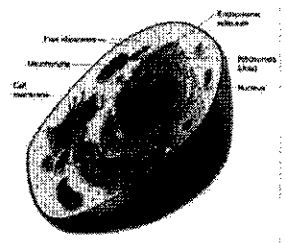
What is the Cell Theory?

1. All living things are made of cells.
2. Cells are the basic units of structure and function in living things.
3. New cells are produced from existing cells.

Differences between Prokaryotic vs Eukaryotic Cells

1. **Prokaryotic Cells:** Single-celled organisms that lack internal membrane bound compartments (Genetic material (DNA) is in a circular molecule) (simple) i.e. bacteria. -Hypothesized that the first type of cells on earth were prokaryotic
2. **Eukaryotic Cells:** Cells with membrane bound compartments with organelles such as, the nucleus. (more complex) i.e. animal and plant cells

Eukaryotic



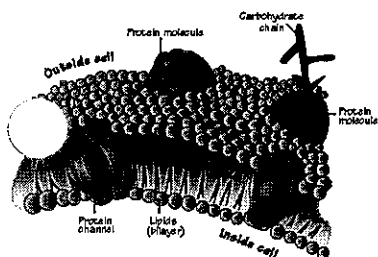
Directions: Write a **P** if the statement refers to Prokaryotes and an **E** if the statement refers to Eukaryotes, if the statement refers to both Prokaryotes and Eukaryotes write a **B** on the line.

- ___ 1. This type(s) of cell does not have bound compartments.
- ___ 2. This type(s) of cell contains DNA.
- ___ 3. This type(s) of cell contains organelles.
- ___ 4. A bacteria cell is an example of this type of cell.
- ___ 5. This type(s) of cell contains a nucleus.

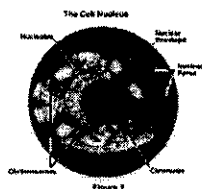
Cell Structures & Functions

All cells are enclosed by a cell membrane (plasma membrane). Within the membrane is the nucleus and the cytoplasm. Within the cytoplasm are organized structures that perform specific functions. These structures are called organelles. **Please Note-**The letters next to the structure of the cell indicates if it is found in **A =animal cells** and **P = plant cells**.

(A, P) Cell Membrane- surrounds the cell. It plays an active role in determining which substances enter and exit the cell. Some substances can pass freely through the cell membrane and others cannot, the membrane is said to be selectively permeable, or semipermeable. The cell membrane is composed of lipids (phospholipids) and proteins.



(A, P) Nucleus- control center for all cell functions. Within the nucleus are chromosomes and at least one nucleolus. The **nucleolus is a site of RNA synthesis**, and it may also be responsible for the production of ribosomes.

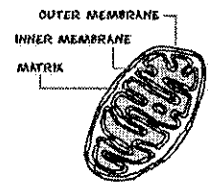


(A, P) Cytoplasm- the material in the cell outside the nucleus. It consists

mainly of water. Within the cytoplasm are the various organelles of the cell. The cytoplasm provides the environment in which the organelles carry on the life processes of the cell.

(A, P) Mitochondria- are found in the cytoplasm. Most stages of cellular respiration occur in the mitochondria. The energy released during respiration is stored in the form of high-energy chemical bonds in molecules of ATP.

(P)Chloroplasts-contain green pigment called chlorophyll, which carries on the process of photosynthesis.



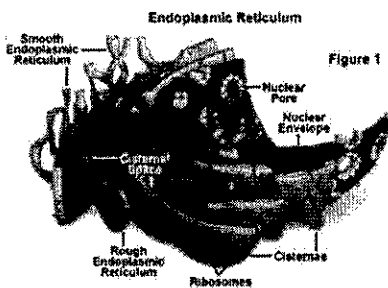
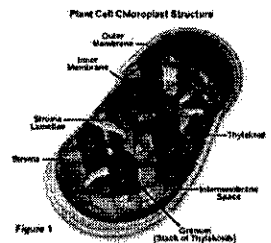
Mitochondria & Chloroplast-Developed from prokaryotic cells? WHAT?!?!

Check out this really good explanation...<http://www.youtube.com/watch?v=fAjev01mDZM>

Related questions:

1. Why are these two organelles unique?
2. What are two characteristics about mitochondria and chloroplast that make it similar to prokaryotic bacteria cells?
3. What is the endosymbiotic theory?

(A, P) Ribosomes- are small, dense granules(look like tiny circles on the diagrams) found free in the cytoplasm and the nucleus and lining the membranes of some endoplasmic reticulum. Ribosomes are composed mainly of RNA. They are the centers of protein synthesis in the cell.

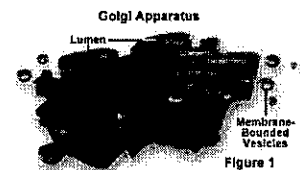


(A, P) Endoplasmic reticulum-is a membrane-bound system of channels or tubes through which materials are transported within the cell. The membranes of the ER may also serve as sites of biochemical reactions. There are two types smooth and rough. The rough appearance is due to the presence of ribosomes on the membrane. **Rough ER** is found mainly in cells involved in protein synthesis. **Smooth ER** which has no ribosomes, is found mainly in cells involved in synthesis of nonprotein substances.

(A, P) Golgi Apparatus- is made up of a series of membrane-enclosed sacs, and it is usually found near the nucleus. This organelle is associated with the production of lysosomes and with the synthesis of various secretions.

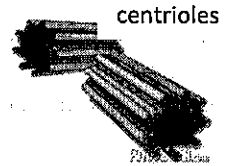
(A) Lysosomes- are “packages” or sacs, of digestive enzymes. They keep the enzymes separated from the rest of the cell contents until they are needed.

(A, P) Vacuoles: are membrane-enclosed structures that are generally filled with water containing various dissolved substances. Vacuoles in animal cells are usually small, and



vacuoles in plants are using large. The pressure created by the large vacuole helps to maintain the rigid structure of the plant cell and of the plant.

(A, P) Centrosome-are small organelles found just outside the nucleus in animal cells. Within the centrosome of animal cells are two small structures called **centrioles**, which are necessary for the movement of chromosomes during cell division.

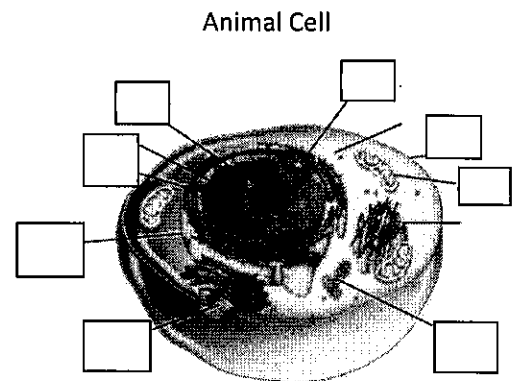
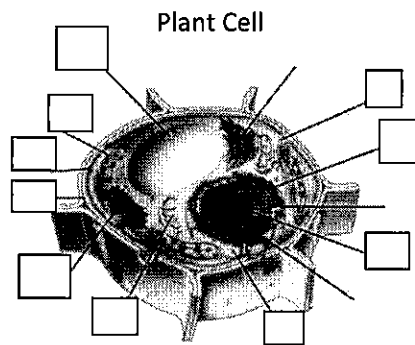


(P) Cell Wall- structure found outside the cell membrane of plant cells. The cell wall is made up mostly of cellulose, and it provides support for the cell.

(A, P)Cytoskeleton- is a filamentous network of proteins that are associated with the processes that maintain and change cell shape and produce cell movements in animal and bacteria cells. In plants, it is responsible for maintaining structures within the plant cell, rather than whole cell movement. **The main types of filaments** the make up the cytoskeleton are Microfilaments and Microtubules.

3. Use the following structure letters to label the structures indicated in the eukaryotic plant and animal cells.

- A. Cell membrane
- B. Nucleus
- C. Nucleolus
- D. Chromosome
- E. Cell Wall
- AB. Centriole
- AC. Mitochondria
- AD. Lysosome
- AE. Endoplasmic reticulum
- BC. Golgi Apparatus
- BD. Vacuole
- BE. Chloroplast



4. Fill in the names of the structures whose functions are listed below. Use the list of structures above for help.

Structure	Function
	Cellular Respiration
	Protein Synthesis
	Contains the hereditary information
	Storage of water, undigested food, and/or waste
	Active in movement of the chromosomes during cell division
	Storage of digestive enzymes
	Transport within the cytoplasm
	Packages secretions

Two Types of Cellular Transport

The cell membrane is semipermeable, some substances can pass through it freely, while others cannot. The movement of substances that can pass freely through the membrane depends only on the concentration gradient for that substance.

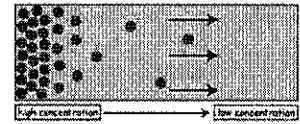
1. Passive Transport

- Does not use energy
- Moves from a high concentration to a low concentration

Examples:

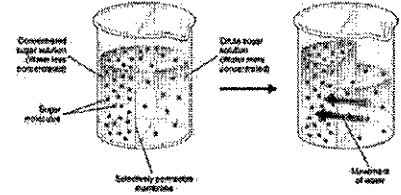
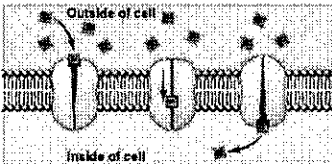
- **Diffusion:** The movement of particles from regions of higher density to regions of lower density across the cell membrane
- **Facilitated Diffusion:** Transport proteins help ions and polar molecules diffuse through the membrane
- **Osmosis:** The diffusion of water across a selectively permeable membrane.

Diffusion

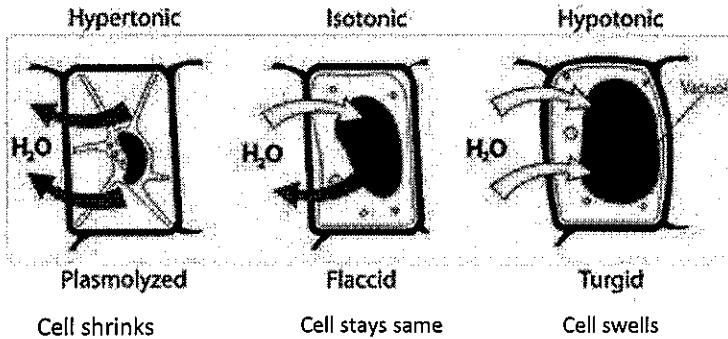


● solute
Solute transport is from the left to the right; movement of the solutes is due to the concentration gradient (dC/dx).

Facilitated Diffusion



Types of Solutions



2. Active Transport

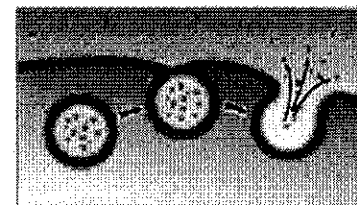
- Requires energy
- Moves from a low concentration to a high concentration

Examples:

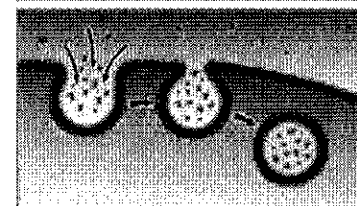
- **Endocytosis:** The movement of a large substance **into** a cell by means of a vesicle
- **Exocytosis:** The movement of material **out** of a cell by means of a vesicle

6. Circle the diagram letter that shows **Endocytosis?** A or B

7. Circle the diagram letter that shows **Exocytosis?** A or B



A



B

Sodium-potassium pump: One of the most important carrier proteins in animal cells. In nerve cells the pump is used to generate gradients of both sodium and potassium ions. These gradients are used to propagate electrical signals that travel along nerves.

→ Watch this cool animation on the sodium-potassium pump, and take the quiz! Record your answers to the questions below as you take the quiz.

http://highered.mcgraw-hill.com/sites/9834092339/student_view0/chapter38/sodium-potassium_exchange_pump.html

1. ____ 2. ____ 3. ____ 4. ____ 5. ____

More Questions!

8. What is passive transport?

9. The paramecium is a fresh water protozoan. The salt content of its cytoplasm is greater than that of the surrounding medium.
 - a. Does water tend to enter or leave the paramecium? Is this process of passive or active transport?

 - b. How does the paramecium expel water? Is this a process of passive or active transport? Explain.

10. Where does the energy for active transport come from?

Practice Questions:

1. Using a microscope, a student observes a small, green organelle in a plant cell. Which energy transformation **most likely** occurs first within the observed organelle?
 - a. ATP to light
 - b. light to chemical
 - c. heat to electrical
 - d. chemical to chemical

2. Carbon dioxide and oxygen are molecules that can move freely across a plasma membrane. What determines the direction that carbon dioxide and oxygen molecules move?
 - a. orientation of cholesterol in the plasma membrane
 - b. concentration gradient across the plasma membrane
 - c. configuration of phospholipids in the plasma membrane
 - d. location of receptors on the surface of the plasma membrane

3. A sodium-potassium pump within a cell membrane requires energy to move sodium and potassium ions into or out of a cell. The movement of glucose into or out of a cell does not require energy. Which statement **best** describes the movement of these materials across a cell membrane?
 - a. Sodium and potassium ions move by active transport, and glucose moves by osmosis.
 - b. Sodium and potassium ions move by active transport, and glucose moves by facilitated diffusion.
 - c. Sodium and potassium ions move by facilitated diffusion, and glucose moves by osmosis.
 - d. Sodium and potassium ions move by facilitated diffusion, and glucose moves by active transport.

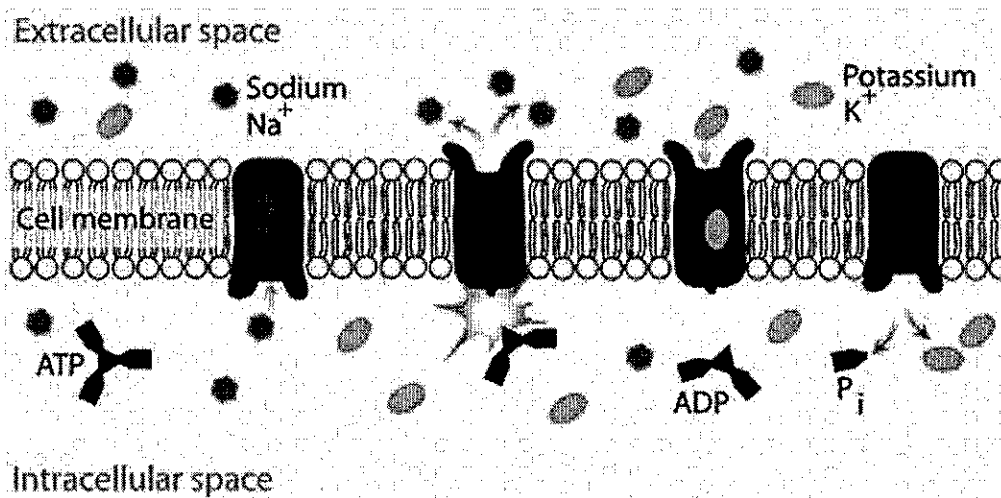
4. The rough endoplasmic reticulum and Golgi apparatus work together in eukaryotic cells. What is one way that the rough endoplasmic reticulum assists the Golgi apparatus?
 - a. It assembles nucleic acids from monomers.
 - b. It breaks down old, damaged macromolecules.
 - c. It packages new protein molecules into vesicles.
 - d. It determines which protein molecules to synthesize.

In many eukaryotic cells, DNA stored in the nucleus is transcribed into messenger RNA. The mRNA is then transported into the cytoplasm where ribosomes assist in their translation into proteins. Finally, these proteins are packaged and sorted in the Golgi apparatus for use in other parts of the cell or in preparation for secretion into other cells.

5. Which of the following statements is supported by this description?
 - a. Various organelles within a cell interact with each other to carry out life processes.
 - b. Organelles within a cell act independently of each other at all times.
 - c. Some organelles are more important than other organelles within a cell.
 - d. Only up to three organelles may interact with each other at any given moment in time.

6. The cell membrane serves many functions. One of the cell membrane's functions is to help the cell maintain homeostasis. Which of the following statements best supports this claim?
 - a. The cell membrane contains a polar region and a nonpolar region.
 - b. The cell membrane contains proteins.
 - c. The cell membrane contains phospholipids.
 - d. The cell membrane regulates what goes in and out of the cell.

In order for nerve cells and muscle cells to function properly, they require a high concentration of potassium ions inside the cells and a high concentration of sodium ions outside the cells. To maintain this condition, cells utilize sodium-potassium pumps embedded within their cellular membranes to move the ions against their concentration gradients.



7. Since sodium-potassium pumps require an input of energy to operate, they are an example of...
 - a. passive transport.
 - b. facilitated diffusion.
 - c. filtration.
 - d. active transport.

8. Most organisms can be divided into two categories - prokaryotes and eukaryotes. What is the main difference between these two categories?

- a. Eukaryotes are living organisms whereas prokaryotes include some nonliving matter.
- b. Prokaryotes do not possess any means of locomotion and are thus unable to move.
- c. Prokaryotes do not possess a nucleus or any other membrane-bound organelles.
- d. Eukaryotes are found in all of the six major taxonomic kingdoms.

When a person inhales, oxygen fills tiny air sacs in the person's lungs. Next, the oxygen moves from these air sacs into small blood vessels that line the lungs, and then it moves into the bloodstream so that it can be transported around the body.

Oxygen moves by random molecular motion from the air sacs of the lungs to the blood vessels because the concentration of oxygen in the air sacs is higher than the concentration of oxygen in the blood vessels.

- 9. This movement of oxygen molecules from an area of higher concentration to an area of lower concentration is known as _____.
 - a. diffusion
 - b. osmosis
 - c. respiration
 - d. photosynthesis

- 10. Energy conversion within an animal cell would be severely limited by removal of the cell's
 - a. lysosomes.
 - b. plastids.
 - c. chloroplasts.
 - d. mitochondria.

Open-ended Question:

11. Some animals can produce a potassium ion concentration inside their cells that is twenty times greater than that of their environment. This ion concentration gradient is maintained by the plasma membrane.

Part A: Identify the process in the cell membrane that produces this difference in concentration.

Part B: Explain the process that occurs as the cell produces the ion concentration gradient.

Part C: Compare the process of potassium ion transport to another mechanism that moves material across the plasma membrane.

Energy

Vocabulary

Photosynthesis
cellular respiration

electron transport chain
ATP

Concepts to Know

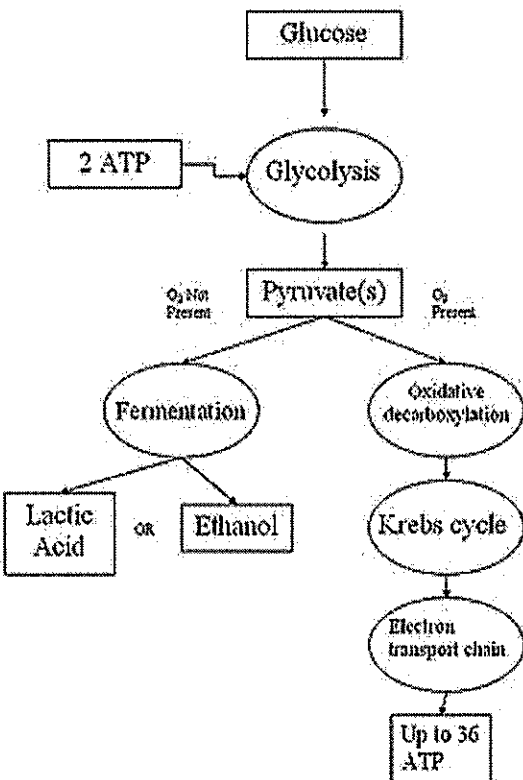
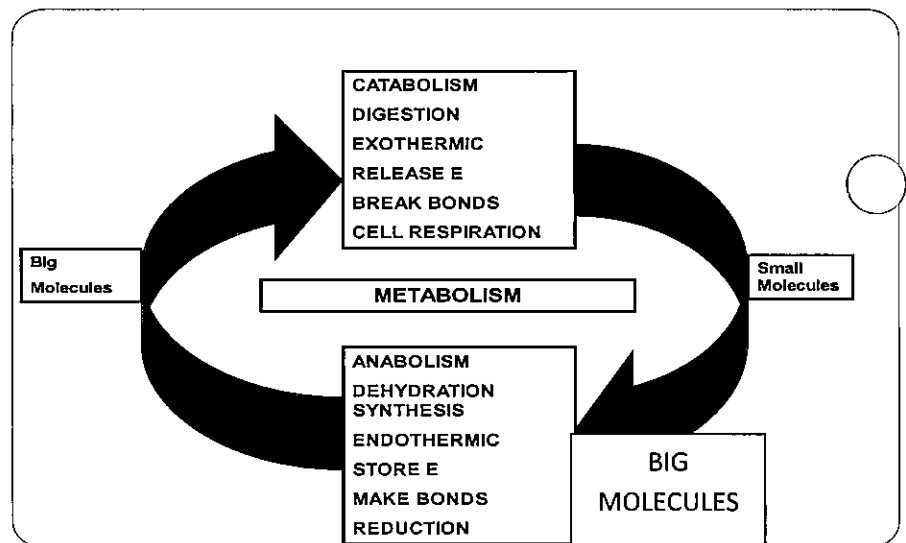
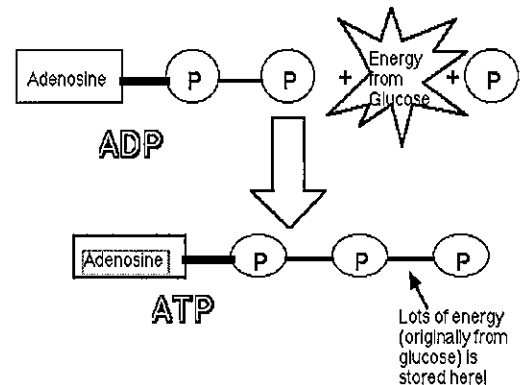
WHAT DOES LIFE NEED? ENERGY!!

It either supplies itself (AUTO-TROPH / self – feed) or it eats something (HETERO – TROPH / other – feed)

The **Laws of Thermodynamics** dictate that no energy can be created or destroyed, it can only change forms. Chemical bonds are literally energy. When you eat something, you get energy for movement or growth from the energy locked in the food's bonds. The trick to life is how to store that energy until you need it. **The short-term storage molecule that ALL life has evolved to use is adenosine triphosphate, or ATP.**

Catabolic Pathways → break down molecules so that Anabolic Pathways → build up molecules

ATP IS THE GO BETWEEN

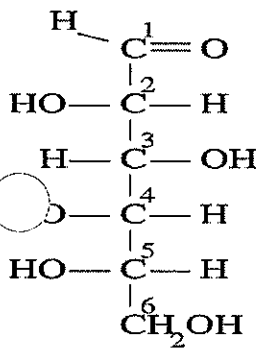
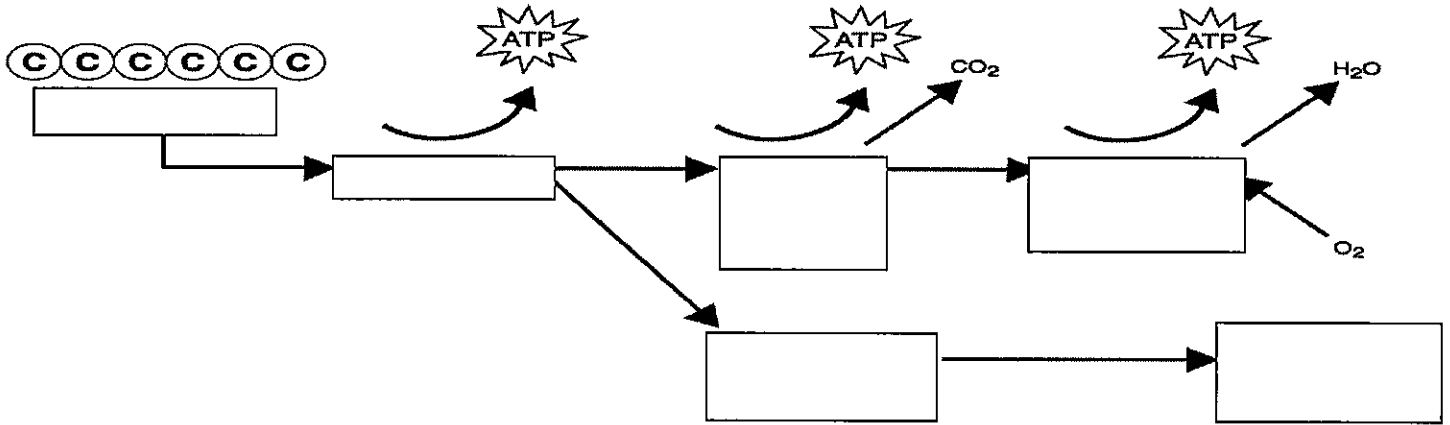


1st Idea: Cell Respiration

- The major way organisms harness energy.
- Large food molecules are taken in and ultimately the monosaccharide GLUCOSE is digested to capture its energy
 - $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$
 - There are multiple steps to the breakdown of glucose so that not all of the energy is released at once
 - The steps are different depending if oxygen (**aerobic**) is present or not (**anaerobic**)
 - Aerobic Respiration: glycolysis → Krebs cycle → electron transport chain (ETC)

- Anaerobic Respiration: glycolysis → fermentation
- Glycolysis occurs in the cytoplasm for prokaryotes and eukaryotes
- The Krebs Cycle and ETC occur in the mitochondria of eukaryotes
- Prokaryotes use their cell membranes to create an electron transport chain

Label the diagram with the following terms: alcohol/lactic acid; Krebs Cycle, glucose, fermentation, glycolysis, ETC

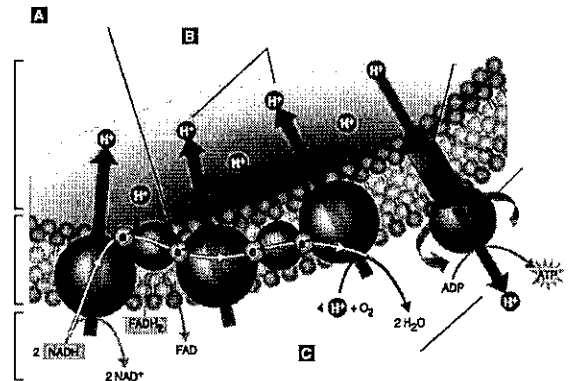


- It's all about rearrangement
- Every line in the picture of glucose to the left is energy (a line = a bond)
- During glycolysis, glucose (6C) is broken in half so a little energy is released with that broken bond...it is put into making ADP into ATP
- Whenever a bond breaks in this process, an electron and a hydrogen need to be accounted for. A molecule NAD⁺ picks them up to form NADH
- This concept continues in the Krebs Cycle – which will eventually break all of the bonds of the original glucose molecule. The carbons will leave as CO₂. The hydrogens and electrons were put into NADH.

• **The MOST important part of Cell**

Respiration is the electron transport chain. All of the NADH that was formed so far drops off the electrons and the hydrogens at the inner membrane of the mitochondria (for eukaryotes). This membrane has proteins in it that pass the electrons to each other. Electrons are a different form of energy and can power the protein channels to open (this is active transport).

- **The point of the electron transport chain** is to pump hydrogen ions (also from the NADH) across the membrane into a tiny space.
- **WHY?** It seems silly, but almost all life does this process. By building a gradient of H⁺ ions in this tiny mitochondrial space, the H⁺ build up and need to diffuse out, through a special channel called ATP synthase (this is passive transport). This molecule literally spins as H⁺ goes through it and makes ATP from ADP.
- **What about the oxygen?** After passing the electron down the chain to make the gradient happen (which is known as *chemiosmosis*), the electron has to go somewhere. It would cause damage in your cell otherwise. Oxygen is there to pick it up and combine it with the hydrogens to make...WATER!



What do I need to know?

The overall equation: _____

What organisms undergo cellular respiration? _____

What are the 3 major steps of aerobic respiration? _____

What will happen if there isn't oxygen present? _____

What is the purpose of cellular respiration? _____

2nd Idea: Photosynthesis

Where does the sugar come from in the first place that will get broken down in cellular respiration?!?!

- Occurs in photosynthetic **autotrophs** (plants, algae, some bacteria); in the chloroplast of eukaryotes
- Has **2 major steps: the light reaction and the Calvin cycle**
- The **Light Reaction generates ATP and NADPH** (an electron and hydrogen carrier) so that the Calvin Cycle can run
- The **Calvin Cycle is the part that makes the sugar**. Carbon dioxide comes into a plant (via leaf stomata) and is joined together with other carbons in the cell to ultimately make glucose (6 carbons). Making bonds requires energy in this process, which is why ATP and some extra electrons and hydrogens are needed.
- $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
- The input of energy to start the light reaction is from sunlight!
- The **sunlight** is powerful enough to knock an electron from a molecule of chlorophyll in the chloroplast. That electron then opens a protein channel in the electron transport chain in a chloroplast. This process is just like chemiosmosis in cell respiration. The difference is oxygen is a product of this reaction. We have to water plants because the electron from the chlorophyll molecule needs to get replaced to keep the process going.

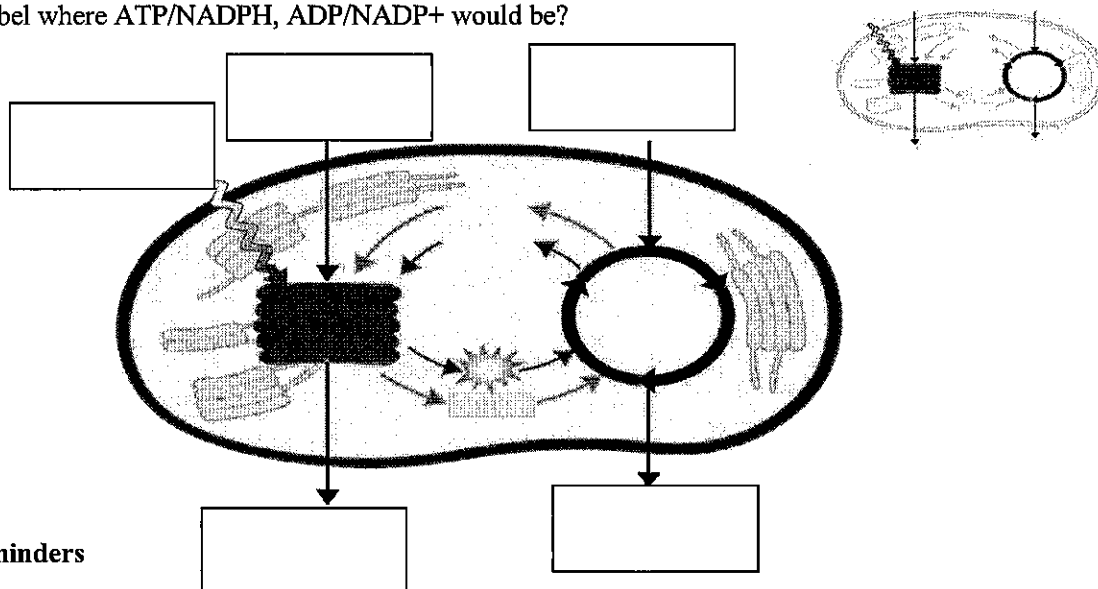
What you need to know:

PLANTS PHOTOSYNTHESIZE AND DO CELL RESPIRATION!!!! They have chloroplasts AND mitochondria!

Major input and outputs of the process.

➔ Label the diagram below with the following: **CO₂, O₂, Water, Glucose, sunlight**

➔ Bonus: can you label where ATP/NADPH, ADP/NADP⁺ would be?



FYI: Photosynthesis Reminders

Light-Dependent Reactions "The Light Reactions"	Light-Independent Reactions "The Dark Reaction"/The Calvin Cycle
<p>WHAT → photosynthetic reactions that requires light.</p> <p>WHERE → thylakoid (membrane & inside)</p> <p>HOW → uses light & water to produce oxygen and converts ADP to ATP and NADP+ to NADPH</p> <p>"WHO" → Photosystem II & Photosystem I Various proteins embedded in the thylakoid membrane</p> <p>WHY → captures sunlight energy to produce ATP which will eventually be used to construct the glucose molecules.</p> <p>WHEN → when the sunlight shines</p>	<p>WHAT → produces sugars by using the energy from ATP & NADPH formed during light-dep rxn</p> <p>WHERE → in the stroma of the chloroplast</p> <p>"WHO" → Rubisco; uses CO₂ from outside & existing carbon molecules in the cell (RuBP)</p> <p>WHEN → doesn't depend on sun</p> <p>WHY → plant needs to produce high-energy glucose molecules for growth & dev't</p> <p>HOW → uses the ATP & NADPH energy stored in those bonds to create the new bonds of glucose</p>

COMPARISON QUESTIONS

Answer **P** for Photosynthesis, **CR** for Cell Respiration, or **B** for both

_____ Releases O ₂	_____ Releases CO ₂	_____ Uses CO ₂
_____ Creates ATP during the process	_____ Produces sugar	_____ Uses sugar

Answer **A** for Animals, **P** for Plants, or **B** for both

_____ Releases O ₂	_____ Releases CO ₂	_____ Uses CO ₂
_____ Creates energy in the form of ATP	_____ Produces sugar	_____ Uses sugar

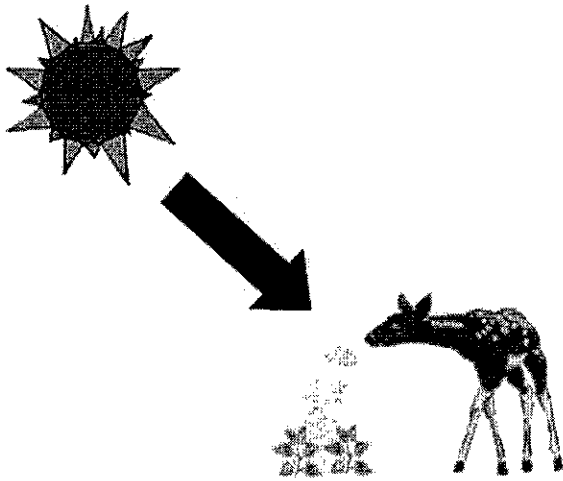
Key Connections

- Autotrophs (photosynthesizers) are always the basis of the food chain. The energy in glucose has to come from somewhere!
- The oxygen on the planet is from photosynthesizers

Practice Questions:

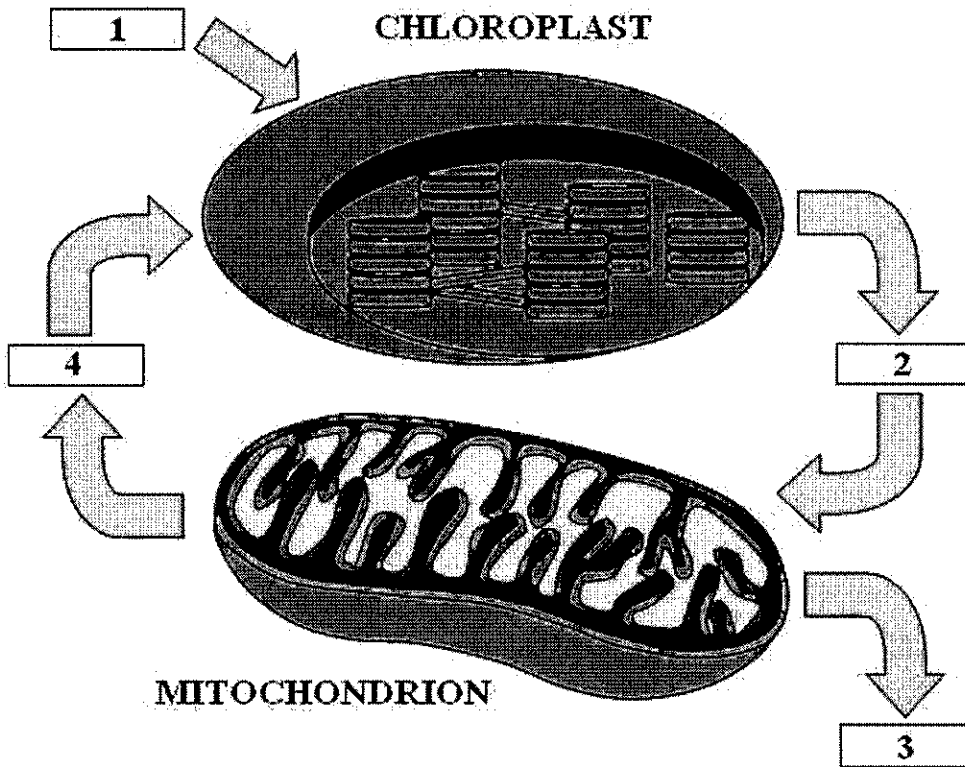
1. Photosynthesis and cellular respiration are two major processes of carbon cycling in living organisms. Which statement correctly describes one similarity between photosynthesis and cellular respiration?
 - a. Both occur in animal and plant cells.
 - b. Both include reactions that transform energy.
 - c. Both convert light energy into chemical energy.
 - d. Both synthesize organic molecules as end products.

The energy for life comes primarily from the Sun.



2. What process provides a vital connection between the Sun and the energy needs of living systems?
- decomposition
 - cellular respiration
 - transpiration
 - photosynthesis

The processes of photosynthesis and cellular respiration form a continuous cycle.



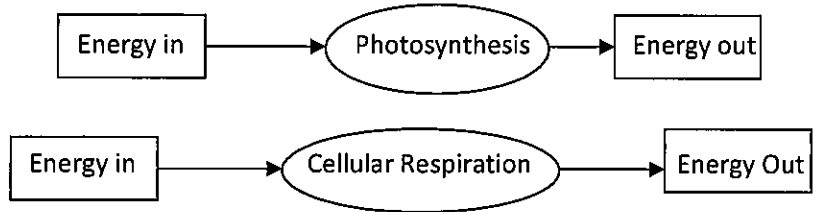
3. During this cycle, the products from one process serve as the starting materials for the other. Which of the following materials correspond(s) to box number 3?
- sunlight
 - carbon dioxide and water
 - ATP (energy) and heat
 - oxygen and glucose

4. A protein in a cell membrane changed its shape to move sodium and potassium ions against their concentration gradients. Which molecule was **most likely** used by the protein as an energy source?

- a. ATP
- b. ADP
- c. catalase
- d. amylase

Open-ended Question:

5. Use the diagrams below to answer the question.



Part A: Complete the chart below by describing energy transformations involved in each process.

Process	Energy Transformations
Photosynthesis	
Cellular Respiration	

Part B: Describe how energy transformations involved in photosynthesis are related to energy transformations involved in cellular respiration.

Cell Reproduction & Genetics

Vocabulary

Allele	Gene	Mitosis
Cell cycle	Gene splicing	Multiple alleles
Chromosomes	Gene therapy	Nondisjunction
Cloning	Gene recombination	Polygenic trait
Co-dominance	Genetic engineering	Recessive inheritance
Crossing over	Genetics	Semiconservative replication
Cytokinesis	Incomplete dominance	Sex-linked trait
DNA replication	Inheritance	Genetically modified organism
Dominant inheritance	Interphase	genotype
Gamete	Meiosis	phenotype

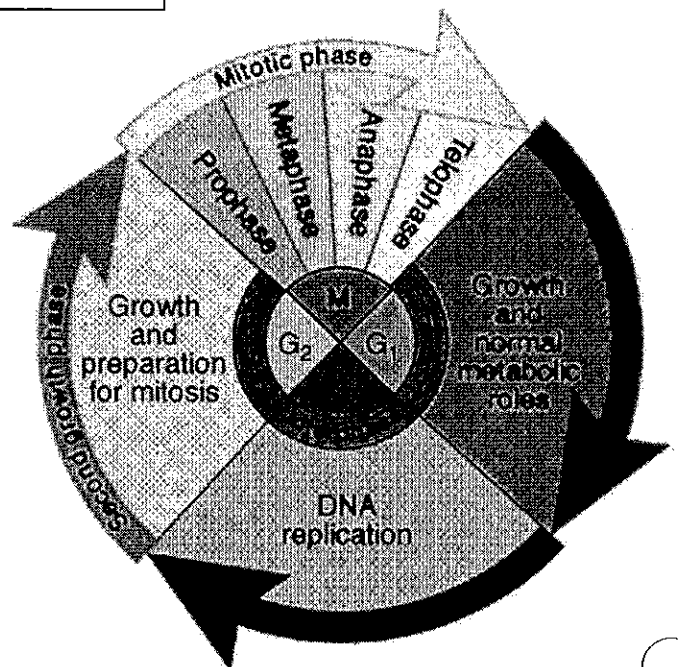
Concepts to Know

Main Concept #1: Describe the events that occur during the cell cycle: interphase, nuclear division (i.e. mitosis), cytokinesis.

- The Cell cycle – period of time from the beginning of one cell division to the beginning of the next
 - During the cell cycle, a cell grows, prepares for division, and divides to form two daughter cells, each of which then begins the cell cycle again
 - Consists of 4 phases
 - M phase – mitosis – the division of the cell nucleus and cytokinesis
 - G1 – intense growth and activity
 - S phase – copying of chromosomes
 - G2 – intense growth and activity
 - G stands for gap

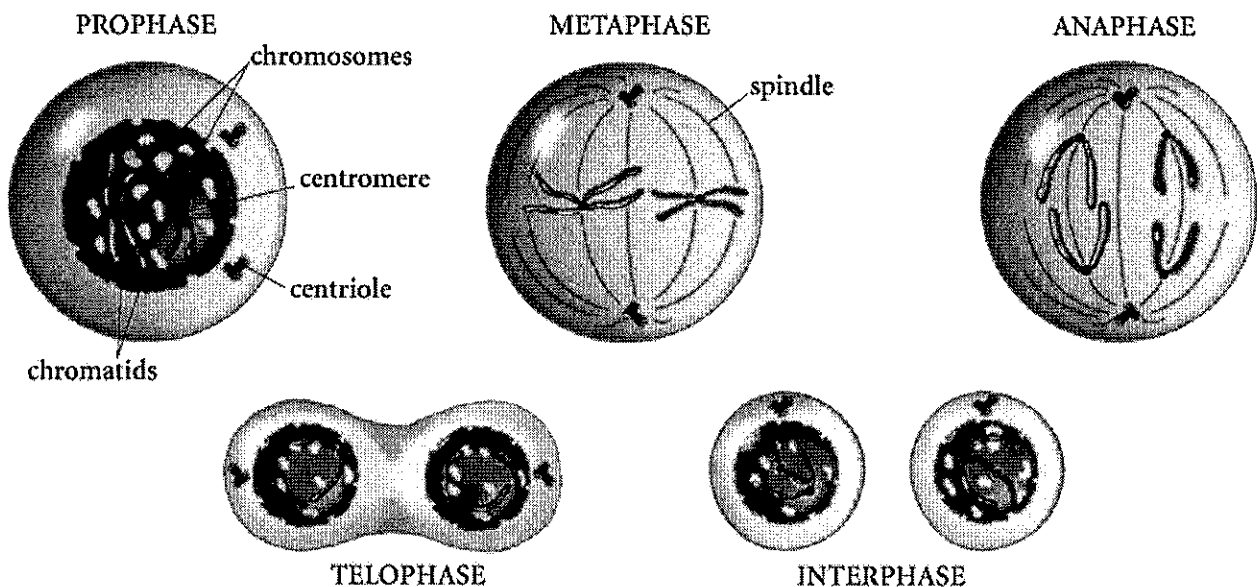
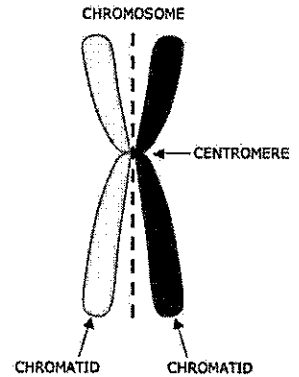
Interphase

- Interphase – time between two cell divisions
 - Interphase can be broken into 3 phases: G1, S, G2
 - G1 → cells do most of their growing, increasing in size and synthesizing new proteins and organelles
 - S → chromosomes are duplicated and the synthesis of DNA molecules takes place
 - Once cell enters S phase, it completes cell cycle
 - G2 → usually shortest of 3 phases
 - Organelles and proteins required for cell division are produced
 - Cell enters M phase once complete



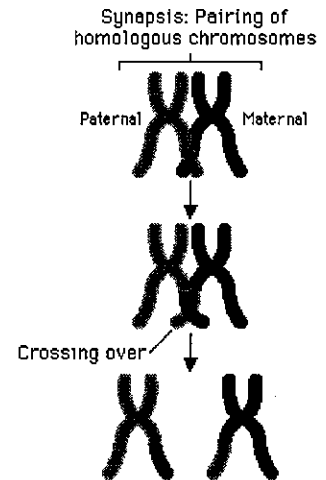
MITOSIS

- Biologists divide the events of mitosis into 4 phases: prophase, metaphase, anaphase, and telophase
 1. prophase – 1st and longest phase of mitosis (50-60% of total time)
 - chromosomes become visible
 - centrioles separate and take up positions on opposite sides of the nucleus
 - focal point that helps organize spindle (fan-like microtubule structure that helps separate the chromosomes)
 - chromosomes attach to spindle at the centromere
 - plants do not have centrioles
 - organize spindle from areas called centrosomes
 - nucleolus disappears
 - nuclear envelope breaks down
 2. metaphase – 2nd phase of mitosis
 - chromosomes line up along center of the cell
 - microtubules connect the centromere of each chromosome to the poles of the spindle
 3. anaphase – 3rd phase of mitosis
 - centromeres that join the sister chromatids split
 - chromatids separate and become individual chromosomes
 - chromatids get pulled apart, to the poles of the spindle
 - ends when they stop moving
 4. telophase – 4th phase of mitosis
 - chromosomes become loose and begin to disperse
 - nuclear envelope reforms
 - spindle breaks apart
 - a nucleolus reappears
 - cytokinesis – division of the cytoplasm
 - usually occurs at the same time as telophase
 - in animals, cell membrane pinches in at the middle
 - in plants, cell plate forms midway through the cell
 - beginning at the cell wall

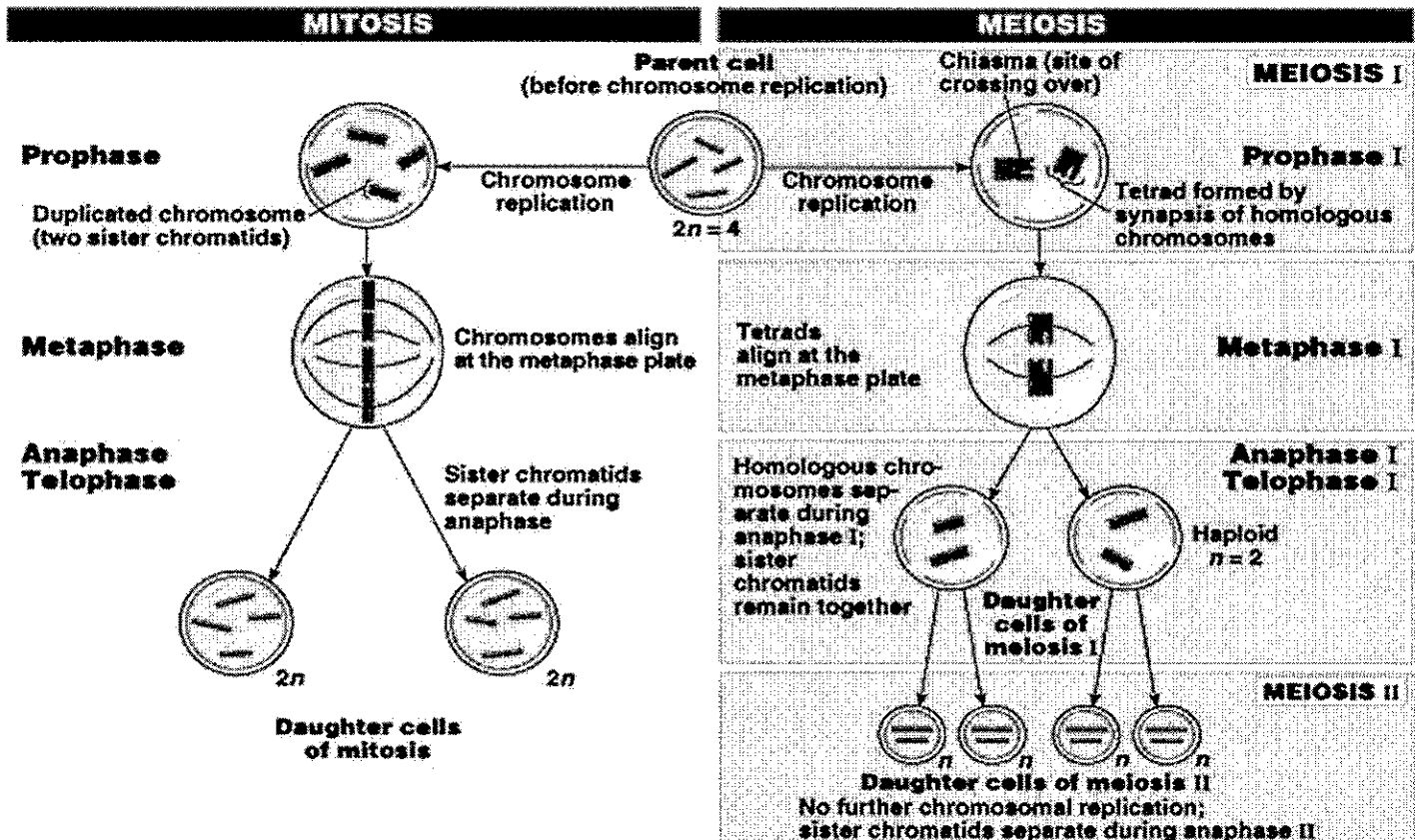


MEIOSIS

- meiosis is a process of reduction division in which the number of chromosomes per cell is cut in half and homologous chromosomes in a diploid cell are separated
 - involves two distinct stages: meiosis I and meiosis II
 - one diploid cell becomes 4 haploid cells
- homologous – two sets of chromosomes (one from mom and one from dad)
 - if a cell has both sets of chromosomes = diploid ($2n$)
 - 2 complete sets of chromosomes with 2 complete sets of genes
 - gametes with only one set of chromosomes = haploid (n)
 - contain only one set of genes
- meiosis I – prior to meiosis I, each chromosome is replicated
 - chromosomes line-up similar to mitosis, except the homologous chromosomes for a tetrad (4 chromatids)
 - occurs during prophase I
 - crossing over may occur – results in the exchange of alleles between homologous chromosomes and produces new combinations of alleles
 - homologous chromosomes separate and two new cells are formed
- meiosis II – cells from meiosis I enter meiosis II
 - cell does not undergo chromosome replication
 - anaphase II – chromatids separate



Main Concept #2: Compare the processes of mitotic and meiotic nuclear division.



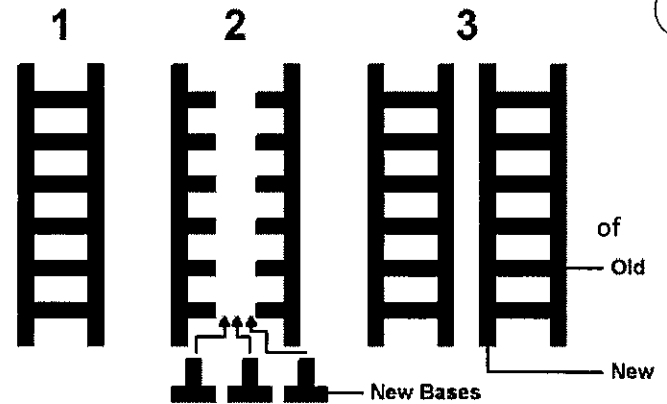
In the table provided, check all of the parts of the cell cycle that apply to the description in the left column. In mitosis, meiosis I, and meiosis II columns – state whether it happens in prophase (P), metaphase (M), anaphase (A), or telophase (T)

Description / Event	Interphase	Mitosis	Meiosis I	Meiosis II	Neither
Nuclear membrane breaks down					
Sex cells result					
Daughter cells are identical to parent					
Body cells result					
Chromatids line up single file during metaphase					
Final chromosome # is the same as the parent cell					
Diploid cells result at end					
Homologous chromosomes join					
Tetrads form					
DNA is replicated					
Chromosomes are double file					
Cytokinesis begins					
Transcription / translation occur					
Spindle fibers form					
Haploid Cells Result					
Sister chromatids separate					
Crossing over happens					
DNA Replication occurs					

- nondisjunction – failure of homologous chromosomes to separate during meiosis
 - if nondisjunction occurs, abnormal numbers of chromosomes may find their way into gametes, and a disorder chromosome numbers may result

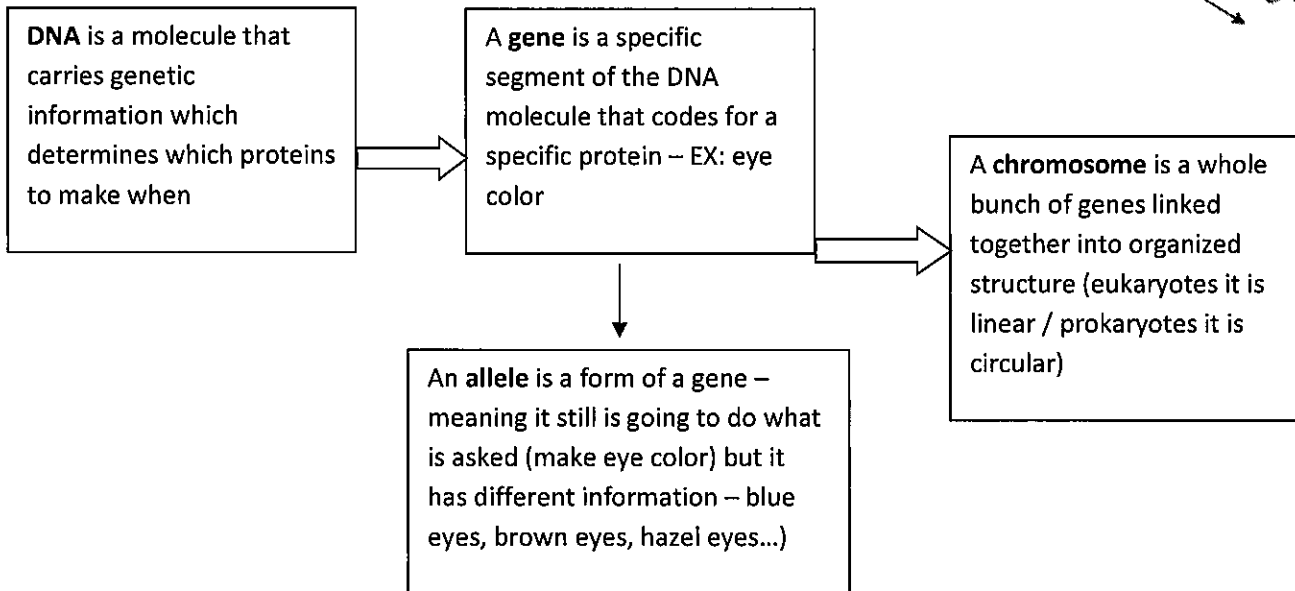
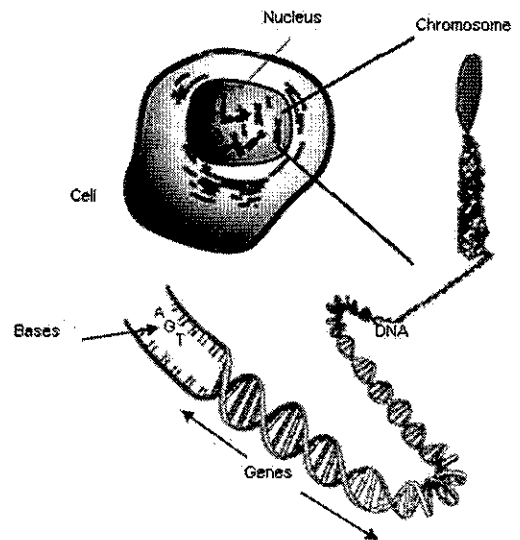
Main Concept #3: Describe how the process of DNA replication results in the transmission and/or conservation of genetic information.

- DNA Replication – copying of DNA
 - Ensures that each resulting cell will have a complete set of DNA molecule
 - During DNA replication, the DNA molecule separates into two strands, then produces two new complementary strands following the rules of base pairing. Each strand of the double helix of DNA serves as a template against which the new strand is made → called semiconservative replication



Main Concept #4: Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.

- Two conclusions from Mendel’s experiments with the pea plant
 1. biological inheritance is determined by factors that are passed from one generation to the next = **genes**
 - each gene controlled one trait with two contrasting characters
 - different forms of a gene = **alleles**
 2. principle of dominance – states that some alleles are dominant and others are recessive
 - organism with dominant allele for a particular form of a trait will always have that form
 - organism with recessive allele for a particular form of a trait will have that form only
- Segregation – separation of alleles
 - Done during formation of gametes (reproductive cells)



Main Concept #5: Describe and/or predict observed patterns of inheritance (ie. dominant, recessive, co-dominance, incomplete dominance, sex-linked, polygenic, and multiple alleles).

- Probability – likelihood that a particular event will occur
 - Probability of two events happening, you multiply the individual probabilities
 - Past outcomes do not affect future ones
 - The principles of probability can be used to predict the outcomes of genetic crosses
- Punnett square – diagram that helps determine gene combinations that might result from a genetic cross
- Capital letters represent dominant alleles; lower case letters represent lower case letters
- Homozygous – have two identical alleles – true-breeding
- Heterozygous – have two different alleles – hybrid – carrier
- Phenotype – physical feature
- Genotype – genetic make-up

- for two genes, alleles segregate independently
 - independent assortment – genes segregate independently and do not influence each other’s inheritance
 - the principle of independent assortment states that genes for different traits can segregate independently during the formation of gametes
- some alleles are neither dominant nor recessive, and many traits are controlled by multiple alleles or multiple genes
 - incomplete dominance – one allele is not completely dominant over another
 - heterozygous phenotype is somewhere between two homozygous phenotypes
 - codominance – both alleles contribute to the phenotype of the organism
 - heterozygous phenotypes have some of both homozygous phenotypes
 - multiple alleles – genes that have more than 2 possible alleles
 - polygenic traits – traits that result from the interaction of many genes
 - these traits are also greatly influenced by the environment

Monohybrid Cross

1. Two fish meet at the coral reef, fall in love, and get married that same night. They decide to make babies right away. The mom fish has a big fluffy tail (TT) while the dad has a very boring flat tail (tt). The dad is worried that he will pass his ugly tail down to his kids. What is the chance that the first child will have a flat tail?

T = fluffy tail t = flat tail

Genotypic Ratio: _____ Phenotypic Ratio: _____

Incomplete Dominance:

1. In Japanese four-o'clocks, the gene for red flower color (R) is incompletely dominant over the white flower color(r). For each of the following situations, predict the genotypic and phenotypic ratios of a red plant crossed with a white plant.

Codominance

1. The palomino horse is a hybrid (mix) showing a golden coat with a lighter mane and tail. A pair of codominant alleles, D1 and D2 is known to be involved in this trait. Horses with the D1D1 genotype are chestnut colored, horses with the D1D2 genotype are palomino, and horses with the D2D2 genotype are white in color.
 - A. Two palomino horses are mated by artificial insemination. What types of offspring could be produced?

Sex-Linked Traits

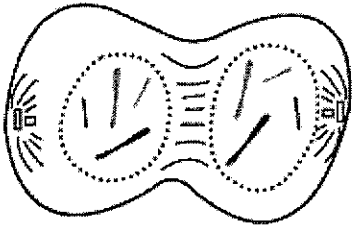
1. White eyed fruit flies are the result of a sex-linked recessive gene. Show the results from a cross between a red-eyed (R) male and white-eyed (r) female fruit fly.

Main Concept #6: Explain how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g., selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy).

- selective breeding – allowing only those animals with desired characteristics to produce the next generation
 - humans use selective breeding to pass desired traits on to the next generation of organisms
- genetic engineering – making changes in the DNA code of living organisms
- Cutting / Splicing DNA
 - Restriction enzymes – cuts DNA at a specific sequence of nucleotides
 - cutting and pasting
 - recombinant DNA – taking DNA and “pasting” it to another organism’s DNA
- transgenic organisms /genetically modified organisms– organisms that contain genes from other organisms
 - using the basic techniques of genetic engineering, a gene from one organism can be inserted into cells from another organism. These transformed cells can then be used to grow new organisms
- clone – member of a population or genetically identical cells produced from a single cell
- gene therapy is the process of attempting to cure genetic disorders by placing copies of healthy genes into cells that lack them

Practice Questions:

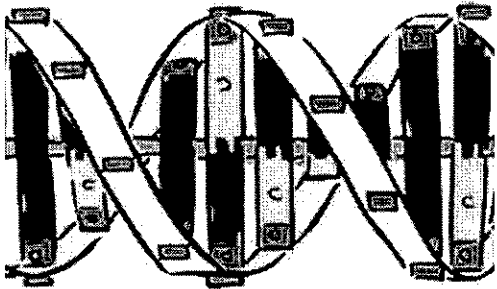
Cell Division



1. Which statement **best** describes the phase of the cell cycle shown?
 - A. The cell is in prophase of mitosis because the number of chromosomes has doubled.
 - B. The cell is in prophase I of meiosis because the number of chromosomes has doubled.
 - C. The cell is in telophase of mitosis because the cell is separating and contains two copies of each chromosome.
 - D. The cell is in telophase of meiosis because the cell is separating and contains two copies of each chromosome.

2. Mitosis and meiosis are processes by which animal and plant cells divide. Which statement **best** describes a difference between mitosis and meiosis?
 - A. Meiosis is a multi-step process.
 - B. Mitosis occurs only in eukaryotic cells.
 - C. Meiosis is used in the repair of an organism.
 - D. Mitosis produces genetically identical daughter cells.

Suppose that the central C-G base pair in the DNA molecule below is substituted by an A-T base pair.



3. What is the most likely result of this mutation?
 - a. genetic variation
 - b. genetic clones
 - c. incomplete translation
 - d. identical offspring

4. Hemophilia is an inheritable genetic disorder that prohibits the proper formation of blood clots. The recessive gene that causes hemophilia is located on the X-chromosome. Given this information, which of the following statements is true?
 - a. In order for a male offspring to be a hemophiliac, his mother must be a hemophiliac.
 - b. In order for a female offspring to be a hemophiliac, her father must be a hemophiliac.
 - c. In order for a male offspring to be a hemophiliac, his father must be a hemophiliac.
 - d. In order for a female offspring to be a hemophiliac, her mother must be a hemophiliac.

5. Which of the following statements is true?
- Mitosis results in the formation of two haploid gametes which can then combine to form a diploid daughter cell.
 - During the process of meiosis, haploid cells are formed. After fertilization, the diploid number of chromosomes is restored.
 - The process of meiosis forms daughter cells which are genetically identical to their parent cells.
 - The daughter cells formed during mitosis are genetically similar to, though not identical to, their parent cell.
6. Which of the following best describes the way that genes, chromosomes, and DNA are related?
- Chromosomes contain several genes, which are made up of sequences of DNA.
 - Genes contain several chromosomes, which are made up of sequences of DNA.
 - Genes contain several sequences of DNA, which are made up of chromosomes.
 - Sequences of DNA contain several genes, which are made up of chromosomes.
7. If a cat has 38 chromosomes in each of its body cells, how many chromosomes will be in each daughter cell after mitosis?
- 19
 - 76
 - 11
 - 38
8. Tom is going to buy two hamsters. He wants to breed them and sell the baby hamsters to a local pet store. The store owner tells him that his customers prefer dark brown hamsters with white bellies, long fur, black eyes, and long tails. Tom found a female hamster with all of those characteristics. Which male hamster should Tom buy in order to have the BEST chance of breeding baby hamsters with MOST of those characteristics?

<u>Hamster W</u>	<u>Hamster X</u>	<u>Hamster Y</u>	<u>Hamster Z</u>
Tan Fur Dark	Brown Fur	Tan Fur	Dark Brown Fur
White Belly	White Belly	White Belly	Dark Brown Belly
Long Fur	Long Fur	Short Fur	Long Fur
Long Tail	Long Tail	Long Tail	Short Tail
Brown Eyes	Brown Eyes	Black Eyes	Black Eyes

- W
- Z
- Y
- X

Open-ended Question:

9. Patau syndrome can be a lethal genetic disorder in mammals, resulting from chromosomes failing to separate during meiosis.

Part A: Identify the step during the process of meiosis when chromosomes would **most likely** fail to separate.

Part B: Describe how chromosome separation in meiosis is different from chromosome separation in mitosis.

Part C: Compare the effects of a disorder caused by chromosomes failing to separate during meiosis, such as Patau syndrome, to the effects of chromosomes failing to separate during mitosis.

Protein Synthesis

Vocabulary

Transcription

Translation

Translocation

Chromosomal mutation

Deoxyribonucleic acid

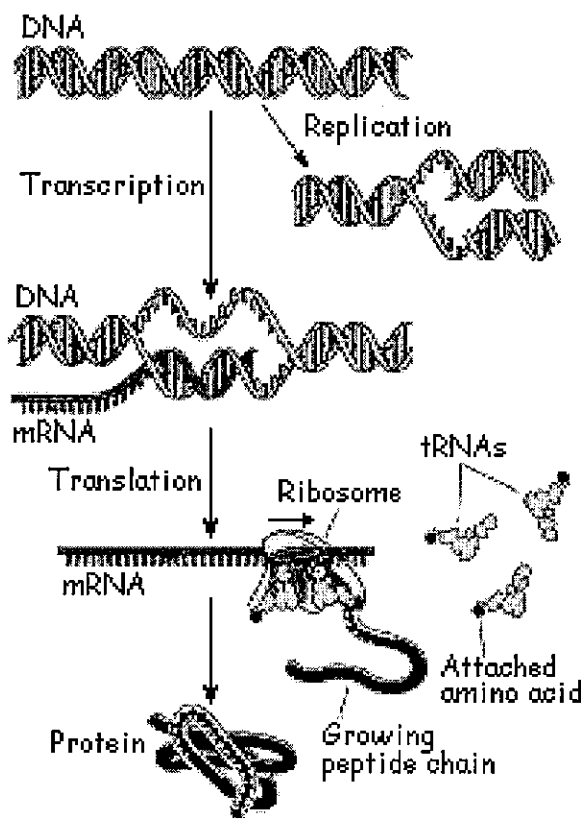
Frame-shift mutation

Gene expression

Mutation

Point mutation

Concepts to Know



The Central Dogma: How our DNA code makes Phenotype **DNA → RNA → Protein**

How are we so different? Why are we not identical to a plant? Or a bacterium? Or each other?

The DNA code is the same in all organisms but the sequence of the letters is different. All life uses A,C,T,G in double-stranded base pairs. This is the same concept that War and Peace is not identical to your iPod Warranty, but they're still written in English. DNA is just a language. A very, very, very important language.

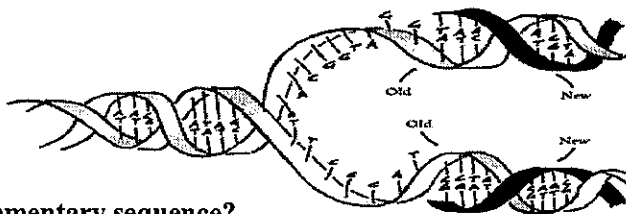
This is why scientists can manipulate life in the laboratory so easily. This is also the key to understanding a single common ancestor.

DNA is the code of life – ACTGs are the alphabet of life, just like 0s and 1s are the binary code of computers. The ACTGs of DNA can be read by enzymes to create a triplet codon that is interpreted into 20 amino acids to make very diverse proteins. **DNA is letters; codons are words; proteins are messages that make sense.**

1st Idea: Life Contains DNA: it is a SELF-REPLICATING molecule.

DNA replicates itself (via DNA polymerase and other enzymes) in a *semi-conservative* manner. This means that at the end of replication, each of the daughter molecules has one old strand, from the parent strand of DNA, and one strand that is newly synthesized. (see pic).

Adenine pairs with Thymine (A = T)
 Guanine pairs with Cytosine (G ≡ C)
 The bonds between the base pairs are **hydrogen bonds**



If given the template strand of DNA below, what is the complementary sequence?

5' A T G T A T G C C A A T G C A 3'

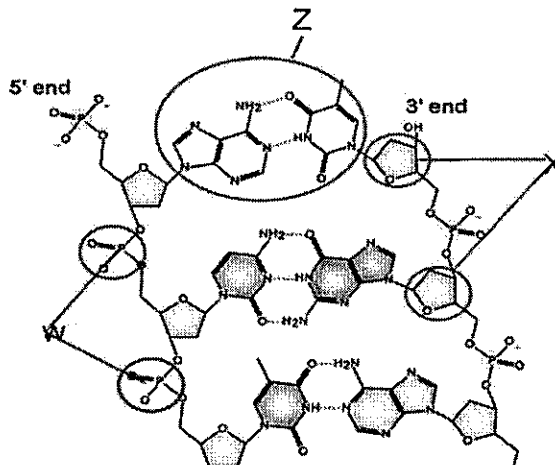
3' _____ 5'

FYI: How'd they figure this stuff out? With radioactive isotopes of nitrogen, sulfur and phosphorus.

DNA proofreading: the enzymes involved make sure this process makes an exact message (only 1 in 10 billion base pairs would be incorrect; better than computer coding mechanisms)

DNA STRUCTURE

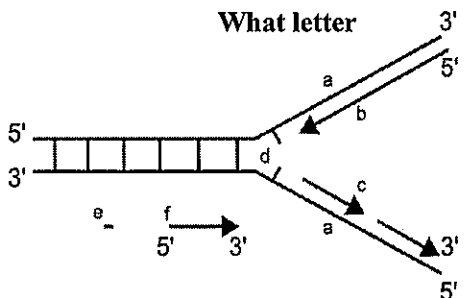
Nucleic Acid (polymer) is made of nucleotides (monomer)
 A nucleotide is made of: a sugar _____,
 a phosphate group _____,
 and a nitrogenous base _____.



IDENTIFY EACH AS W, X, OR Z IN THE DIAGRAM

I. DNA REPLICATION

DNA polymerase is an enzyme (*ends in -ase*). All enzymes have a specific active site. The DNA in this example is the substrate and only can fit into the enzyme (DNA polymerase) a certain way. This is why DNA replication has a **leading** and a **lagging** strand when made. The enzyme can only fit onto DNA via the 3' hydroxyl side, not the 5' phosphate side.

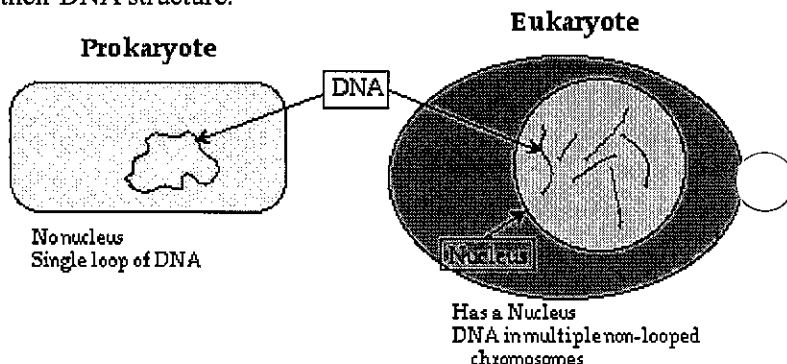


What letter **a** in this diagram represents the *continuous* leading strand? _____
 What letter **b** represents the *Okazaki fragments* of the lagging strand? _____

II. PROKARYOTES VS EUKARYOTES

Prokaryotes ("before nucleus") evolved before eukaryotes ("true nucleus") and have slight differences in their DNA structure.

→ What can you deduce from the picture?



2nd Idea: DNA is the source message but RNA is the working copy

MAJOR DIFFERENCES BETWEEN DNA AND RNA

DNA	RNA
deoxyribose sugar	ribose sugar
thymine	uracil
double helix	single strand (mRNA) or unit (tRNA)
permanent	temporary
in nucleus (some in mitochondria)	leaves nucleus, works in cytoplasm
one kind	many kinds (at least 3)

The DNA is like the encyclopedia you can never check out of the library. However, you are allowed to make copies of the information. That's what RNA is - a copied message of the important pages. Making copies ensures that you don't 'ruin' the original by taking it out of the nucleus (*this only applies to eukaryotes*), you can make copies in bulk, AND you only have to make copies of what you need. You wouldn't copy all 6000 pages of an encyclopedia would you? No! Only the 4-5 pages you might need for a report. In eukaryotes, we only code for ~ 2% of our DNA!

RNA (ribonucleic acid) is the intermediate between DNA and protein. It has slight differences to DNA. See the chart.

TRANSCRIPTION is the process of making RNA from DNA (via the enzyme RNA polymerase). This happens in the nucleus for eukaryotes, but would happen in cytoplasm for prokaryotes.

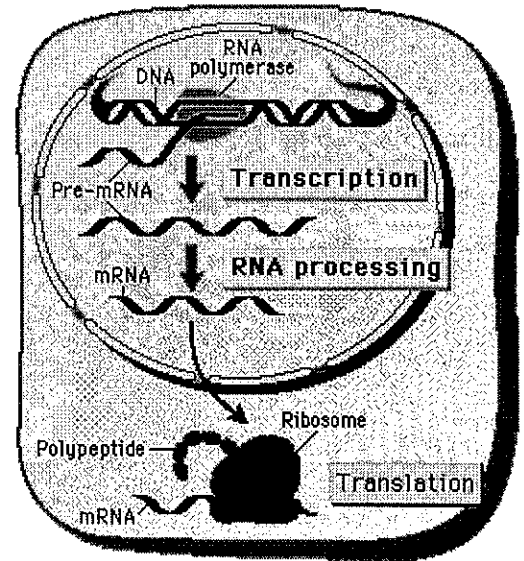
Watch a refresher video of the process on the protein synthesis page for www.udkeystone.wikispaces.com

Can you complete this message?

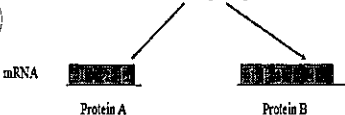
° T A C C C C T T T G G C A T A G A
 ° A U G G G _ _ _ _ _

Important Points about TRANSCRIPTION: DNA → RNA → Protein

- **RNA Polymerase** scans the genome for the promoter region of DNA (the start signal)
- A single-stranded copy of RNA is made of the DNA gene, where **U is complementary to A instead of T**.
- Transcription and Translation occur simultaneously in the cytoplasm for prokaryotes, with no editing needed.
- **Transcription occurs in nucleus for eukaryotes.**
- Eukaryotic messengerRNA has **EXONS** (expressed message) and **INTRONS** (in-between message)
- Introns get spliced (cut out) of the mRNA to make the mature transcript.



Alternative Splicing



WHY INTRONS?

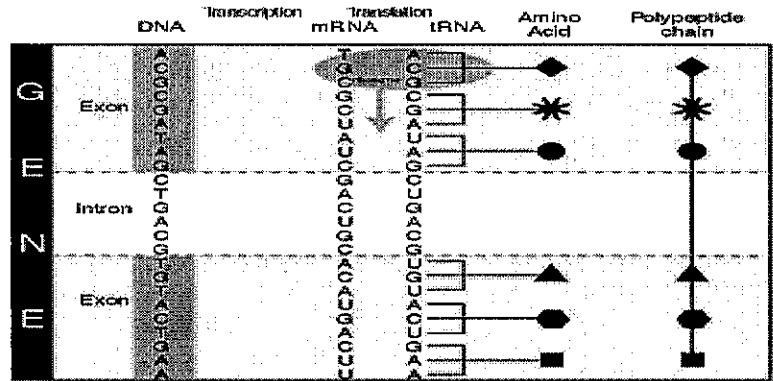
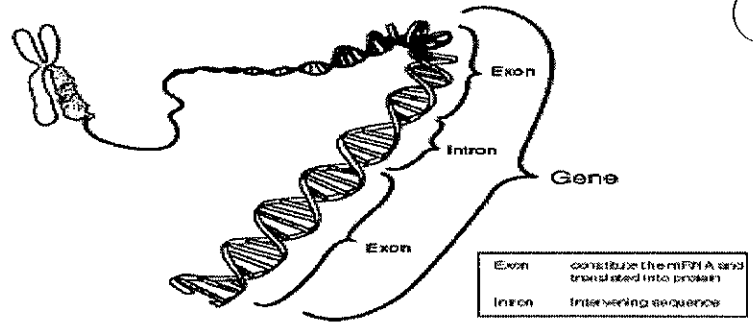
Alternative splicing allows to mix-n-match exons to make different proteins from the same sequence. This is a major source of eukaryotic evolution!

This is like you being able to make 20 different outfits in your closet from 4 pairs of pants and 5 shirts.

3rd Idea: Translation is matching an amino acid to the messageRNA in order to make the protein code

Important points about TRANSLATION

- The mRNA leaves the nucleus → cytoplasm (*in eukaryotes*)
- Message is read at the **ribosome**
- mRNA is read 3 letters at a time
- AUG is the start signal
- 1 Codon (3 letter message) is translated into 1 amino acid
- transferRNA molecule has one end (anticodon) that matches the mRNA . Each anticodon specifies an amino acid.
- There are 20 amino acids
- The amino acids are bonded together as peptide chains...which fold into proteins



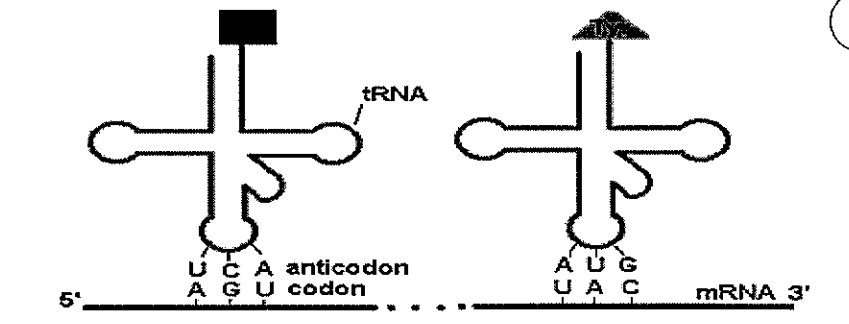
- If a mature mRNA transcript has 300 nucleotides, how many amino acids would that code for?

TRANSLATION :
DNA → RNA → **Protein**

Ex: the message AUGGGGCAAUAA codes for Met-Gly-Gln-
(the * tells the ribosome to stop)

What does this message code for?

AUG CUU CCA GAG UGA



		2nd base in codon					
		U	C	A	G		
1st base in codon	U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G	3rd base in codon
	C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G	
	A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G	
	G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G	

The Genetic Code

- After a polypeptide chain is made from amino acids (at a ribosome), it might be used right away in the cytoplasm, or it might be sent to the Golgi apparatus to have more folding or carbohydrates added.
- Proteins made on free ribosomes will work in the cytoplasm
- Proteins made on the rough ER will go the cell membrane or be excreted

4TH Idea: Mutations in the DNA or RNA sequence produce the wrong amino acid sequence.

*****THE ULTIMATE SOURCE OF EVOLUTION IS MUTATION*****

MUTATION : A change in DNA sequence

- **Point Mutations:** Change one or two base pairs

→ **Insertion, Deletion, Substitution**

Only 2 of these are “frameshift mutations” - that is, they change the codon reading frame.

Other mutation vocabulary

- **Silent Mutation** = the mutation goes unnoticed – it does not change the amino acid sequence or is not in a coding region (the mutation is in an intron, or the 98% of the genome that doesn't code for protein, or in the 3rd base of a codon)
- **Missense** – an insertion, deletion, or substitution that would make the message different
- **Nonsense** – really bad; a stop codon is created and the message stops prematurely

Example: Remember that DNA and RNA are just a language. To emphasize the point of mutation, I am using English (an alphabet with 26 letters, not 4!) Imagine you have the following message:

THE CAT ATE THE RAT

Using the above bolded mutations, label the type of mutation each must be:

_____ **THE HAT ATE THE RAT**

_____ **TTH EHA TAT ETH ERA T**

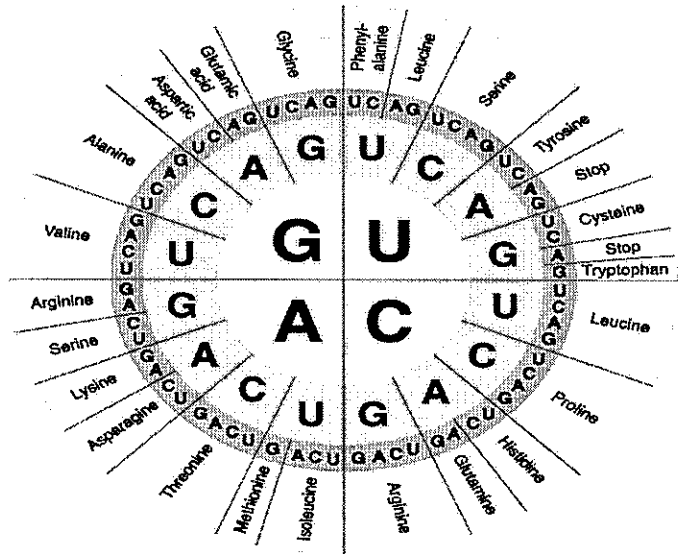
_____ **THE ATA TET HER AT**

The “Central Dogma of Biology” is summarized as:

_____ → _____ → _____

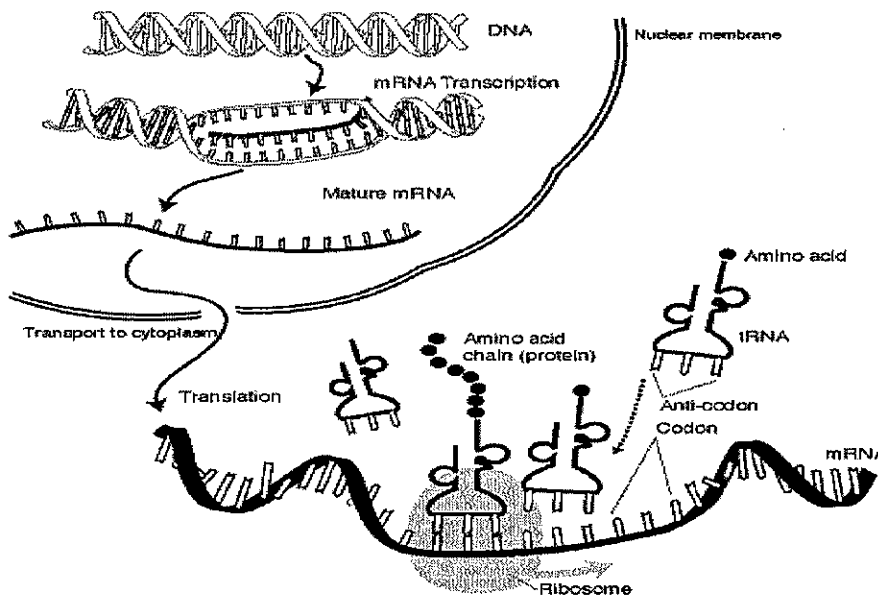
Fill in the chart:

DNA Triplet	mRNA Codon	tRNA Anticodon	Amino Acid
			met
		GGA	
TTC			
	UAG		



→ ORDER THE FOLLOWING

- _____ Intron sequences are spliced out and exons are joined together
- _____ amino acids form peptide bonds as tRNA molecules match the mRNA
- _____ RNA polymerase reads the DNA and builds complimentary sequence
- _____ The mRNA attaches to the ribosome
- _____ The ends of the mature transcript are protected before it leaves the nucleus
- _____ RNA polymerase finds the promoter sequence on DNA
- _____ transfer RNA arrives at the ribosome and the anticodon complements to the mRNA codon



Practice Questions:

1. Which process helps to preserve the genetic information stored in DNA during DNA replication?
 - A. the replacement of nitrogen base thymine with uracil
 - B. enzymes quickly linking nitrogen bases with hydrogen bonds
 - C. the synthesis of unique sugar and phosphate molecules for each nucleotide
 - D. nucleotides lining up along the template strand according to base pairing rule

2. In a flowering plant species, red flower color is dominant over white flower color. What is the genotype of any red-flowering plant resulting from this species?
 - A. red and white alleles present on one chromosome
 - B. red and white alleles present on two chromosomes
 - C. a red allele present on both homologous chromosomes
 - D. a red allele present on at least one of two homologous chromosomes

3. The endoplasmic reticulum is a network of membranes within the cell, and it is often classified as rough or smooth, depending on whether there are ribosomes on its surface. Which statement **best** describes the role of rough endoplasmic reticulum in the cell?
 - A. It stores all proteins for later use.
 - B. It provides an attachment site for larger organelles.
 - C. It aids in the production of membrane and secretory proteins.
 - D. It stores amino acids required for the production of all proteins.

Use the table below to answer the question.

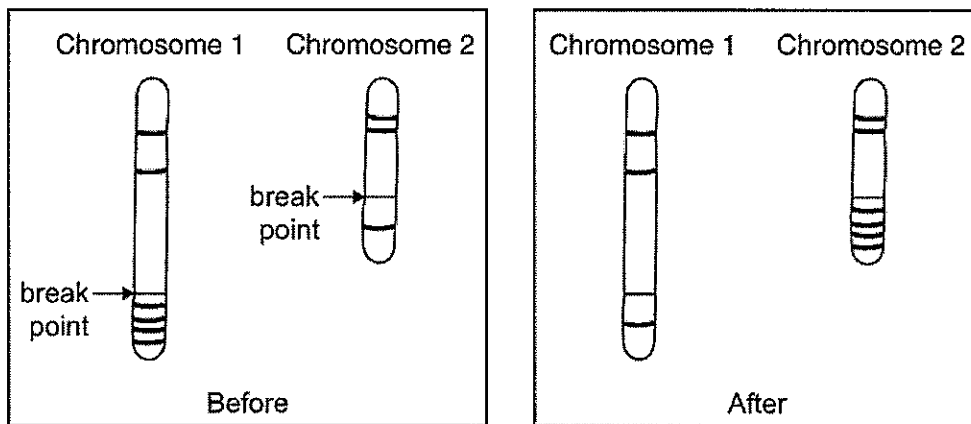
Blood Types

Genotypes	Phenotypes
ii	O
$I^A I^A$, $I^A i$	A
$I^B I^B$, $I^B i$	B
$I^A I^B$	AB

4. Blood type is inherited through multiple alleles, including I^A , I^B , and i . A child has type A blood. If the father has type AB blood, what are all the possible phenotypes of the mother?
- phenotypes O or A
 - phenotypes A or AB
 - phenotypes A, B, AB
 - phenotypes O, A, B, AB

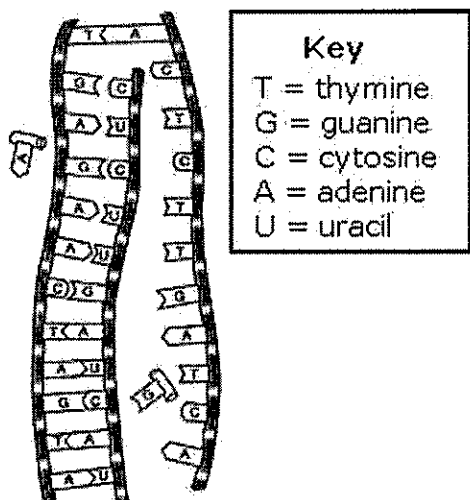
Use the diagram below to answer the question.

Chromosome Change



5. Which type of change in chromosome composition is illustrated in the diagram?
- deletion
 - insertion
 - inversion
 - translocation
6. Which statement describes a cell process that is common to both eukaryotic and prokaryotic cells?
- Both cell types carry out transcription in the nucleus.
 - Both cell types use ribosomes to carry out translation.
 - Both cell types assemble amino acids to carry out transcription.
 - Both cell types carry out translation in the endoplasmic reticulum.
7. A genetic mutation resulted in a change in the sequence of amino acids of a protein, but the function of the protein was not changed. Which statement **best** describes the genetic mutation?
- It was a silent mutation that caused a change in the DNA of the organism.
 - It was a silent mutation that caused a change in the phenotype of the organism.
 - It was a nonsense mutation that caused a change in the DNA of the organism.

- D. It was a nonsense mutation that caused a change in the phenotype of the organism.
8. Genetic engineering has led to genetically modified plants that resist insect pests and bacterial and fungal infections. Which outcome would **most likely** be a reason why some scientists recommend caution in planting genetically modified plants?
- unplanned ecosystem interactions
 - reduced pesticide and herbicide use
 - improved agricultural yield and profit
 - increased genetic variation and diversity
9. Which of the following is primarily responsible for the coding of the amino acids used in the synthesis of cellular proteins?
- DNA
 - transfer RNA
 - ribosomes
 - Golgi apparatus



10. Which statement describes the diagram above?
- DNA transcription is producing ribosomal RNA.
 - DNA translation is producing messenger RNA.
 - DNA transcription is producing messenger RNA.
 - DNA translation is producing ribosomal RNA.

Open-ended Question:

11. A cattle farmer genetically crosses a cow (female) with a white coat with a bull (male) with a red coat. The resulting calf (offspring) is roan, which means there are red and white hairs intermixed in the coat of the calf. The genes for coat color in cattle are co-dominant.

Part A: Although a farm has cattle in all three colors, the farmer prefers roan cattle over white or red cattle. Use the Punnett square to show a cross that would produce only roan offspring.

--	--

Part B: Explain how a roan calf results from one white- and one red-coated parent. In your explanation, use letters to represent genes. Be sure to indicate what colors the letters represent.

Part C: Predict the possible genotypes and phenotypes of the offspring produced from two roan cattle.

Evolution

Vocabulary

evolution
natural selection
speciation
genetic drift
competition
extinction
allele frequency
analogous structure

homologous structure
isolating mechanisms
embryology
genetic migration
endosymbiosis
fossils
founder effect

gradualism
population dynamics
punctuated equilibrium
selective breeding
vestigial structure

Concepts to Know

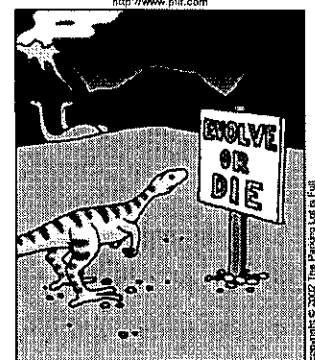
What are evolution and natural selection?

Evolution is how species change over time in response to the environment.

Natural selection is the mechanism by which species evolve.

Play a Game! ... "Who Wants to Live A Million Years?"

THE PARKING LOT IS FULL
By Jack McLarren and Pat Szabok



- Go to <http://science.discovery.com/interactives/literacy/darwin/darwin.html>
- Click "Learn About Natural Selection" and go through the short tutorial.
- After tutorial, play the "Survival Game" and answer the questions that follow.

1. Draw the three critters you initially selected for your population.
2. Did you choose them for any particular reason? Why?
3. As the years progressed, what environmental changes occurred?
4. How did your species' population change over time, through natural selection?
5. Did your species' population survive a million years? Why do you think it did, or it didn't?
6. If you were to do the game again, what would you do differently?
7. Now take the quiz. Record your answers to the questions below as you take the quiz.

- | | | | | |
|---------|---------|---------|---------|----------|
| 1. ____ | 3. ____ | 5. ____ | 7. ____ | 9. ____ |
| 2. ____ | 4. ____ | 6. ____ | 8. ____ | 10. ____ |

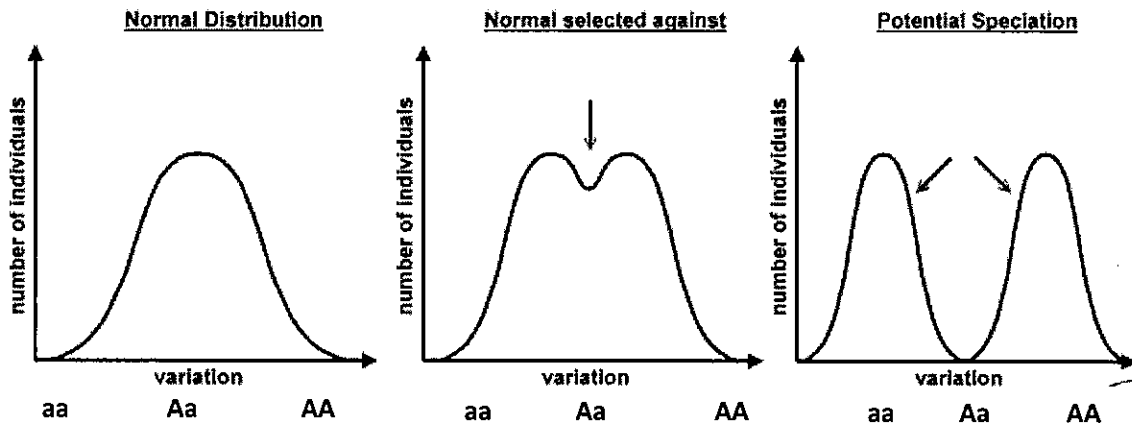
What was your final score on the quiz? ____

So... traits are due to an organism's genes. In the "Survival Game", the critters with genes that made them better adapted to their environment (and environmental changes), survived longer and reproduced. All of the genes and their *alleles* present in a population is referred to as a *gene pool*.

8. Over time, as a result of natural selection, what happens to the amount (or frequency) of favorable alleles in the pool? To the unfavorable genes?

Factors Affecting Gene Frequencies

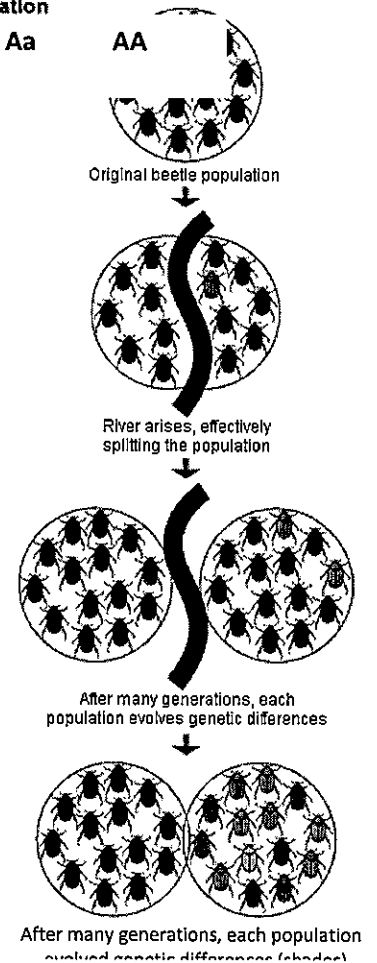
Migration, mutation, and genetic recombination do change the frequency of certain alleles within a gene pool. Some of the genetic variations produce traits harmful to the individual organism, some have no effect, and a few improve the chances of the individual surviving and reproducing within the environment. The frequency of genes that are adaptive will increase in the population with time because the bearers of such genes will reproduce more successfully than those without the adaptive genes. When environmental conditions change, a new set of alleles may prove of high survival value, and the gene distribution within the population can change within a relatively short period of time. This is natural selection. Thus environmental factors exert pressure for selection of certain genes and affect gene frequencies within the population.



9. Looking at the graphs above, there are three genotypes present in a population. What are the three genotypes?
10. Which genotype is not favorable for survival?
11. How has the population changed over time?

Speciation

Speciation is the formation of new species over time as a result of evolution. Isolation of a population affects gene frequencies. Isolation may be caused by **geographic factors** (like a mountain forming dividing a population into two). As conditions change in the two areas, the two populations will experience natural selection separately, facing slightly different environmental conditions. When species have evolved separately enough that they could no longer breed successfully with each other, then the two groups have become **reproductively isolated**. Once the populations are reproductively isolated, they are



generally considered to be now different species. **Thus one species split into two species – one similar to the original, and one new and different.**

12. Other than mountains, what else could cause geographic isolation?

13. Briefly explain an example of reproductive isolation.

What evidence supports evolution?

After the river dries up, genetic differences prevent interbreeding

14. Match the statement with the type of evidence.

- A. Fossil
- B. Anatomical
- C. Physiological
- D. Embryological
- E. Biochemical
- F. Universal genetic code

- _____ A record of ancient life forms in rock.
- _____ The hemoglobin in blood of humans and chimpanzees is remarkably similar.
- _____ A seal's flipper and the similar bat's wing are **homologous structures**.
- _____ All organisms have DNA built from the same nucleotides (A,T,G,C).
- _____ Early stages of development in many species with backbones is very similar.
- _____ **Vestigial structures** remain in some organisms, and no longer serve any apparent function.

Mechanisms of Evolution

Check out this really good explanation... http://glencoe.mcgraw-hill.com/sites/9834092339/student_view0/chapter20/animation_mechanisms_of_evolution.html

Related questions:

15. Do individuals evolve, or do populations evolve?

16. Complete the chart

Mechanism	Definition	Example
Genetic Drift		
Gene Flow		
Mutations		

Nonrandom Mating		

Peppered Moths

Looking at the photo at the right...

17. Which moths will survive better (not get eaten by predatory birds) and reproduce?

18. Over time, what color moths do you expect to only find living in a region with light colored trees? With dark colored trees?



light tree



dark tree

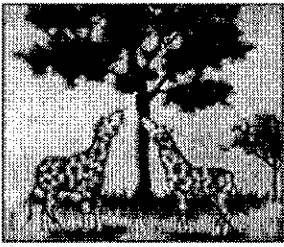
light moths

dark moths

Lamarck was Darwin's rival, and came up with his own theory of natural selection called "use and disuse."

Lamarck's theory is not widely supported by scientific evidence.

Examine the scene below, comparing the sides.

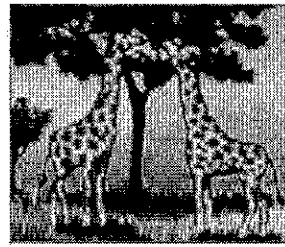


Early giraffes probably had short necks that they stretched to reach food.

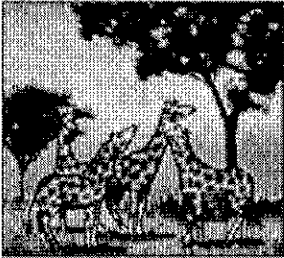
a. Lamarck's proposal



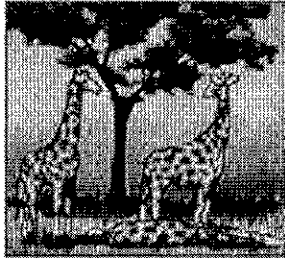
Their offspring had longer necks that they stretched to reach food.



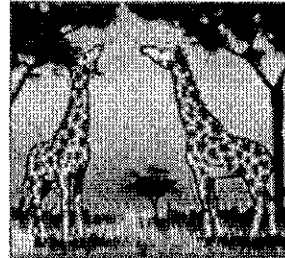
Eventually, the continued stretching of the neck resulted in today's giraffe.



Early giraffes probably had necks of various lengths.



Natural selection due to competition led to survival of the longer-necked giraffes and their offspring.



Eventually, only long-necked giraffes survived the competition.

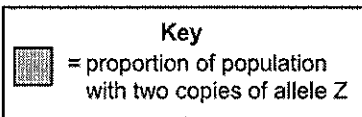
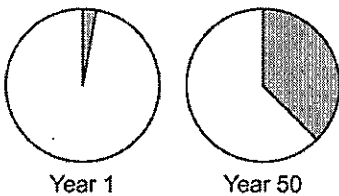
b. Darwin's theory

19. What is the main problem with Lamarck's theory? HINT: Remember only traits that can be inherited will affect the survival of future generations.

Practice Questions:

Use the circle graphs below to answer the question.

Changes in Allele Frequency Over Time

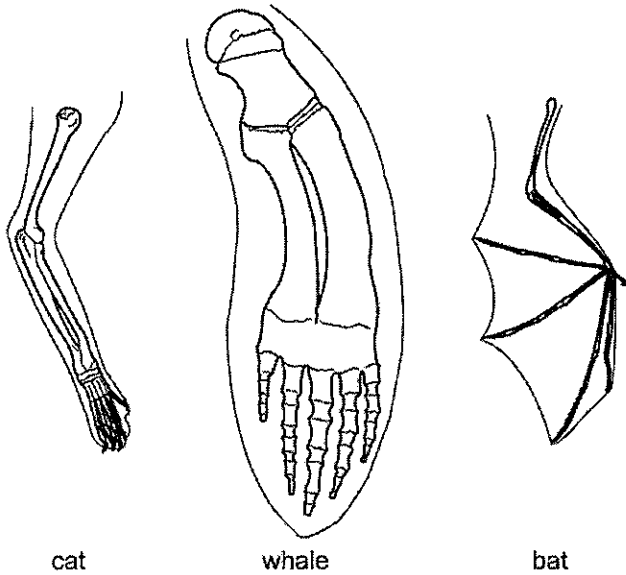


1. The graphs illustrate change in a lizard population over time. Which process **most likely** led to the change in the lizard population?
 - A. natural selection acting on a harmful trait
 - B. natural selection acting on a beneficial trait
 - C. natural selection acting on a dominant trait
 - D. natural selection acting on a recessive trait

2. In North America, the eastern spotted skunk mates in late winter, and the western spotted skunk mates in late summer. Even though their geographic ranges overlap, the species do not mate with each other. What **most likely** prevents these two species from interbreeding?
- A. habitat isolation
 - B. gametic isolation
 - C. geographic isolation
 - D. reproductive isolation
3. A mutation occurs in the genes that code for coat color in deer. Which change will **most likely** result from this mutation?
- A. a change in the selection pressures acting on coat color
 - B. a change in the coat-color genes of deer predator species
 - C. an increase in coat-color diversity in the population
 - D. an increase in the number of genes for coat color in the population
4. Two continental plates collide and begin to build up a mountain range. Gradually, a species of lizards becomes separated by the mountain range. The members on one side can no longer interact with members on the other side. Due to their separation, the two populations of lizards
- a. will evolve in exactly the same manner and remain as one species.
 - b. will likely become extinct within one year.
 - c. will likely evolve into separate species over millions of years.
 - d. will begin hunting one another for food.
5. According to the theory of natural selection, which of the following organisms is most likely to survive in the given environments?
- a. a rabbit with short, brown fur in a cold, snowy, arctic environment
 - b. a large, leafy plant with shallow roots in a hot and dry desert biome
 - c. a bird with a short beak in an area where insects live deep within the ground
 - d. a lizard that exhibits the same coloration as its surrounding plant life
6. What information do fossils provide about the history of organisms on Earth?
- a. Organisms have stayed exactly the same since the Earth was formed.
 - b. Organisms on Earth have not evolved or changed during the last 200 years.
 - c. Fossils do not provide any information about the history of organisms on Earth.
 - d. Organisms on Earth have evolved and changed significantly over time.

Use the illustrations below to answer the question.

Mammalian Forelimbs



7. The skeletons of mammalian forelimbs represent variations of a structure that was present in their common ancestor. What has **most likely** caused the variation in forelimbs?
- A. changes in muscle structure
 - B. changes in the genetic codes
 - C. trait formation due to behaviors
 - D. development of vestigial structures

Open-ended Question:

Use the table below to answer the question.

Sequence Difference Between COII Genes in Some Animals

Animal	Number of Base Differences from a Rat
Mouse	101
Cow	136

8. The gene COII is in the genome of many organisms. A comparison of the number of base differences between the COII gene in a rat and that of two other animals is shown.

Part A: Based on the data, describe a possible evolutionary relationship between rats, mice, and cows.

Part B: Describe how different organisms having a common gene such as COII supports the theory of evolution.

Part C: The COII gene of a monkey has 203 base differences from the same gene in a rat and 210 base differences from the same gene in a mouse. Compare the evolutionary relationships between the monkey, the rat, and the mouse.

Ecology

Vocabulary

biosphere	decomposer	Environment
biome	biogeochemical cycles	Limiting factor
ecosystem	food chain	Nonnative species
biotic	food web	Population
abiotic	Ecological community	Ecological Producer
agriculture	Ecological consumer	Species
Aquatic	Ecology	Succession
Biochemical conversion	Endemic species	Symbiotic relationship
bioenergetics	Energy pyramid	Terrestrial
trophic level	Energy transformation	Habitat

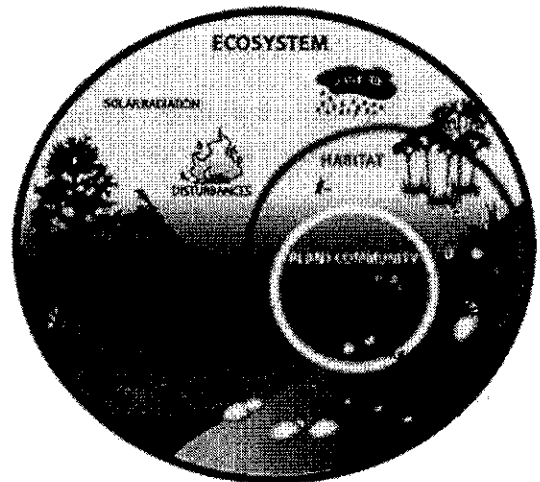
1st idea: Living (biotic) and nonliving (abiotic) factors make up an ecosystem.

1. Which of the following is NOT a basic need for a living organism in any habitat?

Food (nutrients) water shelter (space) Rocks

2. Using the diagram of an ecosystem below, list 5 biotic and 5 abiotic components found in both aquatic and terrestrial ecosystems.

Biotic	Abiotic



3. Fill in the following chart which lists levels of ecological organization from the most basic (lowest) to the most complex (highest) with either an example of that level or a definition of the term.

Level of Organization	Example(s)	Definition/explanation

Organism	A deer, an oak tree, a fish	
Population	A herd of deer, a stand oak trees or a school of fish	Group of organisms of the same species
Community		
Ecosystem	A nature center, like Robbins Park, a fallen log, a pond or lake	
Biome		A region on Earth characterized by a specific climate and dominated by plants and animals suited to living in that climate/geographic area.
Biosphere		Region on Earth containing all living things.

3rd Idea: Energy from the sun flows through an ecosystem as it is passed from one organism to the next. With each transfer some energy is lost as heat.

→ Use the diagrams of food chains below to answer the following questions.

4. The arrows in a food chain always point in the direction of _____.
5. The ultimate source of energy for the Earth and therefore all food chains is the _____.
6. Producers, like a tree, make their own energy. Name the process in which they make energy and write the equation. (Refer back to the "energy" section to help you.)

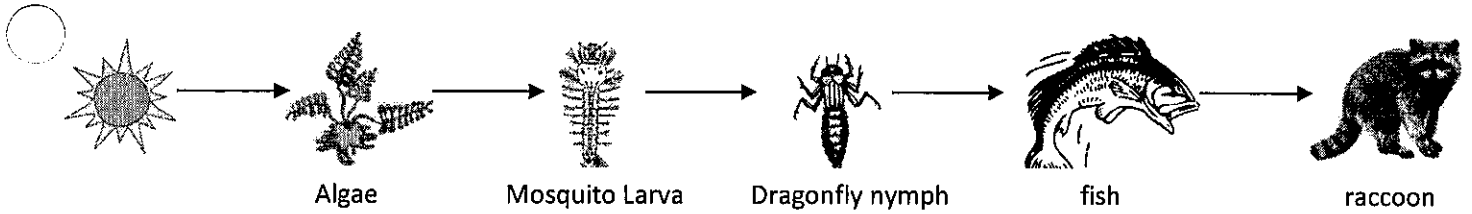
7. Consumers, like a human, get energy from eating (or consuming) something else. Name the process in which they obtain energy and write the equation. (Refer back to the "energy" section to help you.)

8.
 - a. Primary consumers only eat producers. What do we call organisms that only eat producers?
 - b. What do we call organisms that only eat animals? _____ anything? _____

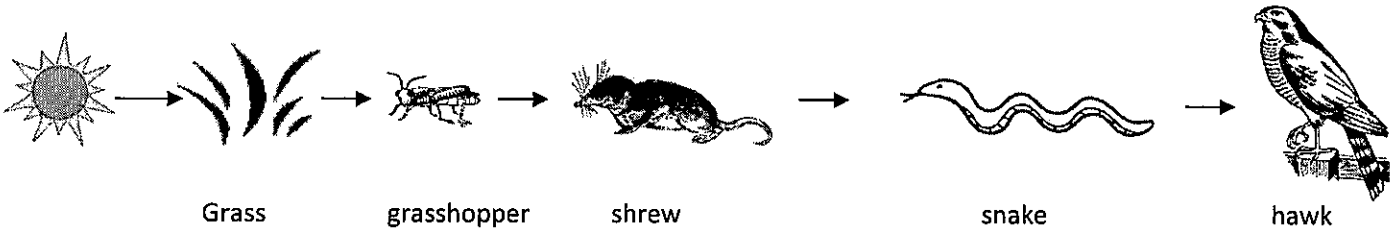
9. What's missing from the Ocean Aquatic Life Zone food chain below? _____

10. LABEL each food chain below with the **producer, primary consumer, secondary consumer, tertiary consumer, and quaternary consumer.**

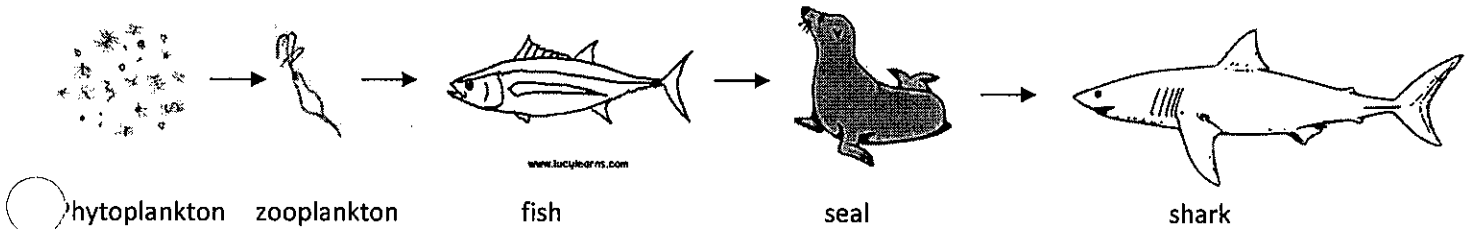
Freshwater aquatic ecosystem



Field Ecosystem (grassland)



Ocean Aquatic Life Zone

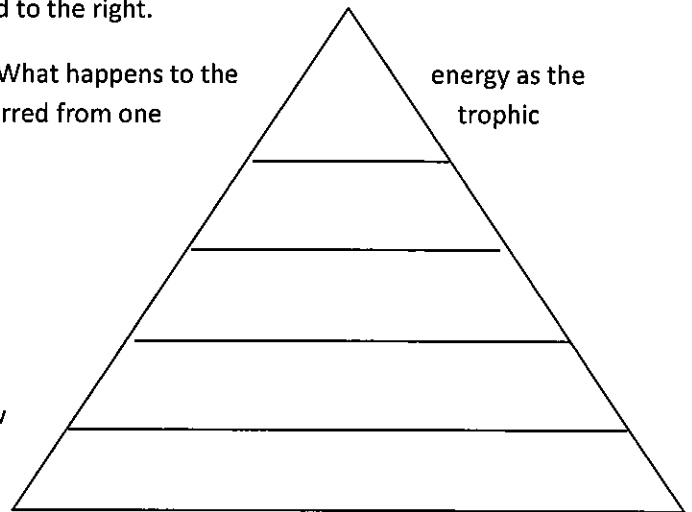


11. A trophic level is the level at which an organism feeds. Choose one of the food chains above and place the organisms in the correct trophic levels on the energy pyramid to the right.

12. A pyramid is used to indicate energy flow in an ecosystem. (What happens to the trophic levels proceed upward?) How much energy is transferred from one level to the next? _____%

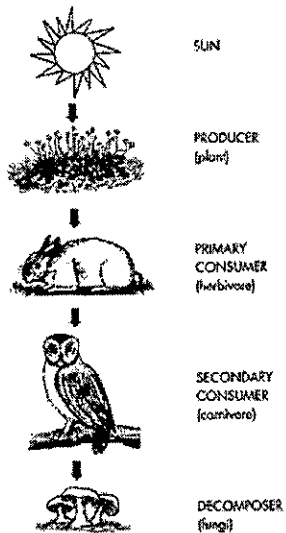
13. Why do many food chains only contain 3-4 links?

14. If there are 10,000 kcal of energy in the producer level? How many kcal of energy make it up to the tertiary consumer level?

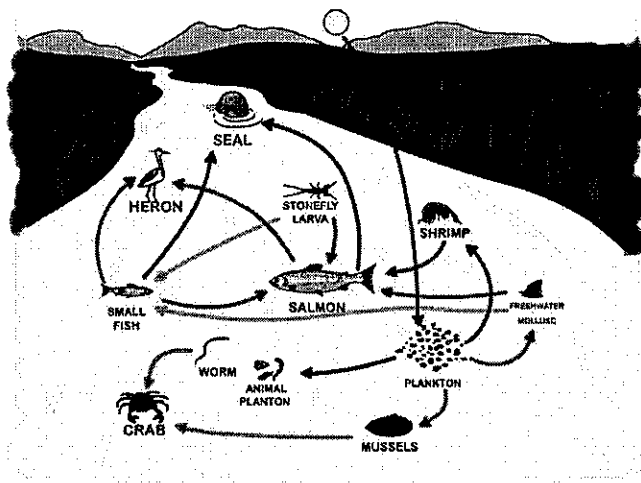


15. The diagrams below represent a food chain and food web. Correctly label each diagram and use them to describe the difference between a food chain and a food web.

Food _____



Food _____



4th Idea: Biotic Interactions in an ecosystem: How living things interact with each other

16. For each case below label the relationship with one of the following labels:
Mutualism, Commensalism, Parasitism, Predator prey, competition

Remember:

- In a mutualistic relationship both species benefit. ++
- In a commensalistic relationship one species benefits, the other is unaffected +0
- In a parasitic relationship one species benefits to the detriment (harm) of the other + -
- In a predator prey relationship, one species catches and eats another + -
- In a competitive relationship, both species want the same resource. - -

- A colony of deep sea polyps "becomes" the shell for a hermit crab providing a life long shell for the crab and gaining transportation for itself in the process.
- A lichen is an algae and a fungus living in symbiosis, both gaining a method by which to obtain food.
- A deer tick lives off of the blood from a white footed mouse often weakening the mouse during its life time.
- A "herd" of hyena follows a lion to snatch the lion's prey once it is killed.
- An orchid is a plant that grows on a tree in the rain forest that gains nourishment from the humidity in the air (an epiphyte). The tree provides structure for the orchid, but is not harmed or benefited in the relationship
- Humans use the habitat of the Ivory Billed woodpecker for development. (not predation)
- An ant "milks" honeydew from an aphid for nourishment while protecting a colony of aphids from predators.
- A hawk and a mouse.
- Trees in a forest grow taller and taller.

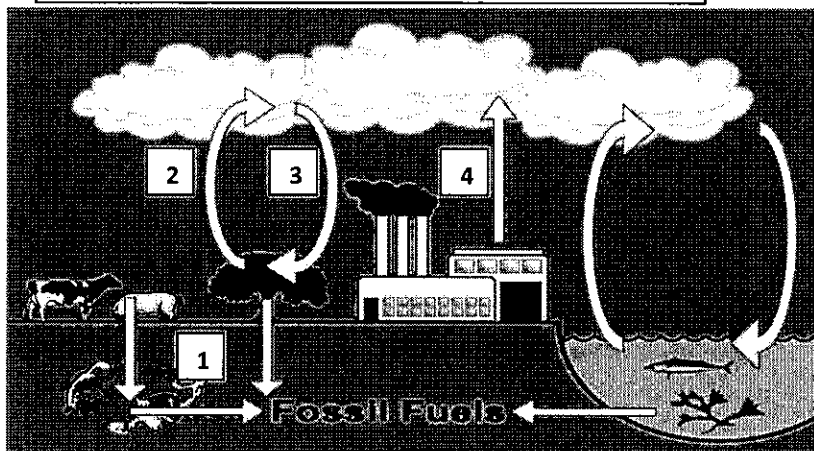
5th idea: Cycles in an ecosystem: While energy flows through an ecosystem in one direction, matter and nutrients are recycled.

Carbon Cycle Review:

17. Look back at the "Organic Chemistry" section to help you fill in the following blanks. Carbon is the basic building block for _____, _____, _____, _____. These are all _____ compounds because they contain Carbon.

Use the words below to fill in the blanks to the right:

- | | |
|----------------|----------------------|
| Combustion | Decomposition |
| Photosynthesis | Cellular Respiration |



Arrow 1 shows _____

Arrow 2 shows _____

Arrow 3 shows _____

Arrow 4 shows _____

18. The Carbon cycle is based on what gas? _____

19. CO₂ is considered "nature's thermostat". Explain what happens when there is more CO₂ in a certain mass of air and what happens when there is less CO₂.

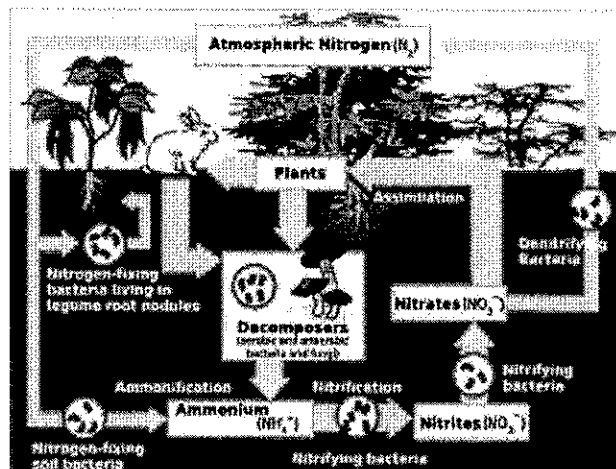
20. Oil, coal, and natural gas are fossil fuels that provide us with energy. Why are fossil fuels considered part of the carbon cycle?

21. Explain the human impacts on the carbon cycle.

Nitrogen cycle review:

Plants and animals need nitrogen in order to form macromolecules. Animals get the nitrogen they need by eating plants or other animals. Even though the atmosphere is 80% nitrogen, plants get their nitrogen from the soil. Use the diagrams to help answer the following questions.

22. Why can't plants use the nitrogen directly from the atmosphere?



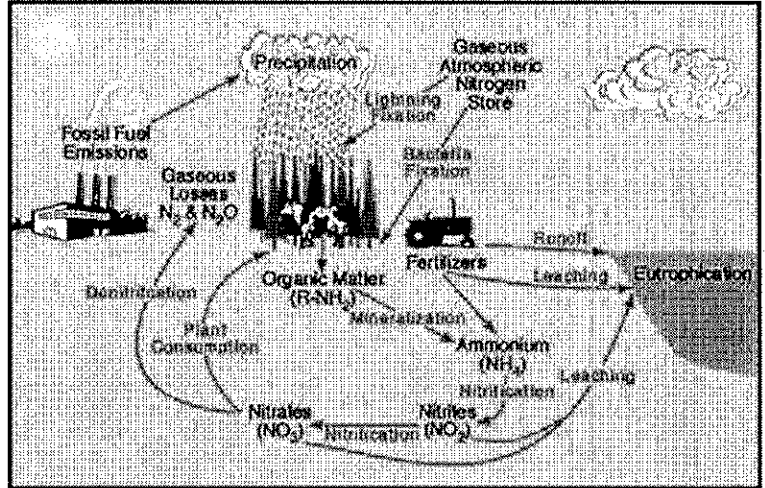
23. What organisms change atmospheric nitrogen into nitrate the form needed by plants? _____

24. How does nitrogen get returned back to the atmosphere?

25. How is acid rain formed from nitrogen compounds?

26. Describe the agricultural practices that affect the nitrogen cycle.

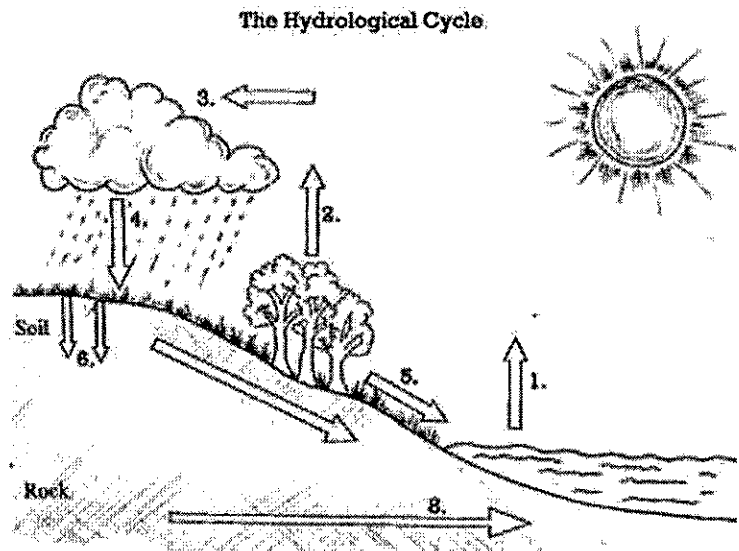
27. Describe how nitrogen is removed from grasslands and forests.



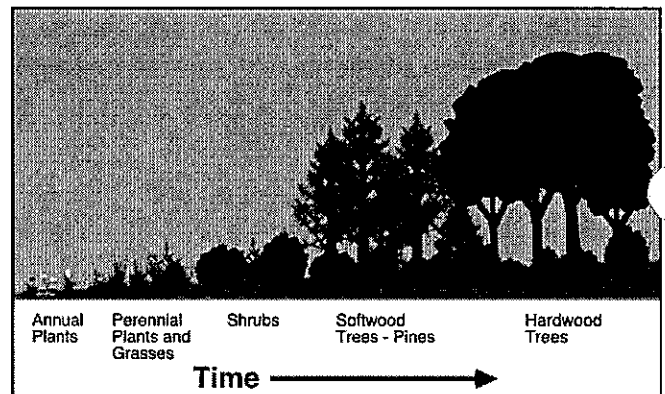
Water Cycle Review:

28. Label the diagram with the steps of the water cycle *transpiration, evaporation, condensation, infiltration, precipitation, runoff*. (#8 is showing seepage.) Can you explain what is happening at each step?

29. Explain 2 ways that humans are impacting the hydrologic (water) cycle.



6th idea: How ecosystems change through time



30. Use the diagram to help you define ecological succession.

31. Write a scenario that would describe how an ecosystem would change due to the following events:

- a. A wetland ecosystem (grassland) with invasive species of plant such as Purple Loosestrife.
- b. A forest ecosystem after a volcanic eruption, similar to Mt.St.Helens.
- c. A coastal ecosystem experiencing warmer waters nearby due to an El Nino event.
- d. A forest ecosystem after a fire.

7th Idea: Effects of Limiting Factors on population dynamics and species extinction

A **limiting factor** is something that, when limited, determines the carrying capacity of an ecosystem for a particular species. The **carrying capacity** is the largest population that an environment can support at any given time. If an important resource is limited, such as food, the carrying capacity will decrease causing individuals in the population to die or migrate. If the

32. Explain how the following limiting factors can change populations and contribute to species extinction. Refer to the "evolution" section if you need help.

- a. Nutrients, water, shelter, clean air
- b. competition for resources, predation and disease

Practice Questions:

Use the table below to answer the question.

Student's Observations of a Pond Ecosystem

Quantitative	Qualitative
37 fish and 3 frogs	Leaves lie on the bottom of the pond.
2 types of aquatic grass	Water insects move along the water's surface
12 small rocks and 1 medium rock	All 3 frogs are sitting on a pond bank
Sand	

1. A group of students measured a ten-square-meter section of a pond ecosystem and recorded observations. Which statement is a testable hypothesis?
- A. The frogs living in the pond represent a population.
 - B. Water is an abiotic component in the pond ecosystem.
 - C. If the fish are given more food, then they will be happier.
 - D. If the frogs are startled, then they will jump into the water.

Use the list below to answer the question.

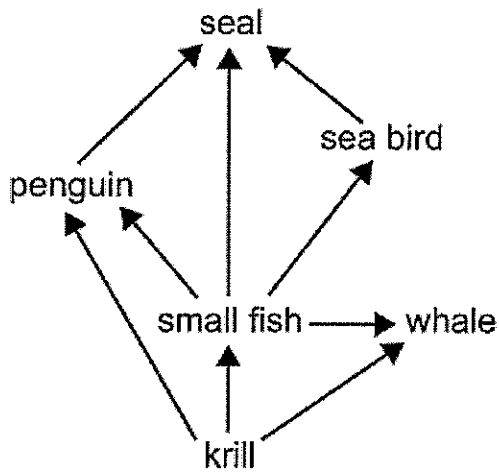
Observations

- two grey wolves
- five moose
- several species of conifer trees
- large granite rock
- shallow pond

2. A student wrote several observations in a field notebook. Which term **best** classifies all of the student's observations?
- A. population
 - B. food chain
 - C. ecosystem
 - D. community
3. A researcher observing an ecosystem describes the amount of sunlight, precipitation, and type of soil present. Which factors is the researcher **most likely** describing?
- A. biotic factors in a forest
 - B. biotic factors in a tundra
 - C. abiotic factors in a prairie
 - D. abiotic factors in an ocean
4. A species of snapping turtles has a tongue that resembles a worm. The tongue is used to attract small fish. Which **best** describes the interaction between the fish and the snapping turtle?
- A. predation
 - B. symbiosis
 - C. parasitism
 - D. competition
5. Which statement correctly describes how nitrogen in the soil returns to the atmosphere?
- A. Soil bacteria convert nitrates into nitrogen gas.
 - B. Decomposers directly convert ammonium into nitrogen gas.
 - C. Plants assimilate nitrites and convert them into nitrogen gas.
 - D. Nitrogen-fixing bacteria in plant roots convert nitrates into nitrogen gas.

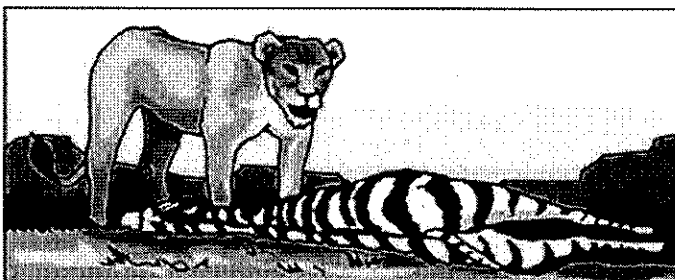
Use the diagram below to answer the question.

Marine Food Web



6. Which sequence correctly describes the flow of energy between organisms in the marine food web?
- from seals to penguins to krill
 - from whales to krill to small fish
 - from sea birds to seals to penguins
 - from small fish to penguins to seals
7. Agricultural runoff can carry fertilizers into lakes and streams. This runoff can cause algae populations to greatly increase. Which effect does this change in the algae population sizes **most likely** have on affected lakes and streams?
- an increase in water level
 - an increase in water clarity
 - a reduction in dissolved oxygen needed by fish and shellfish
 - a reduction in temperature variations near the water's surface
8. A farmer observed that an increase in a field's soil nitrogen content was followed by an increase in producer productivity. What does this observation **most likely** indicate about the relationship between nitrogen and the producers in the field?
- Nitrogen was a biotic factor.
 - Nitrogen was a limiting factor.
 - Nitrogen became a surplus resource.
 - Nitrogen became a selection pressure.

Organisms interact with each other in several ways.



9. What interaction is shown between the lion and the zebra in the picture above?
- predator/prey
 - parasite/host
 - consumer/decomposer
 - consumer/producer

The Mute Swan is a species of bird with an orange-reddish bill and white feathers. It is naturally found in Europe and Asia but can sometimes be found in the United States as a result of the importation of these non-native birds.

10. Mute Swans are one of the heaviest flying birds and consume up to 8 pounds of vegetation each day. How will the migration of Mute Swans into an area most likely affect the birds native to that area?
- The native birds and the Mute Swans will coexist peacefully together.
 - The native birds will immediately migrate to another area.
 - The native birds will decrease in number because there is not enough food for all the birds.
 - The native birds will adapt to consume less food or different types of food.

Biomes are large geographical areas with distinct plants and animals that are adapted to that particular environment.

The largest biome in the world is the taiga which stretches over the northern portions of Eurasia and North America. The taiga is a major biome characterized by lots of snow and very cold temperatures. In fact, the winter temperature range is -54 to -1°C (-65 to 30°F), and the summer temperature range is -7 to 21°C (20 to 70°F).

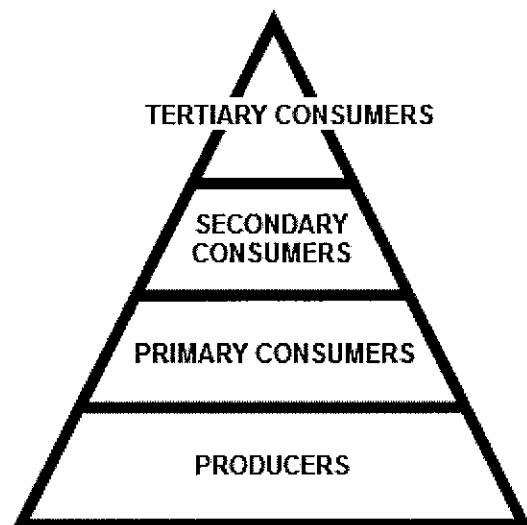
11. Given this description of the taiga, which of the following organisms is best suited to live in this biome?
- camels
 - parrots
 - frogs
 - moose

12. Which of the following is an abiotic factor shown in the picture

- person
- tree
- grass
- cloud



above?



13. The above diagram suggests that
- energy flows from secondary consumers to primary consumers in an ecosystem.
 - tertiary consumers are the ultimate source of energy in an ecosystem.
 - there are more tertiary consumers than producers in an energy pyramid.
 - producers are the foundation of all energy pyramids.

Lake Erie has suffered long term pollution problems. While the situation is improving for this Great Lake, there are still areas of concern. The table below shows an advisory from the early 1990s for eating fish taken from Lake Erie that may contain PCBs.

Recommended Restrictions for Eating Selected Sport Fish (PCB Advisory)

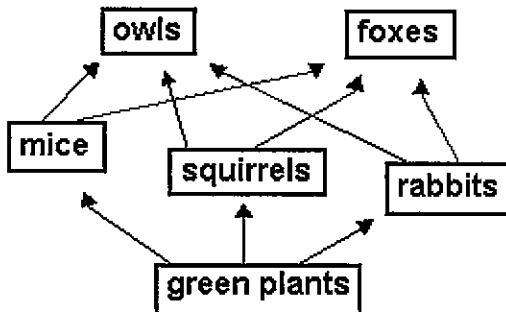
Fish Species	Lake Erie	Ashtabula River	Maumee River	Ottawa River	Portage River
Carp under 20 inches	3	4	3	5	3
Carp 20+ inches	4	4	3	5	3
Channel Catfish	4	4	5	5	3
Freshwater Drum	2	2	2	5	2
Lake Trout	4	4	4	5	4
Largemouth Bass	1	3	2	5	2

Key

1 = No Restriction 3 = One Meal per Month 5 = Do Not Eat!
 2 = One Meal per Week 4 = Six Meals per Year

14. Which Lake Erie tributary is probably most contaminated with PCBs?
- Portage River
 - Ottawa River
 - Maumee River
 - Ashtabula River

Many natural ecosystems have been destroyed by human activity. To better manage our remaining natural ecosystems, we must first understand how the ecosystems are structured. One way to do this is to determine how the organisms in the ecosystem obtain the matter and energy they need to survive. The figure below shows a simplified food web.



Note: The arrows point in the direction that matter and energy flow.

15. Often, organisms compete with each other for a food source. Which of the following pairs of organisms compete with each other for food?
- mice and rabbits
 - squirrels and owls
 - rabbits and green plants
 - mice and owls

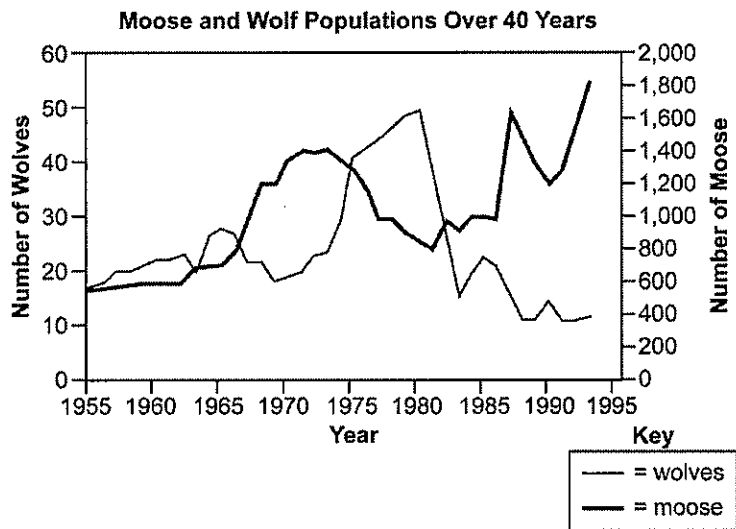
16. A herd of zebra eating grass includes groups of organisms from different species. These groups best exemplify
- a biome interaction.
 - a community interaction.
 - an ecosystem interaction.
 - a population interaction.



17. The Earth's carbon cycle consists of the flow, cycling, and recycling of all of the carbon on the Earth. Every living organism's composition includes the element carbon. How does carbon become part of living organisms?
- Producers take in carbon directly from the soil through their roots, and consumers eat the producers.
 - Producers take in carbon dioxide from the air, and consumers eat the producers.
 - Carbon is a part of sunlight and enters through the skins of all organisms.
 - Consumers take in carbon dioxide from the air, and producers eat the consumers.

Open-ended Question:

Use the graph below to answer the question.



18. Isle Royale is located in Lake Superior. Isle Royale is home to populations of wolves and moose. The interactions between the wolves and moose, as well as the individual population sizes, have been studied since 1958. The graph shows the population sizes over time for both wolves and moose.

Part A: Describe one limiting factor for the moose population.

Part B: Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

Part C: Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.
