Name _____

Biology EOC Review

Courtesy of Mrs. Parker

Liberty HS

Frisco, TX

Compiled by Adrena McDonald

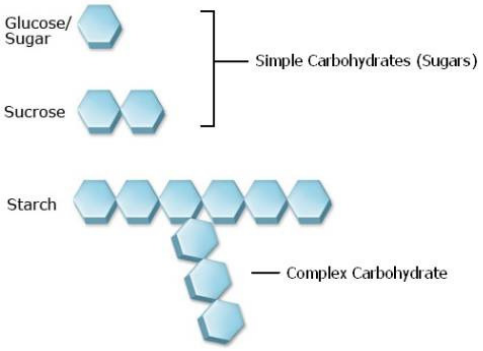
Venture High School - Arlington, TX

Table of Contents

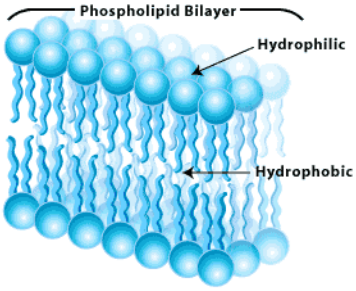
Biochemistry

All living things are made up of four major kinds of **biomolecules**: carbohydrates, lipids, proteins, and nucleic acids.

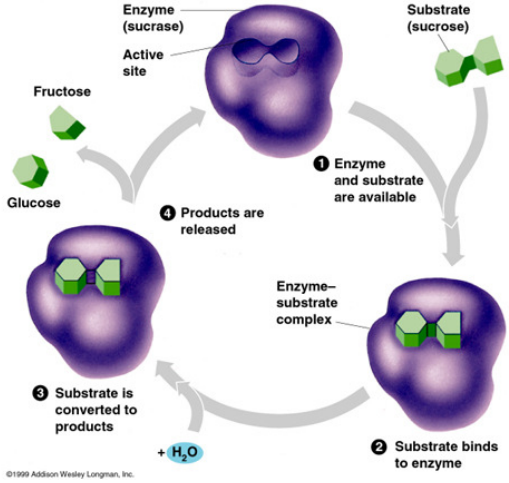
- **Carbohydrates**- made up of carbon, hydrogen, and oxygen in a 1:2:1 ratio. Some carbohydrates provide quick energy (simple sugars), while some store energy (like starches and glycogen), and others provide structure (cellulose and chitin). Building blocks of carbohydrates are called monosaccharides, while complex carbohydrates are called polysaccharides. A common ending for carbohydrates is –ose.

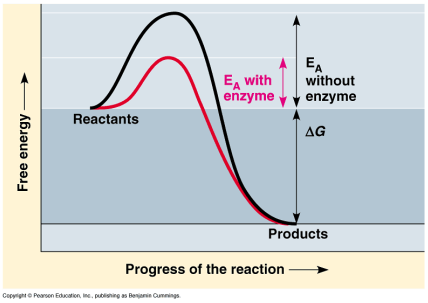


- **Lipids**- are made mostly from carbon and hydrogen atoms, and are formed by glycerol and fatty acid chains. Lipids do not dissolve in water, so cells store energy as lipids. (Lipids store more energy than other organic compounds.) Lipids also provide insulation and make up cell membranes (phospholipid bilayer). Lipids include fats, oils, cholesterol (and other steroids), and waxes.

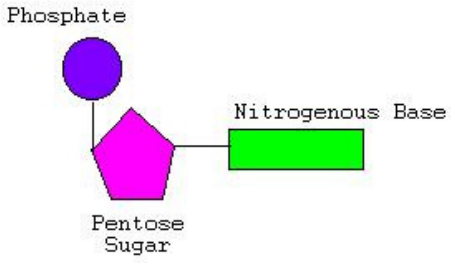


- **Proteins**- are made of carbon, hydrogen, oxygen, and nitrogen. The subunits of proteins are called amino acids. Proteins control cell functions, defend the organism, support transport and movement, and provide structure.
  - **Enzymes** are special proteins that act as catalysts to control the rate of chemical reactions. They lower the activation energy, or energy required for the reaction to proceed. Each enzyme has a specific function that is determined by its shape. Any factor that changes the shape of an enzyme (like temperature or pH) can alter its function. A common ending for enzymes is –ase.





- **Nucleic acids**- are made up of subunits called nucleotides (which consist of a sugar, a phosphate, and a nitrogenous base). The two types of nucleic acids are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). Nucleic acids store information that determines how an organism will grow and develop, and they control the building of proteins in cells.



Practice

1. What do all lipids have in common?
    a. They produce quick energy
    b. They are saturated with hydrogen
    c. They don't dissolve in water
    d. Their compositions differ only by R- groups

2. A protein-digesting enzyme mixes with cholesterol in the digestive tract. What effect does the enzyme have on the cholesterol?
    a. Breaks the cholesterol into amino acids
    b. Breaks the cholesterol into simple sugars
    c. Converts the cholesterol into energy
    d. No effect

3. Enzymes speed up a chemical reaction by
    a. Lowering the amount of energy it needs to get started
    b. Producing complex carbohydrates
    c. Changing the shape of the substrate
    d. Producing heat

4. DNA and RNA are composed of units that are made up of
    a. Chains of nucleotides
    b. Chains of simple sugars
    c. Twisted chains of amino acids
    d. Three very long carbon-hydrogen chains attached to a glycerol molecule

5. What kind of molecule is an enzyme? Why are enzymes important in a cell?

_____
_____
_____

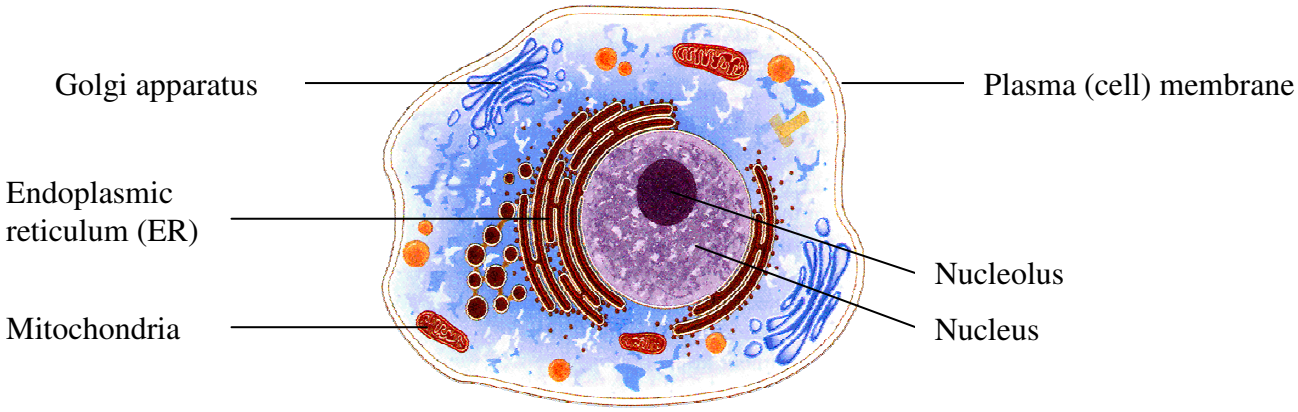
6. Compare and contrast carbohydrates and lipids.

_____
_____
_____

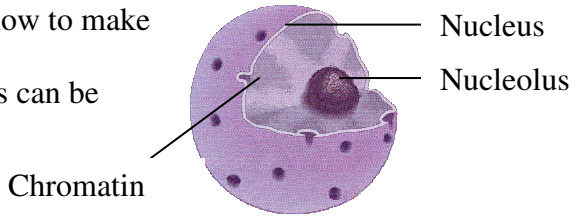
Cells

The **cell theory** states that cells are the basic unit of life, all living things are made up of one or more cells, and that cells come only from other living cells.

Eukaryotic cells are cells that have internal membrane- bound structures. Plants, animals, and fungi are made up of eukaryotic cells. The structures found inside of eukaryotic cells are called **organelles** (little organs), and each organelle has a particular function linked to cell survival.



Nucleus- contains DNA, which holds the instructions for how to make proteins
(all cell parts depend on proteins to function, so the nucleus can be considered the control center of the cell)



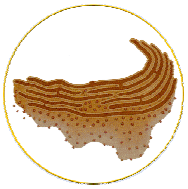
The blueprints for protein production are contained in

chromatin- strands of DNA

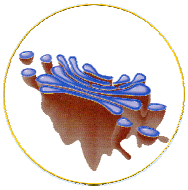
nucleolus- the dark sphere within the nucleus, where ribosomes are made

Ribosomes- the site of protein synthesis (where proteins are made)

Once ribosomes are made in the nucleolus, they move to the cytoplasm (the jelly-like region outside of the nucleus). Ribosomes can then attach to the **endoplasmic reticulum (ER)**, a series of highly folded membranes that act as the highway of the cell. Once proteins are made by the ribosomes, the proteins travel through the ER, and…



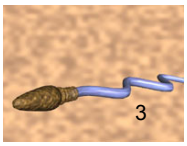
are transferred to the **Golgi apparatus**. The Golgi apparatus is a series of flattened membrane sacs that sorts and distributes proteins.



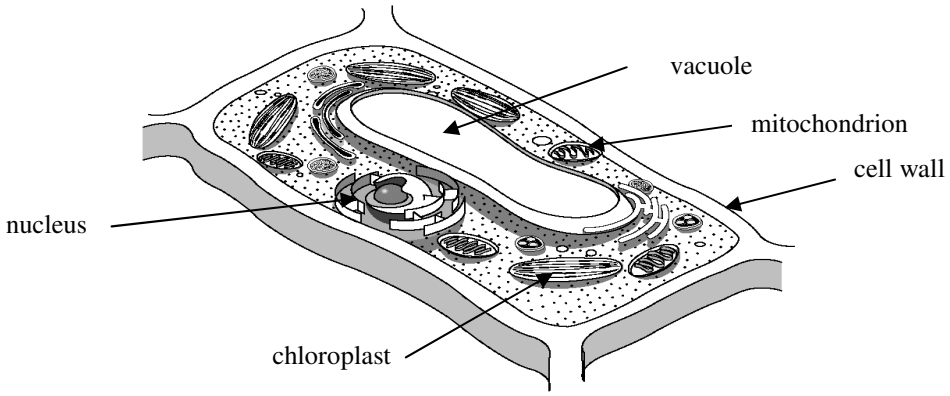
Vacuoles- store things (enzymes, food, and other materials) within the cell

Lysosomes- contain enzymes that digest or break down worn out cell parts, excess food particles, and invading bacteria or virsues

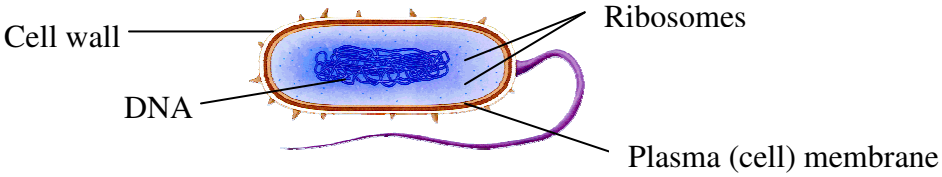
Flagella- some cells have whip-like extensions that they helps them move



Plant cells look different than animal cells because plants have cell walls and chloroplasts, and also usually have a large central vacuole used to store water.



Prokaryotic cells, such as bacteria, lack internal membrane- bound structures. (A prokaryotic cell does not have a nucleus or organelles.) Prokaryotes do synthesize proteins, so they do contain ribosomes.



Practice

1. Which part of the cells acts as a barrier to control what enters and leaves the cell?
   a. cell membrane
   b. cytoplasm
   c. DNA
   d. Nucleus

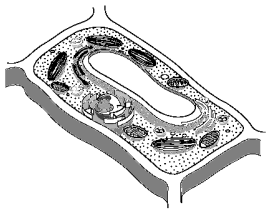
2. Which of the following is a main difference between prokaryotic and eukaryotic cells?
   a. smaller size of eukaryotes
   b. absence of a membrane-bound nucleus in prokaryotes
   c. absence of ribosomes in prokaryotes
   d. absence of organelles in eukaryotes

3. Which statement is false?
   a. Eukaryotes are much more complex than prokaryotes
   b. The components inside a prokaryotic cell lack membranes
   c. Prokaryotes were the first organisms on Earth
   d. Prokaryotes lack genetic material

4. Muscle cells require a great deal of energy. Therefore, they are likely to have a high number of _____ .

a. Golgi
b. Mitochondria
c. ER
d. Lysosomes

5. This cell is most likely a member of which Kingdom?



a. Fungi
b. Animalia
c. Protista
d. Plantae

6. If a cell was unable to produce ribosomes, which of the following would it be unable to make?

a. carbohydrates
b. proteins
c. nucleic acids
d. lipids

7. Which organelle is most like a miniature stomach inside of the cell?

a. Vacuole
b. Endoplasmic reticulum
c. Lysosome
d. Chloroplast

8. Which of the following is not a cell organelle?

a. mitochondrion
b. cytoplasm
c. endoplasmic reticulum
d. lysosome

9. Which of the following would you find in a plant cell but not in an animal cell?

a. cell membrane
b. endoplasmic reticulum
c. nucleus
d. chloroplast

10. Cellulose is which type of organic compound?

a. carbohydrate
b. lipid
c. nucleic acid
d. protein

11. How are eukaryotes different from prokaryotes?

_____
_____
_____

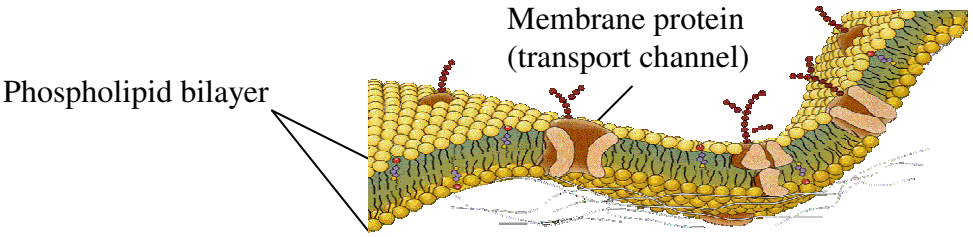
Transport of Materials Into and Out of the Cell

Plasma (cell) membrane- the boundary between the cell and its environment, controls entry of nutrients and removal of wastes- maintains homeostasis

****Homeostasis**- *balance; an ideal internal environment* ***

Selective permeability- the cell membrane is picky- some molecules are allowed to enter a cell while others are kept out

Phospholipid bilayer- The plasma (cell) membrane is made up of two layers, each layer contains phosphate groups and lipids (fats) that allow the membrane to be flexible and picky about what enters and what exits. There are also proteins in the membrane that can help substances move through.

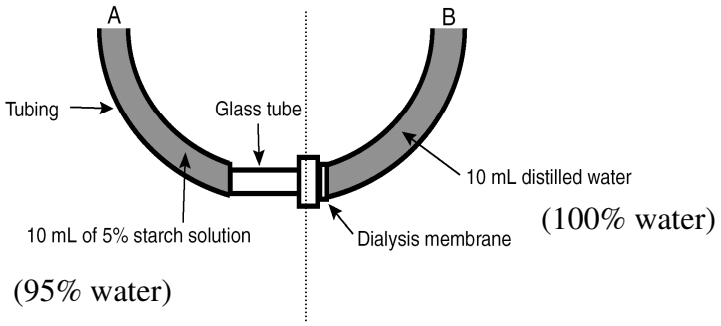


Passive Transport

Some substances can move without using energy. This is called passive transport. If you place a drop of ink in a beaker, the ink will soon spread farther and farther out until it is evenly distributed. The ink did not have to use energy to spread out. Instead, the random movement of particles caused the crowded (highly concentrated) ink molecules to move to less crowded (less concentrated) areas. This movement of solute (dissolved substance) from an area of greater concentration to an area of less concentration is called **diffusion.**

Water molecules can also diffuse. Diffusion of water is called **osmosis**. Water also moves from where there is more water to where there is less water. Look at the diagram below. The dialysis membrane is similar to a plasma membrane in that it is selectively permeable. Water molecules are small enough to pass through, but starch molecule are too large. Because there is a greater concentration of water in side B (100%) than in side A (95%), water will move from side B to side A, and the water level in side A will rise.

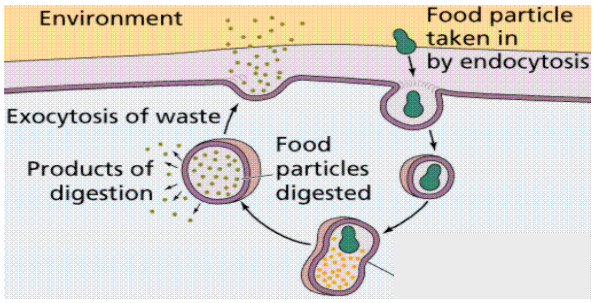
Osmosis Apparatus



Active Transport

Some molecules are too large to enter or exit the cell, or their charges prohibit them from passing through the plasma membrane. If this is the case, the cell can still move them, but it must use energy. Movement of substances that requires energy is called **active transport.**

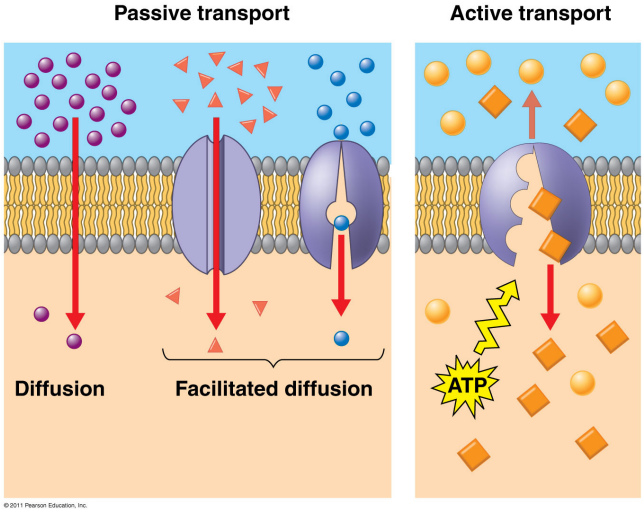
Sometimes proteins in the plasma membrane are used to pump materials out. Sometimes, materials enter and exit the cell using vesicles (pockets of the cell membrane).



Endocytosis uses vesicles to bring materials (like nutrients) into the cell.

Exocytosis uses vesicles to move materials (like waste products) out of the cell.

Summary:



Practice

1. A thermostat maintains an ideal temperature of a room. What cell process is similar to this?
   A. Food storage
   B. Protein synthesis
   C. Active transport
   D. Homeostasis

2. If a saltwater fish (90% water) is placed in fresh water (100% water), water will likely move into the fish cells and kill the fish. This is most likely due to _____.
   A. facilitated transport
   B. osmosis
   C. endocytosis
   D. exocytosis

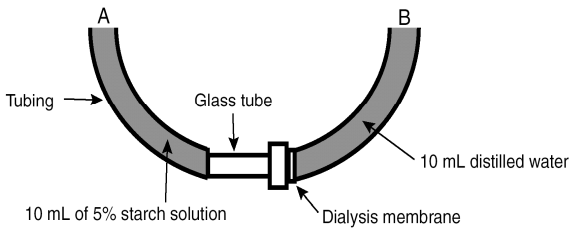
3. Passive transport requires energy / does not require energy *(circle one),* while active transport requires energy / does not require energy *(circle one).*

4. Which process allows large molecules to enter a cell?
   A. endocytosis
   B. exocytosis
   C. osmosis
   D. facilitated diffusion

5. What does it mean that the plasma (cell) membrane is selectively permeable?

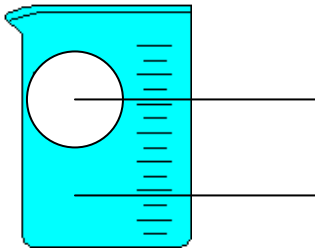
6. The cell membrane maintains homeostasis by controlling
_____
_____.

Osmosis Apparatus



7. Which would most likely cause the liquid in Tube A to rise?
   A. Starch concentrations being equal on each side of the membrane
   B. Water passing from a region of lower starch concentration to one of higher starch concentration
   C. Water and starch volumes being the same
   D. Solute in the tubes changing from a higher temperature to a lower temperature

8. If the cell in the beaker is permeable to only water, the cell will probably_____.
   A. grow and possibly explode
   B. shrink
   C. stay the same



9. Facilitated diffusion is
   A. the same as endocytosis
   B. a special kind of osmosis
   C. a process that requires the cell's energy
   D. a type of passive transport

10. Which of the following is not a part of a prokaryotic cell?
   A. Cytoplasm
   B. Cell membrane
   C. DNA
   D. Organelle

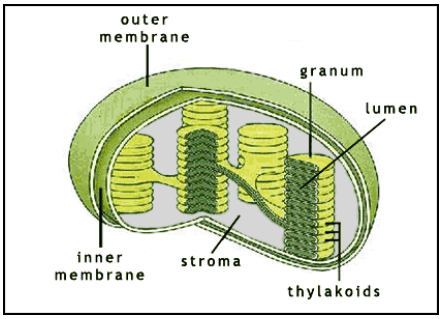
Cellular Energy

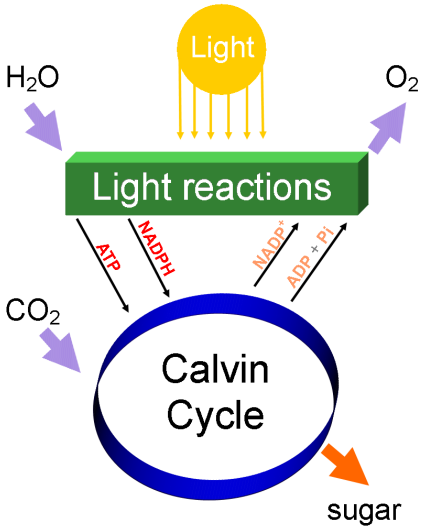
All organisms need energy, but only some living things can directly use the energy of sunlight. **Autotrophs** (producers) make their own food by obtaining energy from sunlight (or inorganic compounds). **Heterotrophs** (consumers) cannot make their own food, and must get their energy from food sources.

Photosynthesis- carried out in the chloroplasts of plants; <u>uses carbon dioxide</u> to store energy in the form of glucose (organic molecules); <u>produces oxygen</u>

$$6CO_2 + 6\,H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

Chloroplasts- found in the cells of green plants- convert light energy into chemical energy, stores energy in food molecules. Chloroplasts contain the pigment chlorophyll, which absorbs mostly blue and red light, and reflects green and yellow (giving plants their green appearance).





<u>Photosynthesis occurs in two stages:</u>

- Light-dependent stage- occurs in the thylakoid membrane, the energy of sunlight is converted into energy carrier molecules (ATP and NADPH) used in the second stage
- Calvin cycle (light-independent stage)- occurs in the stroma, uses the energy from the first stage and CO_2 to form glucose.

The rate of photosynthesis can be affected by:

- The amount of water available
- The amount of sunlight available
- Temperature (must be within an optimal range since the reactions of photosynthesis depend on enzymes)

The plant uses the energy stored in the sugar molecule to carry out life processes. The sugar molecule is also used to build more complex carbohydrates, which can be used in growth and development.

Practice

Why are pigments important to the process of photosynthesis?

_____

_____

How is the Calvin cycle dependent on the first stage of photosynthesis?

_____

_____

Why is photosynthesis important?

_____

_____

The glucose made in photosynthesis is the starting point for **cellular respiration**. Cellular respiration should not be confused with the process of breathing. Breathing simply involves taking in oxygen and eliminating carbon dioxide, but cellular respiration is a series of chemical reactions that change glucose into a usable form of chemical energy (ATP).

Cellular (aerobic) respiration- occurs in mitochondria; uses oxygen to release energy **(ATP)** from food molecules; produces carbon dioxide

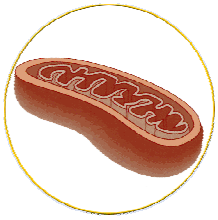
$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6\ H_2O$$

****ATP is energy that drives chemical reactions in cells.****

Cellular respiration begins with a series of steps called **glycolysis**, which converts glucose into pyruvate. If oxygen is present, pyruvate enters *aerobic respiration*, and a great deal of ATP is produced.

If there is no oxygen present, some cells can undergo anaerobic *(without oxygen)* respiration to make ATP. Some microorganisms, such as yeast, carry out alcohol fermentation, which produces ATP and alcohol. In humans, however, muscle cells carry out lactic acid fermentation. For example, if your muscles are fatigued and run out of oxygen they will produce lactic acid, which causes muscle cramps. Only a small amount of ATP is produced in *anaerobic respiration*.

Mitochondria- in **both plants and animals**, breaks down food molecules and transforms food into energy (ATP)= **the "powerhouse" of the cell**



PRACTICE

Why is cellular respiration important?

_____

_____

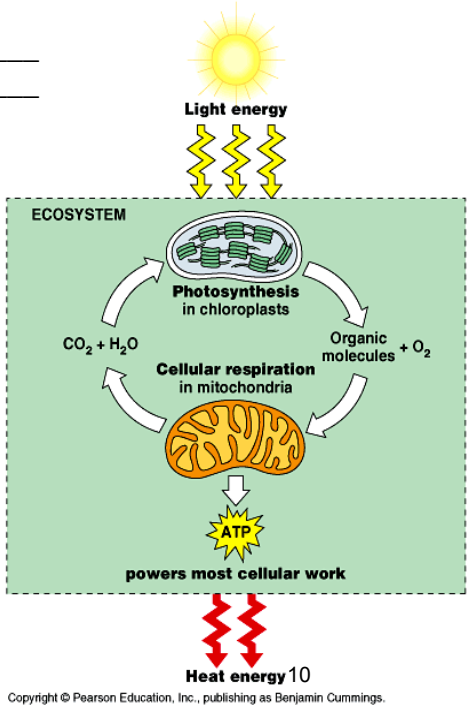
What is the importance of ATP in a cell?

_____

_____

Comparison of Cellular Respiration and Photosynthesis

Process	Reactants	Products	Energy Change
Photosynthesis	Carbon dioxide, water	Glucose, oxygen	Light energy to chemical energy
Cellular Respiration	Glucose, oxygen	Carbon dioxide, water	Chemical energy to other chemical energy



Practice

1. Energy flows through an ecosystem from—
    a. the sun to autotrophs to heterotrophs
    b. the sun to heterotrophs to autotrophs
    c. autotrophs to heterotrophs and back to autotrophs
    d. heterotrophs to autotrophs and back to heterotrophs

2. Which of the following is not an autotroph?
    a. Blue-green bacteria
    b. Algae
    c. Plants
    d. Humans

3. Which compound is a major energy carrier in the process of photosynthesis?
    a. DNA
    b. Water
    c. ATP
    d. Carbon dioxide

4. During photosynthesis, the light reactions take place in the _____, while the Calvin cycle takes place in the _____.
    a. stroma, thylakoid
    b. thylakoid, stroma
    c. grana, thylakoid
    d. stroma, grana

5. Cellular respiration involves an energy conversion. Which of the following represents the energy conversion that occurs during cellular respiration?
    a. light energy to glucose
    b. ATP to light energy
    c. ATP to glucose
    d. glucose to ATP

6. What do both glycolysis and fermentation have in common?
    a. They require oxygen
    b. They produce lactic acid and ethyl alcohol
    c. The require light energy
    d. They produce ATP

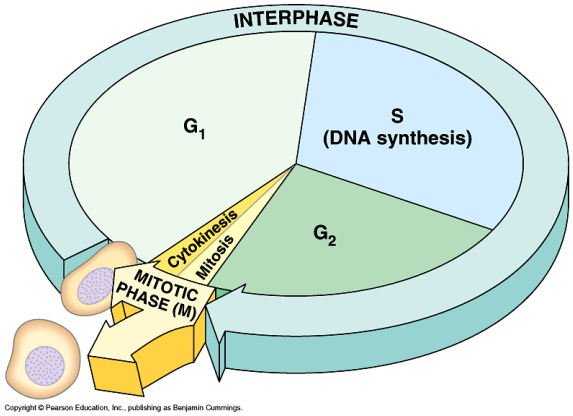
7. Glucose is the starting point for cellular respiration. Which type of biomolecule is glucose?
    a. carbohydrate
    b. lipid
    c. protein
    d. nucleic acid

8. Each chemical reaction that occurs in cellular respiration relies on an enzyme. What role does an enzyme play ni cellular respiration?
    a. an enzyme reverses a chemical reaction
    b. an enzyme converts light energy into chemical energy
    c. an enzyme speeds up a chemical reaction
    d. an enzyme contains the genetic information needed for the chemical reaction to occur

9. Which of the following contains an organelle for respiration?
    a. prokaryote
    b. eukaryote
    c. bacterial cell
    d. cell without a nucleus

The Cell Cycle

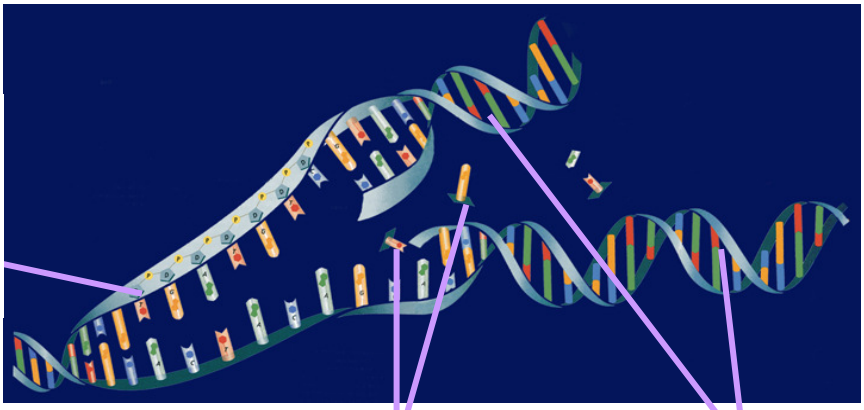
The **cell cycle** is a sequence of several phases through which a cell passes a it grows, prepares for division, and divides.



- **Interphase**- the stage where the cell spends most of its time, divided into…
  - **G1** (first growth) phase- cell undergoes growth, energy conversions, transport or molecules, and synthesis of new molecules (normal cellular functions)
  - **S** (synthesis) phase- a copy of each chromosome is made. One complete set of genetic information will be given to one nucleus that forms as a result of mitosis, and the other complete set will be given to the other nucleus.

(DNA is the instruction manual for the cell. Exact copies of DNA are passed on to the next generation of cells each time a cell divides. The overall process of DNA replication *(DNA copying itself to make new DNA for new cells)* is shown in the diagram below)

1. DNA molecule is unzipped *(bonds between the nitrogen bases are broken by enzymes)*



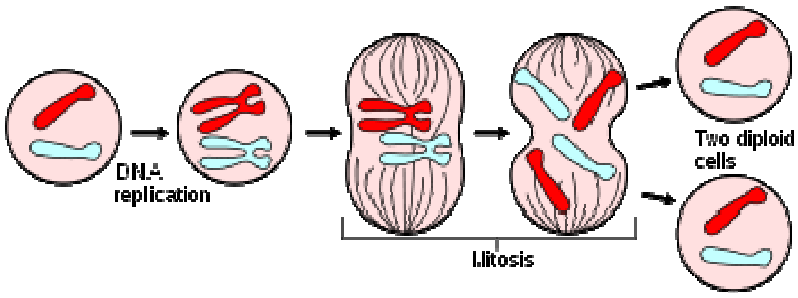
2. Free floating nucleotides are added to their complementary bases

3. Formation of two identical DNA molecules

  - **G2** (second growth) phase- cell prepares for mitosis

Once interphase is complete, the cell is ready to enter mitosis…

- **Mitosis** (M phase)- the process in which a nucleus divides to form two nuclei
    - Chromosomes condense
    - Chromosomes line up along the middle of the cell
    - Each member of a chromosome pair moves to the opposite end of the cell
    - The nucleus divides. Each nucleus ends up with the same number of chromosomes as the original cell.
    - The cytoplasm divides (**cytokinesis**), resulting in two identical cells.



While the events of the cell cycle are usually carefully regulated, mutations may lead to loss of control of the cell cycle. Uncontrolled cell division is known as **cancer.**

PRACTICE

1. The cell cycle includes mitosis. What happens during mitosis?
    a. each chromosome makes a copy of itself
    b. the cell cytoplasm divides to produce two cells
    c. the cell prepares to divide
    d. the nucleus divides so that each cell will receive a complete set of genetic information

2. A yeast cell can complete a cell cycle every 90 minutes. Starting with just one cell, how many yeast cells should be present after 6 hours?
    a. 2
    b. 4
    c. 8
    d. 16

3. During the very early stages of a person's life, the rate of cell division proceeds rapidly. During this time, cells show little growth. What can you conclude from this information about the cell cycle during thses very early stages of development?
    a. the cell cycle consists mainly of a long G1 phase
    b. the cell cycle consists mainly of M and S phases
    c. most cells exit the cell cycle
    d. most cells will not undergo mitosis

4. During the cell cycle, DNA is copied. Which type of biomolecule is DNA?
    a. carbohydrate
    b. lipid
    c. protein
    d. nucleic acid

5. The cell cycle requires energy. Which process supplies this energy so that the cell cycle can take place in all living things?

a. respiration
b. transport
c. homeostasis
d. fermentation

6. Part of the cell cycle involves growth. Growth involves assembling smaller molecules to make large ones. Which process is responsible for making these larger molecules from smaller ones?

a. transport
b. respiration
c. synthesis
d. homeostasis

7. The cell cycle involves the division of the nucleus. Which type of cell undergoes mitosis?

a. prokaryotes
b. eukaroytes
c. bacterial cells
d. only plant cells

8. Why must each chromosome make a copy of itself before the M phase begins?

_____
_____

9. What happens during the M phase of the cell cycle?

_____
_____
_____

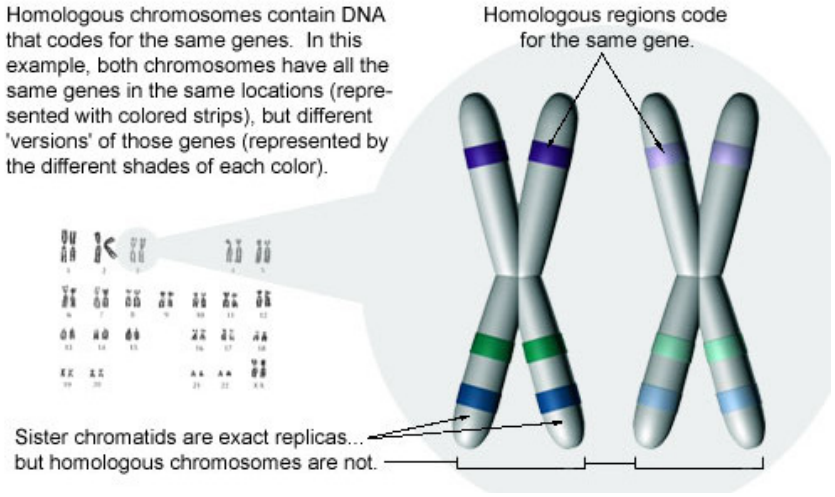
10. Why is the cell cycle important to the growth of an organism?

_____
_____

Meiosis

Meiosis is a special kind of cell division that produces gametes (sperm and egg) that have only half the number of chromosomes as the parent cell.

Your body is made of **somatic cells** that each has 46 chromosomes. Of the 46 chromosomes in each of your body cells, 23 came from one of your parents, and 23 came from the other parent. The two sets of matching chromosomes are called **homologous chromosomes.** A cell (like a somatic cell) that contains both sets of homologous chromosomes is said to be **diploid**. The number of chromosomes in a diploid cell is represented by **2n**. (For example, in humans 2n= 46. The body cells of a fruit fly each contain 8 chromosomes, which is written as 2n= 8.)



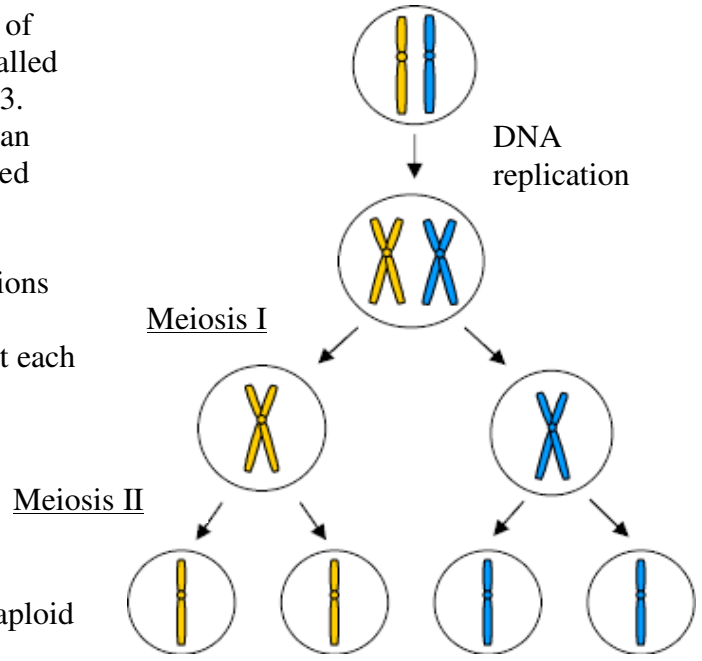
During fertilization, gametes (sperm and egg) unite, which leads to a complex series of steps resulting in development of an adult organism. In order for each generation of organisms to have the same number of chromosomes, gametes must contain only half as many chromosomes as body cells. This way, 1n + 1n = 2n.

Meiosis results in cells that have half the number of chromosomes of the parent cell. Thee cells are called **haploid** cells, and they are represented by **1n** = 23. Before meiosis begins, each chromosome makes an exact copy of itself. The resulting copies are called **chromatids**, and are attached at the centromere.

During meiosis, the cell undergoes two cell divisions called meiosis I and meiosis II. In **meiosis I**, homologous chromosomes separate, ensuring that each new cell receives only one set of information.

The sister chromatids are still attached at the end of meiosis I, but must be separated. **Meiosis II** separates the sister chromatids.

At the end of meiosis, four genetically diverse, haploid gametes are produced.



Practice

1. Which of the following occurs in meiosis?
   A. The chromosomes are copied twice
   B. One cell produces four cells
   C. One cell produces two cells
   D. The nucleus divides once

2. If a parent cell has 18 chromosomes, how many chromosomes would be found in a gamete that this cell produces?
   A. 36
   B. 18
   C. 9
   D. 6

3. Which statement correctly describes what happens as a result of the first meiotic division?
   A. sister chromatids separate
   B. the chromosome number remains unchanged
   C. each cell contains half the number of chromosomes of the original cell
   D. four gametes are formed

4. If a cell contains the alleles GgRr, which of the following represent a possible product of meiosis?
   A. GGRR
   B. Gg
   C. Rr
   D. GR

5. Which process occurs in both mitosis and meiosis?
   A. Cell specialization
   B. DNA replication
   C. Reduction in chromosome number
   D. Two nuclear divisions

6. Why is meiosis necessary in a sexual life cycle?

_____

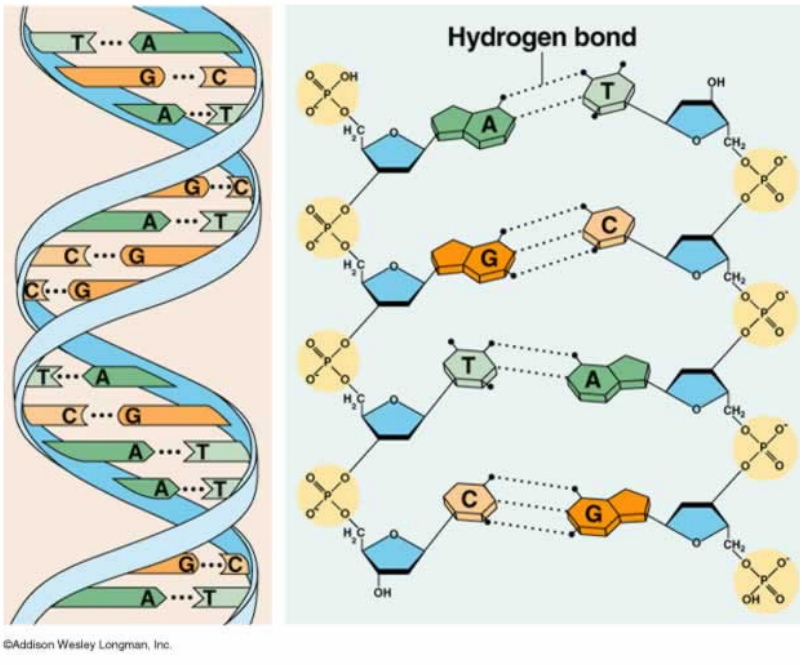
_____

_____

DNA

Nucleic acids store information in cells in the form of a code. **Deoxyribonucleic acid (DNA)** is the master copy of an organism's genetic information. The information in DNA contains instructions used to form nearly all of an organism's proteins. **DNA is the blueprint for how an organism works and how it looks.** For example, DNA determines eye color, body structure, and enzyme production. DNA is passed on every time a cell divides. (The DNA in all of your cells is the same.) DNA is also passed from one generation of an organism to the next.

Nucleic acids are made of smaller subunits called **nucleotides**. A nucleotide is made of a **sugar, a phosphate, and a nitrogen base**. The sugar in DNA is called **deoxyribose**- this is what the "D" in DNA stands for. DNA has four possible nucleotides- adenine (A), thymine (T), cytosine (C), and guanine (G). In DNA, nucleotides form two long chains that form a **double helix** (like a winding staircase). The backbone of the double helix is made up of sugar molecules and phosphate groups, and the two chains are joined together by hydrogen bonds between the nitrogen bases. The two bases that form each rung of the ladder are called a base pair. In DNA, cytosine and guanine form one base pair; thymine and adenine form the other base pair.



If the sequence of one strand on DNA is… ATC CGT GAT

its complementary strand will be… TAG GCA CTA

DNA forms the genetic code of an organism. **The order of the nitrogen bases (A's, T's, C's, and G's) determines everything about every organism because it tells our cells how to make proteins.** A protein is made up of **amino acids.** There are 20 different amino acids, and how your body puts amino acids together determines how you look and how you work. DNA controls eye color and eye shape, hair color and texture, and your other traits by controlling how your proteins are put together.

Practice

1. If the sequence of one strand on DNA is… CTA GCT CCA
   its complementary strand will be… _____

2. If the sequence of one strand on DNA is… TCG CCG ATC
   its complementary strand will be… _____

3. What does the "D" in DNA stand for?

4. Name the three parts of a nucleotide:

5. What molecule determines your eye color, enzyme production, and body structure?
   A. Carbohydrates
   B. Starch
   C. Fatty acids
   D. DNA

6. You look the way you look because of _____.
   A. The amount of guanine in your cells
   B. The number of sugars in your cells
   C. The sequence of nitrogen bases
   D. The strength of your hydrogen bonds

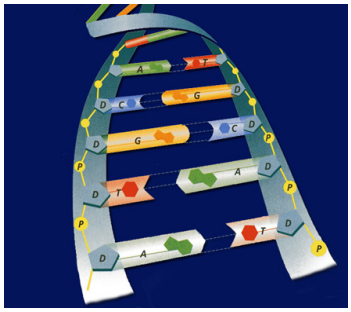
7. The backbone of the double helix is made up of _____ molecules and _____ groups, and the two chains are joined together by hydrogen bonds between the _____.

8. If the DNA of an organism contains 20% adenine, what is its percentage of guanine?
   A. 20%
   B. 30%
   C. 60%
   D. 80%

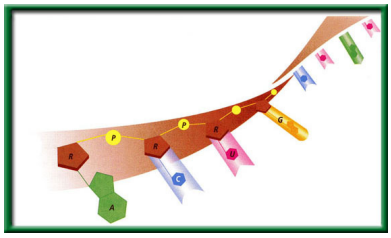
9. Which of the following represents the building block of a DNA molecule?
   A. Nitrogen-containing base
   B. Phosphate group
   C. Deoxyribose sugar
   D. Nucleotide

10. What would you expect to find in all organisms?
   A. The same genetic information
   B. The same sequence of DNA nucleotides in the DNA molecules
   C. The same percentages of DNA base pairs
   D. The same four DNA nucleotides

11. In which organelle must DNA replication occur?
   A. Cell membrane
   B. Cell wall
   C. Ribosome
   D. Nucleus



DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are nucleic acids. They are made up of smaller subunits called nucleotides. Nucleotides are made up of three main parts: a simple sugar (deoxyribose or D), a phosphate group, and one of four nitrogen bases: adenine (A), thymine (T), cytosine (C), and guanine (G). The nucleotides in DNA form two strands, which are held together in the center by the pairing of nitrogen bases. Nitrogen bases always join (or pair) in the same way. Thymine always pairs with adenine and cytosine always pairs with guanine in DNA.



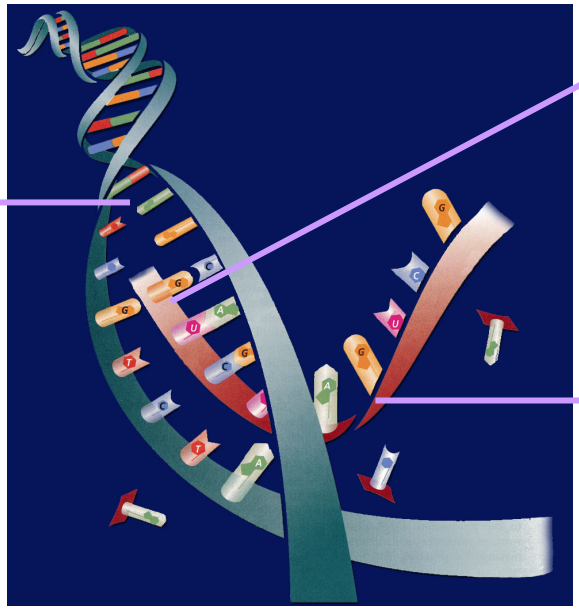
Like DNA, **RNA (ribonucleic acid)** contains four nitrogen bases, but instead of thymine, RNA contains a base called uracil (U). Unlike the double stranded DNA, RNA is made of a single strand of nucleotides, each of which contains the simple sugar ribose (R).

Transcription

DNA is found only in the cell's nucleus, and DNA contains the cell's instructions for how to make proteins. Proteins are made, however, in the cytoplasm of the cell (by the ribosomes). The information must somehow leave the nucleus, but DNA is not permitted to pass through the nuclear membrane. Instead, DNA can be copied into RNA, a copy of instructions that can leave the nucleus and go to the ribosomes. The process of copying DNA into RNA is called **transcription**. (Transcription results in an RNA copy of a DNA strand.) The main enzyme responsible for transcription is **RNA polymerase**.

If a strand of **DNA** is	TAC GCA TCG ATG
its complementary strand of **RNA** will be	AUG CGU AGC UAC

(Remember that RNA has U instead of T!)



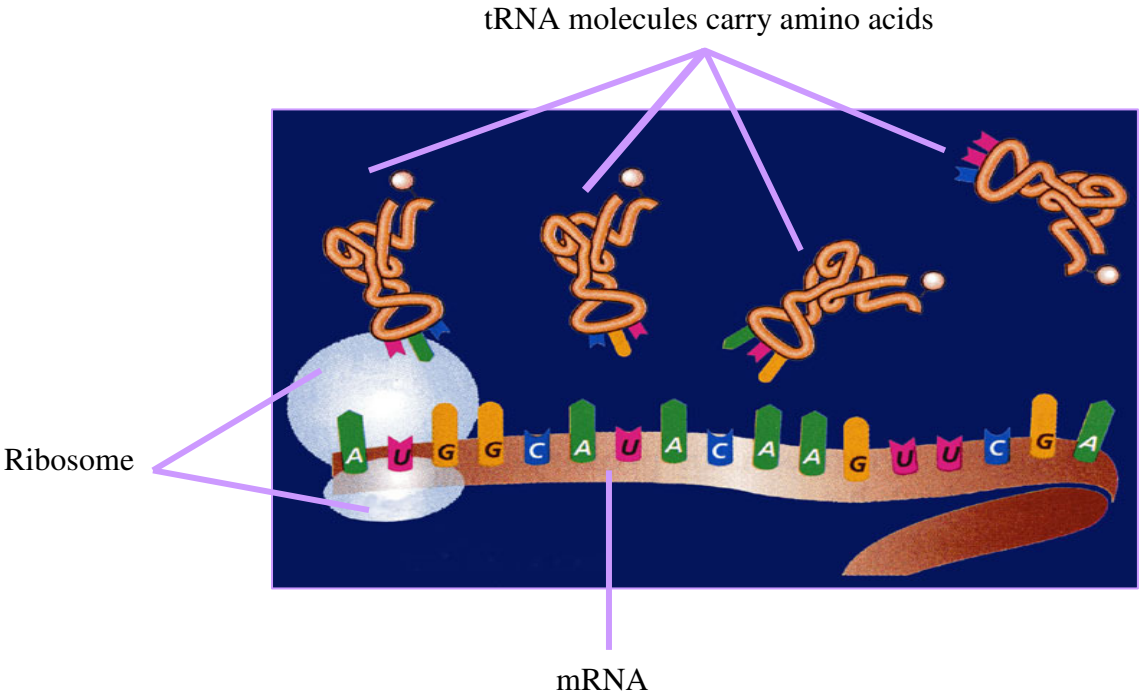
1. DNA molecule is unzipped

2. Free RNA nucleotides pair up with complementary DNA bases

3. A single strand of RNA is produced, which can break away, leave the nucleus, and find ribosomes

Translation

After transcription (DNA is copied into RNA), the messenger RNA (**mRNA**) leaves the nucleus where ribosomes can read the instructions and **make proteins (translation).** Remember that proteins are made up of subunits called amino acids. Translation involves transfer RNA (**tRNA**) molecules, which bring amino acids together in the correct order to build the correct proteins.



The ribosome reads the mRNA in three letter groups called **codons**. You can use a codon chart *(like the one shown below)* to determine which amino acid should be brought in.

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

For example, if a sequence of mRNA is

AUG CAU UGC

then it is coding for the following amino acids:

Met His Cys

Practice

1. How are RNA and DNA similar? How are they different?

_____

_____

2. Which of the following base pairs with adenine (A) in RNA?
   A. Guanine (G)
   B. Uracil (U)
   C. Thymine (T)
   D. Cytosine (C)

3. In order to be transcribed, DNA molecules separate between which of the following parts?
   A. Sugars
   B. Nitrogen bases
   C. Phosphate groups
   D. Ends

4. Which of the following processes results in an RNA copy of a DNA strand?
   A. Transcription
   B. Translation
   C. Replication
   D. Mitosis

5. In order to be translated, RNA must travel to the cytoplasm. In order to reach the cytoplasm, this RNA must pass through
   A. the cell membrane
   B. the mitochondrion
   C. the environment surrounding the cell
   D. pores in the nuclear membrane

6. If a sequence of mRNA is CUG AGU GCA, which of the following is the DNA segment from which it was transcribed?
   A. CGC ATG CGG
   B. GAC UCA CGU
   C. GAG TAC GCC
   D. GAC TCA CGT

7. If a strand of mRNA is CUC GCA GAU, what is the sequence of amino acids that will be produced? *(use the codon chart provided above)*
   A. Ser His Lys
   B. Ile Met Thr
   C. Gly Leu Cys
   D. Leu Ala Asp

8. If a strand of mRNA is UGC CAU GCC, what is the sequence of amino acids that will be produced? *(use the codon chart provided above)*
   A. Cys His Ala
   B. Met Ile Ser
   C. Gly Ala Thr
   D. Tyr Trp Val

9. What is translation?

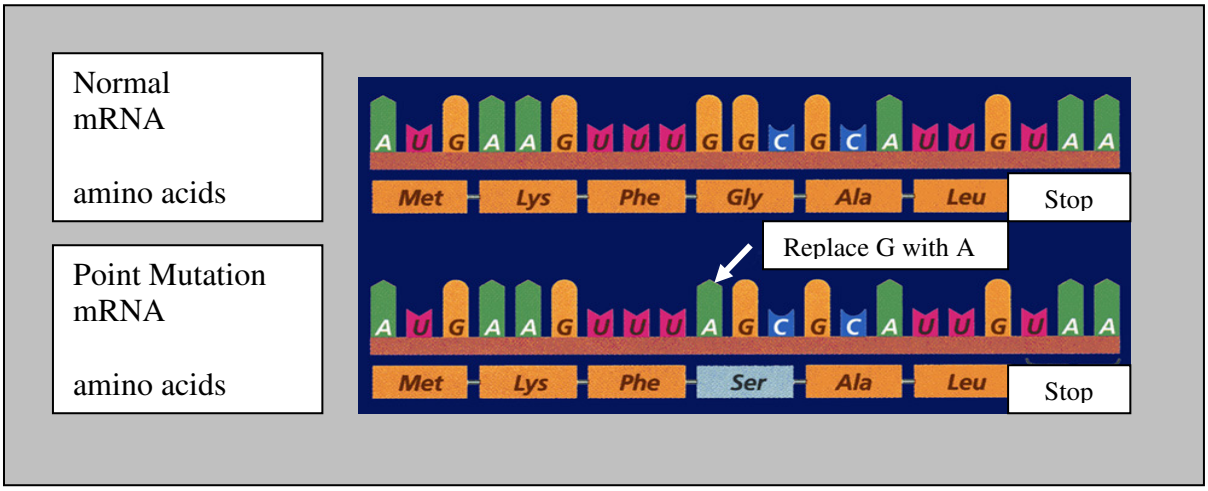
Mutations

A section of DNA on a chromosome that directs the making of a specific protein is called a **gene**. Genes control the traits inherited by an organism. If a change occurs in the sequence of nitrogen bases, the trait may be changed. Human DNA is made up of about 6 billion base pairs, so it is not surprising that sometimes errors occur when DNA is copied or when cells divide.

Any permanent change in the sequence of nucleotides is called a **mutation**. Some mutations, like flower color in plants, are not harmful, but some mutations can cause disease. For example, sickle cell anemia and cystic fibrosis are diseases caused by mutations.

Although many mutations are harmful, they also add genetic diversity to a species. Also, if a mutation causes a change that is beneficial (helpful), the individuals with the helpful mutation will have an advantage over organisms without the mutation.

Example of a mutation:



If a different nucleotide replaces one that was originally present, it is called a **substitution** mutation. If a base is added, it is called an **insertion** mutation. If a base is deleted, it is called a **deletion** mutation.

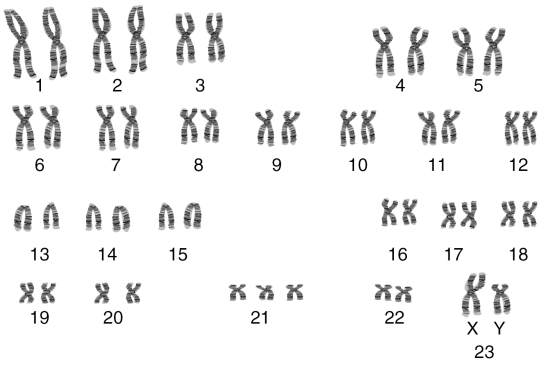
Mutations can also occur at the chromosomal level. For example, a piece of chromosome may break off.

******Any change in DNA or RNA can change which proteins are made, which can change how our cells look and how our cells work******

Causes of mutations

Mutations are usually random events. Some mutations are caused by **mutagens**- substances in the environment like ultraviolet light, X rays, radioactive substances, cigarette smoke, and pollutants. If mutations occur in body (somatic) cells, they can cause cancer. Only changes in gametes (eggs and sperm) are passed on to offspring.

The diagram to the right is a **karyotype**- a picture of chromosomes. Humans normally have 23 pairs of chromosome, but the individual whose chromosomes are shown here has an extra chromosome 21. This condition is called Down's Syndrome, and it is caused by **nondisjuction** (chromosomes separating incorrectly) during meiosis.



Practice

1. What is nondisjunction?
   A. Failure of genes to be passed on to future generations
   B. A mutation caused by the environment
   C. Failure of chromosomes to separate properly
   D. A duplication of genes on a chromosome

2. Mutations in DNA molecules can occur when —
   A. replication of DNA is exact
   B. a DNA enzyme attaches to an RNA codon
   C. RNA codons are replaced by DNA nucleotides
   D. a change occurs in DNA nucleotide bases

Codon Chart

Second Position

First Position (5′)	U	C	A	G	Third Position (3′)
U	Phenylalanine	Serine	Tyrosine	Cysteine	U
	Phenylalanine	Serine	Tyrosine	Cysteine	C
	Leucine	Serine	Stop	Stop	A
	Leucine	Serine	Stop	Tryptophan	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine	Proline	Histidine	Arginine	C
	Leucine	Proline	Glutamine	Arginine	A
	Leucine	Proline	Glutamine	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine	Threonine	Asparagine	Serine	C
	Isoleucine	Threonine	Lysine	Arginine	A
	Methionine	Threonine	Lysine	Arginine	G
G	Valine	Alanine	Aspartic acid	Glycine	U
	Valine	Alanine	Aspartic acid	Glycine	C
	Valine	Alanine	Glutamic acid	Glycine	A
	Valine	Alanine	Glutamic acid	Glycine	G

3. Which of the following changes would be expected in the amino acid chain if the following mutation occurred? *(use the codon chart above)*

ACG GUC CCG ⟶ ACG GCC CCG

A. The amino acid sequence would be shorter than expected.
B. The identity of one amino acid would change.
C. The amino acid sequence would remain unchanged.
D. The identities of more than one amino acid would change.

4. Which part of DNA provides instructions for how to produce a protein?
   A. The sequence of nitrogen bases
   B. The sugar molecules
   C. The phosphate groups
   D. The bonds that hold the sugar and bases together

5. Substitutions, insertions, and deletions are known as "point" mutations because they
   A. change the genetic information of DNA
   B. affect the structure of a chromosome
   C. involve only a single nucleotide
   D. change the amino acid that is inserted into a protein

6. Which of the following can be a mutagen?
   A. an inversion
   B. a toxic chemical
   C. a nucleotide
   D. a random mutation

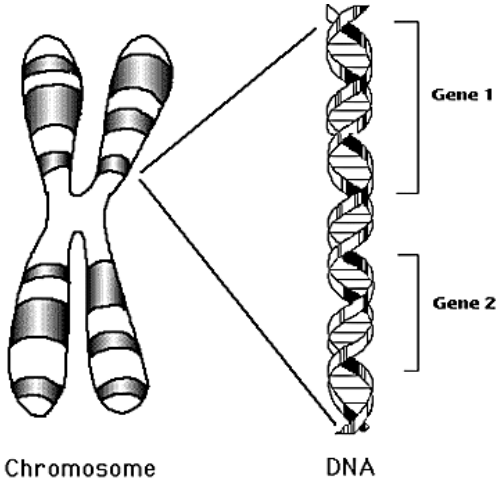
7. The DNA sequence TTT codes for the amino acid lysine. The DNA sequence TTC also codes for lysine. What can you conclude from this information?
   A. a deletion in the genetic instructions may not be significant
   B. adding a nucleotide to a genetic sequence has no effect
   C. any substitution that changes the genetic code affects a trait
   D. this kind of substitution in the genetic code may go unnoticed

8. Which two types of biomolecules are directly affected by a mutation?
   A. nucleic acids and lipids
   B. nucleic acids and carbohydrates
   C. proteins and nucleic acids
   D. proteins and carbohydrates

9. Any permanent change in a gene is called a _____.

10. When can a mutation be passed on to offspring?

Genes and Differentiation



Each of your cells and the cells of all organisms have DNA, which are molecules that contain the information to control the processes that keep cells alive. Your cells' DNA is compacted into chromosomes, which contain the genetic information to determine your traits. Each of your traits is coded for by one or more genes, and each gene occupies a specific location on a chromosome.

The DNA nucleotides that make up a chromosome must be expressed as part of a well-regulated process known as **gene expression**. If a gene is expressed, the protein that it codes for is produced. Only a fraction of the genes in a cell are expressed at one time.

All the cells in an organism contain the same genetic information, since all of the cells develop from a single original cell. Mitosis (and the cell cycle) leads to the production of identical copies of the original cell, resulting in a multicellular organism.

The cells become specialized as a result of **differentiation**. For example, the genes that are expressed in a cell that will become a skin cell must be different from the genes that will become a brain cell. In effect, there must be a selective process of turning genes on and off in cells that will perform different functions in the adult organism.

Practice

1. Which of the following represents the highest level of organization of genetic information?
   A. Nucleotide
   B. Gene
   C. Chromosome
   D. A, T, C, or G

2. Which is true about a gene?
   A. All traits are determined by only one gene
   B. A gene is shaped like a spiral ladder
   C. A gene is made up of chromosomes
   D. A gene occupies a specific place on a chromosome

3. Plants have specialized structures such as roots, stems, and leaves. What process is responsible for the development of these different structures?
   A. Cell cycle
   B. Mutation
   C. Photosynthesis
   D. Differentiation

4. If all of your cells contain the same genetic information, how can your cells have so many different appearances and functions?

_____

_____

Heredity

Traits are inherited from one generation to the next. Each person inherits half of their chromosomes from their mother and half of their chromosomes from their father.
Genes- sections of DNA on a chromosome- control traits. There are different forms of each gene called **alleles**. For example, a gene for flower color may code for white flowers (one version/ allele) or red flowers (another version/ allele).

Some important terms to use in genetics:

Homozygous- the two alleles for a trait are the same
Ex. If a plant inherits two copies of the red allele (RR)
If a plant inherits two copies of the white allele (rr)

Heterozygous- the two alleles for a trait are different
Ex. If a plant inherits one copy of the red allele and one copy of the white allele (Rr)

Genotype- the gene combination that an organism contains

Phenotype- the way an organism looks (its physical appearance)

In simple inheritance, if an organism is heterozygous for a trait, only one form of the trait will be observed. The observed trait is **dominant**. The trait that is masked by the dominant trait is **recessive.**

Punnett Squares are devices used to find out the possible offspring of a cross.

For example… In mice, black fur is dominant to white fur. If two heterozygou individuals (Bb) are crossed:
¾ of the offspring are likely to be black. (BB or Bb)
¼ of the offspring are likely to be white. (bb)

Bb x Bb

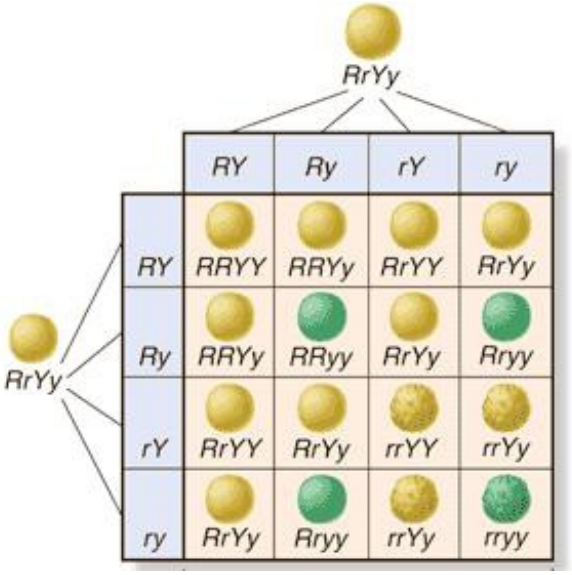
	B	b
B	BB	Bb
b	Bb	bb

In a **dihybrid cross**, scientists examine the inheritance of two traits. While they may appear intimidating, dihybrid crosses follow the same rules as above.

In order to set up a dihybrid cross, you must first determine all possible gametes that each parent can contribute. In pea plants, round is dominant to wrinkled and yellow is dominant to green. Crossing two heterozygous individuals will yield a 9:3:3:1 phenotypic ratio.

RrYy x RrYy

9 yellow and round
3 yellow and wrinkled
3 green and round
1 green and wrinkled



Consider the following example…

Bird Traits

Gene	Trait
G	Green feathers (dominant)
g	Yellow feathers (recessive)
L	Long beak (dominant)
l	Short beak (recessive)

GGLl (male) × Ggll (female)

Notice that the male is homozygous dominant for feathers (GG), therefore he can only donate dominant (G) alleles for feather color to his offspring.

This automatically means that all offspring will carry at least one dominant allele and will therefore have green feather – regardless of female genotype.

Practice

1. There are different forms of each gene called _____.

2. Which of the following is heterozygous?
   A. TT
   B. tt
   C. Tt

3. In fruitflies, long wings (L) are dominant to short wings (l). If the following individuals are crossed, what is the probability that their offspring will have long wings?

Ll X ll

   A. ¼
   B. ½
   C. ¾
   D. 100%

Allele	Trait	Type
T	Bent tail	Dominant
t	Straight tail	Recessive
B	Brown eyes	Dominant
b	Green eyes	Recessive

TtBb (male) X ttBB (female)

4. According to the table above, which of the following phenotypes would probably be seen in all of the offspring from the parents shown above?
   A. Bent tail
   B. Straight tail
   C. Brown eyes
   D. Green eyes

---

5. What is one possible combination that can be found in a gemete fromed by an individual with the genotype AaBB?
   A. AB
   B. Ab
   C. Aa
   D. BB

6. How are genotype and phenotype different?

EVOLUTION

The differences in living things on Earth may be better understood through the study of **evolution**- the gradual change in the characteristics of a species over time.

Charles Darwin is considered to be the founder of modern evolutionary theory. He described natural selection as a mechanism for change. When organisms with favorable characteristics for a particular environment survive, they are able to reproduce and pass on the helpful variations to the next generation. If an organism has a less favorable variation, it is less likely to survive and therefore less likely to reproduce. Each new generation will have more individuals with the helpful traits, and fewer individuals with harmful traits. There is a variety of evidence that supports the theory of evolution.

DNA and Amino Acid Sequences

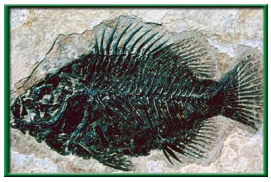
By comparing DNA and amino acid sequences, scientists can determine whether or not organisms are closely related. Close relatives share more similarities in DNA and amino acids than do distant relatives. For example, the table below shows the similarities and differences in several species of insects. Based on the data, the screwworm fly and the silkworm moth are the least genetically related because they show differences in composition of 4 amino acids (cysteine, glutamic acid, glycine, and valine).

Amino Acid Composition of Cytochrome c in Some Organisms

Amino Acid	Fruit Fly	Screwworm Fly	Hornworm Moth	Silkworm Moth
Alanine	10%	10%	10%	10%
Arginine	4%	4%	4%	4%
Aspartic acid	6%	6%	6%	6%
Cysteine	6%	6%	6%	4%
Glutamic acid	12%	12%	8%	8%
Glycine	4%	2%	4%	4%
Valine	2%	1%	4%	6%

Fossils

Fossils are remains of once-living things that are preserved in Earth's layered (sedimentary) rocks. The oldest fossils are bacteria that lived on Earth about 3.8 billion years ago. Although the fossil record is not complete, the general pathway of evolution (change) can be followed.



Anatomical Similarities

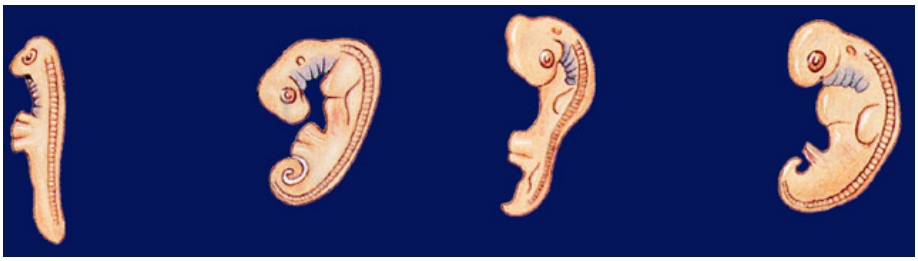
Sometimes structures of different organisms look the same, even if they have different jobs. These structures are called **homologous structures**. For example, the "arms" of a whale, crocodile, and bird are used for different things but look a lot alike. This suggests that the organisms may share a distant common ancestor.

Whale Crocodile Bird

Sometimes organisms have structures that no longer have a job (these structures are called **vestigial structures**). For example, we have an appendix that serves no obvious function now, but may have had a job in a distant ancestor of humans. This provides evidence that structures change over time.

Physiological Adaptations (changes in how an organism works/ breaks down substances)
If a bacterium has a mutation that allows it to break down an antibiotic (a chemical that would otherwise kill it), this physiological change will allow it to survive better then another bacterium without this helpful mutation. If the bacterium is better able to survive an antibiotic, it is also more likely to reproduce and pass on this ability to break down antibiotics (antibiotic resistance).

Embryology
Studying organisms in their earliest forms of development also helps scientists see similarities and possible relationships between organisms. For example, embryos of fish, reptiles, birds, and mammals look very similar. This pattern indicates evolutionary relationships among these species.



Fish Reptile Bird Mammal

Practice

1. Evolutionary relationships can be established by examining molecules such as the protein hemoglobin. Which process is responsible for making protein molecules?
   A. translation
   B. replication
   C. photosynthesis
   D. mitosis

2. _____ _____ are structures seen in different organisms that look the same, even if they have different jobs.

3. Antibiotic resistance illustrates natural selection because if a bacterium is better able to survive an antibiotic, it is also more likely to…
_____.

Animal					
	A	B	C	D	E
Horse	gln	pro	phe	thr	thr
Chicken	gln	glu	phe	ser	thr
Tuna	gln	glu	phe	ser	thr
Frog	gln	ala	phe	glu	thr
Human	gln	pro	tyr	ser	thr
Shark	gln	gln	phe	ser	thr
Turtle	gln	glu	ser	ser	thr
Monkey	gln	pro	tyr	ser	thr
Rabbit	gln	ile	phe	ser	thr

The table above shows a portion of an amino acid sequence found in cytochrome c (a protein used for cellular respiration).

4. Compare the amino acid sequence of human cytochrome C with that of the other 8 vertebrates. For each vertebrate, count the number of amino acids that differ from those in the human and write the number in the table to the right.

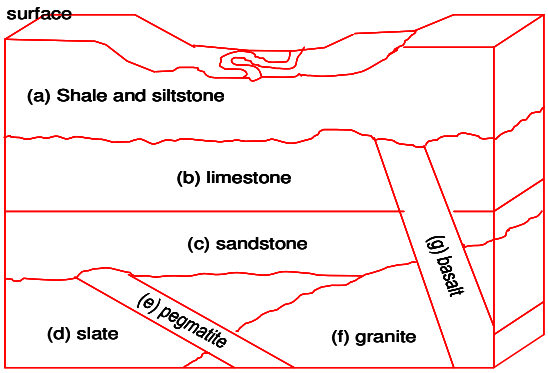
Species	Number of Differences
	0
Horse	
Chicken	
Tuna	
Frog	
Shark	
Turtle	
Monkey	
Rabbit	

5. Based on this information, which vertebrate do you think is most closely related to humans and why?

6. Based on this information, which vertebrate do you think is least related to humans and why?

---

7. If fossils were found in Layer C (sandstone) and Layer A (slate and siltstone), which fossil would be older and why?

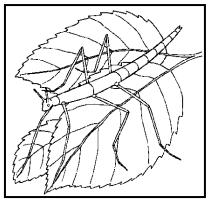


Natural Selection

Natural selection explains how species evolve, or change, over time. Natural selection is based on several key principles:

- Overproduction- Populations tend to produce more offspring than can possibly survive.
- Inherited variation- Each individual has its own traits.
- Competition- Because resources are limited, there is a struggle for survival.
- Selection- The individuals that win the struggle for survival will be able to reproduce.

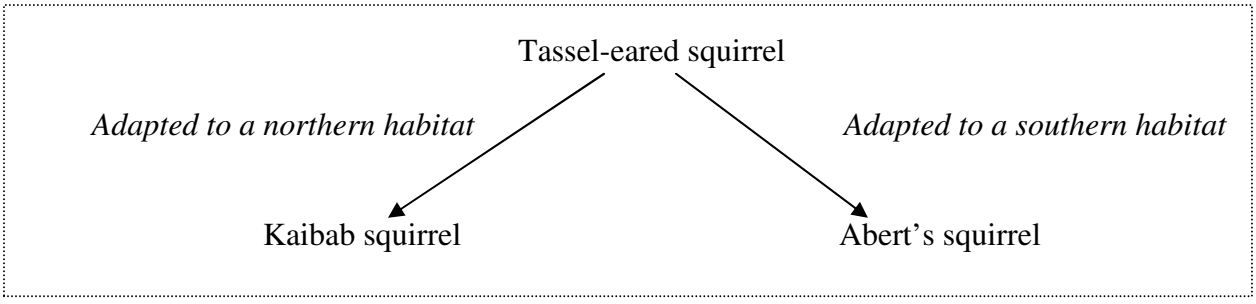
In summary, when organisms with favorable variations (helpful traits) for a particular environment survive and reproduce, they pass the favorable variations (helpful traits) to their offspring. Organisms with less-favorable variations (not helpful traits) are less likely to survive, and therefore less likely to mate. If they do not mate, they will not pass on their traits, and over time we will see fewer and fewer individuals with that trait.



Traits that help an organism survive and reproduce are also known as **adaptations.** Adaptations include body structures, chemical processes, and behaviors that increase survival. For example, if a mutation arises that allows an organism to blend in with their surroundings, they are less likely to be spotted by a predator. If an organism blends in and is not eaten (like the insect shown here), it is more likely to survive and reproduce; thus the camouflage trait will be passed on.

Another example of natural selection is pesticide resistance. Pesticides are chemical designed to kill insect pests. If an insect has mutation that allows them to break down the chemical, the chemical will not kill it. If the insect lives, it can reproduce, and it will pass on the ability to survive even when exposed to pesticides.

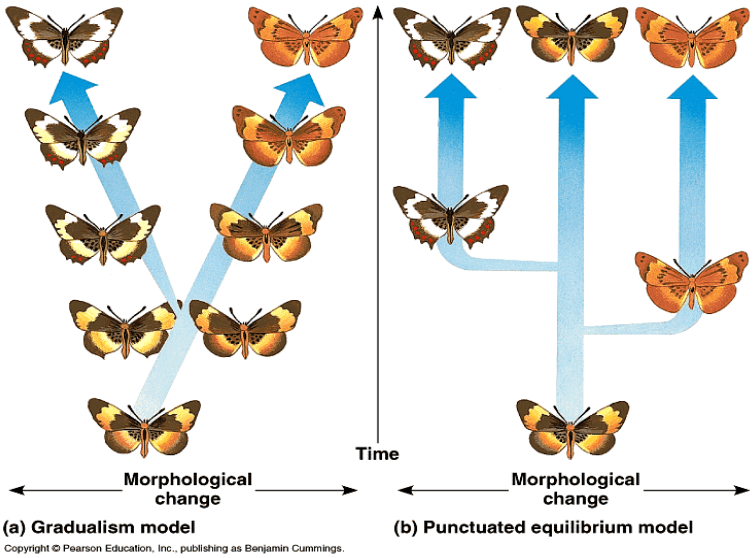
If two groups of a species are separated, they may become quite different as they each adapt to their own environments. **Speciation** is the formation of new species. This occurs if the two groups become so different that they can no longer interbreed (mate with each other). For example, the squirrel population shown below was split into different areas, and is now two different species.



To survive a changing environment, each *species* must adapt to those changes. **Extinction** is the disappearance of a species that occurs when the last member of a species dies.

The fossil record shows different possible patterns of evolution.

- **Gradualism** shows that some species change slowly over very long periods of time.
- **Punctuated equilibrium** involves spurts of change. There may be long periods in which a species remains unchanged, interrupted by change that occurs relatively rapidly. (Keep in mind that "sudden" change in evolution can refer to a period that only lasts for a few million years.)



Practice

1. How does camouflage aid in the evolutionary process?
   A. Camouflage enables an organism to copy the appearance of another species
   B. This adaptation helps an organism mutate
   C. Organisms that are well camouflaged are more likely to escape predators and survive to reproduce
   D. The ability to camouflage is lost during embryonic development

2. Industrialization in England in the early 1900s produced black soot that covered many tree trunks and branches. At the same time, the number of light colored moths in this part of the country decreased over time. Why?
   A. The soot killed only light colored moths
   B. The light-colored moths became extinct
   C. The light colored mothers showed up against the dark tree bark and could be easily seen by birds that fed on them
   D. The light-colored moths became isolated from other moths and speciation occurred

3. Over time, natural selection caused a change in the moth populations mentioned above. Which of the following most likely occurred as the result of natural selection?
   A. All of the moths became light-colored
   B. The dark moths increased in number until most of this species in the area were dark
   C. The birds stopped eating moths and found a new food source
   D. The moths were unable to reproduce and became extinct

4. Periods of drought (absence of rain) broke up the forest into smaller patches of trees. Groups of tree frogs become separated, and changes built up over time. If the tree frogs meet now, they will not be able to reproduce. This is an example of _____, or formation of new species.

5. _____ is the disappearance of a species that occurs when the last member of a species dies.

6. Bryozoans are coral-like sea animals. These organisms first appeared in the fossil record about 140 million years ago and remained relatively unchanged for 40 million years. Then they experienced a great diversification. Which process does this illustrate?

A. gradualism
B. extinction
C. fossil formation
D. punctuated equilibrium

7. Assume that the environment on one of the Galapagos Islands changes. How might this environmental change affect the finches living there?

A. These finches may start to overproduce.
B. These finches may no longer exhibit inherited variations.
C. These finches may lose their adaptations.
D. Thee finches may lack the adaptations needed to survive.

8. A Chinook salmon fish in Alaska can produce between 2000 to 17000 eggs in a single spawning. Which principle of natural selection does this observation support?

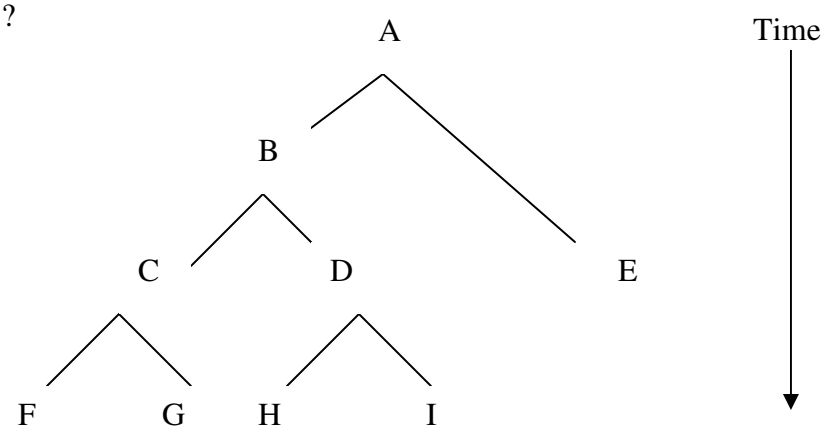
A. Overproduction
B. Inherited variation
C. Struggle to survive
D. Differential reproduction

9. Which of the following provides the "raw materials" for the genetic variations that play an important role in natural selection?

A. mitosis
B. homeostasis
C. cell differentiation
D. mutations

10. The diagram below shows relationships of selected species over time. According to this information, which of these species is expected to have the most differences from the ancestral species (A)?

A. Species B
B. Species D
C. Species E
D. Species G



Taxonomy and Kingdoms Overview

Taxonomy is the branch of biology that is concerned with grouping and naming organisms.

Scientists use organize organisms using the following categories: domain, kingdom, phylum, class, order, family, genus, species. The sentence "Dear King Phillip Cried Out For Good Soup" can help you remember the order of these categories from large to small.

The more categories two organisms share, the more closely related they are. Notice below that the cat and wolf are more closely related to each other than they are to a fly. Cats and wolfs are in the same kingdom, phylum, class, and order.

	Cat	Wolf		Fly
Kingdom	Animalia	Animalia		Animalia
Phylum	Chordata	Chordata		Arthropoda
Class	Mammalia	Mammalia		Insecta
Order	Carnivora	Carnivora		Diptera
Family	Felidae	Canidae		Muscidae
Genus	*Felis*	*Canis*		*Musca*
Species	*F. domesticus*	*C. lupus*		*M. domestica*

Scientists group and name organisms based on their similarities. Scientific names have two parts (binomial nomenclature)- the genus and the species. For example, humans are *Homo sapiens* (Homo= genus; sapiens= species).

Closely related organisms share their genus name. For example, you can tell that the polar bear (*Ursus maritimus*) and the grizzly bear (*Ursus acrtos*) are closely related because they are both part of genus *Ursus*.

Ursus maritimus

Ursus arctos

Ailuropoda melanoleuca

There are three domains: Archae, Bacteria, and Eukarya. Archae and Bacteria contain prokaryotic organisms (which lack nuclei and other membrane-bound organelles). The two prokaryotic domains differ in their chemical makeup, cell wall composition, and response to antibiotics. Members of Eukarya are eukaryotic.

The key characteristics of each kingdom are summarized in the table below:

Domain	Kingdom	Key Characteristics	Examples
Bacteria	**Eubacteria**	Lack nuclei and other organelles (prokarytoes)	*E. coli, Salmonella*
Archae	**Archaebacteria**	Lack nuclei and other organelles (prokarytoes); live in extreme environments	Bacteria that live in hot springs, volcanic vents, sulfur springs
Eukarya	**Protists**	Have nuclei and other organelles (eukarytoes); usually unicellular	Amoeba, paramecium, euglena
	Fungi	Have nuclei and other organelles (eukarytoes); usually multicellular; decomposers (feed on dead organisms); cell walls made of chitin	Mushrooms, molds, yeasts (unicellular)
	Plants	Have nuclei and other organelles (eukarytoes); multicellular; carry out photosynthesis; cells have cell walls made of cellulose	Moss, ferns, flowering plants, trees
	Animals	Have nuclei and other organelles (eukarytoes); multicellular; heterotrophs (consumers)- must feed on other organisms; mobile (can move); cells do NOT have cell walls	Sponges, jellyfish, worms, insects, fish, birds, reptiles, amphibians, mammals

Practice

1. Which of these classifications is most specific?
   A. Family
   B. Phylum
   C. Genus
   D. Order

2. The Ferruginous bird *(Buteo regalis)* is most closely related to which of the following?
   A. Flesh-footed shearwater *(Puffinus carneipes)*
   B. Fulvous whistling duck *(Dendrocygna bicolor)*
   C. Fork-tailed storm petrel *(Oceanodroma furcata)*
   D. Rough tailed hawk *(Buteo lagopus)*

3. An organism that is only one cell big and has a nucleus is most likely a member of which kingdom?

A. Eubacteria
B. Archaebacteria
C. Protista
D. Plantae

4. What process can plant cells carry out that animal cells cannot? _____

5. To which kingdom does each of the following belong?

- Dogwood tree-
- Amoeba-
- Bacteria that live in the hot sulfur springs of Yellowstone National Park-
- Sponges-
- Mushroom-

6. Which of these kingdoms consists of prokaryotic organisms?

A. Eubacteria
B. Protists
C. Fungi
D. Plants

7. An organism that is multicellular, contains organelles, and produces its own nutrients to use as an energy source is most likely a member of which kingdom?

A. Animalia
B. Fungi
C. Archae
D. Plantae

8. Which of the following would not be found in the kingdoms Protista, Fungi, Plantae, or Animalia?

A. Eukaryotes
B. Prokaryotes
C. Single celled organisms
D. Multicellular organisms

9. The Texas longhorn cattle, *Bos bos*, evolved from an ancestor with the scientific name *Bos primingenius*. What can you conclude from this information?

A. They are members of different families
B. They share their genus name
C. They share their species name
D. They belong to the same subspecies

10. What is an advantage of using an organism's scientific name rather then its common name?

A. The scientific name is always given in the native language
B. The scientific name is based upon the organism's kingdom and phylum
C. The scientific name does not depend on any classification system
D. The scientific name clearly identifies the organism

Viruses

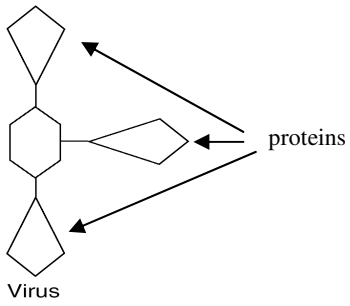
Viruses are made up of nucleic acids (DNA or RNA) surrounded by a protein coat. They are smaller than the smallest bacterium.

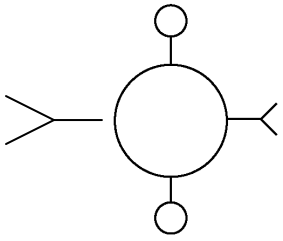
Viruses consist of **nucleic acid** (genetic material) surrounded by a **capsid** (protein coat).

Most scientists consider viruses to be nonliving because they can't carry out the most basic processes of life. Viruses can't metabolize (break down) food to release energy (carry out respiration) or grow.

The only thing that viruses can do is replicate (copy themselves), but to do that they need the help of a living cell. The living cell in which a virus replicates is called its **host cell**.

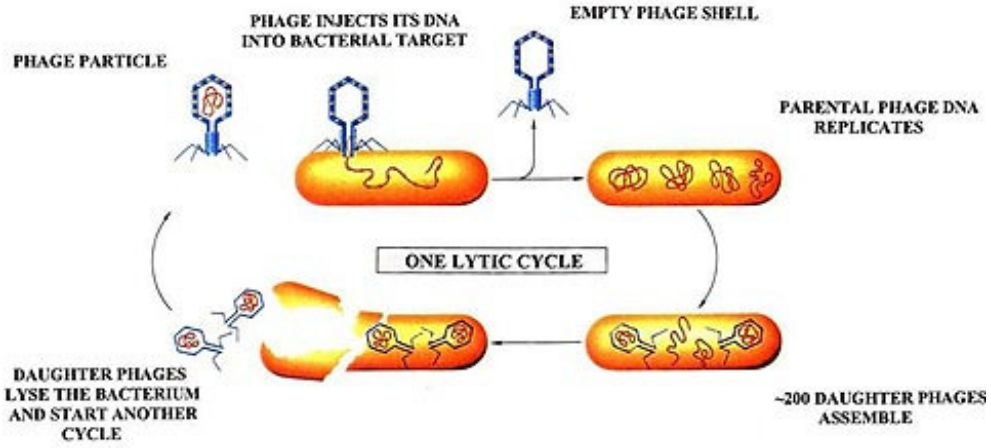
There are proteins on the surface of a virus that allow it to attach to a host cell. (The shape of the protein on the virus must fit the shape of the receptor on the host.) For example, the virus shown below could infect the cell pictured because their shapes would fit together.



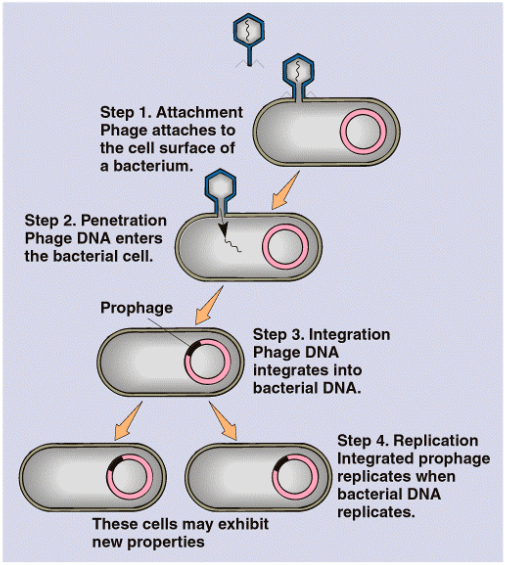

Host cell

When a virus infects a host cell, it injects its DNA or RNA into the host and takes control.

If the host cell makes many copies of the virus (replicates viral DNA), the new viruses explode from the cell and kill the host. The **lytic cycle** is characterized by viral infection, replication and cell destruction.

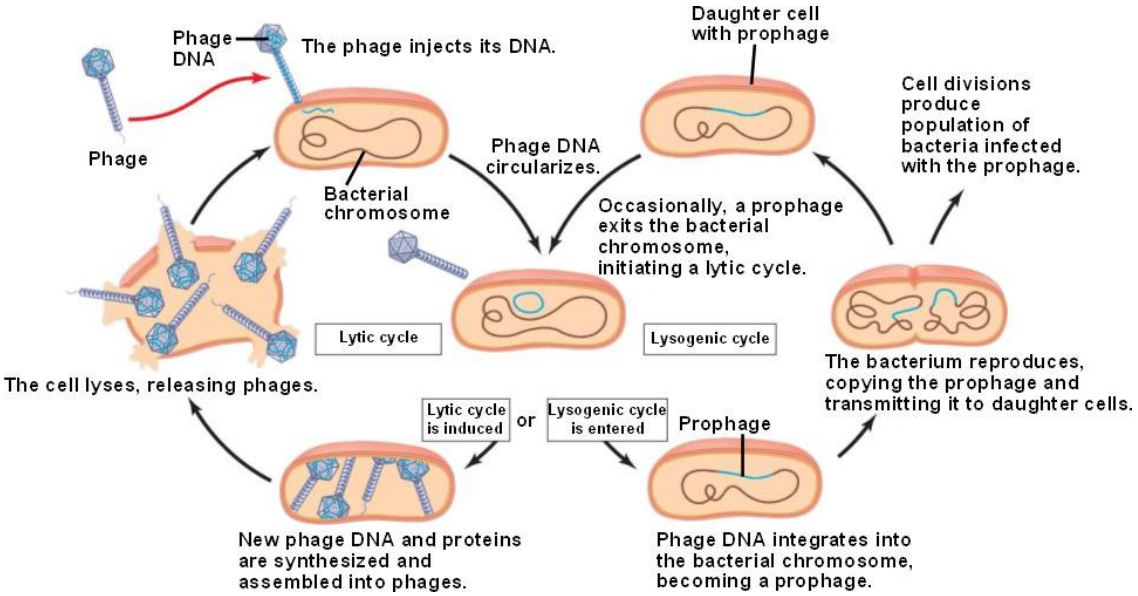


Sometimes, when a virus infects a host cell, it may stay inside the cell but not make new viruses. This is called the **lysogenic cycle**. The virus' DNA becomes a part of the host cell's DNA, and every time the host cell copies and divides, it also copies viral DNA. The viral DNA may remain inactive (a provirus) for a long time, but it can become active when it frees itself from the host's chromosome, which triggers the lytic cycle.



Saunders College Publishing

Relationship Between Lytic and Lysogenic Replication Cycles



Viruses cause human diseases, many of them serious. Some examples of diseases caused by viruses are AIDS, the common cold, rabies, influenza (flu), hepatitis, chicken pox, and warts. Doctors cannot use antibiotics to treat viruses; antibiotics are used to treat bacterial diseases. Antibiotics attack certain life processes that nonliving viruses do not carry out.

Doctors can prevent some viruses using **vaccines**. Vaccines are harmless viruses that stimulate your immune system to fight off harmful viruses. Remember that viruses have proteins on their surfaces that allow them to infect their host cells. Some viruses do not change very often, so the vaccines for these viruses remain effective- smallpox, polio, and measles are all easily prevented using vaccines. However, some viruses have surface proteins that mutate (change) often, and the immune system can't recognize constantly

changing surface proteins. You may be vaccinated today against the flu, but after the virus mutates and forms a new strain, you could become infected again.

HIV, the virus that causes **AIDS**, is one of the most rapidly changing viruses, which is why it is not possible at this time to develop a vaccine against it. AIDS (Acquired Immune Deficiency Syndrome) attacks the body's **helper T cells**, a part of the immune system- the body is unable to defend itself against infections. Most people infected with HIV only develop symptoms years after that have been infected, so an HIV infected person can feel healthy but still spread the disease to others

Practice

1. Viruses can reproduce only under which of the following conditions?
   A. When they are outside a living organism
   B. When they carry out respiration
   C. When they grow or move
   D. When they are inside a host cell

2. What is the main function of the projections on the surface of a virus?
   A. They aid in respiration
   B. They help the virus grow
   C. They help the virus invade its host
   D. They help the virus digest food molecules

3. Which of the following cannot metabolize nutrients?
   A. Viruses
   B. Fungi
   C. Animals
   D. Bacteria

4. What do viruses have in common with living cells? They both…
   A. store genetic information in DNA and RNA
   B. have chloroplasts
   C. use glucose for cellular respiration
   D. have endoplasmic reticulum

5. Which of the following statements is true?
   A. Viruses have no DNA or RNA
   B. Viruses use host cells to reproduce
   C. Viruses contain no proteins
   D. Viruses can be killed by antibiotics

6. Which of the following happens as part of both the yltic cycle and the lysogenic cycle?
   A. New viruses are made
   B. The host cell dies
   C. The entire virus infects the cell
   D. The virus injects its nucleic acid into the host cell

7. The lytic cycle involves several steps. Which of the following is the final step of the lytic cycle.

A. the host cell bursts
B. the virus injects its nucleic acid
C. new viruses begin to be made
D. the viral DNA becomes part of the host cell's DNA

8. What type of cell does HIV attack?

9. Why don't antibiotics work against the flu?

10. Why do scientists consider viruses to be nonliving?

Ecological Relationships

All organisms interact with others (and with their environment) to meet their basic needs. **Symbiosis** is a relationship in which two different organisms live in a close association with each other. Several important relationships include mutualism, commensalism, and parasitism.

- **Mutualism** is a symbiotic relationship in which both species are helped. For example, there is a species of ants that live on a particular type of acacia tree. The ants protect the tree by eating other insects that try to eat the tree. The ants also clear away debris from the tree trunk, which gives it room to grow. In return, the ants receive shelter and nectar from the tree. Another example of mutualism exists between you and bacteria. *E. coli* provides vitamins for your body, and in return, you provide nutrients and shelter (in your intestines) for the bacteria.

- **Commensalism** is a symbiotic relationship where one species is helped and the other species is neither harmed nor helped. For example, Spanish moss grows on the branches of large trees. The moss is helped because the trees provide a safe place to live with plenty of sunlight, but the larger trees are not harmed or helped.

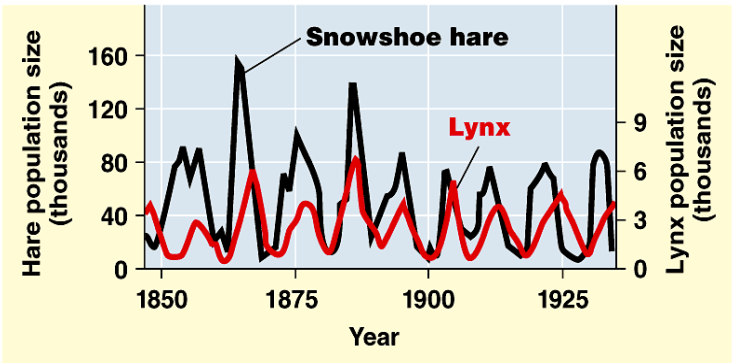
- **Parasitism** is a symbiotic relationship where a **parasite** benefits by harming a **host**. For example, a flea is a parasite of dogs. Parasites do not usually kill their hosts, because without a host, the parasite would die.

While not true symbioses, competition and predation are also important interactions.

Competition is an interaction between two or more species that use the same resources.

Predation is when one organism eats another. For example, hawks kill and eat other animals (like mice). Hawks are **predators** and mice are **prey**. Predation is an important relationship because it provides the predator with the energy it needs to carry out life functions. Predation also controls the size of predator and prey populations. If the predators over-hunt its prey, the population of prey will decrease. Eventually, as the predators run out of food, the predator population will also decrease. With fewer predators, the number of prey will be able to increase. For these reasons, we often see a cycle of population increases and decreases over time.

The relationship between population size of predator (lynx) and prey (snowshoe hare) is evident in the graph below:



Practice

Certain fungi live underground in threadlike nets surrounding the roots of plants. The fungi get food from the roots, and the nets allow plants to extend their roots; this helps the plants get minerals from the soil.

1. What type of relationship do the fungi have with the plants?
   A. Predation
   B. Parasitism
   C. Commensalism
   D. Mutualism

2. Predict what would happen to the plants if the fungi died off.
   A. The plants would thrive
   B. The plants would not be affected
   C. The plants would grow more slowly
   D. The plants would become extinct

---

3. How does parasitism differ from predation?
   A. Parasitism does not occur among mammals
   B. Parasitism does not usually result in the death of an organism
   C. No organism is harmed in a parasitic relationship
   D. No organism is harmed in a predator-prey relationship

4. _____ is when one organism eats another. For example, bears are _____and fish are _____.

5. A parasite is often a pathogen. What does a pathogen do?
   A. provide benefits
   B. search for prey
   C. kill its host
   D. cause disease

6. Birds live in close association with bison. As the bison walk, they kick up insects that the birds can eat. The bison are unaffected by the birds. This is an example of _____.
   A. Parasitism
   B. Commensalism
   C. Mutualism

7. Tapeworms can live in your intestines. They receive nutrients and can make you very sick. This is an example of _____.
   A. Parasitism
   B. Commensalism
   C. Mutualism

8. Insects feed on nectar produced by flowers. When the insects land on the flowers, they pick up pollen and spread the pollen to other flowers, helping the plant reproduce. This is an example of _____.
   A. Parasitism
   B. Commensalism
   C. Mutualism

Ecosystems

- A **population** is a group of individuals that belong to the same species and live in the same area.
- All of the populations in an area make up a **community**.
- An **ecosystem** consists of all living and nonliving things within a certain location. Ecosystems are made up of the interactions that occur among the living organisms of a particular place, and between those organisms and their surroundings. (The living parts of an ecosystem are called **biotic factors**; trees and animals are biotic factors. The nonliving parts of an ecosystem are called **abiotic factors**; soil, water, temperature, and light are abiotic factors.)
- A **biome** is a large area characterized by its climate and the organisms that live there.

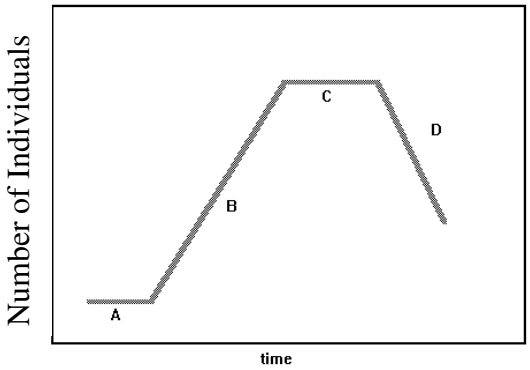
Biodiversity refers to the variety of organisms in a given area. The more diverse an ecosystem is, the more likely it will be to adjust to changing conditions. For example, if an ecosystem is disrupted and a species is lost, an ecosystem rich in biodiversity will likely have other species available to fill in for the loss.

Regardless of which biome a population lives in, all organisms depend on the environment for resources. Due to limited resources, each ecosystem has a maximum number of individuals that it can support, called its **carrying capacity**.

Succession is a natural process of replacement of one community by another community in the same location over time. A **pioneer community** is made up of the first living things to move into a new environment. Pioneer species are usually small, fast-growing plants.

- **Primary succession** is the development of a community in an area where no living things previously existed. Primary succession follows volcanic eruptions or retreating glaciers.
- **Secondary succession** is the replacement of one type of community where an existing community was destroyed or removed. Secondary succession follows a forest fire or deforestation.

Practice



1. What is happening at point B in the graph above? Why?

2. What is happening at point C in the graph above? Why?

3. What is happening at point D in the graph above? Why?

4. Ecosystems include both biotic and abiotic factors. Which of the following is an abiotic factor?

A. a population
B. soil
C. a community
D. organisms

5. The long-term survival of a species is dependent on resources. The survival of the species is less likely if these resources are

A. limited
B. not used by other species
C. plentiful
D. renewable as a result of natural processes

6. The environment can be arranged into different levels of organization. Which of the following shows a correct sequence that proceeds from a smaller level of organization to a larger level?

A. biome… habitat
B. species… population
C. community… population
D. ecosystem… biome

7. Light is an important abiotic factor in all ecosystems. Which cellular process depends on light? _____

8. All organisms within any ecosystem have something in common. All organisms share

A. the components that make up their genetic code
B. the same organelles
C. the same method of obtaining nutrients
D. the ability to reproduce asexually

9. Succession involves one community replacing another. What must be true of each community that appears?

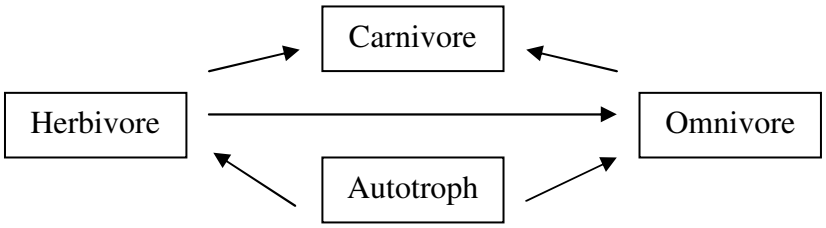
A. the populations are adapted to their environment
B. the populations get larger as the next community is established
C. the populations contain very simple life forms
D. the populations move to a different area to reestablish themselves

Matter and Energy in Ecosystems

The interactions that take place among biotic and abiotic factors lead to transfers of energy and matter. Every species has a particular role, or **niche**, in an ecosystem.

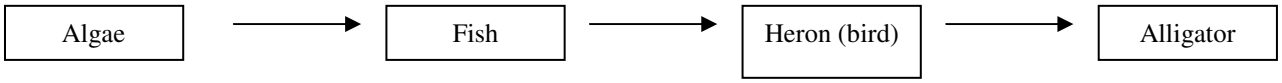
Autotrophs are organisms that use energy from the sun to produce their own food. (Autotrophs are also known as **producers.**)

Heterotrophs are organisms that depend on other organisms for food. (Because they consume rather than make food, heterotrophs are also known as **consumers.)** A heterotroph that eats only plants is known as an **herbivore**. Heterotrophs that eat meat (other heterotrophs) are called **carnivores**. **Omnivores** are heterotrophs that eat both plants and animals. Also, **scavengers** are heterotrophs that feed on animals that are already dead. For example, vultures clean up the bodies of dead animals. **Decomposers** are consumers that break down and absorb nutrients from dead or decaying organisms. Many bacteria and most fungi are decomposers.

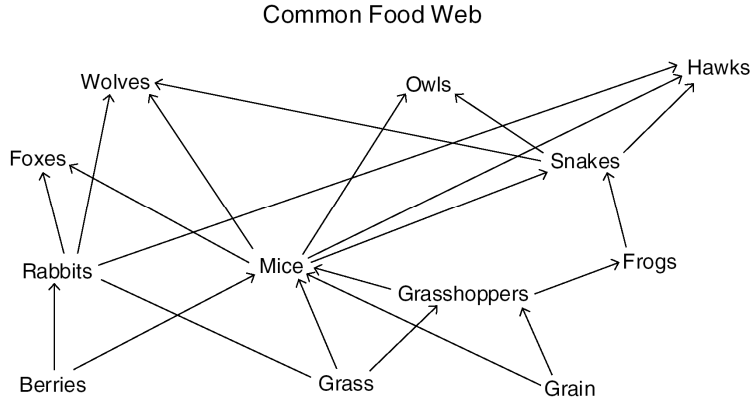


Food chains and **food webs** are pictures that show relationships among organisms. Each link in a food chain/ web represents a feeing step (trophic level). The arrows in a food chain or food web show the direction of energy flow. (That is, *arrows point to the organism that receives the energy*.) **Only about 10% of energy passes to the next level of a food chain. At each level, the other 90% of energy is "lost" to the environment as heat.** Most food chains are only 3-4 links long because by the last link, only a small portion of the original energy is left.

A **food chain** represents one possible path for the transfer of energy in an ecosystem:



A **food web** shows many possible feeding relationships:



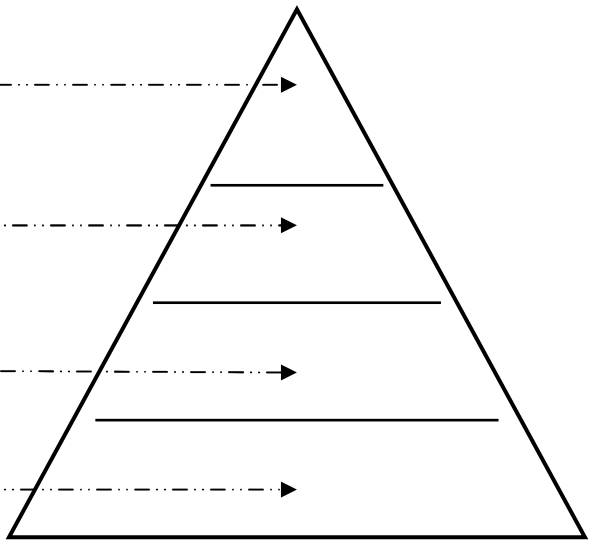
Trophic levels: steps that energy passes through

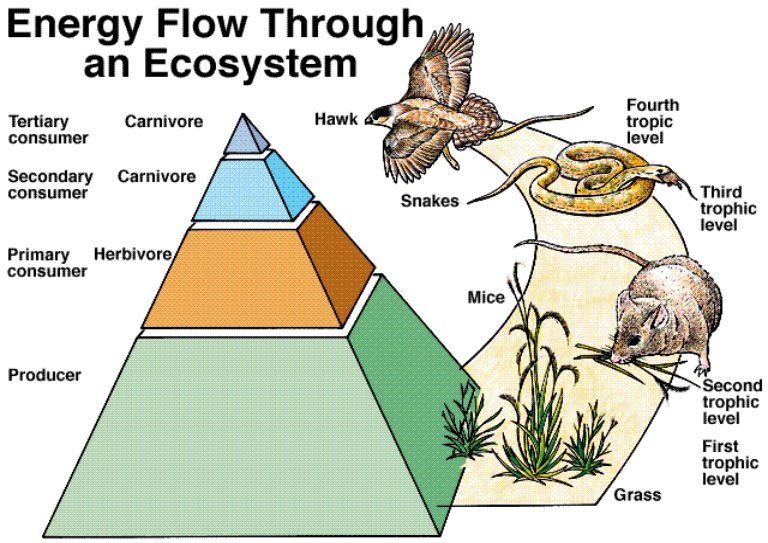
4th trophic level: tertiary consumer
(the third organism that eats)- usually a "top" carnivore

3rd trophic level: secondary consumer
(the second organism that eats)- a **carnivore**
(meat eater)

2nd trophic level: primary consumer
(the first organism that eats)-
always an **herbivore** (plant eater)

1st trophic level: always a **producer**
(an organism that carries out photosynthesis)
(Energy for producers is provided by the sun.)





The passage of energy through an ecosystem is accurately represented as a pyramid because the producers contain the most energy. **Only about 10% of energy passes from one level to the next. At each higher step, some energy is "lost" to the environment as <u>heat.</u>**

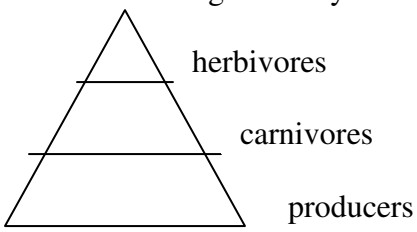
PRACTICE

1. Which of the following is a <u>biotic</u> factor in an ecosystem?
   A. Air
   B. Soil
   C. Water
   D. Tree

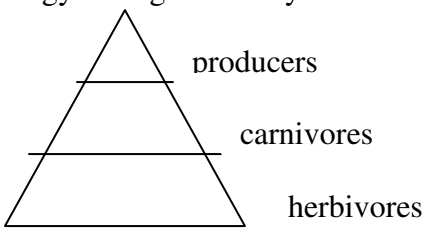
2. Only 10% of energy is passed from one trophic level to the next. What happens to the energy that is not passed on?

3. Which of the following correctly illustrates the flow of energy through an ecosystem?

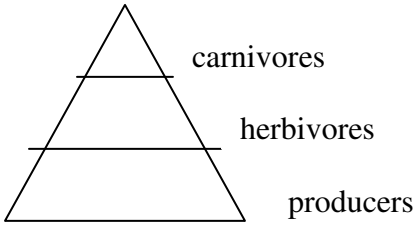
A.



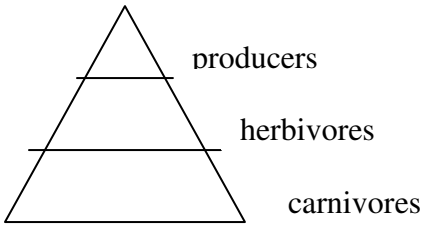
C.



B.



D.



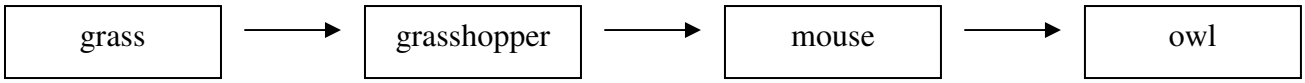
4. Ultimately, what is the source of all energy for life on Earth?

5. Which level of an energy pyramid contains the most energy?

A. producer
B. primary consumer
C. tertiary consumer
D. secondary consumer

6. In the food chain below, the mouse is the _____.

A. producer
B. primary consumer
C. competitor
D. secondary consumer



7. Which of the following are "nature's recyclers"?

A. producers
B. decomposers
C. consumers
D. plants

8. An ecological pyramid is sometimes referred to as a pyramid of numbers. Which level in a pyramid of numbers would contain the fewest organisms?

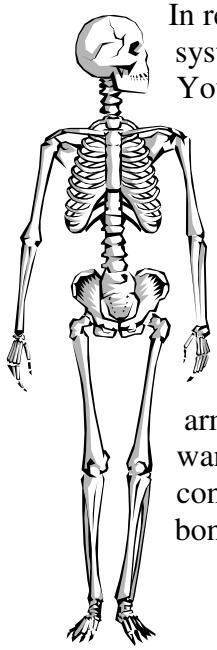
A. producers
B. primary consumers
C. secondary consumers
D. tertiary consumers

9. Food webs show the feeding relationships that exist in an ecosystem. What can impact the stability and therefore the feeding relationships that exist in an ecosystem?

A. presence of adaptations
B. lack of mutations
C. an environmental change
D. zero population growth

Animal Systems- Defense

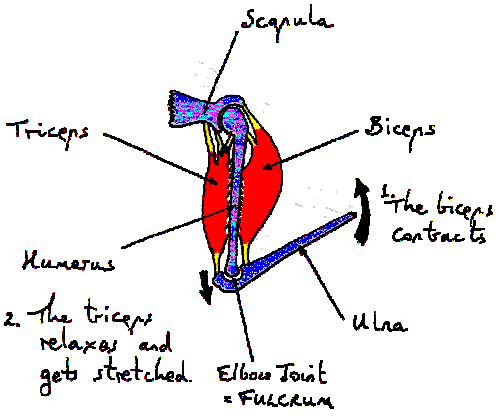
Various organ systems function to defend and protect your body from injury and disease.



In response to danger, many organisms rely on the actions of the skeletal and muscular systems.

Your **skeletal system** provides a framework for the tissues inside your body. Your skeleton protects your internal organs, including your heart, lungs, and brain. Your bones also provide firm points of attachment for your muscles. Bones are alive, and are made of connective tissue.

Your skeletal system functions with your **muscular system** to allow you to move. Your limbs move because muscles contract (shorten). For example, in the diagram below, you are able to bend your arm because your biceps muscle shortens. If you wanted to straighten your arm back out, you could contract your triceps muscle. Muscles are connected to bones with tendons.

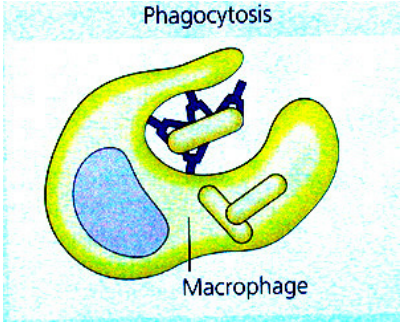


The largest organ in your body is skin. Skin is a covering, which makes it part of your **integumentary system**. Skin helps your body maintain homeostasis (an ideal internal condition). Skin helps maintain homeostasis by:

- regulating body temperature (sweating helps cool you down)
- protecting against physical and chemical damage
- serving as a sensory organ (receives information about pressure, pain, and temperature)

The **immune system** is responsible for fighting disease in our bodies. **Pathogens** (microscopic organisms that can cause disease) sometimes invade out bodies, but the immune system can detect and destroy invaders. The immune system consists of three types of cells:

- macrophages- surround, ingests, and destroys invaders
- T cells- coordinate attacks on invaders
- B cells- produce **antibodies**- proteins that recognize pathogens



Practice

1. What body system represents your first line of defense against disease?

2. What is the primary function of the integumentary system?
   A. To break down nutrients
   B. To aid in movement
   C. To deliver nutrients to the body's cells
   D. To protect the body by maintaining homeostasis

3. The place where two bones meet is called a joint. To what body system do joint belong?
   A. Circulatory system
   B. Skeletal system
   C. Muscular system
   D. Digestive system

4. Which of these systems would best protect you from getting a cold?
   A. Immune system
   B. Digestive system
   C. Excretory system
   D. Circulatory system

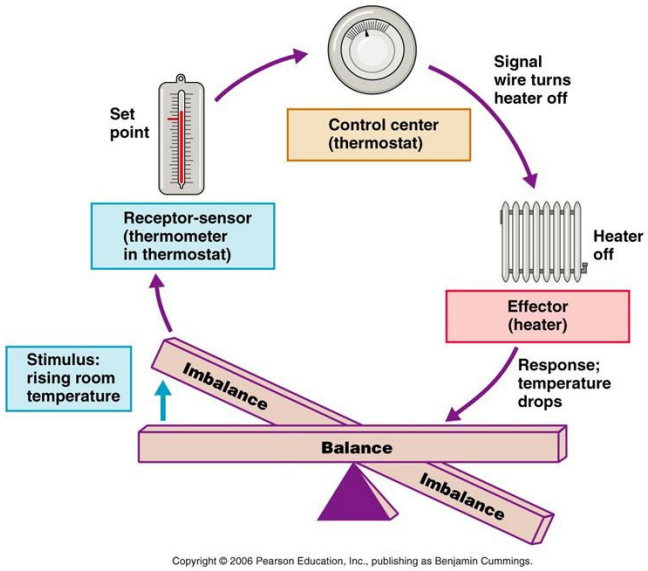
5. Which of the following is directly caused by actions of the muscular system?
   A. Regeneration of nerves
   B. Healing of wounds
   C. Extension of limbs
   D. Release of hormones

6. HIV, the virus that causes AIDS, attacks Helper-T cells. These cells are part of which system?
   A. immune system
   B. integumentary system
   C. excretory system
   D. respiratory system

Homeostasis

All cells and organisms must maintain a constant balance in their internal environment in order to stay alive. **Homeostasis** is the process by which cells maintain a balance. Many organisms use feedback mechanisms to maintain homeostasis. A **feedback mechanism** is a system of checks and balances in which the end product in a series of steps controls the first step in the series. It involves constant communication by various parts of the body.

Thermoregulation is an example of how homeostasis is maintained through a feedback mechanism. In this case, communication takes place between the brain and the skin. The brain monitors body temperature and sends signals to the sweat glands in the skin. If the temperature is too high, the sweat glands will release water. As sweat evaporates, the temperature drops. Once the temperature is back within a normal range, the brain instructs the sweat glands to stop secreting water. This is an example of **negative feedback**, because it shuts off the original stimulus to return the body to normal.



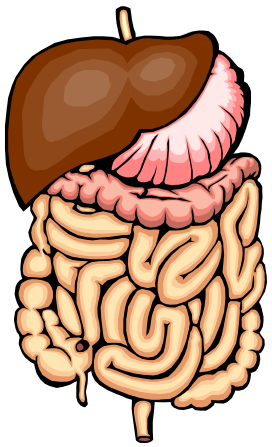
Some homeostatic mechanisms use a positive feedback system. **Positive feedback** is the opposite of negative feedback because it causes a further increase in response. One example is the onset of contractions in childbirth. When a contraction occurs, the hormone oxytocin causes a nerve stimulus, which stimulates the hypothalamus to produce more oxytocin, which increases uterine contractions. This results in contractions increasing in amplitude and frequency. Another example is the process of blood clotting. The loop is initiated when injured tissue releases signal chemicals that activate platelets in the blood. An activated platelet releases chemicals to activate more platelets, causing a rapid cascade and the formation of a blood clot.

Practice

1. Which type of feedback system operates to shut itself off?

2. Compare and contrast negative and positive feedback systems.

Animal Systems- Nutrient Absorption

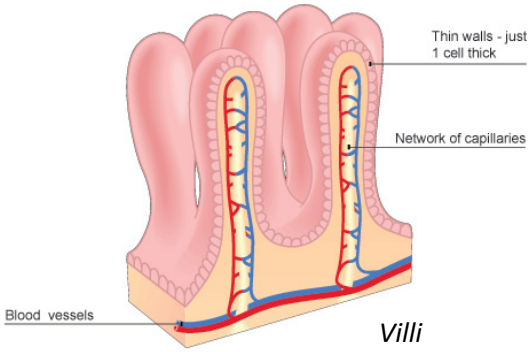


All organisms need energy, and nutrients supply this energy. Nutrients also enable the body to grow and maintain homeostasis. Most multicellular organisms have a **digestive system** made up of organs working together to break down food into simple, useable substances.

The energy of foods is contained in the molecules of lipids, carbohydrates, and proteins, but the molecules are too big to pass through your cells' membranes. The digestive system uses two processes to break down food: mechanical digestion (crushing and mashing) and chemical digestions (using enzymes to break apart bonds).

The muscles in your jaw break food into smaller pieces while enzymes in the mouth start breaking down carbohydrates. The esophagus is a tube that connects your mouth and your stomach. The esophagus uses involuntary muscle contractions to take food to your stomach, which mixes food and breaks it down using digestive enzymes.

Following digestion, the small subunits of food must be absorbed by our cells. The main site of nutrient absorption is the small intestine, which has infoldings called villi that increase the surface area. The greater the surface area, the more nutrients can be absorbed. Each villus has a capillary, a tiny blood vessel that can carry nutrients from the intestines to the rest of the body. (The network of blood vessels in the circulatory system is responsible for transporting substances (such as gases and nutrients) throughout the body.)



Villi

Foods contain substances other then nutrients. Undigested materials are not absorbed, so they pass as wastes through the large intestine, rectum, and anus. Large amounts of water are reabsorbed by the large intestine. Also within the large intestine, E. coli receives nutrients and shelter, and in return produces vitamin K.

Practice

1. In which part of your digestive system are nutrient absorbed?
   a. Mouth
   b. Stomach
   c. Small intestine
   d. Large intestine

2. Antibiotics kill bacteria. What might happen if a person takes so many antibiotics that all the bacteria in the large intestine are killed?
   a. The person may develop a vitamin deficiency
   b. The person sill not be able to absorb nutrients
   c. The person will not be able to store waste in the large intestine
   d. The person will not be able to digest foods

3. Which of the following do the villi of the small intestine reveal about multicellular organisms?
    a. Organs work together to make up an organ system
    b. Different systems work together
    c. Structure and function are related
    d. Villi are unnecessary for absorption to occur

4. Both the stomach and the small intestine secrete large amounts of water to aid in digestion. What happens to this water.
    a. Microorganisms in the large intestine use all of this water
    b. Most of the water is eliminated from the body
    c. This water is changed into nutrients that are absorbed
    d. Most of this water is reabsorbed in the large intestine

5. Capillaries of the circulatory system are responsible for delivering nutrients to all the cells in the body. Where did capillaries first pick up these nutrients?
    a. In a villus
    b. From a bacterium
    c. From undigested materials
    d. In the esophagus

6. Enzymes play an important role in the production of nutrients. What do enzymes do?
    a. They speed up the process of diffusion
    b. They speed up the rates of chemical reactions
    c. The change one type of biomolecule into another type
    d. They slow down the breakdown of macromolecules

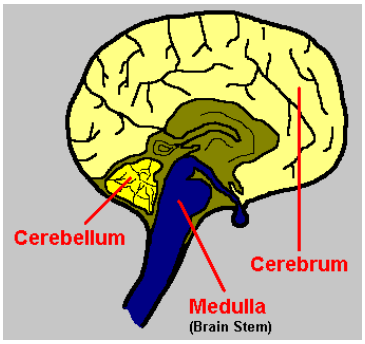
7. Digestion involves the changing of proteins into individual amino acids. Which process does the reverse by assembling amino acids to make a protein?
    a. Transcription
    b. Translation
    c. Replication
    d. Mutation

Animal Systems- Regulation

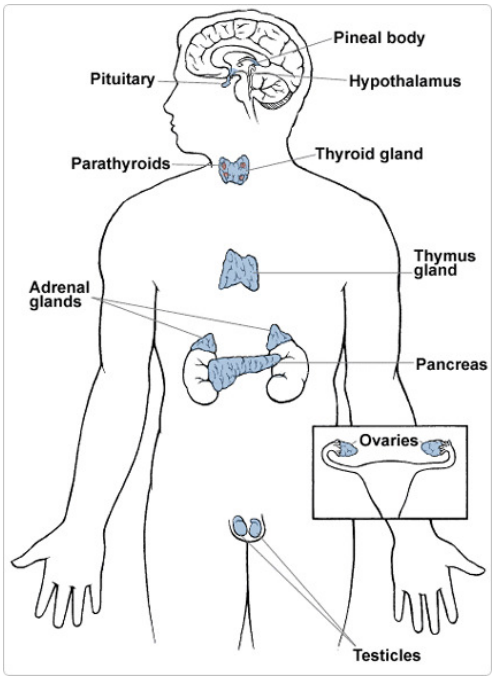
There are several organ systems that work together to maintain an organism's internal environment, despite changes that occur in its external environment.

The **nervous system** collects and interprets information from inside and outside the body. It also coordinates the responses to this information as needed. Some important structures of the brain include:

- Cerebrum- the largest part of the brain, where you think and reason, stores memories, detects stimuli
- Cerebellum- regulates coordination and helps you keep your balance
- Medulla- controls involuntary processes such as blood pressure and heart rate
- Hypothalamus- controls body temperature (the body's thermostat)

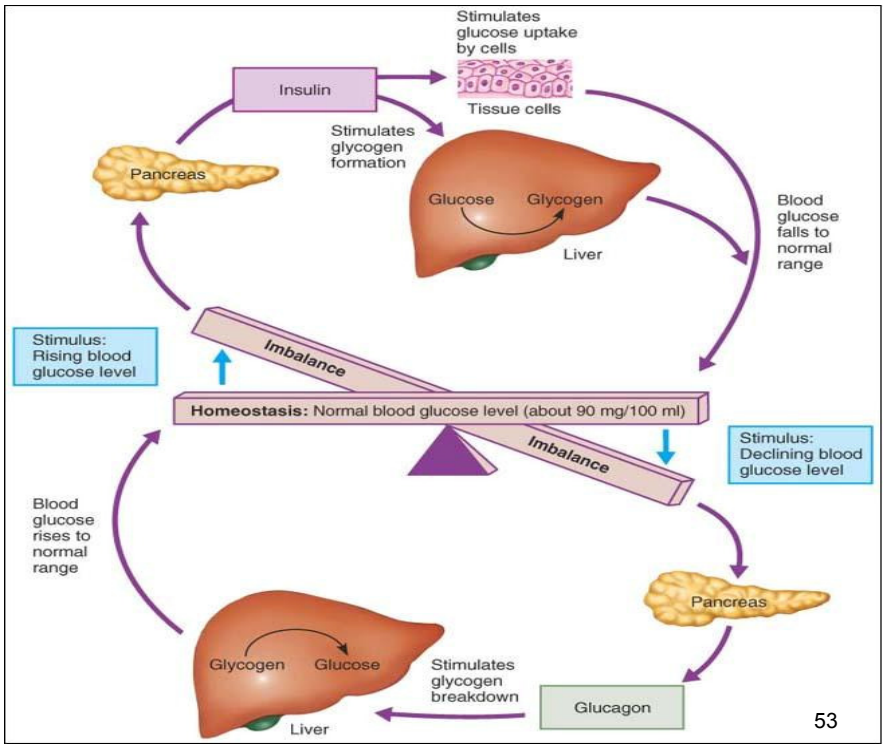


The nervous system is made up of the brain, spinal cord, and nerves. The spinal cord extends along the back of the body, and specialized structures called nerves extend from the spinal cord to all parts of the body.

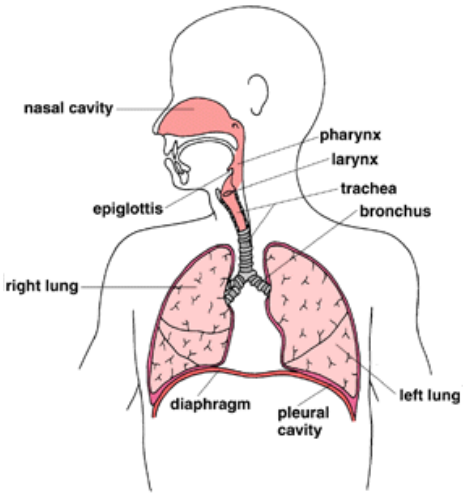


Another system that helps maintain homeostasis is the **endocrine system**, which is made up of **glands** that secrete **hormones** to other parts of the body. Hormones are chemical substances that are made in one organ in the body and travel through the blood to other specific parts of the body where they control activities.

An example of how hormones maintain homeostasis is blood glucose levels. When blood glucose levels rise, insulin is released, which causes glucose to be taken into body cells. If levels of glucose in the blood become too low, a hormone called glucagon causes stored glucose (glycogen) to be released.



Another regulatory system is the **respiratory system**, which regulates blood levels of oxygen and carbon dioxide. As carbon dioxide levels in the blood rise, the brain sends a message to certain muscles to start breathing faster. As a result, the lungs release the excess carbon dioxide into the environment, and at the same time pick up more oxygen from the environment.



Practice

1. Which of the following is common to the nervous, endocrine, and respiratory system?
    a. Hormones
    b. Regulation
    c. Interpreting messages
    d. Positive feedback mechanisms

2. Diabetes is a disease in which the blood glucose level can get very high. What is not functioning properly in a person with diabetes?
    a. Thermoregulation
    b. Nervous system
    c. Blood oxygen content
    d. Negative feedback mechanism

3. A person who gets nervous often breathes faster. What does this show about organ systems?
    a. They work together to regulate body processes.
    b. They work independently to regulate body processes.
    c. They may fail to coordinate body processes.
    d. They do not play a role in regulation of body systems.

4. What normally happens when the blood glucose level fall?
    a. The pancreas stops working
    b. The pancreas secretes insulin
    c. The pancreas secretes glucagon
    d. The pancreas secretes both insulin and glucagon

5. Which two organ systems are mainly responsible for regulation of body processes?
    a. Nervous and endocrine
    b. Circulatory and nervous
    c. Nervous and muscular
    d. Endocrine and skeletal

6. Thermoregulation allows an organism to survive in a changing environment. Therefore, thermoregulation represents
    a. A mutation
    b. A replication
    c. A homology
    d. An adaptation

Animal Systems- Reproduction

The **reproductive system** consists of various organs that work together to produce new individuals. It functions not to keep the organism alive, but rather to maintain the species.

- **Asexual reproduction**-involves only one parent, produces offspring that are genetically identical to the parent (examples: fragmentation and budding)
- **Sexual reproduction**- relies on two parents, produces offspring that are genetically different from the parents and from each other, involves union of gametes (sperm + egg= zygote in a process known as fertilization).

In humans:

- **Males**- testes produce sperm and testosterone (a hormone) that helps regulate sperm production and male characteristics
- **Females**- ovaries produce eggs and estrogen and progesterone (hormones) that regulate the release of eggs and female characteristics. After being released from the ovary, an egg enters the Fallopian tube and travels to the uterus. If it is fertilized, it will stay in the uterus and develop over a month month period. If the egg is not fertilized, it will be released outside the body (during menstruation).

Practice

1. Why are the ovaries and testes considered to be a part of both the reproductive and endocrine systems?

2. Some organisms, such as bacteria, can reproduce by splitting into two new cells. This form of reproduction is called binary fission. Is binary fission an example of asexual or sexual reproduction? Explain your answer.

3. Which is true of asexual reproduction?
    a. It requires the production of sperm and eggs
    b. Offspring are the same as a single parent
    c. It occurs when an egg is released from the ovary
    d. It is more complicated than sexual reproduction

4. Which term is associated with sexual reproduction
    a. Fragmentation
    b. Budding
    c. Fertilization
    d. Single parent

5. Which of the following would not be associated with any part of the reproductive system?
    a. Thermoregulation
    b. Gametes
    c. Meiosis
    d. Chromosomes

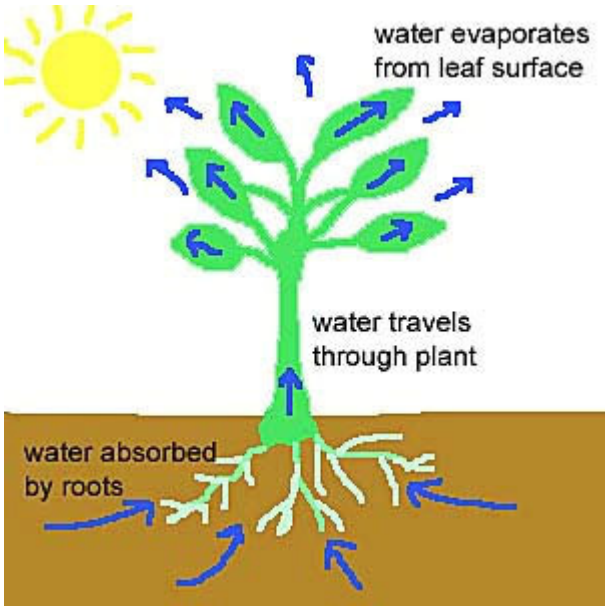
Plant Systems
Transport

Plants use specialized cells to transport water, minerals, and nutrients through the roots, stems, and leaves. Vascular tissue transports materials, such as water, nutrients, and sugars throughout a plant.

- Xylem- transports water and minerals from the plant's roots, up the stem, and to the leaves
- Phloem- transports nutrients, such as sugars, throughout the plant

The driving force behind water movement in a plant is **transpiration** (the loss of water from a leaf). This movement of water from the leaf's surface pulls other water molecules from the root upward. Water molecules stick to each other (and to the walls of xylem) using hydrogen bonds.

Water escapes from the leaf through pores called **stomata**. Stomata are surrounded by guard cells, which are plump and form openings when water is plentiful. These openings are important for gas exchange, so that plants can take in carbon dioxide they need for photosynthesis, and remove the oxygen produced in photosynthesis. When too much water has been lost, the guard cells shrivel, which causes the stomata to close. The stomata must balance the need for gas exchange with prevention of excessive water loss.



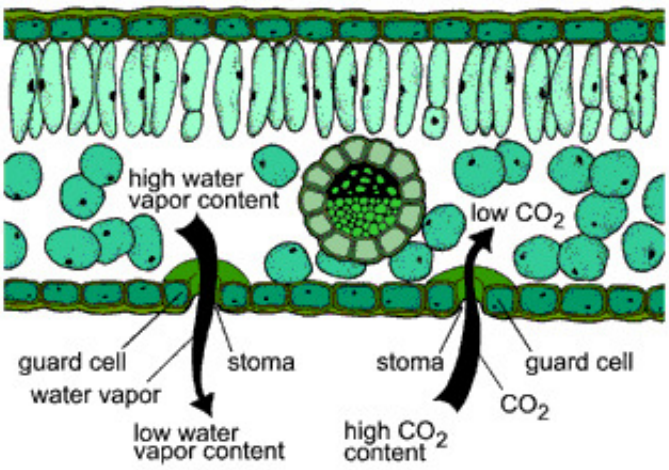


Figure 25. Stomata open to allow carbon dioxide (CO_2) to enter a leaf and water vapor to leave.

Plant Systems
Reproduction

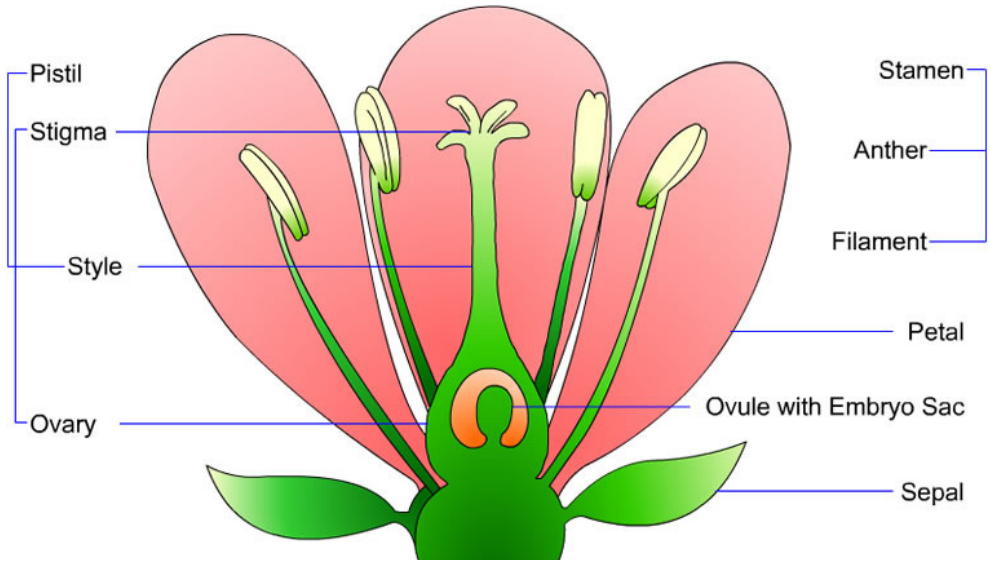
Plants use both asexual and sexual reproduction.

Vegetative propagation is a method of asexual reproduction in plants where one plant gives rise to new plants. This can be done by sending out a horizontal stem, either above or below ground. These are called runners and thizomes.

In **sexual reproduction**, some plants depend on flowers, which come in a variety of shapes and sizes. The colors, fragrances, and nectars are adaptations to attract pollinators. There are four main parts of a flower:

- The **sepals** are often green and make up the outermost part of the flower. The sepals protect the flower while it is a bud.
- The **stamen** is the male reproductive structure of a flower, where pollen is produced. Pollen contains sperm.
- The **pistil** is the female reproductive structure of a flower.
- The **petals** are the colorful parts of the flowers, which attract birds and insects.

Pollinators are important because they transfer pollen (with its sperm) to the pistil. The egg is contained at the base of the pistil within an ovule. When the sperm reach the egg, their nuclei fuse in fertilization. After fertilization, the ovule develops into a seed, which protects the tiny, developing plant. The seed is then dispersed by wind, water, or an animal, and when conditions are right (optimal temperature, water, and oxygen), it will germinate (sprout).



Plant Systems
Response

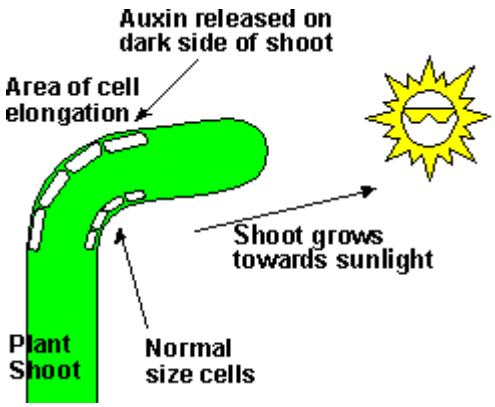
Animals respond to all kinds of things. Dogs run after toys, cats chase mice, and you answer questions when you are called on in class. Even though plants can't run or speak, they still respond to a variety of stimuli, including light, gravity, and even touch.

Plant responses are called **tropisms**. A tropism is the movement of a plant in response to a signal from the environment.

- **Positive tropism**- movement toward a stimulus
- **Negative tropism**- movement away from a stimulus

Since plants do not have nervous systems, they rely on hormones to stimulate or inhibit plant growth. A major class of plant hormones is called **auxin**, which causes plants to grow toward light.

- **Phototropism-** response to light
- **Gravitropism**- response to gravity
- **Thigmotropism**- response to touch



Phototropism

Gravitropism

Thigmotropism

Practice

1. The vascular tissue of a plant transports various substances. Which substance would you expect to find in phloem, but not in xylem?
   a. Glucose
   b. Iron
   c. Potassium
   d. Water

2. Xylem and phloem carry out specific functions in a plant. Which of the following terms does not apply to either xylem or phloem?
   a. Specialized cells
   b. Eukaryotic cells
   c. Differentiated cells
   d. Prokaryotic cells

3. The transport of water through a plant depends on roots absorbing water. Roots depend on osmosis to obtain water. In osmosis, water always
   a. Moves from a high concentration to a lower concentration
   b. Moves from a lower concentration to a higher concentration
   c. Moves so that the concentration of water on one side of the cell membrane is higher than on the other side
   d. Moves until there is no water left on one side of the cell membrane

4. What is the difference between pollination and fertilization?

5. What is a seed and what does it contain?

6. What is the function of the petals in a flower?

7. A growing seed cannot yet carry out photosynthesis. Therefore, a seed must contain
   a. Water
   b. Nutrients
   c. Xylem and phloem
   d. Reproductive structures

8. What do plants and animals have in common in their responses to stimuli?