MCAS Review by Biology High School Standards

1. The Chemistry of Life

Broad Concept: Chemical elements form organic molecules that interact to perform the basic functions of life.

1.1 Recognize that biological organisms are composed primarily of very few elements. The six most common are C, H, N, O, P, S

- **Element**-a substance made of only one kind of atom. A **pure substance** that cannot be broken down by chemical means.
- **Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorous**, and **Sulfur** are used to construct the 4 major organic compounds of life.
- **Compound-**a substance made of two or more elements chemically combined in definite proportions. 2 types:
- **Organic Compound-**compounds that contain carbon; associated with living organisms
- **Inorganic Compound-**compounds that do not contain carbon

1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules

- **Carbohydrate-**an organic compound composed of carbon, hydrogen, and oxygen atoms; stores energy and provides shape or structure to organisms. Types include**: Monosaccharide** (glucose)**, Disaccharide** (sucrose)**, & Polysaccharide** (starch).
- **Lipid-** an organic compound such as fats, oils, waxes, phospholipids, steroids; lipids tend to be insoluble in water **(non-polar**); lipids such as fats and oils store energy very efficiently-more than twice the energy per gram as carbohydrates.
- **Protein-**a complex macromolecule composed of chains of amino acids
  - **Amino Acid-**organic molecules that are the building blocks of proteins
  - **Enzyme-**catalytic proteins that control chemical reactions in living organisms
- **Nucleic Acid-**a large complex organic molecule made of nucleotides (subunits of nucleic acids consisting of a nitrogen base, a 5-carbon sugar, and a phosphate group) molecule that carries hereditary or genetic information for cell function
  - **DNA**-Deoxyribonucleic acid-a double-stranded helical shaped nucleic acid that stores hereditary information. Nucleotides: Nitrogen Base (**ATGC**), phosphate group, deoxyribose.
  - **RNA**-Ribonucleic acid-a single-stranded nucleic acid involved in protein synthesis. **AUGC**, Ribose

1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, which have an effect on enzymes.

- **Enzymes-**catalytic proteins that speed up chemical reactions within living organisms. Enzymes provide activation energy in living organisms by increasing the speed of a chemical reaction.
- **Activation Energy**-the minimum amount of energy that is needed to start a chemical reaction. Chemical reactions are frequently catalyzed by enzymes
- **Chemical Reaction-**a process during which chemical bonds between atoms are broken and new ones are formed producing different substances.
  - **Reactant-**the starting materials for chemical reactions.
  - **Product-**newly formed substances.
- Enzymes function within a narrow range of environmental conditions, therefore changes in pH, temperature, salinity and other environmental conditions will effect the action of enzymes.
  - **pH-**When an ionic compound is placed in water, forming a solution, the compound breaks apart and releases ions…
    - **Acid-** a compound that forms hydrogen (H+) ions in water. 0-6.99999 on the pH scale.
    - **Base-**a compound that produces hydroxide ions in water (OH-) 7.00001 on the pH scale
    - **Neutral-**7 on the pH scale

2. Cell Biology

Broad Concept: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.

2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, and active transport).

- **Organelle-** "little organs" structures in eukaryotic cells that have a specialized function.
- **Nucleus-**the organelle that houses DNA (genetic information) in eukaryotic cells.
  - **Chromosome** "colored body"-a structure made of DNA and associated proteins where genes are located
  - **Nucleolus-**a specialized organelle in the nucleus which produces ribosomes
  - **Nuclear Envelope/Membrane-**a phospholipid bilayer which separates the nucleus from the cytoplasm
  - **Nuclear Pores-**channels in the nuclear envelope which pass substances made in the nucleus (proteins and RNA)
- **Cytoplasm-**a jelly-like material consisting primarily of water and organic compounds occupying the space between the cell membrane and the nucleus. Various organelles are suspended in the cytoplasm.
- **Cytoskeleton-**a network of protein filaments (fibers and tubes) extending throughout the cytoplasm. The cytoskeleton plays a role in cell movement, shape, division, and intracellular transport. The cell membrane and some organelles are anchored to the cytoskeleton

- **Flagella/Cilia**-long thread-like/short hair-like structures that protrude from the cells surface and enable movement
- **Centriole**-microtubules that assist in the division of chromosomes during cellular reproduction.
- **Ribosome**-cell organelles that produce proteins during a process called **protein synthesis.**
- **Endoplasmic Reticulum (ER)-**an extensive system of internal membranes that move proteins and other substances throughout the cell. The ER is often considered an extension of the outer Nuclear Membrane and therefore also consists of a lipid bilayer with embedded proteins.

  Smooth ER- produces lipids and membrane proteins and helps to break down toxic substances like alcohol and drugs
  Rough ER-helps to transport proteins manufactured in the ribosomes, which dot its surface.
  Proteins made in the ribosomes dotting the surface of Rough ER pass into the ER through the ER membrane. Then the ER membrane that contains this completed protein pinches off and forms a small membrane bound sac, known as a **vesicle**.
- **Golgi Apparatus**-a set of flattened membrane-bound sacs that serves as the packaging and distribution center of the cell.Some vesicles produced by Golgi Apparatus release their proteins from the cell, while other newly budded vesicles containing **lysosomes** act as the cells digestive enzymes. Enzymes inside the Golgi Apparatus modify proteins received in vesicles from the ER. The modified proteins are then repacked in new vesicles that bud from the surface of the Golgi Apparatus.

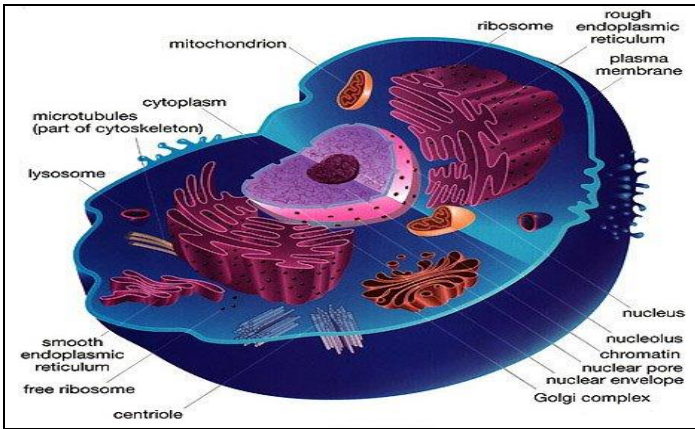
- **Lysosomes**-small spherical organelles that contain digestive enzymes, which help to break down large molecules of carbohydrates, proteins, and lipids for use by the cell. Lysosomes also digest old organelles and act as a cell's recycling center.

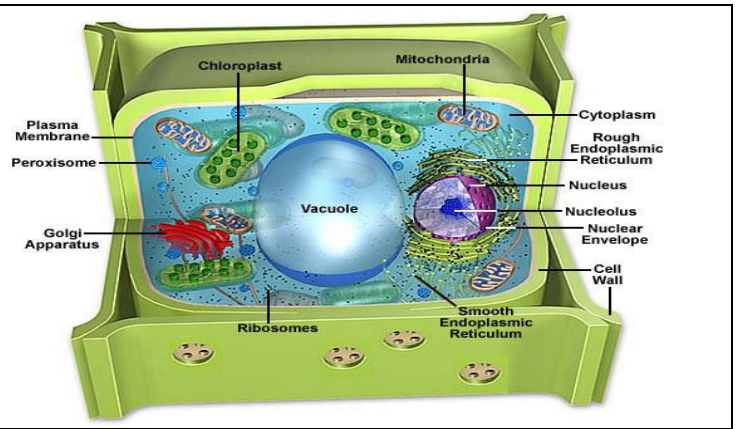
- **Mitochondria**-organelles that harvest energy from organic compounds to make **ATP**, the main energy currency of cells they are the power centers of the cell. Mitochondria are membrane-bound organelles with two membranes: a smooth outer membrane and greatly folded inner membranes called **cristae**, which form the compartments where ATP-producing chemical reactions combine sugar and oxygen to make ATP.

.**Plant Cells** contain three additional structures that are not found in animal cells.

- **Chloroplasts** are oganelles that contain chlorophyll and use light energy to make carbohydrates from carbon dioxide and water using a process called **photosynthesis.**
- **Cell Wall**-provides shape, protection and interconnectivity to the cell. The cell wall consists of a mixture of proteins and carbohydrates, including cellulose.
- **Central Vacuole-** a large organelle that stores water and may contain a variety of substances including ions, nutrients, and wastes.

Plant vs. Animal

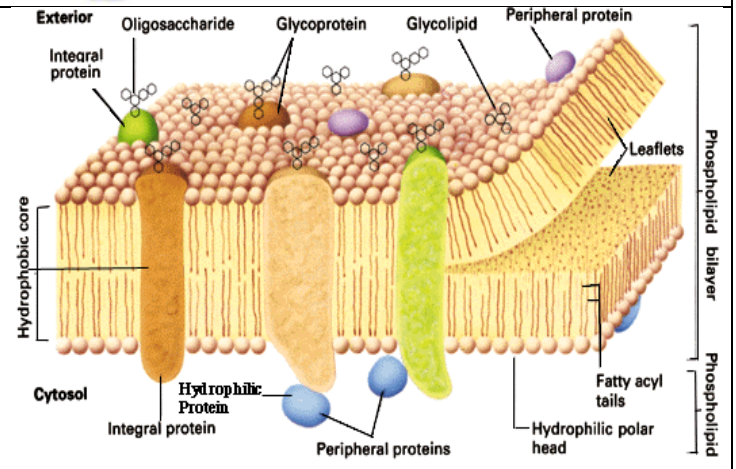




Cell/Plasma Membrane-a thin layer of lipids and proteins that separates the cell's contents from its surrounding environment. The cell membrane consists of a **phospholipid bilayer** with embedded proteins that encloses the cytoplasm of a cell. The selective permeability of the cell membrane is caused by the interaction of phospholipids with water.

1. A hydrophilic "water-loving" phosphate-based polar head-easily dissolves in water.
2. A hydrophobic "water-fearing" non-polar lipid tail which does not dissolve in water.

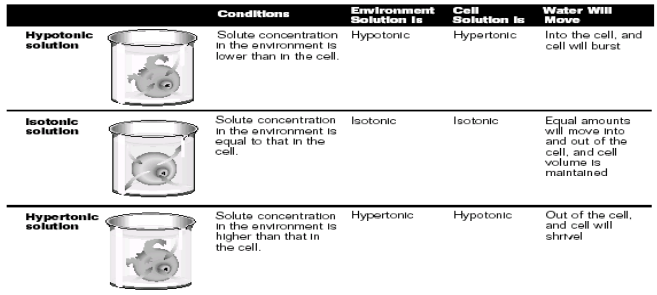
The cell membrane is fluid with the consistency of vegetable oil. Proteins found within and on the membrane form patterns/mosaics and move like slow-moving ships at sea resulting in its description in the **Fluid Mosaic Model**



Passive Transport- the movement of substances across a cell membrane without the input of the cell's energy

- **Diffusion-** the movement of a substance from an area of high concentration to an area of low concentration, known as movement down a concentration gradient. Diffusion is caused by the random motion of particles. If diffusion is allowed to continue **equilibrium** results.
- **Osmosis**-the diffusion of water across a selectively permeable membrane cell

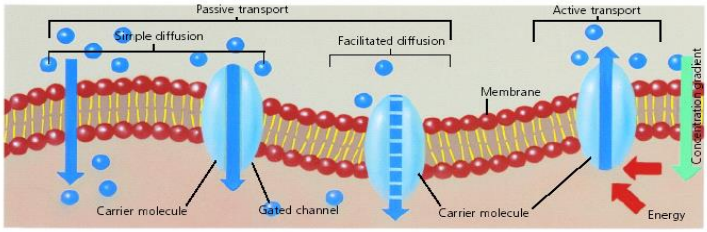
Hypotonic Solution-having the lower osmotic pressure of two solutions. If a cell were placed in a hypotonic solution the concentration of solutes would be lower outside of the cell than inside the cytoplasm of the cell.
Isotonic Solution-a solution of equal osmotic pressure. In an isotonic solution concentration of solutes outside the cell is equal to that inside the cell.
Hypertonic Solution-having the higher osmotic pressure of two solutions. In a hypertonic solution the concentration of solutes is higher outside the cell than in the cytoplasm of the cell.



	Conditions	Environment Solution is	Cell Solution is	Water Will Move
Hypotonic solution	Solute concentration in the environment is lower than in the cell.	Hypotonic	Hypertonic	Into the cell, and cell will burst
Isotonic solution	Solute concentration in the environment is equal to that in the cell.	Isotonic	Isotonic	Equal amounts will move into and out of the cell, and cell volume is maintained
Hypertonic solution	Solute concentration in the environment is higher than that in the cell.	Hypertonic	Hypotonic	Out of the cell, and cell will shrivel

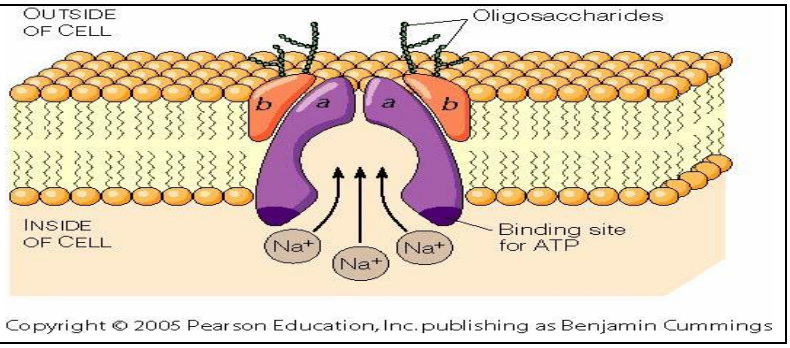
Facilitated Transport- a type of passive transport in which specific substances (such as amino acids and sugars) are transported through proteins down their concentration gradient.

Active Transport-is the movement of a substance across a cell membrane against its concentration gradient. Active Transport requires the expenditure of energy, which is often supplied either directly or indirectly by ATP.



Sodium-Potassium Pump-a carrier protein that transports sodium ions out of a cell and potassium ions into the cell. This pump actively transports both sodium and potassium against their concentration gradients. The S-P Pump:

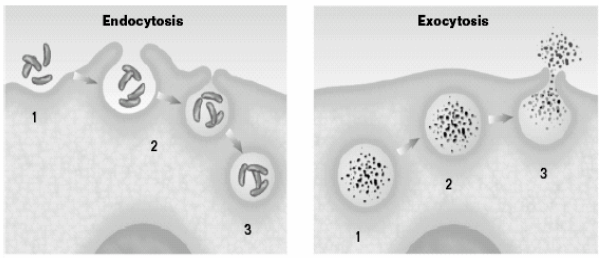
1. prevents the toxic build-up of sodium ions that have diffused into the cell through ion channels
2. helps maintain the concentration gradients of sodium and potassium ions across the cell membrane, which facilitates the transport of other substances.



Vesicles-Substances that are too large to be transported by Carrier Proteins, such as proteins and polysaccharides, are moved across the cell membrane by vesicles.

1. Endocytosis-the movement of a substance into a cell by a vesicle
a. Phagocytosis-"cell eating" is the ingestion of solid particles by endocytosis. The cytoplasmic membrane invaginates and pinches off placing the particle in a phagocytic vacuole. The phagocytic vacuole then fuses with lysosomes and the material is degraded .
b. **Pinocytosis**-"cell drinking" is when a cell takes in liquids.

2. **Exocytosis**-the movement of a substance out of a cell by a vesicle

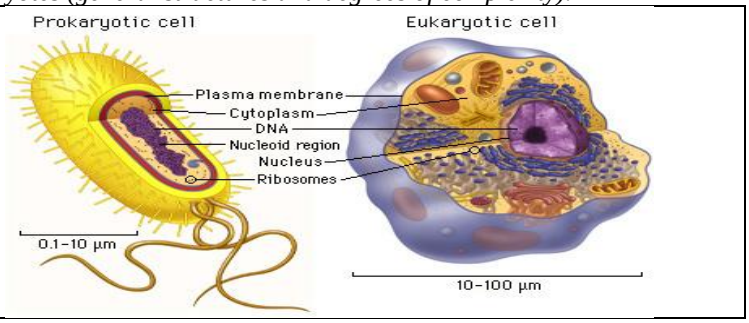


2.2 Compare and contrast, at the cellular level, prokaryotes and eukaryotes (general structures and degrees of complexity).

Prokaryote (before nucleus)-a single-celled organism that lacks a nucleus and other internal compartments (membrane-bound organelles). The Kingdoms Eubacteria and Archaeobacteria (the Monerans) are examples of prokaryotes.

vs.

Eukaryote (true nucleus)-an organism whose cells have a membrane-bound nucleus and membrane-bound organelles. Members of the Kingdoms Protista, Fungi, Plantae, and Animalia are eukaryotes. They evolved about 1.5 bya



2.3 Use cellular evidence (such as cell structure, cell number, and cell reproduction) and modes of nutrition to describe six kingdoms (Archaebacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).

- **Six Kingdom System of Taxonomy-**Animal, Plant, Fungi, Protist, Eubacteria, & Archaebacteria

2.4 Identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.

Photosynthesis is the process by which autotrophs convert light energy to chemical energy by producing organic compounds. Photosynthesis occurs because of the presence of pigments, which absorb certain wavelengths of light while reflecting others.

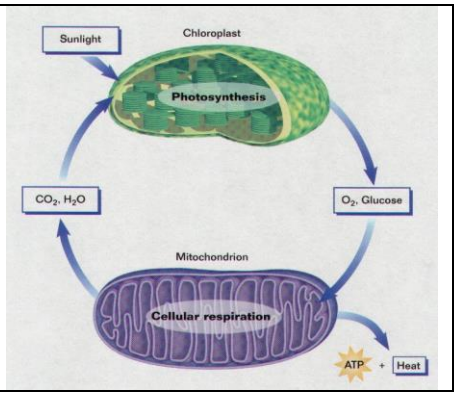
Photosynthesis

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

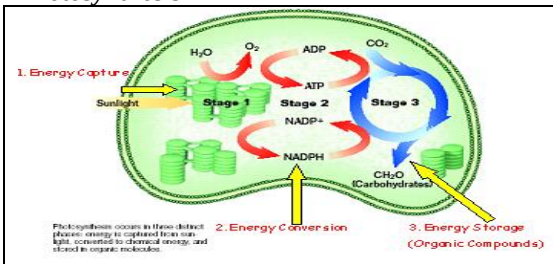
Cellular Respiration

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

Cellular Respiration- the process by which living organisms harvest the energy in food molecules. This occurs when glucose molecules are broken down through a series of chemical reactions which produces ATP. The foods we eat provide our bodies with the raw materials for cellular respiration, which converts proteins, carbohydrates, and lipids into ATP. The O_2 in the air that we breathe makes this process more efficient



Photosynthesis



Three Stages of Photosynthesis:

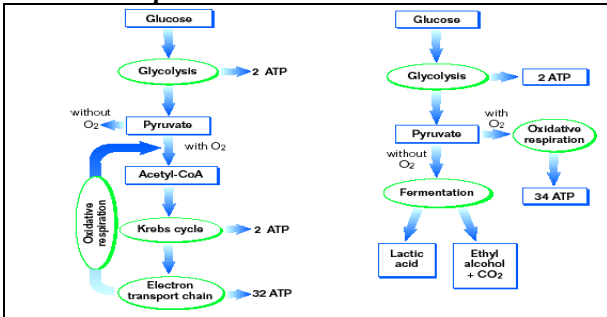
Light Dependent Reactions:

1. **Energy Capture**-water is split into hydrogen ions, electrons, and oxygen. (occurs in the Grana/Thylakoids)
2. **Energy Conversion**-NADPH and ATP are produced. (occurs across the Thylakoid Membrane)

Light Independent Reaction:

3.Energy Storage-The **Calvin Cycle**: The products of the LDR(stored chemical energy in ATP and NADPH) powers formation of organic compounds, using CO_2 (occurs in Stroma).

Cellular Respiration



1. Glycolysis- "to break apart a sweet" Glucose is converted to pyruvate, producing a small amount of ATP and NADH (4 ATP are produced, but two are consumed for a net of 2 ATP). (Glycolysis occurs in the Cytoplasm).

2a. **Aerobic**, which requires oxygen produces 36 molecules of ATP for each molecule of glucose. (occurs in mitochondria)

2b. **Anaerobic**, which does not require oxygen- produces only 2 molecules of ATP for each molecule of glucose.

Alcoholic Fermentation-Produces CO2 and Ethanol (alcohol).

Lactic Acid Fermentation-Produces lactic acid (think yogurt).

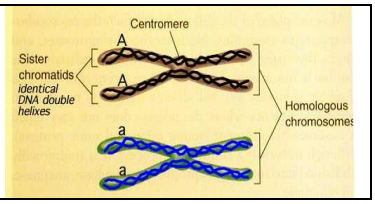
2.5 Explain the important role that ATP serves in metabolism.

- **Energy and ATP-**When our bodies digest food some energy is released as heat, but the majority of the energy is stored temporarily in molecules like ATP, the energy "currency" utilized by cells. This energy is used to power chemical reactions.
- **ATP (Adenosine Triphosphate)-**an organic energy-storing molecule that consists of three distinct parts: ribose (a 5 carbon sugar), adenine (a nitrogen base), and three phosphates. The energy in a molecule of ATP is stored in the bonds between the phosphate groups. When the bonds are broken during ATP Hydrolysis energy is released and **ADP (Adenosine Diphosphate)** is created. Cells will continuously replace the supply of ATP by a attaching a phosphate to an ADP molecule during cellular respiration. ATP synthesis occurs at a rate of approximately 10 million molecules per second/per cell. This interplay is called the **ATP/ADP Cycle.** Energy from ATP is used to provide energy for mechanical functions like muscle cell contraction, to provide energy for Active transport, and to synthesize and break down molecules in cells.

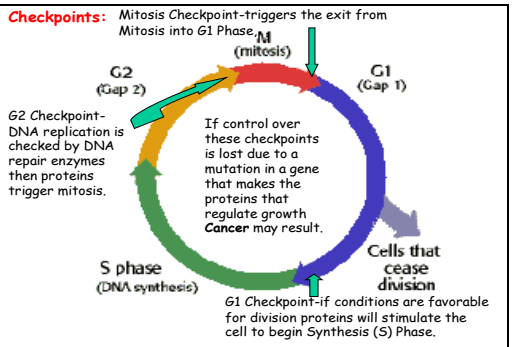
2.6 Describe the cell cycle and the process of mitosis. Explain the role of mitosis in the formation of new cells, and its importance in maintaining chromosome number during asexual reproduction.

- **Mitosis**-a process during cellular division in which the nucleus of a cell divides into two nuclei each with the same number and kind of chromosomes.

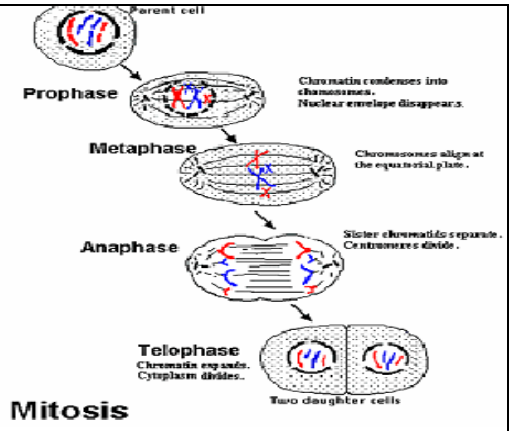
Chromosome-a structure made of DNA and associated proteins on which genes are located. DNA condenses from **chromatin** into chromosomes before the process of cellular reproduction
Chromatin-a thin, tangled bundle of DNA threads found in the nucleus during interphase.
Centromere-the point where sister chromatids are joined
Sister Chromatids-identical copies of genetic material attached at **centromere**
Homologous Chromosomes-pairs of Chromosomes that are similar in size, shape, and genes



Cell Cycle-a repeating 5-phase sequence of eukaryotic cellular growth and division.
Interphase-a period of cell growth and preparation that occurs between periods of division. It is the longest part of the cell cycle (90%) and consists of three parts G1, S, & G2 phases.
The Cell Cycle
1. **G1**-cell grows rapidly, normal cellular functions, DNA=Chromatin
2. **S**-DNA Replication
3. **G2** -Cell prepares for division, synthesis of organelles, microtubules are assembled, centrioles in animals replicate
4. **Mitosis**-nucleus of the cell is divided (1-hour)
5. **Cytokinesis**-division of cytoplasm

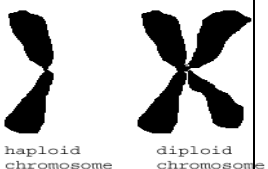


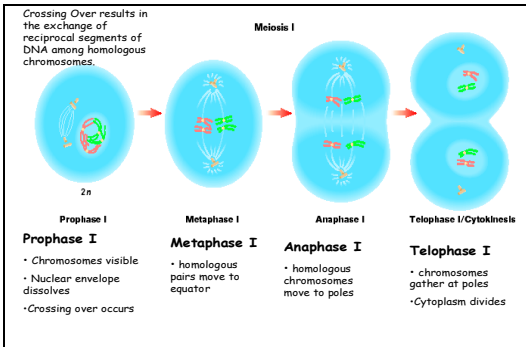
Mitosis-a process during cellular division in which the nucleus of a cell divides into two nuclei each with the same number and kind of chromosomes. **IPMAT**
Prophase:1. Chromatin condenses**,** 2. Nuclear envelope and nucleolus dissolve**,** 3. Centrioles migrate to poles, 4. Spindle forms
Metaphase:
1. Chromosomes align along equator (metaphase plate) 2.Spindle fibers link chromatids to opposite poles of cell
Anaphase:
1. Centromeres divide, 2. Chromatids pulled to poles as spindle fibers shorten. Once separated chromatids become two identical sets of daughter chromosomes.
Telophase: 1. Nuclear envelope forms, 2. Chromosomes uncoil, 3. Mitotic Spindle dissolves**,** 4. Cytokinesis begins along a cleavage furrow
Cytokinesis: Cytoplasm of cell divides in halfCell membrane grows to enclose each cell

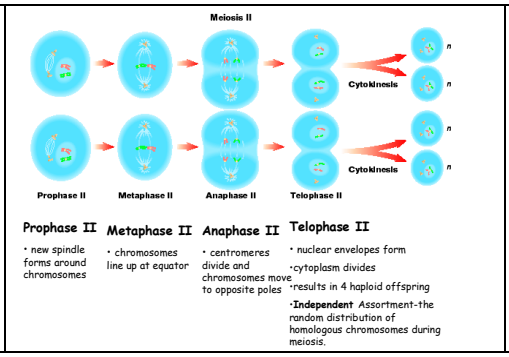


2.7 Describe how the process of meiosis results in the formation of haploid cells. Explain the importance of this process in sexual reproduction, and how gametes form diploid zygotes in the process of fertilization.

Haploid (n)-"single vessel" referring to a cell having one set of chromosomes. Haploid cells are gametes (sex cells)
Gamete-reproductive cells such as sperm or egg they are haploid cells that participate in fertilization by fusing with another haploid cell.
Diploid (2n)-"double vessel" referring to a cell having two sets of chromosomes. Diploid cells are somatic (body/non-sex cells)
Zygote-fertilzed egg. The fusion of two haploid cells forms a zygote.
Fertilization-The fusion of two haploid gametes to form a diploid zygote (a fertilized egg), the first cell of a new individual

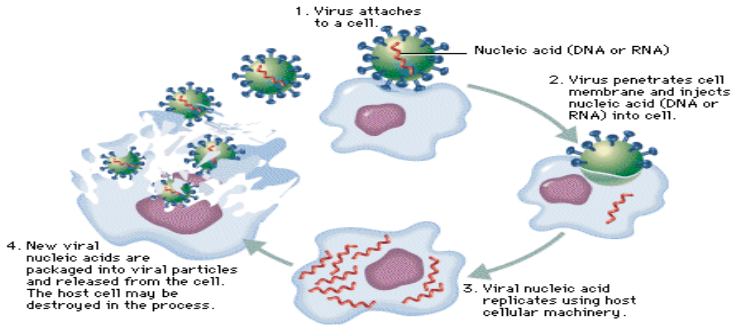
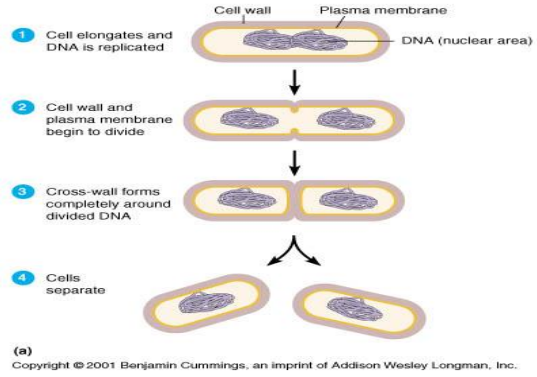






Meiosis-a type of cellular reproduction in which the number of chromosomes is reduced by half so that daughter cells are haploid (n).
a. allows chromosome number to remain stable over multiple generations
b. in humans meiosis yields 4 haploid cells with 23 chromosomes

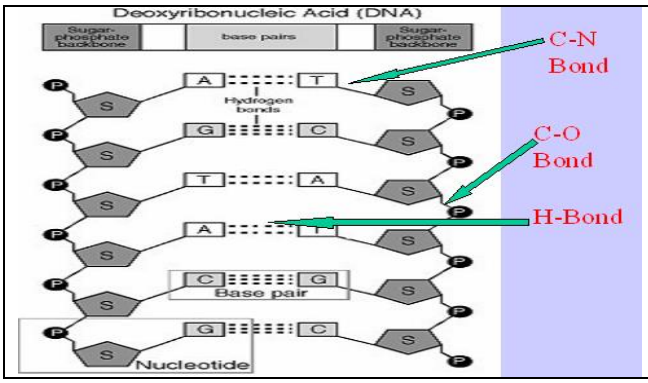
2.8 Compare and contrast a virus and a cell in terms of genetic material and reproduction.

Virus Replication-Once a virus has "infected" a cell, it will use the cell's ribosomes, enzymes and much of the cellular machinery to reproduce  	***Binary Fission***-*bacterial replication-bacteria are living organisms and can reproduce on their own.* 

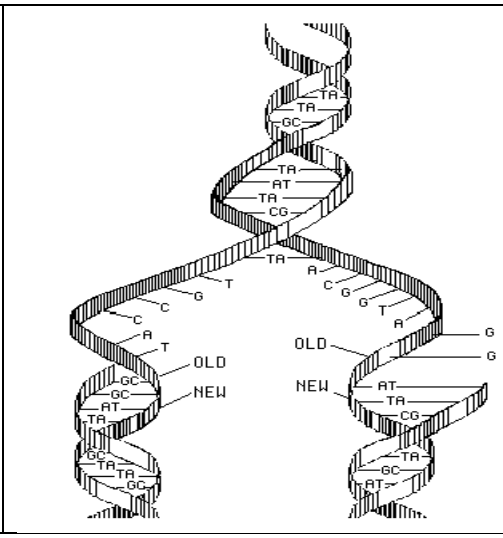
3. Genetics

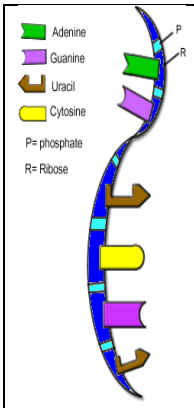
Broad Concept: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins that are characteristic of that organism.

3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.

 	DNA structure is double helix consisting of the following: Nucleotide: 1. Deoxyribose (a five carbon sugar) 2. Phosphate Group 3. Nitrogen Base a. Purines (Adenine & Guanine) Double Ring of C and N b. Pyrimidines (Thymine & Cystosine) Single Ring of C and N Deoxyribose and Phosphate groups form backbone/uprights of ladder. Nitrogen bases are rungs of ladder Chargaff's Rule A=T(triple H-bond) G=C (double H-bond) Strands of DNA are antiparallel.

3.2 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic code. Explain the basic processes of transcription and translation, and how they result in the expression of genes. Distinguish among the end products of replication, transcription, and translation.

DNA Replication: The complementary structure of the DNA double helix serves as a template during DNA Replication. Step 1: Unwinding a. **DNA Helicase (**an enzyme) breaks H bonds b. Double helix unwinds into two Replication Forks c. Proteins attach to each strand to prevent reattachment. Step 2: a. **DNA Polymerases** (enzymes) add new nucleotides according to the base pairing rules-creating two new double helixes. Step 3: a. DNA polymerases prevent reattachment until a new strand has been synthesized. b. DNA polymerases "proofread" to minimize errors (mutations) Resulting in < one error per 1 billion nucleotides. Multiple **Replication Forks** enable a strand of DNA to replicate much faster. 100 sections allow for replication in 8 hours, if not it would take 33 days.	



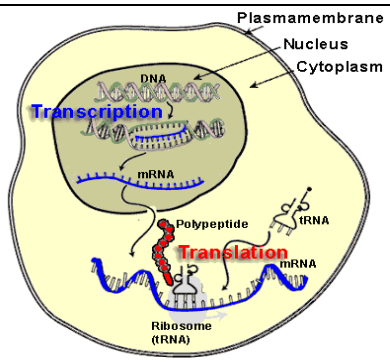
RNA (Rribonucleic Acid)
Difference from DNA
1. Single Strand not double
2. Ribose not Deoxyribose
3. Thymine replaced by Uracil

Remember:
mRNA codons
tRNA anticodons
codon table

Protein Synthesis (Gene Expression)-the process of translating an organism's genotype to phenotype. Genes code for sequences of amino acids that make up proteins.2 Phases:

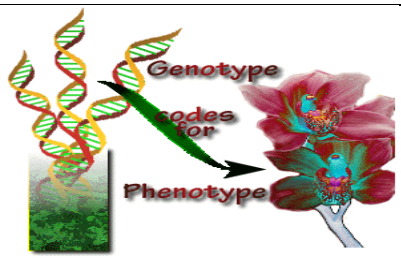
1. Transcription (nucleus)-information in a DNA molecule is copied to **RNA** (transcribe = copy)

2. Translation (cytoplasm/ribosomes)-mRNA is used to make a **protein (**nucleotides translated to **amino acid sequences**)



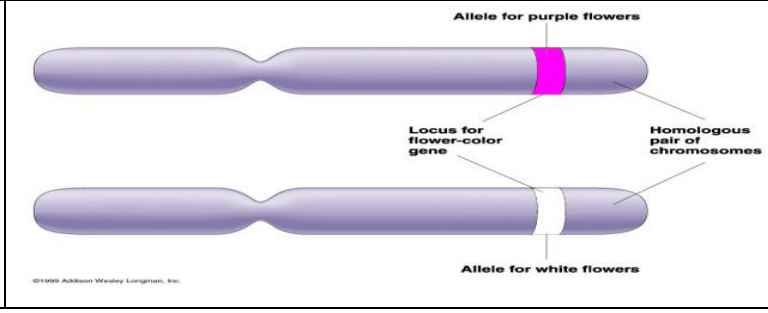
3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.

Mutation-a random change in the sequence of the DNA (frameshift and point mutations)
Genotype-the genetic makeup of an organism as indicated by its set of alleles (ie: YY, Yy, or yy).
Phenotype-the observable characteristics of an organism or the outward expression of its traits.
Gamete-reproductive cells such as sperm or egg they are haploid cells that participate in fertilization by fusing with another haploid cell.
An individual's genetic makeup (genotype) can be translated into observable characteristics (phenotype) because their DNA provides a template for making proteins.



3.4 Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, incomplete dominance, codominant, sex-linked, polygenic, and multiple alleles).

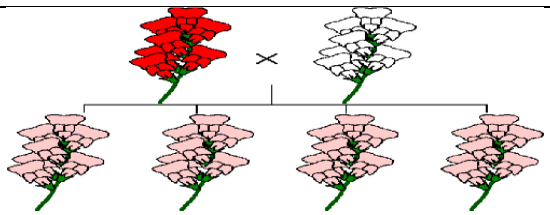
Genes are sections of chromosomes that code for a trait.
Alleles are different forms of a gene.
Letters are used to represent alleles
P (purple flower-dominant)
p (white flower-recessive)
Dominant Allele-a form of a gene that is fully expressed when two different alleles are present.
vs.
Recessive Allele-a form of a gene that is not expressed when paired with a dominant allele.



Homozygous-if the alleles for a particular gene in an individual are the same (ie: PP or pp)
Heterozygous-if the alleles for a particular gene in an individual are different (ie: Pp)

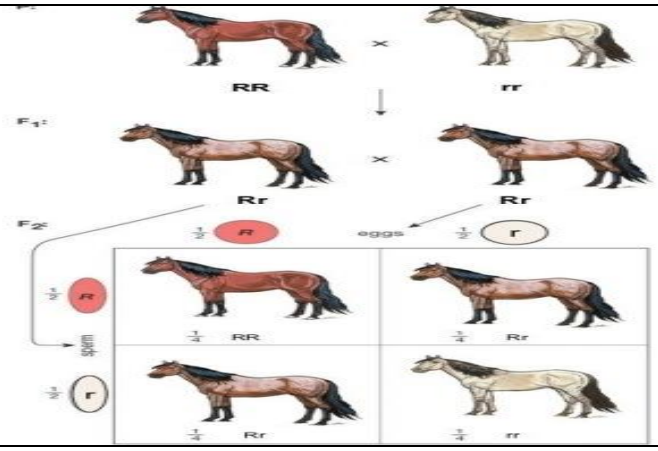
Incomplete Dominance-a condition in which a trait in an individual is intermediate between the phenotype of its two parents. Neither allele is fully expressed. Sickle Cell Anemia in humans is an example of incomplete dominance.

Snapdragons RR-Red Rr-Pink rr-white		Sickle Cell Anemia AA- Not affected Aa-mildly affected aa-Affected

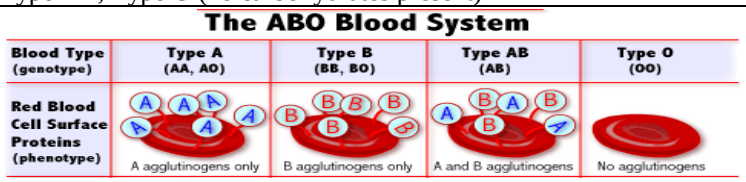


Codominance-a condition in which both alleles for a gene are expressed fully when present

Roan horses are born when a homozygous red horse mates with a homozygous white horse. The resulting offspring has both red and white hairs, which from a distance may look a bit pinkish.



Multiple Alleles-In humans blood type is determined by the different carbohydrates that coat the surface of red blood cells. Type A, Type B, Type AB, Type O (no carbohydrates present)

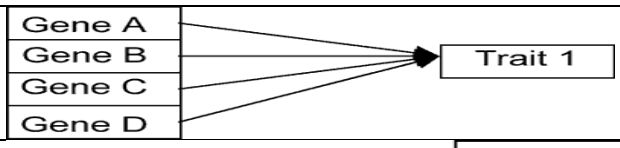


Human blood type genes are an example of a codominant trait with **multiple alleles**. Blood types are phenotypes that can be produced by three different alleles I^A, I^B, and i.

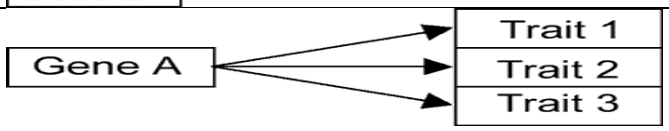
	I^A	I^B	i
I^A	I^AI^A	I^AI^B	I^Ai
I^B	I^AI^B	I^BI^B	I^Bi
i	I^Ai	I^Bi	ii

I^A & I^B-Dominant; i recessive

Polygenic Traits-are traits that are controlled by more than one gene. An example would be eye color, which is a combination of the tone, amount, and position of eye color.

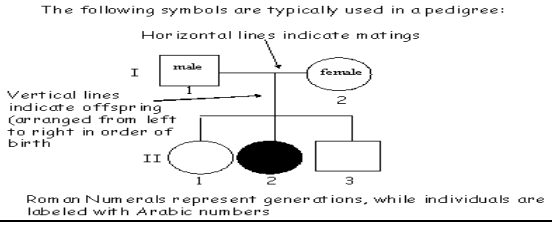


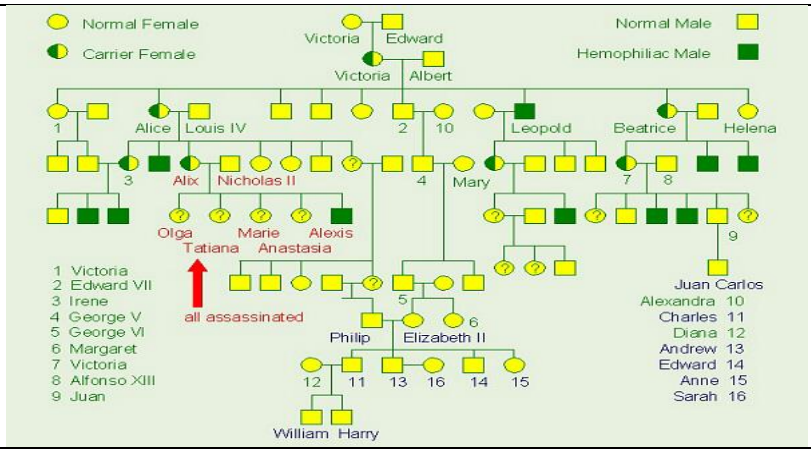
Pleiotropy-when a single gene affects more than one trait. Secondary affects of these genes can be either good or bad. Sickle cell anemia is an example.



Sex-linked (determined by a gene on the X chromosome) traits are usually seen only in males because males only have one X chromosome. **XX vs. XY**

Pedigree-a family history that shows how traits are inherited over several generations.





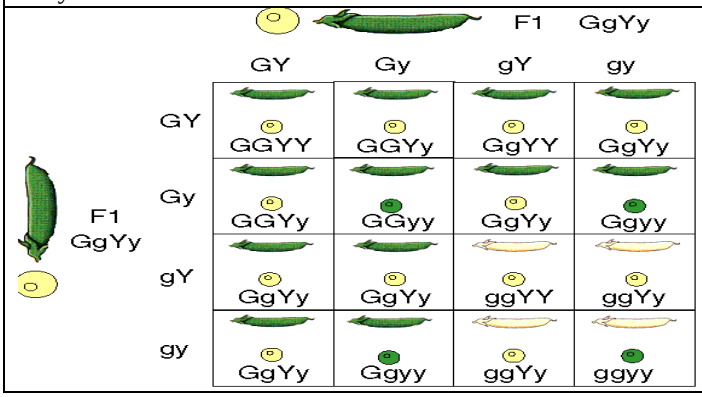
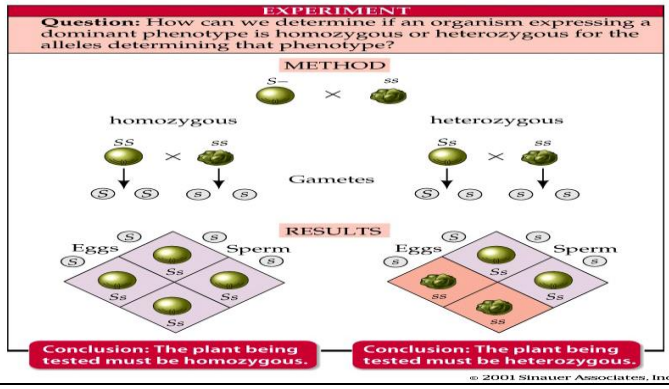
3.5 Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance (such as dihybrid crosses).

Laws of Heredity (Mendel's Laws)

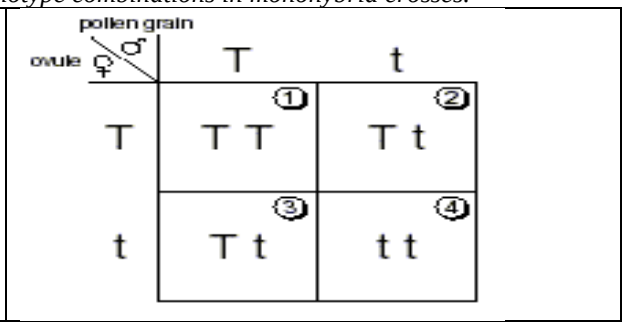
1. Law of Segregation-the two alleles for a trait segregate (separate) when gametes are formed (during meiosis). Because of segregation ½ of an organisms gametes contain one gene from a homologous pair and ½ of the games contain the other gene.

2. Law of Independent Assortment-the alleles of different genes separate randomly and independently of one another during gamete formation. (ie: the alleles associated with the color, size, flower position etc. are not linked to one another)

3. Law of Dominance-if two alleles in a gene pair are different, then one allele (dominant) can control the trait and the other one can be hidden (recessive)

Dihybrid Cross-two contrasting traits- like flipping two independent coins Dihybrid crosses follow the FOIL Rule	**Test Cross**-a cross of an individual whose phenotype is dominant (but whose genotype is unknown) with a homozygous recessive individual.
	

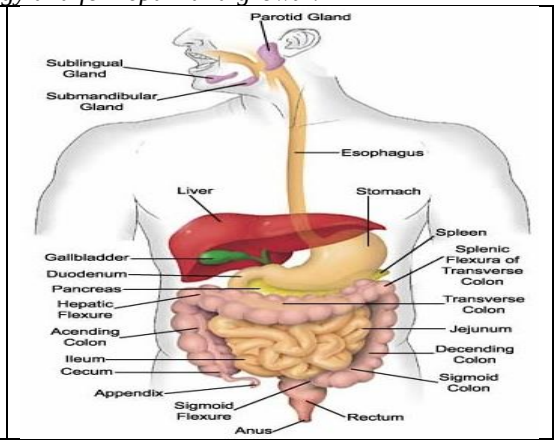
3.6 Use a Punnett Square to determine the probabilities for genotype and phenotype combinations in monohybrid crosses.

Punnett Square-diagrams that predict the expected outcomes of a genetic cross by considering all possible combinations of gametes in the cross. Punnett squares show probabilities not the actual results of crosses between organisms. **Monohybrid Cross**-a cross involving 1 set of contrasting traits. Genotypic Ratio: Homozygous Dominant: Heterozygous Dominant: Homozygous Recessive VS Phenotypic Ratio: Dominant: Recessive	

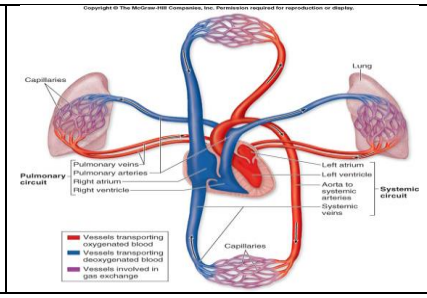
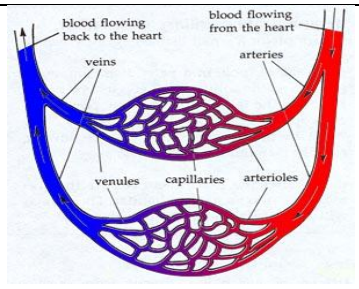
4. Anatomy and Physiology

Broad Concept: There is a relationship between the organization of cells into tissues, and tissues into organs. The structure and function of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

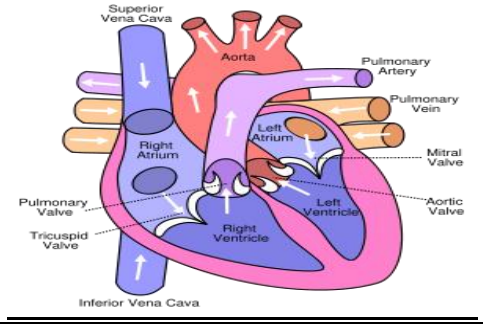
4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.

1. *Mouth*: Mechanical digestion (chewing) and chemical digestion (saliva). Carbohydrate digestion begins with amylase in saliva. **2. *Pharynx and esophagus*:** Bolus down pharynx (epiglottis closes entrance to the trachea) by muscular contractions called peristalsis. **3. *Stomach***: Mechanical Digestion (stomach walls contract to churn food.) Chemical digestion (hydrochloric acid and the enzyme pepsin-which begins breakdown of proteins). Chyme a soft pulp of food is produced and released into the small intestine. **4. *Small Intestine*:** (7 meters long with narrow diameter) Divided into three structural parts: duodenum, jejunum, and the ileum. Digestion of fats begins while digestion of carbohydrates and proteins are completed. The small intestine is also where nutrients are absorbed. **5. *Large Intestine*:** (1.5 meters long with large diameter) Water and water-soluble vitamins are absorbed from Rectum-the final portion of the large intestine where feces is stored until it is eliminated through the anus.	

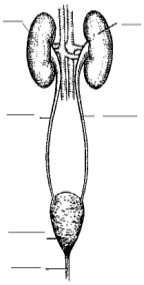
4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood

1. Pulmonary Circuit: (blood b/w heart and lungs) 2. **Systemic Circuit**: (blood b/w heart and body) **Human Blood Vessels:** transport blood throughout the body 1. **Arteries→Arterioles:** carry blood away from the heart. High Pressure due to pumping of heart. 2. **Capillaries:** Most of the gases, nutrients, and wastes in the blood are exchanged with body cells by diffusion through the capillary walls. 3. **Veins→Venules:** carry blood to the heart (Low Pressure)		

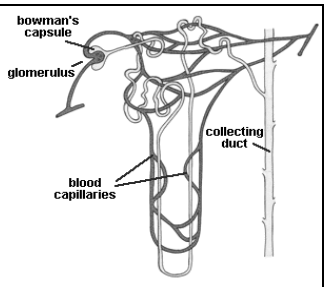
Human Heart: A muscular, four-chambered organ made of cardiac muscle that is responsible for pumping blood through the vessels. The top two chambers are the **atria** (**atrium**) and the bottom two chambers are the **ventricles**.
Right side of the heart: collects deoxygenated blood, in the right **atrium**, from the body and pump it, via the right **ventricle**, into the lungs so that carbon dioxide can be dropped off and oxygen picked up
Left side of the heart: collects oxygenated blood from the lungs into the left **atrium**. From the left **atrium** the blood moves to the left **ventricle** which pumps it out to the body



Kidneys
1. Blood enters the kidneys through vessels that branch from the aorta
2. Kidneys filter wastes from the blood
3. Kidneys converts wastes into urine
4. Urine flows from each kidney through a long tube called the **ureter**
5. **Ureters** carry urine to the bladder
6. When the bladder is full, urine is expelled out of the body through the **urethra**

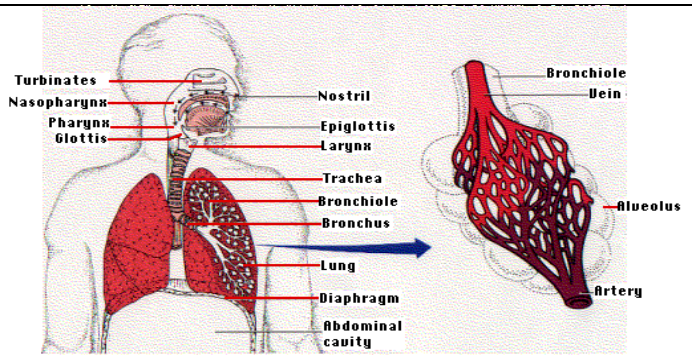


Nephron function
Filtration: occurs in the **glomerulus**
1. Blood pressure forces water, salt, glucose, amino acids, and urea into **Bowman's capsule**. The fluid that enters the renal tubules is called the **filtrate**.
Reabsorption: occurs in the **renal tubules**
2. As the **filtrate** travels through the **renal tubules**, most of the water and nutrients are reabsorbed into the blood. The fluid that remains is urine.
Secretion: occurs in the **renal tubules**
3. Some wastes that may have been reabsorbed such as salts, urea, and uric acid move from the blood directly to the **renal tubules**.



4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.

1. Air enters the body either through the nose or the mouth. As it travels to the lungs, it is being filtered, warmed, and moistened.
2. Nose and mouth passageways join at the **pharynx**. **Pharynx** branches into either the **esophagus** (which leads to the stomach) or the **larynx** (voice box).
3. The **larynx** is situated at the top of the **tracheal** (**trachea**) tube.
4. **Trachea** branches into two **bronchi** that each connects with a lung
5. Within the lung, the **bronchi** branches into smaller tubes called **bronchioles**
6. **Bronchioles** end in small air sacs called **alveoli**

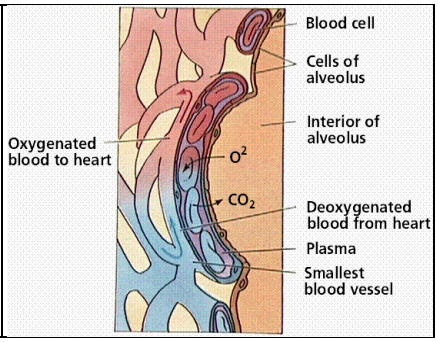


Alveoli Gas Exchange
Gas exchange occurs by diffusion across the membrane of an alveolus and a capillary.

In the alveoli, O_2 is more concentrated than in surrounding capillaries.
In the capillaries of the lungs, CO_2 is more concentrated.

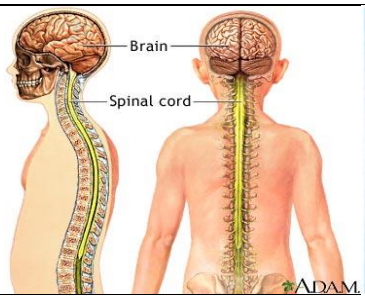
Therefore: O_2 diffuses from the cell membrane of the alveoli to the blood in the capillaries and CO_2 diffuses out of the capillaries into the alveoli where it is exhaled from the lungs

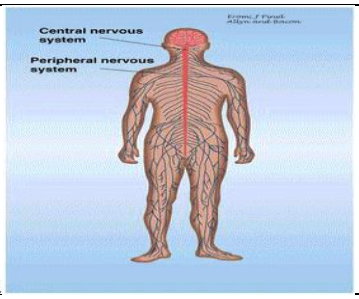
During cellular respiration, cells use O_2 while producing CO_2. O_2 diffuses from the capillaries into body cells and CO_2 diffuses out of body cells into capillaries.



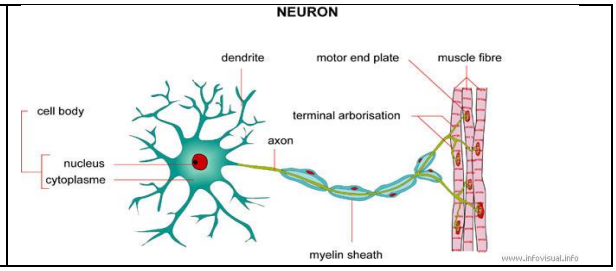
4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication between different parts of the body and the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.

Central Nervous System (**CNS**): the body's main control center and consists of the brain and the spinal cord. The **CNS** processes information and sends instructions to other parts of the body. The spinal cord relays nerve impulses to and from the brain.
Peripheral Nervous System (**PNS**): made up of a network of nerves that extend throughout the body. The PNS gathers information and delivers it to and from the CNS. **Sensory** and **Motor** nerves are part of the PNS.

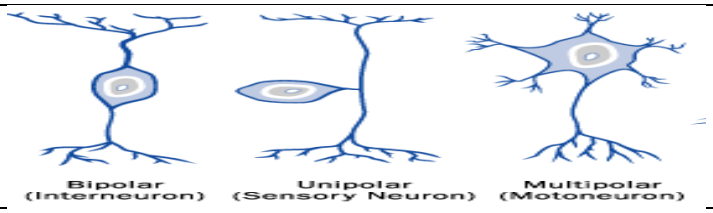




The nervous system consists of two types of cells:
1. **Neurons**: the functional cells of the nervous system. Neurons transmit signals through the body. It is composed of the **cell body** which contains the nucleus, cytoplasm, and organelles. It is also composed of fiberlike extensions called **axons** and **dendrites**. In the PNS, these fibers are bundled into ropelike structures called nerves.
Axon: carries an impulse away from cell body
Dendrite: receives and carries the impulse to the cell body



Types of Neurons
1. **Sensory Neurons**: conduct impulses toward the CNS
2. **Motor Neurons**: conduct impulses away from the CNS
3. **Interneurons**: conduct impulses within the CNS. They connect with sensory, motor, and other interneurons.

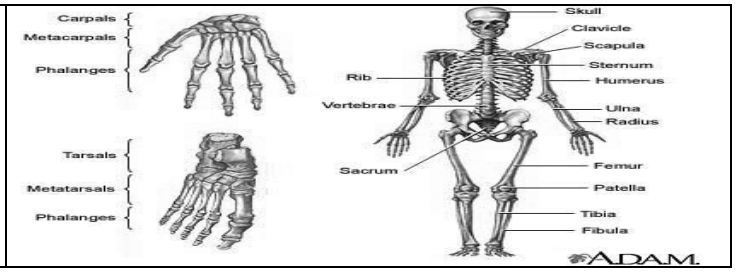


4.5 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscle, bones, cartilage, ligaments, tendons) works with other systems to support and allow for movement. Recognize that bones produce both red and white blood cells.

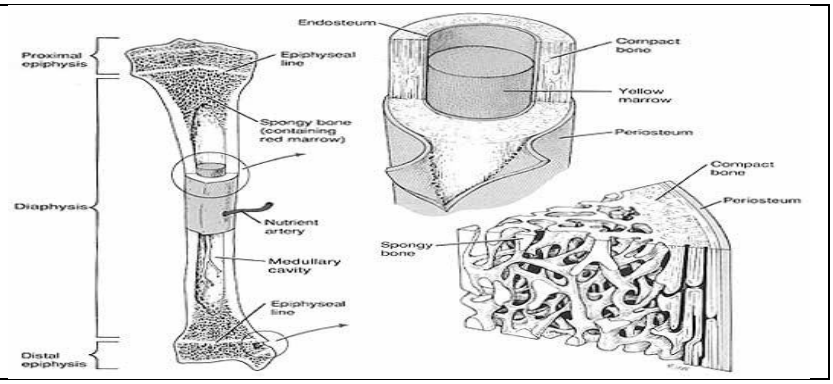
The human skeleton has 206 bones. The skeleton is divided into two parts: the **axial** and the **appendicular** skeletons.

Axial skeleton: composed of the skull, vertebral column, and rib cage. It protects vital organs such as the brain, heart, and lungs.

Appendicular skeleton: composed of the arm and leg bones, with the bones of the pelvis and shoulder areas.



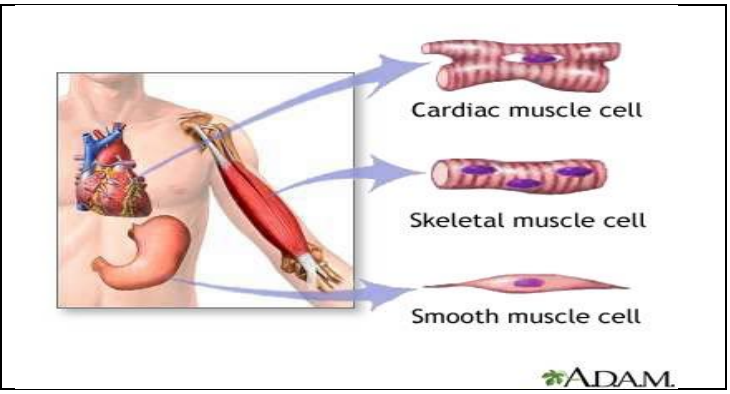
Periosteum-tough exterior membrane that surrounds bones. Blood vessels branch through the periosteum.
Marrow—soft tissue that fills some spaces in bone.
Red Marrow-produces red blood cells, white blood cells, and platelets.
Yellow Marrow-found within the cavities of long bone shafts-composed primarily of fat, which stores energy
Haversian Canals-lengthwise circular channels through which blood vessels and nerves pass.
Canaliculi-small channels in compact bone.
Osteoblasts/Osteocytes-make new bone and maintain mineral concentrations of the bone.



Cushions of **cartilage** in joints keep the ends of the bones from rubbing against each other. Some freely movable joints are also protected by fluid-filled sacs called **bursae**. These sacs absorb the impact of sudden pressure.

Bones and muscles of freely movable joints are bound together by bands of tough connective tissues.
Ligaments are connective tissues that join one bone to another.
Tendons are connective tissues that attach muscles to bones.

Skeletal/Striated-skeletal muscles are voluntary muscles that give us the ability to move. Skeletal muscle tissue is striated (has bands). Striated muscle cells do not divide into two cells during mitosis-only the nuclei divide creating cells with multiple nuclei called muscle fibers.
Smooth-Muscle-involuntary muscles that make up many of the organs in your body. Smooth muscles are controlled by the nervous system and hormones from the endocrine system. Examples: dilation of pupils, peristalsis, blood vessels. Each muscle cell contains only one nucleus.
Cardiac-Muscle-found only in the heart. Both striated and involuntary. Works slowly and constantly to beat for life.

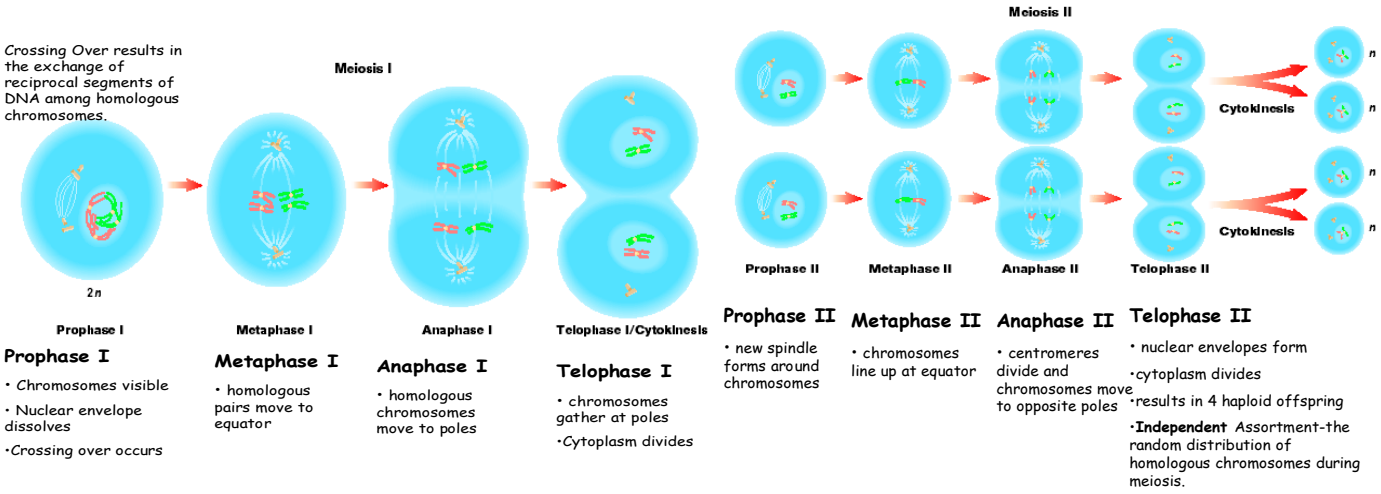


4.6 Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father and that sexually produced offspring resemble, but are not identical to, either of their parents.

Sexual reproduction requires a special form of cell division (meiosis). The number of chromosomes is reduced by half to form gametes.

Gamete-reproductive cells such as sperm or egg they are haploid cells that participate in fertilization by fusing with another haploid cell.
Fertilization-The fusion of two haploid gametes to form a diploid zygote (a fertilized egg), the first cell of a new individual.

Meiosis-a type of cellular reproduction in which the number of chromosomes is reduced by half so that daughter cells are haploid (n).
a. chromosome number remains stable over multiple generations
b. in humans meiosis yields 4 haploid cells with 23 chromosomes

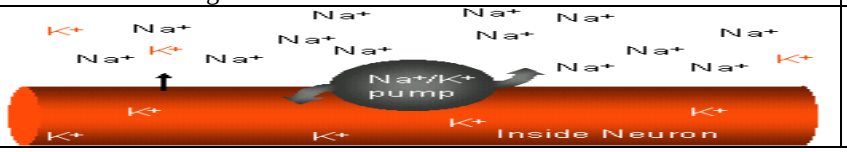


4.7 Recognize that communication between cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.

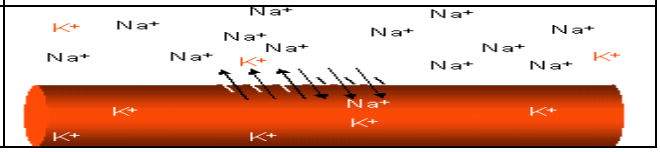
Nerve Impulse Transmission

A nerve impulse is a wave of chemical and electrical change that moves along the membrane of a neuron. A neuron has a **membrane potential** which is an electrical charge difference across the cell membrane. The membrane potential can either be:

Resting potential: the electrical charge across the cell membrane of a neuron in the resting state



Action potential: the reversal and restoration of charges across the cell membrane



Steps in nerve impulse transmission:
1. At rest, the inside of the cell has a negative charge while the outside has a positive charge
2. Upon stimulation, channels in the membrane of the first region open, and sodium ions (Na+) flow into the cell. This causes the inside to be positive while the outside is negative.
3. After Na+ enters the first region of the cell, potassium ions (K+) flow out of the cell, restoring the first region to its resting potential. The reversal of charge opens the channels in the next region of the neuron.
4. A charge reversal in the second region starts a charge reversal in the third region, and so on, as the nerve impulse is transmitted along the neuron.

Synapse

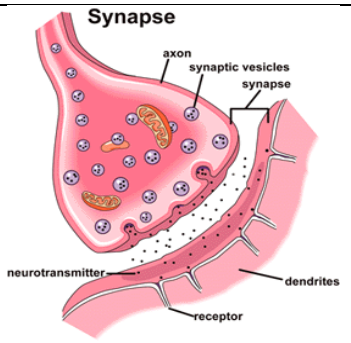
Most neurons do not actually touch one another. Instead, nerve impulses move from neuron to neuron across synapses.

Synapse: junctions with tiny gaps between adjacent neurons and between neurons and organs to which they send messages.

Neurotransmitters: information crosses synapses in the form of chemical messengers.

Nerve impulses traveling between two neurons:

1. At the end of axon, neurotransmitter stored in sacs. Nerve impulse reaches the end of an axon, the impulse causes some of the sacs to fuse with the axon's membrane.
2. Each fused sac releases its neurotransmitter into the synapse gap
3. The neurotransmitter diffuses across the gap and binds to receptors on the next neuron
4. Binding of the neurotransmitter causes a change in membrane potential of the receiving cell



4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

Homeostasis- the maintenance of stable internal conditions in spite of changes in the external environment. The nervous system and the endocrine system regulate and monitor organ systems within the body to ensure stability is maintained throughout the body. ie: the brainstem controls homeostasis in the human body by regulating temperature, respiration rates, etc. Hormones assist in maintaining homeostasis as it relates to nutrition, metabolism, excretion and water and mineral balances. (ie: human sweating to control temperature, dogs panting instead of sweationg to maintain temperature)

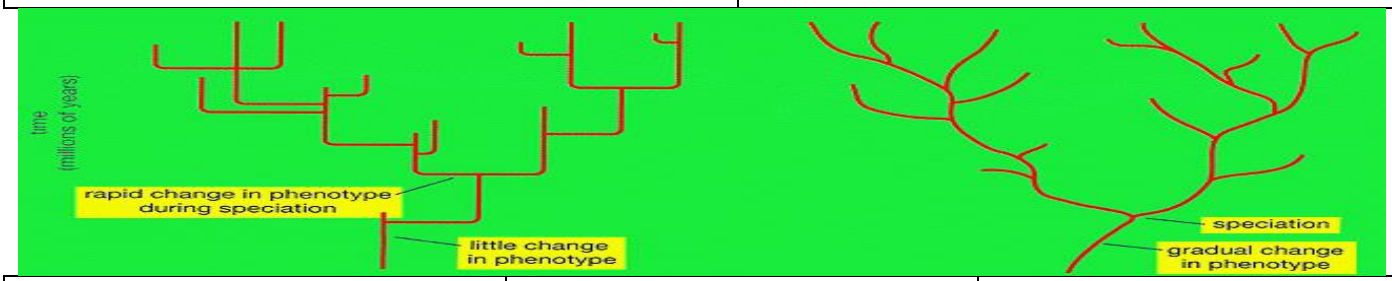
5. Evolution and Biodiversity

Broad Concept: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.

5.1 Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.

Evolution-changes in populations over long periods of time. Evolution represents the change in a gene pool over time.

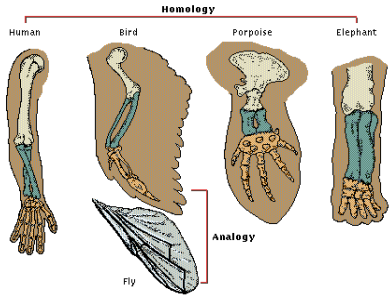
Punctuated Equilibrium-long periods of genetic stability are interrupted by periods of rapid genetic change	**Gradualism**-new species evolve as the genomes of two populations differentiate over enormous spans of time



Homologous Structures-similar traits in different species because of a common ancestor. Homologous Structures show evidence of a common ancestor.

Analogous Structures-a structure that is similar in function, but not inherited from a common ancestor. Analogous Structures are evidence of independent evolution.

Other Records of Evolution

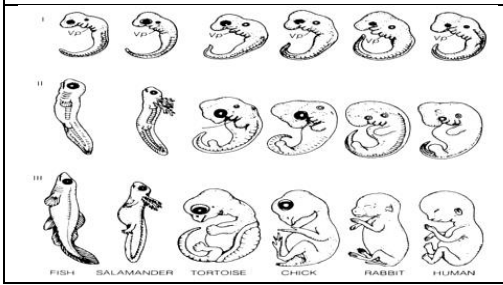


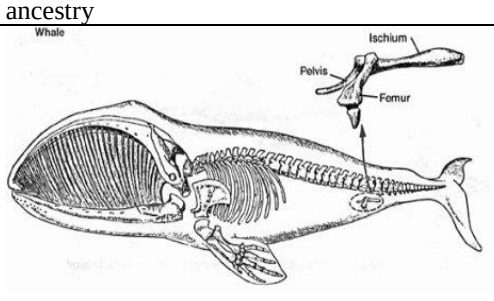
Proteins-scientists look for similar amino acid sequences to determine shared ancestry. ie: the more common the shared ancestry the more amino acid sequences will be the same

Nucleic Acids-scientists can directly estimate the number of changes that have taken place in a gene since divergence from a common ancestor.

Fossil Record-evidence from the fossil record can be used to show evolutionary relationships by comparing homologous and analogous structures and locations of fossil finds.

Comparative Embryology-comparison of the embryonic forms of various living organisms	**Vestigial Structures**-a structure that is unused but is homologous with structures in other species-thereby suggesting a common ancestry



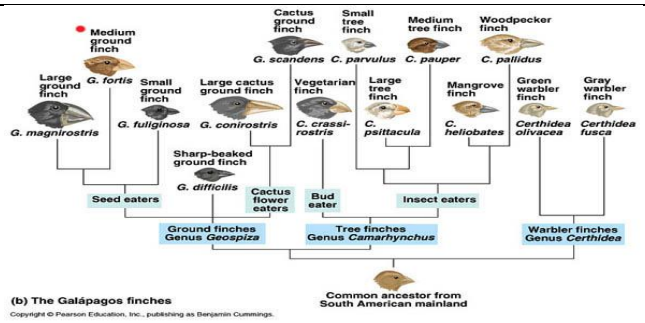


5.2 Describe species as reproductively distinct groups of organisms. Recognize that species are further classified into a hierarchical taxonomic system (kingdom, phylum, class, order, family, genus, species) based on morphological, behavioral, and molecular similarities. Describe the role that geographic isolation can play in speciation.

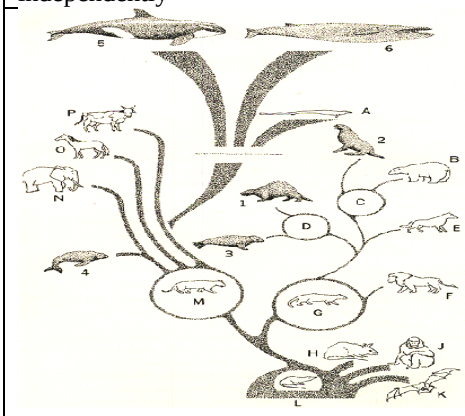
Species-interbreeding populations of organisms that can produce fertile, healthy offspring

Speciation-the evolution of one or more species from a single ancestor species

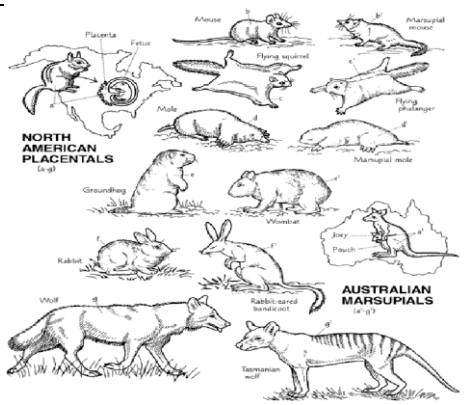
CoEvolution-when organisms interact closely adapt with one another



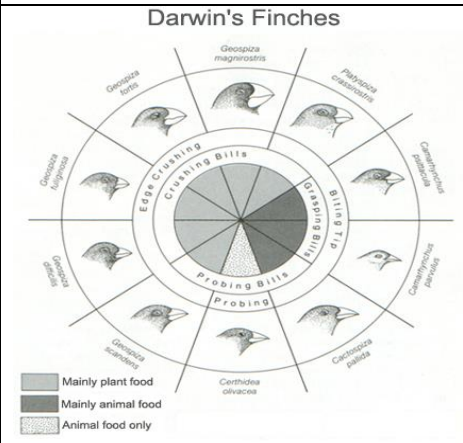
Divergent Evolution-when geographic barriers separate members of a population and isolated populations evolve independently



Convergent Evolution-when natural selection produces analogous adaptations in response to similar environmental conditions

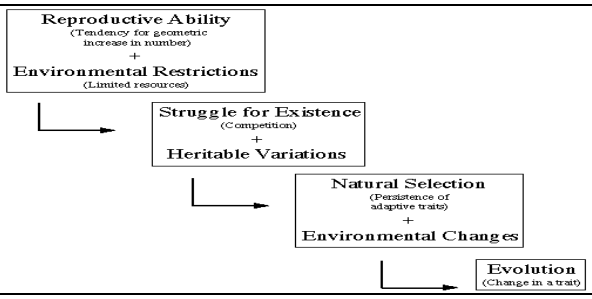


Adaptive Radiation-the evolution of many diversely adapted species from a common ancestor.



5.3 Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity from a population.

Natural Selection-the process by which populations change in response to their environments. This change happens through inherited traits that increase a population's chances of survival and reproduction called adaptations (anatomical structure, physiological process, or behavioral trait**).**



6. Ecology

Broad Concept: Ecology is the interaction among organisms and between organisms and their environment.

6.1 Explain how birth, death, immigration, and emigration influence population size.

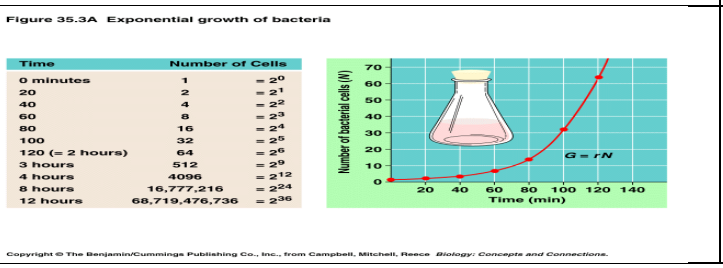
Population Size- the total number of individuals in a population. The population size can affect a population's ability to survive. The smaller the population the more prone it is to extinction.

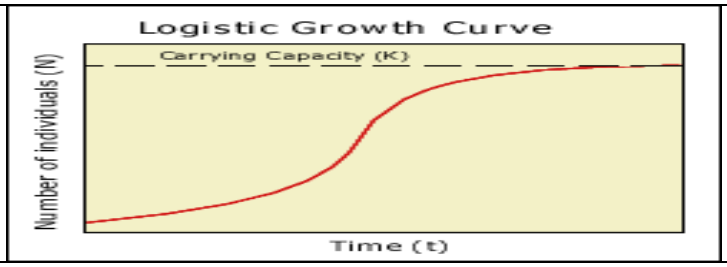
Population Density- the number of individuals in a given area. Population densities can impact reproduction, spread of disease, availability of resources, etc.

Dispersion-the way that a population is arranged in a space. Dispersion is determined by the interactions of a population and its environment

Population Models-In general populations grow when birth rates exceed death rates, populations decline when death rates exceed birth rates, and remain stable when birth and death rates are even.

Exponential Growth Curve-population growth curve in which the rate of population growth stays the same. Exponential growth curves are J-shaped and occur when there are no **Limiting Factors.**	**Logistic Growth Model-**population growth curve in which the rate of exponential population growth is limited by **Density-Dependent Limiting Factors.** In this model birth and death rates will vary with population size and stabilize at an ecosystem's **Carrying Capacity** (the population size that an environment can sustain.





6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.

Factors that affect population size

Density Dependent Limiting Factors-limited resources whose rates of depletion depend upon the density of the population using them. ie: resources such as food & water, diseases, or predator-prey relationships.

Density Independent Limiting Factors-non-density dependent factors that affect the growth of populations. ie: weather, seasonal cycles, natural disasters, human activity "Bad Luck"

Reproductive Strategies

r-Strategists-species characterized by rapid growth, high fertility, short lifespan, and exponential population growth. R-strategists typically live in unstable environments.

K-Strategists-species characterized by slow maturation, few young, slow population growth, and reproduction late in life. K-strategists typically have small population sizes that hover near the carrying capacity. Many endangered species are K-strategists.

6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition, commensalism, and mutualism) add to the complexity of biological communities.

Ecosystem-the combination of all of the communities (biotic features) and all of the abiotic factors in an environment.

Biotic Factors-the living organisms in a habitat (ie: plants, animals, fungi, protests, and bacteria (think of the 6 Kingdoms of life).

Abiotic Factors-the physical aspects of a habitat: soil, water, air, weather, and fire. Abiotic factors are non-living parameters that impact an ecosystem

Population-a group of organisms of the same species living in a specific area.

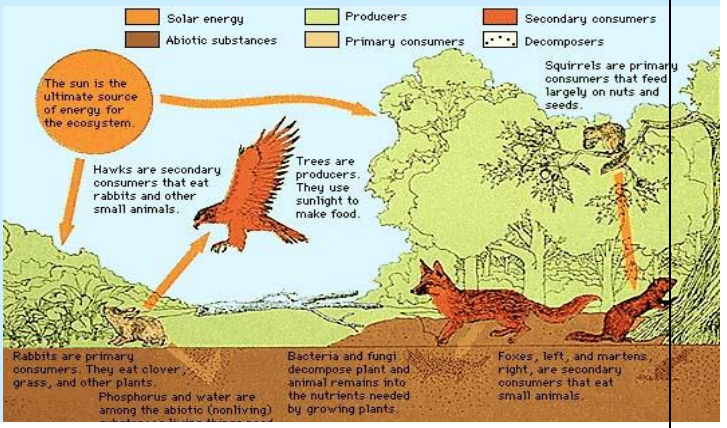
Community-a collection of interacting populations within a given ecosystem. Organisms within a community depend upon each other for survival.

Biodiversity-the number of species living within an ecosystem. Biodiversity is typically viewed from the perspective of the degree of species variety and balance within an ecosystem.

Habitat-the type of environment where a particular population of a species lives.

Niche-the functional role of a particular species in an ecosystem. A niche is the pattern of living of an organism; how an organism lives, the "job" it performs in an ecosystem.

Ecosystem-a community (biotic features) and all of the abiotic (soil, water, weather) aspects of its habitat.



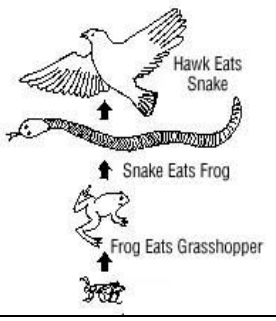
A **Food Chain** models the flow of energy through organisms in a community along a linear pathway. Organisms within a food chain are assigned to different levels within a food chain known as **Trophic Levels. Trophic Levels** consist of groups of organisms that have the same source of energy (a step in a food chain). The term trophic comes from the Greek "trophos" meaning food/to feed.

Symbiosis-an ecological interaction in which two or more species live together in a close long-term association. The three types of symbiotic relationships are mutualism, commensalism, and parasitism.

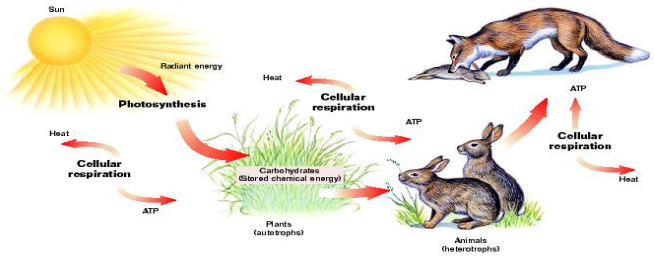
Mutualism-an ecological interaction in which both partners benefit.

Commensalism-an ecological interaction in which one species benefits and the other species is neither harmed nor helped.

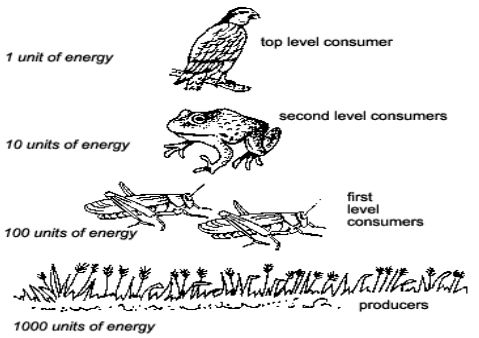
Parasitism-an ecological interaction in which one species feeds on, but does not kill its host



A **Food Web** is a network of interconnected food chains in an ecosystem.
Autotrophs-organisms that use energy from sunlight or inorganic substances to make organic compounds via the process of **photosynthesis** or **chemosynthesis**. The foods made are primarily carbohydrates such as glucose.
Producer-autotrophs that provide food for a community.
Heterotrophs/Consumers-organisms that cannot make their own food and therefore must obtain energy from outside food sources. Heterotrophs use this food to make ATP during **cellular respiration**.

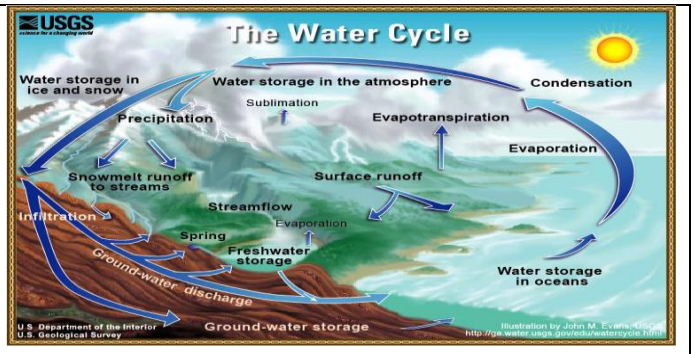


Primary Consumers-organisms that feed directly on producers
Herbivore-a primary consumer that eats only plants.
Secondary/Tertiary/Quaternary Consumers-organisms that feed on organism below them in a food chain.
Carnivore-organisms that eat only meat
Omnivore-orgnanisms that eat both producers and other consumers
Scavenger-organisms that feed on the tissue of dead animals
Detrivore/Decomposer-organisms that feed on wastes and dead organic matter from all trophic levels
An **Energy/Ecological** pyramid shows the relationship between producers and consumers at the trophic levels in an ecosystem. Each trophic level contains only 10% of energy available in the trophic level below.

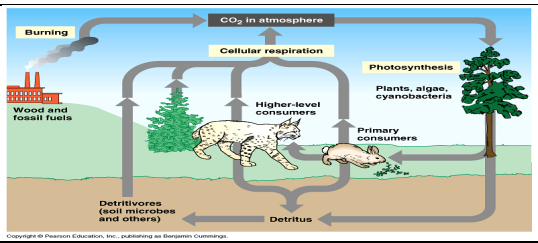


6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem and how oxygen cycles through photosynthesis and respiration.

Water Cycle-the continual movement of water from Earth's surface to the atmosphere and back to the surface again. The water cycle is powered by energy from the sun. Major steps include:
Evapotranspiration-the process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration from plants.
Condensation-the process by which atmospheric water vapor liquefies to form fog, clouds, or the like, or solidifies to form snow or hail.
Precipitation-falling products of condensation in the atmosphere, as rain, snow, or hail.
Runoff-Rainfall not absorbed by soil
Infiltration/Percolation-the slow movement of water through the pores in soil or permeable rock.



Carbon Cycle-the movement of carbon through the non-living environment and living organisms. The carbon cycle is driven by photosynthesis and cellular respiration. Carbon is returned to the atmosphere via the processes of respiration, combustion, and erosion. Photosynthesis results in the storage of carbon (carbon sequestration). Consider Sources vs. Sinks in the Carbon Cycle.
Carbon Sequestration (the storage of carbon) is accomplished by storing carbon in carbon sinks such trees or underground geologic formations.



Nitrogen Cycle-the atmosphere is 79% nitrogen gas, but most organisms are unable to use it in this form because the two nitrogen atoms in this gas are connected by a strong triple covalent bond that is very difficult to break. Some bacteria that live in soil and plants have enzymes that enable them to break N_2 and bind it with ammonia to form NH_3. This process is nitrogen fixation. The stages of the nitrogen cycle are:
1. **Assimilation**-absorption and assimilation of N by organisms.
2. **Ammonification**-production of ammonia by bacteria during decay of urea from urine and feces.
3. **Nitrification**-production of nitrate from urea
4. **Denitrification**-conversion of nitrate (NO_3) to nitrogen gas (N_2)

Legumes such as pea plants have the ability to fix nitrogen.