REVIEW OF BIOLOGICAL PRINCIPLES

Develop an understanding of the physical, chemical, and cellular basis of life.

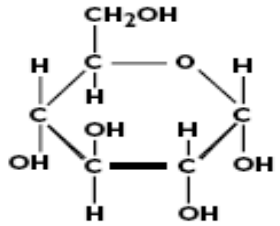
- Structure and Functions of Organic Molecules (carbohydrates, proteins, lipids, nucleic acids)
- Structure and Functions of Cells, Cellular Organelles, Cell Specialization, Communication Among Cells
- Cell as a Living System, Homeostasis, Cellular Transport, Energy Use and Release in Biochemical Reactions
- Structure and Function of Enzymes, Importance in Biological Systems
- Bioenergetic Reactions, Aerobic / Anaerobic Respiration, Photosynthesis

ORGANIC MOLECULES:

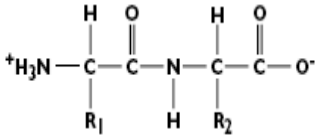
Organic compounds contain carbon and are found in all living things.

- ***Carbohydrates***
  - major source of energy and include sugars and starches
  - made up of carbon, hydrogen, and oxygen with a 2:1 ratio of hydrogen to oxygen
  - plants and animals use carbohydrates for maintaining structure within the cells
- ***Proteins***
  - Nitrogen-containing compounds made up of chains of amino acids
  - 20 amino acids can combine to form a great variety of protein molecules
  - can compose enzymes, hormones, antibodies, and structural components
- ***Lipids***
  - water-insoluble (fats and oils)
  - made up of carbon, hydrogen and oxygen; composed of glycerol and fatty acid
  - provide insulation, store energy, cushion internal organs, found in biological membranes
  - saturated (with hydrogen, single bonds, see example →) and unsaturated (double bonds)
- ***Nucleic Acids***
  - direct the instruction of proteins
  - genetic information an organism receives from its parents
  - two types: DNA (deoxyribonucleic acid) and RNA (ribonucleic acid)

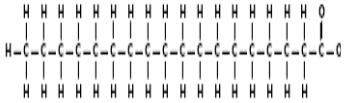
CARBOHYDRATE
(Sugar – Glucose)



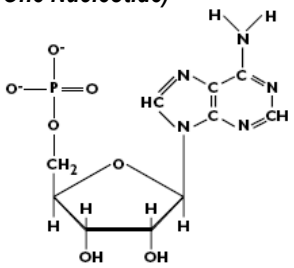
PROTEIN
(One Amino Acid)



LIPID



NUCLEIC ACID
(One Nucleotide)



CELL ORGANELLES:

- ***Chloroplast*** – capture solar energy for photosynthesis (plant cells, some algae)
- ***Golgi Body*** – package, distribute products
- ***Lysosomes*** – digests excess products and food particles
- ***Mitochondria*** – transform energy through respiration
- ***Nucleus*** – contains DNA which controls cellular activities
- ***Ribosome*** – produce proteins
- ***Vacuole*** – store substances
- ***Cell (plasma) membrane*** – phospholipid bilayer that protects and encloses the cell; controls transport; maintains homeostasis
- ***Cell wall*** – rigid second layer that protects and encloses the cell (plant cells and some bacteria)
- ***Cytoplasm*** – fluid-like substance that contains various membrane-bound structures (organelles) that perform various functions
- ***Endoplasmic Reticulum*** – site of chemical reactions
  - ROUGH: contains ribosomes
  - SMOOTH: lipid production
- ***Cytoskeleton*** – provides internal structure
  - MICROFILAMENTS: fibers
  - MICROTUBULES: cylinders

CELL TYPES:

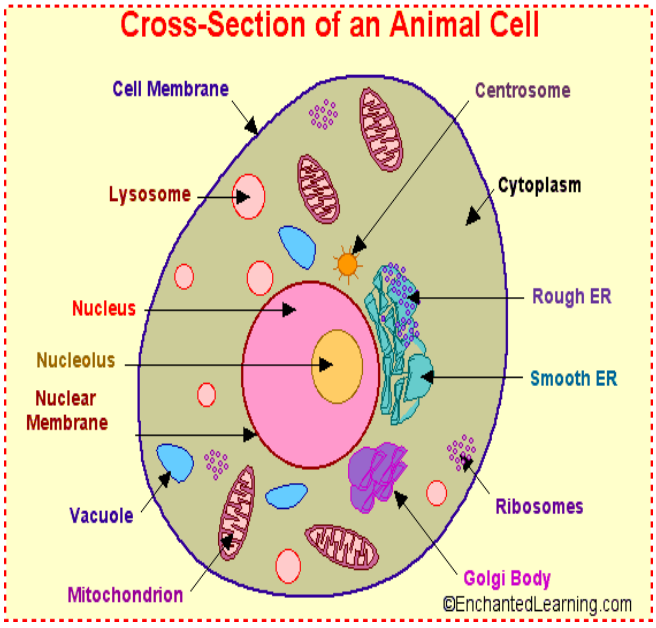
- ***Unicellular*** – organism that exists as a singular, independent cell
- ***Multicellular*** – organism that exists as specialized groups of cells; cells are organized into tissues that perform the same function; tissues form organs and organs make up an organ system
- ***Prokaryote*** – has nuclear material in the center of the cell, but is not enclosed by a nuclear membrane; no membrane-bound organelles; found in bacteria and blue-green bacteria
- ***Eukaryote*** – contain a clearly defined nucleus enclosed by a nuclear membrane and membrane-bound organelles; found in plants, animals, fungi, and protists

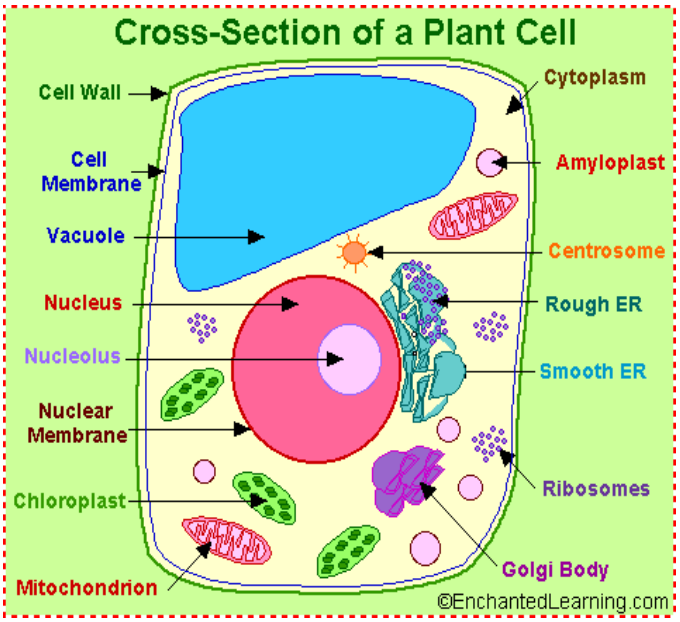
CELL THEORY:

- The cell is the basic unit of life.
- All organisms are composed of cells
- All cells come from pre-existing cells.

CELL SPECIALIZATION:

- cells >>>> tissues >>>> organs >>>> organ systems >>>> organism
- each cell performs a specific function for each tissue or organ
- as cells mature, they shape and contents change
- as cells become specialized they may contain organelles that are NOT common to all cells (for example: plastids, cell wall, vacuole, centriole)
- design and shape of a cell is dictated by its function and the conditions under which it works
- multicellular organisms exhibit greater cellular specialization, such as red blood cells, nerve cells, and gland cells





CELL TRANSPORT:

- ***Passive Transport*** – movement of substances across the plasma membrane without the use of the cell's energy (with the concentration gradient)

1. DIFFUSION – movement of substances across the plasma membrane from an area of high concentration to an area of low concentration
2. OSMOSIS – diffusion of water across the plasma membrane from areas of high concentration to areas of lower concentration
3. FACILITATED TRANSPORT – a carrier molecule embedded in the plasma membrane transports a substance across the plasma membrane following the high-to-low concentration gradient

- ***Active Transport*** – movement of substances across the plasma membrane that requires the use of the cell's energy and carrier molecules; substances are moving from an area of low concentration to an area of higher concentration (against the concentration gradient)

1. ENDOCYTOSIS – large particles are brought into the cell
2. EXOCYTOSIS – large particles leave the cell

- ***HOMEOSTASIS*** – internal equilibrium; the plasma membrane regulates what enters and leaves the cell; a selectively permeable membrane only allows certain substances to pass through
- ***Effect of Concentration on a Cell***

1. HYPOTONIC – water moves in; cell bursts
2. HYPERTONIC – water moves out; cell shrivels
3. ISOTONIC – no net movement; cell maintains equilibrium

HOMEOSTASIS: Self-regulating mechanism that maintains internal conditions (with individual cells and within organs, systems) Example: body temperature, respiration, nutritional balance, etc. Cells communicate their needs to each other mainly through their cell membranes by releasing chemical messengers that, ultimately, tell the hypothalamus gland in the brain that a change needs to be made in the interstitial fluid. Since it is the ruler of homeostasis, the hypothalamus sends neural and chemical signals to other glands, tissues, organs, and organ systems to adjust the internal environment, the interstitial fluid, so that it is more suitable for all the cells at that particular time. And since we are always changing what we are doing, homeostasis needs to change along with our activities, both day and night. This constantly changing internal environment is the process of homeostasis.

- Negative Feedback: Glucose / Insulin levels in cells
- Positive Feedback: Blood platelets / Blood clotting

BIOCHEMICAL REACTIONS: chemical bonds are formed and broken within living things creating chemical reactions that impact the ability to maintain life and carry out life functions

- ***Cellular Respiration*** – food molecules are converted to energy; there are three stages to cellular respiration; the first stage is called glycolysis and is anaerobic (no oxygen is required); the next two stages are called the citric acid cycle and the electron transport chain and are aerobic (oxygen is required)

  $C_6H_{12}O_6 + 6O_2 \Rightarrow 6CO_2 + 6H_2O + \text{ENERGY (36 ATP)}$

- ***Photosynthesis*** – plant cells capture energy from the Sun and convert it into food (carbohydrates); plant cells then convert the carbohydrates into energy during cellular respiration; the ultimate source of energy for all living things is the Sun (in Chemosynthesis, organisms use sulfur or nitrogen as the main energy source)

  $6CO_2 + 6H_2O + \text{ENERGY(from sunlight)} \Rightarrow C_6H_{12}O_6 + 6O_2$

- ***ATP*** – ATP is a molecule that stores and releases the energy in its bonds when the cell needs it; removing a phosphate group (P) releases energy for chemical reactions to occur in the cell and ATP becomes ADP; when the cell has energy, the energy is stored in the bond when the phosphate group is added to the ADP

  $ATP \Leftrightarrow ADP + P + \text{ENERGY}$

- ***Fermentation*** – when cells are not provided with oxygen in a timely manner, this process occurs to continue producing ATP until oxygen is available again; glucose is broken down; there are two types of fermentation

  Lactic Acid Fermentation (muscle cells) $\quad \text{Glucose} \Rightarrow \text{Lactic Acid} + 2ATP$

  Alcoholic Fermentation (plant cells) $\quad \text{Glucose} \Rightarrow CO_2 + \text{Alcohol} + 2ATP$

AEROBIC AND ANAEROBIC RESPIRATION:

Aerobic Respiration –

- requires the presence of oxygen
- release of energy from the breakdown of glucose (or another organic compound) in the presence of oxygen
- energy released is used to make ATP, which provides energy for bodily processes
- takes place in almost all living things

Anaerobic Respiration –

- occurs in the absence of oxygen
- breakdown of food substances in the absence of oxygen with the production of a small amount of energy
- produces less energy than aerobic respiration
- often called fermentation
- seen as an adaptation for organisms that live in environments that lack oxygen

COMPARISON OF CELLULAR RESPIRATION, PHOTOSYNTHESIS AND CHEMOSYNTHESIS

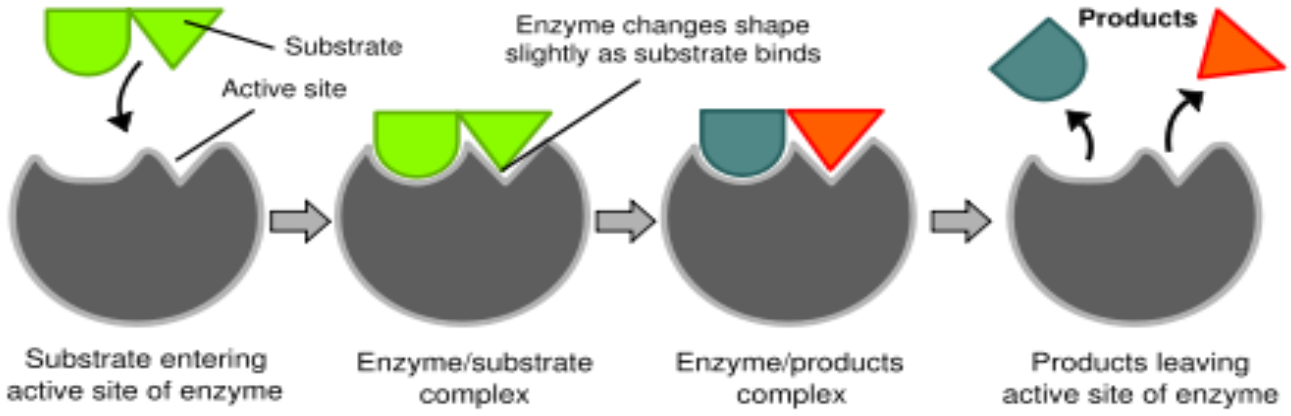
CELLULAR RESPIRATION	***PHOTOSYNTHESIS***	***CHEMOSYNTHESIS***
Food Broken Down	Food Synthesized	Food Synthesized
Energy from Glucose Released	Energy from Sun stored in Glucose	Energy from Methane or Inorganic Material
Carbon Dioxide given off	Carbon Dioxide taken in	(ex: H gas or Hydrogen sulfide)
Oxygen taken in	Oxygen given off	Organisms often called chemotrophs
Produces Carbon Dioxide and Water	Produces Sugars (Glucose) from PGAL	Organisms called extremophiles
Does not require Light	Requires Light	Live in environments without oxygen
Occurs in ALL Living Cells	Occurs only in presence of Chlorophyll	Anaerobic Bacteria
Organisms often called Heterotrophs	Organisms called Autotrophs	Habitats: hydrothermal vents

ENZYMES:

Enzymes are special proteins that regulate nearly every biochemical reaction in the cell. Different reactions require different enzymes.

Enzymes function to:

- Provide energy to cells
- Build new cells
- Aid in digestion
- Break down complex molecules ("substrate" = reactant)
- Catalysts (speed up chemical reactions without being used up or altered)
- Factors that affect enzymes: pH, temperature, and quantity

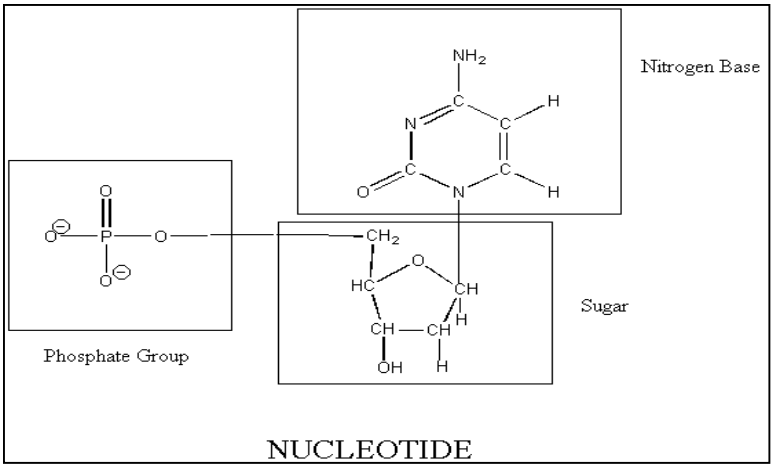


Develop an understanding of the continuity of life and the changes of organisms over time.

- Molecular Basis of Heredity, DNA Replication, Protein Synthesis (Transcription, Translation), Gene Regulation
- Characteristics of Sexual and Asexual Reproduction
- Patterns of Inheritance, Dominant / Recessive / Intermediate Traits, Multiple Alleles, Polygenic Inheritance, Sex-Linked Traits, Independent Assortment, Test Cross, Pedigrees, Punnett Squares
- Impact of Advances in Genomics on Individuals and Society, Human Genome Project, Applications of Biotechnology
- Development of Theory of Evolution by Natural Selection, Origin and History of Life, Fossil and Biochemical Evidence, Mechanisms of Evolution, Applications (Pesticides and Antibiotic Resistance)

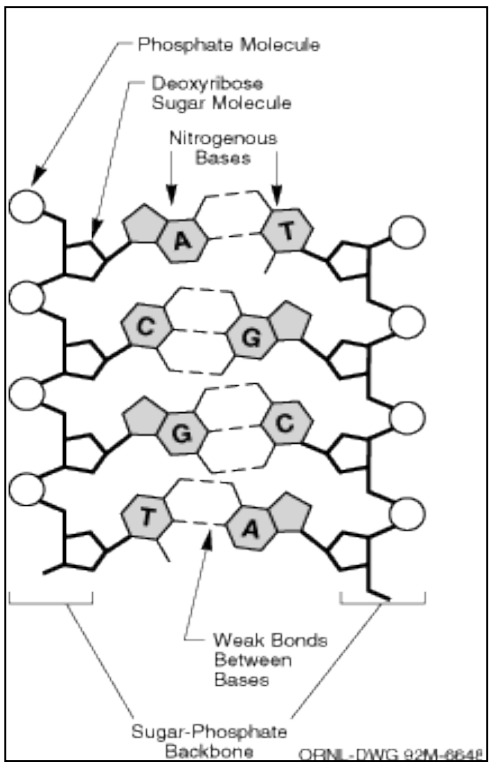
DNA & RNA:

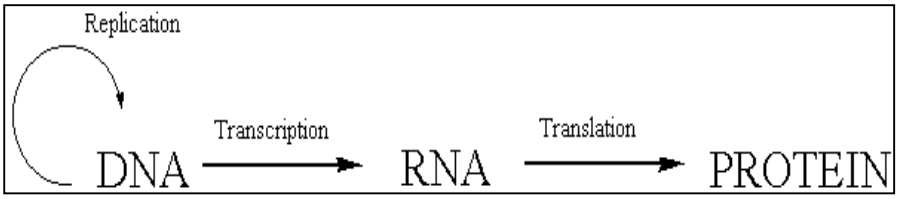
- Nucleic acids composed of nucleotides
- Nucleotides composed of:
  - Phosphate group
  - Sugar
  - Nitrogenous base

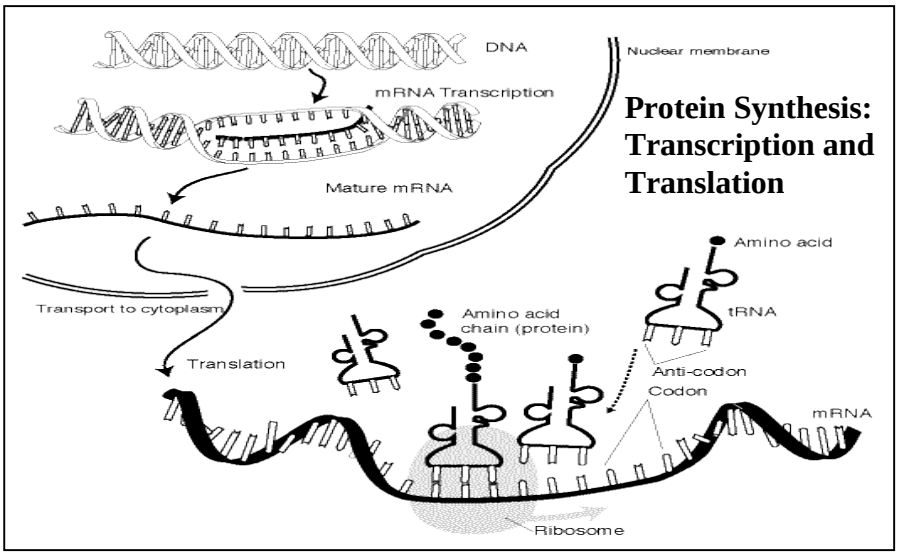


COMPARISON OF DNA AND RNA	
DNA	***RNA***
Deoxyribonucleic acid Double-stranded, twisted helix Never leaves the nucleus Nitrogenous bases: adenine, thymine, guanine, cytosine (Guanine w/Cytosine, Adenine w/Thymine) (Purines opposite the Pyrimidines) (held together by weak hydrogen bonds) Sugar: deoxyribose Controls production of all proteins ***DNA Replication:*** (DNA unravels and each strand makes a new exact copy so that when mitosis takes place, each cell has the exact copy of DNA) DNA coiled into chromosomes in nucleus Tiny sections of DNA are called genes Sequence of bases determines sequence of amino acids in proteins	Ribonucleic acid Single-stranded Leaves the nucleus Nitrogenous bases: adenine, uracil, guanine, cytosine (Guanine w/Cytosine, Adenine w/Uracil) Sugar: ribose Three major types of RNA (Ribosomal – rRNA; Messenger – mRNA; Transfer – tRNA) Leaves the nucleus to carry out functions in cytoplasm ***Transcription:*** (mRNA is made from one strand of DNA, carries message to ribosomes) ***Translation:*** (mRNA translated into a protein at the ribosomes; tRNA transfers amino acids from cytoplasm to ribosomes)

DNA







Asexual and Sexual Reproduction:

Asexual Reproduction – a single parent produces one or more identical offspring by dividing into two cells - mitosis (protists, arthropods, bacteria by binary fission, fungi, plants); produces large numbers of offspring

- offspring are clones of parents (genetically identical)
- common in unicellular organisms, good for stable environments
- budding, binary fission, conjugation
- quick process (low energy requirement) – produces high number of offspring

Sexual Reproduction – pattern of reproduction that involves the production and fusion of haploid sex cells; haploid sperm from father fertilizes haploid egg from mother to make a diploid zygote that develops into a multicellular organism through mitosis

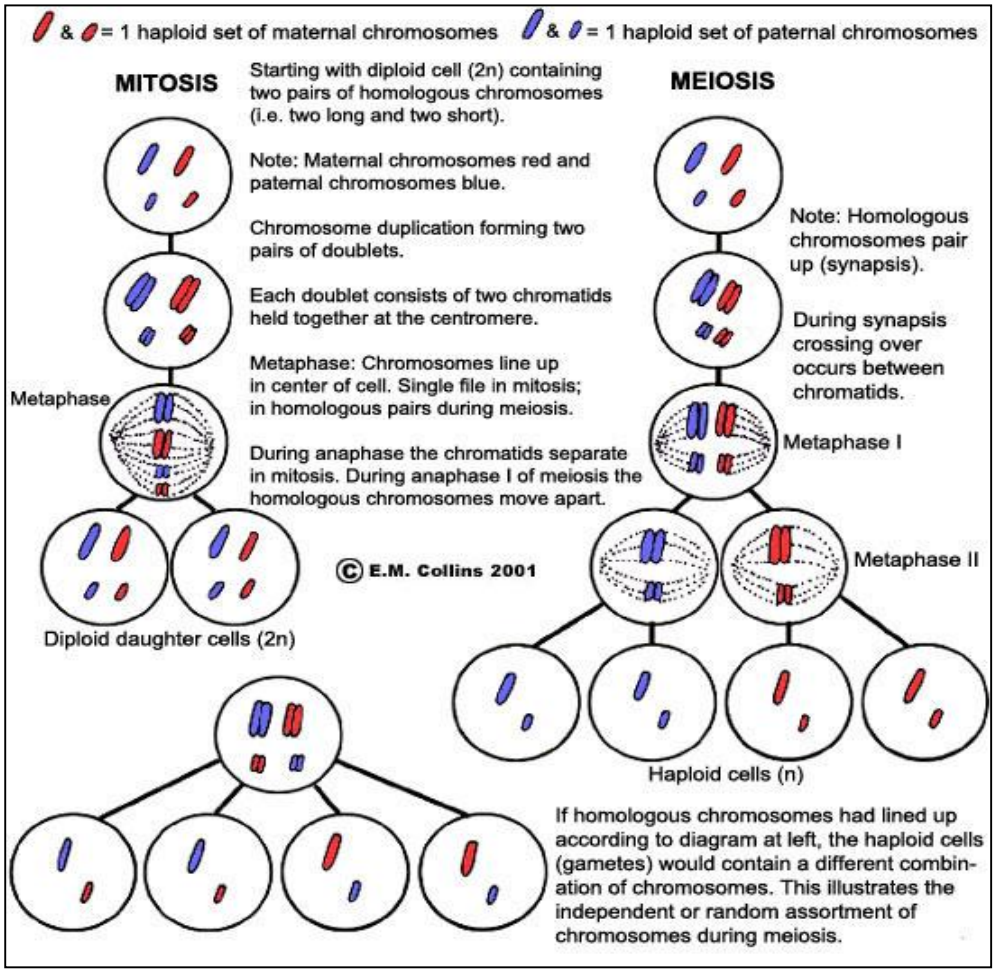
- results in genetic variation (diversity)
- common in multicellular organisms (external or internal fertilization); good for changing environments
- slow process (high energy requirement) – produces low number of offspring
- meiosis = formation of sex cells (gametes)

CELL DIVISION:

- process of copying and dividing the entire cell
- the cell grows, prepares for division, and then divides to form new daughter cells
- allows unicellular organisms to duplicate in a process called ***asexual reproduction***
- allows multicellular organisms to grow, develop from a single cell into a multicellular organism, make other cells to repair and replace worn out cells
- three types: binary fission (bacteria and fungi), mitosis, and meiosis

COMPARISON OF MITOSIS AND MEIOSIS

MITOSIS	***MEIOSIS***
Cell cycle consists of interphase, mitosis, and cytokinesis ***Interphase*** – longest part of cell cycle Growth, metabolism, and preparation for division occurs Duplicates chromosomes (DNA Replication) ***Mitosis*** – division of nucleus of the cell - ***Prophase -*** duplicated chromosomes and spindle fibers appear - ***Metaphase*** – duplicated chromosomes line up randomly in center of cell between spindle fibers - ***Anaphase*** – duplicated chromosomes pulled to opposite ends of cell - ***Telophase*** – nuclear membrane forms around chromosomes at each end of cell; spindle fibers disappear; chromosomes disperse ***Cytokinesis*** – division of plasma membrane; two daughter cells result with exact genetic information *(in plant cells a "cell plate" forms along the center of the cell and cuts the cell in half; cell plate forms new cell walls once the plasma membrane divides)* ***RESULTS:*** Two daughter cells (body cells) Same number of chromosomes as original cell (humans = 46) Cells are diploid (human diploid # = 46 or 23 homologous pairs)	Consists of two cell divisions, but only one chromosome replication (sometimes called reduction division) Each cell division consists of prophase, metaphase, anaphase, and telophase Occurs only in sex cells – to produce more sex cells (gametes) ***First Meiosis Division*** Produces cells containing ½ # of double stranded chromosomes ***Second Meiosis Division*** Results in formation of four cells Each cell w/ ½ # of single-stranded chromosomes (haploid cells) --- ***Sperm*** Each primary sperm cell develops into four haploid cells of equal size. As cells mature, the cells lose most of their cytoplasm and develop a long whip-like tail for movement. ***Egg*** Each primary egg cell develops into one large haploid cell and three smaller haploid cells called polar bodies. The first meiosis division produces one large cell and one polar body. The second meiosis causes the large cell to produce one egg cell and a polar body; the original smaller polar body divides into two polar bodies. The polar bodies eventually disintegrate. The final egg cell is provided with the larger supply of stored nutrients ***RESULTS:*** Four daughter cells (sex cells) ½ # of chromosomes (haploid) with genetic variation (n = 23) Sex cells combine during ***sexual reproduction*** to produce a diploid individual



GENETICS:

- branch of biology that deals with heredity
- Gregor Mendel experimented with sweet pea plants in 1800s
- ***Trait*** – characteristic an individual receives from its parents
- ***Gene*** – carries instructions responsible for expression of traits; a pair of inherited genes controls a trait; one member of the pair comes from each parent; often called ***alleles***
- ***Homozygous*** – two alleles of a pair are identical (BB or bb)
- ***Heterozygous*** – two alleles of a pair are different (Bb); often called "hybrid"
- ***Dominant*** – controlling allele; designated with a capital letter
- ***Recessive*** – hidden allele; designated with lower-case letters
- ***Genotype*** – genetic makeup of an organism (represented by the letters)
- ***Phenotype*** – physical appearance of an organism (description of the letters)
- ***Monohybrid*** – cross involving one trait
- ***Dihybrid*** – cross involving two traits
- ***Punnett Square*** – graphic organizer used to show the probable results of a genetic cross
- ***Pedigree*** – graphic organizer to map genetic traits between generations
- ***Karyotype*** – chart of metaphase chromosome pairs to study chromosome number / diseases
- ***Test Cross*** – mating of an individual of unknown genotype with an individual of known genotype; can help to determine the unknown genotype of the parent

MENDELS LAWS OF HEREDITY:

1. ***Law of Dominance***
- the dominant allele will prevent the recessive allele from being expressed
- recessive allele will appear when it is paired with another recessive allele in the offspring

2. ***Law of Segregation***
- gene pairs separate when gametes (sex cells) are formed
- each gamete has only one allele of each gene pair

3. ***Law of Independent Assortment***
- different pairs of genes <u>*separate independently*</u> of each other when gametes are formed (Anaphase II in Meiosis)

MUTATIONS:
- change in genetic code
- passed from one cell to new cells
- transmitted to offspring if occurs in sex cells
- most have no effect
- ***Gene Mutation*** – change in a single gene
- ***Chromosome Mutation*** – change in many genes
- Can be spontaneous or caused by environmental ***mutagens*** (radiation, chemicals, etc.)

PATTERNS OF INHERITANCE:

Sex Chromosomes
- 23rd pair of chromosomes; Males = XY; Females = XX

Sex-Linked Traits
- traits associated with particular sexes
- X-Linked Traits inherited on X chromosome from mother (ex: colorblindness, baldness, hemophilia)

Linked Traits
- genes are linked on chromosomes; genes on same chromosome are inherited together; ex: red hair and freckles
- one trait controlled by many genes (ex: hair color, eye color, skin pigment)

Multiple Alleles
- presence of more than two alleles for a trait (ex: eye color)

Polygenic Inheritance
- one trait controlled by many genes (ex: hair color, skin color); genes may be on the same or different chromosomes

Codominance
- phenotypes of both homozygous parents are produced in heterozygous offspring so that both alleles are equally expressed (ex: black chicken + white chicken = checkered chickens), (ex: sickle cell anemia)

Incomplete Dominance
- phenotype of a heterozygote is intermediate between the two homozygous parents; neither allele is dominant, but combine to display a new trait (ex: red flower + white flower = pink flower)

Dominance / Recessive ness
- observed trait is controlled by a homozygous genotype
- ex: dominance disease – Huntington's; ex: recessive disease – Cystic Fibrosis and Tay Sach's

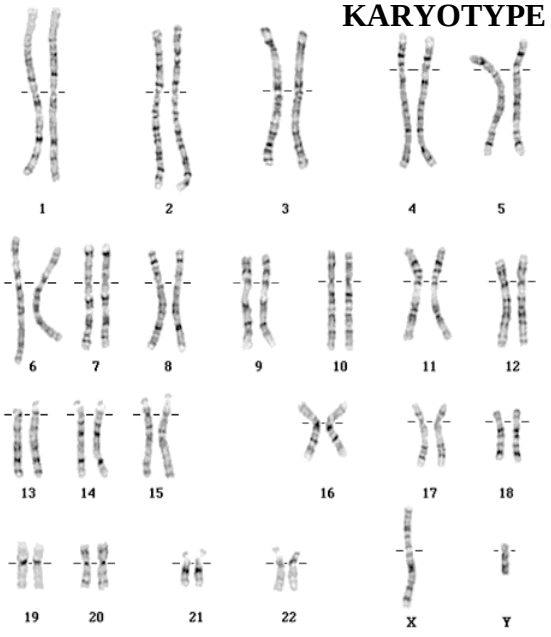
SOURCES OF VARIATION:

Crossing Over
- genes from one chromosome are exchanged with genes from another chromosome
- occurs regularly during meiosis and leads to greater genetic variation
- many different phenotypes are a result of the random assortment of genes that occurs during sexual reproduction

Nondisjunction
- during meiosis, homologous pairs of chromosomes don't separate
- results in half the sex cells having an extra chromosome and the other half having one less chromosome
- if fertilization occurs with an abnormal sex cell, zygote formed will have either one extra (***trisomy***) or one less (***monosomy***) than the diploid number (ex: Down's Syndrome caused by extra 21st chromosome)

Genetic Variation
- influenced by crossing over, mutations, genetic engineering, random assortment of genes, natural selection
- genetic variation controlled by sexual reproduction (does not occur in asexual reproduction)
- gene regulation vs. gene expression – the expression of genes is regulated by turning genes on / off or amount of action
- environment can influence magnitude of gene expression (ex: improper nutrition can prevent proper bone growth)

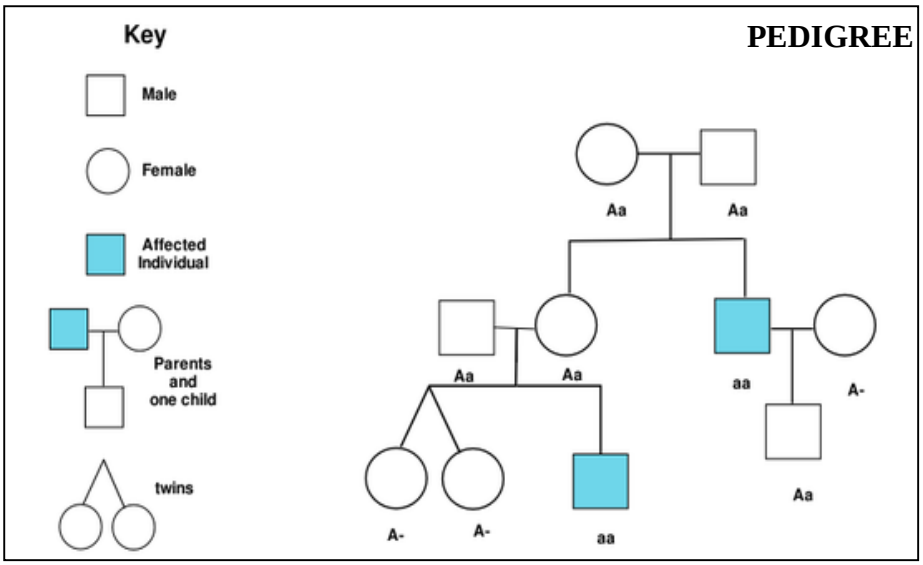
KARYOTYPE

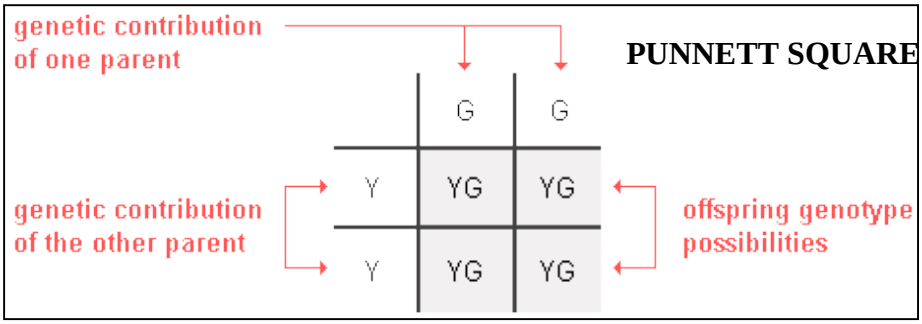


LAWS OF PROBABILITY TO PREDICT INHERITANCE:
- Punnett Squares provide a shorthand way of finding expected proportions of possible genotypes and phenotypes in the offspring of a cross.
- Fertilization must occur at random
- Results are expected, not actual; results based on chance
- Results predicted by probability are more likely to be seen when there is a large number of offspring
- a ***monohybrid*** cross contains four boxes; a cross between two heterozygous individuals would reveal a 1:2:1 genotype ration and a 3:1 phenotype ratio in the offspring; the probability that the offspring will show a dominant phenotype is ¾, or 75%
- a ***dihybrid*** cross contains sixteen boxes; a dihybrid cross reveals two traits for both parents; a cross between two heterozygous individuals would reveal a 9:3:3:1 phenotype ratio in the offspring

KARYOTYPE: to identify gender or chromosomal abnormalities

GENETIC ENGINEERING (GENOMICS):
- sometimes called biotechnology
- process of transferring a gene (DNA) from one organism to another
- Organisms with transferred gene now produce "recombined" genetic code (called "recombinant DNA")
- Ex: insulin produced through bacteria
- Ex: oil-eating bacteria
- Has application in medicine, environment, industry, agriculture, selective breeding
- Human Genome Project
- DNA Fingerprinting





EVIDENCE OF EVOLUTION:

- **Fossils** – may appear in rocks, ice, amber; when fossils are arranged in order of their age, the fossil record provides a series of changes that occurred over time; comparison of anatomical characteristics reveals shared ancestry
- **DNA** - when gene or protein sequences from organisms are arranged, species thought to be closely related based on fossil evidence are seen to be more similar than species thought to be distantly related
- **Embryology** – embryos of different vertebrates look alike in their early stages, giving the superficial appearance of a relationship

NATURAL SELECTION and THEORY OF EVOLUTION:

- proposed by Charles Darwin
- process by which organisms that are best suited to environment survive and pass genetic traits on to offspring
- has no effect on increased production of offspring, fossil formation, or changes in habitat
- ***adaptation*** – organisms with the most suited traits will survive
- ***evolution*** – change in a species over time (not a single individual, but the group)
- ***microevolution*** – evolution that occurs within the species level; results from genetic variation and natural selection within a population
  - antibiotic resistance
  - pesticide resistance
- ***macroevolution*** – evolution that occurs between different species; focuses on how groups of organisms change
  - convergent evolution – two species evolve similarly
  - divergent evolution – a group of species evolve differently
  - adaptive radiation – a group of species adapt separately to environments
  - speciation – formation of a new species
  - geographic isolation – physical barrier divides a population, results in individuals that cannot mate, leads to a new species
  - reproductive isolation – genetic mutation or behavioral change prevent mating

Develop an understanding of the unity and diversity of life.

- Classification of Organisms according to Evolutionary Relationships, Historical Development and Changing Nature of Classification Systems, Eukaryotic vs. Prokaryotic Organics, Eukaryotic Kingdoms, Dichotomous Keys
- Processes by which Organisms or Representative Groups accomplish Essential Life Functions
- Adaptations affecting Survival and Reproduction, Structural Adaptations in Plants and Animals, Disease-Causing Viruses and Microorganisms, Co-Evolution
- Interactive Role of Internal / External Factors in Health and Disease, Genetics, Immune Response, Nutrition, Parasites, Toxins
- Patterns of Animal Behavior as Adaptations to the Environment, Innate / Learned Behavior

CLASSIFICATION:

- process in understanding how organisms are related and how they are different
- ***taxonomy*** – branch of biology that studies grouping and naming of organisms
- history of classification systems
  - 4th Century B.C., Aristotle proposed two groups (plants and animals) and used common names for identification, based on "blood" and "bloodless"
  - early 1700s, Carolus Linnaeus developed a system based on physical characteristics
    - two kingdoms (plants and animals)
    - developed "genus" and "species"
    - designed system of naming called ***binomial nomenclature*** ("two names") which gave each organism two names, a genus and a species, Genus always capitalized, both should be underlined or italicized
- ***Six kingdoms: Archaebacteria, Eubacteria), Protista, Fungi, Plantae, and Animalia***
- a ***dichotomous key*** is a tool used to identify organisms by using pairs of contrasting characteristics
- basis of current classification: phylogeny, DNA / biochemical analysis, embryology, morphology, Phylogenetic trees

LEVELS OF CLASSIFICATION:

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species

CLASSIFICATION OF HUMANS:

Kingdom *Animalia* (multicellular organisms that eat food)
Phylum *Chordata* (dorsal hollow nerve cord, notochord, pharyngeal slits)
Class *Mammalia* (hair, mammary glands, endothermy, four-chambered heart)
Order *Primates* (nails, clavicle, orbits encircled with bone, enlarged cerebrum, opposable digits)
Family *Homidae* (bipedal – walk erect on two feet, advanced tool use)
Genus *Homo* ("human" like)
Species *Homo sapiens*

COMPARISON OF EUKARYOTE TO PROKARYOTE:

Prokaryote – has nuclear material in the center of the cell, but is not enclosed by a nuclear membrane; no membrane bound organelles; examples: bacteria and blue-green algae

Eukaryote – contain a clearly defined nucleus enclosed by a nuclear membrane and membrane bound organelles; examples: plants, animals, fungi, and protists

COMPARISON OF KINGDOM CHARACTERISTICS

MONERA	PROTISTA	FUNGI	PLANTAE	ANIMALIA
Bacteria Prokaryote Unicellular, colonial Aerobic / anaerobic Decomposer Heterotrophic Photosynthetic (some) Chemosynthetic (some) Pathogenic Medicinal Classified by shape Binary fission Vaccines, antibiotics Ex: *streptococcus*	Protists Eukaryote Unicellular Multicellular Aerobic Pathogenic / parasitic Animal-like (protozoa) Plant-like (algae) Medicinal, food source Mobile Ex: *amoeba*	Eukaryote Multicelluar Aerobic Decomposer Lack chlorophyll Pathogenic Saprophytic / parasitic Medicinal, food source Heterotrophic Sexual / asexual Alternation of generations Often symbiotic with algae Ex: *mushroom*	Eukaryote Multicellular Aerobic Producer Photosynthesis Cell wall (cellulose) Vascular system, seeds Poisonous Medicinal, food source Alternation of generations Roots, stems, leaves Pollination(fertilization) Germination Ex: *oak*	Eukaryote Multicellular Aerobic Consumer Cellular respiration Invertebrates Vertebrates Symmetry Ex: *Homo sapiens*

Note: Current classification systems reveal six kingdoms, where Monerans are divided into ***Archaebacteria (ancient bacteria, anaerobic nature)*** and ***Eubacteria (true bacteria, aerobic nature)***.

VIRUSES:

Note: ***Viruses*** are not considered living organisms!

- composed of a nucleic acid surrounded by a protein coat
- use living cells to replicate viral nucleic acid
- infects a living cell when the virus injects its nucleic acid into the host cell; the viral nucleic acid replicates and makes more viruses
- two processes to infect host cells: the lytic cycle and the lysogenic cycle
- **lytic:** virus attached to host cell injects its nucleic acid into host; nucleic acid is immediately replicated; host bursts; releases virus
- **lysogenic:** host infected but does not immediately die; viral DNA is replicated along with host DNA; virus becomes dormant; spontaneously enters lytic cycle and cell bursts – may be years later
- viruses can infect animals, plants, and bacteria
- viruses do not respond to drug treatment
- immunity must be acquired naturally or from vaccinations

DICHOTOMOUS KEYS:

- device used to aid in identifying a biological specimen
- offers two alternatives at each juncture, each choice determining the next step; breaks down subgroups by their evolutionary relationships
- can be used for field identification of species, as found in field guides by focusing on practical characteristics

Example:

1. Leaves usually without teeth or lobes: 2
1. Leaves usually with teeth or lobes: 5
2. Leaves evergreen: 3
2. Leaves not evergreen: 4
3. Mature plant a large tree — Southern live oak *Quercus virginiana*
3. Mature plant a small shrub — Dwarf live oak *Quercus minima*
4. Leaf narrow, about 4-6 times as long as broad — Willow oak *Quercus phellos*
4. Leaf broad, about 2-3 times as long as broad — Shingle oak *Quercus imbricaria*
5. Lobes or teeth bristle-tipped: 6
5. Lobes or teeth rounded or blunt-pointed, no bristles: 7
6. Leaves mostly with 3 lobes — Blackjack oak *Quercus marilandica*
6. Leaves mostly with 7-9 lobes — Northern red oak *Quercus rubra*
7. Leaves with 5-9 deep lobes — White oak *Quercus alba*
7. Leaves with 21-27 shallow lobes — Swamp chestnut oak *Quercus prinus*

Source: Wikipedia (http://en.wikipedia.org/wiki/Dichotomous_key)

PLANTS	INVERTEBRATES	VERTEBRATES
Spore-Producing Plants	Three types of symmetry	Have a coelom (true body cavity)
Nonvascular, produce spores	*No symmetry (disorganized)*	Skeletal systems (endoskeleton)
Remain small– absorb water by osmosis	*Radial symmetry* (around a central point)	Strong, flexible backbone (support)
Sperm swim to fertilize eggs	*Bilateral symmetry (equal on both sides)*	Bilateral symmetry
Live in moist environments	Specialized bodily functions	Aquatic or terrestrial environments
Reproduce sexually	No backbone, usually outer covering	Organized systems
Alternation of Generations	(exoskeleton)	***Jawless fishes***
(You see the gametophyte generation)	May be hydrostatic (water-based, aquatic)	Lampreys
Mosses and liverworts	***Sponges (Porifera)***	***Cartilaginous fishes***
Vascular Plants	No symmetry	Sharks, cartilage
Two types of vascular tissue	***Cnidarians (Coelenterata)***	***Bony fishes***
Xylem – transports water and minerals (UP)	Jellyfish, hydrostatic, radial symmetry	Bass, trout
Phloem – transports sugars (DOWN)	Specialized stinging cells in tentacles	Scales, paired fins, gills, bone
Produce spores	***Flatworms (Platyhelminthes)***	External fertilization
Club mosses, horsetails, ferns	Leeches, bilateral symmetry	***Amphibians***
Require water for reproduction	Suckers for removing fluids from host	Salamanders, frogs
Alternation of Generations	***Roundworms (Nematoda)***	Moist skin and lack scales
(you see the sporophyte generation)	Parasites, radial symmetry	Have gills as young, lungs and limbs as adults
Seed Producing Vascular Plants	***Segmented worms***	External fertilization
Vascular, Produce seeds	earthworms	***Reptiles***
Seed = embryo protected by a seed coat	decomposers	Snakes, turtles
Two groups based on reproduction	***Mollusks (Mollusca)***	Dry, scaly skin
Gymnosperms – cone-bearing	Clams, oysters (bivalves)	Internal fertilization
Angiosperms – flowering	Hard outer shell (calcium carbonate)	Terrestrial eggs (leathery shells)
- monocots (corn) and dicots (flowers)	Food source	Developed lungs, strong limbs
Roots – anchor, absorb water, store food	***Arthropods (Arthropoda)***	***Birds***
Stems – support, transport	Crabs, insects (segmented body)	Hawks, eagles, robin
Leaves – photosynthesis, produces food	Pollinators, bilateral symmetry	Feathers, hollow bones, strong muscles
Adaptations – seed, pollen, fruit, flowers	***Echinoderms (Echinodermata)***	Efficient heart and lungs for flying
Pollination – fertilization, germination	starfish	Internal fertilization (terrestrial amniotic egg)
	radial symmetry	***Mammals***
		Humans, monkeys, whales
		Hair or fur
		Internal fertilization (internal development)

REPRESENTATIVE GROUPS AND ESSENTIAL LIFE FUNCTIONS								
	Unicellular Protists	Annelid Worms	Insects	Amphibians	Mammals	Nonvascular Plants	Angiosperms	Gymnosperms
Transport	Diffusion	Closed Circulatory System	Open Circulatory System	Closed Circulatory 3 Chambers	Closed Circulatory 4 Chambers	NO Xylem NO Phloem	Xylem and Phloem Transpiration, Conduction, and Absorption	
Excretion	Pinocytosis Phagocytosis Diffusion	Coelom with Septa	Malpighian Tubes	Cloaca Cloaca Vent	Kidneys Bladder Anus	Transpiration (water) Photosynthesis (carbon dioxide)		
Respiration	Aerobic Mitochondria Photosynthesis	Skin Blood Vessels	Tracheal Tubes	Gills Lungs Moist Skin	Lungs	Cellular Respiration in Mitochondria Release Oxygen, Burn Glucose		
Regulation	Flagella, Cilia Pseudopodia Eyespot	Nerve Cord Lateral Nerves Vascular System	Brain, Ventral Nerve Cord	Ectotherms	Endotherm Brain Neocortex	NO Roots NO Stems NO Leaves	Roots, Stems and Leaves Tracheids and Sieve Tube Members	
Nutrition Filter Feeders>	Internal Digestion (Pinocytosis)	Filter Feeders Scavengers Deposit Feeders	CoEvolution with Plants for Pollination	Carnivores Attached Tongue	Herbivores Carnivores	Water and Sugars (Photosynthesis) Nitrogen Sunlight		
Synthesis	Form Cysts Starch Spores	Regeneration	Honey, Wax, Silk, Lacquer, etc.	Glandular Secretions (Poison)	Sweat Milk	Glucose	Glucose Seeds Flowers	Glucose Seeds Cones
Reproduction	Sexual Asexual	Asexual (fission) Sexual (hermaphrodite)	Sexual Ovoviviparous Viviparous	Sexual Direct Development	Sexual	Sexual Asexual Alternation of Generations (AoG)		

MAJOR SYSTEMS AND ORGANS		
SYSTEM	**FUNCTION**	**BASIC ORGANS, AND STRUCTURAL PARTS**
Circulatory	Transports nutrients, fluids, gases	Heart, veins, arteries
Digestive	Breaks down food into essential nutrients	Mouth, esophagus, stomach, intestines
Endocrine	Controls body functions through hormones	Glands which secrete hormones
Excretory	Removes cellular wastes from the blood	Bladder, kidneys, urethra
Immune	Protects the body against invading organisms	White blood cells
Integumentary	Protects the body by forming the body's outer layer	Skin, hair, nails
Muscular	Moves the body with the help of the skeletal system	Muscles
Skeletal	Supports the body internally	Bones, cartilage, ligaments, tendons
Nervous	Coordinates sensory input with motor output	Brain, spinal cord, sense organs
Reproductive	Provides a means of producing offspring	Testes (male), ovaries and uterus (female)
Respiratory	Controls the exchange of gases	Nose, pharynx, larynx, trachea, bronchi, lungs

Growth and Development	Spores (AoG) Water Bases Habitat	True Segmentation Replication	Eggs Metamorphosis	Eggs in Jelly Tadpole Stage Metamorphosis	Placenta Eggs (few)	Water Based Habitat	Land Based Flowers	Land Based Cones

REPRODUCTION, GROWTH, DEVELOPMENT:

Reproduction – production of offspring by an organism; a characteristic of all living things (can be sexual or asexual); exists for the continuation of the species, not the individual

Growth – increase in the amount of living material and formation of new structures in an organism; a characteristic of all living things; ex: getting bigger, growing muscle, longer bones, etc.

Development – all the changes that take place during the life of an organism; a characteristic of all living things; ex: infancy, youth, puberty, adulthood, death

ANIMAL BEHAVIORAL ADAPTATIONS:
Behavior – animal's response to a stimulus
Innate behavior – instinct; influenced by genes
Ex: bird defending its nest
Learned behavior – changed by experience
Ex: training a pet to respond to a specific name
Social behavior – interactions between members of the same species
Ex: mating and caring for offspring
Territorial behavior – organisms defend an area to keep out other organisms (ex: animal marking trees)
Reflex – automatic, neuromuscular action (ex: knee jerk)
Taxis – response to a directional stimulus; organism is motile

ADAPTIVE RESPONSES:
- **Mimicry –** structural adaptation that allows one species to resemble another species; may provide protection from predators
- **Camouflage –** structural adaptation that enables species to blend with their surroundings; allows a species to avoid detection
- **Migration –** instinctive seasonal movements of animals from place to place
  - **Emigration –** movement of individuals from a population; leaving the

CIRCADIAN RHYTHMS AND RHYTHMIC BEHAVIOR:
- 24 hour cycle in plants, animals, fungi, and bacteria
- Biological rhythms can be daily, weekly, seasonal, annual
- Can be influenced by external factors such as sunlight and temperature
- Rhythmic behavior can be passed through genes to offspring
- Include behaviors such as sleeping, eating, brainwave activity, hormone production, cell regeneration, mating and sexual reproduction, hibernation, estivation, etc.

PLANT TROPISM:
Growth responses that result in curvature of plant organs towards or away from stimuli due to different rates of elongation
Geotropism – response to gravity; roots have positive geotropism; stems have negative geotropism
Phototropism – response to light (leaves)
Hydrotropism – response to water (roots)
Thigmotropism – response to touch (venus flytrap)
Chemotropism – response to chemicals

DISEASE CAUSING MICROORGANISMS:
- **Microorganisms** are living organisms, usually unicellular bacteria, than can only be seen with a microscope.
- Benefits of microorganisms: help us to digest food, encourage normal development of the immune system, fight off bad organisms
- **Microbes** (or **pathogens**) include viruses, bacteria, fungi, and parasites, which cause disease when our immune system can't fight them
- Microorganisms can be identified based on their size, shape, color, ability to form colonies, etc.
- Process of growing the organism is called a culture, and can be used to test sensitivity of organisms to various antibiotics which will help a doctor determine which drug to use in treating an infection.
- An infectious disease in humans occurs when balance is disturbed by: exposure to an organism, normal microorganisms in the body become pathogenic, or the human immune system does not act fast enough or strong enough.
- Most common areas on the body for microorganisms: skin, mouth, upper airway, intestine, genitals

DEFENSES AGAINST INFECTION:

First Line of Immune Defense:

- **Physical Barriers** - skin, mucous membranes (linings of the mouth, nose, eyelids), airways, stomach acid, pancreatic enzymes, bile, intestinal secretions, urinary secretions

Second Line of Immune Defense:

- **Blood** – increasing the number of certain types of white blood cells that engulf and destroy invading microorganisms
- **Inflammation** – release or substances from damaged tissue isolates area to attack and kill invaders and dispose of dead and damaged tissue, and to begin repair; blood supply increases which brings more white blood cells to swollen area
- **Fever** – body temperature increases to enhance defense ability (controlled by hypothalamus in brain); causes shivers, chills, body aches; normal body temperature is 98.6ºF, a fever is considered higher then 100ºF.

Third Line of Immune Defense:

- **Immune Response** – immune system responds by producing substances that attack invaders (ex: killer T cells, phagocytes) and the immune system produces antibodies that attach to and immobilize the invader to kill it; antibodies will "remember" the infectious organism so it will kill it upon next exposure; immune system is present all over the body and tightly bound to blood and lymph systems; tissues and cells that provide antibodies include red bone marrow, thymus, spleen, circulating lymphatic system, and white blood cells.
- There are two types of immunity:
- *Natural Immunity* – created by body's natural physical barriers or in the form of antibodies passed from mother to child
- *Acquired Immunity* – created by exposure to a specific microorganism, which is "remembered" by the body's immune system - *Immunization* – body's ability to fight off certain organisms is stimulated or enhanced

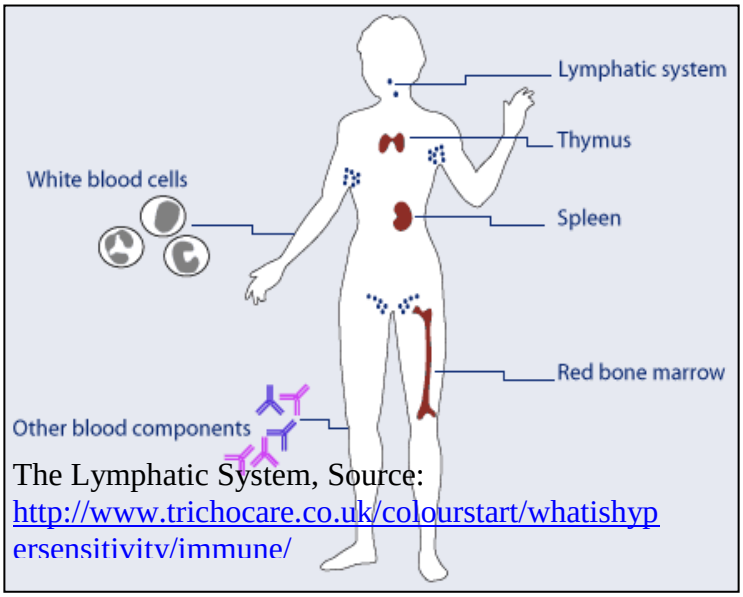
1. Active Immunization – contain either noninfectious fragments or whole pieces of bacteria or viruses that have been weakened so they will not cause infection but will instead cause the production of antibodies (vaccination)
2. Passive Immunization – antibodies against a specific infectious organism are given directly to the person (vaccine may not be available)

External Defenses:

- **Antibiotics** – organic substances synthesized by microorganisms or at a lab used to treat infectious diseases or to prevent them; each antibiotic is specific to a certain bacteria; can be administered by mouth, vein, or muscle
- **Hygiene** – keeping a clean environment that limits exposure to infected bodily fluids, decomposing material, or infected people will prevent the spread of infection

EXAMPLES OF INFECTIOUS ORGANISMS:

- **Bacteria** – microscopic, single celled
  - *Streptococcus pyogenes* (strep throat)
  - *Escherichia coli* (urinary tract or intestinal infection)
- **Viruses** – cannot reproduce on its own (invades a host cell)
  - *Varicella zoster* (chicken pox)
  - *Rhinovirus* (common cold)
- **Fungi** – yeasts, molds, mushrooms
  - *Candida albicans* (yeast infection)
  - *Tinea pedis* (athlete's foot)
- **Parasites** – organism such as a worm or single celled animal (**protozoan**) that survive by living inside another organism (host)
  - *Enterobius vermicularis* (pinworm)
  - *Plasmodium falciparum* (malaria)



The Lymphatic System, Source: http://www.trichocare.co.uk/colourstart/whatishypersensitivity/immune/

ANTIBIOTIC RESISTANCE:

- some bacteria are resistant to antibiotics because they have enzymes that can destroy the antibiotics or because of genetic mutation that allow them to grow despite the antibiotics
- increasing numbers of microorganisms have become resistant to antibiotics are violent and untreatable, now called "superbugs"
- overuse of antibiotics has led to the development of resistant bacteria

How can you prevent the spread of antibiotic resistance?

- avoid antibiotics unless they are clearly needed
- do not take antibiotics without the advice of a doctor
- take the full course of prescription
- do not save antibiotics for later
- do not demand antibiotics from the doctor

Develop an understanding of ecological relationships among organisms.

- Interrelationships among Organisms / Populations / Communities / Ecosystems, Techniques of Field Ecology, Abiotic / Biotic Factors, Carrying Capacity
- Flow of Energy and Cycling of Matter in the Ecosystem, Relationship of Carbon Cycle to Photosynthesis and Respiration, Trophic Levels, Direction and Efficiency of Energy Transfer
- Human Population and its Impact on Local Ecosystems and Global Environments, Historic and Potential Changes in Population, Factors associated with Population Change, Climate Change, Resource Use,

ENERGY FLOW IN AN ECOSYSTEM

SUN >>>>> GRASS >>>>> MICE >>>>> HAWK

Sunlight is the main energy source for living things. Energy flows through an ecosystem from the sun to organisms within the ecosystem in one direction. Two main groups of organisms in the ecosystem are the producers and consumers.

Producers – autotrophs, use sun's energy to make their own food, plants (grass)

Consumers – heterotrophs, cannot make their own food, eat other living things to get their energy (mice- primary consumers; and hawk- secondary consumer)

STRUCTURE OF AN ECOSYSTEM

Organism >>>>> Species >>>>> Population >>>>> Community >>>>> Ecosystem >>>>> Environment

Species – group of organisms that can interbreed

Population – units of single species

Community – groups of interacting populations

Ecosystem – groups of interacting communities

Habitat – place where an organism lives

Niche – organism's role within its habitat

Sustainable Practices / Stewardship

GROUPS OF ORGANISMS		
Consumer	**Energy Source**	**Example**
Herbivore	Eat plants	Deer
Carnivore	Eat other animals	Lion
Omnivore	Eat plants and animals	Human
Decomposer	Break down dead organisms	Bacteria & Fungi

SYMBIOTIC RELATIONSHIPS:

Symbiosis – permanent, close association between one or more organisms of different species

Mutualism – a symbiotic relationship in which both species benefit (ex: in subtropical regions, ants protect acacia trees by fighting invaders, acacia tree provides nectar to ants)

Commensalism – symbiotic relationship in which one species benefits and the other species is neither harmed nor benefited (ex: Spanish moss grows on and hangs from limbs of trees, but does not obtain any nutrients from tree, nor harm the tree)

Parasitism – symbiotic relationship in which one organism benefits at the expense of another, usually another species (ex: parasites such as bacteria, roundworms, tapeworms live in the intestines of organisms to obtain nutrients and reproduce, but cause disease in the organisms)

FOOD CHAIN:

- Path of energy from producer to consumer
- Each level is called a trophic level (trophic = energy)
- Approximately 10% energy is transferred to next level
- 90% used for personal metabolism and development

FOOD WEB:

- Interconnected food chains
- Shows all possible feeding relationships at each trophic level in a community

ECOLOGICAL PYRAMID:

- Representation of energy transfer
- Pyramid of Energy – each level represents energy available at that level, 90% decline
- Pyramid of Biomass – each level represents amount level above needs to consume
- Pyramid of Numbers – each level represents number of organisms consumed by level above it

SOME EXAMPLES OF ENVIRONMENTAL LIMITING FACTORS

Biotic (living)	**Abiotic (nonliving)**
Plants	Climate
Animals	Light
Bacteria	Soil
Prey	Water
Food Sources (Nutrients)	Shelter
	Pollution

SPECIES / POPULATION SURVIVAL:

- **Natural Selection –** mechanism for change in populations; occurs when organisms with favorable variations survive, reproduce, and pass their variations to the next generation; "survival of the fittest"
- **Adaptation (Behavioral or Physiological) –** evolution of a structure, behavior, or internal process that enables an organism to respond to environmental factors and live to produce offspring
- **Limiting Factors (Environmental) –** any biotic or abiotic factor that restricts the existence, numbers, reproduction, or distribution of organisms
- **Genetic Mutations –** any change or random error in a DNA sequence (one gene or many; somatic cells or gametes)
- **Biodiversity –** variety of life in an area; usually measured as the number of species that live in an area
- **Evolution (Macroevolution vs. Microevolution) –** gradual change in a species through adaptations over time
- **Endangered Species** – number of individuals in the species falls so low that extinction is possible
- **Extinction** – disappearance of a species when the last of its members die

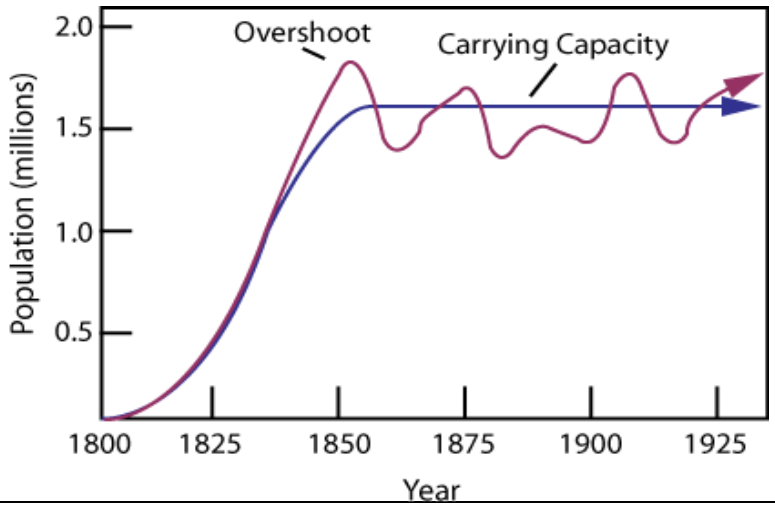
CHARACTERISTICS OF LIVING THINGS:

- require food for energy to carry out life processes
- use energy to maintain homeostasis
- respond to stimuli in the environment
- grow and develop
- reproduce similar offspring
- pass genetic information to their offspring
- composed of cells
- composed of organic based compounds

ALTERNATION OF GENERATIONS:

- type of life cycle found in some algae, fungi, and all plants where an organism alternates between a haploid (n) gametophyte generation and a diploid (2n) sporophyte generation

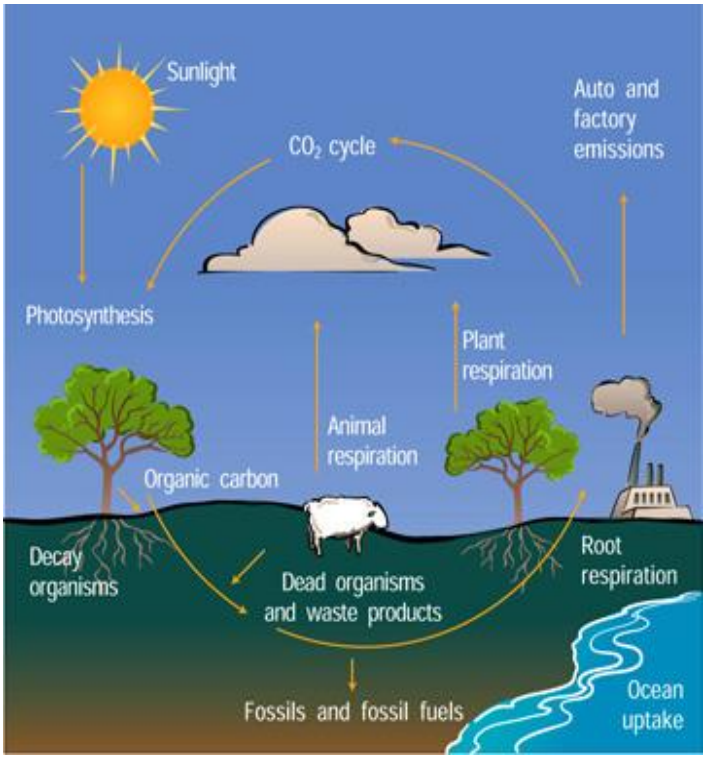
FLUCTUATIONS IN CARRYING CAPACITY

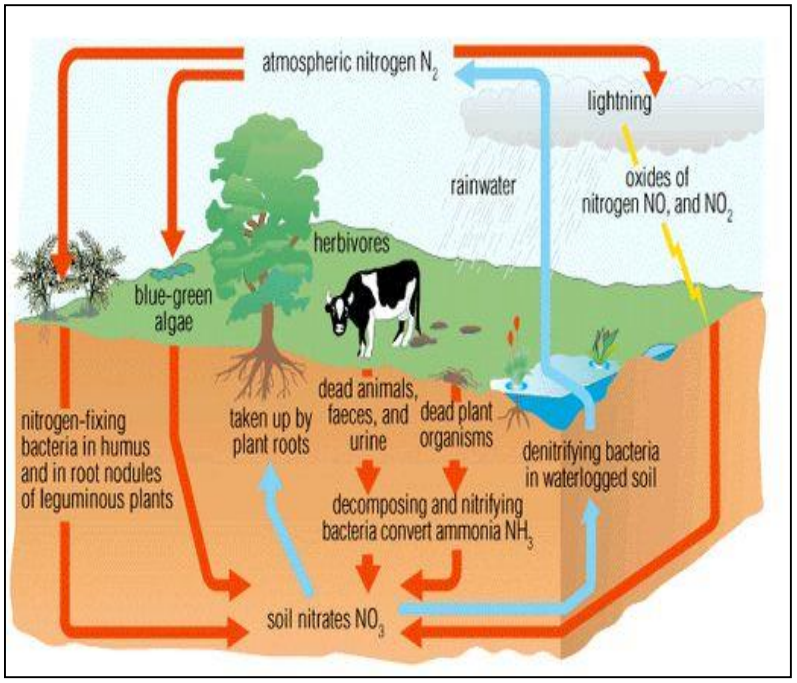


ECOLOGY FIELD STUDY:

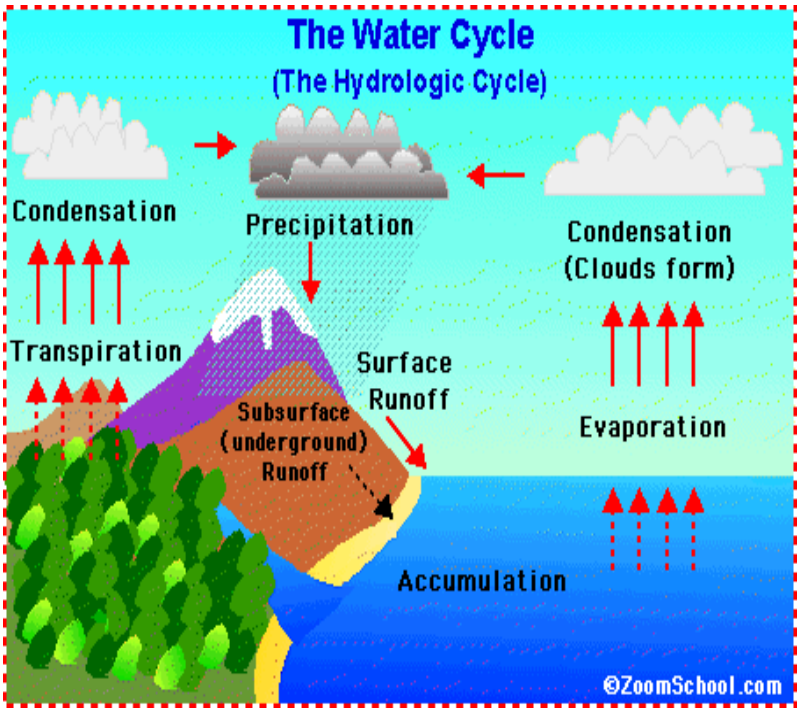
- using specific methods and procedures to study plants and animals in their natural setting, and to observe interrelationships of living and non-living factors in a specific habitat
- observations might include: temperature recordings, location, soil description, number and kinds of plants and animals, food source(s), rainfall amount, change in growth, interactions between organisms, identification of organisms into genus and species, temperature variations from morning to afternoon to night, light levels (at different times of day), sound levels (at different times of day), photographs, diagrams of levels (ground level, canopy level, etc.) and the animals and plants at each level, water sampling, quadrant studies, graphs of growth
- field study requires the collection of data and the analysis of data through graphs, charts, diagrams, etc.
- field study also requires the recording of all observations, data, etc. into a legitimate field notebook that would include personal interpretations, photographs, newspaper clippings, etc.

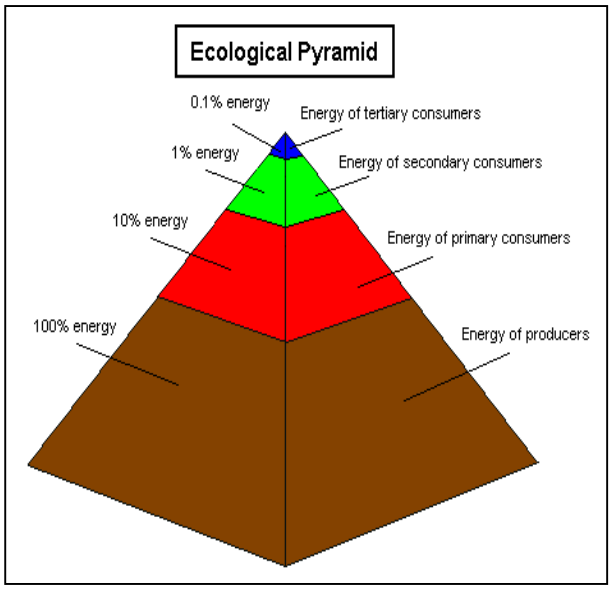
CYCLES:
(Matter cannot be created nor destroyed, but can be converted/recycled to other forms)
Water Cycle – water is recycled through evaporation, condensation, precipitation, runoff, groundwater, aquifers, respiration, transpiration, excretion, decomposition
Nitrogen Cycle – producers take in nitrogen compounds in soil and pass to consumers that consume the producers; decomposers (bacteria) break down nitrogen compounds and release nitrogen gas to air or usable nitrogen so the soil
Carbon Cycle – carbon is recycled through respiration, photosynthesis, fuel combustion, decomposition; carbon can be atmospheric or dissolved, or can be found in organic compounds within the body

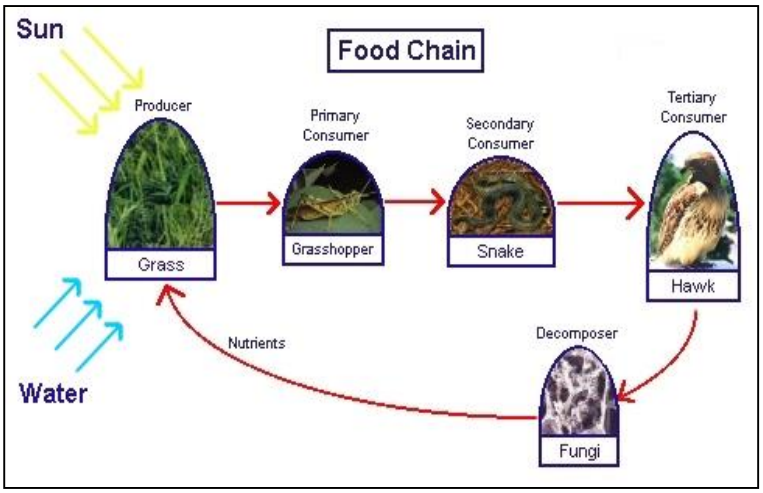


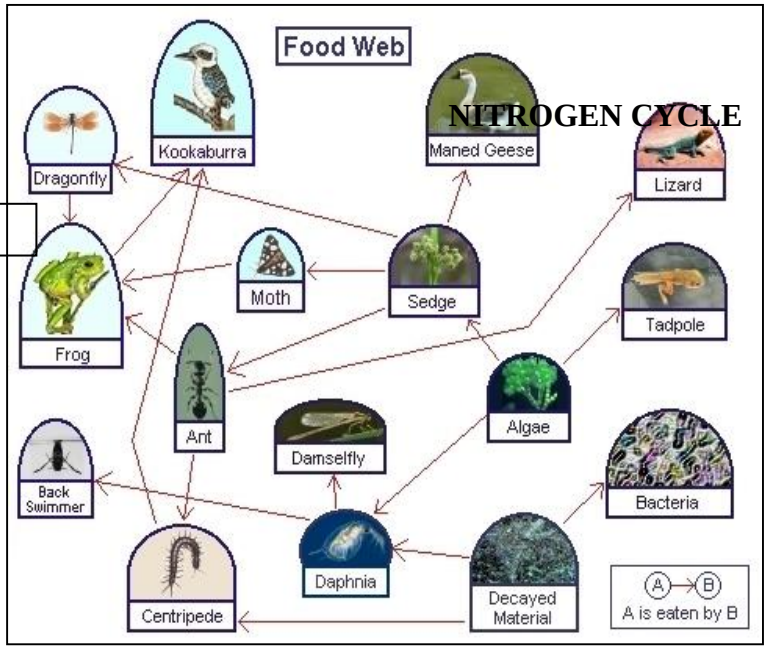


CARBON CYCLE



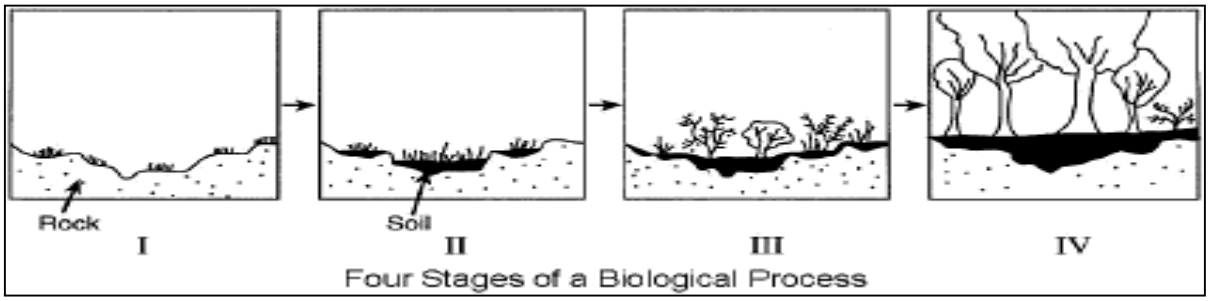






NITROGEN CYCLE

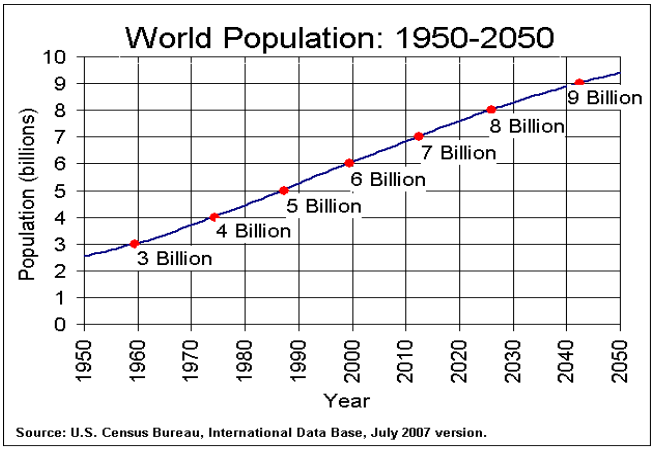
TYPES OF ECOSYSTEMS (BIOMES):
AQUATIC: based on flow, depth, temperature, chemistry
TERRESTRIAL: based on geography, rainfall, temperature
Tropical Rain Forest – significant diversity, warm, moist
Savanna – grassland with isolated trees, warm year-round, consistent rainfall, borders deserts
Desert – hot, dry, minimal rainfall, middle latitudes
Temperate Grassland – variety of grasses, cold winters, warm summers, seasonal rainfall, borders savannas
Temperate Forest – deciduous, seasonal growth and weather patterns
Taiga – coniferous, borders tundra
Tundra – cold, frozen
Marine – oceans, saltwater, large diversity
Freshwater – lakes, streams, lower diversity



SUCCESSION:
- orderly, natural changes, and species replacements that take place in communities of an ecosystem over time
Primary Succession – colonization of barren land by pioneer organisms (soil must be developed)
Secondary Succession – sequence of changes that take place after a community is disrupted by natural disasters or human actions (soil already present)

FACTORS THAT AFFECT POPULATION CHANGE:

- natural increase of a population depends on the number of births and deaths
- if births outnumber deaths, there will be an increase in population
- growth rate of a population measured in terms of birth rate (number of births per 1000 people per year) and death rate (number of deaths per 1000 people per year)
- fertility rates (number of babies), life expectancy, migration / immigration also contribute to population change
- study of population is called demography; a census is a measure of the population at a particular time



IMPACT OF HUMANS ON THE ENVIRONMENT:

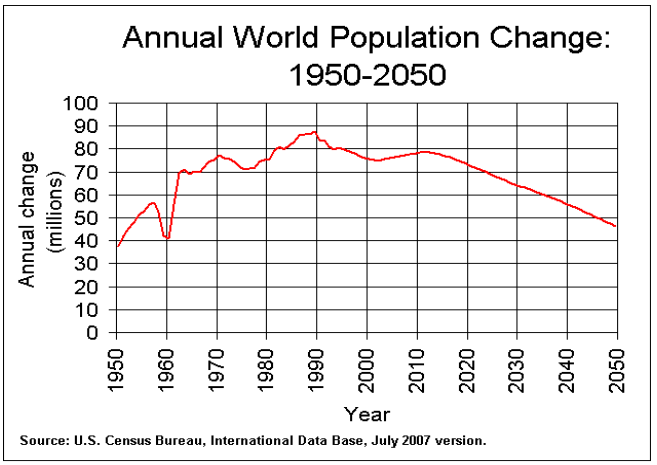
- caused extinction of species through hunting, fishing, agriculture, industry, urban development
- growing population = greater demands on environment
- affected quality and quantity of land, air, water resources
- Pollution = pollutants
- Air Pollution = smog, acid rain, dust, smoke, gases, fog, carbon dioxide
- Water Pollution = sewers, industry, farms, homes, chemical waste, fertilizer, dirty dish water
- Land Pollution = landfills, dumpsites, runoff, negligence, urban wastes

CONSERVATION EFFORTS:

- conserve energy resources
- protect and conserve material resources
- control pollution (recapture wastes, carpooling, solid waste neutralization)
- wildlife conservation protect animals from habitat loss, over-hunting, pollution
- reduce, reuse, recycle programs
- sanitation and waste disposal programs

CRITICAL ISSUES:

- Global Warming, Pesticides, Population Growth



FACTORS THAT AFFECT CLIMATE CHANGE:

- distance from the sea
- ocean currents
- Direction of prevailing winds
- relief (altitude / mountains)
- proximity to the equator
- El Nino phenomenon
- human population growth
- pollution
- industry

FACTORS THAT AFFECT RESOURCE USE AND SUSTAINABILITY:

- population count
- number of producers and consumers
- percapita consumption
- rate of industrial, urban, and infrastructure development
- wealth of country / municipality
- amount of precipitation
- renewable or nonrenewable status
- pollution / degradation of land
- industry, manufacturing, commercialism
- recycling programs
- conservation programs
- substitution programs
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