ORGANIC MOLECULES:

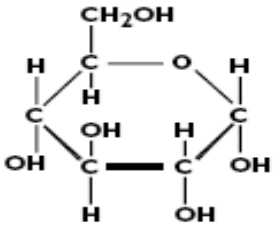
Organic compounds contain carbon and are found in all living things.

- ***Carbohydrates***
  - Simple sugars – glucose monomer
  - major source of energy(breaks down for ATP in cellular respiration)
  - made up of CHO, $C_6H_{12}O_6$
  - plants and animals use carbohydrates for maintaining structure within the cells (cellulose)
  - Plant long-term storage → Starch
- ***Proteins***
  - Made up of CHON.
  - Monomer: chains of amino acids held together by peptide bonds
  - 20 amino acids (determined my mRNA codon table)
  - Examples: enzymes, hormones, antibodies, and structural components
  - Rebuilds muscle and provides cell transportation
- ***Lipids***
  - water-insoluble (fats and oils)
  - made up of CH composed of glycerol and fatty acid chain
  - provide insulation, store energy, cushion internal organs,
  - Saturated → single Carbon to carbon bonds; unsaturated double carbon to carbon bonds
  - Phospholipid bilayer if the cell membrane!
- ***Nucleic Acids***
  - direct the instruction of proteins.
  - Composed of nucleotides, stores and transmits genetic information an organism receives from its parents (DNA and RNA).

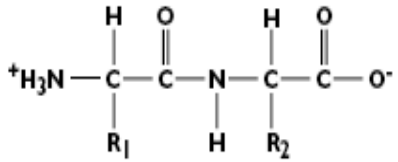
CELL THEORY:

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

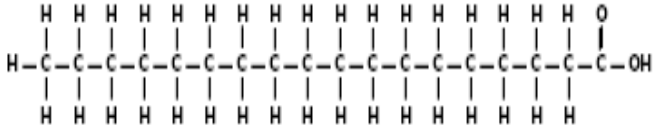
CARBOHYDRATE
(Sugar – Glucose)



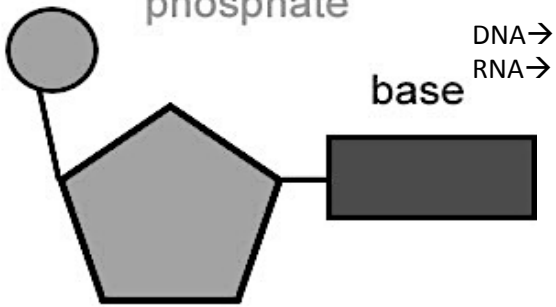
PROTEIN
(One Amino Acid)



LIPID



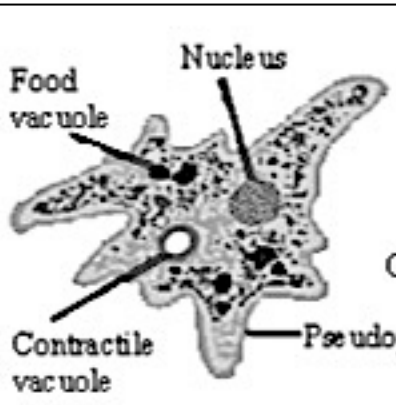
NUCLEIC ACID
(One Nucleotide)



DNA→ A, T, G, C
RNA→ A, U, G, C

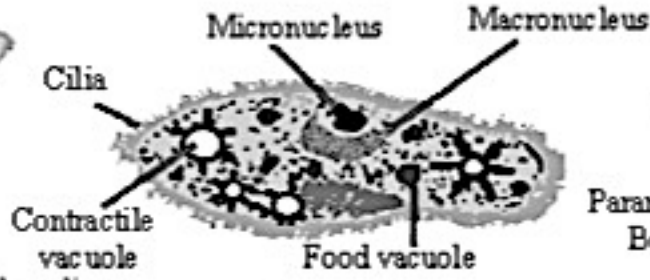
CELL TYPES:

- ***Unicellular*** – organism that exists as a singular, independent cell → Paramecium, euglena, Amoeba and Bacteria
- ***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 → Animals, Plants, Fungus…....
- ***Prokaryote*** – BACTERIA (and blue-green algae) - has nuclear material in the center of the cell, but is NOT a real, membrane-bound nucleus
- ***Eukaryote*** – EVERYTHING BUT BACTERIA! contain a clearly defined nucleus enclosed by a nuclear membrane and membrane-bound organelles; plants, animals, fungi, and protists (Euglena, paramecium and amoeba)



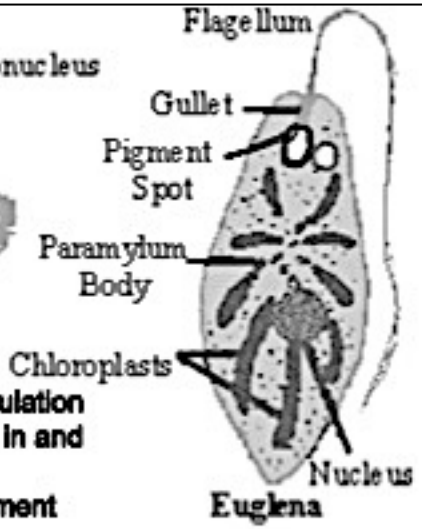
Amoeba

***Contractile Vacuole for osmoregulation for homeostasis (regulates water in and out of the cell)**
***Pseudopodia for capturing prey and movement**
***Usually asexual**



Paramoecium

***Contractile Vacuole for osmoregulation for homeostasis (regulates water in and out of the cell)**
***cilia capturing prey and movement**
***Usually asexual**

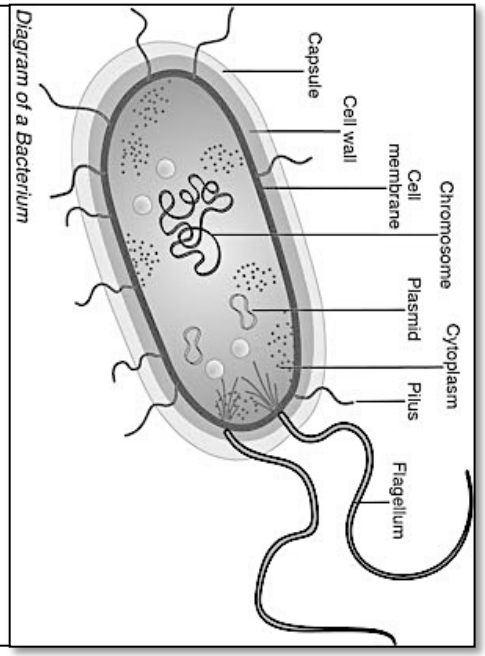


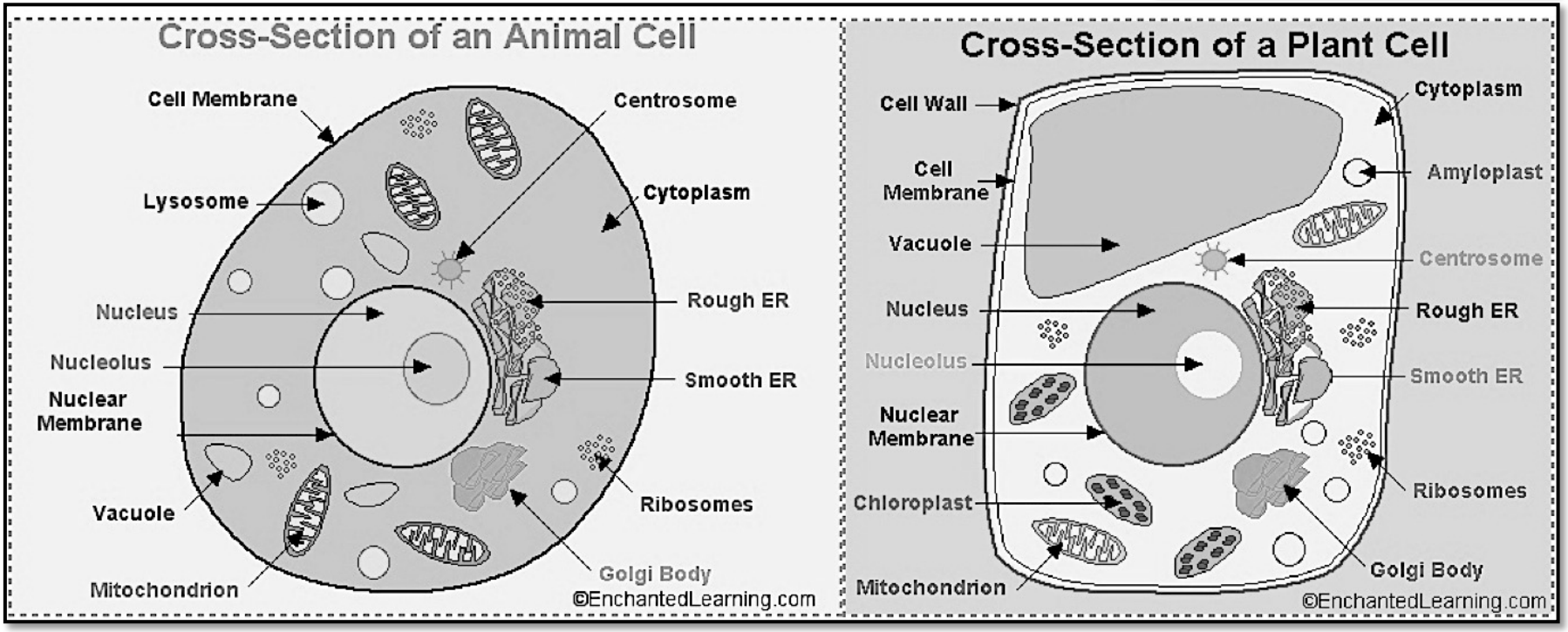
Euglena

***Contractile Vacuole for osmoregulation for homeostasis (regulates water in and out of the cell)**
***Flagella for movement**
***Photo-taxis – responds to light as they can undergo photosynthesis**
***Usually asexual**

CELL ORGANELLES:

- ***Chloroplast*** – capture solar energy for photosynthesis (plant cells, some algae, euglena) ; radiant energy to chemical energy
- ***Golgi Body*** – package, distribute products
- ***Lysosomes*** – digests excess products and food particles
- ***Mitochondria*** – transform energy through aerobic (cellular) respiration; ATP
- ***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 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 small substances, such as Oxygen gas, 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 or channel protein 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); carrier proteins

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 in solutions that are:***
  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) REGARDLESS of outside conditions
Example: body temperature, respiration, nutritional balance, pH etc.

Cells communicate their needs to each other mainly through their cell membranes by releasing chemical messengers that, This constantly changing internal environment is the process of homeostasis.

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

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

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)

  $C_6H_{12}O_6 + 6O_2 \Rightarrow 6CO_2 + 6H_2O +$ **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)

  $6CO_2 + 6H_2O +$ **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 + 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) — Glucose $\Rightarrow$ Lactic Acid + 2ATP

  Alcoholic Fermentation (plant cells) — Glucose $\Rightarrow$ CO_2 + 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 mitochondria

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

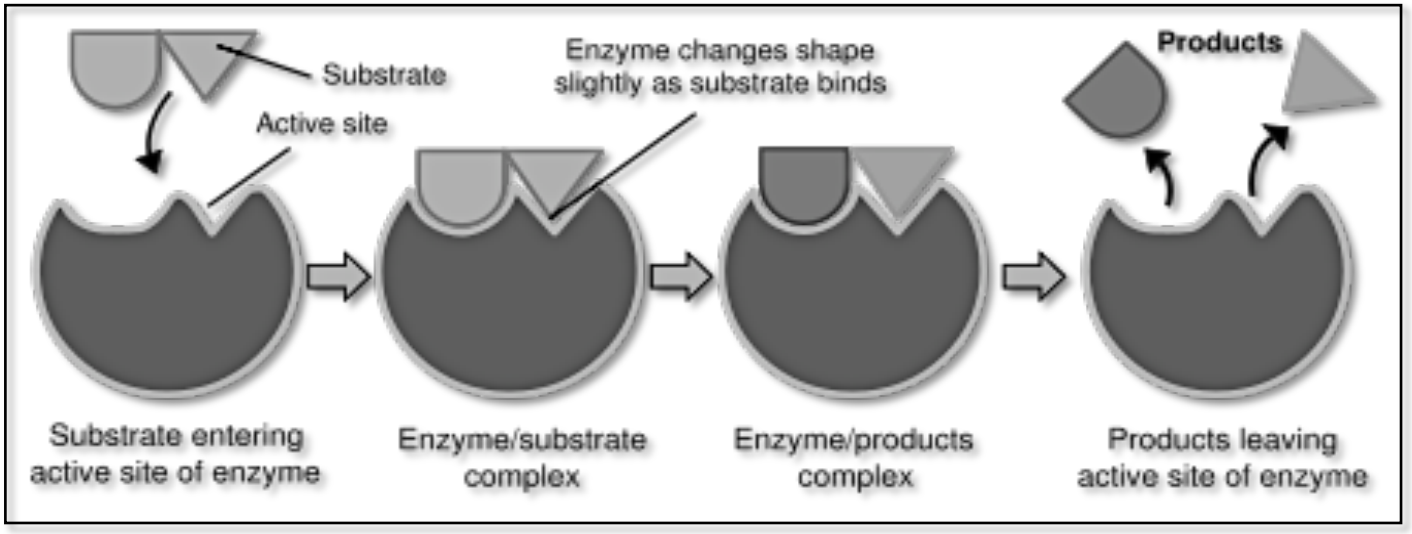
COMPARISON OF CELLULAR RESPIRATION, PHOTOSYNTHESIS AND CHEMOSYNTHESIS

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

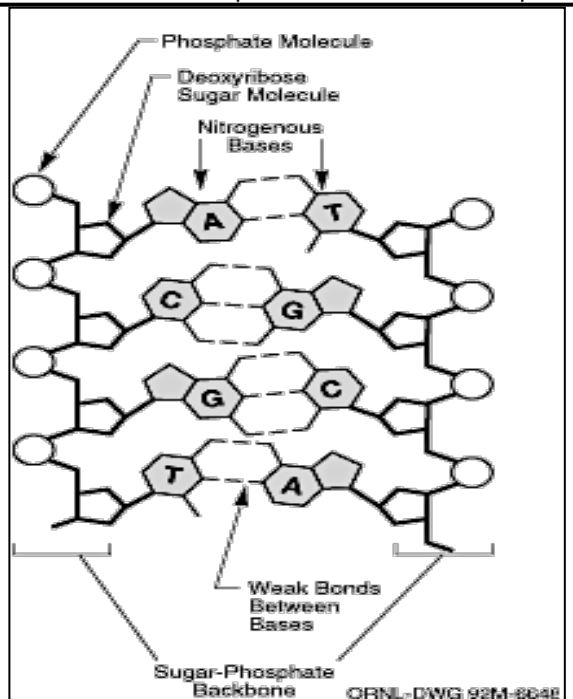
ENZYMES:

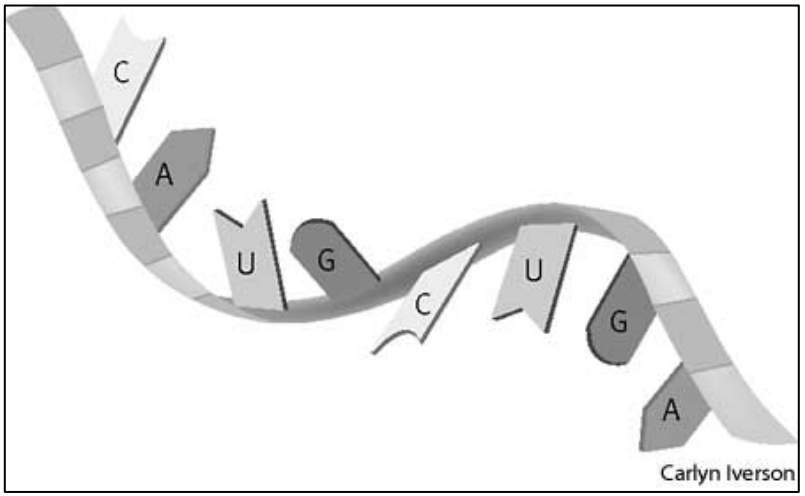
Enzymes are special proteins that regulate nearly every biochemical reaction in the cell. Different reactions require different enzymes. Enzymes function to:

- Provide energy to cells
- Digests
- 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
- (Remember –ases are enzymes)

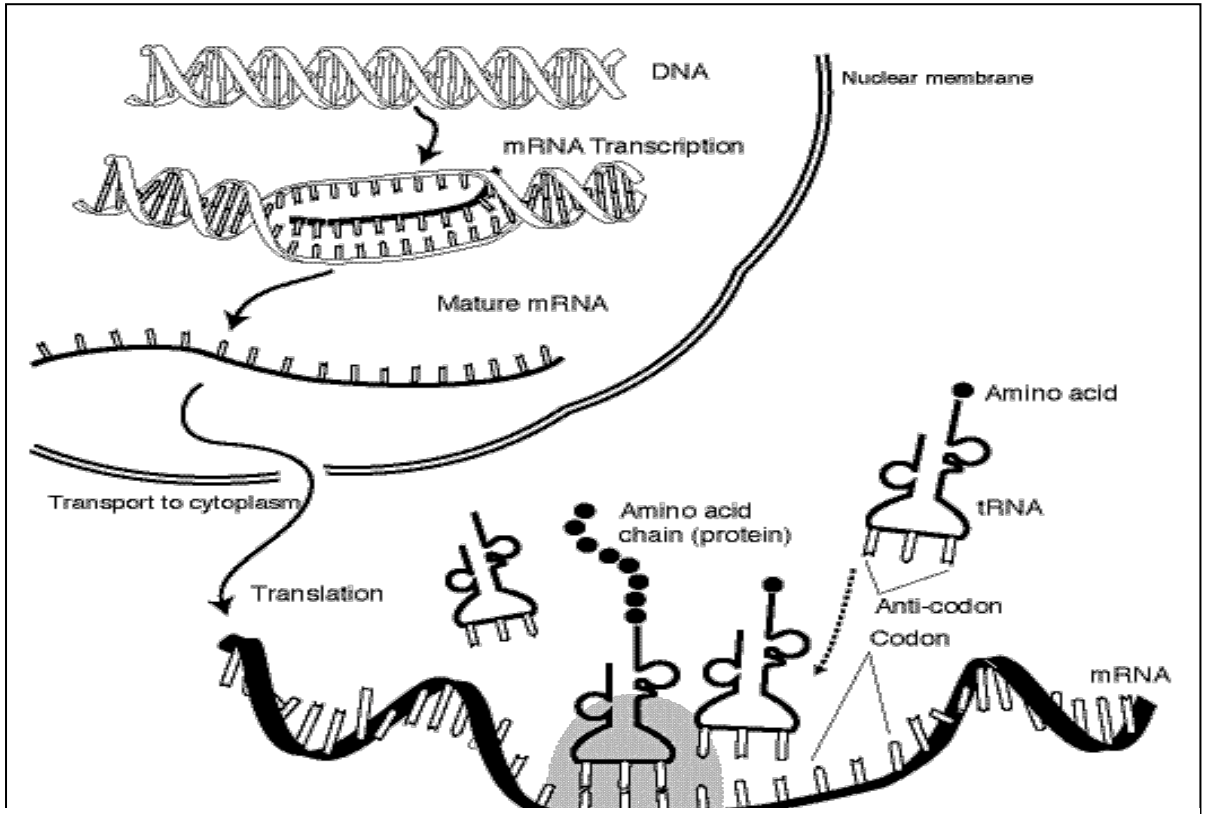


COMPARISON OF DNA AND RNA	
DNA	***RNA***
Deoxyribonucleic acid Double-stranded, twisted helix Never leaves the nucleus Nitrogenous bases: adenine, thymine, guanine, cytosine (Guanine w/Cytosine, Adenine w/Thymine) (Purines opposite the Pyrimidines) (held together by weak hydrogen bonds) Sugar: deoxyribose 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)





Protein Synthesis: Transcription and Translation



DNA/RNA and Genetics

- Molecular Basis of Heredity, DNA Replication, Protein Synthesis (Transcription, Translation), Gene Regulation
-)

Asexual and Sexual Reproduction:

Asexual Reproduction – a single parent produces one or more identical offspring by dividing into two cells - mitosis (2n->2n)
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 (Bacteria)

Mitosis- Identical daughter cells

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, sperm and egg)

Cell Cycle – Interphase (G1, S, G2), Mitosis and Cytokinesis

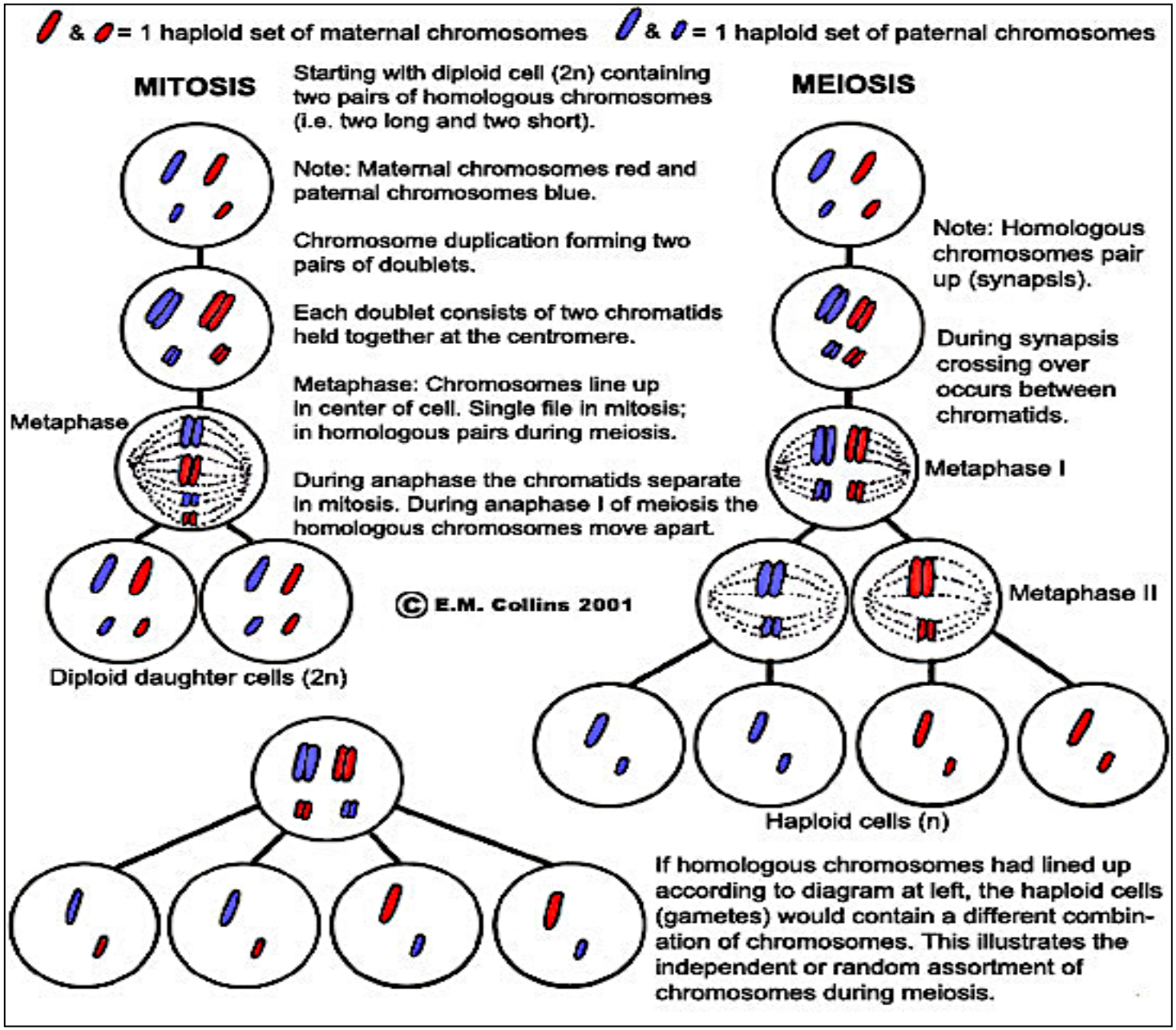
- process of copying and dividing the entire cell
- the cell grows, prepares for division, and then divides to form new daughter cells
- allows unicellular organisms to duplicate in a process called ***asexual reproduction***
- allows multicellular organisms to grow, develop from a single cell into a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

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

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, fertilization*** to produce a diploid individual


& = 1 haploid set of maternal chromosomes
& = 1 haploid set of paternal chromosomes
MITOSIS
Starting with diploid cell (2n) containing two pairs of homologous chromosomes (i.e. two long and two short).
Note: Maternal chromosomes red and paternal chromosomes blue.
Chromosome duplication forming two pairs of doublets.
Each doublet consists of two chromatids held together at the centromere.
Metaphase: Chromosomes line up in center of cell. Single file in mitosis; in homologous pairs during meiosis.
Metaphase
During anaphase the chromatids separate in mitosis. During anaphase I of meiosis the homologous chromosomes move apart.
© E.M. Collins 2001
Diploid daughter cells (2n)
MEIOSIS
Note: Homologous chromosomes pair up (synapsis).
During synapsis crossing over occurs between chromatids.
Metaphase I
Metaphase II
Haploid cells (n)
If homologous chromosomes had lined up according to diagram at left, the haploid cells (gametes) would contain a different combination of chromosomes. This illustrates the independent or random assortment of chromosomes during meiosis.

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 *separate independently* 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.)

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

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

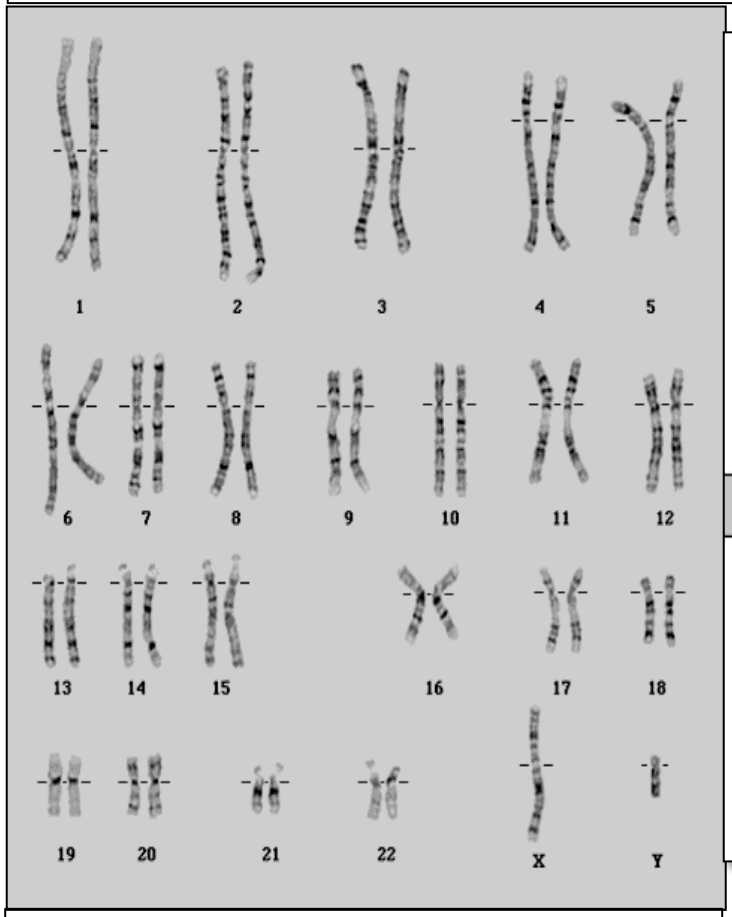
- during meiosis, homologous pairs of chromosomes don't separate
- results in half the sex cells having an extra chromosome and the other half having one less chromosome
- if fertilization occurs with an abnormal sex cell, zygote formed will have either one extra (***trisomy***) or one less (***monosomy***) 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)

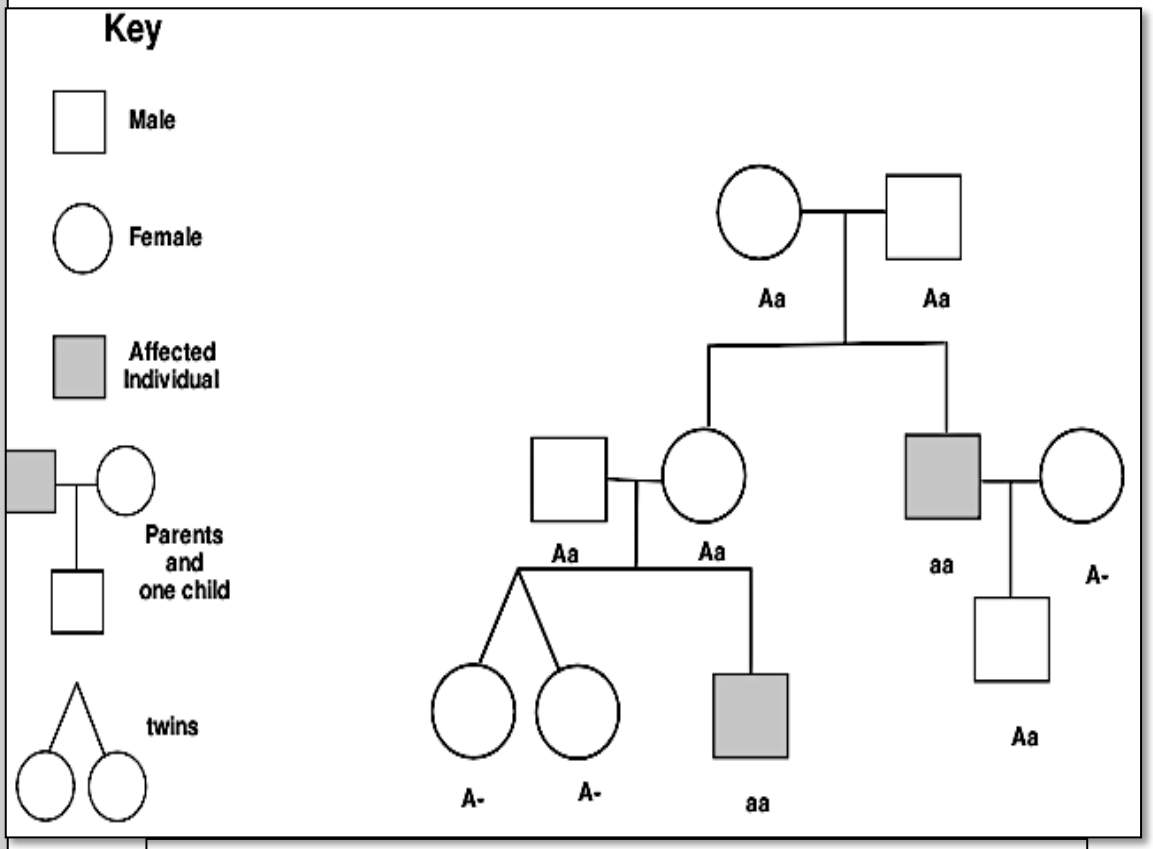
KARYOTYPE – Picture of your chromosomes

KARYOTYPE: to identify gender or chromosomal abnormalities



This karyotype is of a NORMAL Male; Remember if there was an extra chromosome #21, the person would have down syndrome; caused by non-disjunction

PEDIGREE



Shows traits, phenotypes, diseases passed down from generation to generation

Punnett Square –
If we let b=bald and B =not bald

Mother's Genes \ Father's Genes	B	b
b	Bb	bb
b	Bb	bb

Genotypic ration: 0BB:2Bb:2bb
Phenotypic ratio: 2Bald:2 non-bald

BB = Homozygous Dominant
bb = homozygous recessive
Bb = Heterozygous

Complete Dominance - Mendelian
BB = Homozygous Dominant
bb = homozygous recessive
Bb = Heterozygous
**Sickle Cell Anemia is recessive
**Huntington's is Dominant

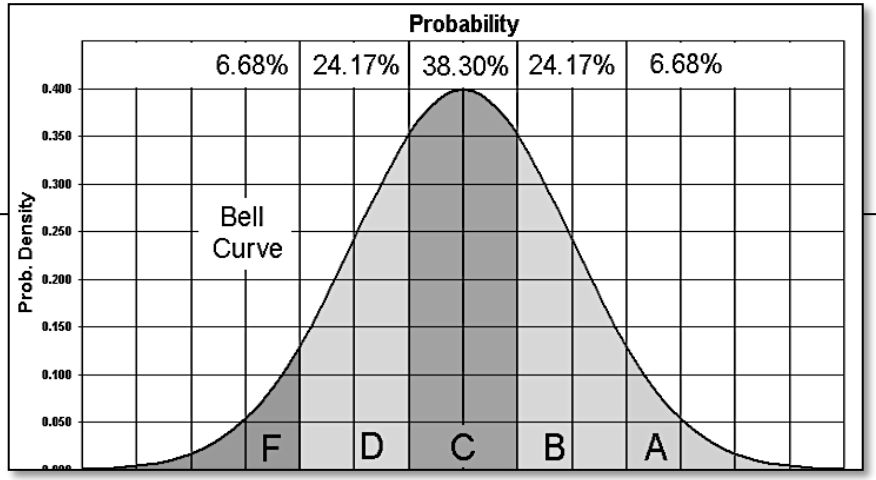
X-Linked recessive
X^NX^N (normal female) X^NX^n (Normal female carrier) X^nX^n (Affected Female)
X^NY (Normal Male) X^nY (Affected Male)
If mom is a carrier, SHE determines if her son will have it!! Males CANNOT be Carriers!
**Hemophilia and Red/Green Colorblindness are both X-linked recessive

CoDominant – Shows BOTH traits at the same time (think of polka dots, stripes, etc). BOTH Are Dominant
BB=Black chicken WW=White chicken BW = black AND white checkered chicken

Incomplete Dominance – Once allele not completely dominant over the other – Think of paint blending
PP= Red Flower P'P' = White Flower P'P = Pink Flower

Multiple Alleles- One trait (blood type) more than two different types of alleles (A, B and O)
I^AI^A or I^Ai are both Type A - I^BI^B or I^bi both type B -m I^AI^B is codominant type AB
A and B are both Dominant to type O which has the genotype ii

Polygenic – Many genes, not alleles, for one trait. Has variation in a population such as height, skin color, hair color, eye color – Example: AaBbCcDd - Follows a bell curve: Most people in the middle (heterozygous)



Classification and Evolution

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

-Anatomical : homologous structures, analogous structures, and vestigial structures
-Geographical- islands, land masses

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

ORIGINS OF LIFE:
Biogenesis – idea that living organisms came only from other living organisms

Spontaneous Generation – mistaken idea that life can arise from nonliving materials; sometimes called Abiogenesis
- Francesco Redi performed controlled experiments that tested spontaneous generation of maggots from decaying meat – disproved idea.
- Louis Pasteur performed controlled experiments that tested spontaneous generation of microorganisms in nutrient broth – disproved idea.

Different theories of where life came from:
-Creator, spontaneous generation, big bang, lightening strike, deep sea vents

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

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

CLASSIFICATION OF HUMANS:

Domain Eukarya
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*

Dichotomous Key For Leaves

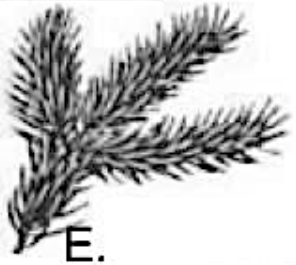
1.	a. Needle leaves	go to 2
	b. Non-needle leaves	go to 3
2.	a. Needles are clustered	Pine
	b. Needles are in singlets	Spruce
3.	a. Simple leaves (single leaf)	go to 4
	b. Compound leaves (made of "leaflets")	go to 7
4.	a. Smooth edged	go to 5
	b. Jagged edge	go to 6
5.	a. Leaf edge is smooth	Magnolia
	b. Leaf edge is lobed	White Oak
6.	a. Leaf edge is small and tooth-like	Elm
	b. Leaf edge is large and thorny	Holly
7.	a. Leaflets attached at one single point	Chestnut
	b. Leaflets attached at multiple points	Walnut


A. _____


B. _____


C. _____


D. _____


E. _____


F. _____


G. _____


H. _____

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 population
  - **Immigration –** movement of individuals into a population
- **Hibernation –** state of reduced metabolism occurring in animals that sleep during parts of cold winter months; an animal's temperature drops, oxygen consumption decreases, and breathing rate declines
- **Estivation** – state of reduced metabolism that occurs in animals living in conditions of intense heat
- **Mating / Reproduction –** production of offspring for the survival of the species; can be seasonally scheduled

PLANTS

Spore-Producing Plants
Nonvascular, produce spores
Remain small– absorb water by osmosis
Sperm swim to fertilize eggs
Live in moist environments
Reproduce sexually
Alternation of Generations
(You see the gametophyte generation)
Mosses and liverworts

Vascular Plants
Two types of vascular tissue
Xylem – transports water and minerals (UP)
Phloem – transports sugars (DOWN)
Produce spores
Club mosses, horsetails, ferns
Require water for reproduction

Seed Producing Vascular Plants
Vascular, Produce seeds
Seed = embryo protected by a seed coat
Two groups based on reproduction
Gymnosperms – cone-bearing (like pines)
Angiosperms – flowering
  - monocots (corn) and dicots (flowers)
Roots – anchor, absorb water, store food
Stems – support, transport
Leaves – photosynthesis, produces food
Adaptations – seed, pollen, fruit, flowers
Pollination – fertilization, germination

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

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

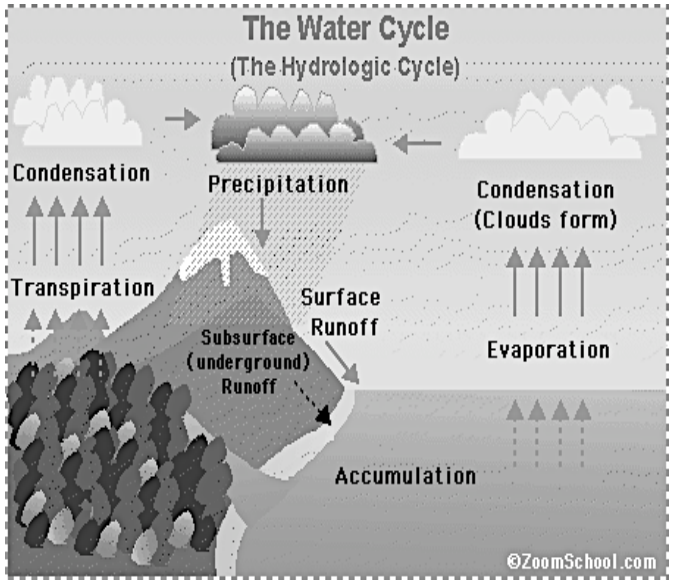
ECOLOGICAL PYRAMID:
- Representation of energy transfer
- Pyramid of Energy – each level represents energy available at that level, 90% decline
- Pyramid of Biomass – each level represents amount level above needs to consume
- Pyramid of Numbers – each level represents number of organisms consumed by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

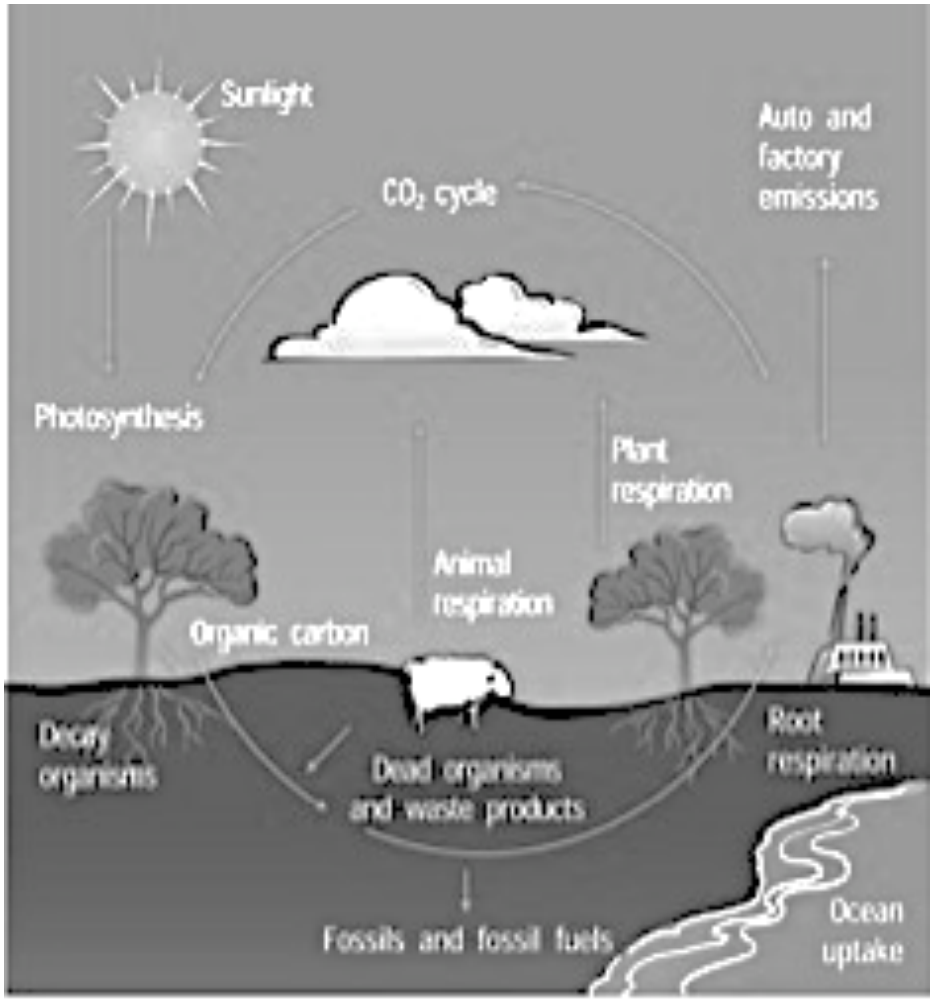
SOME EXAMPLES OF ENVIRONMENTAL LIMITING FACTORS

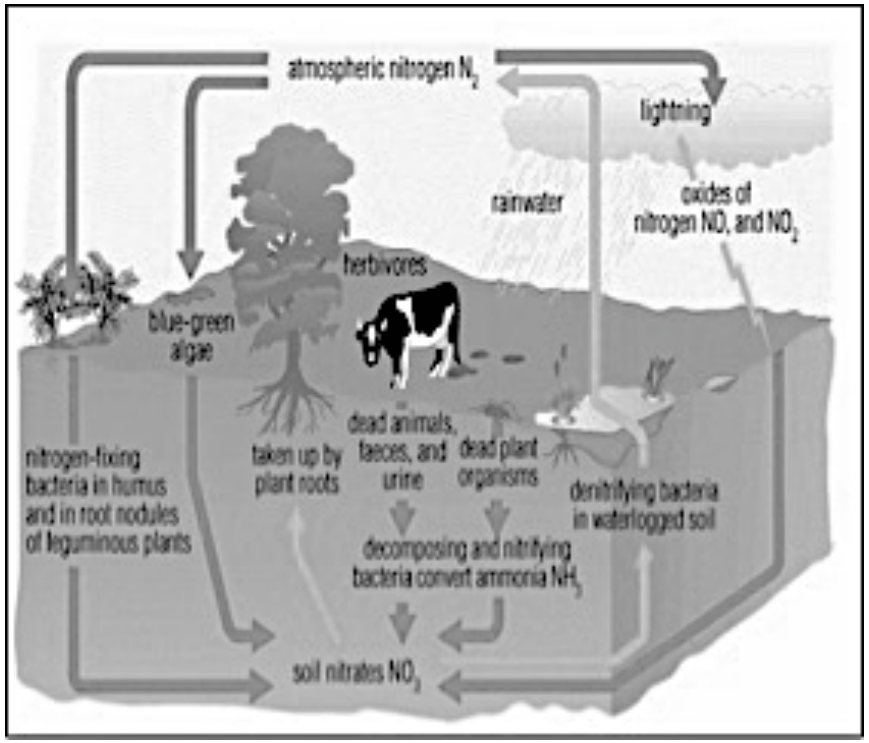
Biotic (living)	Abiotic (nonliving)
Plants	Climate
Animals	Light
Bacteria	Soil
Prey	Water
Food Sources	Shelter
(Nutrients)	Pollution

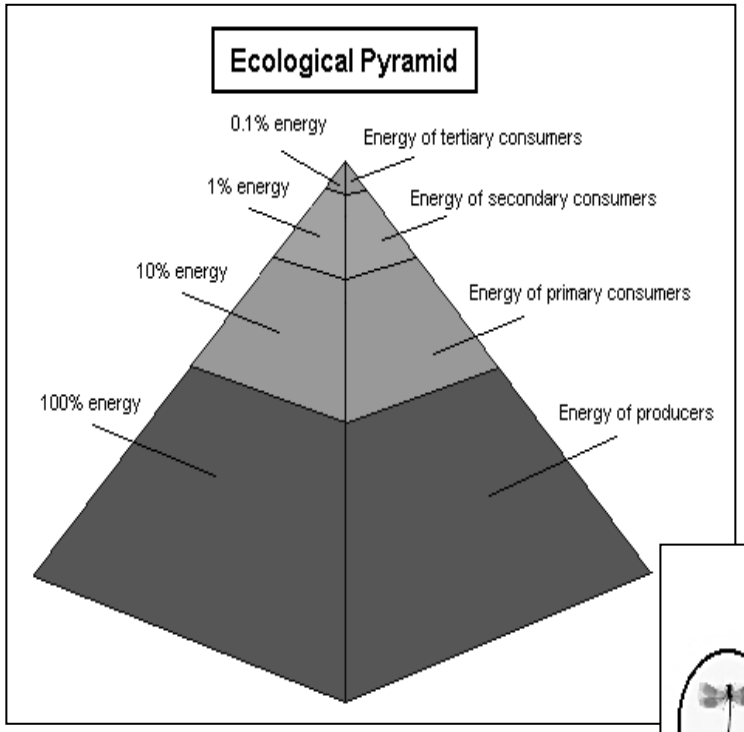
SPECIES / POPULATION SURVIVAL:
- **Natural Selection –** mechanism for change in populations; occurs when organisms with favorable variations survive, reproduce, and pass their variations to the next generation; "survival of the fittest"
- **Adaptation (Behavioral or Physiological) –** evolution of a 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

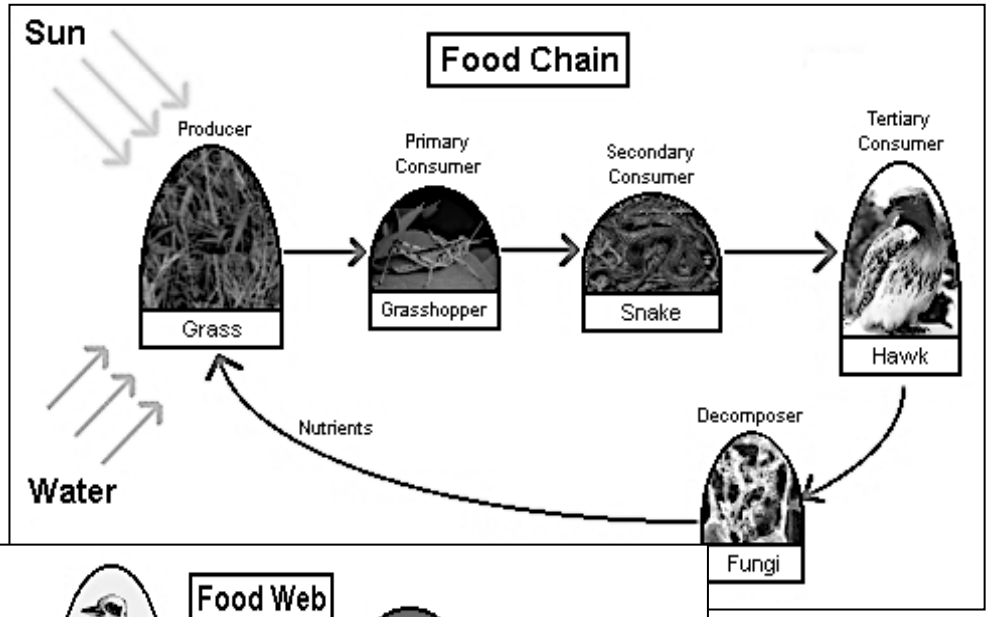
CYCLES:
(Matter cannot be created nor destroyed, but can be converted/recycled to other forms)
Water Cycle – water is recycled through evaporation, condensation, precipitation, runoff, groundwater, aquifers, respiration, transpiration, excretion, decomposition
Nitrogen Cycle – producers take in nitrogen 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

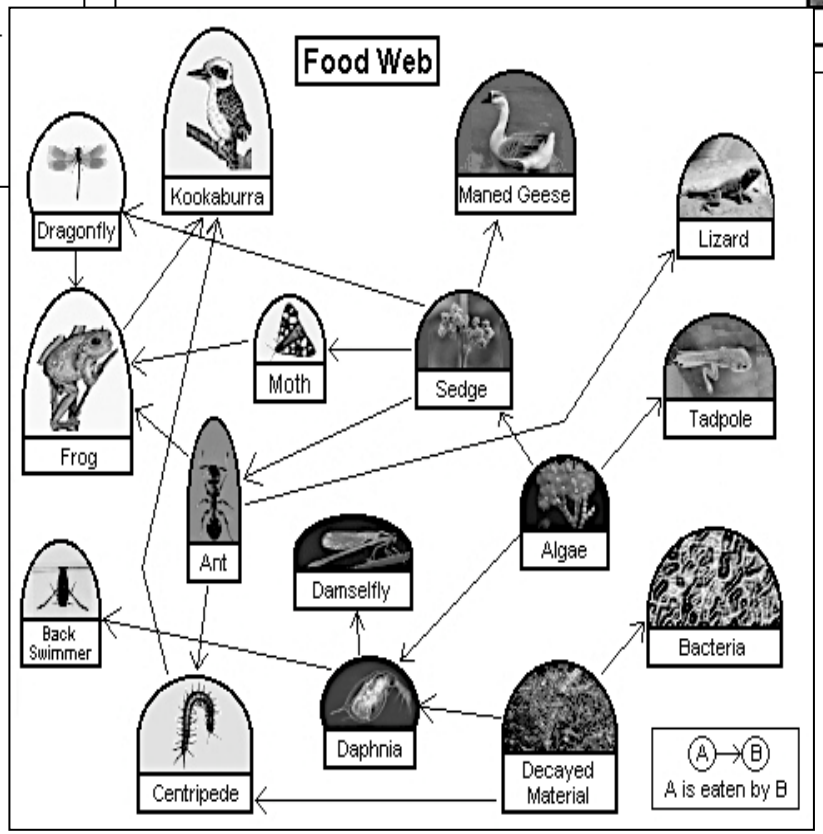

The Water Cycle
(The Hydrologic Cycle)
Condensation
Precipitation
Condensation
(Clouds form)
Transpiration
Surface
Runoff
Subsurface
(underground)
Runoff
Evaporation
Accumulation
©ZoomSchool.com

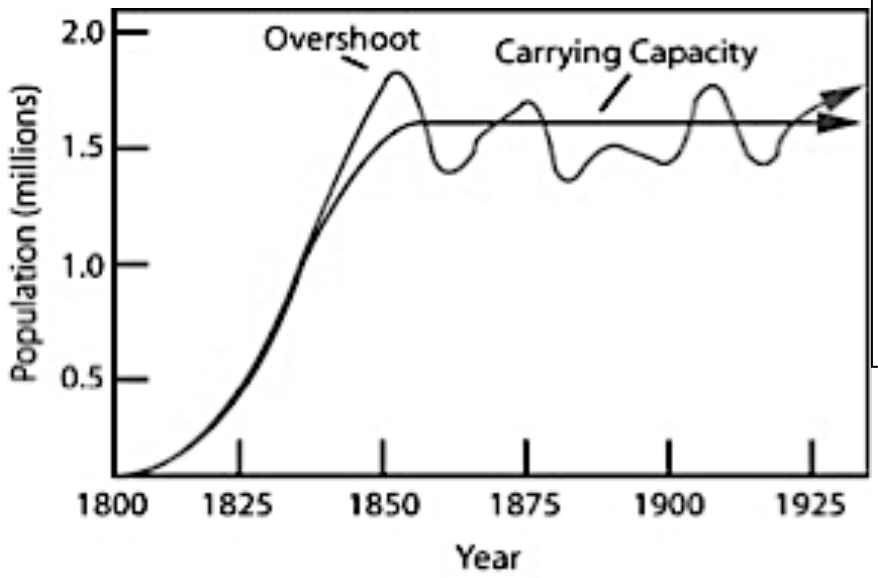

Sunlight
Auto and
factory
emissions
CO_2 cycle
Photosynthesis
Plant
respiration
Animal
respiration
Organic carbon
Decay
organisms
Dead organisms
and waste products
Root
respiration
Fossils and fossil fuels
Ocean
uptake


atmospheric nitrogen N_2
lightning
rainwater
oxides of
nitrogen NO, and NO_2
herbivores
blue-green
algae
nitrogen-fixing
bacteria in humus
and in root nodules
of leguminous plants
taken up by
plant roots
dead animals,
faeces, and
urine
dead plant
organisms
denitrifying bacteria
in waterlogged soil
decomposing and nitrifying
bacteria convert ammonia NH_3
soil nitrates NO_3


Ecological Pyramid
0.1% energy
Energy of tertiary consumers
1% energy
Energy of secondary consumers
10% energy
Energy of primary consumers
100% energy
Energy of producers


Sun
Food Chain
Producer
Primary Consumer
Secondary Consumer
Tertiary Consumer
Grass
Grasshopper
Snake
Hawk
Nutrients
Decomposer
Fungi
Water


Food Web
Kookaburra
Maned Geese
Dragonfly
Lizard
Moth
Sedge
Frog
Tadpole
Ant
Algae
Damselfly
Back Swimmer
Bacteria
Daphnia
Centripede
Decayed Material
A is eaten by B



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:

- human population growth
- pollution
- industry
-greenhouse gasses
- excess CO2
-Deforestation