Ap Bio study guide for the Ap exam
this study guide is designed to be used in context with Mrs. Allen's top 5 for exam time study guide - please use responsibly

Biochemistry:

Water and its properties

- water is polar because the oxygen region of the molecule has a partial negative charge, and each hydrogen has a partial positive charge.
- cohesion is the linking of like molecules, (so water joins to water) because of hydrogen bonds
- adhesion is the climbing of one substance to another (water attaches to water)
- transpiration is the movement of water molecules up very thin tubes (this helped with water evaporating from stomata)
- specific heat is the amount of energy that it take to increase a substance 1 degree (waters is high)
- water has a high surface tension
- water is less dense as a solid

Organic molecules

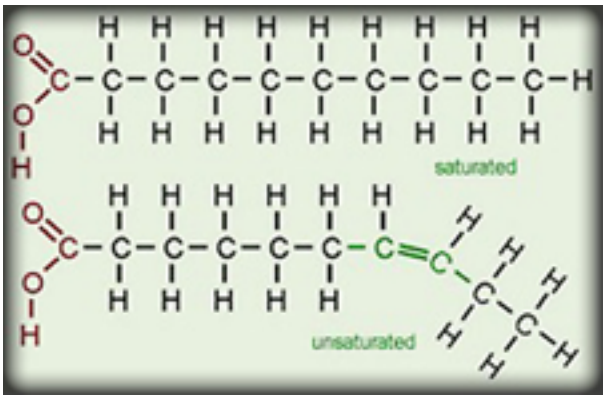
- all organic molecules consist of Carbon, Hydrogen, Oxygen, phosphorus, Sulfur,
- Oxygen and Nitrogen are highly electronegative therefore they produce polar molecules
- hydrocarbons:
  - are stable molecules
  - have very little attraction (gases at room temperature)
- Carbon can have 4 stable covalent bonds

Condensation vs. hydrolysis

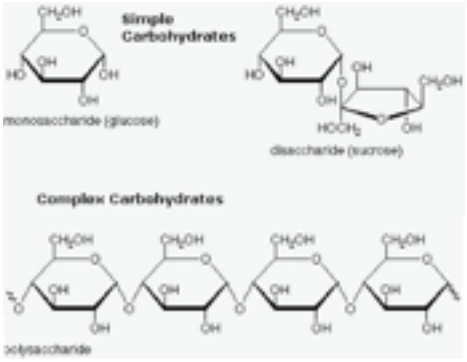
- Condensation (dehydration synthesis) reactions create polymers from monomers. the two monomers are joined by removing one molecule of water (formation)
- hydrolysis occurs when water is added to split large molecules (digestion)

4 categories of organic molecules

- lipids, carbohydrates, Nucleic acids, and proteins
- Lipids:
  - are hydrophobic
  - they aren't polymers because they are assembled from a variety of compounds
  - fats = glycerol + 3 fatty acids
  - fatty acids are non polar hydrocarbon chains
  - lipids are for energy storage
  - phospholipids make up sell membranes
    - have a hydrophilic (polar) head that includes a phosphate group
    - and two fatty acid tails, which are hydrophobic
  - Unsaturated fats
    - have double bonded carbons
    - tend to be liquids at room temperature
    - produced by plants
  - saturated fats
    - have no double bonded carbons

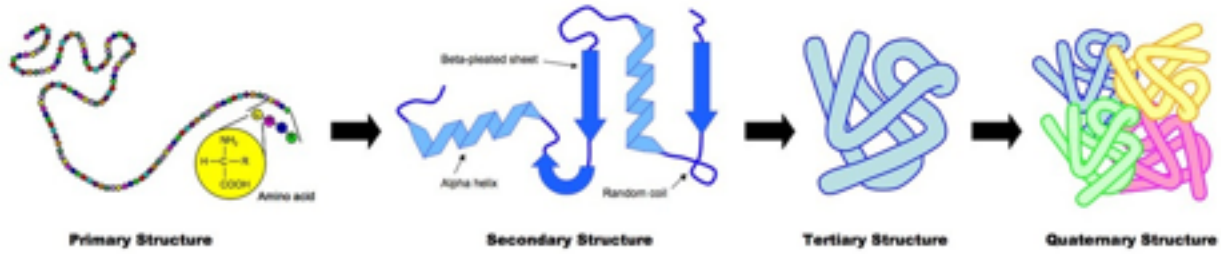


  - tend to pack solidly at room temperature
  - are a commonly produced by animals
- Carbohydrates
  - include both simple sugars (glucose, fructose) and polymers (starch)
  - all carbohydrates exist in a ratio of 1 carbon to 2 hydrogens to 1 oxygen or CH2O
  - monosaccharides are the monomers of carbohydrates. examples: glucose(C6H1206) and ribose (C5H10O5)
  - polysaccharides are polymers of monosaccharides like starch, cellulose, and glycogen
  - carbohydrates are used for energy storage (sugars) and structural support (cellulose and chitin)

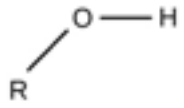
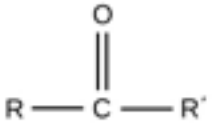
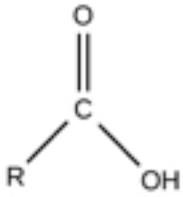
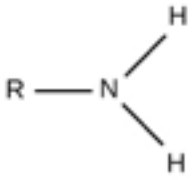
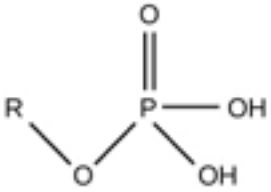
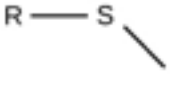


- Proteins
- are made up of animo acid monomers
- amino acids contain a central carbon bonded to a carboxyl group and an amino group on the other end
- peptide bonds link amino acids
- protein shape is crucial to function. (sickle cell)
- proteins will denature when it loses its shape and ability to function due to heat, ph, or other disturbance

primary stucture	peptide bonds
secondary structure	hydrogen bonds
tertiary structure	hydrophobic interactions, van de Waals, hydrogen bonds, disulfide bridges
quaternary structure	**2 or more tertiary**



- Nucleic acids
  - DNA and RNA
  - nucleotides are the monomers and have 3 parts
    - nitrogenous base (adenine, thymine, cytosine, and guanine) in DNA and (adenine, uracil, cytosine, and guanine) in RNA
    - pentose (5-carbon sugar)
    - and a phosphate group
    - DNA is the molecule of heredity

Functional Group	Structure	Properties
Hydroxyl		Polar
Methyl		Nonpolar
Carbonyl		Polar
Carboxyl		Charged, ionizes to release H^+. Since carboxyl groups can release H^+ ions into solution, they are considered acidic.
Amino		Charged, accepts H^+ to form NH_3^+. Since amino groups can remove H^+ from solution, they are considered basic.
Phosphate		Charged, ionizes to release H^+. Since phosphate groups can release H^+ ions into solution, they are considered acidic.
Sulfhydryl		Polar

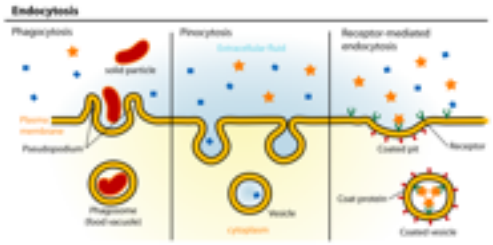
Membranes and water potential

- **M**embranes under the fluid mosaic model (the phospholipids slide around each other) is semipermeable and has a
  - phospholipid bilayer that is hydrophilic on its surface and hydrophobic in the interior
  - double bonds in the hydrophobic tails cause them to kink (unsaturated) and contribute to the fluidity of the membranes
  - proteins and glycoproteins in the membrane function as channels, carriers, enzymes, receptors and in recognition
- diffusion allows molecules to move across a membrane **down the concentration gradient**
- osmosis allows water to move across the membranes **down the concentration gradient** (pores = aquaporins)

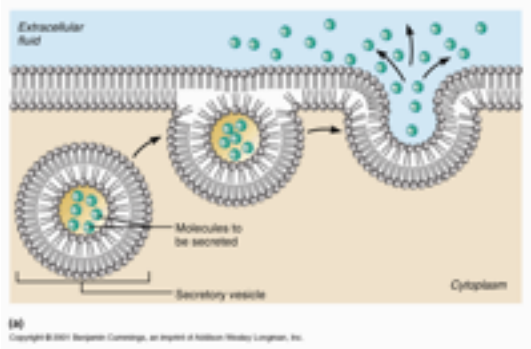
- facilitated diffusion allows molecules to move across membranes through channel proteins **<u>down the concentration gradient</u>**
- water potential and the flow of water are driven by the presence and concentration of solutions

$$\psi = \psi_p + \psi_S$$

$$\text{Water Potential} = \text{Pressure Potential} + \text{Solute Potential}$$

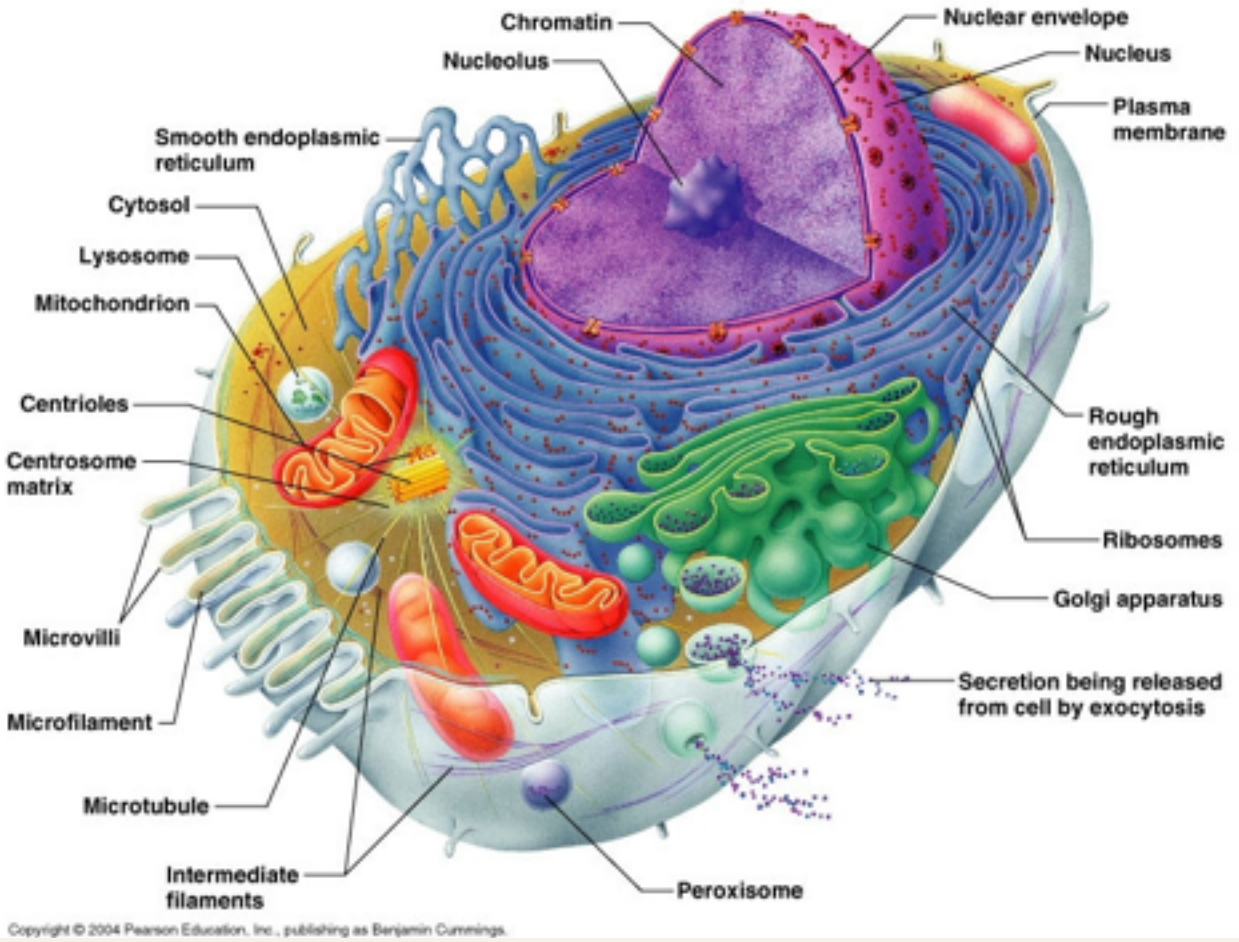


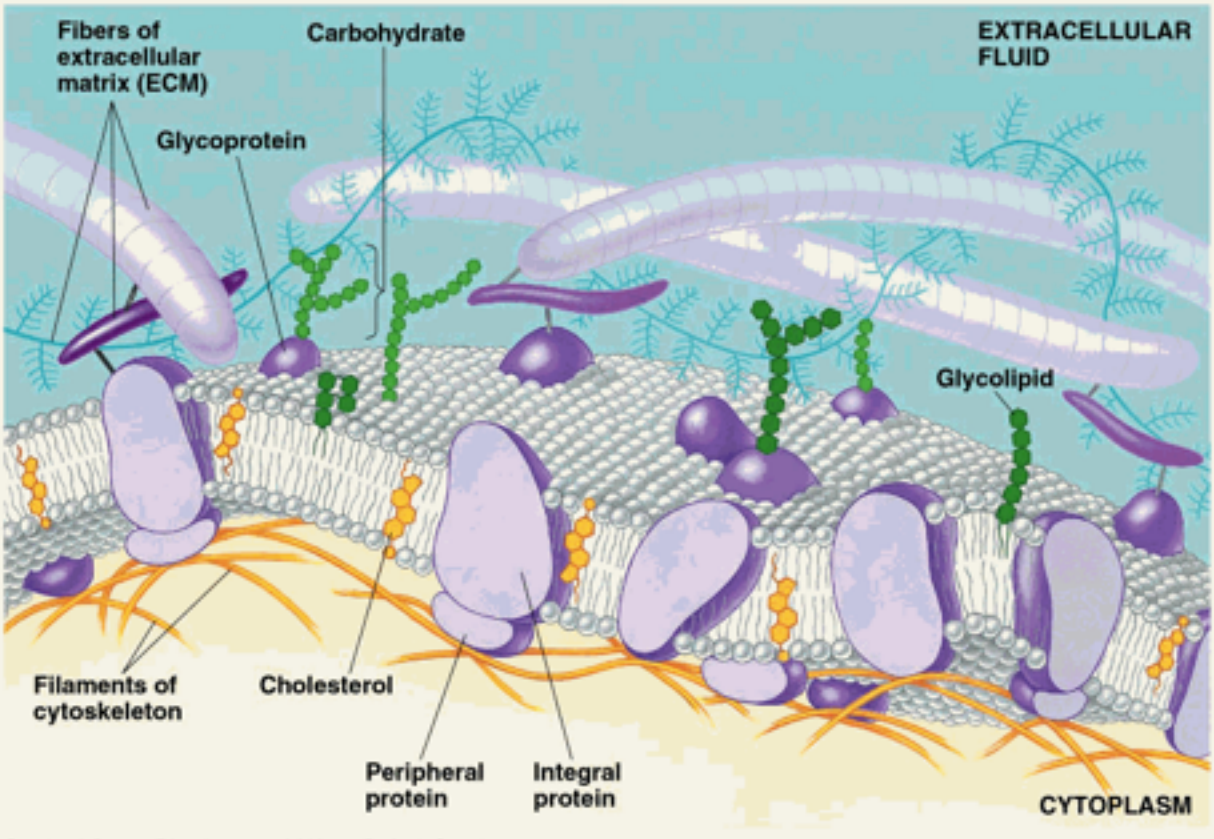
- solute potential= -ICRT
  - I = ionization constant (1 for sucrose)
  - C= molar concentration
  - R= pressure constant (R=.0831)
  - T=Temperature in Kelvin (c=273)
- active transport enquires energy and flows a**<u>gainst the concentration gradient</u>**
  - endocytosis (is an energy-using process by which cells absorb molecules) phagocytosis, pinocytosis, receptor-mediated endocytosis
  - exocytosis (is a process in which an intracellular vesicle (membrane bounded sphere) moves to the plasma membrane to allow stuff in)



<u>Cell structure and function</u>

- big ten:
- nucleus-contains most of the cells DNA, contains a double envelope covering
- nucleolus- is a region of the nucleus where ribosomal RNA complexes with proteins to form ribosomal subunits
- rough endoplasmic reticula- associated with ribosomes, these ribosomes synthesize proteins that are generally secreted by the cell
- smooth endoplasmic reticula- has three primary functions: synthesis of lipids, metabolism of carbohydrates, and detoxification of drugs and poisons
- lysosome- are membrane- bound sacs of hydrolytic enzymes that can digest large molecules (proteins, polysaccharids, fats, nucleic acids)
- ribosome- are proteins factories
- golgi apparatus- proteins from transport vesicles are modified, stored, and shipped around the cell
- cytoskeleton- responsible for support, motility, and regulating some biochemical activities
  - microtubules- shape and support the cell and help organelles move
  - microfilaments- made of actin, are involved with movement'
  - intermediate filaments- more permanent fixtures for maintaing shape
- chloroplast-is the site of photosynthesis
- mitochondria- is the sight of cellular respiration, the metabolic process that use oxygen to generate ATP by extracting energy fro sugars and fats
- cell membrane- selectively permeable membrane
  - it allows some thing to move across it easily



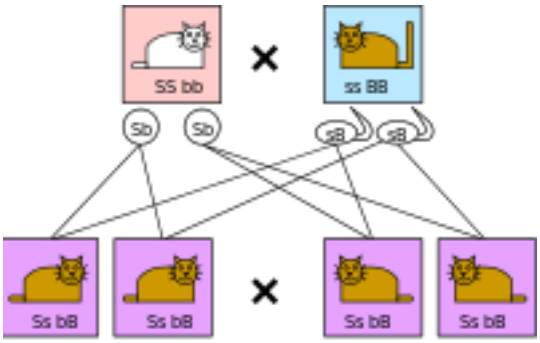


- held together with weak attractions

- **<u>the difference between prokaryotic cells and eukaryotic cells</u>**

characteristics	prokaryotic cells	eukaryotic cells
plasma membranes	yes	yes
ribosomes	yes	yes
membrane-bound organelles in cystol	no	yes
nucleus	no	yes
size	1-3	10-100

- evidence for the endosymbiotic theory of eukaryotic evolutions
  - the mitochondria has different DNA than the cell
  - chloroplasts look very similar to cynobacteria



<u>Genetics</u>

- understand monhybrid and dihybrid crosses
- understand complet dominance, incomplete dominance, co-dominance, test cross, and sex linked crosses
- predict the genotypes of the parents from the proportions of genotypes in offspring
- **you must be able to predict the parents genotypes from offspring and offspring for two generations**
- test your predictions with the chi square

$$X^2 = \Sigma \frac{(O - E)^2}{E}$$

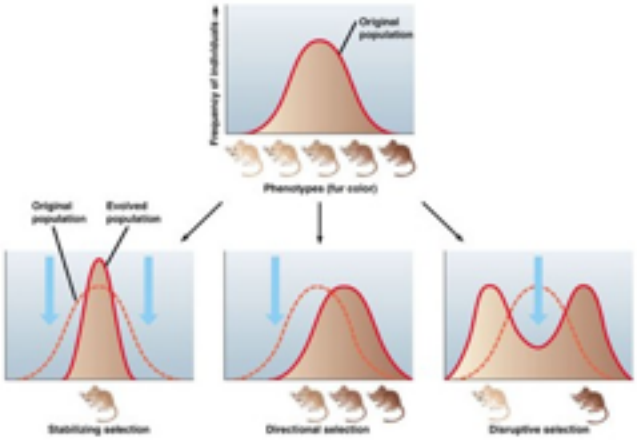
<u>Mendelian genetics</u>

- sources of variation in sexually reproducing species
  - independent assortment- during metaphase 1, chromosomes line up and can pair up in any combination, with any homologous pair
  - crossing over- during prophase 1 there is exchange of genetic material on homologous chromosomes between non sister chromatids
  - fertilization- each egg and sperm is different, this results in an independent assortment and crossing over, each combination is unique

  - mating strategies- unique among species
- meiosis is cell devision that produces 4 haploid cells and reduces chromosome number from two sets to 1 set. Prophase 1 is where homologous chromosomes synapse and crossing over takes place
- interpret human pedigrees
  - X linked dominant- is a dominant gene from the x chromosome
  - X linked recessive - a recessive gene from the x chromosome
- point mutations are mutations to just one base pair, either an insertion or deletion
- chromosomal mutations can lead to new species

Evolution and speciation

- evolution is defined as the change in gene frequencies in a population over time.
- natural selection works on phenotypes
- mutation and sexual reproduction work hand in hand to produce genetic variation. mutations are rare and random but are produced by random mixing of genes in sexual reproduction and by random changes in genes
- things that change the frequency of genes:
  - natural selection-results in alleles being passed on to the next generation in different frequencies than the previous. individuals that are better suited to there environment will pass their genes on
  - genetic drift- unpredictable fluctuation. comes in two forms
    - founder effect- few individual become isolated from a large population and form a new one with different genes from the original
    - bottle neck effect- a sudden change is the environment drastically reduces the size of the population. the few survivors pass on there genes
  - gene flow- occurs when new genes are gained and lost through the movement of animals
  - Hardy Weinburg
    - $p^2 + 2pq + q^2 = 1$/ p+q=1
    - 5 conditions of Hardy Weinburg
    - no new mutations
    - random mating
    - no natural selection'
    - large population size
    - no gene flow



- speciation
  - is the process in which a new species arise
  - this occurs then two populations become isolated so eventually the two new populations cant reproduce (geological processes,)
- a biological species - is a group of populations whose members have the potential to interbreed in nature and produce fertile like offspring

- allopatric speciation:

Pre-zygotic Isolating Mechanisms		**Example**
Temporal Isolation	Occurs when two species mate or flower at different times of the year	Different frog species live in the same pond but breed at different times
Ecological Isolation	Occurs when two species inhabit similar regions, but occupy different habitats	Lions and tigers occupy different habitats and do not interbreed (usually)
Behavioural Isolation	Occurs when two species respond to different specific courtship patterns	Some crickets are morphologically identical but only respond to species-specific mating songs
Mechanical Isolation	Occurs when genital differences prevent copulation (animals) or when flowers are pollinated by different animals (plants)	Bush babies have distinctly shaped genitalia that will only fit other members from the same species
Post-zygotic Isolating Mechanisms		**Example**
Hybrid Inviability	Hybrids are produced but fail to develop to reproductive maturity	Frogs of the genus *Rana* can form hybrid tadpoles which die before adulthood
Hybrid Infertility	Hybrids fail to produce functional gametes	Mules are the sterile hybrids of a male donkey and a female horse
Hybrid Breakdown	The F1 hybrids are fertile but the F2 generation fail to develop or are infertile	The offspring of hybrid copepods have a reduced potential for survival or reproduction

  - sympatric speciation: a small part of the population forms a new species without geographical divide (example: polyploid)
  - gradualism vs. punctuated equilibrium
    - gradualism is when new species from slowly over time
    - punctuated equilibrium is when there is no speciation for a long time then a fast event that causes sudden change in species
- selection
  - sexual selection is a form of natural selection in which individuals with certain traits are more likely to obtain mates as they are more desirable
  - evidence for evolution includes fossils, morphology, embryology, and biochemical factors such as DNA, RNA, and proteins
  - you must be able to evaluate data that represents the possible effects of environmental change on the evolution of population.

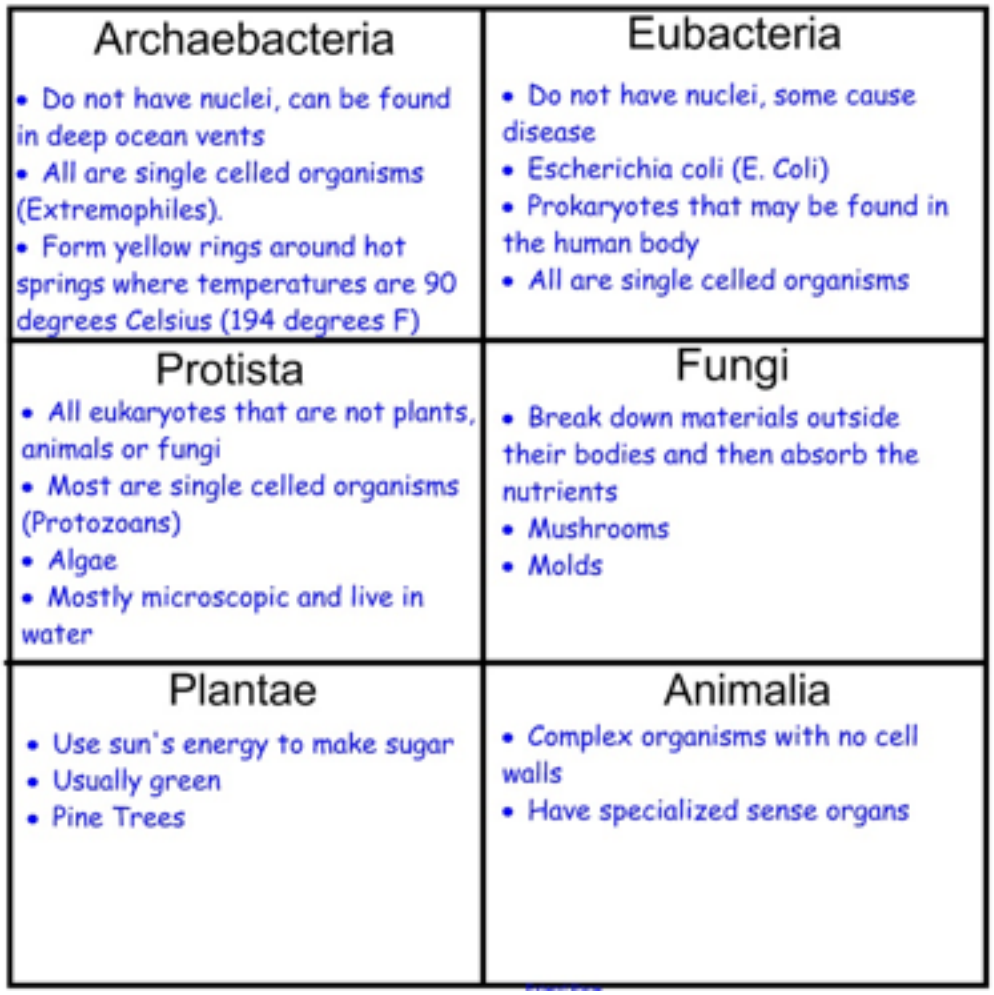
Diversity and Classification

- the three domains
  - Bacteria, Archaea, Eukarya
    - bacteria and archaea contain prokaryotic organisms while eukarya contains eukaryotic organisms

characteristic	bacteria	archaea	Eukarya
nuclear envelope	no	no	yes
membrane- enclosed organelles	no	no	yes
introns	no	yes	yes

characteristic	bacteria	archaea	Eukarya
histone proteins associated with DNA	no	yes	yes
circular chromosome	yes	yes	no

- the 6 kingdoms

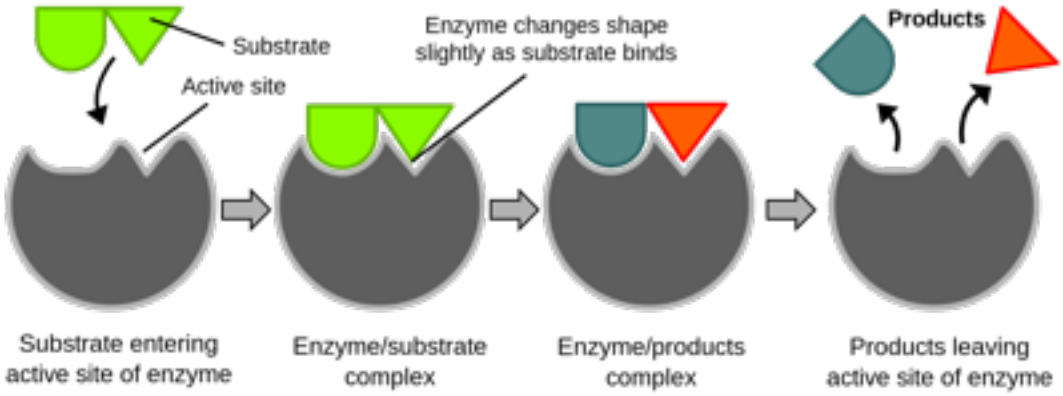


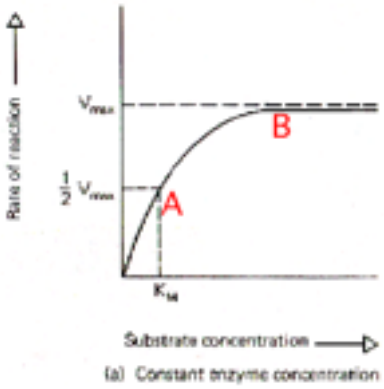
- major evolutionary adaptations for plants and animals in terms of becoming terrestrial (IDK)
  - plants
    - evolved for green algae more than 500 million years ago
    - plants enabled all other animals to survive on land by producing oxygen
    - moving on to land made it easier to find sunlight, more carbon dioxide, and rich soils
    - but challenges included lack of water, desiccation, and lack of structural support against gravity
    - alternation of generations is where plants have tow multicellular stages
  - animals
    - invertebrates where the first to move onto land and evolved from things like sponges
    - pharyngeal slits evolved to allow oxygen to be absorbed from the air
    - the spine evolved leading to the evolution of vertebrates

- fungi and bacteria recycle nutrients from dead plants and animals back into the ecosystem
  - they help with plants absorbing food from the ground (mycorrhizal fungi)
  - help animals digest food in there gut
- **you must be able to evaluate cladograms of both vertebrates and the 4 major plant groups**

<u>enzymes and free energy</u>

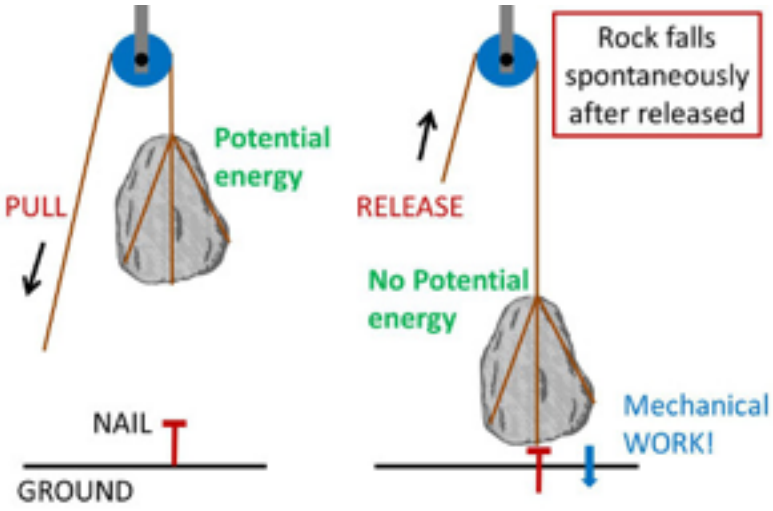
- enzymes catalyze biochemical reactions by reducing the activation energy
- enzymes for the most part are proteins
- enzymes in reactions are effected by things like ph,temperature, and salinity
- the induced fit model of enzyme reactions



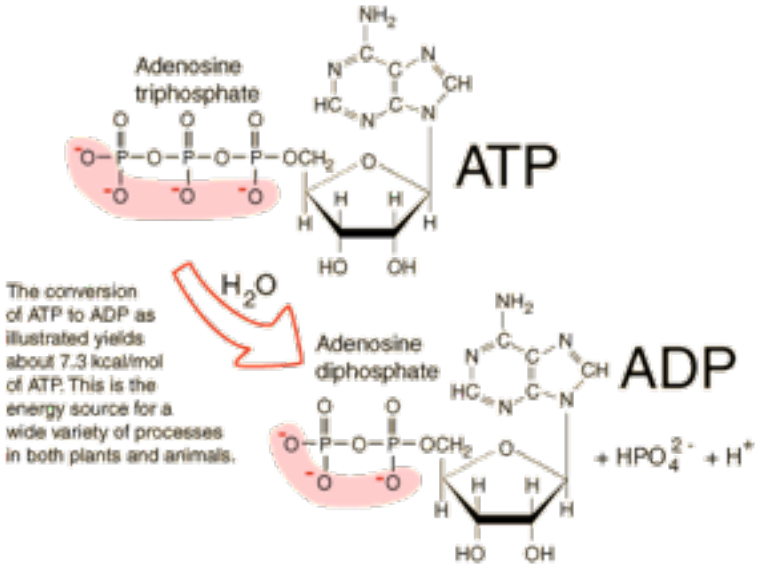


- as the concentration of the substrate increase the rate of reaction also increases until the point in which all the enzymes are being used at any given time then it levels off.
  - an enzyme increase will effect a reaction the same way
- laws of thermodynamics
  - the first law states that energy of the universe is constant and that energy cant be created nor destroyed just transferred
  - the second law states that every energy transfer or transformation increases the entropy, or the amount of disorder or randomness in the universe (energy is lost)
  - exergonic reactions are when energy is released and they occur spontaneously
  - endergonic reactions require energy in order to proceed. they absorb free energy.
  - coupled reactions - chemical reaction having a common intermediate in which energy is transformed from one reaction to another
  - redox reactions - chemical reaction involving the transfer of one or more electrons from one reactant to another; also called oxidation-reduction reaction.

- gibbs free energy is the energy available in a substance to do work

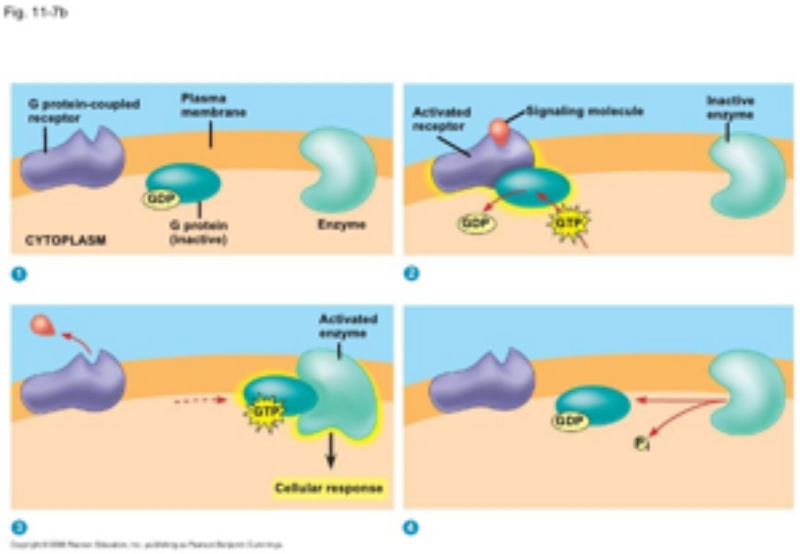


- ATP as energy
  - when the phosphate group in ATP is hydrolyzed energy is release



Cell communication

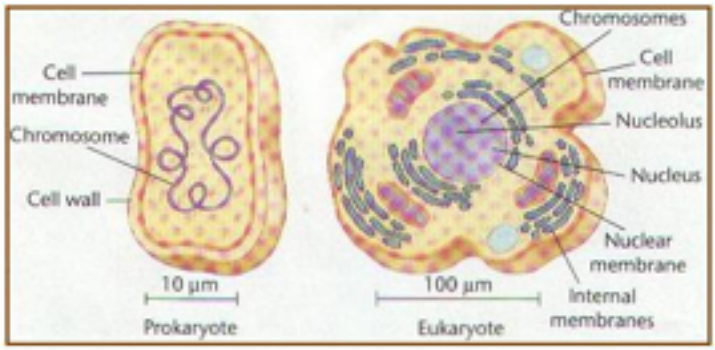
- there are 3 stages
  - reception- the target cell's detection of a signal molecule coming from outside the cell
  - transduction- the conversion of the signal to a form that can bring about a specific cellular response
  - response- the specific cellular response to a signal molecule
  - a ligand (signal molecule) is the key that unlocks the receptor
  - signal transduction pathway often involves a phosphorylation cascade which amplifies the signal



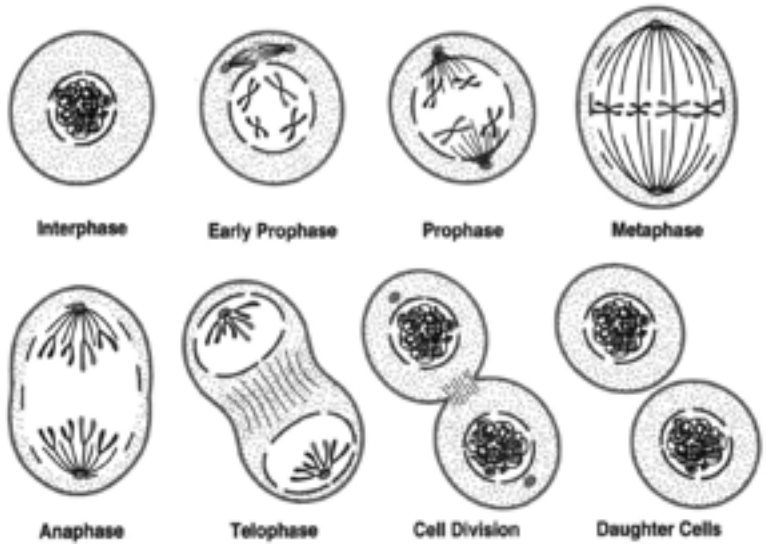
  - this whole process can lead to either a cell response in the cytoplasm or gene expression
  - apoptosis is cell signaling that leads to a controlled suicide
    - cell is systematically dismantled and digested
    - this saves the other cells from damage from rotting cell
    - triggered by signals
    - in multicellular organism it is vital for a normal nervous system, immune system, and normal morphogenesis of the hands and feet

The cell cycle

- mitosis results in two daughter cells that are identical to the parent
- prokaryotes contain circular chromosomes, normally the genome is a circle with extra circles or plasmids
- in eukaryotes DNA is housed in the nucleus and is rapped around proteins called histones
- G0 phase is normal cell nor growth
- in the G1 phase the cell grows while carrying out normal cell function

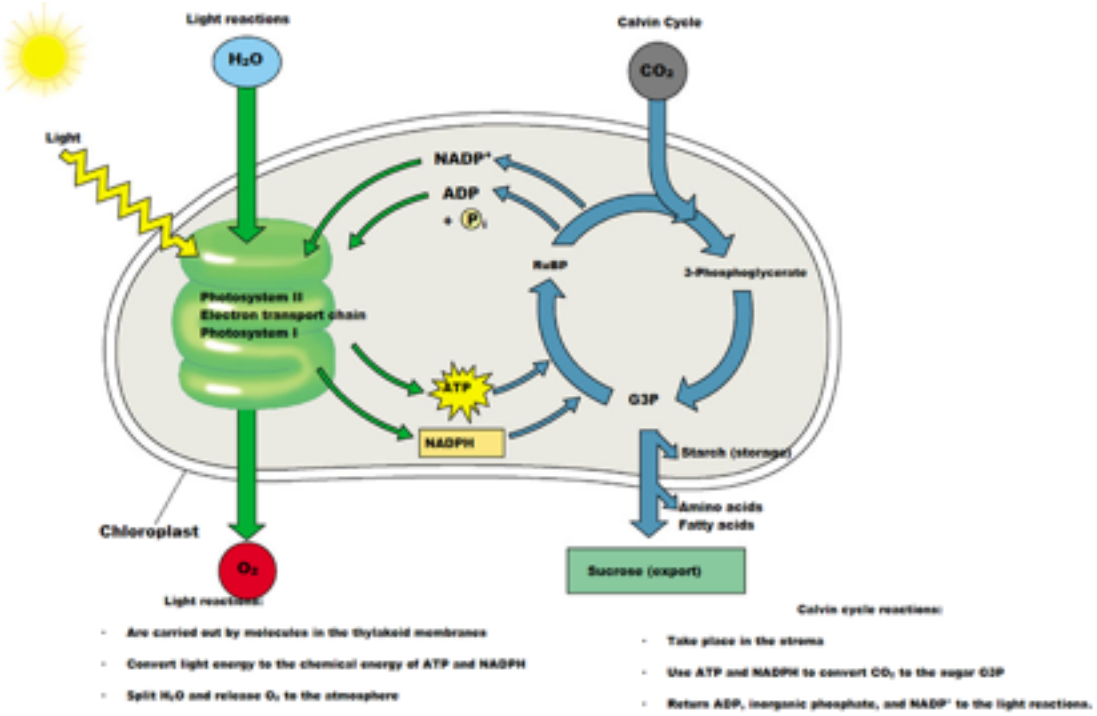


- in S phase the cell continues to carry out its unique functions but duplicates its chromosomes
- in the G2 phase the cell carries out mitosis
- the G1 checkpoint is the most important, at this point the cell gets the go ahead signal to go through the whole cell cycle. if the cell doesn't receive the signal it goes into its non-dividing phase
- Kinases control the cell cycle but the are only activated by cyclin
- cyclin dependent kinases (cdks) are the ones that are dependent on cyclin and are important in the G1 and G2 phases



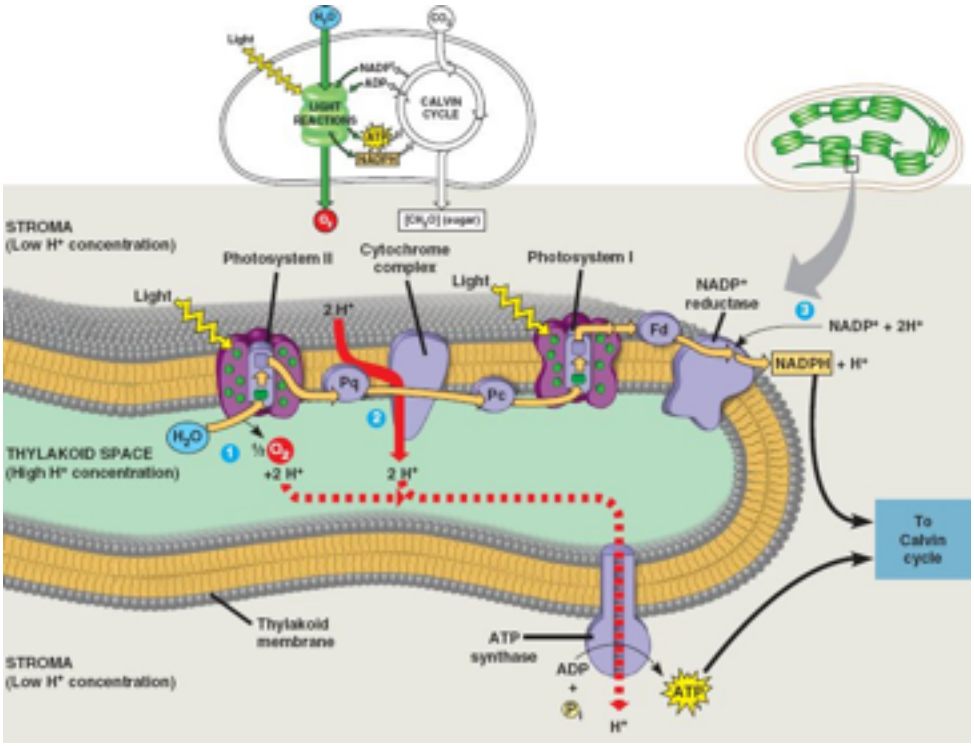
- prophase
  - chromatin becomes more tightly coiled into chromosomes
  - nucleoli disappears
  - the spindle fibers begin to form in the cytoplasm
- pro-metaphase
  - nuclear envelope begins to fragment, microtubules attach to chromosomes
  - two chromatids of each chromosome are held together by a centromere
- metaphase
  - microtubules move chromosomes to equator of cell
  - centrioles are at the opposite poles of the cell
- anaphase
  - sister chroma tides begin to separate, pulled apart by motor molecules
  - the cell elongates
  - at the end of this phase, the opposite ends of the cell contain equal sets of chromosomes
- telophase
  - nuclear envelope reforms around the sets of chromosomes
  - chromosomes become less condensed
  - cytokinesis begins, cleavage furrow forms in animals, cell plate in plants
  - prokaryotes divide by binary fusion

energy of life - photosynthesis



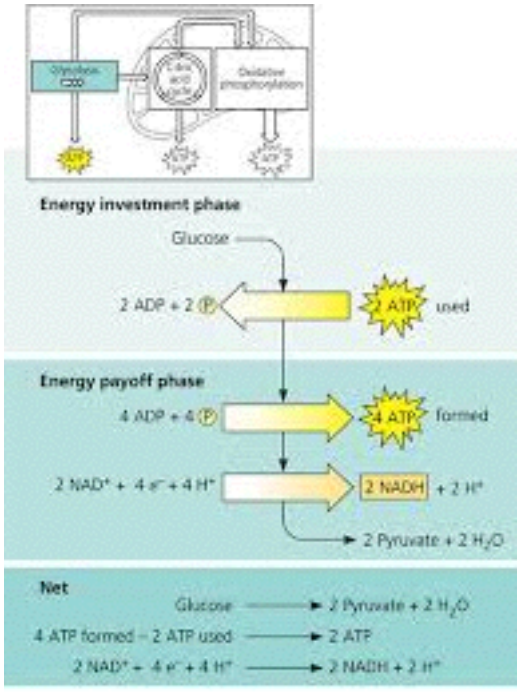
- C3 plants have Co2 enter the plant through stomata, but water quickly escapes through transpiration which on hot dry days can lead dehydration
  - but if stomata are left closed it leads to photorespiration draining carbon reserves from the calvin cycle
- C4 plants have two strategies for dealing with photorespiration
  - structuralualy - separating the two parts of photosynthesis into two different cells
  - biochemically- the extra enzyme PEP cardoxylase fixes carbon. PEP doesn't combined with O2 reducing photorespiration
- CAM plants
  - CAM = crassulacean acid metabolism
  - keep stomata closed during the day and at night the stomata opens and CO2 is fixed to organic acids and stored
- water is necessary for photosynthesis because it is split in photosystem 2 to replace electrons excited in sunlight and passed to the electron transport chain. producing the oxygen we breath

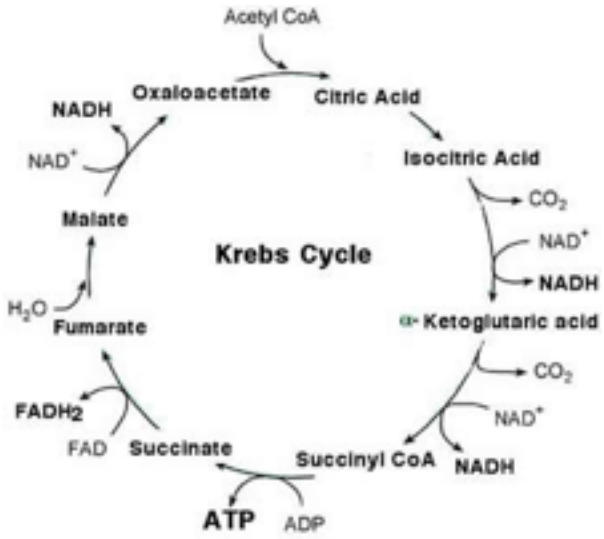
- NAPDH is the final electron acceptor for the light reactions of photosynthesis



cellular respiration

- anaerobic respiration oxidizes NADH to NAD+ so that is can be used again for glycolysis
- energy budget is 2.5 ATP for every NADH and 1.5 ATPS for each FADH2
  - for each glucose = 30-32 ATP
  - oxidative phosphorylation= 26-28 ATP
- you must be able to predict what will happen if something happens to oxidative phosphorylation and chemiosmosis

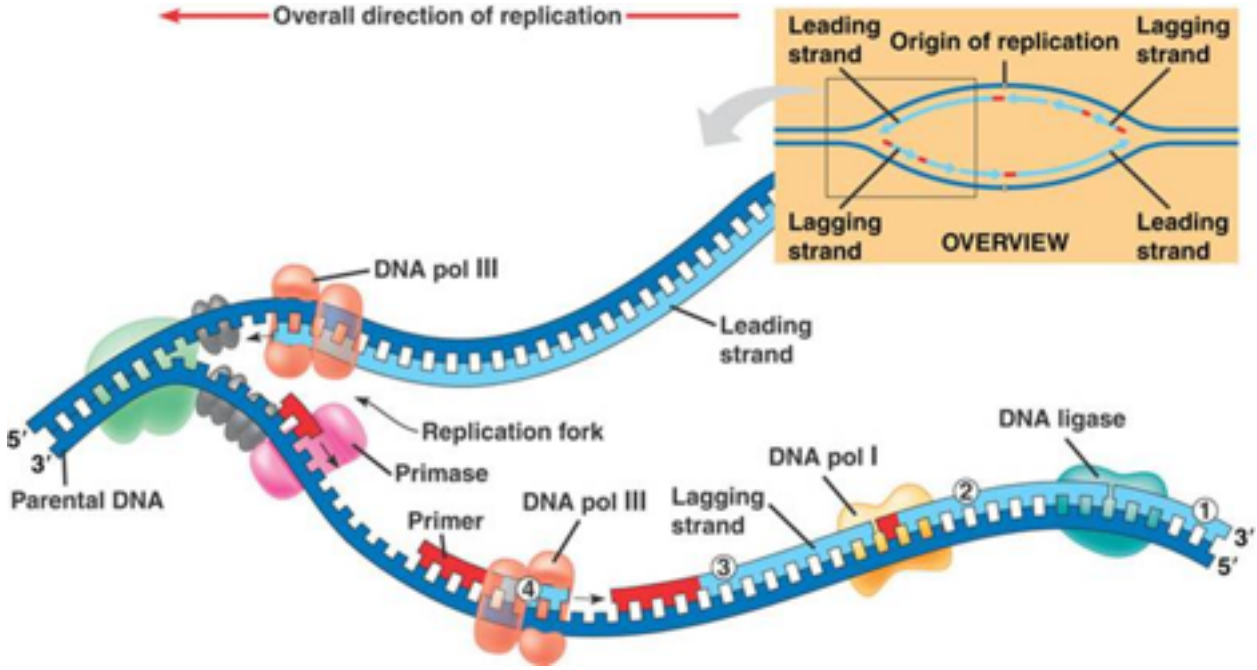




  - chemiosmosis uses stored energy in the form of an H+ gradient across the membrane to do cellular work
  - oxidative phosphorylation is used because ADP is phosphorylated and oxygen is necessary to keep electrons flowing
- O2 is the final electron acceptor in cellular respiration

Molecular genetics

- DNA replication is the making of DNA from an existing DNA strand.
  - at the end each strand has one old strand and one new strand
- steps to DNA replications
  - replication begins at the origins of replication
  - single stranded binding proteins bind to the origin of replication and form a replication bubble by separating the now strands
  - DNA polymerases catalyze he elongation of new DNA at the replication fork
  - DNA polymerase adds nucleotides to the growing chains (A=T, G=C) from the 5 to the 3 direction
  - the lagging strand is synthesized in separate pieces call okazaki fragments, which are sealed together by DNA ligase



  - Understand how DNA replication can be disrupted
  - DNA replication people
    - Fredrick Griffith - understood smooth and rough strains of bacteria
    - O.T. Avery -concluded that DNA had a transforming factor
    - Hershey and Chase - used a radioactive isotope of phosphorus to tag the DNA in bacteria
    - James Watson and Francis Crick - solved the puzzle of DNA shape as a double helix
    - Wilkins and Franklin both worked on X-ray crystallography to visualize DNA
    - **you must understand protein synthesis (3-5 of the study guide)**

BioTechnology

- Biotechnology use DNA processes (replication,protein synthesis) to provide information or produces products for human needs
- electrophoresis is a lab technique used to separate macromolecules primarily from DNA or Proteins
  - an electro current is used to to cause negative DNA to move to a positive electrode
  - gel is used as a matrix to separate molecules based on size
  - DNA must be stained to be viewed
- Polymerase chain reaction - amplifies genes: uses transcriptase to make DNA for mRNA
- Short Tandem Repeats - short DNA sequences that are repeated many times in a row
- Gene Transformation- when the genetic material of a cell is altered by the incorporation of foreign DNA
- BLAST
- gene transformation allows us to insert genes into a plastid in order to get bacteria to produce needed proteins
- Restriction enzyme digests allow us to use restriction enzymes to cut DNA at specific locations

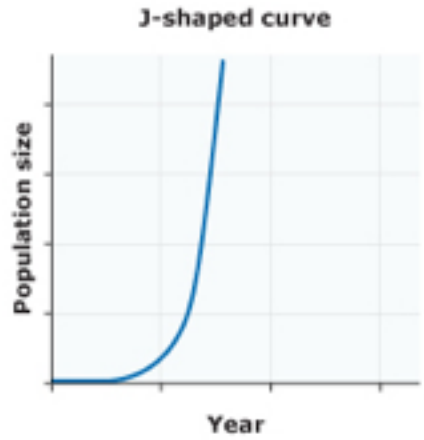
Plant form and function

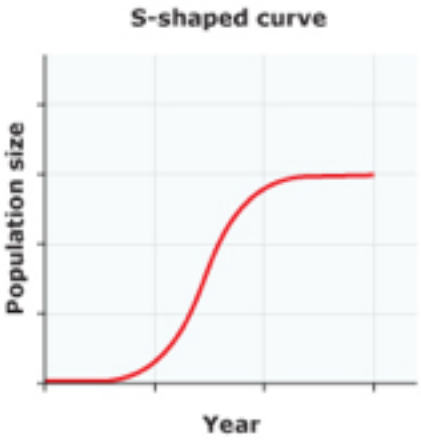
- Transportation is the loss of water vapor from the leaves and other parts of the plant that are in contact with air. the water moves from high to low water potentials.
- a form of chemiosmosis allow minerals to be taken up by roots. root hairs are extensions of plant epidermis and increase surface area of water, minerals, and oxygen uptake.
- plant roots have a symbiotic relationship with a fungus called mycorrhyzea. this is a beneficial to both and is extremely important from an ecological standpoint.

Animal form and function

- homeostasis is when animals maintain relatively constant internal environmental conditions
- negative-feedback system - the animal responds to the stimulus in a way the reduces the stimuli. (sweating when hot)
- positive feedback system- a change in some variable that triggers a mechanism that amplifies the change (a babies head on sensors near the opening of uterus increase contractions)
- the endocrine system regulates hormones and distributes them throughout the body
- the nervous system transmits information between specific locations in the body
  - three kinds of cells receive nerve impulses-neurons, muscle cells, and endocrine cells
- the immunes system obviously fights infection and foreign invaders in the body
  - innate immune responses are barrier defenses
    - barriers - skin, mucous membranes
    - cellular innate immune system are phagocytic white blood cells and antimicrobial proteins
  - adaptive immune system are T and B cells and antibodies more specific than the innate immune system

- **you must be able to know the major structure of nerves, brain, and neuron action potential**
- **and understand the concept of immunology**





Ecology

•exponential growth is the J curve
•keystone species are species that exerts control over the ecosystem because it has an important niche
•Symbiosis
•parasitism - parasite host relationship, parasite benefits host doesn't
•mutualism benefits both species
•commensalism - benefits one species doesn't effect the other
•ecological succession below

- **<u>Also look at the back page of Mrs. Allens study guid and the math under each topic</u>**
- **<u>look over protein synthesis its not on here!!!!</u>**