Biology I

1st Semester Notes

August-December 2004

Thomas, 6th Period

Introduction to Biology: Greek and Latin roots, prefixes, and suffixes

- Ana, de- away, onward, from
- Cyto- cell
- Meta- center or change
- Mitosis- thread
- Chrom, chroma- color
- Inter- between
- Telo- end
- Hydro, aqua- water
- Bi or Di- two
- Tetra- four
- Micro- small
- Solv- to loosen
- Soma, some- body
- Auto- self
- Carn- flesh
- Con, com, cum, col- with or together
- Ex, exo, extra- out outside beyond
- Hemi, semi- half
- Hetero- other
- Hydro- water
- Inter- between
- Trans- across
- Micro- small
- Omni- all
- Pes, ped, pod- foot
- Mono, uni- one
- Soma- body
- Therm- temperature
- Mer- part
- Gyne, gyno- female
- id- compound
- kenisis- motion
- osis- state
- Phase- stage, appearance
- phase- stage
- gen- born or birth
- Pro- forward, before
- lysis- to break
- mer- part
- Tri- three
- A, An- not, not, without
- Macro- large
- De- from, down, away
- Anti- against, opposite
- Bio- life
- Chloro- green
- Eu- tree
- Geo- earth
- Herb- grass
- Homo (GK)- same, alike
- Homo (L)- man
- Intra- within
- Iso- equal
- Mega- large
- Per- through
- Photo- light

•Poly- many
•Stasis- staying
•Zo- animal
•Syn- together
•Andro- male

Chapter 1: Characteristics of Living Things

All Living Things Have-

1. Cells (must have cellular bases) all must have at least one
2. Organization at molecular, cellular, and organism levels
3. Energy requirements and metabolism (not everything eats, but everything does need fuel)
4. Responds to environment: stimulus/response- adaptations (response for survival)
5. Growth (cell division and enlargement) and development (changes)
6. Reproduction (ensures copy and survival)

Chapter 2: The Scientific Method

Traditional Model- Start-off: Problem,
Hypothesis,
Research,
Materials,
Procedures,
Data,
Conclusion (I conclude that…)
Conclusion's an explanation of why something happened. When you make a conclusion, don't simply restate, explain.

Hypothesize- Inductive vs. Deductive reasoning
Inductive (reasoning that'd done when you try to form very broad theories)
Deductive (reasoning from a broad, general example to a specific thing)
i.e.- IN- Because this red snake is poisonous, all other red snakes are poisonous too.
DE-Because all red snakes are poisonous, this specific red snake must be poisonous.

Experimenting- Constants (not controls) vs Variables
*Constants have to stay the same throughout the entire experiment.
A control is a comparison group, not the same as a constant.

Variables- Independent (things you change deliberately- the stuff you're testing) when graphed: stays on x axis
Dependent (response to the change) when graphed: stays on y axis

•Write hypothesis so they illustrate independent AND dependent variables
If (independent variable) then (dependent variable) …
•Titles follow the same format: The effect of…

The Three Types of Controls
1. No treatment control (best kind of control)
2. Known standard
3. Experimenter selected control

Collective Data- Quantitative Data vs. Qualitative Data
Quantitative (refers to numbers or numbering, this is the best method of data collection)
Qualitative (refers to adjs/nouns, more subjective) – may be nominal (placed into categories) or ordinal (ranked- e.g. slow, medium, fast)

Order of data should-
1. Match hypothesis to better see patterns
2. Be in alphabetical order when no other logical order is present

-Do many trials to balance low and high data points (the more complex the experiment, the more chance of errors)
-If you have multiple independent variables, do T-test or ANOVA (Analysis of Variables) to analyze interactive effects
-Average your data: mean (average) median (number in the middle) mode (number that appears most)
-Determine statistical significance of data when possible (use statistics to determine validity)

•Log/Field Reports (descriptive data): Journalizing- making observations for behavioral study

1. Get baseline data first (you need to know what's normal to compare situations)
2. Have rest/recovery periods when dealing with live subjects
3. Randomize trials (to make data more valid)

DISPLAYING YOUR DATA:

Data Tables: (use standard format for easy use)

1. Vertical columns- for independent variables, dependent variables, and derived quantity (average)
   Start at the top. If needed, go from left to right.
2. Divide your dependent variable columns for trials

e.g.

	PULSE RATE				
	Before Exhale			After Exhale	
(trials)	1	2	3	1	2	3

3. Order values of independent variables (smallest to largest)
4. Record dependent variable's values, then average the trials
5. Graph Data
   a. Independent Variables on x-axis, Dependent Variables on y-axis (what happened always goes on vertical axis)
   b. Bar graphs- discrete data (type, number, trials) where intervals between data have no meaning
      (e.g.- boys and girls, they can't affect each other by data)
   c. Line graphs-
      i. Continuous data (example- measuring pulse every hour)
      ii. Measurement involve scales with equal intervals, and intervals between data points have no meaning (points)
   d. Determining interval values for axis:
      i. First, find the difference between the smallest and largest values
      ii. Then divide by 5 (usually)
      iii. Round to nearest convenient counting number
   e. Summarizing Trends on a Line Graph:
      i. When there are many points, draw lines or curves that best fit in the general areas of the points plotted
         1. If data's all over the place, tighten your constants.
         2. If something's way off, then your measurement/data collection may have been inconsistent
      ii. If at a certain point the data "plateaus", be sure to show it *distinctly*
   f. Structural Data- (a picture-labeled diagram)
      i. Label Diagrams with titles
      ii. Ruled guidelines and printed labels
      iii. Provide magnification information

Laws or Principles- Proven or established fact

Theories- Hasn't been established to absolute perfection. There may be gaps in the information. It's not a guess. It's a work in progress that hasn't been disproved, but still has "holes."

TOOLS AND TECHNIQUES 8/25/04

Study technique: don't just memorize, RELATE.

Microscopes-

1. Compound light microscope (most common)
   - Magnification and Resolution –resolve image by focusing
   - (zoom in) (clarity, visual detail)
   - Objective and Ocular Lens- called compound- 2 eyepieces
   - (under nose-piece), (actual eye piece, 10x)
   - Magnification regarded as TOTAL magnification
2. Stereomicroscopes
   - 2 eyepieces- 1 piece/eye (simpler construction)
   - Look at items too large
   - AKA dissecting Microscope
   - Gives 3D image (microscope is flat)
3. Transmission Electron Microscope (TEM)- like big boxes
   - (Look at thing 2 or 3 cell layers thick)
   - It's a vacuum, has beam of electrons, straight thru sample
   - Incredible Detail, 100s' to 1000's times normal size
   - 2D Image, Picture's black and white
4. Scanning Electron Microscope (SEC)
   - Beam of electrons, sweep across surface of object, instead of down like TEM, scans/reflects light
   - 3D image, but not as magnified 10's of 1000's magn.
5. Scanning Tunneling Electron Microscope (STM)
   - Uses probe to get work done, Million's magnification, 3D, can see e- cloud! (newest)
6. Phase Contrast Microscope
   - Can see living cells
   - Creates interference, so you see in shadows, gives you depth light (Micros have BRIGHT light)

Separation Techniques-

1. Get electrophoresis (most common, especially in forensics)
   - To separate, load up in gel, load object, to have negative/positive charge, separation's based on size
   - Make bands on a graph, separation of size and change
2. Cell fracturing and Centrifuging (turning on central gravity)
   - (breaking)
   - Put your cells in a blender
   - Centrifuging- separation by density: dense at bottom, light at top
3. Chromatography
   - Refers to dissolving- items dissolved with pigments based on solubility (must know which solvent to use)

FOR QUICK ASSESSMENT OF EXPERIMENTAL DESIGN SKILLS:

THE EXPERIMENTAL DESIGN DIAGRAM

Title: The Effect of the _____ on the _____.
(Independent Variable) (Dependent Variable)

Hypothesis: If the _____ _____.
(Independent Variable) (Describe how it will be changed)

then the _____ will _____.
(Dependent Variable) (Describe the effect)

Independent Variable (IV): ----------> IV:

Levels of the IV:
(Draw in one column for each level) ----------> | | | |

Number of Trials ----------> | | | |

Dependent Variable (DV): ----------> DV:

Constants (C): ----------> C:

Chapter 3

8/30/04
Organisms and Interactions in Environments

- Ecosystems and Communities
    - Ecosystems- physically distinct system of living and nonliving things interacting supporting and sustaining each other
    - Biotic and Abiotic factors- living and nonliving factors
    - Communities- all living populations that interact with each other (various species)
        - Biospheres are divided into biomes→various ecosystems→communities
    - Populations- one species living in one place
    - Habitats and Niches
        - Habitats are environments/surroundings
        - Niches are organisms' role in the environment, such as how they use their resources, where, when, etc.
    - Fundamental Nice Vs. Realized
        - Fundamental- a niche involving limitless resources
        - Realized- niche in a circumstance found in the real world
    - Competitive Exclusion Principle- no two organisms can occupy the same exact niche because competition is too direct, 2 competition results- move out, or die

9/1/04
Interactions Between Organisms

- Trophic Levels
    - Represents a step in the transfer of energy and matter in an ecosystem
    - Herbivores, carnivores, omnivores, scavengers, decomposers (detrivores)
- Consumer Levels-
    - The level in which the organism consumes
    - Consumer levels, for all organisms constantly change depending on what they eat
    - First order- herbivores, Decomposers- occur anywhere on the pyramid
- Food Chain
    - Simple model to show how matter and energy moves
    - Represents only one route for the transfer of matter and energy
    - Algae→ fish → heron
- Food Web
    - Expresses all possible feeding relationships
    - For example, bear can eat elk, chipmunk, and seeds. There's more than one thing for the bear to consume.
- Ecological Pyramids
    - Depicts energy conversions in a an ecosystem
    - Energy, numbers, biomass (dry weight component- which is weight minus water)
        - Energy: illustrates that energy decreases at each succeeding trophic level (90% of the energy is lost at each level, 10% energy transfer)
        - Numbers: based on population sizes of organisms at each trophic level (Population sizes decrease at each higher trophic level)
        - Biomass: weight of living material at each trophic level (Calculated by finding the average weight of an organism of each species and multiplying by the estimated number of organisms in the population— as trophic level gets higher, biomass decreases)
- Biological Magnification- there are poisons/toxins in environment, when you go higher up the food chain, there's more and more toxin. The more you eat, the more toxin from "body fat."
- Symbiosis- parasitism, mutualism, and commensalisms
    - Symbiosis is the longer term living relationship, could be permanent
    - Parasitism- host is damaged, parasite benefits
    - Mutualism- both benefit
    - Commensalism- one benefits, other is not affected, neither hurt nor helped
- Biochemical Cycles
    - Hydrolic cycle: evaporation, condensation, precipitation, transpiration
        - Transpiration- form of evaporation- water evaporation from plants
    - Carbon cycle: photosynthesis, respiration, decomposition; combustion
        - Combustion- roadkill, bacteria decomp by bloating it with CO_2

- Greenhouse effect- heat trapping because of CO_2 "layer" (bouncing heat off of CO_2 to keep heat in)
- Nitrogen Cycle: **nitrogen fixation** (bacteria in plants root nodules "fix the nitrogen into organic compounds) **ammonification** (soil bacteria convert organic compounds to ammonia and ammonium**) nitrification** (more soil bacteria convert to Nitrate) **dentrification** (soil bacteria take nitrate and convert back to nitrogen into the air)
  - Nitrogen- plentiful, useless to humans because we intake and exhale nitrogen without using it
- Phosphorous Cycle- plants get phos from dirt, use, animals eat plants, animals die, phos goes back to dirt
  - No gas- cycles as phosphate
  - Long cycle- to get phos from lake, must have geologic uplifting/weather/erosion- i.e. earthquake

Chapter 4

9/1/04
Community Distribution: Succession/Biomes

- Primary Succession- new intro of life, not even old soil, everything new- from scratch
- Secondary- there was a community there, but something happened (ex-fire)
- Seral and Climax
  - Changing terrain/environment- things get replaced
  - Succession occurs at the end, stable almost
  - Seral- intermediate community that alters the environment
- Eutrophication- adding nutrients to a system (may be run offs, or deposits that don't belong there)
  - Could be harmful/helpful, depending on the situation

Marine Biomes

- Horizontal zones:
  1. intertidal zone (zone between low and high tide)
  2. neritic (area over ocntinental shelf— deep slope)
  3. open sea (oceanic)
- Vertical Zones:
  1. photic (where light penetrates)
  2. aphotic (no light zone)
  3. bathyal or Benthic (on the bottom)
  4. abyssal (canyons/valleys under water)

***Plankton**- stuff that floats, **Nekton**- swims, **Benthos**- living on the bottom, **Bioluminescence**- make their own light in deep dark places like benthos/abyssal

Freshwater Biomes

- Oligatrophic lakes
  - New, deep lake, usually formed by Glacier action
  - Not many fish/plants
- Eutrophic lakes
  - Eutrophied, nutrition already there
  - Many decayed matter, fertile, shallow
- Estuaries
  - Fresh water meets salt water
  - Near coastlines
  - Brackish- not so salty

Effect of Latitude on Climate

- Diffs in latitude and angle of heating result in 3 main climate zones
  - Polar zones- sun's rays strike earth at very low angles; it's too cold!
  - Temperate zone- between polar and tropical zones: you get seasons
  - Tropical zones- near equator; most direct sun; so nearly always warm
    - Tropic of cancer- equator to 23.5 degrees north
    - Tropic of Capricorn- equator to 23.5 degrees south

- Heat transport in the Biosphere
    - Unequal heating at Earth's surface drives winds and ocean currents
    - Heated air over equator rises, cold air over arctic sinks
    - Winds move from areas of sinking air to areas of rising air
        - Similar patterns occur in the ocean
        - Surface water is moved by winds
        - Landmasses interfere with air movement; the result? you see clouds and rain

Terrestrial Biomes

- Tundra and permafrost (partly frozen soil)
- Taiga (boreal or coniferous forest) deciduous- evergreen trees, elk and moose
- Temperate (deciduous) forests
- Grasslands- prairies, steps, combus, savannahs- most fertile soil
- Tropical rainforests and epiphytes (plants that live on the other plants for support)- various life, equator
- Deserts- dry- very hot/very cold cacti, arthropods, reptiles

Chapter 5

9/9/04
Populations

- Biotic potential- capable of reproducing a lot of its own organisms
- Carrying capacity- maximum population size environment can sustain
    - Density dependent- population size counts
        - Space, food/resource, stress/diseases
    - Density independent factors- independent
        - Environment disasters, temperature, climate
- Dispersion Patterns
    - Clumped (most common)- clustered together
        - Resource clumps→ animals clump
    - Uniform (like trees, spreading out)
    - Random- very rare (i.e. mountain lion- clump when mating, normally spaced away)
- Growth Patterns
    - Exponential Growth
        - Lag phase, acceleration, doubling time
        - Characteristic shape- J Curve
        - Stabilized Growth
        - Deceleration at carrying capacity
        - S curve- hover at carrying capacity
- Growth Rate
    - [(B+I) – (D+E)]/ Total Population
        - B- birthrate, I- immigration, D- death, E-emmigration
    - Multiply 100 for %
    - Doubling time= 70/GR
    - Replacement Reproduction
        - + value- population increase
        - - value- population decrease

Chapter 6

9/13/04
Use of Resources and Biodiversity

- Water conservation and Pollution

- Desalination plants- factories take salt out of water (evaporate, condense, let water drip)
- Watersheds- areas of water where all freshwater rivers (or bodies of water) come together
- Chemical pollution- toxic dumping, natural fertilizer runoff (could cause explosion of alga blooms, which could deprive the fish and life of oxygen)
- Thermal pollution- charging temperature of water- warm water holds less oxygen- suffocation

- Air Pollution
  - Particulates and gases (such as sulfur, etc)- like matter or car exhaust
  - Thermal Inversions (i.e.- fog, but it's not harmful)- change normal pattern of warm→cold air, smog= harmful
  - Acid precipitation with sulfur and nitrogen oxides
    - Precipitation can be rain/sleet/snow, etc.
    - Acids damage tissue
  - Ozone depletion- O_3 damaged by CFC (chlorofluorocarbons)- ozone protects from ultraviolet light
  - Greenhouse effect
    - Too much CO2 in the air, trapping too much heat- global warming

Energy Conservation
- Minimum use of fossil fuels: there are alternative resources
- Fusion and fission: Fiss-splitting atom- huge amt of clean power, no pollution, risk- radiation. Fus- 2 atoms bonded to form helium, can be found in sun, takes too much HEAT, "can't be done"
- Solar (solar panels), Wind (wind mills, turbines), Geothermal (hoping to get steam from geysers), Hydroelectric power (find power in dams→ turns water turbines)

Soil Erosion
- Prevent erosion: 1. Contour plowing (hill-plant horizontally across hill, not up and down, across)
  2. Terracing (planting like stair steps)
  3. Strip Cropping AKA contraplowing (plant alternating rows, 1st row corn, 2nd row beans, one of the plants are used to hold soil in, retains water too, rows keep dirt in place
  4. Windbreaks (natural breaks, such as trees/fences to hold soil in)- diff crops per season
  5. Crop rotation- 1 season beans, next- seeds, next- beans- sutff using diff minerals so the for one whole year minerals beans uses have time to grow back, when growing beans again, corn minerals grow back

Threats to Biodiversity (threats to multiple species)
- Habitat loss/degredation (destruction/pollution)
- Habitat fragmentation (cut area into little pieces, such as for houses and civilization)
- Edge effect- diff ecosystems' edgeline meet, at the intersection exists HIGH biodiversity, by effecting edge, u disrupt 2 habitats

Conservation Biology
- Preserve resources and species
- Captive breeding programs and refugees ← (natural state land) -this is the case for plants too

Chapter 7: Basic Inorganic/Organic Chemistry

9/17/04

Chars of matter-

Matter- anything has mass and takes up space

Unit of matter is atom- protons (1 mass unit) neutrons (1 mass unit) and electrons (considered 0)
Dalton/AMV- unit of measurement

•Atoms- electrically neutral
Elements (can't be broken down)
90 natural elements- about 25 used in normal
most biologically important- CHNOPS then Ca, K, Na, Cl, Mg
atomic # = # of protons
atomic mass= # of protons and neutrons

Isotopes and radioactive Isotopes-
Isotopes of an atom have same atomic # as its similar atom, but has different atomic mass (more neutrons)
Radioactive- unstable isotopes- give off one or more parts to become more stable (can be used for diagnosis)
Halflife- how much time for half to decay
Exponential- ½, $½^2$, $½^3$, $½^4$

Electron Energy Levels (shells)
First-2, second-8, third- 18
lose/gain to be stable; outer level must be filled

•Each orbital: 2e- (Orbital is where you find electron 90% of the time)
Octet Rule: if it has 8 e- in the level it can be stable anyway

•Ground vs Excited State
Ground- light off, at lowest energy level
Excited- light on, going onto the highest level the energy inputs

•Bonds
Bonding is interactions between valance electrons (outer shell electrons)
Electronegativity- attraction of free (valance) electrons
High- strong pull (ex-oxygen)
Low- low pull, won't share

Ionic bonds- transfer electrons
*ion- a charged atom
Cations- positively charge ion (lose e-)
Anions- negatively charge ion (gain e-)

Chars of ionic bonds-
Crystals (form crystals), electrolytes (conduct electricity), solids (no gases/liquids)
Best between metals and nonmetals (strongest ionic bonds between right and left side of elements chart)

Covalent Bonds
Share pairs of electrons- can share 1 pair (single bond), 2 pairs (double bond), 3 pairs (triple bond)
Can be polar (unequal sharing) or nonpolar (equal sharing)
Polar: e- spend more time on one nucleus, unequal sharing one; one side becomes more or less charged- positive/negative
(ex- H2O. H's are a slightly more positive, but O is slightly more negative)

9/20/04

•Covalent Bonds- solid line
-share pairs of electrons
-single, double, or triple bonds
-nonpolar or polar covalent bonds
-polar- due to unequal sharing of electrons
-O=C=O and N=N are nonpolar
--all diatomic molecules are nonpolar
(diatomic molecules have one or more of the same atom)

•Weak Bonds- dotted line
-hydrogen bonds

-hydrophobic or hydrophilic interactions
-hydrophobic- doesn't form bond with water
ex. Oil and nonpolar covalent bonds
-hydrophilic- forms bond with water
ex. Polar covalent bonds

•Molecules vs. Compounds
-(Elements are 2 or more pure atoms)
-Molecule- more than one atom (smallest amount of a compound)
ex. H2O and H2
-Compounds- more than one element
ex. H2O
-Molecular Formula- what element and how many of each (ex- H2O)
-Structural Formula- arrangement, how molecules are distributed

-Molecular Weight- sum of atomic masses (as in the # of proton & neutron) that are present in the compound
H2O2- atomic mass- H=1 O=16
1(2)+16(2)=34
-Compound Properties- (or properties of a compound) - #, type, and arrangement of the atoms

•Chemical Reactions- making or breaking bonds
-metabolism- sum of all our chemical reactions
-anabolism- synthesis, reactions that put things together
ex. Anabolic steroids
-catabolism- decomposition, taking things apart
ex. Digestion

*Chemical Reactions- energy required to start reaction

•Reactants and products in chemical equations
-Reactant= H2 + O2→H2O2= Product
-Reactant = H2O2→ H2 + O2= Product
-Balancing Equations
# of atoms in reactants must equal the # of atoms in the product
-Synthesis reactions- 2 things combined to form a 3rd thing (A+B→AB)
-Decomposition Reactions- One thing breaks down to 2 things (AB→A+B)
-Exchange/Replacement Reactions- the things are exchanged
AB + C=AC + B (Single)
AB+CD=AC + BD (Double)

9/21/04

Thermodynamics-

•First law of thermodynamics- matter can be changed (it can be neither created nor destroyed)
•Second- If left to itself (with no other outside factors) system tends toward greatest stability
•Endergonic (endothermic) Reactions- more energy going in than going out
•Exergonic Reactions (exothermic)- opposite: more energy going out than in
•Mixtures- not always solutions- salt/pepper, don't dissolve/distribute evenly
(can easily pick apart parts, can see it, in solutions you can't)
•Solutions- types of mix, all one thing, distributed evenly
•Solvents- what's doing the dissolving (i.e. water/liquid)
•Solutes- get dissolved
•Concentration- how much solute you have in given amount of solvent
•Saturation- 100% concentrated (maximum amount of solute)
add beyond this point, falls to the bottom (normal- won't super-saturate)

Rules of Solubility

1. Like dissolves like (polar dis polar, non dis non)
2. Network crystals are insoluble (like diamonds, tight compact structure)
3. Ionic bonds will disassociate in polar solvents (cation away from anion)

Intermediate Solutions (large particle sizes, halfway dissolved, not completely)

- Suspensions- blood (only thing suspending them is the circulatory movement)
- Colloid [semi solid]- jello-like Ex: cytoplasm – if not for movements, solid sinks to bottom

Colloid States: all colloids have these 2 states

1. Sol (liquid state)
2. Gel States (semi solid)

Aqueous Solutions

- Water is a polar covalent compound
- Chars (all) due to formation of Hydrogen bonds
  - Cohesion- (H_2O forming bonds to other water molecules)
  - Adhesion (forming with any other charged substances)
  - Capillary action- cohesion and adhesion simultaneously
  - High Surface Tension- line of H bonds at surface against air
  - High Heat Capacity- (stabilizing) big add of heat/subtraction to make little change in the temp
  - Specific Heat- amount of heat needed to change 1g of H_2O by 1 degree Celsius
  - High Heat of Vaporization- transformation from liquid to gas takes much heat to go from liquid to gas; liquid to solid lost much heat (lots of heat involved in changing states)

9/22/04

Acids, Bases, pH

- could only work with water as solvent (pour into here)
- ph stands for percent hydrogen
- when measuring, measuring H ions

H_2O

H^+ Hydrogen ion

(acid)- sour, if strong, corrosive, eating away

OH^- Hydroxide ion

(base) increase Hydroxide or could absorb H, taking it out of water, bitter, feel soapy/slimy, if strong- corrosive

pH Scale-

0----------7----------14

H^+ Neutral OH^-

$pH = -\log [H^+]$ $^{H^+ = OH^-}$

Using scale of base 10 (logarithm) (neg scale-lower-stronger acid –much stronger-)

*Strong H+ and OH- Reactions

$HCl + NaOH \rightarrow NaCl + H_2O$

(Salt)

You get salt H_2O when you have strong H^+ and OH^-

*Buffers- things that resist pH change (prevent sometimes)

9/24/04

Inorganic and organic compounds

- Inorganic compounds do not contain <u>carbon</u> 90% of the time
- Characteristics of an inorganic:
  - Nonliving
  - small number of atoms
  - no carbon and hydrogen together

- metals or nonmetals
- ionically bonded

- Characteristics of organic compounds:
  - Living (usually, either that or part of a living compound)
  - Large number of atoms
  - Covalently bonded
  - Carbon and Hydrogen appear in the same compound

- Functional groups – group of atoms that give certain carbon skeletons very definite qualities (some act like acids or bases, some are seen in only certain locations) (the structural basic) These are all <u>polar</u>
  - Amino group (NH_2)
    - Found at the end of the a carbon molecule chain
    - Found in proteins in organic compounds
    - Found in nucleic acids (DNA/RNA)
    - $NH_2 + H^+ \rightarrow NH_3$
    - It acts like a **base**; it absorbs hydrogens
    - Also known as a nitrogen base
  - Carboxyl group (COOH)
    - Seen at the end of a molecular chain, double bonded with one oxygen and bonded with OH
    - Tends to lose the hydrogen atom and become ionized
    - Acts like an **acid** because it donates the hydrogen (it gives/adds H+ ions) OH stabilize H ions, by donating. Because of donation, any acids add H+ ions to solvents.
    - Found commonly in carbohydrates, proteins (because carboxyl group is the building block of the amino group) and the ends of fatty acid chains (lipids)
    - O - C - OH
  - Hydroxide group (OH)
    - Hanging off of a molecular chain as OH
    - **Very polar**
    - Dissolve in water easily due to polarity
    - It can act like a base if it is alone and free
  - Phosphate group (PO_4)
    - Phosphate is in the middle with four oxygen atoms linked off of it, one oxygen with a double bond; and a carbon linked off of one oxygen with one bond
    - Seen in nucleic acids like DNA, energy molecules (ATP, fuel in body)
    - **Very polar**
- (Isomers) monomers, and polymers
  - (Isomer – same unit) ---> see as separate group (same molecular formula, different molecular structure)
    - Molecules that have the same molecular formula but a different structural arrangement
    - Each isomer has its own chemical properties depending upon arrangement
    - Glucose and fructose are isomers ($C_6H_{12}O_6$)
  - Monomer – one unit
    - Building block, like Legos
  - Polymer – many units
    - Building blocks, like Legos
  - Dehydration synthesis/condensation
    - You form water first between two monomers which therefore creates a bond between the monomers → condensation
    - Two or more monomers linked by covalent bonding is called a polymer

- Hydrolysis
  - Inserting a molecule of water in between the covalent bonding breaks the polymers apart
  - The exact opposite of condensation

- Organic compounds: carbohydrates
  - *Sugars, fruits, cereal, bread*
  - CH_2O is the general formula (1:2:1 ratio; look for 2:1 in hydrogen vs. oxygen)
  - –*ose* ending for names (glucose, cellulose, fructose)
  - Monosaccharide monomer
    - The building block for a carbohydrate is the monosaccharide monomer
    - Monosaccharide means one sugar
    - Most common monosaccharide is glucose
  - Quick energy: mono-, disaccharides
    - Quick energy as in a few minutes or hours
    - Disaccharides are double sugars (sucrose, candy sugar)
- Energy storage or structural carbohydrates: polysaccharides (also known as complex carbohydrates for polysaccharides)
  - Starch
    - Polysaccharide that plants use; this is how plants store energy
  - Glycogen
    - Animal form of starch
    - How we store our carbohydrates (muscles and liver) which isn't much
  - Cellulose
    - Structural carbohydrate
    - This is what you find in the cell walls of plants
    - *Long strings of celery*
    - Do not digest cellulose, but it's good for fiber and cleans intestines

9/27/04

: Lipids- fatty acids and glycerol monomers

H:O ratio greater than 2:1 with long, nonpolar chains

•Fats oils, waxes, steroids-->related to lipids

•2 diff types of lipids- saturated vs unsaturated

unsaturated- somewhere in C chain, you have H bonds, but at least 1 double bond, (less full of H)

1 Double bond- monounsaturated

2 Double bonds- polyunsaturated

•Carbs- 50/60 percent of diet

: Proteins (10 percent of diet)- building blocks- amino acids

monomers- building blocks

amino acid monomers

amino (at one end) and carboxyl groups (at other end) , R groups (monomers- building blocks)

•Peptide bonds: dipeptides polypeptides (3/ more in a chain)

•Levels of Protein structure

1. Primary level (linear sequence of amino acids) aa-aa-aa-aa (amino acids)
2. Secondary level (Helix/pleated sheath) (charges keeping it in shape, bonds)
3. Tertiary (globular proteins (egg whites- globulus protein)
4. Quaternary (2 or more of tertiary) (hemoglobin)

If you alter the shape, you alter the function.

•Denaturing Proteins- pH, high heat (altering structure, unraveling protein)

•Proteins as biological catalysts (speeds up reactions)

Enzymes (proteins) lower activation energy- ex. Someone pulling your bicycle over a hill

Lock and key mechanism for enzyme (your key fits into a lock)

You have an enzyme which has an activation site, the hole where you will soon put the key in, and the substrate, which is the key
Substrate-->Enzyme (-ase suffix) ex. (lactose-->lactase)

•Coenzymes (not proteins, not enzyme, another organic substance) ex-vitamins in your body, coenzymes are helpers of enzymes, organic
(co factor is inorganic assistance for enzymes)

: Nucleic acids

DNA, RNA (nucleotide monomers, 5 carbon sugar, attached to phosphate, N base)
Dna is info storage/genetic information (DNA is instruction-blueprint)
RNA is DNA assistance

Chapter 8: Cell Structure and Functions

10/4/04

•History of Cell Theory
- Anton Von Leeuwenhoek
  - Dutch-lens maker
  - Discovered primitive way to make microscope
- Robert Hooke
  - Gave cell its name "cell"
  - Idea from seeing monk's cells/prisons (from cork cell)
- Robert Brown
  - Named and described function of nucleus
- Schleiden, Schwann, Virchow
  - Proposed cell theory

•Parts of the Cell Theory
- Cells are the basic unit of structure and functions for life
- Living things are made up of at least 1 cell
- Cells come from other cells

•Things that Don't Fit Cell Theory
- Viruses
  - Not nonliving not living, not cells (no structure of cells)
  - Have genetic material, can reproduce
- First Cell
  - Where did first one come from? (cell comes from cells)
- Mitochondria and Chloroplast
  - Have their own DNA that can separate
  - Have ribosomes
  - Can reproduce
  - Almost like they're acting independently

•Cell Sizes and Groupings
(Reproductive single cells)
- Mycoplasmas
  - Special bacteria- smallest cells
- Ostrich eggs
  - Largest cells
- Nerve cells
  - Largest in our body
- Unicellular, multicellular, colonial/aggregate
  - None/dependent on another- more than one/ super glue together unicellular independent put together

•Two Cell Types
- Prokaryotes
  - No membrane bound nucleus
  - No membrane bound organelles
  - Bacteria and cyanobacteria (only 2 examples)
- Eukaryotes (most this type)
  - Nuclear envelope (membrane-have genetic material)
  - Membrane bound organelles
  - More advanced

- All cells except bacteria

•Cell Structures (all cells have)
- Cell membrane
- Nucleus (genetic stuff)
- Cytoplasm

10/5/04

•Fluid Mosaic Model of Cell Membrane Structures
-Fluid- bunch of lipids in membrane
-Mosaic- proteins within lipids
-Bilayer of phospholipids with embedded proteins (stuck in the layers)
-Polar heads of lipids on outside, nonpolar tails on inside of membrane
-Channel proteins- like an open door- letting things come in and out, if thing small, goes in, if big, not
-Carrier Proteins- walking through the wall- changes shape to let things thru, very SELECTIVE
-Recognition Proteins- (identification markers) glycoprotein, glycolipid
-Membrane is semi-permeable (allows stuff to go in/ through)
Small, nonpolar gases enter most easily thru lipids
-Cytoplasm: Cytosol + Organelles
Cytolsol- liquid part
Organelles (all stuff inside cell)

•Nucleus (control center)
- Controls cell processes
- Has DNA, RNA, proteins (is a manual to operate cell)
  - DNA- genetic blueprint/book
  - RNA- assistant to carry messages across
- Chromatin vs Chromosome state for DNA
  - Chromatin- loose (tangled up, not clear)
  - Chromosome- condensed (visible only during mitosis/meiosis)
- Nucleolus
  - Makes ribosomes
  - Instructions
  - Has RNA
- Nuclear Envelope

•Ribosomes and the Endoplasmic Reticulum (ER)
- Ribosomes- in charge of protein synthesis (putting chain of amino acids together)
  - Free- loose, unattached
    - Make proteins inside the cell
  - Bound- bundled together
    - Attached to ER (ER's a fold of membrane)
    - Make proteins for export
- Endoplasmic Reticulum- internal transport
  - Smooth
    - No ribosomes on it
    - Detoxifies
  - Rough
    - Has ribosomes
    - Make proteins for export

•Golgi Apparatus and Mitochondria
- Golgi bodies- process, package, secrete chemicals
- Mitochondria- cell respiration, energy organelle
  - Have own DNA
  - Can replicate

•Cytoskeleton and Vacuoles
- Cytoskeleton - for movement and support
  - Microfilaments- long skinny solid threads (Mardi gras beads)
    - More for support than movement
  - Microtubules- straw-like

- Vacuoles- Storage
  - Animals- have many
  - Plants- one big one in the middle

•Structures Limited to Animal Cells
- Lysosome- like round bubble
  - Break down things
  - Hydrolytic atoms present here (Hydrolytic means the stuff that splits by inserting water)
- Cillia and Flagella
  - Flagella- like tail
  - Cillia- like hair
- Centrioles
  - Make fibers that attach to chromosomes and pull them apart

•Structures NOT in Animals (Mostly Plants)
- Placids
  - Chloroplasts (store chlorophyll-green)
  - Chromoplasts (store any other colored pigment- not green)
  - Leucoplasts (store food)
- Cell Wall
  - Cellulose in plant cells (cellulose- cell wall's made from this)
  - Other substances in bacterium, fungal cells
  - Secondary cell walls in plants with wood (such as xylem/phloem)

Chapter 9: Transport Across Cell Membranes

10/7/04
PASSIVE TRANSPORT (no energy needed)
- Brownian motion- random movement of molecules (hit each other)
  - Notice that molecules vibrate and collide
- Diffusion: molecules move from high to low concentration
  - Move down or with a concentrated gradient (move to be equally balanced)
  - Gradient- difference between high and low concentration
  - Uses Brownian motion as part of this diffusion
- Rate of Diffusion
  - Affected by temperature (hotter-faster)
  - Affected by pressure
  - Affected by concentration
- Osmosis- diffusion of water across a membrane (high→low concentration)

•Types of Osmotic Solutions (3)
- Hypotonic (less-solution): Less solutes, more water (in relation to something else)
- Hypertonic: more solutes, less water
- Isotonic: equal water (= solutes)

•Role of Osmosis in Cell Transport
- Plant turgor pressure- hypotonic solutions
  - Turgor-water pressure as vacuole presses cell wall (hypotonic environment-beneficial to plant rigidity)
- Plant plasmolysis
  - Hypertonic solution- water moves out, vacuole and cell wall shrivels/shrinks
  - Bunches up and collapses
- Animal Cell Cytolysis (cell bursting- no cell wall)
  - Hypotonic solution
- Animal Cell Collapse
  - Hypertonic solution
  - (Blood cell crenation- shrivel up- no drinking ocean water)
- Best solution in animals is isotonic, plants is hypotonic

•Facilitated Diffusion
- Passive transport that uses a carrier PROTEIN
- May occur because substance is too large/polar to go freely across cell membrane
- Carrier changes shape when adjusting to different substances that is to be transported

- Glucose Transport- large and polar- use carrier protein

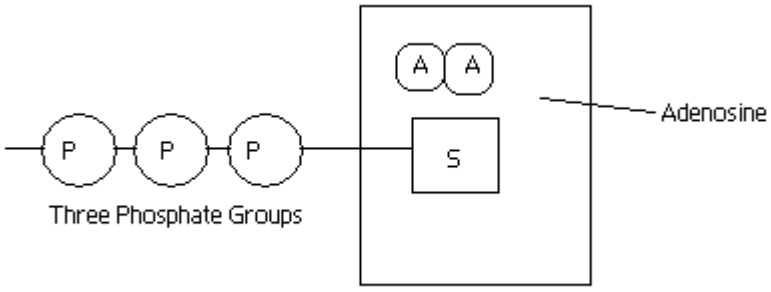
10/8/04
ACTIVE TRANSPORT
- Requires ATP energy and a carrier protein
- Membrane "pumps"- force molecules to move against concentration gradient
- Moving from low→high concentration (ex. Energy involved, pedal uphill)
- Where do you use this? Glucose storage in liver muscles

•Buck Transport of Large Molecules (could be protein/whole cells)
- Exocytosis
  - Something in cell's packed in vacuole, vacuole moves, fuses with the cell membrane, release substance
- Endocytosis
  - Substance is outside, cell wraps around it, substance diffuses inside the cell
  - Two types of endocytosis movements:'
    - Pinocytosis- involves bunch of little things
    - Phagocytosis- involves big thing all at once

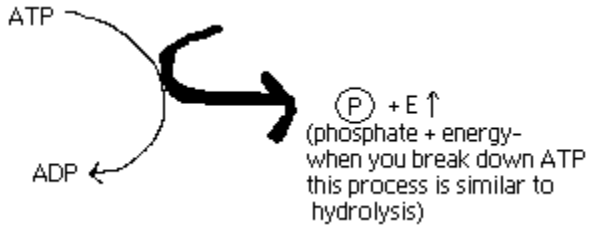
Chapter 10: Photosynthesis and Respiration

(10/13/04)
•ATP-ADP cycle
- ATP- adenosine triphosphate
- ADP- adenosine diphosphate (the partner)
- Both ATP and ADP are nucleotides
- Nucleotide structure
  - A sugar (5 carbon sugar), adenine, and 3 PHOSPHATES

Three Phosphates- used to store energy and release energy, "rechargeable batteries"

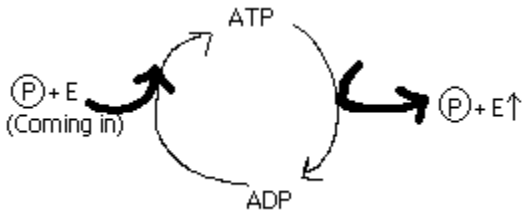


- When energy's needed- ATP is broken down to ADP (Take off 3rd phosphate)



*Note- (the ↑ sign = give off)

- When energy is stored, ATP is rebuilt

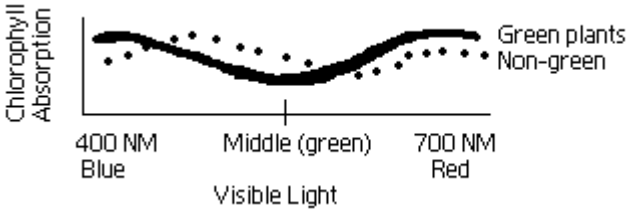


- ATP ←→ ADP + P + E

•Chars of Photosynthesis

Autotrophs- make their own food, ex. Plants

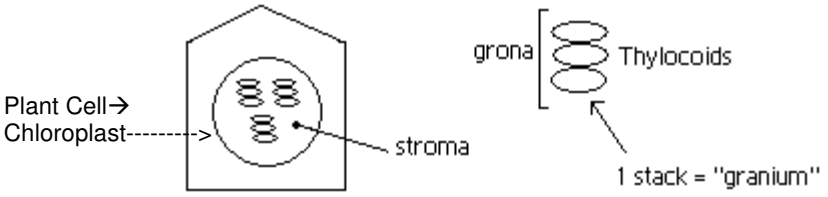
- Definition of photosynthesis in autrotrophs-
  Use light to convert inorganic energy to energy in carbs, releasing O2 and H2O
- Uses photons (packages of light) of visible light
  - Absorption Spectrum- UIB G YOR (Roy G Biv backwards)
  - Chlorophyll- doesn't do too well with greenlight- can't absorb it, it reflects it
  - Blue and red work well, it's the best



- Pigments: Chlorophyll (green), Carotenes (red), and Xanthophylls (yellow)

•Chloroplast Structure-

- Thylakoids (individual) stacked in grona surrounded by stroma
  - Are like little discs
  - Contains chlorophyl
- Stroma- liquid around thylakoids in chloroplast

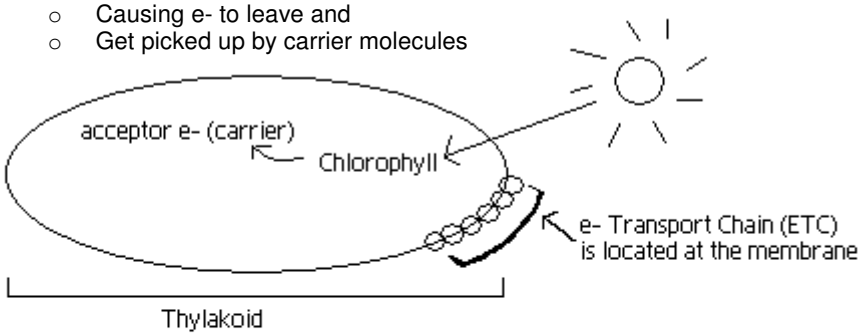


10/14/04

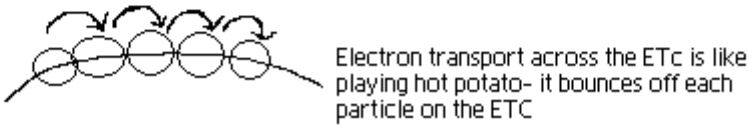
LIGHT DEPENDENT REACTIONS

(must have light-light is necessary to have a reaction)

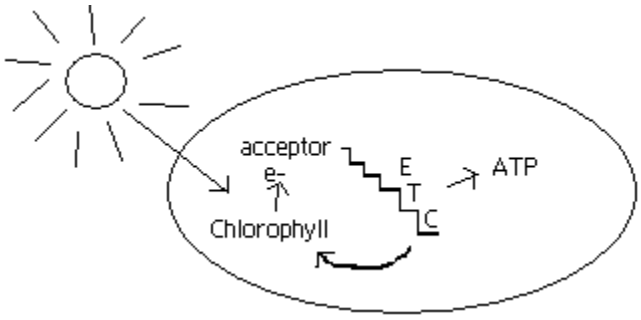
- Occurs in the thylakoids, which are the individual discs that contain chlorophyll:
- Reaction 1
  - Chlorophyll absorbs light,
  - Causing e- to leave and
  - Get picked up by carrier molecules



In the **Calvin Cycle**, e + H^+ + NADP → NADPH.

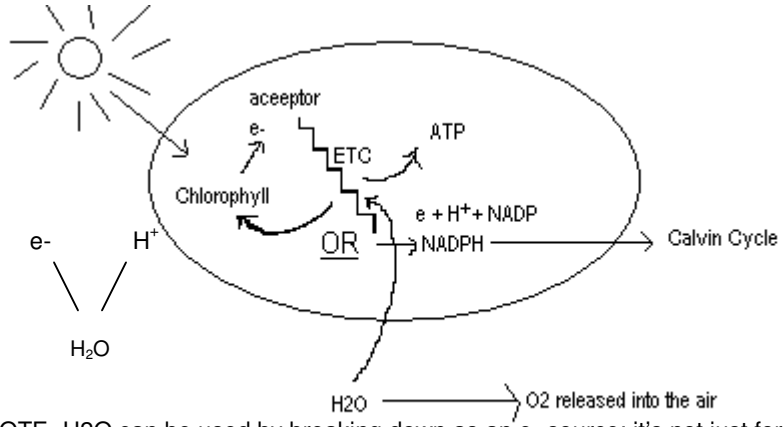


  - e- travel along an Electron Transport Chain (ETC)
  - To make ATP then return to chlorophyll (goal of the reactions- to make ATP)



OR

- Reaction 2
  - e- (along with H+) can be picked up by NADP (like an empty bus- transportation) to form NADPH (full bus- after all the e- and H+ jump on the bus, you get a full bus)
  - e- not recycled are replaced by e- from H2O; O2 is released

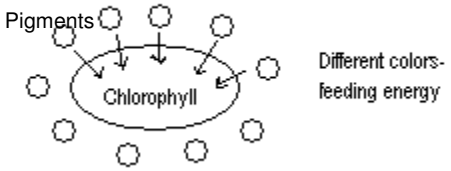


NOTE- H2O can be used by breaking down as an e- source; it's not just for turgor pressure
For turgor pressure, water helps plants stand up, and as an electron source, it splits for e- reactions

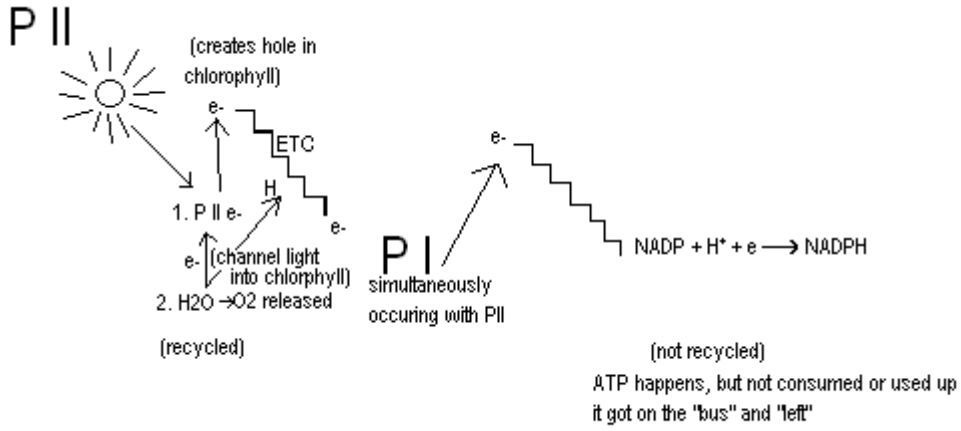
- Reaction 3
  - H+ from split water molecule join with NADP
  - NADPH and ATP are used in the Calvin Cycle
    (Light not required→ plants can live in complete darkness, but you need NADPH & ATP)

PHOTOSYSTEMS

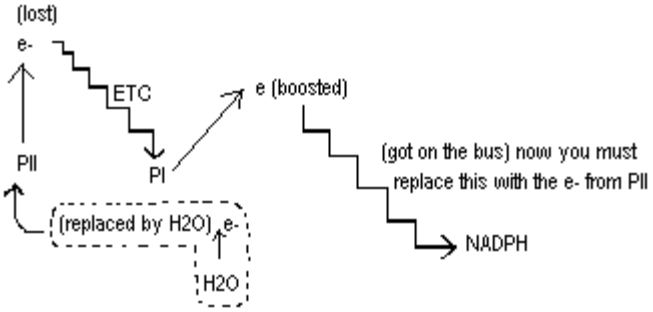
- Groups of pigments where light energy is channeled to Chlorophyll e-



- 2 types of photosystems: 1 & 2 (different chlorophyll), 2 happens first (it feeds plants)
  - Photosystem II-
    - Chlorophyll absorbs light, e- passed to ETC, then enzymes break up water and use its e- to replace ones lost by chlorophyll

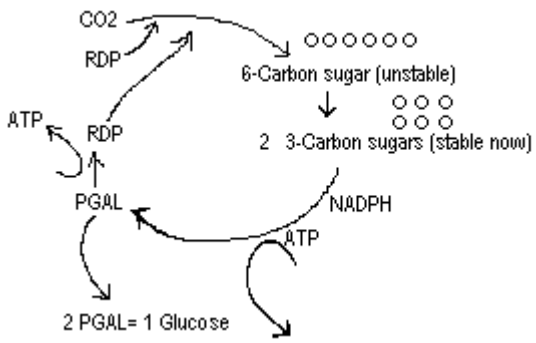


- Photosystem I-
  - Chlorophyll e- escape and are picked up by NADP+ to form NADPH
  - Lost e- in Photosystem I are replaced by e- from Photosystem II

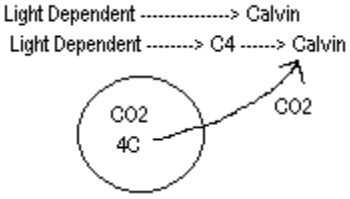


LIGHT INDEPENDENT REACTIONS

- The Calvin Cycle
  - What it does- convert CO2 (inorganic) to sugars (organic)
  - Occurs in the stroma of chloroplasts (stroma's the gel-like stuff)
  - CO2 diffuses into stroma from and and is picked up by RDP
    "Carbon fixation." RDP-CO2 acceptor molecule
  - An unstable 6-carbon molecule forms then splits into 3 carbon sugars
  - 3 carbon sugars are modified by ATP and NADPH to form PGAL
  - Most PGAL is recycled to form more RDP, BUT
    (If you chain PGAL to PGAL, you get Dehydration Synthesis)
  - For every 2 PGALs that must exit the cycle, 1 glucose and 1 H2O result
  - Two "turns" of cycle creates glucose
  - Calvin cycle is called C3 cycle (3 sugars), and is the most common photosynthesis cycle
  - C3 → 3 Carbon Sugars



- Other Photosystem Pathways
    - C4 (4 carbon sugars) cycle is for hot, high, or dry areas
    - Done by corn, crab grass, sugar cane
    - Transfer more CO2 to Calvin Cycle by forming a 4 carbon sugar first
    - From a light dependent action you can yield the Calvin Cycle, the C4 cycle is exactly like this except the C4 is added between the light dependent reaction and the Calvin cycle



    - This reduces the chances of losing water due to evaporation when the plants need light, and it's very efficient
- CAM plants are also heat adaptive
    - Done by cacti, pineapple
    - Take in CO2 at night (so this means that dehydration won't be a problem, but what about light?)
    - This solves the problem: The plant takes in CO2 at night, stores it as organic acids
    - Then feeds the carbon to the Calvin Cycle in the day time

10/18/04
CELLULAR RESPIRATION

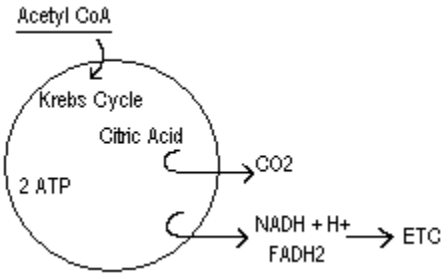
Photosynthesis- $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$
Respiration- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 38$ ATP + heat

- Breaks down food to release energy
- Transfers potential energy of glucose to ATP using oxygen (usually)
- All respiration begins with glycolysis (splitting glucose) in the cytoplasm
    - Anaerobic Process (no oxygen)
        - Splits glucose into 2 pyruvates, 2 ATP, 2 NADH, and 2 H+, releases heat

NaO2
Cytoplasm
Glycolysis
↓
Glucosis
↓
2 Pyruvates
2 ATP
2 NADH + H^+ (diff bus co. – NADH, missing the "p")
_____
Heat

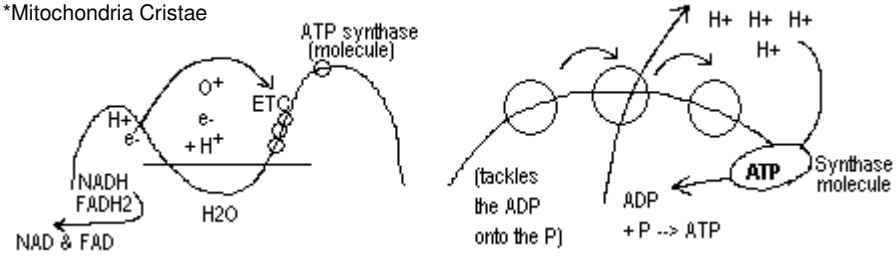
    - Aerobic Respiration (oxygen is present)
        - Occurs in mitochondria
        - Transition reaction converts pyruvates to acetyl CoA, and Co2 is released

O_2
Mitochondria (Matrix)
Transition Reaction
↓
Pyruvates + CoA (release CO_2)
↓
Acetyl CoA
_____
↓
2. Krebs Cycle →



*Krebs Cycle AKA Citric Acid cycle
Begins when Acetyl CoA joins with another molecule to form citric acid
As Krebs Cycle continues, citric acid's broken down and CO2 is released
NADH and FADH2 take e- and H+ to ETC; 2 ATP is formed

*Mitochondria Cristae



*ETC: NADH and FADH2 take e- to cristae of mitochondria (membrane- physical structure)
(food like foreign money- you convert it to ATP which can be used for many processes)
e- go through an ETC; 34 ATP made
O2 is final e-/H+ acceptor to form water

*Summary: net gain of ATP by aerobic respiration is 36-38 ATP
Glycolysis- 2 ATP, Krebs Cycle- 2 ATP, ETC- 34 ATP

- Anaerobic Respiration (no oxygen is present)
  - 2 Fermentations:
    - Lactic Acid fermentation- muscles and bacteria do this type
    (oxygen deficit/debt)
    Burning sensation
    Not enough ATP
    - Alcoholic Fermentation- yeast cells do this type
    (makes CO2 and ethanol- makes bread rise, NO ATP)
  - Runs on 2 ATP from glycolysis
  - No ATP made by lactic acid or alcoholic fermentation (doesn't last long)
  - Occurs in cytoplasm only

LACTIC ACID- Glucose→Glycolysis (pyruvic acid)→Lactic acid + 2 ATP
ALCOHOLIC- Glucose→Glycolysis (pyruvic acid)→CO2+Alcohol+2 ATP
CELL RESP.- Glucose→Glycolysis (pyruvic acid)→CO2+H2O+36 ATP

Chapter 11: Cellular Respiration

(10/25/04)
Purpose of Cell Reproduction
- forms daughter cells
- reduce surface area to volume ratio
  (it takes longer to cook big steak than if you chop them to pieces)
- increase # or replace cells

Asexual Cell Reprodcution
- binary fission of bacteria- split in two
  (Simplest from) cell too large→replicate chromosomes→split in 2
- Spores [of molds and other fungi]
  Forms protective wall, is a common reproduction
- Budding- in yeast, uneven division of cytoplasm
  Gets too large→pinch off→daughter cell smaller than parent
- Regeneration- invertebrates
  Deviates new animals or parts from an existing one
  In plants regeneration is called vegetative propagation

Chapter 12: Mitosis and Meiosis

(10/25/04)
The Cell Cycle- sequence of events from mitosis to mitosis

- Includes interphase (regular life), mitosis (division), and cytokinesis (cytoplasm division)
    - **Interphase** (most of the cell's life cycle)
        - It's the period between cell divisions
        - G_1- cell grows rapidly (G_1- $Growth_1$)
        - S phase- (synthesize) DNA replication
        - G_2- cell prepares to divide (prep being made to div chromos)
    - **Mitosis**- nuclear division in somatic (body) cells that reproduce 2 daughter cells that are identical copies of the parent cell
        - Prophase (first stage)
            - Chromatin condenses around histones to form chromosomes
            - See chromatids connected by a centromere
            - Nucleoli and nuclear envelope disappear
            - In animal cells, centrioles separate and move toward poles
            - Chromosomes attach to spindle fibers
        - Metaphase (middle stage)
            - Chromosomes line up at the equator of the cell
        - Anaphase (third stage)
            - Centromeres separate and single chromosomes move to poles
        - Telophase (fourth stage)
            - Chromosomes at poles uncoil, spindle disappears, nuclear membrane and nucleoli return
            - Cytokinesis (doesn't have to happen- optional) may begin
                - In animal cells: cleave furrow forms
                - In plants, cell plates form to divide the cytoplasm, then new cell wall forms

10/28/04
Uncontrolled cell division= cancer

- Cancer cells ignore contact inhibition signals (uncontrolled division)
  (When getting crowded, cells inhibit growth, but cancer ignores that)
- When cancer cells migrate –AKA metastasis— you get "malignancy"
  (When it spreads, it prevents other cells from doing their jobs)
  Benign (still in the same area) vs. Malignant (spread)

Cancer Causing Agents

- Heredity (passing through families) -or aging process- mutation
- Chemicals (certain stuff like hydrocarbons- exposure)
- Radiation (exposure to sunlight, atomic bombs, etc)
- Viruses (feline leukemia, infected with virus- alterations of DNA)

Sexual Reproduction and Meiosis

- Meiosis is nuclear division that reduces the chromosome # of a diploid cell (2 sets of chromosomes or 2N) to that of a haploid cell (1 set of chromosomes or 1N)
- Humans- 46 in diploid, 23 in haploid
- Meiosis produces gametes (sex/reproductive cells)- egg and sperm
- Gametes (1N) fuse to form zygotes (2N)- zygotes are sperm + egg (fertilized egg)
- Meiosis involves 2 divisions (mitosis- only 1)
- Meiosis I reduces the chromosome #
- Meiosis II divides replicated chromosomes

    - Meiosis I (reduction phase)
        - Prophase 1-
            - Synapsis occurs as homologous chromosomes pair up to form a tetrad (4 chromatids)
            - Homologous chromosomes are similar chromosome pairs that define similar functions. 1's from dad. The other's from mom. *refer to a gene map
            - Crossing over of nonsister chromatids allows for genetic variety (randomization)

        - Metaphase 1-
            - Tetrads line up at equator
        - Anaphase 1-
            - Homologous pairs separate and move to poles
        - Telophase 1-
            - 2 new haploid pairs cells form (half the # of parent)
            - No replications of DNA between meiosis I and meiosis II

    - Meiosis II
        - All phases of meiosis II look like a phase of mitosis except two cells are seen
        - Meiosis II produces 4 haploid cells
        - No duplication involved
        - Starts with haploid cells

- Egg and Sperm Formation
    - Oogenesis
        - See unequal division of cytoplasm to make 1 egg + 3 polar bodies
        - Polar bodies disintegrate
    - Spertnatogenesis
        - 4 Sperms are made

Chapter 13 and 16

- Famous Experiments
    - Griffith and transformation: genetic material from heat-killed bacteria was transferred to live cells
    - Avery et. al.- discovered that DNA is the nucleic acid that stores and transmits info. From one generation to the next.
    - Hershey-Chase experiment: concluded that genetic material is DNA, not protein part of chromosomes
        - Used radioactive markers (phosphorous and sulfur)
- Structure and Function of DNA
    - DNA is a nucleic acid made of nucleotides: Phosphate, deoxyribose, N base
    - Bases: adenine, guanine, cytosine, thymine
    - T and C are single-ringed pyrimidines
    - G and A are double-ringed purines
- Watson-Crick Model
    - Used Chargaff's rules:
        - A bonds with T
        - G bonds with C
        - A purine bonds with a pyrimidine
    - Used x-ray diffraction or crystallography picture from Franklin and Wilkins double helix shape
    - Double helix format
        - Backbones of alternating sugars and phosphates
        - Complementary base pairs H bonded in middle
- DNA= Genetic Code (master code)
    - Sequence of bases determines substances made by cells
    - Genes made of DNA control basic structure of proteins
- DNA Replication
    - Each side of DNA is a template for making a new side
    - Helicase enzyme "unzips" the helix
    - Complementary nucleotides bond to each side of unwound DNA
    - DNA polymerase enzyme "proofs" the bonding
    - Replication is semi-conservative
    - Each replicant has one old and one new strand
- RNA Structure
    - A single-stranded nucleic acid made of a phosphate, ribose, and a N base
    - Bases are A, G, C, and U; Uracil replaces Thymine
- Types of RNA
    - Messenger- mRNA: a copy of DNA code
    - Transfer- tRNA: takes amino acids to mRNA

    - Ribosomal- rRNA: part of ribosome structure
- The Hereditary Code
    - DNA is master code
    - Order of bases tells order of amino acids in a polypeptide
    - A triple code is used for each amino acid
    - 64 codes: 61 for amino acids; 3 for “stop”
    - Start code is “AUG” for methionine
    - Redundancy in code is a safeguard against mistakes
- Transcription
    - Making an mRNA copy of the DNA code
    - RNA polymerase binds to DNA at promoters (specific base sequences)
    - DNA “unzips” and RNA nucleotides pair with complementary bases on one side of DNA molecule
    - MRNA- an edited complementary version of a DNA code for a protein
    - Noncoding introns are cut out, leaving only coding exons
    - MRnA goes to cytoplasm and attaches to a ribosome
- TRNA Structure
    - One end codes for a specific amino acid
    - Other end has an “anticodon”- a complement to an mRNA codon
- Protein Synthesis= Translation
    - MRNA codons determine order of amino acids
    - MRNA binds to ribosome at AUG
    - TRNA picks up methionine and brings it to Aug site
- Translation
    - Ribosome moves to next codon
    - Next tRNA- amino acid combo binds to mRNA
    - First amino acid is transferred to second one; first tRNA leaves
    - Elongation of polypeptide continues until a “stop” code is read
    - Ribosome and mRNA break apart and new polypeptide chain leaves
- Mutations in the Code
    - Point mutations- single base pairs involved
    - Frameshifts- due to insertions or deletions and alter everything afterwards
    - Chromosomal mutations involve many bases or genes
    - Deletions, insertions, inversions, translocations
    - Transposons=jumping genes
- Nondisjunctions
    - Chromosomes don’t separate during meiosis
    - Monosomy: 2N-1; missing a chromosome
    - Trisomy: 2N+1; an extra chromosome
    - Polyploidy- 3N, 4N
- Eukaryotic Gene Regulation
    - Eukaryote genes are controlled individually and in very complex ways
    - “TATA box”- occurs frequently before many euk. Genes to mark just before point where transcription begins (transcription control)
    - Hox genes- control development of organs and tissues in embryos; determine basic body plan
    - Manipulation or mutation in hox genes can dramatically alter the organism
- Gene Regulation in Prokaryotes
    - How does a simple cell “know” whether to turn a gene on or off?
    - Common example is the lac operon model
    - Bacteria use the lac gene to make lactase to break down the sugar lactose, so gene must be “on”
    - If another food source is present, the gene can be turned “off”
    - Lac genes are turned “on” by presence of lactose: lactose binds to repressor molecules, repressors fall off of the operator site
    - Now polymerase can transcribe lac genes
    - If no lactose is present, the repressor binds to operator site
    - The switch is now in the “off”position b/c polymerase can’t transcribe the lac genes;
- Biotechnology
    - Recombinant DNA: DNA from 2 or more sources
    - Uses a vector for delivery of genes
    - Plasmids (circular DNA) are most common vectors

- Other vectors are viral DNA, retroviruses, gene guns
  - Plasmid, or other vector, and DNA are cut by a restriction enzyme
  - Restriction enzyme may leave "sticky ends" or gaps
  - Ligase enzyme seals sticky ends of plasmid and DNA to form hybrid DNA
  - Recombinant DNA is now used to give a new gene to an organism
- Most studied and used organism in biotech is the bacterium E. coli
- Gene Therapy- correct doe mistakes
- DNA Fingerprinting using PCR, restriction enzymes and separation of fragments by gel electrophoresis
- Product genetically engineered products like
  - Hormones, insulin
  - Polymerase chain reaction
  - DNA probes to find specific genes
- Vaccines
- Oil- or mineral eating bacteria
  - Ex- In digging for gold in rocks bacteria eat gold, gold is extracted from bacteria
- Transgenic Organisms
  - Ex- Make human proteins organisms expressing foreign DNA
  - Ex- Human protein in pig milk
- Human Genome Project
  - Sequencing genetic code for humans and other organisms
  - Linkage maps- locating of a gene on a chromosome- 1% recomb. = 1 map unit

Genetics (11/12/04)

T- tall (Dominant)
t- short (recessive)
TT or tt or Tt- diff combinations
TT/tt= homozygous- pure (2 of the same)
Tt= heterozygous- hybrid

P	Tall x Short (parent generation)	
F_1	Tall x Tall (same generation–inbreeding-)	
F_2	Tall : Short	3:1

P	Tall x Short	TT x tt
F_1	Tall x Tall	Tt x Tt
F_2	Tall : Short	3:1

• Methods

Punnette Square

	T	t
T	TT	Tt
t	Tt	tt

gentoypic ratio 1 TT : 2 Tt : 1 tt
phenotypic ratio 3 Tall : 1 short

FOIL

Tt x Tt
TT, Tt, Tt, tt

genotype 1 : 2 : 1
phenotype 3 : 1

Fractions

Tt x Tt

1/2 T × 1/2 T
1/2 t × 1/2 t

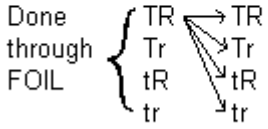
1/4 TT : 2/4 Tt : 1/4 tt

• Dihybrid Trihybrid Crosses

T- tall R- red
t- short r- white

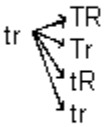
TtRr x TtRr *must determine all possible gametes

Done through FOIL



Probability Method- If you have a dihybrid cross, you work seperately

ttrr x TtRr



TtRr x ttrr

Tt x tt 1/2Tt 1/2tt
Rr x rr 1/2Rr 1/2rr

1/2 Tall 1/2 short
1/2 Red 1/2 white

1/4 Tall, Red : 1/4 Tall, white
1/4 short, Red : 1/4 short, white

1 : 1 : 1 : 1

Trihybrid

TtRrGg x TtRrGg Dominant- always 3/4
Recessive-always 1/4

(classic structure-
everything's hybrid
nonclassic- one
non hybrid)

•Incomplete Dominance

R- Red RR
R'- white R'R'
RR'- Pink RR' (blended together)

•Codominance

R- red
R'-white
RR'- Red & White appear (roan)
In a codominant situation, the red and white do not blend.
The organism would be speckled with red and white.

RR' x RR'
¼ RR: ½ RR': ¼ R'R'
(red) ↓ (white)
pink/roan
(incomp) (codom)

•Multiple Alleles

I^A - Antigen A (1st allele)
I^B - Antigen B (2nd allele)
i - no antigen

(codominant alleles)

→ Blood Types

A	I^AI^A, I^Ai	Anti B antibody
B	I^BI^B, I^Bi	Anti A antibody
AB	I^AI^B,	no antibodies
O	ii	Anti A, Anti B antibodies

What are the possible genotypes of the offspring of parents who have type A and type AB phenotypes?

A? x AB

(always assume an O in the case of missing info)

Ai x AB

Possibilities: AA, AB, Ai, Bi

•Polynomials

$(p+q)^n$

With two coins, find out the ratio of all possibilities and combinations of heads or tails.

p-head (in one coin, there's a ½ chance that the coin will land a head)
q-tails (in one coin, there's a ½ chance that the coin will land a tail)

$(p+q)^2$ – The exponent stands for two coins
$p^2 + 2pq + q^2$

p^2=2 heads	2pq=head and tail	q^2=2 tails
$(½)^2$	$2(½)(½)$	$(½)^2$
¼	2/4	¼

With three coins, find out the ratio of all possibilities and the combinations of heads or tails.

$(p+q)^3$ – The exponent stands for three coins
$p^3 + 3p^2q + 3pq^2 + q^3$

p^3=3 heads	$3p^2q$=2 heads, 1 tail	$3pq^2$=1 head, 2 tails	q^3=3 tails
$(½)^3$	$3(½)^2(½)$	$3(½)(½)^2$ $(½)^3$	
$^1/_8$	$^3/_8$	$^3/_8$	$^1/_8$

•Sex-Linked

Always on X chromosome

C –normal
-C – colorblind

$X^{-C}X^{-C}$ x X^Cy
The female can only give X^{-C}
X^{-C} → $X^{-C}X^C$
↓
$X^{-C}y$

If their offspring was a girl, she would only be a carrier $X^{-C}X^C$
If their offspring was a boy, he would be guaranteed to be colorblind $X^{-C}y$

•Sex-Influenced

Autosomal- like any other trait (ex- tall vs short, thick vs thin)
Hormonally influenced

Females with the heterozygous genotype for baldness are normal. Males with heterozygous genotype for baldness become bald. Determine the chance of baldness in males and females of parents who both have heterozygous genotypes for baldness.

H – normal hair HH
H' – bald trait H'H'

HH' x HH'
¼ HH: ½ HH': ¼ H'H'

Females- ¼ chance
Males- ¾ chance

Genetics Guide Notes

- Principle of Dominance and Recessiveness-
  - Dominant- observed trait
  - Recessive- trait that disappeared
- Principle of Segregation (and process used)
  - Two alleles for each trait must be separate when gametes form, a parent therefore passes on at random only one allele for each trait to each offspring
  - It explains the results of Mendel's criss-cross between F1 tall plants. Each tall plant in the F1 generation carried one dominant allele for tallness and one unexpressed recessive allele for shortness. It received the allele for tallness from its tall parents and the allele for shortness from its short parent in the P1 generation. Because each F1 plant has two different alleles, it can produce two different types of gametes- "tall" gametes and "short" gametes. During fertilization gametes randomly pair to produce 4 combinations of alleles.
- Principle of Independent Assortment
  - Genes for different traits are inherited independent of each other
- Homozygous- the two alleles for the trait are the same
- Heterozygous- the two alleles for the trait are different
- Allele- gene form for each variation of a trait in an organism
- Phenotype- the way an organism looks
- Genotype- genetic combination of a trait
- Mendel
  - Austrian Monk at the Augustinian monastery
  - Carried out the first important studies of heredity
- Linkage
  - When traits are associated and may be passed with another trait
  - This happens because the traits are so close together on the same chromosome
- Testcross (and genotype used)
  - Cross of an individual of known genotype with an individual of unknown genotype in order to determine the genotype of the unknown individual.
  - Usually, the organism of known genotype is homozygous recessive for the trait in question
  - If the known genotype is homozygous recessive and the unknown is homozygous dominant, all offspring will show the dominant phenotype. If the unknown genotype is heterozygous, the 1:1 ratio would be observed.
- Classic Phenotypic Ratios
  - HH x HH = 1 Dom
  - HH x Hh = 1 Dom
  - Hh x Hh = 3:1 Dom:Rec
  - Hh x hh = 2:2 Dom:Rec
  - hh x hh = 1 Rec
  - HH x hh = 1 Dom
- Incomplete Dominance- phenotype of the heterozygous zygote is intermediate between both homozygous traits (blends)
- Codominance- phenotype of both homozygous traits are produced (speckled)
- Multiple Alleles
  - Traits controlled by more than 2 alleles
  - Alleles separate when gametes form
  - The zygote gets only one allele from each parent

- Crossing Over
  - Nonsister chromatids exchange genetic material
  - Crossing over is dependent on Meiosis. In mitosis, crossing over does not take place.
- Autosomes- pairs of homologous, or matching, chromosomes- 22 in humans
- Sex Chromosomes- 23rd pair of chromosomes in humans, determines gender- XX, Xy
- Sex Linkage- traits controlled by genes located on sex chromosomes
- Sex Determination
  - Sex chromosomes- 23rd pair appear as either XX or Xy
  - SRY gene- found on the y chromosome- alters the expression of a number of genes in order to distinguish male and female features
- Mutations- mistakes or changes in DNA sequence
  - Point- change in one single base pair in DNA
  - Chromosomal- chromosomes break and rejoin incorrectly
  - Germ- mutation in a germ cell, or gamete
  - Frameshift- a single base pair's added/deleted, causing a complete shift in the coding sequence afterwards
- Nondisjunction- failure of homologous chromosomes to separate during meiosis
- Polyploidy
  - In meiosis, sometimes there's a total lack of seperation of homologous chromosomes
  - The resulting gamete, therefore, has a diploid set of chromosomes instead of the haploid set it's supposed to have
  - When the gamete is fused with another gamete, creating a zygote, the zygote ends up with more than two sets of chromosomes. It could end up having three or more sets. The resulting situation is then called polyploidy.
- Deletion- losing parts of chromosomes because of damage and non-repairment by repair enzyme resulting in the loss of amino acid sequence
- Addition- duplicated segment/extra segment of chromosome, adding amino acid sequence- when the chromosome is damaged the repair enzyme repeats the DNA sequence more than once.
- Translocation- a segment of chromosome is moved and connected with a nonhomologous chromosome
- Phenylketonuria aka PKU
  - Recessive disorder- results from absence of an enzyme that converts the amino acid, phenylalanine, to a different amino acid, tyrosine.
  - Because phenylalanine cannot be broken down, it and its by-products accumulate in the body and result in severe damage to the nervous system
- Huntington's Disease
  - Genetic disorder- autosomal dominant allele- lethal
  - Nervous system undergoes degeneration, resulting in uncontrolled, jerky movements of the head and limbs and mental deterioration
- Turner Syndrome
  - Presence of a single X chromosome, rather than normal pair.
  - Genotype XO. They have one X and no y, and so are females
  - They lack ovaries and sex characteristics don't fully develop
  - Short in stature and sterile
- Down Syndrome
  - Trisomy 21- 3 chromosomes on 21st pair
  - Mental retardation. Usually short and have loose joints. Slanted eyes, small ears. Small nose with flattened nasal bridge.
- Klinefelter Syndrome
  - All male patients- extra X chromosome- XXy
  - They are males because of the appearance of the y chromosome
  - Tall, long limbs, sterile. Mental retardation.
- Sickle Cell Anemia
  - Blood disorder- autosomal recessive trait
  - Red blood cells are sickle shaped- contain hemoblobin that differs from the norm in just one amino acid.
  - Short life span.
  - Person suffers from anemia- low number of red blood cells.
  - Blood cells clog small blood vessels, causing tissues to become damaged and deprived of oxygen and nutrients.
- Amniocentisis

- Process- long needle passed through abdominal wall of pregnant woman to withdraw a small amount of the fluid that surrounds the 14-to-16 year old fetus
- Checks for diseases/abnormalities

Chapter 17-19: Evolution Unit

12/3/04
Big Bang Theory on the origin of the Universe
- 15 billion years ago, matter started out in one small area, then exploded;
- Red shift (light shift towards red end of the light spectrum) moving away- universal expansion

Life on Earth:
- Biogenesis
  - Living things from living things (origin)
- Abiogenesis
  - Spontaneous generation
  - Abiogenesis disproved by Louis Pasteur

Origin Theories
- Oparin's hypothesis on assembly of organic molecules
  - Ammonia (NH_3), methane (CH_4), water vapor, and Hydrogen rearranged
  - Essential ones are CHNO (carbon, hydrogen, nitrogen, oxygen) which are found in the formula, separately
  - Cataylsts –UV light, sunlight, lightning- break things down to rearrange them
- Miller-Urey experiment
  - Using Oparin hypothesis to make a lab experiment
  - Coacervates- accumulation of droplets of different types of organic molecules
  - Microspheres (protenoids)- round, made of only one type of molecule (made of just proteins)
- Cell Type Characteristics
  - Semi permeable membrane
  - Capable of simple chemical reactions
  - Can grow, get bigger
- Heterotroph Hypothesis (How Oxygen started)
  - First cells were anaerobic chemosynthetic heterotrophic bacteria
  - They started eating
  - Not enough food, some adapted, became autotrophs to make their own food
  - Autotrophs evolve for adaptation
  - Autotrophs gave off oxygen
- Endosymbiotic Hypothesis (Eukaryotic Cell evolution)
  - Eukaryotes are complex
  - Cells- have complex organelles
  - Organelles were once independent prokaryotes
  - Eventually, organelles such as mitochondria shared relationship and permanently embedded into the cell

Evidence for Evolution of Fossils
- Sedimentary rock strata (weathered striped layers)
  - Imprints- like spray paint picture
  - Molds- hollow
  - Casts- what fills in the mold
- Petrification and Amber
  - Petrification- Mineral replacement to rock
  - Amber- Trapped in sap and crystallized
- Relative vs Absolute Age
  - Index Fossils- reference fossils, used to find relative age, or the layer which the fossil's found
  - Halflife- readioactive isotopes decay at predictable rate. The isotope of approximate age is selected to detect the amount of isotopes left which therefore detects the absolute age of the fossil, or the actual date age.

Evidence for Evolution: Geologic Time Scale

- Precambrian Era
    - First, longest, oldest
    - Life first evolved- complexities being formed
- Paleozoic Era
    - Fish, amphibians
- Mesozoic Era
    - Jurassic period with Dinosaurs
    - Warm blooded traits
    - Extinction theory- asteroid impact (global shift in climate- dinosaurs were too big and not well enough adapted)
    - Mammals were around near the end- most were rodent sized and so were not dominant
- Cenozoic Era
    - Mammals
    - Modern World
    - Currently in Quaternary period
    - Last major extinction- mastodon and saber toothed tiger

Evidence for Evolution Comparisons
- Comparative Biochemistry
    - What we're like or they're like on a molecular level
- Homologous Structures
    - Same anatomy (bone structure) or similar
    - Different functions
    - Determines common ancestry
- Analagous Structures
    - Same function or similar
    - Different structure
    - Opposite of homologous structures
    - Probably don't have common ancestry
- Vestigial Structures
    - Appendix, Wisdom teeth, etc
    - Really small structures that used to be big but not anymore
    - Structures may used to have a function but not anymore
- Comparative Embryology
    - Embryo resemblance
    - The more similarities in development, the closer they may be to each other, and then the closer their ancestry

Theories of Evolution
- Lamarck's Theory of "Use and Disuse"
    - The more the need, the more development of the structure in use
    - Ex- Long Neck Giraffe Theory
    - With disuse it may shrink and completely dissolve
    - Inheritance of acquired traits were disproved by Weissman
        - He pulled wings off of fruit flies and bred them but the next generation still had wings
        - He chopped tails off of baby mice, but new generation had tails
        - Weissman showed that disuse cannot take away traits
- People who Influenced Darwin:
    - Hutton and Lyell- World has changed slowly over time and gradually (If rocks- nonliving things- can change, certainly living things can)
    - Malthus- organisms tend to reproduce way too much, the best way to go is to let them starve and die off, famine is good
- Beliefs at the Time of Darwin
    - World changed much too slow to let change be possible
    - Evolution did not exist- Creation did

Darwin's Theory of Natural Selection
1. Variation within populations
2. Overpopulation results in competition
3. Environment selects traits best suited to it

Types of Natural Selection

- Stabilizing Selection- get rid of extremes and favors middle traits
- Directional Selection- leans to one of the extremes
- Disruptive selection- favors both extremes- gets rid of middle ground
- Sexual Selection- similar to directional, but female chooses mate on narrow request, demanding very definite preference
    - Peppered moth example- At the turn of 1900s, England was heavily polluted. In the countryside there was no pollution. Light moth was best adapted for this environment. Darker tree trunks of silt from the city made dark moths more suited for survival in the city.

Natural Selection

- Survival of the most genetically adapted
- Organisms who live longer and reproduce more often pass on their genes more often
- Differential reproductive selection- reproductive selection based on qualities that best fit tough survival and competition

Patterns of Evolution

- Divergent Evolution
    - Common ancestry gradually leading to diversion into different environments
    - Pressures of different environments pushes them to further different developments
    - Adaptive Radiation theory by Darwin- describing the changes in the Darwin Finches
- Convergent Evolution
    - Two different species get closer over time in the same environment
- Coevolution
    - Very close relationship between two or more species
    - If one changes, the other changes because of the direct relationship
    - The species involved in coevolution change together

Species Concept (what makes them the same species)

- Morphological concept
    - Shape, body structure, arrangement, appearance
    - Apparent similarities- if they look alike
- Biological Concept
    - They must produce fertile offspring
- Population
    - They live in the same place at the same time, producing fertile offspring
    - Gene Pool and Allele frequencies
        - Gene Pool- All of the alleles of all of the genes in a population
        - Allele frequencies- How often a particular allele shows up, by %

Hardy Weinburg Law of Genetic Equilibrium

- Explains the requirements it takes for a population to never change
- Requirements:
    - NO mutations- because it introduces a new allele
    - NO gene flow (migration)- because it causes differences between two populations to disappear
    - NO natural selection- favoritism toward one trait
    - NO genetic drift- chances or events, like natural disasters effect a large part of a population
    - YES random mating- “selective preference” must be eliminated
- To Calculate Allele Frequency
    - Use “p” for frequency of dominant allele
    - Use “q” for frequency of recessive allele
    - Never calculate P first- dominant phenotypes can be genotypes Homozygous Dominant and Hybrid, but all recessive phenotypes will always be Homozygous Recessive.
        - 430 Gray Mice (GG, Gg)
        - 70 White Mice (gg)
        - Total= 500 Mice
            - First, calculate recessive percent (70/500=0.14)
            - Then use the formula “% of recessive=q^2” (0.14=q^2)
            - Find q. (q=0.37)
            - Then, using the “p+q=1” formula, find p. (1-q=p=0.63)

        - The Allele frequency for Gray Mice are 63%
        - The Allele frequency for White Mice are 37%

Speciation
- New species arise due to geographic and/or reproductive isolation
- Reproductive isolation can be behavioral, temporal, geographic, or chromosomal

Rates of Evolution
- Microevolution (gradualism)
    - Little by little- an accumulation of small changes over the years
- Macroevolution (punctuated equilibrium)
    - For long periods of time there were little to no change, but suddenly at one point, new species arrived

Primate and Human Evolution
- Philogeny- tracks species over time- finds levels of ancestry and branches of new species that were created from one specie
    - Dotted- Unclear path
    - Solid- exact knowledge and evidence to know the right path
- Primate Characteristics
    - Primate refers to "the order" (not genus, species, etc) class- Mammalia
    - Major feature- opposable thumb, full range color-binocular(2 eyed)-stereoscopic(depth-3d) vision
    - Upper Limb Anatomy- ball and socket joint, shoulder blade, large collar bone, brain size

Primate Evolution
- Purgatorious (oldest primate fossil known)
- 2 big groups of Primates
    - Prosimian- primitive, ex- Lemur
    - Anthropoids- advanced, ex- Monkeys, Apes, etc
- Only humans belong to the Hominid group
    - Ex- Neanderthal, Homo Erectus, Cro Magnon

Human Evolution
- Australopithecus: "Lucy," first (oldest known) hominid
- Homo Habilus- handy man known for tools
- Homo Erectus- upright man, used fire
- Homo Sapiens: Neanderthal man, Cro Magnon man

Mitochondrial Eve Theory
- mDNA passes from mothers to offspring
- According to molecular clock tracking changes in mDNA, modern man descended from an African female about 200,000 years ago

Taxonomy: "The Classification System"

- Definition- the science of grouping and naming organisms
- Classification- puts organisms into groups to show evolutionary descent as well as physical similarities
- Aristotle's scheme- grouped based on habitat and physical differences
- Linnaeus's scheme
    - Binomial Nomenclature (2 word naming system) rules
        - Always capitalize first letter of first word
        - Underline the entire species name- ex. <u>Homo sapiens</u>
        - Capitalize genus, lowercase species
        - When you mention many scientific names of species within the same family you abbreviate- ex. H. sapiens, H. erectus, H. habilus
        - All categories are written in Latin
        - Capitalize all categories
    - Latin
        - Dead language
        - Does not change meaning over time

        - All words have specific definitions
- Genus and “Specific Epithet”
    - Specific Epithet describes the member of genus.
        - Ex- In the name Homo sapiens, “Homo” is the genus, and “sapiens” is the specific epithet
- Variety Designation
    - Variety Designation further describes the Specific Epithet.
        - Ex- In the name Homo sapiens neaderthal, “Homo” is the genus, “sapiens” is the specific epithet, and “neaderthal” is the variety designation
- Hierarchical Categories
    - Domain
    - Kingdom
    - Phylum-animals/Division-plants
    - Class
    - Order
    - Family
    - Genus
    - Species
- Human Classification
    - Kingdom- Animalia
    - Phylum- Chordata
    - Subphylum- Vertebrate
    - Class- Mammalia
    - Order- Primates
    - Family- Hominidae
    - Genus- Homo
    - Species- Homo sapiens
- Three Domains
    - Bacteria- Kingdom Eubacteria
    - Archaea- Kingdom Archaebacteria
    - Eukarya- all other kingdoms