BIOLOGY AHA FINAL EXAM REVIEW

BSCS Biology Textbook Chapters = 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12

Nature of Science

A. Terms:

1. **Observation:** What is seen or measured.
2. **Inference:** A conclusion based on observation or evidence.
3. **Hypothesis:** An untested prediction. A good hypothesis states both cause and effect ("If-then" statement).
4. **Theory:** A broad explanation of natural events that is supported by strong evidence.

B. **Graphing**

C. **Controlled Experiment:** Compares the results of an experiment between two (or more)
groups.

1. **Experimental group:** Group being tested or receiving treatment. (ex: new drug)
2. **Control group:** "Normal" group. Should be identical to experimental group in every way except one: it does not receive the treatment (i.e.: no drug, or given the original drug or a placebo).
3. **Placebo:** A sugar pill or other "fake" treatment give to the control group so subjects do not know which group they are in.
4. **Independent Variable:** Variable that is being tested; the variable the experimenter is manipulating (ex: new drug). In a graph the independent variable is always plotted on the X-axis.
5. **Dependent Variable**: Variable that is measured at the end of an experiment; the results (ex: does patient get better?) The dependent variable is always plotted on the Y-axis.)
6. **Control Variable:** Variable that stays the same or constant throughout the experiment (the same in both the experimental and control group).

D. **Characteristics of a good experiment.**

1. Can be repeated by anyone and get the same results.
2. Have large sample size/many test subjects.
3. Are performed for longer periods of time.
4. Test only one variable.

5. Are peer reviewed – examined by several scientists to determine its accuracy.
6. Does not have to agree with the hypothesis. A scientist's guess is allowed to be incorrect – and usually is.
7. Is objective – the experiment and conclusion are fair and unbiased. Fact and opinion are not mixed.

EXAMPLE OF EXPERIMENT

A scientist is testing the effect of temperature on the growth of a common houseplant. The scientist believes that higher temperatures will result in an increase in growth of the plant.

Hypothesis: If the temperature is increased, the growth of the houseplant will increase because higher temperatures are required for the plant enzymes to function correctly.

Independent Variable: The temperature the houseplant is placed in (Scientist is manipulating the temperature of the room the plant is in.)

Dependent Variable: The growth of the houseplant as **measured** by its height (Scientist is measuring the height of the plant.)

Control Variables: Type of plant, amount of water plant receives, amount of sunlight plant receives, location of plant, and amount of nutrients (Scientist is keeping all these factors the same in all groups of plants.)

Control Group	***Experimental Group(s)***
House plants found at normal temperature (room temperature)	Group 1: Plants found at 20 deg. C Group 2: Plants found at 30 deg. C Group 3: Plants found at 40 deg. C Group 4 Plants found at 50 deg. C

Whenever you are designing an experiment, make sure to have all of the components above!

EVOLUTION

A. Basically states that modern species evolved from earlier, different species and share a common ancestor.

Main Mechanisms of Biological Evolution

1. Mutations	• **Mutations** *are changes in DNA* • Gives rise to variation among individuals • May be passed onto the next generation of offspring if mutation occurs in egg cell or sperm cell
2. Migration	• Immigration or emigration can cause a change in a population's gene pool. This process is called **gene flow.**
3. Genetic Drift	• Caused by an unusual event that Happens by chance • ***Kills* or *somehow separates*** all **except** a few individuals in a population
4. Natural Selection**	• *Process by which traits that improve an organism's chances for survival and reproduction are passed on more frequently to future generations than those that do not.*

B.** Charles Darwin proposed that **natural selection** is the mechanism that causes species to change. The requirements in natural selection are:

1. Overproduction of offspring.
2. Competition for limited resources.
3. Survival and reproduction OR death.
4. Individuals vary in characteristics, some of which are heritable.
5. Individuals vary in fitness, or reproductive success.

C. Organisms that are better adapted to their environment and able to reproduce
successfully are considered "fit". Unfit organisms die, and their traits are eventually removed from the gene pool.

NOTE: Evolutionary fitness has nothing to do with *physical fitness*.

Stronger is not always better.

D. Evolution is usually driven by a change in the environment.

E. To evolve, variations must exist in a species BEFORE the environment changes. **They do not get a trait just because it is needed.**

F. **Variations** exist primarily as the result of **sexual reproduction and mutation.**

G**. Species with more variation** are better able to survive environmental changes. **Adaptations** are heritable traits (can be passed onto offspring) that increases an individual organism's fitness.

H. **Gradualism** *is a theory that says change occurs slowly*. **Punctuated equilibrium** *is a theory that says evolution happens in quick spurts.*

I. Creation of new species usually requires geographic isolation, which eventually results in reproductive isolation.

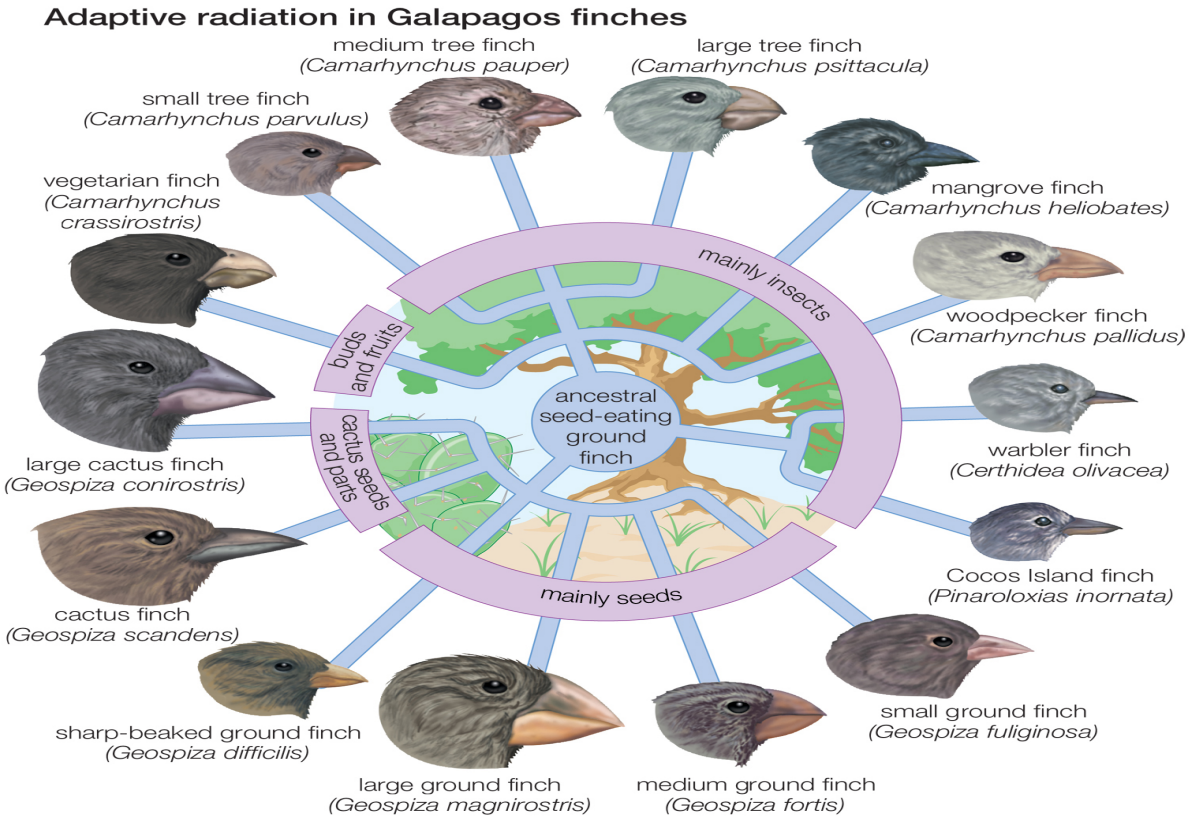
J. **Evidence in support of evolution** comes from the fields of geology (fossil record and radioactive dating), genetics, biochemistry, anatomy and embryology (among others).

- ***Fossil Evidence*** shows structures of older organisms. They show the history of life on earth and how different groups of organisms have changed over time.
- ***Similarity in DNA*** shows the relationship between species (most convincing piece of evidence)
- ***Embryological Development***: In their early stages of development, chickens, turtles and rats look similar, providing evidence that they shared a common ancestry.
- ***Anatomical Evidence:***
  1. **Homologous structures** in different organisms are inherited from a ***common ancestor***.
  2. **Analogous structures** are inherited from unique ancestors and have come to resemble each other because they ***serve a similar function***.
  3. **Vestigial structures** are remains of a structure that was functional in some ancestors but **is no longer functiona**l in the organism in question.

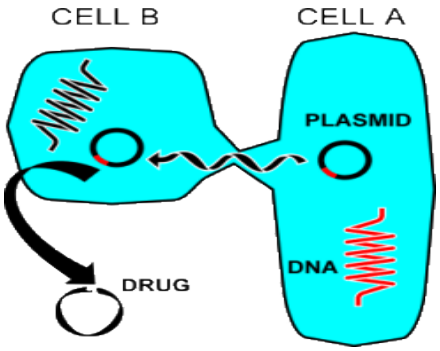
     --- Most birds have well-developed wings; some bird species have reduced wings and do not fly.

     --- Humans have a tailbone but no tail.

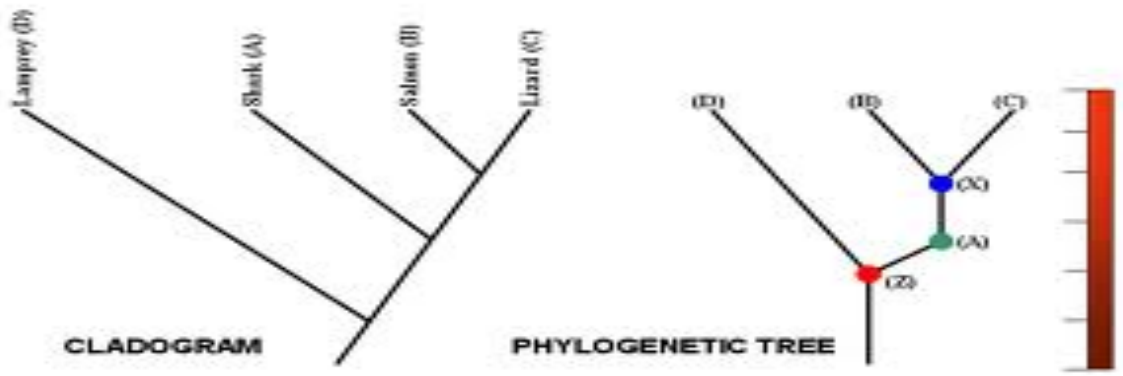
4. ***Geographic Distribution of Related Organisms***: Organisms in different areas of the world look similar when found in similar environments.



Galapagos Finches eventually developed different sized and shaped beaks depending on the food commonly found in the island they lived on.



To the left are two bacteria cells. The plasmid (circular DNA) contains genes that code for antibiotic resistance. Bacteria cells with this antibiotic resistance gene will not be killed by antibiotics. They can pass this on to other bacteria cells through conjugation (bacteria sex). Antibiotic resistance is a form of natural selection.



Cladograms and phylogenetic trees show evolutionary relationships. The points where lines intersect indicate a *common ancestor*. When species share a common ancestor, it means that they are closely related. You can expect their DNA sequences to have many similarities.

Homeostasis (Equilibrium)

Homeostasis *is the ability of an organism to maintain internal balance***.**

All living things must maintain homeostasis.

1. To maintain homeostasis, organisms carry out the same basic life functions: nutrition, excretion, transport, respiration, growth, synthesis, regulation and synthesis. (Be familiar with these terms!)
2. All life processes make up an organism's metabolism.
3. Failure to maintain homeostasis causes disease and death.

RESPIRATION: Organisms get energy by breaking the bonds of sugar molecules. The released energy is used to make a molecule of ATP, which gives all organisms their energy. Oxygen is required. Carbon dioxide is a waste product.

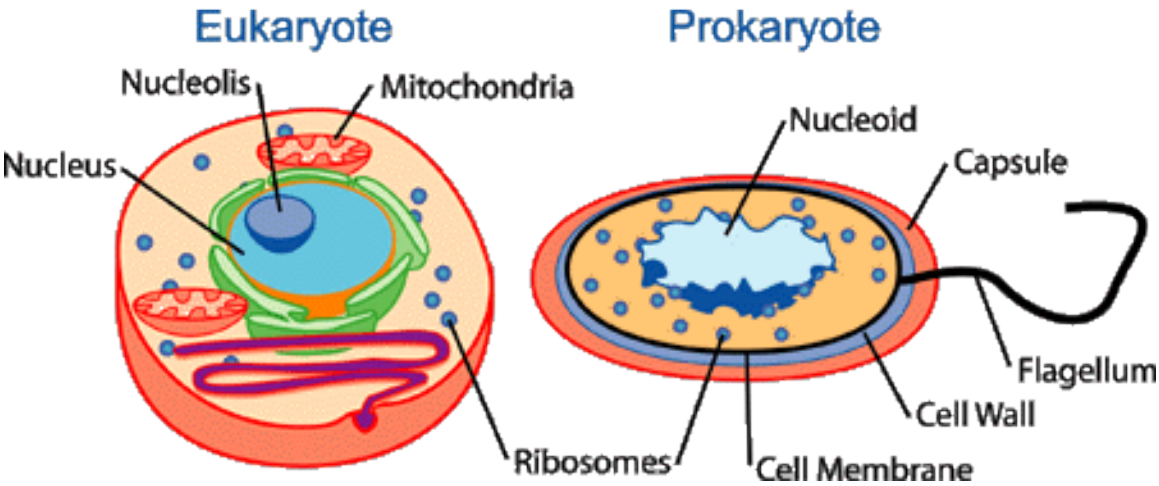
1. **Aerobic respiration requires oxygen**, and yields more ATP (energy) for a molecule of sugar than **anaerobic (no oxygen) respiration**.
2. When humans are forced to get energy from anaerobic respiration, we produce lactic acid that damages muscles ("the burn" you feel during exercise).

Chemistry of Life

1. The most **common elements** in living things are (in order) Carbon, Hydrogen, Oxygen and Nitrogen (CHON).
2. **Organic Compounds** have Carbon AND Hydrogen (ex: $C_6H_{12}O_6$ is organic, H_2O, CO_2, and NO_3 are not). Organic molecules are also larger than inorganic molecules.

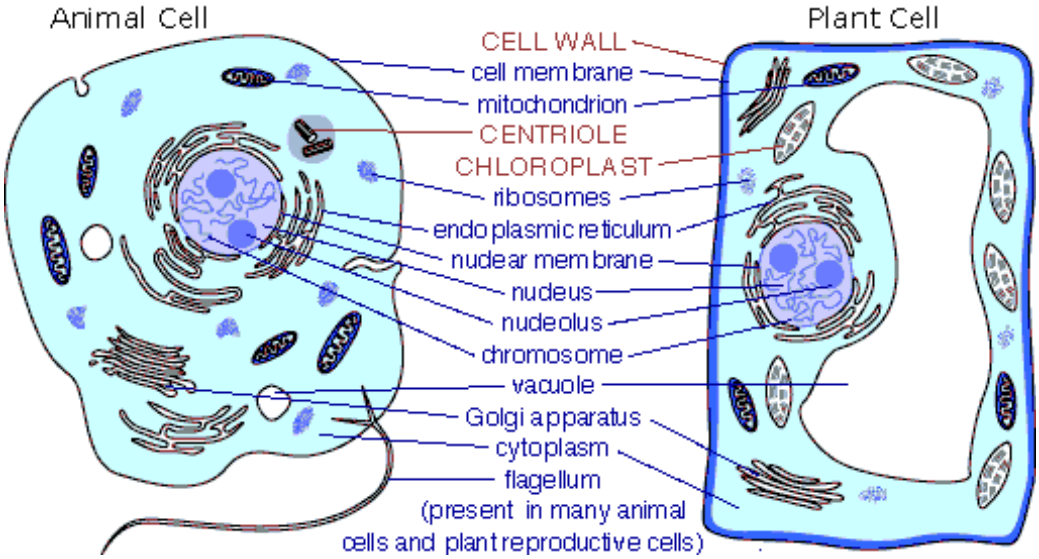
CELLS

Cells *are the basic unit of life*. All living things are made of cells.



PROKARYOTE VS EUKAROYTE

- ***Prokaryotes do not have a nucleus or membranous structures inside*** (DNA flows in the cytoplasm)
- ***Eukaryotes have a nucleus***



STRUCTURES FOUND IN **PLANTS ONLY**: Chloroplast, cell wall
STRUCTURES FOUND IN **ANIMALS ONLY**: Centrioles

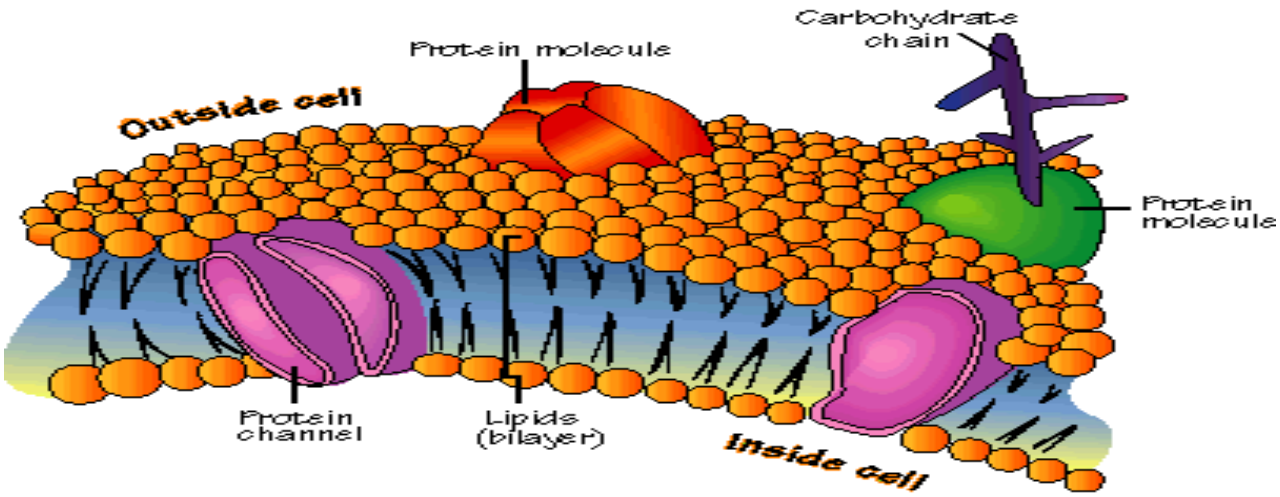
MAIN ORGANELLES INSIDE THE CELL

Cell Structure (Organelle)	***Function***
Cell membrane**	SEPARATES INSIDE AND OUTSIDE OF CELL. The membrane enclosing a cell is made up of two lipid layers called a "bilipid" membrane. The lipids that are present in the plasma membrane are called "phospholipids." These lipid layers are made up of a number of fatty acid building blocks. The fatty acid that makes up this membrane has two different parts to it- a small water loving head- hydrophilic head.
Cell wall (plants only)	PROTECTION and SUPPORT. Plasmodesmata are openings found in the cell wall used to communicate and transport materials between plant cells because the cell membranes are able touch and therefore exchange needed materials.
Nucleus	HOLDS DNA. The nucleus is the control center of the cell. It is the largest organelle in the cell and it contains the DNA of the cell.
Ribosome	PROTEIN SYNTHESIS. Organelles that help in the synthesis of proteins. Some ribosomes are found in the cytoplasm, but most are attached to the endoplasmic reticulum. While attached to the ER, ribosomes make proteins that the cell needs and also ones to be exported from the cell for work elsewhere in the body
Cytoplasm	SPACE-FILLER. All the contents not in the nucleus. "Free space" filled with mostly water.
Vacuole	STORAGE. Contains large amounts of water and stores other important materials such as sugars, ions and pigments.
Mitochondria	PROVIDES ENERGY. Packages the energy of the food into ATP molecules
Chloroplast *(plant only)*	PHOTOSYNTHESIS. The cell organelle in which photosynthesis takes place. In this organelle the light energy of the sun is converted into chemical energy. Contains chlorophyll (pigment that makes plants green.)

The Cell Membrane**

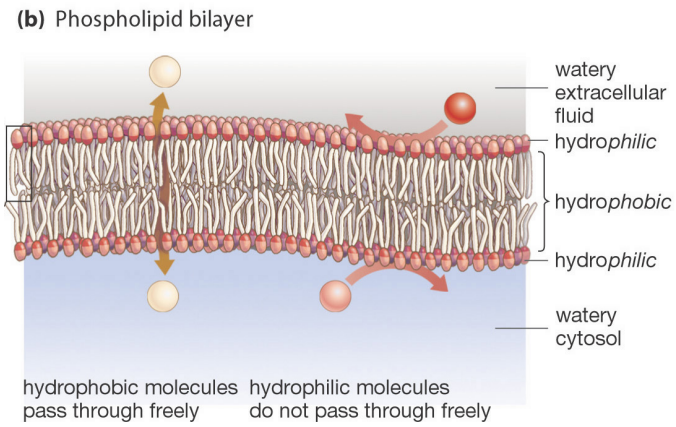
4. **The cell membrane** is made of lipids and proteins. It shows ***selective permeability*** – that is only some molecules can pass through it (typically small molecules like water and oxygen). Large molecules (like starch or protein) need to be moved by active transport.

a. NOTE: Students often assume cells have a cell wall OR a cell membrane. ALL cells have a cell membrane, including those with cell walls (plants, fungi, some bacteria and protists). The cell wall is mostly for protection; the cell membrane is needed to control movement into and out of the cell. The animal kingdom is the only kingdom that completely lacks cell walls.



Functions of the Cell Membrane

- ✓ **Protective barrier**
- ✓ **Regulate transport in & out of cell (selectively permeable)**
- ✓ **Allow cell recognition**
- ✓ **Provide anchoring sites for filaments of cytoskeleton**

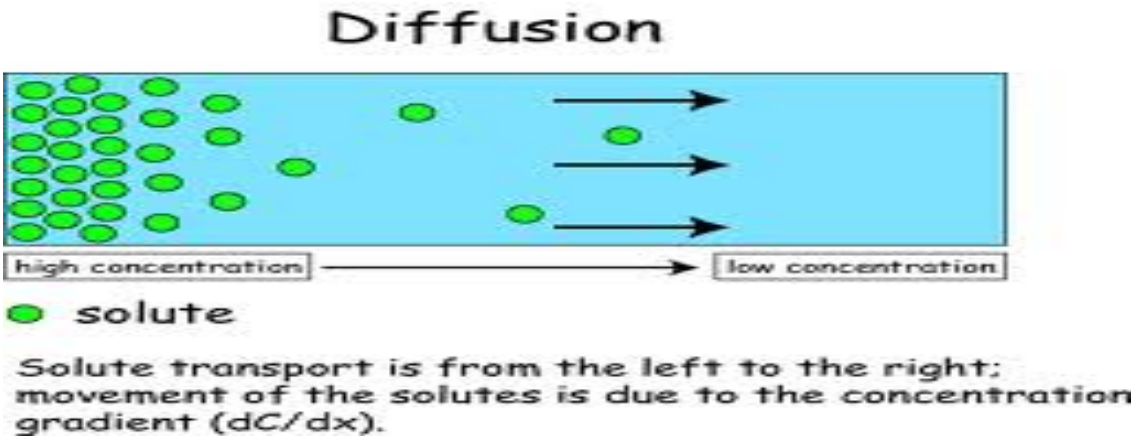


- **Polar heads are hydrophilic "water loving"**
  - Hydrophilic DO NOT pass through easily
  - Ions or anything charged molecules cannot pass through easily
- **Nonpolar tails are hydrophobic "water fearing"**
  - Hydrophobic molecules DO pass easily
  - Hormones, steroids, and uncharged molecules pass through easily (carbon dioxide and oxygen are nonpolar)

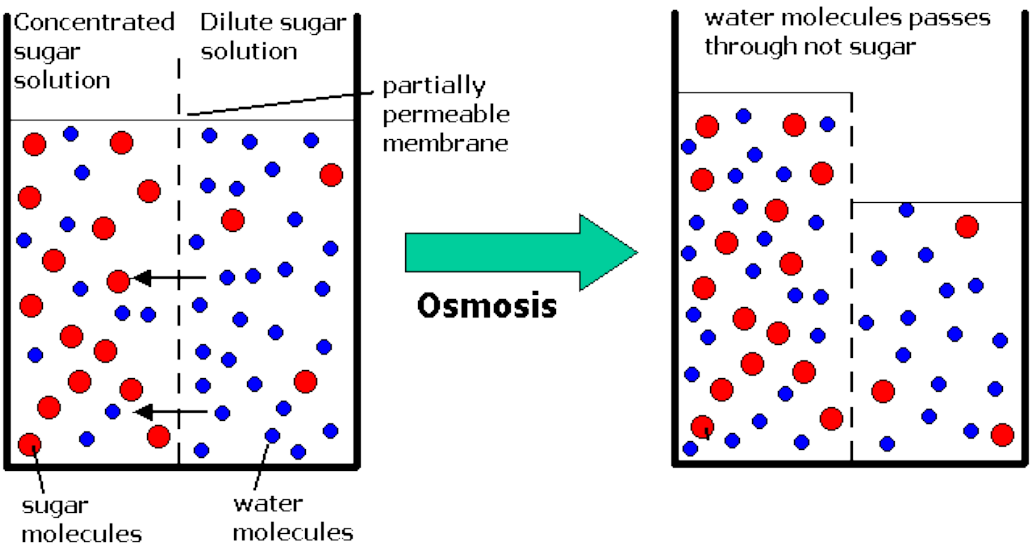
MOVEMENT OF MATERIALS IN AND OUT OF THE CELL

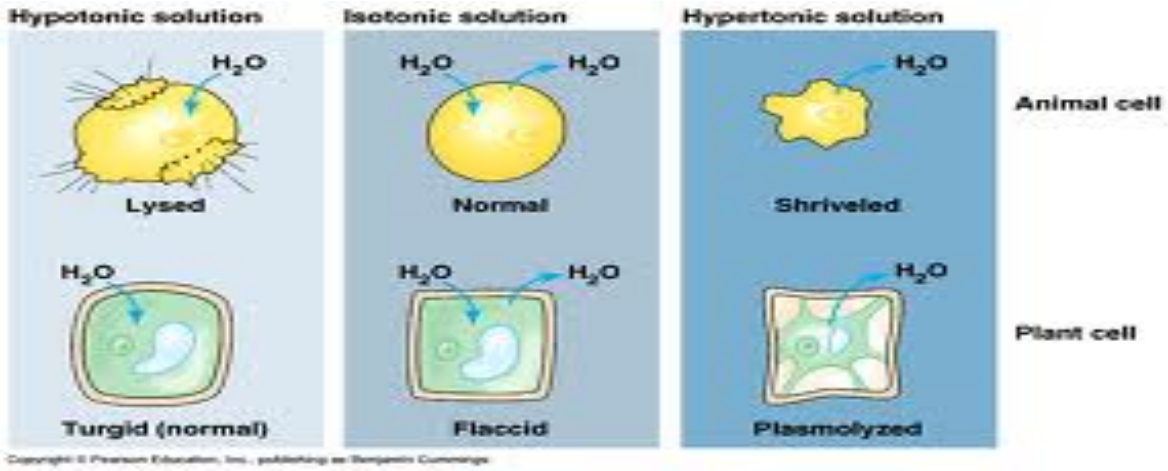
1. **PASSIVE TRANSPORT =** *movement of materials WITH the concentration gradient. NO ENERGY REQUIRED.*

- **Diffusion:** *The passive movement of material from an area of HIGH concentration to an area of LOW concentration*



Osmosis: *The diffusion of water through a selectively permeable membrane*

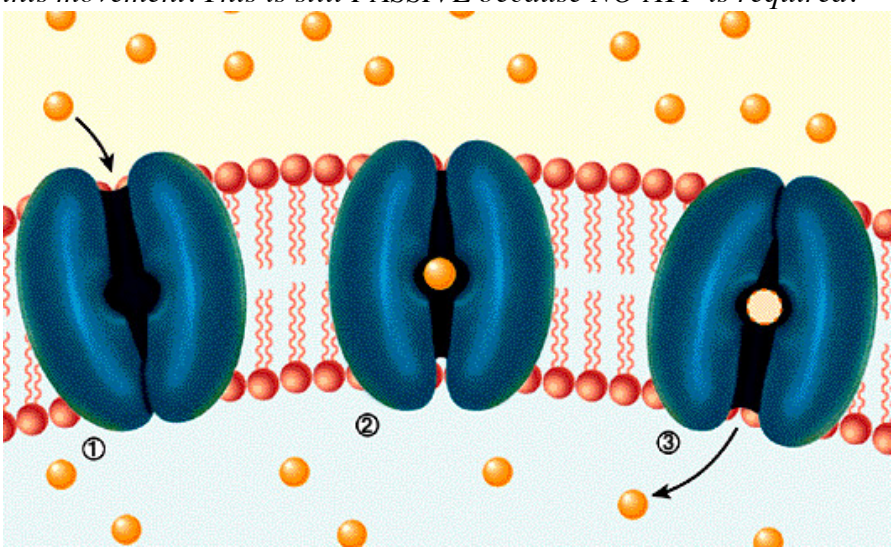




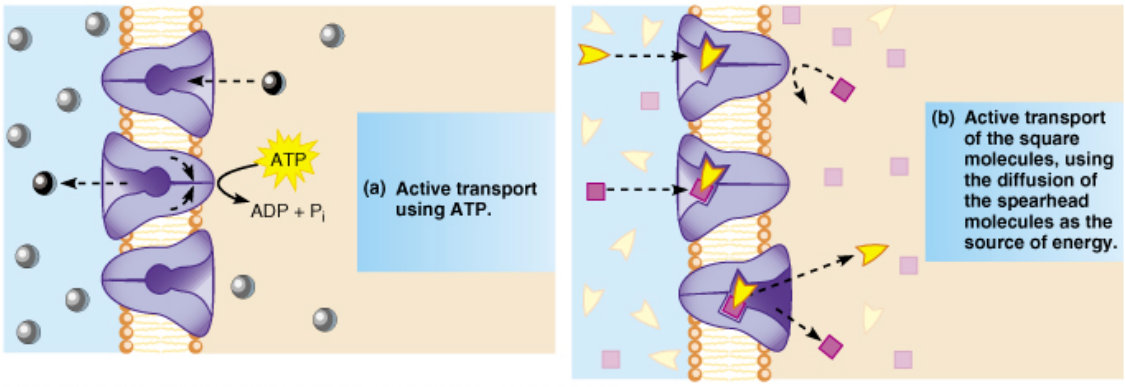
Hypotonic	Isotonic	Hypertonic
INSIDE: higher concentration of solute OUTSIDE: lower concentration of solute NET FLOW OF WATER: Water flows from the outside the inside of the cell.	INSIDE: equal concentration of solute OUTSIDE: equal concentration of solute NET FLOW OF WATER: Water moves in and out of the cell, but has NO NET MOVEMENT.	INSIDE: lower concentration of solute OUTSIDE: higher concentration of solute NET FLOW OF WATER: Water flows from the inside to the outside of the cell.

*Remember water "follows" the solute.

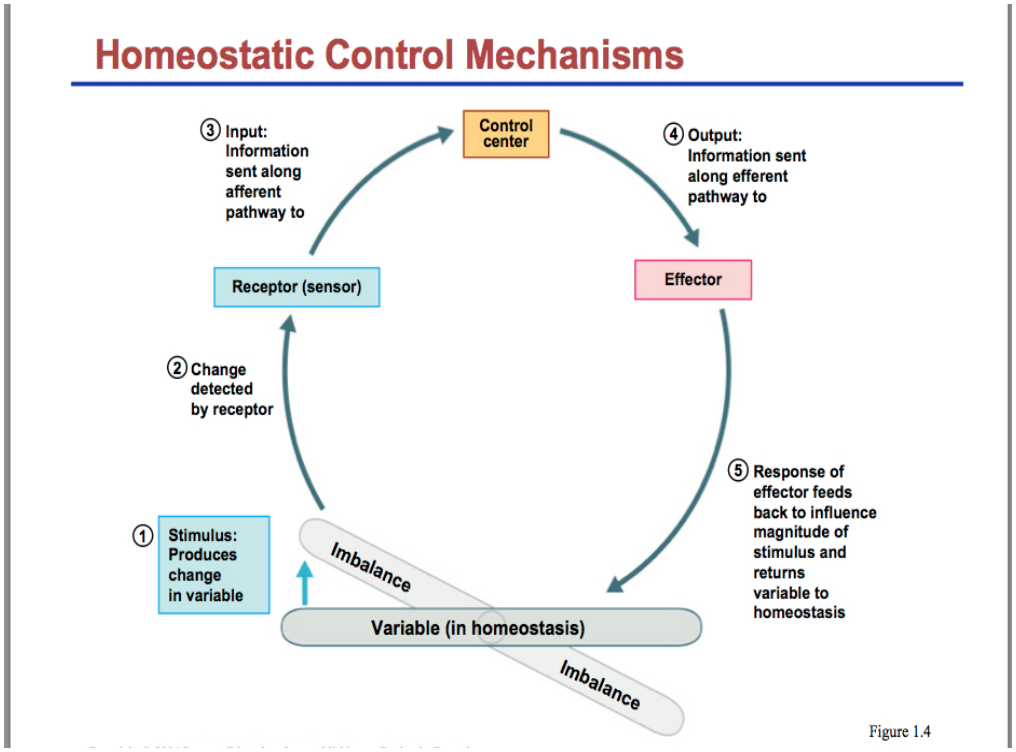
- **Facilitated Diffusion:** *The passive movement of material from an area of high concentration to an area of low concentration THROUGH A PROTEIN CHANNEL. Some molecules need "help" passing through the membrane because of size or polarity. Protein channels help "facilitate" this movement. This is still PASSIVE because NO ATP is required.*



2. **ACTIVE TRANSPORT =** *Movement of materials from LOW concentration to HIGH concentration using a protein carrier that requires energy (costs ATP). Oftentimes referred to as moving AGAINST the concentration gradient.*



"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

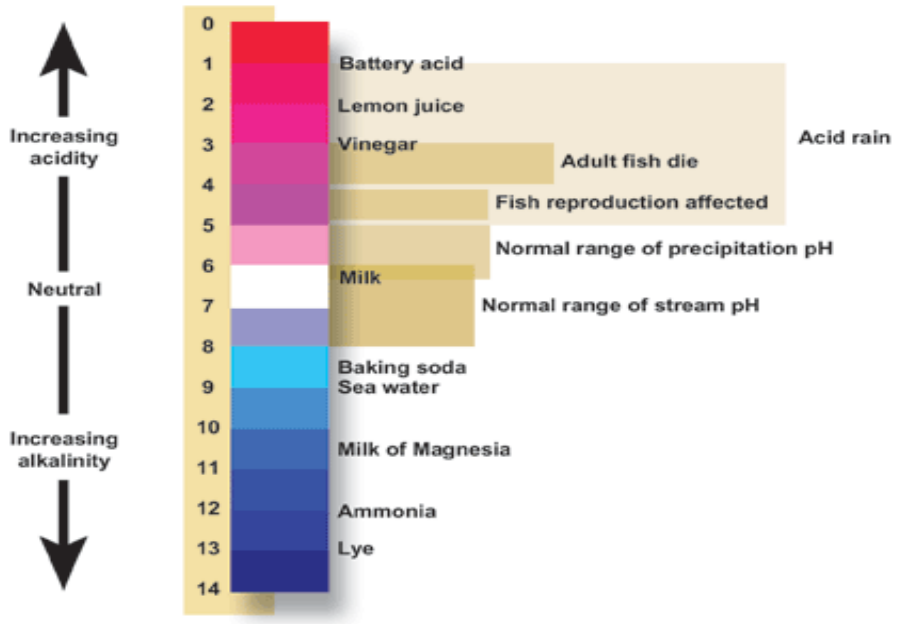


ACIDS, BASES, and pH

1. The separation of water molecules into ions causes solutions to be acidic, basic, or neutral.
2. The pH scale measures how acidic or basic a solution is.

- **<u>pH of 7—Neutral</u>: Equal concentrations of H^+ and OH^-**
- **<u>pH below 7—Acidic</u>: Relatively high concentration of H^+**
- **<u>pH above 7—Basic/Alkaline:</u> Relatively high concentration of OH^-**

Acids	Bases
1. Taste Sour 2. Affect indicators (red = acid) 3. Neutralize Bases 4. Often produce hydrogen gas 5. pH between 0 and LESS than 7 6. The closer pH is to 0, the stronger the acid	1. Taste Bitter 2. Feel Slippery 3. Neutralize Acids (Antacids) 4. Affect indicators (base=blue) 5. pH between >7 and 14 6. Dissolve grease (Drano, Windex) 7. The closer pH is to 14, the stronger the base



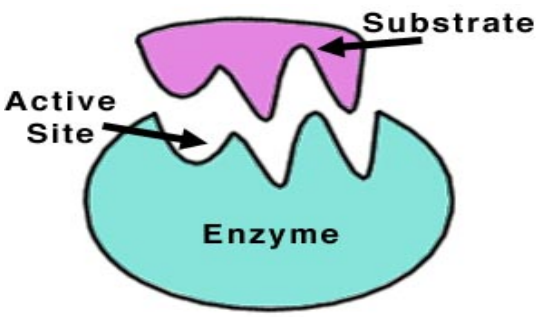
- pH = measure of how acidic a compound is
  - High pH = less acid (a.k.a. more basic/alkaline)
  - Low pH = more acidic (a.k.a. less basic/alkaline)

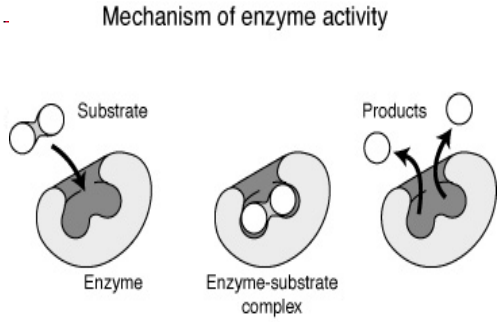
It is important for the body to maintain acid-base homeostasis because the body's proteins may denature (unfold) if the pH is too high or too low. All proteins work best at certain pH, depending on the type of protein it is.

*****A BUFFER system helps maintain the internal pH of the body. A buffer is a solution that resists a change in pH.**

ENZYMES

Enzymes are catalysts – they affect the rates of chemical reactions.
All enzymes have a specific shape that fits perfectly with another molecule called a substrate

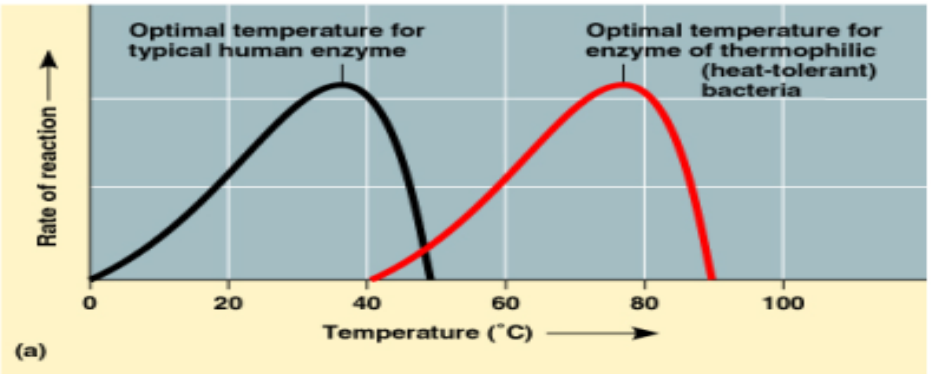




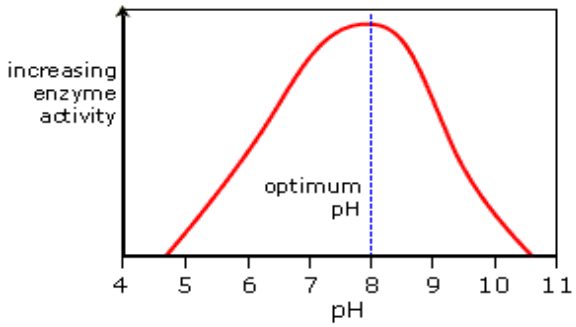
1) **lock and key model** – one type of enzyme fits one type of molecule. Change its shape and the enzyme will no longer work or will slow down significantly. **Substrate,** *or reagent(s)*, fits into the **active site**, *where*

chemical reactions occur.

2) **Very high temperatures** cause proteins and enzymes to lose their shape so that they no longer work properly. This is why high fevers are dangerous.

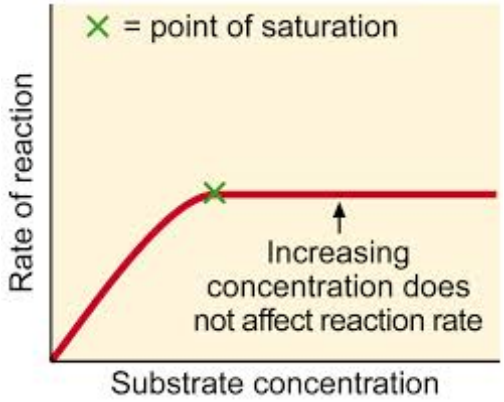


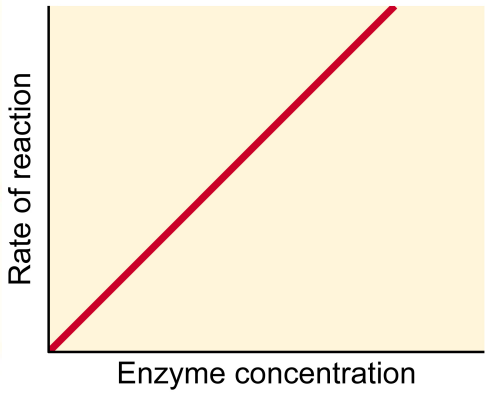
3) It is important for the body to maintain acid-base homeostasis because the body's **proteins may denature (unfold) if the pH is too high or too low**. All proteins work best at certain pH, depending on the type of protein it is.



4) **Substrate concentration and enzyme concentration** also affect enzyme activity.

- Doubling substrate concentration may increase enzymatic reaction. (up to a certain point)
- Doubling enzyme concentration may also increase enzymatic activity.





Enzyme	Location	Temperature (°C)	pH
ptyalin	mouth	36.7–37.0	6.5–7.0
pepsin	stomach	37.3–37.6	1.0–3.0
trypsin	small intestine	37.3–37.6	7.5–9.0

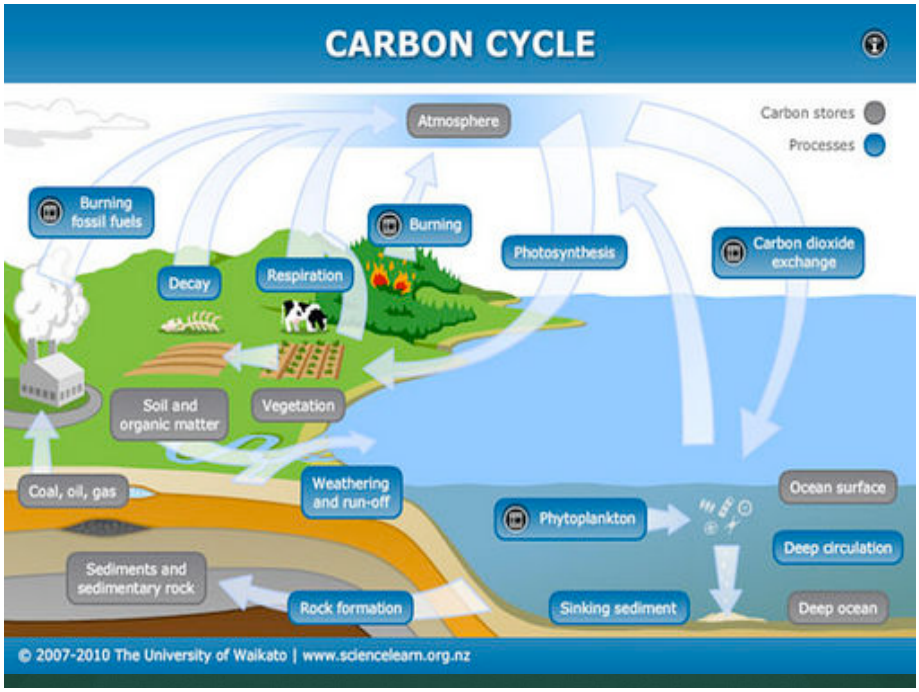
****If the enzyme is placed at a temperature outside of its optimal temperature range, it can denature (unfold), which changes the shape of its active site. Changing the shape of its active site means it can no longer participate in chemical reactions (or at least it slows it down significantly) since it cannot bind to the substrate. The same effect is seen is it is placed in an environment outside its optimal pH range.**

MACROMOLECULES

Macromolecules *are large organic molecules necessary for life*.

Macromolecules	*Function*	*Examples*
Lipids:	• Many functions: long-term energy storage (provides greatest amount of energy), insulation, makes up cell membrane, nerve insulation	Fats, waxes, hormones, triglycerides, vitamin K
Proteins:	• Enzyme is one of the most important type of protein. • Serve many functions: movement, transport, structure, defense, and hormones	Amylase, pepsin, ATP synthase *Most enzymes have the suffix "–ase"

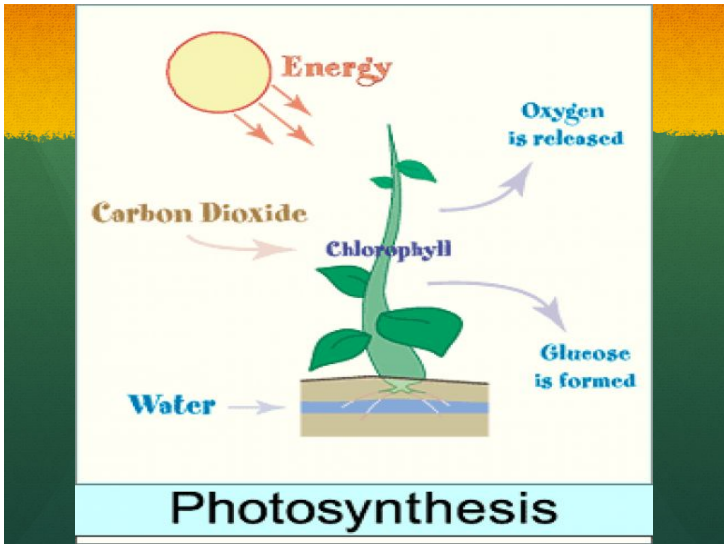
	• Proteins are made from **amino acids**. • Proteins also make hormones and many body and cell structures	
Nucleic Acids	• Direct protein production • Provides code for different traits	DNA and RNA
Carbohydrates	• Provides short-term energy and structure • *Monosaccharride* = cannot be broken down (e.g. glucose) • *Disaccharride* = contains two monosaccharides (e.g. sucrose) • *Polysaccharride* = contains more than two monosaccharides (e.g. cellulose, glycogen, and starch)	Glucose, starch, glycogen, chitin *Many sugars have the suffix "–ose"



Sources of carbon:

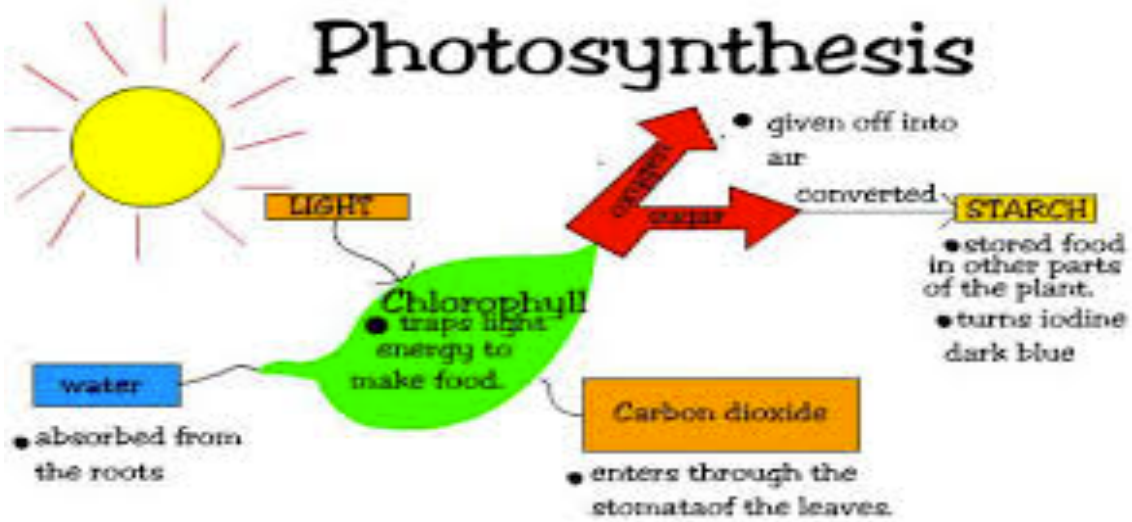
- **Cellular respiration**

- **Burning of fossil fuels**
- **Exhaust from automobiles and factories**



Photosynthesis is carried out by plants, alga and blue-green bacteria (autotrophs). It takes the radiant energy of the sun and puts it in the bonds of sugar molecules. Photosynthesis occurs mostly in the chloroplast of plant cells.

- ***Materials needed for photosynthesis***: carbon dioxide (CO_2), water, and energy from the sun
- ***Products of photosynthesis:*** sugar molecules (glucose) and oxygen
- **ONLY PRODUCERS (AUTOTROPHS) UNDERGO PHOTOSYNTHESIS**



Cellular Respiration: Organisms get energy by breaking the bonds of sugar molecules. The released energy is used to make a molecule of ATP, which gives all organisms their energy.

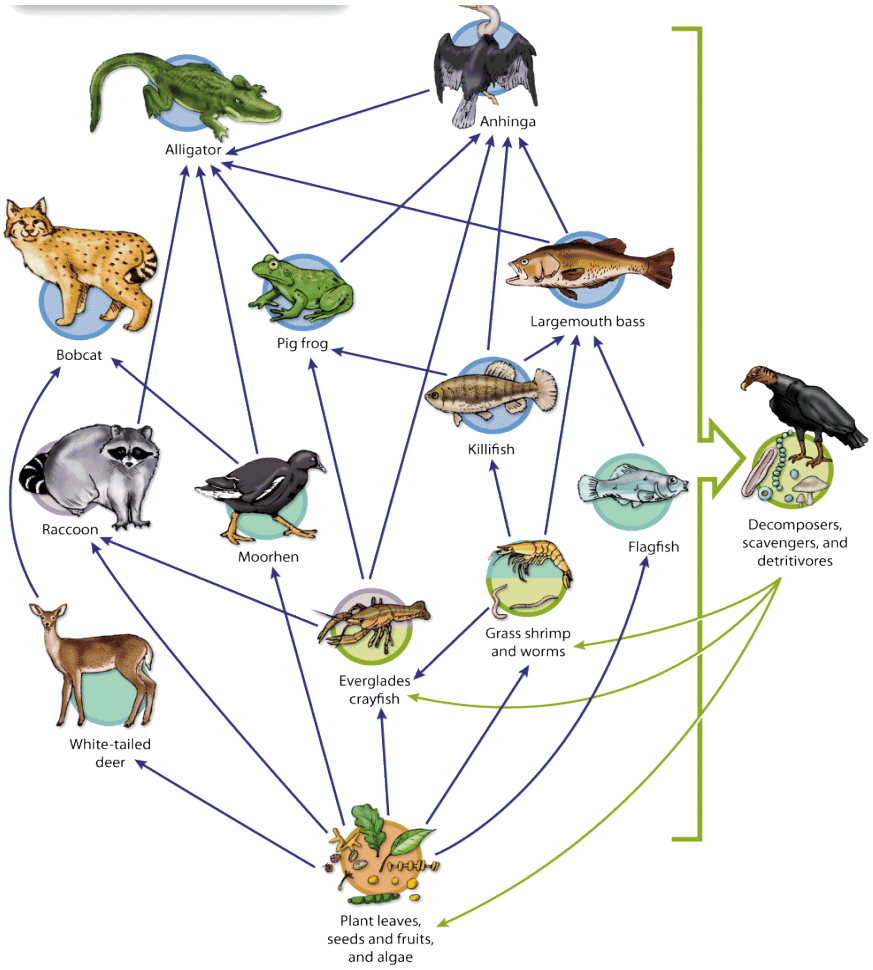
- ***Materials needed for cellular respiration:*** sugar and oxygen

(anaerobic)

- ***Products of cellular respiration:*** energy (ATP), carbon dioxide, and water
- **CONSUMERS and PRODUCERS UNDERGO CELLULAR RESPIRATION**

ECOLOGICAL RELATIONSHIPS

A. Understand how organisms interact with their environment (food webs, nutrient cycles). **Ecosystem** *includes all of the living things and their physical environments within a particular area.*



- **Food chain:** Linear series of feeding relationships
- **Food web:** Shows the overlapping and interconnected food chains present in a community

SPECIES INTERACTIONS

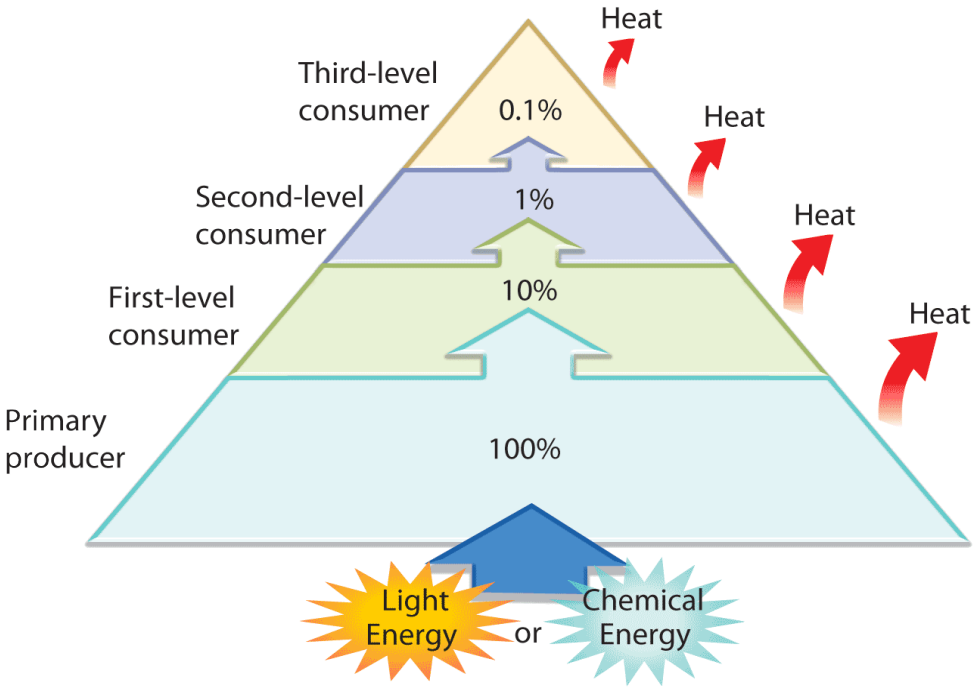
Interaction	*Effect on Species A*	*Effect on Species B*	*Description*
Commensalism	**+**	**0**	One species benefits while the other is not affected
Competition	**-**	**-**	Species are competing for the same resource
Mutualism	**+**	**+**	Both species benefit
Parasitism	**+**	**-**	One species benefits while the other is harmed
Predation	**+**	**-**	One species is hunted while the other hunts

B. **Energy** is needed to keep an ecosystem going. The energy comes from the sun and is made usable by **producers** (plants and other autotrophs). They create their own food through photosynthesis.

C. Energy is passed on to other organisms in the form of food. Since all organisms must use energy for their own needs, most energy is lost before it can be passed to the next step in the food chain. As a result, organisms high on the food chain have less energy available to them and must have smaller populations.

Consumers • *rely on other organisms for energy and nutrients* • Use oxygen to break bonds in sugar and release its energy through cellular respiration (primary producers do this, too)	
Herbivores	*Eat plants*
Carnivores	*Eat meat*

Omnivores	*Eat both plants and meat*
Detritivores	*Eat dead bodies; scavengers. Helps recycle nutrients within an ecosystem*
Decomposers	*Breaks down nonliving matter. Helps recycle nutrients within an ecosystem*



- *An organism's rank in a feeding hierarchy is its* **trophic level**.
- **Primary producers** always occupy the first trophic level of any community.
- In general, only about **10% of the energy** available at any trophic level is passed to the next; most of the rest is lost to the environment as heat.

E. There are many roles in an ecosystem (niche), but competition between species usually results in only one species occupying a niche at any one time. Often, organisms with similar needs will divide resources.

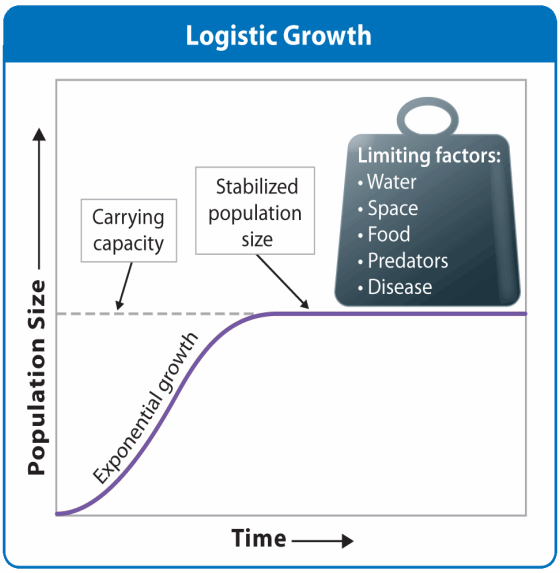
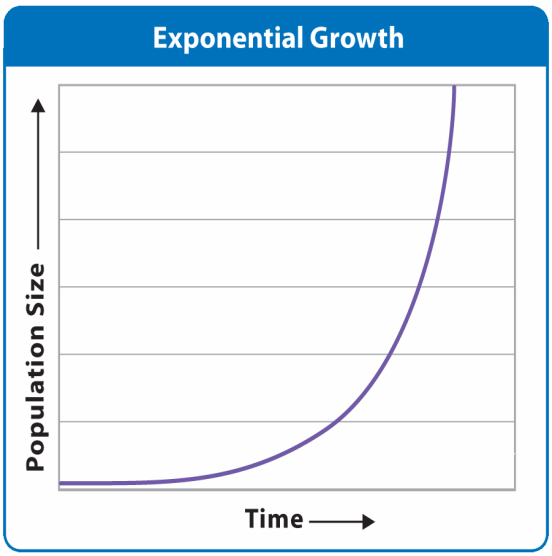
POPULATION

- ***Immigration*** = organisms coming into a population
- ***Birth Rate (Natality)*** = Rate at which organisms reproduce
- ***Emigration*** = organisms leaving a population
- ***Death Rate (Mortality)*** = Rate at which organisms die

Population Growth Rate = (Immigration + Birth Rate) – (Emigration + Death Rate)

Abiotic factors *are parts of an ecosystem that have* ***never been living****.*
Example: sunlight, water, air, rocks

Biotic factors *are parts of an ecosystem that are* ***living or used to be living****.*
Example: rotting tree, plants, bacteria, squirrels

	
• ***Carrying capacity*** **– largest population size a given environment can sustainably support** • **Growth almost always slows and stops due to limiting factors.**	• **Population increases by a fixed percentage every year.** • **Normally occurs only when small populations are introduced to an area with ideal environmental conditions** • **Rarely lasts long**

Asexual vs. Sexual Reproduction

Asexual	***Sexual***
Advantages: faster, easier, only requires one "parent"	*Advantage:* variety
Disadvantage: No variety, offspring are the same as parent	*Disadvantages*: more time, effort and risk, requires two parents

MITOSIS

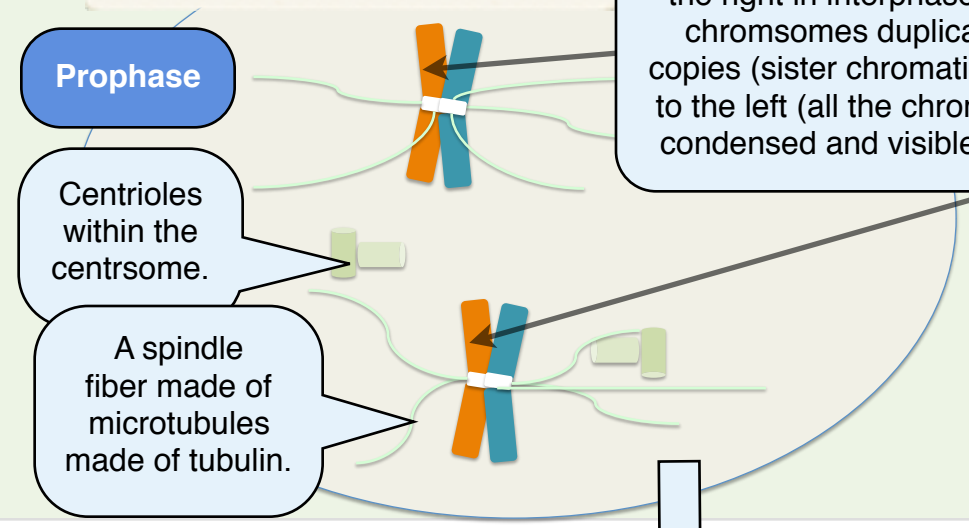
INSERT: http://www.biology101.org/studyguides/mitosis.pdf

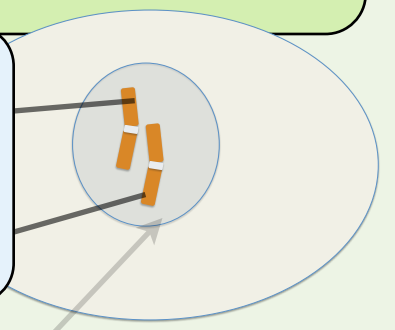
STUDY GUIDE FOR

Mitosis

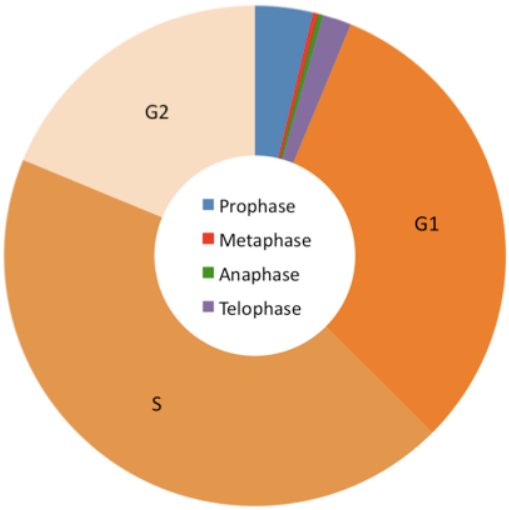
Mitosis is the process where a eukaryotic cell doubles its chromosomes (DNA) and then divides into two cells that are copies of the orginal cell. It is how new cells are made when an organism (like you) grows or repairs damaged tissue (like a cut).

A cell with 2 chromosomes is shown to the right in interphase. Each of these chromsomes duplicates to produce copies (sister chromatids) shown in blue to the left (all the chromosomes are not condensed and visible until prophase).

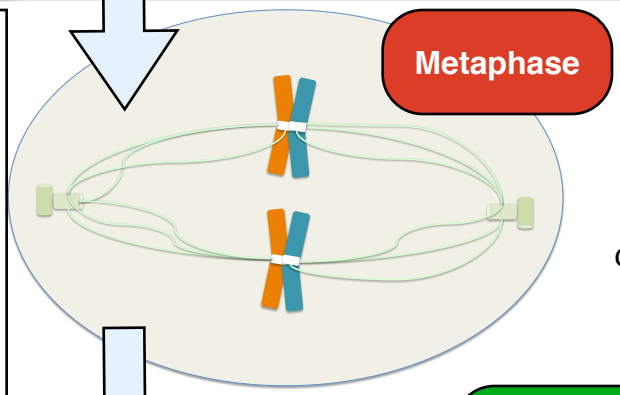




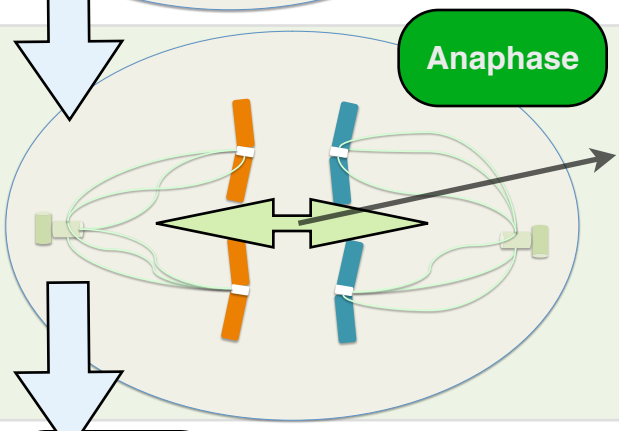
In prophase, the spindle fibers begin to form and attach to the **centromeres** (shown in white) of each pair of **sister chromatids**. The **nuclear envelope** dissolves and the **centrioles** move towards opposite poles of the cell. A protein structure called the **kinetochore** connects the spindle fibers to the centromeres.



Mitosis is part of a larger cell cycle. When not in mitosis the cell is in **interphase** which is divided into **G1** (Gap1), **S** (Synthesis) and **G2** (Gap 2). The chromosomes are actually duplicated in the S phase but not visible until prophase. The relative time of each stage is shown in the pie chart above.

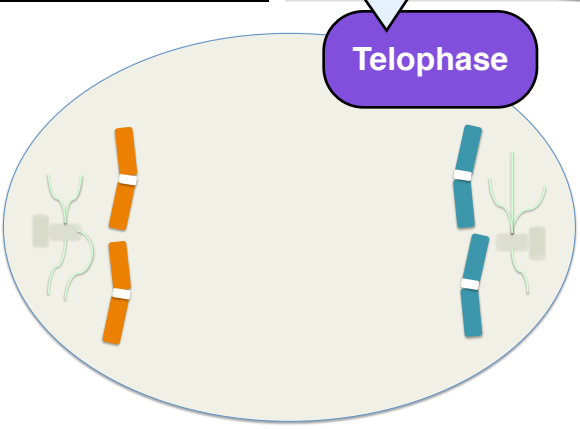


The spindle fibers pull the chromsomes to the center of the cell (the **metaphase plate)**. We call this stage metaphase, once all the centromeres are aligned in the center of the cell.

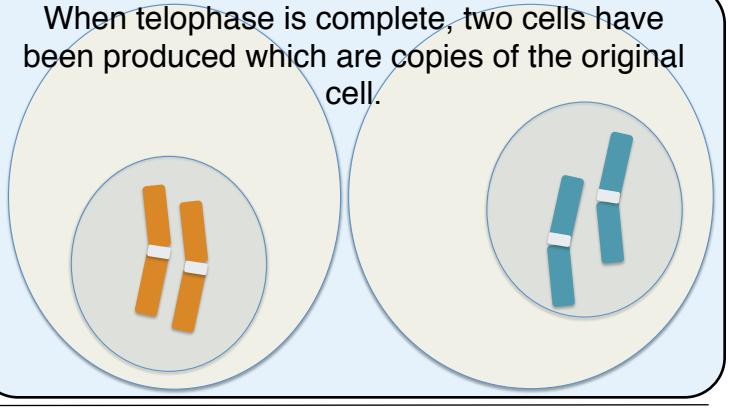


Anaphase is the stage of mitosis when the sister chromatids are pulled apart (they **disjoin**) and each copy is pulled to an opposite pole of the cell.

In telophase the cell divides in half (**cytokinesis**), spindle fibers disappear and the nuclear envelope forms around each set of chromsomes.



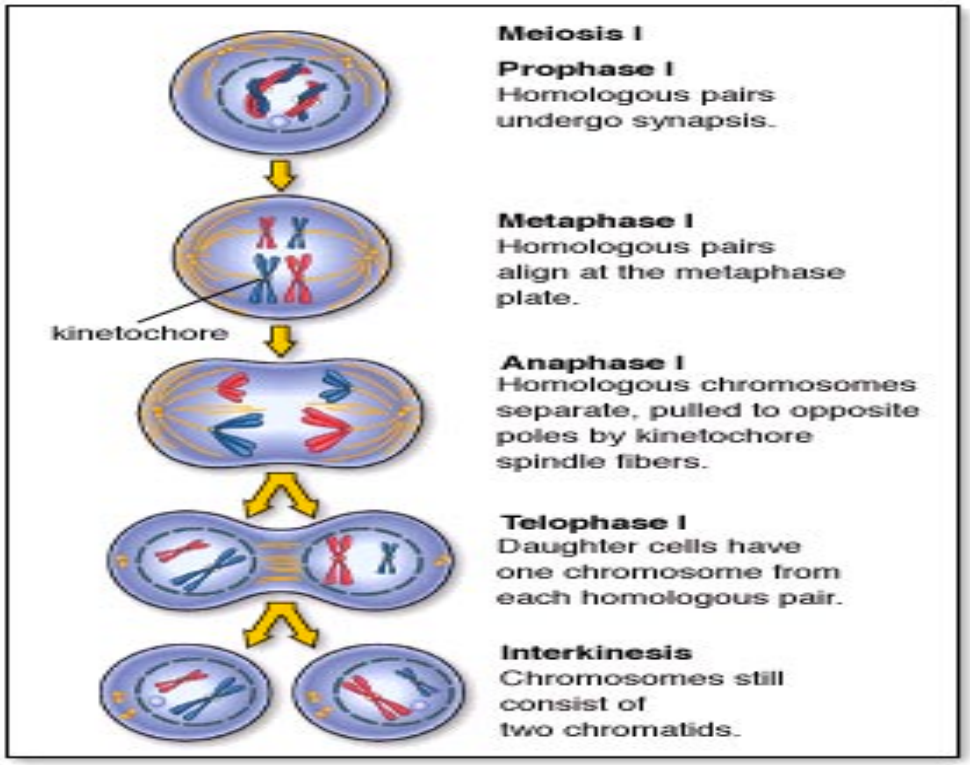
When telophase is complete, two cells have been produced which are copies of the original cell.

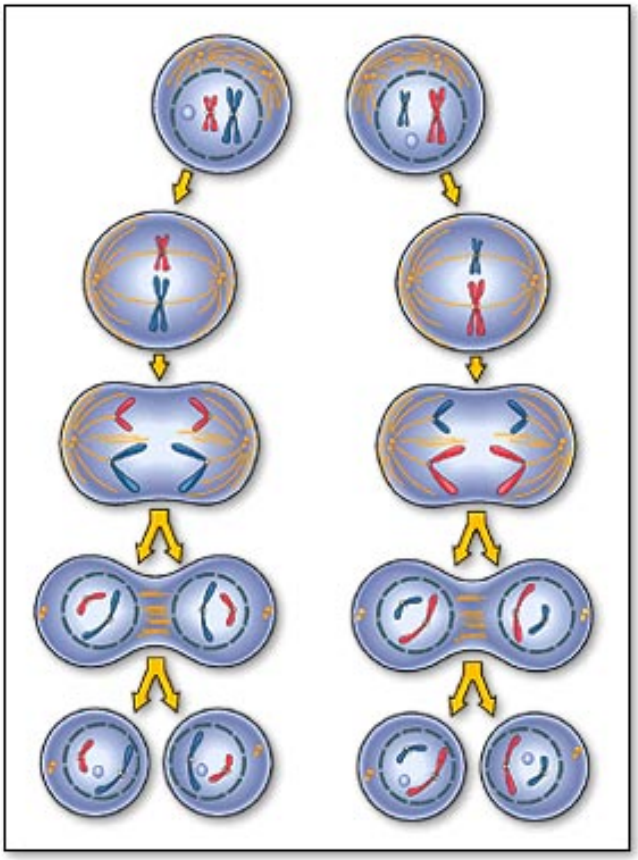


"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

MEOISIS





Meiosis II separates sister chromatids

Prophase II
Cells have one chromosome from each homologous pair.

Metaphase II
Chromosomes align at the metaphase plate.

Anaphase II
Daughter chromosomes move toward the poles.

Telophase II
Spindle disappears, nuclei form, and cytokinesis takes place.

Daughter Cells
Meiosis results in four haploid daughter cells.

Mitosis vs Meiosis

MITOSIS	***MEIOSIS***
1. Somatic (body) cells undergo mitosis 2. One division => two IDENTICAL, diploid (2n) cells. 3. Chromosome number in the daughter cells is the same as in the parent cell. 4. Large organisms use mitosis for growth and healing. Simple organisms use it to reproduce.	1. Sexual reproduction 2. One cell divides twice to make four DIFFERENT cells. 3. All 4 cells are haploid (n) meaning they have half the number of chromosomes found in the parent cell. 4. Makes gametes (sex cells). In humans 4 sperm cells or 1 egg and three polar bodies are produced each time meiosis occurs. 5. Separates pairs of homologous chromosomes so that offspring get one chromosome of each pair from a different parent.

E. Fertilization occurs in the fallopian tube. A fertilized egg is called a zygote and has a normal number of chromosomes (2n).

F. The fetus develops in the uterus. Cells divide without becoming larger (cleavage). After a few days, cells begin to differentiate – that is they start to form different types of cells (nerve, skin, bone, etc). At this stage the embryo is very vulnerable to alcohol, drugs, etc. because the important organs and systems are just starting to develop.

GENETICS AND HEREDITY

A. Humans have 46 chromosomes, or 23 homologous pairs.

B. Chromosome pairs carry alleles for the same trait. We all have two alleles for each gene—1 from each parent, 1 on each member of the homologous pair.

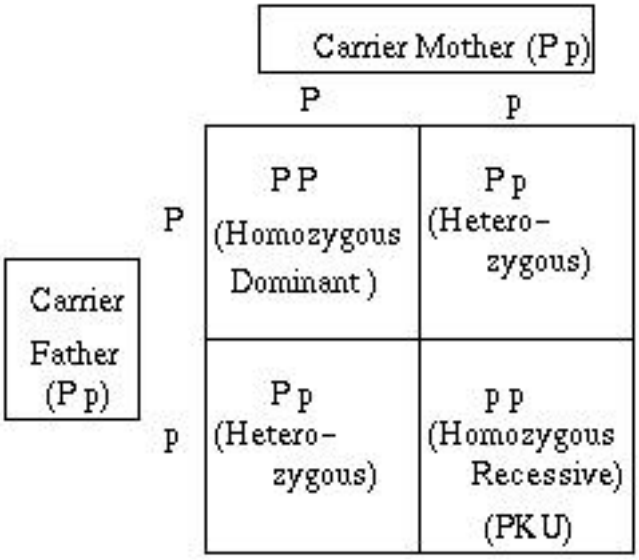
C. While genes determine our traits, the environment can affect expression of genes.

D. Each chromosome has hundreds or thousands of genes. Each gene codes for a particular protein (1 gene = 1 protein).

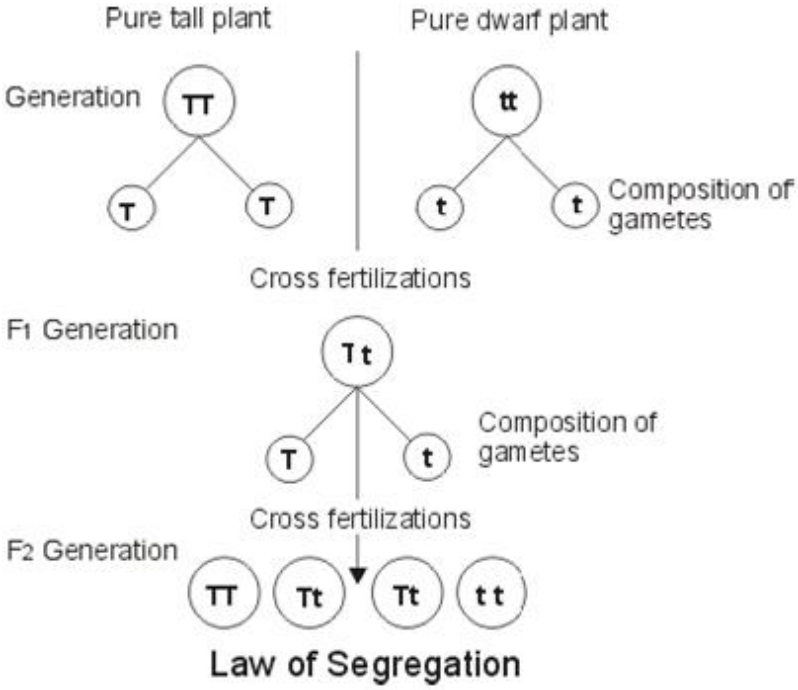
A person can be **heterozygous** or **homozygous** for any gene.

- **Heterozygous**-different types of gene (ex: Tt)
- **Homozygous**
    1. **Homozygous dominant**-same type of *dominant gene* (ex: TT)
    2. **Homozygous recessive**-same type of *recessive gene* (ex: tt)

PUNNETT SQUARE



Mendel's Law of Segregation

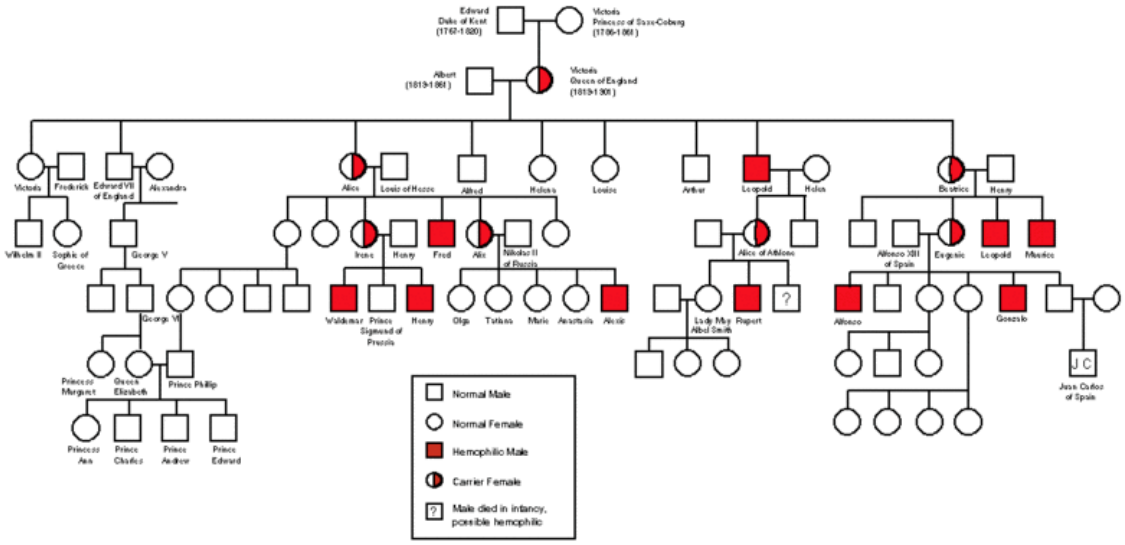


Law of segregation states the principle stating that during the production of gametes the two copies of each hereditary factor segregate so that offspring acquire one factor from each parent.

"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

Recombination is when genetic factors from each parent are combined during the "crossing over" phase of Meiosis.

PEDIGREE



SEX-LINKED TRAITS

White-Eyed Male

Red-Eyed Female	X^r	Y
X^R	X^RX^r	X^RY
X^R	X^RX^r	X^RY

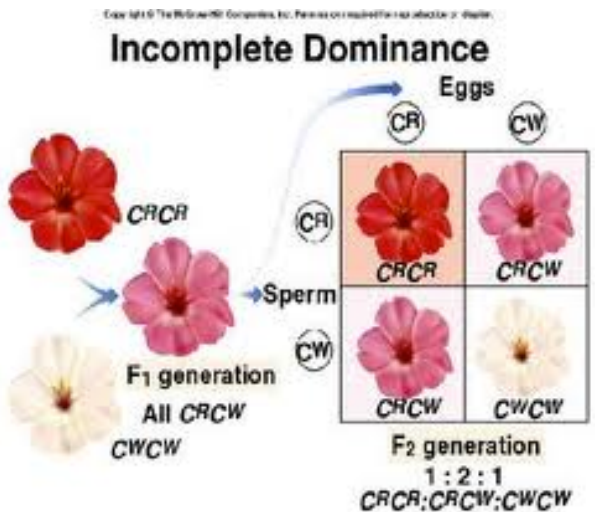
All offspring have red eyes.

Possible Punnett Square of Hemophilia

	X^H	X^h
X^H	X^HX^H	X^HX^h
Y	X^HY	X^hY

- Hemophilia is sex-linked, meaning the allele that codes for the hemophilic trait is found on the 23rd chromosome, also known as the sex chromosome. Certain diseases cannot be passed on from father to son because of this sex-linkage.

Incomplete Dominance

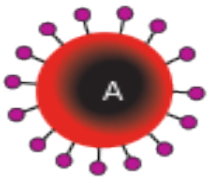
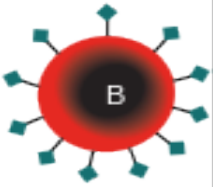
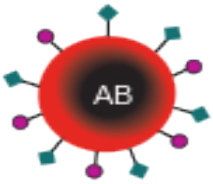
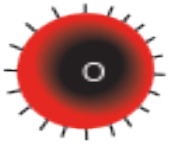
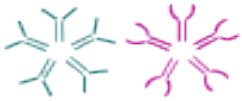


Neither allele is dominant or recessive. Having both allele will result in a *third* phenotype. (something in "between")

Codominance

BOTH alleles are dominant and are expressed simultaneously. Perfect example: blood type. Allele for both type A and type B blood are both dominant so together they are **codominant**. See "Genetics of Blood Type" below.

GENETICS OF BLOOD TYPE

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red Blood Cell	 A antigen	 B antigen	 A and B antigens	None

Phenotype (Blood type)	Genotype
Type A	$I^A I^A$ or $I^A i$
Type B	$I^B I^B$ or $I^B i$
Type AB	$I^A I^B$
Type O	i i

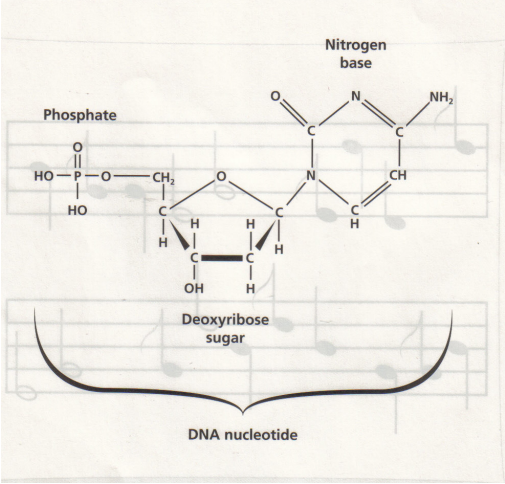
Two Alleles Controlling Human Blood Type

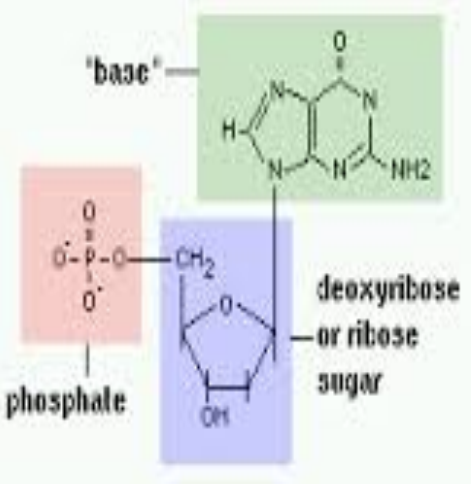
Symbol	Allele Description
I^A	produces antigen A on red blood cells
I^B	produces antigen B on red blood cells

"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

MOLECULAR GENETICS

DNA Nucleotide:

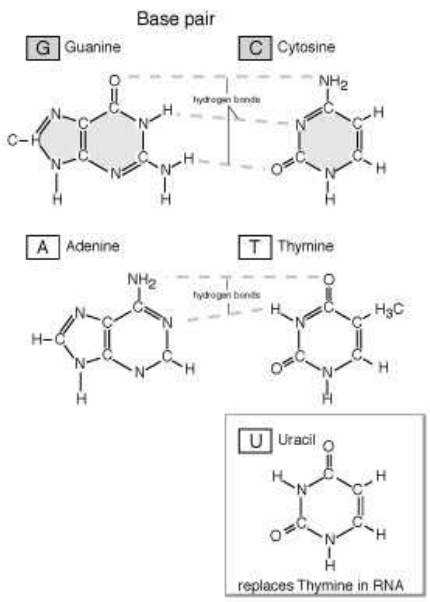


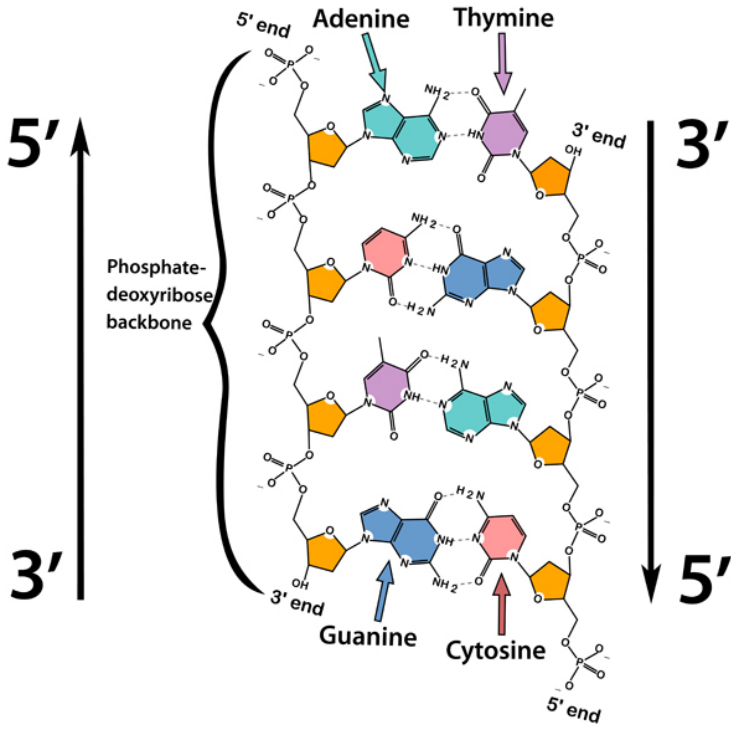


E. DNA (deoxyribonucleic acid) is made of 4 bases: ATCG.

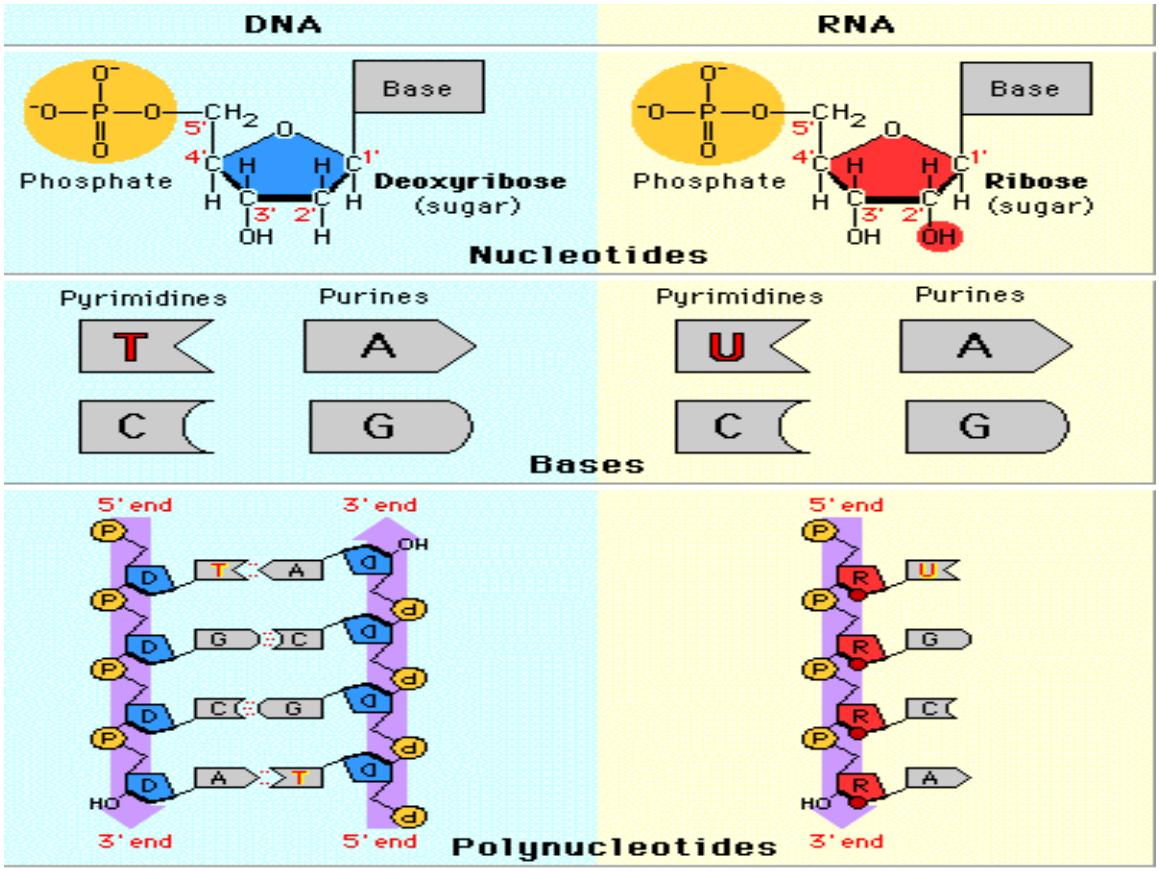
A = adenine
T = thymine
C = cytosine
G = guanine

Base pairs: A=T, C-G (in **RNA**, A-U and C-G)

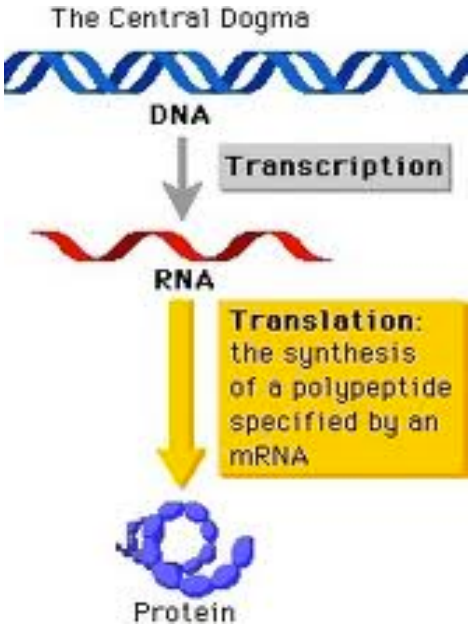




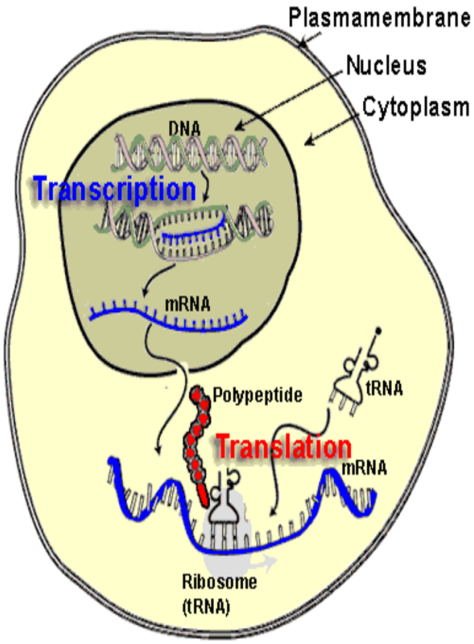
"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie



CENTRAL DOGMA OF MOLECULAR BIOLOGY



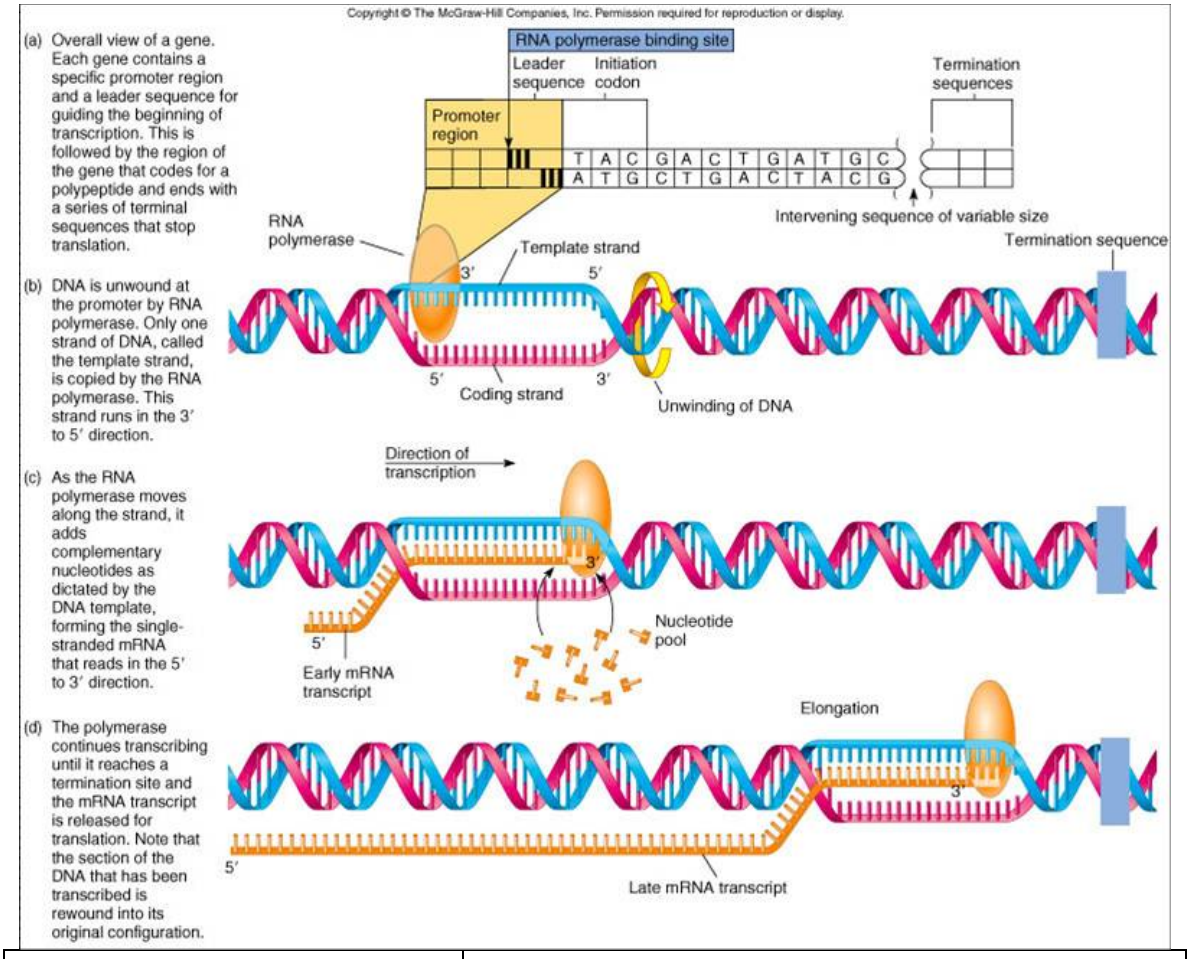
Transcription and Translation



- A three-letter codon represents a specific amino acid. These amino acids are assembles into proteins.
- RNA carries the genetic code to ribosomes. The ribosomes then synthesize protein.

TRANSCRIPTION

"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie



Transcription Step	
1. Initiation	-Transcription Factors and RNA polymerase bind to the promoter region (contains TATA box) -DNA helix is unwound and is ready to be transcribed
2. Elongation	-RNA polymerase moves along protein encoding gene and adds nucleotides to create mRNA in the 5' – 3' direction
3. Termination	- RNA polymerase reaches the terminator region of protein encoding gene -All enzymes and factors are released

TRANSLATION

"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

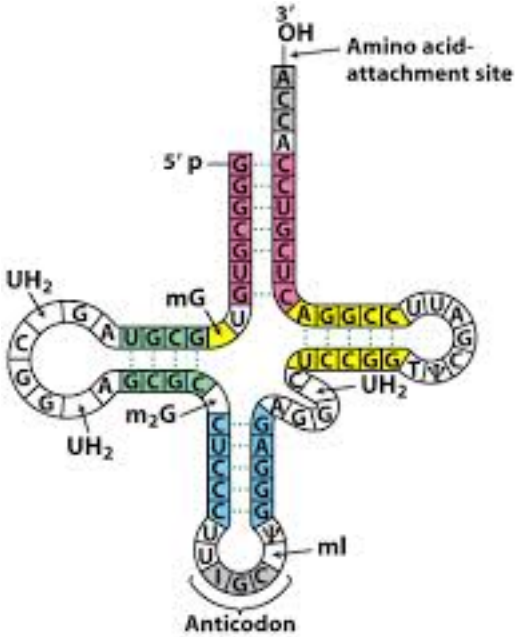
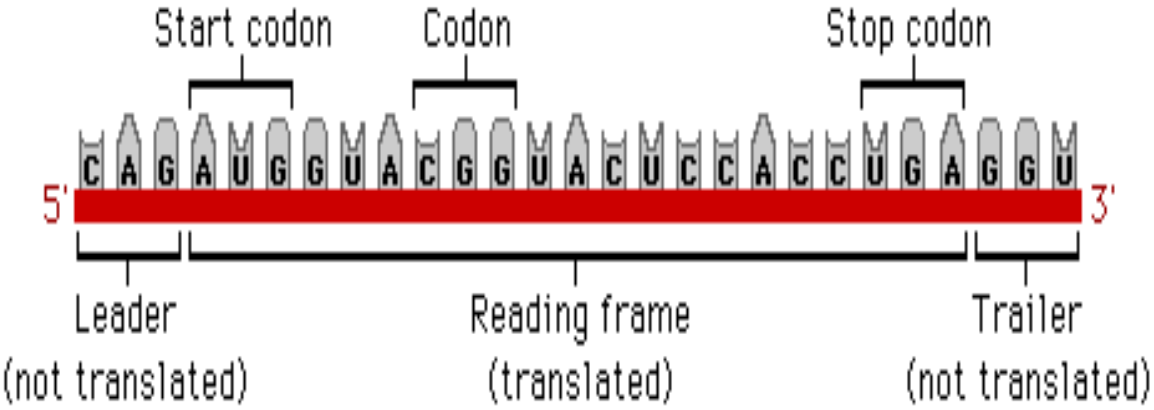
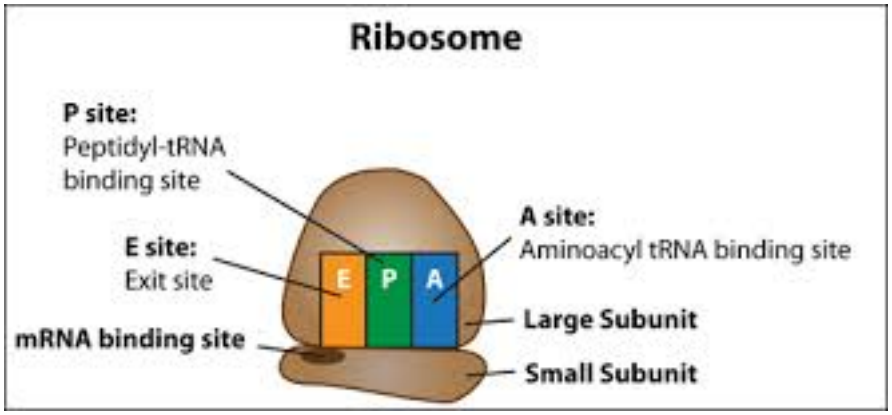


Figure 30.2
Biochemistry, Seventh Edition
© 2012 W. H. Freeman and Company





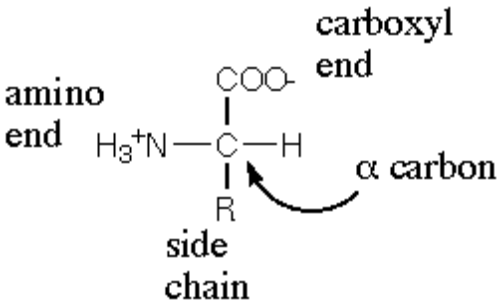
"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

Universal Genetic Code Chart
Messenger RNA Codons and the Amino Acids for Which They Code

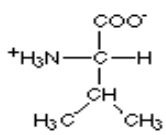
FIRST BASE	SECOND BASE: U	SECOND BASE: C	SECOND BASE: A	SECOND BASE: G	THIRD BASE
U	UUU, UUC: PHE UUA, UUG: LEU	UCU, UCC, UCA, UCG: SER	UAU, UAC: TYR UAA, UAG: STOP	UGU, UGC: CYS UGA: STOP UGG: TRP	U C A G
C	CUU, CUC, CUA, CUG: LEU	CCU, CCC, CCA, CCG: PRO	CAU, CAC: HIS CAA, CAG: GLN	CGU, CGC, CGA, CGG: ARG	U C A G
A	AUU, AUC, AUA: ILE AUG: MET or START	ACU, ACC, ACA, ACG: THR	AAU, AAC: ASN AAA, AAG: LYS	AGU, AGC: SER AGA, AGG: ARG	U C A G
G	GUU, GUC, GUA, GUG: VAL	GCU, GCC, GCA, GCG: ALA	GAU, GAC: ASP GAA, GAG: GLU	GGU, GGC, GGA, GGG: GLY	U C A G

"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie

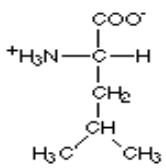
Amino Acids



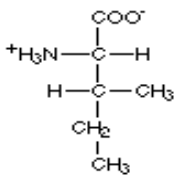
Amino acids with hydrophobic side groups



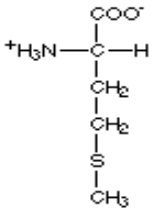
Valine (val)



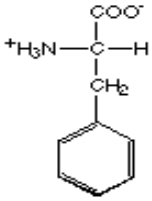
Leucine (leu)



Isoleucine (ile)

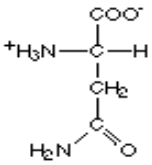


Methionine (met)

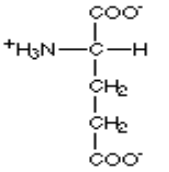


Phenylalanine (phe)

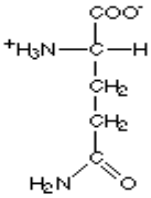
Amino acids with hydrophilic side groups



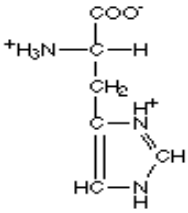
Asparagine (asn)



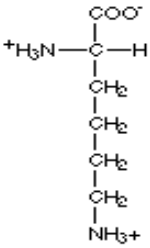
Glutamic acid (glu)



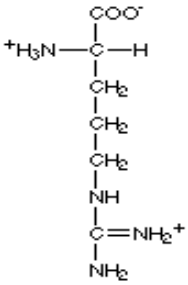
Glutamine (gln)



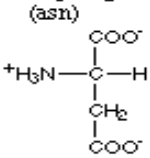
Histidine (his)



Lysine (lys)

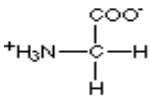


Arginine (arg)

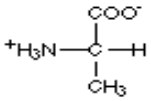


Aspartic acid (asp)

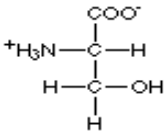
Amino acids that are in between



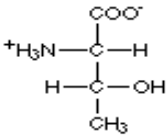
Glycine (gly)



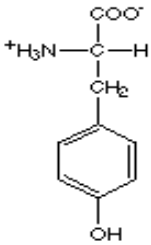
Alanine (ala)



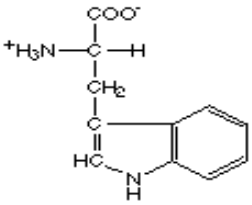
Serine (ser)



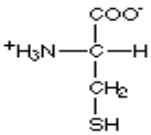
Threonine (thr)



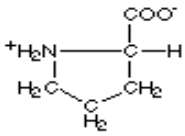
Tyrosine (tyr)



Tryptophan (trp)

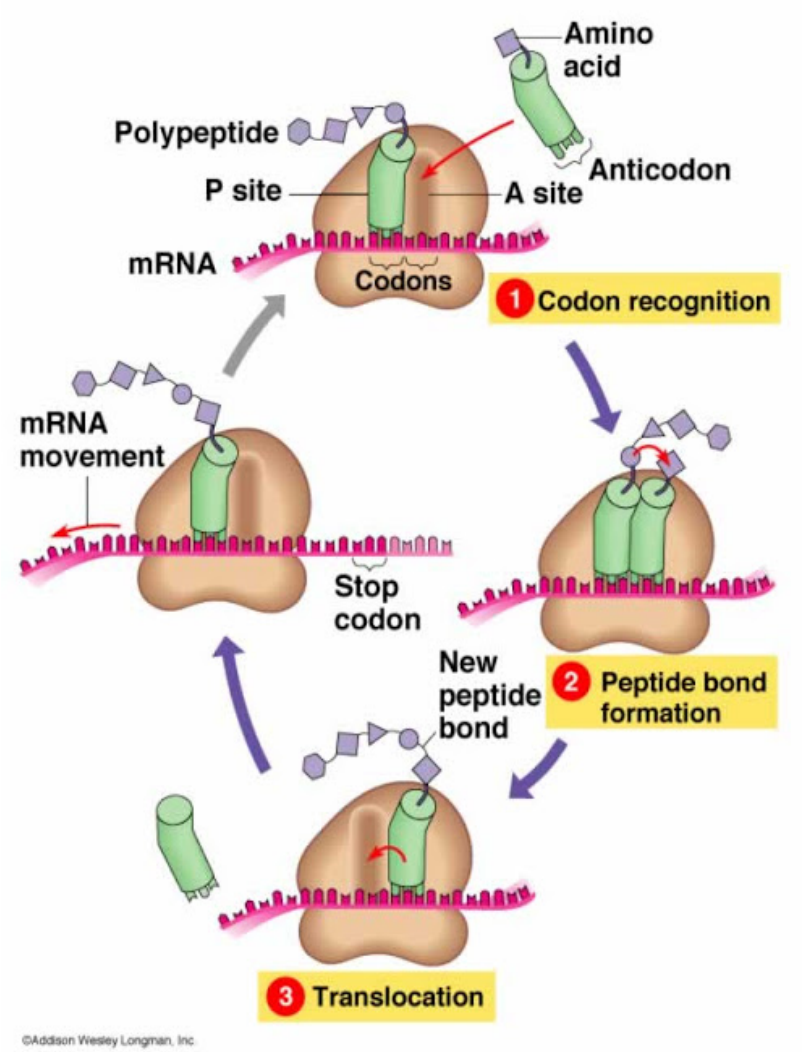


Cysteine (cys)



Proline (pro)

TRANSLATION SUMMARY

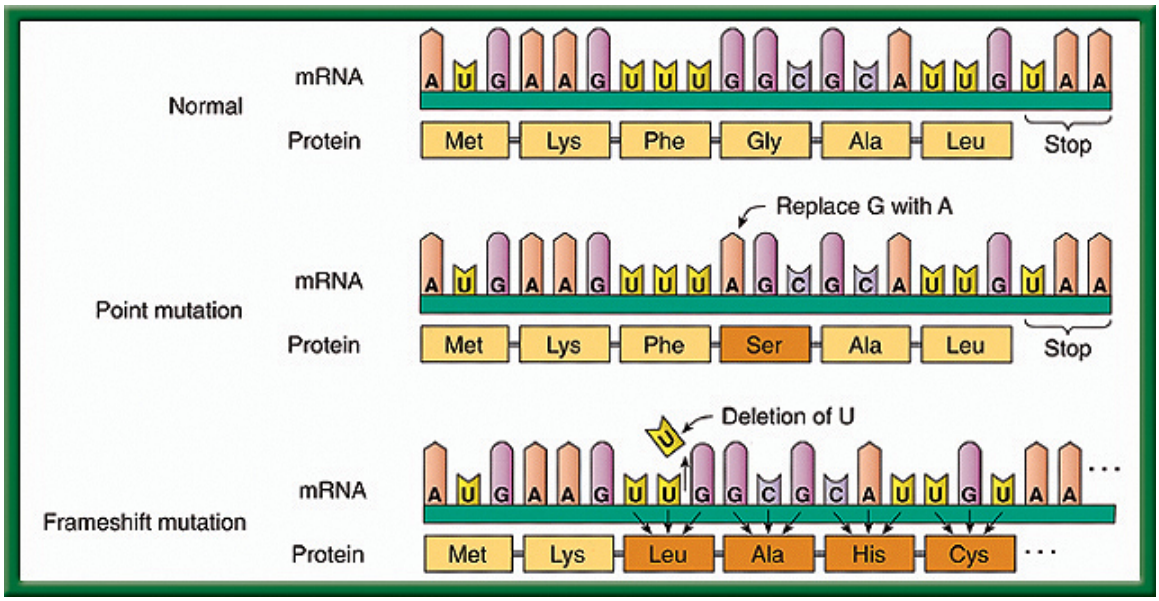


Translation Steps	
1. Initiation	• 5' G-cap of mRNA binds to ribosome • Start codon AUG and anticodon with Methionine bind **a P site** • **A site** is open and ready to receive new tRNAs
2. Elongation	• Codon recognition • Peptide bond formation (multiple amino acids together are called polypeptides) • Translocation: ribosome moves along mRNA, aminoacyl tRNA shifts from A site to P site
3. Termation	• A stop codon is reached (UAA UAG UGA)

	• All parts release

MUTATIONS

H. Changes to DNA are called **mutations**. Mutations that occur in somatic (body) cells DO NOT get passed onto offspring. *They can only be passed on if they occur in reproductive cells (sperm or egg).*

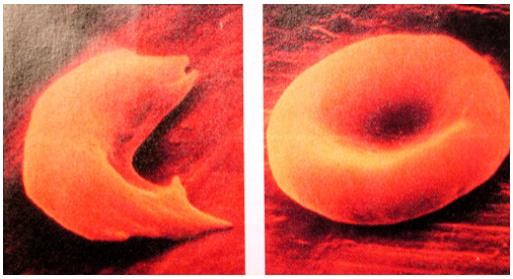


POINT MUTATION	FRAMESHIFT MUTATION
A point mutation is **a change in one base pair** in a DNA sequence. A point mutation can cause an amino acid to change, which will change the structure of the protein being made.	A frameshift mutation is when one nucleotide is **added (insertion) or deleted (deletion)** from the DNA strand. A frameshift mutation is much worse than a point mutation because it causes the entire DNA sequence to be shifted over!

A	wild type	TACAACGTCACCATT AUGUUGCAGUGGUAA ↓ met-leu-gln-trp-STOP	DNA mRNA protein
B	silent mutation	TACAATGTCACCATT AUGUUACAGUGGUAA ↓ met-leu-gln-trp-STOP	DNA mRNA protein
C	missense mutation	TACAAGGTCACCATT AUGUUCCAGUGGUAA ↓ met-phe-gln-trp-STOP	DNA mRNA protein
D	nonsense mutation	TACAACGTCACTATT AUGUUGCAGUGAUAA ↓ met-leu-gln-STOP	DNA mRNA protein
E	frameshift mutation	TATCAACGTCACCATT AUAGUUGCAGUGAUAA ↓ ile-val-gly-val-ile-	DNA mRNA protein

Sickle cell anemia is a blood disease caused by a point mutation.
A single nucleotide is changed from "A" to "T" which causes the amino acid to change from glutamic acid to valine:

Amino acids: Thr – Pro – Glu – Glu
Normal DNA: ACT CCT GAG GAG
Sickle cell DNA: ACT CCT GTG GAG
Amino acids: Thr – Pro – Val – Glu



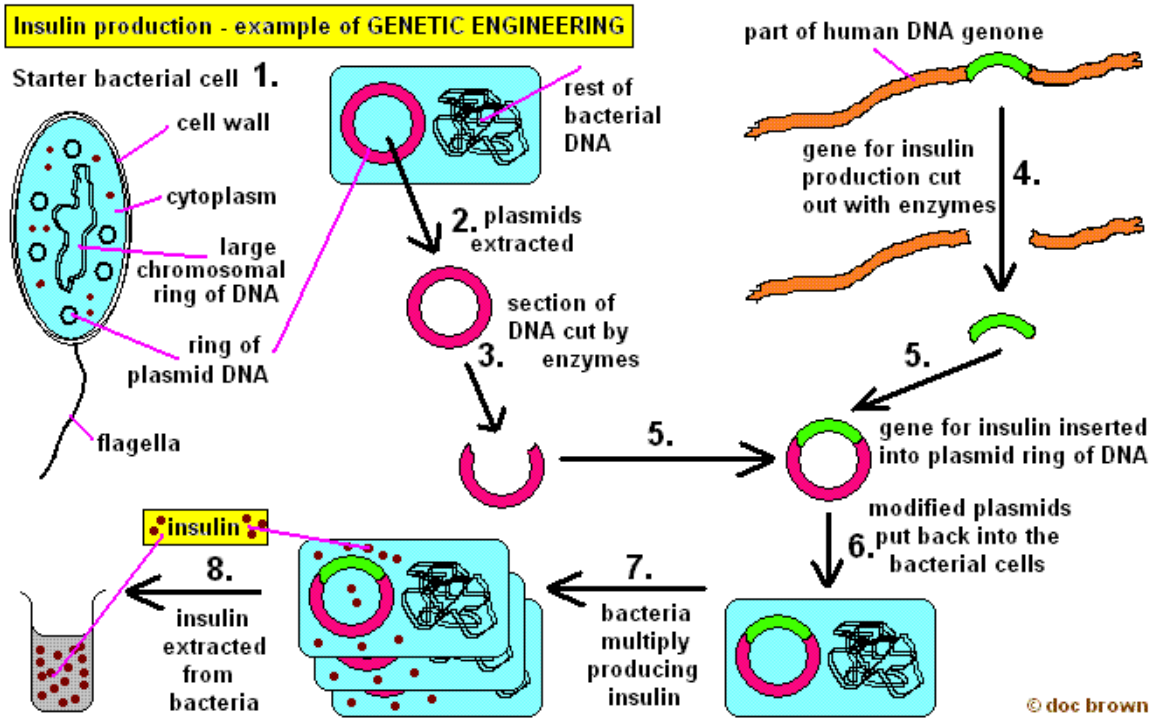
SICKLE CELL NORMAL

GENETIC ENGINEERING

K. *Genetic engineering or gene splicing inserts genes of one organism into the genes of another*. Enzymes are used to **cut and copy the DNA segments**. Bacteria are often used because they have no nucleus protecting their DNA and they reproduce very quickly, allowing large amounts of medicine (insulin) to be made.

a. The example of **gene splicing** you MUST know:

The gene to make human insulin was inserted into bacteria. These bacteria can now make insulin that is exactly the same as human insulin. This insulin is used by diabetics. This is safer than the cow and sheep insulin that were used in the past.

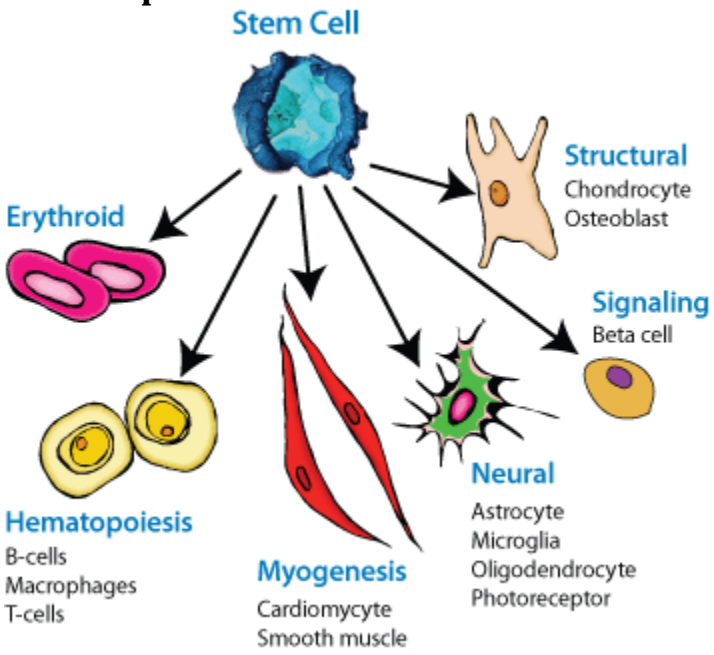


L. New technologies (karyotyping, DNA fingerprinting) are making it easier to diagnose and treat genetic disease, though we cannot yet cure them.

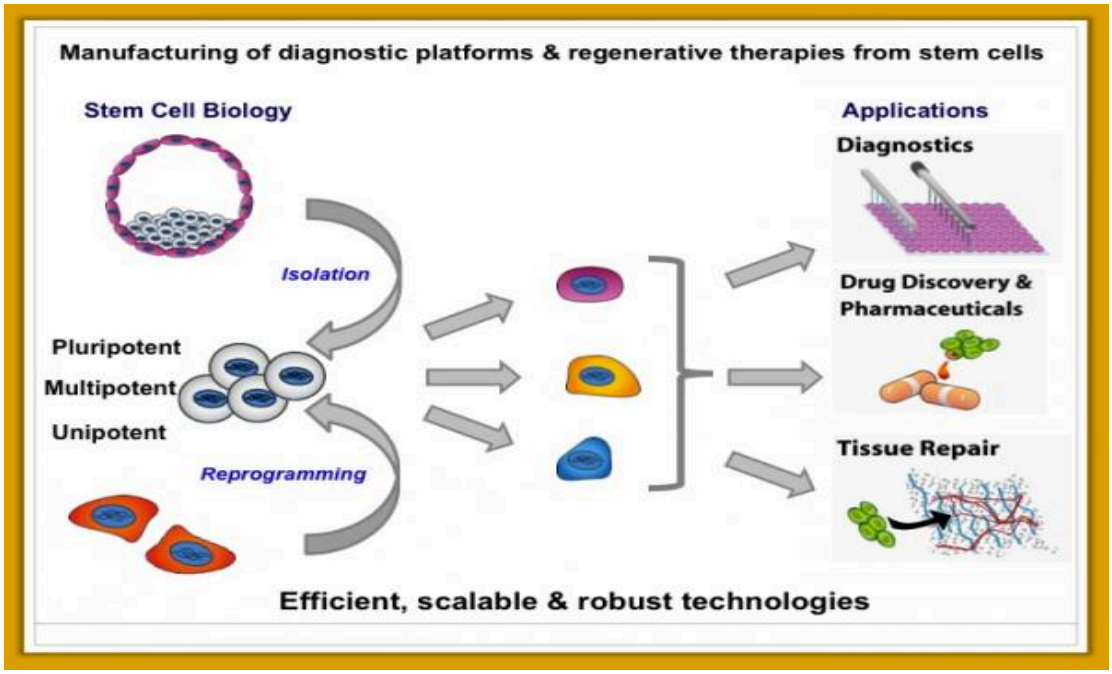
M. Genetic research has posed many ethical problems (ie right and wrong) that science alone cannot answer.

CELL DIFFERENTIATION

All cells in the body contain the same genes. Only some of these genes are **turned on** (that is, your eye cells contain the instructions on how to make bones, but only the genes to make new eye cells are actually turned on).
Cell differentiation can be controlled during **translation and transcription**.



"Most of the important things in the world have been accomplished by people who have kept on trying when there seemed no hope at all." - Dale Carnegie



Stem Cell Research Controversy

"It is embryonic stem cells that cause controversy. Removing the stem cells requires the destruction of the embryo, which some people liken to destruction of a human being. The issue comes down to the question of when life begins: Those who believe that life starts at the moment of conception think that harvesting embryonic stem cells is akin to murder. Some critics of this viewpoint have argued that these embryos were marked for destruction and then donated by their owners, meaning that these embryos would never have come to term anyway, but others predict that this excuse might lead to more ethically questionable actions in the future, such as harvesting embryos specifically for research. In recent years, researchers have tried to find ways to obtain embryonic stem cells without destroying the embryos. One method of deriving stem cells from mice embryos has proven successful. Researchers are also experimenting with reprogramming adult stem cells to act more like embryonic stem cells. These cells, known as **induced pluripotent stem cells**, hold promise, but scientists would still like the opportunity to pursue work with the embryonic stem cells." (SOURCE: http://science.howstuffworks.com/life/genetic/ethical-to-use-stem-cells.htm)