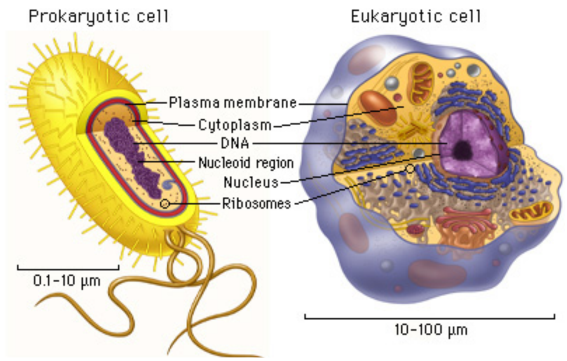
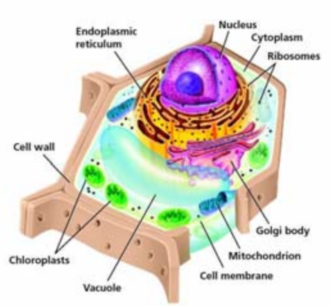
Robert E. Lee EOC Biology Quick Review

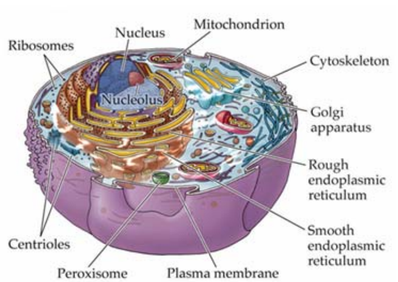
B.4.A

Prokaryotic Cells: Smallest, Simplest cells, bacteria cells, contains no nucleus or other membrane bound organelles

Eukaryotic Cells:
Complex cellular organization
A. Membrane: Bound organelles including the following:
1. Nucleus: DNA, Chromosomes control cellular activities via genes
2. Nucleolus: Located within nucleus, site for ribosome synthesis
3. Rough endoplasmic reticulum: With ribosomes, involved in protein synthesis
4. Smooth endoplasmic reticulum: Without ribosomes, involved primarily in lipid synthesis
5. Golgi apparatus: Packaging center for molecules; carbohydrate synthesis
6. Lysosome: Contains hydrolytic enzymes for intracellular digestion
7. Mitochondrion: ATP production
8. Nuclear membrane: Encloses nucleus and controls what enters and leaves the nucleus
9. Golgi apparatus: Secretes and stores secretions for transport out of the cell
10.. Ribosomes - sites of protein production- RNA) - protein synthesis
11. Flagellum – locomotion (bacteria)
12. Pili - used for attachment to other bacteria or to a host
13. Vacuoles: Stores food, water, wastes and building materials larger in plants
14. Chloroplast: Site of photosynthesis in plant cells
15. Cell wall: Protective out barrier of plant cells

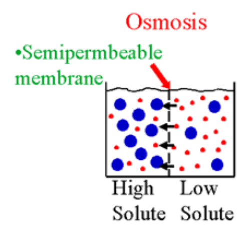


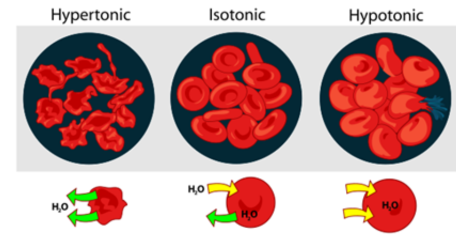




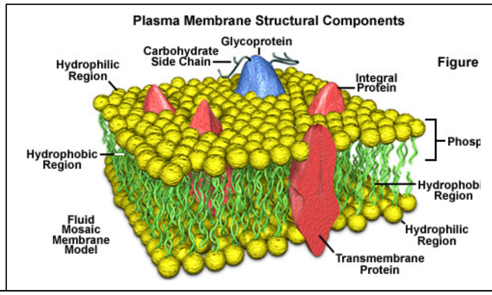
4.B

Passive Transport :
A. Relies on thermal energy of matter; the cell does not do work.
I. Diffusion: Movement from an area of high to low concentration
2. Facilitated diffusion: A permease, or membrane enzyme, carries substance
3. Osmosis: Diffusion across a semi-permeable membrane
4. Bulk flow: Mass movements of fluids affected by pressure and solutes

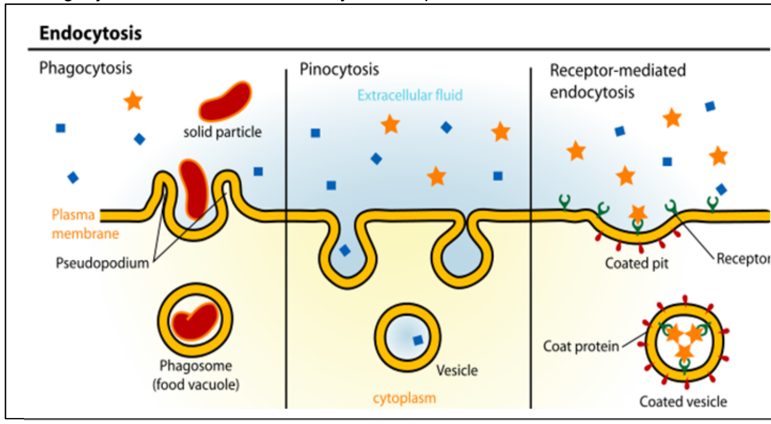


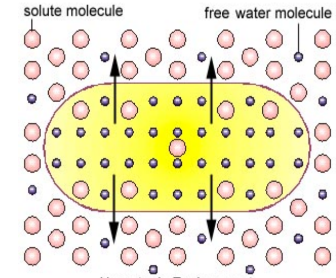


Active Transport A. Relies on the cell providing energy supply; there are three categories:
I. Membrane pumps: Permease used to move substance, usually in the opposite direction of diffusion.

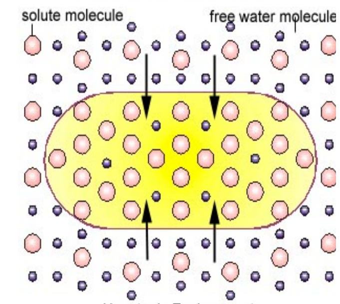


2. Endocytosis: Materials are brought into cell via:
a. Phagocytosis: Solids b. Pinocytosis: Liquid

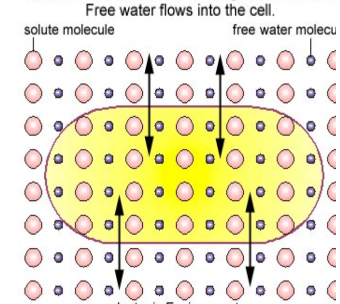




Hypertonic Environment:
The solute concentration is greater outside the cell; the free water concentration is greater inside.
Free water flows out of the cell.

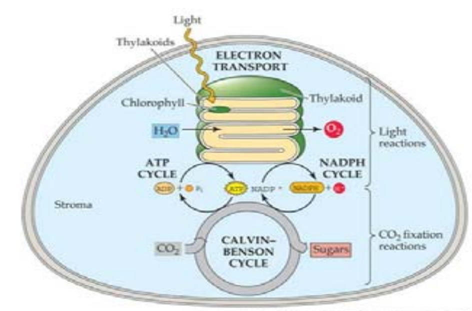


Hypotonic Environment:
The solute concentration is greater inside the cell the free water concentration is greater outside.
Free water flows into the cell.



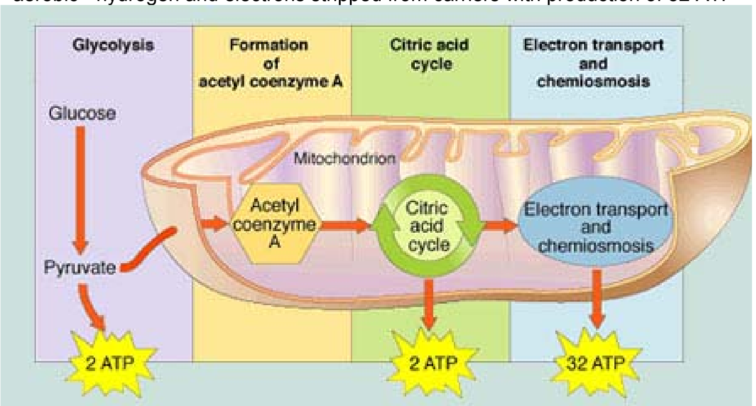
Isotonic Environment:
The solute concentration and the free water concentration are the same inside and outside the cell.
Water flows in and out of the cell at an equal rate.

PHOTOSYNTHESIS - chloroplasts –
$6CO_2 + 6H_2O$ + (light, chlorophyll) → $C_6H_{12}O_6 + 6O_2$
Sunlight or radiant energy is captured by chlorophyll and carotenoid photopigments (found in cytoplasm in prokaryotes and chloroplasts in eukaryotes) in two main steps:
A. Light-dependent reactions (Light Reactions):
The captured light energy is transferred to electrons that come from H_2O; O_2 is a by-product
B. Light-independent reactions (Dark Reactions):
Energized electrons are transferred to CO_2 (reduction reactions) to form glucose (in the Calvin-Benson cycle)

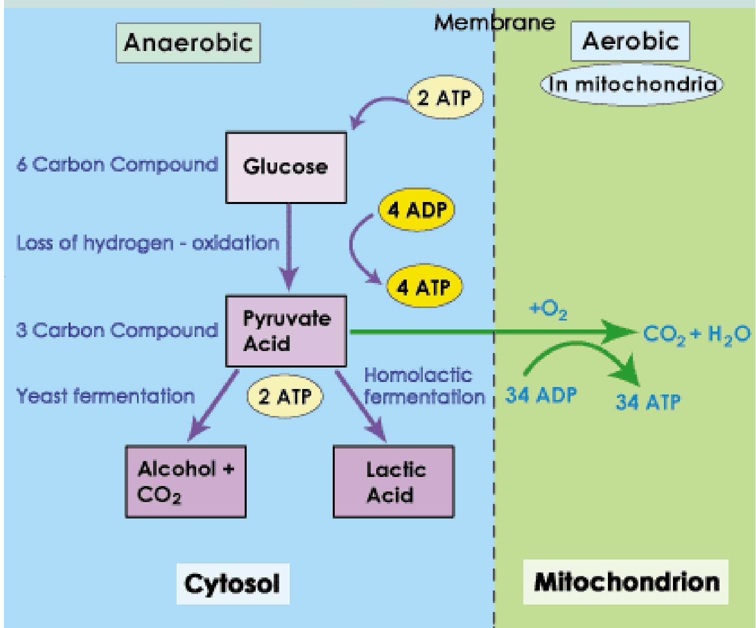


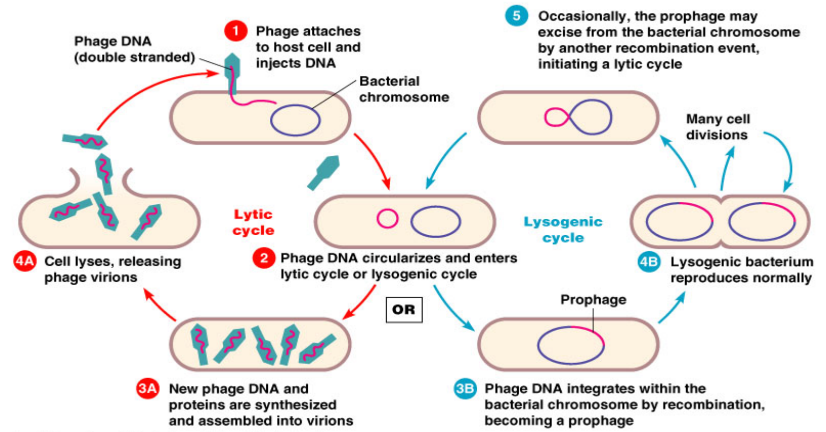
Robert E. Lee EOC Biology Quick Review

CELLULAR RESPIRATION - generates ATP (Mitochondria)
1. Glycolysis - initial stage of respiration -
cytoplasm - anaerobic - activation of glucose (by ATP), with production of pyruvate (net
gain of 2 ATP)
2. Krebs (citric acid) cycle - second stage of respiration - mitochondria - aerobic - pyruvate broken down with production of CO_2, 2 ATP, and many electron carriers
3. Electron (hydro ge n) transport chain - third stage of respiration - mitochondria - aerobic - hydrogen and electrons stripped from carriers with production of 32 ATP



$$C_6H_{12}O_6 + 6\,O_2 + 6H_2O \longrightarrow 6\,CO_2 + 12\,H_2O +$$
Energy (in the chemical bonds of ATP)





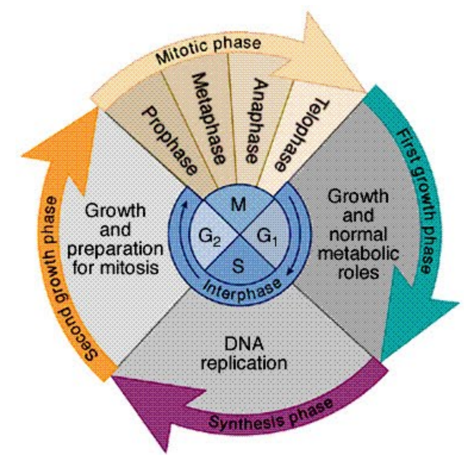
Viruses and Cells

Characteristic	Virus	Cell
Structure	DNA or RNA core, capsid	Cell membrane, cytoplasm; eukaryotes also contain nucleus and organelles
Reproduction	only within a host cell	independent cell division either asexually or sexually
Genetic Code	DNA or RNA	DNA
Growth and Development	no	yes; in multicellular organisms, cells increase in number and differentiate
Obtain and Use Energy	no	yes
Response to Environment	no	yes
Change Over Time	yes	yes

4.C Viruses:
1. Not alive.
2. Contain:• DNA or RNA to take control of the host cell's transcription/translation.
• Protein shell to "trick" the cell into acceptance.
3. • Anti-biotic usually will not work on viruses.
4. Vaccine- A protein shell or a similar virus given to a person whose immune system will produce antibodies to kill the virus.
• HIV- Viruses attack T-cells (white blood cells).
Influenza- "flu".
Smallpox- Like very bad chickenpox

5.A Cell cycle:

Phase	Events within cell
G_1	Intensive cellular synthesis, mitochondria, chloroplasts (in plants), ER, lysosomes, Golgi complex, vacuoles and vesicles produced. Nucleus produces rRNA, mRNA and tRNA and ribosomes are synthesized. Cell produces structural and functional proteins. Cell metabolic rate high and controlled by enzymes. Cell growth occurs. Substances produced to inhibit or stimulate onset of next phase.
S	DNA replication occurs. Protein molecules called histones are synthesized and cover each DNA strand, Each chromosome has become two chromatids.
G_2	Intensive cellular synthesis. Mitochondria and chloroplasts divide. Energy stores increase. Mitotic spindle begins to form.
Mitosis	Nuclear division occurs in four phases
C	Equal distribution of organelles and cytoplasm into each daughter cells



5A

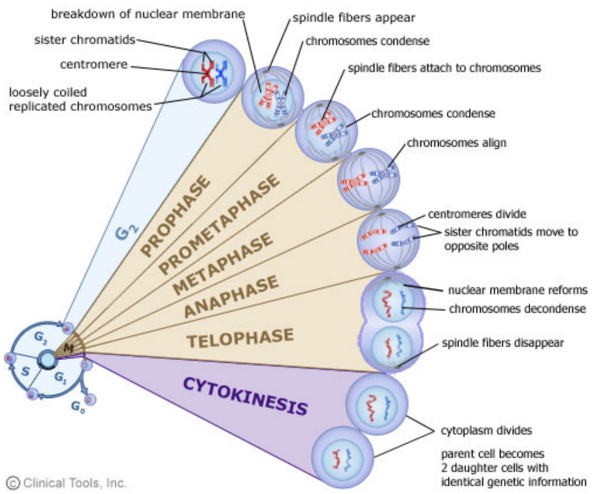
Mitosis - Four Mitotic Stages:

A. Prophase: Chromosomes condense and organize; nuclear membrane and nucleoli disappear; spindle apparatus assembled and attached to centromeres of duplicated chromosomes

B. Metaphase: Spindles line up duplicated chromosomes along equator of cell, one spindle to each half or chromatid of duplicated chromosome

C. Anaphase: Centromere of each duplicated chromosome is separated and paired chromatids are pulled apart

D. Telophase: Chromosomes uncoil ; nucleoli reappear; cytokinesis occurs and two genetically identical daughter cells are produced

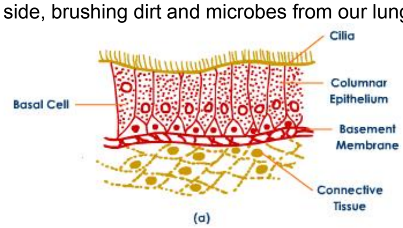


5B Cell Specialization

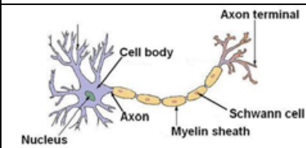
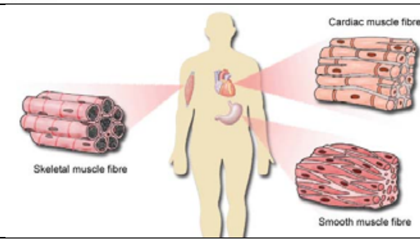
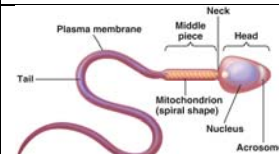
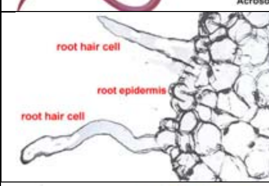
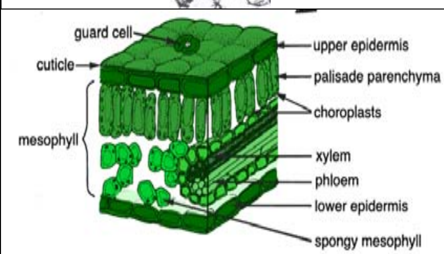
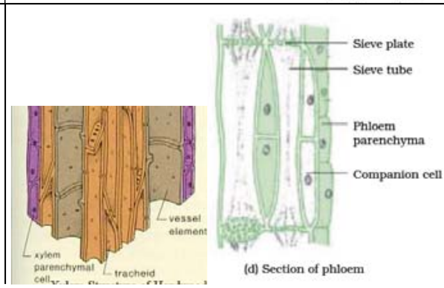
Specialized cells

There are many different types of cells which have special jobs, or functions. Specialized cells have some of the same features, such as a membrane, cytoplasm and a nucleus, but they are not all identical. Different types of cell often have very different shapes and structures. Leaf cells have chloroplasts so they can absorb light energy for making food. Root cells are good at absorbing water from the soil. The differences between types of cell make them good at doing a certain job. We say the cells are adapted for a particular function

Lung epithelial cells: Our lungs are lined with epithelial cells. They are covered with tiny hair-like cilia. Cilia wave from side to side, brushing dirt and microbes from our lungs.



5B Specialized Cells

Function	Picture	Structure
Nerve cells: Carry messages to other parts f the body		**Nerve cells** (or neurons) are very long so that they can carry messages to different parts of the body. They have many branches at the end so that they can connect with many other nerve cells
Muscle cells: They are classified as skeletal, cardiac, or smooth muscles. Their function is to produce force and cause motion. Many mitochondria in red muscle cells (ATP source) .		**Striated** = Strong, but tire easily = shaped like long fibers. **Smooth** = visceral, involuntary muscles, no stripes, single nucleus per cell. Weak, but doesn't tire easily = shaped like almonds, tapered on both ends. **Cardiac** = heart muscles, involuntary, has stripes, single nucleus per cell, strong and doesn't tire easily = highly branched, shaped like fibers cross-linked to one another.
The main function of **red blood cells** is to carry oxygen from the lungs to the parts of the body where it is needed. **White blood cells** to fight bacteria and attack infection	Red blood cell 	They are shaped to give them a large surface area so they can absorb oxygen more easily. The cytoplasm contains a chemical called 'hemoglobin', which carries oxygen
Spermatozoon carry genetic information to an egg.		They have a tail which they use for swimming. They have special structures which release the energy they need for swimming. The head of the sperm contains special chemicals that help it to penetrate an egg.
Root hair cells absorb water and minerals from the soil.		The 'hair' reaches far into the soil and gives the cell a large surface area, as so much of its surface is exposed. This means the cell can absorb lots of water for the plant.
Palisade l Cells. They are specialized for carrying out photosynthesis. **Guard Cells**, a specialized cell on the undersurface of leaves for controlling gas exchange and water loss		**Palisadel** cells are packed with chloroplasts to absorb light. They are tall and narrow so that lots of palisade cells can fit close together. **Guard** cells occur in pairs and are shaped so that a pore, or stomata, exists between them. 
Xylem's Parenchyma Cells_ provided reinforcement **Tracheid** principal water and mineral conducting element **Phloem'sSieve Tubes and Companion Cells:** Sieve elements have no nucleus and only a sparse collection of other organelles. They depend on the adjacent companion cells for many functions.		Xylem Tissue consists of Xylem Vessels and **Parenchyma Cells**. Xylem **Tracheid** are long, tapering with lignified walls; have pits, but no perforations; dead at maturity .Xylem transports water up the plant can helps to support it. Phloem Tissue is made up of **Sieve Tubes** and Companion Cells. Sieve tubes line up and their ends form Sieve Plates through which substances can move**. Companion Cells** lie next to Sieve Tube Cells and allow them to stay alive.

5C Environmental factors can alter the way our genes are expressed, making even identical twins different. The development and maintenance of an organism is orchestrated by a set of chemical reactions that switch parts of the genome off and on at strategic times and locations. Epigenetics is the study of these reactions and the factors that influence them.

Cells Listen for Signals

The epigenome changes in response to signals. Signals come from inside the cell, from neighboring cells, or from the outside world (environment).

Early in development, most signals come from within cells or from neighboring cells. Mom's nutrition is also important at this stage. The food she brings into her body forms the building blocks for shaping the growing fetus and its developing epigenome. Other types of signals, such as stress hormones, can also travel from mom to fetus.

After birth and as life continues, a wider variety of environmental factors start to play a role in shaping the epigenome. Social interactions, physical activity, diet and other inputs generate signals that travel from cell to cell throughout the body. As in early development, signals from within the body continue to be important for many processes, including physical growth and learning. Hormonal signals trigger big changes at puberty.

Many factors in a cells internal or external environment affect which genes are expressed. Gene expression affects how a cell differentiates.

A. **Internal Conditions that Affect Cell Differentiation:**

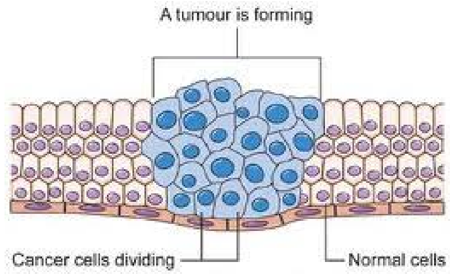
Proteins and hormones that are made within the organism. Certain protein within cells transmit information and trigger (start or activate) hormones (enzymes) that carry forward the information for cell growth/differentiation.

B. **External Conditions that Affect Cell Differentiation**:

The release of these hormones is affected by environmental factors, such as temperature changes , the supply of oxygen, and available nutrients--- affect gene expressions.

Pollution can also influence gene expression because they can mock or mimic chemical signals sent by cells. This may cause some genes to be expressed that normally wouldn't be expressed.

Climate factors often affect gene expression. Ex: The length of day or night may trigger when plants may bloom flowers, drop their leaves, etc.



5D. Cancerous cells also look and act differently from normal cells. In most normal cells, the nucleus is only about one-fifth the size of the cell; in cancerous cells, the nucleus may occupy most of the cell's volume. Tumor cells also often lack the differentiated traits of the normal cell from which they arose. Whereas normal secretory cells produce and release mucus, cancers derived from these cells may have lost this characteristic. Likewise, epithelial cells usually contain large amounts of keratin, but the cells that make up skin cancer may no longer accumulate this protein in their cytoplasm.

The key difference between normal and cancerous cells, however, is that cancer cells have lost the restraints on growth that characterize normal cells. Significantly, a large number of cells in a tumor are engaged in mitosis, whereas mitosis is a relatively rare event in most normal tissues. Cancer cells also demonstrate a variety of unusual characteristics when grown in culture; two such examples are a lack of contact inhibition and a reduced dependence on the presence of growth factors in the environment. In contrast to normal cells, cancer cells do not cooperate with other cells in their environment. They often proliferate indefinitely in tissue culture. The ability to divide for an apparently unlimited number of generations is another important characteristic of the cancerous state, allowing a tumor composed of such cells to grow without the constraints that normally limit cell growth.

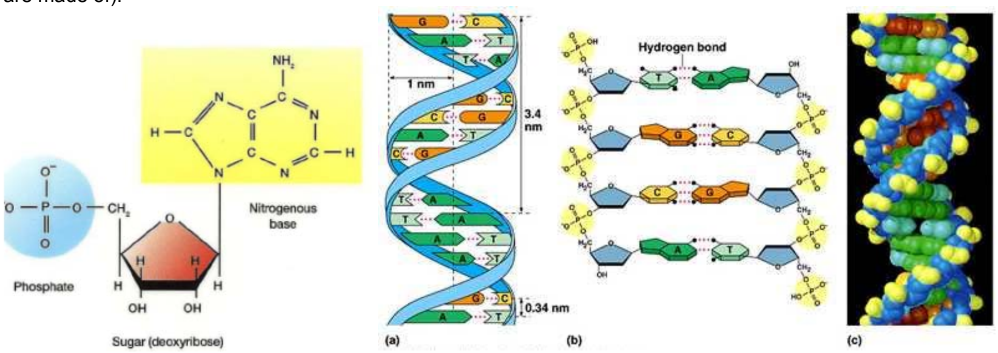
Cell division is highly controlled. Cell growth and division depend on protein signals and other environmental signals. Many proteins within the cell control the phases of the cell cycle. Signals from surrounding cells or even from other organs can also regulate cell growth and division. Environmental conditions, including the availability of nutrients, also affect the cell cycle.

6A A. NUCLEOTIDES - subunits of nucleic acids
1. Phosphate →2. Sugar (deoxyribose in DNA, ribose in RNA)→3. Nitrogenous base (four in DNA): Adenine (A),Thymine (Tl, Guanine (G), Cytosine (C)

B. STRUCTURE OF DNA
1. Sugar-phosphate groups - sugar is deoxyribose
2. Nucleotides
3. Double helix - sugar-phosphate groups form backbone (sides of "ladder"), pairs of nucleotides form "rungs of ladder"; nucleotide pairs joined by hydrogen bonds; A always pairs with T, C always pairs with G

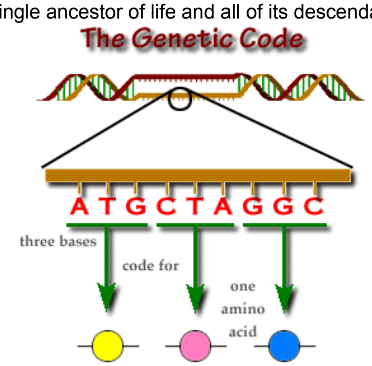
It is a DNA blueprint which specifies how all the cells are built, how they will function and how they might divide to produce new, daughter cells. The genome is coded in a DNA molecule. The structure of DNA is built from four different nucleotide bases arranged in a linear string. The bases themselves are: adenine (a), guanine (g), cytosine (c) and thymine (t). Every cell in the organism's body contains a complete copy of the genome which was inherited from the parents.

The genetic code is made of triplets of bases called codons. A codon codes for a single amino acid and a series of amino acids results in a protein. The series of amino acids determine the identity of the protein (the stuff we are made of).

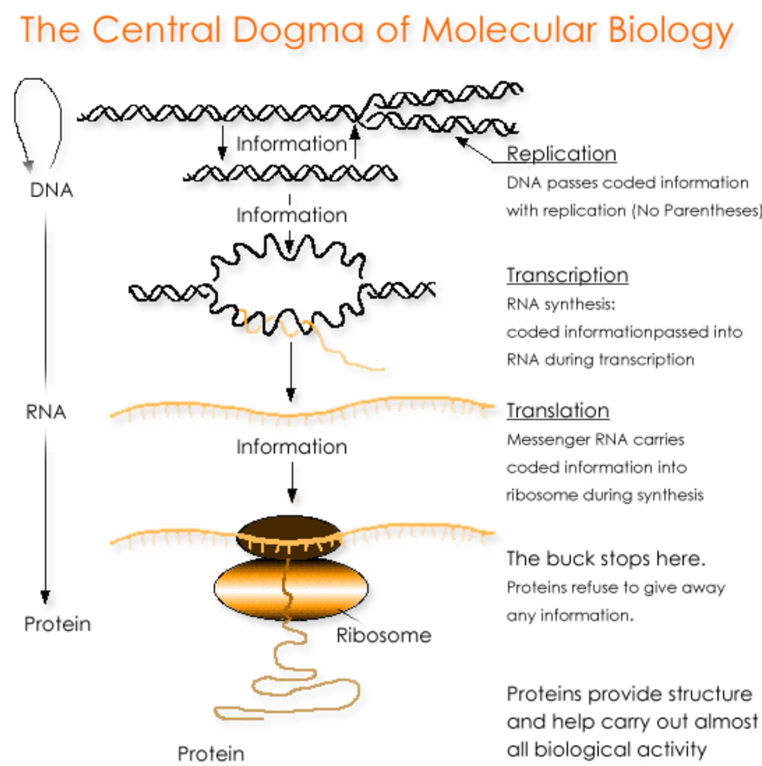


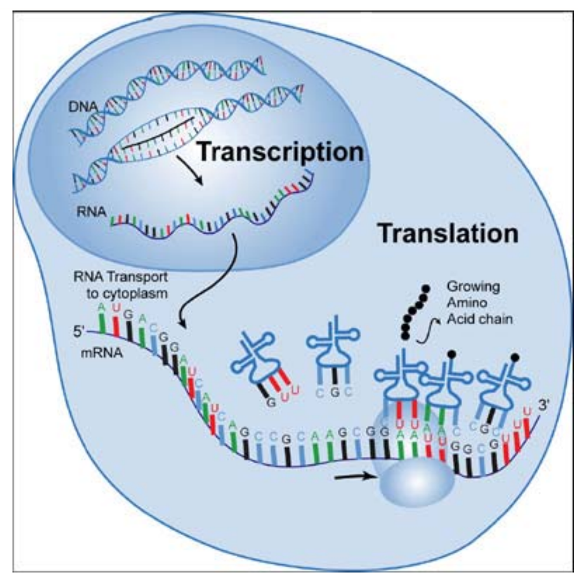
6B. A thread of genetic similarity connects us and the roughly 10 million other species in the modern world to the entire history of life, back to a single common ancestor more than 3.5 billion years ago. And the evolutionary view of a single (and very ancient) origin of life is supported at the deepest level imaginable: the very nature of the DNA code in which the instructions of genes and chromosomes are written. In all living organisms, the instructions for reproducing and operating the individual is encoded in a chemical language with four letters -- A, C, T, and G, the initials of four chemicals. Combinations of three of these letters specify each of the amino acids that the cell uses in building proteins.

Biologically and chemically, there is no reason why this particular genetic code, rather than any of millions or billions of others, should exist. Yet every species on Earth carries a genetic code that is, for all intents and purposes, identical and universal. The only scientific explanation for this situation is that the genetic code is, this code was the one carried by the single ancestor of life and all of its descendants, including us.



6C





6D.

Prokaryotes have two levels of metabolic control

- Vary the numbers of specific enzymes made (regulation of gene expression) Slow, but can have a dramatic effect on metabolic activity
- Regulate enzymatic pathways (feedback inhibition, allosteric control) Rapid and can be fine-tuned, but if the enzyme system does not have this level of control, then it is useless

Gene Regulation in Eukaryotes

- **Chromatin Remodeling**

The region of the chromosome must be opened up in order for enzymes and transcription factors to access the gene

- **Transcription Control**

The most common type of genetic regulation
Turning on and off of mRNA formation

- **Post-Transcriptional Control**

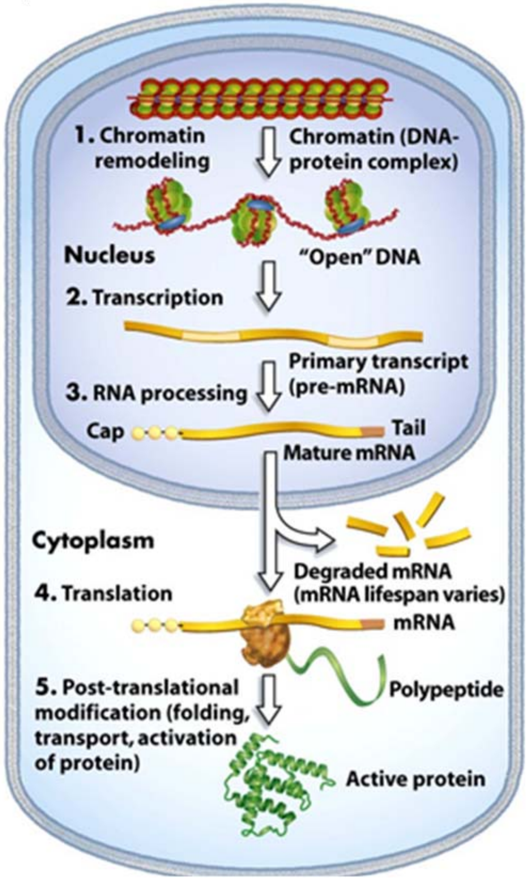
Regulation of the processing of a pre-mRNA into a mature mRNA

- **Translational Control**

Regulation of the rate of Initiation

- **Post-Translational Control (protein activity control)**

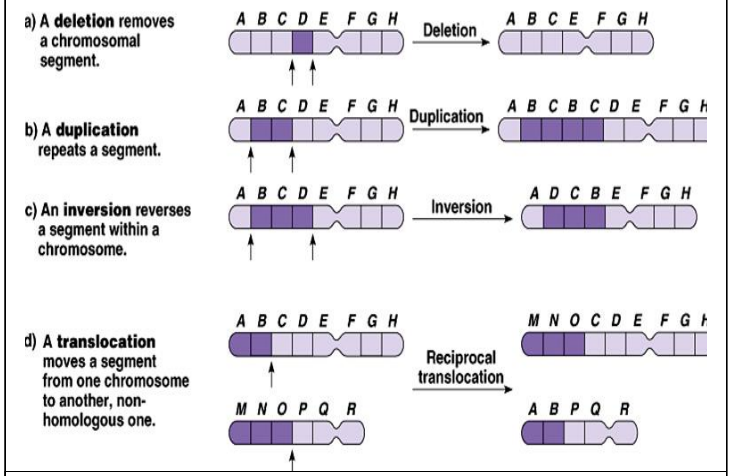
Regulation of the modification of an immature or inactive protein to form an active protein



6E.

2 ways DNA Mutations occur:

- DNA damage from environmental agents such as ultraviolet light (sunshine), nuclear radiation or certain chemicals.
- Mistakes that occur when a cell copies its DNA in preparation for cell division.



6F.

DEFINITIONS

1. **Gene** - a location on a chromosome; typically codes for one polypeptide
2. **Alleles** - different forms of a gene
3. **Chromosome** - structure made up of DNA and associated proteins
4. **Genotype** - genetic makeup of an organism
5. **Phenotype** - visible expression of genetic makeup
6. **Homologous** chromosomes - contain genes for same traits
7. **Homozygote** - possesses identical alleles for a given gene on homologous chromosomes
8. **Heterozygote** - possesses different alleles for a given gene on homologous chromosomes
9. **Crossing over** - paired chromosomes break; the fragments reunite in new combinations
10. **Sex chromosomes** - determine the sex of an individual; in humans, X and Y chromosomes;
XY for males, XX for females
11. **Autosome** - chromosome that is not a sex chromosome

A. GENETIC CROSSES -

1. P - generation of individuals for initial cross
2. F_1 - generation that results from initial cross
3. F_2 - generation that results from cross of F_1 individuals
4. True-breeding - individuals that consistently produce offspring with the same form of a trait when crossed
5. **Dominant allele** - expressed in heterozygous condition; masks recessive allele
6. **Recessive allele** - not expressed in heterozygous condition; expressed only when individual is homozygous for the allele

7. **Punnett square** - predicts the possible results for a particular trait or set of traits of a cross between a given pair of individuals; indicates probability that anyone offspring will have a particular genotype and phenotype

Plant height: T, t
Flower color: P, p

Monohybrid Cross

	T	t
T	TT	Tt
t	Tt	tt

Predicted offspring ratio:
3:1 tall:short

Dihybrid Cross

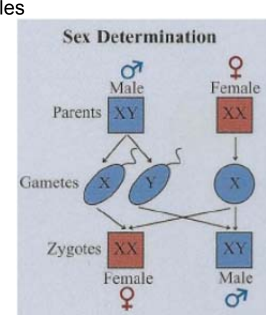
	TP	Tp	tP	tp
TP	TTPP	TTPp	TtPP	TtPp
Tp	TTPp	TTpp	TtPp	Ttpp
tP	TtPP	TtPp	ttPP	ttPp
tp	TtPp	Ttpp	ttPp	ttpp

Predicted offspring:
9/16 tall with purple flowers
3/16 tall with white flowers
3/16 short with purple flowers
1/16 short with white flowers

B**. LAW OF SEGREGATION** - the two alleles for a particular character separate, or segregate, into different gametes (during meiosis)
C**. LAW OF INDEPENDENT ASSORTMENT** -alleles of different genes are independent of one another and may be sorted into different gametes during meiosis; one source of variation
between parents and offspring

NON-MENDELIAN INHERITANCE

A. **INCOMPLETE DOMINANCE** - no allele completely dominates another; results in a phenotype intermediate to that of parents
B**. CODOMINANCE** - both alleles are expressed; human blood types are an example
C. **SEX DETERMINATION** In humans, there are 44 autosomes and two sex chromosomes: X and Y in males, X and X in females



D. **SEX-LINKED TRAITS** - traits determined by alleles on one of the sex chromosomes; males tend to exhibit sex - linked traits and females tend to carry them (e.g., hemophilia, color-blindness)

6G.

MEIOSIS: THE SOURCE OF OUR DIFFERENCES

Why are children born of the same parents different? The explanation for these differences lies in the details of Meiosis I. During Prophase I, tetrads are formed. The chromatids of homologous chromosomes are very close to each other. In fact, they often overlap and actually exchange pieces in a process called crossing-over.

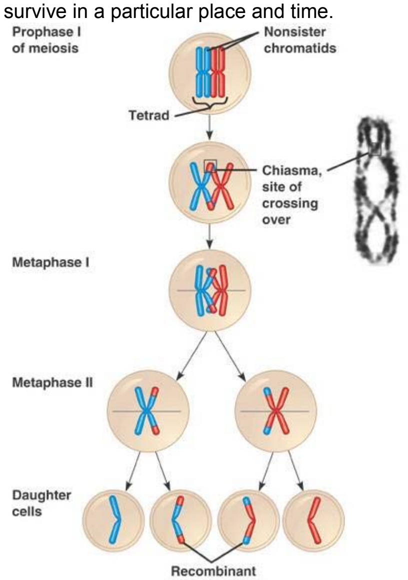
Why is crossing-over important?

Suppose we are looking at a pair of homologous chromosomes from a plant. The same genes are located at the same places on each chromosome. However, the version of the gene may be different on each chromosome. For example, both chromosomes have a gene for plant height and a gene for flower color. But chromosome A has the genes for tall plants and white flowers, while chromosome B has the genes for short plants and yellow flowers. After crossing-over, the positions of genes on a chromosome are altered. The new arrangement puts the genes for tall plants and yellow flowers on the same chromosome, and the genes for short plants and white flowers on the same chromosome. This is obviously a new combination of genes. As a result of crossing-over, genetic recombination has occurred.

2. There is no rule as to how chromosomes line up. Any number of maternal may be on one side; any number of paternal on the other. Each time meiosis occurs, the lining up can be different. This is known as independent assortment. The number of possible different assortments is huge.

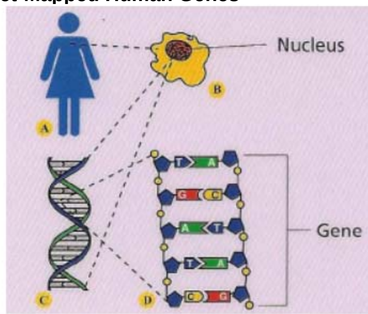
1. Meiosis maintains the normal species chromosome number by preparing haploid gametes. The two haploid gametes are able to fuse during sexual reproduction to make a diploid zygote, with the characteristic species chromosome number.

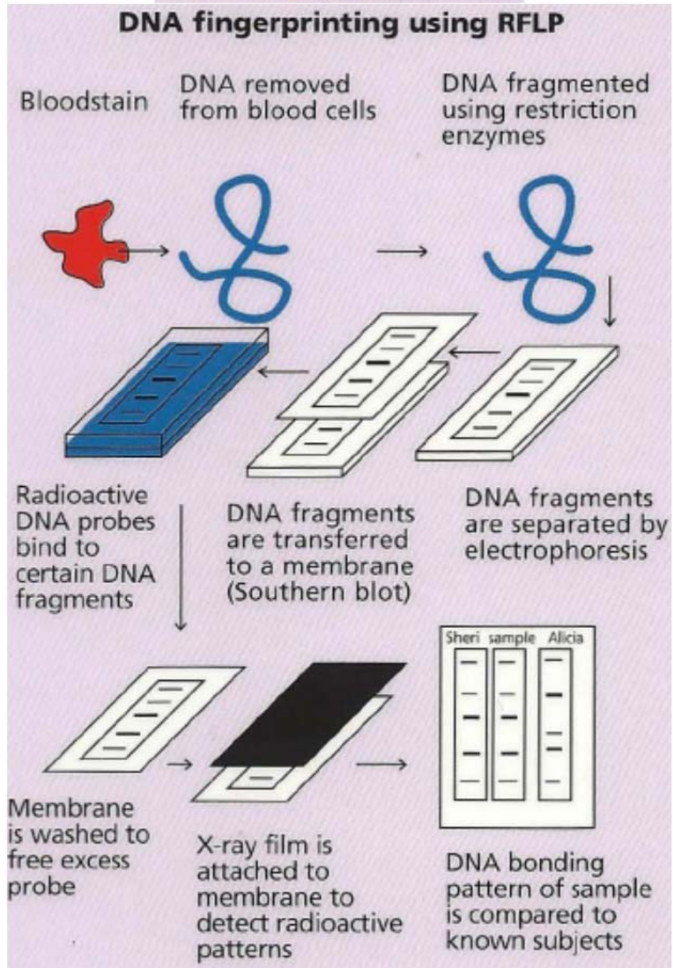
2. Meiosis increases genetic variability by recombining genes in eggs and sperm.. This genetic variation is what natural selection acts on. A greater variety of characteristics in offspring increases the chances that some individuals will be better suited than others to survive in a particular place and time.



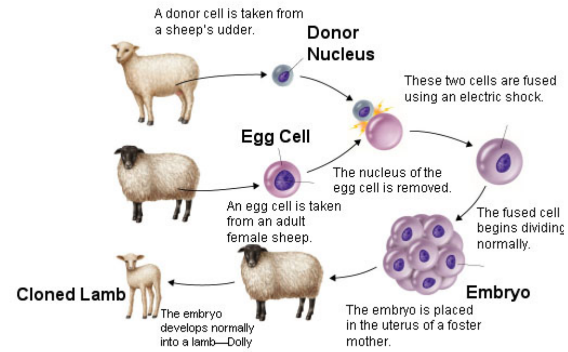
6H.

Genomic Project-Mapped Human Genes



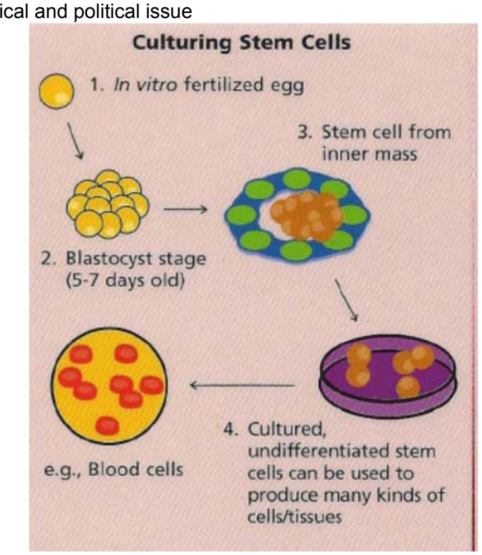


The PCR method – a copying machine for DNA molecules
DNA molecules can be mass-produced from incredibly small amounts of material with PCR. **Kary Mullis'** discovery allows the chemist to mimic the cell's own natural DNA replication process in a test tube. It has now become much easier to characterize and compare the genetic material from different individuals and organisms.



Therapeutic cloning

1. Use of reproductive cloning to create human embryos to procure stem cells, which have potential to develop into adult tissues
2. These special cells may hold the key to treatments for many diseases (heart, cancers, Alzheimer's, Parkinson's) and afflictions (injury to spinal cord, including paralysis)
3. Stem cells can also be retrieved from human embryos produced by regular fertilization processes (in vivo or in vitro) or adults (e.g., bone marrow)
4. Stem cell procurement via cloning and embryos is a growing ethical and political issue



7A.

Artificial selection

I. Human-controlled breeding of species strongly supports the idea that, over time, nature could also influence changes in populations
2. Humans have selected for traits to increase the attractiveness (to us) of the offspring (e.g., "cute" dogs, chickens that produce many eggs, wheat that yields numerous, plump grains)
3. Domesticated species often do poorly in the wild, as traits (i.e ., variations) selected by humans would not necessarily be advantageous in nature

B. **Biogeography: Geographic distribution of species** can show organisms are related
I. Flightless birds, such as African ostriches, Australian emus, and South American rheas are found (naturally) only in the southern hemisphere, on separate continents
2. Either flight-lessness in these birds evolved independently three times (possible, but improbable) or they arose from a common, flightless ancestor
3. If the latter explanation is correct, and they could not fly, how then could they get to these disparate southern continents while being excluded from the northern hemisphere?
4. Geological evidence indicates the continents were once one large land mass that subsequently broke up into pieces (plate tectonics) that moved (continental drift) first into northern and southern portions, and later into the present-day continents
5. This geological concept also explains why marsupial mammals (e.g., kangaroos) developed only on Australia, as this continent was geographically isolated from areas where placental mammals evolved

C. Fossils

Although the fossil record has gaps (some structures/organisms do not fossilize well), fossils provide valuable information about evolutionary changes or modifications in organisms (including transitional forms, e.g., horses with toes, whales with hind limbs, ferns with seeds) that have taken place over many generations. Estimating the age of fossils involves looking at their physical positions in sedimentary rocks (relative dating) and radiometric isotope techniques (absolute dating)

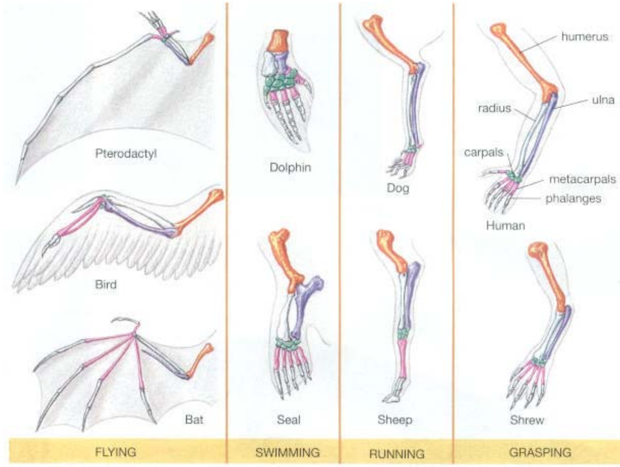
D. Molecular clocks look at changes in portions of genomes of organisms; also used to help determine the age of evolutionary events

E. Homologies:

1. Anatomical similarities of related life forms
2. Provide strong evolutionary evidence of relatedness
3. Example: Forelimbs of vertebrates are composed of the same basic bones in disparate groups, but differ based on adaptations necessary for the specific environmental needs (i.e., walking, swimming, flying)

F. Vestigial structures

a. Those present are usually in a rudimentary, nonfunctional form
b. Show anatomically-related structures that are likely to disappear completely in future generations
c. Example: The vestiges of pelvic bones within the body in some modern-day baleen whales



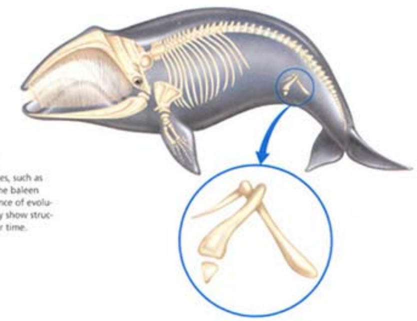


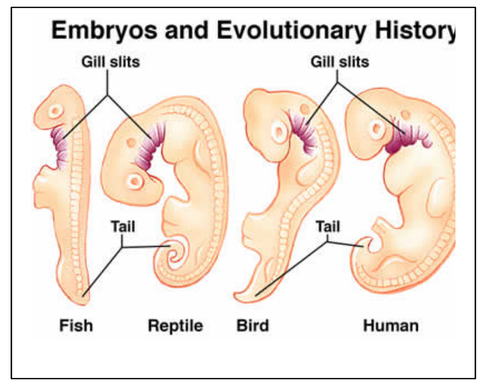
Figure 15.8
Vestigial structures, such as pelvic bones in the baleen whale, are evidence of evolution because they show structural change over time.

G. Adaptation

1. In England, the peppered moth shifted from predominantly light coloring to dark when air pollution darkened the trees on which it lives. Predators can easily spot moths that contrast with their background, limiting the abundance of these types of moths in the population. Subsequent air quality measures have lightened trees and light-colored moths are again the predominant form
2. Additional examples of selection observed in living organisms involve increasing drug resistance: e.g., bacteria-antibiotics, insecticides and HIV-drug therapies

H. Embryology

Human embryos pass through a number of embryonic stages inherited from their ancestors because they have inherited the developmental mechanisms from a common ancestor. These mechanisms are modified in a way that is unique to an organism's way of life. The similarities in comparative embryology are also evident in the early stages of development. For example, fish, bird, rabbit, and human embryos are similar in appearance in the early stages. They all have gill slits, a two-chambered heart, and a tail with muscles to move it. Later on, as the embryos grow and develop, they become less and less similar.



I. Geographic distribution

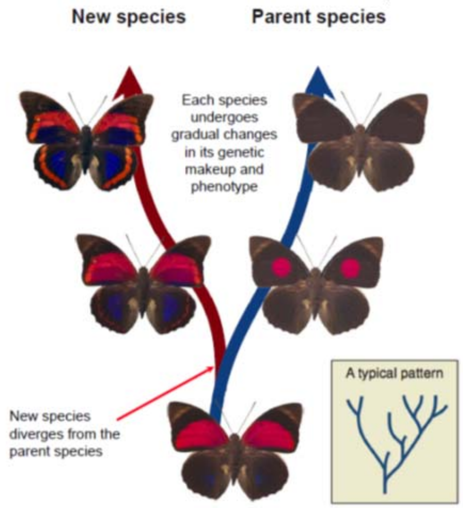
Darwin found 13 species of finches not found anywhere else in the world. He concluded that the finches had evolved from a common ancestor that probably reached the island many generations earlier. In the isolation of the Galapagos Islands, the original finches had probably evolved into the 13 species.
Other geographic distributions also help to explain evolution. For instance, alligators are located only in certain regions of the world, presumably because they have evolved in those regions. The islands of Australia and New Zealand have populations of animals found nowhere else in the world because of their isolated environments.

J. Comparative Biochemistry

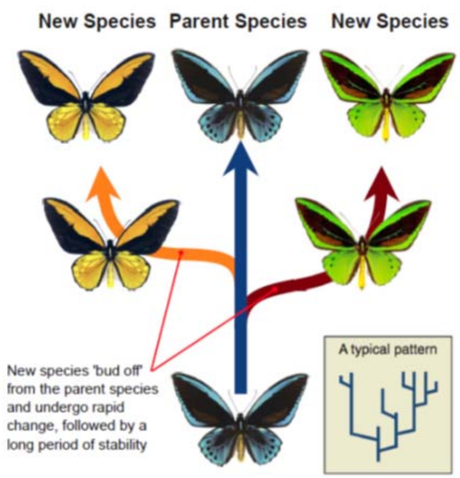
The same mechanisms for trapping and transforming energy and for building proteins from amino acids are nearly identical in almost all living systems. The structure of the genetic code is almost identical in all living things. This uniformity in biochemical organization underlies the diversity of living things and points to evolutionary relationships.

7B.

The fossil record is a substantial, but incomplete, record of evolutionary history:



- **Gradualism** assumes that populations slowly diverge from one another by accumulating adaptive characteristics in response to different selective pressures.
- If species evolve by gradualism there should be transitional forms seen in the fossil record (as with the evolution of the horse).



Punctuated Equilibrium
- There is abundant evidence in the fossil record that, instead of gradual change, species stay much the same for long periods (stasis) and then have short bursts of evolution that produce new species quite rapidly.
- According to this **punctuated equilibrium theory,** most of a species existence is spent in stasis and little time is spent in active evolutionary change.

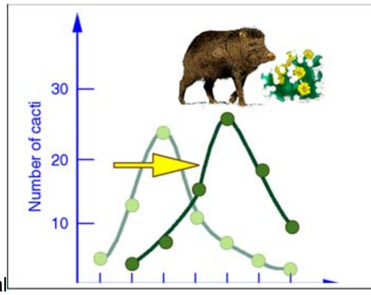
7C.

Natural selection: The mechanism for how evolution occurs
1. Species have high potential for rapid reproduction
2. Population sizes eventually level off and remain fairly constant over time
3. There is competition for reproduction and survival of offspring
4. Variations (from random mutations and shuffling of genes via meiosis) exist in behavior, physio,logy, structure, etc.
5.Naature selects individuals (i.e., the fittest or just fortunate) for survival and reproduction to pass these favorable characteristics (adaptations) via their genes to their offspring
6. Over time, natural selection "can" lead to genetic changes in populations - i.e., evolution .
7. Microevolution: Small-scale changes
8. Macroevolution: Larger-scale changes; can lead to evolution of new species and groups

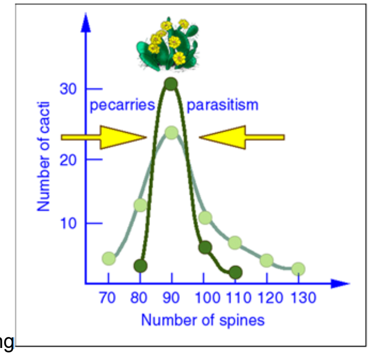
7D. Natural Selection and Variation-

- Organisms produce many more offspring than can survive, which results in a 'struggle for existence', or competition to survive.
- Natural selection will operate among any entities that reproduce, show inheritance of their characteristics from one generation to the next, and vary in 'fitness' (i.e., the relative number of offspring they produce) according to the characteristics they possess.
- The increase in frequency of the melanic, relative to the light colored, form of the peppered moth Biston betularia clearly illustrates how natural selection causes both evolutionary change and the evolution of adaptation.
- Selection may be directional, stabilizing, or disruptive.
- The members of natural populations vary with respect to characteristics at all levels. They differ in their morphology, their microscopic structure, their chromosomes, the amino acid sequences of their proteins, and in the DNA sequences.
- The members of natural populations vary in their reproductive success: some individuals leave no offspring, others leave many more than average.
- In Darwin's theory, the direction of evolution, particularly of adaptive evolution, is uncoupled from the direction of variation. The new variation that is created by recombination and mutation is accidental, and adaptively random in direction.
- Two reasons suggest that neither recombination nor mutation can alone change a population in the direction of improved adaptation: there is no evidence that mutations occur particularly in the direction of novel adaptive requirements, and it is theoretically difficult to see how any genetic mechanism could have the foresight to direct mutations in this way.

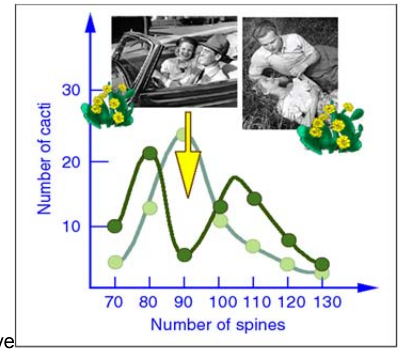
Directional



Stabilizing

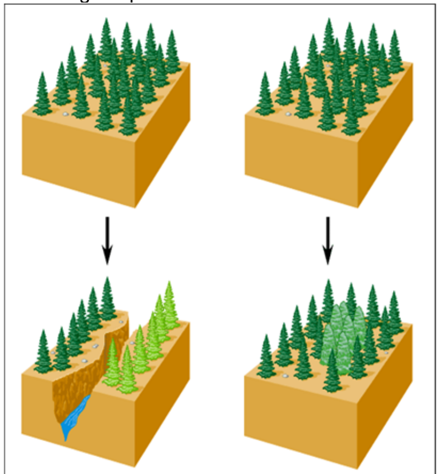


Disruptive



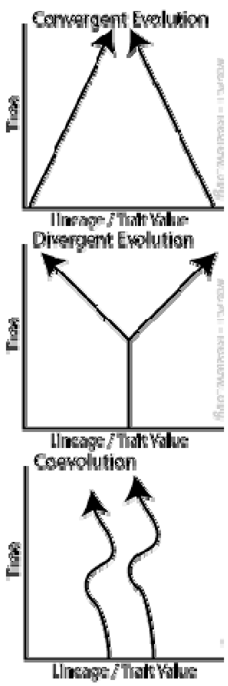
7E.

Speciation refers to the process by which new species are formed.
Speciation occurs when **gene flow** has **ceased** between populations where it previously existed. Speciation is brought about by the development of **reproductive isolating mechanisms** which maintain the integrity of the new gene pool.



Types of Speciation

- **Allopatric** speciation: Populations become geographically separated, each being subjected to different natural selection pressures, and finally establishing reproductive isolating mechanisms.
- **Sympatric** speciation: A population forms a new species within the same area as the parent species.
- **Parapatric** speciation: The speciation populations are only partially separated geographically, so some individuals on each side are able to meet across a common boundary during the speciation process.



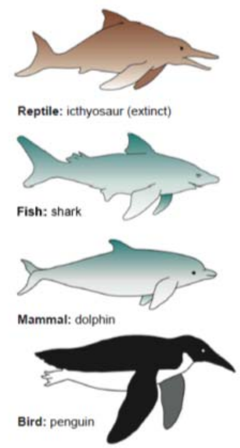
Convergent Evolution
Not all similarity is inherited from a common ancestor:
Species from different evolutionary branches may resemble each other if they have similar ecological roles.
Not all similarity is inherited from a common ancestor:
Species from different evolutionary branches may resemble each other if they have similar ecological roles.

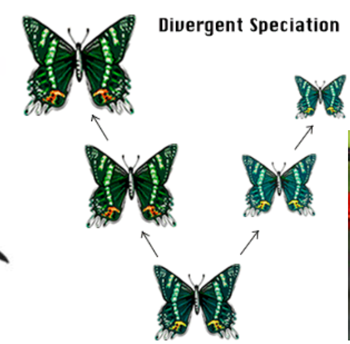
Divergent Evolution
The diversification of an ancestral group into two or more species in different habitats is called divergent evolution.
When divergent evolution involves the formation of a large number of species to occupy different niches this is called an adaptive radiation.

Coevolution
Coevolution is used to describe cases where two (or more) species reciprocally affect each other's evolution. Coevolution
Coevolution is used to describe cases where two (or more) species reciprocally affect each other's evolution.
Each party in a co-evolutionary relationship exerts selective pressures on the other and, over time, the species become mutually dependent on each other.
Coevolution is a likely consequence when different species have close ecological interactions with one another. These relationships include:

- Predator-prey relationships
- Parasite-host relationships
- Mutualistic relationships such as those that have arisen between plants and their pollinators

1. Reproductive isolating mechanisms (**RIMs**) prevent successful breeding between different species. They are **barriers** to **gene flow**.
A single barrier may not completely isolate a gene pool, but most species have more than one isolating mechanism operating to maintain a distinct gene pool.
Prezygotic isolating mechanisms act before fertilization to prevent successful reproduction.
Ecological or **habitat**: Different species may occupy different habitats within the same geographical area, e.g. desert and coastal species, ground or tree dwelling. In New Zealand, Hochstetter's and Archey's frogs occur in the same relatively restricted region but occupy different habitats within that range.
Temporal (time-based): Species may have different activity patterns; they may be nocturnal or diurnal, or breed at different seasons.
In this hypothetical example, the two species of butterfly will never mate because they are sexually active at different times of the year
Behavioral: Species may have specific calls, rituals, postures etc. that enable them to recognize potential mates (many bird species have elaborate behaviors).
Structural: For successful mating, species must have compatible copulatory apparatuses, appearance, and chemical make-up (odor, chemical attractants).
Gamete mortality: If sperm and egg fail to unite, fertilization will be unsuccessful.
2. Postzygotic isolating mechanisms act after fertilization to prevent successful reproduction.
Hybrid inviability: The fertilized egg may fail to develop properly
Fewer young may be produced and they may have a low viability (survivability).
Hybrid sterility: The hybrid of two species may be viable but sterile, unable to breed (e.g. the mule).
Hybrid breakdown: The first generation may be fertile but subsequent generations are infertile or non-viable.
Geographical barriers prevent species interbreeding but **are not considered to be RIMs** because they are not operating through the organisms themselves.





7F.

Genes in populations versus individuals

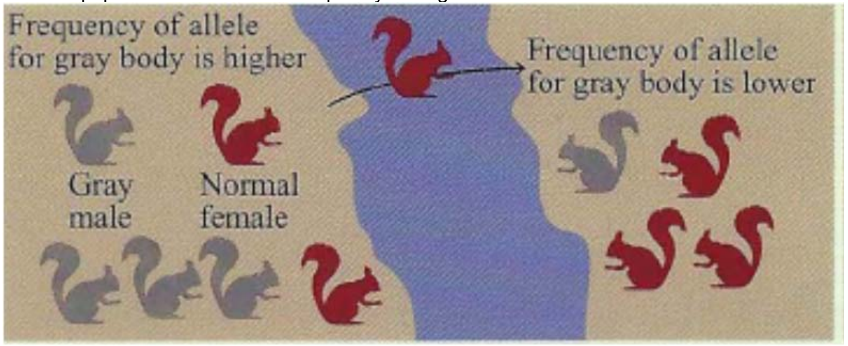
A. Populations evolve just as do species
B. Genotype: Genetic composition of an individual
C. Gene Pool: Genetic composition of a population of individuals; that is, all alleles for all genes in a population
D. Evolution involves changes in gene pools over time; to understand changes in gene pools as populations evolve, an understanding of non-evolving populations is necessary

The Hardy·Weinberg Law

A. Both allelic frequencies and genotypic ratios (i.e. gene pools) remain constant from generation to generation in sexually producing populations, if the following conditions of equilibrium exist:
1. Mutations do not occur
2. No net movement of individuals out of or into a population occurs
3. All offspring produced have the same chances for survival, and mating is random; that is, no natural selection occurs
4. The population is large so that chance would not alter frequencies of alleles

Hardy-Weinberg & Natural Populations

A. Few (if any) populations are in equilibrium; therefore, changes in allele frequencies and thus gene pools do occur in natural populations
B. The Hardy-Weinberg Law helps to identify the mechanisms of these evolutionary changes by predicting that one or more of the four conditions required are not met; that is:
1. Mutations occur
2. Individuals leave and enter populations
3. Nonrandom mating and natural selection occur
4. Small populations exist Allele Frequency Changes

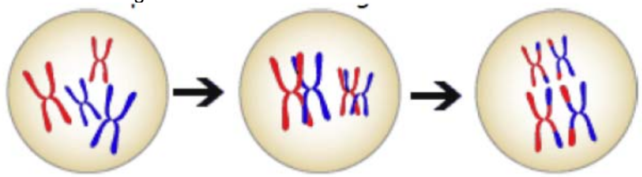


So, what are the sources of genetic variation?

Genetic Variation

Without genetic variation, some of the basic mechanisms of evolutionary change cannot operate. There are three primary sources of genetic variation, which we will learn more about:
Mutations are changes in the DNA. A single mutation can have a large effect, but in many cases, evolutionary change is based on the accumulation of many mutations.
Gene flow is any movement of genes from one population to another and is an important source of genetic variation.
Gene flow has several important effects on evolution:
Within a population:
It can introduce or reintroduce genes to a population, increasing the genetic variation of that population.
Across populations:
By moving genes around, it can make distant populations genetically similar to one another, hence reducing the chance of speciation. The less gene flow between two populations, the more likely that two populations will evolve into two species.

Sex can introduce new gene combinations into a population. This genetic shuffling is another important source of genetic variation.
Genetic shuffling is a source of variation.



Mutation is a change in DNA, the hereditary material of life. An organism's DNA affects how it looks, how it behaves, and its physiology—all aspects of its life. So a change in an organism's DNA can cause changes in all aspects of its life.
Genetic drift—along with natural selection, mutation, and migration—is one of the basic mechanisms of evolution.
In each generation, some individuals may, just by chance, leave behind a few more descendants (and genes, of course!) than other individuals. The genes of the next generation will be the genes of the "lucky" individuals, not necessarily the healthier or "better" individuals. Genetic drift can cause populations to lose genetic variation.

Bottlenecks and Founder Effects

Genetic drift can cause big losses of genetic variation for small populations.
Population bottlenecks occur when a population's size is reduced for at least one generation. Because genetic drift acts more quickly to reduce genetic variation in small populations, undergoing a bottleneck can reduce a population's genetic variation by a lot, even if the bottleneck doesn't last for very many generations.

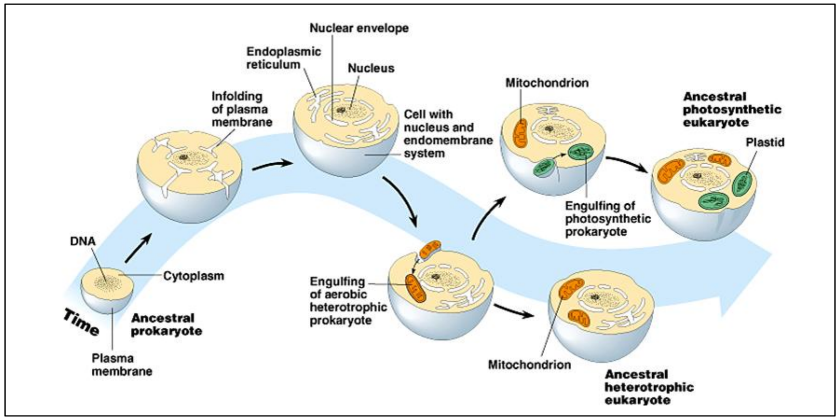
Founder effects

A founder effect occurs when a new colony is started by a few members of the original population. This small population size means that the colony may have:
- reduced genetic variation from the original population.
- a non-random sample of the genes in the original population.

7G.

Endosymbiosis

Evolution of eukaryotes
- origin of mitochondria
- engulfed aerobic bacteria, but did not digest them
- mutually beneficial relationship natural selection
- origin of chloroplasts
- engulfed photosynthetic bacteria, but did not digest them
- mutually beneficial relationship natural selection!



8A.

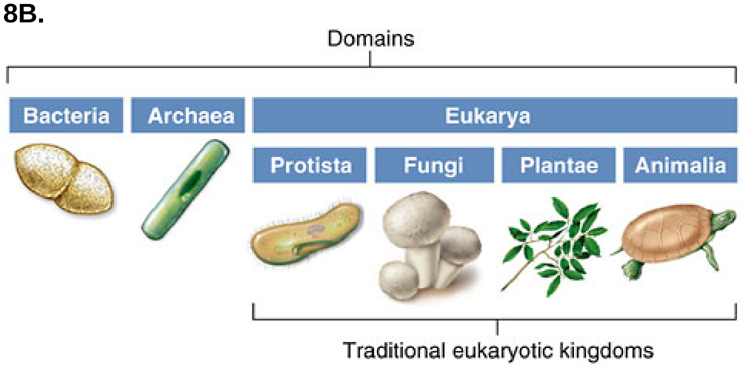
Taxonomy is the classification of organisms in a hierarchical system or in taxonomic ranks (e.g. domain, kingdom, phylum or division, class, genus, species) based on shared characteristics or on phylogenetic relationships inferred from the fossil record or established by genetic analysis.
There are a number of goals to biological classification, in addition to the obvious need to be able to precisely describe organisms. Creating a system of classification allows scientists to examine the relationships between various organisms, and to construct evolutionary trees to explore the origins of life on Earth and the relationship of modern organisms to historical examples. You may also hear biological classification referred to as "taxonomy."

Biologists use taxonomic systems to organize their knowledge of organisms. These systems attempt to provide consistent ways to name and categorize organisms. Common names of organisms are not organized into a system. One species may have many common names, and one common name may be used for more than one species. For example, the bird called a robin in Great Britain is a different bird from the bird called a robin in North America. To avoid confusion, biologists need a way to name organisms that does not depend on language or location.

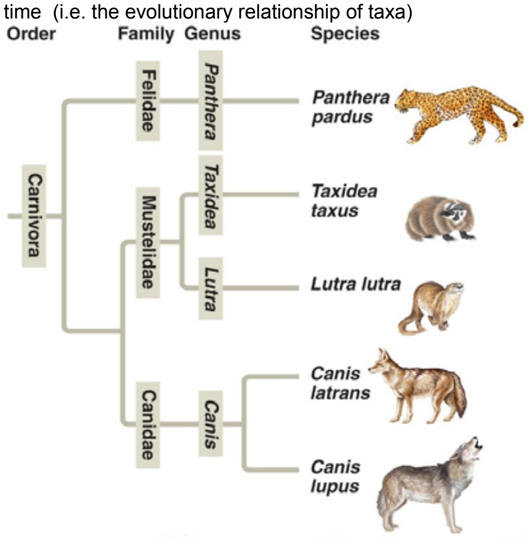
Biologists also need a way to organize lists of names. A system that has categories is more efficient than a simple list. So, biologists group organisms into large categories as well as smaller and more specific categories. The general term for any one of these categories is a taxon (plural, taxa). The system of biological classification used today was developed by Linnaeus, an 18th century scientist, although it has been refined extensively over the centuries to reflect new information in the sciences.
Binomial nomenclature – "2 name system" uses the genus and the species to identify an organism. (homo sapien)
Modern taxonomists now classify organisms according to their phylogeny, or evolutionary history.
This has become a branch of biology called systematics and uses the following information

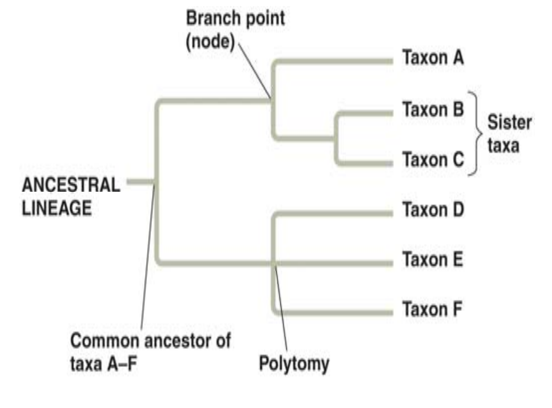
1. Fossil record
2. Morphology
3. Embryological patterns of development
4. Chromosomes and macromolecules (DNA and proteins)
5. Cladistics is the classification of organisms because of a shared derived characteristic (such as feathers) that is thought to only have evolved in one group from a common ancestor

8B.



Taxonomic Diagrams
'**Phylogeny**' is the evolutionary relationships among organisms; the patterns of lineage branching produced by the true evolutionary history of the organisms being considered. Phylogenetic trees generally show divergence of lineages through time (i.e. the evolutionary relationship of taxa)

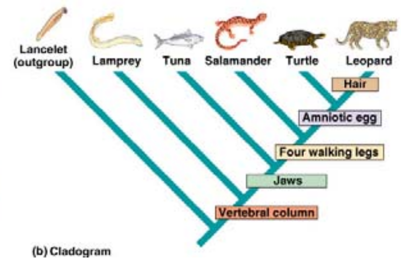




TAXA

CHARACTERS	Lancelet (outgroup)	Lamprey	Tuna	Salamander	Turtle	Leopard
Hair	0	0	0	0	0	1
Amniotic (shelled) egg	0	0	0	0	1	1
Four walking legs	0	0	0	1	1	1
Jaws	0	0	1	1	1	1
Vertebral column (backbone)	0	1	1	1	1	1

(a) Character table



(b) Cladogram

Some trees merely express order of divergence (cladograms):

- Dichotomous Keys Identify Organisms
- Dichotomous keys contain pairs of contrasting descriptions.
- After each description, the key directs the user to another pair of descriptions or identifies the organism.

Some Key Ideas in Dichotomous Key Construction

1. Use constant characteristics rather than ones that disappear or vary with the season or other environmental factor.
2. Use characteristics which can be directly observed.
3. Use quantitative measurements with an amount or dimension rather than vague terms like "big" and "small."
4. Precede the descriptive terms with the name of the anatomical part to which it applies.

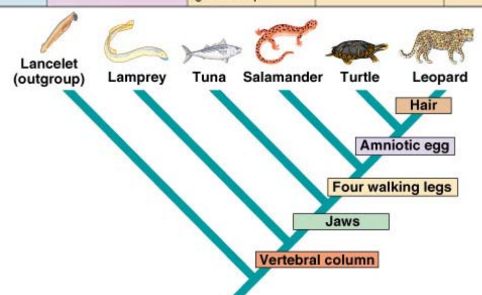
Rules to Follow When Using a Dichotomous Key

1. Always read both choices, even if the first seems to be the logical.
2. Understand the meaning of the terms involved in the key.
3. When measurements are given, use a scale to measure the specimen. Do not guess at a measurement.
4. Living things are always variable, so do not base your organism identification in the field on a single observation.

8C.

Classification of Living Things

DOMAIN	Bacteria	Archaea	Eukarya			
KINGDOM	Eubacteria	Archaebacteria	Protista	Fungi	Plantae	Animalia
CELL TYPE	Prokaryote	Prokaryote	Eukaryote	Eukaryote	Eukaryote	Eukaryote
CELL STRUCTURES	Cell walls with peptidoglycan	Cell walls without peptidoglycan	Cell walls of cellulose in some; some have chloroplasts	Cell walls of chitin	Cell walls of cellulose; chloroplasts	No cell walls or chloroplasts
NUMBER OF CELLS	Unicellular	Unicellular	Most unicellular; some colonial; some multicellular	Most multicellular; some unicellular	Multicellular	Multicellular
MODE OF NUTRITION	Autotroph or heterotroph	Autotroph or heterotroph	Autotroph or heterotroph	Heterotroph	Autotroph	Heterotroph
EXAMPLES	*Streptococcus, Escherichia coli*	Methanogens, halophiles	*Amoeba, Paramecium,* slime molds, giant kelp	Mushrooms, yeasts	Mosses, ferns, flowering plants	Sponges, worms, insects, fishes, mammals



ANIMAL PHYLA

Phylum	Characteristics	Example
Porifera	aquatic; pores in body allow flow of water to bring in nutrients and take out waste products	sponges
Coelenterata	aquatic; have stinging cells to capture prey; may be free-swimming or sedentary	jellyfish, coral
Platyhelminthes	flat body; one opening to digestive system; often live as parasites in humans	flukes, tapeworms
Aschelminthes	smooth, round body tapered at both ends; two openings to digestive system; often parasitic	nematodes
Annelida	segmented worms; closed circulatory system	earthworms
Mollusca	most have unsegmented bodies, hard shells	clams, snails
Echinodermata	marine; usually having five radial arms	starfish
Arthropoda	jointed exoskeletons and at least three pairs of jointed legs	insects, crabs, spiders
Chordata	inner skeleton; gills at some point in development; hollow, dorsal nerve cord	humans, horses, geckos, trout

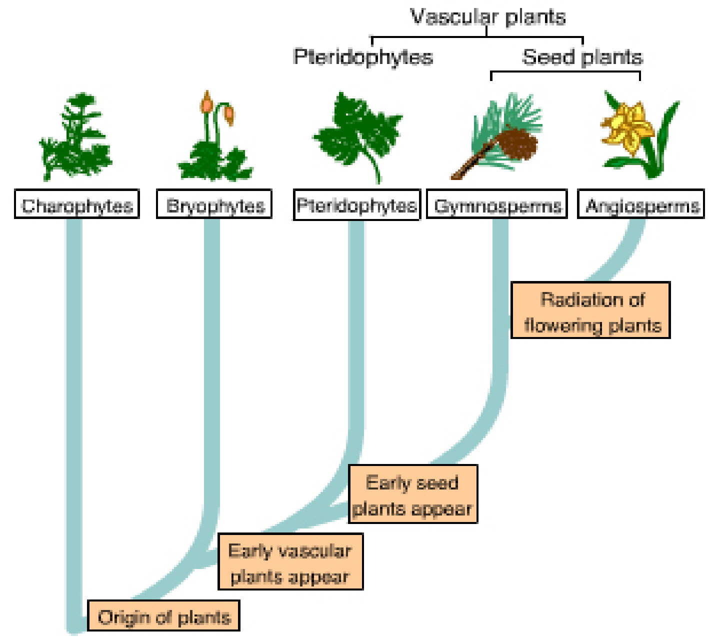


TABLE 30-1 *The 12 Phyla of the Plant Kingdom*

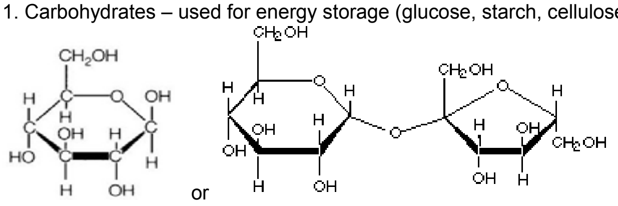
Type of plant	Phylum	Common name
Nonvascular	Bryophyta	mosses
	Hepatophyta	liverworts
	Anthocerophyta	hornworts
Vascular, seedless	Psilotophyta	whisk ferns
	Lycophyta	club mosses
	Sphenophyta	horsetails
	Pterophyta	ferns
Vascular, seed		
Gymnosperms	Cycadophyta	cycads
	Ginkgophyta	ginkgoes
	Coniferophyta	conifers
	Gnetophyta	gnetophytes
Angiosperms	Anthophyta	flowering plants
	class Monocotyledones	monocots
	class Dicotyledones	dicots

9A.

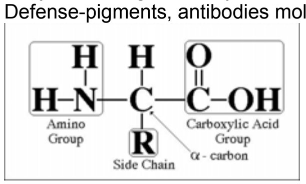
Macromolecules – molecules, in living things, which contain carbon.
A. The use of repeating units:
1.) Monomer – single repeating unit in a larger molecule (polymer)
2.) Polymer – large molecule made of monomers

Four Types

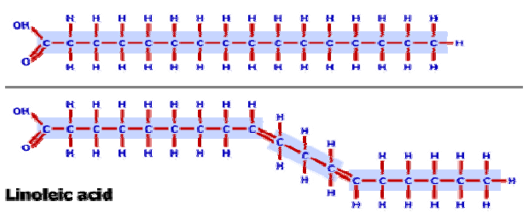
1. Carbohydrates – used for energy storage (glucose, starch, cellulose)



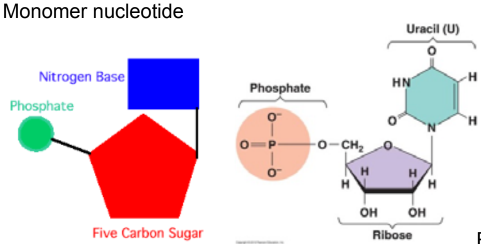
2. Proteins – used for
Support/Structural-cartilage, skin, ligaments
Movement-muscles
Enzymes-biological catalysts
Defense-pigments, antibodies molecules; made of chains of amino acids



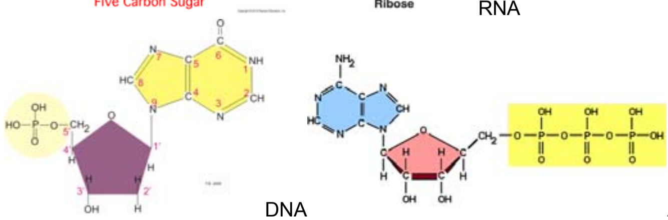
3. Lipids – used as energy storage, and as hormones (fats, oils, waxes, & steroids) phospolipds make up cell membranes



4. Nucleic Acids – the genetic material of the cell store energy in ATP (DNA, RNA & ATP)
Monomer nucleotide



RNA



DNA

ATP

9B.

COMPARISON BETWEEN PHOTOSYNTHESIS & RESPIRATION	PHOTOSYNTHESIS	RESPIRATION
EQUATION	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
LOCATION	Chloroplast	Mitochondria
OCCURS	In light	All the time
INPUT REACTANTS	CO_2 & H_2O	$C_6H_{12}O_6$ & O_2
OUTPUT PRODUCTS	$C_6H_{12}O_6$ & O_2	CO_2 & H_2O
ENERGY SOURCE	Visible light (sunlight)	Chemical bonds (in food)
RESULT	Storage of energy	Release of energy
REACTION	Reduction (reduction of CO_2 to glucose)	Oxidation (oxidation of glucose to CO_2)
METABOLISM	Anabolic: produces sugars Endergonic → requires energy (light energy - sunlight)	Catabolic: breaks sugars Exergonic → produces energy (products less energy than reactants)
ENERGY FORMATION	ATP & NADPH (inner thylakoid membrane)	ATP, NADH & $FADH_2$ (All NADH & $FADH_2$ converted to ATP in the inner mitochondrial membrane; some ATP produced by substrate-level phosphorylation)

photosynthesis

$$6CO_2 + 6H_2O + \text{energy} \longrightarrow C_6H_{12}O_6 + 6O_2$$

energy in

aerobic respiration

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$$

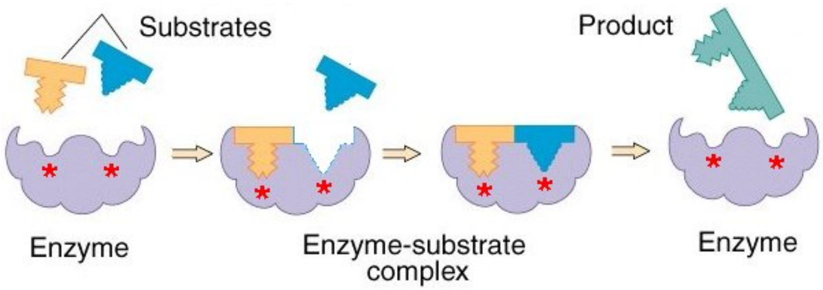
energy out

9C.

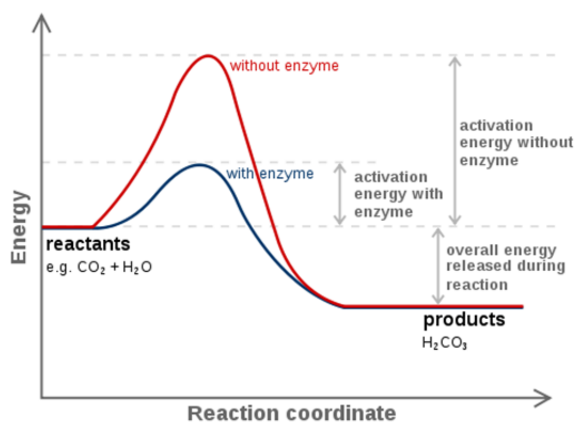
1. Proteins that function as biological catalysts are called enzymes.
2. Enzymes speed up specific metabolic reactions.
3. Low contamination, low temperature and fast metabolism are only possible with enzymes.
4. Metabolism is fast, with the product made to a high degree of purity.

General Properties
- Catalysts
- Protein
- Specific
- Reversible — can catalyze the reaction in both directions
- Denatured by high temperature and change in pH
- Rate of action affected by temperature and pH

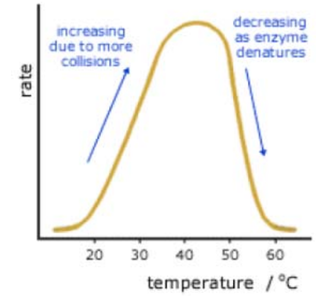
Induced fit Model

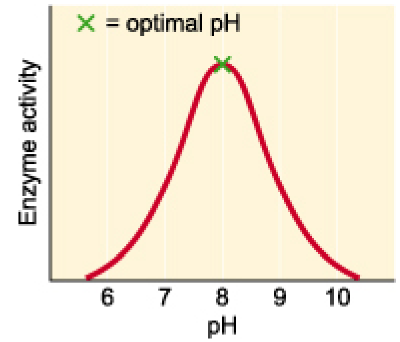


Active sites in the uninduced enzyme are shown schematically with rounded contours. Binding of the first substrate (gold) induces a physical conformational shift (angular contours) in the protein that facilitates binding of the second substrate (blue), with far lower energy than otherwise required. When catalysis is complete, the product is released, and the enzyme returns to its uninduced state. The induced fit model has been compared to a hand-in-glove model, wherein it may be difficult to insert the first finger into the proper place, but once done, the other fingers go in easily because the glove is now properly aligned.



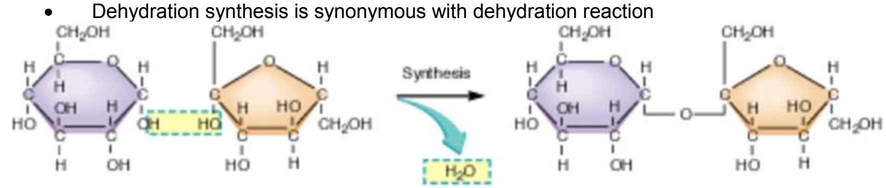
Increases rate by lowering the activation energy(the energy needed to bring about a reaction)



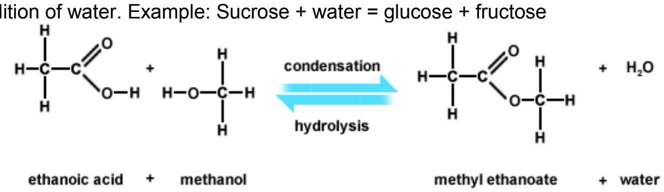


9D.

- Polymerization is the linking together of monomers to form polymers
- Polymerization in biological systems typical occurs via dehydration synthesis
- A condensation reaction occurs via the loss of a small molecule, usually from two different substances, resulting in the formation of a bond
- Dehydration reaction is synonymous with condensation reaction except that dehydration reaction is limited to those condensations in which the small molecule is water
- Dehydration synthesis is synonymous with dehydration reaction



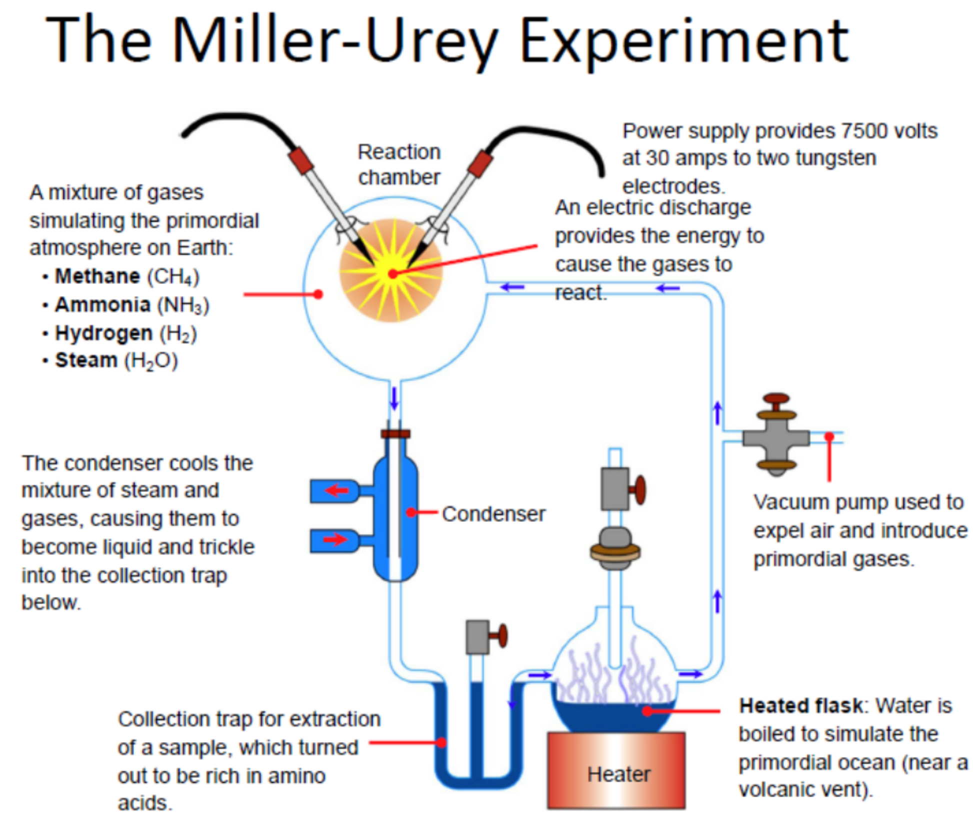
- Hydrolysis: is a catabolic process by which the bonds between monomers are broken by the enzyme and the addition of water. Example: Sucrose + water = glucose + fructose



Prebiotic Experiments

In the 1950s, **Stanley Miller** and **Harold Urey** designed experiments to **recreate the conditions of primitive Earth**.

- They aimed to create the biological molecules that were the Prebiotic Experiments
- In the 1950s, Stanley Miller and Harold Urey designed experiments to recreate the conditions of primitive Earth.
- They aimed to create the biological molecules that were the forerunners to the development of the first living organisms.
- At the time of the experiments, Earth's early atmosphere was thought to be made up of methane, water vapor, ammonia, and hydrogen gas.
- The experiment produced amino acids, so it seemed that the building blocks of life are relatively easy to create.
- Many types of organic molecules have even been detected in deep space.
- forerunners to the development of the first living organisms.
- At the time of the experiments, Earth's early atmosphere was thought to be made up of methane, water vapor, ammonia, and hydrogen gas.
- The experiment produced amino acids, so it seemed that the building blocks of life are relatively easy to create.
- Many types of organic molecules have even been detected in deep space.



RNA molecules have the ability to act both as blueprint and as enzymes. This characteristic offers a way around the "chicken-and-egg" problem that: genes require enzymes to form; enzymes require genes to form. The first stage in the evolution of life may have involved RNA molecules performing RNA molecules have the ability to act both as blueprint and as enzymes. This characteristic offers a way around the "chicken-and-egg" problem that: genes require enzymes to form; enzymes require genes to form. The first stage in the evolution of life may have involved RNA molecules performing the catalytic activities necessary to assemble themselves from a nucleotide soup. At the next stage, RNA molecules would begin to synthesize proteins. There is a problem with RNA as a prebiotic molecule because the ribose is unstable. This has led to the idea of a pre-RNA world (PNA).

10A.

Skeleton Interactions
Muscles connect to your skeleton and they contract and move the skeleton along. Your skeletal system is made up of cartilage and calcified bone that work together. They help the process of movement happen in a smoother manner. The calcified bones of your skeleton also work with the circulatory system. Marrow inside of your bones helps produce the cells inside of you blood. Both red blood cells and white blood cells are created in your bones.

Muscular System Interactions
The nervous system is connected to most of the cells in your muscular system. You have smooth muscles that line your digestive system and help move food through your intestines. Smooth muscle also surrounds your circulatory system and lymph system. Those muscle tissues are spread throughout your body and are even involved in controlling the temperature of your body.

Circulatory System Interactions
Every cell that needs oxygen needs access to the fluids in your circulatory system. The circulatory system and its fluids are super important to your digestive system that has absorbed nutrients from your food. Guess what? Hormones created by your endocrine system are sent through the body by the circulatory system.

Respiratory System Interactions
With gases like oxygen and carbon dioxide (CO2), other compounds can be brought into the body by the respiratory system. Smoke can clog the alveoli in your lungs. You can inhale viruses and bacteria that could get you sick. You can also take in larger chemical compounds that can poison your body. All of these compounds can enter your blood stream via your respiratory system.
Although it does not happen in all animals, your respiratory system also interacts with your digestive system. Your mouth and pharynx are both used to swallow and to breathe. There is a branching point where you will find the epiglottis that directs food to your stomach and air to your lungs. Your respiratory system even connects with the nervous system in your nose where you smell.

Digestive System Interactions
The digestive system works very closely with the circulatory system to get the absorbed nutrients distributed through your body. The circulatory system also carries chemical signals from your endocrine system that control the speed of digestion.
The digestive system also works in parallel with your excretory system (kidneys and urination). While the digestive system collects and removes undigested solids, the excretory system filters compounds from the blood stream and collects them in urine. They are closely connected in controlling the amount of water in your body.

Excretory System Interactions
The excretory system is a close partner with both the circulatory and endocrine system. The circulatory system connection is obvious. Blood that circulates through the body passes through one of the two kidneys. Urea, uric acid, and water are removed from the blood and most of the water is put back into the system.
The endocrine system is the major controller of the excretory system. As levels of compounds and fluids are monitored, kidney function must be constantly altered to provide the best internal environment for your cells. If you drink too much water, hormones are released that allow for more urine production. If you are dehydrated, less urine will be produced. The kidneys are also tied to the endocrine system with the adrenal gland position on the top of each kidney. The adrenals release adrenaline into your body.

Nervous System Interactions
Your nervous system interacts with every other system in your body. In the same way that all of your cells need oxygen transported by the circulatory system, all of your tissues and organs require instruction and direction from the nervous system. There is obvious interaction between your muscles and your nervous system. That interaction helps you move around and interact with your environment.
There are many hidden interactions going on within your body. Your endocrine system works closely with your brain and central nervous system to control the creation of specific hormones and enzymes. Your digestive and excretory systems work with the nervous system in both conscious and unconscious ways. While digestion goes on without your thoughts, eating, peeing, and pooping are under your control.

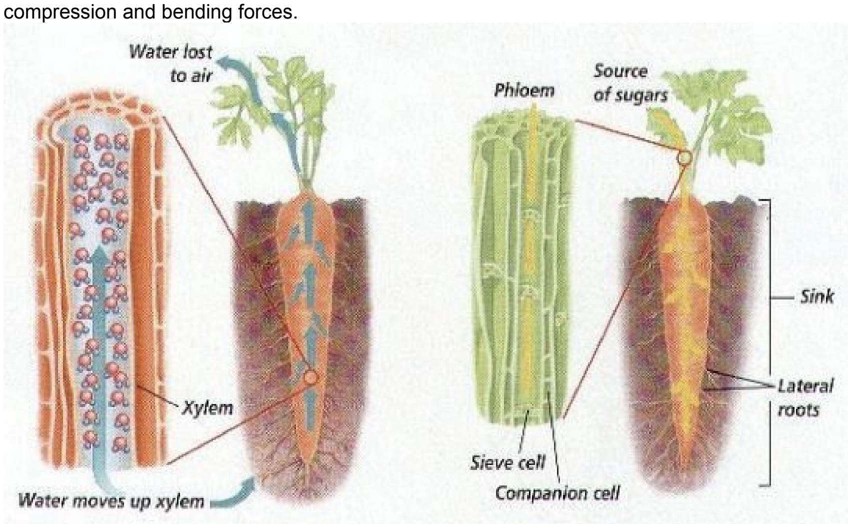
Endocrine System Interactions
The endocrine system is everywhere and the chemicals produced by the system act in a variety of ways on every cell of your body. The circulatory system is the transport system for endocrine information. While the nervous system uses neurons, the endocrine chemicals and hormones must circulate through the body via blood vessels.
Many glands in your body secrete hormones into the blood. You have a pituitary gland in the base of your skull that releases hormones that control blood pressure and your excretory system. You have a thyroid gland in your neck that controls your bone growth rate and metabolism. You even have a tiny little adrenal gland above your kidneys that releases adrenalin if you get excited. Endocrine glands are everywhere.

Integumentary System Interactions
Your skin is one of the first defense mechanisms in your immune system. Your skin has tiny glands that secrete sweat and oil. Those glands are termed exocrine glands and are not like the glands of your endocrine system. While it may feel a bit slimy, those fluids decrease the pH on the surface of your skin and kill microorganisms. There are even enzymes in your sweat that can digest bacteria.
The integumentary system also works closely with the circulatory system and the surface capillaries through your body. Capillaries near the surface of the skin open when your body needs to cool off and close when you need to conserve heat. We can't leave out the important sense of touch. Your nervous system depends on neurons embedded in your skin to sense the outside world.

Immune System Interactions
The immune system is like a small police force that constantly patrols every organ and tissue in your body. It works closely with the circulatory system for transportation needs and the lymphatic system for production of lymphocytes.
Lymph System Interactions
The lymph system collects and transports. Collection of fluids begins at the capillaries of the circulatory system and then the fluid directed through a series of vessels that become the thoracic duct. That duct is connected to the largest vein in your body, the superior vena cava, and returns the fluid to your heart and circulatory system.
The lymph fluid moves through the vessels as you move the voluntary muscles in your body. Ever go on a plane and have your feet swell up? Because you are sitting in one place and not moving around, fluid collects in your feet and they swell. The more you move, the more effective your lymphatic system becomes.

10B.

Plants have two different types of 'transport' tissue. **Xylem transports water** and solutes from the roots to the leaves, **phloem transports food** from the leaves to the rest of the plant. Transpiration is the process by which water evaporates from the leaves, which results in more water being drawn up from the roots.
Plant transport
No heart, no blood and no circulation, but plants do need a **transport system** to move food, water and minerals around. They use two different systems – **xylem** moves water and solutes from the roots to the leaves – **phloem** moves food substances from leaves to the rest of the plant. Both of these systems are rows of **cells** that make **continuous tubes** running the full length of the plant.
Xylem
Xylem cells have extra reinforcement in their **cell walls**, and this helps to support the **weight** of the plant. For this reason, the transport systems are arranged differently in **root** and **stem** – in the root it has to resist forces that could pull the plant out of the ground. In the stem it has to resist compression and bending forces caused by the weight of the plant and the wind.
Stem – the xylem and phloem are arranged in bundles near the edge of the stem to resist compression and bending forces.

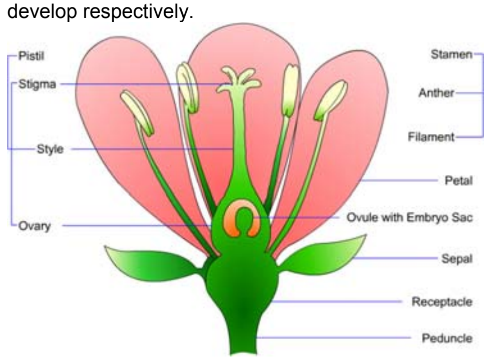


A The open ends of xylem vessel cells form complete pipelike tubes.
B Sugars in the phloem of this carrot plant are moving to sinks.

Comparison of xylem and phloem

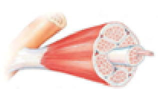
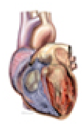
Tissue	Process	What is moved	Structure
Xylem	Transpiration	Moves water and minerals from roots to leaves	Columns of hollow, dead reinforced cells
Phloem	Translocation	Moves food substances from leaves to rest of plant	Columns of living cells

PLANT REPRODUCTION - THEY'LL MAKE MORE
. Reproduction is one of two things.
(1) One cell can split into two, giving you two identical cells. That type is asexual reproduction.
(2) The second type is when two cells, each with half of the DNA needed, combine and create a living cell. That type is sexual reproduction.
In more evolved plants, the second is the one that occurs more often.
MAKING MORE **MOSSES**
Sporophytes are the reproductive structures you will find in mosses. They are actually a phase of the moss life cycle that feeds off the green parent plant (the gametophyte). The sporophyte is a stalk that grows after the haploid sperm of one moss plant is able to mix with the haploid egg of a female moss plant. The resulting diploid cell grows into the sporophyte stalk. When ready, spores stored in the sporophyte are released and they grow into new moss plants.
CONFIERS AND THEIR CONES
While there are male and female mosses, conifers produce two types of cones on the same tree. One of the cone types gives off pollen (the staminate cone). The other type of cone catches the pollen if the wind is moving in the right direction. Better yet, the wind blows the pollen to another conifer of the same species, and a cone (called the ovulate cone) catches the pollen. Again, the pollen and megaspore (receiving haploid cell) are haploid and combine to form a diploid cell. That diploid cell grows into a zygote (baby conifer) that eventually lives in a seed.
FLOWERS AND POLLEN
The most advanced of the plants have their own way of sexually reproducing. It is a very fancy and very complex process. Plants that rely on flowers for reproduction are also very dependent on outside help such as insects and animals. While conifers have the two structures on one tree, flowering plants went one step further and put the devices that make and receive pollen in the same structure.
How does that help? A bee might go to one flower and get a little pollen on its back. If it goes to another flower of the same species, that pollen can land on the stigma. From that point, one haploid male nucleus combines with a female nucleus and the other haploid male nucleus combines with a polar nucleus. If successful, an embryo and seed/fruit develop respectively.



Plant Response Auxins
The interactions of hormones and stimuli in the environment often results in a bending or turning response in the plant called a tropism. When the plant turns toward a stimulus, the tropism is said to be positive. If the plant turns away from a stimulus, the tropism is negative.
One of the most familiar plant responses is the bending of the stem toward a light source. Light is the stimulus, and the response of the plant is called a phototropism. A geotropism is a turning of the plant away from or toward the earth. A negative geotropism is a turning away from the earth, such as by a plant stem that grows upward . A positive geotropism is a turning toward the earth, such as in a root that grows downward.

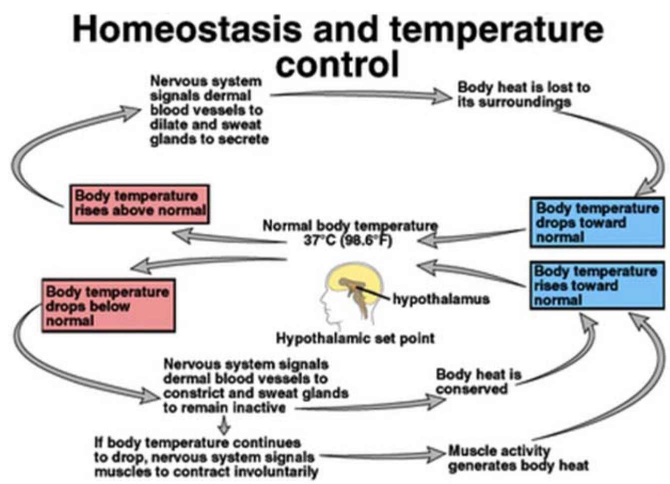
10C.

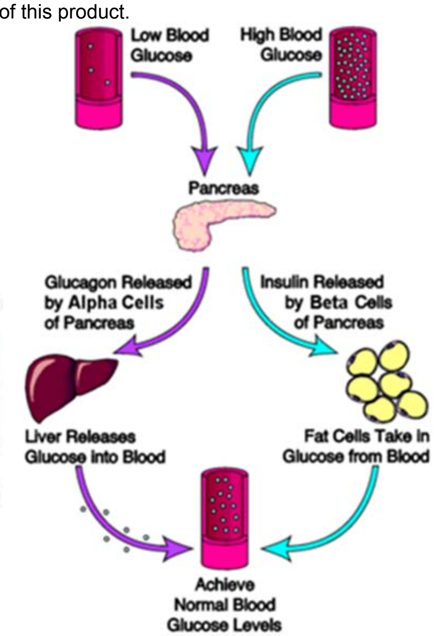
Level of Organization	Explanation	Example
 Atomic Level	Atoms are defined as the smallest unit of an element that still maintains the property of that element.	Carbon, Hydrogen, Oxygen
 Molecular Level	Atoms combine to form molecules which can have entirely different properties than the atoms they contain.	Water, DNA, Carbohydrates
 Cellular Level	Cells are the smallest unit of life. Cells are enclosed by a membrane or cell wall and in multicellular organisms often perform specific functions.	Muscle cell, Skin cell, Neuron
 Tissue Level	Tissues are groups of cells with similar functions	Muscle, Epithelial, Connective
 Organ Level	Organs are two or more types of tissues that work together to complete a specific task.	Heart, Liver, Stomach
 Organ System Level	An organ system is group of organs that carries out more generalized set of functions.	Digestive System, Circulatory System
 Organismal Level	An organism has several organ systems that function together.	Human

11A.

Homeostasis is the maintenance of a stable internal environment - temperature, amount of water and amount of glucose. If temperature is too high, the enzymes could become denatured. Too low, and metabolic processes will be too slow. Lack of water causes water to be drawn out via osmosis causing metabolic reactions to stop, whereas too much water will cause the cell to burst. Lack of glucose causes respiration to stop, whilst too much glucose may draw water out of the cell via osmosis.
Homeostasis is achieved using a negative feedback control loop, involving a receptor and an effector. The receptor receives information about the parameter being regulated, the input, and sets off a series of events culminating in an action by the effector, the output. Continuous monitoring keeps the parameter around an ideal level, and in negative feedback a rise in the parameter results in something happening that makes the parameter fall.
A positive feedback system is a problem - for example in high carbon dioxide concentration air, a person breathing will have high carbon dioxide concentrations in the blood, causing the carbon dioxide receptors to increase the breathing rate, breathing in more carbon dioxide.
Internal Communication

- The body must have good internal communication, using the endocrine and nervous systems, to maintain homeostasis.
- Feedback inhibition limits the operation of a system or causes it to shut down when it senses too much of a certain product (such as water, glucose, salt, heat, CO2 etc.)
- It will cause the system to "turn back on" when there is too little of this product.





11B.

A population is a group of individuals of the same species inhabiting the same area.
How do organisms live together?
Community is a populations of different species that live in the same place
Ecosystem

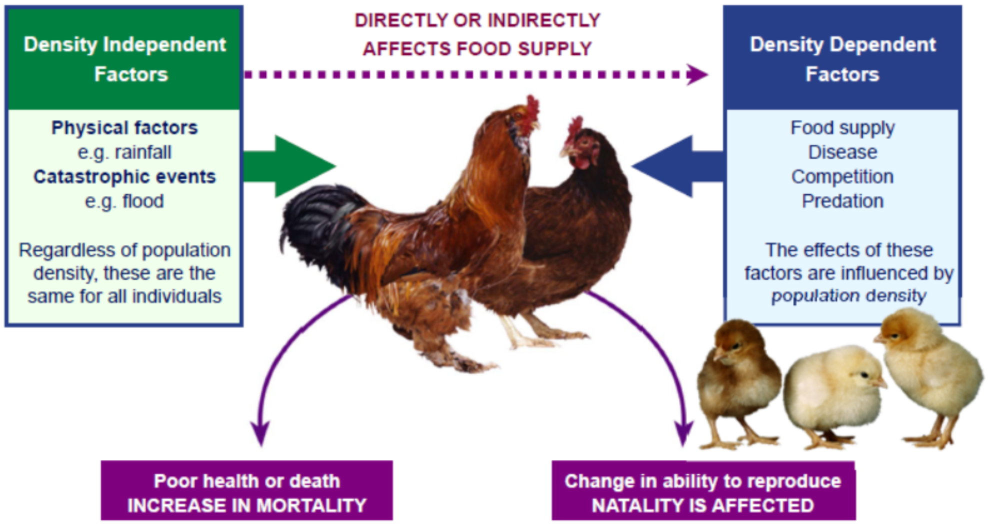
- Living (Biotic) factors all plants & animals living in an area
- Physical (Abiotic) factors soil, rock, temperature, moisture, sunlight

Populations

- Organisms do not generally live alone. A population is a group of organisms from the same species occupying in the same geographical area.

.Population Regulation

- Population size is regulated by environmental factors that limit population growth. These may be dependent or independent of the population density**.**



Limits to Growth

- Limiting Factor: – any factor that limits the size of a population
– Examples: – Predation, disease, natural disasters, food shortage, etc.

Density-Dependent Factors • A limiting factor that depends on a populations size

- Examples:
– Competition
– Predation
– Parasitism and Disease

•Density Dependent Factors Density dependent factors exert a greater effect on population growth at higher population densities.

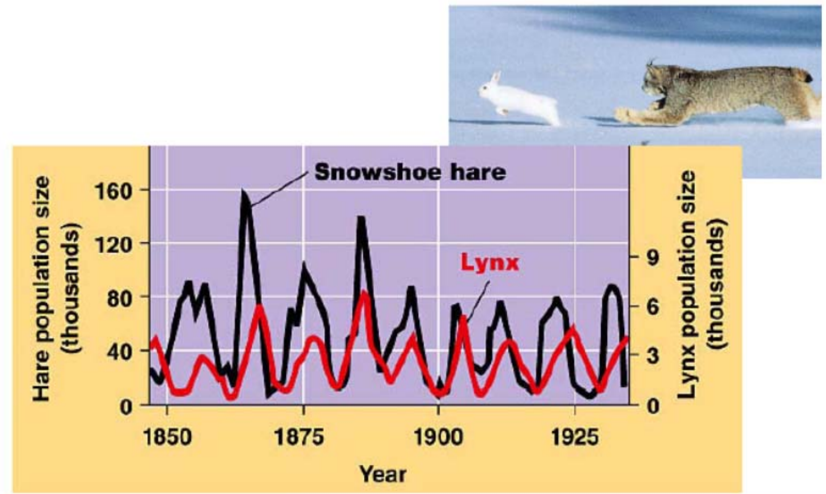
At high densities, individuals:
Compete more for resources.
Are more easily located by predators and parasites.
Are more vulnerable to infection and disease.

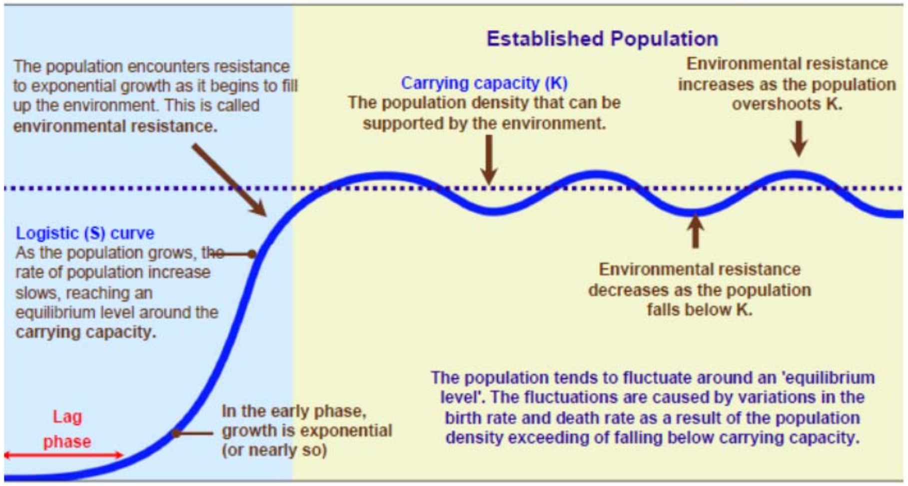
‣Density dependent factors are biotic factors such as food supply, disease, parasite infestation, competition, and predation.

Density Independent Factors ‣ The effect of density independent factors on a population's growth is NOT dependent on that population's density:

Physical (or abiotic) factors
temperature
precipitation
humidity
acidity
salinity etc.
Catastrophic events
floods and tsunamis
fire
drought
earthquake and eruption

About every 10 years, both hare and lynx populations have a rapid increase (a "boom") followed by a sharp decline (a "bust")





11C.

Viruses v. Bacteria

Viruses	v.	Bacteria
Very Small	Size	Larger, but still microscopic
NOT A CELL	Type of Cell	Prokaryote
Non Living	Living?	Living
Invades host and makes copies of itself	Reproduction	Binary fission (grow and split)

Virus		Bacteria
NONE	Treatment	Antibiotics
Vaccines, good hygiene	Prevention	Vaccines, good hygiene
NONE	Benefits	Helps with digestion (in stomach)
Chickenpox, AIDS	Example	Streptococcus, e-coli, anthrax
	Drawing	

- **Characteristics of Bacteria**
- • Unicellular
- • Prokaryotic
- • Can be autotrophs or heterotrophs
- • Can be aerobic or anaerobic
- • Can be motile or non-motile - For motility bacteria have cilia or flagella

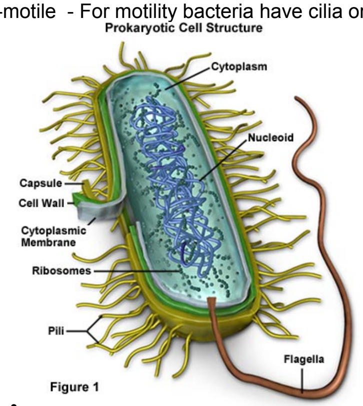


Figure 1

Bacteria can be beneficial
- Make essential soil mineral elements available to the plant: nitrogen fixation
- Decompose organic matter and improve soil nutrient content
- Bacteria can aid in producing drugs, hormones, or antibodies.
- Bacteria can even help to break down oil to make clean-up after an oil spill easier
- Bacteria help in the production of fuel
- Some bacteria decompose compost, garbage and sewage and help make methane. Methane is a valuable natural gas. It is used widely as a fuel.
- Some bacteria are now being engineered to produce various types of fuel including gasoline, biodiesel and ethanol.
- Bacteria help in the production of fuel
- Some bacteria decompose compost, garbage and sewage and help make methane. Methane is a valuable natural gas. It is used widely as a fuel.
- Some bacteria are now being engineered to produce various types of fuel including gasoline, biodiesel and ethanol.

Disease causing bacteria are call PATHOGENIC

Pathogenic (harmful) bacteria cause disease by destroying cells or by producing toxins that stop the cell from doing its job
- Staphylococcus aureus-food poisoning when toxins are ingested
- Streptococcus pyogenes-causes strep throat—red spots on your throat are red blood cells the bacteria have destroyed
- Clostridium botulinum-produces toxins that cause paralysis for 4-6 months (botox injections are made of these toxins!!!)

Controlling Bacterial Growth
- Pasteurization is used to remove bacteria from food
- Antiseptics can kill bacteria on tissues
- Antibiotics are used to kill bacteria that have entered the body
- Vaccines can prevent bacterial infections by stimulating the immune system

12A.

Species interactions may involve only occasional or indirect contact (predation or competition) or they may involve a close association between speciesCompetition

• Organisms of different species competing over limited resources

• Resources are any necessity of life Competition is one of the most familiar of species relationships. It occurs both within (intraspecific) and between (interspecific) species.

‣ Individuals compete for resources such as food, space, and mates. In all cases of competition, both parties (the competitors) are harmed to varying extents by the interaction.

. Symbiosis is a term that encompasses a variety of such close associations, including parasitism (a form of exploitation), mutualism, and commensalism.

Mutualism

• A symbiotic relationship in which both organisms benefit from the relationship

Commensalism

• A symbiotic relationship in which one organism benefits and the other is neither helped nor harmed

Parasitism

• A symbiotic relationship in which one organism lives in or on another organism (the host) and harms it to gain food.

12B.

• An adaptation (or adaptive feature) is an inherited feature of an organism that enables it to survive and reproduce in its habitat.

• Adaptations are the end result of the evolutionary changes that a species has gone through over time.

Adaptations may be:
behavioral
physiological
structural (morphological)

Exploiting a Habitat

• Organisms have adaptations to exploit, to varying extents, the resources in their habitat.

• Where resource competition is intense, adaptations enable effective niche specialization and partitioning of resources.

In the African savanna, grazing and browsing animals exploit different food resources within the same area or even within the same type of vegetation.

Plants and Browsers

• The large thorns and dense, tangled growth form of the acacias of the African savanna are adaptations to counter the effects of browsing animals such as antelope.

• Organisms have adaptations for:
Biorhythms and activity patterns, e.g. nocturnal behavior
Locomotion (or movement)
Defense of resources
Predator avoidance
Reproduction
Feeding

• These categories are not mutually exclusive.

• Plant Adaptations

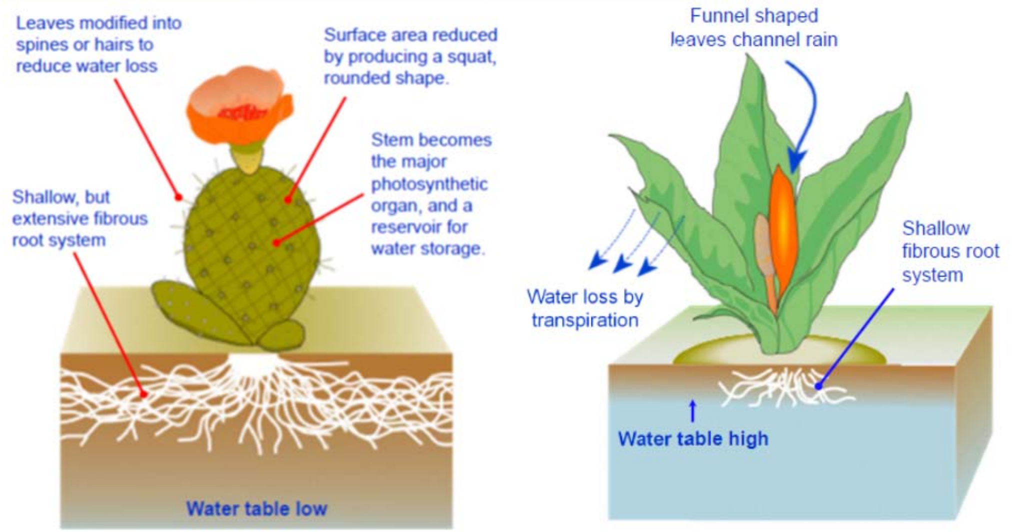
• The adaptations found in plants reflect both the plant's environment and the type and extent of predation to which the plant is subjected.

• Many plant adaptations are concerned with maintaining water balance. Terrestrial plant species show a variety of structural and physiological adaptations for water conservation.

• Plants evolve defenses, such as camouflage, spines, thorns, or poisons, against efficient herbivores.

Conserving water

Adaptation for water conservation	Effect of adaptation	Example
Thick, waxy cuticle to stems and leaves	Reduces water loss through the cuticle	*Pinus* spp., ivy, sea holly, prickly pear
Reduced number of stomata	Reduces the number of pores for water loss	Prickly pear, *Nerium* sp.
Leaves curled, rolled or folded when flaccid	Reduces surface area for transpiration	Rolled leaf: marram grass, Erica spp.



Tropical Forest Plants

Tropical forest plants live in areas of often high rainfall. Therefore, they have to cope with high transpiration rates.

adaptations are associated with detecting and avoiding predators.

Structural adaptations
Widely spaced eyes gives a wide field of vision for surveillance of the habitat and detection of danger.
Long, mobile ears enable acute detection of sounds from many angles for predator detection.
Long, strong hind legs and large feet enable rapid movement and are well suited to digging.
Cryptic coloration provides effective camouflage in grassland habitat.

Functional adaptations
High reproductive rate enables rapid population increases when food is available.
Keen sense of smell allows detection of potential threats from predators and from rabbits from other warrens.
Microbial digestion of vegetation in the hindgut enables more efficient digestion of cellulose.
High metabolic rate and fast response times enables rapid response to dangers.

- Behavioral Adaptations in Rabbits
- The behavioral adaptations of rabbits reflect their functional position as herbivores and important prey items in many food webs.

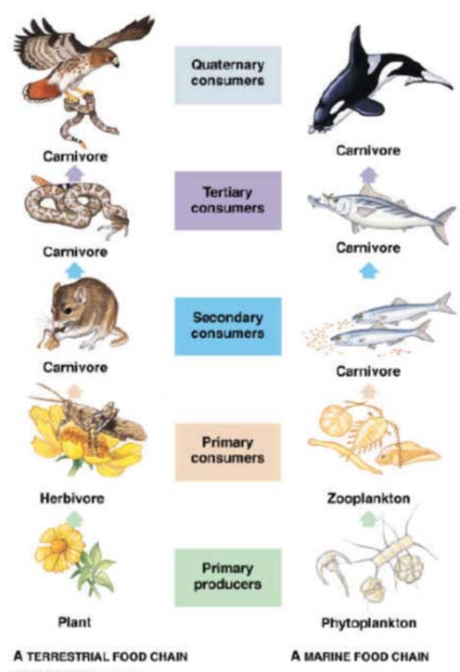
12C.

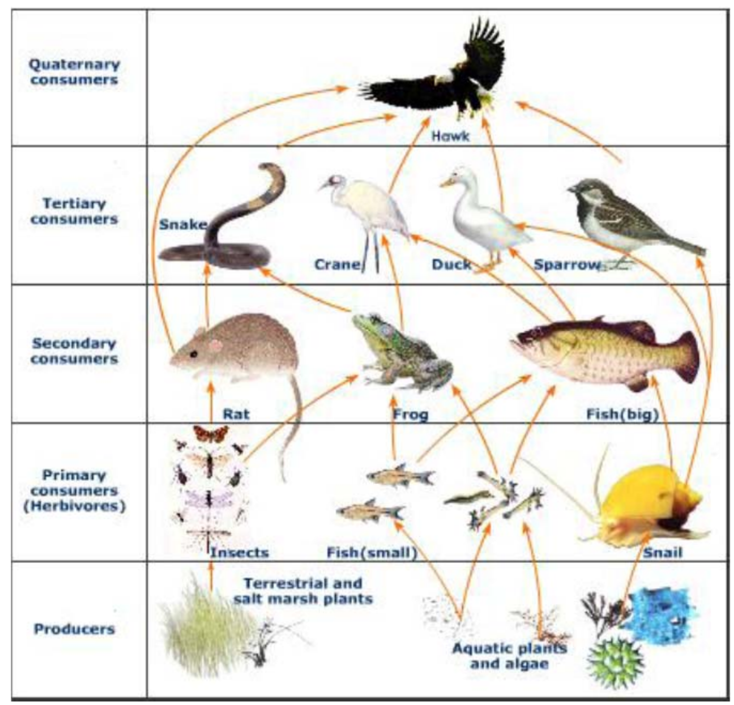
FOOD CHAINS WEBS AND PYRAMIDS

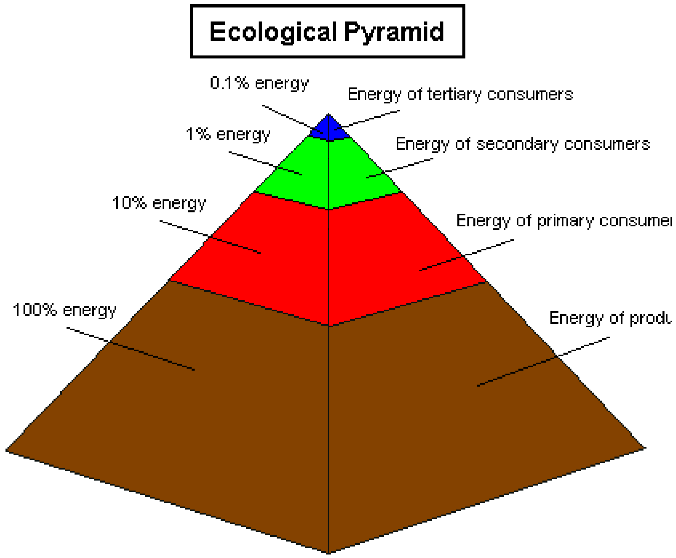
The food chain consists of four main parts:

1. The Sun, which provides the energy for everything on the planet.
2. Producers: these include all green plants. These are also known as autotrophs, since they make their own food. They make up the bulk of the food chain or web.
3. Consumers: In short, consumers are every organism that eats something
else.. Primary consumers are the herbivores, and are the second largest biomass in an ecosystem. The animals that eat the herbivores (carnivores) make up the third largest biomass, and are also known as secondary consumers. This continues with tertiary consumers, etc.
4. Decomposers: These are mainly bacteria and fungi that convert dead matter
into gases such as carbon and nitrogen to be released back into the air, soil, or
water. Decomposers are necessary since they recycle the nutrients to be used again by producers.

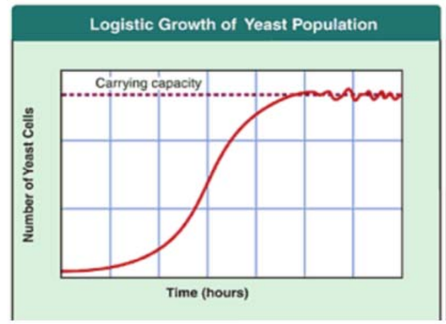
- Autotrophs – produce their own food (example: plants).
- Herbivore – plant eaters (example: deer).
- Omnivore – eats both plants and meat (example: bear).
- Carnivore – eats primary meat (example: coyote).
- Decomposers – breaks down dead tissue (example: bacteria).
- Producer- also known as autotrophs, produces its own food.
- Consumer is any animal that does not produce its own food; it is considered a primary, secondary or tertiary consumer depending on where it may be found in a food chain or food web.



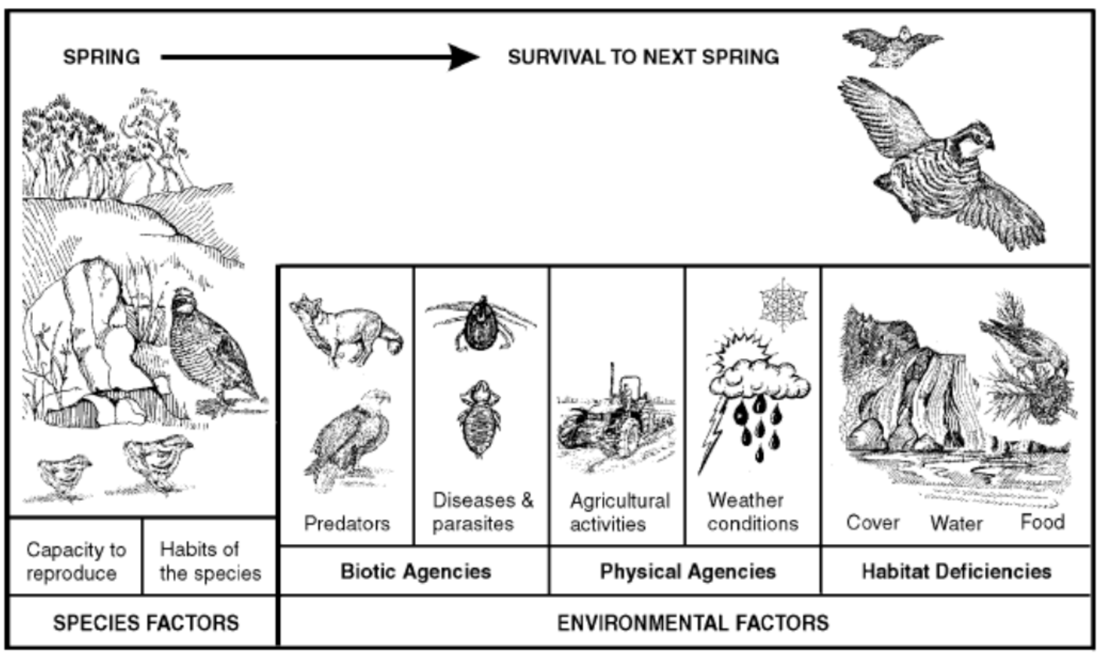




Density **dependent** factors are biotic factors such as food supply, disease, parasite infestation, competition, and predation.
Density – **Independent** factors • Affect all populations in similar ways regardless of the population • Ex.) unusual weather, natural disasters, seasonal cycles, human activities
Density – Independent Factors
• In response to such factors, many species show a characteristic crash in population size
• Environments are always changing, and most populations can adapt to a certain amount of change
• Populations often grow and shrink in response to such changes
• Major upsets in an ecosystem can lead to long term declines in certain populations
Six major extrinsic factors are
• weather, • disease, • food, • cover, • distribution of source and sink habits, and • other species.
Limiting factors effect the Carrying Capacity (the maximum number of individuals an ecosystem can support



12D.



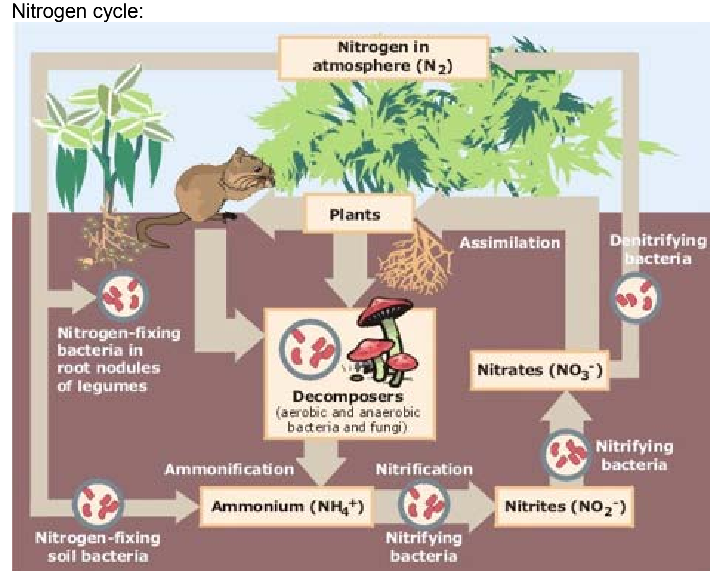
Density dependent factors exert a greater effect on population growth at higher population densities.
At high densities, individuals:
- ✓ Compete more for resources.
- ✓ Are more easily located bypredators and parasites.
- ✓ Are more vulnerable to infection and disease.

12E.

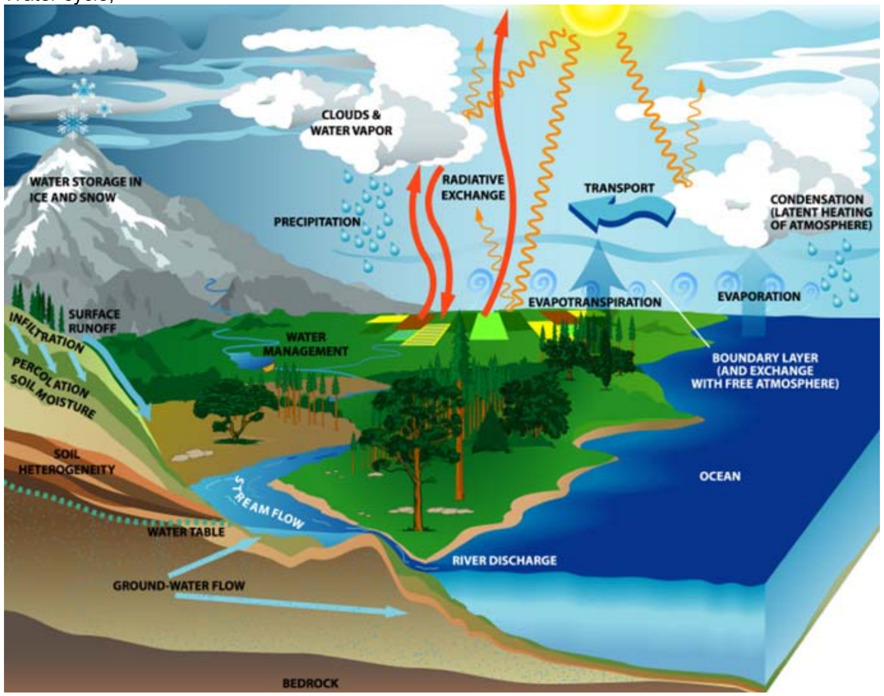
Ecosystems need three processes to occur in order to be self-sustaining:
- Capture of energy
- Transfer of Energy
- Cycle of Nutrients

There are Two Inputs in an ecosystem which is necessary. They are:
- Energy flows through ecosystem
- Nutrients cycles through ecosystem

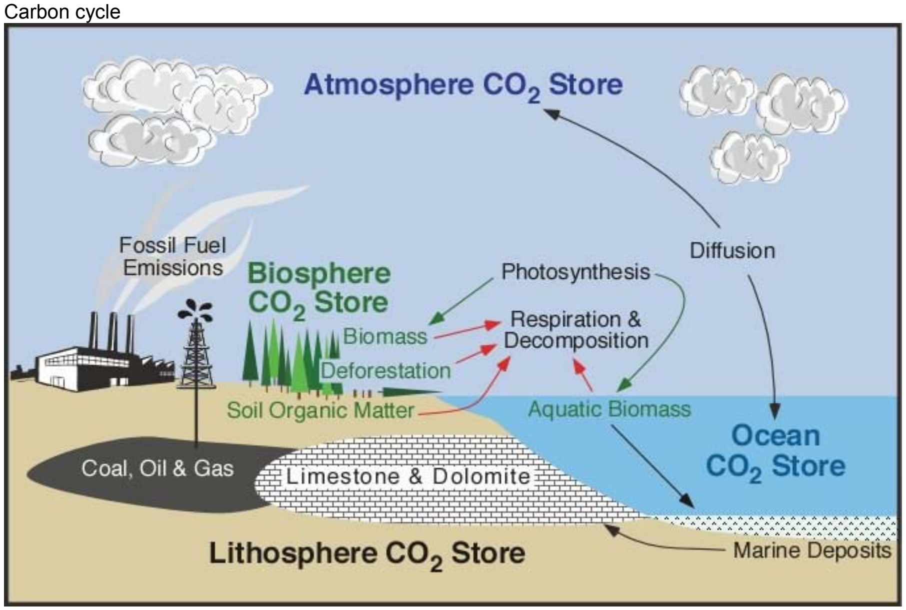
Nitrogen cycle:



Water cycle;



Carbon cycle



12F.

Human impact on the natural world has increased dramatically as the scope and intensity of human activities have increased.

‣ Unresolved problems include the loss of tropical forests, the buildup of 'greenhouse' gases, and the loss of biodiversity

Desertification

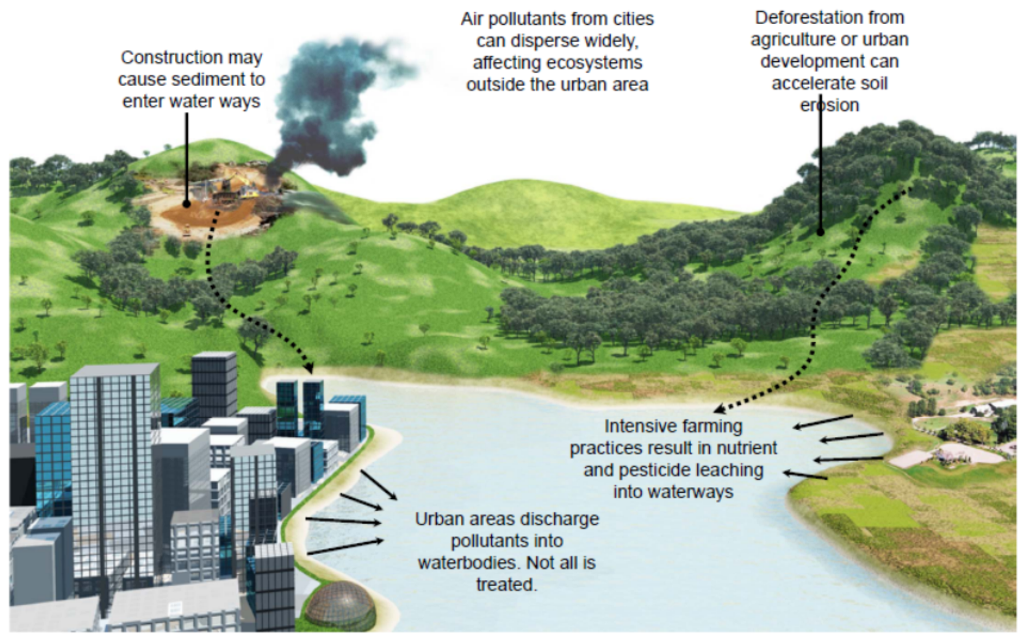
- The change of grasslands and range into desert
- Causes of Desertification
- Poor Land Management
- Overgrazing
- Poor farming techniques
- Incorrect irrigation

Food

- Although food production is generally adequate to meet human needs there are problems with distribution. Over 1 billion people remain undernourished.
- Overfishing of key fish stocks to levels where recovery is unlikely has occurred in many fishing grounds.

Deforestation

- Clearing of forests for agriculture, lumber, etc.
- **Acid rain** (or more correctly termed acid deposition) can fall to the Earth as rain, snow or sleet, as well as dry, sulfate-containing particles that settle out of the air. It is a world-wide problem.



Greenhouse Effect

- The term 'greenhouse effect' describes the natural atmospheric warming caused by gases such as CO2 in the atmosphere, which act as a thermal blanket in the atmosphere, letting in sunlight, but trapping the heat that would normally radiate back into space.
  - o About 75% of the natural greenhouse effect is due to water vapor. The next most significant is carbon dioxide.
  - o Without this process Earth's temperature would be around 0^{o}C.

Stratospheric Ozone

- A thin veil of renewable ozone exists in a band of the upper stratosphere,17-26 km above the Earth's surface.
- Stratospheric ozone absorbs about 99% of the harmful incoming ultra violet (UV) radiation from the sun and prevents it from reaching the Earth's surface. from the surroundings.

Bioaccumulation

- Bioaccumulation (also called biological magnification) occurs when highly persistent pesticides, which cannot be metabolized or excreted, are stored and accumulate in the fatty tissues of the body.
- There is a progressive concentration of the pesticides with increasing trophic level; higher order consumers are at greater risk because they eat a large number of lower order consumers.

The Need for Biodiversity

- There is a growing awareness that biodiversity is required in order to maintain ecosystem stability.
- More diverse ecosystems, with many species interactions, are generally better able to withstand disturbances.
- For this reason a great deal of effort is being put into maintaining numbers and varieties of plants and animals.

Endangered Wildlife

- Around 800 years ago, New Zealand became the last large landmass to be inhabited by humans.
- Since that time, nearly half of its native birds have become extinct.

3F.

1655 - Robert Hooke (1635-1703) of Britain designed his own microscope and discovered matter made up of what he called cells.

1759 - C.F. Wolff (1733-1794) of Germany proposed a general cell theory.

1838 - Matthias J. Schleiden (1804-1881) of Germany published a cell theory as applied to plants.

1839 - Theodor Schwann (1810-1882) of Germany published cell theory as applied to animals.

1857 - Gregor Johann Mendel (1822-1884), an Austrian monk, began experiments with pea plants. He later became known as the "father of genetics."

1859 - English biologist **Charles Darwin** (1809-1882) published "On the Origin of Species," explaining units of heredity and variations in species.

1865 - Mendel announced his theories of heredity, known as Mendel's Laws.

1869 - Sir Francis Galton (1822-1911) of Britain published his book, *Hereditary Genius*, claiming that heredity alone is responsible for a person's character traits.

1882 - German biologist Walther Fleming (1843-1905) used dyes to stain cells; he discovered rods he called "chromosomes."

1886 - Dutch botanist Hugo de Vries (1848-1935) created term "mutation" while experimenting with primroses.

1887 - Belgian biologist Edouard van Beneden (1846-1910) discovered that all organisms of the same species have the same number of chromosomes.

1900 - De Vries published a paper that included the laws of inheritance as do two others: German botanist Karl Erich Correns (1864-1933) and Austrian botanist Erich Tschermak von Seysenegg (1871-1962).

1901 - De Vries published a paper on mutations.

1902 - American biologist Walter Stanborough Sutton (1877-1916) demonstrated that chromosomes exist in pairs that are structurally similar.

1903 - Sutton proved that sperm and egg cells have one of each pair of chromosomes.

1908 - American biologist Thomas Hunt Morgan (1866-1945) with Alfred H. Sturtevant of the U.S. showed that genes were located on chromosomes; he experimented with Drosophelia (fruit flies) to investigate sex chromosomes, and discovered X and Y chromosomes, sex-linked traits, and crossing-over.

1909 - Danish botanist Wilhelm Ludvig Johannsen (1857-1927) proposed that each portion of a chromosome that controls a phenotype be called a "gene" (Greek: "to give birth to").

1913 - Alfred Henry Sturtevant (1891-1970) began constructing a chromosome map for Drosophelia (it was completed in 1951 for all four Drosophelia chromosomes).

1919 - Hermann Joseph Muller (1890-1976) of the U.S. experimented with Drosophelia to create more mutant flies.

1941 - George W. Beadle (1903-1989) of the U.S. and Edward L. Tatum (1909-1975) of the U.S. discovered that genes control the production of enzymes.

1944 - Oswald T. Avery (1877-1955) of the U.S. announced that DNA alone is the substance responsible for heredity.

1952 - Francis H. C. Crick (1916-) of Britain and James D. Watson (1928-) of the U.S. made a model of the DNA molecule and proved that genes determine heredity.

1950's - **Maurice Wilkins** (1916-), **Rosalind Franklin** (1920-1957), Crick and Watson discover chemical structure of DNA, starting a new branch of science--molecular biology.

1957 - Arthur Kornberg (1918-) of the U.S. produced DNA in a test tube.

1966 - The Genetic code was discovered; scientists are now able to predict characteristics by studying DNA. This leads to genetic engineering, genetic counseling.

1972 - Paul Berg (1926-) of the U.S. produced the first recombinant DNA molecule.

1982 - The first recombinant DNA drug approved by the FDA--genetically engineered insulin for diabetics.

1983 - Barbara McClintock (1902-1992) of the U.S. was awarded the Nobel Prize for her discovery that genes are able to change position on chromosomes.

1988 - An international team of scientists began the project to map the human genome.
The Late 1980's - The first crime conviction based on DNA fingerprinting, in Portland Oregon.
1990 - Gene therapy was used on patients for the first time.
1994 - The FDA approved the first genetically engineered food--FlavrSavr tomatoes engineered for better flavor and shelf life.
1995 - DNA testing in forensics cases gains fame in the O.J. Simpson trial.
1997 - Dolly the Sheep--the first adult animal clone.
1998 - Three generations of mice were cloned from the nuclei of an adult, eight identical calves were cloned, the rough draft of the human genome map was produced.