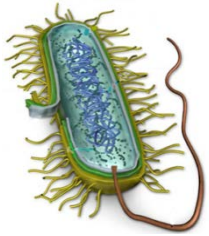
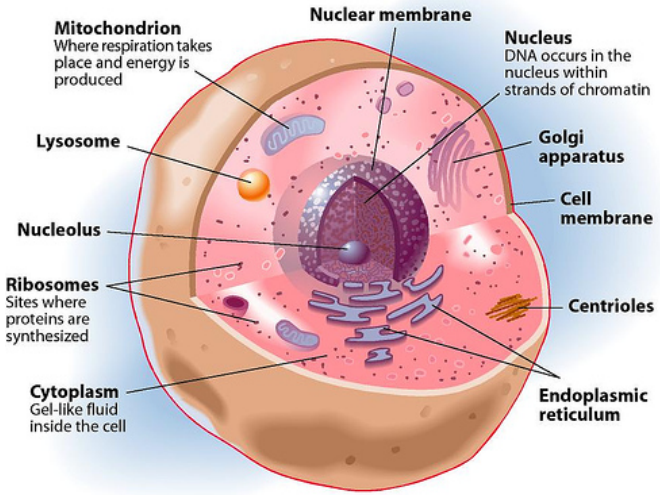
B.4.A compare and contrast prokaryotic and eukaryotic cells

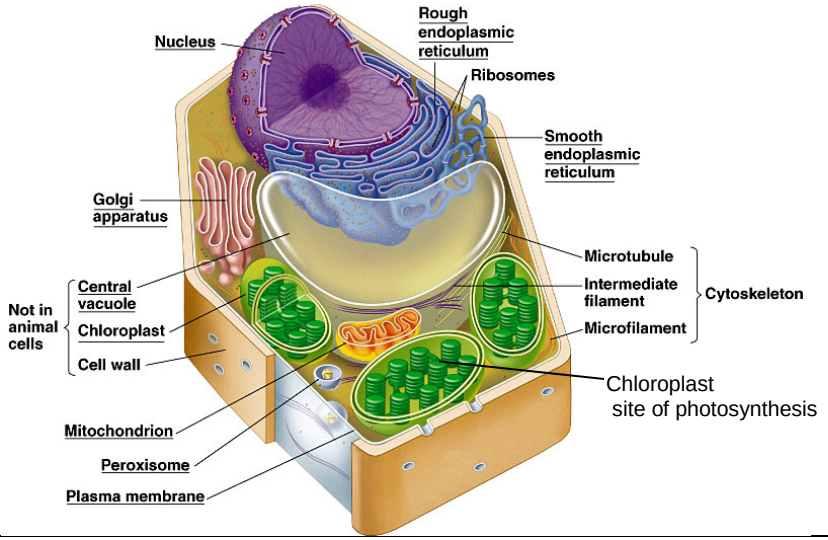
Prokaryotic Cells:



Eukaryotic Cells: Animal



Plant Plant



Prokaryotic Cells
-do not have a nucleus – DNA floats freely in cell
-do not have membrane-bound organelles
-much smaller than eukaryotes
-divide by binary fission
-bacteria

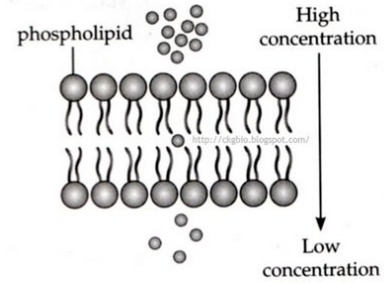
-both have DNA as their genetic material
-both have a cell membrane
-both have ribosomes

Eukaryotic Cells
-have a nucleus
-have membrane-bound organelles
-much larger than prokaryotes
-undergo mitosis

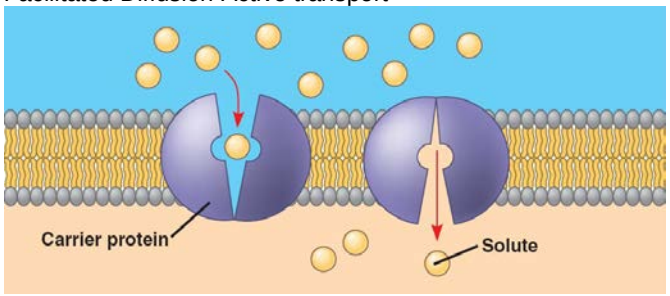
B.4.B investigate and explain cellular processes, including homeostasis, energy conversions (covered 9B), transport of molecules, and synthesis of new molecules (covered 6C)

Diffusion: movement of molecules from a high to low concentration; energy is NOT required

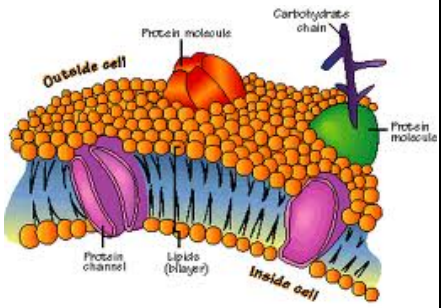
Simple Diffusion-Passive transport



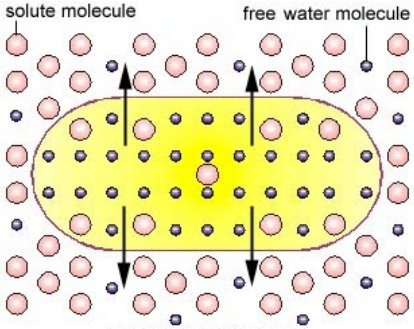
Facilitated Diffusion-Active transport



Osmosis: type of diffusion; movement of water molecules from a high to low concentration through a semi-permeable membrane

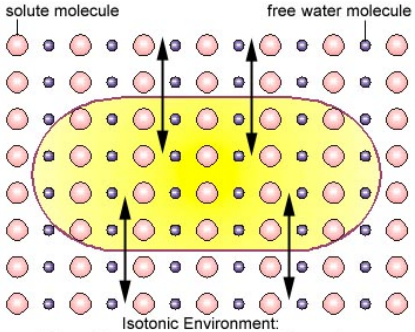


Hypertonic (cell shrinks/shrivels)



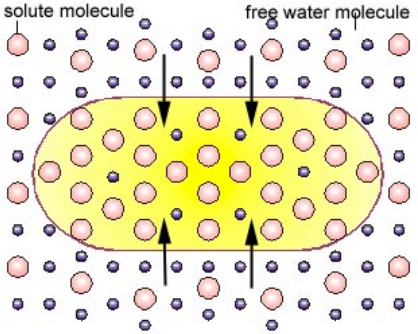
Hypertonic Environment:
The solute concentration is greater outside the cell; the free water concentration is greater inside.
Free water flows out of the cell.

Isotonic (cell stays the same)

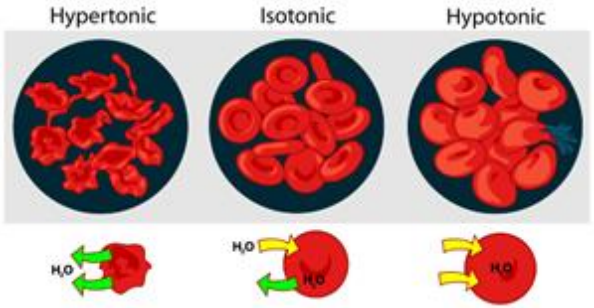


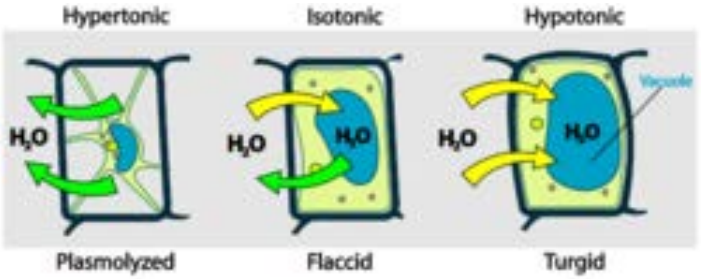
Isotonic Environment:
The solute concentration and the free water concentration are the same inside and outside the cell.
Water flows in and out of the cell at an equal rate.

Hypotonic (cell swells/enlarges)

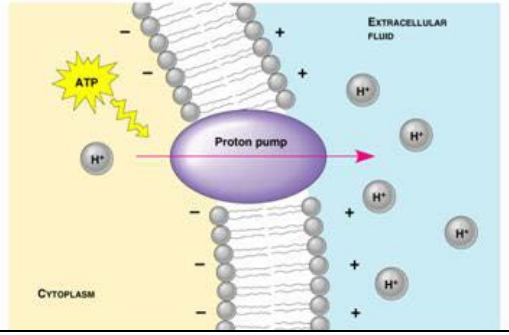


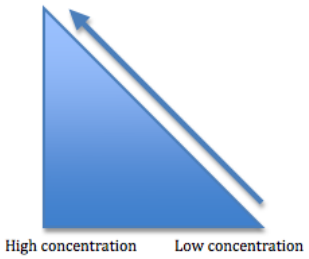
Hypotonic Environment:
The solute concentration is greater inside the cell; the free water concentration is greater outside.
Free water flows into the cell.





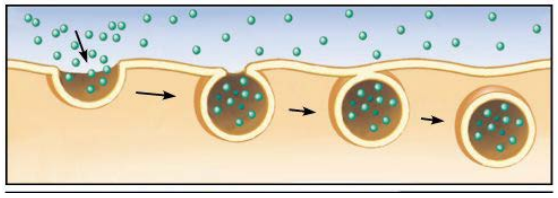
Active transport: movement of molecules from a low to high concentration; requires energy (ATP)



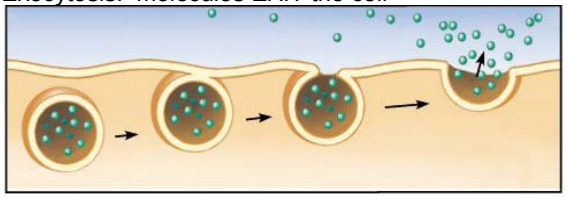


Bulk transport: movement of large quantities of molecules at once

Endocytosis: molecules ENTER the cell

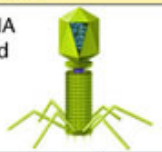


Exocytosis: molecules EXIT the cell



B.4.C compare the structures of viruses to cells, describe viral reproduction, and describe the role of viruses in causing diseases such as human immunodeficiency virus (HIV) and influenza

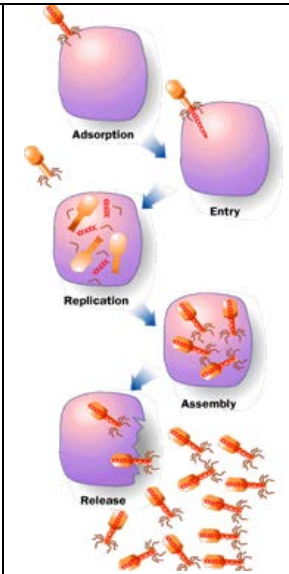
Viruses and Cells

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

Examples of Viral Diseases and Infections:

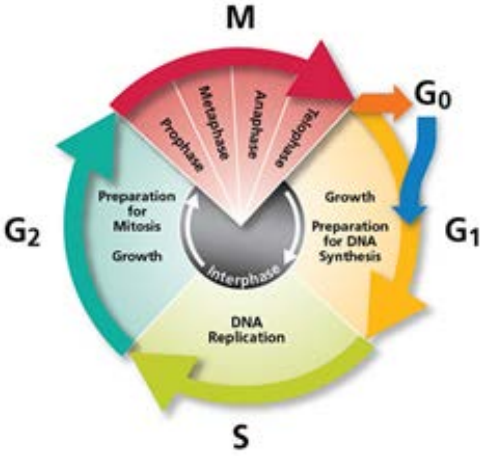
- HIV/AIDS
- Influenza (flu)
- Common cold

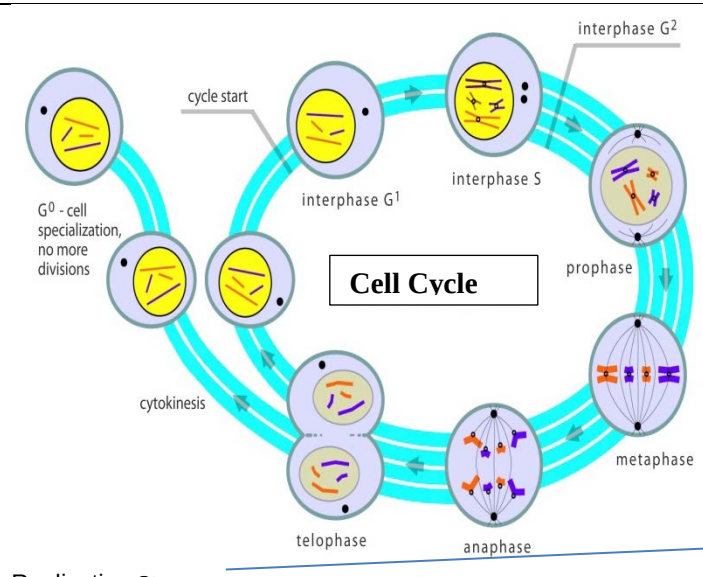
These diseases can NOT be treated with antibiotics. Antibiotics kill bacteria only, not viruses.

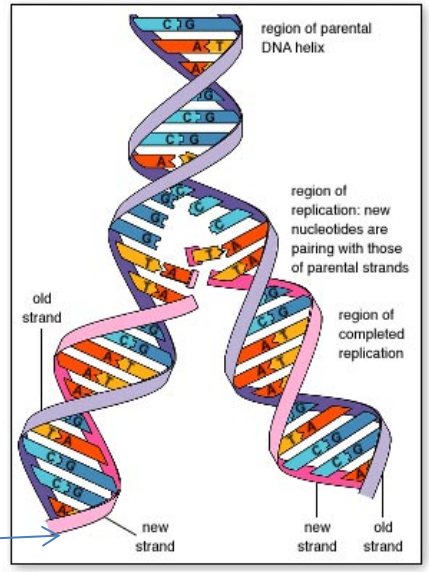


B.5.A describe the stages of the cell cycle, including deoxyribonucleic acid (DNA) replication and mitosis, and the importance of the cell cycle to the growth of organisms

Phase	Events within cell
G_1	Intensive cellular synthesis (make more organelles)
S	DNA replication occurs, 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 (prophase,metaphase, anaphase telophase)
C	Equal distribution of organelles and cytoplasm into each daughter cells



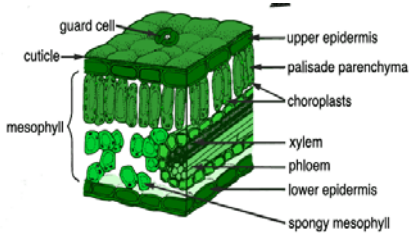
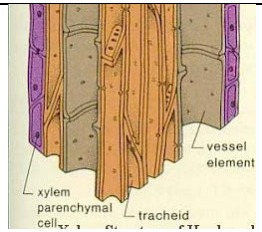
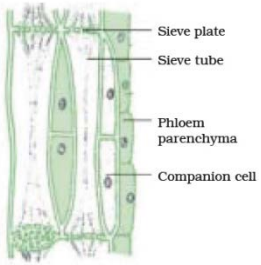
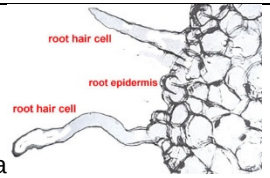
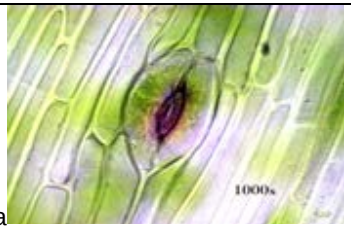
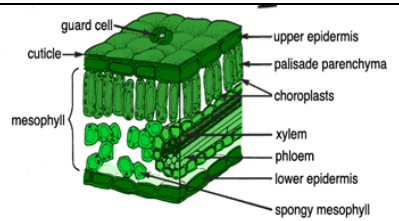


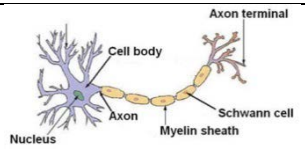
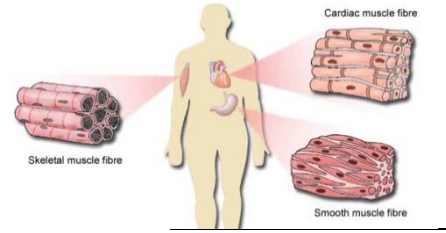
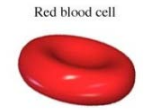
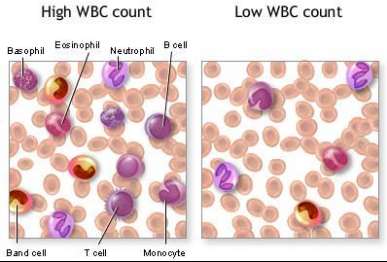
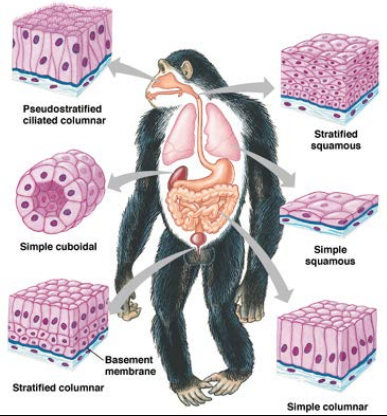
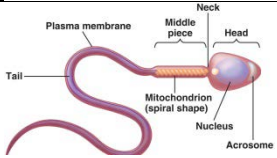


Replication Steps

The double helix is unwound.
The hydrogen bonds between the nitrogen bonds are broken to separate the two strands of DNA.
Each original strand is used as a template to build a new strand. Complementary base pairing occurs (A pairs with T and C pairs with G).

Two molecules of DNA are produced (half original and half new). This is known as semi-conservative replication

B.5.B examine specialized cells, including roots, stems, and leaves of plants; and animal cells such as blood, muscle, and epithelium			
Cell	Tissue	Function	Location
Parenchyma	Parenchyma (ground) 	Many functions Leaf: photosynthesis; allows for gas exchange Root: storage of sugars; transport water	Throughout plant (roots, stems, and leaves)
Tracheid	Xylem (vascular) 	Serve as conducting cell to transport water throughout plant	Throughout plant (roots, stems, and leaves)
Sieve tube member/element	Phloem (vascular) 	Serve as conducting cell to transport sugars throughout plant	Throughout plant (roots, stems, and leaves)
Companion cell		Aid in conducting sugars throughout plant; found along side sieve tube member	Throughout plant (roots, stems, and leaves)
Root hairs	n/a 	Increase surface area for absorption of water	Roots
Guard cells	n/a 	Regulate the opening and closing of pores in the leaf called stoma(ta)	Leaf 
Pollen	n/a	Produce sperm	Flower (in angiosperms); cone (in gymnosperms)
Ovule	n/a	Produce egg	Flower (in angiosperms); cone (in gymnosperms)

Function	Picture	Structure
Nerve cells: Carry messages to other parts of 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. Muscle cells contain many mitochondria for ATP (energy). .		**Skeletal =** striated; voluntary; found in muscles of arms and legs **Smooth** = not striated; involuntary; found lining the digestive tract **Cardiac** = striated; involuntary; found in the heart
The main function of **red blood cell**s is to carry oxygen from the lungs to the parts of the body where it is needed.		They are shaped to give them a large surface area so they can absorb oxygen more easily. The cytoplasm contains a protein called 'hemoglobin', which carries oxygen
White blood cells fight pathogens and help stop infections.		White blood cells are capable of 'eating' bacteria and breaking them down. A high white blood cell count indicates that your body is fighting a pathogen.
Epithelial cells comprise tissues that line organs.		Epithelial tissue is comprised of multiple layers. This is often used for protection (i.e. the skin).
Spermatozoon carry genetic information to an egg.		They have a tail which they use for swimming. They have mitochondrion to release the energy they need for swimming. The head of the sperm contains special chemicals that help it to penetrate an egg.

B.5.C describe the roles of DNA, ribonucleic acid (RNA), and environmental factors in cell differentiation

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.

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.

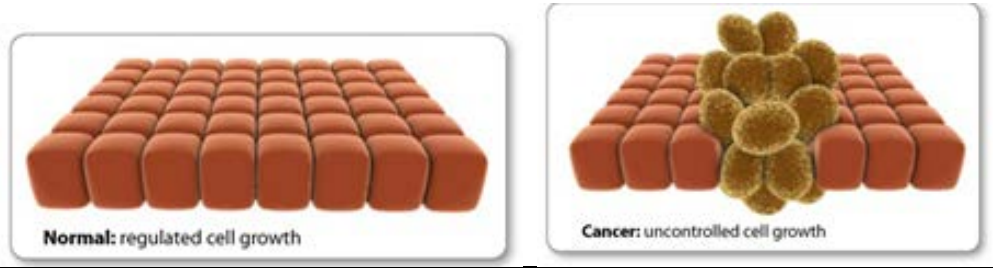
B. **External Conditions that Affect Cell Differentiation**:

The release of these hormones is affected by environmental factors, such as temperature changes and pollution , --- affect gene expressions.

B.5.D recognize that disruptions of the cell cycle lead to diseases such as cancer

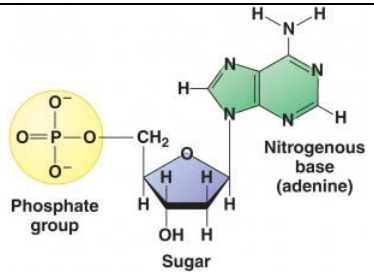
Cancer is

- Uncontrolled mitosis
- Uncontrolled cell division
- A result of failed checkpoints, allowing the cell to continue to divide without regulation

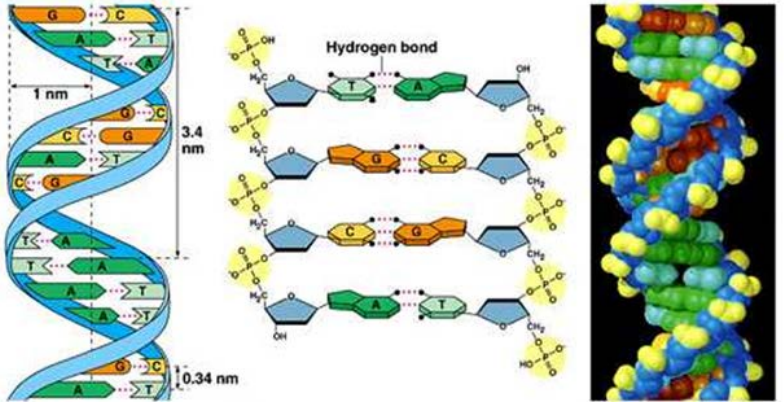


B.6.A identify components of DNA, and describe how information for specifying the traits of an organism is carried in the DNA

Nucleotide: monomer of DNA
- Sugar (deoxyribose)
- Nitrogenous base
  - Adenine (A)
  - Thymine (T)
  - Cytosine (C)
  - Guanine (G)
- Phosphate group

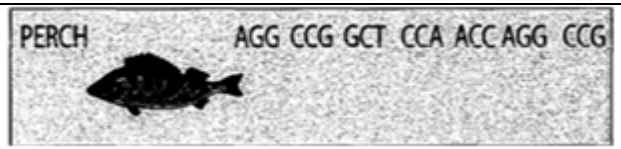


Structure of DNA
- Two strands
- Backbone is of alternating sugar and phosphate molecules
- Interior consists of base-pairs of nitrogen bases (complementary base pairing)
  - A always pairs with T
  - C always pairs with G
  - Hydrogen bonds hold the nitrogen bases together
- Two strands twist to form a double helix

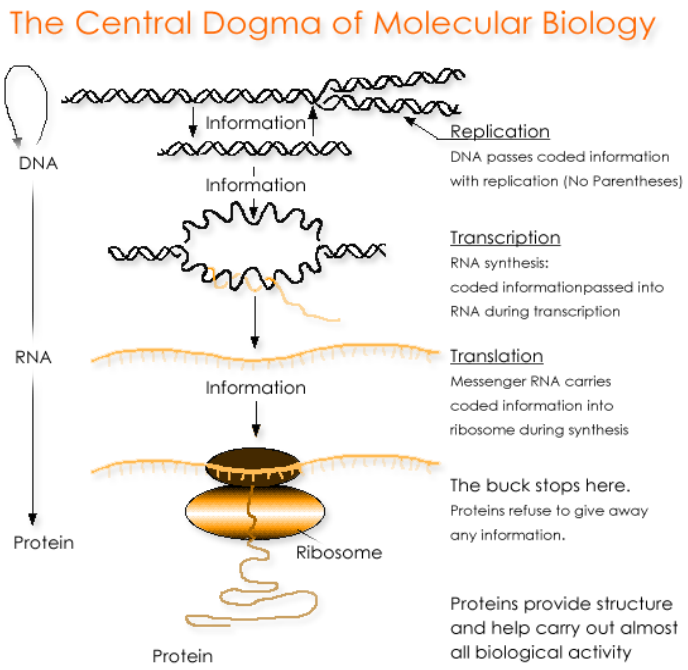


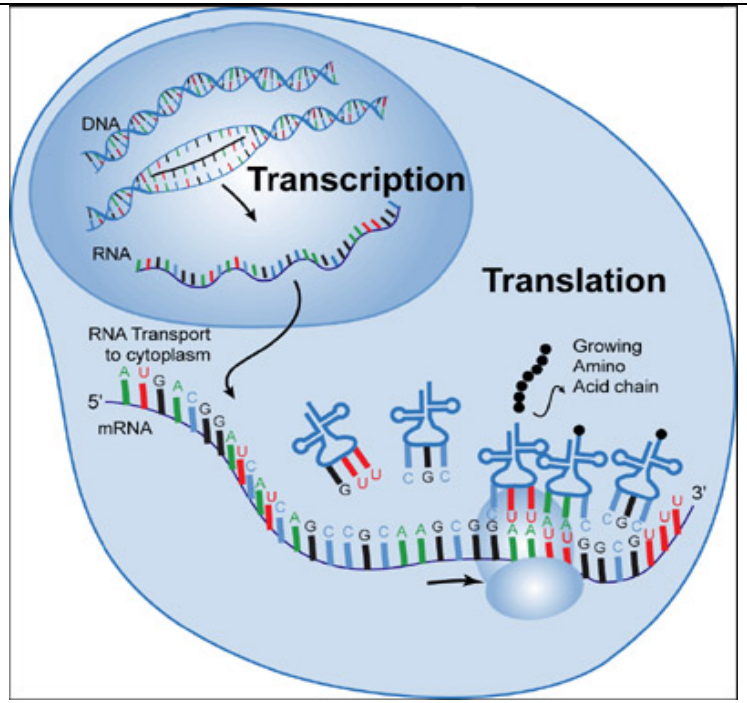
B.6.B recognize that components that make up the genetic code are common to all organisms

ALL living organisms contain A, T, C, and G in their DNA.
ALL living organisms use that DNA to make proteins from the same twenty amino acids.



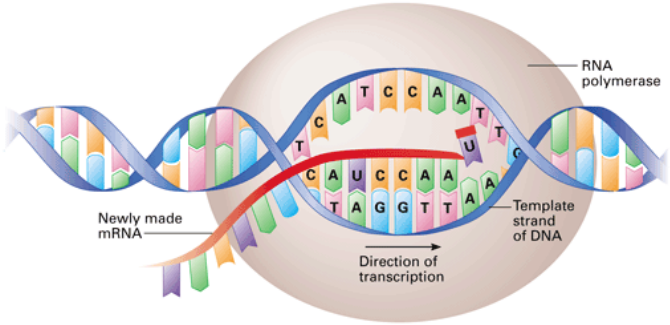
B.6.C explain the purpose and process of transcription and translation using models of DNA and RNA





Transcription

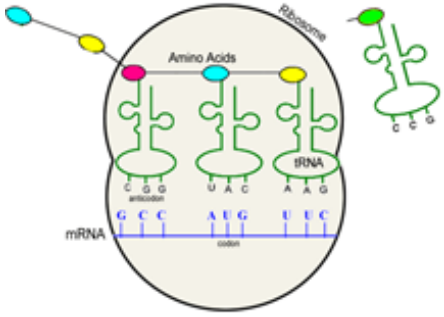
- The use of DNA to make RNA
- Occurs in the nucleus of the cell
- RNA base-pairs with the template strand of DNA
- Remember: *RNA has uracil (U) instead of thymine (T)



Translation

- The use of RNA to make proteins
- Occurs in the cytoplasm of the cell
- Requires the use of three types of RNA
- Messenger RNA (mRNA): copy of DNA's message to code proteins; contains codons (three base sequences)
- Transfer RNA (tRNA): carries amino acids to the ribosomes; contains anti-codons (three base sequences that pair up with mRNA)
- Ribosomial RNA (rRNA): makes up structure of ribosome

Anti-codon on tRNA pairs with mRNA codon to bring proper amino acid into the ribosome. Amino acids are connected until a stop codon is reached.



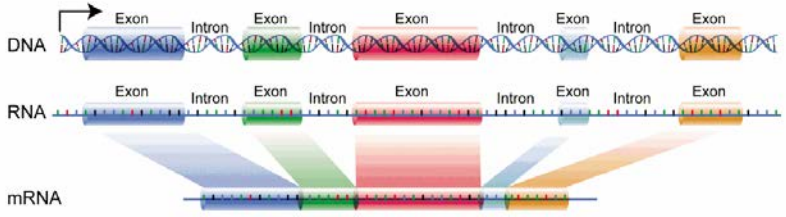
B.6.D Recognize that gene expression is a regulated process.

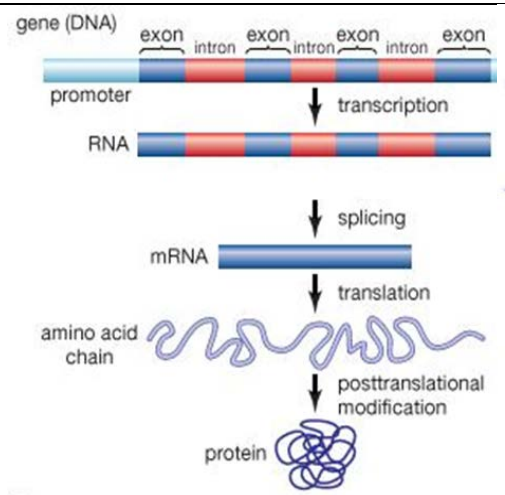
Steps of transcription

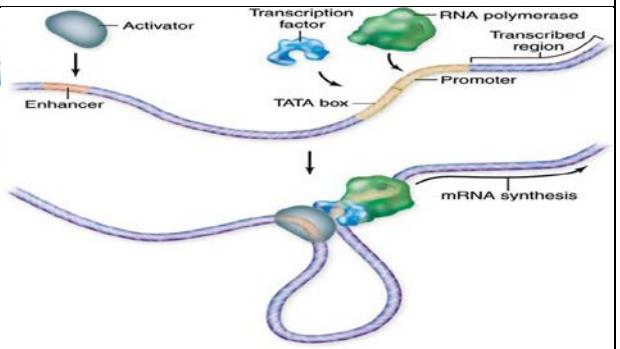
Transcription factors bind to the **DNA**.
RNA polymerase binds to the **promoter** region of DNA.
RNA polymerase uses DNA as a template to make **RNA**.
*** Note: When transcription factors are NOT bound to the DNA, RNA will not be produced. ***

Exons: genes that will be **expressed**; they **remain** in the mRNA sequence

Introns: not needed by a cell and are **removed**







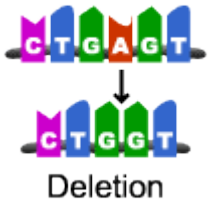
B.6.E identify and illustrate changes in DNA and evaluate the significance of these changes

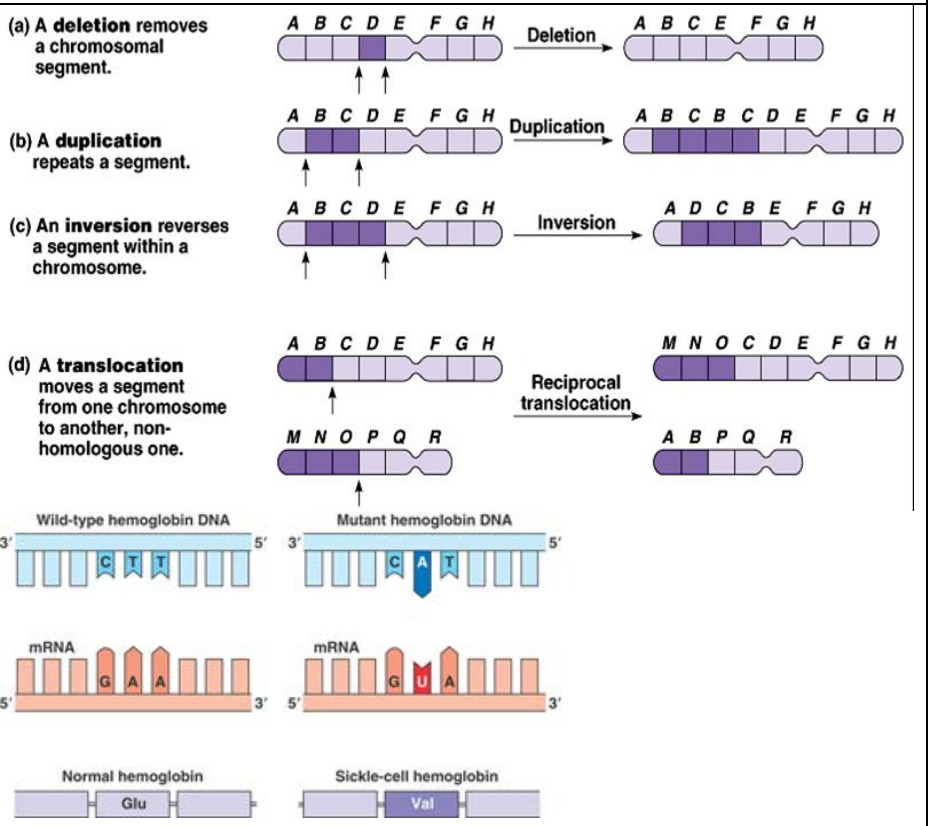
Chromosomal mutation
Deletion: chromosomal segment is removed (genetic information is permanently lost)
Duplication: chromosomal segment is repeated
Inversion: segment within a chromosome is reversed
Translocation: moves a segment from one chromosome to another
Non-disjunction: chromosome fails to separate properly during meiosis

Mutation in nucleotide sequence
Point mutation: single nucleotide is changed (a.k.a substitution)
Frameshift mutation: nucleotides are either deleted or inserted

Point Mutation

Frameshift Mutations





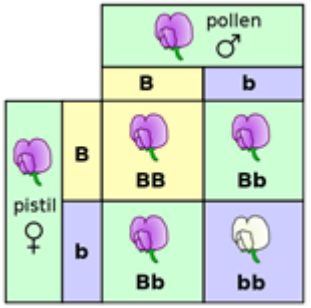
B.6.F predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance

Mendelian Genetics Definitions

Gene – section of DNA that codes for proteins
Alleles - different forms of a gene; either dominant or recessive
Chromosome - structure made up of DNA and proteins
Genotype - genetic makeup of an organism (ex. AA, Aa, aa)
Phenotype - visible expression of genetic makeup; physical traits (ex. blue eyes)
Homologous chromosomes – pair of chromosomes that contain genes for the same traits; one from mom and one from dad
Homozygous - possesses identical alleles for a given gene on homologous chromosomes (ex. AA or aa); also known as true-breeding
Heterozygote - possesses different alleles for a given gene on homologous chromosomes (ex. Aa); also known as hybrids
Sex chromosomes - determine the sex of an individual; in humans, X and Y chromosomes; XY for males, XX for females
Autosome - chromosome that is not a sex chromosome
P generation- individuals for initial cross
F1 generation - offspring from initial cross
F2 generation - offspring that results from cross of F1 individuals
Dominant allele - masks recessive allele; expressed in homozygous dominant and heterozygous conditions; represented by capital letters (i.e. A, B, H, L)
Recessive allele - not expressed in heterozygous condition; expressed only when individual is homozygous for the allele; represented by lowercase letters (i.e. a, b, h)
Monohybrid cross – only one trait is involved (ex. Bb x Bb)
Dihybrid cross – two or more traits are involved (ex. BbSs x BbSs)

Non-Mendelian Genetics

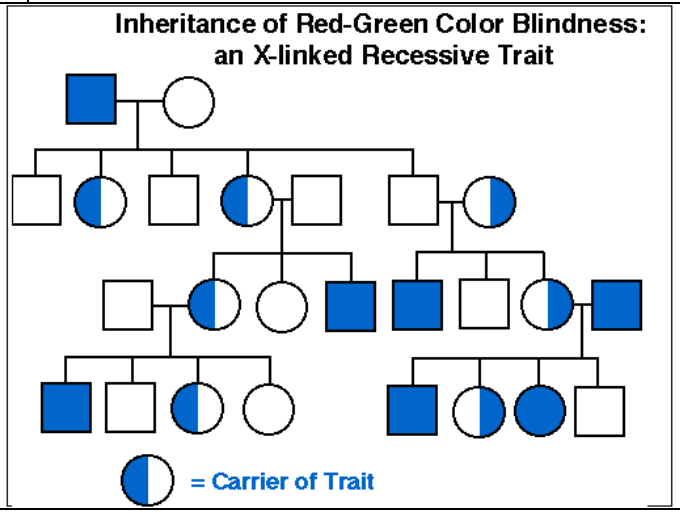
Incomplete dominance - no allele completely dominates another; results in a phenotype intermediate to that of parents
Ex. A red flower (RR) crossed with a white flower (WW) produces pink flowers (RW).
Codominance - both alleles are expressed
Ex. A red cow (RR) crossed with a white cow (WW) produces a white AND white cow (RW).
Ex. A person with Type AB blood has a genotype of IAIB.
Multiple alleles – more than two alleles exist for a trait
Ex. Human blood types have three possible alleles (IA, IB, and i).



Guinea pig male \ Guinea pig female	Gametes	BS	Bs	bS	bs
	BS	BBSS	BBSs	BbSS	BbSs
	Bs	BBSs	BBss	BbSs	Bbss
	bS	BbSS	BbSs	bbSS	bbSs
	bs	BbSs	Bbss	bbSs	bbss

Pedigree

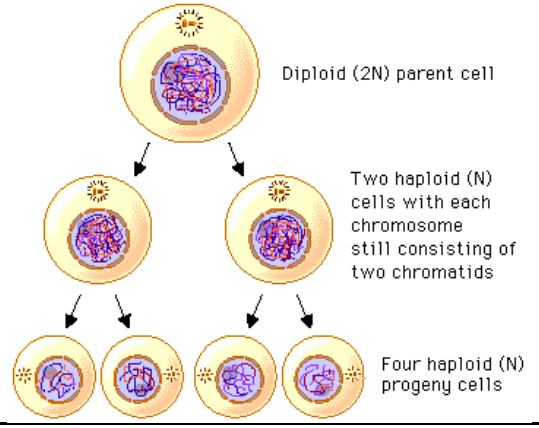
Square = male
Circle = female
Shaded = affected
Non-shaded = normal
Half-shaded = carrier
Possible genotypes for x-linked recessive diseases (example: colorblindness)
Males
X^EY: normal
X^eY: colorblind
Females
X^EX^E: normal
X^EX^e: carrier (normal phenotype, but can pass recessive allele to offspring)
X^eX^e: colorblind



B.6.G recognize the significance of meiosis to sexual reproduction

Meiosis

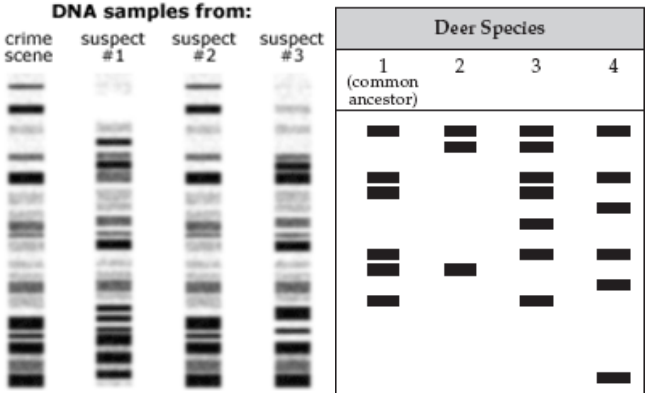
- Creates four genetically unique daughter cells due to crossing over (exchange of DNA between homologous chromosomes)
- Reduction in chromosome number from diploid to haploid
  - Diploid: two sets of chromosomes (one from mom, one from dad)
  - Haploid: one set of chromosomes
- Results in sex cells or gametes



B.6.H describe how techniques such as DNA fingerprinting, genetic modifications, and chromosomal analysis are used to study the genomes of organisms

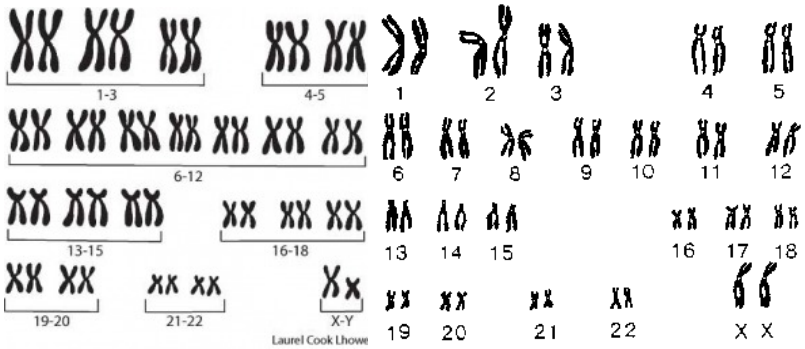
Gel electrophoresis

- DNA is cut into smaller pieces using restriction enzymes
- An electrical current is applied
- DNA is separated by size. Shorter fragments move farther down the gel than longer fragments.

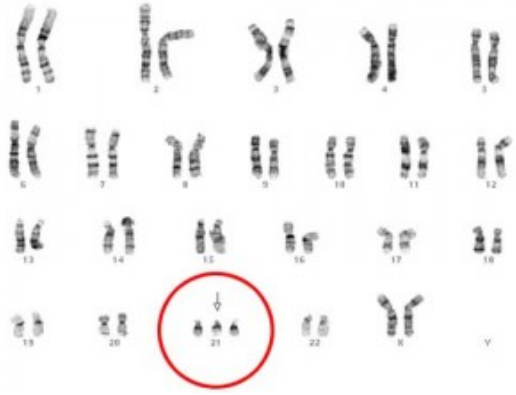


Suspect #2 matches the crime scene sample.
Deer species #3 is most closely related to deer species #1 because they have five DNA bands in common.

Karyotype

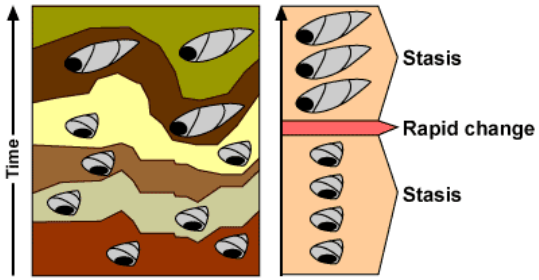


Normal male **Normal female**



Down's Syndome Female (extra #21 chromosome)

B.7.A analyze and evaluate how evidence of common ancestry among groups is provided by the fossil record, biogeography, and homologies, including anatomical, molecular, and developmental



Fossil Record

Bottom layers contain the oldest fossils
Upper layers contain the youngest fossils

Biogeography = study of distribution of species in space and time

Isolation of populations may lead to speciation

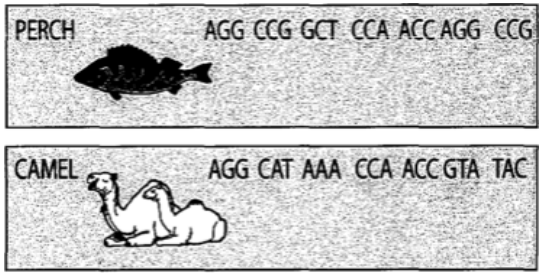
For example, all ratites (flightless birds) shared a common ancestor on the supercontinent of Pangea. When Pangea separated, populations became isolated and gave rise to different species (i.e. ostrich, emu, kiwi).

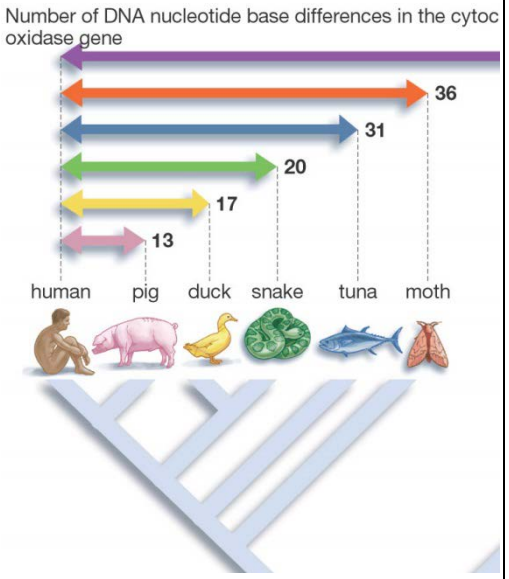
Homologies = similarity of the structure, physiology, or development of different species based upon their descent from a common ancestor

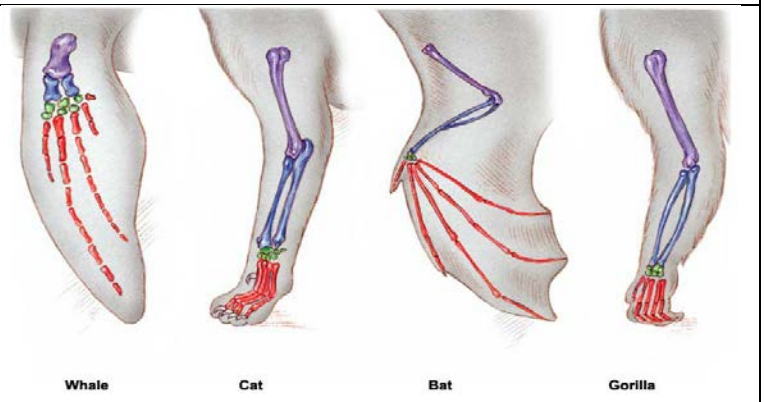
Anatomical: similar bone structure

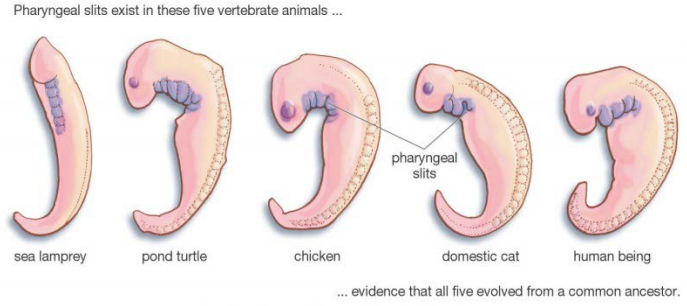
Molecular: DNA and protein sequences

Developmental: embryology

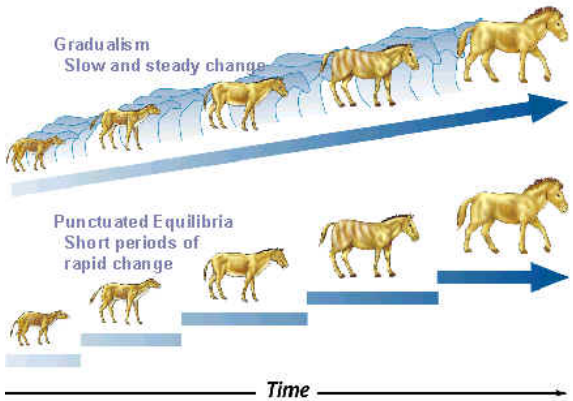








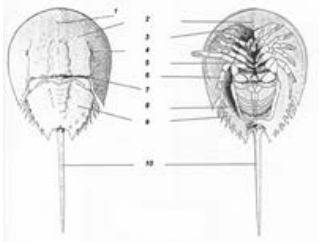
B.7.B analyze and evaluate scientific explanations concerning any data of sudden appearance, stasis, and sequential nature of groups in the fossil record

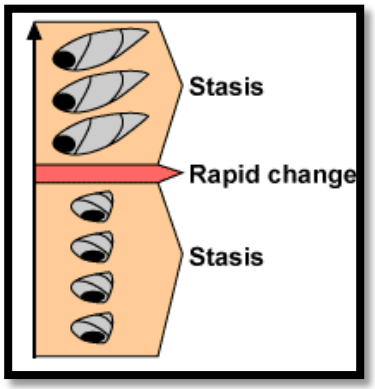


Stasis

Populations remain unchanged for long periods of time

Examples: *Ginkgo biloba* and Horseshoe crab

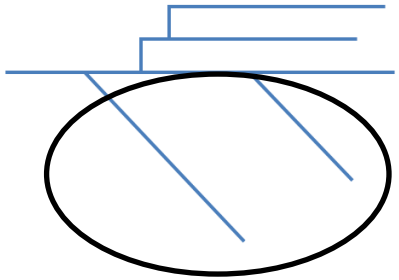


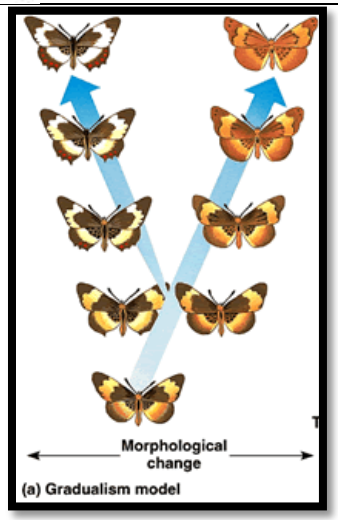


Gradualism

Slow and steady change over time

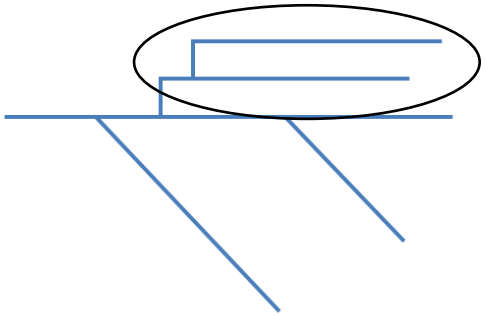
Transitional fossils are present





Punctuated equilibrium

Populations change quickly and then stay the same.



B.7.C analyze and evaluate how natural selection produces change in populations, not individuals

Lamarckian Evolution

Larmack believed that individuals could change to develop adaptations for the environment.

For example, short-necked giraffes would grow longer necks within their lifetime to reach tall leaves.

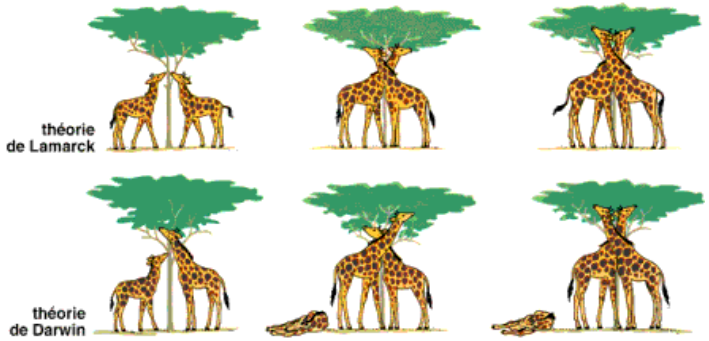
Rejected in scientific community

Darwinian Evolution

The organisms that are best adapted for an environment survive and reproduce, passing on successful traits to the next generation.

For example, short-necked giraffes died because they could not reach food. Genes coding for short-necked giraffes became reduced in the giraffe population. Long-necked giraffes survived and passed on their genes to the next generation.

Accepted in scientific community



B.7.D analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success

Steps of natural selection:

1. **There is genetic variation in traits.**

For example, some beetles are green and some are brown. These differences on based on DNA.

2. **There is differential reproduction**.

Since the environment can't support unlimited population growth, not all individuals get to reproduce to their full potential. In this example, green beetles tend to get eaten by birds and survive to reproduce less often than brown beetles do.

3. **There is heredity.**

The surviving brown beetles have brown baby beetles because this trait has a genetic basis.

End result:

The more advantageous trait, brown coloration, which allows the beetle to have more offspring, becomes more common in the population. If this process continues, eventually, all individuals in the population will be brown.

B.7.E analyze and evaluate the relationship of natural selection to adaptation and to the development of diversity in and among species

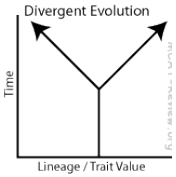
Speciation – formation of new species; results when there is a limit of gene flow between populations where it previously existed

Reproductive barriers include

Geographic isolation (populations are physically separated)

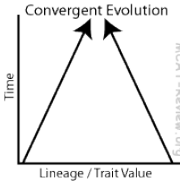
Temporal isolation (populations are breeding at different times of the day or year)

Behavioral isolation (populations use different mating calls or rituals)



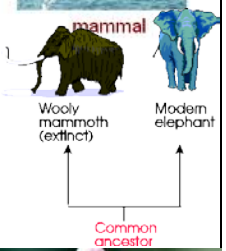
Convergent evolution – the evolution of similar adaptations because of similar habitats

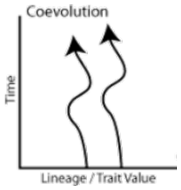
For example, sharks and dolphins have similar tail and fin structure. However, they are not closely related. They look similar because they live in similar habitats.



Divergent evolution - the process of two or more related species becoming more and more dissimilar

For example, the kit fox and red fox once had a common ancestor. The red fox lives in mixed farmlands and forests, while the kit fox lives on the plains and in the deserts. This geographic isolation resulted in the development of different adaptations and the divergence into two species.





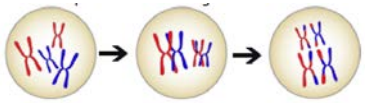
Coevolution – the concurrent evolution of two species completely dependent on each other

For example, if a plant is pollinated by one type of insect. If the insect population evolves, the plant population must evolve to maintain its existence.

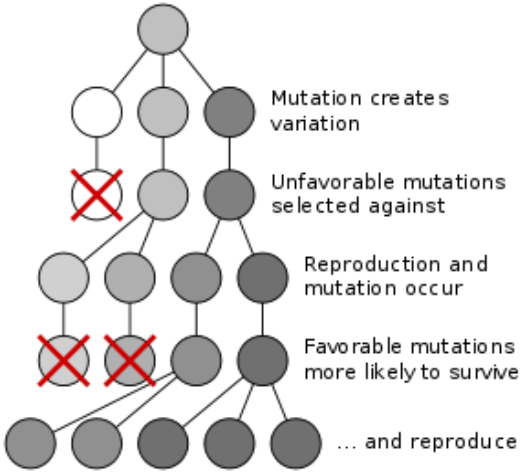
Adaptation – an inherited characteristic that allows for an organism's increased chance of survival

B.7.F analyze and evaluate the effects of other evolutionary mechanisms, including genetic drift, gene flow, mutation, and recombination

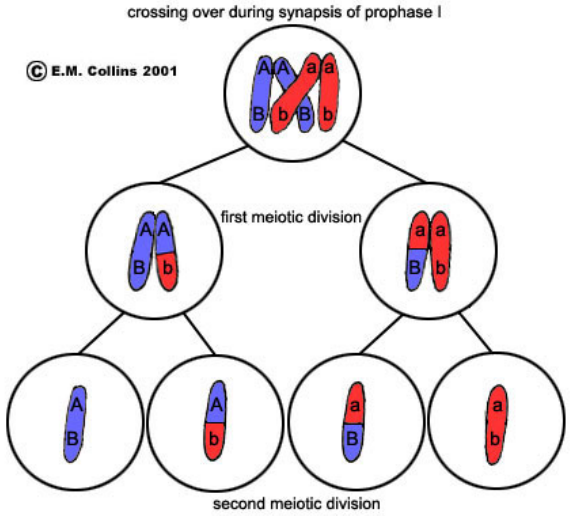
Genetic drift – random changes in allele frequencies
Gene flow – individuals can migrate into new populations and interbreed, which incorporates their genes into the new population
Mutation – change in DNA creates genetic variation within a population; may lead to a favorable adaptation
Recombination (gene shuffling) – creates genetic variation within a population



Mutation

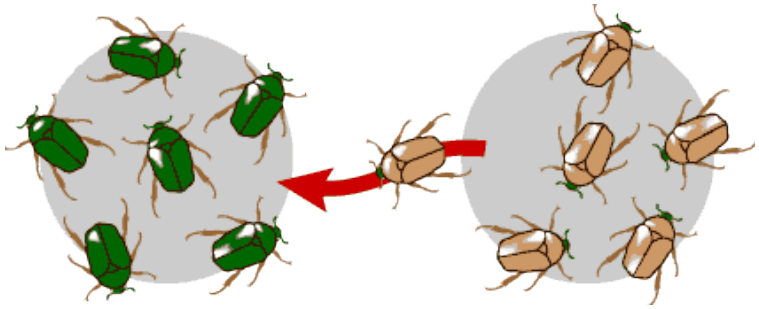


Recombination



Genetic Drift

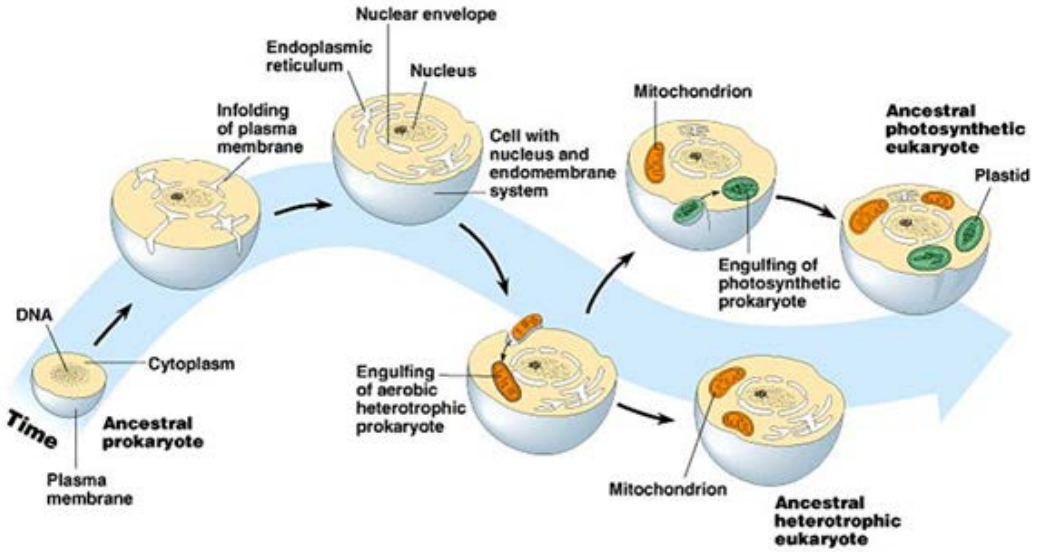
Gene Flow



B.7.G analyze and evaluate scientific explanations concerning the complexity of the cell

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!



B.8.A define taxonomy and recognize the importance of a standardized taxonomic system to the scientific community

Taxonomy is the classification of organisms in a hierarchical system.
Organisms are assigned a scientific name using binomial nomenclature.
Scientific name = Genus + species
The genus of a scientific name is always capitalized. The species is lower-cased. The whole name is written in italics. Scientific names are standardized and universal. Common names vary by region and may lead to confusion. A scientific name is unique to each species. **Ex. *Homo sapiens*, *Zea mays***
There are a number of **goals to biological classification**

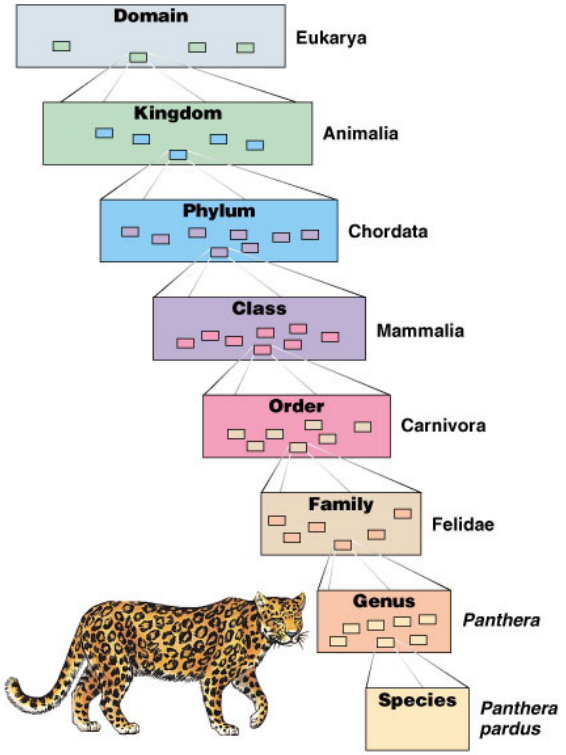
- to examine the relationships between various organisms,
- to construct evolutionary trees to explore the origins of life on Earth
- to provide consistent ways to name and categorize organisms.

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.

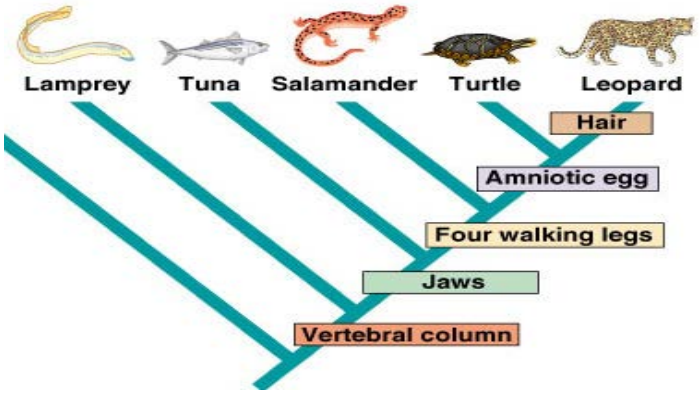
Classification of Living Things						
DOMAIN	Bacteria	Archaea	Eukarya			
KINGDOM	Eubacteria	Archaebacteria	Protista	Fungi	Plantae	Animalia

B.8.B categorize organisms using a hierarchical classification system based on similarities and differences shared among groups

Hierarchical classification
Most broad category is a domain
Most specific category is a species
You can remember the order from Kingdom to Species by using the following mnemonics: "King Philip Came Over for Great Spaghetti" or "Kids Put Candy on Father's Green Shirt."
If Species A, B, and C all belong to the same family; and species A and B belong to the same genus. Species A and B are the most closely related.



Phylogenetic Trees or Cladograms



Cladograms are primarily based on similarities between DNA and protein sequences.
Species to the far left are the most ancestral.
The closer together organisms appear on the cladogram, the more similarities they share.
Organisms possess are characteristic if they are to the right of the labeled trait. For example, the turtle has a vertebral column, jaws, four walking legs, and an amniotic egg. However, it does have hair.

Dichotomous keys help to classify organisms based on their characteristics. How to use a dichotomous key:
Always start at #1 on the dichotomous key, regardless of the organism chosen.
Read options 'a' and 'b' for #1. Determine which description matches the organism in question. Follow the directions after the matching description.
Continue until description matching the organism reveals the name of organism.

What tree is this?
1a. leaves broad.....go to 2
1b. leaves needle-like.....go to 3
2a. margin smooth.....persimmon
2b. margin toothed.....elm
3a. cone woody and elongated...pine
3b. cone soft and round.....ceda

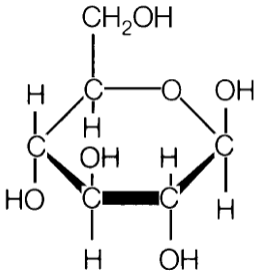
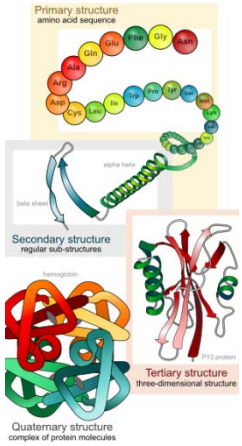
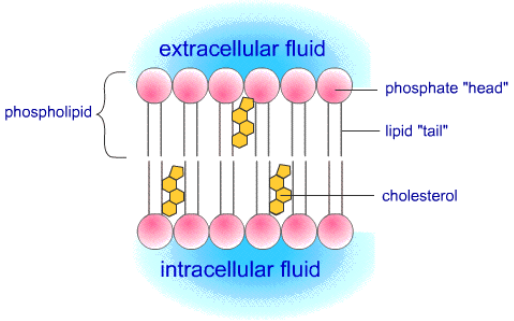
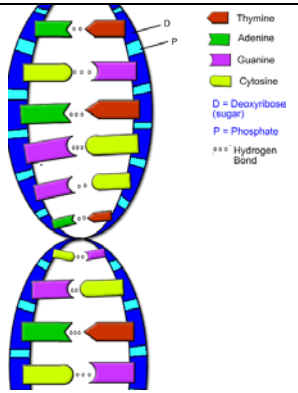
B.8.C compare characteristics of taxonomic groups, including archaea, bacteria, protists, fungi, plants, and animals

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

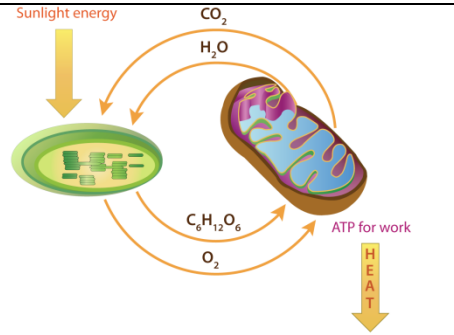
Autotroph – capable of producing its own food
Heterotroph – NOT capable of producing its own food; must obtain food from another source

B.9.A compare the structures and functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids

	Carbohydrates	Proteins	Lipids	Nucleic Acids
Atoms	Carbon, hydrogen, oxygen	C, H, O, nitrogen, sometimes sulfur	C, H, O	C, H, O, nitrogen, phosphorous
Mono-mer	Monosaccharide	Amino acid	No monomer	Nucleotide
Function	Short-term energy storage; structural support; component of cell walls	Transport molecules, act as enzymes (speed up rate of chemical reactions)	Long-term energy storage; main component of cell membrane	Store genetic information; act as instructions to make proteins
Example	Sugars, glucose, sucrose, cellulose, deoxyribose, ribose	Hemoglobin	Phospholipids, oils, fats	DNA, RNA
Picture/Diagram				

B.9.B compare the reactants and products of photosynthesis and cellular respiration in terms of energy and matter and **B.4.B**

COMPARISON BETWEEN PHOTOSYNTHESIS & RESPIRATION	PHOTOSYNTHESIS	RESPIRATION
EQUATION	$8CO_2 + 8H_2O \rightarrow C_6H_{12}O_6 + 8O_2$	$C_6H_{12}O_6 + 8O_2 \rightarrow 8CO_2 + 8H_2O$
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

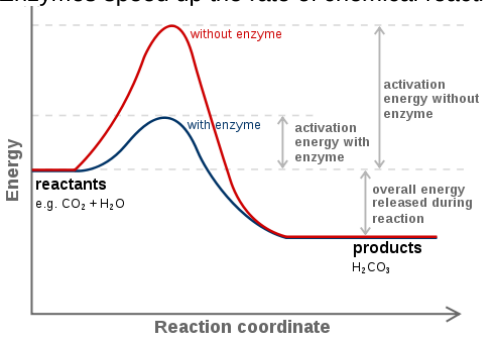
- It takes place in a chloroplast.
- Carbon dioxide and water react, using light energy, to produce glucose and oxygen.
- Light energy from the sun changes to chemical energy in glucose.

Cellular respiration

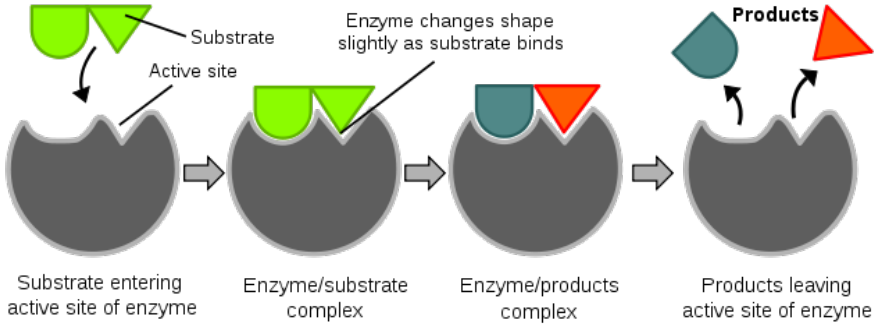
- It takes place in a mitochondrion.
- Glucose and oxygen react to produce carbon dioxide, water, and energy (ATP).
- Chemical energy in glucose changes to chemical energy in ATP.

B.9.C identify and investigate the role of enzymes

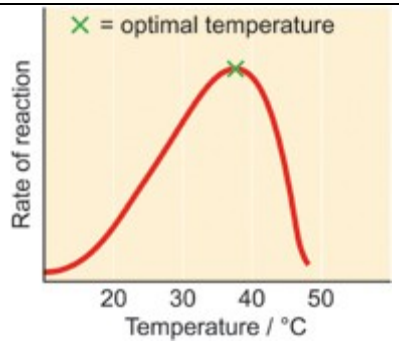
Enzymes speed up the rate of chemical reactions.

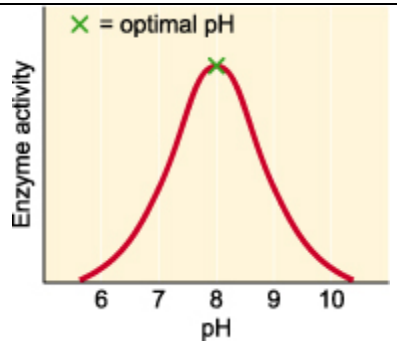


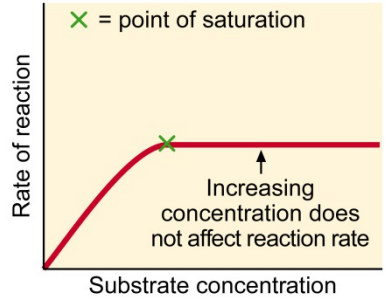
Enzymes are proteins that react with substrates to create products.



Enzymes are affected by temperature, pH, and substrate concentration on enzymes.







B.9.D analyze and evaluate the evidence regarding formation of simple organic molecules and their organization into long complex molecules having information such as the DNA molecule for self-replicating life

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

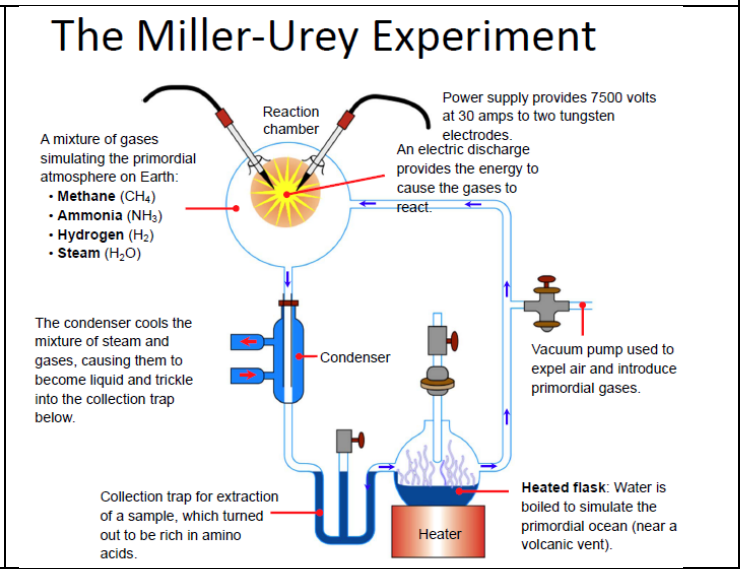
In the 1950s, **Stanley Miller and Harold Urey** designed experiments to recreate the conditions of primitive Earth.

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)



B.10.A describe the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals

An animal's organ systems interact to perform many functions.

Regulation	The endocrine system makes certain hormones. Blood in the circulatory system carries them to the skeletal system to control the amount of calcium released from bones.
Nutrient Absorption	Food is broken down in the stomach mechanically by the muscular system (churns food) and chemically by water, acid, and enzymes in the digestive system; nutrients are then absorbed by blood in the circulatory system
Reproduction	Certain hormones produced in the endocrine system control ovulation in a female's reproductive system
Defense	Mucus in the lungs traps a virus in the respiratory system. T-cells in the immune system destroy virus- infected cells. Nerves in the nervous system sense pain from a fire on the skin

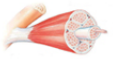
B.10.B describe the interactions that occur among systems that perform the functions of transport, reproduction, and response in plants

Function	Example of interactions
Transport	The root system uptakes water. Xylem vessels transport water to the leaves in the shoot system. Phloem vessels transport sugars and nutrients throughout the plant.
Reproduction	The reproductive organs in a flower are the pistil (female) and the stamen (male). A seed is a mature, pollinated ovule (fertilized egg). Hormones in a plant's root system help trigger the growth of a seed in the shoot system.
Response	When one side of a plant does not receive enough light, a hormone that causes growth is produced in the shoot system's leaves. It is transported to the darker side. As the dark side grows, the plant bends toward the light.

Response
Phototropism: plant movement in response to light
Gravitropism: plant movement in response to gravity
Thigmotropism: plant movement in response to touch

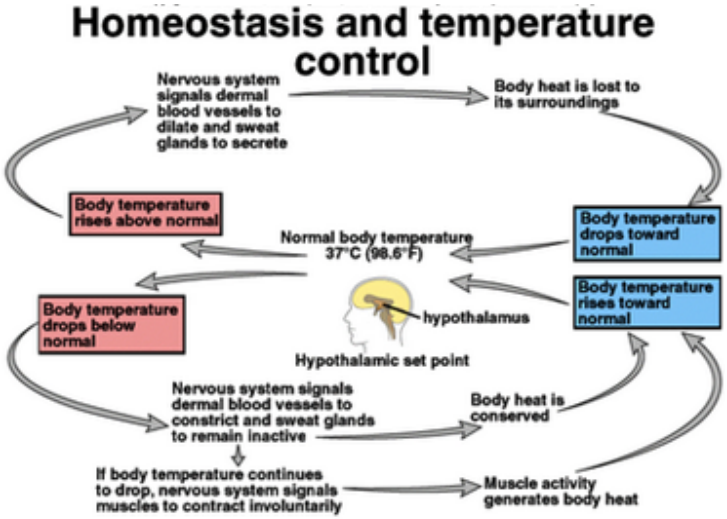


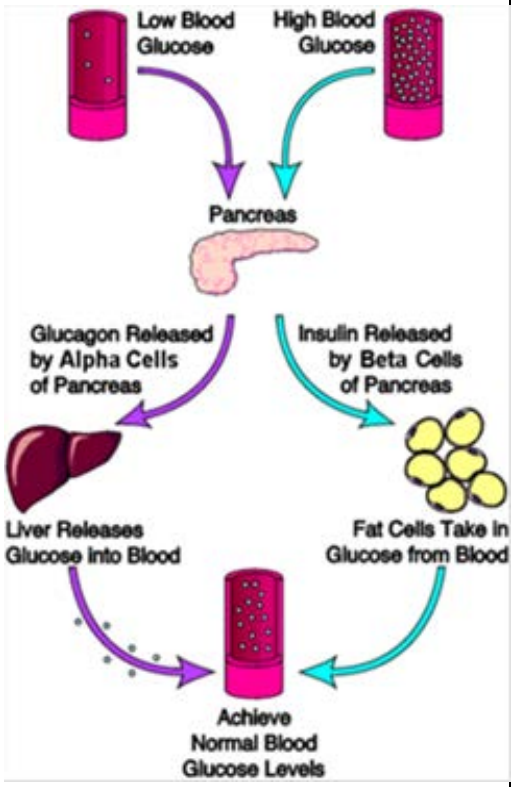
B.10.C analyze the levels of organization in biological systems and relate the levels to each other and to the whole system

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

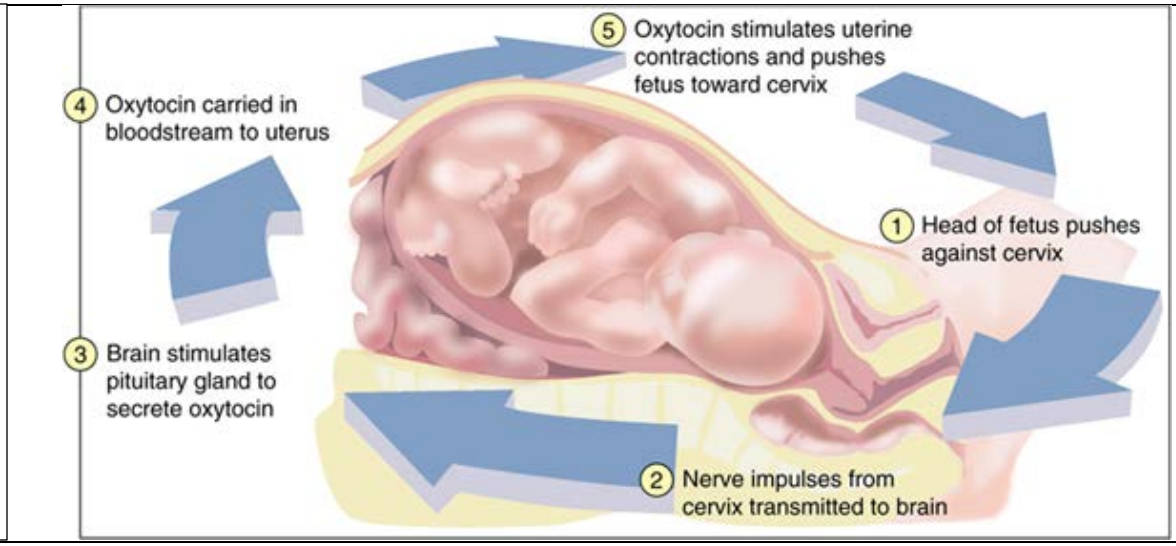
B.11.A describe the role of internal feedback mechanisms in the maintenance of homeostasis

In **negative feedback** the body responds to an extreme condition by reversing the current direction of change.
Example: Maintaining stable blood glucose levels
Low blood sugar… pancreas releases glucagon… liver releases glucose into blood… normal blood sugar obtained
High blood sugar… pancreas releases insulin… fat cells take glucose from blood… normal blood sugar obtained
Example: Maintaining stable body temperature
High body temperature… blood vessels dilate and sweat glands secrete sweat… body temperature returns to normal
Low body temperature… blood vessels constrict and muscles contract… body temperature returns to normal

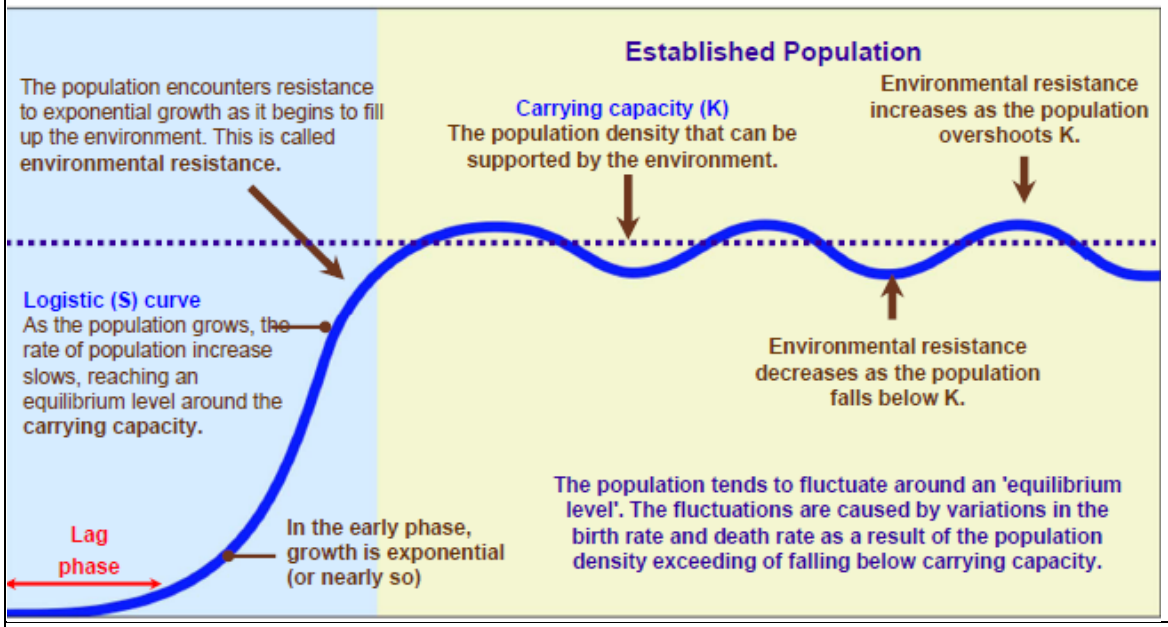




In **positive feedback** the body responds to an extreme condition by promoting the current direction of change.
Example: Giving birth
Oxytocin is continuously secreted to stimulate uterine contractions.



B.11.B investigate and analyze how organisms, populations, and communities respond to external factors

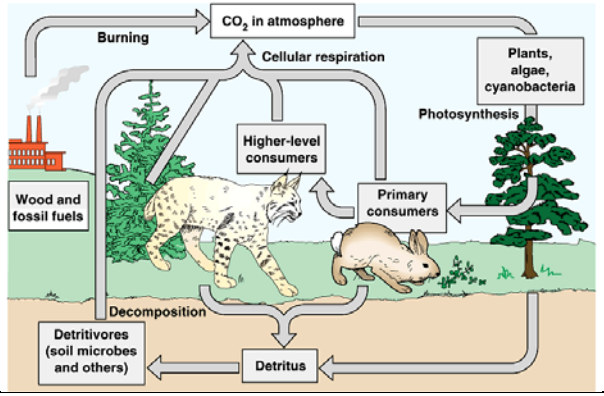


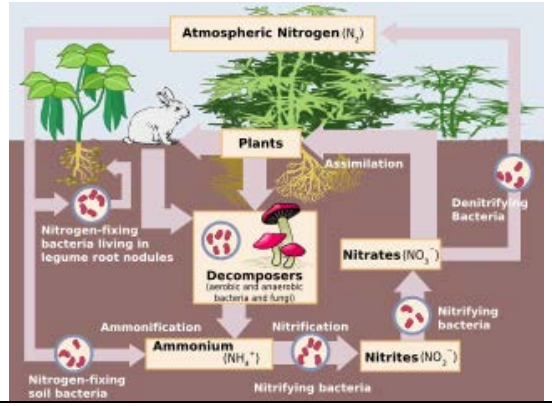
Limits to Growth
Limiting Factor: any factor that limits the size of a population
Density dependent factors exert a greater effect on population growth at higher population densities.
Examples: predation, disease, natural disasters, food shortage, competition,.
Density Independent Factors : The effect of density independent factors on a population's growth is NOT dependent on that population's density:
Examples: Physical (or abiotic) factors: temperature, precipitation, humidity, Catastrophic events

B.11.C summarize the role of microorganisms in both maintaining and disrupting the health of both organisms and ecosystems

Microorganisms:
Tiny organisms (like bacteria or protists) that can only be seen in a microscope. They play a critical role in the maintenance and disruption of the health of both individual organisms and entire ecosystems.
Example: The bacteria E. coli is critical for the digestive process in many warm- blooded organisms. Outside of the intestines, E. coli can sicken or kill certain organisms

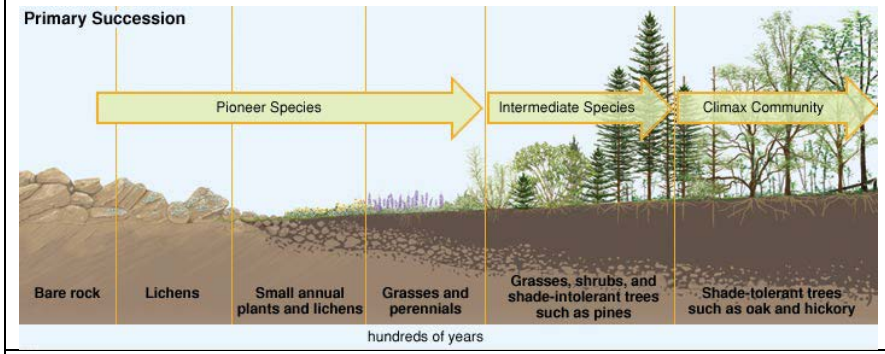
Beneficial Roles of Bacteria	Harmful Roles of Bacteria
Decompose organic material	Spoil food
Change nitrogen from one form to another in the nitrogen cycle	Produce harmful or damaging toxins
Have role in making drugs(like penicillin), foods(like yogurt and cheese), and vitamins	Cause of shortage of oxygen in lakes where blooms occur
Help absorb nutrients in the human digestive system	Cause diseases

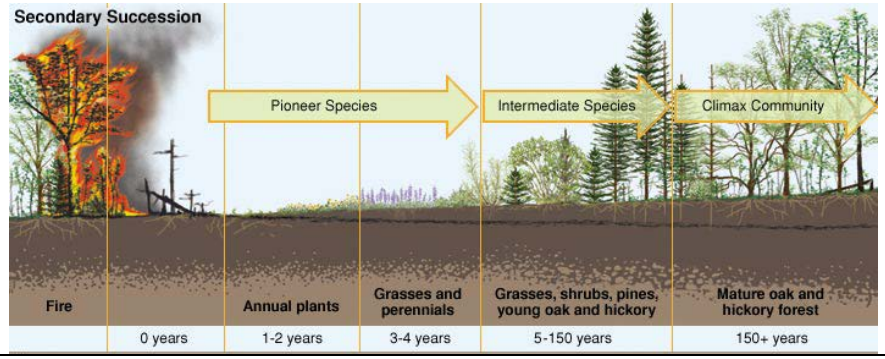




B.11.D describe how events and processes that occur during ecological succession can change populations and species diversity

Ecological succession: the sequence of predictable changes in a community over time; usually follows a disturbance (i.e. wildfire, hurricane, tornado)
Primary succession: no soil exists
Secondary succession: soil remains after disturbance
Stage of succession influences the animals that will be found there. For example, woodpeckers will not be present in an ecosystem until it has trees present





B.12.A interpret relationships, including predation, parasitism, commensalism, mutualism, and competition among organisms

Symbiotic relationships
Mutualism (+/+): both organisms benefit
Ex. Hummingbird and Flower: Hummingbird gets nectar (+) and the flower get pollinated (+)
Ex. Oxpecker bird removes and eats ticks from a rhino. The oxpecker bird get food (+) and the rhino is rid of harmful ticks (+).
Commensalism (+/o): one organism benefits, the other is neither helped nor harmed
Ex. Hermit crabs live in shells made and then abandoned by snails. Hermit crabs get a place to live (+), but this relationship neither helps nor harms the snails (o).
Ex. Cattle egrets eat insects that are stirred up by cattle walking in a field. The egret gets food (+), while the cattle are neither helped nor harmed (o).
Parasitism (+/-): the parasite is benefited, while the host is harmed (NOT immediately killed)
Ex. A flea feeds on a mouse's blood. The flea gets food (+), while the mouse is harmed (-).
Ex. A tapeworm attaches to the intestinal wall of a dog. The tapeworm gets food (+), while the dog is harmed (-)..
Community interactions
Predation: predator kills and consumes prey
Ex. A lion attacking and killing a zebra.
Competition: organisms compete for the same limited resource (i.e. food, water, habitat space, mates)
Ex. A hyena and lion fighting over a zebra carcass.
Ex. Two male hippos fighting to establish mating rights in an area

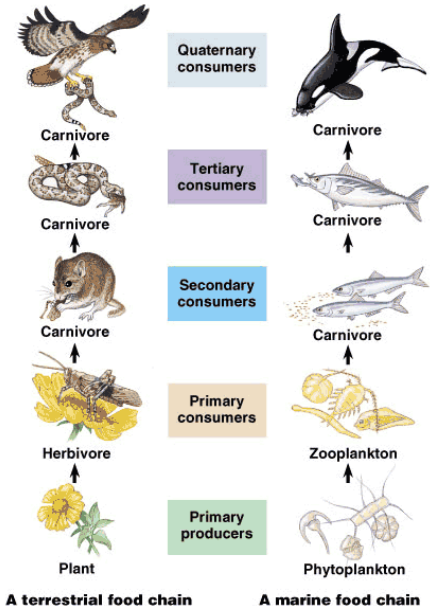
B.12.B compare variations and adaptations of organisms in different ecosystems

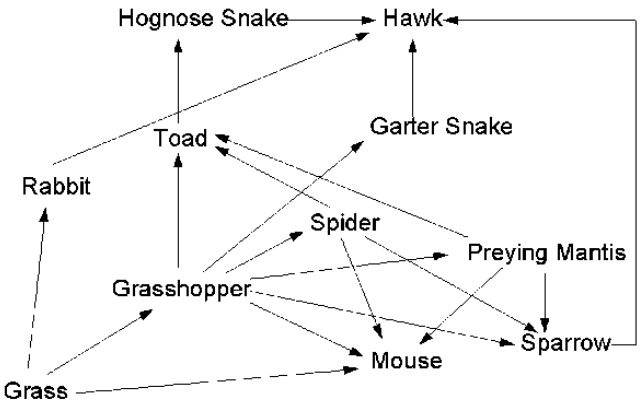
Within a population, individuals differ from one another. Many of these differences are genetically based. Environmental factors can also lead to individual differences because they influence how genes are expressed. **Genetic variation** is the difference in the genotypes within a population. Ex: Humans have different eye and hair color, skin color, shape of faces, certain health disorders, etc. Genetic variation helps species survive because if all organisms within a population were genetically identical, then all of them would be equally vulnerable to a change in the environment or disease. The entire population could die off due to a predator, a new competitor, or the arrival of a new disease which would put the species in danger.
What are adaptations? An **adaptation** is a heritable trait that helps an organism survive in its environment. It may be a physical trait such as a beak size or shape or a behavioral trait such as how to protect itself or find food.
Some adaptations are specific to certain ecosystems. Ex: some insects camouflage themselves to fit in the environment. Ex: chameleon
Some organisms in different ecosystems have similar adaptations. Ex: animals that graze grasslands such as zebras, buffalos, and llamas. They all have flat teeth for grinding grass, a long and complex digestive system to break down grass, and sturdy hooves for walking and running.
•**Deciduous forest**- This biome has a wide range of temperatures and precipitation. The organisms that adapted to survive the seasonal weather changes.
To survive the winters, these animals often do not move much and some may hibernate or sleep. Other animals migrate to other places until warm weather returns to the forest.
•**Desert-** In this biome, plants and animals have adaptations that help them conserve water. Ex: Leaves of a cacti, needles, waxy covering and shallow roots spread so it can soak up as much rain and dew before it evaporates.
Many animals are nocturnal animals and move only during the night because it is so hot in the desert. They also may have physical adaptations to keep cool. Ex: the long ears of rabbits and foxes.

B.12.C analyze the flow of matter and energy through trophic levels using various models, including food chains, food webs, and ecological pyramids

Trophic level: a single step in a food chain or food web
Producer: photosynthetic organisms (ex. grass)
Primary consumer: eats the producer (ex. grasshopper)
Secondary consumer: eats the primary consumer (ex. mouse)
Tertiary consumer: eats the secondary consumer (ex. snake)
Quaternary consumer: eats the tertiary consumer (ex. hawk)

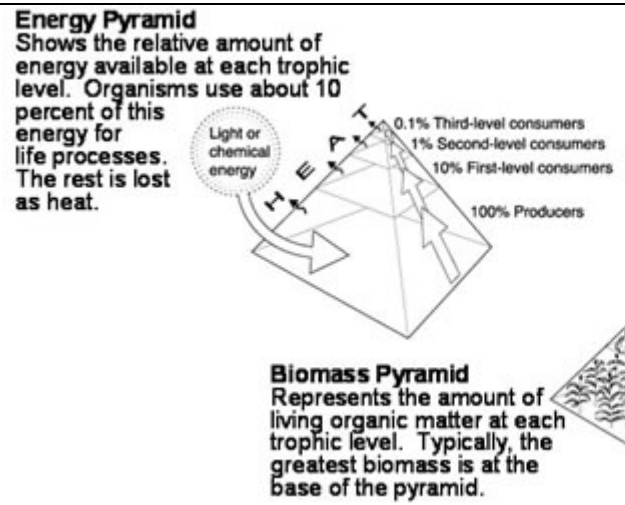
Arrows show transfer of **ENERGY**. All energy originates with the sun.

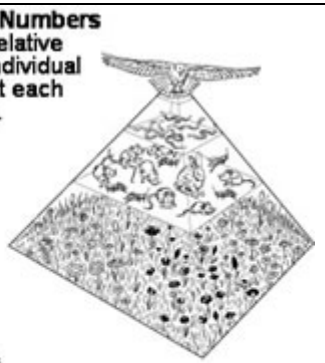




Types of consumers (heterotrophs)
Herbivore: eats plants only (ex. cow)
Carnivore: eats animals only (ex. lion)
Ominvore: eats both plants and animals (ex. bear, humans)
Decomposer: externally digest dead organic matter (ex. bacteria, fungi)
Detritivore: internally digest dead organic matter (ex. earthworm, vulture)

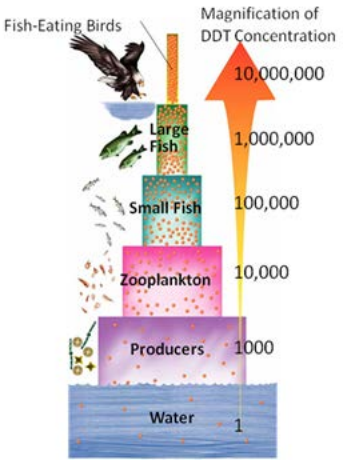
Ecological Pyramids
Energy Pyramid: Shows the relative amount of energy available at each trophic level. Organisms use about 10 percent of this energy for life processes. The rest is lost as heat.
Biomass pyramid: Represents the amount of living organic matter at each trophic level. Typically, the greatest biomass is at the base of the pyramid.
Pyramid of Numbers: Shows the relative number of individual organisms at each trophic level.





Continue: B.12.C analyze the flow of matter and energy through trophic levels using various models, including food chains, food webs, and ecological pyramids

Biomagnification = concentrations of a harmful substance increase in organisms at higher trophic levels in a food chain or food web



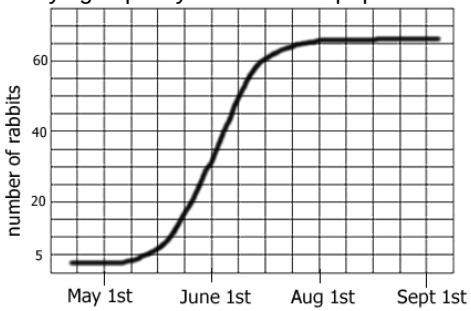
B.12.D recognize that long-term survival of species is dependent on changing resource bases that are limited

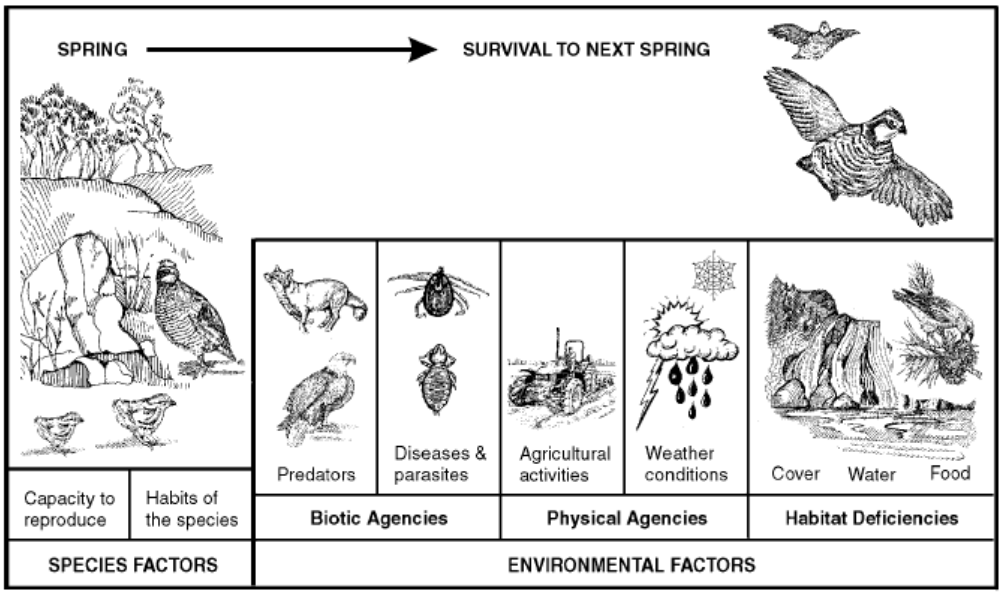
Organisms compete for limited resources, such as, food, water, habitat space, and mates.

Density-dependent limiting factors limit the population size when the population is large and dense.
Competition for resources – competition increases as the population size increases
Predation – as the prey pop increases, the predator population increases and vice versa
Disease and parasites – spread easier in large populations

Density-independent limiting factors limit all population sizes (large or small)
Extreme weather – drought, flood, freezing
Human activities – pollution, habitat destruction

Population Growth Curve
Exponential phase: population shows rapid increase in growth due to unlimited resources
Plateau phase: population has reached its carrying capacity (i.e. the maximum population that the habitat can support)
Carrying capacity for the rabbit population on the right is approximately 65 rabbits





B.12.E describe the flow of matter through the carbon and nitrogen cycles and explain the consequences of disrupting these cycles

The carbon cycle is a process that moves carbon between the atmosphere, the Earth's surface, and living things. Carbon is recycled through respiration, photosynthesis, fuel combustion, decomposition; carbon can be atmospheric or dissolved, or can be found in organic compounds within the body.

How does the carbon cycle works?

- In the atmosphere, carbon exists mostly as carbon dioxide. Carbon dioxide leaves the atmosphere when it dissolves in water or is taken up by plants for photosynthesis.
- It is released in the atmosphere during cellular respiration, geologic processes such as volcanic eruptions, and when fossil fuels or forests are burned.

What are some consequences of disruptions of the carbon cycle?

- Over the past 100 years, the levels of carbon dioxide in Earth's atmosphere have increased. Human activities such as the burning fossil fuels and forests are releasing carbon dioxide into the atmosphere at alarming rates and it is being released faster than it can be removed by natural processes.
- Increasing levels of carbon dioxide is a major contributing factor to the global climate change. Scientists say that increasing carbon dioxide which is a greenhouse gas that helps keep heat from leaving the atmosphere. The higher carbon dioxide levels are causing rising temperatures and climate change.
- The Greenhouse effect also affects the oceans. When CO_2 or carbon dioxide dissolves in water, carbonic acid forms which causes the water to become more acidic (acidification). This negatively affects marine organisms that have a low tolerance for changing pH levels

Nitrogen Cycle – producers take in nitrogen compounds in soil and pass to consumers that consume the producers; decomposers (bacteria) break down nitrogen compounds and release nitrogen gas to air or usable nitrogen so the soil. The nitrogen cycle involves the exchange of nitrogen between living things and their environment.

- Nitrogen gas is removed from the atmosphere by a process called **nitrogen fixation**.

Nitrogen fixation is the process by which bacteria change nitrogen gas into a form that plants can use.

- Certain **bacteria** in the soil and water are able to fix nitrogen. Some of these bacteria live in the roots of certain plants. Lightning also fixes nitrogen.

What are some consequences of disruptions to the nitrogen cycle?

One problem

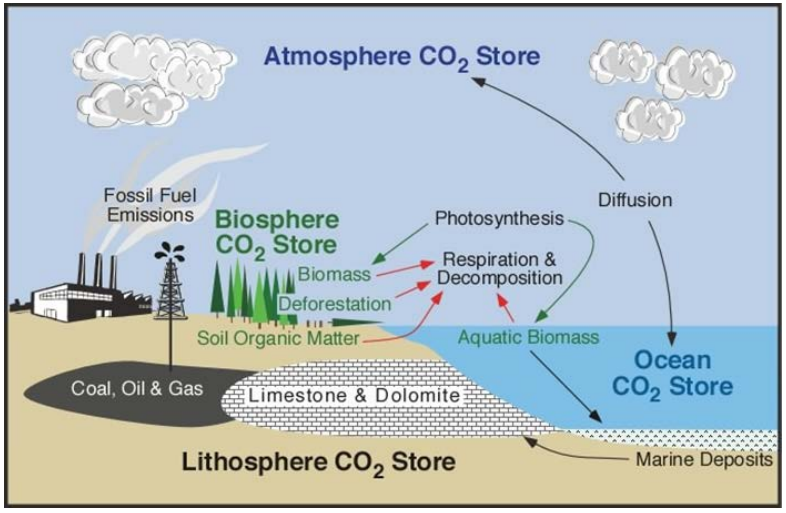
To increase plant growth, farmers and gardeners mix nitrogen containing fertilizer into the soil. The fertilizer runoff can affect the balance of nitrogen in bodies of water. In a process called eutrophication, nitrogen dissolves in the body of water and stimulates the growth of plants and algae.

When plants and algae die, the bacterial populations that feed on dead matter boom. These bacteria consume so much oxygen from water that fish and other aquatic animals cannot survive.

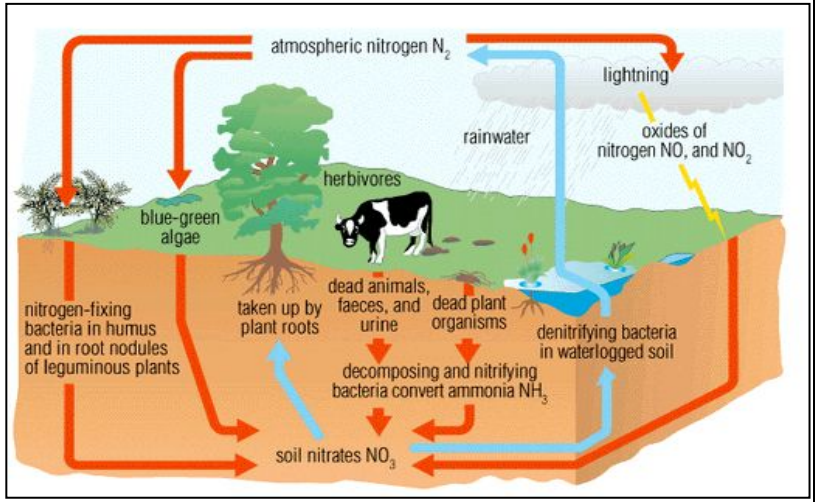
Another problem

Acid precipitation can also disrupt the nitrogen cycle. Acid precipitation can lead to the death of plants and animals by altering the pH levels of soil and water. It can also cause harmful metals from pipes to enter drinking water.

Carbon Cycle

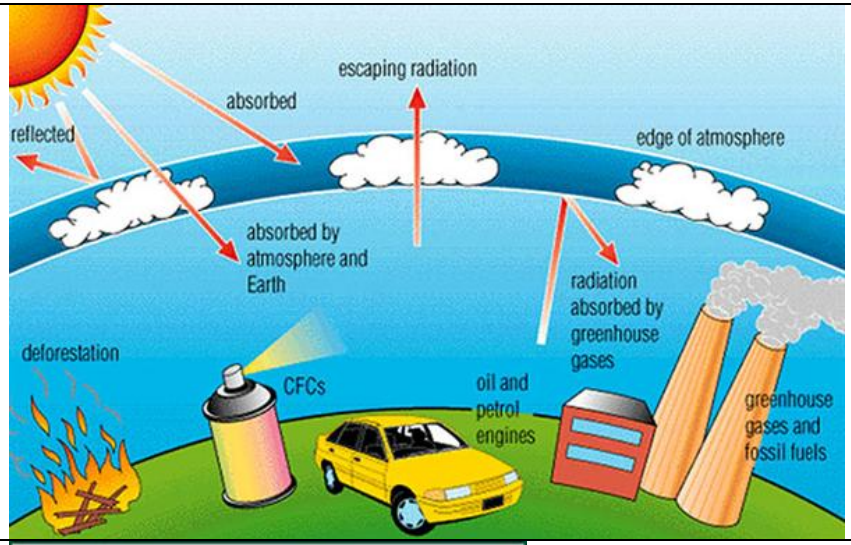


Nitrogen Cycle:

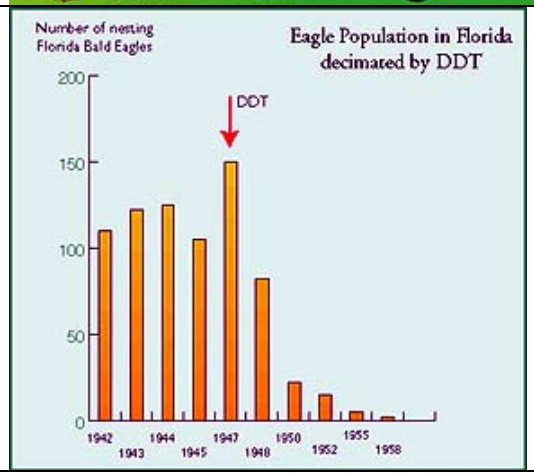


B.12.F describe how environmental change can impact ecosystem stability.

Greenhouse effect
Increased levels of carbon dioxide and greenhouse gases traps radiation from the sun. This results in increased temperatures worldwide, known as global warming.



Pollution
Bald eagles were once endangered because of the dangerous pesticide DDT. DDT would become concentrated in the eagles because of their high level in the food chain. Females would lay eggs with extremely thin shells, which led to the failed development of the chicks.
The graph shows the decline of the eagle population in Florida after the introduction of DDT.



Acid precipitation
Acid rain accumulates in stream, rivers and lakes. Many organisms can only survive in a specific pH range. When their habitat becomes too acidic they will die.