

MCAS Biology Review!

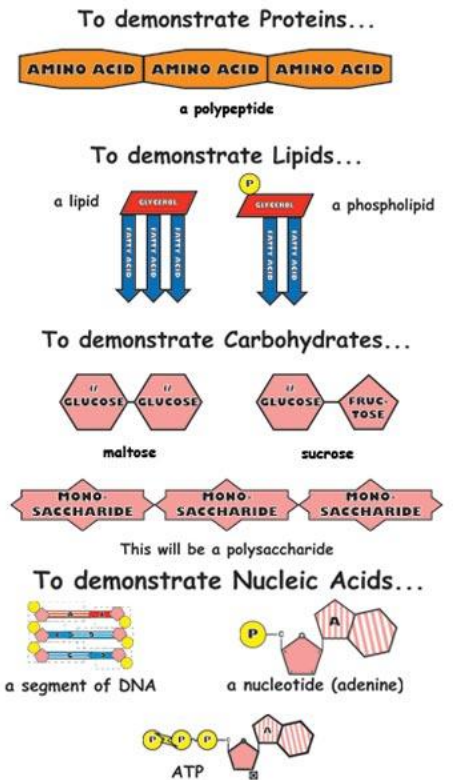
Cells and Their Processes

Compounds

- A **compound** is a combination of 2 or more **atoms**
- An **organic** compound is a compound that contains **carbon** atoms that have combined with each other
- An **inorganic** compound is a compound with **no** combination of **carbon** atoms

The **Four** Types of Organic Compounds (The Macromolecules of Life)

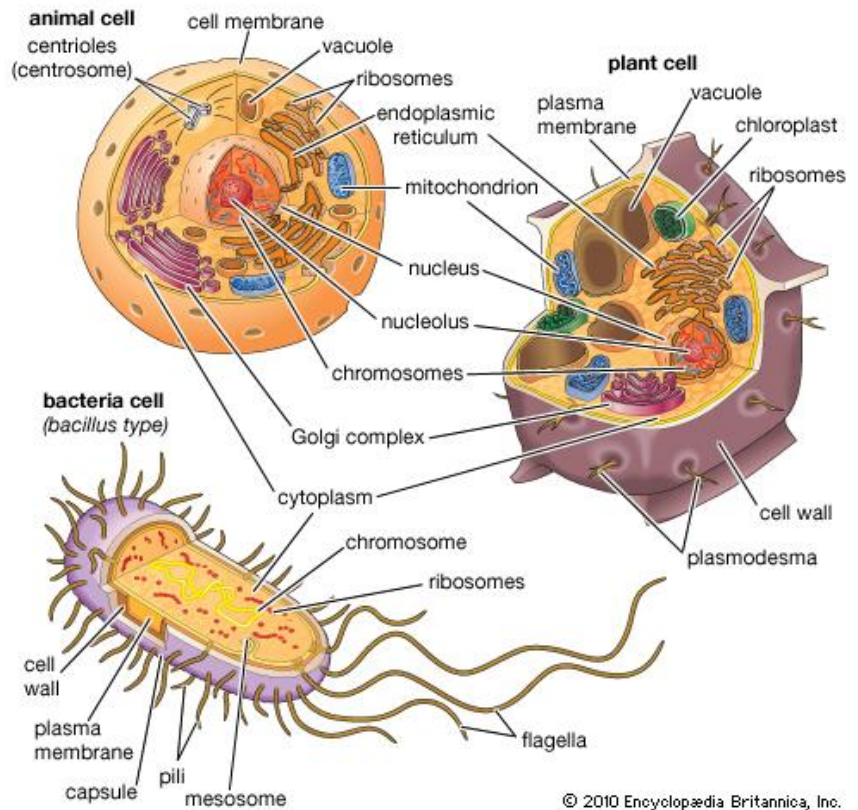
- **Carbohydrates:** Sugars used for **short term energy**
- **Lipids:** Fats and oils used for **long term energy**
- **Proteins:** Made up of **amino acids**; used for construction materials and chemical reactions in the body
 - **Enzymes:** Special types of proteins that speed up chemical reactions in the body but are not changed by the reactions. Enzyme **names** end in – **ase!**
 - **Warmer** temperatures **SPEED UP** enzymes, **cooler** temperatures **SLOW** them down.
 - **TOO HOT** can kill an enzyme and **slow** it down!
- **Nucleic acids:** DNA and RNA; contains genetic information



Cells

- A cell is the smallest unit that is alive and can carry on all the processes of life
- Cells make up organisms (living things)
 - **Unicellular** organisms are made up of **1 cell**
 - **Multicellular** organisms are made up of **many cells**
- Cells contain **organelles**, which are specialized compartments that carry out a specific function
- Types of cells
 - **Eukaryotic** cells **contain a nucleus**, such as animal and plant cells
 - **Prokaryotic** cells **contain no nucleus**, such as bacteria

Some typical cells



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Animal Cells – Eukaryotic - HAVE A NUCLEUS!

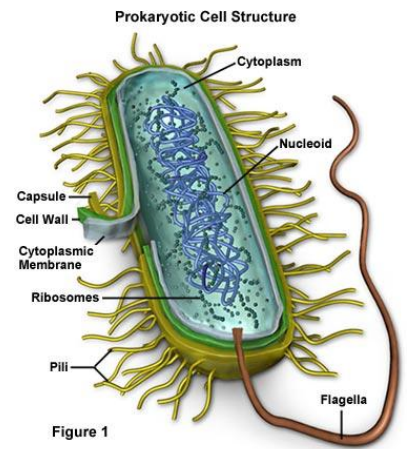
- Usually round ○
- **Organelles** (cell parts) include
 - **nucleus:** controls cell activities
 - **cell membrane:** controls what enters and leaves the cell and also protects the cell
 - **endoplasmic reticulum (ER):** streets for compounds to move through the cell
 - **Golgi body:** packages protein
 - **Ribosomes:** make proteins
 - **Mitochondria:** Makes energy for the cell
 - **Lysosome:** Has enzymes that digest waste and old organelles
 - **Cytoplasm:** Fills the empty space of the cell
 - **Vacuole:** Stores food, water, and waste
 - **Centrioles:** Help in cell division and is only found in animal, not plant, cells

Plant Cells – Eukaryotic – HAVE A NUCLEUS!

- Usually square/rectangle
- Organelles include
 - Everything that an animal cell has plus more!
 - **Chloroplast:** Traps sunlight to make food for the plant
 - **Cell wall:** Protects the cell

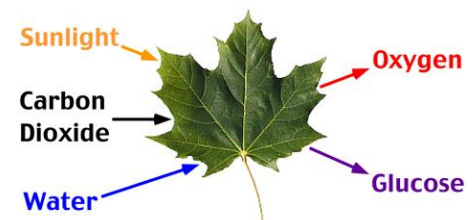
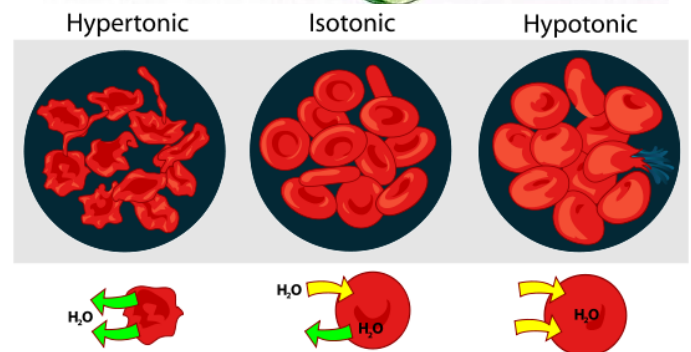
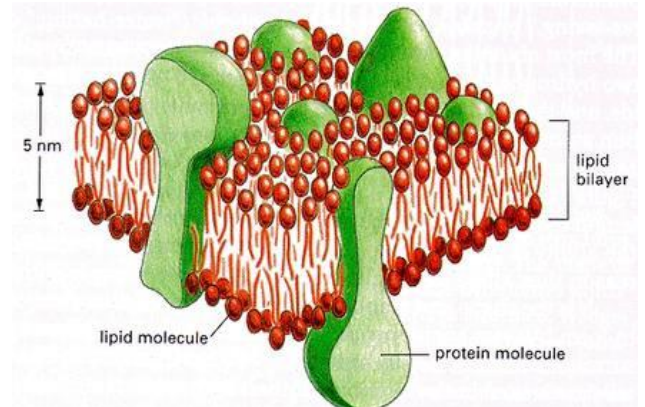
Bacterial cells – Prokaryotic – NO NUCLEUS!

- Smaller and simpler than plant or animal cells
- Bacteria are **unicellular**
- No nucleus - **PROKARYOTIC**
- Have a single closed loop of DNA, cell wall, cell membrane, cytoplasm and ribosomes
- Some have a **capsule** (shell for protection), **pili** (short hair like structures to hold onto host cells), and **flagella** (whip like structure for movement)



Cell membrane – Lipid Bilayer

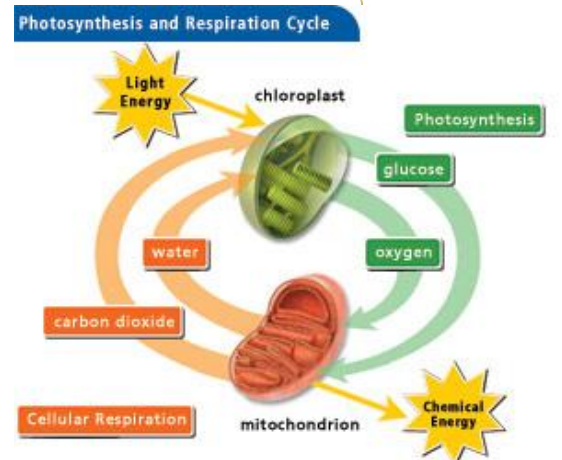
- Made up of molecules called **phospholipids**
- Phospholipid bilayer is the 2 layers of phospholipids that make up the cell membrane
- Cell membrane is fluid, which means that it is constantly flowing and moving over the cell
- Cell membrane is selectively permeable, which means that it allows small compounds, but not large ones, to pass right through
- There are different ways that materials are **transported across the cell membrane**
 - **Passive transport:** requires **no energy**
 - **Diffusion:** compounds move from *high to low concentration*
 - **Osmosis:** diffusion of *water*
 - **Active transport:** **needs energy**, compounds move from *low to high concentration*
 - **Endocytosis:** large compound are brought into the cell
 - **Exocytosis:** large compounds are exported out of the cell
- Types of solutions
 - **Hypotonic** solutions cause water to move **into the cell** so the cell swells up
 - **Hypertonic** solutions cause water to **move out of the cell** so the cell shrivels up
 - **Isotonic** solutions cause **no movement** of water into or out of the cell



Photosynthesis

- Process by which organisms use **energy from sunlight to make their own food (glucose - sugar)**
- **Glucose is a simple sugar**
- Photosynthesis occurs in the **chloroplasts** of **plant cells** and some bacteria
- Chloroplasts have a **green pigment (color) called chlorophyll**
- Light energy is completely changed into chemical energy (glucose)
- Chemical **equation** for photosynthesis

$$6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$$



Cellular Respiration

- Process that breaks down glucose to make energy for an organism
- **ATP**: compound that **stores energy** in an organism
- Occurs in the **mitochondria** of the cell
- **Two types** of cellular respiration
 - **Aerobic respiration**: needs oxygen to occur
 - Mostly happens in animals and plants
 - Chemical equation for respiration
 $C_6H_{12}O_6 + O_2 \rightarrow 6CO_2 + 6H_2O + ATP \text{ energy}$
 - Aerobic respiration is the **opposite of photosynthesis**
 - **Anaerobic respiration**: does not require oxygen to occur
 - Mostly happens in bacteria and yeast
 - Also called **fermentation**, makes **less ATP** than aerobic respiration

Chromosomes

- DNA strands in the nucleus that contain the directions on how to make and keep an organism alive
- Made up of genes, which are traits of an organism
- Cells will die if their DNA is damaged or removed
- Humans have mostly **diploid** cells, which means that we have **2 of each type of chromosome**
 - **Homologous chromosomes** are 2 of the **same type of chromosome**
 - We have two sets of chromosomes... **23 chromosomes from mom + 23 chromosomes from dad**
 - 46 chromosomes total!
- Human **gametes (sperm and egg cells)** are **haploid** cells, which means that they have only one set of chromosomes
 - Sperm and egg cells have 23 chromosomes in all
- **Autosomes**: Chromosomes that do **not** determine gender (boy or girl)
- **Sex chromosomes**: Chromosomes that determine gender (boy or girl)
 - Girls are XX, Boys are XY

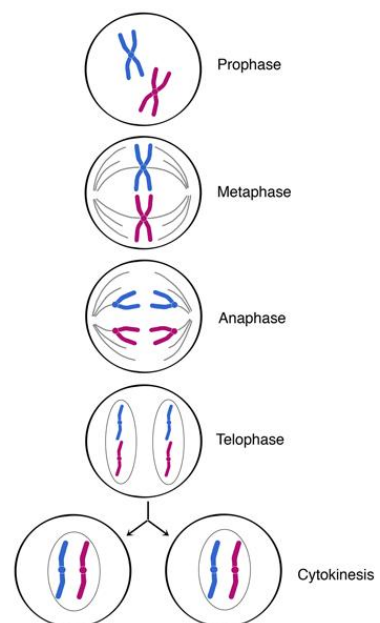
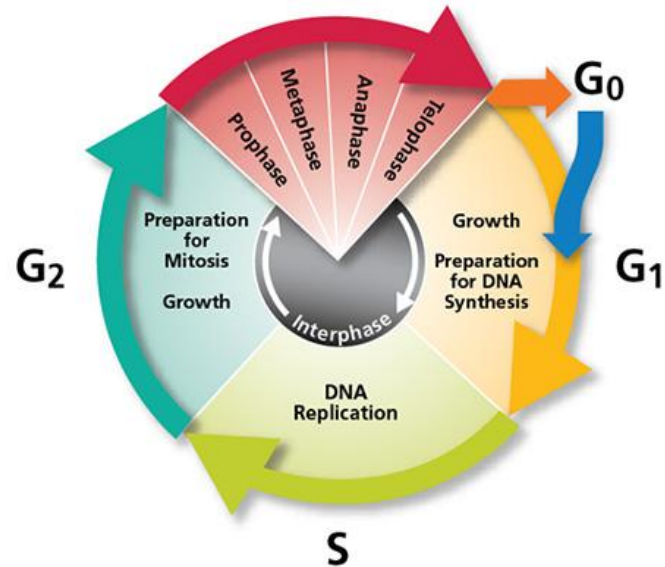
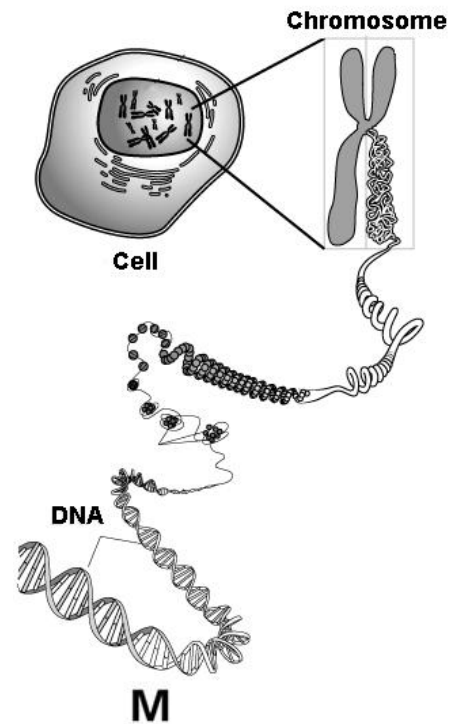
Cell Cycle

The cell cycle are the life stages of a cell

1. M phase: Mitosis (cell division) occurs
 2. G₁ phase: Cell grows
 3. S phase: DNA synthesis (chromosomes are copied)
 4. G₂ phase: Cell grows
 5. M phase begins again
- Chromosomes (DNA) **must be copied** before mitosis so that new cells receive the **same** chromosomes found in old cells

Mitosis

- Division of a cell into **2 identical** cells
- **Before** mitosis: Chromosomes have copied themselves
 - **Sister chromatids**: original chromosome and its exact copy are attached to each other
- Phases of mitosis
 1. **Prophase**: Nuclear membrane falls apart and spindle fibers start to form
 2. **Metaphase**: Sister chromatids line up along the middle of the spindle fibers
 3. **Anaphase**: Sister chromatids separate and move to opposite ends of the cell
 4. **Telophase**: Spindle fibers break down and new nuclear membrane forms around each set of chromosomes

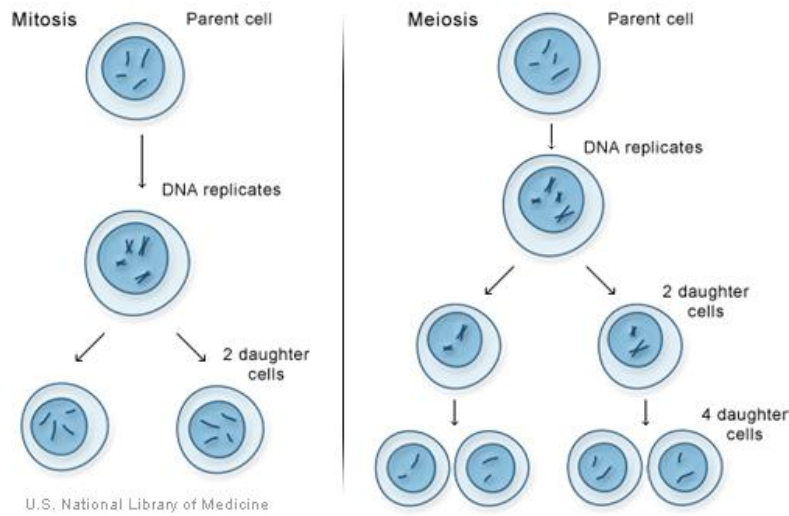


- **Cytokinesis** occurs when the cytoplasm actually divides, forming two new cells

Genetics

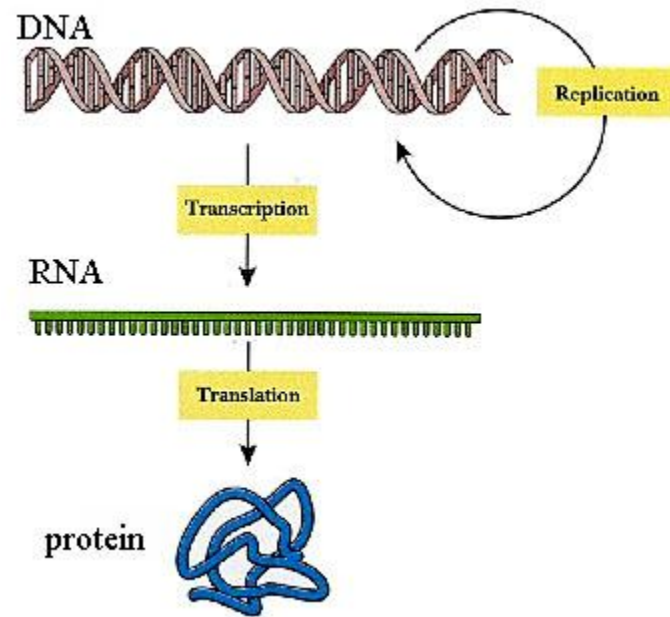
Meiosis

- Cell division that produces **gametes (sex cells)**, such as **sperm** and **egg** cells
- **Fertilization:** Process of an egg and a sperm cell combining to produce a **zygote**
 - **Zygote:** Baby that is only 1 cell big
 - **Egg cell (23 chromosomes) + sperm cell (23 chromosomes) = baby (46 chromosomes)**
- Steps in meiosis
 - 1. **Meiosis I:** Chromosome pairs separate into two new cells
 - 2. **Meiosis II:** Each chromosome separates from its copy into **4 new cells... each with HALF THE AMOUNT of DNA as the parent cell!**
- In meiosis, **one** cell becomes **four** cells but in **mitosis**, one **cell** becomes **two** cells



DNA

- **Deoxyribonucleic acid**
- Makes up the chromosomes in the nucleus and **never** leaves the nucleus
- A chromosome is a chain of different genes
- DNA has a **double helix** shape
- Has four types of bases: **adenine (A), guanine (G), thymine (T), cytosine (C)**
- **A binds T** and **G binds C**
- DNA is **complementary**, which means that the bases on one strand **match up** to the bases on the other strand
 - For example: Strand 1: ATG CCT GAC
Strand 2: TAC GGA CTG
- **DNA replication** is the process by which DNA copies itself and each **new** piece of DNA is made up of **1 old strand and 1 new strand**

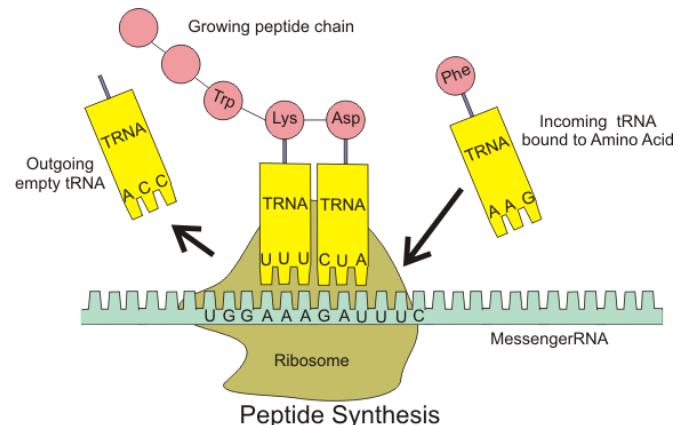


RNA

- **Ribonucleic acid**
- RNA is a copy of DNA that goes out into the cytoplasm to tell a ribosome how to make a protein
- RNA is single stranded and has **uracil (U)** rather than thymine (T)
 - **U binds A** and **G binds C**
 - If the DNA is: ATG CCA AAG
Then the RNA will be: UAC GGU UUC

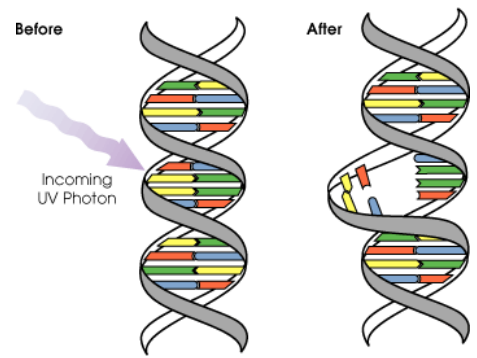
Using DNA to make protein

- 1. **Transcription:** DNA in the nucleus is used to make **messenger RNA (mRNA)**
- 2. **RNA** moves out into the **cytoplasm** to meet the **ribosome**
 - RNA carries the directions to other parts of the cell
- 3. **Translation:** The RNA attaches to a **ribosome** and is used to make a protein
 - Proteins do all the work in the cell
 - Every **3** bases in RNA is called a **codon** and codes for **1 amino acid**



Mutations

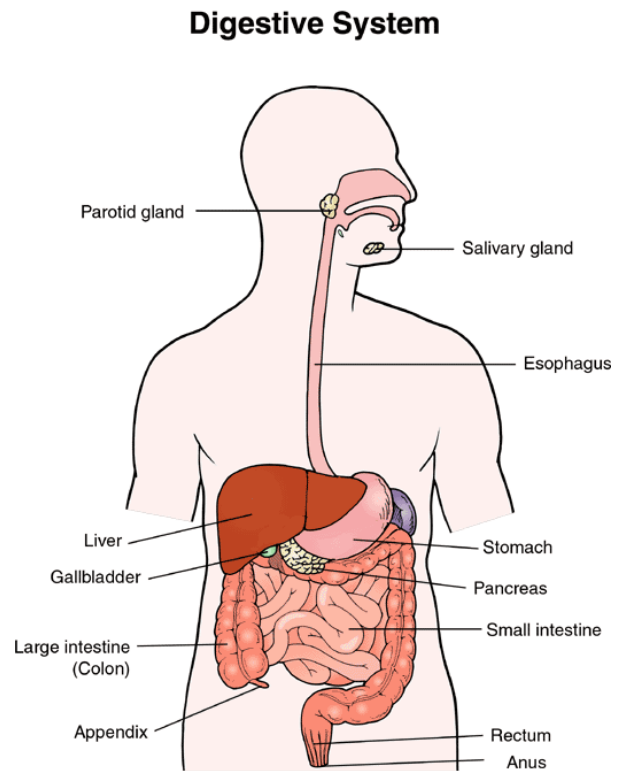
- A **mutation** is a **change** in a gene or chromosome
- If the mutation happens in a body cell, it only affects the organism that carries it
- If the mutation happens in a sex cell, it can be passed on to offspring
- Mutations can be
 - harmful if they reduce an organism's chances for reproduction or survival
 - helpful if they improve an organism's chances for survival
 - neutral if they do not produce an obvious changes in an organism
 - lethal if they result in the immediate death of an organism
- Mutations can occur randomly or be caused by a **mutagen**, which is a factor in the environment like UV and chemicals



Body Systems

Digestive System

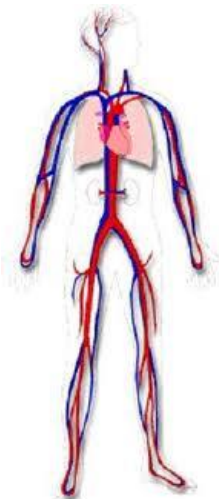
- **Function (Job):** to break down food into nutrients (digestion) and to absorb them into the blood for energy (absorption).
- **Chemical digestion** is using chemicals (like enzymes or acid) to break down food.
- **Mechanical digestion** is physically crushing or squishing food.
- **Parts:**
 - **Mouth:** chemical and mechanical digestion start here using teeth to chew and saliva to break down carbohydrates
 - **Pharynx:** the throat, where food and air pass through
 - **Esophagus:** long tube that takes food to stomach
 - **Stomach:** strong organ that mechanically (squishes) and chemically (using acid) digests food.
 - **Small Intestine:** very long, **most chemical digestion happens here** using enzymes from pancreas and bile from gall bladder and liver. **Most nutrient absorption happens here!**
 - **Villi:** tiny finger like structures inside the small intestine that help absorb nutrients from food.
 - **Gall bladder:** stores bile to be released into small intestine
 - **Bile:** green liquid that helps digest fat. Made in liver and stored in gall bladder.
 - **Pancreas:** makes enzymes to help with digestion.
 - **Liver:** Makes bile.
 - **Large Intestine:** absorbs water from undigested food.
 - **Rectum:** place at end of large intestine where waste waits to be excreted.
 - **Anus:** hole where waste leaves your body.



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Circulatory System

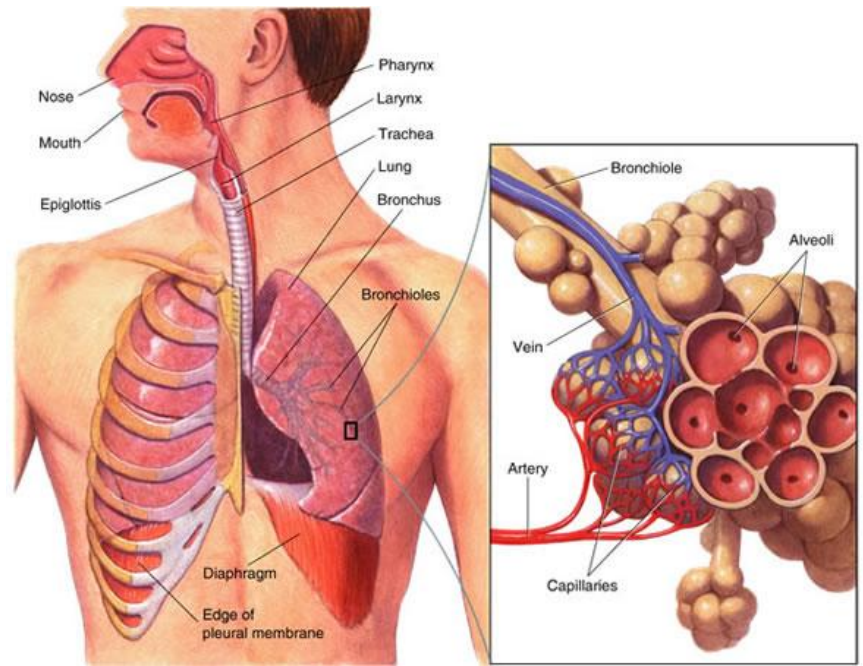
- **Function (Job):** to transport oxygen, carbon dioxide, nutrients and wastes around our body (in the blood)
- **Parts:**
 - **Heart:** pumps blood to the body and to the lungs
 - **Arteries:** send **oxygen rich** blood away from the body to the cells
 - **Veins:** take **oxygen poor** blood back to heart from the body
 - **Capillaries:** tiny tubes on each cell where oxygen and nutrients are given to cell and carbon dioxide and wastes are taken away.
 - **Blood:** red liquid that transports oxygen, nutrients, wastes, blood cells and carbon dioxide to and from your cells.
 - **Red blood cells:** carry oxygen to body cells.



From the Texas Heart Institute

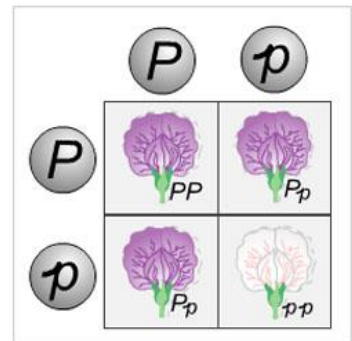
Respiratory System

- **Function (Job):** to transport oxygen, carbon dioxide, nutrients and wastes around our body (in the blood)
- **Parts:**
 - *Nose:* to bring air in
 - *Pharynx:* the throat, where food and air pass through
 - *Larynx:* the voice box, contains vocal cords
 - *Epiglottis:* flap of skin that covers trachea when swallowing so food does not go into lungs
 - *Trachea:* windpipe, brings air to bronchi
 - *Bronchi:* two tubes that take air to each lung
 - *Lungs:* two part organ where oxygen is absorbed
 - *Bronchioles:* small tubes that spread air throughout your lungs
 - *Alveoli:* tiny air sacs surrounded by capillaries, oxygen diffuses from these sacs into the blood while carbon dioxide fuses from blood into alveoli.



Mendelian Genetics

- Humans have 2 genes for every trait
 - **Alleles:** Different forms of a single trait, like blue and brown are two eye color alleles
- **Dominant gene:** “Stronger” of 2 genes and shows up in the organism
 - Represented by a **capital letter**
 - **B** is the **dominant** gene for **brown eyes**
- **Recessive gene:** “Weaker” of 2 genes and **only** is shown when there is **no dominant gene present**
 - Represented by a **lowercase letter**
 - **b** is the **recessive** gene for **blue eyes**
- **Homozygous** (purebred): When 2 genes are **alike** for a trait, **two of the same letter type!**
 - **BB** is **homozygous** for brown eyes, **bb** is homozygous for blue eyes
- **Heterozygous** (hybrid): When 2 genes are **different** for a trait
 - **Bb** is **heterozygous**
 - **Heterozygous organisms** always show the **dominant trait!**



Punnett Squares

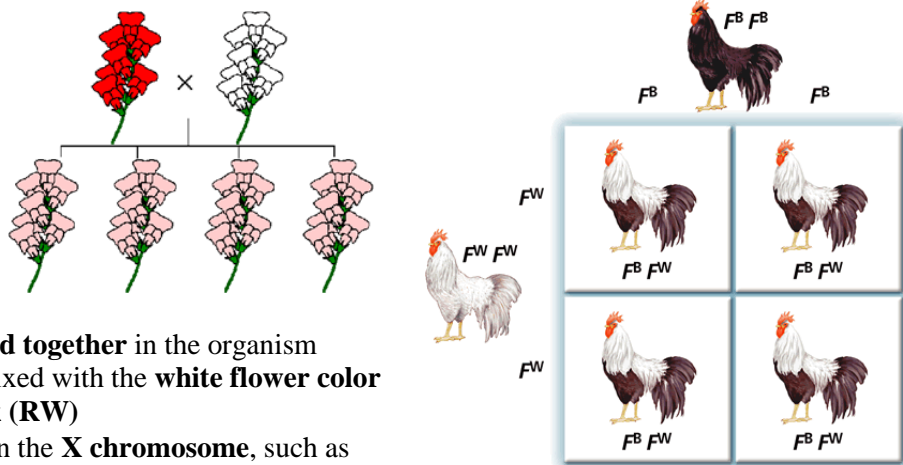
- Punnett squares are charts that are used to show the possible gene combinations in a **cross** (mating) between 2 organisms
 - * Let's say that **B** is the **dominant gene** for brown eyes and **b** is the **recessive gene** for blue eyes*
- **Genotype:** The genes of an organism (**Bb**)
- **Phenotype:** The **physical appearance** of an organism, what it looks like (**Brown eyes**)

<u>Parents</u> Bb x bb		<u>Offspring genotype</u> 50% Bb 50% bb
	B b	
b	Bb bb	<u>Offspring phenotype</u> 50% Brown eyes 50% blue eyes
b	Bb bb	

<u>Parents</u> Bb x Bb		<u>Offspring genotype</u> 25% BB 50% Bb 25% bb
	B b	
B	BB Bb	<u>Offspring phenotype</u> 75% Brown eyes 25% blue eyes
b	Bb bb	

Human Genetics

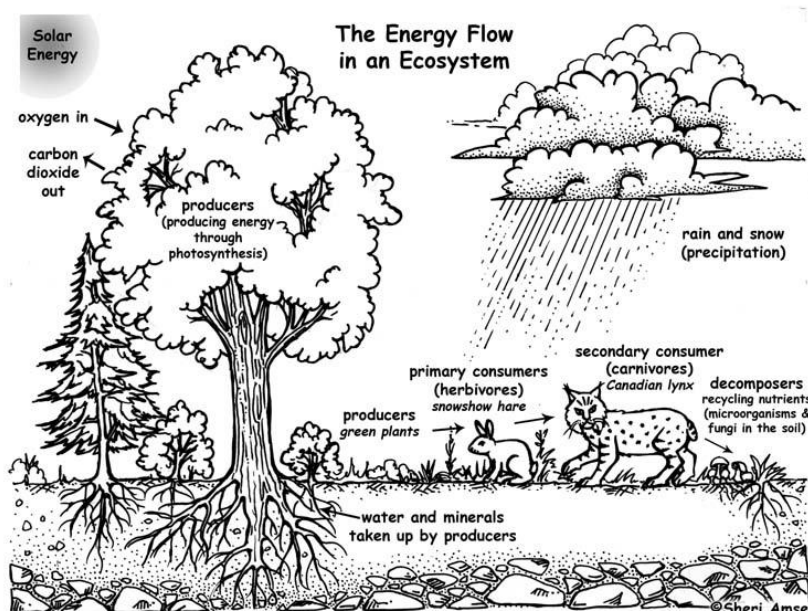
- **Codominance** occurs when 2 dominant genes are shown in an organism
 - A cat with **black and white spots** is **codominant**, (BW) → **Black and White both dominant**
- **Incomplete dominance** occurs when 2 dominant genes are expressed and **blended together** in the organism
 - If the **red flower color gene (R)** is mixed with the **white flower color gene (W)** then the babies will be **pink (RW)**
- A **sex-linked** trait is a trait that is found on the **X chromosome**, such as **colorblindness**
 - Females are XX so have 2 copies of sex-linked traits
 - Males are XY so have 1 copy of sex-linked traits



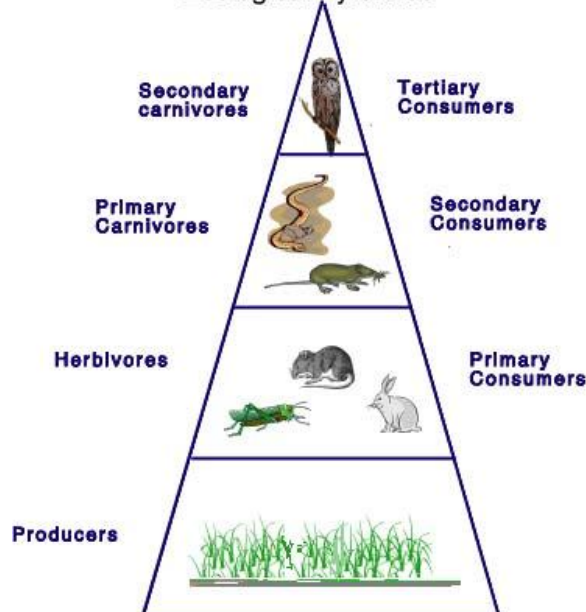
Ecology

Ecology

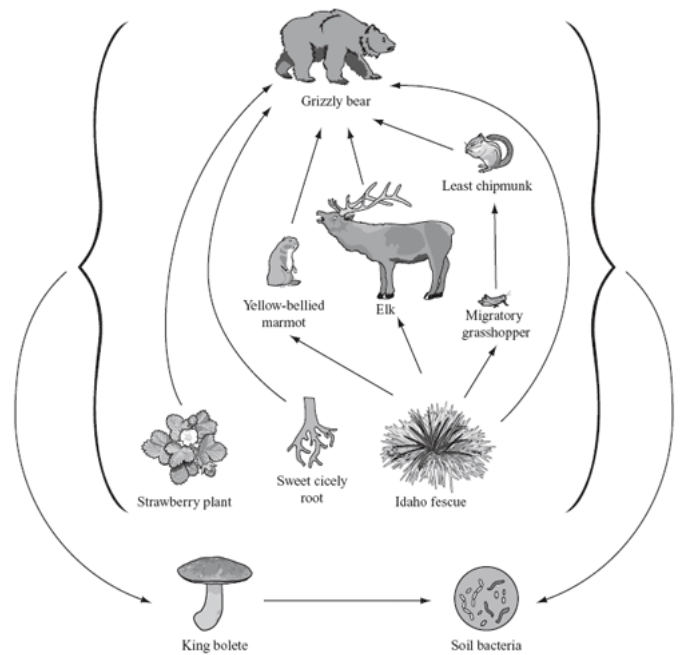
- **Ecology** is the study of how organisms fit into their environment
- A **community** is the **organisms** that live in a particular environment
- A **habitat** is the **physical location** of a community
- An **ecosystem** is a **collection of organisms and their physical environment**
- The **diversity** of an ecosystem measures the **number of species living there**
- There are different feeding groups of organisms
 - **Autotrophs**: Organisms that **make their own food**, like **plants** and some bacteria
 - **Heterotrophs**: Organisms that **cannot make their own food**, like animals
 - **Herbivores**: Eat **plants**
 - **Carnivores**: Eat **meat**
 - **Omnivores**: Eat **plants and meat**
- There are different factors in an ecosystem
 - **Abiotic** factors are **nonliving** things
 - **Biotic** factors are **living things**, such as
 - **Producers**: Organisms that take in **energy from the sun to make food (plants)**
 - **Consumers**: Organisms that **eat other organisms** for energy
 - **Decomposers**: Special type of consumer that eats waste products and **recycles dead organisms** for energy
- There are different **trophic levels** in a food chain
 - A **trophic level** is a **feeding level** in an ecosystem
 - A **food chain** is a lineup of organisms that shows who eats who (grass → bird → fox → wolf)
 - 1st trophic level is usually a **producer**
 - 2nd trophic level is a **primary consumer**
 - 3rd trophic level is a **secondary consumer**
 - 4th trophic level is a **tertiary consumer**
 - Last trophic level (**after the top consumer**) is a **decomposer** (eats dead stuff)



Ecological Pyramids

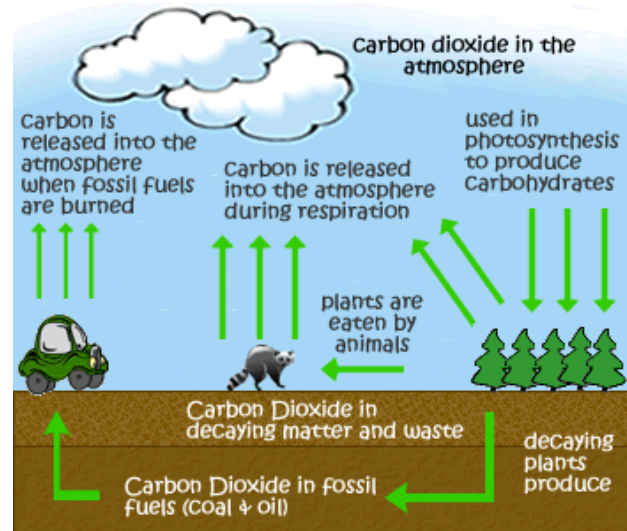


- Every time an organism eats, it gets energy from its food
 - So energy is transferred from the 1st to the 2nd to the 3rd trophic level and so on (**but some of this energy gets lost along the way!**)
 - This means that the **PRODUCERS** have the **MOST energy TOP** consumer has the **LEAST** amount of **energy**
 - Energy pyramid: Picture showing how much energy is transferred to the different trophic levels in a food chain
- A food web is a network of connected food chains



Cycles of Matter

- **Water, nitrogen, carbon, and oxygen** are **recycled** in the environment through cycles
- The **nitrogen** cycle
 - **Nitrogen in the atmosphere is taken in by bacteria that live in plant roots (nitrogen fixation)**
 - The nitrogen is passed onto the plants and any animals that eat the plants
 - Once the plant or animal has **died, decomposers** (bacteria) again **eat the nitrogen in the dead material** and **send it back to the atmosphere (denitrification)**
- The **water** cycle
 - **Precipitation**, such as rain and snow, fall to the earth
 - The water either
 - goes into the ground for plants to use and the plants give off excess water back to the atmosphere (**transpiration**)
 - or runs off the land to lower-lying bodies of water where it **evaporates** back into the atmosphere
- The **oxygen-carbon** cycle
 - **Carbon dioxide** from the atmosphere is **used by plants** who use it **during photosynthesis** and **release oxygen** back into the atmosphere
 - **Oxygen** in the atmosphere is taken in by animals and plants who use it during respiration and release carbon dioxide back into the atmosphere



Interaction in an environment

- Each organism has a **niche**, or **role**, to play in its environment
- **Competition** is a struggle between organisms for resources, such as food, water, shelter
- **Predators** are organisms that catch, kill, and eat other organisms called **prey**
- **Symbiosis** is a close relationship between 2 organisms
 - There are three types of symbiosis
 - 1. **Commensalism** is when **one** of the 2 organisms **benefits** from the symbiosis
 - 2. **Mutualism** is when **both** organisms **benefit** from the symbiosis
 - 3. **Parasitism** is when one organism **benefits** (parasite) and the other organism is **harmed** (host) from the symbiosis
 - The parasite feeds on the host while it is still alive, weakening but not killing it
- An **adaptation** is a helpful trait (characteristic) that helps an organism survive.
- Populations of organisms increase and decrease due to overpopulation of a competitor or predator, disease, lack of food or water or shelter, and extreme weather



The Theory of Evolution

Evolution

- **Evolution is a change in a species over time**
- The theory of evolution was stated by Charles Darwin and is **based on natural selection**
- **Natural selection** says that **organisms with good traits that fit an environment are more likely to survive and reproduce than organisms without these favorable traits**
- The theory of evolution is supported by **evidence** that includes
 - o **Adaptations:** structures and behaviors that organisms have evolved in order to survive better in their environments
 - o The **fossil record** which is information about all known fossils
 - o **Comparative anatomy** which is when the bodies of different organisms are compared to see if they are related
 - **Homologous structures** are **body structures** on different organisms that are **similar**
 - **Vestigial structures** are body structures that may have served a purpose in ancient ancestors but no longer are functional in current organisms
 - o The fact that all vertebrate **embryos** look very similar as they develop before birth
 - o The fact that the **DNA** of closely related organisms is very similar

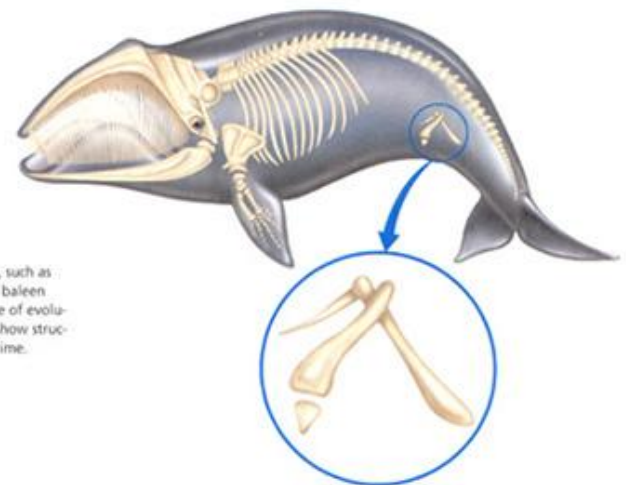
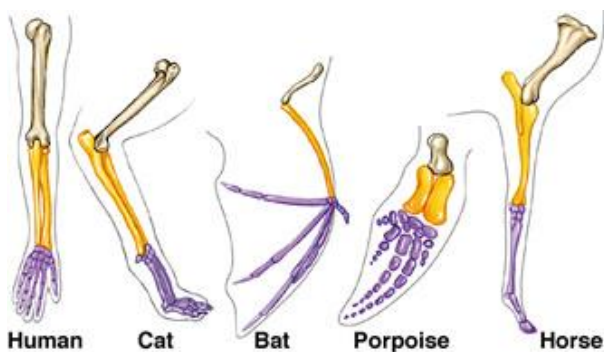
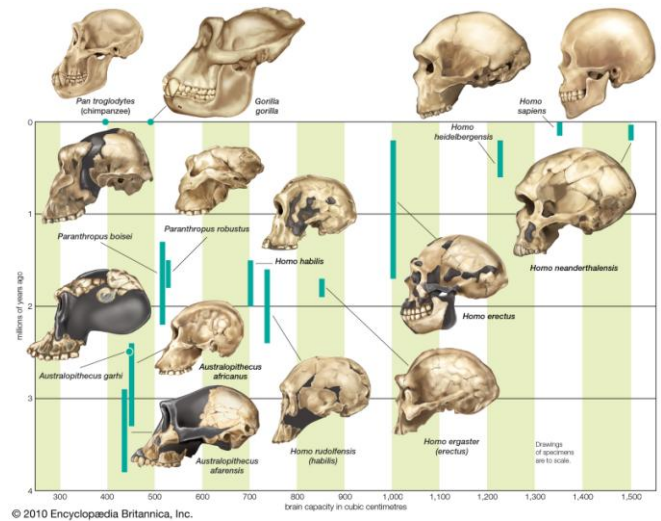
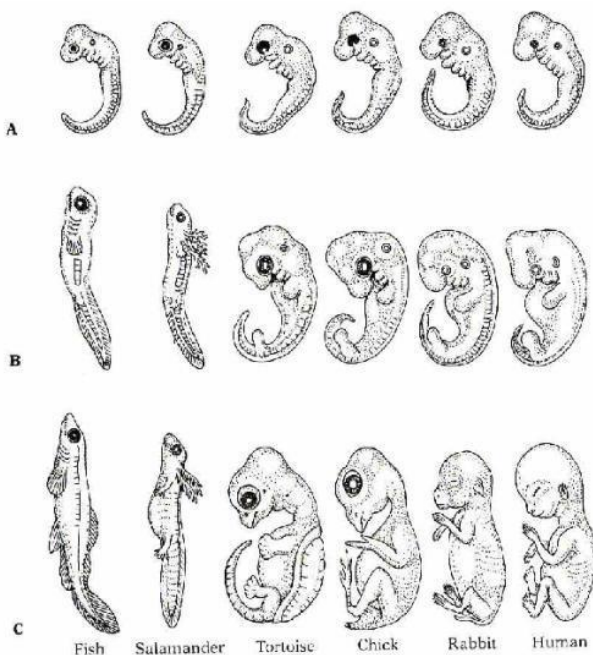
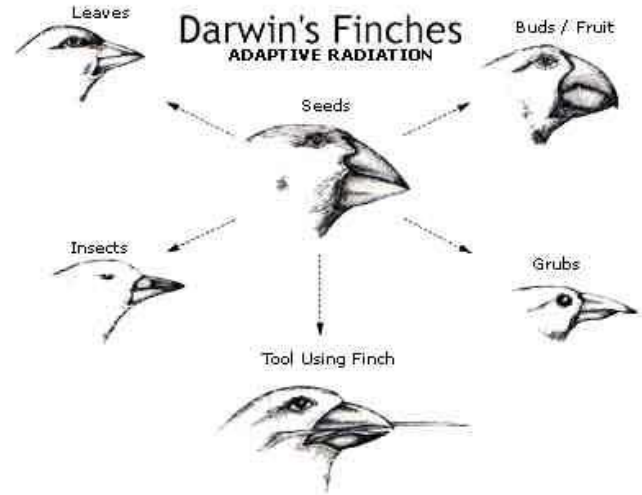
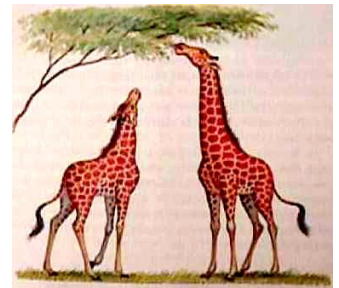


Figure 15.8
Vestigial structures, such as pelvic bones in the baleen whale, are evidence of evolution because they show structural change over time.

Taxonomy/Classification

- **Taxonomy** is the science of **classifying** living things (**putting things into groups based on similarities**)
- Organisms are organized into 7 different **levels of taxonomy** (King Philip came over for good spaghetti)
 - o 1. Kingdom – most broad
 - o 2. Phylum
 - o 3. Class
 - o 4. Order
 - o 5. Family
 - o 6. Genus
 - o 7. Species – most specific
- **Closely related organisms have more levels of taxonomy in common than unrelated organisms!**
 - o There are **six kingdoms** of living things
 - o 1. **Archaeobacteria**: bacteria that live in extreme environments
 - o 2. **Eubacteria**: common bacteria
 - o 3. **Protista**: Single-celled organisms
 - o 4. **Fungi**: Mushrooms, yeasts, molds
 - o 5. **Animalia**: animals
 - o 6. **Plantae**: plants
- Every organism has a unique **two-word scientific name** that is written in **Latin**
 - o The first word is the **genus (capitalized)**, the second word is the **species (lower case)** (Humans are *Homo sapiens*)
- Some scientists prefer to organize organisms into domains rather than kingdoms
 - o There are three domains (Archie eats eels)
 - o 1. **Archaea**: Bacteria that live in extreme environments – NO nucleus
 - o 2. **Eubacteria**: Common bacteria – NO nucleus
 - o 3. **Eukarya**: Organisms that HAVE A NUCLEUS!

