Water and Macromolecules Review

Homeostasis – the maintenance of constant internal conditions inside organisms

Quantitative vs Qualitative DATA – Quantitative = numbers, Qualitative = description

Hypothesis – is a prepared answer for a scientific question (observations, data and inferences)

Theory –proposed explanation for a wide variety of observations and experimental results; it can NOT be proven and will never become a LAW

Law – something that is proven and cannot be disputed (LAW of Independent Assortment)

Independent variable – (Manipulated) – the one that is changed

Dependent variable – (Responding) – what happens

Biotechnology

- Gene therapy
- DNA fingerprinting
- Genetically Modified Organisms (GMOs)
- Recombinant DNA – can occur because all living organisms have nucleotides and the same base pairs are present A-T and G-C
- Genetic screening- used to determine if a person has a genetic disorder and can pass to offspring

PROPERTIES OF WATER:

- Polar – has a region with a slight positive charge and one with a slight negative charge
- Has Hydrogen bonds holding water molecules together
- Solvent – dissolves more things than any other substance
- Expands upon freezing (Ice is less dense than liquid water so it floats on water)
- High heat specificity – absorbs lots of heat, regulates temp of cells and earth
- Cohesion- causes surface tension WATER LIKES WATER
- Adhesion – water sticks to other substances – water climbing from roots to top of a plant

MACROMOLECULES

Carbon is the most important element!!!!!

Carbon has unique bonding properties. **Covalent bonding** to other things

Monomer is a subunit (small unit)

Polymer – made up of many monomers

1. ***Carbohydrates*** – Energy Source (Contains C, H and O) RATIO 1:2:1
   - **EXAMPLES – PASTA, RICE, GLUCOSE, POTATO, STARCH,CELLULOSE**
   - Monosaccharide - 1 sugar – immediate Energy Source, **glucose**
   - Disaccharide – 2 sugars – Ex. Sucrose, Lactose
   - Polysaccharides – many sugars – STORED ENERGY
     - **Animals store excess glucose as GLYCOGEN**
     - **Plants store excess glucose as STARCH**
     - **Cell wall contains CELLULOSE** and is most abundant on earth
     - Chitin – provides protection EX – exoskeletons – crabs, insects, lobsters

2. ***Lipids*** – Mainly C and H (O and P)
   - Fats, oils, waxes, steroids and cholesterol
   - Long-term energy storage (Fat)
   - **Important in Biological Membranes – Phospholipid bilayer**
     Glycerol head is hydrophilic (likes water - polar)
     Fatty acid chain is hydrophobic (hates water – non-polar)

3. ***Proteins*** –Made of C, H, O and N
   - ***Monomer is Amino Acid*** 20 AA (body makes 12 but you must consume 8)
   - Put a bunch of AA together and you make a polypeptide chain (PROTEIN)
   - Examples of Proteins – Enzymes, hair, nails, insulin, antibodies, hemoglobin
   - Made in ribosomes
   - Can get from eating meat, fish, nuts, beans etc

4. ***Nucleic Acids*** – Made of C, H, O, N, P
   - Two types – **DNA (stores genetic info)** and **RNA (Protein synthesis)**
   - Monomer – nucleotide that has 3 parts:
     1. **Sugar – Deoxyribose or Ribose**
     2. **Phosphate group**
     3. **Nitrogen-containing base**

Cells Study Guide

Cell: smallest unit of living matter that can carry out all processes required for life. The basic unit of living organisms.

Cell theory: one of the first unifying concepts in biology. It has 3 major principles.

* All organisms are made of cells.
* All existing cells are produced by other living cells.
* The cell is the most basic unit of life.

Late 1500's Zacharias Janssen: Dutch eyeglass maker who invented the compound microscope, allowing scientists to study organisms more closely.

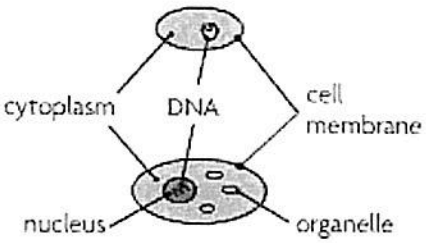
Contributors to Cell Theory

1665 Robert Hooke: English scientist, and the first to identify and name cells. He examined cork under a three-lens compound microscope.
1674 Anton van Leeuwenhoek: Dutch tradesmen who made better lenses to examine cloth. His single-lens microscopes allowed him to view organism even better than Hooke's microscope. Leeuwenhoek was one of the first people to describe living cells.
1838 Matthias Schleiden: German scientist who studied plant tissue under microscopes and proposed that plants are made of cells.
1839 Theodor Schwann: German scientist who concluded that all living things are made of cells. He also noted the structural similarities between animal & plants cells.
1855 Rudolf Virchow: German scientist who proposed that all cells come from existing cells.

Prokaryotic vs. Eukaryotic Cells

VISUAL VOCAB

Prokaryotic cells do not have a nucleus or other membrane-bound organelles.



Eukaryotic cells have a nucleus and other membrane-bound organelles.

Prokaryotic: do not contain a nucleus or other membrane-bound organelles. The DNA is suspended in cytoplasm.
All prokaryotes are microscopic single-celled organisms and belong to an ancient class of cells that appeared on Earth long before eukaryotic cells.

Eukaryotic: contain a nucleus and other membrane-bound organelles. The nucleus contains the DNA.
Eukaryotes can be multicellular or single-celled organisms.

Cell Structures shared by animal & plant cells

Cytoplasm: jellylike substance inside cells that contains molecules and in some cases organelles.
Cytoskeleton: network of proteins supports and shapes the cell. Long threads and fibers crisscross the entire cell. The 3 types of fiber it's composed of are microtubules, intermediate filaments, & microfilaments.
Organelles: membrane-bound structure specialized to perform a distinct process in a cell.
Nucleus: storehouse for genetic information (DNA).
Endoplasmic Reticulum: network of thin, folded membranes that produce, process, & distribute proteins.
Ribosomes: links proteins together to form amino acids and is the site of protein synthesis.
Golgi Apparatus: stack of flat membrane-enclosed cases that process, sort, & deliver proteins. ("UPS" of cell)

Vesicles: contains and transports materials within cytoplasm.
Mitochondria: supplies energy to the cell and has its own ribosomes & DNA. (The Power House of the cell)
Vacuole: stores materials such as water, food, or enzymes.
Centrosome: produces microtubules.

Differences between plant and animal cells

Plant Cells	Animal Cells
Contain chloroplasts, a central vacuole, and a cell wall. Do NOT contain centrioles and lysosomes.	**Contain centrioles and lysosomes. Do NOT contain chloroplasts, a central vacuole, or a cell wall.**
1. Chloroplasts: carry out photosynthesis. **2. Central Vacuole:** single large vacuole that gives plant support & strengthens cell. It contains a watery substance & takes up most of the cell. **3. Cell Wall:** provides rigid support, protection, & shapes cell. Composition varies based on the needs of the organism. In plants & algae it's made of cellulose.	**1. Centrioles:** divide DNA during cell division. **2. Lysosomes:** defend cells from invading bacteria & viruses & break down damaged/worn-out cell parts.

Cell Membrane

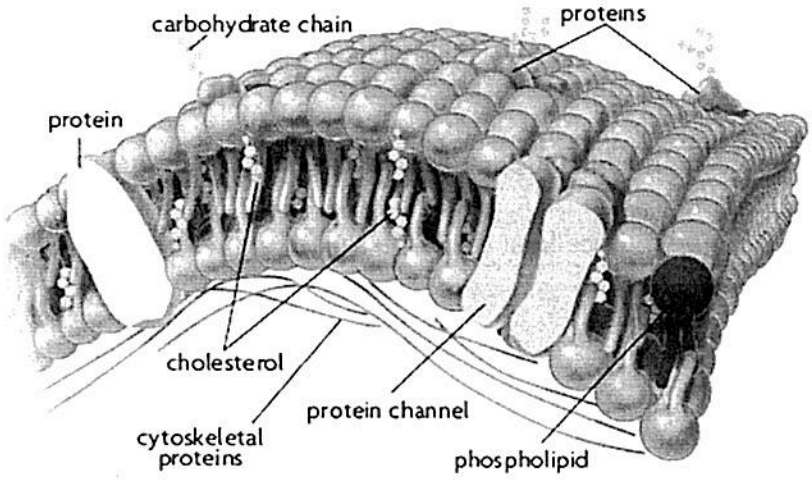
The boundary between a cell and the outside environment. It controls the passage of materials into & out of the cell and is also called the plasma membrane.

Composition: consists of a double layer of phospholipids (phospholipid bilayer).

* **Phospholipid:** has 3 basic parts-a charged phosphate group, glycerol, & 2 fatter acid chains.

Phospholipid bilayer is embedded with proteins, carbohydrates, & cholesterol.

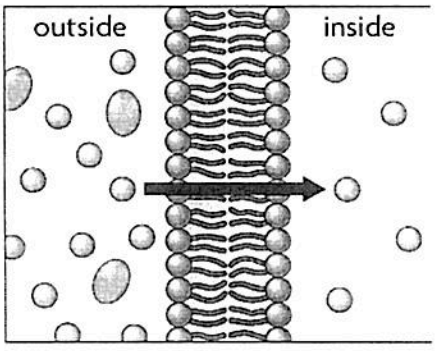
* **Proteins:** help materials cross the membrane with a protein channel, but some also serve as key parts of the cytoskeleton.
* **Carbohydrates:** are attached to membrane proteins & serve as identification tags that enable cells to distinguish one type of cell from another.
* **Cholesterol:** strengthens cells membrane.



Fluid Mosaic Model: describes arrangement of molecules in the cell membrane. The cell membrane is flexible, not rigid. The phospholipids in each layer move from side to side, sliding past each other. It acts like fluid, similar to a film of oil on water. The variety of molecules studding the membrane is similar to the arrangement of tiles that make up a dynamic mosaic.

Selective Permeability

A property of the cell membrane that allows some, but not all, molecules to cross. It allows a cell to maintain homeostasis in spite of changing conditions outside the cell.



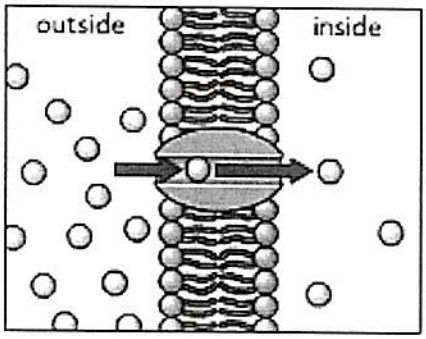
Passive and Active Transport

Passive Transport: movement of molecules across the cell membrane that **does not** require energy. It may also be described as diffusion across a membrane.

* **Diffusion:** movement of molecules in a fluid or gas from a region of higher concentration to a region of lower concentration. It's the result of the natural motion of particles. Concentration is the number of molecules of a substance in a given volume. **Concentration gradient** describes the difference in concentration of a substance from one location to another.
* **Osmosis:** diffusion of water molecules across a semipermeable membrane from an area of high concentration to an areas of lower water concentration.

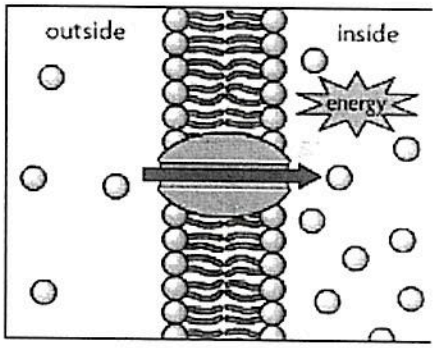
Effects of Osmosis

* **Isotonic Solution:** a solution is isotonic to a cell if it has the same concentration of solutes as the cell. Equal amounts of water enter & exit the cell, so the cells size is constant.
* **Hypertonic Solution:** a hypertonic solution has more solutes than the cell. More water exits the cell, causing that cell to shrink or even die.
* **Hypotonic Solution:** a hypotonic solution has fewer solutes than the cell. More water enters the cell, causing the cell to expand or even burst.



* **Facilitated Diffusion:** enables molecules that can't directly cross the phospholipid bilayer to diffuse through transport proteins in the membrane.

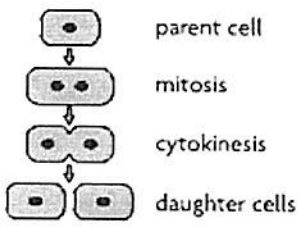
Active Transport: Cell uses energy to move substances against concentration gradient, going from a lower concentration to a higher concentration.



Cell Growth & Division

VISUAL VOCAB

Mitosis is the division of the cell nucleus and its contents.



Cytokinesis divides the cell cytoplasm.

The entire process of cell growth & division can also be referred to as the cell cycle.

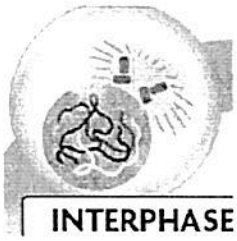
The cell cycle as a whole includes all 4 phases of mitosis, cytokinesis, and interphase.

At the end of the processes of mitosis and cytokinesis, 2 genetically identical daughter cells exist.

Mitosis is involved only in asexual reproduction, and provides new cells for an organisms development, growth & repair.

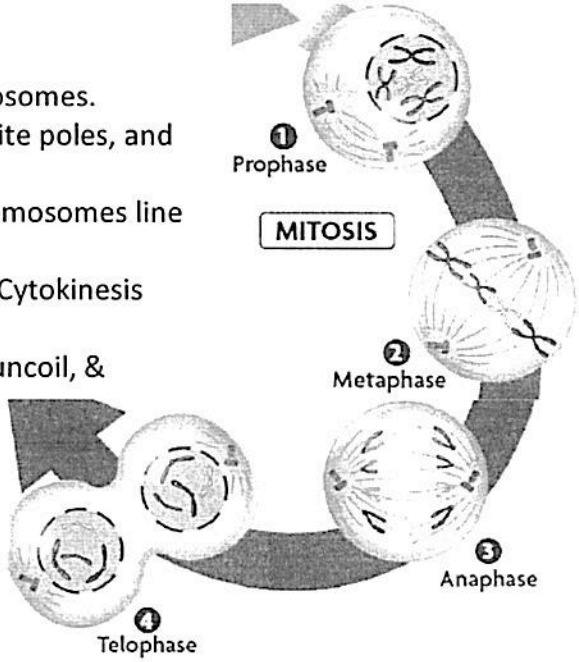
Mitosis has 4 phases: prophase, metaphase, anaphase, and telophase.

Cytokinesis completes the process of cell division by dividing the cells cytoplasm into 2 cells.



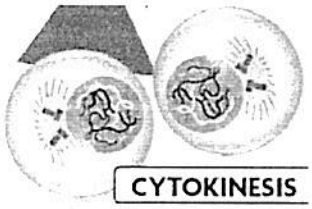
Interphase: prepares the cell to begin the process of division all over again by copying the cell's DNA and providing time for the cell to grow.

Mitosis: divides the nucleus of the cell into 2 nuclei, each containing an identical set of DNA. It has 4 phases- Prophase, Metaphase, Anaphase, Telophase. **(PMAT)**

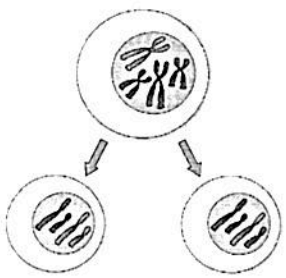
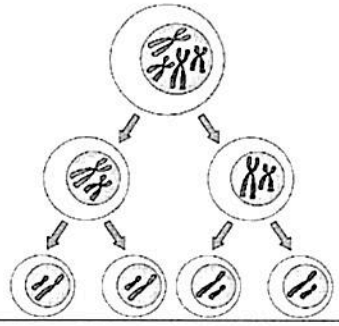


1. Prophase: DNA & proteins condense into tightly coiled chromosomes. Nuclear envelope breaks down, centrioles begin moving to opposite poles, and spindle fibers form.
2. Metaphase: spindle fibers attach to each chromosome & chromosomes line up along the axis.
3. Anaphase: chromatids separate to opposite sides of the cell. Cytokinesis usually begins during late anaphase, or early in telophase.
4. Telophase: Nuclear membranes start to form, chromosomes uncoil, & spindle fibers fall apart.

Cytokinesis: divides the cytoplasm between 2 daughter cells. DNA in each cell is identical.



Differences between Mitosis & Meiosis

Mitosis	Meiosis
• Produces genetically identical cells • Results in diploid cells • Takes place throughout an organisms life cycle • Involved in asexual reproduction • Has 1 cell division • Involves body cells	• Produces genetically unique cells • Results in haploid cells • Takes place at certain times in organisms life cycle • Involved in sexual reproduction • Has 2 cell division • Involves sex cells
	

Photosynthesis FACTS

Plants capture energy from sunlight and store it as chemical energy in the form of sugar – glucose

Chloroplast – organelle where photosynthesis takes place

Equation:

CO2 and H2O are reactants

O2 and C6H12O6 are products

Chlorophyll – light-absorbing molecule in chloroplast (pigment)

Grana are stacks of thylakoids

Thylakoids are flat membranes containing chlorophyll

Stroma is the fluid around the grana inside a chloroplast

Plants look green because they reflect the green wavelength of light

Light-dependent reaction:

Captures energy from sunlight

Reactant – water

Product – oxygen

Provides ATP and Hydrogen (NADPH) to light-independent reaction

Takes place in grana, a stack of membrane structures

Light-independent reaction: (Also called CALVIN CYCLE)

Reactant – carbon dioxide

Product – glucose, sugar

Does NOT need light, uses ATP from Light-dependent reaction

Takes place in stroma

Organisms that make their own food are called **producers or autotrophs**

Glucose and Oxygen produced in Photosynthesis are used for Cellular Respiration. They are the reactants for Cellular Respiration.

Cellular Respiration FACTS

Cellular Respiration releases energy by breaking down food molecules

Oxygen and glucose are used to produce ATP – energy

Plant and animal cells make ATP using the process of cellular respiration

ATP (energy) released when a phosphate (P) is removed – making ADP

Add a Phosphate (P) to ADP and you will get another ATP

ATP – high energy molecule ADP – lower energy molecule

Takes place in the mitochondria which has lots of folds so there are more places for the reactions to occur

Aerobic – needs oygen **Anaerobic – does NOT NEED Oxygen**

SEQUENCE OF Cellular Respiration – Glycolyis (anaerobic) – Krebs (aerobic) – ETC (aerobic)

Glycolysis – is an anaerobic process

Takes place in the cell cytoplasm

Makes pyruvate (pyruvic acid) which is the starting molecule for KREBS CYCLE

Net 2 ATPs

If Oxygen is present – Cellular Respiration occurs, if no O2- fermentation

Krebs Cycle Starts with pyruvic acid

Occurs in the mitochondria

Net 2 ATPs

Electron Transport Chain (ETC)

Needs oxygen O2

Occurs in the mitochondria

Produces lots of ATP – up to 34 ATP

Fermentation: NO OXYGEN PRESENT

Lactic Acid - forms when there is not enough O2 present for Cellular Respiration, happens in the muscles, "feel the burn"

Alcoholic – cheese, bread and yogurt are made by fermentation, CO2 produced

Plant Study Guide for the EOC

Plant Organs

Root – support the plant and absorb, transport and store nutrients

Stem – supporting structure that connects roots and leaves and carries water and nutrients between them

Leaves – where most photosynthesis occurs (cuticle, epidermis, mesophyll, veins)

Not all leaves alike:

- Pine needles – narrow waxy leaves that reduces water loss
- Cactus – leaves are non-photosynthetic thorns that help protect
- Tropical plants -Large leaves that are used to capture lots of sunlight for photosynthesis

Flower- seed bearing structure, contains reproductive parts pollinated by wind and animals usually

Cones – seed bearing structure

Processes

1. **Photosynthesis** – light energy is converted to chemical energy, uses carbon dioxide and water to produce oxygen and glucose
2. **Cellular Respiration** – produces ATP (energy) for the organism to use, happens in living things including plants Photosynthesis products are CR reactants. They are interrelated.
3. **Transpiration** –loss of water in plants through the leaves, uses the stomata, surrounded by the guard cells that open and close due to the water pressure
4. **Reproduction** – making new plants through either *sexual* - pollination and sex organs OR *asexual processes* – regeneration, budding, vegetative propagation

Tissues

1. **Meristematic** – found only in the tips of roots and shoots, responsible for plant growth
2. **Ground** – most photosynthetic processes occur here, mainly leaves – makes up the majority of the plant
3. **Dermal** – covers the outside of plants, thick epidermis, cuticle on the upper and stomata and guard cells on the lower epidermis
4. **Vascular** - transports water, minerals, nutrients and organic compounds to all part of the plant EX – xylem and phloem

Structures

1. **Guard Cells** – surround the stoma and can open and close to regulate water loss and gas exchange by responding to water pressure
2. **Xylem** – vascular tissue that transports water, minerals and nutrients from the roots to the rest of the plant
3. **Phloem –** vascular tissue that transports the products of photosynthesis (carbohydrates) throughout the plant
4. **Stomata** – pore on the underside of a leaf that allows carbon dioxide and oxygen to diffuse into and out of the leaf (gas exchange)
5. **Seed** – structure used by some land plants to store and protect the embryo, can be spread by animals wind and water

DNA NOTES:

- Located in the nucleus
- Double helix – 2 strands
- Made up of nucleotides:
  1. Phosphate group
  2. Sugar (deoxyribose)
  3. Nitrogen base pairs (A-T and G-C)
- Boss of the cell – gives directions for all the cell organelles
- Goes through replication (copies itself) during Synthesis – S phase of interphase
- Replication is one template and one new strand to produce the 2 copies of DNA for the daughter cells
- Replication - DNA opens up in many places along the DNA so replication is very fast
- DNA Polymerase- enzyme that bonds the nucleotides together
- Send mRNA out with instructions to make protein at the ribosome
- mRNA is transcribed from the DNA but DNA never leaves the nucleus
- Remember Donald N. Armstrong and Ronald N. Armstrong fairy tale
- Always look for **A paired with T** and **G paired with C in DNA**
- Watson and Crick discovered the structure of DNA

Mutations

Types of Mutations:

- ***Point mutations***
- ***Frameshift***
- ***Insertion/Deletions***

Normally point mutations can have a limited effect on the sequence

Frameshift mutations can be the most dangerous and cause the most damage to the DNA. This can happen from an insertion or a deletion

Mutations can lead to genetic diversity! *This is a good thing!*

Crossing–over in homologous chromosomes can lead to genetic diversity, too. *This happens in meiosis during prophase*

ONLY mutations in Gametes can be passed to offspring. Mutations in body cells effect only the organism they are in.

RNA NOTES:

Three types of RNA:

mRNA – carries the instructions for building a protein from DNA to the ribosome. It leaves the nucleus and goes to the ribosome. DNA stays in the nucleus HAS CODONS!

rRNA – RNA that is in the ribosome and guides the translation of the mRNA into a protein

tRNA – HAS ANTICODONS that pair up with the Codon and drop off the amino acids in the right spot in the polypeptide chain

Base Pairs in RNA: **A pairs with U** AND **G pairs with C**

CODON – specifies a particular Amino Acid to put in the polypeptide chain to form a protein, 3 nucleotides = 1 codon

Start codon – the first codon in the sequence of building a protein

Stop Codon – the last codon that signals that all of the amino acids have been added to the chain

Transcription – produces a mRNA molecule from a DNA template

Translation – it converts/translates the mRNA to a polypeptide chain (AA in a chain) involves anticodons and tRNA

STEPS TO BUILD A PROTEIN:

1. DNA (uncoils and mRNA is made from 1 side of the DNA)
2. Transcription – mRNA uses the codons to select the right amino acids to build the protein
3. Translations- tRNA uses anticodons to drop off the right amino acid in the chain. It looks for the codon and pairs with the right one using the anticodon
4. Polypeptide chain – a bunch of amino acids held together in a chain
5. Protein – when all of the correct amino acids have been added, the protein has been built – Start codon tells it to start putting the amino acids in a chain and the stop codon tells it that all the amino acids are there and it has built the right protein

Classification Study Guide

Linnean classification – used physical similarities to classify organisms There are seven levels of the Linnean Classification:

From the broadest to the most specific:

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species

Organisms can be classified based on physical similarities, evolutionary relationships, homologous structures, vestigial structures or now using molecular evidence. Understand that genetics provides more evidence of hoe closely organisms are related.

DOMAIN – Largest of all classification categories. There are 3:

1. **Archaea –**
    - Single cell prokaryote (no nucleus and no membrane bound organelles
    - RNA sequences
    - Lives in extreme environments (hot, acidic, cold, deep)
    - NO cell wall
2. **Bacteria –**
    - Single cell prokaryote (no nucleus and no membrane bound organelles
    - Most have cell wall
    - Reproduce - binary fission and budding

3. **Eukarya –**
    - Eukaryotes
    - Have nucleus and membrane bound organelles
    - Single or multicellualar

There are 4 Kingdoms under Eukarya:

1. **Protista** – The "catch all" category
    - Some are plant-like, have chloroplast EX -diatoms, dinoflagelletes
    - Some are animal-like EX - Protozoa, Paramecium
    - Some are fungi-like EX – slime molds

Usually single celled but can be multicellular

2. **Fungi** – Decomposers, Heterotroph (consumer)
    - No true roots, stems or leaves
    - EX - Mushrooms

3. **Plantae** – Autotroph (makes own food), multicellular, photosynthetic
    - Cell walls made of cellulose
    - EX – Plants, water and land plants

4. **Animalia** – Heterotroph (consumer), multicellular
    - Eukaryotic
    - Cell walls supported by collagen, NO cell wall
    - Most are organized into specialized tissues which make up organs
    - Most reproduce sexually
      EX: sponges, worms, fish reptiles, birds and mammals

IMMUNE SYSTEM NOTES

Non-specific Defenses: *(DOES NOT TARGET A SPECIFIC PATHOGEN)*

Skin, largest organ in your body, protects from pathogens (bacteria, viruses, fungi, protozoa and parasites) from entering your body

- **Mucus membranes** – traps pathogens in sticky mucus
- **Stomach acids** – kills pathogens if ingested
- **Sweat and tears** – wash away pathogens from skin/eyes

Inflammatory Response – body responds to pathogen entering the body – get red, swells, pus etc White blood cell production (macrophages- natural killer cells) and protein production (interferon)

Ex. You cut your finger and bacteria enters

FEVER - a low fever is good – it helps fight infection by making body less suitable for growth of harmful pathogens

Specific Defenses: *(Targets a specific pathogen)*

Immune response

Attacks specific pathogens by using specialized cells and proteins (white blood cells)

Phagocyte – a cell that destroys pathogens by surrounding and engulfing them

T Cells – destroys body cells that are infected with the pathogen

B cells – produces proteins that inactivate pathogens that have not yet infected body cells

Antibodies – are proteins made by white blood cells that attack and kill the pathogen

Types of Pathogens: bacteria, viruses, fungi, protozoa, parasites

HISTORY:

Louis Pasteur – helped make the connection between microorganisms and disease. Called it the GERM THEORY – specific organisms caused disease

Types of Pathogens: bacteria, viruses, fungi, protozoa, parasites

Types of Immunity:

1. **Active Immunity– Immunity that your body produces in response to a specific pathogen that had infected or infecting your body**

   You have been exposed to the disease and are protected from it (Memory Cells) OR
   You have received a vaccination to stimulate protection
   (Ex. Chicken pox, flu vaccine)

2. **Passive Immunity – Immunity that occurs without the body undergoing an immune response**
   EX –Transferred of antibodies between mother and child done through the umbilical cord or mother's milk

3. **Acquired Immunity** –occurs after your immune system reacts to a pathogen invasion. It keeps you from becoming sick by a particular pathogen more than once. This is LONG Lasting.

   Vaccines – artificially produce acquired immunity. It allows you to develop memory cells and acquired immunity against an illness without contracting the disease, provides body with antibodies. It contains the antigen of a pathogen.

   You have received a vaccination to stimulate protection
   Ex. (Chicken pox, flu vaccine)

   How can you get Acquired Immunity?

   - From mom
   - From a prior exposure
   - From a vaccine

Antibiotics – drugs used to help the body fight infections by killing or inhibiting the growth of microorganisms, however they DO NOT combat viruses such as HIV

Antibiotic resistance – occurs when bacteria mutate so that they are no longer affected by antibiotics, called "Super Bugs"