Bio Notes Official

TOK and EE	Notes

Unit 1 - Immunity

▼ ***Types Of Immune Cells***

1. Neutrophil
2. Eosinophil
3. Basophil
4. Monocyte
5. T Cell
6. B Cell
7. Macrophages

▼ ***Innate Immunity - Physical Barriers (1st Line Of Defense)***

Innate immunity is the type of immunity that protects the body from invading pathogens by creating a rapid immune response prompted by antigens, which activate the Innate Immune System. The Innate Immune System is always directed towards invasive species and pathogens.

The Physical Barriers help slow down the infiltration of the pathogen into the body. These physical barriers include secretions such as sweat or tears, physical “stoppers” such as mucous, and other defense systems such as saliva and stomach acid. These take place on the skin, the gastrointestinal tract, the respiratory system, the nose, the throat, body hair, eyes, and eyelashes. In cases such as mucous, tears, and sweat, the main priority is to trap the pathogens once secreted, wheras other physical barriers aim to slow down the spread of the pathogen.

▼ ***Innate Immunity - Non Specific Innate Responses (Second Line Of Defense)***

This line of defense is active once the 1st line of defense fails. It consists primarily of one action known as PHAGOCYTOSIS.

Phagocytosis occurs thanks to the type of white blood cell known as a phagocyte. Phagocytosis starts with the detection of proteins on the outer layer of the pathogen. It then anchors itself to the plasma membrane of the cytoplasm through said proteins. Afterwards, the phagocyte engulfs the bacteria, where the lysosome begins to break it down into harmless proteins and molecules. Undigested parts of the pathogen turn into an antigen known as MAJOR HISTOCOMPATABILITY COMPLEX. Also known as MHC, this antigen is used by T Cells to detect pathogens.

- ***Adaptive Immunity - Specific Adaptive Responses (Third Line Of Defense)***

  The MHC's that are transfered to the T cells alarm the immune system, causing B cells to form antibodies depending on the antigen recieved. If the B cells are unable to respond or produce antibodies, Helper T cells start a cell-mediated response in which killer T Cells secrete cytokines kill the cell completely.

  In cellular immunity, a killer T cell recognizes and kills a virus-infected cell because of the viral antigen on its surface, thus aborting the infection because a virus will not grow within a dead cell.

- ***Pathogens***

  - Bacteria

    Bacteria are simple celled organisms with a cilia and a flagella for travelling and anchoring. The cytoplasm contains the nucleoid, which is the genetic information of the bacteria. The Bacteria has a cell wall, which surrounds the capsule, which contains the cytoplasm and the organelles.

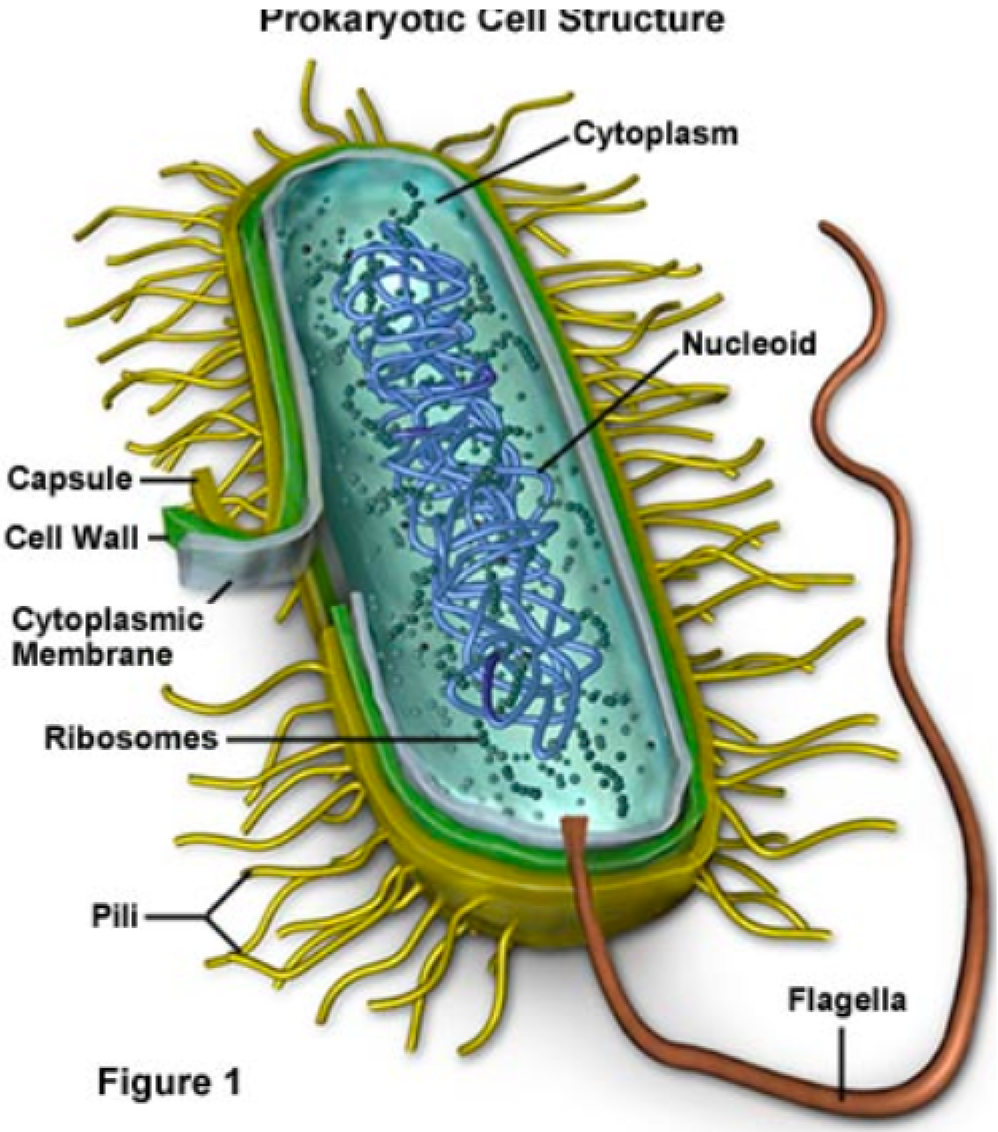
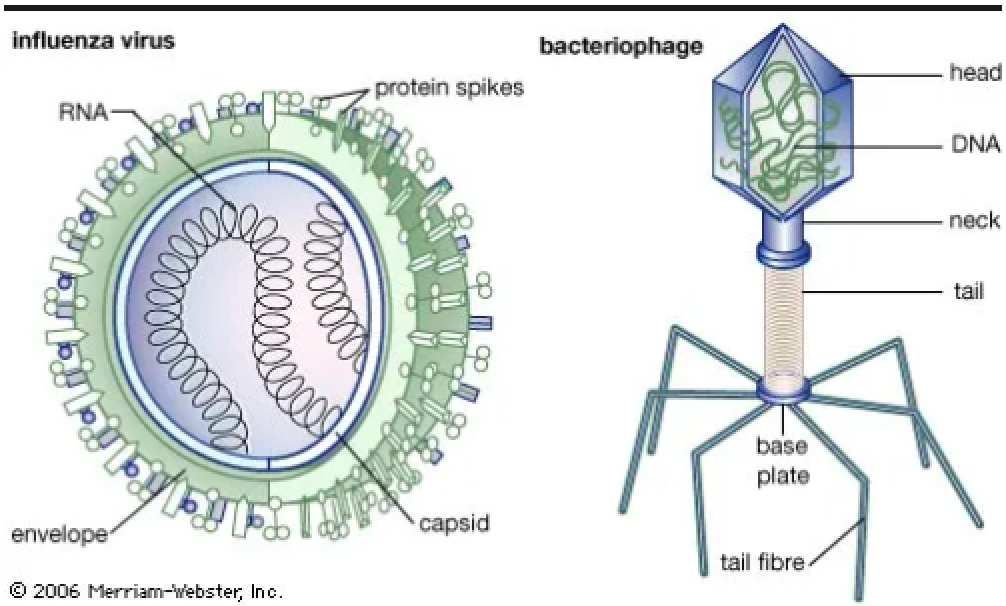


Figure 1

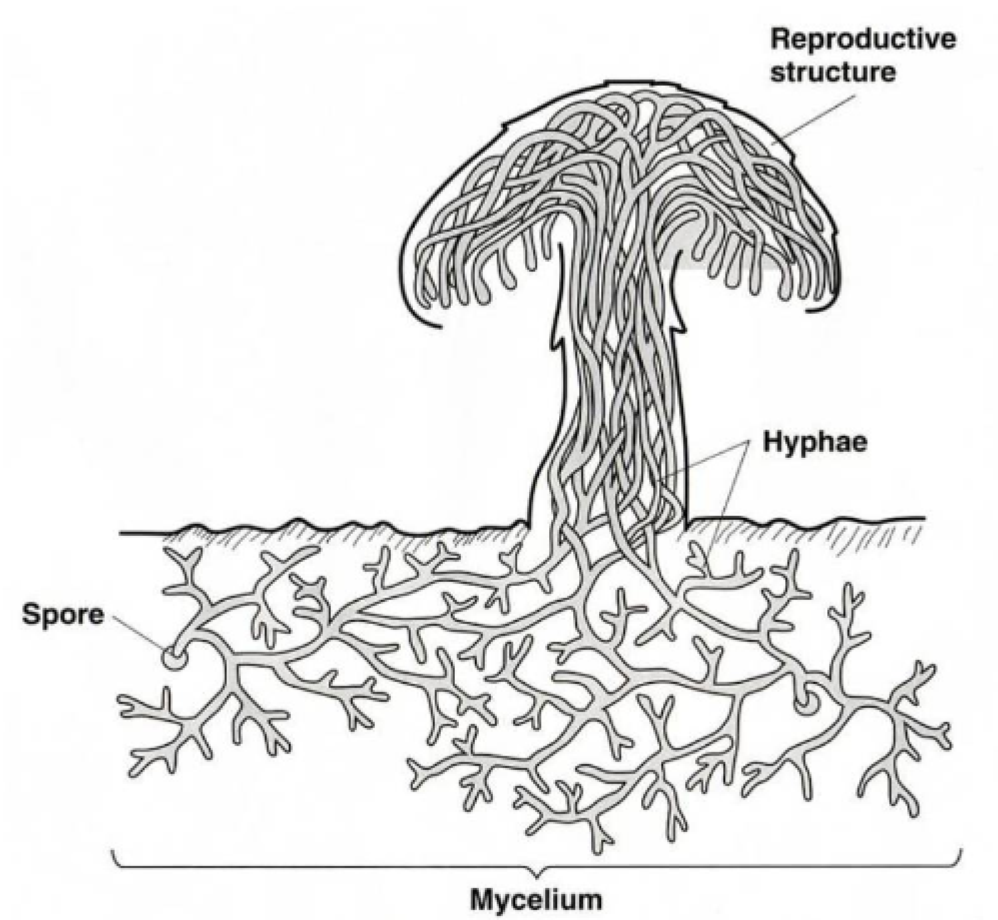
▼ Viruses

Spikes and proteins protect the elements in a virus and they surround an envelope, which contains a nucleocapsid, which stores either DNA or RNA. The DNA and RNA includes genetic information for replicating. Viruses are microscopic infectious agents that can only replicate inside the living cells of an organism. They consist of genetic material (either DNA or RNA) encapsulated in a protein coat. Unlike bacteria, viruses are not considered living organisms because they cannot carry out essential metabolic functions on their own and rely on host cells to reproduce. When a virus enters a host cell, it hijacks the cellular machinery to produce more virus particles, which can then infect other cells. This process can cause various diseases in humans, animals, plants, and even bacteria.



▼ Fungi

Multicellular organisms which have cell walls. Fruiting Bodies are responsible for making spores. The said spores are responsible for the reproduction of fungi. Mycelium, or the so called roots of the fungi, absorbs nutrients for nourishment. Mycelium is created by Hyphae, which makes a sort of exoskeleton for the fungi.



- ***Must Know Diseases***
  - HIV

    Also known as Human Immunodeficiency Virus, this is a viral disease caused by sexual intercourse. It weakens the immune system. This allows for a pathogen to easily infect a person, and, since there is no proper immune system left to fight these infections, the body fails to defend against them. This leads to Acquired Immunodeficiency, also known as AIDS. It is transmitted by intercourse with a person, whos' fluids such as gamete fluids enter another persons body. It also occurs due to blood transfusions, although these cases are very unlikely. There is no cure for HIV, however, the life of an HIV paitent can be maintained through proper care.

  - Measles

    Measles is a respiratory infection spread from person to person through the spread of respiratory droplets produced when an infected person sneezes or coughs. Measles can also spread when an infected person breathes, making it highly contagious. Symptoms of measles include high fever, cough, runny nose, red and watery eyes, and rashes all over the body. There are no specific medications for measles, however, the body can fight off the virus in 2 to 3 weeks at minimum.

▼ Malaria

Malaria is a dangerous viral disease which occurs when a protozoa infects a mosquito which feeds on humans. This is why Malaria can be considered a protozoan disease. Symptoms include high temps, headaches, muscle pains, fever, yellow skin, etc. Malaria is treated with prescription drugs to kill the protozoa..

▼ Polio

Polio is a viral infection which occurs due to contact with contaminated feces or contaminated water and food. Polio can spread from contact as well. Polio is an incredibly dangerous virus. 1 out of 4 infected people will show symptoms of the virus. These symptoms are a lot like flu symptoms - cold, cough, nausea, headache, etc. A small proportion will also develop dangerous symptoms that can damage the brain. One of these symptoms is paralysis, which is permanent disability or death. 2 out of 10 of 100 people who have paralysis due to polio die, as the virus affects muscles required for breathing such as the diaphragm. There is no treatment for polio.

▼ Cholera

An acute disease caused by the contamination of water with feces. It is generally not threatening, however, in the past, it has been life threatening to European towns. Symptoms of Cholera include vomiting, thirst, etc. Doctors look for dehydration indications in the body when treating cholera. If left untreated, in can lead to kidney failure, shock and coma. It could also lead to death within a certain amount of hours. Several Antibiotics can be used to treat cholera as they are effective against it.

▼ ***Treatment***

▼ *Principles Of Treatment*

- ▼ *Principles Of Prevention*
- ▼ *Antibiotics*
- ▼ *Vaccines*

Unit 2 - Biomolecules

▼ ***Biomolecules***

▼ **Vocabulary**

Polarity - Distribution of charge around the molecule

Non Polar Molecules - Charge is evenly distribution, forms between non metals with same electronegative value. May contain any type of chemical bond but the partial charges cancel each other out.

Polar Molecules - Has regions of partial charge, forms between atoms of elements with different electronegative value, and contain covalent or ionic bonds that are arranged so their partial charges do not cancel each other out.

Polar Molecules - Water, NH3 (ammonia), SO2 (Sulfur Dioxide), Hydrogen Sulfide (H2S), Ethanol (C2H6O)

Non Polar Molecule - Noble Gases, Homonuclear Diatomic Elements: H2, N2, O2, Cl2, CO2, Benzene (C6H6), Carbon Tetrachloride (CCL4), Methane (CH4), Ethylene (C2H4)

Hydrophobic Compound - Compounds that do not dissolve in water. Most of these are Non Polar molecules, and exmaples of those are fats, lipids, and oils.

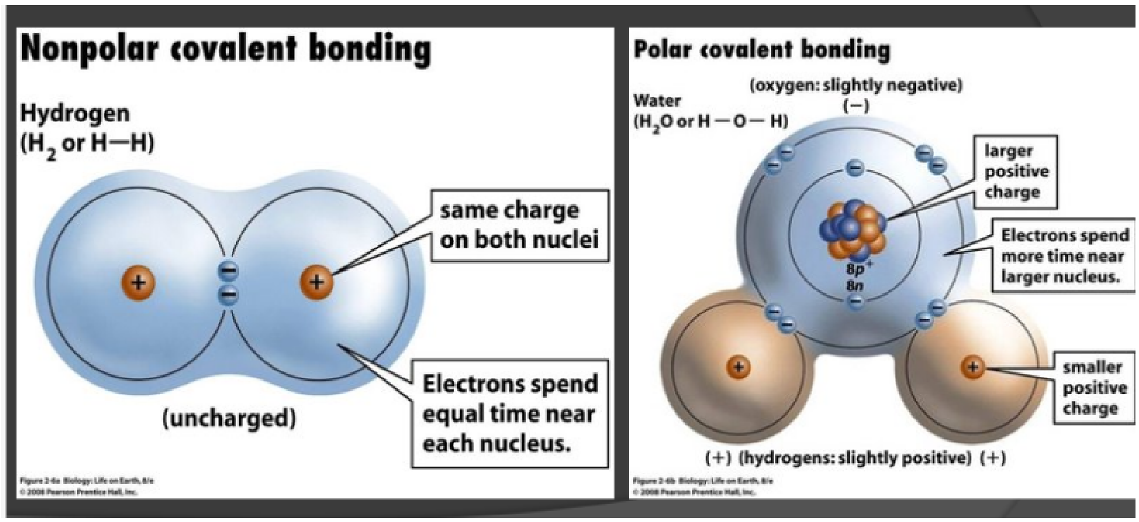
Hydrophilic Compound - Compounds that dissolve in water readily. These have Ionic Compounds and are polar molecules. For example, Alchohol and Sugars.

Monomers - Small molecules/compounds that come together to form a polymer.

Polymers - Chains of Monomers.

Hydrolysis - Process by which polymers can be broken apart or digested to obtain their monomers and the energy inside of them.

Polymerization or Condensation - Process by which polymers can be built or synthesized by the cells to complete certain tasks and store energy for later use.



▼ Chemical Bonding In Life

Covalent Bonds - Between non metals and non metals. Occur between atoms of the same molecule.

Hydrogen Bonds - Hold together two strands of DNA together. Present between molecules of water.

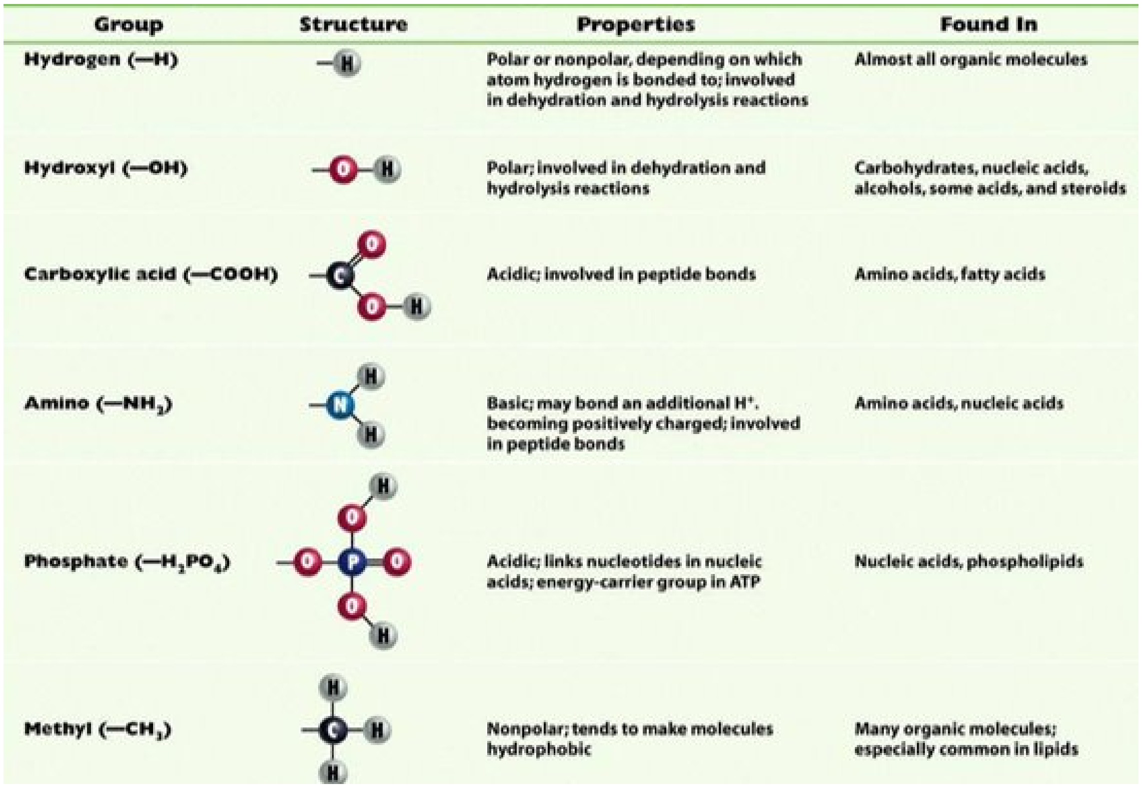
Peptide Bonds - Between amino acids in a polypeptide chain.

Phosphodiester Bonds - Present between different nucleotides of DNA.

Ester Linkages - Between fatty acids and glycerol leading to triglycerides.

Glycosidic Linkages - Smaller sugar molecules which are part of larger sugar molecules.

▼ Functional Groups In Biomolecules



Group	Structure	Properties	Found In
Hydrogen (—H)		Polar or nonpolar, depending on which atom hydrogen is bonded to; involved in dehydration and hydrolysis reactions	Almost all organic molecules
Hydroxyl (—OH)		Polar; involved in dehydration and hydrolysis reactions	Carbohydrates, nucleic acids, alcohols, some acids, and steroids
Carboxylic acid (—COOH)		Acidic; involved in peptide bonds	Amino acids, fatty acids
Amino (—NH_2)		Basic; may bond an additional H^+, becoming positively charged; involved in peptide bonds	Amino acids, nucleic acids
Phosphate (—H_2PO_4)		Acidic; links nucleotides in nucleic acids; energy-carrier group in ATP	Nucleic acids, phospholipids
Methyl (—CH_3)		Nonpolar; tends to make molecules hydrophobic	Many organic molecules; especially common in lipids

▼ **Organic And Inorganic Compounds**

Organic - Contains C and H. Usually larger than inorganic molecules, organic molecules dissolve in water. Examples of these are Carbs, Proteins, Lipids, and Nucleic Acids. All organic molecules are a polymer chain of a certain amount of monomers.

Inorganic - Do not contain C. Theyre usually smaller than organic molecules, and they dissociate in water to form ions. Water and Oxygen are examples of these.

▼ **Biomolecules fr this time**

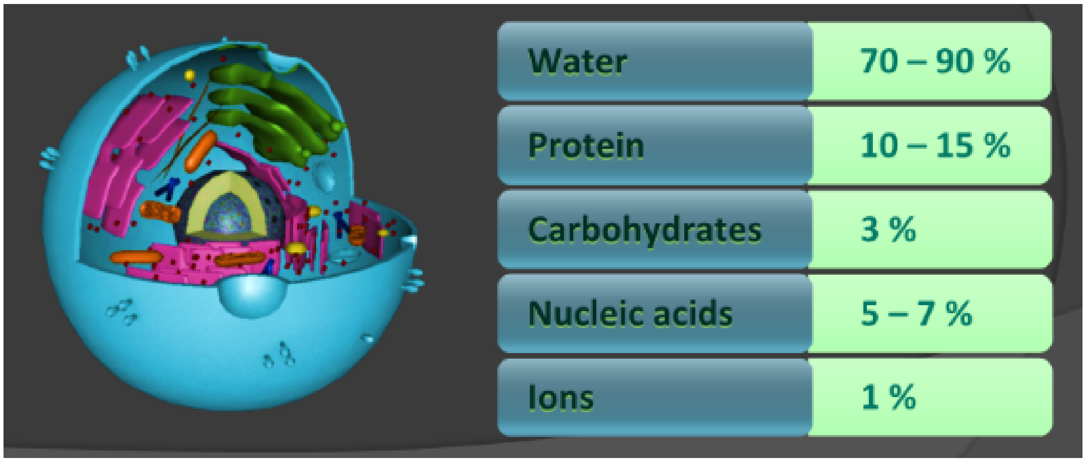
▼ *Types Of Biomolecules*

Biomicromolecule - They are small in size, have low molecular weight, simple structures, and are highly solluble in intracellular fluid. They consist of the Inorganic and Organic Molecules.

Biomacromolecule - Large in size, have high molecular weight, complex structures, and are insoluble in intracellular fluid.

▼ *Elements in Biomolecules*

All biomolecules contain Hydrogen. Inorganic Compounds contain only hydrogen, so carbon is another secondary element.



ELEMENT	% WEIGHT OF	
	EARTH'S CRUST	HUMAN BODY
Hydrogen (H)	0.14	0.5
Carbon (C)	0.03	18.5
Oxygen (O)	46.6	65.0
Nitrogen (N)	Very little	3.3
Sulphur (S)	0.03	0.3
Sodium (Na)	2.8	0.2
Calcium (Ca)	3.6	1.5
Magnesium (Mg)	2.1	0.1
Silicon (Si)	27.7	Negligible

▼ *Biomicromolecules*

Molecular Weight of Biomicromolecules range from 18 to 800 Dalton.

▼ **Amino Acids**

They are formed of an amino group (-NH2), a carboxylic acid group (-COOH), Hydrogen and a Variable Group (R). They are substituted methane's. The variable groups change according to the type of amino acid.

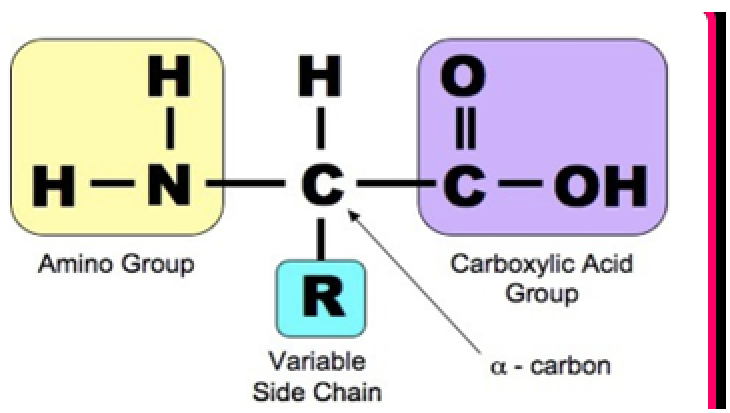
The Variable Group R changes depending on the amino acid. For instance, the R group in Glycene is a Hydrogen, wheras the R group in Alanine is CH3.

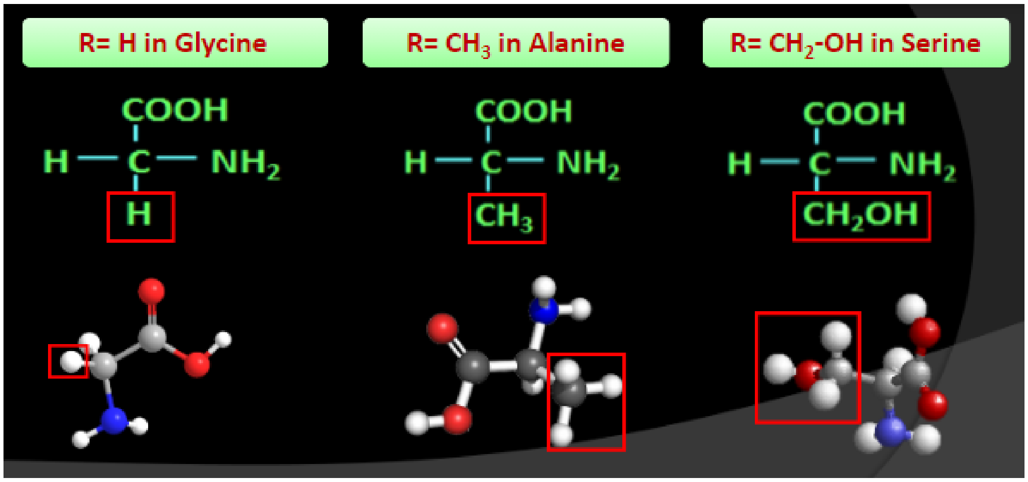
There are 3 types of Amino Acids - Acidic, Basic, and Neutral. These are obviously based on their ph values.

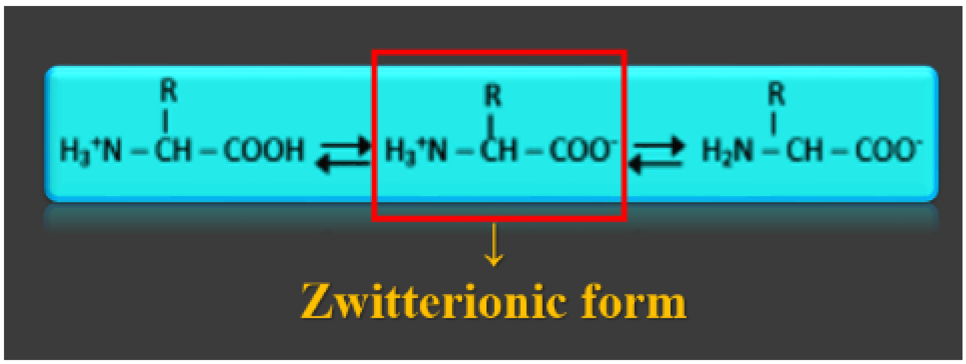
They can also be classified as Essential and Non Essential Amino Acids.
Essential Amino Acids - Cannot be synthesized by the body and need to be supplied through the diet.

Non-Essential Amino Acids - They can be synthesized through the body.

Amino acids are ionizable in nature, specifically the amino and carboxylic group. Because of this condition, the ph of an amino acid changes the structure of the said amino acid. When the Amino and Carboxylic group are ionized, the Amino Acid is called a Zwitterion.







▼ **Lipids**

Being water insoluble, these biomicromolecules consist of C, H, and O, but the Oxygen in Lipids is less compared to Carbon and Hydrogen.

▼ Simple Lipids

Simple lipids are formed of Fatty Acids and Alchohols, such as Glycerol.

They are made using a variable hydrocarbon chain, also known as an R group, and a carboxylic acid group.
The formula for the simple lipids is R-COOH.

- ▼ Compound Lipids

  These are esters of fatty acids and alcohol, with additional groups, including phosphate. Compound lipids are most prominently found in cell membranes.

  Phospholipids are a compound lipid which is comprised of fatty acids, glycerol, and a phosphate group.

- ▼ Derived Lipids

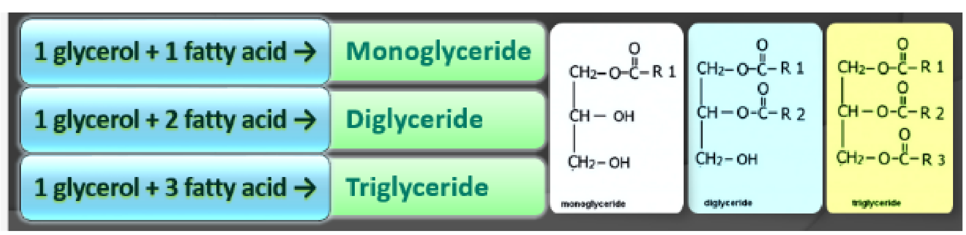
  Derived lipids are a product of hydrolysis of simple and compound lipids.

  Cholesterol is an example of a derived lipid which is known to be dangerous to health.

- ▼ Fatty Acids

  You can make simple lipids with two types of fatty acids:
  1. Saturated Fatty Acids - Those with no double or triple bonds between carbon atoms.
  2. Unsaturated Fatty Acids - Those with one or more double bonds between carbon atoms.

  Fatty Acids are esterfied with glycerol through an ester bond, forming monoglycerides, diglycerides, and triglycerides, which are lipids.

- ▼ Another Classification For Lipids

  Fats - Lipids with higher melting point

  Oils - Lipids with lower melting point

▼ **Sugars**

Sugars are a sweet, water soluble carbohydrate. They are formed with C, H, and O, with a atom ratio of 1:2:1, meaning there is 1 carbon and 1 oxygen for 2 hydrogen.

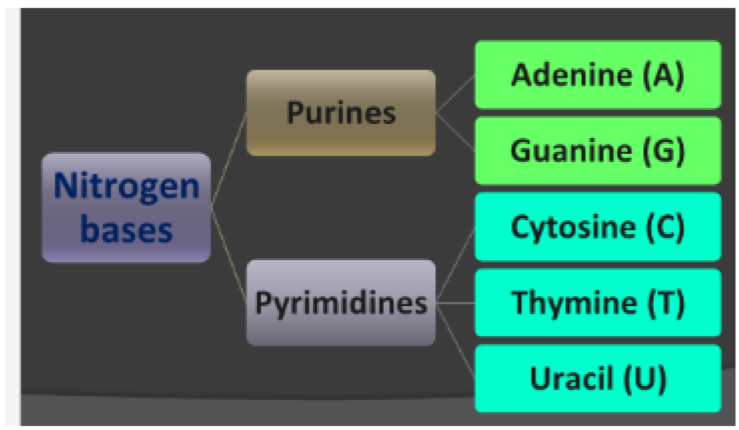
▼ Nitrogen Bases and Nucleotides.

Nitrogen Bases are cyclic compounds which contain nitrogen. They are found in nucleic acids.

Nitrogen Bases come together with sugar to form a Nucleoside. For example, Adenine combines with sugar to form adenosine.

This nucleoside links with a phosphate, forming a Nucleotide. For example, an Adenosine + Phosphate gives Adenylic Acid.

Nucleotides are heterocyclic compounds which make up DNA and RNA, which are Nucleic Acids.



N. base + Sugar →	Nucleoside
Adenine + Sugar →	Adenosine
Guanine + Sugar →	Guanosine
Cytosine + Sugar →	Cytidine
Thymine + Sugar →	Thymidine
Uracil + Sugar →	Uridine

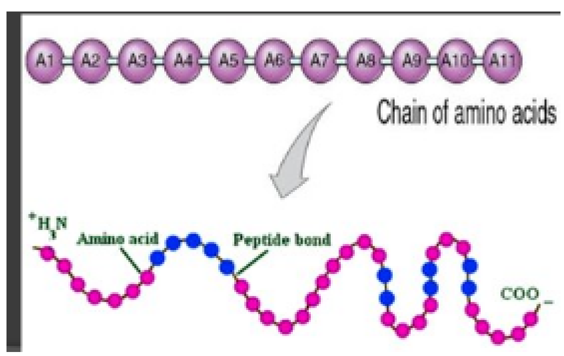
N. base + Sugar + Phosphate →	Nucleotide
Adenine + Sugar + Phosphate →	Adenylic acid
Guanine + Sugar + Phosphate →	Guanylic acid
Cytosine + Sugar + Phosphate →	Cytidylic acid
Thymine + Sugar + Phosphate →	Thymidylic acid
Uracil + Sugar + Phosphate →	Uridylic acid

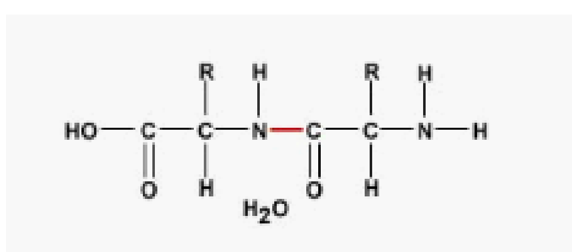
▼ *Biomacromolecules*

Biomacromolecules have a molecular weight greater than 1000 Da. They are also polymers of Biomicromolecules.

▼ Proteins

Proteins are a heteropolymer of Amino Acids. They are polypeptides, meaning they are linear chains of amino acids chained together by peptide bonds. A peptide bond is formed when a Carboxylic Group of one amino acid reacts with an Amino Group of the next amino acid by releasing a molecule of water.



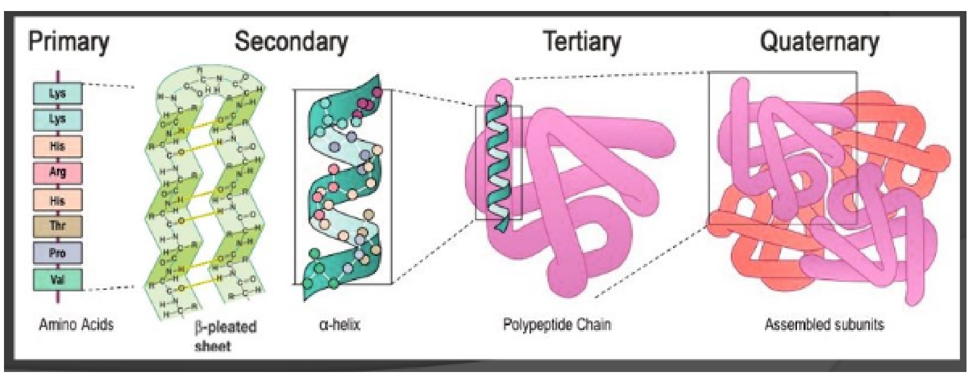


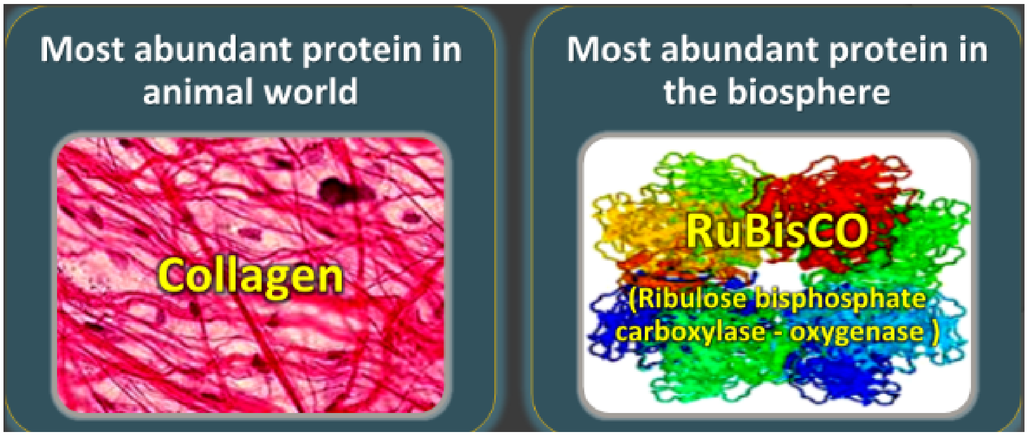
The functions of protein are for:

1. Growth And Tissue Repair
2. Transporting Nutrients Across Cell Membranes
3. Acting as an intercellular ground substance
4. Acts as antibodies to fights infectious organisms
5. Acts as receptors
6. Some are hormones, enzymes, pigments, etc.

▼ Structural Levels Of Protein

1. Primary Structure - It describes the sequence of amino acids, meaning the positional information in a protein.
2. Secondary Structure - Here, one or more polypeptide chains are folded in the form of a helix.
3. Tertiary Structure - Here, helical polypeptide chain is further folded like a hollow woolen ball.
4. Quaternary Structure - Here, more than one polypeptide chains form tertiary structure and each chain functions as subunits of protein.





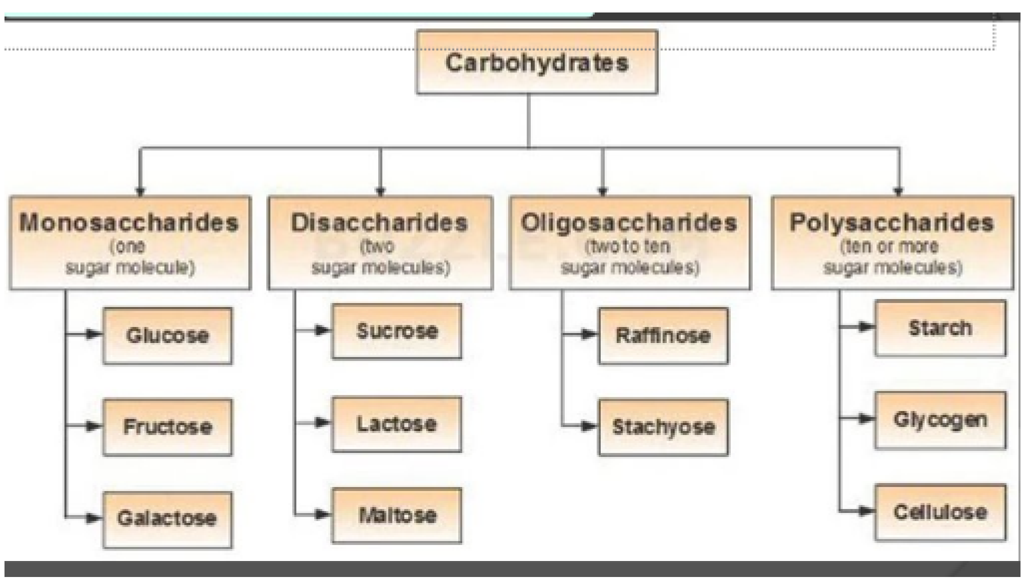
▼ Polysaccharides

Polysaccharides are polymers of sugars. Examples of these are Starch, Cellulose, Glycogen, and Inulin.

Glycogen and Cellulose are specifically heteropolymers of Glucose.

Although some polysaccharides are polymers of sugars, some also are formed of amino-sugars. These types of polysaccharides are the most complex of them all, and they sometimes form exoskeletons for some fungi/athropods.

Glycosidic Bonds are formed when two sugars come together to form a polysaccharide. This bond removes an H2O Molecule.



▼ Nucleic Acids

Nucleic Acids are a heteropolymer of Nucleotides, meaning that many nucleotides come together to form a polynucleotide, also known as a Nucleic Acid.

There are 2 types of Nucleic Acids:

1. DNA (Deoxyribonucleic Acids)
2. RNA (Ribonucleic Acids)

▼ Secondary Structure Of DNA

DNA consists of 2 Polynucleotide Strands arranged antiparallelly as a double helix. This structure of DNA was proposed/discovered by Wattson and Crick.

In DNA, a nucleotide consists of a Nitrogen Base, Deoxyribose Sugar, and A Phosphate Group.

The Backbone/ladder of the DNA is formed by the Sugar-Phosphate-Sugar chain. The Steps of the Ladder are formed thanks to the Nitrogen Base Pairs.

ADENINE

THYMINE

GUANINE

CYTOSINE

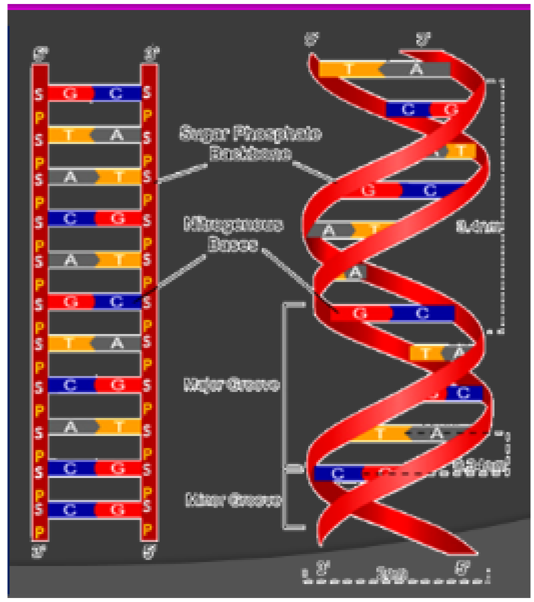
The bonding always goes:

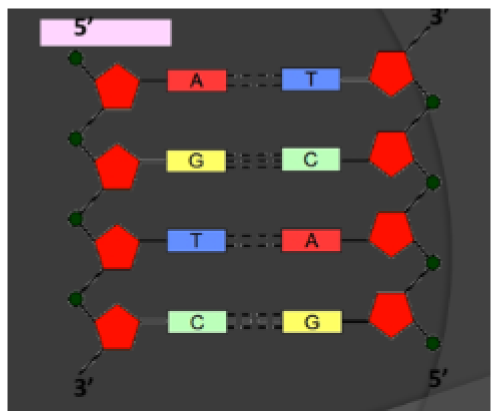
AT (by 2 Hydrogen Bonds)

CG (by 3 Hydrogen Bonds)

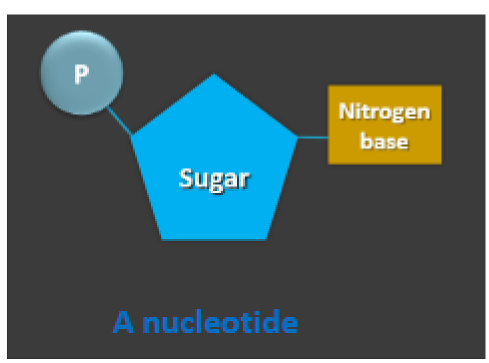
A phosphate molecule links the 3′ carbon of the sugar of one nucleotide to the 5′ Carbon of the sugar of the next nucleotide. These are formed using an Ester Bond. Since there are two on each side, this is called a phosphodiester bond.

The bond between the sugar and the nitrogen base is called an N-Glycosidic Bond.





One full turn has 10 steps (10 base pairs). Length Of One Full Turn is 34 A (but swedish), and at each step the strand turns 36 degrees (360 degress for a full turn)



- Lipids????

  Although Lipids are strictly not a macromolecule, since their weight does not exceed 800 Da, it comes under a Biomacromolecule because many lipids are arranged into structures like cell membranes. When a tissue is grinded, cell membranes are broken and form water insoluble vesicles. They cannot be filtered along acid soluble fraction.

Metabolism

- All biochemical reactions taking place inside a living system together constitute to metabolism. Digestion, Respiration, nutrition, etc.
- The intermediate products of metabolic reactions are called Metabolites. The flow of metabolites in metabolic pathways has a definite rate and direction. This metabolite flow is called dynamic state of body constitutients.
- Types of Metabolites

  Primary - They have identifiable functions in physiological processes and necessary for life. (Amino Acids, Sugars, Nucleic Acids, Lipids, Vitamins)

  Secondary - They are not directly involved in normal growth, development, or reproduction. They are found in plants, fungal and microbial cells.
- Types Of Metabolic Pathways

  Anabolic - Simpler molecules form complex structures. This consumes energy.

  Catabolic - Complex molecules become simple structures. This releases energy.
- Digestion
- Respiration

Enzymes

Enzymes are biological catalysts which influence the speed of biochemical reactions. All enzymes are proteins, but not all proteins are enzymes. Enzymes react with a specific substrate through the lock and key method to produce a product, where the lock is the enzyme, with a specific site which fits the key, being the substrate. The hole in the lock is the active site.

The main goal for enzymes is to speed up a reaction without losing energy/destroying the enzyme. This leads to 10k times more yield when using an enzyme than without one.

▼ Lock And Key Model

1. Substrate binds to the active site of enzyme.
2. This induces some changes in enzyme so that the substrate is tightly bound with active site of enzyme to form enzyme-substrate complex.
3. The active site breaks chemical bonds of substrate to form Enzyme-product complex.
4. The enzyme releases the products and the free enzyme is ready to bind to other molecules of the substrate.

▼ Concept Of Activation Energy

Activation energy is the additional energy required to start a chemical reaction. In an exothermic or endothermic reaction, the substrate must go through a much higher energy state. It is called transition state energy.

Enzymes reduce the activation energy required to start the chemical reaction. As a result, the speed of the reaction increases.

▼ Factors effecting Enzyme Activity

1. Temperature - All enzymes have a specific temperature at which they work optimally. Any higher, however, the enzyme activity starts to decrease as higher temperatures would cause it to denature. At cooler temperatures, enzymes are temporarily inactive.
2. pH - in the same way, enzymes work optimally at different pH levels.
3. Concentration Of Substrate - With the increase of concentration of substrate, the velocity action rises at first, reaching a maximum velocity at Vmax. After this, the enzyme activity does not increase, as

there are no free enzyme molecules to bind with additional substrate molecules.

4. Presence of inhibitors - Inhibitors are similar to substrates and they compete with the substrate for the binding site of the enzyme, which causes the substrate to not bind and the enzyme reactivity declines.

- ***Photosynthesis***
  - What is it
    - It is a physico-chemical process by which green plants use light energy (solar energy) to synthesis organic compounds. This is the basis of life on earth as Plants are the basic autotrophs on land. All living forms are dependant on sunlight for energy.
    - The importance of photosynthesis:
      a. Primary source of food on earth
      b. Releases oxygen into the atmosphere
    - Photosynthesis is often associated with the actions of the green pigment known as chlorophyll in the leaf.
  - Equations

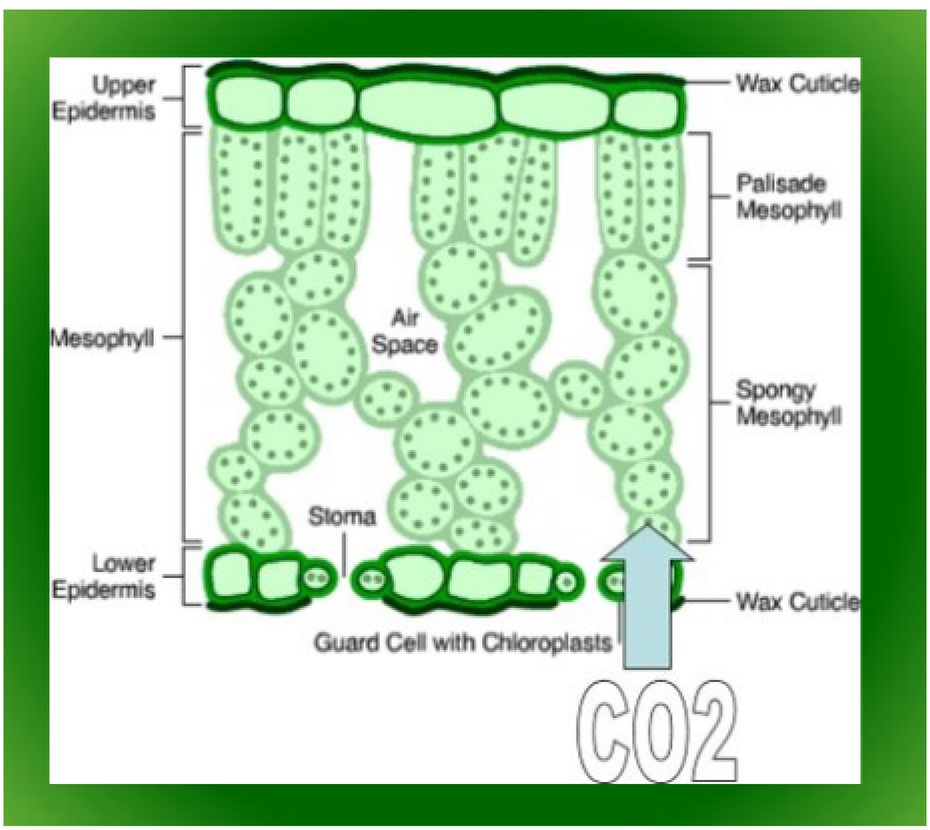
    An equation was devised by Cornelius Van Niel which states that:

    $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$

    This is the overall correct eq for photosynthesis.
  - Leaf
    - The leaf is the part of the plant known for housing photosynthesis factories, specifically chlorophyll.
    - Cellular Respiration is the process by which cells use sugar to release stored energy.
    - Leaf Structure
      - Epidermis - Covers the upper and lower parts. The upper epidermis is the outer layer of cells that covers the leaf, forming the

boundary separating the plants inner cells from the external world. It protects against water loss, regulates gas exchange, and absorbs water in some species. The Lower Epidermis contains pores called Stomata which are surrounded by chloroplast-containing Guard Cells. These stomata regulate gas exchange between the air and the interior of the leaf. There is a higher number of these in the lower epidermis than the upper.

- Mesophyll - Part of the leaf that is inside it and is rich in chloroplasts. The Mesophyll consists of the 2 types of leaf cells, the spongy and the palisade which have a cell wall, a nucleolus, and a chloroplast suspended in a cytoplasm. The palisade layer has a lot more chloroplasts, whereas the spongy layer does gas exchange and carbon dioxide absorption.
- Veins - Vascular Tissue. Theyre made out of Xylem and Phloem, which bring water and minerals from the roots into the leaf and move sap with dissolved sucrose out of the leaf respectively.

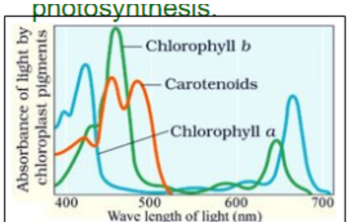


- ▼ Photosynthesis fr this time
  - ▼ Sites and Pigments
    - Chloroplasts - photosynthesis takes place in green leaves and other green parts of the plants. Chloroplasts give the plant its green color which it is often associated with. They help to get the optimum quantity of incident light. The chloroplasts contains a membranous system, which consists of grana, stroma, lamellae, and fluid stroma. Grana are made of granum, which is a group of membrane bound sacs called thylakoids which contain the leaf pigments.

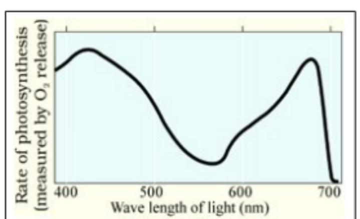
      This membrane system is important as it allows the leaf to trap light energy and synthesize ATP and NADPH. These are called light reactions. In the stroma however, enzymatic reactions incorporate CO2 into the plant for synthesizing sugar, which in turn forms starch, making a dark reaction.
    - Pigments involved in photosynthesis:
      - Chlorophyll A - Bright or Blue Green

      - Chlorophyll B - Yellow Green
      - Xanthophylls - Yellow
      - Carotenoids - Yellow/Yellow Orange.

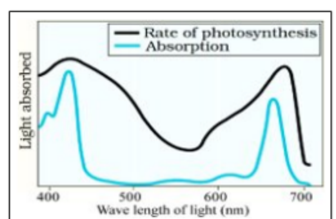
      These are accessory pigments. They absorb light at a different wavelength depending on the pigment and transfer the energy to chlorophyll a.



Graph showing absorption spectrum of chlorophyll *a*, *b* & carotenoids.



Graph showing action spectrum of photosynthesis.



Graph showing action spectrum superimposed on absorption spectrum of chlorophyll *a*.

▼ Photosystems

Photosystem 1 - Also known as P700 as it absorbs 700nm light.
Photosystem 2 - Also known as P680 as it absorbs 680nm light.

both systems have chlorophyll A and accessory pigments.

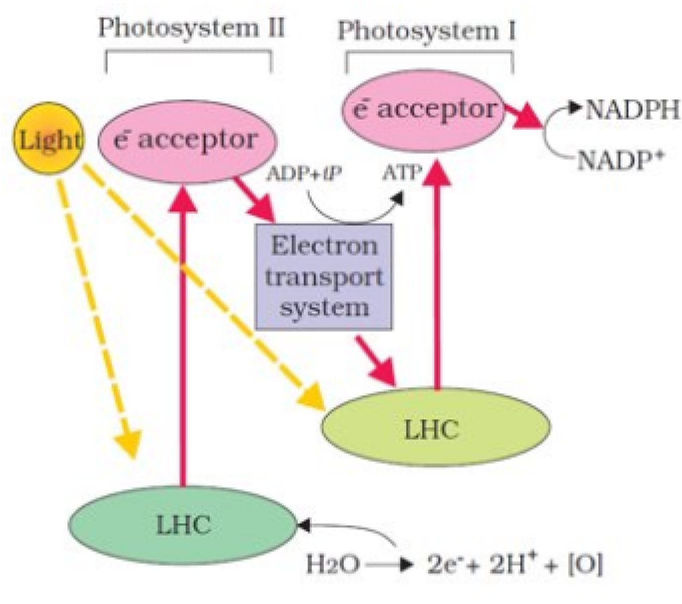
▼ Photochemical Phase (light reactions)

Light Reactions include:
- Light absorption
- Water Splitting
- Oxygen Release
- Formation of ATP and NADPH.

▼ Stages

1. When PSII absorbs red light of 680 nm wavelength, the electrons are excited and transferred to an electron acceptor.
2. This electron acceptor passes them to a chain of electrons transport system. The movement of the electrons is downhill, and the pigments at PS1 accepts these electrons.
3. While this is happening, PS1 electrons are also excited at 700 nm of light, leading to those electrons being transferred to another accepter molecule. These electrons are moved downhill to a molecule of NADP+, which, as a result, is reduced to NADPH + H+.
4. In PS2, the Water Splitting Complex in the inner side of the thylakoid membrane splits Water into H+, O, and electrons. Using this method, PS2 can provide electrons continuously to replace those removed from PS1 during the 700nm excitement. The H+ that is formed, which are basically protons, are used to reduce NADP to NADPH. O2 is liberated by-product of photosynthesis.

Photophosphorylation is the process by which the synthesis of ATP by cells in the mitochondria and the chloroplasts occurs. This converts ADP into ATP in the presence of light.



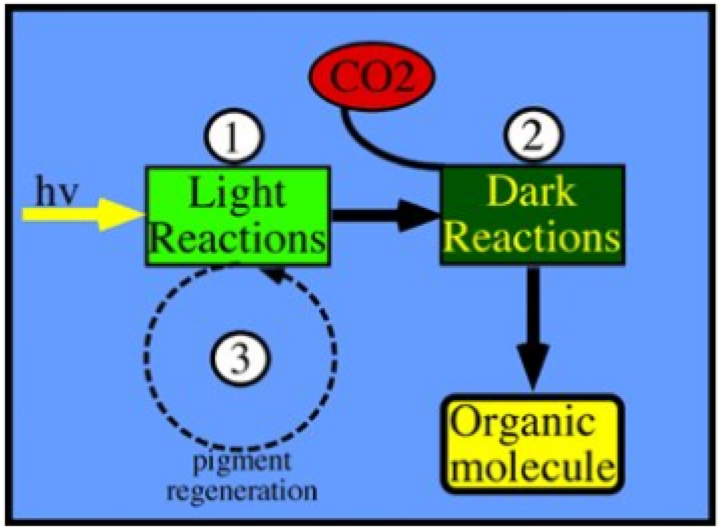
Z scheme of light reaction

▼ Biosynthetic Phase (Dark Reaction, uses ATP and NADPH)

Although this reaction is called Dark Reactions, they do not directly depend on the light but are dependent on the products of the light reaction. It uses ATP and NADPH to drive the processes for the synthesis of food.

This phase assimilates CO2, which can be done by C3 pathway or C4 Pathway.

In a dark reaction, RUBISCO is an enzyme which is used to stimulate stuff.



▼ Factors Affecting Rate Of Photosynthesis

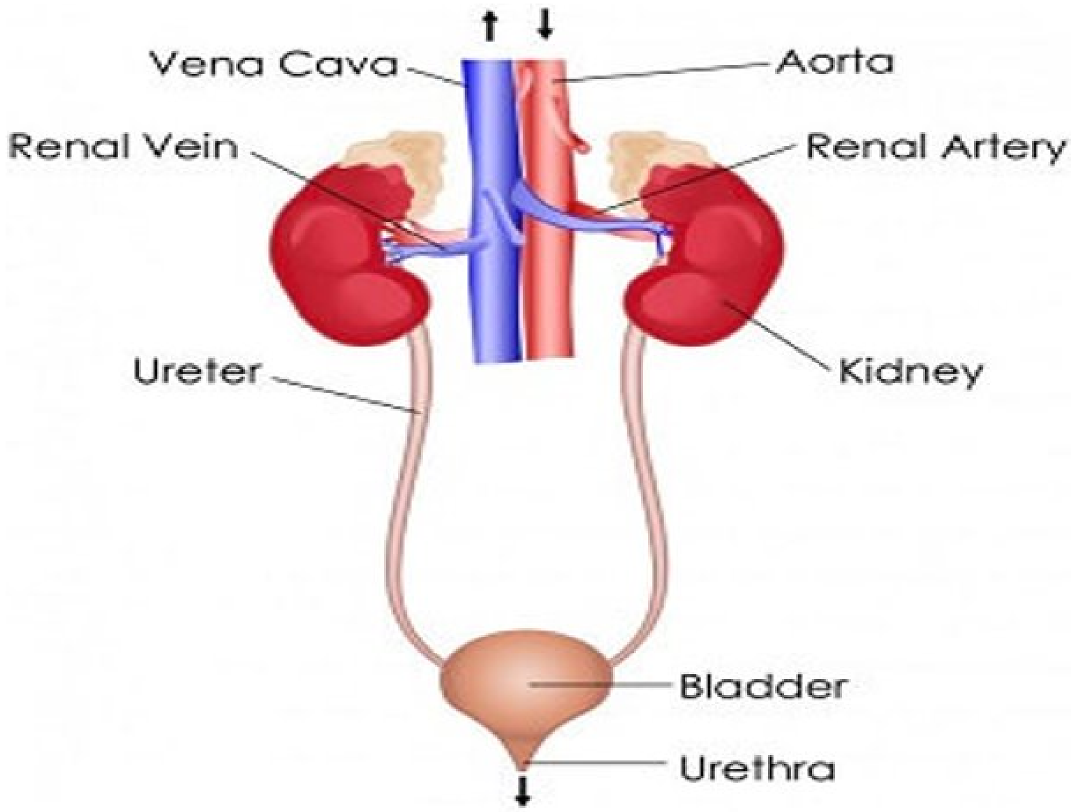
search this shit up I couldnt care less

Unit 3 - Control And Coordination

▼ Diffusion

- The process of removal of nitrogenous products (byproducts of various metabolic processes) from the body.
- Regulates the water and salt content in the blood.
- The excretory system is a system of organs and tissues that takes part in the separation, collection and elimination of waste products. Its basically a pair of kidneys, a pair of ureters, a urinary bladder and a urethra.

EXCRETORY SYSTEM IN HUMANS



▼ Excretion Products

Kidneys:

- Urea
- Uric Acid
- Ammonia
- Excess Sodium and Pottasium Ions

Lungs:

- Carbon Dioxide

▼ Parts of Kidneys

Kidneys - Filter Blood and take out urea, uric acid, etc from deoxygenated blood. Theyre a pair of reddish brown bean like structures with millions of nephrons which do the work for the kidneys. The left kidney has been placed higher than the other. The renal artery brings in blood with waste and the renal vein takes deoxygenated blood back to the heart.

Nephron - A nephron is the core filtration unit for the Kidney. There are millions of Nephrons in each kidney.

Ureters - Pass along Urine to the Bladder through Peristalsis. They are 30 cm long. Moves downward from the kidney and opens up in the bladder.

Bladder - Its a sac like structure which receives urine from the Ureters and stores 300-800 Ml of it.

Urethra - Removes Urine in the urinary bladder and disperses it outside of the human body. There is a muscular spincther between the bladder and the Urethra, which moves when the body wants to excrete.

ADH - Anti Diuretic Hormone. This hormone regulates water in the blood, in both cases of excess or less water. Sweat and salty foods reduce water in the blood. ADH is released by the pituitary gland.

Too less water - Pituitary Gland Releases ADH, ADH makes kidneys absorb less water, less water lost in the urine, water levels in the blood go back to normal

Too much water - Pituitary Gland releases ADH, ADH makes Kidneys absorb more water, more water lost in the urine, water levels in the blood go back to normal.

This is a negative feedback mechanism.

▼ Nephrons

- **Information:**

  Nephrons are the basic, structural, and functional unit of the Kidney, their job is to filter the toxin-full deoxygenated blood and are located in both the cortex and the medulla of the Kidney. There are millions of Nephrons in each kidney.

- **Structure of Nephron:**

A nephron has 3 parts:

1. Malpighian Body
2. Renal Tube
3. Collecting Duct

MALPIGHIAN BODY:

The
glomerulus is a cluster of capillaries near the Nephron which are important in the process of the filtration of un-needed waste from the deoxygenated blood. It has an **afferent arteriol**e, which brings blood with excretory products to the nephron, and an **efferent arteriole**, which carries blood from the Glomerulus. Because the Afferent Arteriole has a bigger diameter than the efferent, blood from the afferent arteriole comes in with high pressure to the efferent arteriole. It is one half of the Malpighian Body, the other halve being the **Bowmans Capsule**, whose job is to accommodate the Glomerulus.

RENAL TUBULE:

The Renal Tubule has two parts - The
Bowmans Capsule (which is also a part of this) and the proximal convoluted tubule. This **Proximal Convoluted Tubule** goes down and loops up, forming the “**loop of henle**”, leading to the **Distal Convoluted Tubule**, which opens up into the collecting duct.

COLLECTING DUCT:

The collecting duct forms a sort of pyramid like structure in the pelvis. From the pelvis, the ammonia and uric acids in the duct go down through the ureters, through the gall bladder, through the urethra, to the outside world.

- **Mechanism Of Urine Formation:**
  1. Glomerular Filtration
  2. Selective Absorption
  3. Tubular Secretion
  4. Collection

Glomerular Filtration - Due to the narrowness of the efferent arteriole, ultrafiltration occurs, leading to the expulsion of uric acid, ammonia, etc and sodium ions and water from the blood in the glomerulus to the Bowmans Capsule. The product is known as the glomerular filtrate.

Reabsorption - This glomerular filtrate passes through the PCT (Proximal Convoluted Tubule), where capillaries try to absorb much of the necessary things which was excreted - water, amino acids, calcium, etc - back into the bloodstream. This also happens in the Distal Convoluted Tubule. The amount of water absorbed is determined by the excess amount of water in the body.

Tubular Secretion - The process by which Capillaries around the Distal Convoluted Tubule provide extra waste to the tubule, such as urea, uric acid, and creatinine. Potassium and Hydrogen are also excreted to maintain the pH of the Urine.

The further concentration of Urine occurs in the collecting duct where the Anti Diuretic Hormone (produced in the body to maintain water levels) is triggered.

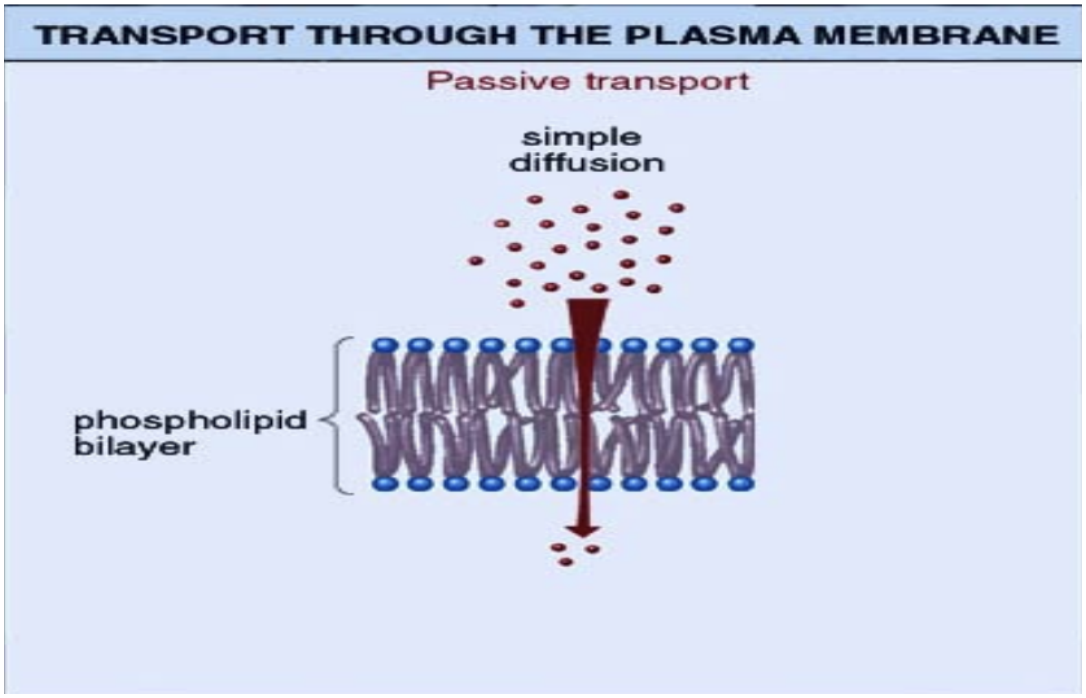
Collection - The now formed urine flows through the ureter to the bladder, where it is stored until it is released by the urethra. The Bladder is muscular, which means that it can be controlled through the nervous system, which is why we can usually stop the urge to urinate for a while.

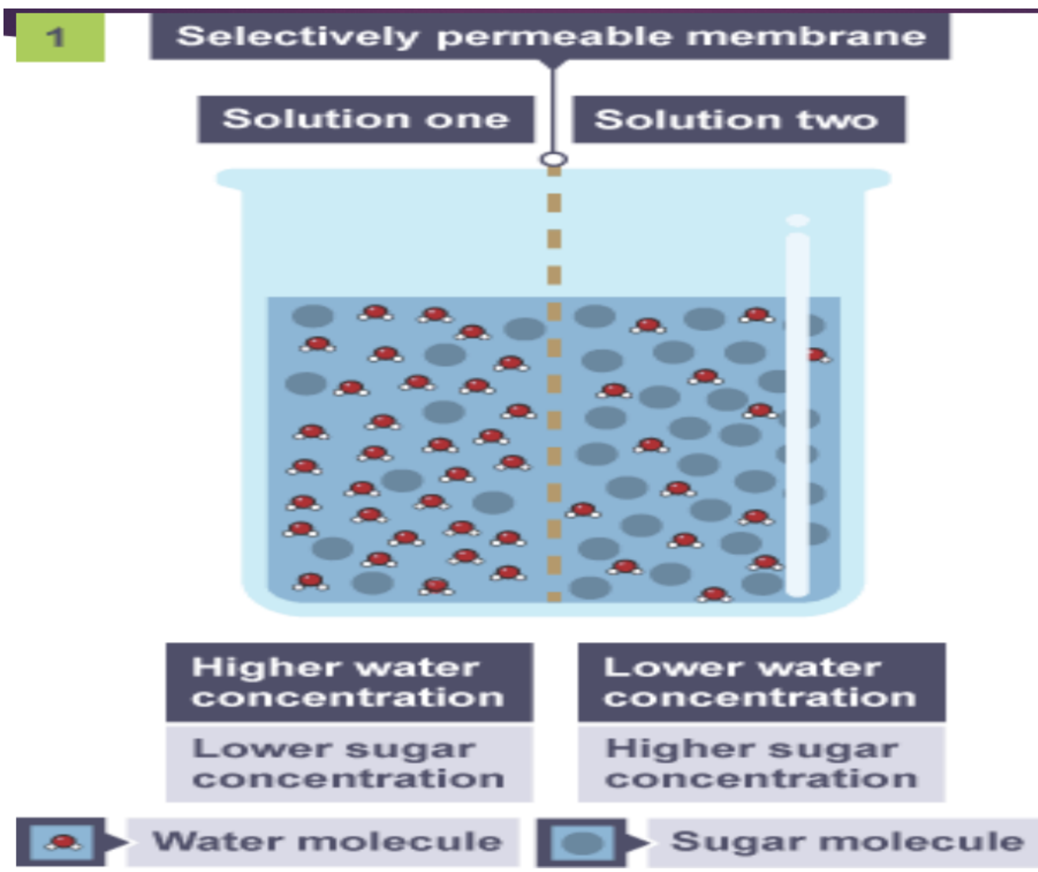
Osmosis

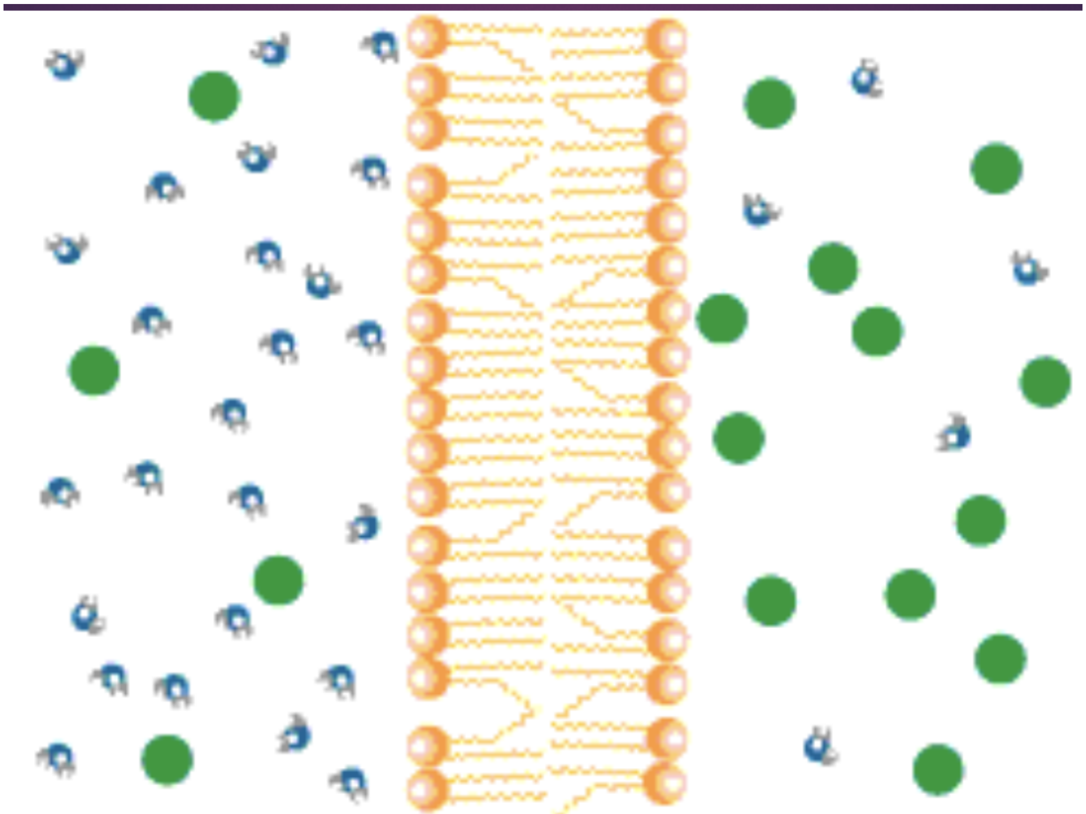
Osmosis

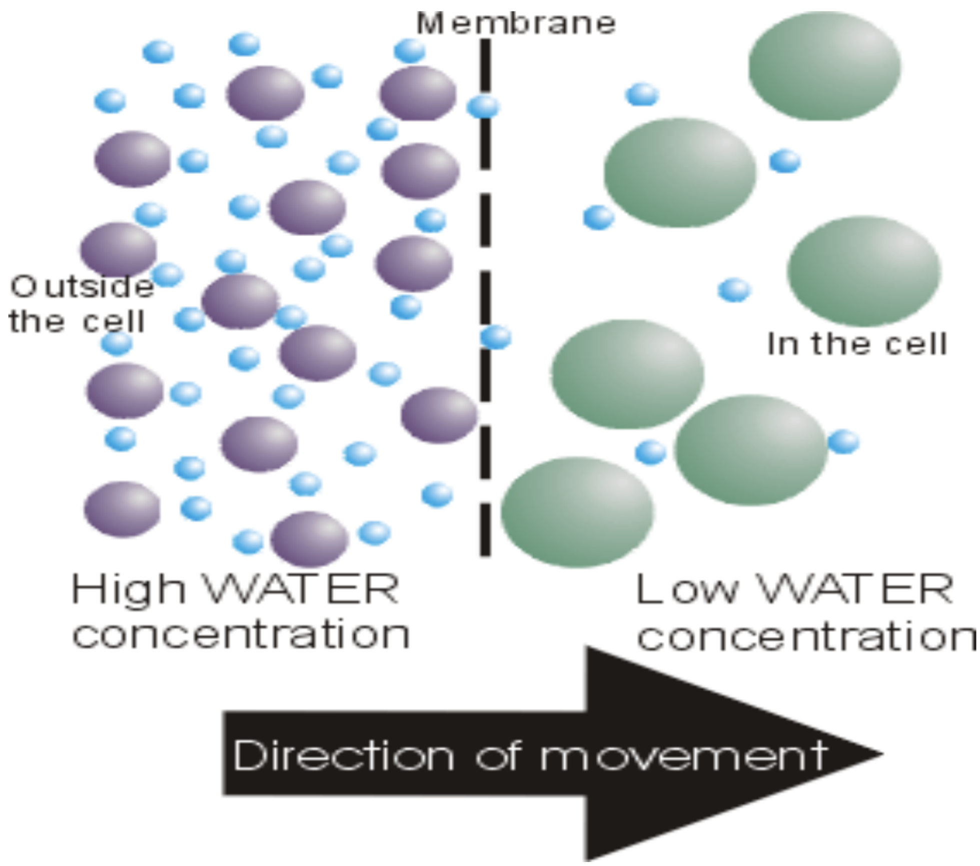
- Osmosis is a diffusion process in which water molecules move from an area of high concentration to an area of low concentration through a selectively permeable membrane.
- The selectively permeable membrane, also known as a partially permeable or semi-permeable membrane, allows some substances to pass through while blocking others.
- The concentration of water molecules is higher in a dilute solution and lower in a concentrated solution.
- Osmosis is a fundamental biological process that helps cells regulate their internal environment.

Small molecules pass through – ex: water
Large molecules can't pass through – ex: proteins and complex carbohydrates


TRANSPORT THROUGH THE PLASMA MEMBRANE
Passive transport
simple diffusion
phospholipid bilayer


1
Selectively permeable membrane
Solution one
Solution two
Higher water concentration
Lower sugar concentration
Lower water concentration
Higher sugar concentration
Water molecule
Sugar molecule





▼ Endosmosis

1. Definition: The movement of water from a lower solute concentration to a higher solute concentration through a selectively permeable membrane.
2. Mechanism: In endosmosis, water flows into cells or tissues through the membrane in response to a concentration gradient, which results in the cells or tissues becoming turgid, or swollen.
3. Examples:
   a. The water uptake by plant cells through their semi-permeable membrane leads to turgor pressure and maintenance of the plant's shape.
   b. The water uptake by red blood cells in the human body through their semi-permeable membrane.

▼ Exosmosis

1. Definition: Exosmosis is the process of diffusion of solvent (usually water) from a region of high concentration to a region of lower concentration through a selectively permeable membrane.
2. Mechanism: Exosmosis occurs when the concentration of solute is higher inside a cell than in the surrounding environment. This creates an osmotic pressure, which drives water out of the cell.
3. Examples:
    - Plant cells: When a plant cell is placed in a solution with a lower concentration of solute, water moves out of the cell through the cell wall and plasma membrane, causing the cell to shrink.
    - Dialysis: In medical procedures such as dialysis, a semipermeable membrane is used to separate high and low-solute concentration solutions. Water moves from the high-concentration solution to the low-concentration solution, effectively purifying the solution.

▼ Reverse Osmosis

- Reverse osmosis is a membrane treatment process for separating dissolved solutes from water
- Most commonly used for drinking water purification to remove salt and other contaminants
- Involves applying pressure greater than the osmotic pressure on one side of the solution
- Uses a semipermeable membrane to filter out contaminants down to the smallest particles
- RO concentrate refers to filtered-out contaminants.

▼ Process

- Osmotic pressure is the minimum pressure required to prevent solvent flow through a semipermeable membrane
- Reverse osmosis occurs when a pressure greater than the osmotic pressure is applied to the solution side

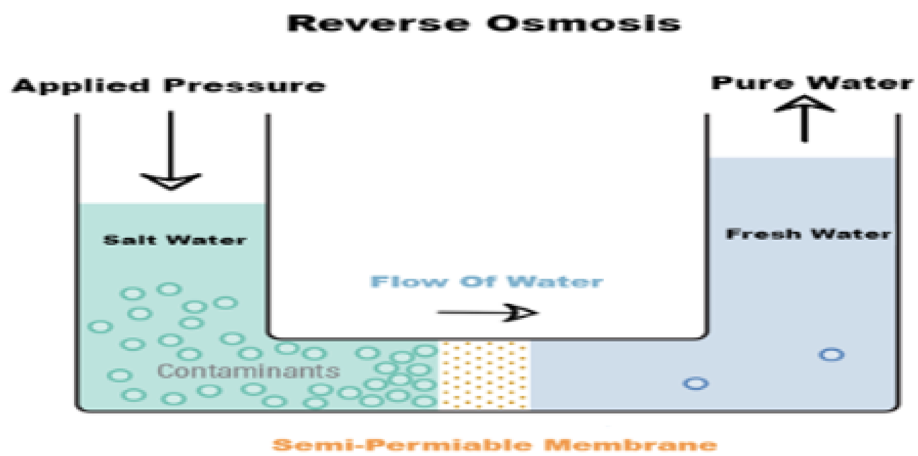
- The pressure must be higher than the osmotic pressure for reverse osmosis to occur
- Osmotic pressure is a colligative property dependent on the concentration of the solution
- Reverse osmosis is widely used in water purification
- Many water purifiers use reverse osmosis as one of the steps in the purification process.

▼ How does it work?

- Experiment setup: freshwater and a concentrated aqueous solution on opposite sides separated by a semipermeable membrane
- Pressure is applied on the side with the concentrated solution
- Result: water molecules move from the concentrated solution to the freshwater side through the membrane
- The experiment demonstrates the process of reverse osmosis.

To expand on the experiment:

- The semipermeable membrane used should allow water molecules to pass through while preventing the passage of solutes or larger particles in the concentrated solution
- The pressure applied should be greater than the osmotic pressure, which can be calculated based on the concentration of the concentrated solution
- The movement of water molecules from the concentrated solution to the freshwater side will result in a reduction of solute concentration in the concentrated solution and an increase in water concentration in the freshwater side



▼ Benefits

- reverse osmosis effectively removes various types of dissolved and suspended particles and biological entities (e.g. bacteria) from water
- Wide application in treating liquid waste or discharge
- Used in purifying water to prevent diseases
- Helps in desalinating seawater
- Has medical applications: bacteria, viruses, and pyrogen materials are rejected by the intact membrane, resulting in the water of quality similar to distilled water
- Compact units require little space, making them well-suited for home dialysis
- The average membrane life is a little over 1-2 years before replacement is necessary.

▼ Example

Reverse osmosis is a means of pulling clean water out of polluted water or saltwater by pushing water through a membrane under pressure. An example of reverse osmosis is the process by which contaminated water is filtered under pressure.

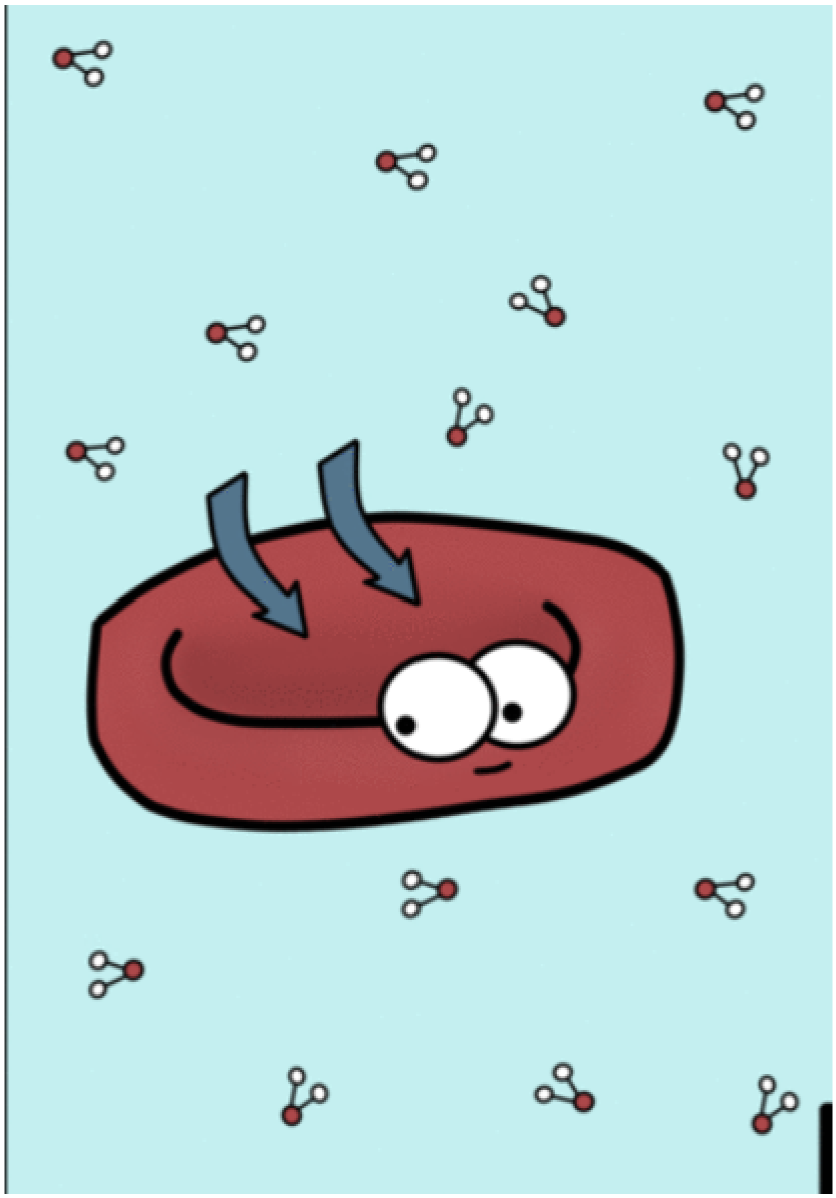
▼ Disadvantages

- Drawback of reverse osmosis (RO) water: can significantly reduce beneficial minerals that contribute to overall health
- Loss of beneficial minerals can result in negative effects, including:
    - Tiredness
    - Muscle cramps
    - General weakness
    - Cardiovascular disorders (in severe cases)
- Individuals who primarily consume RO water may be at risk for these side effects.
- Reverse osmosis water is often stripped of important minerals such as calcium, magnesium, and potassium that are found in regular drinking water. These minerals are essential for maintaining good health, particularly for heart and muscle function.
- As a result, relying solely on RO water for hydration can lead to mineral deficiency and cause various negative side effects, including muscle weakness, fatigue, and heart problems.
- It is important to consider the potential risks of consuming RO water and to make informed decisions about one's water consumption. This can include supplementing with other sources of minerals or drinking a balanced mix of RO and mineral-rich water.

▼ Hypotonic

- Hypotonic solution is a solution with a lower concentration of solute compared to another solution.
- The hypotonic solution has a higher water concentration compared to the other solution.
- This means that the water molecules in the hypotonic solution will move to the side with the higher concentration of solute.
- This movement of water across the selectively permeable membrane leads to the equilibration of solute and water concentrations on both sides.

- This process is known as osmosis and can lead to swelling or bursting of cells if the hypotonic solution is applied to cells.
- In biological systems, hypotonic solutions are important for maintaining the balance of water and solute within cells.



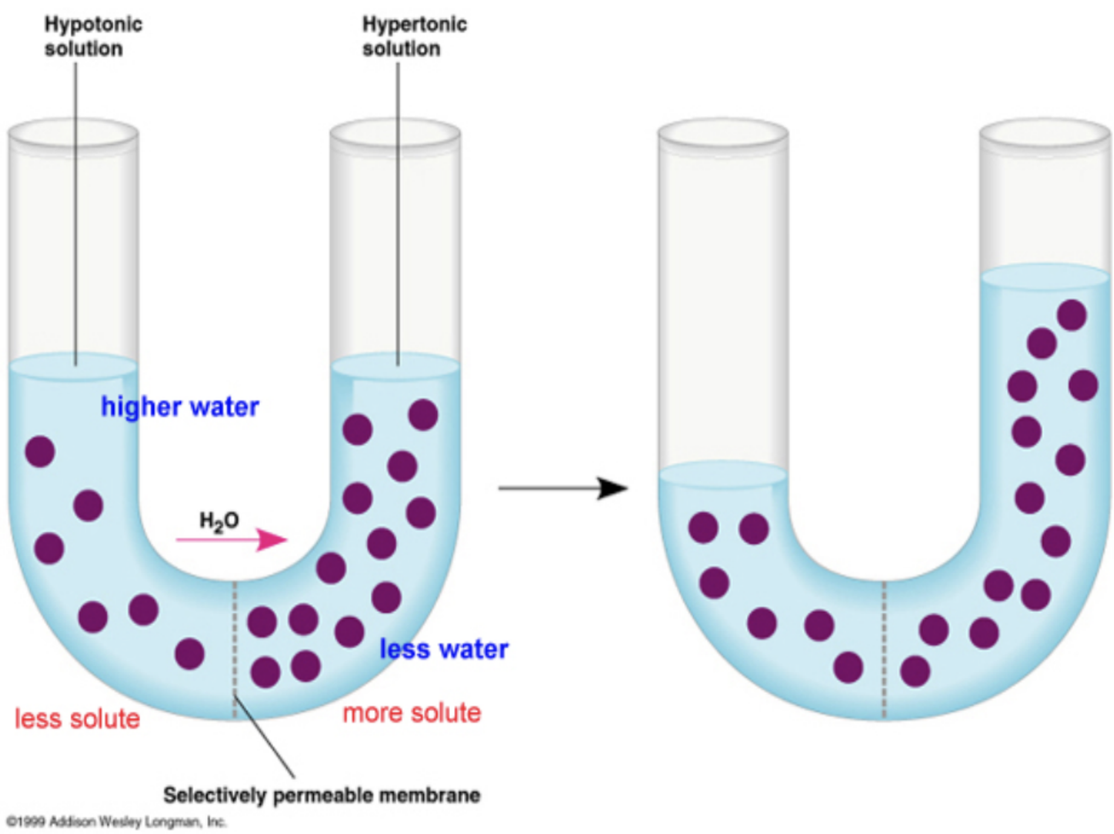
▼ part 2

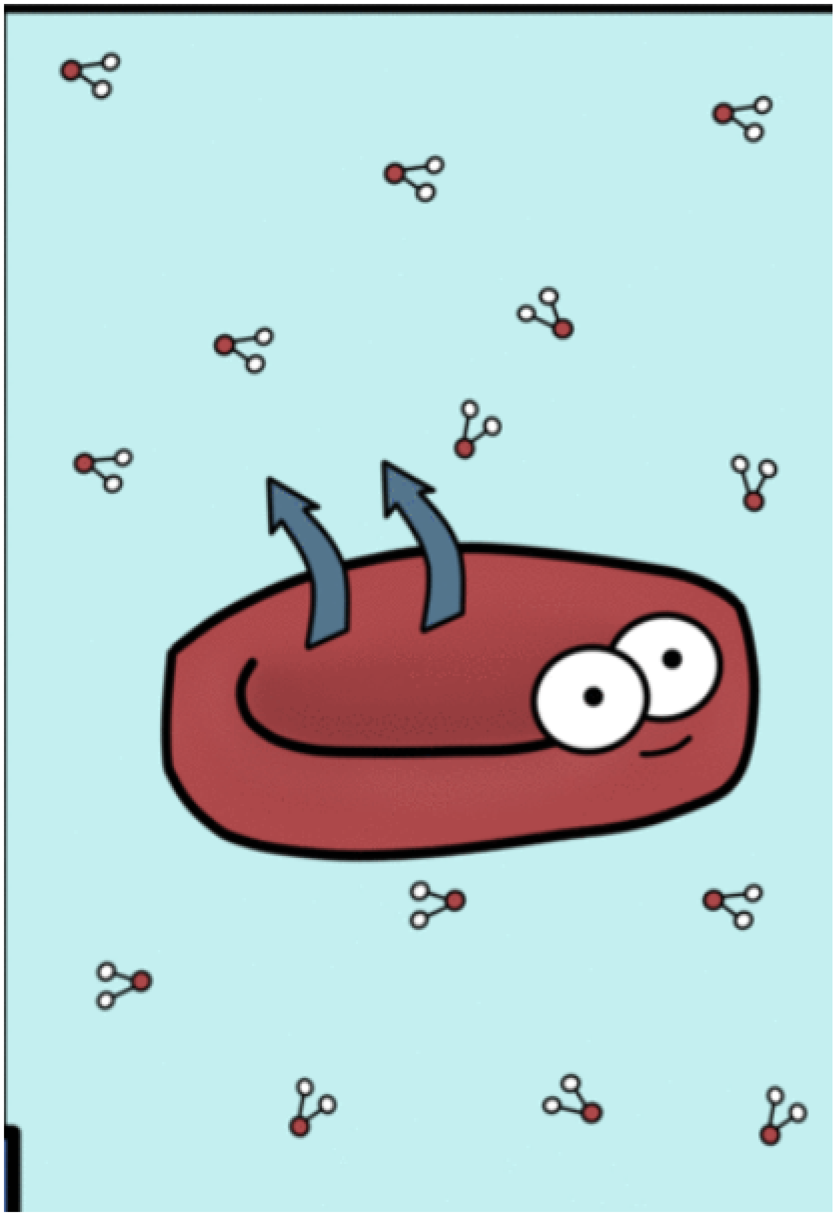
1. Cell swelling: When a cell is placed in a hypotonic solution, water moves into the cell due to osmosis, causing the cell to swell.

2. Medical applications: Hypotonic solutions are used in medical settings, such as for intravenous (IV) fluid replacement in dehydrated patients.
3. Examples: Examples of hypotonic solutions include sugar water and saline solutions.

▼ Hypertonic

1. Definition of hypertonic solution: a solution with a higher concentration of solute relative to another solution
2. Characteristics: Causes water to move out of cells into the surrounding solution
3. Example: High-sugar solution for preserving fruits and vegetables.





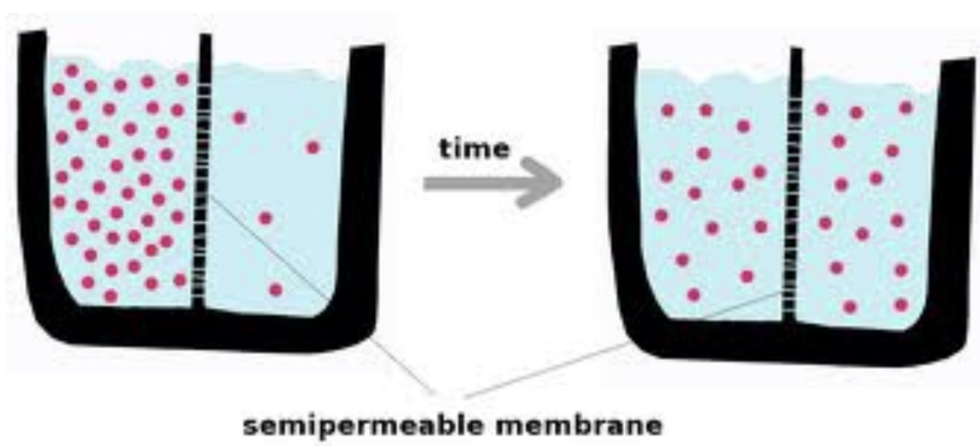
▼ Difference between Hypotonic and Hypertonic

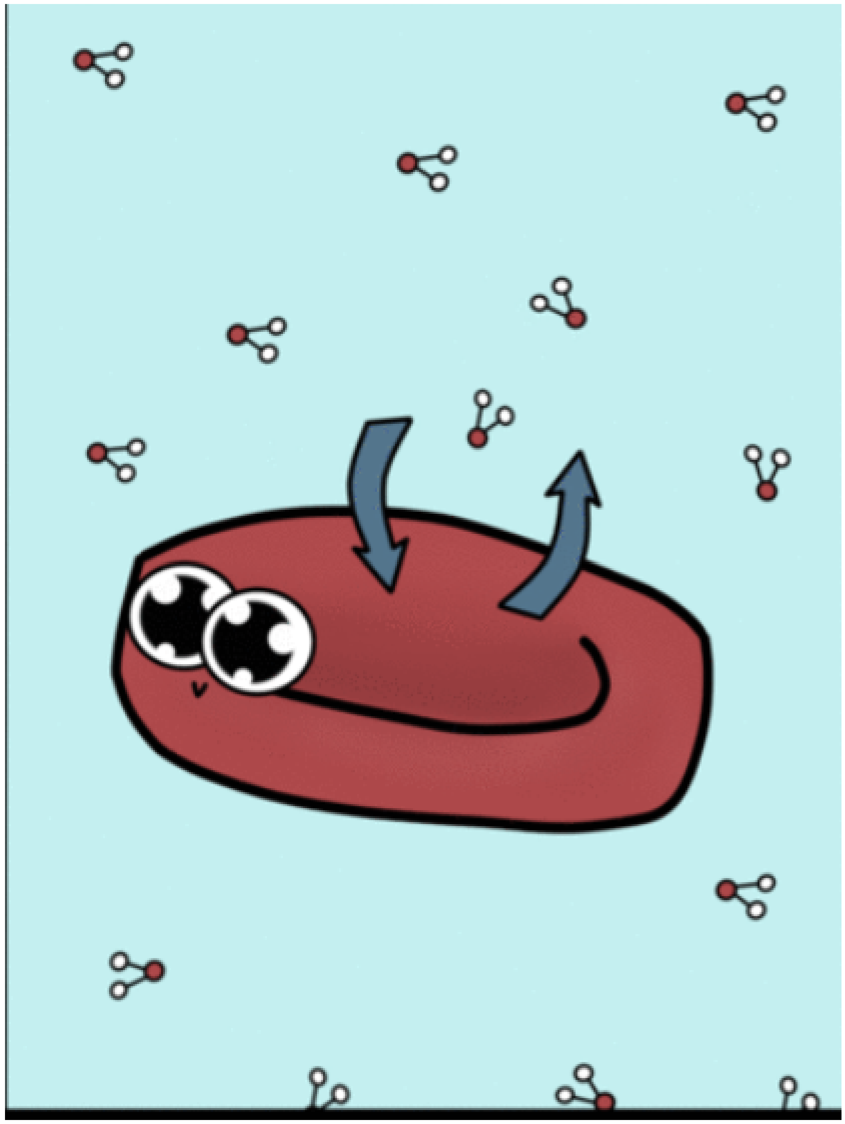
1. Osmosis: In hypotonic solutions, water will tend to flow into the solution due to osmosis, leading to a potential increase in cell size or swelling. In hypertonic solutions, water will tend to move out of the solution, leading to potential shrinkage or dehydration of cells.
2. Cell behavior: In hypotonic solutions, cells can absorb water and potentially burst. In hypertonic solutions, cells can lose water and potentially become dehydrated and/or shriveled.

3. Medical Applications: Hypotonic solutions are often used in medical settings to hydrate cells, while hypertonic solutions can be used to dehydrate cells or remove excess fluid from the body.

▼ Isotonic

1. Isotonic solution - A solution in which the solute concentration is equal on both sides of the membrane.
2. Equal concentration of solutes - In an isotonic solution, the concentration of solutes is equal on both sides of the membrane, resulting in equal osmotic pressure.
3. No net movement of water - Because of the equal concentration of solutes, there is no net movement of water across the membrane.
4. Example: Saline solution used in medical procedures is often isotonic, meaning it has the same salt concentration as human cells.
5. Maintaining cell volume - Isotonic solutions are used to maintain the volume of cells, as they do not cause cells to swell or shrink.





Active Transport

1. Active transport is the movement of ions or molecules against a concentration gradient, which requires the expenditure of energy.
2. This process helps to maintain the balance of ions or molecules inside and outside the cell.
3. Active transport is used by cells to bring in essential nutrients or to get rid of waste products.
4. It is driven by the energy from cellular processes, such as ATP (adenosine triphosphate) hydrolysis.
5. This process is important for maintaining homeostasis, which is the balance of conditions in the cell or organism.

6. Examples of active transport include the sodium-potassium pump and the uptake of glucose by the cell.

▼ Root hair cells

1. Root hair cells are specialized cells found in the root of a plant that helps absorb water and nutrients from the soil.
2. Active transport in root hair cells involves the movement of ions and other substances against their concentration gradient, from an area of lower concentration to an area of higher concentration.
3. This process is powered by energy from ATP (adenosine triphosphate), a molecule produced by the cell's mitochondria.
4. Active transport in root hair cells is essential for the proper absorption of nutrients and water and helps ensure the survival and growth of the plant.
5. An example of active transport in root hair cells is the uptake of mineral ions such as potassium (K+) and nitrogen (NH4+). These ions are taken up against their concentration gradient, requiring the expenditure of energy.

▼ Circulatory System

The circulatory system is a vital organ system that is responsible for transporting blood, oxygen, and nutrients throughout the body. Here are some key points, examples, and definitions related to the circulatory system:

Key Points:

1. The circulatory system consists of the heart, blood vessels, and blood.
2. The heart is a muscle that acts as a pump, propelling blood through the blood vessels.
3. Blood vessels are tubes that carry blood throughout the body, including arteries, veins, and capillaries.
4. Arteries carry oxygen-rich blood away from the heart, while veins carry oxygen-poor blood back to the heart.

5. Capillaries are small blood vessels that connect arteries and veins and allow for the exchange of oxygen and nutrients with the body's tissues.

Examples:

1. An example of how the circulatory system works is when the heart pumps oxygen-rich blood through the arteries to the body's tissues, where the oxygen is then used to fuel cellular metabolism.
2. Another example is the role of the circulatory system in fighting infections. When the body is exposed to harmful bacteria or viruses, the circulatory system helps to distribute white blood cells and antibodies to the affected area to help fight the infection.

Definitions:

1. Blood: A fluid that circulates in the circulatory system and carries oxygen and nutrients to the body's tissues and removes waste products.
2. Heart: A muscular organ that pumps blood through the circulatory system.
3. Arteries: Blood vessels that carry oxygen-rich blood away from the heart.
4. Veins: Blood vessels that carry oxygen-poor blood back to the heart.
5. Capillaries: Small blood vessels that connect arteries and veins and allow for the exchange of oxygen and nutrients with the body's tissues.

▼ What does it carry

The circulatory system carries several important substances throughout the body, including:

1. Oxygen: The circulatory system transports oxygen from the lungs to the body's tissues, where it is used to fuel cellular metabolism.
2. Nutrients: The circulatory system delivers nutrients, such as glucose and amino acids, to the body's tissues to support growth and repair.
3. Hormones: The circulatory system carries hormones, chemical messengers produced by the endocrine glands, to target tissues throughout the body.
4. Waste products: The circulatory system helps to remove waste products, such as carbon dioxide, from the body's tissues and

transport them to the kidneys and lungs for elimination.

5. Immune cells: The circulatory system helps to distribute white blood cells and antibodies to the affected area when the body is exposed to harmful bacteria or viruses.

▼ 2 types of blood

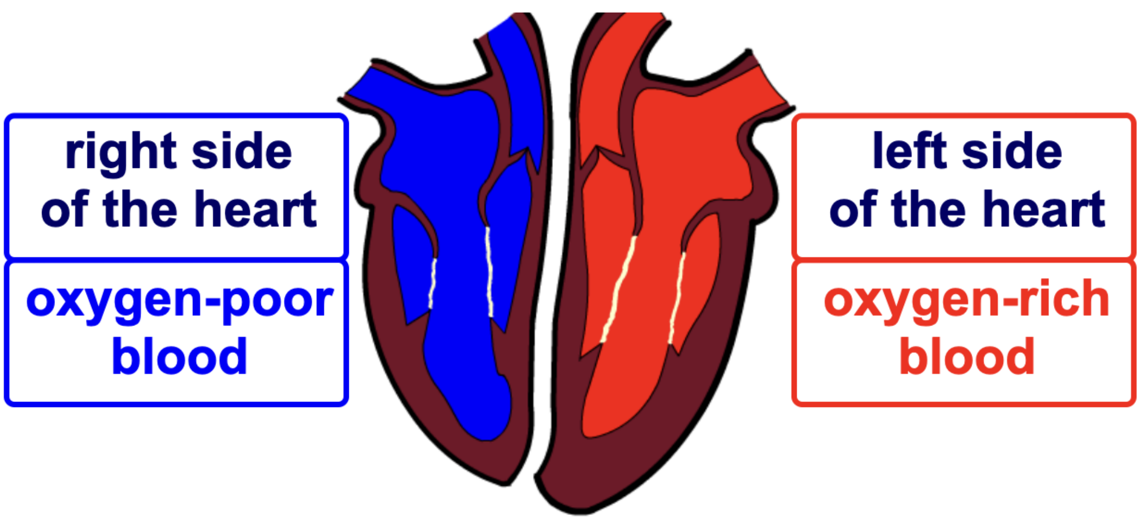
Oxygen Rich Blood
blood traveling to the body cells with high oxygen content and low carbon dioxide content

Oxygen Poor Blood
blood travels away from the body cells with low oxygen content and high carbon dioxide content

It is important they don't mix

▼ Inside The Heart

The inside of the heart is divided into two sections so that the two types of blood (oxygen-rich and oxygen-poor) are kept apart.



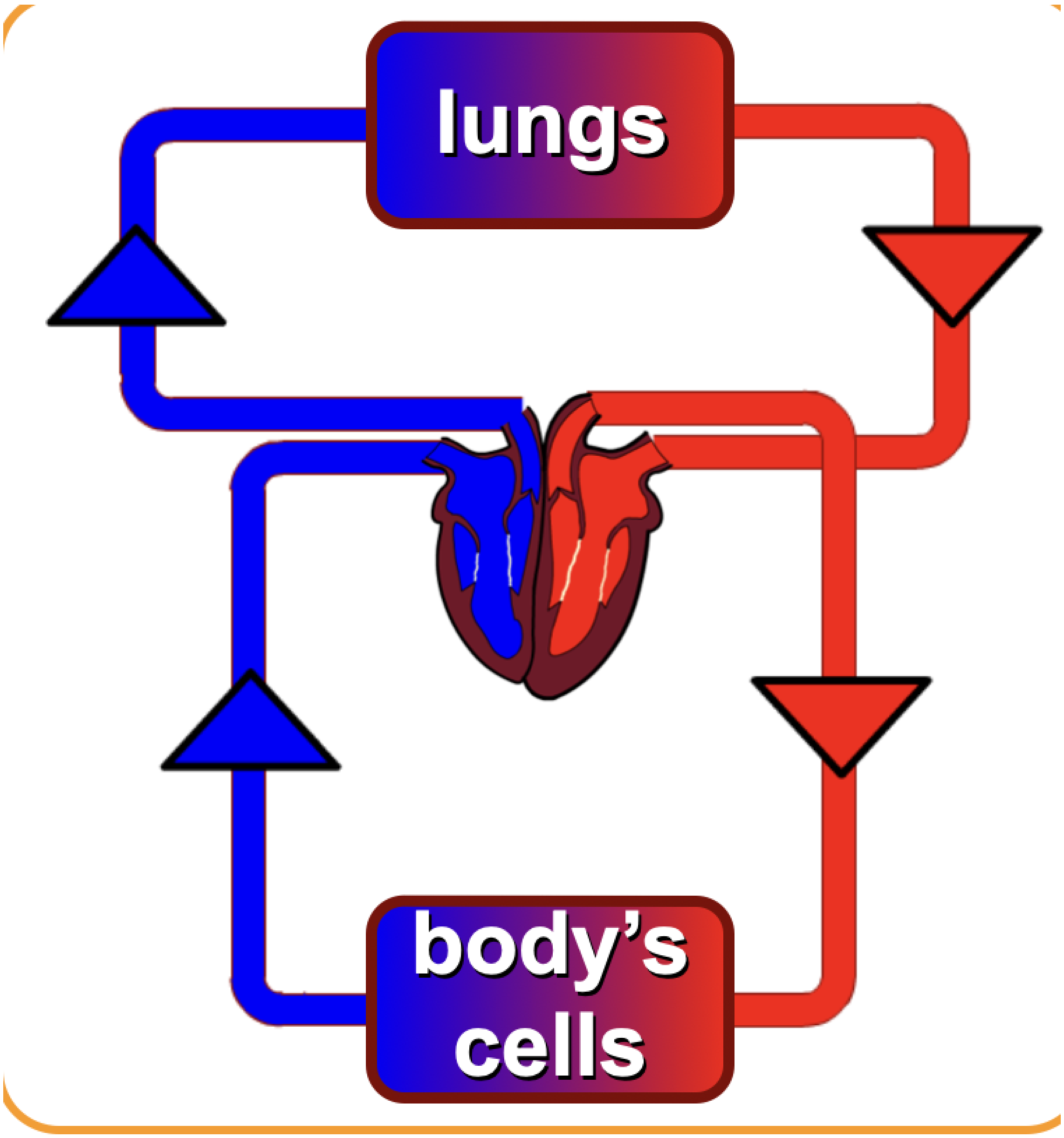
Remember that the heart is always labelled as if it is in a body **facing you**, so the right side of the heart is on the left of the diagram.

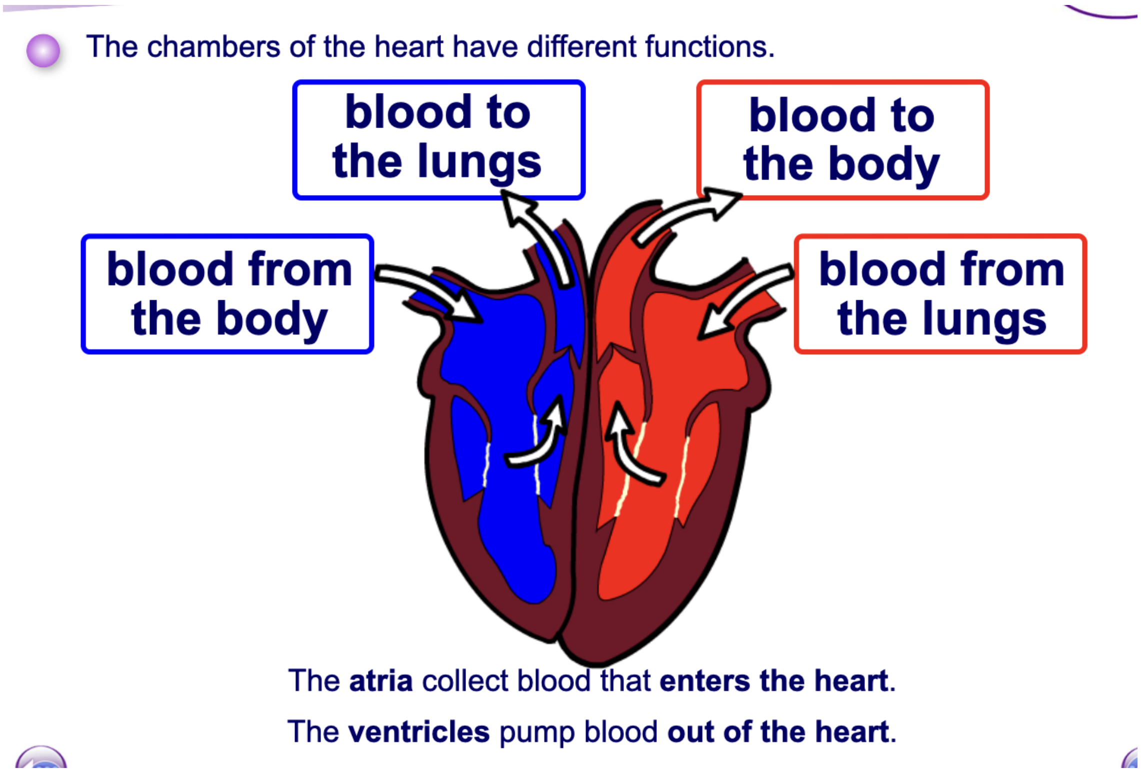
▼ How does blood circulate around the body?

The circulation of blood around the body is a complex process that involves several key steps. Here is a step-by-step overview of how blood circulates around the body:

1. The heart contracts: The heart is a muscular organ that acts as a pump, propelling blood through the blood vessels. When the heart muscle contracts, it pumps blood out of the heart and into the arteries.
2. Blood flows through arteries: Arteries are blood vessels that carry oxygen-rich blood away from the heart to the body's tissues. As blood flows through the arteries, it is under high pressure, which helps it to reach the far corners of the body.
3. Blood enters capillaries: Capillaries are small blood vessels that connect arteries and veins. They are found in the tissues and organs, where they allow for the exchange of oxygen and nutrients with the body's tissues.
4. Oxygen and nutrients are exchanged with the tissues: In the capillaries, oxygen, and nutrients diffuse from the blood into the body's tissues, where they are used to fuel cellular metabolism. At the same time, waste products, such as carbon dioxide, diffuse from the tissues into the blood.
5. Blood flows into veins: Veins are blood vessels that carry oxygen-poor blood back to the heart. Blood in the veins is under low pressure, and the walls of the veins contain valves that prevent blood from flowing backward.
6. Blood returns to the heart: When the blood reaches the heart, it is pumped into the right atrium, the upper chamber of the heart. From there, it is pumped into the right ventricle, the lower chamber of the heart, and then into the lungs, where it picks up a fresh supply of oxygen.
7. The oxygen-rich blood returns to the heart: After picking up oxygen in the lungs, the oxygen-rich blood returns to the heart and is pumped into the left atrium, the upper chamber of the heart. From there, it is pumped into the left ventricle, the lower chamber of the heart, and then back out into the arteries, starting the cycle all over again.

These are the steps involved in the circulation of blood around the body. The heart, blood vessels, and blood work together to ensure that oxygen and nutrients are delivered to the body's tissues and that waste products are removed.





▼ How does the heart pump blood?

The heart pumps blood in a rhythmic fashion, creating the characteristic "lub-dub" sound that you can hear with a stethoscope.

1. Contraction of the atria: The atria are the upper chambers of the heart. They contract simultaneously, causing the blood to be forced into the ventricles.
2. Relaxation of the ventricles: The ventricles are the lower chambers of the heart. When the atria contract, the ventricles relax, allowing them to fill with blood.
3. Contraction of the ventricles: The ventricles then contract simultaneously, forcing the blood out of the heart and into the arteries. This is the most powerful part of the heartbeat and creates the first sound of the "lub-dub" sound.
4. Relaxation of the heart: After the ventricles contract, the heart relaxes, allowing it to fill with blood again and start the cycle over. This is the

second sound of the "lub-dub" sound.

Example: Imagine squeezing a balloon to represent the heart and the blood it pumps. When you squeeze the balloon, the blood inside it is forced out. This is similar to how the ventricles contract and pump blood out of the heart. When you release the squeeze, the balloon fills with air again. This is similar to how the heart relaxes and fills with blood.

Points:

1. The heart pumps blood in a rhythmic fashion.
2. The atria contract and force blood into the ventricles.
3. The ventricles relax and fill with blood.
4. The ventricles then contract and pump blood out of the heart and into the arteries.
5. The heart then relaxes and fills with blood again.
6. This cycle repeats constantly to ensure that blood is circulated throughout the body.

▼ Blood Flow

Superior and Inferior vena cava → right atrium → tricuspid valve → right ventricle → pulmonary valve → pulmonary artery → lungs (exchange of gases O_2 & CO_2) → pulmonary vein → left atrium → mitral valve (bicuspid valve)→ left ventricle → aortic valve → aorta → arteries → body systems

▼ Types of Blood Circulation

▼ **Pulmonary Circulation**

Pulmonary circulation refers to the flow of blood from the heart to the lungs and back to the heart.

1. Purpose: The primary purpose of pulmonary circulation is to deliver oxygen-poor blood from the heart to the lungs, where it can pick up oxygen and get rid of carbon dioxide.
2. Route: Blood flows from the right ventricle of the heart to the lungs through the pulmonary artery, then returns to the heart through the pulmonary vein.

3. Oxygen exchange: In the lungs, the oxygen-poor blood picks up oxygen from the air we breathe and gets rid of carbon dioxide. This process is called gas exchange.
4. Importance: Pulmonary circulation is crucial for supplying the body with oxygen and getting rid of carbon dioxide, which is a waste product produced by our cells.

▼ Systemic Circulation

Systemic circulation refers to the flow of blood from the heart to the rest of the body and back to the heart.

1. Purpose: The primary purpose of systemic circulation is to deliver oxygen-rich blood from the heart to the body's tissues, where it can provide oxygen and nutrients.
2. Route: Blood flows from the left ventricle of the heart to the body's tissues through the arteries, then returns to the heart through the veins.
3. Supply of oxygen and nutrients: In the body's tissues, the oxygen-rich blood provides oxygen and nutrients to cells, allowing them to function properly.
4. Waste removal: The blood also carries waste products, such as carbon dioxide, away from the cells and back to the heart for elimination.
5. Importance: Systemic circulation is crucial for supplying the body's tissues with the oxygen and nutrients they need to function and for removing waste products.

▼ Difference between them

Systemic circulation and pulmonary circulation are two separate circulatory systems in the body, with different functions and routes. Here are some basic points that highlight the differences between the two:

1. Purpose: The purpose of the systemic circulation is to deliver oxygen-rich blood to the body's tissues and to remove waste products, while the purpose of pulmonary circulation is to deliver oxygen-poor blood to the lungs and to pick up oxygen.

2. Route: Systemic circulation involves the flow of blood from the left ventricle of the heart to the body's tissues through the arteries and back to the heart through the veins. Pulmonary circulation involves the flow of blood from the right ventricle of the heart to the lungs through the pulmonary artery and back to the heart through the pulmonary vein.
3. Oxygenation: Blood in the systemic circulation is oxygen-rich, while blood in the pulmonary circulation is oxygen-poor.
4. Function: The systemic circulation provides the body's tissues with oxygen and nutrients, while pulmonary circulation helps to oxygenate the blood and get rid of waste products.
5. Separation: The two circulations are separated by the heart and the lungs, allowing for a more efficient exchange of oxygen and waste products.

These basic points help to illustrate the key differences between systemic and pulmonary circulation and the important role each plays in maintaining the health and well-being of the body.

- ▼ Respiration
  - ▼ Difference between Respiration and Breathing

    Respiration and breathing are related but distinct physiological processes that are essential for life. Here are some expanded points that describe these processes in detail:

    Respiration:

    1. Definition: Respiration is the process by which living cells use oxygen to oxidize nutrients and release energy for biological work.
    2. Steps: Respiration involves the following steps:
       a. Oxygen is transported to the cells via the bloodstream.
       b. The cells then use oxygen to break down glucose and other nutrients, releasing energy in the form of ATP.
       c. Carbon dioxide is produced as a waste product of this process.

3. Importance: Respiration is essential for providing the energy that cells need to carry out their functions, including growth, repair, and metabolism.

Breathing:

1. Definition: Breathing is the exchange of gases between the atmosphere and the body.
2. Steps: Breathing involves the following steps:
   a. Inhaling: During inhalation, the diaphragm and rib muscles contract, causing the chest cavity to expand and the lungs to fill with air.
   b. Exhaling: During exhalation, the diaphragm and rib muscles relax, causing the chest cavity to contract and air to be expelled from the lungs.
3. Oxygen exchange: Breathing allows for the exchange of oxygen from the atmosphere into the body and the release of carbon dioxide from the body into the atmosphere.
4. Importance: Breathing is essential for providing the body with the oxygen it needs to carry out cellular respiration and for removing waste products, such as carbon dioxide.

▼ Respiratory Organs

1. Nostrils: The nostrils are the external openings of the nose, which lead into the nasal cavity. The nostrils are responsible for filtering, warming, and moistening incoming air.
2. Nasal cavity: The nasal cavity is a bony, air-filled space within the head that lies above the roof of the mouth and behind the nose. The nasal cavity plays an important role in filtering, warming, and moistening inhaled air.
3. Pharynx: The pharynx is a muscular tube that lies behind the nose and mouth and serves as a common passageway for food and air.
4. Larynx: The larynx, also known as the voice box, is a structure in the neck that connects the pharynx to the trachea. The larynx plays a critical role in preventing food and liquid from entering the trachea and lungs.

5. Trachea: The trachea, also known as the windpipe, is a tube-like structure that extends from the larynx to the bronchi and carries air to and from the lungs.
6. Bronchi: The bronchi are two tubes that branch off from the trachea and lead into the lungs. The bronchi are responsible for delivering air to the smaller airways within the lungs.
7. Lungs: The lungs are two spongy, air-filled organs located within the chest that are responsible for exchanging gases between the atmosphere and the bloodstream.

These are the main respiratory organs that make up the human respiratory system. Each of these organs plays an important role in the exchange of gases between the atmosphere and the body, ensuring that the body has an adequate supply of oxygen and can get rid of waste products, such as carbon dioxide.

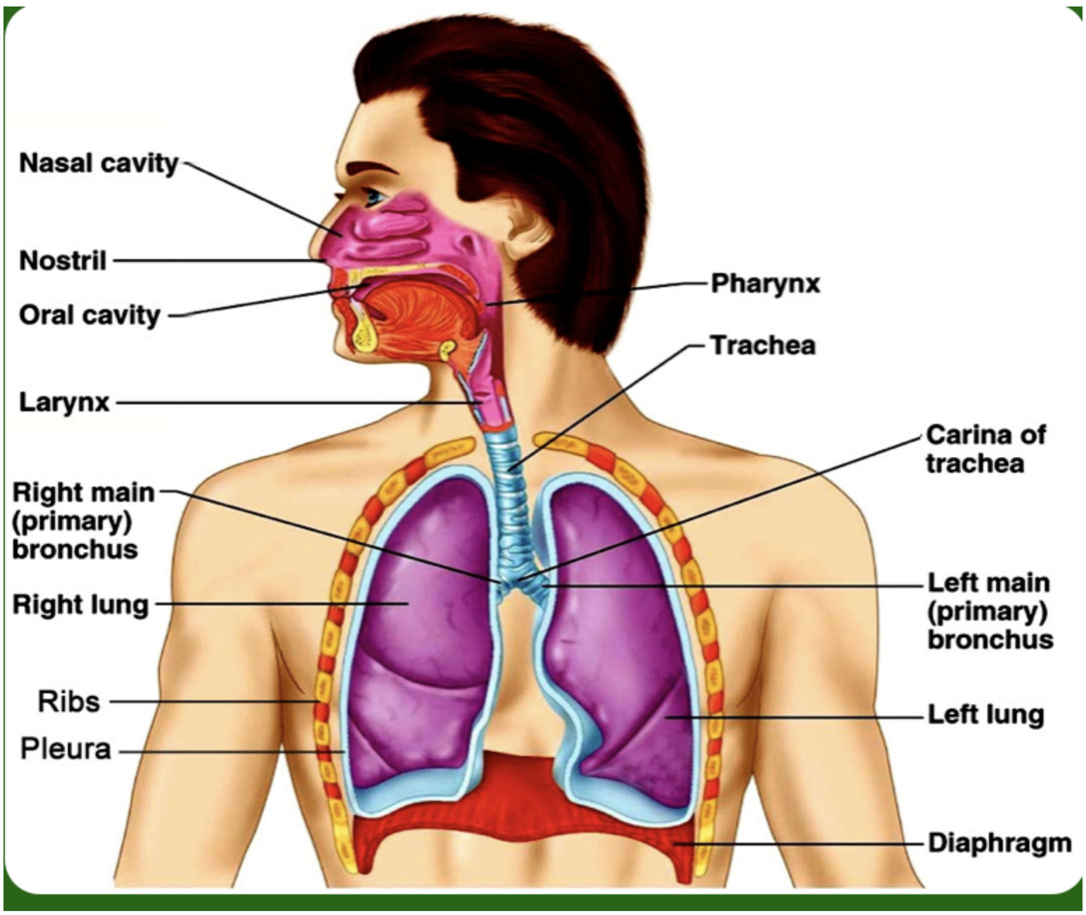
▼ Air Tract

The air passage, also known as the air tract, is a series of connected structures that run from the nostrils to the lungs, allowing for the movement of air into and out of the body. Here are some key points about the air passage:

1. Definition: The air passage refers to the structures and pathways that air follows as it moves into and out of the body.
2. Components: The air passage is made up of a number of structures, including the nostrils, nasal cavity, pharynx, larynx, trachea, bronchi, and lungs.
3. Functions: The air passage performs several important functions, including:
   a. Filtering: The air passage filters out large particles, such as dust and pollen, as air is breathed in.
   b. Warming and Moistening: The air passage warms and moistens incoming air, helping to keep the airways and lungs moist and preventing damage to the delicate tissues.
   c. Transporting: The air passage transports air to and from the lungs,

allowing for the exchange of gases between the atmosphere and the bloodstream.

4. Airways: The air passage is divided into two main types of airways: the conducting airways and the respiratory airways.
   a. Conducting airways: The conducting airways include the nostrils, nasal cavity, pharynx, larynx, trachea, and bronchi. These structures do not participate in gas exchange but instead serve to filter, warm, and moisten incoming air and transport it to the respiratory airways.
   b. Respiratory airways: The respiratory airways include the bronchioles and alveoli, which are responsible for exchanging gases between the atmosphere and the bloodstream.



▼ Types of cells

1. Epithelial cells: Epithelial cells are cells that line the surfaces of organs and tissues within the body. In the respiratory system, epithelial cells line the airways and help to filter, warm, and moisten incoming air.
2. Goblet cells: Goblet cells are specialized epithelial cells that produce and secrete mucus, which helps to trap inhaled particles and prevent them from reaching the lungs.
3. Cilia: Cilia are tiny, hair-like structures that line the airways and help to move mucus and trapped particles toward the pharynx, where they can be expelled from the body.
4. Alveolar cells: Alveolar cells are specialized cells found within the alveoli of the lungs. Alveolar cells participate in gas exchange, facilitating the transfer of oxygen from the air into the bloodstream and the removal of carbon dioxide from the bloodstream into the air.
5. Endothelial cells: Endothelial cells line the blood vessels within the lungs and play an important role in maintaining the flow of blood and facilitating gas exchange.
6. Smooth muscle cells: Smooth muscle cells are specialized muscle cells that are found in the walls of the airways and bronchioles. These cells can contract and relax, changing the diameter of the airways and regulating the flow of air in and out of the lungs.

These are some of the key types of cells found in the human respiratory system, each of which plays an important role in facilitating the exchange of gases between the atmosphere and the bloodstream. Together, these cells help to ensure that the body has an adequate supply of oxygen and can get rid of waste products, such as carbon dioxide.

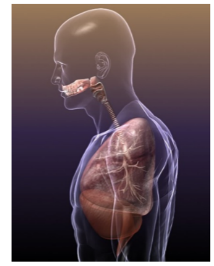
▼ Significance of Respiration

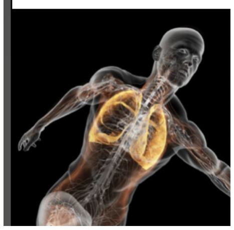
1. Energy production: Respiration is the process by which the body releases energy from food. During respiration, the body oxidizes glucose and other nutrients, producing energy that can be used for a variety of biological functions.
2. Oxygen supply: Respiration provides the body with an adequate supply of oxygen, which is necessary for cellular respiration and other

metabolic processes. Without an adequate supply of oxygen, cells, and tissues cannot function properly, leading to a range of health problems.

3. Carbon dioxide elimination: Respiration also helps to remove waste products, such as carbon dioxide, from the body. If these waste products are not removed, they can build up to harmful levels and interfere with the functioning of cells and tissues.
4. Blood oxygenation: Respiration helps to oxygenate the blood, which is necessary for the proper functioning of the circulatory system. Blood carries oxygen to all parts of the body, supplying cells and tissues with the oxygen they need to function properly.
5. Acid-base balance: Respiration plays a role in regulating the acid-base balance of the body. Carbon dioxide, which is produced as a waste product during respiration, can cause the blood to become more acidic if it is not removed. The respiratory system helps to regulate this acid-base balance by removing excess carbon dioxide from the body.

These are some of the key points that highlight the significance of respiration, demonstrating why this process is essential for the health and well-being of all living organisms. By providing the body with energy, oxygen, and the ability to remove waste products, respiration helps to support the normal functioning of cells and tissues and maintain overall health.





Types of Respiration

Aerobic respiration

1. Definition: Aerobic respiration is a metabolic process that occurs in the presence of oxygen and results in the release of energy from glucose and other nutrients.
2. Process: During aerobic respiration, glucose, and other nutrients are oxidized in the presence of oxygen, producing carbon dioxide, water, and energy in the form of ATP. This process occurs in the mitochondria of cells and is essential for the production of energy in the body.
3. Efficiency: Aerobic respiration is much more efficient than anaerobic respiration, producing much more energy per molecule of glucose. This is because aerobic respiration can extract more energy from glucose by breaking it down into smaller molecules and harnessing the energy released in the process.
4. Importance: Aerobic respiration is essential for the proper functioning of the body. It provides cells with the energy they need to carry out a variety of functions, including growth, repair, and the production of new cells.
5. Physical activity: Aerobic respiration is also important during physical activity, as it provides energy for the muscles to work.

When a person engages in physical activity, their body demands more oxygen to produce energy, which is why they breathe more heavily.

$$\text{Glucose} \xrightarrow{\text{presence of oxygen}} \text{Pyruvate} \xrightarrow{\text{presence of oxygen}} CO_2 + H_2O + \text{Energy}$$

Anaerobic respiration

1. Definition: Anaerobic respiration is a metabolic process that occurs in the absence of oxygen and results in the release of energy from glucose and other nutrients.
2. Process: During anaerobic respiration, glucose is broken down into smaller molecules, producing energy in the form of ATP. However, this process produces much less energy than aerobic respiration and generates lactic acid as a waste product.
3. Efficiency: Anaerobic respiration is much less efficient than aerobic respiration, producing much less energy per molecule of glucose. This is because anaerobic respiration cannot extract as much energy from glucose as aerobic respiration, which is why it is considered a less efficient form of respiration.
4. Importance: Despite its lower efficiency, anaerobic respiration is still an important process in the body. It provides cells with a source of energy when there is not enough oxygen available, such as during periods of intense physical activity.
5. Physical activity: Anaerobic respiration is particularly important during intense physical activity, as it provides energy for the muscles to work when oxygen levels are low. This type of respiration is why athletes and other physically active individuals sometimes feel muscle fatigue or discomfort during exercise.

$$\text{Glucose} \xrightarrow[\text{in cytoplasm}]{\text{presence of oxygen}} \text{Pyruvate} \xrightarrow[\text{in muscle cells}]{\text{absence of oxygen}} \text{Lactic acid + Energy}$$

- Steps of Respiration
  - Glycolysis
    1. Glycolysis is the first step in cellular respiration, which is the process by which cells generate energy in the form of ATP.
    2. Glycolysis occurs in the cytoplasm of cells and involves a series of 10 enzymatic reactions that convert glucose into two molecules of pyruvate.
    3. Glycolysis is an anaerobic process, meaning that it does not require oxygen. However, the pyruvate that is produced during glycolysis can be further processed in the presence of oxygen to generate additional ATP through aerobic respiration.

  - Citric Acid Cycle
    1. The citric acid cycle takes place in the mitochondria of eukaryotic cells and involves a series of eight enzymatic reactions that oxidize acetyl-CoA (the product of the previous stage of respiration) to produce ATP, CO_2, and reducing equivalents in the form of NADH and $FADH_2$.
    2. The first step of the citric acid cycle involves the condensation of acetyl-CoA with oxaloacetate to form citrate, which is then metabolized through a series of oxidation and decarboxylation reactions to regenerate oxaloacetate and produce ATP and reducing equivalents.
    3. The citric acid cycle is highly regulated and is sensitive to changes in energy demand and supply within the cell. For example, the cycle is stimulated by high levels of ADP and inhibited by high levels of ATP, indicating that the cycle is most active when the cell requires more energy.
    4. The citric acid cycle is an essential pathway for generating energy in eukaryotic cells, and defects in the cycle can lead to a variety of

metabolic disorders

- Oxidative Phosphorylation

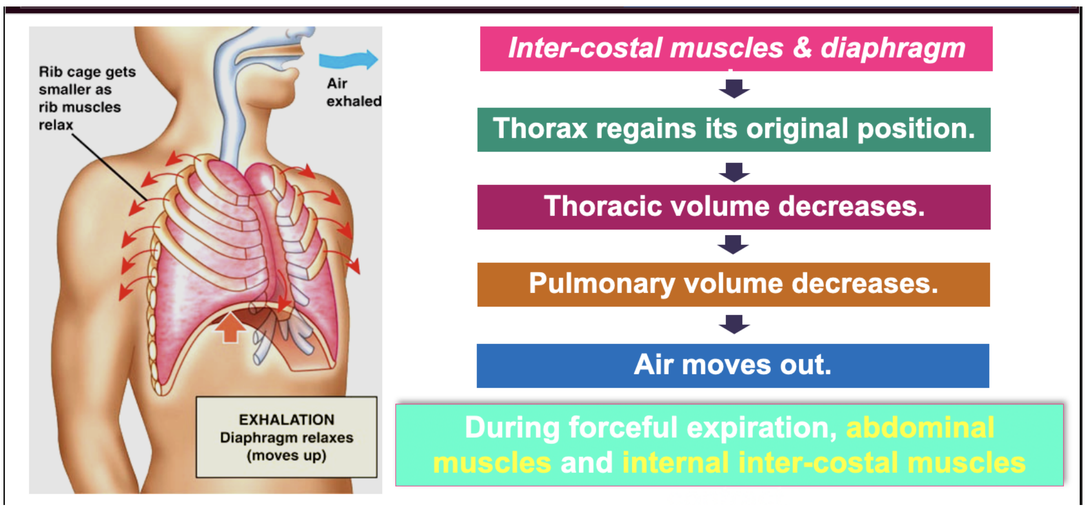
  1. Oxidative phosphorylation takes place in the inner mitochondrial membrane of eukaryotic cells, and in the plasma membrane of some prokaryotic cells. It is the process by which energy in the form of electrons is used to generate ATP.
  2. The process of oxidative phosphorylation involves the transfer of electrons along a series of electron carriers in the inner mitochondrial membrane, from higher to lower energy states. This releases energy that is used to pump protons (H+) across the membrane, creating an electrochemical gradient.
  3. The electrochemical gradient generated during oxidative phosphorylation is then used to drive the synthesis of ATP by the enzyme ATP synthase. ATP synthase acts like a tiny turbine, using the energy from the electrochemical gradient to convert ADP and inorganic phosphate (Pi) into ATP.
  4. Oxidative phosphorylation is the most efficient way for cells to generate ATP, producing up to 36 ATP molecules per molecule of glucose. However, the process also requires oxygen as the final electron acceptor, and defects in oxidative phosphorylation can lead to a variety of metabolic disorders.

MECHANISM OF BREATHING

1. Definition: Breathing is the process of inhaling and exhaling air, which allows for the exchange of oxygen and carbon dioxide between the body and the atmosphere.
2. Inspiration: Inspiration, or inhalation, is the process of taking air into the lungs. This is achieved by the expansion of the thorax, which creates a negative pressure that draws air into the lungs.
3. Expiration: Expiration, or exhalation, is the process of expelling air from the lungs. This is achieved by the contraction of the diaphragm and intercostal muscles, which compresses the lungs and pushes air out.

4. Lung compliance: Lung compliance is a measure of the ease with which the lungs expand and contract during breathing. The lungs are elastic and can change their volume in response to changes in pressure, making them compliant.

5. Control of breathing: Breathing is controlled by a complex network of nerves and muscles, including the diaphragm, intercostal muscles, and the respiratory centers in the brain. These systems work together to regulate the rate and depth of breathing, ensuring that oxygen and carbon dioxide are exchanged effectively.



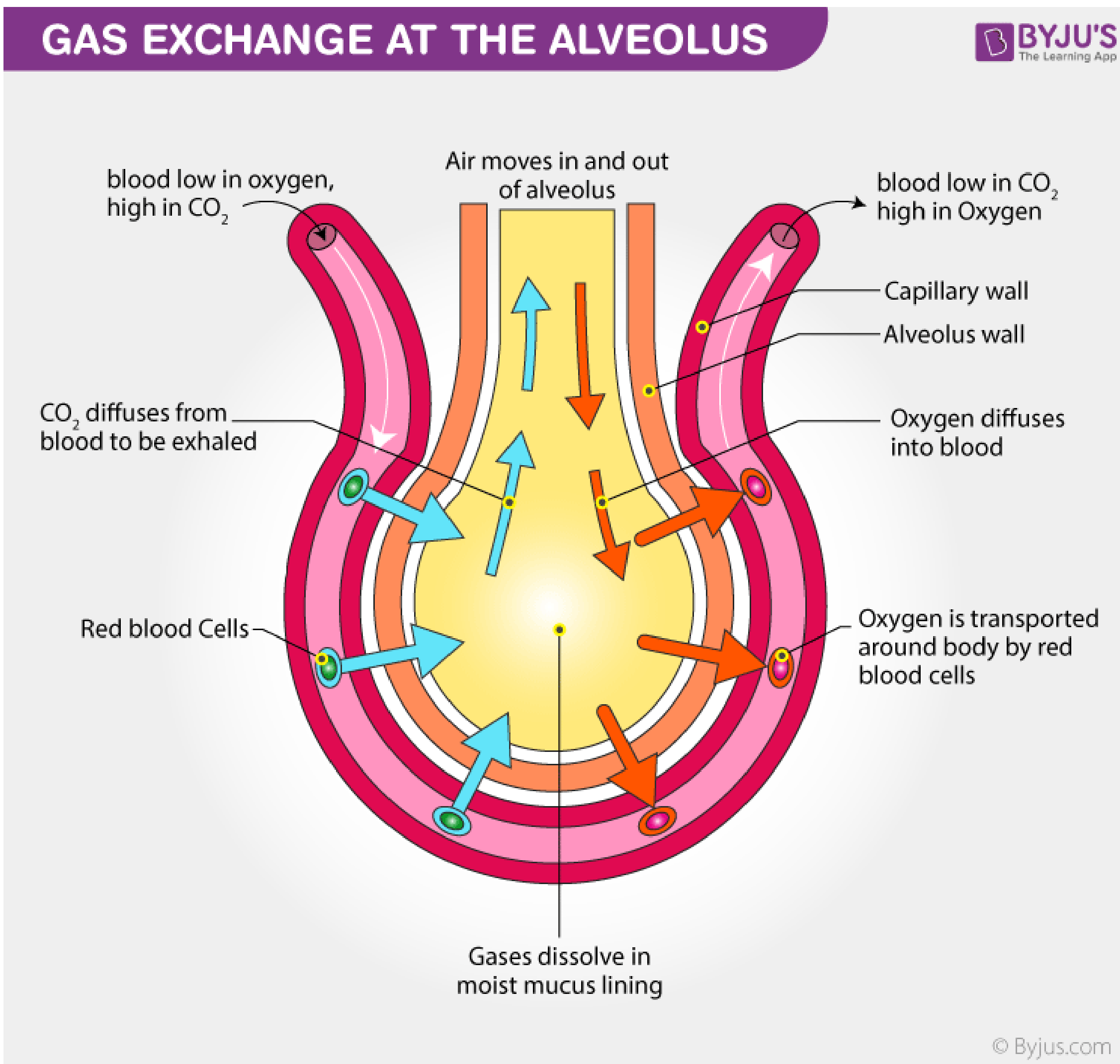
▼ Gases Transport (Not Important for Sa3)

▼ Gaseous Exchange In Humans

1. Gaseous exchange refers to the process by which oxygen (O2) is taken in by the body and carbon dioxide (CO2) is eliminated. This process is essential for respiration, which is the process by which cells produce energy.

2. In humans, gaseous exchange takes place primarily in the lungs, where the air is drawn in through the nose and mouth, then passes through the trachea and bronchi to reach the alveoli. The alveoli are tiny air sacs in the lungs where gas exchange occurs.

3. During gaseous exchange, oxygen diffuses from the alveoli into the bloodstream, where it is carried by red blood cells to the body's tissues. Carbon dioxide, which is produced as a waste product of cellular respiration, diffuses from the tissues into the bloodstream and is transported back to the lungs for elimination.
4. Gaseous exchange is a complex process that is regulated by a variety of physiological and environmental factors, including oxygen and carbon dioxide concentrations, blood pH, lung volume, and airway resistance.



▼

▼ Transpiration In Plants

1. Transpiration is the process by which water is lost from the aerial parts of the plant in the form of water vapor. This includes the leaves, stems, and flowers.
2. Water moves through the plant in a continuous transpiration stream, from the roots to the leaves. The water is transported through the xylem vessels, which are specialized structures that can transport water and minerals from the roots to the rest of the plant.
3. Transpiration creates tension or "pull" on the water in the xylem vessels by the leaves. This pull is created by the evaporation of water from the leaves. Water molecules are cohesive, so the pull on the water in the xylem vessels allows water to be drawn up through the plant.
4. The transpiration stream is an important mechanism for the transport of water and nutrients in plants. It allows plants to take up water and minerals from the soil and transport them to the leaves where they can be used for photosynthesis and other metabolic processes. Transpiration also helps to cool the plant by removing excess heat from the leaves. However, excessive transpiration can lead to water stress and damage to the plant.
   root → stem → leaf

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   ▼ **Significance of transpiration in plants**

   1. One of the functions of the transpiration stream is to transport mineral ions throughout the plant. This is important for the growth and development of the plant, as these ions are necessary for a variety of metabolic processes.
   2. Another function of the transpiration stream is to provide water to keep cells turgid. Turgor pressure is what helps support the plant's

structure and keep it upright. Without adequate water, the plant can wilt and eventually die.

3. The transpiration stream also provides water to leaf cells for photosynthesis. This is essential for the plant's ability to produce energy and carry out metabolic processes.
4. Finally, the transpiration stream helps to keep the leaves cool by evaporating water. As water evaporates from the leaves, it carries away excess heat, which helps to regulate the temperature of the plant. This is important for ensuring that the plant doesn't overheat, which could cause damage to its tissues.

▼ Transpiration and Stomata in Plants

1. Transpiration is the process by which plants lose water through the stomata in their leaves. It is an important mechanism for regulating water balance and temperature in the plant.
2. Most of the water that reaches the leaves through the xylem is lost through transpiration, with less than 1% being used for photosynthesis and growth.
3. Transpiration can be studied using cobalt chloride paper, which changes color from blue to pink when it absorbs water.
4. Stomata are openings in the leaves that allow for gas exchange between the plant and the environment. They are open during the day and closed at night, and their opening or closing is controlled by the turgidity of the guard cells that surround them.
5. The inner walls of the guard cells lining the stomatal aperture are thick and elastic, while the outer walls are thin. When the turgidity of the guard cells increases, the outer walls bulge out and pull the inner walls into a crescent shape, opening the stomata. The orientation of the cellulose microfibrils in the guard cells makes it easier for the stoma to open. When the guard cells lose turgidity due to water loss, the inner walls regain their original shape, closing the stomata. The number and distribution of stomata can vary between different types of leaves.

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Transport in plants

1. ylem and phloem are two types of plant tissues that are responsible for transporting different substances throughout the plant.
2. Xylem is responsible for transporting water and mineral salts from the roots up to other parts of the plant. This process is driven by transpiration, which causes water to evaporate from the leaves and draw water up from the roots.
3. On the other hand, Phloem is responsible for transporting sucrose and amino acids between the leaves and other parts of the plant. This allows the plant to distribute nutrients and energy throughout its tissues, supporting growth and development.

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Xylem Sap

1. The cohesion of water molecules and their attraction to polar surfaces (adhesion) allows water to move as a continuous column through xylem vessels from the roots to the leaves.
2. Surface tension, which is the result of the attraction between water molecules, helps give water a high tensile strength and capillarity. This allows water to resist pulling forces and rise in thin tubes like the tracheary elements in plants.
3. Xylem vessels from the roots to the leaf veins provide water for photosynthesis, and there is a continuous thin film of water over the cells. As water evaporates through the stomata, water is pulled into the leaf from the xylem, creating a 'pull'.

4. The lower concentration of water vapor in the atmosphere compared to the substomatal cavity and intercellular spaces helps water to diffuse into the surrounding air, which further aids in the pull of water up through the plant.
5. The forces generated by transpiration can create pressures sufficient to lift a column of water the size of a xylem vessel over 130 meters high.

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▼ Transport Of Food

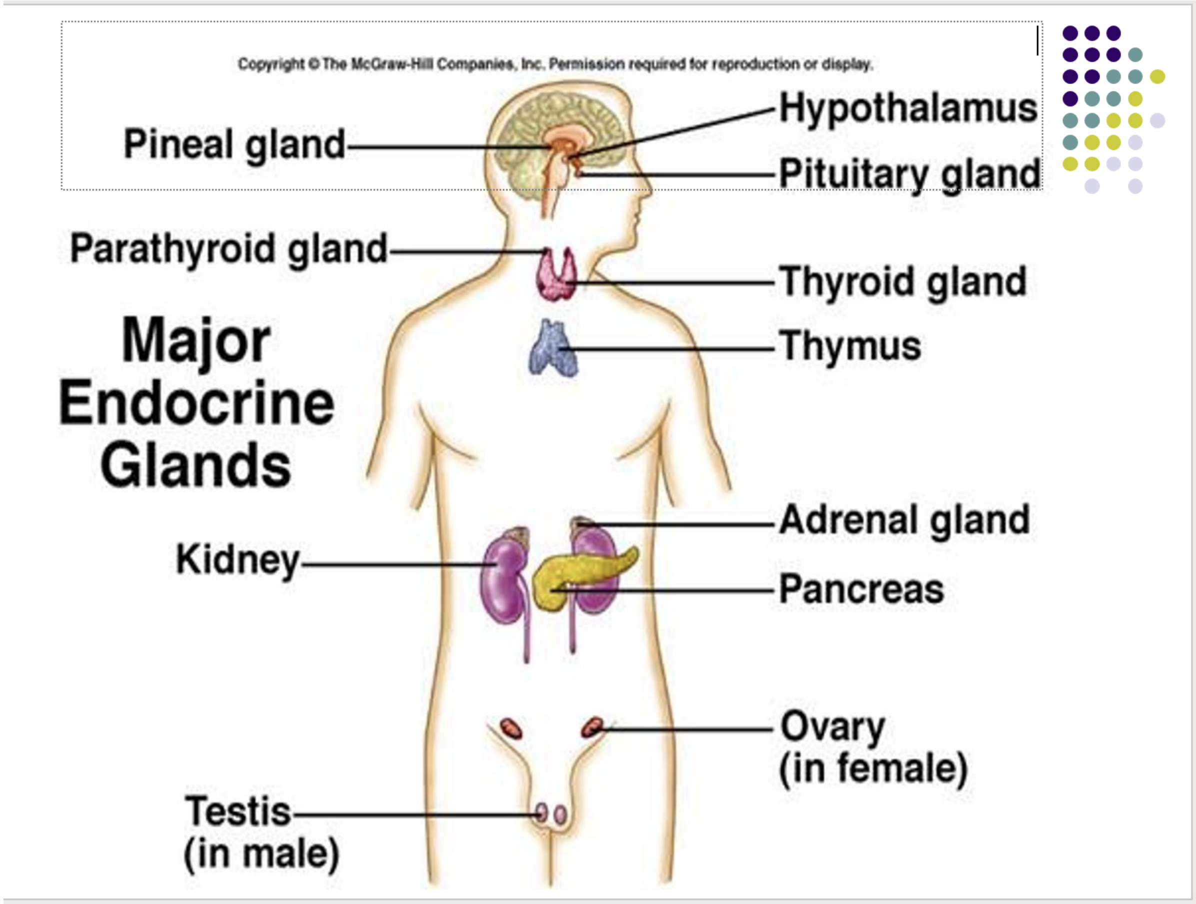
- Sugars and amino acids are the soluble products of photosynthesis.
- Phloem tubes transport these substances throughout the plant.
- Phloem cells are living and joined end to end with sieve plates that allow for easy flow of substances.
- The transport of sucrose and amino acids from regions of production to regions of storage or use is called translocation.
- Transport in the phloem can go in many different directions depending on the stage of development of the plant or the time of year.
- Dissolved food is always transported from the source (where it's made) to the sink (where it's stored or used).
- During winter, phloem tubes may transport dissolved sucrose and amino acids from the storage organs to other parts of the plant so that respiration can continue.
- During a growth period (such as in the spring), storage organs (such as roots) are the source and growing areas of the plant are the sinks.

- After the plant has grown (usually during the summer), the leaves become the source, producing large quantities of sugars, and the roots become the sinks, storing sucrose as starch until it is needed again.
- The phloem transports glucose, amino acids, and other substances from leaves to roots, shoots, fruits, and seeds.
- Sieve tubes and companion cells help in transporting the food in upward and downward directions.
- Sucrose and amino acid-like materials are transported from leaves to phloem using energy (active transport), increasing the osmotic pressure of the tissue causing water to move and materials in the phloem to tissues according to the plant's needs.

▼ Potometer

Unit 4 - Control And Coordination The Sequel cause I forgot the name of this unit

▼ Endocrine System



▼ Endocrine Glands

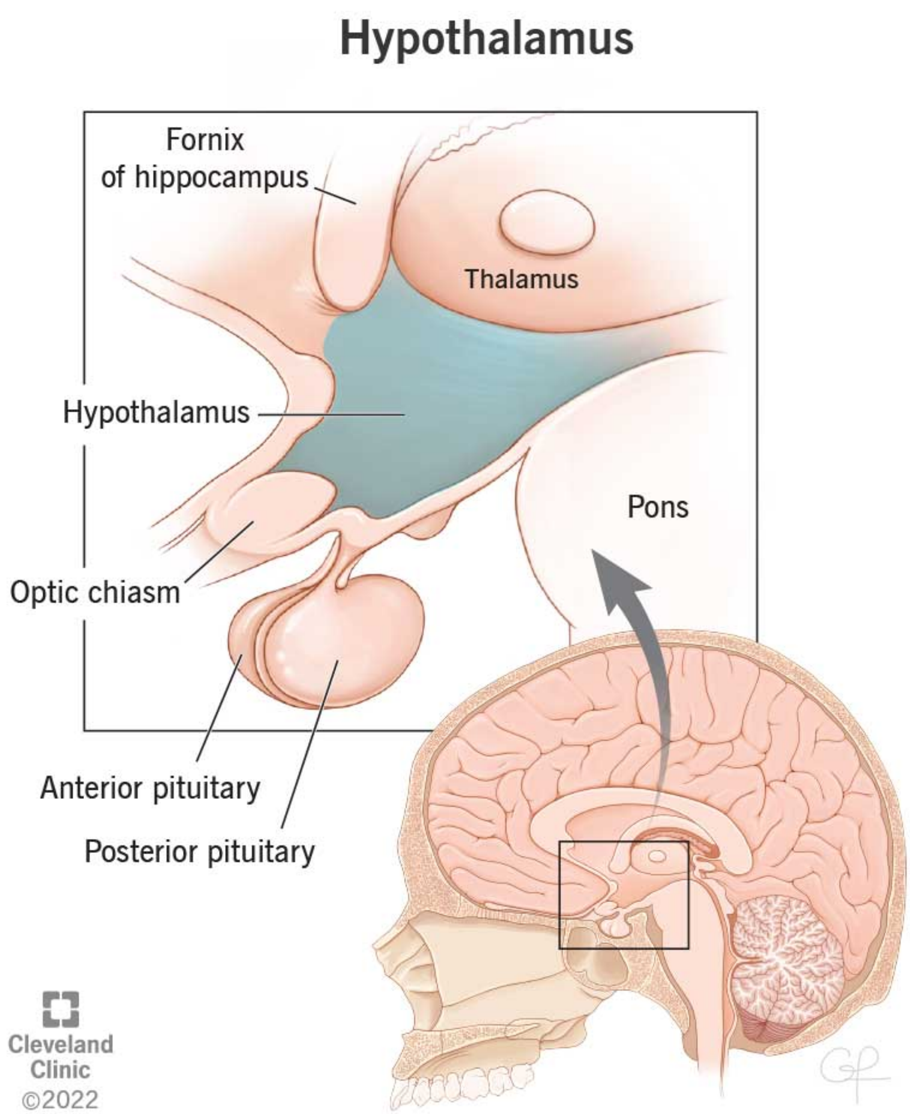
- Hormone replacement therapy can be used to treat hormonal imbalances caused by the dysfunction of endocrine glands.
- Dysfunction of endocrine glands can lead to various hormonal disorders, including diabetes, thyroid disorders, and growth hormone deficiencies.
- The activity of endocrine glands is regulated by the nervous system, as well as feedback mechanisms that maintain hormone balance in the body.
- Endocrine glands are located throughout the body, and each gland produces specific hormones that serve different functions.
- Examples of endocrine glands include the pituitary gland, thyroid gland, adrenal gland, and pancreas.

- The hormones produced by endocrine glands regulate various physiological processes in the body, including growth and development, metabolism, and reproduction.
- Endocrine glands are ductless, meaning they do not have a tube or duct for the hormones to travel through. Instead, the hormones are secreted directly into the bloodstream.
- The hormones produced by endocrine glands traveling through the bloodstream to specific target organs or tissues.
- Hormones are chemical messengers that are released directly into the bloodstream.
- Endocrine glands are structures or groups of cells and tissues that are responsible for producing hormones.

▼ Hypothalamus

- produces neurohormones –releasing and inhibitory hormones.
  - The hypothalamus is a small, almond-shaped structure located in the brain, just below the thalamus and above the pituitary gland.
  - It is composed of different nuclei or clusters of neurons, each with a specific function.
  - The hypothalamus produces and releases various hormones that regulate physiological functions in the body, including:
    - Gonadotropin-releasing hormone (GnRH), which stimulates the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from the pituitary gland.
    - Thyrotropin-releasing hormone (TRH), stimulates the release of thyroid-stimulating hormone (TSH) from the pituitary gland.
    - Growth hormone-releasing hormone (GHRH), stimulates the release of growth hormone (GH) from the pituitary gland.
    - Corticotropin-releasing hormone (CRH), stimulates the release of adrenocorticotropic hormone (ACTH) from the pituitary gland.

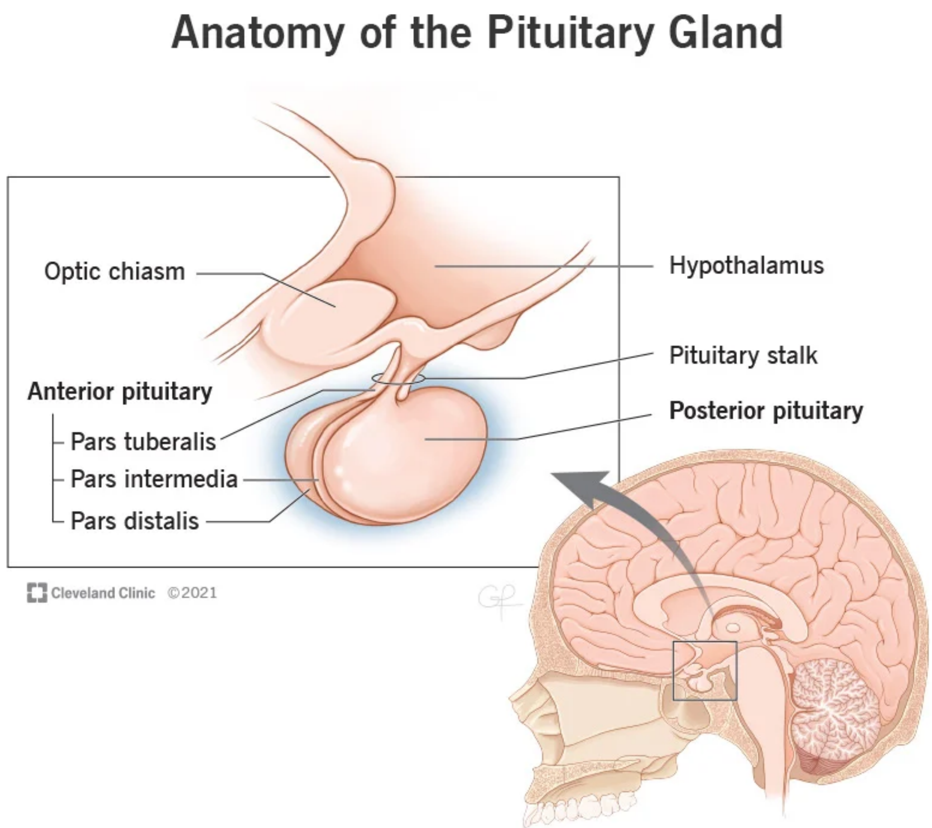
- The hypothalamus plays a vital role in regulating various physiological functions, including hunger, thirst, body temperature, sleep, and circadian rhythms.
- Dysfunction of the hypothalamus can lead to various hormonal imbalances, including infertility, growth disorders, and thyroid disorders.



▼ Pituitary

- The pituitary gland is a small, pea-sized gland located at the base of the brain, just below the hypothalamus.

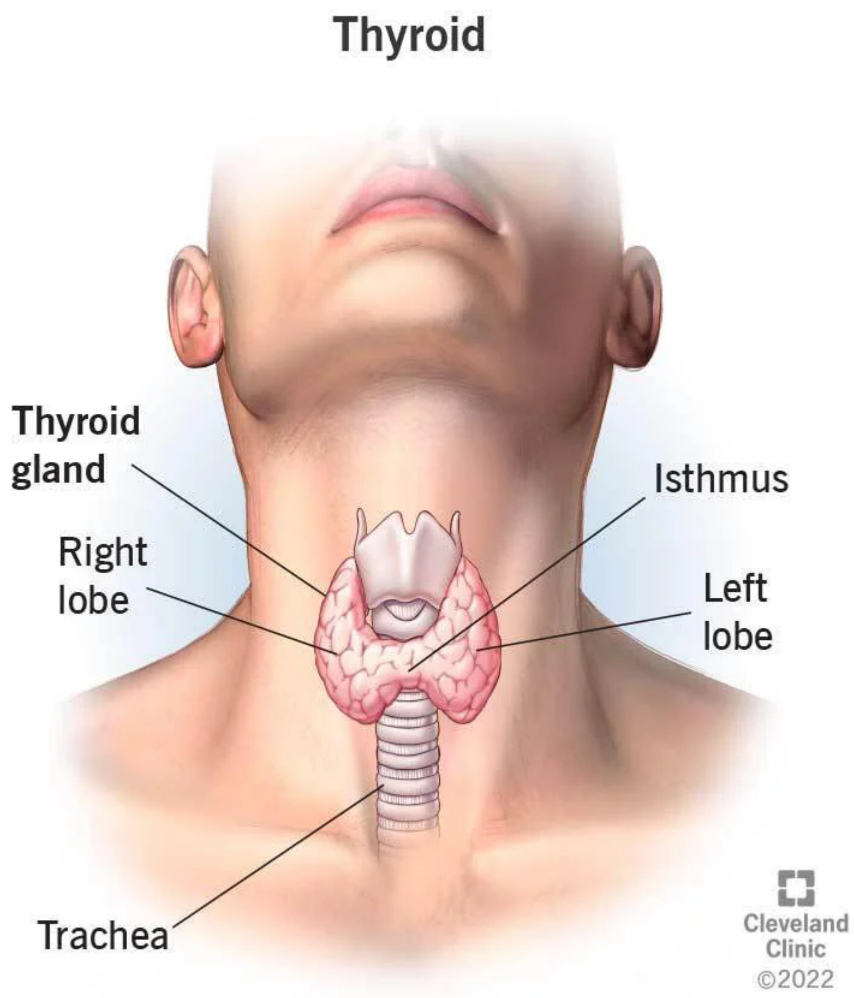
- It is divided into two parts: the anterior pituitary (adenohypophysis) and the posterior pituitary (neurohypophysis).
- The anterior pituitary produces and releases various hormones, including:
    - Adrenocorticotropic hormone (ACTH)
    - Thyroid-stimulating hormone (TSH)
    - Follicle-stimulating hormone (FSH)
    - Luteinizing hormone (LH)
    - Prolactin
    - Growth hormone (GH)
- The posterior pituitary stores and releases two hormones produced by the hypothalamus:
    - Oxytocin
    - Vasopressin (also known as antidiuretic hormone, or ADH)
- The pituitary gland plays a vital role in regulating various physiological functions, including growth and development, metabolism, stress response, and reproduction.
- Dysfunction of the pituitary gland can lead to various hormonal imbalances, including growth disorders, thyroid disorders, and infertility.



- Thyroid
  - The thyroid gland is a butterfly-shaped gland located in the neck, just below the Adam's apple.
  - It consists of two lobes connected by a narrow band of tissue called the isthmus.
  - The thyroid gland produces and releases two main hormones:
    - Thyroxine (T4)
    - Triiodothyronine (T3)
  - T4 and T3 play a vital role in regulating metabolism, growth, and development in the body.
  - The production and release of T4 and T3 are regulated by thyroid-stimulating hormone (TSH), which is produced by the pituitary

gland.

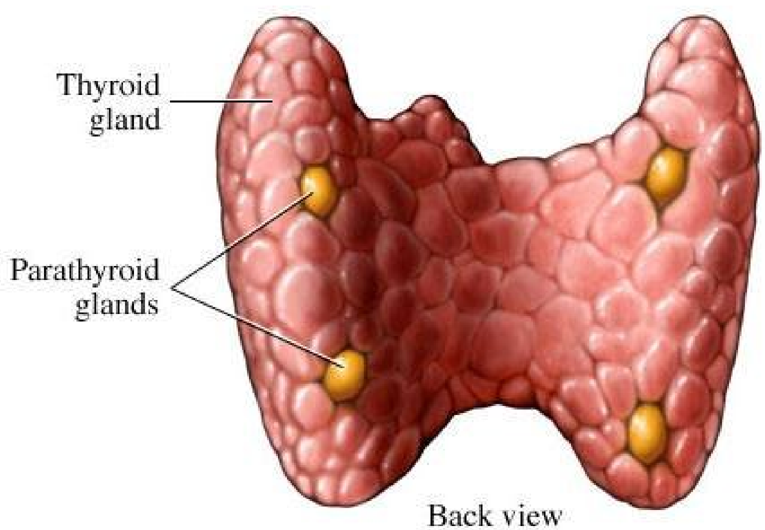
- The thyroid gland also produces and releases calcitonin, which regulates calcium levels in the body by promoting the uptake of calcium into bone tissue.
- Dysfunction of the thyroid gland can lead to various hormonal imbalances, including hyperthyroidism (overactive thyroid) and hypothyroidism (underactive thyroid).



▼ Parathyroid

- The parathyroid gland is a small gland located in the neck, near the thyroid gland.

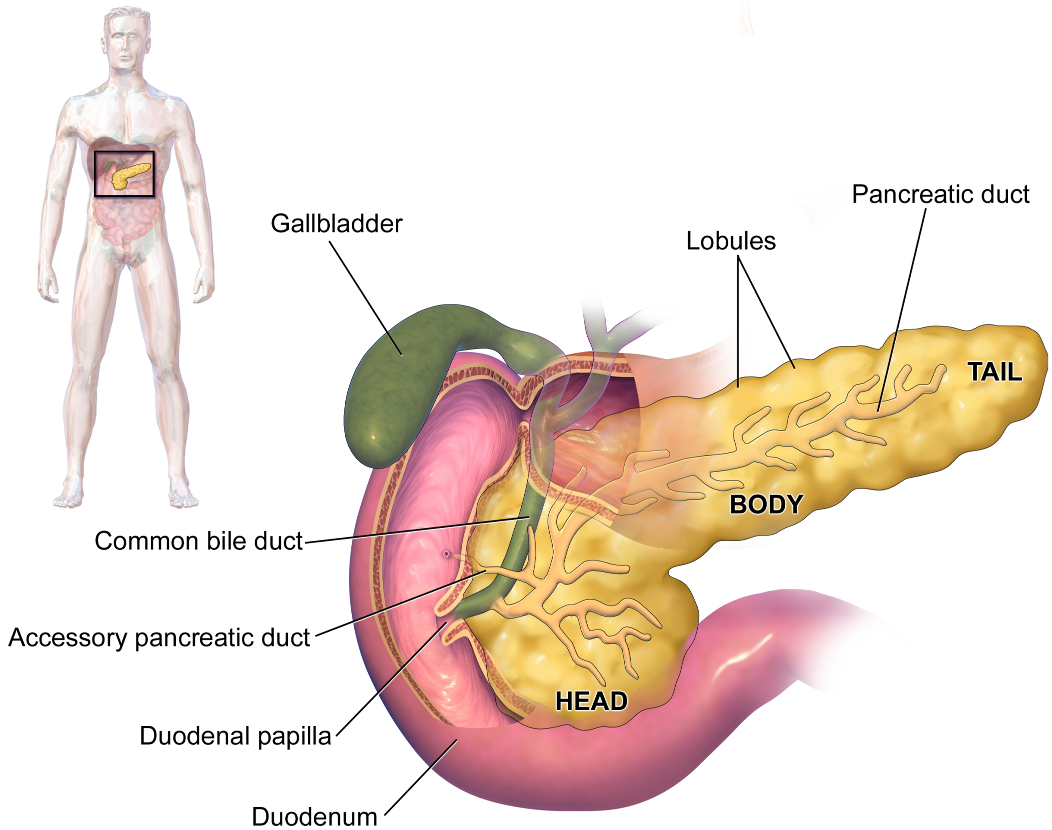
- There are usually four parathyroid glands, although some people may have more or fewer.
- The parathyroid gland produces and releases a parathyroid hormone (PTH).
- PTH plays a vital role in regulating calcium levels in the body by:
  - Stimulating the release of calcium from bone tissue
  - Increasing the reabsorption of calcium in the kidneys
  - Increasing the absorption of calcium in the intestines
- PTH also regulates phosphate levels in the body by promoting the excretion of phosphate in the kidneys.
- Dysfunction of the parathyroid gland can lead to various hormonal imbalances, including hyperparathyroidism (overactive parathyroid gland) and hypoparathyroidism (underactive parathyroid gland).



▼ Pancreas

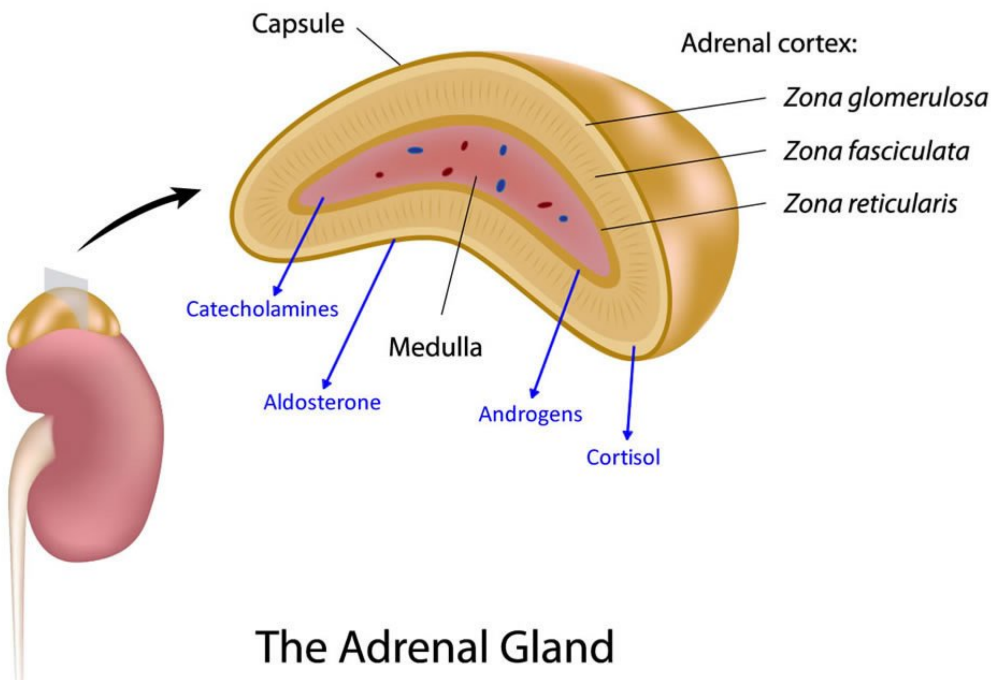
- The pancreas gland is a large gland located in the abdomen, behind the stomach.
- It is divided into two main parts: the exocrine pancreas and the endocrine pancreas.

- The exocrine pancreas produces and releases digestive enzymes into the small intestine to aid in the digestion of food.
- The endocrine pancreas produces and releases several hormones, including:
    - Insulin
    - Glucagon
    - Somatostatin
- Insulin plays a vital role in regulating blood sugar levels in the body by promoting the uptake of glucose into cells for energy or storage.
- Glucagon plays a vital role in regulating blood sugar levels in the body by stimulating the liver to release glucose into the bloodstream.
- Somatostatin plays a role in regulating insulin and glucagon secretion, as well as digestion and absorption of nutrients.
- Dysfunction of the pancreas gland can lead to various hormonal imbalances, including diabetes mellitus.



▼ Adrenal gland

- The adrenal glands are located above each kidney.
- They consist of the outer adrenal cortex and inner adrenal medulla.
- The adrenal cortex produces several hormones, including:
    - Cortisol: regulates metabolism and stress responses
    - Aldosterone: regulates blood pressure and electrolyte balance
    - Androgens (such as testosterone): important for male characteristics
- The adrenal medulla produces two important hormones:
    - Epinephrine (adrenaline): helps prepare the body for "fight or flight" responses to stress
    - Norepinephrine: helps regulate heart rate and blood pressure



The Adrenal Gland

▼ Testes(Males)

- Testes are male reproductive glands located in the scrotum outside the body cavity.
- They produce testosterone hormone, which is essential for the development of male reproductive organs, secondary sex characteristics, and sperm production.
- Testes are oval-shaped glands, each about the size of a golf ball.
- Leydig cells in the testes produce testosterone hormone.
- Spermatogenesis is the process by which the testes produce sperm cells.
- Testosterone and sperm cells are released from the testes into the male reproductive system.

▼ Ovaries (Females)

- Ovaries are a pair of reproductive glands located in the pelvis of females.
- They produce two main hormones: estrogen and progesterone.

- Estrogen helps regulate the menstrual cycle, promotes breast development, and affects the development of secondary sexual characteristics in females.
- Progesterone helps prepare the uterus for pregnancy and regulates the menstrual cycle.
- The ovaries also produce small amounts of androgens, such as testosterone, which play a role in female libido and overall health.

▼ Difference Between Hormones and Glands

- Hormones are chemical messengers that are produced by glands and secreted into the bloodstream to travel to target organs and tissues throughout the body.
- Glands are organs that produce and secrete hormones, as well as other substances like enzymes, saliva, and sweat.
- Hormones are specific molecules that have a specific target and function in the body, while glands are the organs that produce and release those hormones.
- Hormones are responsible for regulating a wide variety of bodily functions, including growth and development, metabolism, mood, and sexual function, while glands have a variety of functions beyond just hormone production.
- The endocrine system is the body's system of glands that produce and secrete hormones, while the exocrine system includes glands that secrete substances like sweat, saliva, and digestive enzymes.

▼ Feedback Mechanism

1. The body uses a feedback mechanism to regulate the timing and amount of hormone released.
2. When blood sugar levels rise, cells in the pancreas detect the increase and respond by producing more insulin.
3. Insulin helps to lower blood sugar levels.

4. As blood sugar levels fall, insulin secretion is reduced to maintain a balance.

Human Nervous System

A physically connected network of cells, tissues, and organs that allow us to communicate with and react to the environment and perform life activities.

Functions

1. Sensing the world: The nervous system allows us to sense the world around us through our five senses. Here are some examples:

- Vision: We use our eyes to see things. For example, we can see a colorful butterfly flying in the garden or read a book.
- Hearing: We use our ears to hear sounds. For example, we can hear a bird chirping or someone talking to us.
- Smell: We use our noses to smell different things. For example, we can smell freshly baked cookies or flowers in a garden.
- Taste: We use our tongues to taste different foods. For example, we can taste sweet ice cream or sour lemonade.
- Touch: We use our skin to feel different textures and temperatures. For example, we can feel the soft fur of a cat or the warmth of the sun on our faces.

1. Transmitting information: The nervous system allows information to be transmitted from our senses to our brain and spinal cord. Here are some examples:

- When we see a red traffic light, our eyes send a signal to our brain to tell us to stop.
- When we touch a hot stove, our skin sends a signal to our brain to tell us to move our hands away.
- When we hear someone calling our name, our ears send a signal to our brain to tell us to turn and look.

1. Processing information: The nervous system processes the information it receives from our senses and decides what to do. Here are some examples:

- When we see a ball flying towards us, our brain tells us to move out of the way so we don't get hit.
- When we hear a dog barking, our brain tells us that there may be a dog nearby and we need to be careful.
- When we smell smoke, our brain tells us that there may be a fire and we need to leave the area.

1. Producing a response: The nervous system allows us to respond to the information we receive. Here are some examples:

- When we see our friend waving at us, our brain tells us to wave back.
- When we hear a baby crying, our brain tells us to go and check on the baby.
- When we touch a soft blanket, our brain tells us to wrap ourselves in it to stay warm.

▼ Neurons

- Neurons have three main parts: the cell body, dendrites, and axon.
- The cell body contains the nucleus and other important cellular components.
- Dendrites are short, branching projections that receive signals from other neurons or from sensory receptors.
- The axon is a long, thin projection that sends signals to other neurons, muscles, or glands.
- Neurons communicate with each other through synapses, small gaps between the axon of one neuron and the dendrites of another.

1. Glial Cells: Glial cells are another type of cell in the nervous system that provide support and protection for neurons. Here are some key points to know about glial cells:

- Glial cells make up about half of the cells in the brain.
- They come in different types, including astrocytes, oligodendrocytes, and microglia, each with different functions.
- Astrocytes provide structural support and regulate the chemical environment around neurons.
- Oligodendrocytes produce myelin, a fatty substance that wraps around axons and helps to speed up signal transmission.
- Microglia are involved in the immune response and help to clear away damaged cells and debris.

Overall, neurons and glial cells work together to allow the nervous system to function properly. Neurons send messages to each other and to other parts of the body, while glial cells provide support and protection to ensure that neurons can do their job effectively.

▼ Types of Neurons

1. Sensory neurons: Sensory neurons are specialized cells that detect stimuli (changes) in the environment and send signals to the brain or spinal cord. Here are some key points to know about sensory neurons:

- They are found in sensory organs such as the eyes, ears, nose, tongue, and skin.
- They can detect different types of stimuli such as light, sound, smell, taste, and touch.
- When they detect a stimulus, they send a signal to the brain or spinal cord.

1. Interneurons: Interneurons are neurons that relay sensory signals from sensory neurons to the brain or spinal cord, and then send signals back to motor neurons. Here are some key points to know about interneurons:

- They are found in the brain and spinal cord.
- They help to process and integrate sensory information and coordinate motor responses.

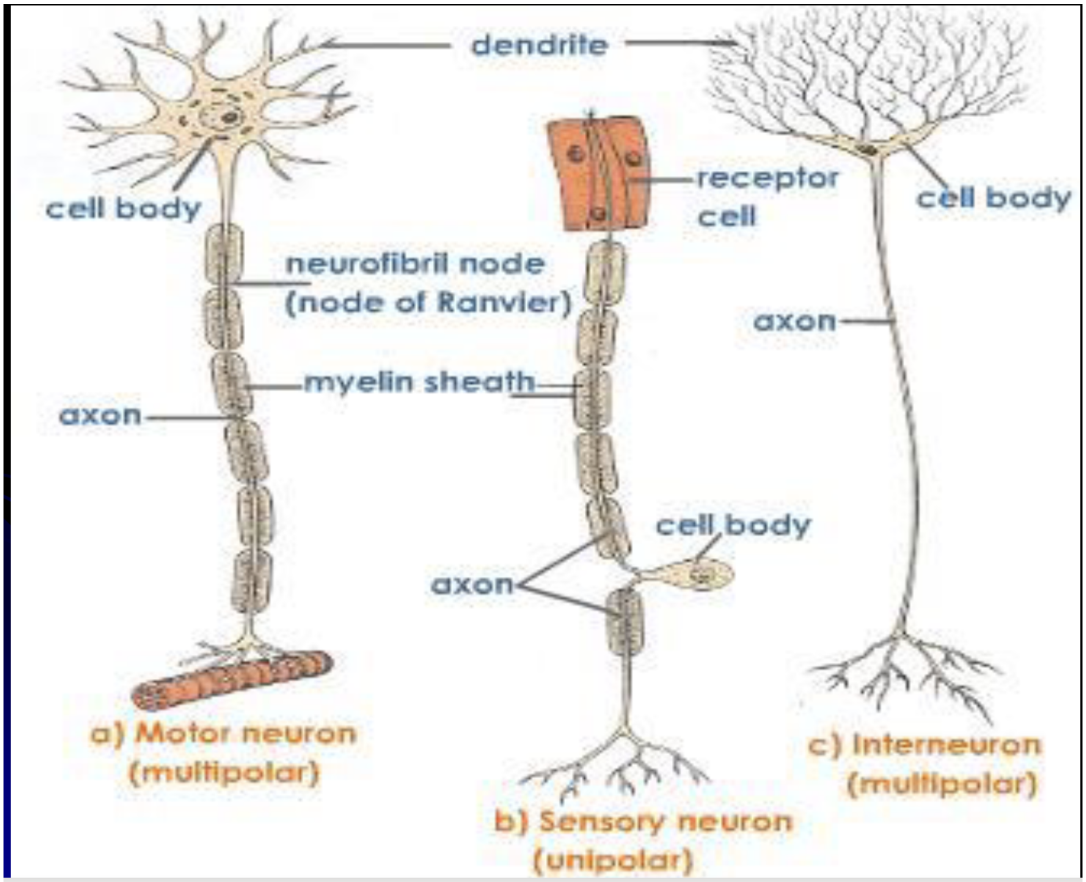
- They connect sensory neurons to motor neurons, allowing for quick and coordinated responses to stimuli.

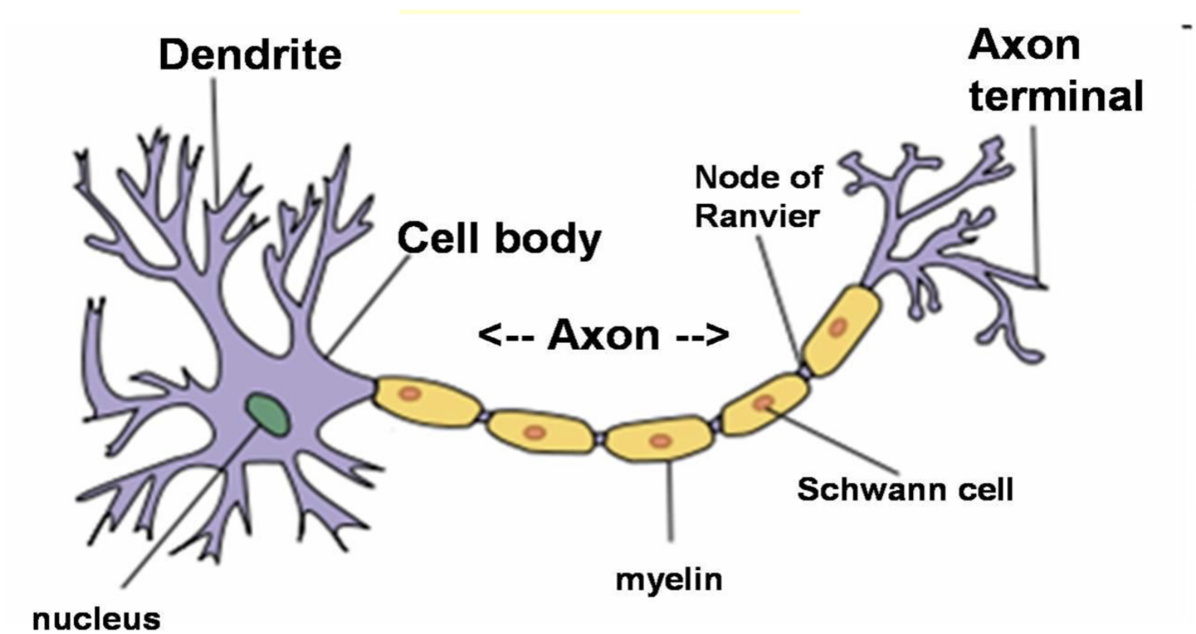
1. Motor neurons: Motor neurons are neurons that pass messages from the brain or spinal cord to the rest of the body for muscle response. Here are some key points to know about motor neurons:

- They are found in the brain and spinal cord.
- They control muscle movement and are responsible for carrying out motor responses to stimuli.
- When they receive a signal from the brain or spinal cord, they send a message to muscles to contract or relax.

1. Reflex arc: The reflex arc is a coordinated pathway that allows for a quick and automatic response to a stimulus, without the need for conscious thought. Here are some key points to know about the reflex arc:

- When a sensory neuron detects a stimulus, it sends a signal to an interneuron in the spinal cord.
- The interneuron then sends a signal to a motor neuron, which activates the appropriate muscle response.
- This pathway allows for a rapid response to potentially dangerous or harmful stimuli, such as pulling your hand away from a hot stove without thinking about it.





▼ Nerve impulses

- Definition: A nerve impulse is a signal that travels along the axon (nerve fiber) of a neuron, allowing for communication between different parts of the body.
- Classification: Nerve impulses can be classified into two types: excitatory and inhibitory. Excitatory impulses increase the likelihood that the next neuron will fire, while inhibitory impulses decrease the likelihood.
- Structure: Nerve impulses are generated by changes in the electrical charge across the cell membrane of a neuron. This charge is maintained by ion channels in the membrane that allow ions to flow in and out of the cell. When a stimulus causes a change in the charge across the membrane, ion channels open and allow ions to flow in, triggering an action potential that travels along the axon.
- Function: Nerve impulses allow for communication between different parts of the body, including the brain, spinal cord, muscles, and organs. They are responsible for controlling movement, sensation, thought, and other bodily functions. Without nerve impulses, our bodies would not be able to function properly.

▼ Central Nervous System (CNS)

- The central nervous system (CNS) receives, interprets, and sends signals to the peripheral nervous system (PNS). The CNS consists of two main parts:

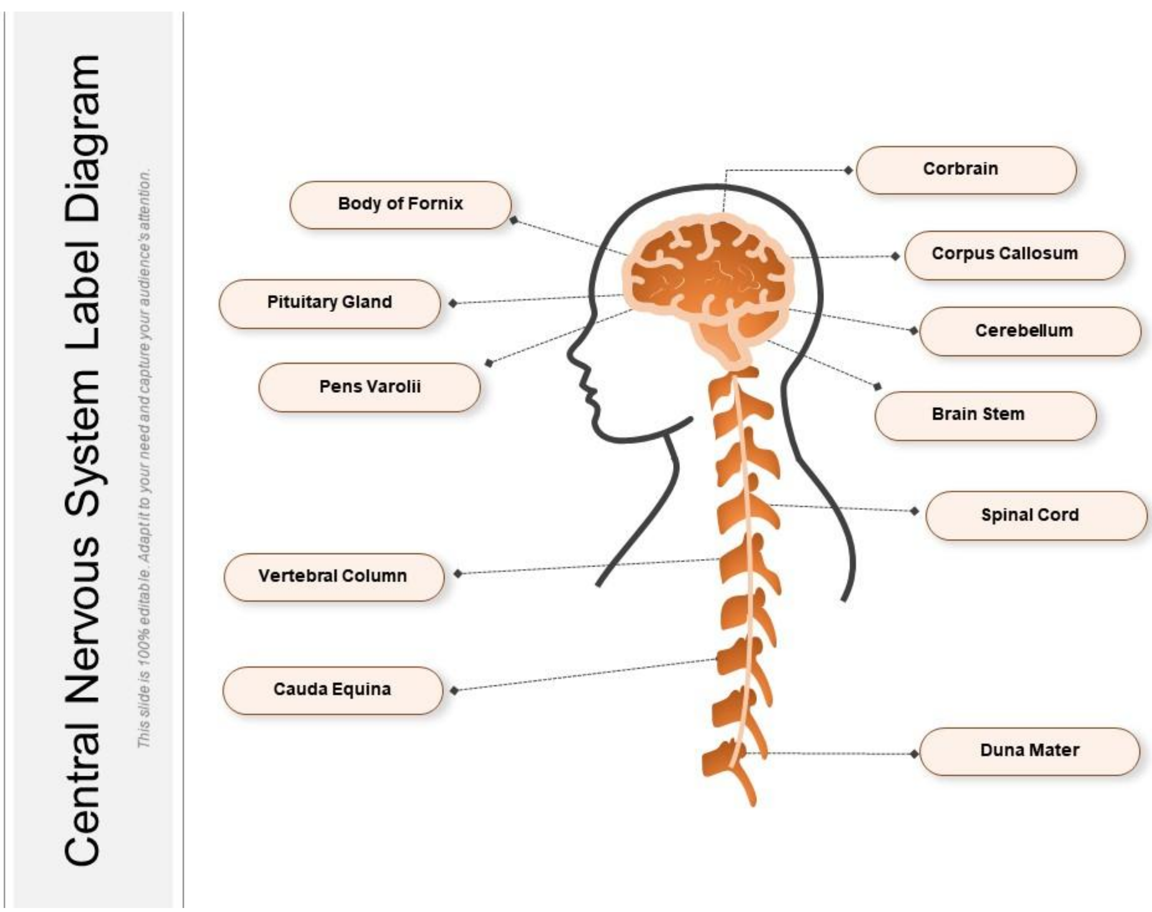
1. The brain: The brain is the main control center of the CNS. It is located inside the skull and has many different parts that work together to control our thoughts, feelings, and actions. Here are some key points to know about the brain:

- It is divided into different regions, each with its own specific functions, such as the frontal lobe (which is responsible for decision-making and problem-solving) and the occipital lobe (which is responsible for vision).
- It is protected by the skull and surrounded by protective membranes called meninges.
- It receives and interprets information from the senses (such as sight, sound, and touch) and controls our voluntary and involuntary actions (such

as movement, breathing, and heartbeat).

1. The spinal cord: The spinal cord is a long, thin tube of nerve tissue that runs from the base of the brain down to the lower back. It is responsible for connecting the brain to the rest of the body and relaying nerve impulses between them. Here are some key points to know about the spinal cord:

- It is protected by the vertebrae (bones of the spine) and surrounded by cerebrospinal fluid (which acts as a cushion).
- It contains bundles of nerve fibers (axons) that transmit signals to and from the brain.
- It is divided into different regions, each with its own specific functions, such as the cervical region (which controls the arms and upper body) and the lumbar region (which controls the legs and lower body).



▼ PERIPHERAL NERVOUS SYSTEM (PNS)

- The peripheral nervous system (PNS) connects the CNS to all organ systems in the body. The PNS is made up of two types of neurons:

1. Sensory neurons: These neurons detect stimuli from the environment and send signals to the CNS for processing. For example, when you touch a hot stove, the sensory neurons in your skin detect the heat and send a signal to your brain to let you know that your hand is in danger.
2. Motor neurons: These neurons carry signals from the CNS to the muscles and glands in the body, stimulating a response. For example, when you decide to move your arm, the motor neurons in your brain send a signal to the muscles in your arm to contract and move.

- The PNS is divided into two major subsystems:

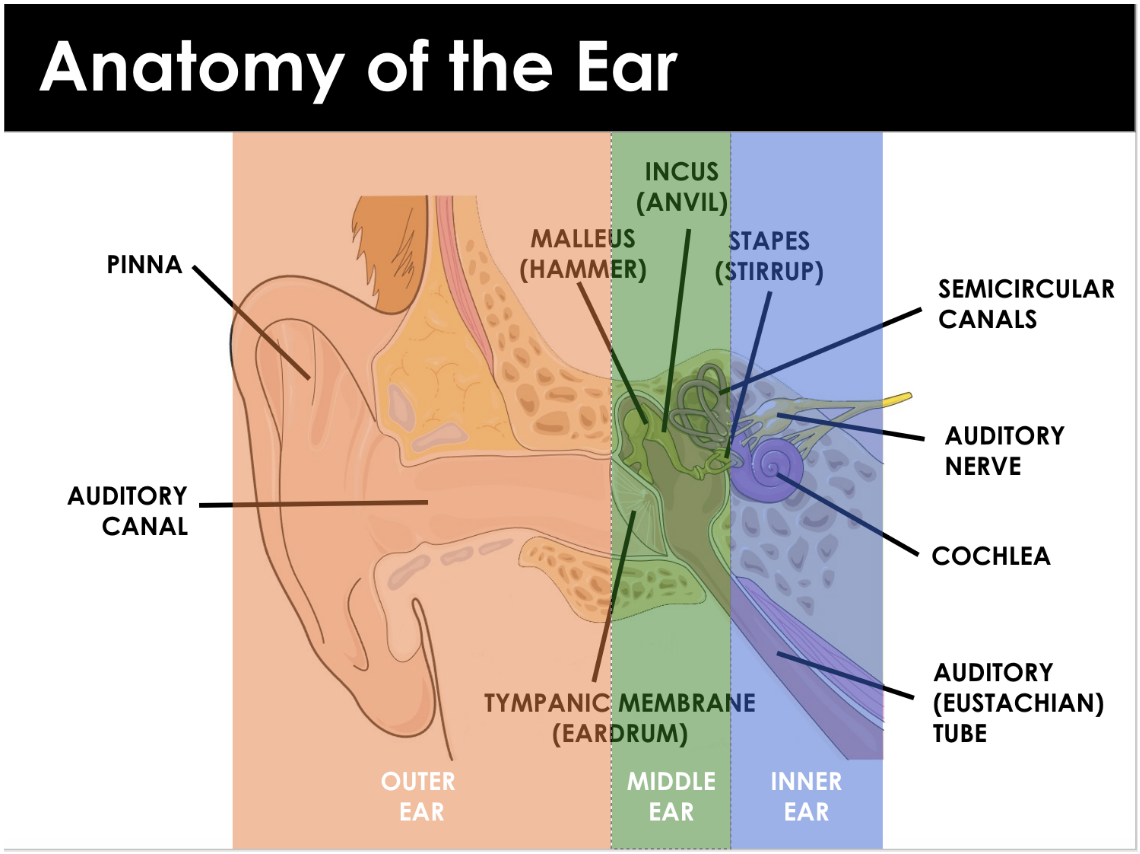
1. Somatic nervous system: This system is responsible for voluntary movements and sensory perception, such as balance and movement. For example, when you choose to walk, the somatic nervous system coordinates the movement of your muscles and joints to help you maintain balance and move forward.
2. Autonomic nervous system: This system is responsible for involuntary movements, such as digestion and the fight or flight response. For example, when you eat food, the autonomic nervous system controls the contractions of your digestive muscles to break down the food and absorb nutrients.

▼ Ear

The ear is part of our body that helps us hear sounds.

- When sound waves enter our ears, they are sent to the cochlea, which is a special part of the ear that helps us hear.
- The cochlea converts the sound waves into nerve impulses that travel to the brain.
- The brain then interprets these impulses and creates the sound that we hear.

▼ Anatomy of the Ear



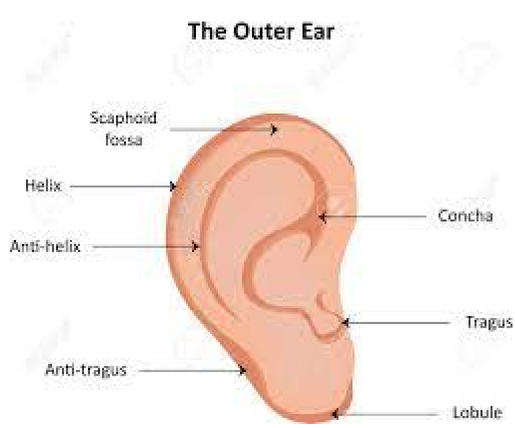
▼ Areas of the Ear

1. Outer ear: This is the part of the ear that we can see on the outside of our head. It has a flap of skin called the pinna, which collects sound waves and sends them down a tube called the auditory canal.
2. Middle ear: This is part of the ear that's between the outer ear and the inner ear. It has three tiny bones called the hammer, anvil, and stirrup, which help to pass sound waves along to the inner ear. There's also a small tube called the Eustachian tube that helps to balance the air pressure on both sides of the eardrum.
3. Inner ear: This is part of the ear that's deep inside our head. It has a snail-shaped organ called the cochlea, which helps to convert sound waves into nerve signals that can be sent to the brain. The inner ear also has three tiny tubes called semicircular canals, which help us to keep our balance.

▼ Outer Ear

- The pinna is made up of elastic cartilage, which makes it flexible and allows it to change shape.
- The pinna's unique shape and position on the head helps to capture sound waves and funnel them into the auditory canal.
- The auditory canal is a narrow, tube-like structure that is lined with tiny hairs and wax-producing glands. These structures help to trap dirt, dust, and other debris and prevent them from entering the middle ear.
- The eardrum, or tympanic membrane, is a thin, cone-shaped membrane that separates the outer ear from the middle ear. Its main function is to vibrate in response to sound waves and transmit these vibrations to the ossicles in the middle ear.
- The eardrum is composed of three layers: an outer layer of skin, a middle layer of fibrous tissue, and an inner layer of the mucous membrane.
- The eardrum also serves as a barrier to protect the middle and inner ear from infection-causing bacteria and viruses.

Overall, the outer ear is designed to gather and amplify sound waves, protect the middle and inner ear from damage and infection, and funnel sound waves toward the middle ear.



▼ Middle Ear

- The middle ear is a small, air-filled space located behind the eardrum.
- It is an important part of the ear because it helps to amplify and transmit sound waves from the outer ear to the inner ear.

- The middle ear contains three small bones, known as ossicles, which are the smallest bones in the human body.
- The malleus, incus, and stapes work together as a lever system to transfer the vibrations of the eardrum to the inner ear.
- The malleus is connected to the eardrum, the incus connects the malleus to the stapes, and the stapes is connected to the oval window of the inner ear.
- The auditory tube, also known as the Eustachian tube, connects the middle ear to the back of the throat and helps to regulate air pressure in the middle ear.

▼ Bones

MIDDLE EAR BONES:
MALLEUS (HAMMER)
• Looks like a tiny hammer
• Attaches to the eardrum and transmits its vibrations to the incus
INCUS (ANVIL)
• Looks like a tiny anvil or stirrup
• Receives vibrations from the malleus and passes them on to the stapes
STAPES (STIRRUP)
• Looks like a tiny stirrup
• Receives vibrations from the incus and transmits them to the oval window of the cochlea
• The stapes is the smallest bone in the human body

The middle ear bones work together to amplify and transmit sound vibrations from the eardrum to the inner ear.

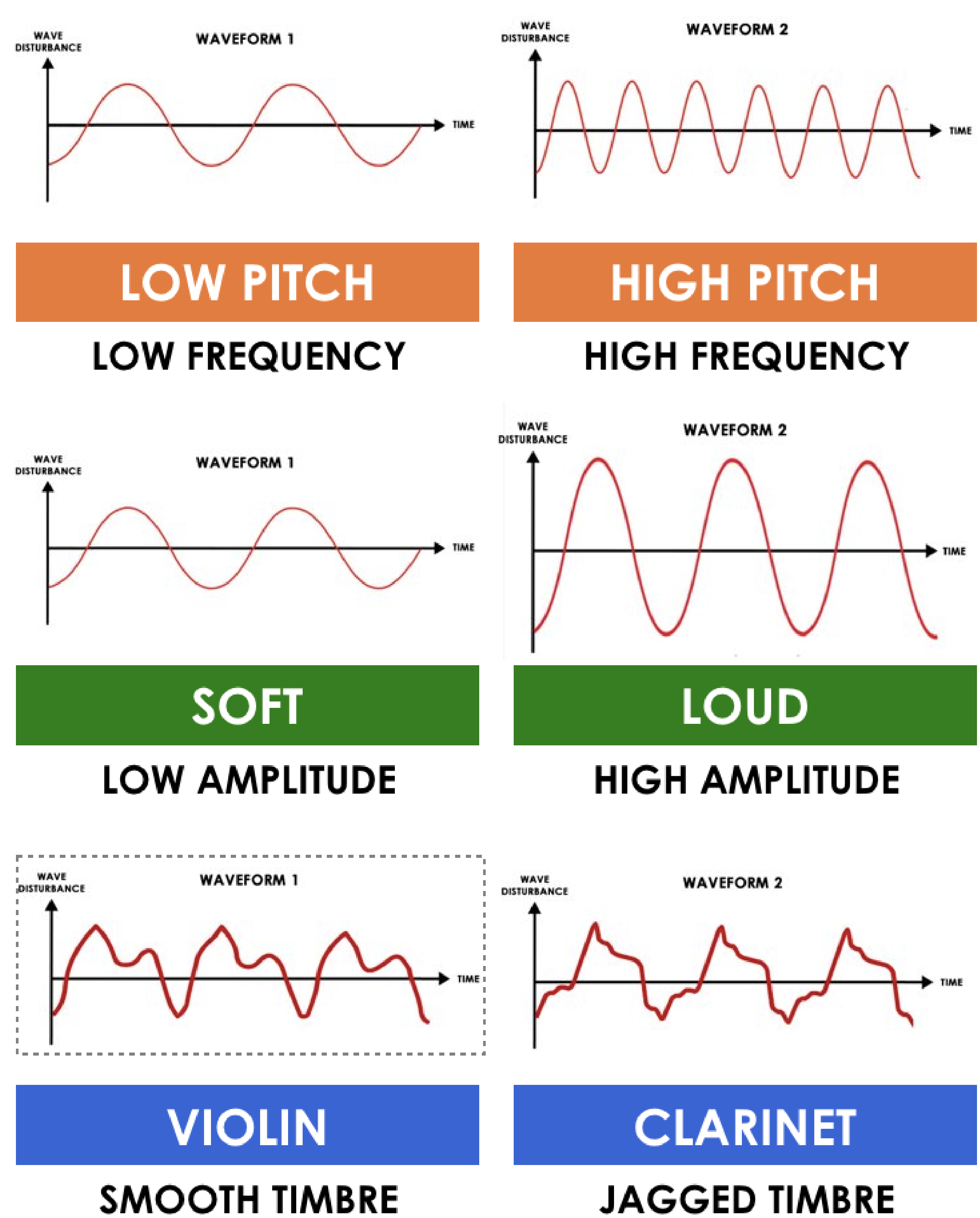
▼ Inner Ear

- The inner ear is responsible for converting pressure waves in the cochlea into electrical signals that can be interpreted by the brain as sound.
- The cochlea is a spiral-shaped, fluid-filled structure that contains sensory hair cells that are essential for hearing.

- When sound waves reach the inner ear, they cause the oval window to vibrate, which creates pressure waves in the fluid within the cochlea.
- These pressure waves cause the hair cells to move back and forth, which stimulates them to send electrical signals to the brain via the auditory nerve.
- The semicircular canals are another part of the inner ear that are responsible for detecting changes in head movement and position, helping to maintain balance and equilibrium.
- The inner ear is a complex and delicate structure that is essential for both hearing and balance

▼ Hearing

Hearing is the perception of sound waves made by objects
• Sound waves have three properties: pitch, volume, and timbre
• Pitch or frequency is the number of vibrations per second; higher frequency results in higher-pitched sound
• Loudness or intensity is the wave amplitude; higher amplitude results in a louder sound
• Timbre or quality is the unique pattern of sound waves created by different objects
• Waveform 1 and Waveform 2 represent different sound waves with varying frequencies, amplitudes, and timbres
• A low pitch or frequency corresponds to a low number of vibrations per second, while a high pitch or frequency corresponds to a higher number of vibrations per second
• Soft sounds have a low amplitude, while loud sounds have a higher amplitude
• The violin has a smooth timbre, while the clarinet has a jagged timbre



▼ Steps to Hearing

1. At the outer ear, sound waves are gathered and focused by the pinna down the ear canal to the eardrum

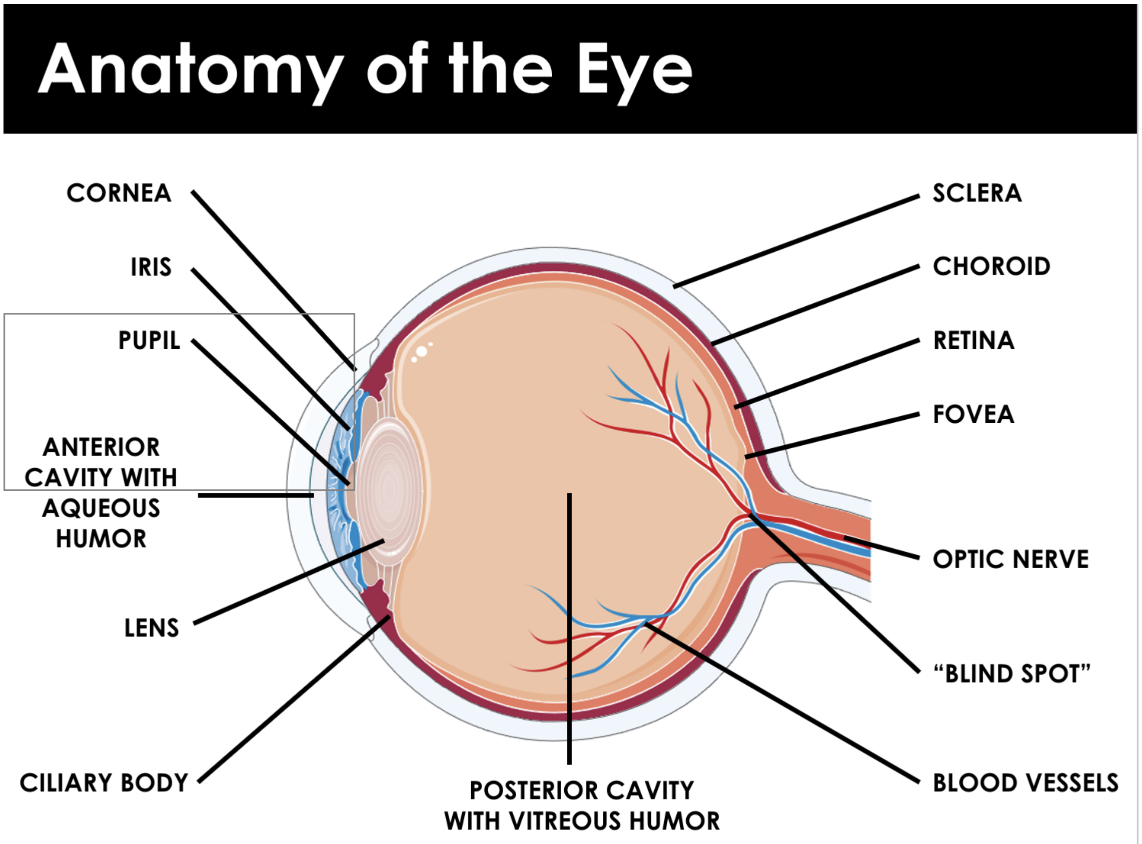
2. The energy from the compression waves of sound causes the eardrum to vibrate
3. The eardrum vibrations are conducted and amplified by the 3 middle ear bones: the malleus, incus, and stapes
4. The stirrup transmits the energy from the compression waves to the fluid-filled cochlea as pressure waves
5. The pressure waves in the fluid within the cochlea moves sensory hair cells inside the cochlea, which converts the motion of the hair cells into nerve impulses
6. Nerve impulses travel along the auditory nerve to the auditory cortex in the brain, which interprets the pattern of nerve impulses as sound

▼ Eyes

The eye is responsible for our sense of sight.

- It collects light or radiant energy from the environment.
- The light is focused onto the retina which contains sensory receptors.
- The sensory receptors detect the light and convert it into nerve impulses.
- These impulses are carried along sensory neurons to the brain.
- The visual cortex in the brain interprets the impulses to form an image.

▼ Anatomy of the Eye



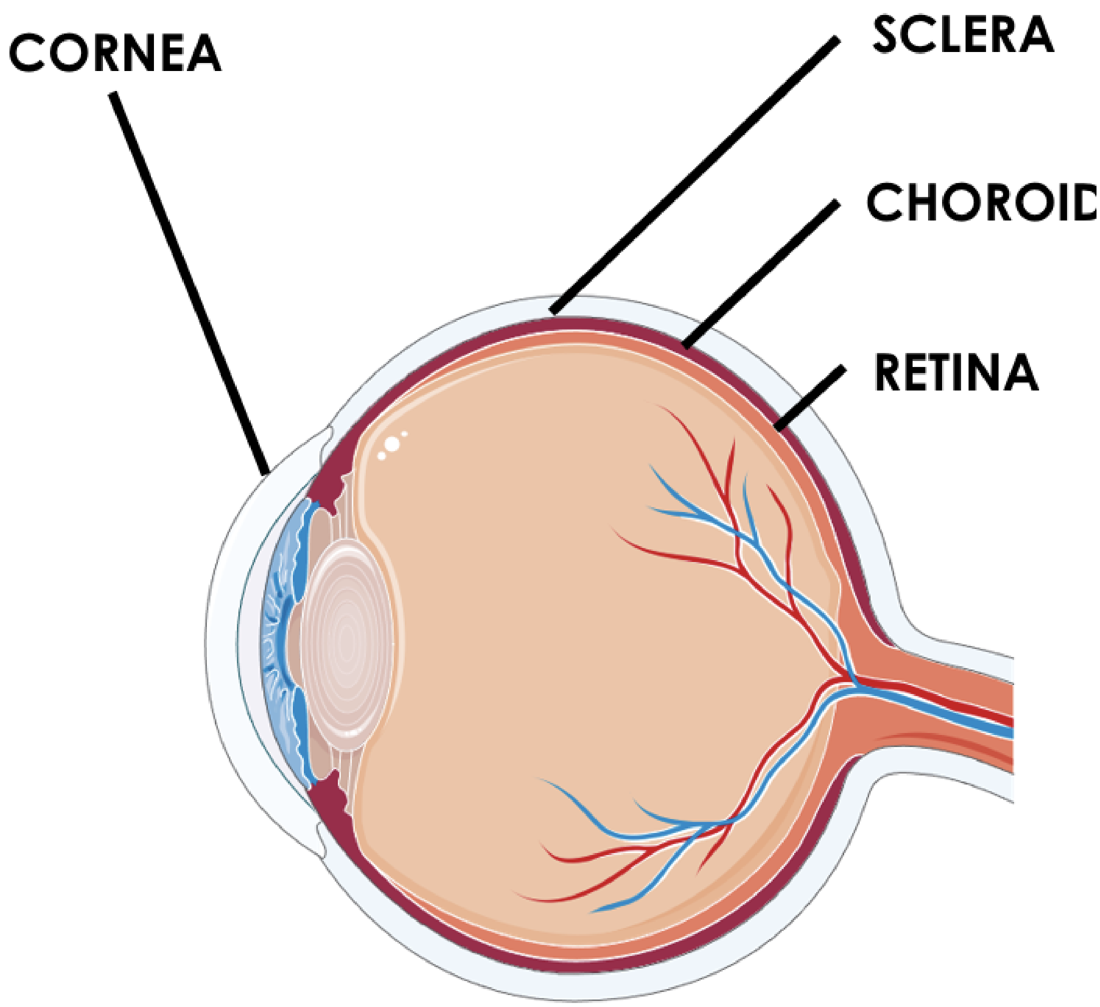
▼ Outer Layers of The Eye

The wall of the human eye is comprised of 3 layers

• The outer, fibrous coat consists of the white sclera, and the transparent front area of the sclera called the cornea, which allows light into the eye

• The choroid is the middle layer which contains numerous blood vessels for the retina

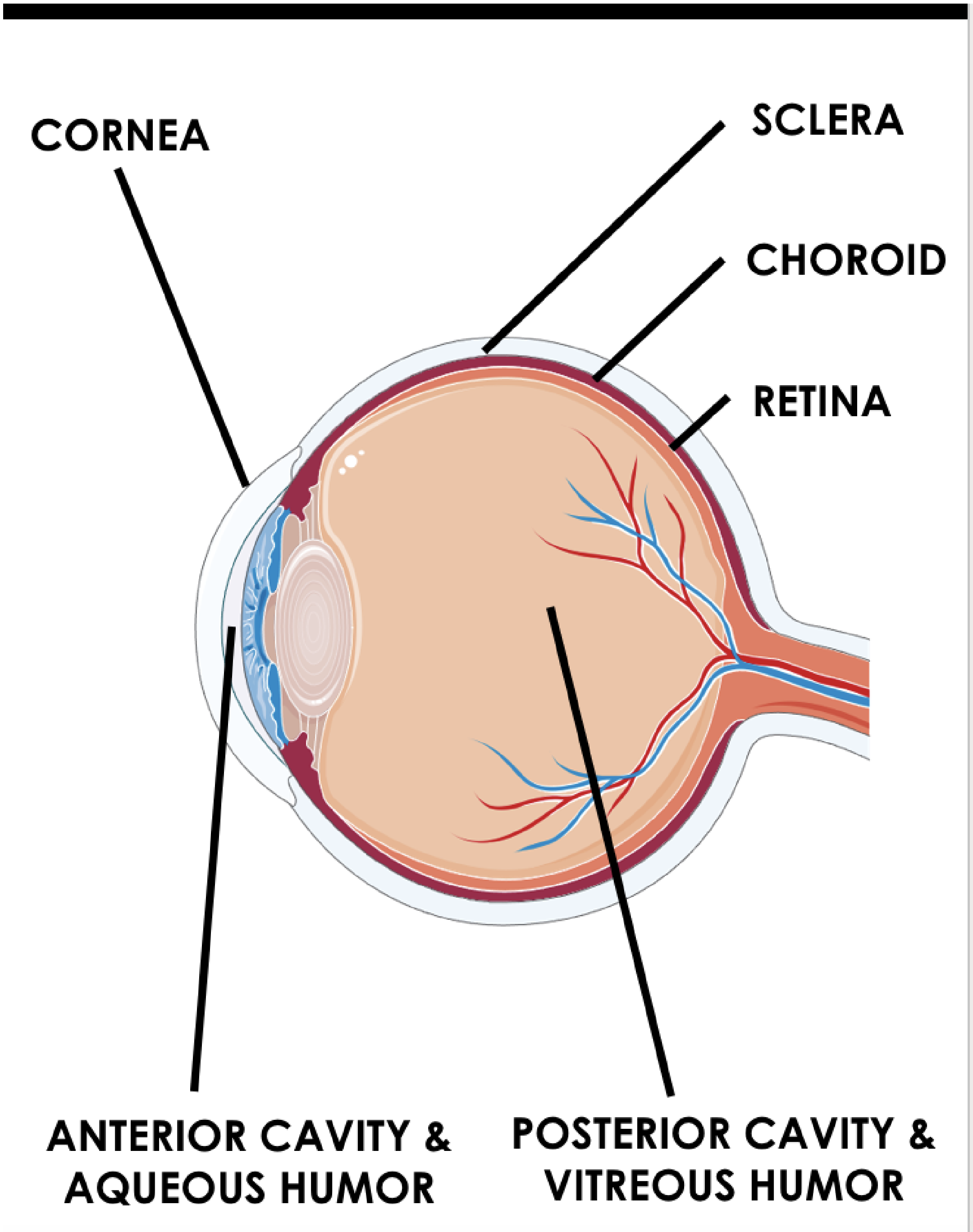
• The retina is the innermost layer, which contains the receptors that detect light



▼ Cavities of the eye

- The eye contains two fluid-filled cavities called the anterior and posterior cavities.
- The anterior cavity is located at the front of the eye, between the cornea and lens.
- The anterior cavity is filled with a watery fluid called aqueous humor, which nourishes and protects the lens and cornea.
- The aqueous humor also helps maintain the shape of the eye and plays a role in regulating intraocular pressure.

- The posterior cavity is located at the back of the eye, between the lens and retina.
- The posterior cavity is filled with a gel-like fluid called vitreous humor, which helps maintain the shape of the eye and supports the retina.
- The vitreous humor is also involved in the transmission of light to the retina.
- Both aqueous and vitreous humor play important roles in the overall health and function of the eye.



▼ Front Anatomy Of the eye

The pupil is a small opening in the center of the eye that allows light to enter

• The iris is a ring of muscles around the pupil that contracts or expands to adjust the size of the pupil and regulate the amount of light entering the eye; it also gives the eye its color

• The lens is a clear, flexible structure located behind the iris that changes shape to focus light onto the retina at the back of the eye
• The ciliary body is a ring of muscles located behind the iris that controls the shape of the lens, allowing it to adjust its focus on near or far objects

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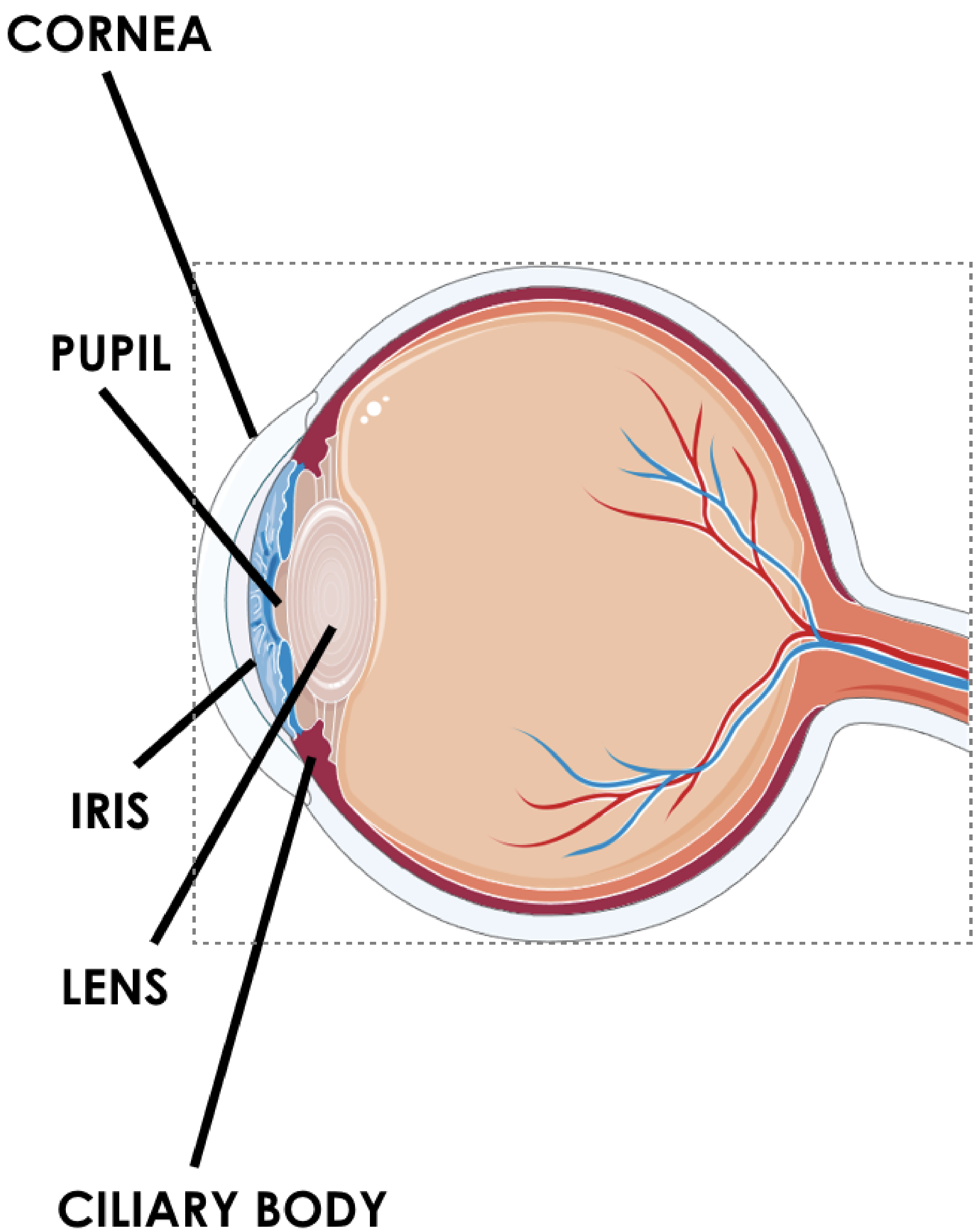


▼ Rear Anatomy of the eye

The retina is the layer at the back of the eye that detects light and sends nerve impulses to the brain along the optic nerve.

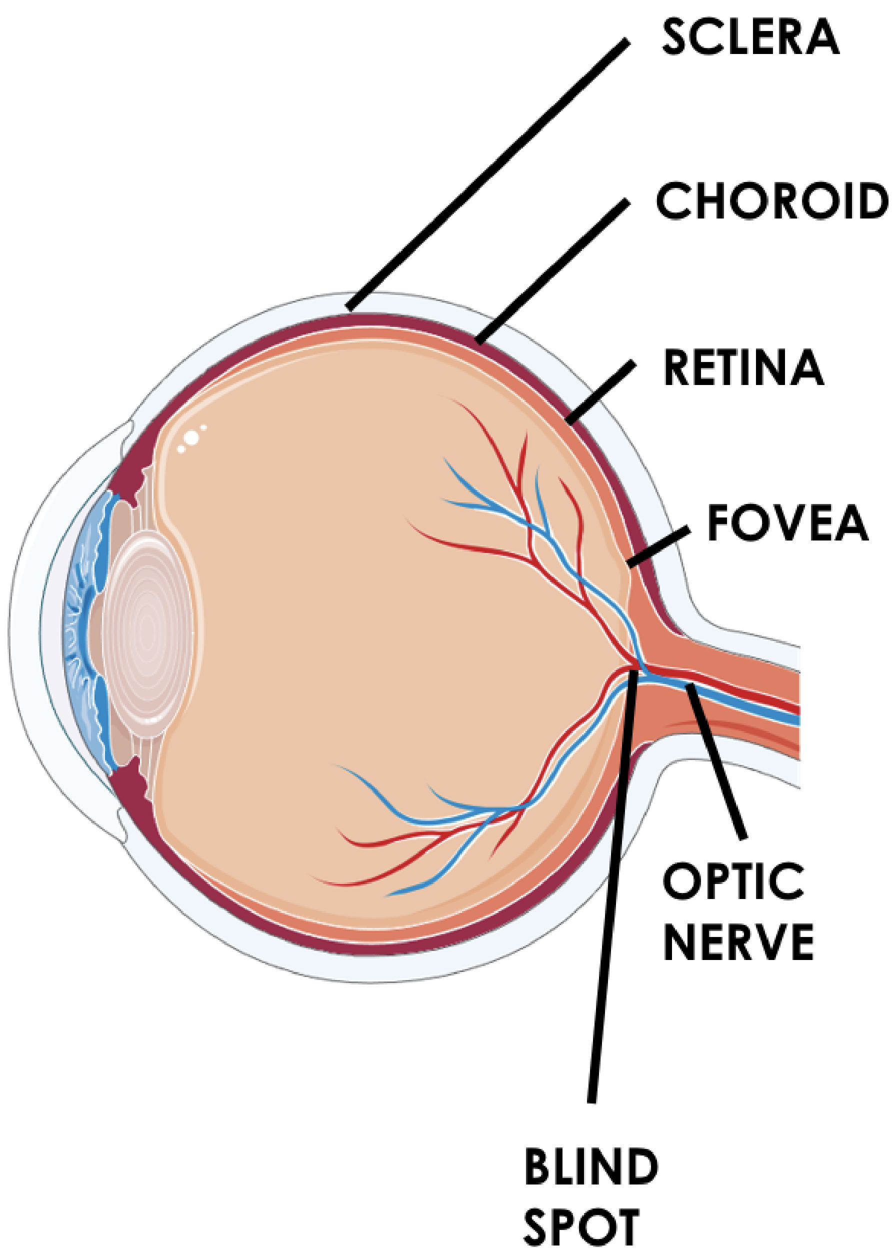
• There are over 120 million photoreceptor cells on the retina that are responsible for detecting light.

• The two types of photoreceptor cells are called rods and cones.

• Rods are more sensitive to light and help us see in dim lighting conditions, while cones are responsible for color vision.

• The fovea is a small dip in the center of the retina where most of the cone cells are located, making it responsible for our sharpest and clearest vision.

• The "blind spot" is a small area on the retina where the optic nerve exits the eye, containing no photoreceptor cells and therefore creating a gap in our visual field.

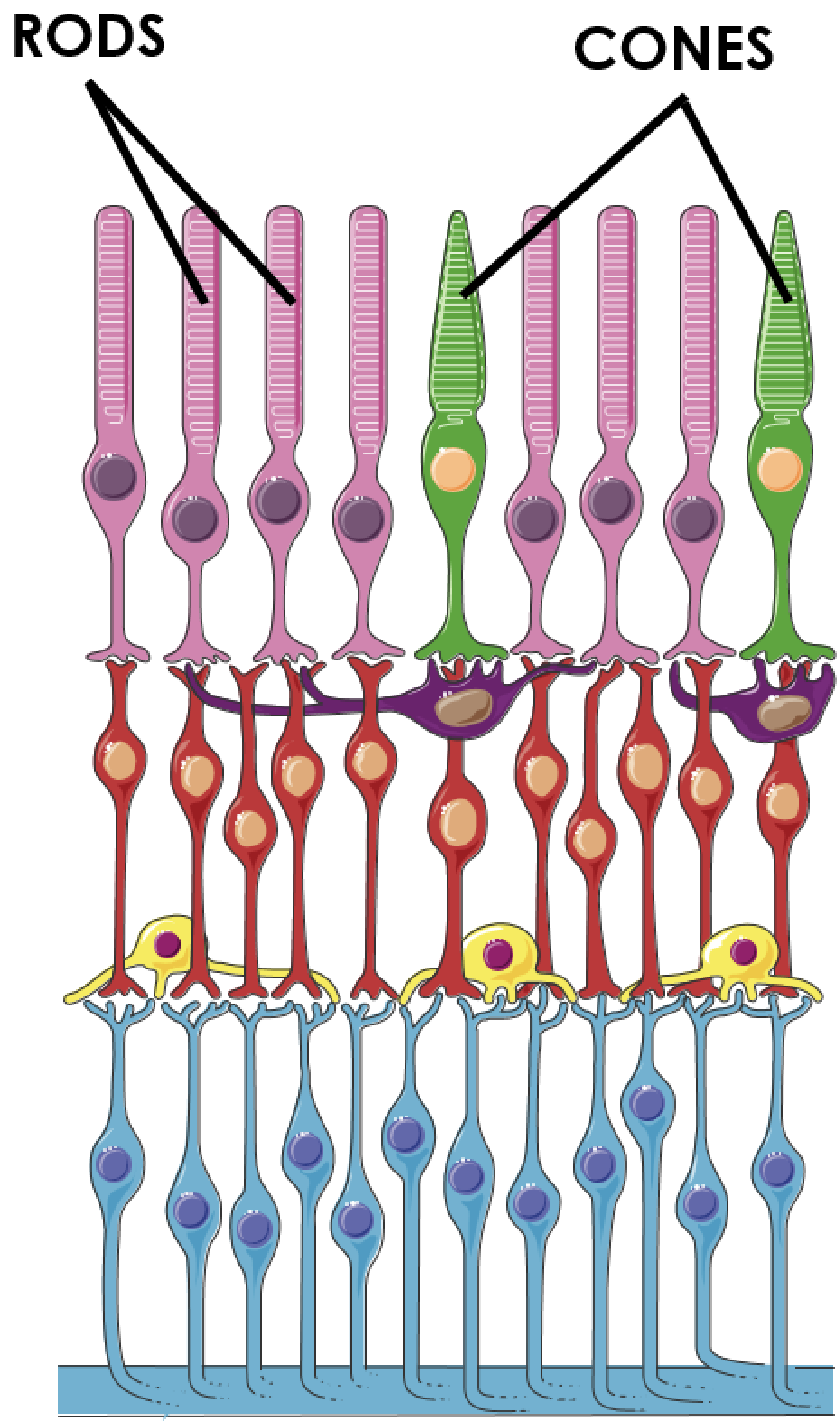


▼ Rods and Cones

Sensory cells in the retina called rods and cones detect the different properties of incoming light.

• Cones detect the color of light and come in three forms for the primary colors of light they detect: red, green, and blue.

- Cones are found in the center of the retina and are highly concentrated at the fovea, which is responsible for sharp central vision.
- Rods detect the brightness of light and therefore only "see" in black and white.
- Rods are more sensitive than cones to low levels of light and are responsible for vision in dim light conditions.
- Rods are found at the retina's edges, and there are approximately 20 times more rods than cones in the retina.


RODS
CONES

▼ Steps to vision

Summary - Steps to Vision

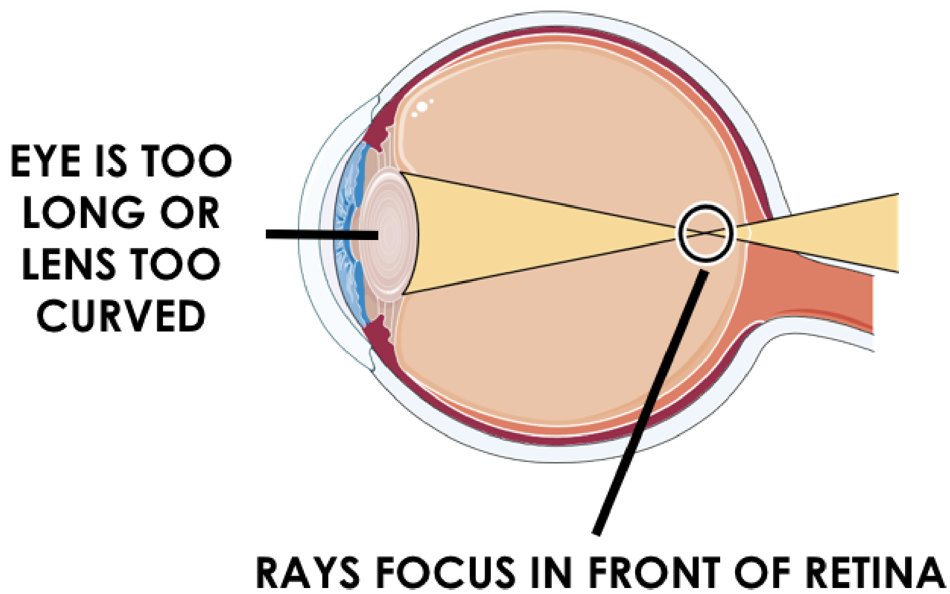
1. Light rays enter the eye through the cornea, a clear front portion of the sclera that focuses light into the eye
2. Light pass through the pupil, whose diameter is controlled by a ring of muscles called the iris
3. Light passes through the lens, a transparent convex lens which precisely focuses the rays onto the retina
4. The retina is lined with light-sensitive cells: cones cells detect the color of light and rod cells detect the brightness
5. Stimulated rod and cone cells from each eye send electrical impulses to the brain along optic nerves
6. The optic cortex area of the brain interprets the impulses and forms a visual image in the mind about the image

▼ Vision Disorders

▼ Nearsightedness

Nearsightedness
Also called: myopia
• Nearsightedness is a condition where objects that are far away appear blurry, while close objects appear clear
Causes:
• Occurs when the eyeball is too long or the cornea is too curved, causing light rays to focus in front of the retina
Symptoms:
• Difficulty seeing distant objects clearly
• Squinting or straining to see objects in the distance
• Headaches or eye strain
• Nearsightedness may develop gradually or rapidly and typically begins in childhood
• This condition tends to run in families
• Nearsightedness usually stabilizes in early adulthood
Treatment:

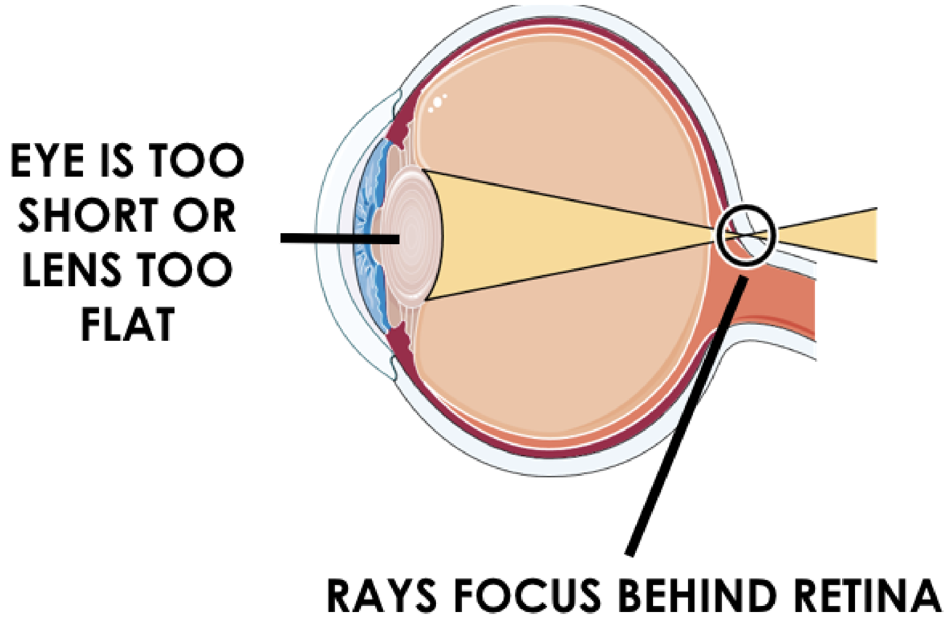
• Eyeglasses or contact lenses with a negative concave lens can correct nearsightedness by altering the way light enters the eye
• Laser surgery can also be used to change the shape of the cornea or lens to improve focus



▼ Farsightedness

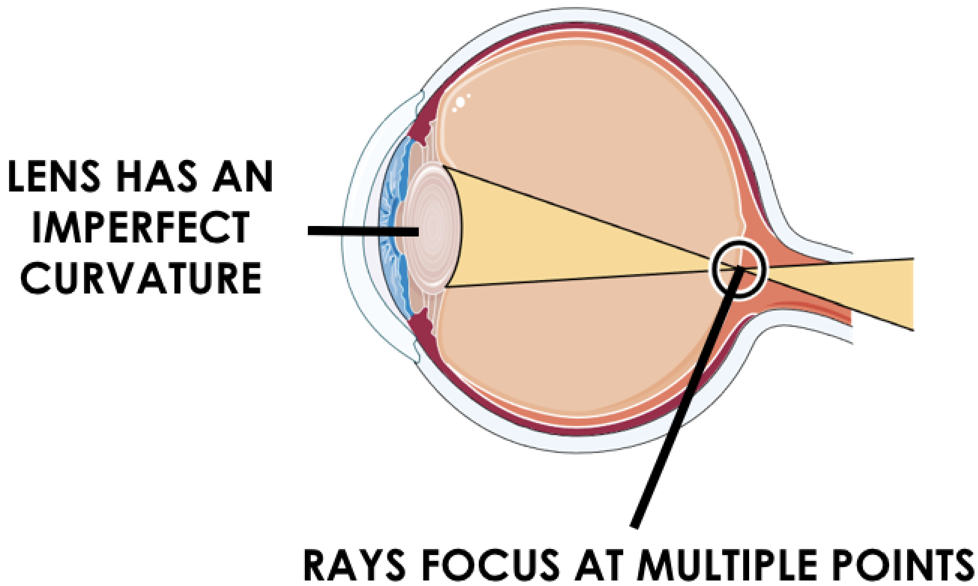
Farsightedness:
• Also called hyperopia
• A condition where faraway objects appear clear but nearby objects are blurry
Causes:
• Occurs when the eyeball is too short or the cornea is too flat, causing light rays to focus behind the retina
Symptoms:
• Nearby objects appear blurry
• Eye strain and headache may occur during reading, writing, computer work, or drawing for extended periods
• Many children are born farsighted and "outgrow" it as their eyeballs lengthen with normal growth
Treatment:
• Eyeglasses or contact lenses with a positive (convex) lens to help

focus light onto the retina
• Laser surgery to change the shape of the cornea or lens for more permanent correction



▼ Astigmatism

A common imperfection in the curvature of the eye causing blurred vision.
• It is caused by the cornea not being perfectly spherical, resulting in distorted images as light rays are prevented from reaching a single point of focus.
• Symptoms include blurry vision at all distances and eye strain or headache, especially after reading or other prolonged visual tasks.
• Treatment options include special astigmatism eyeglasses or contact lenses, as well as laser surgery to change the shape of the cornea or lens.



▼ Function of Sensory Receptors

Sensory receptors are specialized cells that detect and respond to different types of stimuli or changes in the environment. They play a crucial role in the nervous system by providing the brain with information about the external and internal environment.

Here are some examples of sensory receptors and their functions:

1. Vision: Photoreceptor cells in the eyes detect light and send signals to the brain to create a visual image.
2. Hearing: Hair cells in the inner ear detect sound waves and send signals to the brain to create a sound perception.
3. Touch: Mechanoreceptor cells in the skin, muscles, and other tissues detect pressure, temperature, and pain, providing information about the texture, shape, and temperature of objects.
4. Taste: Gustatory receptor cells in the tongue detect different types of tastes, such as sweet, sour, bitter, salty, and umami.
5. Smell: Olfactory receptor cells in the nose detect different types of odors and send signals to the brain to create a sense of smell.

- Reflex arc/Reflex action

  A reflex arc is a neural pathway that mediates a reflex action. A reflex action is an automatic and rapid response to a stimulus, which is performed without conscious thought or control. Reflex actions are essential for maintaining the body's homeostasis and protecting us from harm.

  Here are some key points about reflex arcs and reflex actions:

  1. Definition: A reflex arc is a neural pathway that mediates a reflex action. The pathway consists of a sensory receptor, a sensory neuron, an interneuron, a motor neuron, and an effector organ (such as a muscle or gland).
  2. Function: The reflex arc allows for rapid and automatic responses to stimuli that are potentially harmful or that require a quick response. This helps to protect the body from injury and maintain homeostasis.
  3. Examples of reflex actions: Some examples of reflex actions include the knee-jerk reflex, which is elicited by tapping the patellar tendon with a reflex hammer, causing a quick extension of the knee joint. Another example is the withdrawal reflex, which occurs when you touch a hot surface and quickly pull your hand away.
  4. Reflex arc components: The components of a reflex arc include the sensory receptor (which detects the stimulus), the sensory neuron (which transmits the signal to the spinal cord), the interneuron (which processes the information and determines the response), the motor neuron (which transmits the signal to the effector organ), and the effector organ (which performs the reflex action).

  Overall, reflex arcs and reflex actions are important for maintaining homeostasis and protecting the body from harm. They allow for rapid and automatic responses to stimuli, without the need for conscious thought or control.

- Control and Coordination in plants
  - Tropisms
    - When a plant grows, it can respond to different things in its environment. One of these responses is called a tropism.

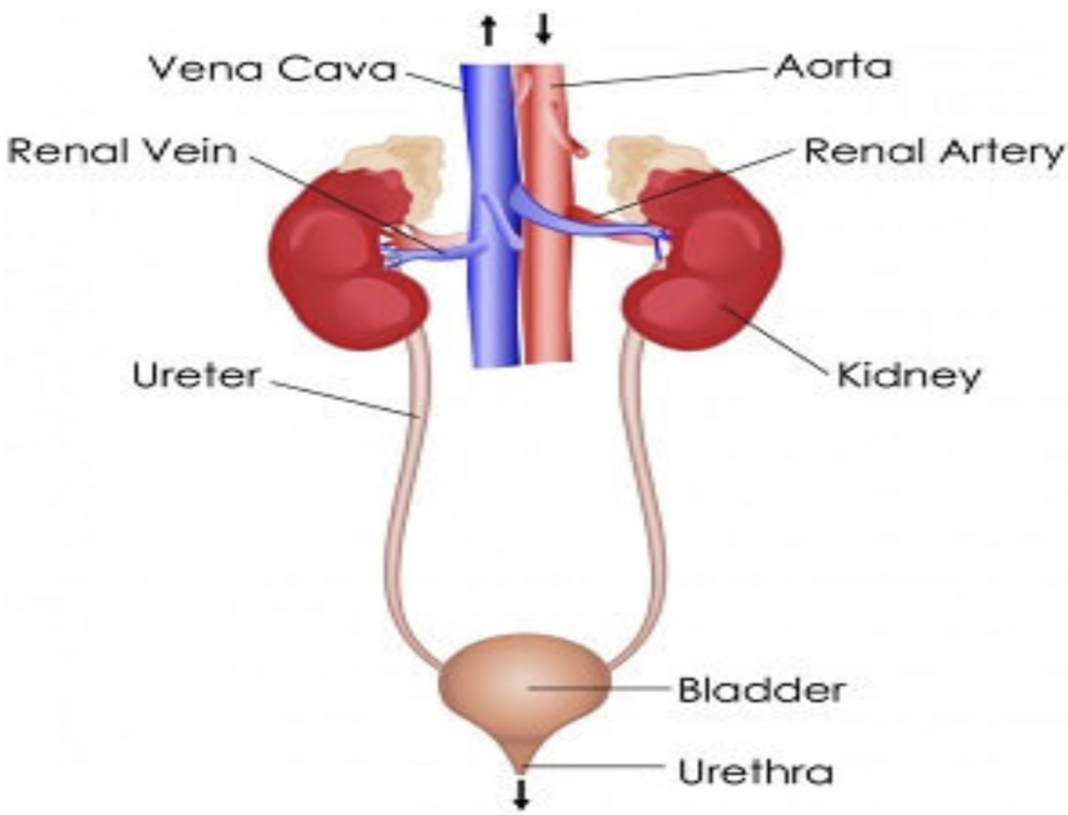
- A tropism is when a plant grows in a certain direction because of a stimulus (something that affects it).
- There are different types of tropisms depending on the stimulus. For example, when a plant grows towards light, it's called phototropism. When a plant grows towards water, it's called hydrotropism.
- Phototropism is important for plants because they need sunlight to do photosynthesis, which is how they make food. By growing towards the light, plants can get as much sunlight as possible.
- Phototropism is a positive tropism because the plant grows towards the light. If the plant grew away from the light, it would be a negative phototropism.
- Tropisms can take a while to see results because they involve cell division and growth. But over time, you can see how the plant has responded to the stimulus.

▼ Geotropism

- Geotropism is another type of tropism, but this one is related to gravity.
- When a plant grows, its roots grow down towards the force of gravity. This is called positive geotropism.
- On the other hand, when a plant's shoot grows against the force of gravity (i.e. upwards), this is called negative geotropism.
- If a plant is laid on its side, something interesting happens. A chemical called auxin gathers in the lower half of the stem and root.
- Auxin is a plant hormone that helps to control growth. When it's in the lower half of the stem, it stimulates cell elongation in the shoot (the part of the plant above the soil).
- This means that the shoot starts to curve upwards, because the cells on the lower side of the stem grow longer.
- However, when auxin is in the lower half of the root, it actually reduces cell elongation. This means that the cells on the lower side of the root don't grow as much, and the root starts to curve downwards.

- So, when a plant is laid on its side, the shoot grows upwards and the root grows downwards. This helps the plant to re-orient itself so that the shoot can grow towards the light and the roots can grow towards water and nutrients in the soil.

▼ Excretory system



▼ Excretion

Excretion in multicellular organisms:

1. Excretion is the process of removing nitrogenous products from the body.
2. It helps regulate the water and salt content in the blood.
3. Nitrogenous waste products, such as urea, uric acid, and ammonia, are by-products of various metabolic processes.

4. These waste products are unwanted and toxic to the body.
5. Removal of waste products maintains a favorable internal environment in the body.
6. Carbon dioxide is eliminated by the lungs.
7. Ammonia, urea, uric acid, and excess sodium and potassium ions are eliminated by the kidneys.
8. The filtered excess water, salts, and urea form a liquid called urine.
9. The excretory system is a system of organs and tissues that takes part in the separation, collection, and elimination of waste products.
10. The excretory system consists of a pair of kidneys, a pair of ureters, a urinary bladder, and a urethra.

Excretion in unicellular organisms:

1. Specific excretory organs are absent.
2. Waste products like ammonia and carbon dioxide generally pass out from the surface of the body into surrounding water by simple diffusion.

▼ Kidneys

1. Kidneys are a pair of reddish-brown bean-shaped structures located in the abdominal cavity, attached to the dorsal body wall, with one on either side of the vertebral column.
2. The left kidney is positioned slightly higher than the right one.
3. The size of each kidney is approximately 10cm in length, 5-6cm in width, and 4cm in thickness.
4. The renal artery carries oxygenated blood with waste products to each kidney.
5. The renal vein carries deoxygenated blood from which waste products have been removed.
6. Nephrons are the structural, functional, and filtration units of the kidneys.

7. Each kidney contains about 1 million nephrons.
8. Nephrons filter blood and remove waste products, excess water, and electrolytes, producing urine.
9. The urine flows through the renal pelvis into the ureter, which carries it to the urinary bladder for storage.
10. The kidneys also play a role in regulating blood pressure, producing hormones, and maintaining acid-base balance in the body.

- Ureters

1. Ureters are a pair of whitish narrow muscular tubes that are approximately 30cm in length.
2. Each ureter arises from the hilus part of the kidney and moves downwardly towards the urinary bladder.
3. The ureters are responsible for transporting urine from the kidneys to the urinary bladder.
4. The ureters have a narrow lumen, which helps prevent the backflow of urine from the bladder to the kidneys.
5. The muscular walls of the ureters undergo peristalsis, which is a rhythmic contraction and relaxation, to move the urine down the ureter and into the bladder.
6. The ureters are lined with a smooth mucous membrane that helps facilitate the passage of urine.
7. The ureters have a valve-like mechanism at their junction with the bladder that helps prevent the reflux of urine back into the ureters.
8. The ureters are essential for maintaining proper urinary function and preventing urinary tract infections.
9. Any damage or obstruction in the ureters can lead to serious complications, such as kidney damage and urinary incontinence.

- Urinary Bladder

1. The urinary bladder is a sac-like structure located in the pelvic region of the abdomen.

2. Its main function is to store urine until it is eliminated from the body.
3. The urinary bladder has a muscular wall that contracts and expands to control the flow of urine.
4. The storage capacity of the urinary bladder varies between individuals, but it can typically hold between 300-800ml of urine.
5. The bladder is lined with a mucous membrane that helps prevent the absorption of urine and the secretion of mucus.
6. The urinary bladder has a triangular shape, with the base of the triangle at the top and the apex at the bottom.
7. The bladder is connected to the ureters by two small openings, called ureteric orifices.
8. The urethra, a tube that carries urine out of the body, is connected to the bladder at the apex of the triangle

▼ Urethra

1. The urethra is a tubular structure that forms a part of the urinary system in humans and other mammals.
2. It is responsible for transporting urine from the urinary bladder to the outside of the body for elimination.
3. The length of the urethra varies between males and females, with males typically having a longer urethra.
4. The opening of the urinary bladder is guarded by a muscular sphincter known as the internal urethral sphincter. This sphincter helps prevent the involuntary release of urine.
5. In males, the urethra also carries semen during ejaculation.
6. The urethra is lined with a mucous membrane that helps protect the surrounding tissues from the acidic urine passing through it.
7. In females, the urethral opening is located near the vaginal opening, while in males, the urethral opening is located at the tip of the penis.
8. The urethra is composed of smooth muscle tissue that contracts to help push urine out of the body during urination.
9. The external urethral sphincter is a voluntary muscle that allows us to control when we urinate.

10. The urethra can be susceptible to infections and other conditions, such as urethritis or urethral stricture, which can affect its function and cause discomfort or pain during urination.

▼ Nephron

- The nephron is the structural and functional unit of the kidney responsible for the filtration and elimination of waste products.
- Each kidney contains millions of nephrons, with a portion located in the cortex and medullary regions.
- The nephron consists of three parts: the Malpighian body (glomerulus and Bowman's capsule), the renal tubule, and the collecting tube.
- The glomerulus is a cluster of fine blood capillaries, with an afferent arteriole bringing blood to the nephron and an efferent arteriole carrying blood away.
- Due to the smaller diameter of the efferent arteriole, blood moves out with high pressure, allowing for the filtration of waste products.
- Bowman's capsule accommodates the glomerulus and leads to the proximal convoluted tubule, which extends to the U-shaped Henle's loop and the distal convoluted tubule.
- The distal convoluted tubule opens into the collecting duct, which forms pyramids in the kidney that open into the pelvis.
- The pelvis leads to the ureter, which carries urine to the urinary bladder for storage.
- The urinary bladder is a sac-like structure located in the pelvic region of the abdomen with a storage capacity of 300-800 mL.
- The opening of the urinary bladder is guarded by a muscular sphincter, and urine is eliminated from the body through the urethra.

▼ Mechanism of Urine Formation

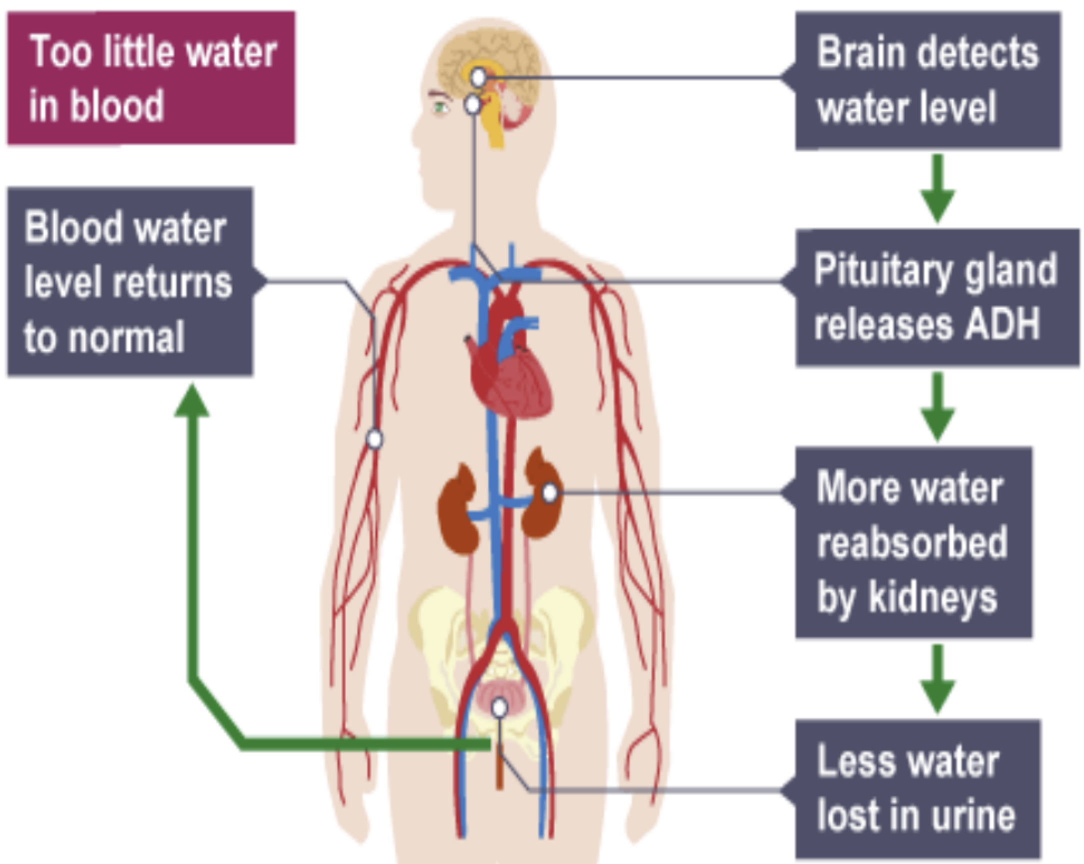
- Urine formation has four components: glomerular filtration, selective absorption, tubular secretion, and collection.

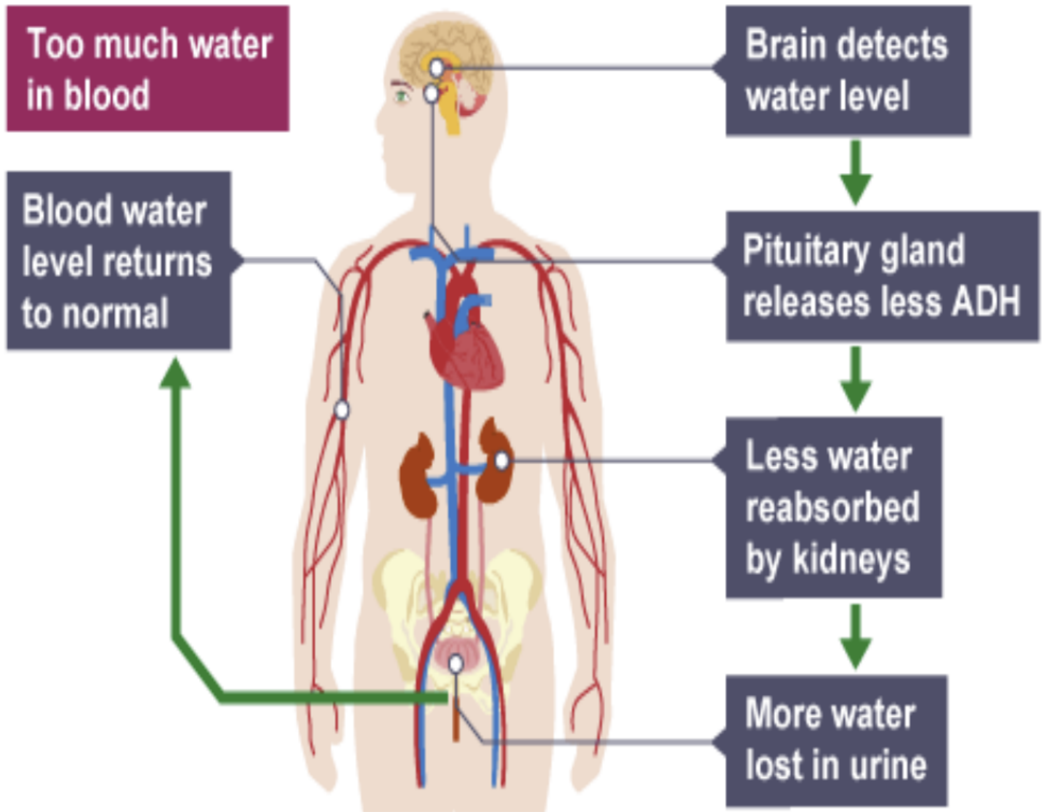
- Glomerular filtration: Blood flows inside the glomerulus under pressure, and small volumes of solutes and water are filtered out and enter the Bowman's capsule, forming the glomerular filtrate (primary urine).
- Primary urine volume is 125ml per minute or 180lts per day.
- Reabsorption: The useful components of the glomerular filtrate, including glucose, amino acids, vitamins, ions, and water (75%), are reabsorbed by the peritubular capillaries around the proximal convoluted tubule (PCT) and distal convoluted tubule. Extra salts, potassium, and hydrogen are secreted into the renal tubule to maintain the proper concentration and pH of the urine.
- Further concentration of urine occurs in the collecting tubules in the presence of Antidiuretic hormone or Vasopressin.
- ADH maintains water balance in the body, and its deficiency can cause excessive, repeated dilute urination (diabetes insipidus).
- Collection: The urine formed in each kidney eventually enters a long tube called the ureter, which connects the kidneys with the urinary bladder.
- Urine is stored in the urinary bladder until the pressure of the expanded bladder leads to the urge to pass it out through the urethra.
- The bladder is muscular and under nervous control, allowing us to control the urge to urinate.

▼ Anti-diuretic hormone (ADH)

- Anti-diuretic hormone (ADH) is a hormone that helps control the water content of the blood.
- ADH is released into the bloodstream by a gland in the brain, called the pituitary gland, in response to changes in the concentration of blood plasma.
- If the concentration of the blood plasma is too high (due to factors such as dehydration or excess sweating), more ADH is released into the bloodstream.
- The increased levels of ADH cause the kidneys to reabsorb more water from the urine into the bloodstream, resulting in decreased urine output.

- If the concentration of the blood plasma is too low (due to factors such as excess drinking), less ADH is released into the bloodstream.
- The decreased levels of ADH cause the kidneys to reabsorb less water from the urine into the bloodstream, resulting in increased urine output.
- Consuming salty foods can also affect the concentration of the blood plasma, which can, in turn, affect the release of ADH.
- When there is too little water in the blood, the kidneys produce concentrated urine to conserve water in the body.
- When there is too much water in the blood, the kidneys produce dilute urine to eliminate the excess water from the body.
- If there is a deficiency of ADH, it can lead to a condition called diabetes insipidus, where the kidneys produce an excessive amount of dilute urine, leading to dehydration and electrolyte imbalances.





- Kidney disease
    - Some diseases can be diagnosed by testing urine.
    - Glucose in the urine indicates diabetes where the glucose levels in the blood are so high that the kidney is unable to reabsorb it and it leaves the body in urine.
    - Protein in the urine indicates damage in the kidney, as proteins in the blood are usually too large to pass through into the nephron tubule.
    - Kidney diseases include glomerulonephritis, pyelonephritis, polycystic kidney disease, and nephrotic syndrome, among others.
    - These diseases can cause damage to the nephrons, leading to reduced kidney function.
    - Reduced kidney function can result in the accumulation of waste products in the body, which can be life-threatening.

- A person can live a normal life with just one kidney working at full capacity.
- However, if both kidneys are damaged due to an accident, disease, or genetic defect, then the person will require extensive treatment to sustain life.
- Treatment options include dialysis, kidney transplant, and medication to manage symptoms.
- Lifestyle changes such as maintaining a healthy diet, exercising regularly, and quitting smoking can also help to manage kidney disease.

▼ Dialysis

Dialysis is a medical procedure that is used to replace the function of the kidneys in patients with kidney failure. Here are some key advantages and disadvantages of dialysis:

Advantages of dialysis:

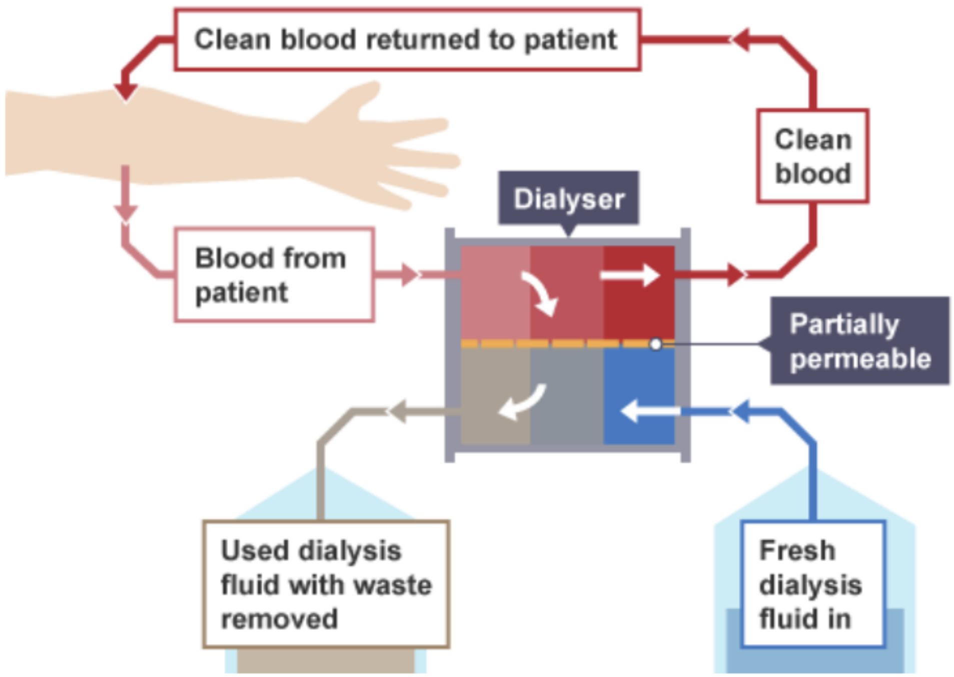
1. It can keep a patient alive whilst they are waiting for a suitable donor to be found. Dialysis can help to maintain a patient's health and prevent further damage to their body whilst they wait for a kidney transplant.
2. It does not involve major surgery. Unlike a kidney transplant, dialysis does not require invasive surgery, which can be beneficial for patients who are not suitable candidates for surgery.

Disadvantages of dialysis:

1. Patients need to follow a carefully controlled diet. Dialysis patients need to limit their intake of certain foods and fluids to ensure that their body does not build up excess waste products and fluids.
2. Patients need to spend many hours every week attached to a dialysis machine. Dialysis treatment typically requires several hours, three to four times a week, spent attached to a machine that filters the blood. This can be very time-consuming and limit the patient's ability to work or engage in other activities.
3. Dialysis machines are very expensive. Dialysis treatment is a costly medical procedure that requires specialized equipment and trained

medical staff. This cost can be a burden for patients and their families.

4. Dialysis will only be successful for a certain amount of time. Although dialysis can help patients to manage kidney failure and maintain their health, it is not a permanent solution. Over time, dialysis can become less effective, and patients may experience a decline in their overall health.



▼ Kidney transplant

Kidney Transplantation:

A kidney transplant involves replacing a failed kidney with a healthy one from a donor. The donated kidney is connected near the patient's bladder. Advantages:

- After the transplant, the patient no longer has diet restrictions.
- Long periods of time on dialysis are no longer necessary.
- Although not a life-long cure, a kidney transplant will generally allow the patient to live a fuller life for longer than a patient on dialysis.

Disadvantages:

- It is difficult to find a donor organ with a matching tissue type.
- The risk of organ rejection is a major problem. Rejection is where the immune system of the patient receiving the kidney recognizes the transplant as non-self and destroys it. Therefore, it is essential that any transplanted kidney is as similar as possible to the patient’s tissue type.
- Patients who have undergone kidney transplants need to take drugs that suppress the immune system, leaving them susceptible to contracting other diseases.
- Regular doctors' appointments to detect signs of organ rejection are required.
- Major surgery is required.

Close family members are most likely to have similar tissue types. When this is the case, a living donation can occur. However, the patient will still need to take immunosuppressant drugs for the rest of their life.

▼ Homeostasis

1. Homeostasis: Homeostasis refers to the body's ability to maintain stable internal conditions despite changes in the external environment. This is crucial for the proper functioning of cells, tissues, and organs in the body.
2. Receptors: Receptors are specialized cells or structures that detect changes in the environment, such as changes in temperature, pressure, or the presence of certain chemicals. These changes are called stimuli, and they trigger a response from the body to maintain homeostasis.
3. Coordination centers: Coordination centers are specialized regions in the body that receive information from the receptors and coordinate a response. The brain, spinal cord, and pancreas are examples of coordination centers that play a role in maintaining homeostasis.
4. Effectors: Effectors are cells or organs that produce a response to maintain homeostasis. Muscles and glands are examples of effectors that can respond to changes in the environment. For example, when the body temperature increases, sweat glands release sweat to cool the body down.

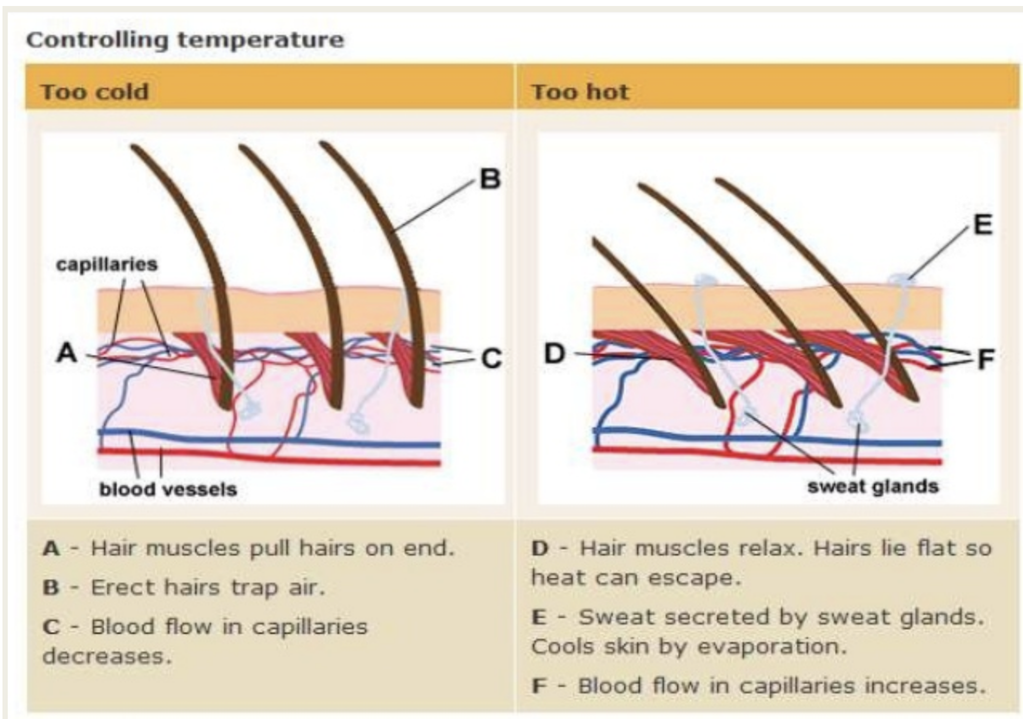
5. Hormones: Hormones are chemical messengers produced by glands in the body. They can travel through the bloodstream to target cells or organs and produce a response. Hormones play an important role in maintaining homeostasis by regulating various physiological processes, such as metabolism, growth, and development.
6. Nervous system: The nervous system is responsible for coordinating rapid responses to changes in the environment. It consists of the brain, spinal cord, and nerves that transmit information throughout the body. The nervous system plays a critical role in maintaining homeostasis by regulating various physiological processes, such as heart rate, breathing, and digestion.
7. Chemical responses: Chemical responses involve the use of hormones and other chemical messengers to maintain homeostasis. For example, insulin is a hormone produced by the pancreas that regulates glucose levels in the blood. When glucose levels are high, insulin is released to lower them and maintain homeostasis.

Overall, the body's ability to maintain homeostasis is crucial for the proper functioning of all the body's systems and organs. Receptors, coordination centers, effectors, hormones, and the nervous system all play important roles in maintaining homeostasis and ensuring that the body is able to adapt to changes in the environment.

- ▼ Factors to keep it in balance
    - ▼ Temperature
        1. Body temperature is controlled during homeostasis to maintain the optimum temperature for enzyme function, which is around 37°C.
        2. The thermoregulatory center in the hypothalamus of the brain is responsible for regulating body temperature, and it contains receptors sensitive to the temperature of the blood.
        3. When the body gets too hot, sweat glands release more sweat, which evaporates and transfers heat energy from the skin to the environment. Blood vessels leading to the skin capillaries dilate,

allowing more blood to flow through the skin, and more heat to be lost to the environment.

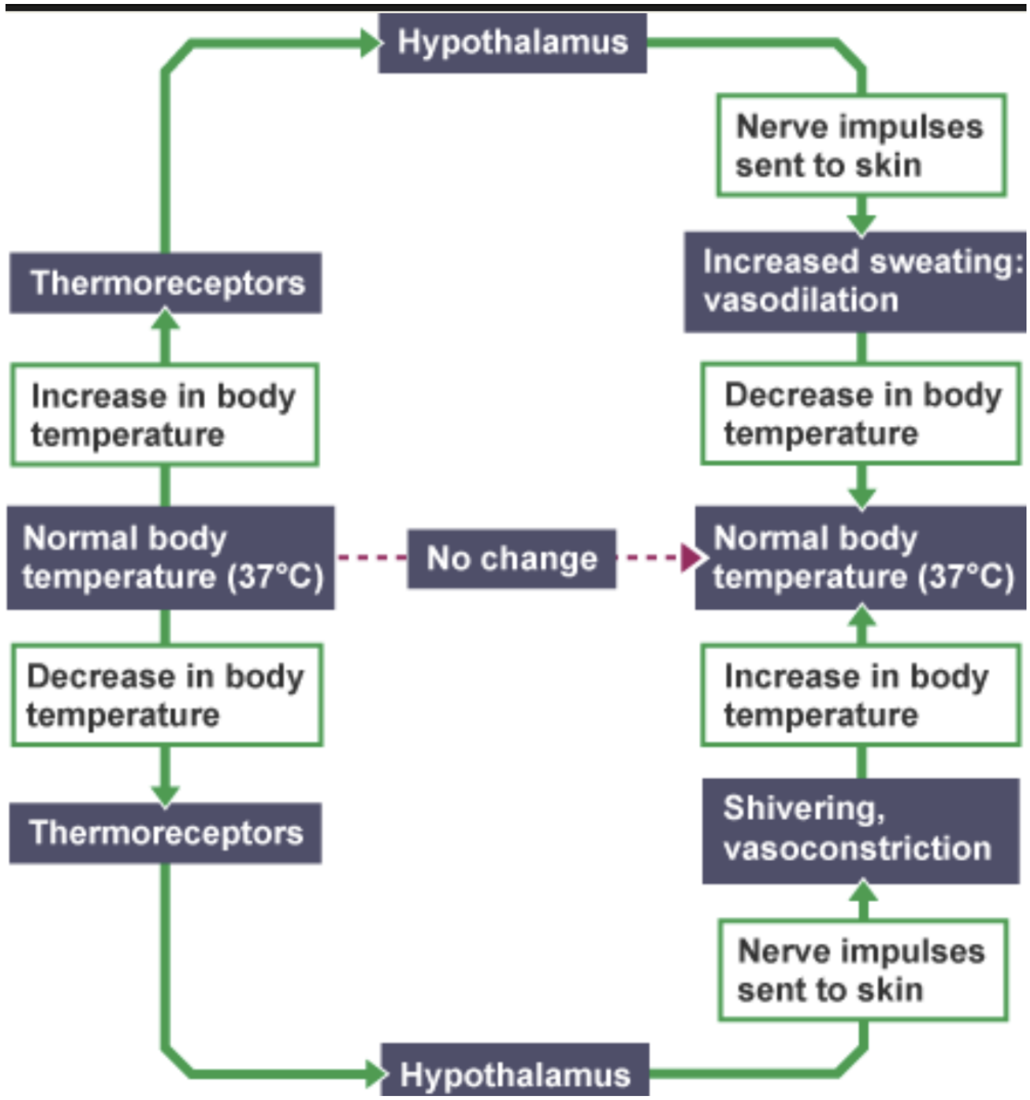
4. When the body gets too cold, skeletal muscles contract rapidly, and we shiver to generate heat through respiration. Blood vessels leading to the skin capillaries constrict, allowing less blood to flow through the skin and conserve the core body temperature.
5. The hairs on the skin help control body temperature by lying flat when we are warm and standing upright when we are cold. This traps a layer of insulating air next to the skin, conserving heat.
6. The control of body temperature is an example of a negative feedback mechanism that regulates shivering, sweating, and blood flow in the skin capillaries.



Controlling temperature

A - Hair muscles pull hairs on end.
B - Erect hairs trap air.
C - Blood flow in capillaries decreases.

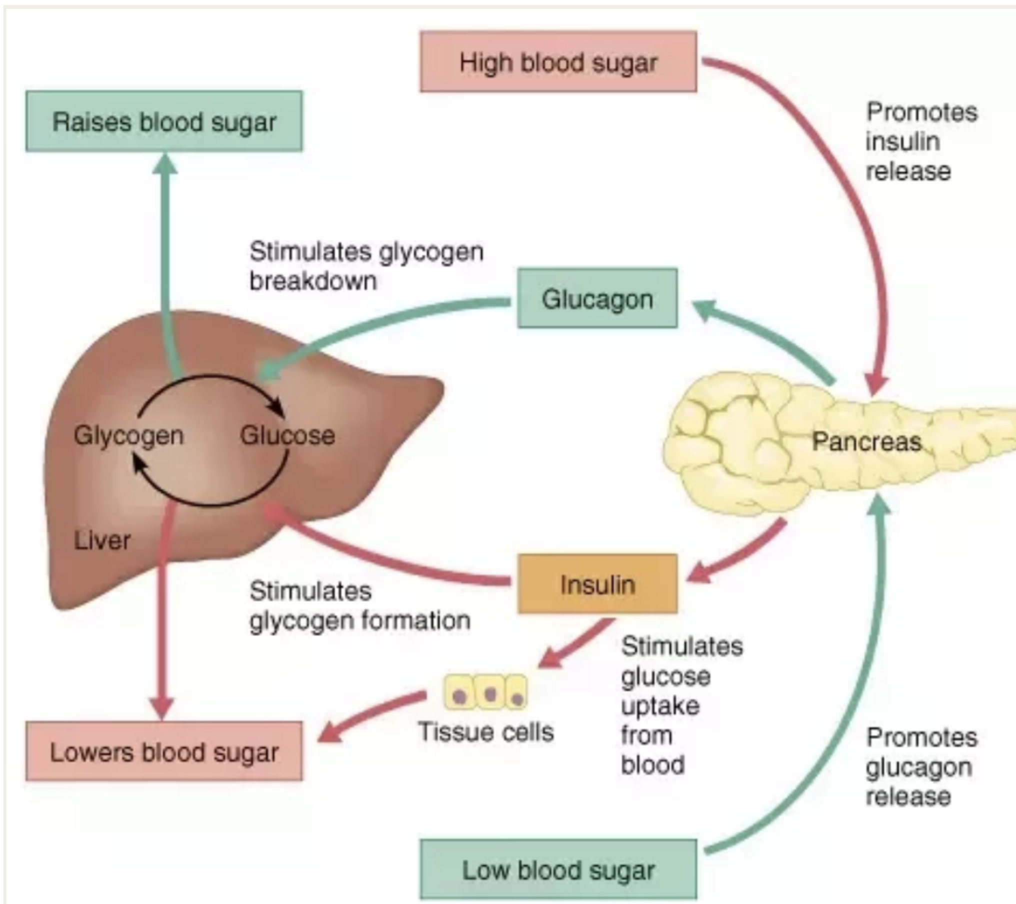
D - Hair muscles relax. Hairs lie flat so heat can escape.
E - Sweat secreted by sweat glands. Cools skin by evaporation.
F - Blood flow in capillaries increases.

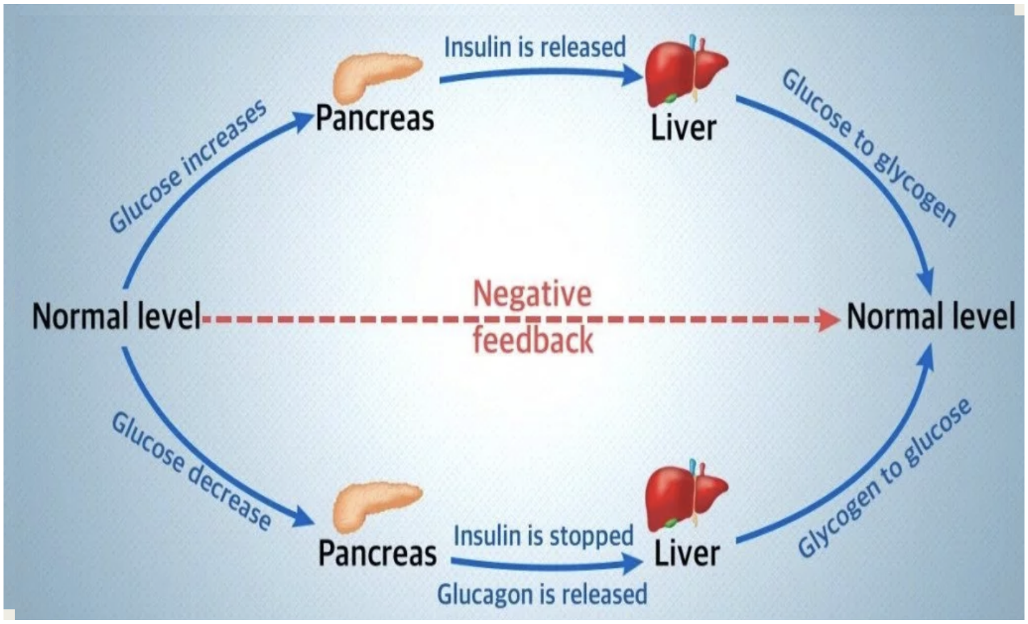


▼ Blood Sugar levels

- Blood sugar levels must be kept constant to ensure the body has a regular supply of glucose for respiration in cells.
- After a meal, digested sugar enters the blood.
- The pancreas detects higher blood sugar levels and releases the hormone insulin.
- Insulin travels in the blood and instructs muscle and liver cells to store glucose as glycogen.
- This process reduces the amount of sugar in the blood to normal levels.

- If blood sugar levels are too low, a second hormone called glucagon is released by the pancreas.
- Glucagon instructs cells to break glycogen down into glucose, which raises blood sugar levels back to normal.





▼ Water Content

- The body needs to maintain a balance of water to function properly. Too much or too little water can cause problems for cells and organs.
- The hypothalamus in the brain monitors the concentration of water in the blood. It triggers the release of the hormone ADH (antidiuretic hormone) from the pituitary gland if the concentration is too high or too low.
- ADH acts on the kidneys to control how much water is excreted in urine. If the concentration of water in the blood is too low, ADH causes the kidneys to reabsorb more water, resulting in less urine output. If the concentration of water is too high, ADH is not released, and the kidneys produce more urine to remove excess water from the body.
- The thirst mechanism also helps to maintain water balance. If the body is dehydrated, the hypothalamus triggers a thirst response, which encourages the person to drink more fluids.
- Sweating is another way the body maintains water balance. When the body gets too hot, sweat glands release water onto the skin, which cools the body down. However, excessive sweating can

cause dehydration, so the body needs to balance the amount of water it loses through sweating with the amount it takes in through drinking and food.

▼ C02 Levels

- Carbon dioxide (CO_2) is a waste product produced by cells during respiration.
- CO_2 is transported in the blood to the lungs, where it is removed from the body during exhalation.
- Homeostasis helps to regulate the amount of CO_2 in the blood by controlling the rate and depth of breathing.
- When CO_2 levels in the blood rise, receptors in the brain detect this and send signals to the respiratory muscles to increase the rate and depth of breathing.
- This causes more CO_2 to be removed from the body, bringing the CO_2 levels back into balance.
- Conversely, when CO_2 levels in the blood decrease, the brain signals the respiratory muscles to decrease the rate and depth of breathing, allowing more CO_2 to accumulate in the blood and again bringing the CO_2 levels back into balance.
- This process is an example of a negative feedback mechanism, where the body's response opposes the original change in order to maintain balance.
- Keeping CO_2 levels in balance is important for maintaining the body's pH levels, which can be disrupted if there is too much or too little CO_2 in the blood.

▼ pH

- The pH scale measures how acidic or basic a solution is. The pH of blood is normally around 7.4, which is slightly basic.
- Homeostasis helps to keep the pH of the blood within a narrow range to maintain proper function of cells and organs in the body.

- The body's main pH buffer system is the carbonic acid-bicarbonate buffer system, which helps to regulate the pH of the blood.
- If the blood pH drops too low (becomes too acidic), the body uses buffers to neutralize excess hydrogen ions and bring the pH back to normal. The kidneys also excrete excess acid in the urine.
- If the blood pH rises too high (becomes too basic), the body uses buffers to neutralize excess bicarbonate ions and bring the pH back to normal. The lungs also excrete excess carbon dioxide, which helps to balance the pH.
- The regulation of blood pH is controlled by several organs, including the lungs, kidneys, and liver, which work together to maintain a stable pH balance in the body.
- The body also has a system of feedback mechanisms that help to detect changes in blood pH and trigger appropriate responses to correct any imbalances.
- Examples of feedback mechanisms involved in regulating blood pH include the respiratory system (which controls the amount of carbon dioxide in the blood) and the renal system (which controls the amount of acid or base excreted in the urine).
- Imbalances in blood pH can lead to a variety of health problems, including acidosis (when blood pH is too low) and alkalosis (when blood pH is too high).

▼ Osmoregulation

Osmoregulation is the process of controlling water levels and mineral salts in the blood.
This is important to protect cells from losing or gaining too much water by osmosis, which can lead to inefficient cell function.
If the concentration of water is the same inside and outside the cells, they remain in their normal state.
If the water concentration is too high outside the cells, water enters the cell by osmosis, and they may burst.

To maintain a balance of water levels, the kidneys remove excess water from the blood, and regulate the levels of salts in the blood.
This helps to maintain a constant water potential in the blood, and ensures that the cells are functioning efficiently.
Overall, osmoregulation is vital for the survival of living organisms.

▼ Feedback mechanisms

1. Feedback mechanisms are processes by which the body maintains stability or homeostasis by detecting and responding to changes in the internal or external environment.
2. Negative feedback mechanisms are the most common type of feedback mechanisms in humans. They involve a change in a parameter causing a response that counteracts or opposes the change, bringing the parameter back to its original level.
3. For example, the regulation of body temperature is an example of a negative feedback mechanism. When the body temperature rises above the normal range, the brain sends signals to the sweat glands to release sweat, which cools the body through evaporation. This helps to bring the body temperature back to its normal range.
4. Another example of negative feedback is the regulation of blood glucose levels. When blood glucose levels rise, the pancreas releases insulin, which promotes the uptake of glucose by cells and storage of excess glucose as glycogen in the liver and muscles. This helps to bring the blood glucose levels back to its normal range.
5. Positive feedback mechanisms are less common and involve a change in a parameter causing a response that amplifies or reinforces the change, pushing the parameter further away from its original level.
6. An example of positive feedback is the process of childbirth. As the baby's head pushes against the cervix, it sends signals to the brain to release oxytocin, which stimulates the contraction of the uterus, pushing the baby further down the birth canal. This continues until the baby is born.
7. Overall, feedback mechanisms are essential for maintaining homeostasis in the human body, and they involve a complex interplay of physiological

processes that work together to keep our internal environment stable and functioning properly.

▼ Factors Affecting Reaction Time

This shits easy