6.1 DIGESTION AND ABSORPTION

Digestive System:

- Breaks down molecules into smallest form:
  - Proteins —> Amino Acids
  - Lipids —> Glycerol and Fatty Acids
  - Carbohydrates —> Modnosaccarides
  - Nucleic Acids —> Nucleotides

- fundamentally a long tube called the **alimentary canal** with two accessory organisms, the pancreas and the liver
  - begins with mouth and ends with anus
  - food moves down through muscular contractions, not gravity

LIVER:

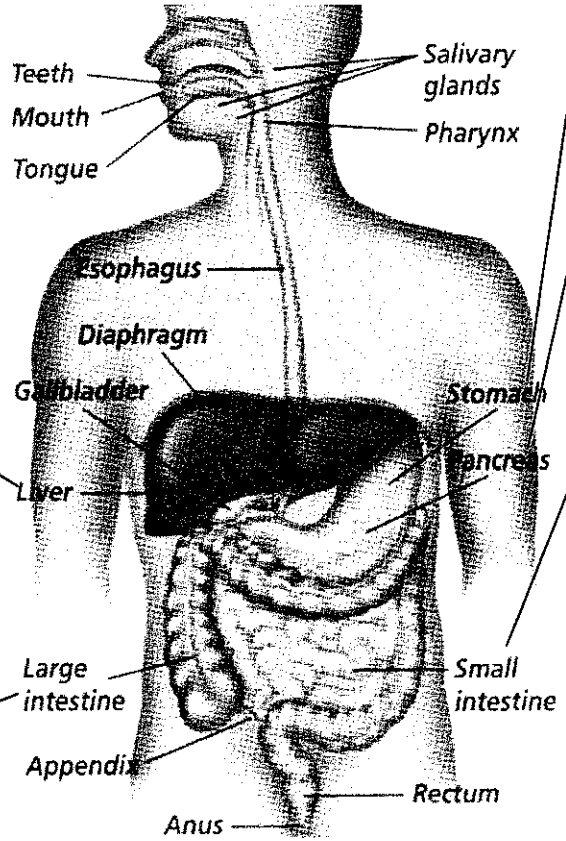
- filters the blood coming from the digestive tract
- detoxifies chemicals and metabolizes drugs
  - secretes bile that ends up in the intestines

GALLBLADER:

- outside the liver
- stores extra bile that the liver makes, releasing it when you eat a meal with fats that need to be digested

LARGE INTESTINE

- absorbs water from remaining indigestible food and transmits the useless waste from the body



STOMACH:

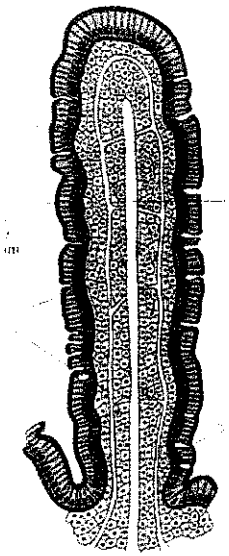
- Breaks down and digests food in order to extract necessary nutrients
  - uses pepsin and lipase

PANCREAS:

- Secretes enzymes into the lumen of the small intestines
- Amylase, lipase, and an endopeptidase are secreted

SMALL INTESTINES:

- Contraction of circular and longitudinal muscle of the small intestine sizes food with enzymes and move it along the cut
- Enzymes digest the macromolecules
- Made up of **Villi**
  - increase the surface area of epithelium over which absorption is carried out
  - absorb monomers formed by digestion as well as mineral ions and vitamins
- different methods of membrane transport are required to absorb different nutrients
  - both active and passive

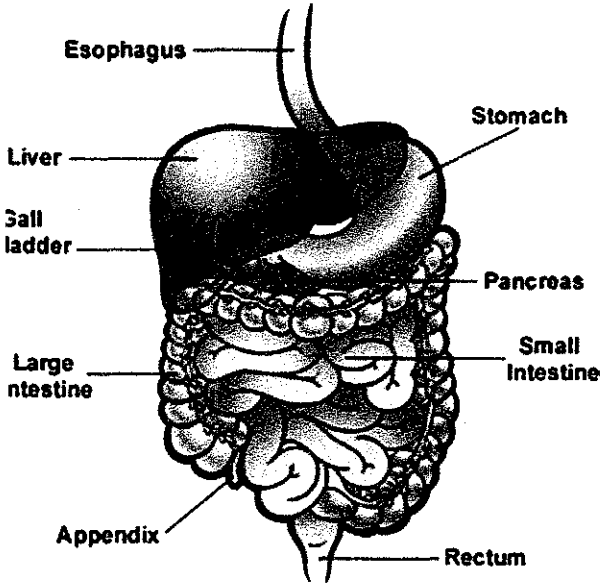


6.1

Human Digestive System

Understandings:

- The contraction of circular and longitudinal muscle of the small intestine mixes the food with enzymes and moves it along the gut
- Enzymes digest most macromolecules in food into monomers in the small intestine
- The pancreas secretes enzymes into the lumen of the small intestine
- Villi increase the surface area of epithelium over which absorption is carried out
- Villi absorb monomers formed by digestion as well as mineral ions and vitamins
- Different methods of membrane transport are required to absorb different nutrients



4 steps

Ingestion – eat

Digestion – break down into smaller molecules

Absorption – molecules move from digestive tract into blood and lymph

Transport – circulatory system delivers molecules to cells

Purpose of digestion

The food is made of cells and macromolecules which are: carbs, lipids, proteins, and nucleic acids (all are essential for your body to function.) These macros are too big to cross the cell membrane however so, the digestive system breaks polymers down into monomers so that they can get into said cells then the cells use the monomers to build macromolecules.

6.1 DIGESTION AND ABSORPTION

Purpose of Digestion:

Macromolecules are too big to cross cell membranes. The digestive system breaks polymers down into monomers that can get into cells. Cells then use monomers to build macromolecules.

Digestion Process: enzyme facilitated

1. *Ingestion:* eat the food
2. *Digestion:* series of chemical reactions where ingested food is converted into smaller and smaller molecular forms by enzymes
3. *Absorption:* small molecular forms are absorbed through the cells of your digestive system and pass into blood or lymphatic vessels
4. *Transport:* circulatory system delivers the small molecular nutrients to the body

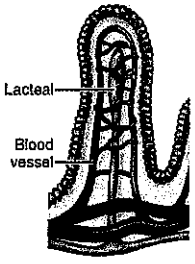
Food Molecules: digested by enzymes in the small intestine

Molecule Type	Molecular Form Ingested	Form After Digestion
Proteins	Proteins	Amino Acids
Lipids	Triglycerides	Glycerol and Fatty Acids
Carbohydrates	Poly, Di, and Monosaccharides	Monosaccharides
Nucleic Acids	DNA, RNA	Nucleotides

Villi: absorb monomers formed by digestion as well as mineral ions and vitamins

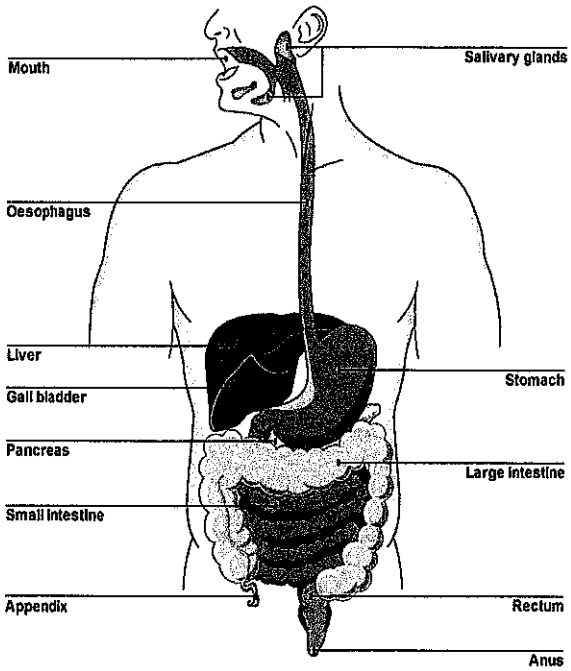
Villi increase surface area of the epithelial layer (direct contact with nutrients) over which absorption is carried out

—> nutrients are then absorbed into an inner capillary bed, or the lacteal, which is a small vessel of the lymphatic system



☆ Different methods of membrane transport are required to absorb different nutrients

Anatomy of the Human Digestive System



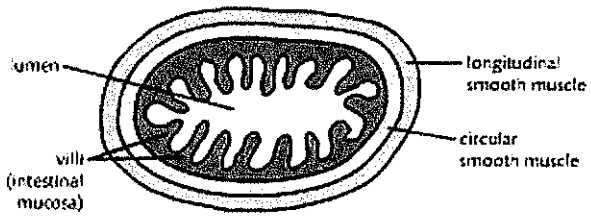
Accessory Organs:

Pancreas: produces hormones (insulin and glucagon), three enzymes (lipase, amylase, and endopeptidase), releases these enzymes into the first portion of the small intestine

Liver: detoxifies body, stores vitamins, synthesizes bile

Gall Bladder: stores bile, takes in fats and breaks them down into fatty acids and glycerol

Small Intestine:



Longitudinal smooth muscle moves food through the intestines in one direction. Circular smooth muscle mechanically digests food. These contractions mix food and enzymes as it moves throughout the gut.

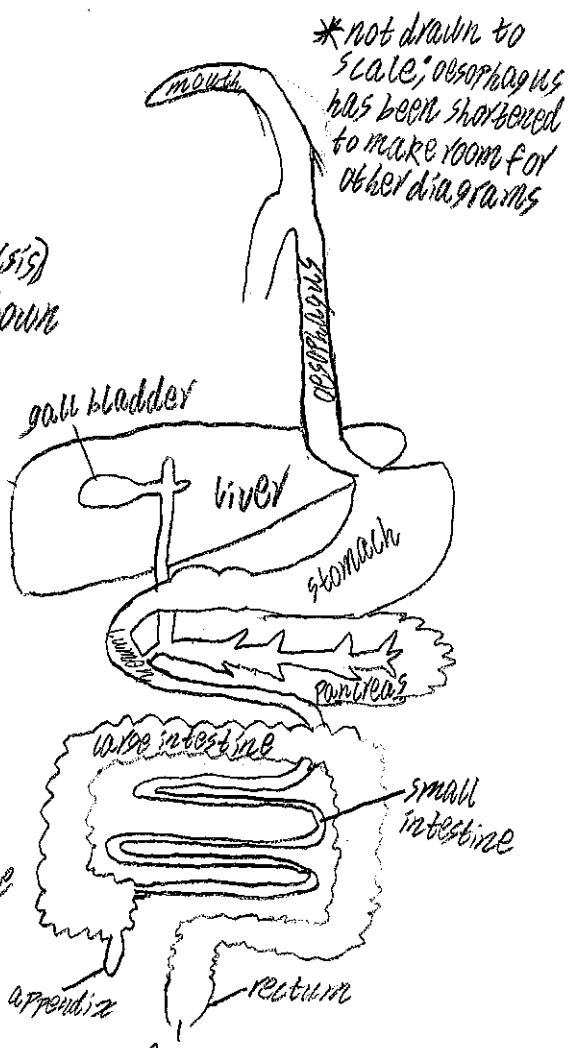
6.1 Digestion and Absorption

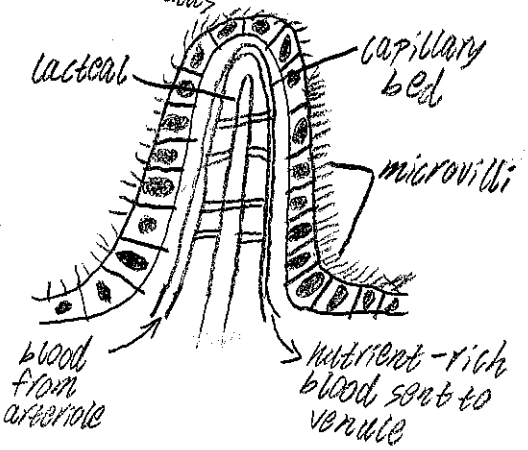
- The digestive system is one long <u>alimentary tube</u> that uses <u>peristalsis</u> via smooth muscles to move food along.

<u>ingestion</u>: mouth chews food
- saliva contains <u>amylase</u> used to break polysaccharides down into monomers

<u>digestion</u>: Food reaches <u>stomach</u> where acids are mixed with food in a circular motion called <u>churning</u> (also involves peristalsis)
- the acids also include enzymes called <u>proteases</u> that break down polypeptides into amino acids. Food is now turned into <u>chyme</u>.
- While in the <u>lumen</u>, an interjoining between the pancreas, the liver, and the gall bladder release more fluids into the food
- <u>Pancreas</u> releases <u>pancreatic juices</u>
  - consists of amylase (carbs), protease (proteins), lipase (lipids/fatty acids), nuclease (nucleotides), and endopeptidase (a class of protein - dissolving enzymes)
- <u>Liver</u> detoxifies any harmful products from food and synthesizes bile. Also stores vitamins from food.
- <u>Gall bladder</u> contains bile made from the liver and takes in fatty acids and glycerol.
- Absorption of nutrients is done mainly with the small intestine

<u>Absorption</u>:
- The small intestine is lined with "fingers" called <u>villi</u>
- These villi have "hairs" called <u>microvili</u> that give the small intestine even more surface area for absorption.
- absorbed nutrients enter the bloodstream through a one cell thick barrier called the <u>capillary bed</u>
- most nutrients are delivered to the capillary bed, but larger monomers, like fatty acids, are absorbed into the <u>lacteal</u>.
- villi/epithelial cells absorb nutrients via diffusion (both active and passive).
- The <u>large intestine</u> absorbs water and ions from food before the waste is expulsed.
- The <u>appendix</u> fills the system with a "good bacteria" after sickness to jump-start the recovery process, but is not used very often and is not part of the digestive system.





6.2 — The Blood System

ARTERIES

- Arteries transport blood at away from the heart to the lungs and the rest of the body.
- Must maintain high pressure in order to do this.
- Specialized structure:
↪ narrow lumen facilitating high pressure.
↪ thick walls surrounded in collagen
↪ inner layer of muscle and elastic fibres that assist flow by contracting and stretching between pump cycles. Fibers maintain the blood pressure between.

CAPILLARIES

- Capillaries provide a blood supply blood through tissue to each and every cell.
- Thin, permeable walls allow the exchange of material between tissue cells and the blood at very low pressures.

VEINS

- Veins pool blood from tissue capillary and send to towards the heart at low pressures.
- Specialized structure:
↪ thin walls and very wide lumen to maximise blood flow.
↪ valves to prevent backflow and prevent pooling at the lowest extremities.

BLOOD FLOW

- Blood is pumped out of the heart via ventricular contractions.
- Flow through the arteries is dependent on repeated pulses and the high pressure within the artery.
↪ Elastic fibers stretch and expand the lumen.
↪ Muscle fibers form rigid layer to support high blood pressure. Allows muscle fibers to contract/narrow the lumen, increasing pressure.

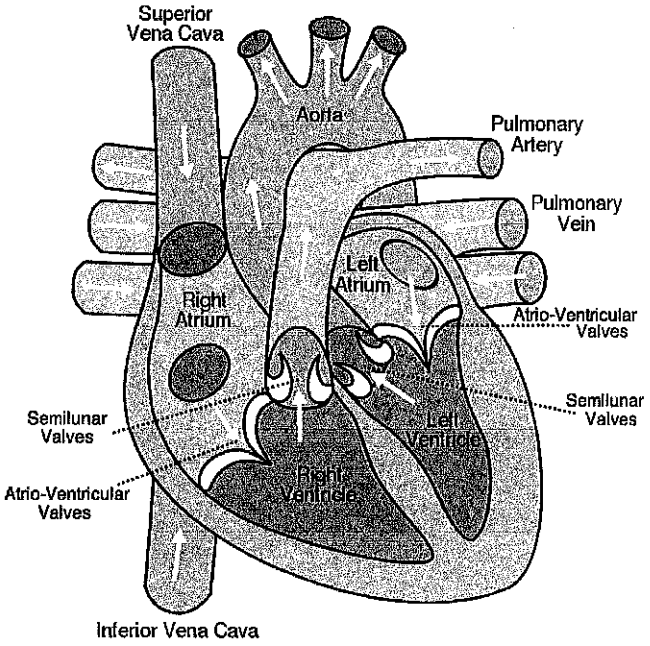
LUNGS

- Oxygen diffuses from the air inside the alveoli into the blood in the capillaries, while carbon dioxide diffuses in the opposite direction. Oxygenated blood then leaves the lungs through pulmonary veins, which return it to the left heart, completing the pulmonary cycle.

COMPARISON

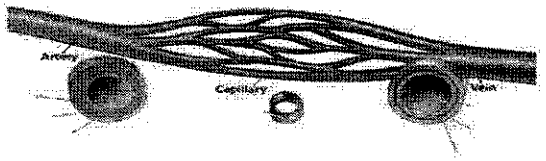
	Arteries	Veins	Capillary
Function	Away	Towards	To cells
Pressure	High	Low	Low
Lumen	Narrow	Wide	Narrow
Valves	No	Yes	No
Layers	Three	Three	One

THE HEART



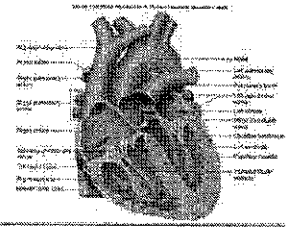
- Chambers: two Atrium on top, two Ventricular on bottom.
- Valves: two Atrioventricular between chambers, two Semilunar between chamber and arteries.
- Vessels: Vena Cava, Pulmonary Vein, Pulmonary Artery, Aorta.
- Heartbeat is controlled by a group of specialised muscle cells in the right atrium called the sinoatrial node → pacemaker by sending electric signals with specific delays.
- Can be increased or decreased by signals from two nerves from the medulla or by epinephrine which increases the heart rate before or during physical activity.

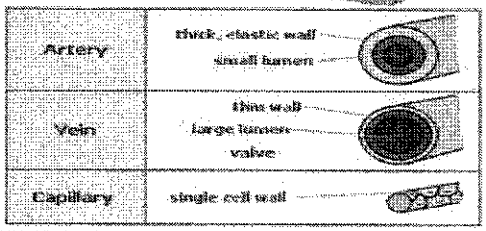
6.2 The Blood System

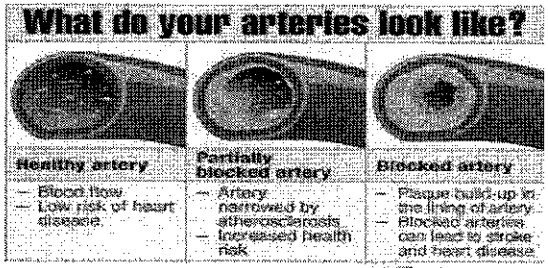


Arteries/Veins/and Capillaries

- Blood Pressure is sustained in the heart to keep blood moving
- Arteries convey blood at high pressure from the ventricles to the tissues of the body. Arteries have muscle cells and elastic fibers in their walls.
    - The muscle and elastic fibers assist in maintaining blood pressure between pump cycles.
- Capillaries have permeable walls that allow for exchange of materials between cells and the tissue and the blood in the capillaries.
    - Blood flows through tissues in capillaries.
    - Capillaries are key in transfer of materials and molecules to cells and blood stream
- There's separate circulation for the lungs that are utilized by the veins that lead to the lungs and the new reoxygenated blood is moved via arteries
- Veins collect blood at low pressure from the tissues of the body and return it to the atrium of the heart.
- Valves in veins and the heart ensure circulation of blood by preventing backflow.







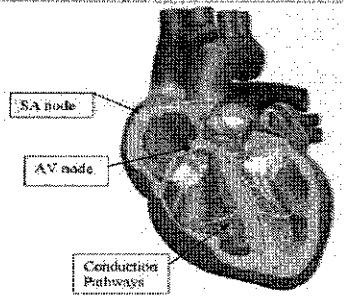
Plaque-cholesterol, calcium, fats and other materials that are capable of blockage

-Plaque buildup with calcium or other materials can lead to blockage of an artery which results in blood clots that can have a range of effects depending on the location of the clot and the severity

-For example the buildup of plaque in the arteries leads to atherosclerosis and occlusion in the coronary arteries can lead to a heart attack

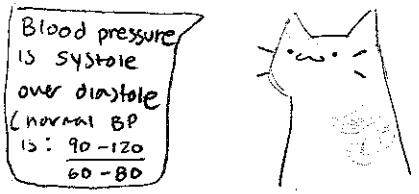
HeartBeat

- The heartbeat is initiated by a group of specialized muscle cells in the right atrium called the Sinoatrial node.
- The sinoatrial node acts as a natural pacemaker.
- The notice sends out an electrical signal that stimulates the contraction as it is propagated through the walls of the atria and then the walls of the ventricles.
    - The heart rate can be increased or decreased by impulses brought to the heart from the medulla of the brain.
    - Epinephrine increases the heart rate to prepare for physical activity.



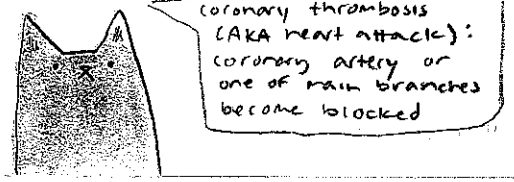
CHANGES IN PRESSURE WITHIN THE HEART CHAMBERS KEEP THE BLOOD MOVING

- valves open and close depending on the pressure of the blood on each side of the value
- diastole: heart that is not contracting
- Systole: the heart is contracting
- Wall of each atrium is thin muscle, is not capable of creating very much pressure
  - no need for great pressure because of the volume of blood aquired passively



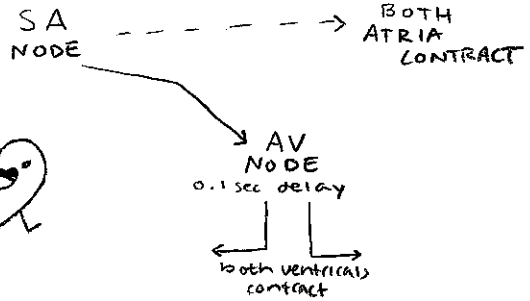
HEART PROBLEMS

- Atherosclerosis: slow build up of materials in the arteries that is collectively called plaque
  - plaque: composed of lipids, cholesterol, cell debris, and calcium
  - eventually leads to partial / complete occlusion
    - occlusion: plaque build up becomes so substantial that the blood vessel can no longer supply healthy volume of blood

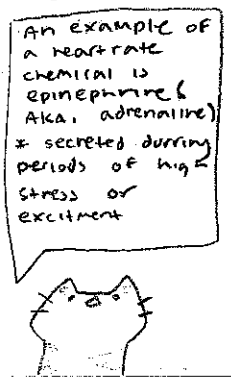


CONTROL OF HEART RATE

- Majority of heart muscle is made up of cardiac muscle
- The heart beat is initiated by a group of specialized muscle cells in the right atrium called the sinoatrial node (SA node)
- SA node acts as a pacemaker by sending out an electrical signal to initiate contraction of both atria
  - SA node sent out every 0.8 sec
- atrioventricular node (AV node): receives signal from SA node, delays for 0.1 sec, then sends out another electrical signal

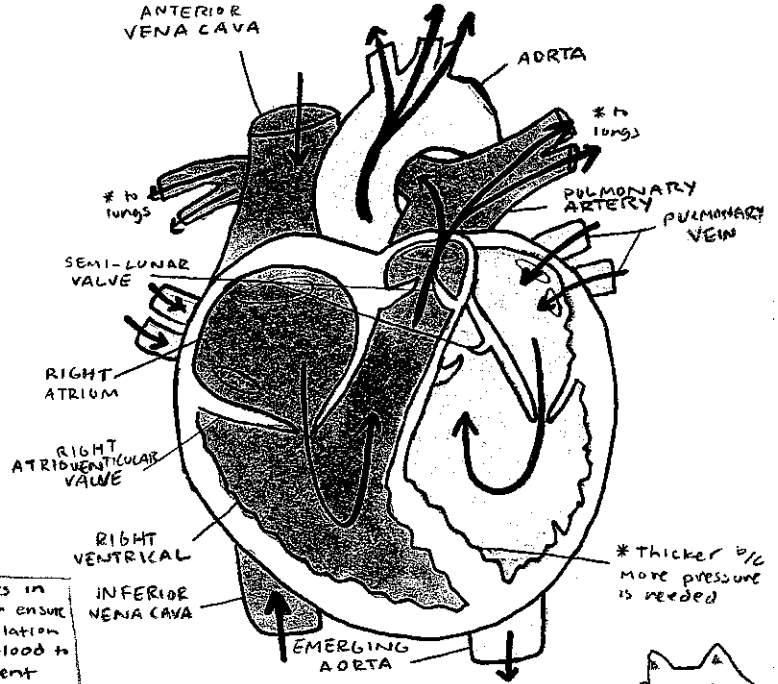


- heart rate can be increased or decreased by impulses brought to the heart through two nerves from the medulla of the brain
- heart rate can be influenced by chemecals



BODY
↓
R.A
↓
R.V
↓
LUNGS
↓
L.A
↓
L.V
↓
Body

Valves in heart ensure circulation in blood to prevent backflow (open, close)



: deoxygenated blood

ARTERIES, CAPILARIES, AND VEINS

Capillaries have permiable walls that allows exchange of materials btw cells in tissue & blood in the capillary

- arteries: take blood away from the heart
- veins: take blood towards the heart
- capilaries: connect arteries and veins (exchange materials)
- arters convey blood at high pressure from the ventricals to the tissues of the body
- arteries have elastic fibers in their walls, help maintain high blood pressure
- the muscle and elastic fibers assist in maintaining blood pressure between pump cycles
- seperate circulation for the lungs

Artery:	CAPILLARY	VEIN
thin walled	wall is 1 cell thick	thin walled
no exchanges	all exchanges occur	no exchanges
No internal valves	no internal values	internal values present
internal pressure high	internal pressure low	internal pressure low

6.2

The Blood System

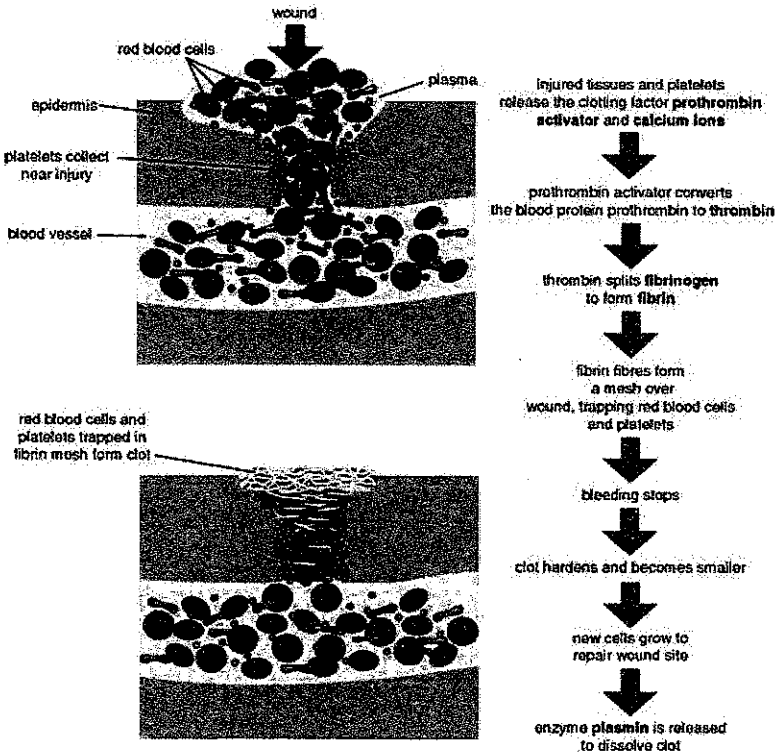
Defense Against Infectious Diseases

Pathogen-Any living organism or virus that is capable of causing a disease

Specific Immunity-One type of antibody to fight specific pathogen

Non-specific Immunity-An antibody produced to fight any pathogen

Blood Clotting:



Blood clots in coronary arteries means that the heart is not receiving oxygen and is being deprived of nutrients. This leads to dead patches on tissue in the heart. The heart being deprived of oxygen means that sufficient ATP is not being created which means that the heart cannot pump efficiently and becomes irregular.

Helper T Cells-regulator cells that activate specific B cells, raises alarm

B cells- antibody producing cell that targets and recognizes specific pathogen

The skin and the mucus membranes are the primary defense against pathogens. A secretion of sebum keeps the skin pH levels low and moist so that bacteria is not able to grow. The mucus membranes are physical barriers that trap in particles that are expelled or take in the particles.

Antibody Production: Antibodies are created by lymphocytes. Protein and other molecules that aren't antigens are recognized as "foreign"; Helper T lymphocytes raise the alarm and cause a chemical reaction that activates the B lymphocytes (B cells) which then target and recognize the specific pathogen.

Antigens are "self" cells that belong to the body. Antibodies are used to fight pathogens and are produced by the lymphocytes, can be specific or non-specific.

Antibiotics are used for blocking the process of prokaryotic cells because all bacteria cells are prokaryotic. Viruses cannot be treated with antibiotic because they do not have a metabolism and viruses are non-living and only produce from host cells.

HIV spread the transmission of bodily fluids. The effects of HIV lead to the Helper T cells not being able to send out an alarm and chemical reaction to the B cell which then produce the antibody that recognizes and targets the pathogens, meaning there are no antigens being produced. Most HIV patients die from other causes than HIV because the pathogens enter the body without an alarm.

Florey and Chain's experiment: 8 mice were injected with pathogens and the split into two groups of 4. One group received penicillin and the other group did not. The group that received the penicillin lived while the group that didn't receive the penicillin died. As a result from this, penicillin kills bacteria but does not kill the host cell.

6.3 Defense Against Infectious Diseases

Primary Defense:

- Skin has two layers
  - Top: epidermis
  - Bottom: Dermis
- Epidermis is replaced by dying dermal cells
  - Good barrier → Not truly alive
- Dermis has sweat glands, capillaries, sensory receptors, and dermal cells (strength and structure)
- Mucous membrane produces and secretes a lining of mucous that traps pathogens

Clotting:

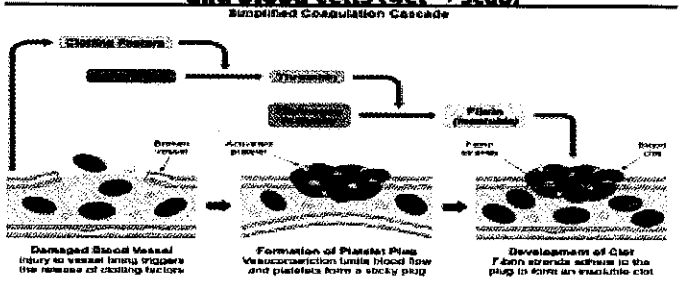
- Blood vessels are severed and start to bleed → clotting
- Prevents further blood loss and blood pressure
- Barrier against pathogens

Platelets:

- Small and circular
- Acts as a makeshift plug
- Releases clotting factors

Fibrin:

- Cascade of reactions results in thrombin production
  - Turns soluble fibrinogen into fibrin
- Meshes cuts together and traps platelets and blood cells (gel → scab)

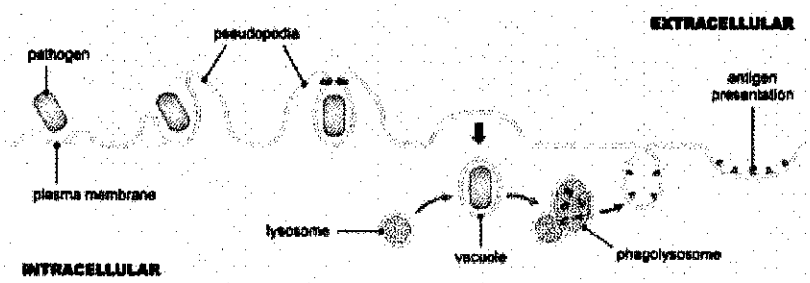


Antibodies:

- Surface of pathogens are foreign (antigens) and stimulate certain immune responses
- Antibodies are produced by lymphocytes (white blood cells)
  - B Cells: recognize and target certain pathogens
    - Produce antibodies
  - T Cells : release chemicals to activate specific B lymphocytes
    - Raises and releases alarm (cytokines)

Phagocytes:

- If pathogens get past skin and mucous, white blood cells are the last defense



Antibiotics:

- Inhibit growth on microorganisms
- Most antibiotics are anti-bacterial
- Targeted by antibiotics are bacterial DNA replication, transcription, translation, ribosome function, and cell wall formation

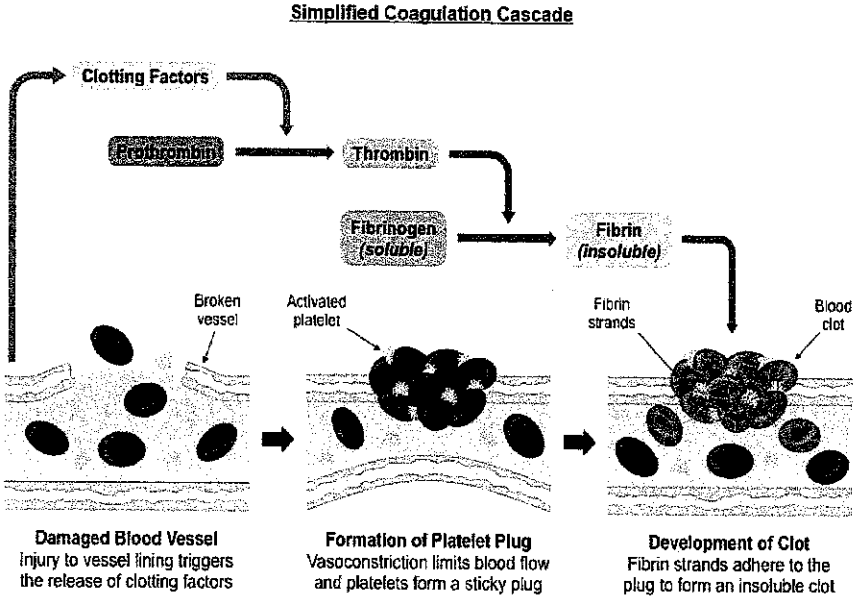
Viruses:

- Viruses can't be treated with antibiotics because they don't have a metabolism
- Are non-living
- Can only reproduce inside a living cell

6.3 Defense Against Infectious Disease

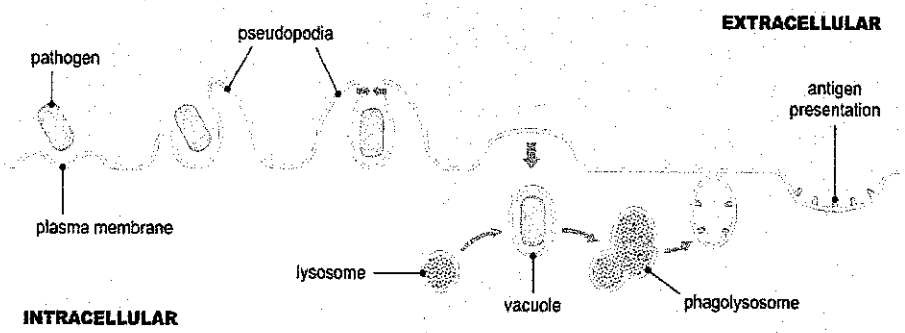
ESSENTIAL IDEA: The human body has structures and processes that resist the continual threat of invasion by pathogens.

BLOOD CLOTTING: Seals cuts in skin; prevents entry of pathogens until new tissue has grown to heal cut variation • Clotting in coronary arteries can lead to heart disease/attack



NON-SPECIFIC IMMUNITY:

Ingestion of pathogens by phagocytes gives non-specific immunity to diseases



VOCABULARY

•**Pathogen**: any living organism capable of causing infectious disease

•**Antigen**: foreign substance that induces immune response (especially antibody production)

•**Antibody**: produced by lymphocytes to combat antigens; Y-shaped

HIV:
transmitted by blood; destroys helper T-cells and weakens immune system

ANTIBIOTICS, BACTERIA, AND VIRUSES:
•Florey and Chain conducted experiments with penicillin on mice infected with bacteria

•Antibiotics block processes that occur in prokaryotic cells, but not eukaryotic cells

•Some bacteria strains have evolved with genes which confer resistance to antibiotics, and some bacteria have multiple resistance

•Viruses cannot be treated with antibiotics because they lack a metabolism

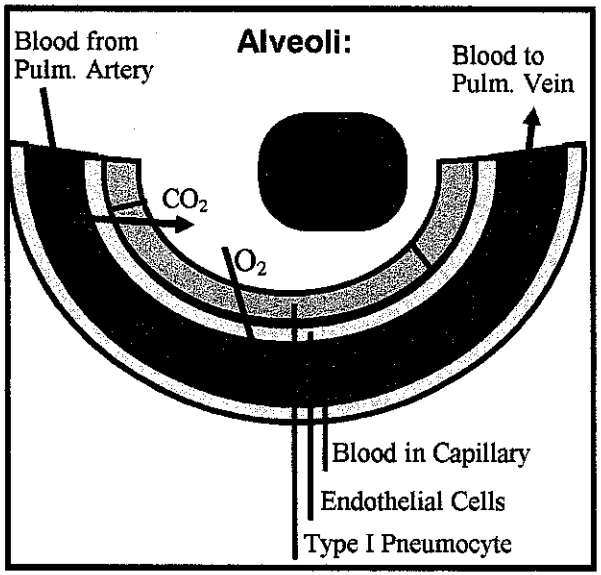
SKIN AND MUCOUS MEMBRANES:
Form primary defense against pathogens that cause infectious diseases

SPECIFIC IMMUNITY:
Production of antibodies by lymphocytes in response to particular pathogens gives specific immunity

6.4 — Gas Exchange

Lungs: To get to the lungs, air must travel through the nose or mouth, and then the trachea. Once in the thoracic cavity, the trachea divides into the two (right and left) primary bronchi. The primary bronchi branch into continually smaller bronchi, which branch into the bronchioles, which get progressively smaller (microscopic) until they reach the alveoli. The alveoli are tiny sacs made up of pneumocytes (see below). They are covered by capillaries which allow for gas exchange between the lungs and the blood.

Ventilation: Ventilation is the process of continually bringing air into and out of the lungs. This process continually expels the gases in the lungs, which contain relatively high concentrations of carbon dioxide (CO_2), and replaces them with the air around us, containing relatively high concentrations of oxygen. By maintaining this concentration gradient, CO_2 can passively diffuse out of the pulmonary capillaries, while oxygen passively diffuses into the blood. This is how blood is re-oxygenated in the pulmonary vessels.

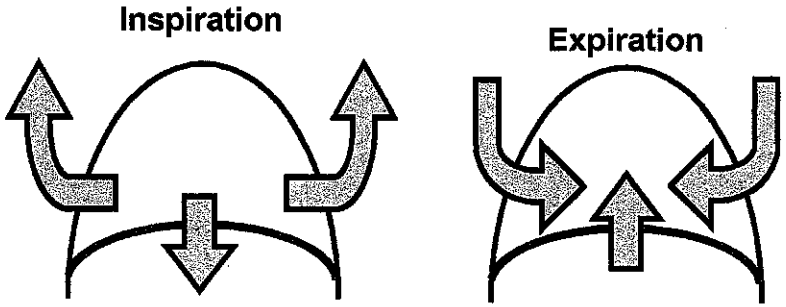


The lungs are actively ventilated to ensure that gas exchange can occur passively.

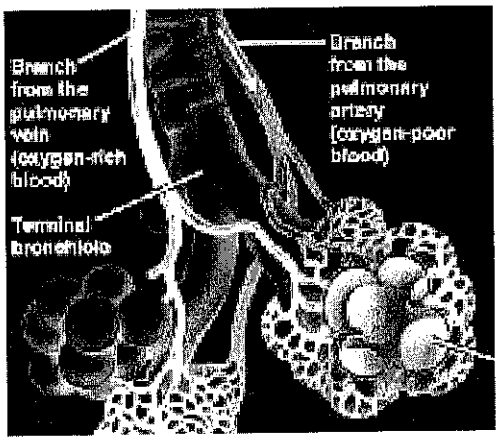
Pneumocytes: There are two types of pneumocytes, identified very creatively as either Type I or Type II Pneumocytes. Type I Pneumocytes are extremely thin, and form a barrier between the lung and the blood vessels; gases can passively diffuse through these cells, but they are incapable of undergoing mitosis. Type II Pneumocytes secrete a fluid which acts as a surfactant to keep the walls of the alveolus from sticking together. Type II Pneumocytes are also capable of undergoing mitosis to create either more Type II Pneumocytes or new Type I Pneumocytes.

Muscles: There are four different muscle groups which are primarily involved in respiration: the internal intercostal muscles (IIMs), the external intercostal muscles (EIMs), the diaphragm, and the abdominal muscles. The EIMs and the diaphragm contract to cause inspiration, while the IIMs and the abdominal muscles contract during expiration. By contracting and relaxing at opposite times, the muscles responsible for inspiration and the muscles responsible for expiration demonstrate antagonistic muscle actions.

Emphysema & Lung Cancer: Emphysema is a type of COPD where the alveoli are progressively destroyed, typically caused by smoking. This prevents effective gas exchange. Lung cancer is most often caused by the inhalation of carcinogens, especially cigarette smoke, and can lead to decreased respiratory efficiency and bleeding in the lungs. It is very unstable and can metastasize to a wide range of places, and is associated with a high mortality rate.



6.4 Gas exchange study guide



-Ventilation:

Refers to the maintaining of concentration gradients of oxygen and carbon dioxide between air coming in and blood flowing through alveoli in the capillaries.

-Type 1 pneumocytes:

Carry out gas exchange (oxygen from breathing in and carbon dioxide from the body) and have a very large total amount of surface area for diffusion.

Type 2 pneumocytes:

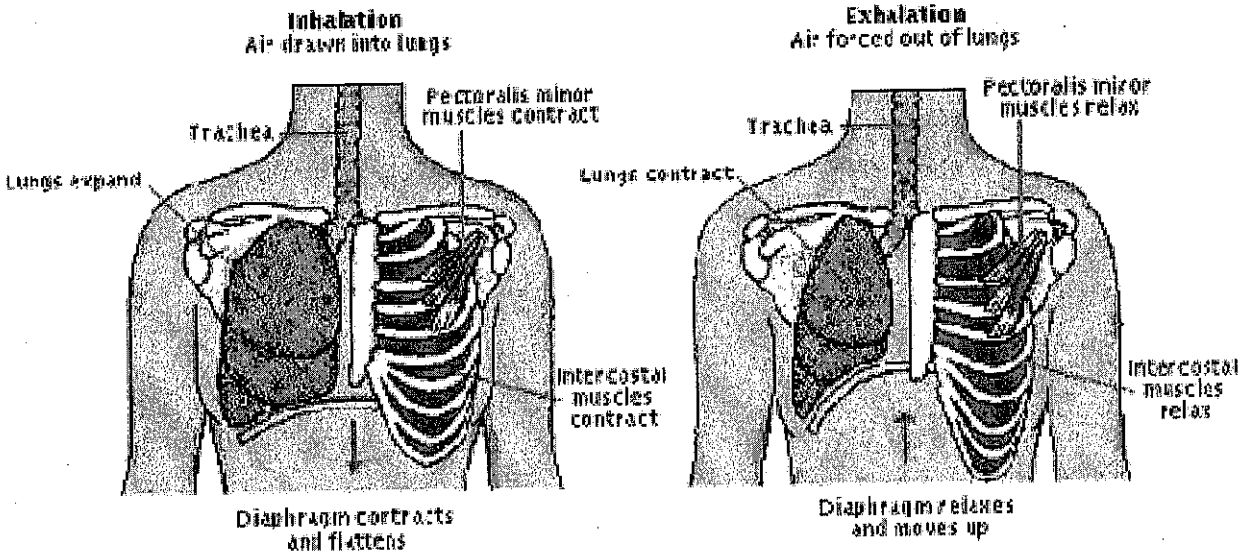
-Secrete a surfactant that creates a moist surface inside the alveoli to prevent the sides of the alveolus from adhering(sticking) to each other by reducing surface tension.

Airway:

Air enters the ventilation system through the nose and mouth and then it goes to the trachea. Air then goes to the bronchi that branch off into bronchioles in the lungs that then lead to alveoli. At the end of each bronchioles are groups of alveoli, where gas exchange occurs (oxygen and carbon dioxide).

Inspiration and expiration:

- Muscle contractions cause the pressure to change in lungs that either make air come out of the lungs or make air come in.
- Different muscles are used when inhaling and exhaling: diaphragm, inner intercostal muscles and external intercostal muscles.



Inspiration: external intercostal muscles contract, internal intercostal muscles relax, and diaphragm contracts. Expiration is the opposite.

6.4 Gas Exchange

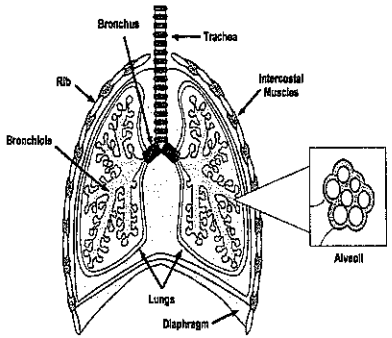
Key Terms:

Ventilation: the exchange of air between the atmosphere and the lungs - achieved by the physical act of breathing

Gas Exchange: the exchange of oxygen and carbon dioxide between the alveoli and bloodstream - via passive diffusion

Cell Respiration: the release of energy (ATP) from organic molecules - enhanced by the presence of oxygen

Pneumocytes: cells that line the alveoli and comprise of the majority of the inner l]surface of the lungs



Understandings:

Ventilation maintains concentration gradients of oxygen and carbon dioxide between air in alveoli and blood flowing in adjacent capillaries

Type I pneumocytes are extremely thin alveolar cells that are adapted to carry out gas exchange

Type II pneumocytes secrete a solution containing surfactant that creates a moist surface inside the alveoli to prevent the sides of the alveolus adhering to each other by reducing surface tension

Air is carried to the lungs in the trachea and bronchi, and then to the alveoli in bronchioles

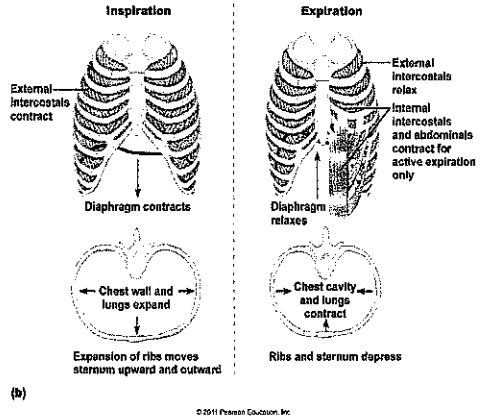
Muscle contractions cause the pressure changes inside the thorax that force air in and out of the lungs to ventilate them

Different muscles are required for inspiration and expiration because muscles only do work when they contract

Muscle Contraction:

Muscles responsible for inspiration: diaphragm and external intercostal

Muscles responsible for expiration: abdominal muscles and internal intercostals



Mechanism of Breathing:

- The contraction of respiratory muscles changes the volume of the thoracic cavity (the chest).
- When the volume of the thoracic cavity increases, the pressure in the thorax decreases, according to the principle of Boyle's law.
- Gases will move from a region of high pressure to a region of lower pressure, similar to movement along a concentration gradient.
    - When the pressure in the chest is less than the atmospheric pressure, air will move into the lungs
    - When the pressure in the chest is greater than the atmospheric pressure, air will move out of the lungs
- Atmospheric pressure is lower at higher altitudes, meaning a greater increase in chest volume is required before a pressure differential is formed - making it harder to breathe at high altitudes

Defense against infectious diseases: 6.4

1st Line of Defense Against Disease: Skin + Mucous Membrane

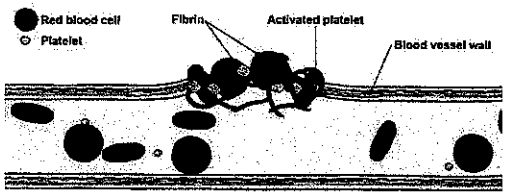
- Body exposed to pathogens
- Skin has 2 layers that keeps germs out
- Area w/out skin (ie nose) has membrane

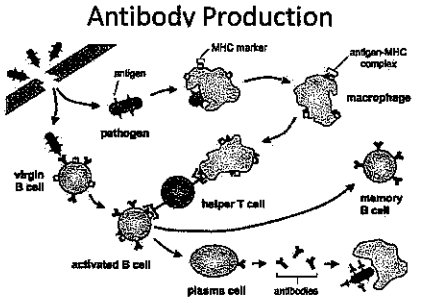
2nd Line of Defense Against Diseases: White Blood Cells

- Occurs when pathogens get past skin
- Phagocytic white blood cells ingest pathogens
- Results in non-specific immunity to pathogen + diseases

Blood Clotting 101

- Skin cut, blood vessels severed
- Cut is sealed by clot, prompted by clotting factors released from platelets
- Reactions result in soluble fibrinogen converted to insoluble fibrin
- Fibrin forms mesh in cut, traps platelets + blood cell
- Prevents pathogens entering until new tissue grown at cut
- And a clot is born!





Antibodies: Our Baby Warriors

- Proteins on pathogens recognized as invaders (antigens)
- Response: Antibodies produced by lymphocytes, prompted by Helper T Cells
- B Cells produce the antibody
- Lymphocyte produces specific antibody for specific antigen

Antibiotics

- Antibiotic = chemical inhibiting microorganisms, mostly antibacterial
- Block prokaryotic cell processes, not eukaryotic cell processes
- Viruses don't have metabolism, can't be blocked w/ antibiotics
- Overuse of antibiotics - evolution w/ genes than cause bacteria resistance to antibiotics

Vocab!

- Mucous Membrane: soft, thin skin in trachea, nasal, urethra, vagina
- Platelets: cellular fragments circulating in blood
- Antigen: surface protein elliciting immune response
- Phagocytosis: endocytosis, substances taken up by cell, forming a vesicle.
- HIV: Immunodeficiency virus, replicates and kills Helper T-cells

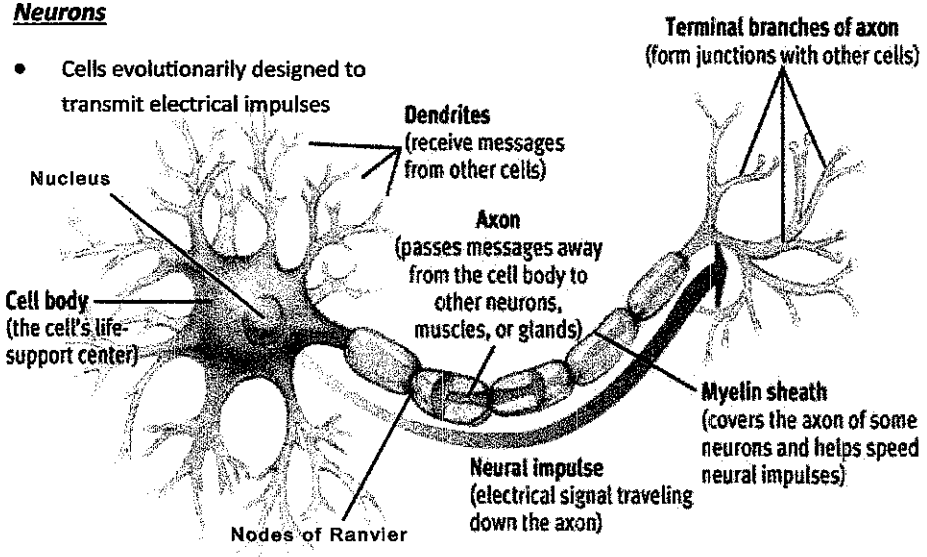
6.5 Neurons & Synapses

Organization of the Human Nervous System

- Central Nervous System (CNS)- brain & spinal cord; receive and interpret sensory info
  - Sensory Neurons— bring info to CNS
  - Motor Neurons— carry response to muscles
  - Nerves– group of many individual neurons in 1 single structure
  - Connection from CNS to body made of 2 sets of nerves
    - Spinal Nerves– directly from spinal cord; 31 pairs; some sensory, some motor
    - Cranial Nerves– directly from brainstem; 12 pairs

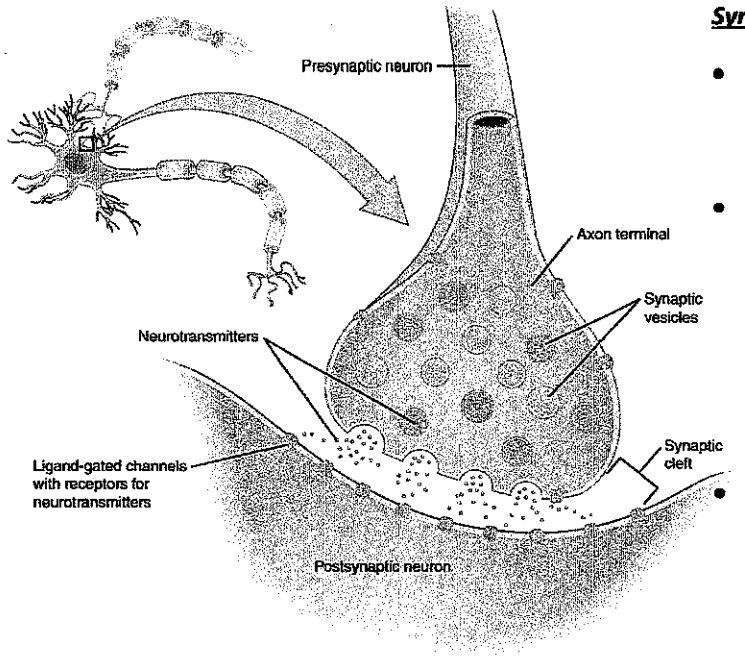
Neurons

- Cells evolutionarily designed to transmit electrical impulses



Saltatory Conduction by Neurons that have a Myelin Sheath

- Myelination– neurons coated in Schwann Cells that causes nerve impulse to travel faster; allows areas of neuron to be skipped; less ATP used
  - Saltatory Conduction– allows impulse to skip from one node of Ranvier to next one



Synapses

- Adjoined neurons creating chemical communications
- Pre-synaptic terminal buttons transfer message from action potential to post-synaptic neuron dendrites
- Releases neurotransmitters into the synapse to next neuron or cell

Nerve Impulse

- Action Potential– impulse sent down neuron to transmit signal
- Resting Potential– time period during which area of neuron is ready to send action potential
  - Polarized– created by active transport of sodium ions out of cell and potassium ions into cell making the inside of the cell positive: Sodium-potassium pump
- Depolarization– sending the impulse
  - Sodium diffuses back into cell: impulse or action potential
    - Cell becomes temporarily positive: depolarization
    - Opens up sodium channels into next area of axon: Propagation
  - Threshold Potential– minimum action potential needed to self-propagate along axon
    - Starts at receptor neuron: neuron that transduces physical stimulus into action potential
    - part of cell reaches action potential: sodium ions diffuse into next part of cell to help it reach action potential; self-propagation occurs as result of local current
    - If not reached, action potential will not continue and message will not be passed
- Repolarization– sodium and potassium ions actively diffuse back to original positions

The Central Nervous System is the brain and the spinal cord

Depolarization: sending an impulse

Each action potential must reach a min. threshold to send a signal

6.5 – Neurones and Synapses

1) Neurones transmit electrical impulses

NERVES DONT CARRY IMPULSES! - Individual neurones in the nerves do!

2) The myelination of nerve fibers allows for salutatory conduction.

Myelin sheath increases the rate at which action potential moves down the axon.

3) Neurones pump sodium and potassium ions across their membranes to generate a resting potential .

Active Transport

A sodium - potassium pump moves Sodium + Potassium in opposite ways

4) An action potential consists of depolarization and repolarization of the neurone.

Repolarization: Not sending an impulse

5) Nerve impulses are action potentials propagated along the axons of Neurones.

action potential can be best studied on a non-myelinated neurone.

6) Propagation of nerve impulses is a result of local currents that cause each successive part of the axon to reach the threshold potential.

Each successive area of a neurone membrane reaches threshold and causes the next area to do the same

Treshold is reached = impulse sent

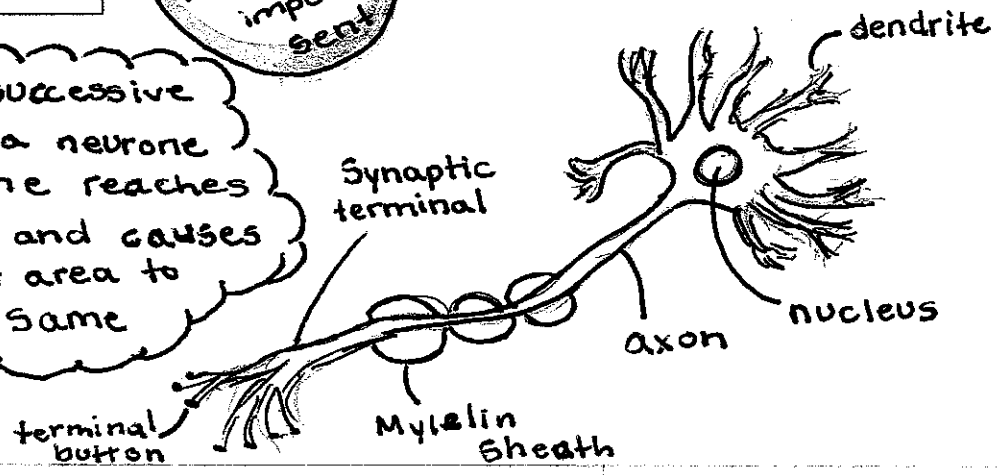
7) Synapses are junctions between neurones and between neurones and receptor or effector cells.

Synaptic terminals match up with dendrites

8) When presynaptic neurones are depolarized they release a neurotransmitter into the synapse

INSTANTANEOUS (nearly)

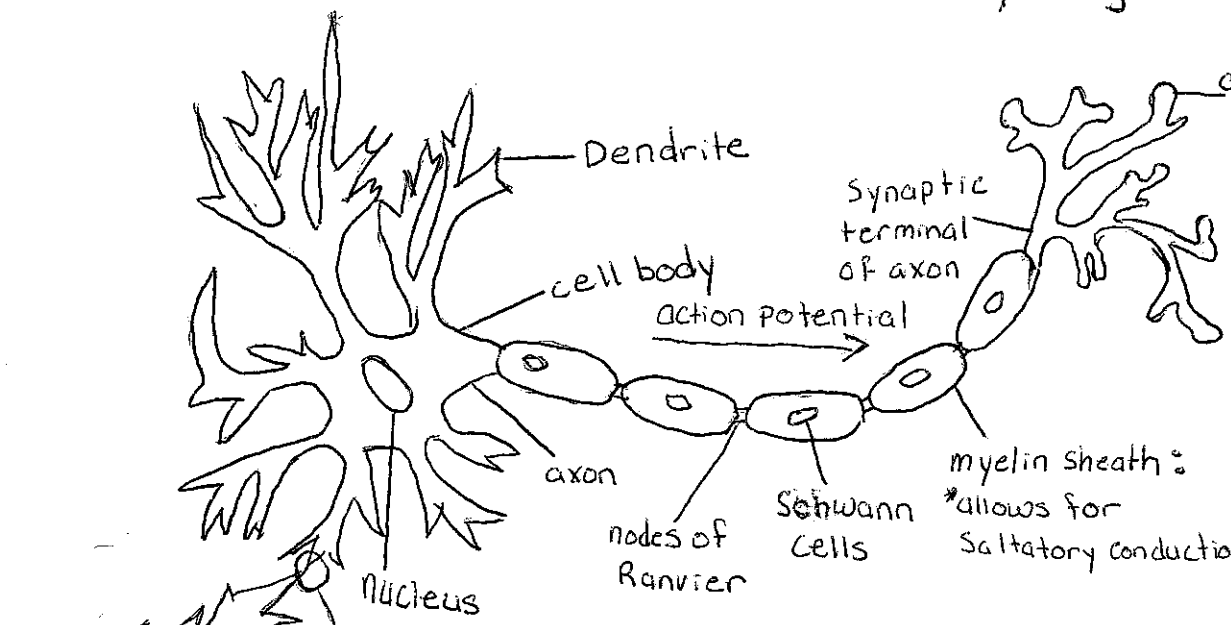
9) A nerve impulse is only initiated if the threshold potential is reached



6.5 Neurones and Synapses

*Understandings

*Neurones - Cells that have been evolutionary designed to transmit electrical impulses.

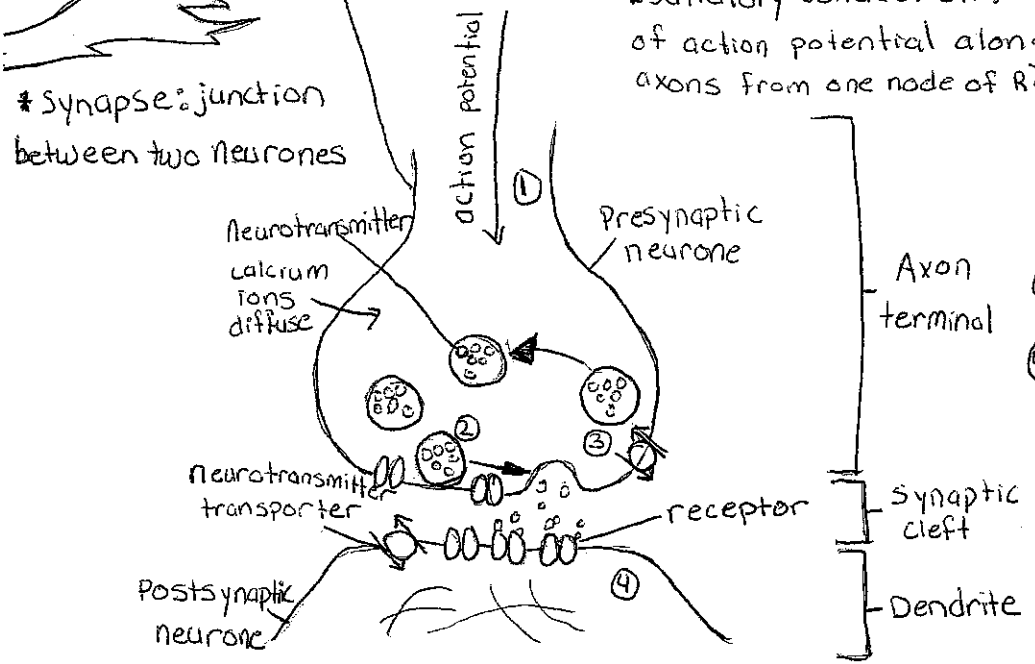


Resting Potential: is the electrical potential across plasma membrane of cell that is not conducting an impulse
- *generated by neurone pumping sodium and potassium ions across membranes.

Action Potential: *reversal (depolarization) and restoration (repolarization) of *electrical potential across plasma membrane as a nerve impulse passes along the axon of neurones
- *local currents cause each successive part of axon to reach threshold potential as result of propagated nerve impulses

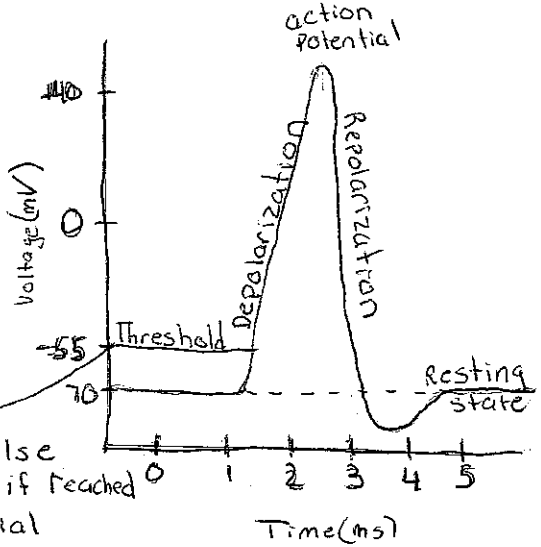
*Saltatory conduction: Propagation of action potential along myelinated axons from one node of Ranvier to next node

*Synapse: junction between two neurones



1. action potential arrives
2. vesicle fuses with plasma membrane
3. neurotransmitter is released into synaptic cleft
4. neurotransmitter binds to receptor

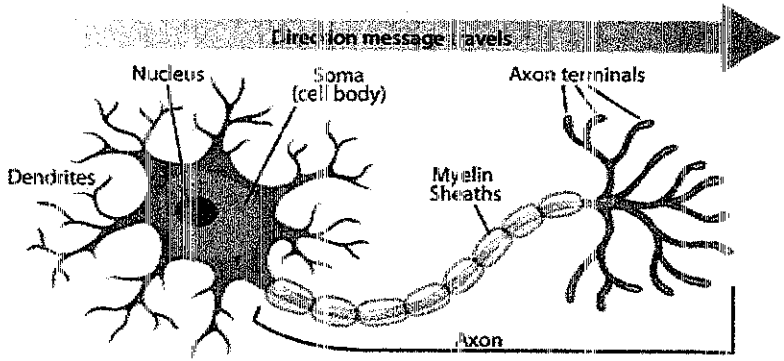
*Depolarized presynaptic neurones release neurotransmitters into synapse



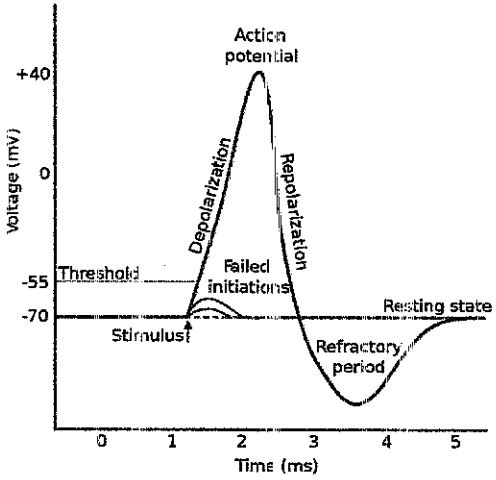
*the nerve impulse is only initiated if reached threshold potential

6.5 NEURONS AND SYNAPSES

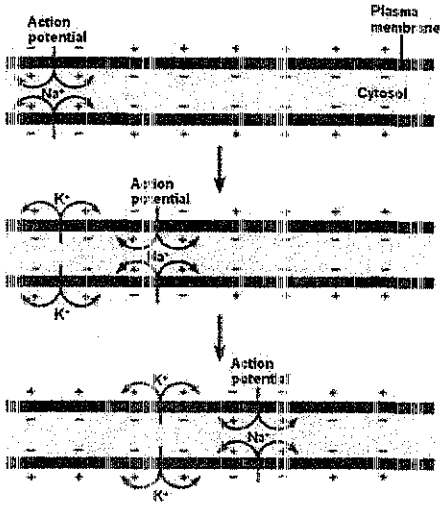
Neurons transmit the message, synapses modulate the message



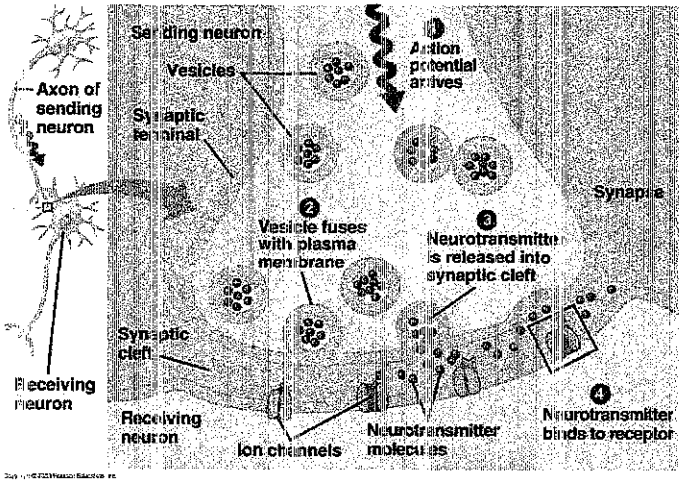
- **Human Nervous System:** Made up of the brain and spinal cords (made of relay neurons) and peripheral nerves (made of sensory and motor neurons).
- **Neurons:** Individual cells that carry electrical impulses through the body. They transmit electrical impulses, which help with internal communication.



- **Resting Potential:** No impulse is currently being sent. Created by sodium and potassium ions being pumped across the neurons' membranes.
- **Depolarization:** Sending an impulse. Neurons change from resting to action potential. Change from negative to positive charge. Sodium channels open.
- **Repolarization:** Returning to resting potential. Change from positive to negative charge. Sodium channels close and Potassium channels open.
- Impulses are only initiated after **Threshold Potential** is reached.
- Action Potential = 50+ mV. Resting Potential= -70mV
- mV=membrane potential



- Sodium and Potassium move along the neurons' axons from high to low concentration gradients.
  As sodium diffuses, it brings cell to action potential.
  Sodium diffuses faster than potassium.
  High concentrations have positive charges because Sodium and Potassium have positive charges.



- **Synapses:** When neurons are depolarized, they release neurotransmitters into the synapse during synaptic transmission, creating communication between neurons and receptors.
- **Neurotransmitters:** Chemicals that send signals across synapses and are released from vesicles in the synaptic terminal buttons of the first neuron
- **Presynaptic neuron:** Sends neurotransmitter.
- **Postsynaptic neuron:** Receives neurotransmitters

6.6 - *Hormones, homeostasis, and reproduction*

Homeostasis: achieved by an expected value/set point within certain limits for physiological variables.

Thyroxin: secreted by the thyroid gland to regulate the metabolic rate and help control body temperature

Leptin: secreted by cells in adipose tissue and act on the hypothalamus of the brain to inhibit appetite

People who are obese, have an high amount of leptin, but studies have shown that these people are desensitized to the effects. Some suggests, leptin helps more when fat is low and the appetite needs to increase.

Melatonin: secreted by the pineal gland to control circadian rhythms

"Jet lag" occurs when a person travels several time zones over multiple periods of time. The melatonin production of the circadian rhythm is interrupted since the new sleep schedule is not compatible with the production of melatonin

Male Hormone:

- Testosterone causes pre-natal development of male genitalia and both sperm production and development of male secondary sexual characteristics during puberty
- A gene on the Y chromosome causes embryonic gonads to develop as testes and secrete testosterone

Female Hormone:

- Estrogen and progesterone cause pre-natal development of female reproductive organs and female secondary sexual characteristics during puberty
- The menstrual cycle is controlled by negative and positive feedback mechanisms involving ovarian and pituitary hormones

IVF - drugs to suspend the normal secretion of hormones, followed by the use of artificial doses of hormones to induce superovulation and establish a pregnancy

Diabetes:

Type I - 10%	Type II - 90%
An autoimmune disease where the immune system destroys β cells and no insulin is produced. Treated with insulin injections.	The body no longer responds to insulin (insulin resistance). It is treated through a change in diet since it's common.

Insulin and glucagon are secreted by β and α cells of the pancreas respectively to control blood glucose concentration

Reproduction systems: male (left) and female (right)