

# Body Systems

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Note, pages are numbered.

Systems are color coded.

Drawings are to scale only by accident.



# DIGESTIVE SYSTEM

The digestive system breaks food down into a form the body can use (molecules)

Organs of the digestive system are either Alimentary or Accessory Organs.  
Food passes through Alimentary Organs, but not Accessory Organs.

The alimentary organs form the gastrointestinal tract, which runs from mouth to anus.

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Note sources will appear at bottom of page.

Many sources are used for multiple systems, they will not be listed twice. Hand-drawn images are done with use of sources listed. Outside drawings will be placed next to source.

Sources: Modern Biology, Holt, Rinehart and Winston

# DIGESTIVE SYSTEM

## Alimentary Organs

Mouth - mechanical phase of digestion begins, surface area of food is increased

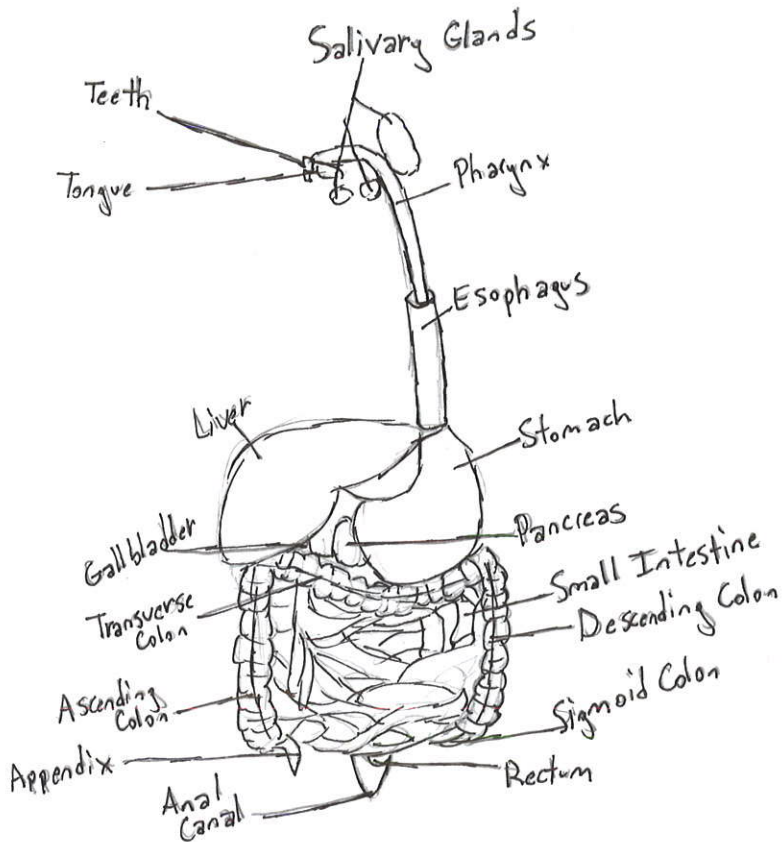
- chemical digestion, salivary amylase begins the chemical digestion of carbohydrates

- includes salivary glands, teeth and tongue

pharynx - is an open passageway for both air and food  
- epiglottis prevents food entering respiratory tract

esophagus - brings food from pharynx to stomach

stomach - stores food and starts digestion  
- secretes gastric juice to start digestion



# DIGESTIVE SYSTEM

small intestine - most of the absorption of nutrients occurs in small intestine

- longest section in gastrointestinal tract

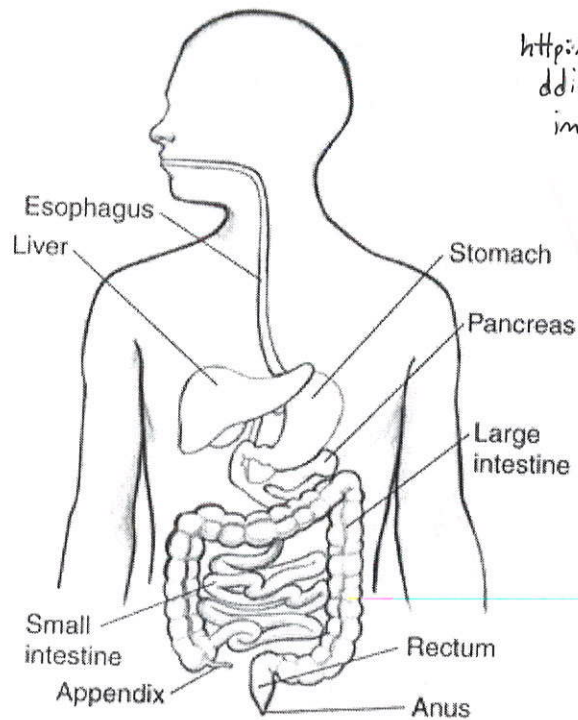
large intestine - also called the colon

- recovers water that went into the gastrointestinal tract

rectum - last part of colon

- where feces are stored until they can be removed.

anus - end of gastrointestinal tract



<http://digestive.niddk.nih.gov/ddiseases/pubs/intestinaladhesions/images/DigestiveSystem...>

# DIGESTIVE SYSTEM

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## Accessory Organs

Salivary Glands - deliver saliva (through ducts) to the mouth

- Saliva lubricates food and contains the enzyme salivary amylase, which starts breaking down carbohydrates

Liver - produces bile, which has digestive enzymes

- Bile is stored in the gall bladder, (another accessory organ) until it is needed

Gall bladder - stores bile

- Delivers bile to small intestine (through duct)

Pancreas - makes enzymes

- delivers enzymes into small intestine

Enzymes, which are mentioned a lot, are important for the chemical digestion of food. What enzymes do is hasten the reactions that digest food.

Sphincters - layer of muscle that forms ringlike valves

- Sphincters close off the digestive tube, so control the movement of food along the gastrointestinal tract

# DIGESTIVE SYSTEM

## Physical vs. Chemical Digestion

Physical Digestion is the mechanical breakdown of food, it changes the food physically but doesn't change what it is.

Chemical Digestion alters the makeup of food, turning complex molecules into less complex ones.

Chemical Digestion generally occurs after Physical Digestion.

The digestion of protein begins in the stomach with the enzyme pepsin. Pepsin breaks proteins down into smaller polypeptides.

The polypeptides are further broken down in the small intestine, into amino acids.

Digestion of carbohydrates begins with saliva. Carbohydrates pass through the stomach more quickly than fats or proteins. Pancreatic juice contains the enzyme pancreatic amylase which digests carbohydrates.

Bacteria inside the digestive tract digest cellulose (plant sugars) which is important because humans can't.

# DIGESTIVE SYSTEM

## Lactose intolerance

- many people do not make enough of lactase, the enzyme that digests lactose (milk sugar), so the lactose isn't digested. The unused sugar increases the amount of water in the small intestine and bacteria eat the sugar, producing acids and gases. Lactose intolerance can result in bloating, intestinal cramps and diarrhea. Symptoms can be avoided by taking lactase pills before eating dairy products.

## Appendicitis -

- the appendix is infected and swells. Surgery is necessary so that the appendix doesn't burst. Because of the location of the appendix on the large intestine, if it bursts the contents of the colon can end up inside the abdominal cavity, which is very serious. Appendicitis is usually marked by pain around the belly button that moves ~~to~~ to the lower right.



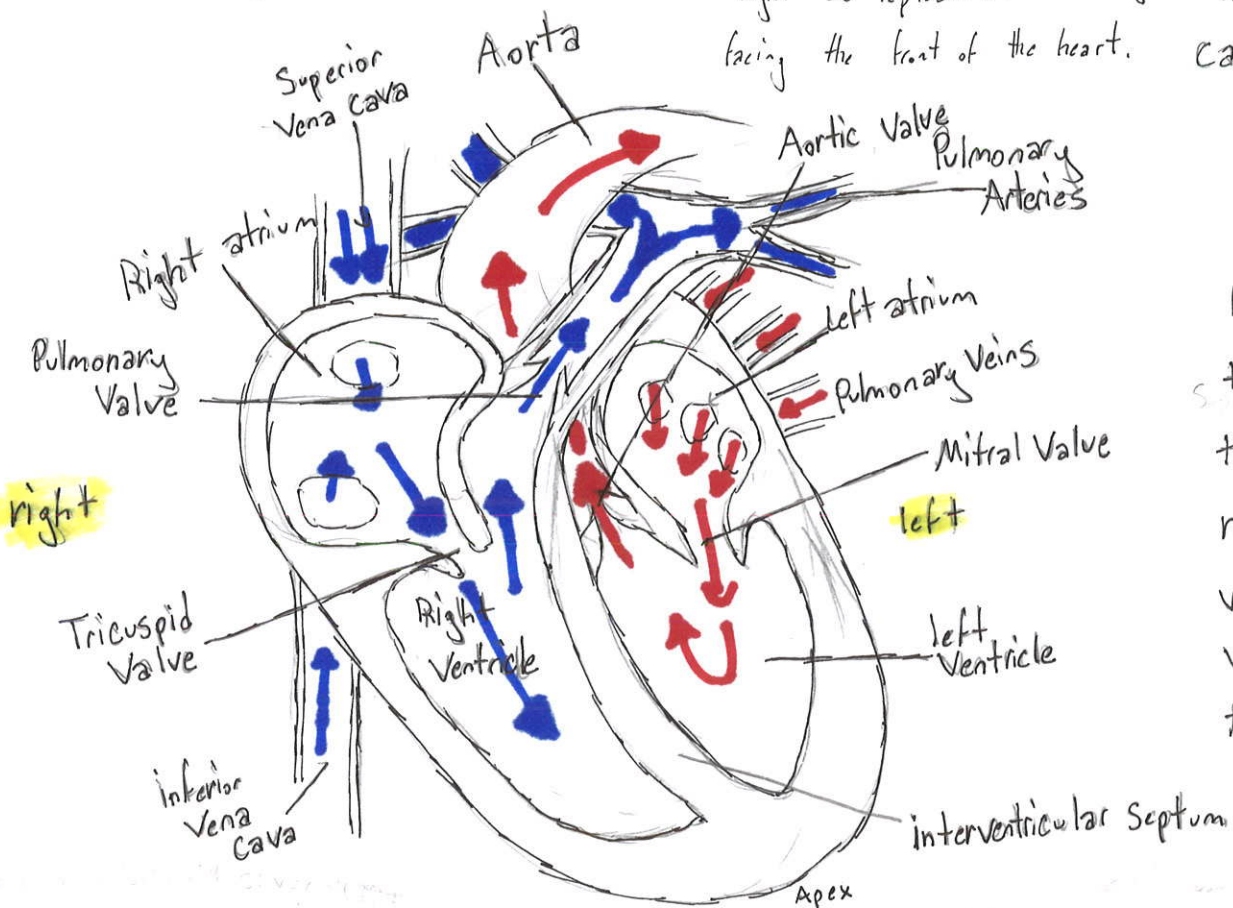
# CIRCULATORY SYSTEM

The circulatory system acts as a transport system for the cells of the body.

Note red is used to represent oxygenated blood and blue deoxygenated blood.

Also note that left and right are represented as though facing the front of the heart.

The heart is the central organ of the cardiovascular system.



Deoxygenated blood returns to the heart via the Superior and Inferior Vena Cava. From there it flows into the right atrium. From the right atrium, blood flows through the tricuspid valve into the right ventricle. The right ventricle contracts (and the tricuspid valve closes to prevent backflow) pushing blood into the pulmonary arteries. The ventricle relaxes and the pulmonary semilunar valve closes to prevent backflow.

# CIRCULATORY SYSTEM

From the pulmonary arteries, deoxygenated blood goes to the lungs. Oxygenated blood returns to the heart via the pulmonary veins.

From the pulmonary veins, blood enters the left atrium. It flows through the mitral, or bicuspid, valve into the left ventricle. The left ventricle contracts (and the bicuspid valve closes) forcing blood through the aortic semilunar valve and into the aorta. From the aorta, blood flows throughout the body and returns via the superior and inferior Vena Cava.

Veins? Arteries? Capillaries?

Veins function to return blood from the body, while arteries carry blood under pressure away from the heart.

Capillaries are the smallest vessels, and connect the smallest of the veins to the smallest of the arteries.

The wall of an artery has 3 layers. The inner layer is composed of endothelium. The middle layer has smooth muscle and elastic connective tissue. The outermost layer is thin and made of connective tissue.

The capillaries have only the inner layer.

Veins have the same 3 layers as the arteries, however the middle layer contains much less smooth muscle.

# CIRCULATORY SYSTEM 9

Blood contains blood cells and plasma.

Most of the blood cells are erythrocytes, red blood cells.

Red blood cells have hemoglobin, which they use to carry oxygen. Red blood cells lose their nucleus in order to have more room for hemoglobin.

The other type of blood cell is leukocytes, white blood cells. White blood cells protect against disease.



erythrocytes have a biconcave shape, which means they are thin in the center and thicker on the edges.

The shape increases surface area.

plasma is mostly water, but contains platelets, plasma proteins, gases and plasma nutrients.

plasma nutrients include amino acids, simple sugars, nucleotides and lipids (absorbed from the digestive tract)

# CIRCULATORY SYSTEM

## Closed and Open Circulatory Systems...

In a closed circulatory system, blood travels through the body in blood vessels. Humans have a closed system.

So what doesn't?

Among other things, clams. An open circulatory system has blood, or rather hemolymph, that moves throughout the body cavity.

The circulatory systems of fish, amphibians, reptiles and mammals are all somewhat different.

Like humans, the fish circulatory system has a heart, arteries, capillaries and veins. However, the fish heart is two chambered, having one atrium and one ventricle.

Unlike fish, and like humans, Amphibian circulation is divided into pulmonary and systemic circuits. Amphibians have a three chambered heart, with two atria and one ventricle. While blood from both circuits enters the ventricle simultaneously, the ventricle is structured to prevent the blood mixing.

# CIRCULATORY SYSTEM

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Like amphibians, the Reptilian Circulatory System contains both systemic and pulmonary circuits. The reptilian heart is three chambered with a partially formed septum in the ventricle.

Reptiles have a more flexible system, in that they can direct blood flow away from the pulmonary circuit. ~~The ventricle~~

The Mammalian heart has two atria and two ventricles. One set of atrium and ventricle pump to the pulmonary circuit, the other to the systemic circuit. Blood never mixes between the circuits.

## Sickle Cell Disease, Or Sickle Cell Anemia

Sickle cell disease is caused by a single base mutation in DNA. That mutation alters the structure of the Hemoglobin the body produces. When the oxygen supply is low, the mutated Hemoglobin crystallizes and the erythrocytes that carry it are bent into a sickle shape. The sickled erythrocytes can block small blood vessels and cause joint pain and organ damage. Because the mutant cells die more quickly, the Spleen must work harder to recycle them as they die, increasing the chance of infection.

Sickle cell disease is inherited. A person with sickle cell disease received the mutant allele from both parents. Someone with only one allele for the disease would have erythrocytes of both types.

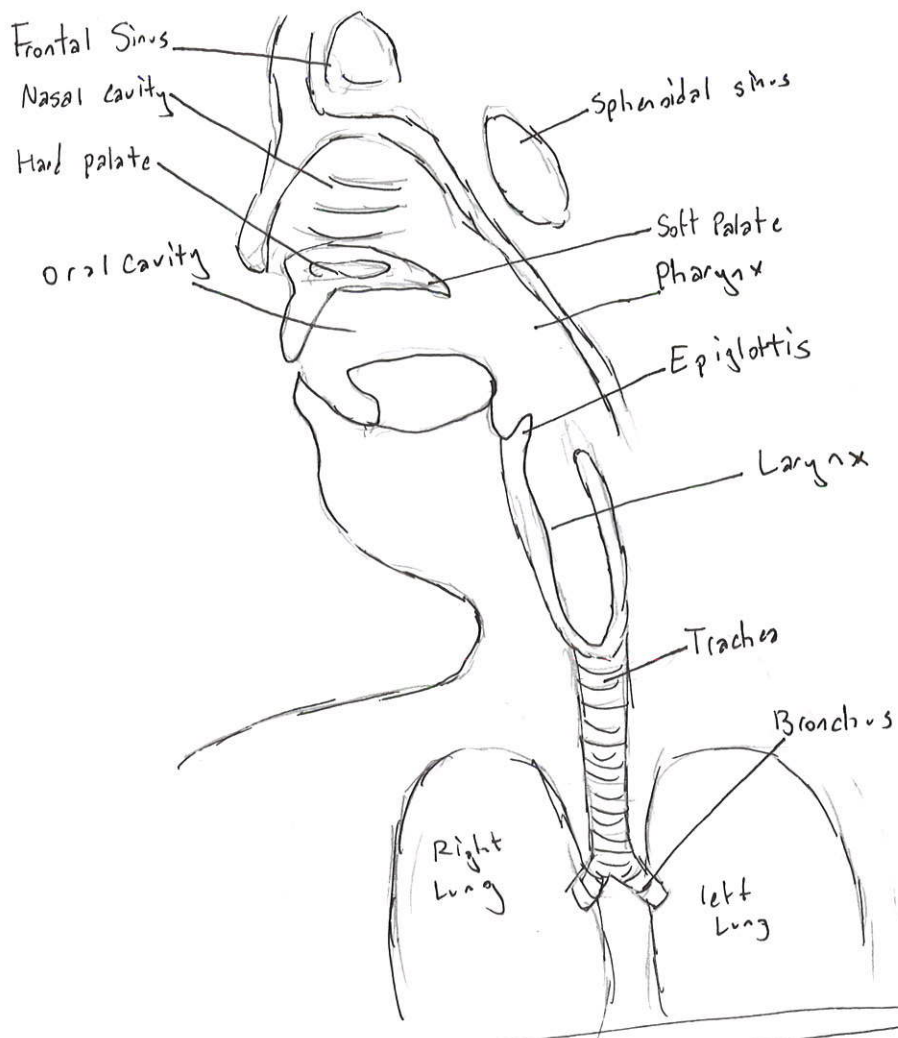
A bone marrow transplant can cure Sickle Cell disease, but has a 15% risk of death. Hydroxyurea has been used to delay sickling,

# CIRCULATORY SYSTEM

Atherosclerosis - deposits of fatty stuff, like cholesterol, build up on the inside of artery walls. The deposits, plaque, interfere with the flow of blood through the vessels. Atherosclerosis may make the arteries less elastic so they can burst under pressure. Atherosclerosis can also cause blood clots to form, making blood deficiency and tissue death more likely. The likelihood of getting Atherosclerosis can be affected by genetics as well as by diet, blood pressure and the use of tobacco.

# RESPIRATORY SYSTEM

The Respiratory system functions to facilitate the exchange of gases between the atmosphere and the body cells.



Hemoglobin - It's part of both respiratory and circulatory systems!

The respiratory system gets oxygen to the hemoglobin and the circulatory system gets the hemoglobin and the oxygen it carries to the cells of the body.

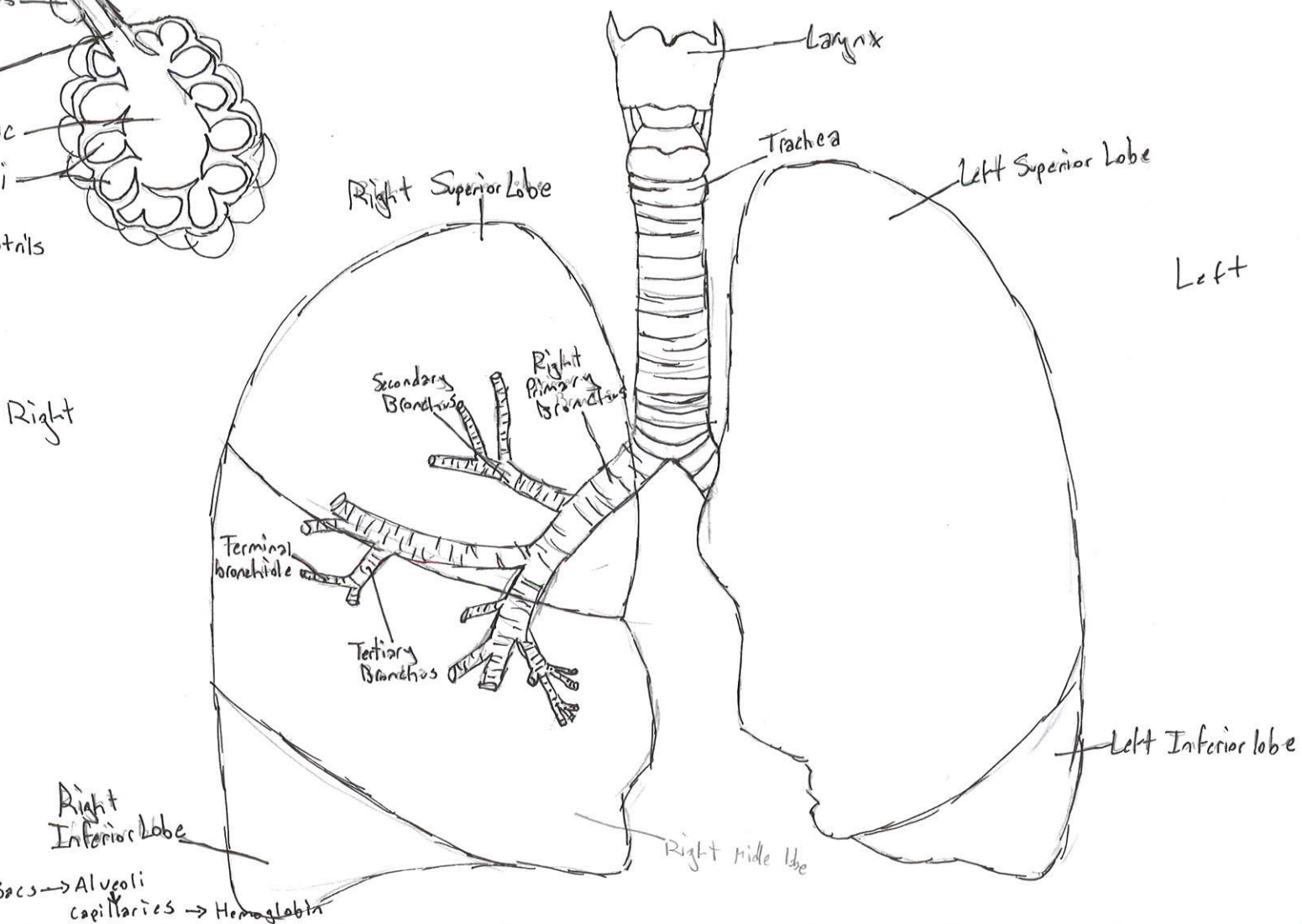
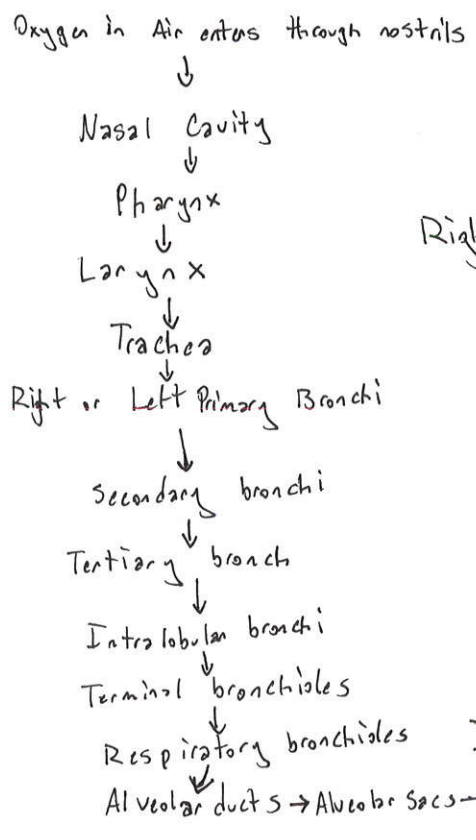
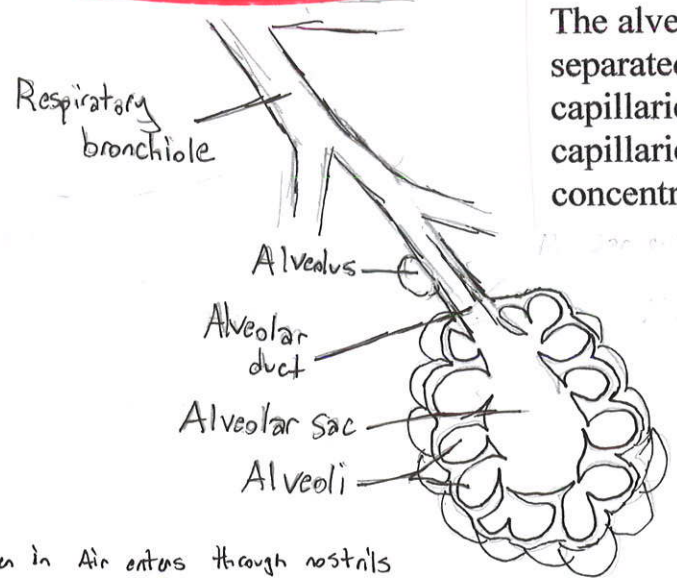
Like oxygen, carbon dioxide can be transported by Hemoglobin, however most of the carbon dioxide is transported as bicarbonate ions. ( $\text{HCO}_3^-$ )

Each hemoglobin molecule can bind up to 4 oxygen molecules. Hemoglobin + oxygen is called oxyhemoglobin

Hemoglobin + Carbon dioxide is called carbaminohemoglobin

# RESPIRATORY

The alveoli are tiny air sacs at the end of the smallest respiratory tubes. The alveoli are separated by thin walls that have tiny pores in them. The walls of the alveoli contain capillaries and a layer of epithelium. Gas exchange occurs between the air and the capillaries and occurs because gases diffuse from a high concentration to a low concentration.





During inhalation the diaphragm contracts, moving downward. This decreases the pressure in the lungs and outside air enters the lungs.

During exhalation the diaphragm relaxes, returning to its normal position, and the surface tension between the alveolar linings shrinks the alveoli. This increases the pressure within the lungs and air is forced outward.

#### Altitude sickness-

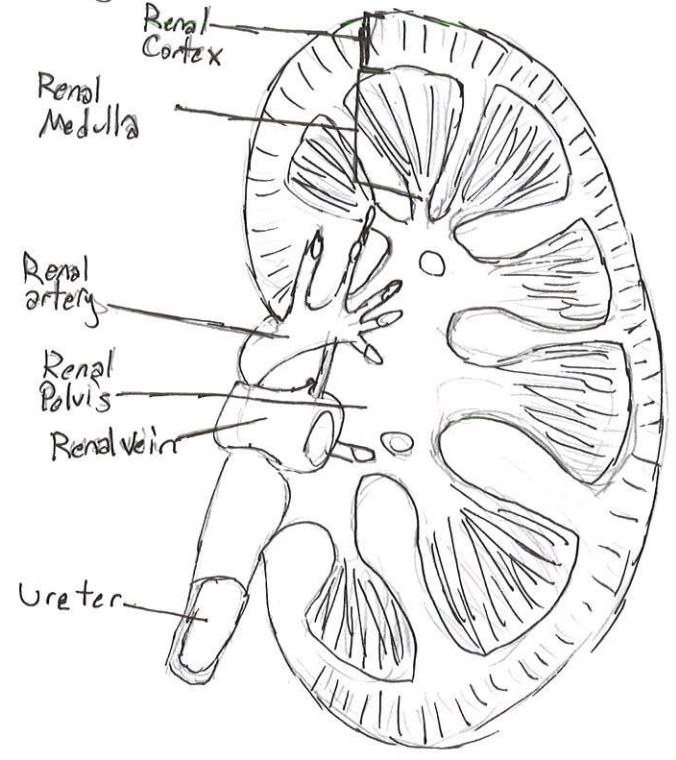
- Experienced in varying levels by about 100,000 mountain climbers a year
- High Altitude Pulmonary Edema
- Sudden Severe Headache, nausea, vomiting, rapid heart rate and breathing, bluish skin
- As people climb, oxygen diffuses more slowly from alveoli into bloodstream, so oxygen supply dwindles. Body tries to get more oxygen by increasing breathing and heart rate, but if it can't keep pace with decreasing oxygen supply, Altitude sickness results.
- Treated by giving oxygen and descending to lower altitude.

#### Obstructive Sleep Apnea-

- Caused by an airway blockage
- May stop breathing for ten to twenty seconds many times during the night.
- Causes Fatigue, Headache, Depression, Drowsiness
- Diagnosed in sleep lab
- Can be treated with device strapped to nose that maintains air flow into respiratory track

# EXCRETORY SYSTEM

The excretory system is responsible for the elimination of Nitrogen waste.



Kidney

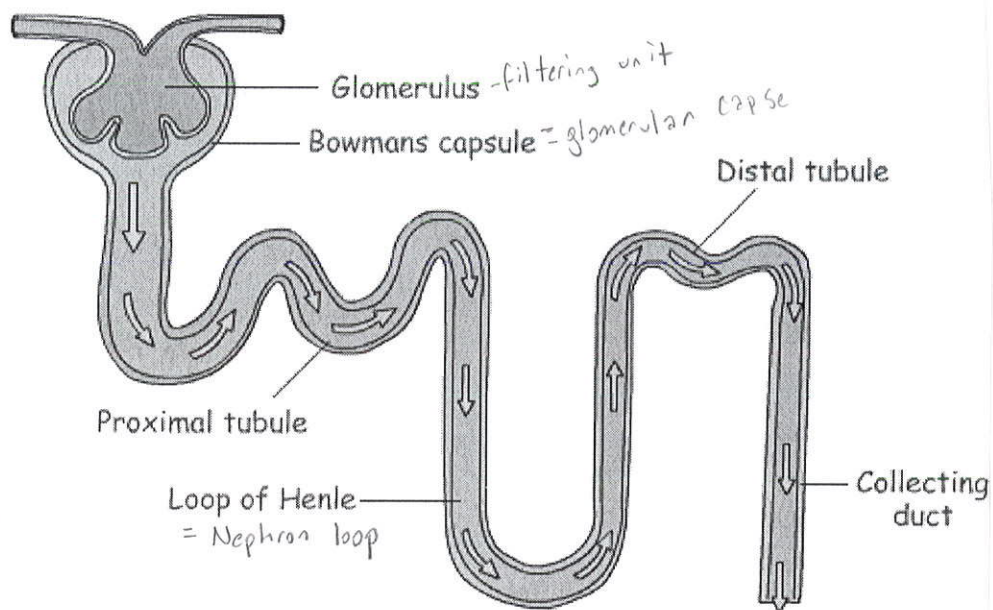
Nitrogen waste can be excreted in three forms:  
Ammonia, Urea and Uric Acid.

Ammonia excretion is more common in aquatic animals, including most bony fishes, like salmon.

Urea is excreted by mammals, most adult amphibians, sharks, some marine bony fishes and turtles. Urea is less toxic than Ammonia, so requires less water to dilute, however it must be synthesized from Ammonia. Humans excrete urea.

Uric acid is excreted by insects, land snails, birds and many reptiles. Uric acid is relatively ~~not~~ nontoxic and can be excreted as semisolid paste, however it requires more energy to synthesize. Sparrows excrete Urea.

# Excretory System



<http://www.hcc.bcu.ac.uk/physiology/nephron2.jpg>

The renal corpuscle contains a glomerulus and glomerular capsule.

A glomerulus is a filtering unit made of a tangle of capillaries.

The tubule that exits the glomerular capsule is the proximal convoluted tubule.

The functional unit of the kidney is the nephron.

The nephron consists of a renal corpuscle and a renal tubule.

Following the proximal convoluted tubule is the Nephron loop.

In a Nephron loop, one side descends toward the renal pelvis and the other turns back up to the glomerular capsule.

Several tubules merge in the renal cortex to form collecting ducts.

The first step in urine formation is filtration from the glomerular capillaries: glomerular filtration.

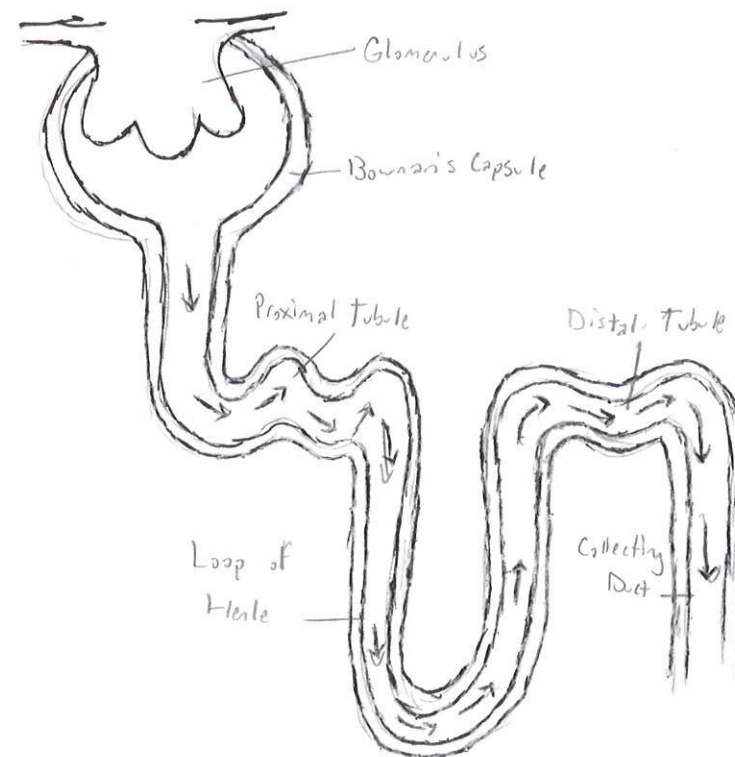
After filtration, most filtered fluids are returned to blood stream via tubular reabsorption.

Some substances are removed by tubular secretion.

Urinary Excretion = Filtration  
+ Secretion  
- Reabsorption

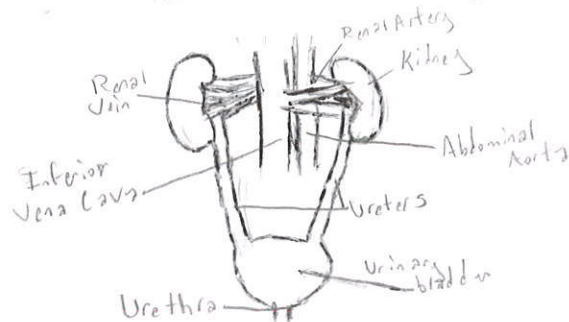
### Kidney Stones -

- Stones may be found anywhere in urinary tract
- Stones can be surgically removed
- Stones can be shattered externally using shock waves
- About 60% pass spontaneously
- If stone is in Ureter, produces severe pain
- Can also produce nausea and vomiting
- As of 1990, about 5% of US got Kidneys stones



### Interstitial Cystitis- Painful Bladder Syndrome

- Bladder pain, frequent and urgent urination
- Affects both women and men, but twice as many women
- Can be treated with diet and lifestyle changes, bladder retraining, exercise, physical therapy, reducing stress, oral medicines, bladder stretching, bladder medicines, nerve stimulation, surgery



# IMMUNE SYSTEM

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The Immune system's functions <sup>is to</sup> defend the organism against pathogens (things that cause disease, such as viruses or cancer cells)

The major organs involved in the immune system are the organs of the lymphatic system.  
The lymphatic system contains the lymph nodes, the thymus and the spleen.

us generates T lymphocytes.

The Lymph Nodes filter lymph and contain white blood cells (specifically macrophages).

The Spleen houses white blood cells (macrophages), and is responsible for removing stuff from the blood (like old red blood cells and cellular debris)

Antibodies are produced by the immune system in response to antigens.  
Antigens serve to differentiate the cells of the body from the cells of other things.  
The immune system uses antigens to recognize cells of the body, so it doesn't attack them.

Antibodies are produced by the immune system, and they disable specific antigens.

# IMMUNE SYSTEM

Alzheimer's disease- incurable brain disease that destroys memory and thinking skills

Estimated that 5.1 Americans have alzheimer's disease

Most common cause of dementia in older people

Characterized by plaques and tangles in the brain accompanied by the loss of connections between neurons of the brain

First symptoms tend to be memory loss, but decline in other aspects of thinking can also be present

Treated with drugs that regulate neurotransmitters, though the drugs cannot fix the underlying problem

Tay-Sachs disease- inherited disorder in which neurons of brain and spinal cord are destroyed

Most commonly becomes evident in infancy

Children lose motor skills and eventually have seizures, loss of sight and hearing, intellectual disability and paralysis

Tay-Sachs is very rare in the general population

Disease is autosomal recessive

<http://www.nia.nih.gov/alzheimers/publication/alzheimers-disease-fact-sheet>

<http://ghr.nlm.nih.gov/condition/tay-sachs-disease>

# IMMUNE SYSTEM

Innate immunity is present from birth and exists before exposure to pathogens

Innate defenses are very general (don't target specific pathogens)

The skin and mucous membranes are part of the innate defenses, as they serve the general purpose of helping to prevent pathogens from entering the body

Acquired immunity is present after encounters with pathogens (foreign substances, abnormal body cells and the like)

Very specific, can distinguish between pathogens and respond in specific ways

Lymphocytes response to pathogens is an acquired immunity

Humoral Immunity involves the production of antibodies

Antibodies are produced by the B lymphocytes in response to specific pathogens

Cell-Mediated immunity involves T-Cells, which destroy target cells

# IMMUNE SYSTEM

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There are two types of lymphocytes (lymphocytes are leukocytes, white blood cells) B lymphocytes and T lymphocytes. B lymphocytes (B cells) produce antibodies (proteins that attack foreign molecules) and T lymphocytes (T cells) attack cells directly

Lymphocytes all start out the same, what type they develop depends on where in the body they mature. Lymphocytes that leave the bone marrow and mature in the heart become T cells, while lymphocytes that remain in the bone marrow become B lymphocytes.

When an antigen activates a lymphocyte (T or B) the cell divides into effector cells and memory cells. The effector cell will combat the antigen (how it does so depends on what type the lymphocyte was) and the memory cell allows for the immune system to "remember" to pathogen

Antibiotics affect bacteria by stopping the enzyme-using processes specific to the bacteria, but viruses have few of their own enzymes so aren't affected by antibiotics



# IMMUNE SYSTEM

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Acquired Immunodeficiency Syndrome (Aids) is the most advanced stage of infection with the human immunodeficiency virus (HIV)

HIV destroys the body's T Cells, compromising the immune system, making infection more likely

HIV is spread through body fluids

Medications that treat HIV prevent the virus from replicating itself

Aids is marked by immunodeficiency, so people with aids then to get ill frequently and seriously

There is no cure for Aids

Goodpasture's Syndrome- Autoimmune disease (body attacks self, specifically cells of the lungs and kidneys)

Symptoms include fatigue, nausea, difficulty breathing, paleness, coughing up blood, painful urination

Treated with drugs that suppress the immune system

Disease may last only a few weeks or up to two years

Rare, may have a genetic component

[http://aidsinfo.nih.gov/contentfiles/HIVandItsTreatment\\_cbrochure\\_en.pdf](http://aidsinfo.nih.gov/contentfiles/HIVandItsTreatment_cbrochure_en.pdf)

<http://kidney.niddk.nih.gov/kudiseases/pubs/goodpasture/>

# ENDOCRINE SYSTEM

Endocrine System - all hormone-secreting cells

Hormones regulate long-term developmental processes

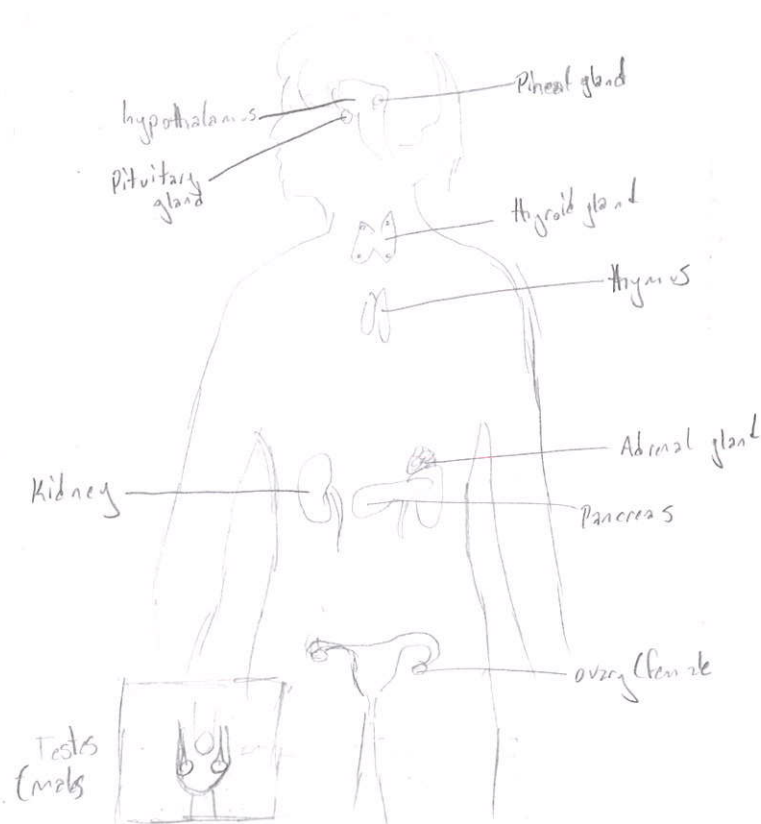
Homeostasis is the constant physiological condition of the body  
- basically having the right amount of the right stuff

One function of the endocrine system is maintaining homeostasis. The pancreas uses the hormones Insulin and Glucagon to ensure the right amount of glucose is in the blood.

hypothalamus - integrates endocrine and nervous system  
initiates endocrine signals appropriate to environmental conditions

pituitary gland - Produces oxytocin, Antidiuretic hormone, Growth hormone, Prolactin, Follicle-stimulating hormone, Luteinizing hormone, Thyroid-stimulating hormone, Adrenocorticotropic hormone

Oxytocin stimulates the contraction of the uterus



# ENDOCRINE SYSTEM

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Pineal Gland - Produces Melatonin, which is involved in biological rhythms

Thyroid Gland - Produces Triiodothyronine and Thyroxine and Calcitonin  
Calcitonin ~~raises~~ lowers Calcium levels

Adrenal Glands - Produce Epinephrine, norepinephrine, Glucocorticoids, Mineralocorticoids  
Glucocorticoids raise the level of glucose in the blood

Pancreas - Produces Insulin and Glucagon. Insulin lowers blood glucose level and  
Glucagon raises blood glucose level

Gonads: Testes - Produce Androgens, which support Sperm formation

Ovaries - Produce Estrogen and Progesterone, which promotes growth of the uterine lining

# ENDOCRINE SYSTEM

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Diabetes Mellitus - Diabetes type I - Insulin dependent

Usually appears before age twenty

Accounts for about 15% of diabetes

Autoimmune disorder; immune system attacks beta cells of the pancreas (the cells that produce insulin)

Treated with Insulin injections

Diabetes Mellitus - Diabetes type II - Noninsulin dependent

Usually in people over forty

Cells lose receptors and are less able to respond to insulin

Treatment includes careful control of diet, exercising, drugs + maintaining a desirable body weight

Both types are diagnosed by a glucose-tolerance test

# ENDOCRINE SYSTEM

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Hashimoto's Disease (chronic lymphocytic thyroiditis or autoimmune thyroiditis)

Chronic inflammation of the thyroid gland

\*Autoimmune -remember, cells of immune system attack cells of the body

Inflammation results in damage that reduces gland function, hypothyroidism

-Most common cause of Hypothyroidism in the US

Symptoms can include: fatigue, weight gain, cold intolerance, muscle and joint pain, constipation, thinning hair, depression and slowed heart rate (symptoms caused by the hypothyroidism)

Women are seven times more likely to get Hashimoto's Disease than men

When hypothyroidism is present, the disease is treated with synthetic thyroid hormones, which serve to restore endocrine function

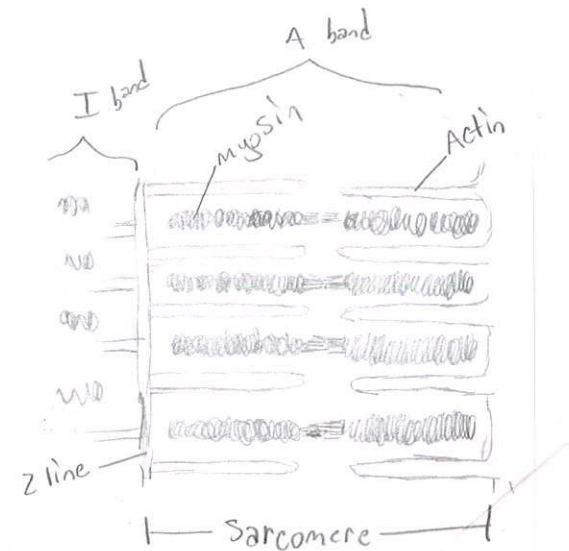
# Muscular System

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The muscular system functions to move the animal, or move parts inside the animal

Skeletal muscle, or striated muscle, is attached to bones and is specifically responsible for conscious movement. It's called striated muscle because the arrangement of the filaments that make it create a pattern of light and dark bands.

The two types of myofilaments that make up the muscle are thin and thick. Thin filaments are two strands of actin and one strand of regulatory protein, while thick filaments are made of myosin.



The sliding filament model can be used to explain muscle contraction. According to the model, filaments basically slide past each other, shrinking the muscle. Myosin forms a crossbridge with actin, bringing the thin filament closer to the center of the sarcomere. (Sarcomere's are the basic unit for muscle contraction)

A skeletal muscle will only contract when stimulated. When it's at rest, the binding sites on the thin filament are blocked by the protein tropomyosin. To uncover the binding sites, Calcium ions bind to regulatory proteins that control the position of tropomyosin. So when Calcium ions are present, the binding sites are open, when the ions are absent the binding sites are closed, preventing muscle contraction.

The presence of Calcium ions is triggered by the neurotransmitter acetylcholine. When at rest, the muscle cell stores calcium ions in it's sarcoplasmic reticulum, the ions are released when acetylcholine is present.

## MUSCULAR SYSTEM

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Muscles use ATP to contract; Hydrolysis of ATP triggers the binding of Myosin to Actin and the formation of the cross-bridge. ATP is also used in the active transport of Calcium ions into the sarcoplasmic reticulum.

There are three types of muscles, all of which use the same mechanism of contraction. The three types are Skeletal, Cardiac and smooth.

Cardiac muscle is only found in the heart. It is striated like skeletal muscle, but cardiac muscles intercalated disks that the entire heart contract. Cardiac muscle is an involuntary muscle. Cardiac muscle is self-exciting and rhythmic.

Smooth muscle lacks striations, it is mostly found in the walls of hollow organs. It is an involuntary muscle. Smooth muscle is slower to contract and relax than skeletal muscle, but it can contract longer with the same amount of ATP.

### Mysasthenia Gravis-

- Autoimmune disorder which destroys the receptors for acetylcholine at the neuromuscular junction.
- Weak and easily fatigues muscles, flat smile, nasal voice, difficulty chewing and swallowing, limb weakness, can affect respiratory muscles.
- Treated with the removal of the thymus gland, drugs that inhibit acetylcholinesterase, immunosuppressant drugs, plasma exchange
- Doesn't affect sensation or reflexes

# MUSCULAR SYSTEM

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## Myotonic Dystrophy-

- inherited type of muscular dystrophy
- progressive muscle wasting and weakness in lower legs, hands, neck and face
- Slow to relax certain muscles after use
- Symptoms usually develop in twenties or thirties
- Disability doesn't usually occur until fifteen or twenty years after onset of symptoms
- Two types, caused by different gene mutations
- Type one can sometimes be seen at birth (congenital myotonic dystrophy)
- Symptoms of type two are usually milder
- Most common form of muscular dystrophy that begins in adulthood -affects 1 in 8,000 worldwide
- Currently no cure or specific treatment
- Ankle supports and leg braces can help with muscle weakness,
- Autosomal dominant inheritance



# SKELETAL SYSTEM

## SKELETAL SYSTEM

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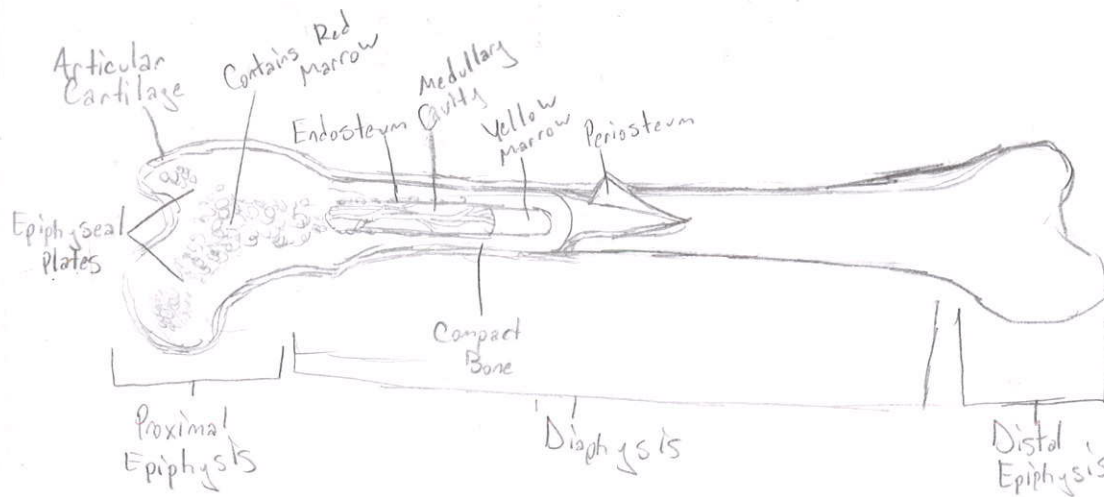
The skeleton functions in support, protection and movement. There are three types: hydrostatic skeleton, exoskeleton and endoskeleton.

**Hydrostatic skeleton** -Made of fluid under pressure in a closed body compartment. Changing the shape of the fluid-filled compartment allows animals with a hydrostatic skeleton to control form and movement. Roundworms have a hydrostatic skeleton.

**Exoskeleton** -Hard encasement on surface of animal. The animal must have adaptations in order to cope with growth; Arthropods shed their shells and grow new ones while clams enlarge their shell by adding to the edges.

**Endoskeleton** -Hard elements within soft tissues. Humans have an endoskeleton made from bone.

Muscles are joined to bone by tendons and bones are connected together by ligaments at joints. Muscles contract to move bones, bones move past each other at joints (shoulders, knees, elbows), allowing the organism to move.



Femur

## SKELETAL SYSTEM

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**Osteonecrosis-** Disease caused by lack of blood supply to bone (permanent or temporary)

- Tissue dies without blood supply and bone may collapse
- Usually occurs on the ends of the femur
- Can affect multiple bones
- Characterized by gradually developing pain, first on pressure then even at rest
- Treated with electrical stimulation, range-of-motion exercises, anti-inflammatory drugs
- Surgical treatments include bone grafts, joint replacement, osteotomy, core depression
- 10,000-20,000 people develop Osteonecrosis each year

**Osteoarthritis-** Most common form of Arthritis

- Characterized by joint pain and stiffness
- Cartilage of joint is worn away
- Most often affects joints of hands, knees, hips and spine
- Treated with exercise, weight control, relief from joint stress, pain medications and surgery
- Estimated 27 million Americans older than 25 have osteoarthritis

[http://www.niams.nih.gov/Health\\_Info/Osteonecrosis/default.asp#d](http://www.niams.nih.gov/Health_Info/Osteonecrosis/default.asp#d)

[http://www.niams.nih.gov/Health\\_Info/Osteoarthritis/default.asp#2](http://www.niams.nih.gov/Health_Info/Osteoarthritis/default.asp#2)

# SENSES

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Sensory receptors function in sensory transduction, amplification, transmission and integration.

Sensory transduction is the conversion of a stimulus' energy into a change in membrane potential

Amplification is when the energy of the stimulus increases along the sensory pathways

Mechanoreceptors- sense change caused by mechanical energy, stimuli like pressure, touch, stretch, sound.. mechanoreceptors are responsible for the sense of touch, so are found in the skin, though location varies depending on what type of energy they sense

Chemoreceptors- sense solute concentration of a solution and specific receptors that respond to specific types of molecules. Chemoreceptors are used to detect changes in blood composition

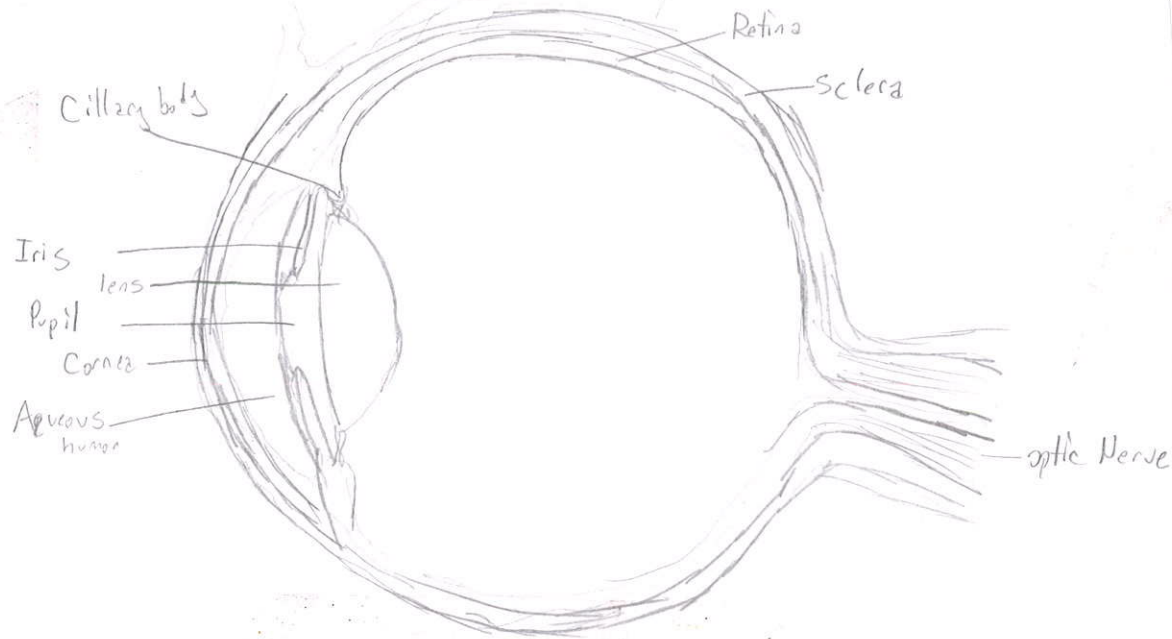
Electromagnetic Receptors- detect forms of electromagnetic energy (visible light, electricity, magnetism)

Photoreceptors- sense visible light, tend to be located in the eyes

Thermoreceptors- respond to temperature, hot or cold, located in the skin

Pain receptors (nociceptors)- are dendrites in the epidermis (nerve endings in the surface of the skin)

In the retina, there are rods and cones. Rods have a visual pigment called rhodopsin. Rhodopsin changes shape when it absorbs light (bleaching). In very bright light, the rhodopsin is bleached and rods are unresponsive. Moving from a light to dark environment causes sudden temporary blindness because the rods remain unresponsive from the light and the cones don't have enough light to work.



Human Eye

The Reproductive System functions to produce offspring and continue the species.

Reproduction can be either Sexual or Asexual

**Sexual**

Creation of Offspring from fusion of haploid gametes.

Gametes are made by meiosis

Female gamete = egg

Male Gamete = sperm

egg + sperm = Zygote

Increases Genetic Diversity

**Asexual**

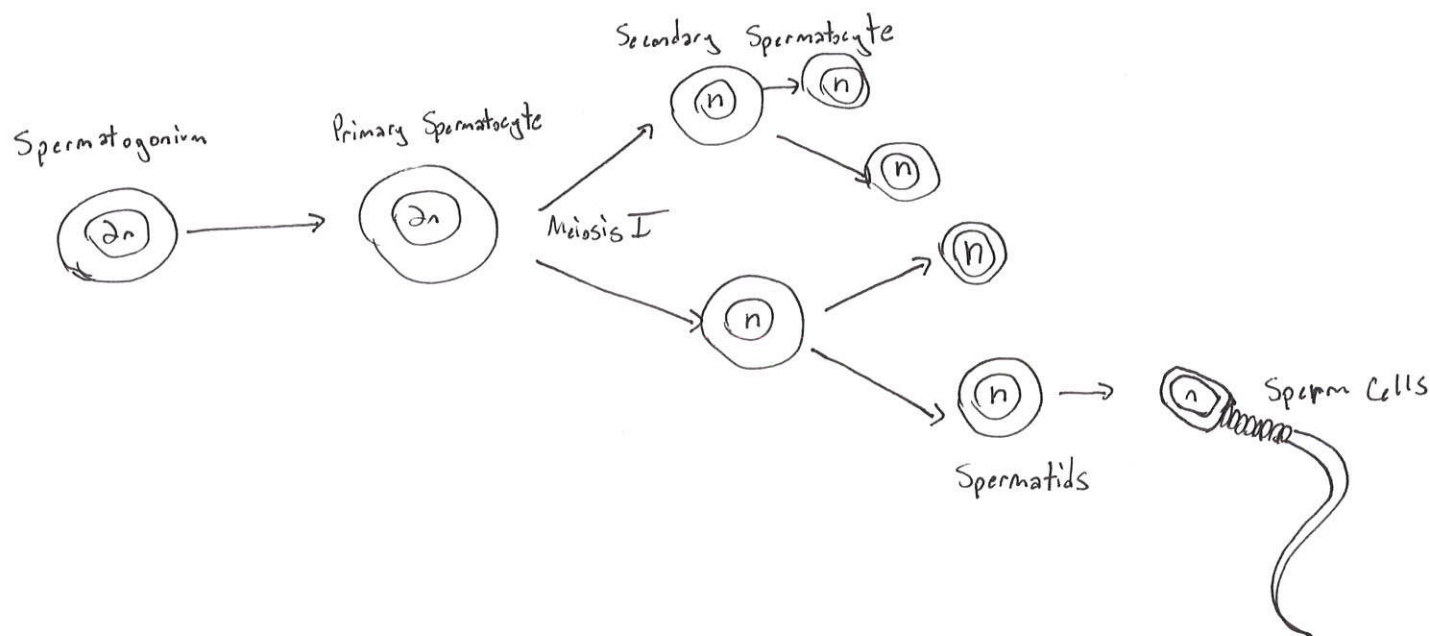
Offspring receive genetics from a single parent

Usually only mitotic division

Fission - parent separates into multiple individuals

Budding- New individuals grow from existing ones

Fragmentation- separated parts form new individuals

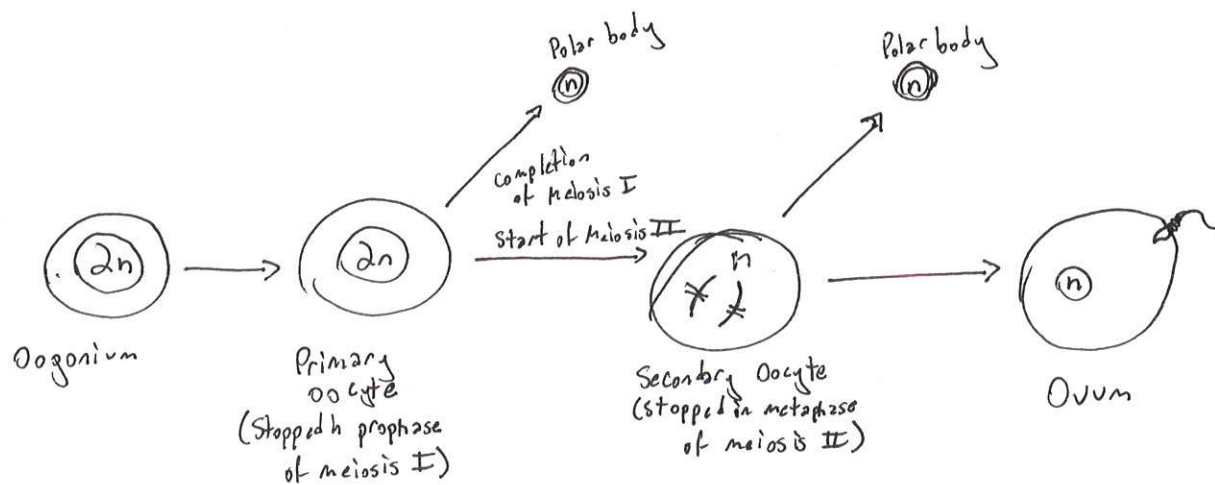


Spermatogenesis

In spermatogenesis (the production of sperm) spermatogonia divide to increase their numbers and eventually form primary spermatocytes. Spermatocytes divide by meiosis to form secondary spermatocytes with the first division and to form spermatids with the second. Spermatids then mature into sperm cells.

In oogenesis (the production of eggs) Oogonium divide by mitosis to increase their numbers. Once the numbers have increased sufficiently, meiosis begins in the primary oocyte. However, meiosis stops at prophase I and remains stopped until puberty, when hormones eventually trigger the oocyte to continue division. Meiosis stops again at metaphase II. The secondary oocyte is then released. (generally one per month). Meiosis does not start again until the secondary oocyte is combined with a sperm. Then oogenesis is completed, forming an ovum.

The meiotic divisions in oogenesis divide cytoplasm unevenly, with the smaller cells being polar bodies. Uneven distribution of cytoplasm insures that if the secondary oocyte becomes an ovum, it will have more nutrients.



Oogenesis

Female mammals have one of two types of cycles: menstrual or estrous

Humans and some other primates have menstrual cycles, while other mammals have estrous cycles. In an estrous cycle, if pregnancy does not occur, the uterine lining is reabsorbed by the uterus, while in a menstrual cycle the lining is shed in bleeding (menstruation). Estrous cycles also have larger behavioral changes; Most mammals will copulate only near ovulation.

The Human reproductive cycle involves both the uterine cycle and the ovarian cycle.

The ovarian cycle begins with the pituitary gland secreting hormones that stimulate follicle growth. The follicles make estrogen. As the follicle grows, it increases its estrogen output. This causes the pituitary gland to increase more hormones to stimulate follicle growth (an example of positive feedback) and causing the follicle to mature.

After the follicle matures (the end of the follicular phase) the follicle and wall of the ovary next to it rupture, releasing the secondary oocyte (this is ovulation). After ovulation comes the luteal phase, when the hormones from the pituitary gland stimulate the remains of the follicle to turn into a corpus luteum, which produces progesterone and estrogen. The progesterone and estrogen inhibit the pituitary hormones (negative feedback). At the end of the luteal phase, the corpus luteum disappears and the production of progesterone and estrogen stops, allowing the pituitary gland to start producing hormones to stimulate follicle growth.

### Uterine Cycle-

Estrogen secreted by the growing follicles causes the endometrium to thicken (proliferative phase). Before ovulation the uterus is prepared for an embryo. After ovulation, estrogen and progesterone stimulate the endometrium to be maintained and developed, including the growth of endometrial glands. Endometrial glands make a fluid that could sustain an embryo before it attaches to the lining of the uterus. (Secretory phase of uterine cycle). When the corpus luteum disintegrates, hormone levels drop, causing spasms of the arteries in the uterine lining. The upper two thirds of the endometrium disintegrates which causes menstruation (menstrual flow phase).

If the oocyte is fertilized by a sperm, conception (happens in the oviduct), the resulting zygote will begin dividing, which is called cleavage. The first five to seven divisions form the morula, a cluster of cells. Within the cluster a fluid-filled cavity develops, called the blastocoel. By the time the morula becomes a blastula (hollow sphere of cells) the blastocoel is fully developed.

The blastula is rearranged during gastrulation to form a three layered embryo. The embryo is called the gastrula. The layers are germ layers: ectoderm, endoderm and mesoderm.

During organogenesis, regions of the germ layers form the beginnings of organs. The mesoderm forms the notochord, skeletal system, circulatory and lymphatic systems. The ectoderm forms the epidermis (outer layer of skin), the nervous system and the lens of the eye. The endoderm forms the lining of the digestive tract as well as the liver and the pancreas.



### Testicular Cancer-

Symptoms include pain, swelling or lumps in groin area

Treatment includes surgery, radiation and/or chemotherapy

Incidence is about 5.4 per 100,000 men each year

### Ectopic Pregnancy-

fertilized egg grows somewhere other than the uterus, usually the fallopian tube

Usually results in miscarriage

Can be a medical emergency if tube ruptures

Symptoms can include abdominal pain, shoulder pain, vaginal bleeding, faintness or dizziness

Treated by removal of ectopic tissue

Approximately 100,000 ectopic pregnancies occur each year

<http://www.nlm.nih.gov/medlineplus/testicularcancer.html>

<http://seer.cancer.gov/statfacts/html/testis.html>

<http://www.nlm.nih.gov/medlineplus/ectopicpregnancy.html>

[http://www.cdc.gov/reproductivehealth/UnintendedPregnancy/EctopicPreg\\_factsheet.htm](http://www.cdc.gov/reproductivehealth/UnintendedPregnancy/EctopicPreg_factsheet.htm)

# NERVOUS SYSTEM

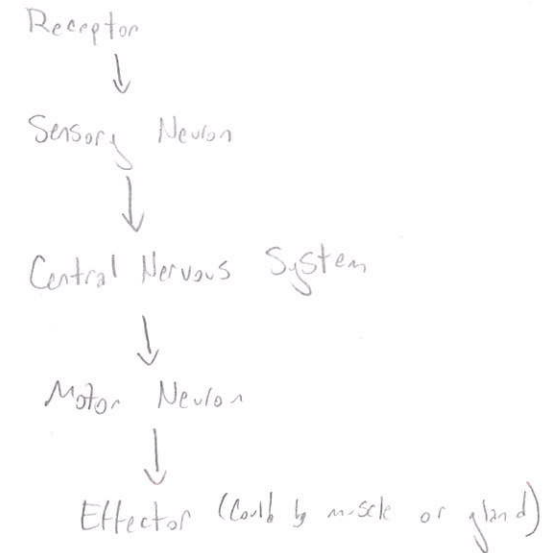
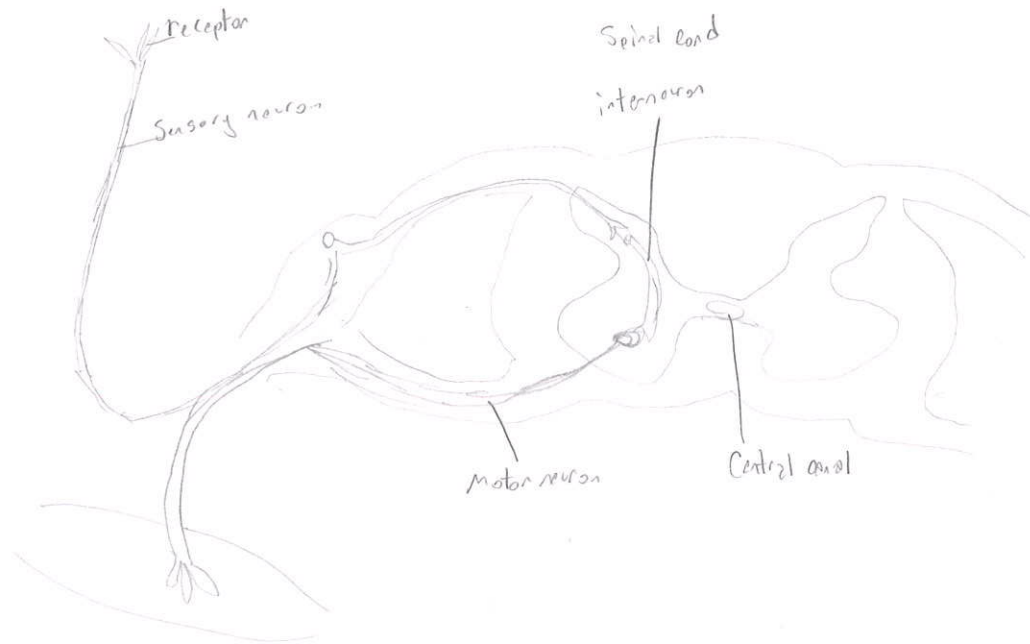
The Nervous System functions to control movement and process sensory information

The Nervous System can be divided into two sections: Central and Peripheral

Central Nervous System includes the brain and Spinal Chord

Peripheral Nervous System includes everything that branches off from the brain and spinal chord, that is cranial nerves and spinal nervous

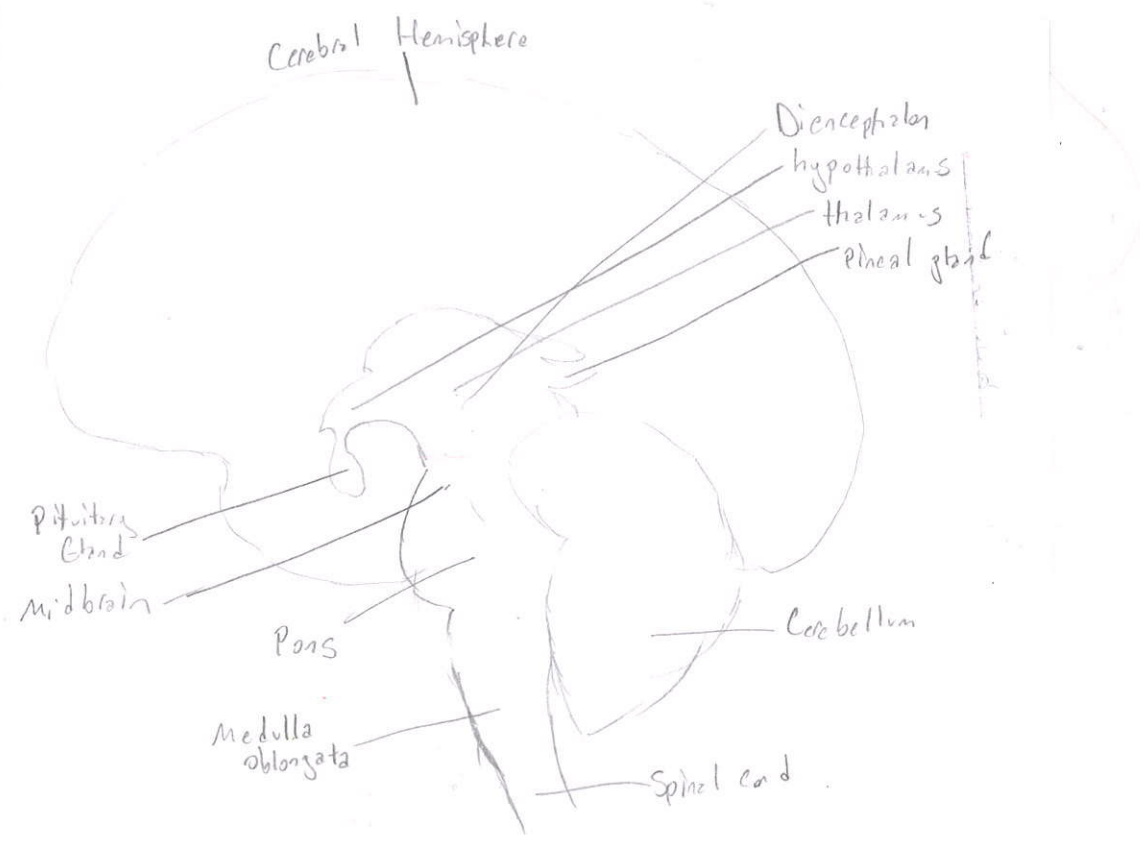
Reflex Arc



# NERVOUS SYSTEM

The major parts of the brainstem include the medulla oblongata, the pons, and the midbrain  
The Medulla oblongata is the center for several automatic functions such as breathing and heart beat  
The Pons regulates the breathing centers in the medulla oblongata  
The midbrain integrates sensory information, sending it to specific regions in the rest of the brain

The Diencephalon includes the epithalamus, the thalamus and the hypothalamus.  
The epithalamus is made up of the pineal gland and the choroid plexus which produces cerebrospinal fluid  
The thalamus is basically a relay station. It sends sensory information into the cerebrum and passes on motor information that leaves the cerebrum  
The hypothalamus regulates the pituitary gland, it regulates hunger and thirst



# NERVOUS SYSTEM

The Cerebellum is responsible for coordination, it integrates sensory and motor information to control movement and balance

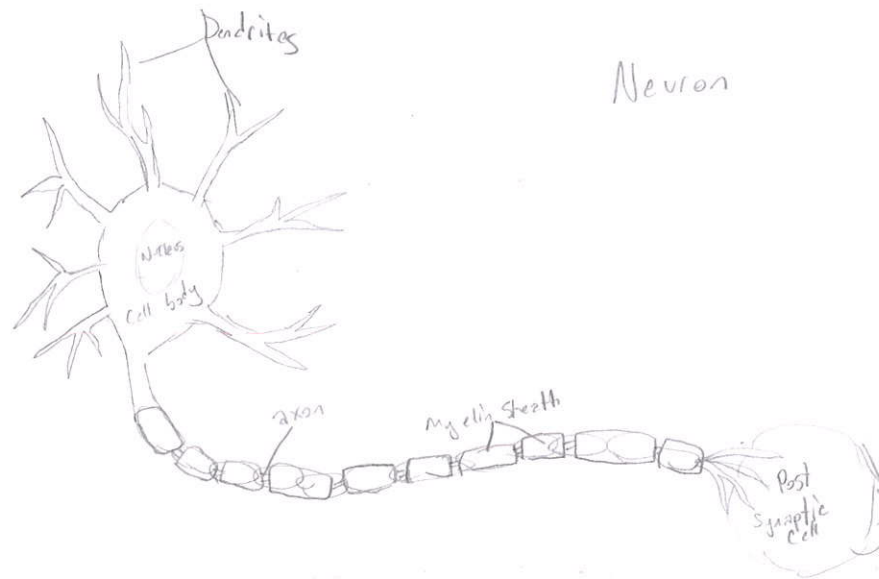
The Cerebrum is divided into left and right hemispheres. In humans the most complex part of the brain is the cerebral cortex. The cortex is responsible for what is considered higher thinking.

Neurons are the cells that transport the signals of the nervous system.

Neurons have membrane potential, specifically a negative charge inside the cell relative to the outside.

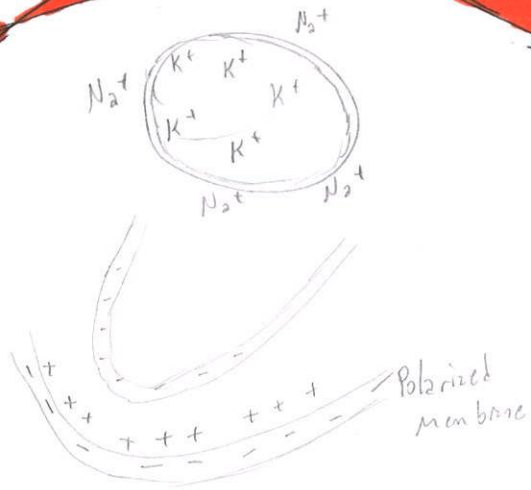
When a stimulus is strong enough to depolarize the membrane, an action potential results and the membrane potential resets.

An action potential is regenerated along the axon. It's conducted by a series of depolarization towards the synaptic terminals.



# NERVOUS

# SYSTEM



Resting potential, cell membrane isn't very permeable to sodium and potassium

membrane potential = resting potential

Membrane potential then resets.

This takes time.

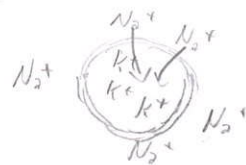
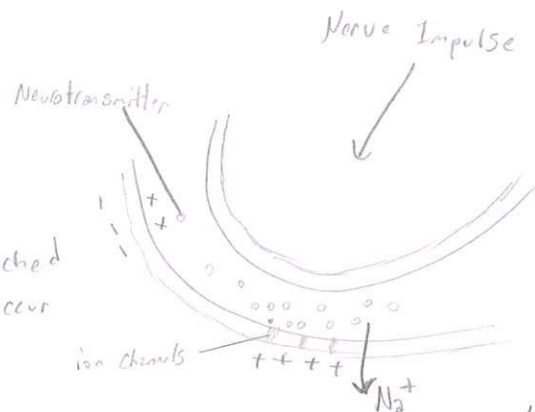
The refractory period is the period during which membrane potential resets

Impulses are conducted down the axon

Myelin acts as insulation, effectively allowing the action potential to "skip" depolarizing sections of the membrane, allowing for faster transmission

At the end of the axon, neurotransmitters are released at the synapse (Gap between cells). If there are sufficient neurotransmitters, an action potential starts on the next neuron.

Threshold potential must be reached for action potential to occur  
Requires sufficient depolarization



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