BARLOW

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Human Organ Systems

The body is made of trillions of cells. Cells that perform a single function are organized into tissues. Tissues are organized into organs. Organs that perform closely related functions are grouped into **organ systems**. An organ system is the most complex level of organization. The lesser complex levels are organs, tissues and cells (listed in decreasing complexity).

There are 12 major organ systems found in the human body. In this text, you will study nine of them:

1. Skeletal System
2. Muscular System
3. Circulatory System
4. Respiratory System
5. Nervous System
6. Digestive System
7. Urinary System
8. Endocrine System
9. Female and Male Reproductive System

Other Organ Systems

There are three other important organ systems of the human body:

1. The **integumentary system** consists of the skin, hair, nails, sweat and oil glands. This system regulates body temperature and protects the body from infection, injury, and UV light.
2. The **immune system** is composed of numerous types of white blood cells. These cells work together to protect us from disease and fight infections.
3. The **lymphatic system** is composed of lymph vessels and lymph nodes. This system drains fluid from tissues and filters pathogens and debris from the fluid.

Name: _____

Human Body Tissue

The human body is made up of *trillions* of cells. These cells interact with each other and work together. The cells organize themselves into tissues. **Tissues** are groups of cells that work together to perform a single function.

There are four major types of tissues you will study:

1. **Epithelial Tissue.** Epithelial tissue helps protect the body, regulate the exchange of substances in and out of structures in the body, produces hormones and is important to our senses.
2. **Connective Tissue.** Connective tissue supports, connects or separates different types of tissue in the human body.
3. **Muscular Tissue.** Muscle tissue is found everywhere in the body and is important to movement. Muscle tissue helps move substances throughout the body, helps move external parts of the body and can produce heat to keep the body warm.
4. **Nervous Tissue.** Nervous tissue is specialized to react to stimuli. It reacts to stimuli by conducting impulses to various organs in the body. This allows the body to respond to stimuli. The cells of nervous tissue are easy to stimulate and transmit information very fast.

Why study tissues?

Organs are made of groups of tissues that work together. Organs work together to carry out essential life functions. We better understand how organs function if we study the structure and function of tissues that organs are made of. We also study tissues to learn about how so many human body cells work together to perform all the functions we need to live.

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Epithelial Tissue

Epithelial tissue (aka epithelium) covers the surface of the body. It lines internal organs and forms many glands. There are four functions of epithelial tissue:

1. Epithelium protects the body from toxins, pathogens and trauma. For example, the skin provides a barrier between the external environment and the internal body. Skin is the first line of defense against foreign substances.
2. Epithelium helps regulate the exchange of substances in the body. For example, epithelium lines the intestines to help with absorption of nutrients. Epithelium that makes up capillaries helps with movement of nutrients and waste into and out of the blood.
3. Epithelium makes up glands. The epithelium of glands produces hormones, sweat, enzymes or mucus.
4. Specialized epithelium that contains nerve endings helps our senses. This type of epithelium is found in sensory sites such as the nose, ears, skin, and eyes.

There are three basic shapes of epithelial cells:

1. **Cuboidal** epithelium is composed of cube shaped cells – the height and width of the cells are about the same.
2. **Columnar** epithelium is composed of column shaped cells – the height is greater than the width.
3. **Squamous** epithelium is composed of "squashed" shaped cells – the width is greater than their height.

Epithelial tissue that is one-cell thick is called **simple epithelium**. Epithelial tissue that is two or more cells thick is called **stratified epithelium**. For example, a single layer of cube shaped epithelial cells is called simple cuboidal. A double layer of squashed shaped cells is called stratified squamous. All epithelial cells rest on "scaffolding" called **basement membrane**. The basement membrane provides a platform for epithelial cells to grow and regenerate after an injury.

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Connective Tissue

Connective tissue supports, connects or separates different types of tissue in the human body. It is important to storage of energy in the human body and helps protects internal organs too. Connective tissue provides the structural framework of the human body and connects different body tissues together.

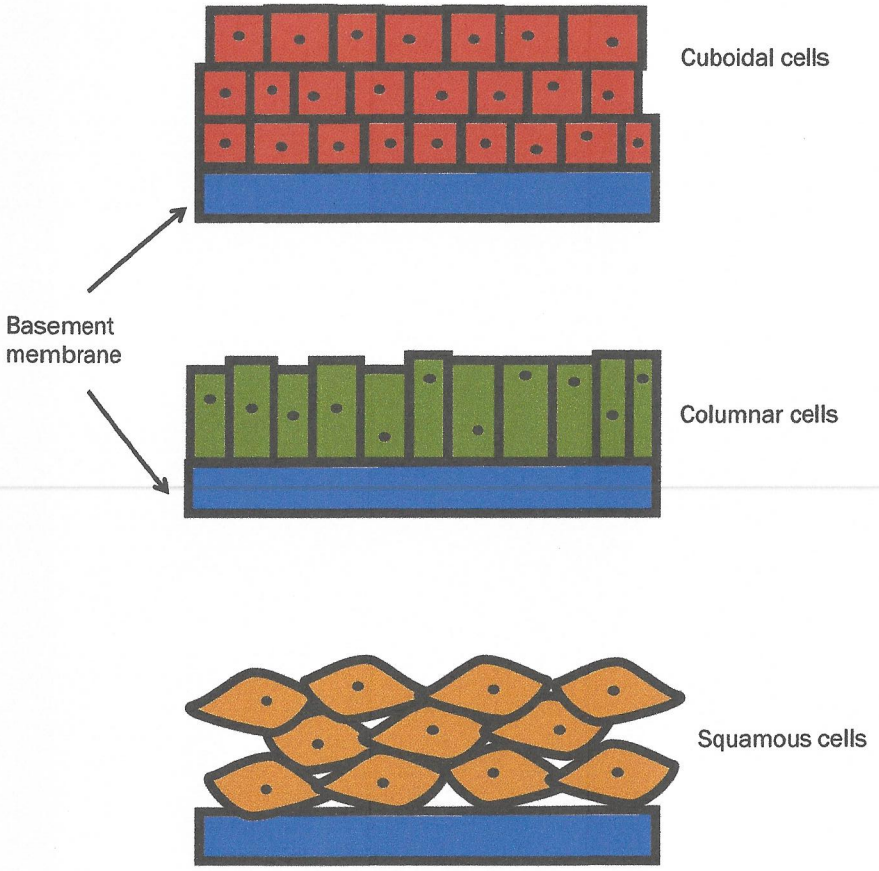
There are three major types of connective tissue:

1. **Bone** is hard and rigid connective tissue. Bone is composed of living cells and protein fibers that are surrounded by calcium deposits. Bone is not solid. There are blood vessels and nerves that run through canals in bone. Within bones are cavities that contain soft tissue called bone marrow. There are two types of bone marrow: red and yellow. Red bone marrow produces red blood cells, some white blood cells and platelets. Yellow bone marrow stores fat.
2. **Adipose (or fat) tissue** is loose connective tissue. It is found beneath the skin, around organs and in yellow bone marrow. Its main function is to be storage for fat, which is burned to make energy for the body. Fat provides a protective padding around organs. It also is an insulator from heat and cold.
3. **Blood cells** are another type of connective tissue. Red blood cells (RBC) are shaped like disks that are thinner in the middle. They contain hemoglobin and transport oxygen around the body. White blood cells (WBC) are larger than RBCs. They attack foreign substances or invaders and help to fight disease. Platelets are another type of blood cell. Platelets stop bleeding. They are cell fragments that release chemicals to clot blood.

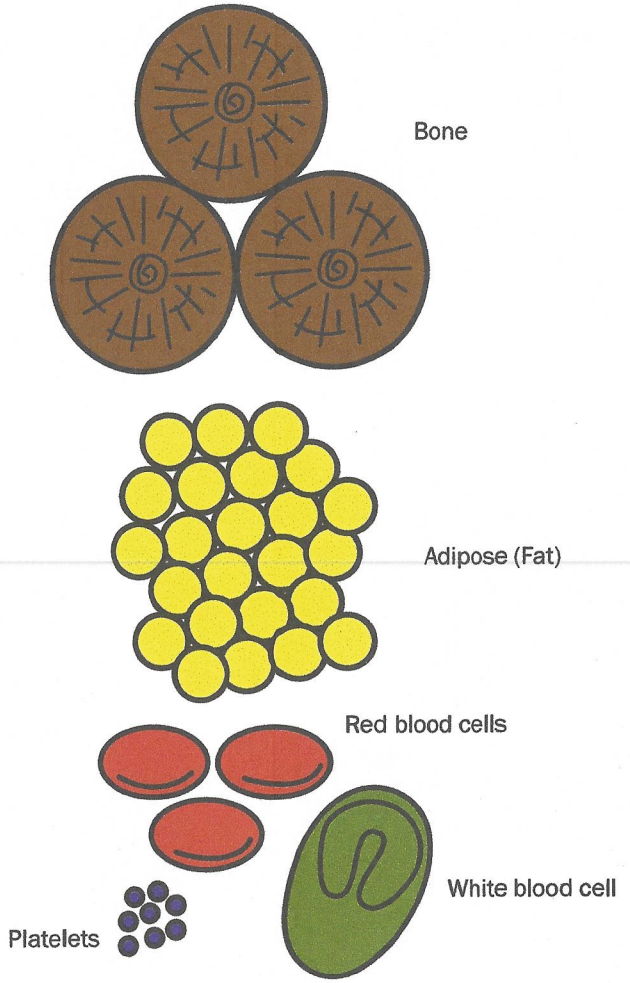
Cartilage, Tendons and Ligaments

Cartilage, tendons and ligaments are other types of connective tissue. Cartilage is not as rigid as bone. It is flexible and and is found at joints, the ears and nose. It provides cushion between bones at joints and adds structure to the ears and nose. Tendons and ligaments are strong and fibrous tissue. Tendons connect muscle to bone. Ligaments connect bones to each other.

Epithelial Tissue



Connective Tissue



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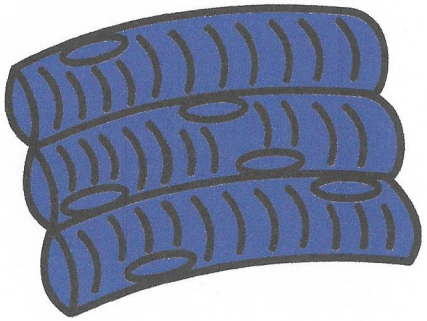
Muscle Tissue

Most students think muscle tissue is found only below the skin and in the heart. Muscle tissue is found everywhere in the body and is important to movement. Muscle tissue can contract and relax. In other words, muscle tissue can tighten and "loosen." This helps move substances throughout the body. Muscle tissue can also contract to hold or pick up objects, move the body in the environment and even produce heat to keep the body warm.

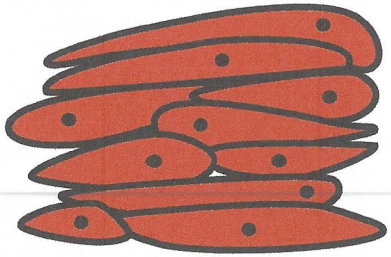
There are three major types of muscle:

1. **Skeletal muscle** is found attached to bones. Skeletal muscle is responsible for voluntary movements such as walking, typing and blinking. Skeletal muscle is made of large, multinucleated (have more than one nucleus) cells. Skeletal muscle has dark bands or stripes called striations.
2. **Cardiac muscle** is only found in the heart. Cardiac muscle cells are striated. They usually have one nucleus but sometimes have two or three. Cardiac muscle is not under voluntary control. You cannot consciously control cardiac muscle. Cardiac muscle cells are connected to each other through special junctions called gap junctions. Gap junctions allow cardiac muscles cells to contract together simultaneously.
3. **Smooth muscle** is found in hollow structures such as the stomach, blood vessels, small and large intestines, bronchi, uterus and bladder. Smooth muscle helps move substances throughout the body. For example, smooth muscle moves food through the digestive tract and controls the way blood flows through the circulatory system. Smooth muscle dilates and contracts the pupil of the eye too. Like cardiac muscle, smooth muscle is not under voluntary control. Smooth muscle cells look very different from skeletal and cardiac muscle. Smooth muscle cells have one nucleus and are not striated. These muscle cells look "squashed."

Muscle Tissue

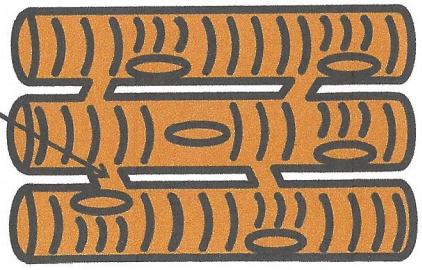


Skeletal muscle



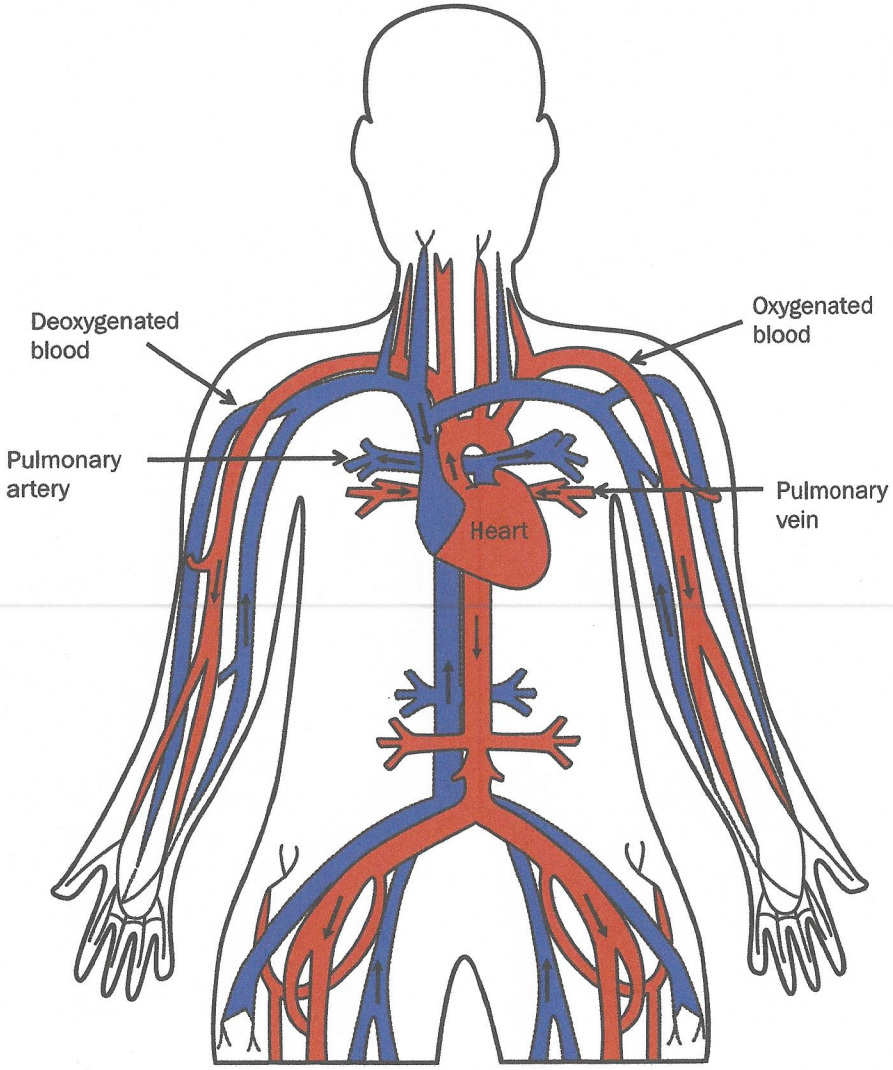
Smooth muscle

Gap junctions



Cardiac muscle

Circulatory System



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Circulatory System

The **circulatory system**'s main functions are to bring oxygen, nutrients and hormones to cells, remove cell waste and help regulate body temperature. The flow of blood from the heart to the lungs is referred to as pulmonary circulation. The flow of blood from the heart to the body is referred to as system circulation. The main structures of the circulatory system are blood vessels, the heart and blood.

Blood Vessels

There are three major types of blood vessels: arteries, veins and capillaries.

1. **Arteries** are large vessels that carry blood away from the heart and to tissues of the body. All arteries carry oxygenated blood except for the pulmonary arteries. The walls of these vessels are thick and muscular in order to withstand the powerful pressure produced by the heart when it contract and pumps blood into arteries.
2. The **capillaries** are the smallest blood vessels. They are so narrow that cells must pass through single-file. The walls of capillaries are only one-cell thick so nutrients and oxygen can diffuse into tissues and waste and carbon dioxide can diffuse into the blood.
3. Once blood has passed through the capillaries, it is returned to the heart by **veins**. Veins are large vessels but not as thick-walled as arteries. They contain valves to keep blood flowing in the right direction. All veins except for the pulmonary veins carry deoxygenated blood.

Heart

The heart pumps blood to the lungs and other parts of the body. It is made of cardiac muscle. Cardiac muscle is a special type of muscle that does not fatigue easily. This allows the heart to continuously contract. When the heart contracts, blood is forced out of the heart. When it relaxes, the heart fill with blood. *You'll will learn more about the heart in a different activity.*

Blood

The blood is composed of plasma and blood cells. The **plasma** comprises about 55% of the total blood volume. It is about 90% water and 10% dissolved nutrients, gases (carbon dioxide), salts, enzymes, hormones, waste products and proteins.

The remaining portion of blood is mostly made of blood cells. There are three major types of blood cells:

1. **Red blood cells** are the most numerous cells in the blood. They are also called erythrocytes. They are shaped liked disks and are red in color. These cells contain hemoglobin, a protein that binds and carries oxygen to tissues throughout the body.
2. **White blood cells**, also called leukocytes, are less common than red blood cells. These cells are responsible for fighting pathogens and guarding against infections. There are many types of white blood cells. White blood cells called macrophages protect the body by engulfing and digesting bacteria and other disease-causing microorganisms. White blood cells called mast cells release chemicals known as histamine that increase blood flow to an affected area. Other white blood cells known as lymphocytes are involved in the immune response and produce antibodies that fight disease and help produce immunity.
3. **Platelets**, also called thrombocytes, are cell fragments that are important to blood clotting. When platelets come in contact with a broken blood vessel, they release clotting proteins that cause a series of chemical reactions. This leads to the formation of a clot. The clot stops bleeding and prevents further blood loss.

Name: _____

The Heart

The heart pumps blood to the lungs and other parts of the body. It is made of cardiac muscle. Cardiac muscle is a special type of muscle that does not fatigue easily. This allows the heart to continuously contract. When the heart contracts, blood is forced out of the heart. When it relaxes, the heart fill with blood.

There are four chambers inside the heart: right atrium, left atrium, right ventricle and left ventricle. The left and right sides are separated by a thick wall of muscle called the **septum**. Blood enters the heart through the left and right atrium. Blood leaves the heart through the left and right ventricles. The left ventricle is larger than the right ventricle because blood is pumped to the whole body from the left ventricle whereas the right ventricle only pumps blood to the lungs.

Valves, which are composed of connective tissue, control the flow of blood through the heart. Valves allow blood to flow in only one direction and prevent backwards flow of blood through the heart.

Blood Flow

Deoxygenated blood enters the heart through the superior and inferior vena cava. The **superior vena cava** carries oxygen-poor blood from the head and upper limbs. The **inferior vena cava** carries oxygen-poor blood from the abdomen and lower limbs. The deoxygenated blood enters the **right atrium** of the heart.

Then the blood passes through the **tricuspid valve** to the **right ventricle**. When the right ventricle contracts, blood is forced through the **pulmonary valve** into the **pulmonary artery**. The pulmonary artery carries blood to the lungs.

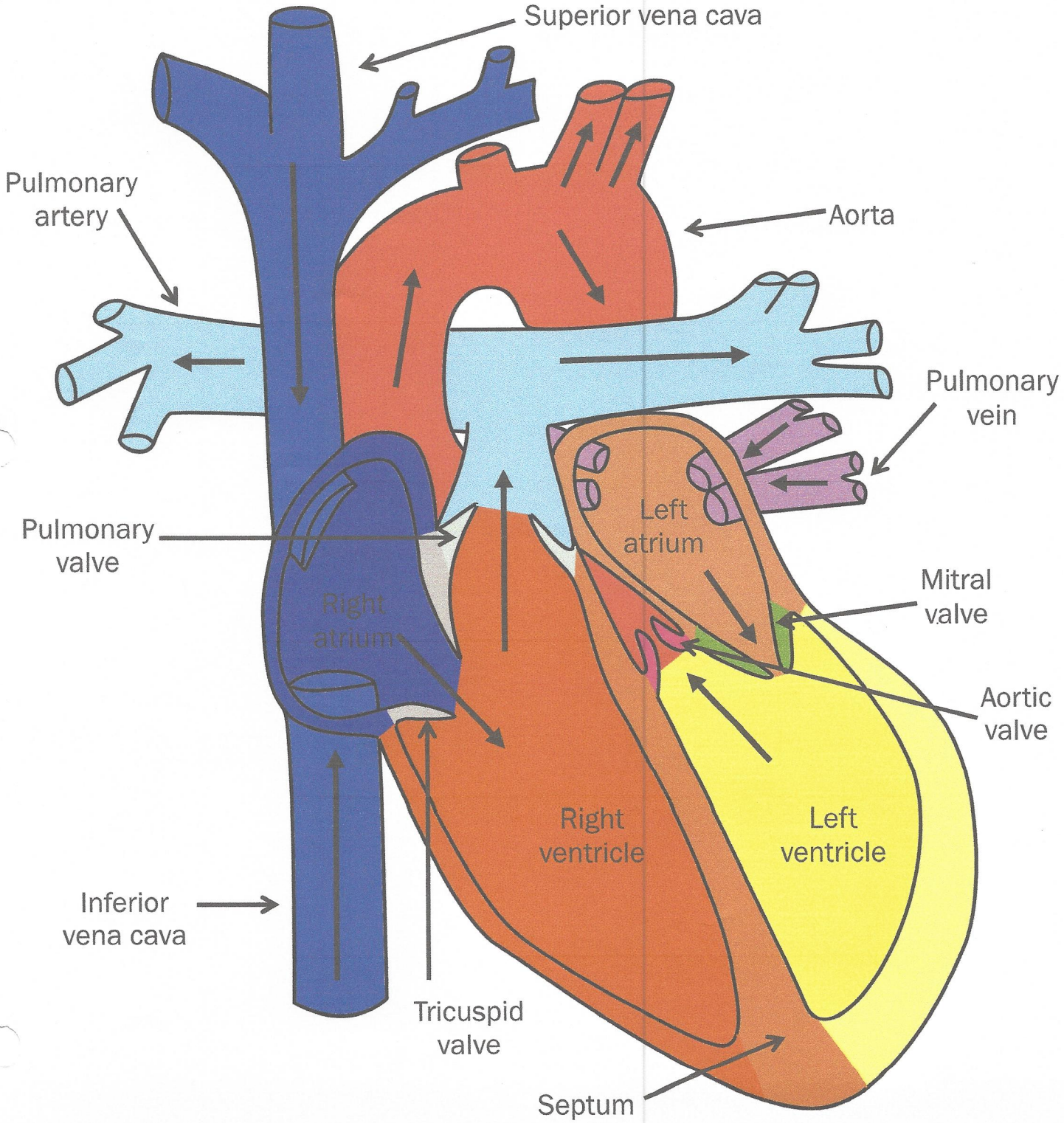
At the lungs, oxygen diffuses into the blood and carbon dioxide diffuses out of the blood. This turns the oxygen-poor blood into oxygen-rich blood.

The **pulmonary vein** carries oxygen-rich blood back to the heart. The oxygenated blood enters the **left atrium** of the heart. Blood passes through the **mitral value** (also called the bicuspid valve) into the **left ventricle**.

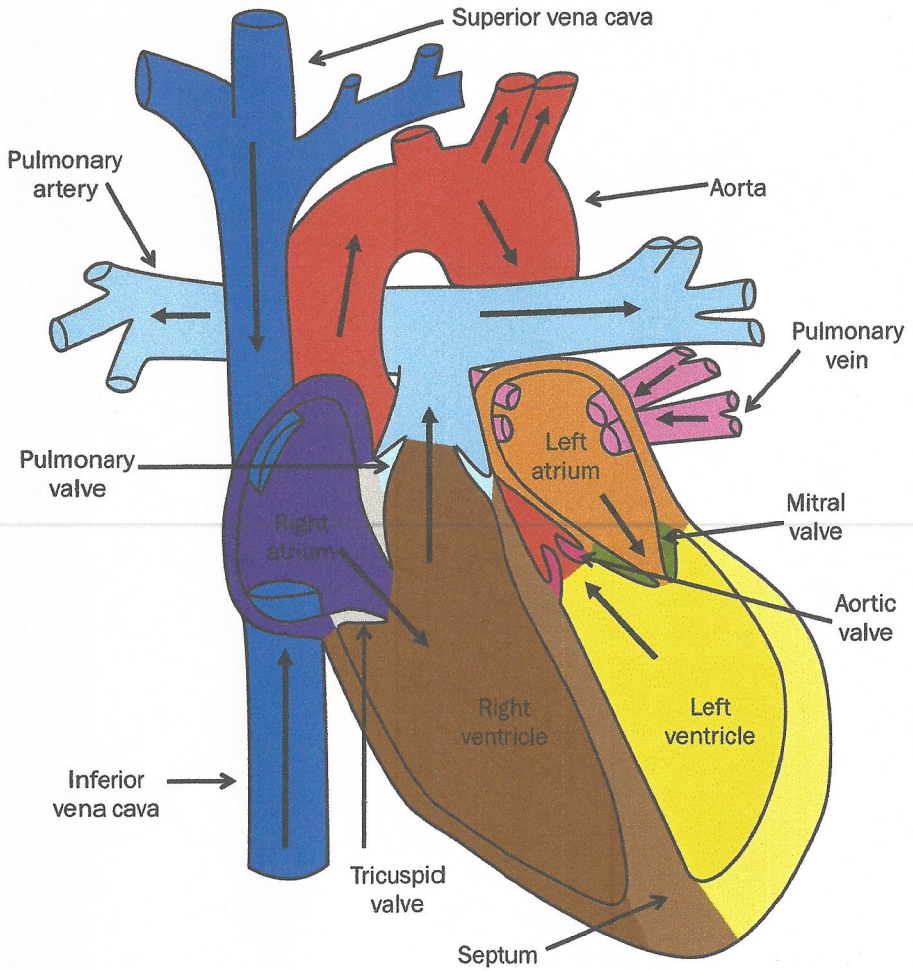
The oxygenated blood is pumped out of the left ventricle through **aortic valve** into the **aorta.** The aorta is the largest artery in the body. It carries the blood to the rest of the body.

Oxygen is delivered to body cells. Carbon dioxide is picked up at the body cells. The deoxygenated blood (carrying carbon dioxide) returns to the heart through the superior and inferior vena cava. The blood flows through the heart, to the lungs and back, all over again.

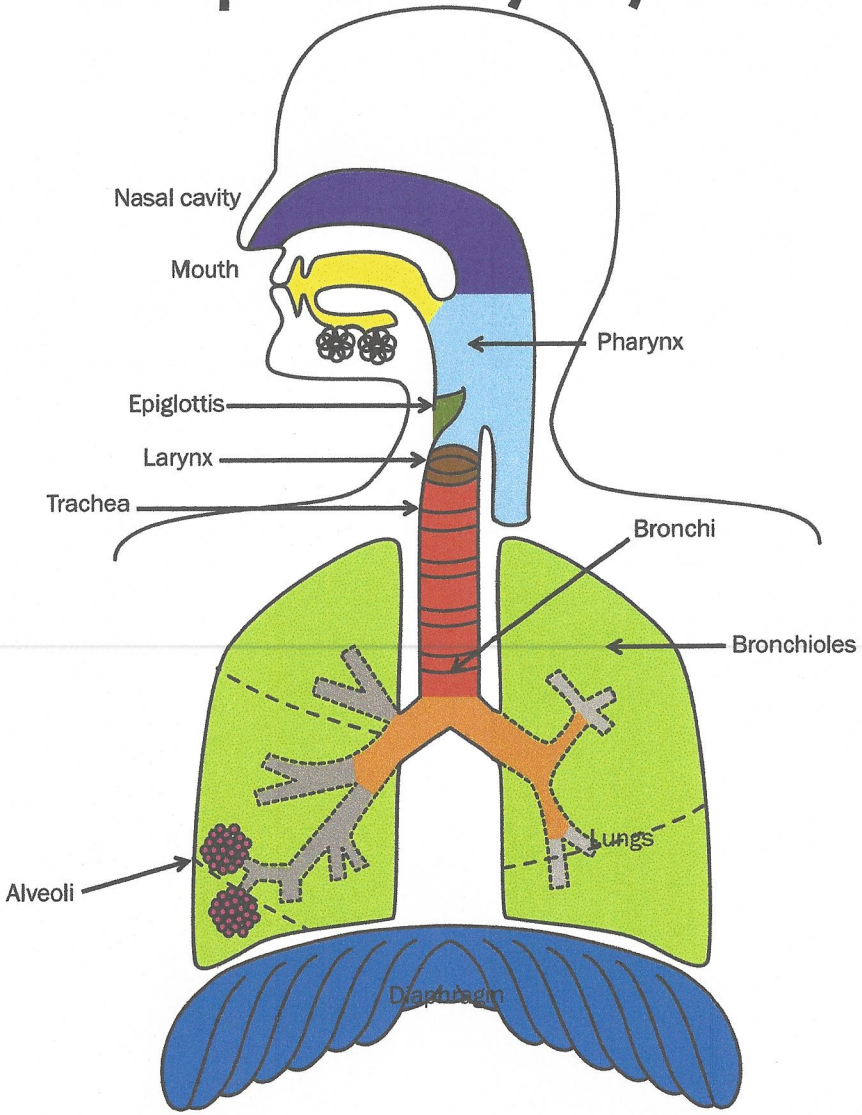
The Heart



The Heart



Respiratory System



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Respiratory System

The respiratory system allows the exchange of the gases between the air and body. This exchange takes place in the lungs. The lungs provide oxygen for the body. They remove carbon dioxide from the body as well.

Respiration vs. Breathing

Respiration and breathing are two different things. Respiration usually refers to cellular respiration. **Cellular respiration** is the breakdown of food to produce energy. We call the energy ATP. Cellular respiration *can* take place without oxygen. This is called anaerobic respiration. However, cellular respiration produces MUCH more energy when oxygen is present. This is called aerobic respiration.

Breathing is the inhalation and exhalation of air. Breathing allows for uptake of oxygen and release of carbon dioxide in the lungs. Breathing is important to respiration because it provides the oxygen needed for aerobic respiration. Breathing also gets rid of carbon dioxide produced by respiration. Because breathing is so important to respiration, we call the organ system that supports breathing the respiratory system.

A large muscle at the bottom of the chest cavity called the **diaphragm** controls breathing. When the diaphragm contracts, it increases the volume of the chest cavity. The diaphragm moves down when it contracts and so air is inhaled. When the diaphragm relaxes, the volume of the chest cavity decreases. The diaphragm moves up and air is exhaled.

Gas Exchange

Air first enters the body through the **nasal cavity** or **mouth**. The air then passes through the **pharynx**. Food also passes through the pharynx into the digestive system during swallowing. A small flap of tissue called the **epiglottis** covers the entrance into lungs to prevent food from entering the lungs when you swallow. When you breath, the epiglottis stays open so air will enter into the lungs.

Air enters the lungs through the **trachea** (windpipe). The trachea is a sturdy tube that leads to the lungs. Rings of cartilage keep the trachea open. You can feel the rings of cartilage if you move your fingers up and down the front of your neck.

At the top of the trachea is the **larynx**. The larynx contains tissue known as vocal cords. Muscles pull the vocal cords together and they vibrate when air moves between them. This causes the vocal cords to produce sound.

Air passes through the trachea into two large passageways inside the lungs. These passageways are called **bronchi**. Each bronchus leads into one of the lungs. The bronchi lead into smaller passageways called **bronchioles**. The bronchioles divide into smaller and smaller passageways until the reach **alveoli**.

Alveoli are tiny air sacs. Capillaries surround them. Gas exchange takes place at the alveoli. When you breath in, air fills up the air sacs. Oxygen in the air diffuses across the alveoli walls and into the capillaries. At the same time, carbon dioxide diffuses out of the blood, across the walls of the capillaries and into the alveoli. When you exhale, the carbon dioxide travels up and out of the lungs and through your mouth or nose.

Name: _____

Digestive System

The digestive system is a one-way tube that passes through the body. The digestive system converts food into simple nutrients that can be used by cells of the body. The simple nutrients are absorbed by the body and wastes are eliminated. The digestive system mechanically and chemically digests food. Some organs do physical work on food to break it down into smaller pieces. This is mechanical digestion. Other organs release enzymes that break down food molecules. This is chemical digestion.

Digestion begins in the **mouth**. Your teeth and tongue grind and chew food into smaller pieces. This is mechanical digestion. As your teeth tear and crush food, **salivary glands** release salivary amylase. Salivary amylase is an enzyme. It chemically digests carbohydrates such as starch. As you swallow food, it passes through the **pharynx** and into the **esophagus**. To prevent food from entering the lungs, a flap of tissue called the **epiglottis** closes over the trachea. It blocks food from entering the lungs.

Food travels down the **esophagus** into the stomach. The esophagus is composed of smooth muscle. The esophagus squeezes the food down into the stomach. This movement is called peristalsis. The **stomach** continues mechanical and chemical digestion. The stomach contracts to churn and mix the food. The stomach releases hydrochloric acid and pepsin. The acid kills bacteria and activates the pepsin. Pepsin is an enzyme that digests protein.

The stomach releases the digested food, called chyme, into the **small intestines**. The small intestines are divided into three parts: duodenum, jejunum and ileum. Digestion continues in the first part of the small intestines. Absorption of nutrients takes place in the second and third parts.

Chyme enters the first part of the small intestines known as the duodenum. Enzymes and digestive fluids from the pancreas and liver enter into the duodenum with the chyme.

The **pancreas** is a gland located behind the stomach. It has three important functions. The pancreas produces sodium bicarbonate, which helps neutralize stomach acid. The pancreas produces insulin and glucagon. Insulin and glucagon are hormones. The pancreas releases the hormones into the blood to regulate blood sugar levels. Third, the pancreas releases enzymes into the duodenum. It releases amylase, trypsin and lipase, which digest carbohydrates, proteins and fat.

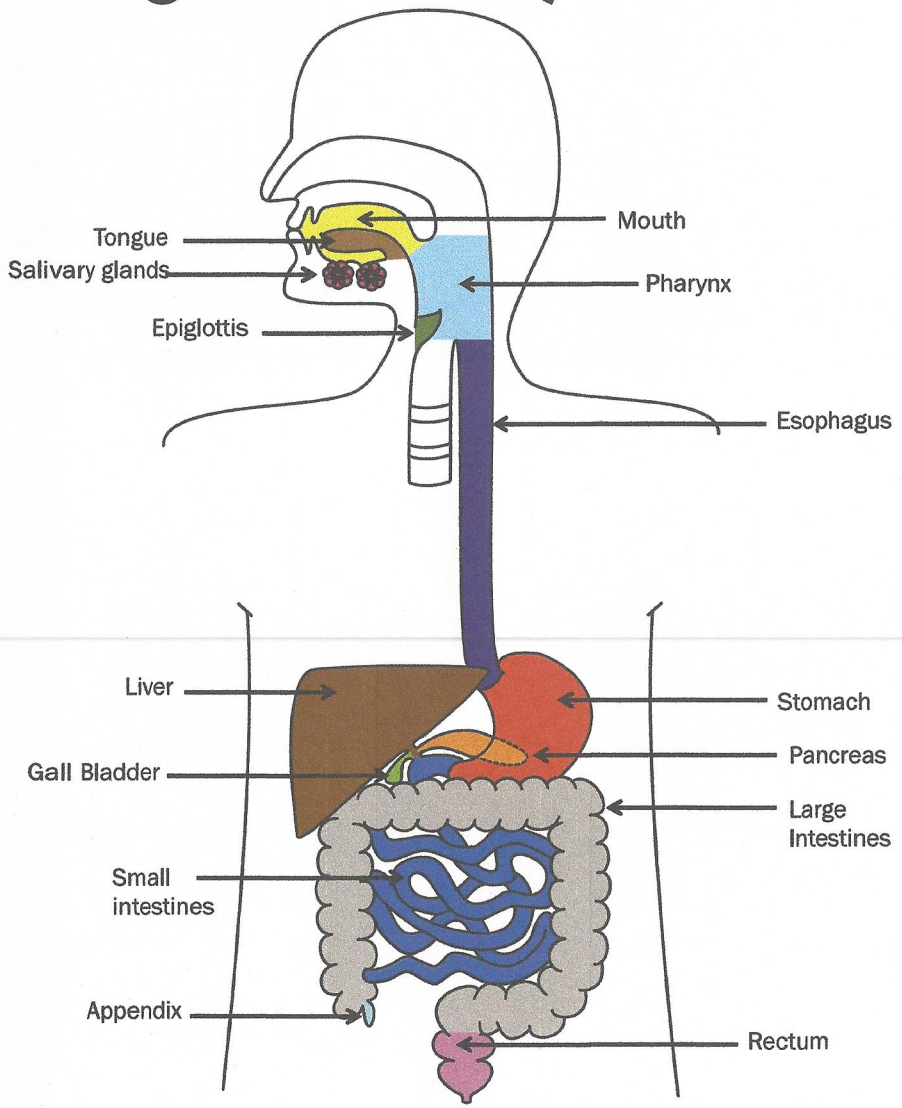
The **liver** produces a fluid known as bile. Bile helps dissolve fat in digestive fluid. This allows enzymes to digest fats. The **gallbladder** is a small pouch-like structure that stores excess bile produced by the liver.

Chyme continues to move into the second and third part of the small intestine – the jejunum and ilium. Absorption of nutrients takes places in these parts of the small intestines. These parts of the small intestines are well adapted for nutrient absorption because the inner surface has many folds and finger-like projections called villi. The villi increase the surface area of the small intestines. This allows more nutrients to be absorbed. Nutrients diffuse into the blood through capillaries lining the inside of the villi.

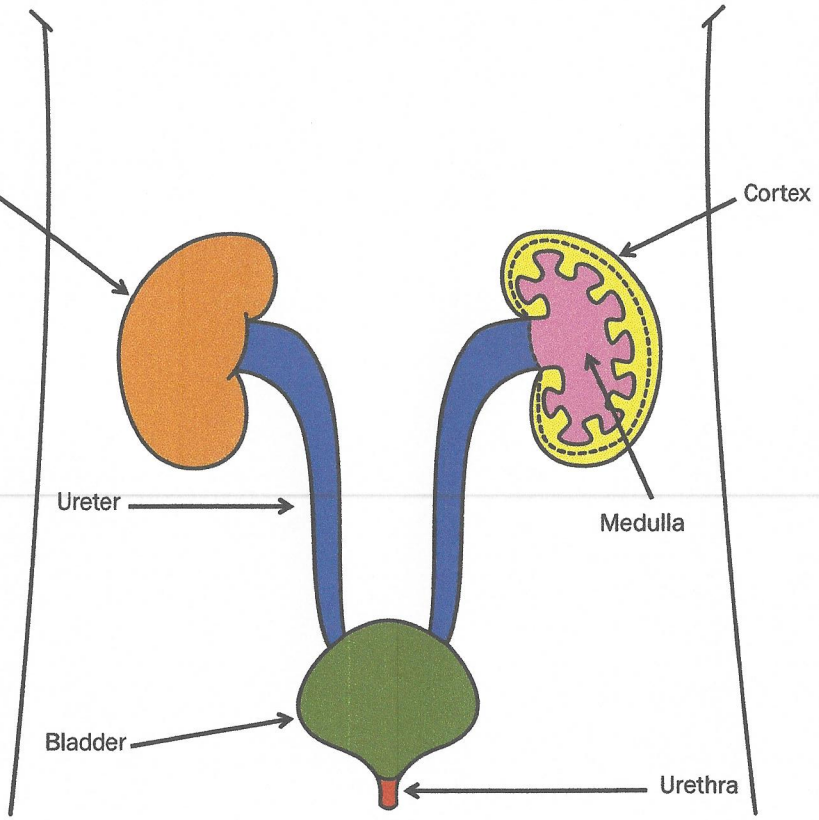
By the time the digested products reach the end of the small intestines, only indigestible material, water and cellulose (fiber) remain. These materials move into the **large intestines**. They first pass a small sac-like structure called the **appendix**. The appendix doesn't help humans digest food. In fact, scientists aren't exactly sure what is the function of the appendix. Once past the appendix, the materials are truly in the large intestines. The large intestines absorb water from the undigested material. Water is absorbed through the walls of the large intestines into the bloodstream. This causes the undigested materials to become concentrated. It is then called waste. The waste moves from the large intestines into the **rectum** and is eliminated from the body.

Colonies of bacteria are present in the large intestines. The bacteria produces substances your body cannot produce on its own. For example, some bacteria produces Vitamin K. Vitamin K is important to blood clotting. These bacteria use substances in the waste to make vitamin K. You often think of bacteria causing sickness, but these bacteria are essential to maintaining good health.

Digestive System



Urinary System



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Urinary System

The **urinary system** is *really a* "sub-organ system." It is a part of the excretory system. The **excretory system** eliminates waste from the body. The excretory system includes the lungs, skin and kidneys. The lungs eliminates or excretes carbon dioxide – gaseous waste. The skin eliminates excess water and salts. The kidneys are the most important organ of the excretory system. They removes different kinds of waste in the blood. For this reason, we will focus on just the kidneys and their related structures. These organs/structures make up the urinary system.

The urinary system removes waste in the blood. Two kidneys are the main structure of the urinary system. The kidneys filter the blood of toxins. They also eliminate nitrogenous wastes and excess salts from the body. The kidneys also maintain water and pH balance in the blood by excreting excess water ("waster waste") and other substances in the blood.

The **kidneys** are located on both sides of the body in the lower back. There are two parts to the kidney: **outer renal cortex** and **inner renal medulla**. The filtration of blood takes place in the renal cortex. Within the cortex are microscopic structures call nephrons. Nephrons are the actual structures that filter blood.

Nephrons empty impurities (the substances filtered out of the blood) into a collecting duct. The impurities emptied into the collecting duct contain urea, excess salts and water. This material is called urine. It travels down a tube called the **ureter**. The material is collected and stored into the **bladder**. When the bladder is full, urine is released from the body through the **urethra**.

Filtration and Reabsorption

The removal of impurities is a complicated process. It involved filtration and reabsorption of substances. Hormones are important in controlling this process. For example, the pituitary gland releases a hormone called ADH (anti-diuretic hormone). It tells the kidney to retain water when the body is dehydrated.