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Unit 16 - Animal Systems

- *Demonstrate the levels of biological organization from its type of cell to tissue to organ to system.*
- *Describe how systems work together*
- *Identify the major functions of the body systems:*
- *Describe how the respiratory, circulatory, and muscular systems interact to regulate the exchange of oxygen and carbon dioxide*
- *Describe how the excretory and circulatory systems help regulate the elimination of metabolic waste*
- *Describe how the digestive, circulatory, and muscular systems interact to perform nutrient absorption*
- *Describe how the endocrine, reproductive and nervous systems interact to perform the function of reproduction*
- *Describe how the muscular, skeletal, and nervous systems interact to help prevent injury*
- *Describe how the integumentary, immune, and respiratory systems interact to defend or fight against illness*

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Menu

Levels of Organization

Homeostasis

Feedback Loops

Negative Feedback

Positive Feedback

Immune System

Digestive System

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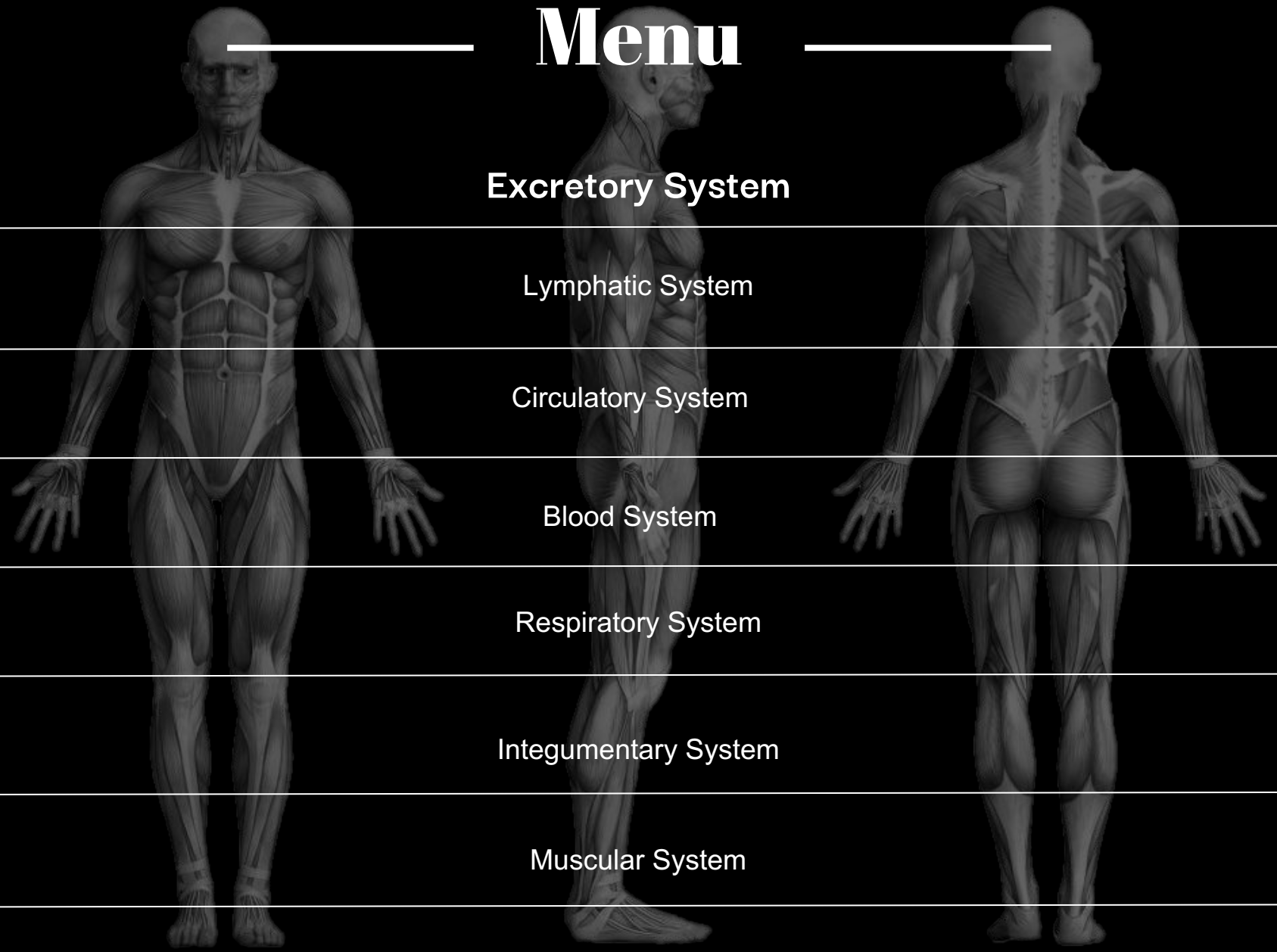
Menu



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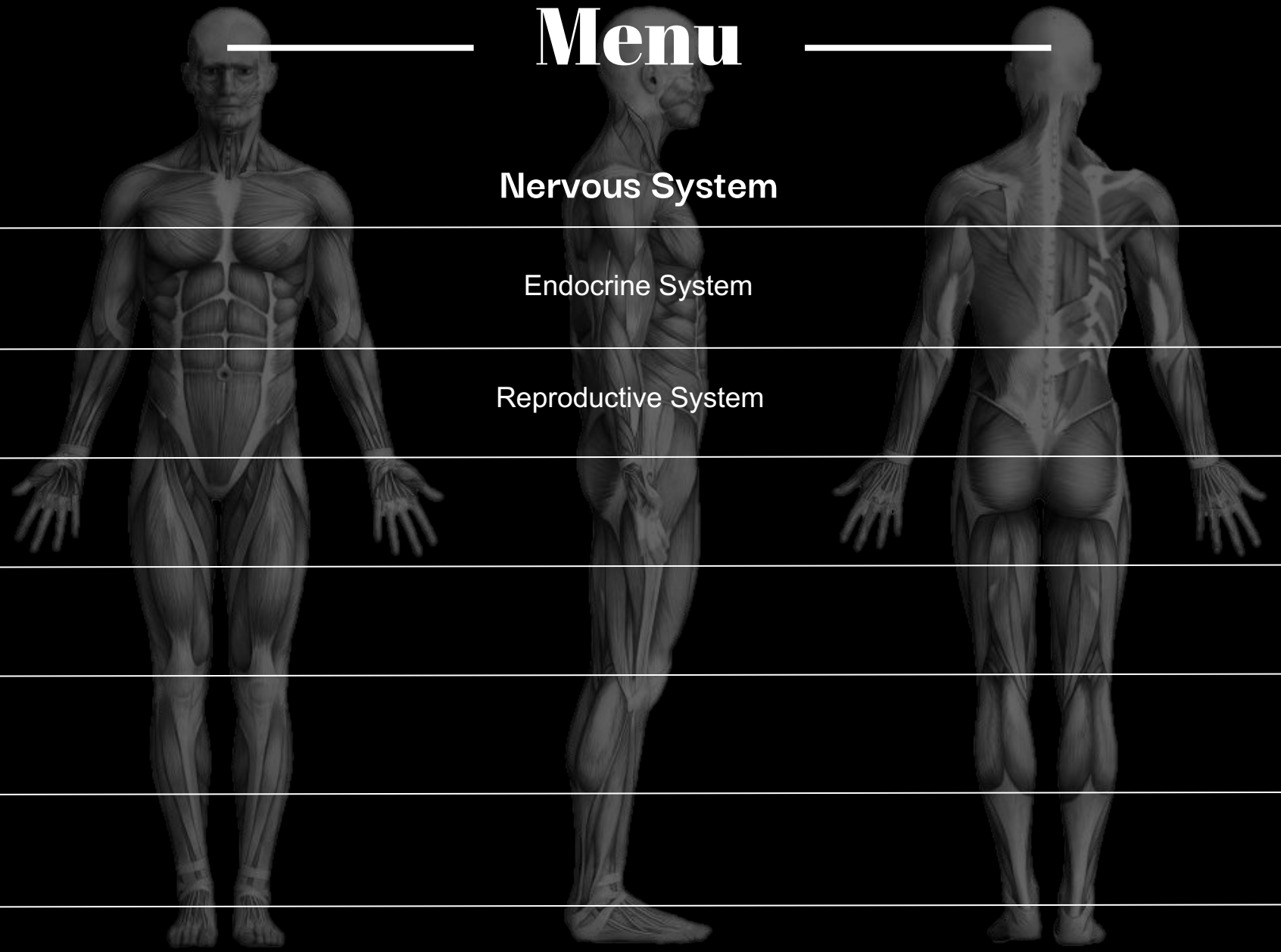
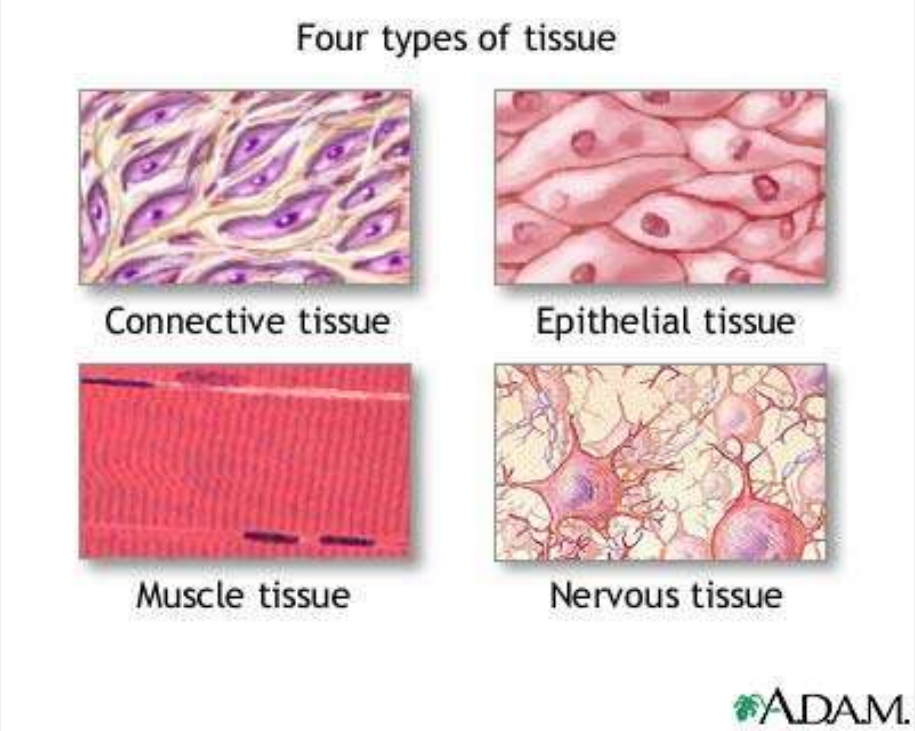
Menu

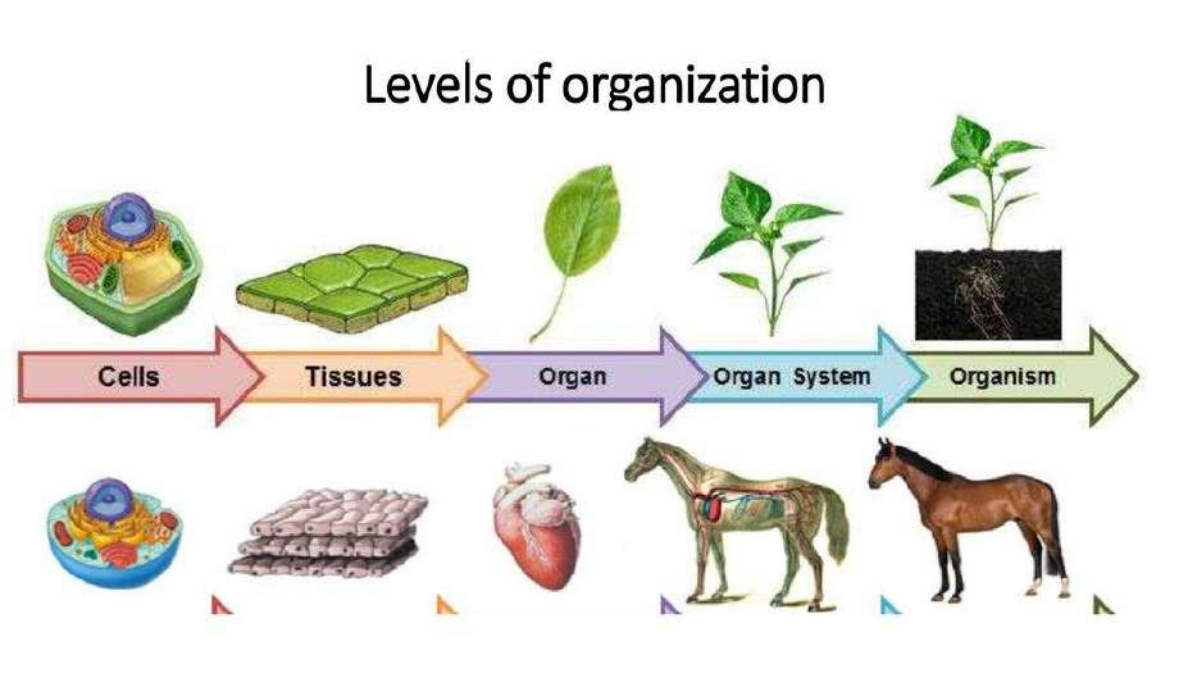


Levels of Organization

- The levels of organization in a multicellular organism include:
  - Cells → Tissues → Organs → Organ systems → Organism
- Cells: are the basic units of structure and function in living things. In multicellular organisms, cells are specialized to perform certain functions.
- Tissues: are groups of similar cells that perform a single function
  1. **Epithelial tissue**: covers body surfaces.
  2. **Connective tissue**: supports the body and connects its parts.
  3. **Nervous tissue**: carries messages throughout the body.
  4. **Muscle tissue**: enables the body to move.



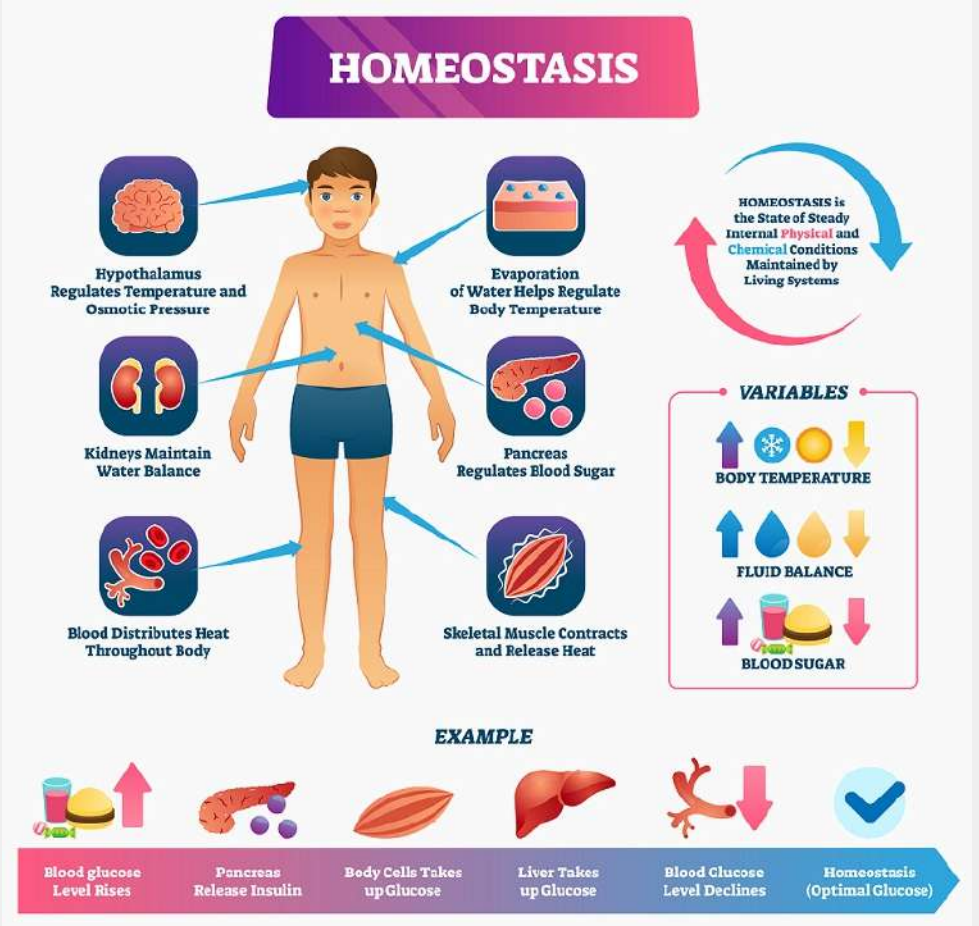
Levels of Organization



- An **organ**: is a group of tissues that work together to perform a complex function.
- An **organ system**: is a group of organs that perform related functions.
  - Humans have 11 organ systems.
  - Organ systems work together to maintain stable conditions in the body; the process of maintaining a stable internal condition is called **homeostasis**.
  - **Homeostasis** may involve feedback inhibition, or negative feedback. For example, the nervous system senses when the body cools and signals

Homeostasis

- **Homeostasis**: refers to stability, balance, or equilibrium within a cell or the body. It is an organism's ability to keep a constant internal environment.
- Homeostasis is an important characteristic of living things. Keeping a stable internal environment requires constant adjustments as conditions change inside and outside the cell.
  - The adjusting of systems within a cell is called **homeostatic regulation**.
  - Because the internal and external environments of a cell are constantly changing, adjustments must be made continuously to stay at or near the set point (the normal level or range).
  - Homeostasis can be thought of as a **dynamic equilibrium** rather than a constant, unchanging state.



Feedback Loops

- **Feedback regulation**: occurs when the response to a stimulus has an effect of some kind on the original stimulus.
  - The type of response determines what the feedback is called.
    1. **Negative feedback:** occurs when the response to a stimulus reduces the original stimulus.
    2. **Positive feedback:** occurs when the response to a stimulus increases the original stimulus.

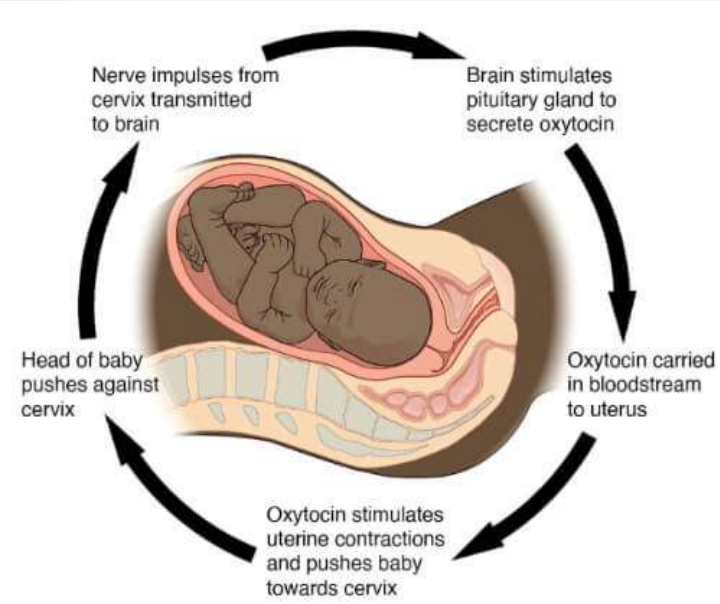


Fig: **Positive Feedback** (Childbirth)

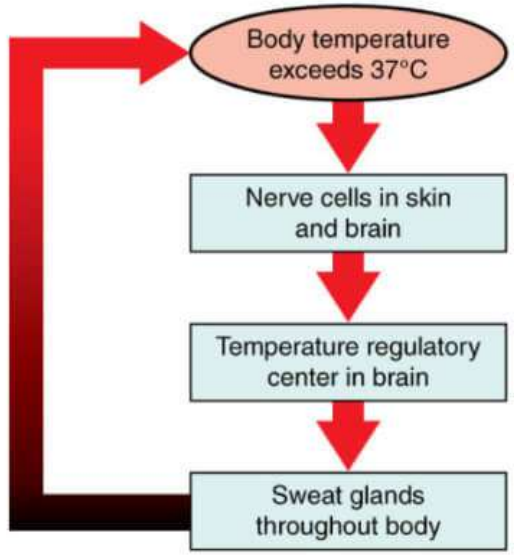


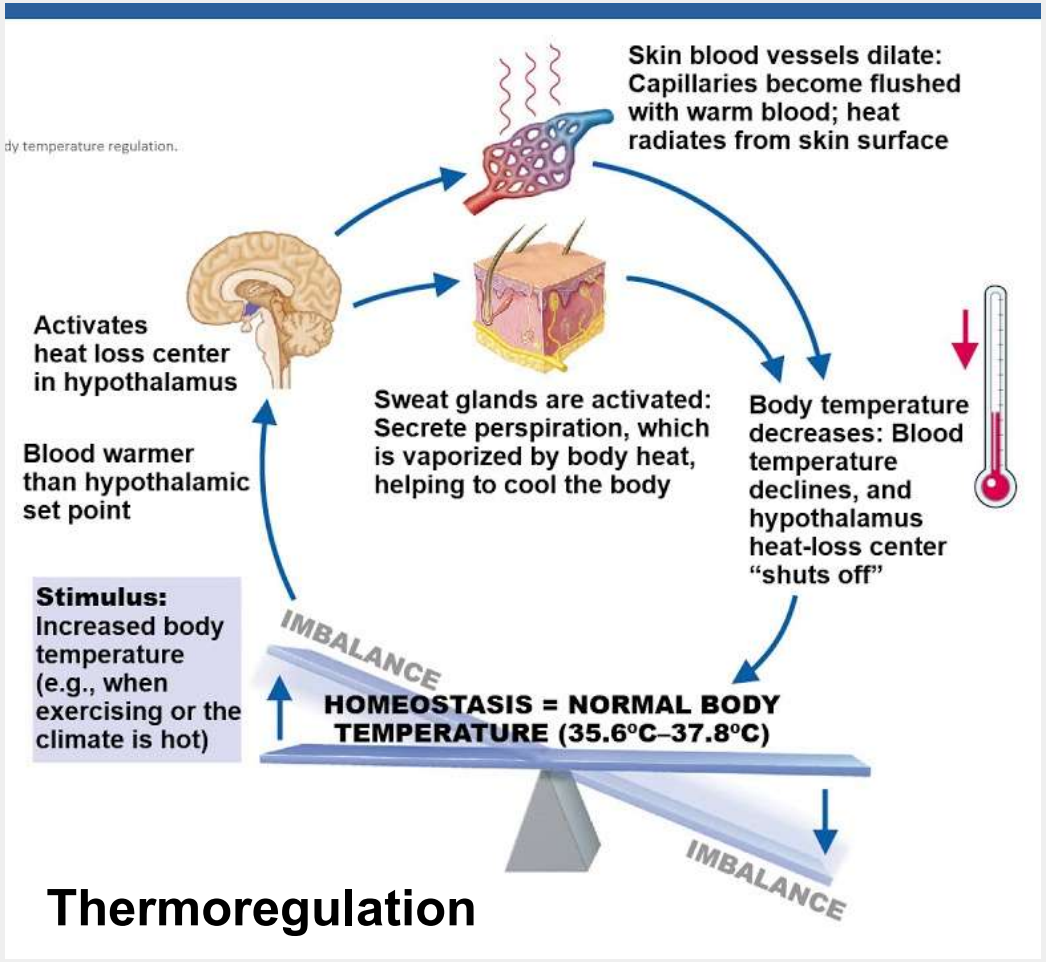
Fig: **Negative Feedback** (Temperature Regulation)

Negative Feedback

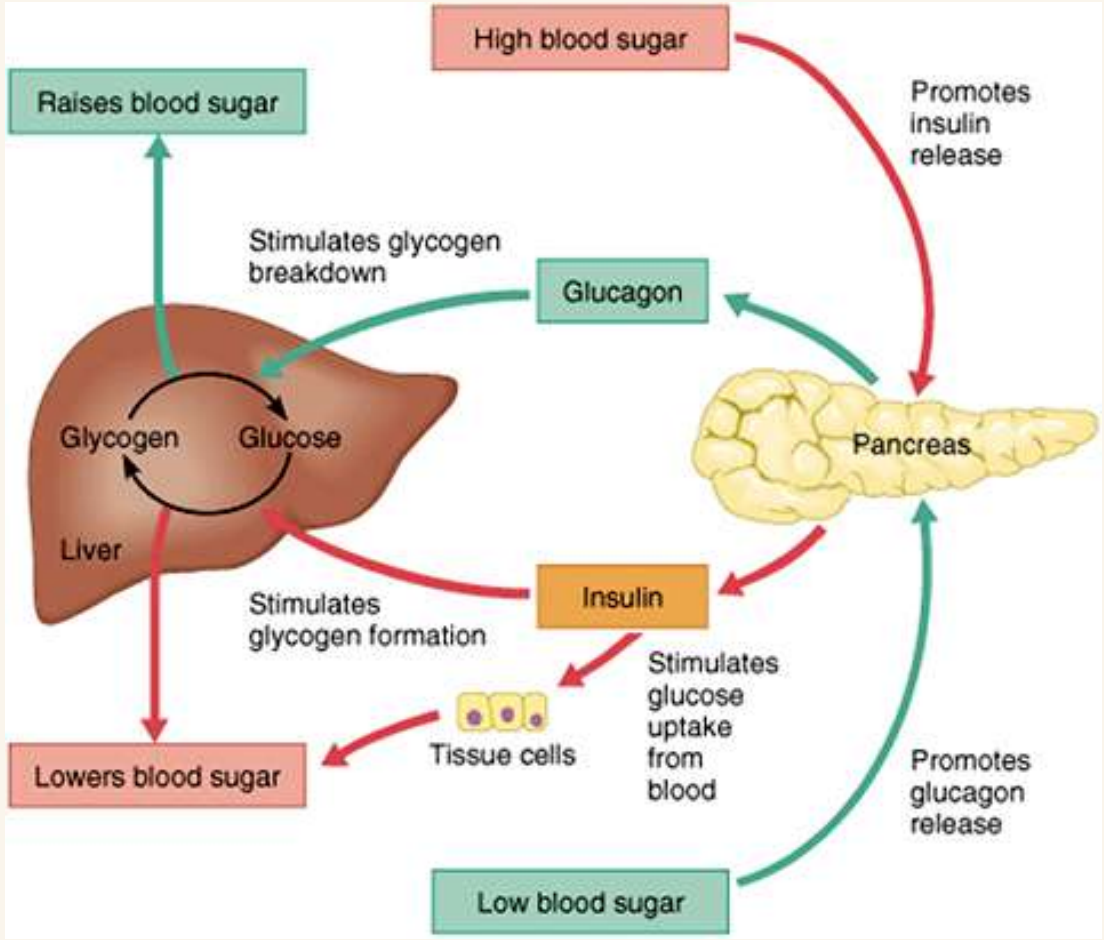
Common Feedback Loops

- Is the **most common** feedback loop in biological systems.
  - The system acts to reverse the direction of change.
  - Since this tends to keep things constant, it allows the maintenance of homeostatic balance.
  - **EX:** when the concentration of carbon dioxide in the human body increases, the lungs are signaled to increase their activity and exhale more carbon dioxide, (your breathing rate increases).
    1. **Thermoregulation** is another example of negative feedback. When body temperature rises, receptors in the skin and the hypothalamus sense the temperature change. The temperature change (**stimulus**) triggers a command from the brain. This command, causes a response (the skin makes sweat and blood vessels near the skin surface dilate), which helps decrease body temperature.
    2. **Chemoregulation**: Control of blood glucose level is an example of negative feedback. Blood glucose concentration rises after a meal (the stimulus). The hormone insulin is released by the pancreas, and it speeds up the transport of glucose from the blood and into selected tissues (**the response**). Blood glucose concentrations then decrease, which then decreases the original stimulus. The secretion of insulin into the blood is then decreased.

Negative Feedback



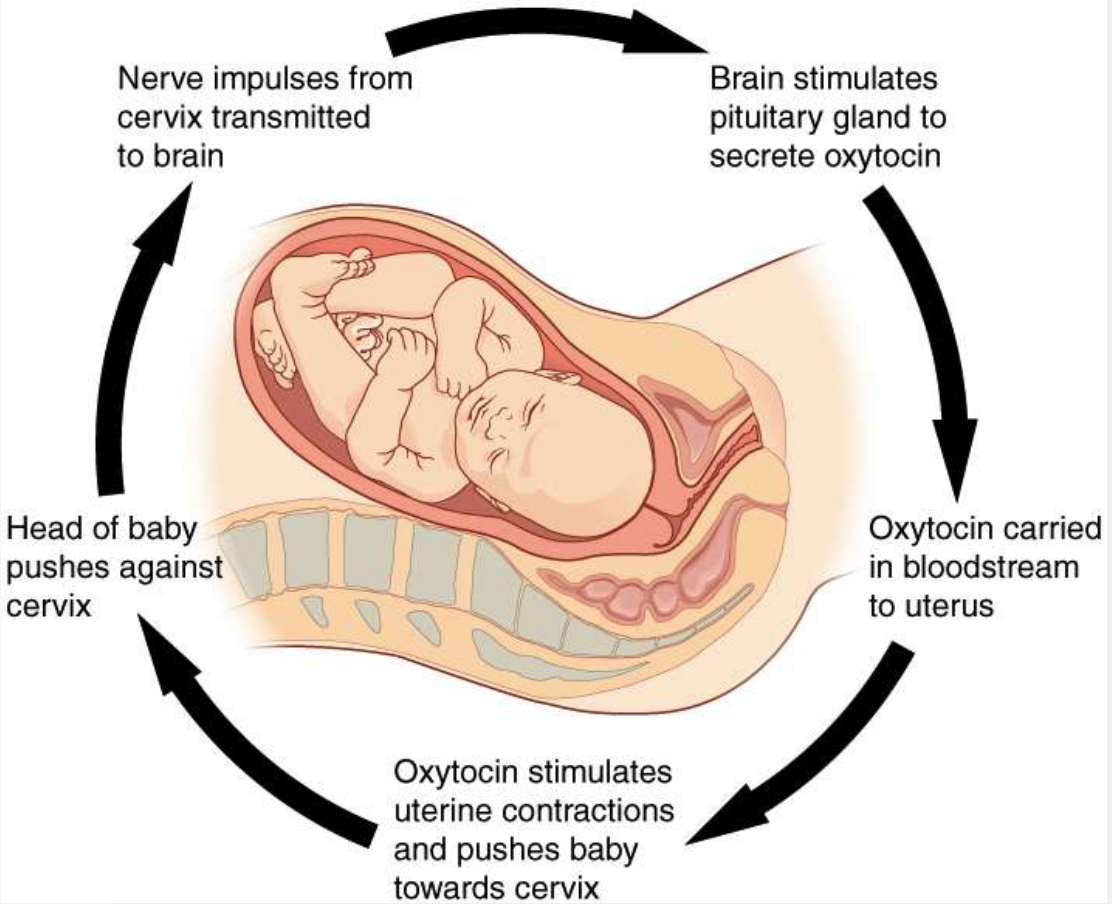
Thermoregulation



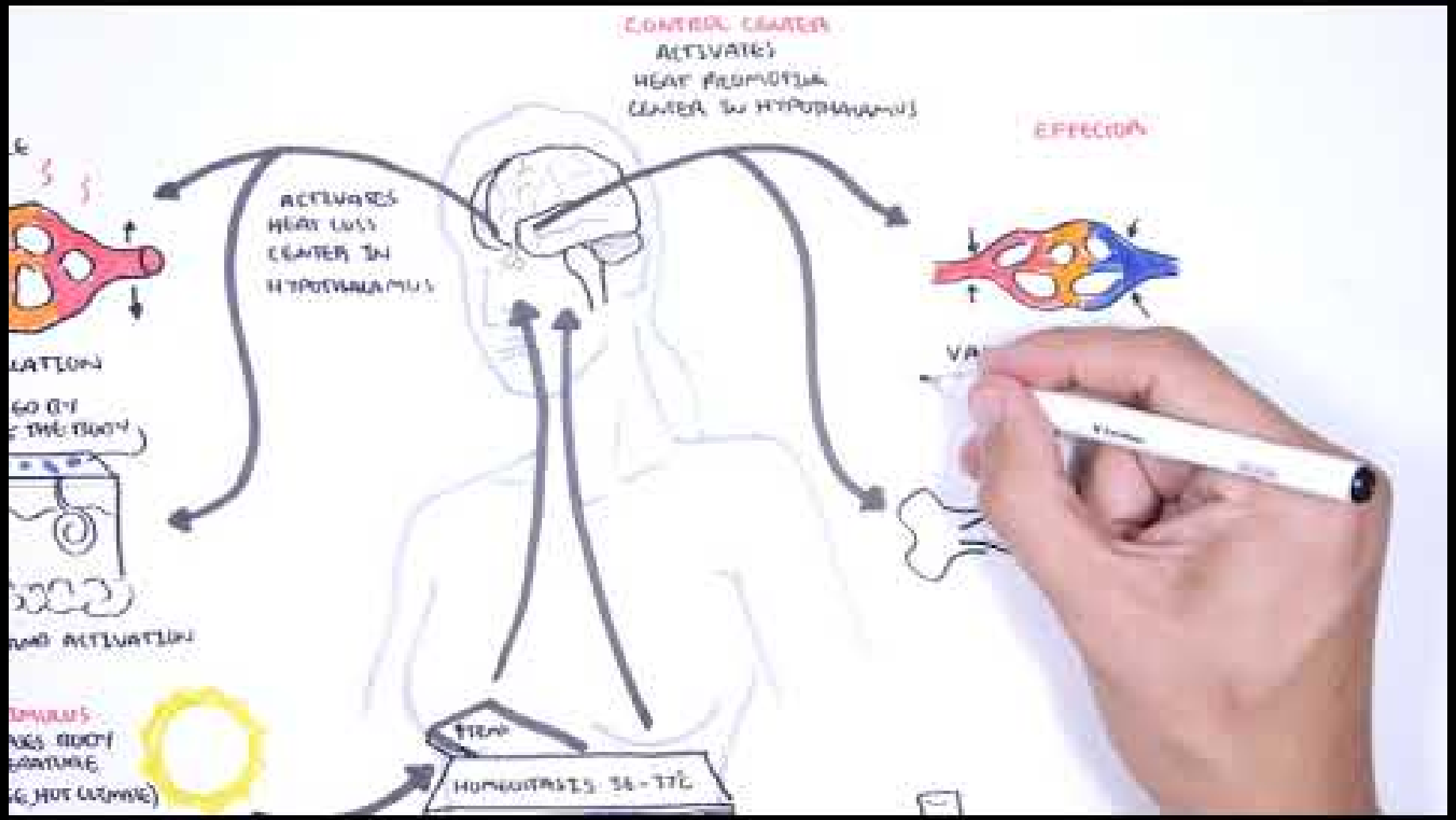
Chemoregulation

Positive Feedback

- Positive feedback is less common in biological systems.
  - Positive feedback acts to speed up the direction of change. An example of positive feedback is lactation (milk production).
  - EX: As the baby suckles, nerve messages from the mammary glands cause the hormone prolactin, to be secreted by the pituitary gland. The more the baby suckles, the more prolactin is released, which stimulates further milk production. Not many feedback mechanisms in the body are based on positive feedback.
  - Positive feedback speeds up the direction of change, which leads to increasing hormone concentration, a state that moves further away from homeostasis.



Types of Homeostatic Regulation in the Body			
	Homeostatic Processes	**Hormones and Other Messengers**	**Tissues, Organs and Organ Systems Involved**
Osmoregulation / Excretion	Excess water, salts, and urea expelled from body	Antidiuretic hormone (ADH), aldosterone, angiotensin II, carbon dioxide	Kidneys, urinary bladder, ureters, urethra (urinary system), pituitary gland (endocrine system), lungs (respiratory system)
Thermoregulation	Sweating, shivering, dilation/constriction of blood vessels at skin surface, insulation by adipose tissue, breakdown of adipose tissue to produce heat	Nerve impulses	Skeletal muscle (muscular system), nerves (nervous system), blood vessels (cardiovascular system), skin and adipose tissue (integumentary system), hypothalamus (endocrine system)
Chemical Regulation	Release of insulin and glucagon into the blood in response to rising and falling blood glucose levels, respectively; increase in breathing rate in response to increases carbon dioxide levels in the blood, and release of carbon dioxide into exhaled air from lungs, secretion of erythropoietin by kidneys to stimulate formation of red blood cells	Insulin, glucagon, cortisol, carbon dioxide, nerve impulses, erythropoietin (EPO)	Pancreas (endocrine system), liver (digestive system); adrenal glands (endocrine system) lungs (respiratory system), brain (nervous system), kidneys (urinary system)



Introduction to the Immune System

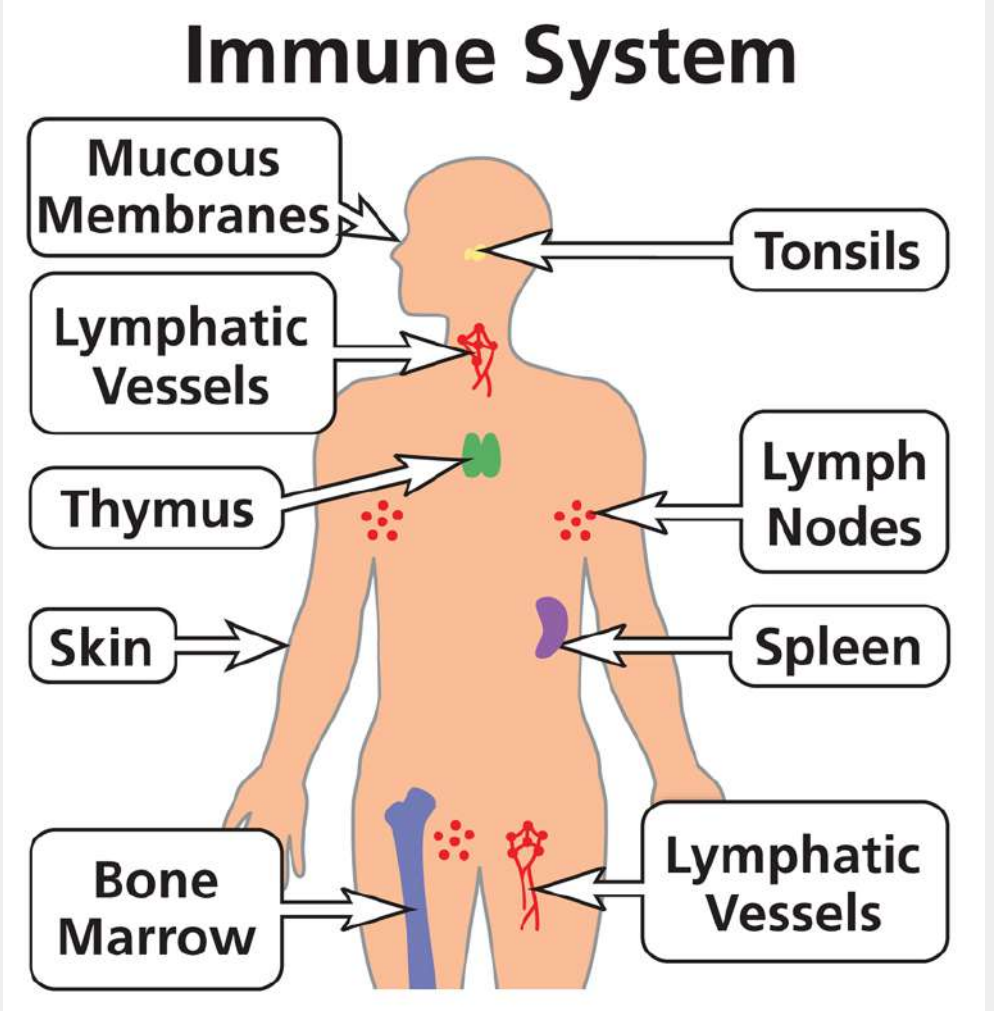
Infectious Disease

A disease: is any change, other than an injury, that disrupts the normal functions of the body.

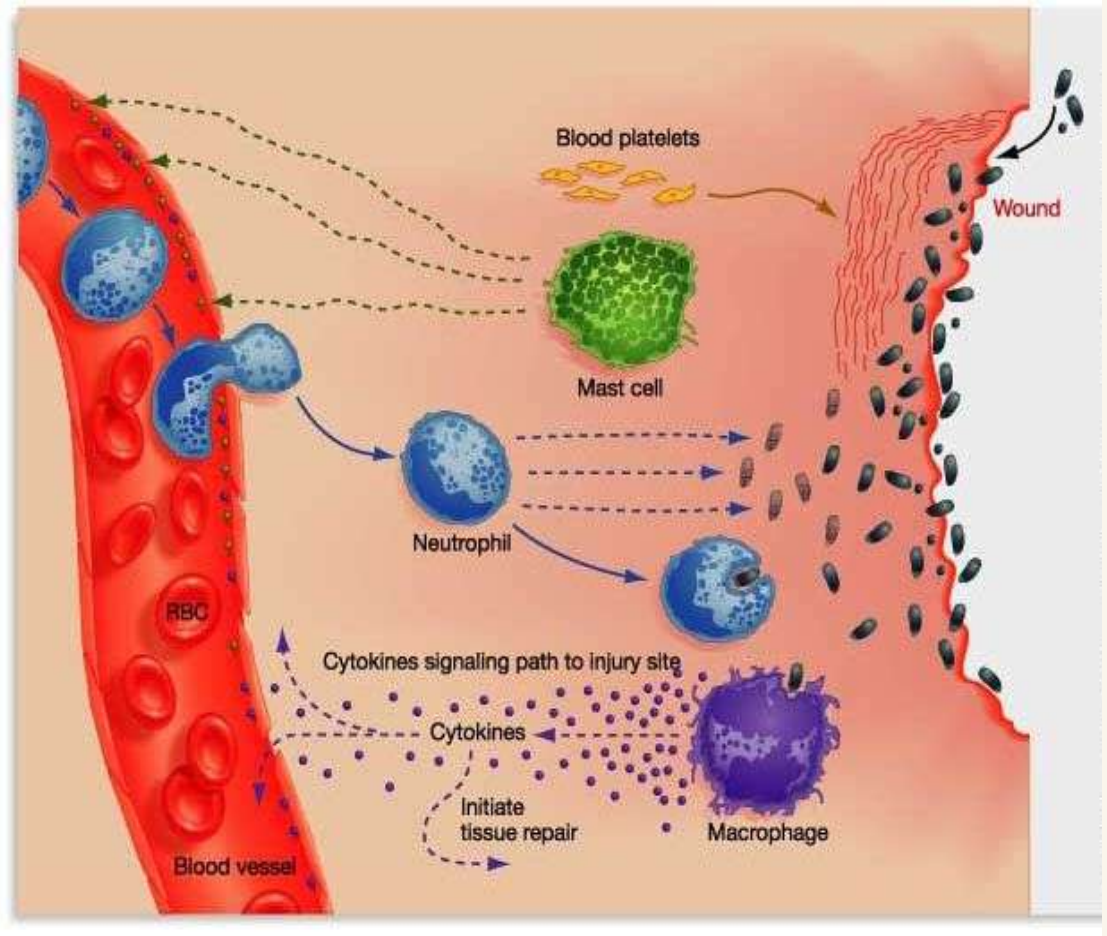
- Diseases are produced by agents such as bacteria, materials in the environment such as cigarette smoke, or inherited conditions.
- Disease-causing agents are called pathogens. Diseases caused by pathogens are called infectious diseases.
- Types of pathogens include: viruses, bacteria, protists, worms, and fungi.
- Many are spread from one person to another through coughing, sneezing, or physical contact. Some are spread through contaminated water or food. Others are spread by infected animals.
- Vectors are animals that carry pathogens from person to person.
- Antibiotics are drugs that kill bacteria without harming the cells of the host. Antiviral drugs fight certain

Immune System

- **Immune system:** is the body's main defense against pathogens. It produces cells that identify, attack, destroy, and "remember" each type of pathogen that enters the body.
- This process is called **immunity**.
- The immune system has both **nonspecific** and **specific** defenses.
  - The skin is the most important nonspecific defense. It forms a barrier that few pathogens can get through. Mucus, saliva, and tears trap pathogens and contain an enzyme that kills bacteria. If pathogens manage to enter the body, other nonspecific defenses go to work.



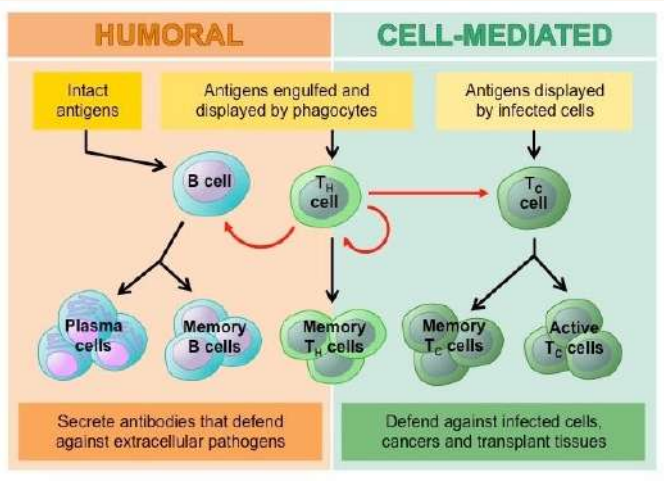
Inflammatory Response



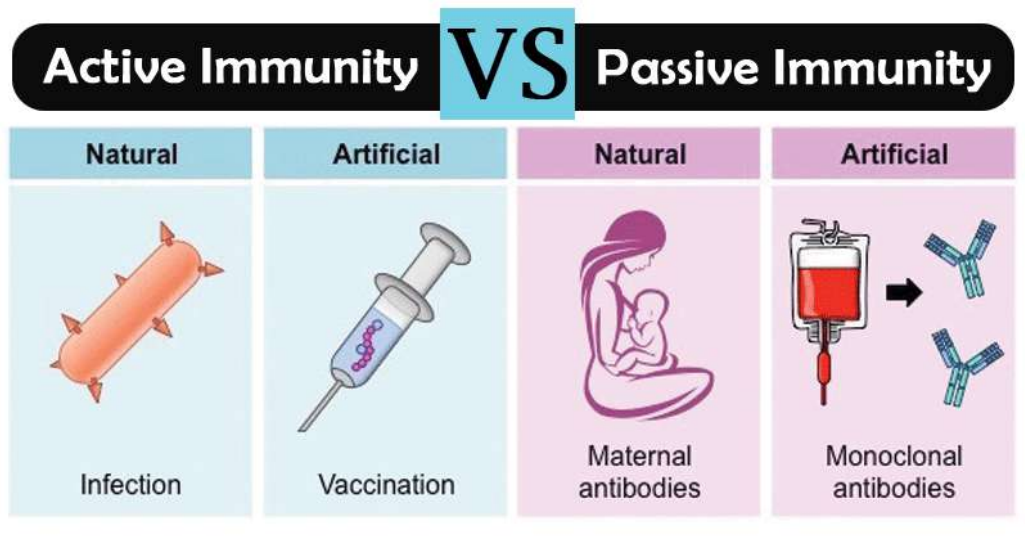
- The **inflammatory response** occurs when tissue is damaged by injury or infection.
    1. Blood vessels near the site expand, and white blood cells enter the tissues to fight infection.
    2. The immune system also releases chemicals that cause a fever. The higher body temperature slows the growth of many pathogens.
    3. In addition, cells infected with a virus may produce proteins called **interferons**, which interfere with the growth of the virus.
- If a pathogen is able to get past the nonspecific defenses, the immune system reacts with specific defenses against that particular pathogen - **the immune response**.
- A substance that triggers the immune response is known as an

Immune Response

- *There are two types of immune response:*
  - Humoral immunity
    1. White blood cells, called B cells, produce antibodies that travel through the bloodstream and attack pathogens in the blood.
    2. Antibodies are proteins that recognize and bind to specific antigens.
  - Cell-mediated immunity (figure right).
    3. In cell-mediated immunity, white blood cells, called T cells, track down and destroy abnormal or infected cells.
    4. T cells also attack the cells of transplanted organs. This is called rejection. It can be prevented with drugs.
    5. After a pathogen is destroyed, certain B cells or T cells, called memory cells, remain in the body.
    6. Memory cells can quickly respond to the same pathogen if it enters the body again. This greatly reduces the chance that the disease develops again



Active vs Passive Immunity



- Immunity can be acquired in other ways:
  - Vaccination is the injection of a weakened or mild form of a pathogen to produce immunity. This type of immunity is called Active immunity.
  - Active immunity appears after exposure to an antigen.
  - Another type of immunity is called Passive immunity.
    1. It is produced when antibodies enter the body.
    2. Antibodies may be injected to fight an infection.
    3. Antibodies also pass from mother to fetus.
    4. Passive immunity lasts only as long as the antibodies remain in the body. The figure left shows all types of immunity.

Immune System Disorders

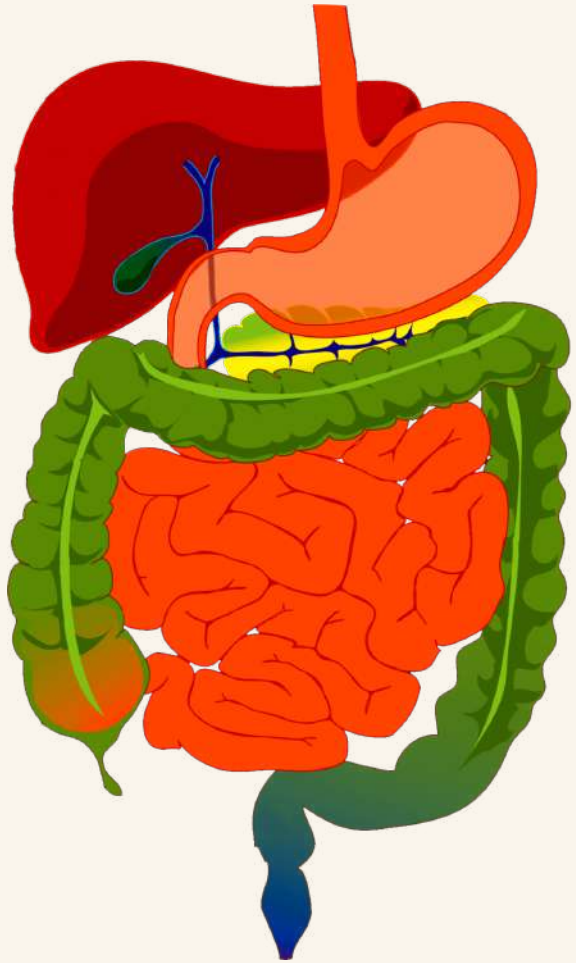
- There are three types of immune system disorders:
  - **Allergies**: are overreactions of the immune system to antigens such as pollen. Antigens that cause allergic reactions are called **allergens**. In response to allergens, the body produces chemicals called **histamines**, which cause symptoms such as sneezing and watery eyes. Some allergic reactions lead to asthma. **Asthma** is a chronic respiratory disease in which the air passages become narrower than normal. This may cause coughing and difficulty breathing.
  - **Autoimmune diseases**: occur when the immune system attacks the body's own cells. For example, in **Type I diabetes**, the immune system attacks cells of the pancreas that make insulin. Other examples of autoimmune diseases are **rheumatoid arthritis, myasthenia gravis, and multiple sclerosis** (MS).
  - **Immunodeficiency diseases:** occur when the normal immune response breaks down. The most common immunodeficiency disease is AIDS. It is caused by the human immunodeficiency virus (**HIV**). HIV can be transmitted through the exchange of body fluids such as blood. The only no-risk behavior with respect to HIV and AIDS is abstinence. At present, there is no cure or vaccine for **AIDS**.

Crash Course - Innate Immunity: LINK

Crash Course - Adaptive Immunity: LINK

Green, Hank. “Crashcourse.” *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

Digestive System



- The **function** of the digestive system is to break down food into simpler molecules that can be absorbed and used by the cells.
- The human digestive system is a one-way tube that includes the **mouth → pharynx → esophagus → stomach → small intestine → and large intestine → anus → rectum.**
- Other structures—including the **salivary glands, pancreas, and liver**— add secretions to the digestive system.
- Digestion starts in the mouth. The teeth tear and crush food. This begins the process of mechanical digestion.
  - **Mechanical digestion** is the physical breakdown of large pieces of food into smaller pieces.
  - **Chemical digestion** is the breakdown of large food molecules into smaller molecules.
    - → Salivary glands in the mouth secrete saliva, which contains the enzyme amylase. Amylase breaks down starches into sugars. This begins the process of chemical digestion.

Pathway of Food

- The chewed clump of food that is swallowed is called a **bolus**.
- It passes through the **pharynx** and into the **esophagus**.
- The esophagus is a tube that connects the throat with the **stomach**. Muscle contractions, called **peristalsis**, squeeze the food through the esophagus.
- Food from the esophagus empties into the stomach. The stomach is a large muscular sac. Both chemical and mechanical digestion takes place in the stomach. Glands in the lining of the stomach produce an acid and the enzyme pepsin.
- This mechanical digestion produces a liquid mixture called **chyme**. From the stomach, chyme passes into the small intestine. Most of the chemical digestion and absorption of food occur in the small intestine.
- Nutrients are absorbed by cells lining the surface of the **small intestine**. The surface area is greatly increased by tiny fingerlike projections called **villi** (singular: villus).
- Chyme next enters the **large intestine**. The primary function of the large intestine is to remove water from the undigested material. After most of the water has been removed, the remaining waste passes out of the body.

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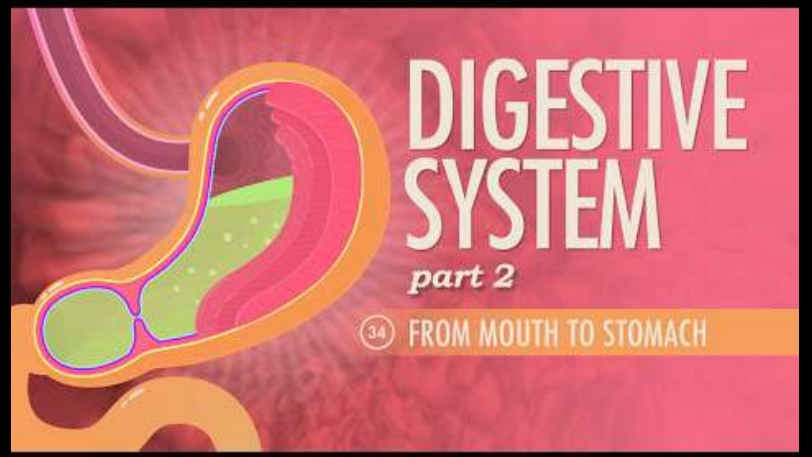


Crash Course - Digestive 2: LINK

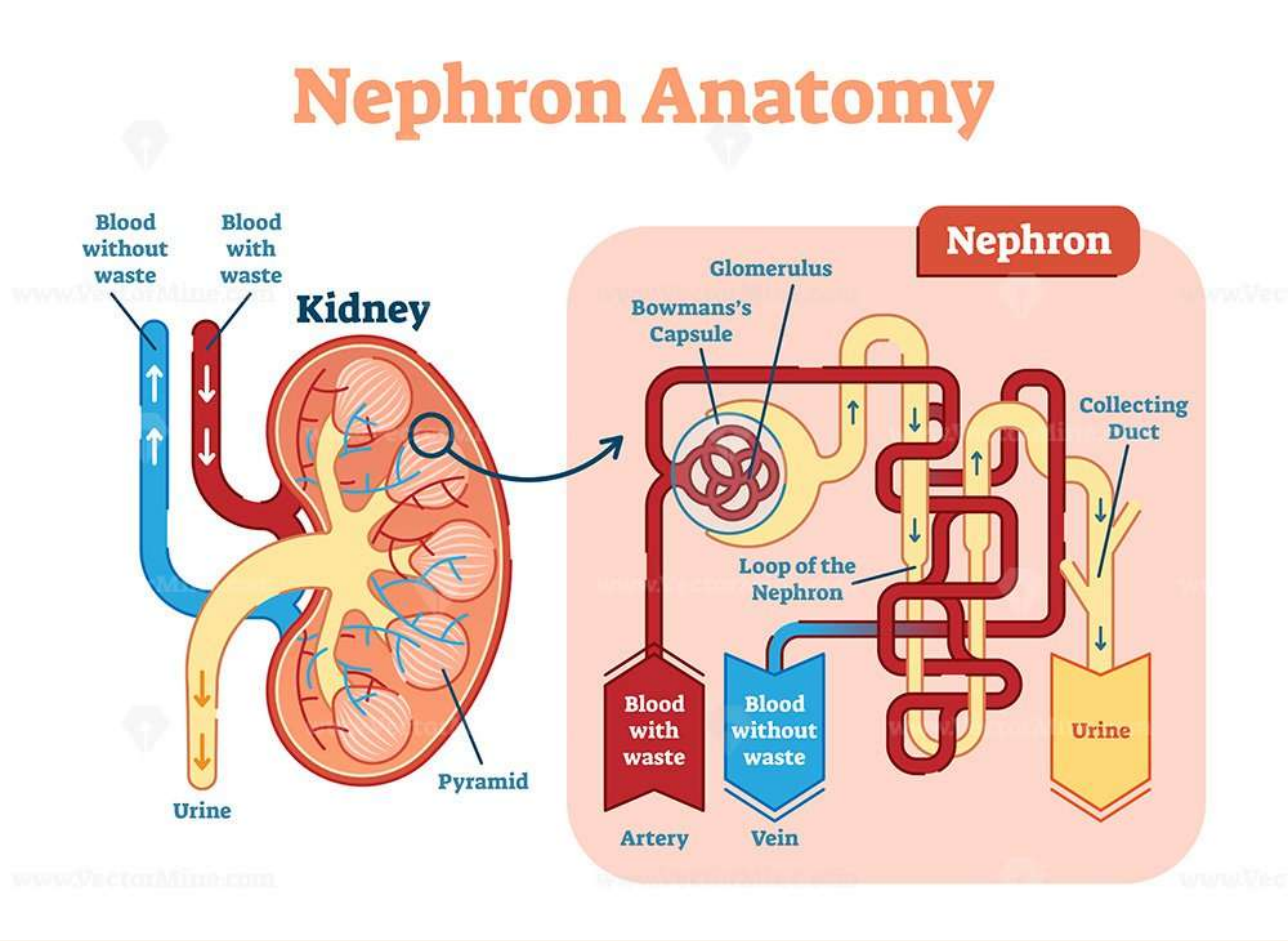
Crash Course - Digestive 3: LINK

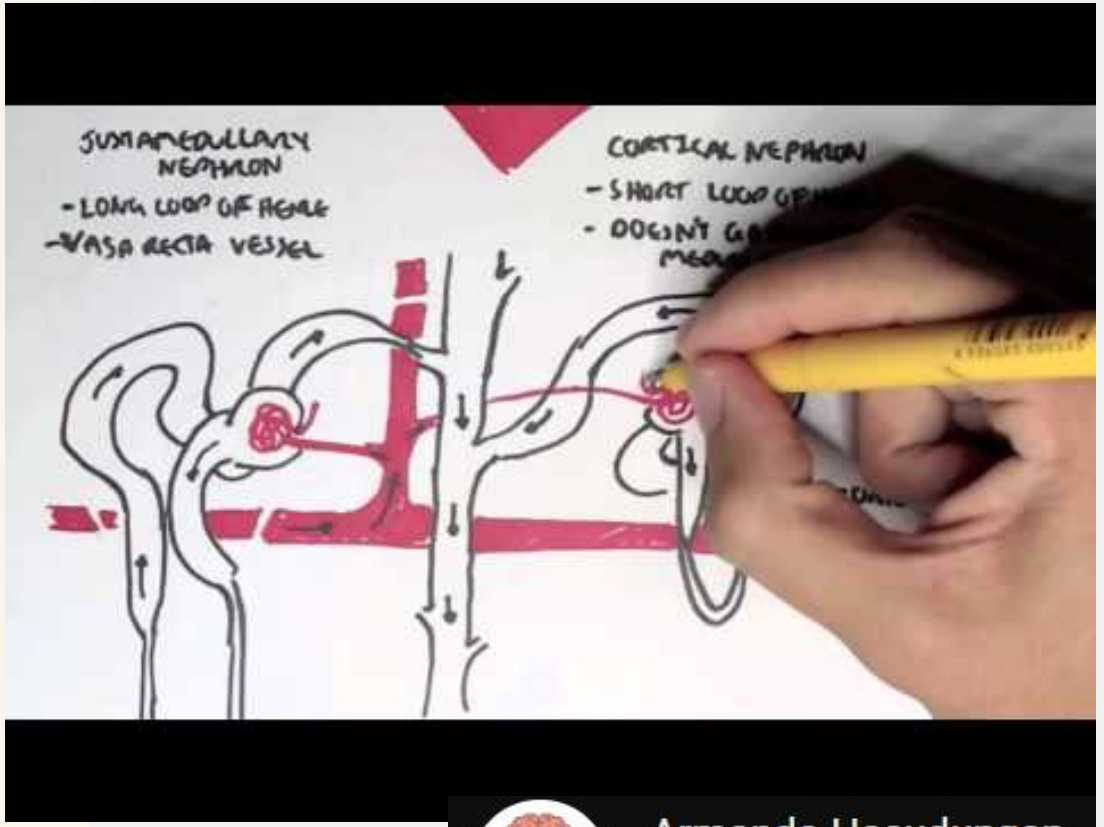
Green, Hank. “Crashcourse.” *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

Excretory System

- **Excretion**: is the process by which the body eliminates these wastes.
- The main organs of excretion are the **kidneys**.
  - The kidneys play an important role in homeostasis.
  - They remove waste products from blood, maintain blood pH, and control water content of blood. The two kidneys are located in the lower back. Blood containing wastes enters the kidneys.
  - The kidneys remove urea, excess water, and other substances from the blood.
  - The basic unit of function of a kidney is the **nephron**.
    - ➔ Each nephron is a small independent processing unit. Blood goes through two separate processes in a nephron: filtration and reabsorption.
    - ➔ **Filtration** removes wastes from the blood. It occurs in a structure of the nephron known as the **glomerulus**.
    - ➔ **Bowman's capsule** - **Reabsorption** returns some of the filtered materials back to the blood.
    - ➔ The fluid that remains is called urine. Urine contains urea, excess salts, and other substances. Some of the water is removed from the urine in a structure called **the loop of Henle**

Excretory System





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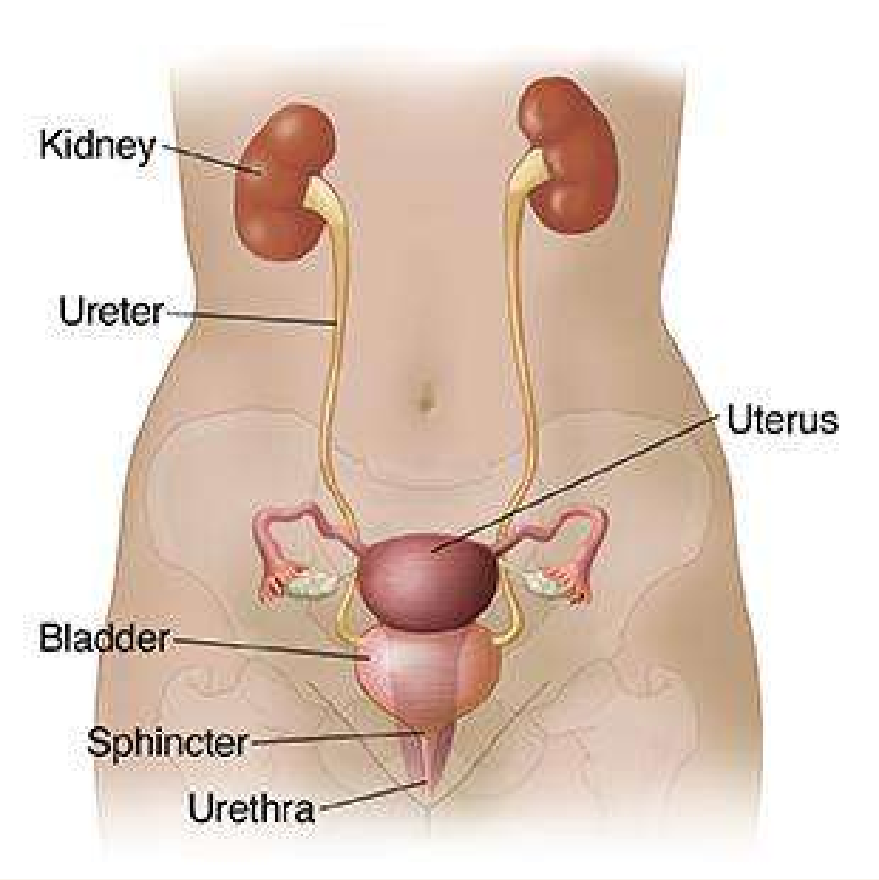
Urinary Tract



- A tube, called the **ureter**, leaves each kidney and carries urine to the urinary bladder.
- The **urinary bladder** is a saclike organ that stores urine until it can be released from the body.
- Urine passes from the body through a tube called the **urethra**.
- The kidneys are controlled by hormones and by the composition of the blood. If the blood becomes too concentrated, the kidneys return more water to the blood. If the blood becomes too diluted, the kidneys return less water to the blood - **Negative Feedback**

Lymphatic System

- As blood circulates, some fluid leaks from the blood into the surrounding tissues.
- However, more than 3 liters of fluid leak from the circulatory system into surrounding tissues every day. A network of vessels, nodes, and organs called the lymphatic system (figure right) collects the fluid that is lost by the blood and returns it back to the circulatory system.
- The fluid is known as lymph.
  - Lymph collects in lymphatic capillaries and slowly flows into larger and larger lymph vessels. Like large veins, lymph vessels contain valves that prevent lymph from flowing backward.
  - Returns it to the circulatory system through two openings in the superior vena cava.
  - Along the length of the lymph vessels are small bean-shaped enlargements called lymph nodes. Lymph nodes act as filters, trapping bacteria and other microorganisms that cause disease.
  - Certain lymphocytes called T cells mature in the thymus before they can function in the immune system. T cells are the cells that recognize foreign “invaders” in the body. The spleen helps to cleanse the blood and removes damaged blood cells from the circulatory system.

Lymphatic System

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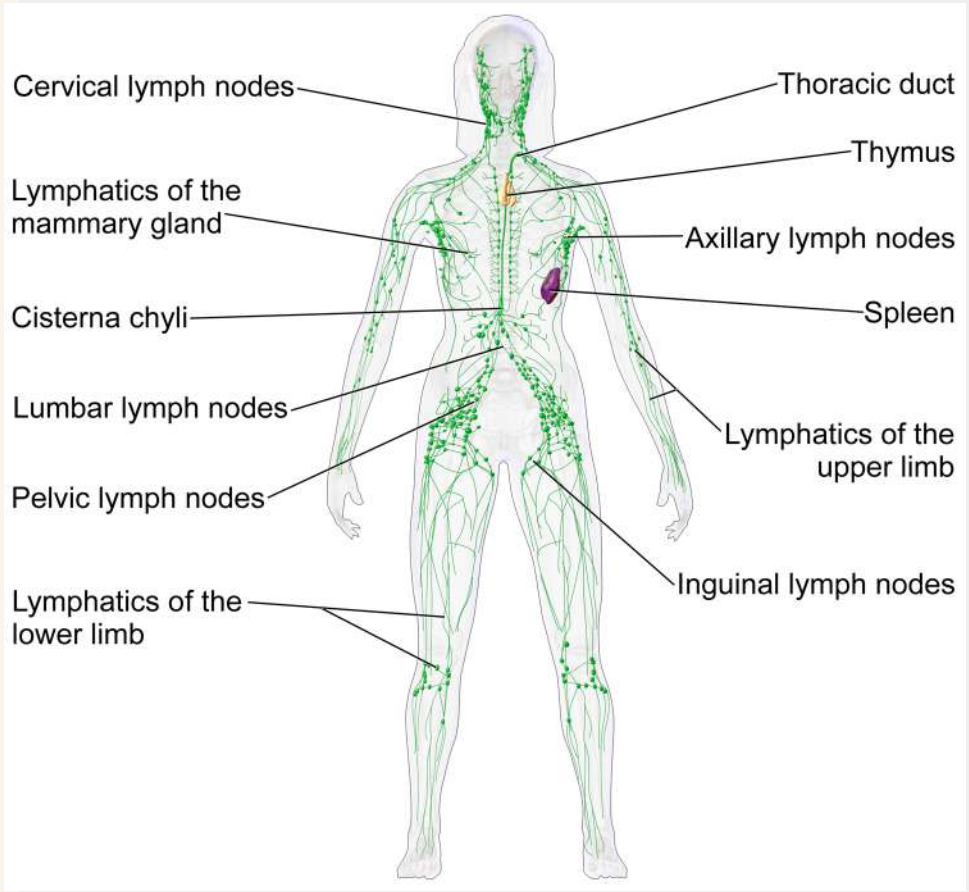
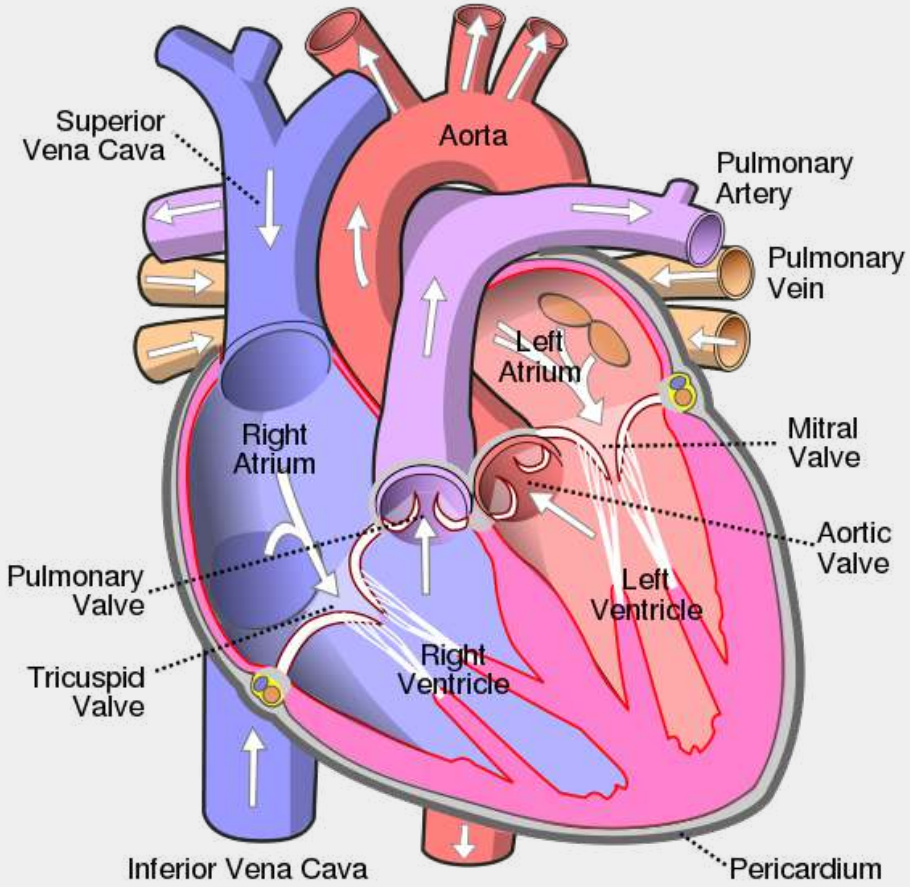


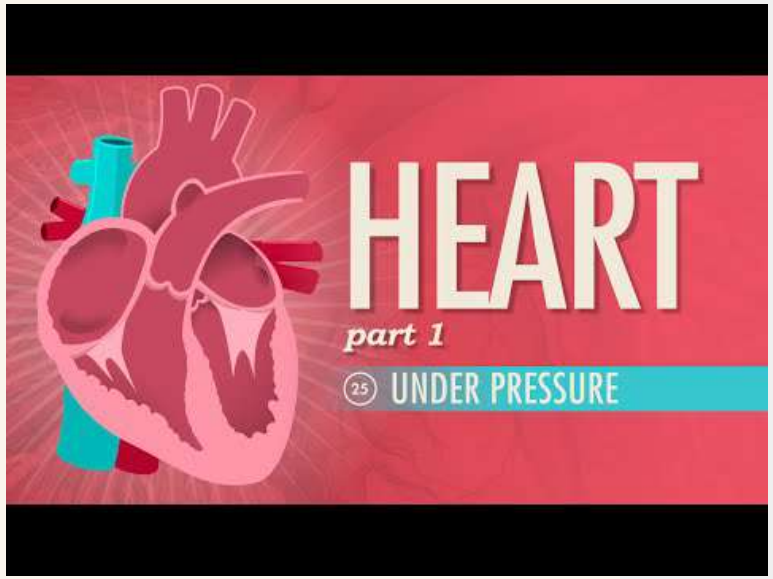
Green, Hank. "Crashcourse." *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

Circulatory System

- The **circulatory system** consists of: **heart, blood vessels, and blood**.
- Together with the respiratory system, the circulatory system supplies the body's cells with nutrients and oxygen and removes carbon dioxide and other wastes from the body.
- The heart is located near the center of the chest. It is composed almost entirely of muscle.
  - Contractions of the myocardium pump blood through the circulatory system.
  - The heart is divided into right and left halves by a wall called the **septum**. Each half of the heart has two chambers, for a total of four chambers.
  - The upper two chambers, or **atria** (singular: atrium), receive blood entering the heart.
  - The lower two chambers, or **ventricles**, pump blood out of the heart.
  - The right side of the heart pumps blood from the heart to the lungs. This pathway is the **pulmonary circulation**.
  - The left side of the heart pumps blood to the rest of the body. This pathway is the **systemic circulation**.



Circulatory System



Crash Course - Heart 1: LINK

Crash Course -Heart 2: LINK

Green, Hank. "Crashcourse." *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

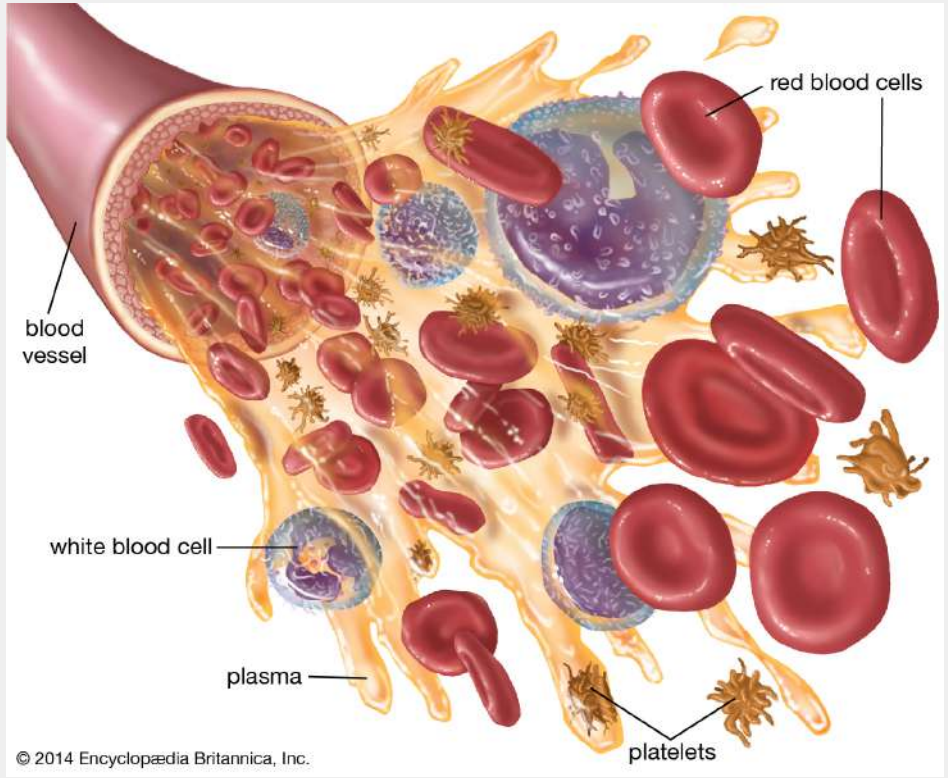
Hasudungan, Armando. "Armando Hasudungan." *YouTube*, YouTube, https://www.youtube.com/@armandohasudungan/search.

Vessels of the C.S.

- When blood leaves the heart for the body, it passes into a large blood vessel called the **aorta**.
- As blood flows through the rest of the circulatory system, it moves through three types of vessels: arteries, capillaries, and veins.
    1. **Arteries** are large vessels that carry blood away from the heart. From arteries, blood flows into capillaries, the smallest vessels.
    2. **Capillaries** bring nutrients and oxygen to the cells and absorb carbon dioxide and other wastes.
    3. From the capillaries, blood flows into **veins** and is returned to the heart. Large veins contain valves that keep blood moving toward the heart. The pumping of the heart produces pressure. The force of the blood on artery walls is called blood pressure.
- Diseases of the circulatory system, called cardiovascular diseases, are leading causes of death.
- Two causes of these diseases are high blood pressure and **atherosclerosis** (figure right), in which fatty deposits build up in arteries. Both high blood pressure and atherosclerosis force the heart to work harder and can lead to heart attack and stroke. Cardiovascular diseases are easier to prevent than cure.

Blood

- **Blood** is a type of connective tissue containing dissolved substances and specialized cells.
- Blood is almost half cells and just over half fluid. The fluid portion of blood is called plasma.
  - **Plasma** is mostly water. Proteins in plasma help to clot blood and fight infections.
  - Cells in blood include **red blood cells, white blood cells, and platelets**. Red blood cells transport oxygen.
  - A protein called **hemoglobin** in red blood cells binds to oxygen and carries it throughout the body.
  - **White blood cells** guard against infection, fight parasites, and attack bacteria. There are many types of white blood cells. White blood cells known as lymphocytes produce antibodies. **Antibodies** are proteins that help fight infection.
  - **Platelets** — along with plasma proteins—make blood clotting possible. Platelets cluster around a wound and release proteins called clotting factors, leading to the formation of a clot.



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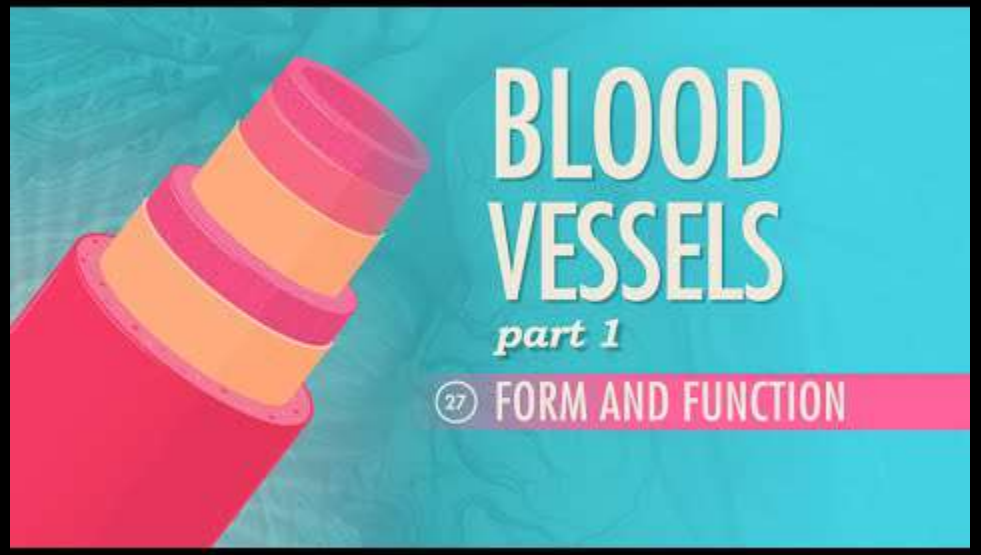

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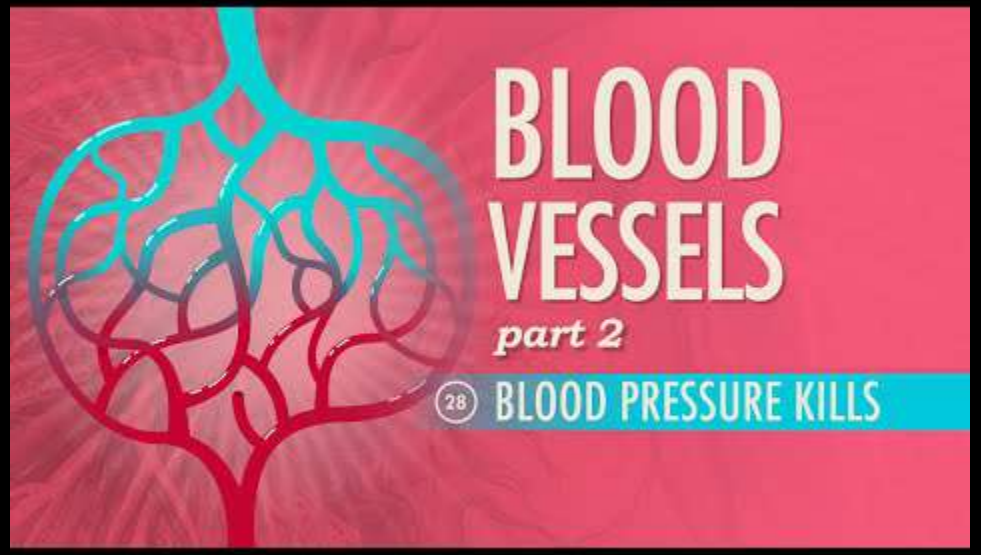
Crash Course - Vessels 2: LINK

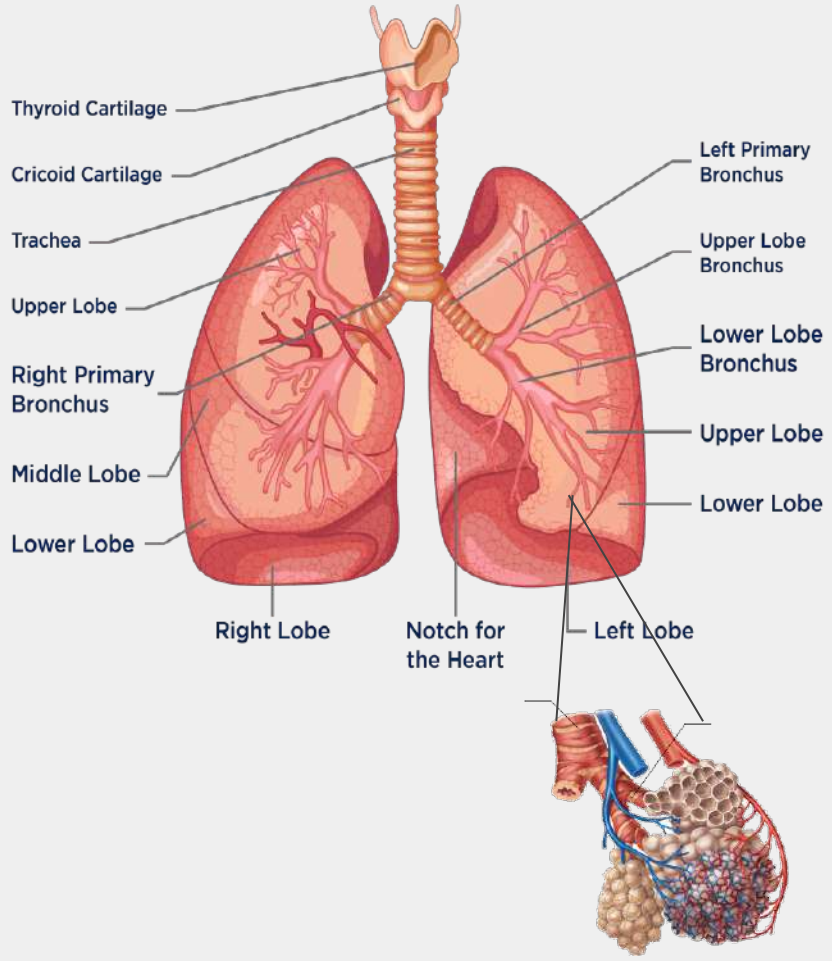


Crash Course - Blood 2: LINK

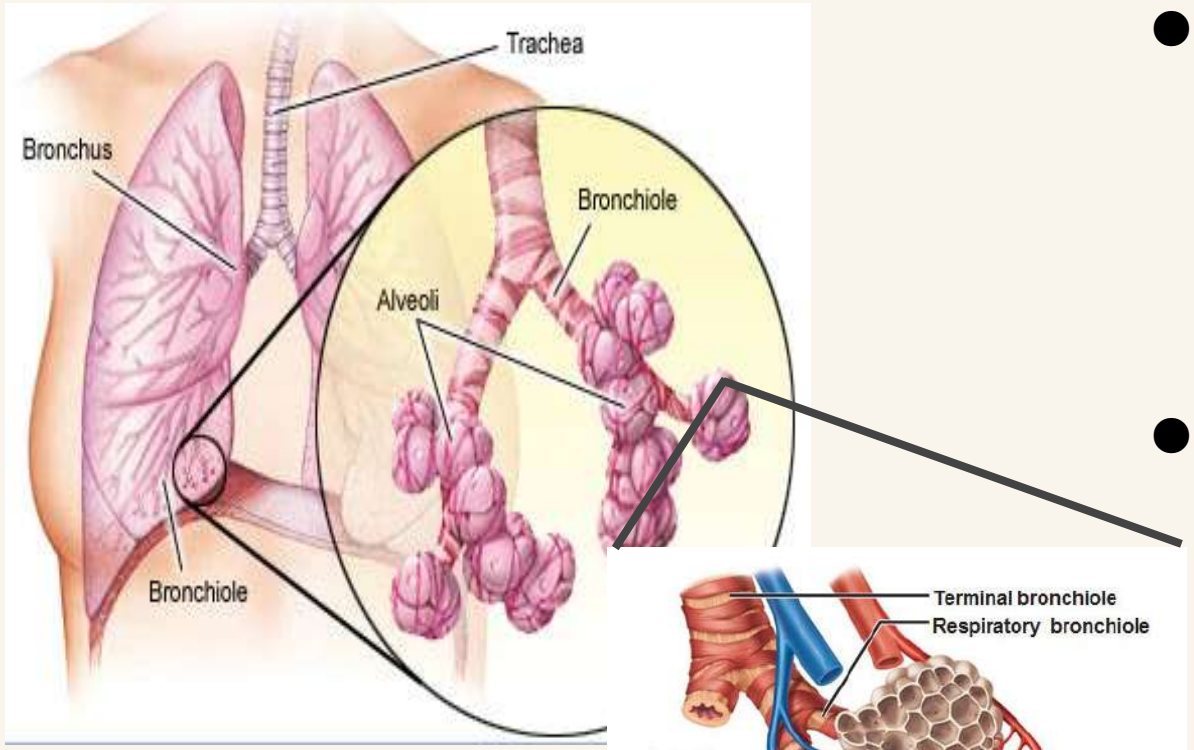
Green, Hank. “Crashcourse.” *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

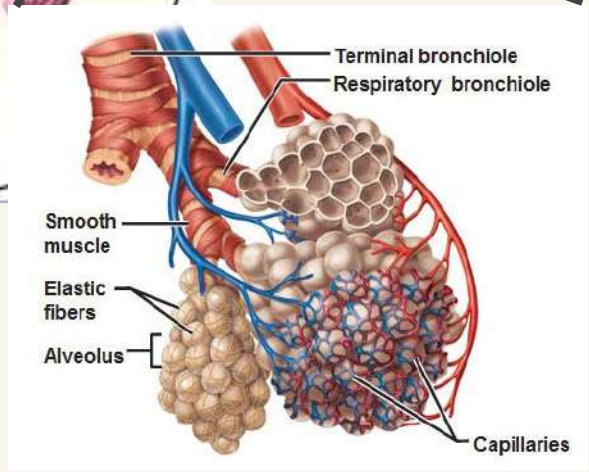
Respiratory System

- One meaning of **respiration** is the exchange of gases between an organism and the environment. The human respiratory system brings about the exchange of oxygen and carbon dioxide between the blood, the air, and tissues.
- The **respiratory system** (figure right) consists of the **nose → pharynx → larynx → trachea → bronchi → bronchioles → lungs → alveoli.**
  - Air from the nose enters the **pharynx**, a tube in the throat. Air moves from the pharynx into the trachea.
  - At the top of the **trachea** is the **larynx**, which contains the vocal cords.
  - From the trachea, air passes into two large passageways in the chest called **bronchi** (singular: bronchus).
  - Each bronchus leads into one of the **lungs**. Within each lung, the bronchus subdivides into smaller passageways, called **bronchioles**.



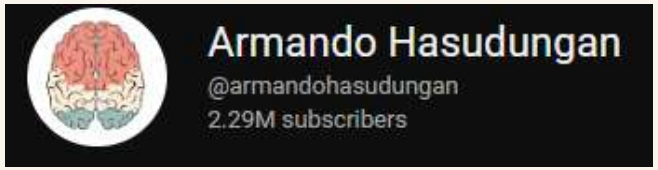
Alveoli & Gas Exchange



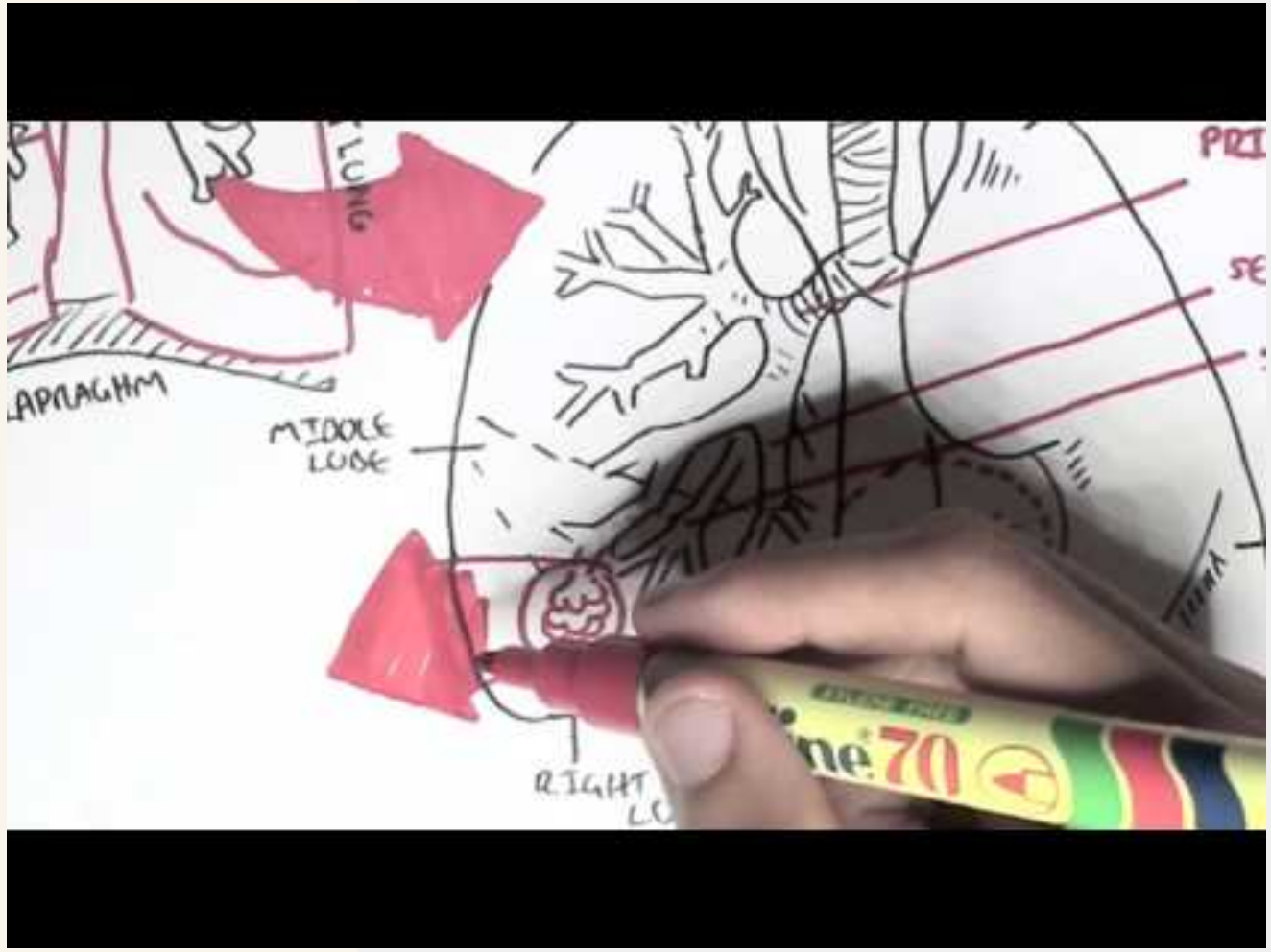


- The **bronchioles** continue to subdivide until they reach millions of tiny air sacs called **alveoli** (singular: alveolus). Each alveolus is surrounded by capillaries.
  - ➔ Oxygen crosses the thin capillary walls from the alveolus into the blood. Carbon dioxide in the blood crosses in the opposite direction into the alveolus
- Breathing (figure left) is the movement of air into and out of the lungs. At the bottom of the chest cavity is a muscle called the **diaphragm**.
  - ➔ When the **diaphragm contracts** the chest cavity becomes larger. This creates a partial vacuum in the chest. Air pressure causes air to rush in and fill the lungs.
  - ➔ When the **diaphragm relaxes**, the chest cavity becomes smaller. Increased pressure inside the chest forces air back out of the lungs. The rate of breathing is controlled by the level of carbon dioxide in the blood.

Respiratory System

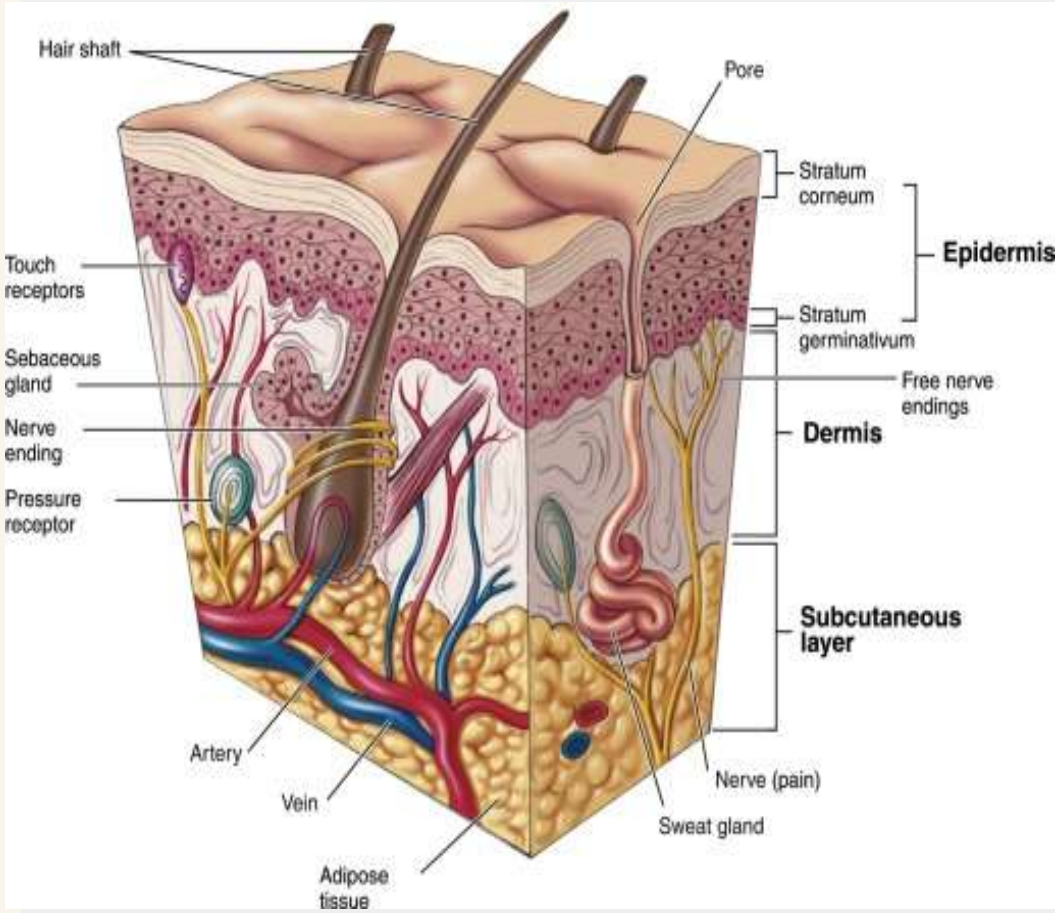


Hasudungan, Armando. “Armando Hasudungan.” *YouTube*, YouTube, https://www.youtube.com/@armandohasudungan/search.

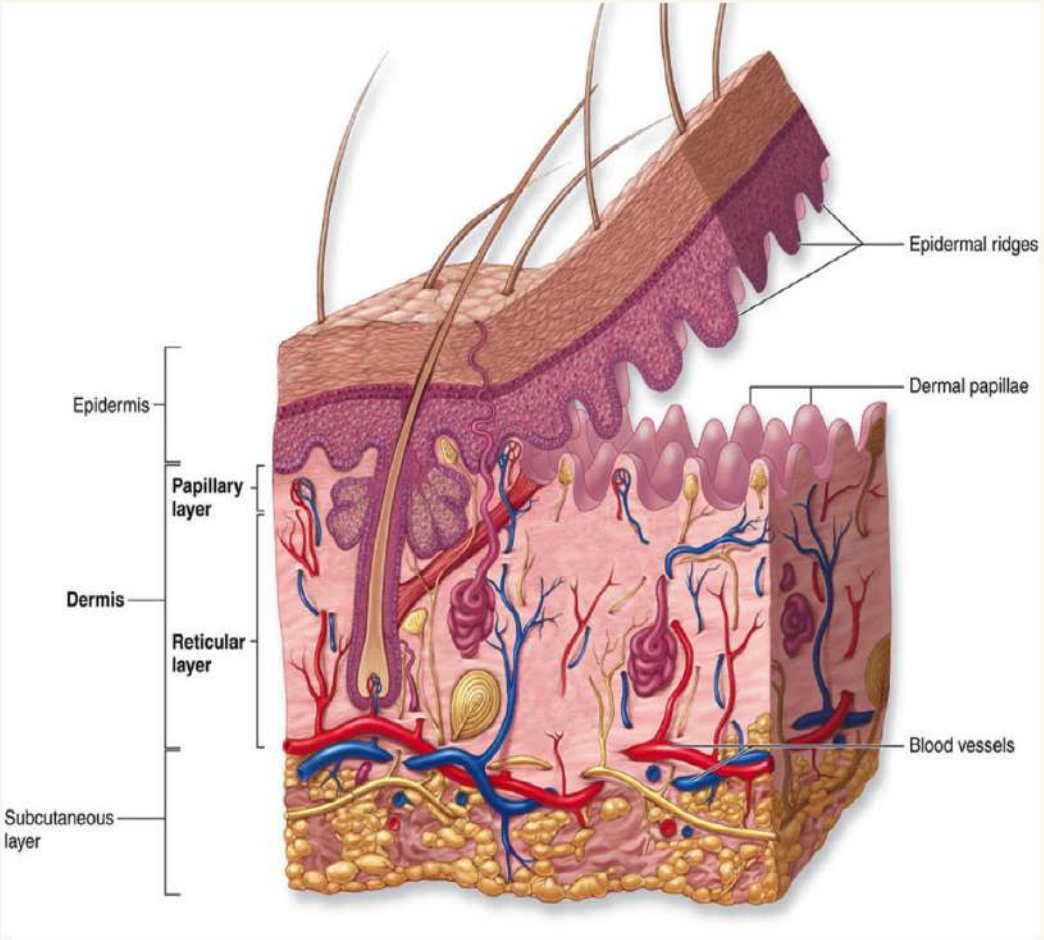


Integumentary System

- The **skin** is the single largest organ of the body. It is also the largest component of the **integumentary system.**
- The integumentary system:
  - serves as a barrier against infection and injury
  - helps to regulate body temperature
  - removes waste products from the body
  - and provides protection against ultraviolet radiation from the sun.
- The skin is made up of two main layers: the **epidermis** and the **dermis**.
  - The epidermis (figure right) is the outer layer of the skin. Cells of the epidermis produce keratin. **Keratin** is a tough, fibrous protein that helps keep the epidermis flexible and waterproof. The epidermis also contains cells, called melanocytes, which produce melanin. **Melanin** is a dark brown pigment that helps protect the skin from ultraviolet rays.

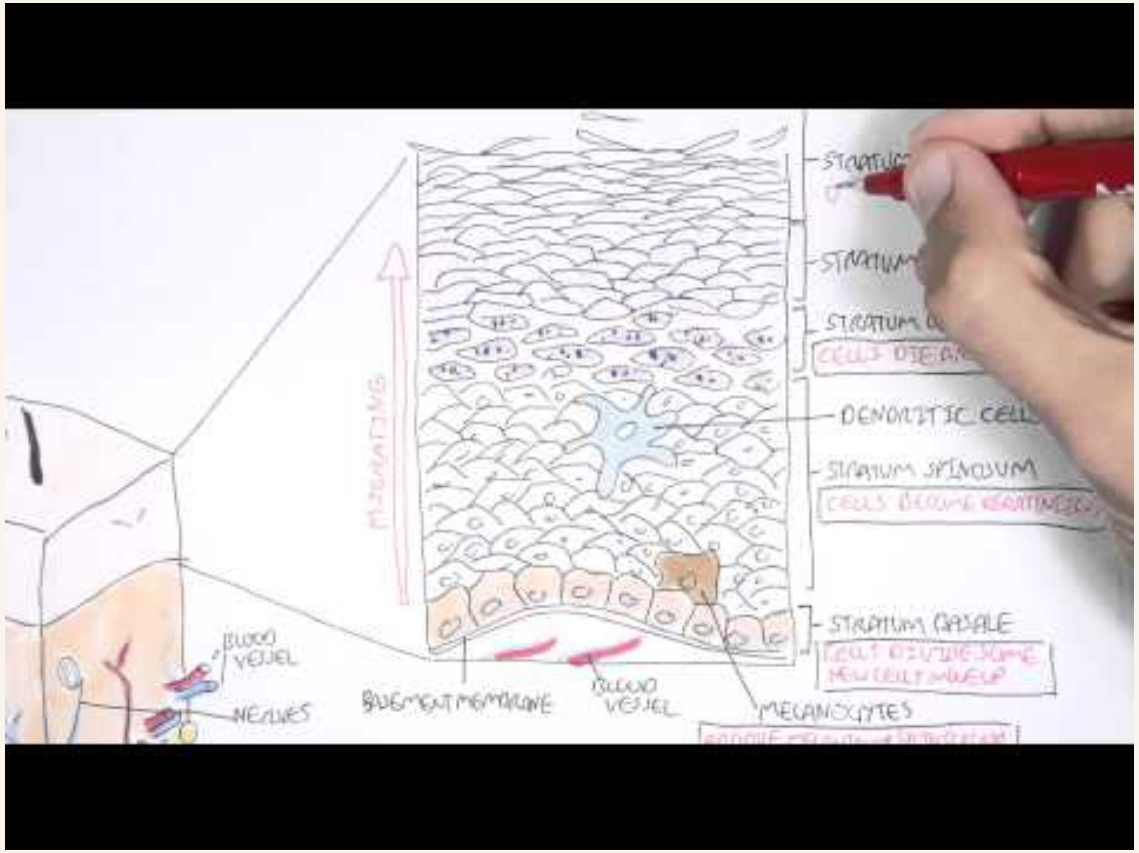


Dermis



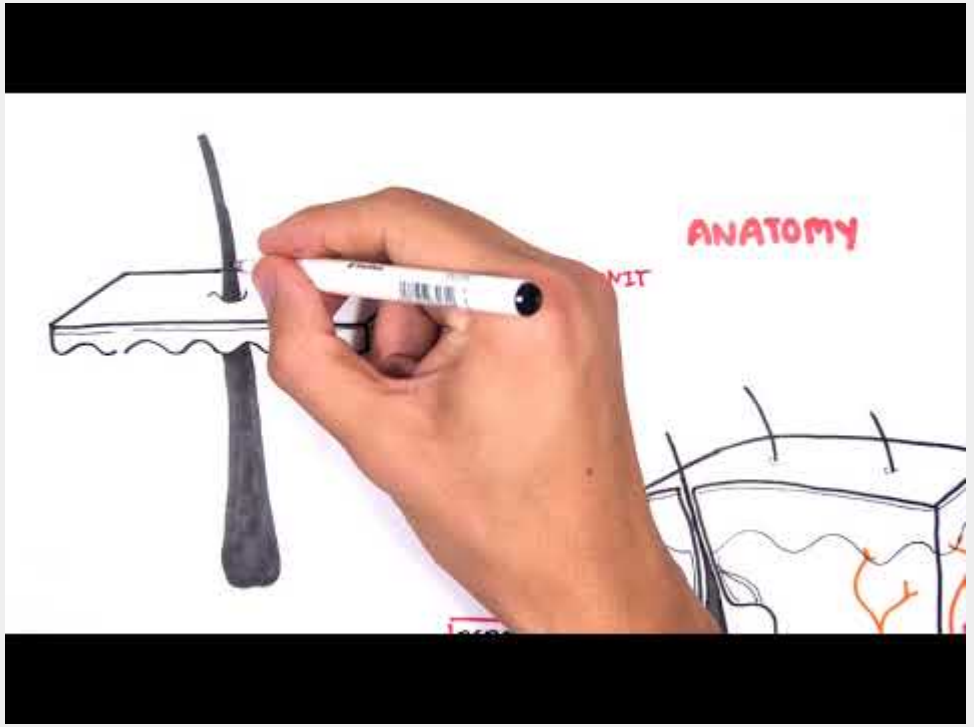
- The **dermis** is the inner layer of skin. It contains nerves, blood vessels, glands, and other structures not found in the epidermis.
- The dermis works with other organs to maintain homeostasis.
    1. It helps to regulate body temperature. Sweat glands in the dermis produce sweat when the body gets too hot. When the sweat evaporates from the skin, it cools the body. Too much sunlight can produce skin cancer.
    2. Both hair and nails are composed mainly of keratin. Hair on the head protects the scalp from sunlight and cold. Hair in the nostrils and around the eyes prevents dirt from entering the body. Hair is produced by structures called hair follicles. Hair follicles are located in the dermis. Nails grow from an area called the nail root. Nails protect the tips of the fingers and toes.

Integumentary System



The Skin Anatomy, Physiology and Microbiology

Introduction to Skin Anatomy and Physiology



Armando Hasudungan
@armandohasudungan
2.29M subscribers

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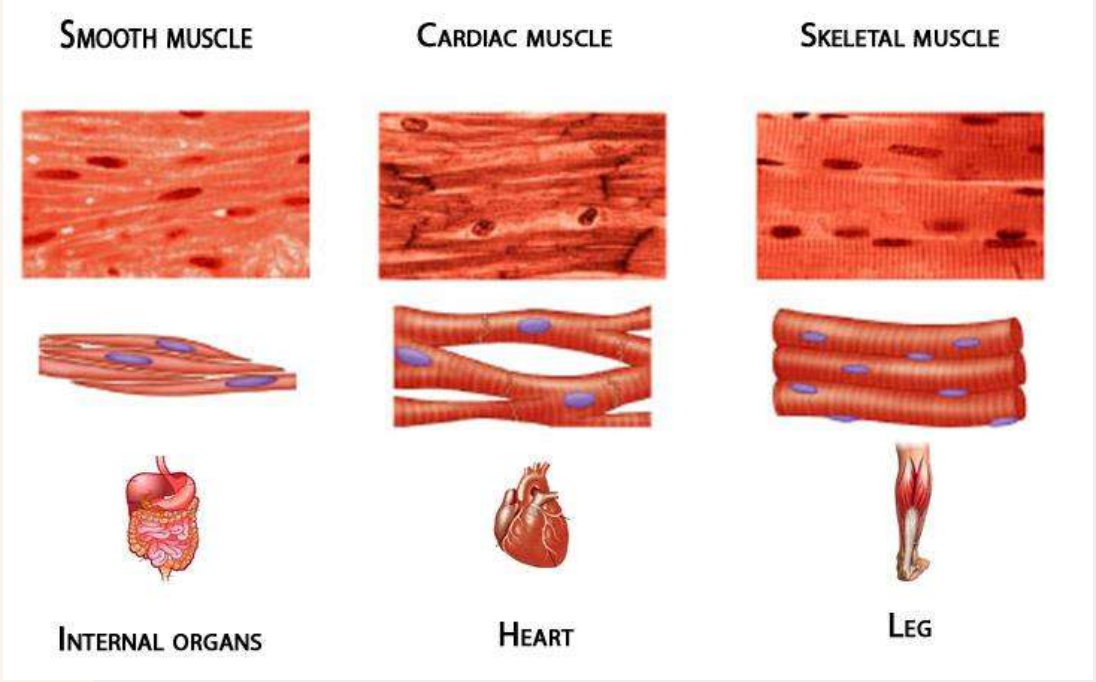
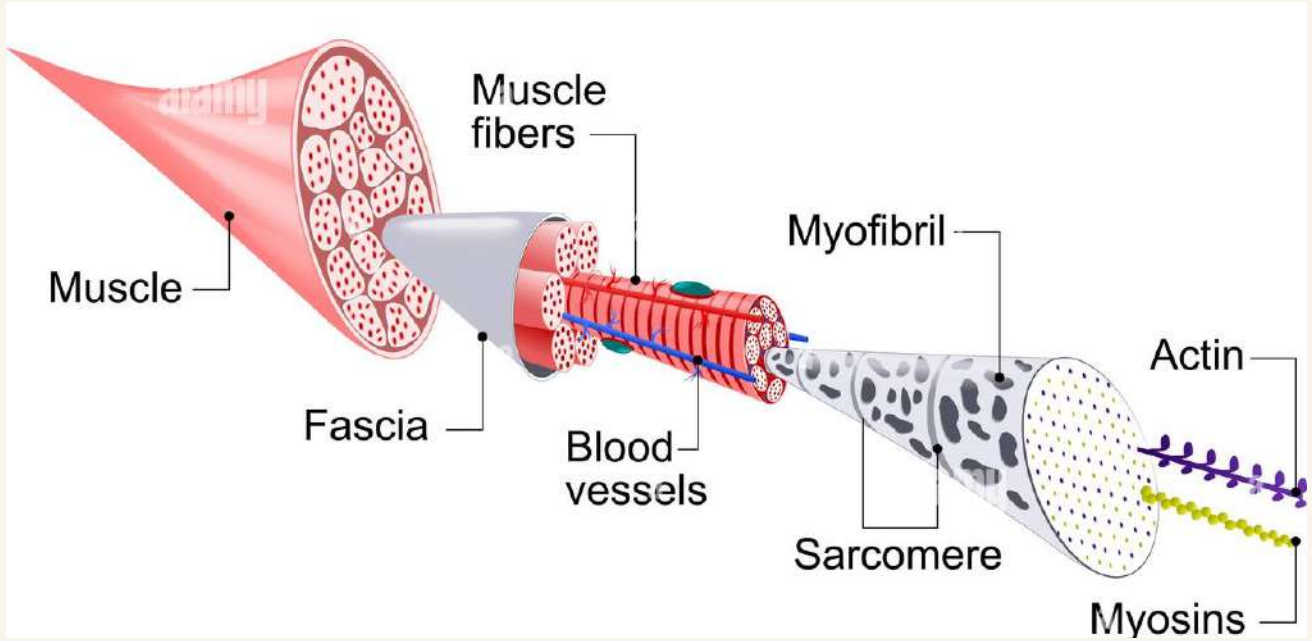
Muscular System

- **Muscle tissue** is found everywhere in the body.
- There are three different types of muscle tissue:
  - skeletal, smooth, and cardiac (figure right).
  - **Skeletal muscles** are usually attached to bones. They appear to be striped, so they are also called striated muscles. Skeletal muscles are responsible for voluntary movements such as dancing.
  - **Smooth muscles** line blood vessels and the digestive tract. They are not striated or under conscious control. Smooth muscles move food through the digestive tract and control the flow of blood through the circulatory system.
  - **Cardiac muscle** is found only in the heart. Like smooth muscle, it is not under conscious control. Skeletal muscle cells are called muscle fibers.



Muscle Fibers

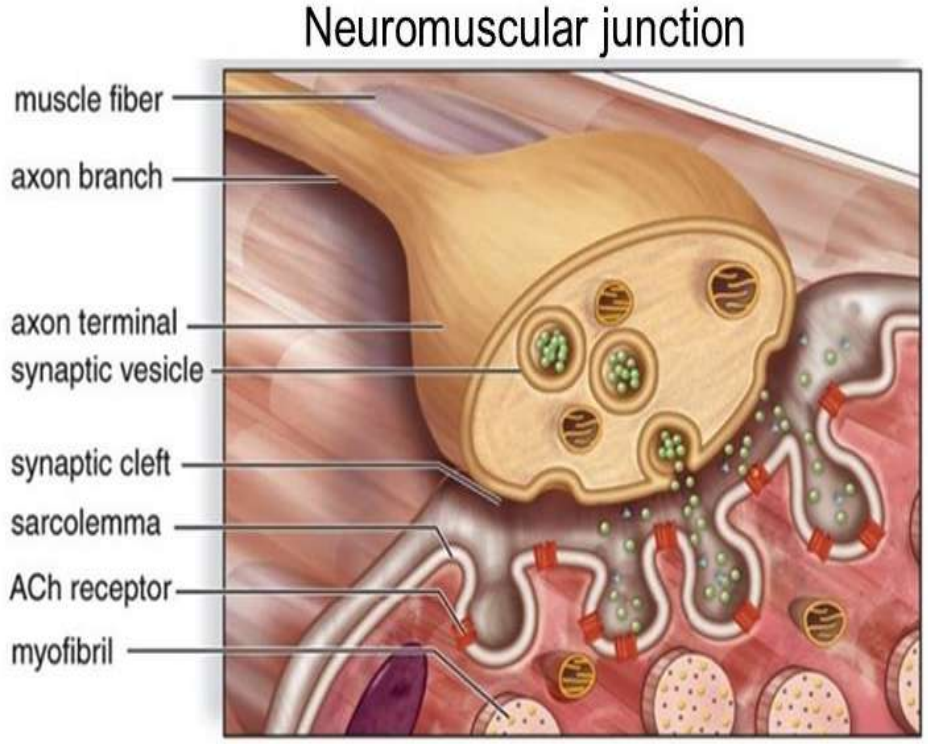


- Muscle fibers are composed of smaller structures called **myofibrils**.
- Each myofibril is made up of even smaller structures called filaments.
  - ➔ Filaments can be thick or thin.
  - ➔ Thick filaments are made of a protein called **myosin**.
  - ➔ Thin filaments are made of a protein called **actin**.
  - ➔ A muscle contracts when the thin filaments in the muscle fiber slide over the thick filaments.

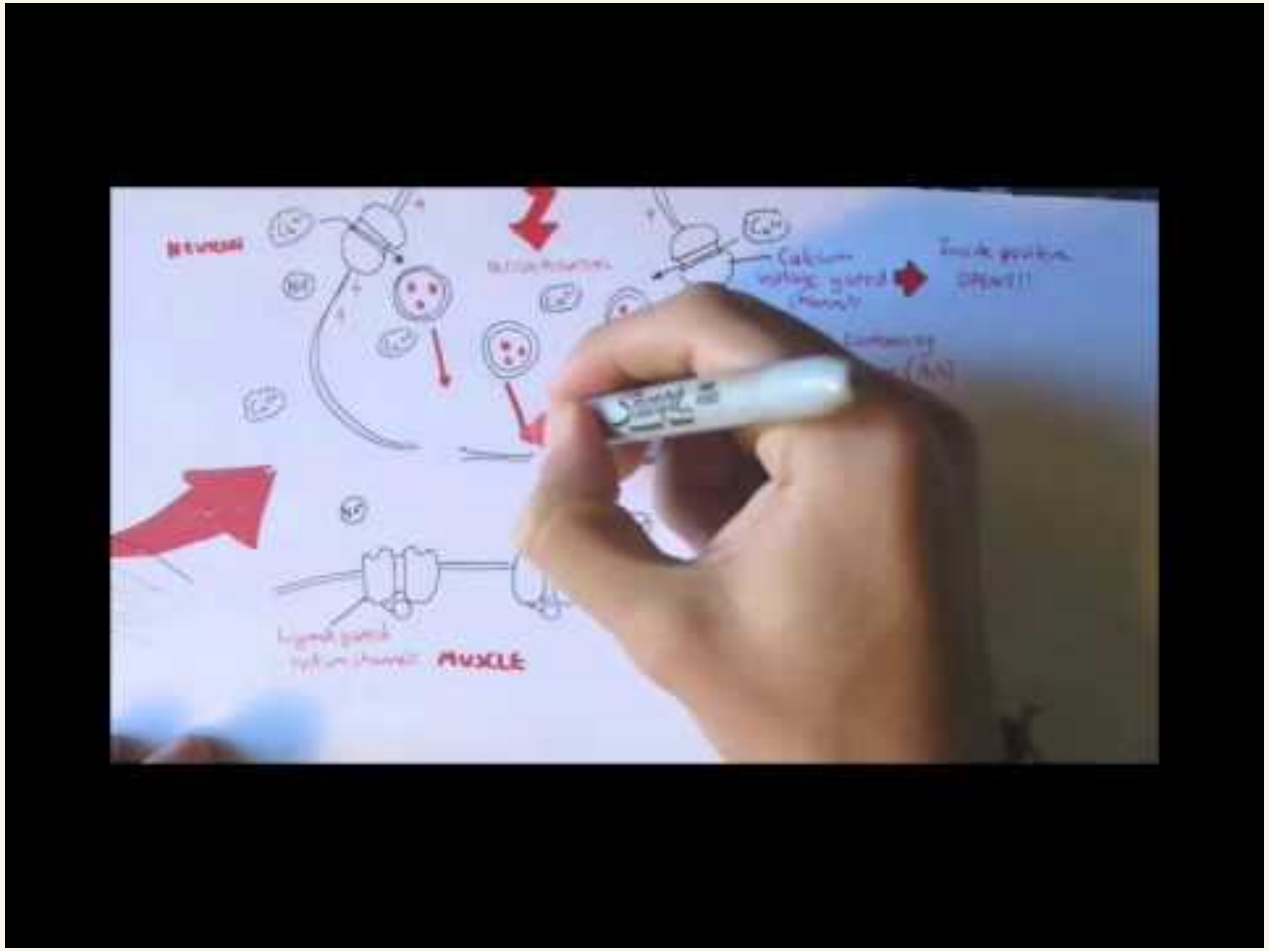
Neuromuscular Interaction

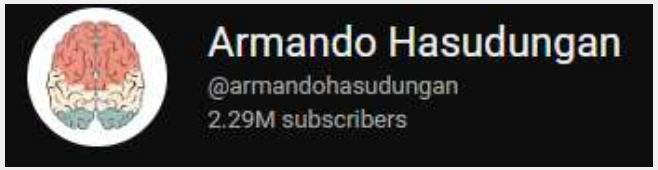
Impulses from motor neurons control the contraction of skeletal muscles.

- The point of contact between a motor neuron and a muscle fiber is called a **neuromuscular junction** (figure right).
- A **neurotransmitter** called **acetylcholine** is released by the motor neuron into the **synapse/synaptic cleft**.
  - Acetylcholine transmits the impulse across the synapse to the skeletal muscle cell. The more muscle cells that are stimulated to contract, the stronger the contraction.
  - Skeletal muscles are joined to bones by tough connective tissues called tendons. Tendons pull on bones and make them work like levers. Muscles provide the force to move the



Neuromuscular Junction





Neuromuscular Junction

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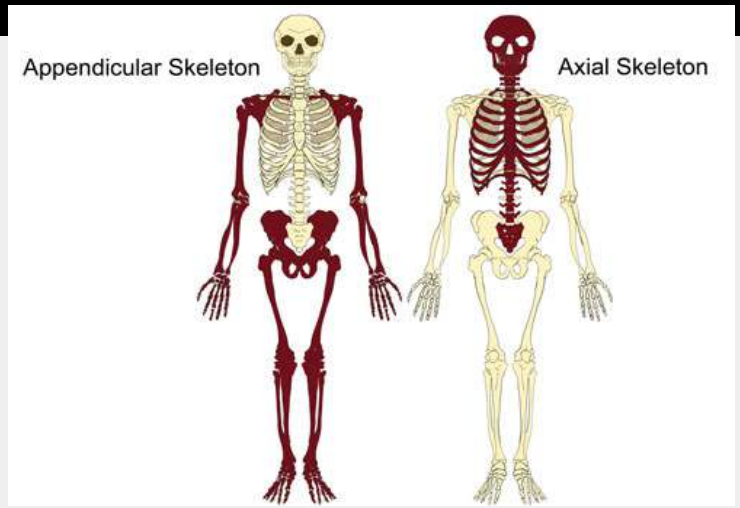
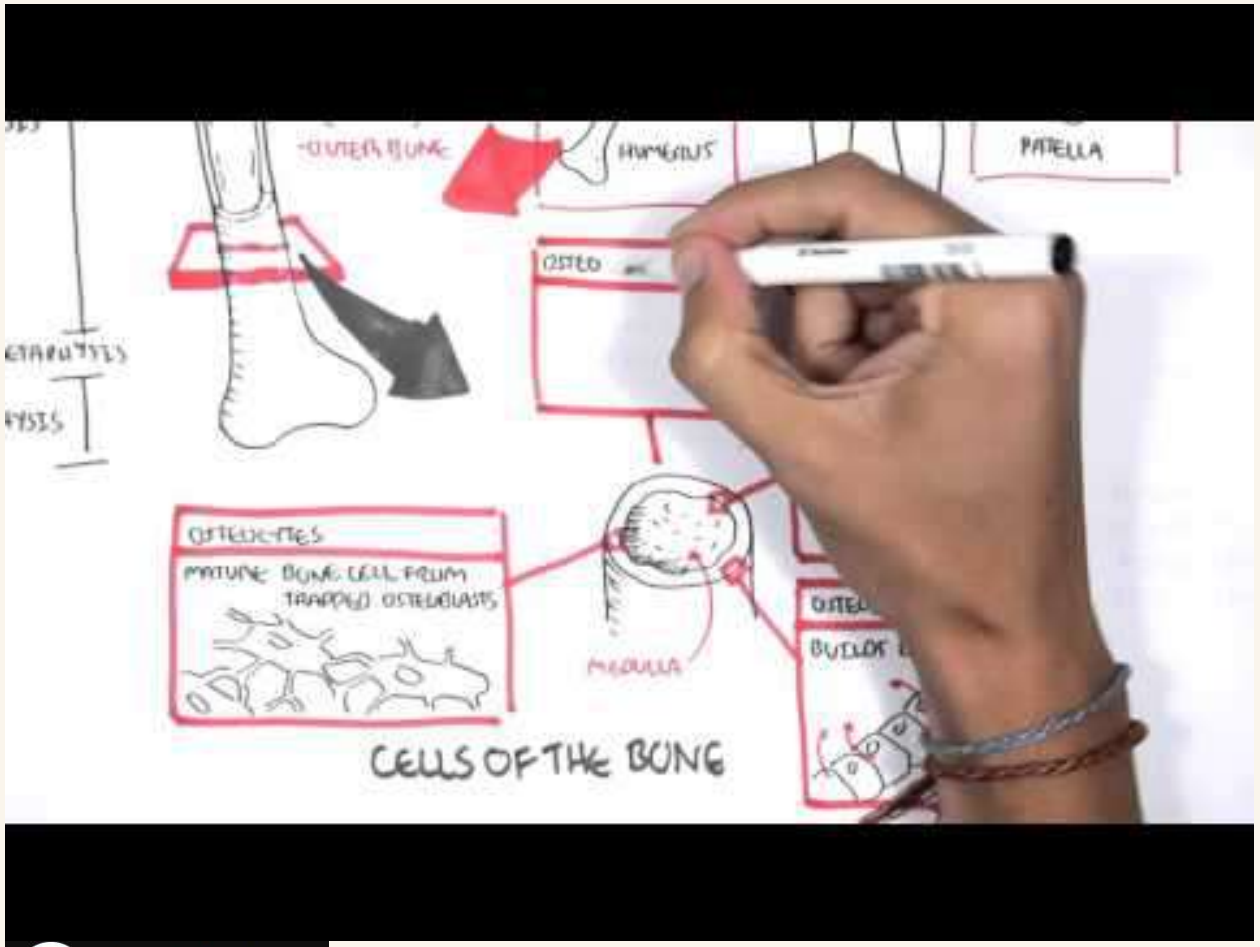
Skeletal System



- The **skeletal system:**
  - supports the body
  - protects internal organs
  - provides for movement
  - stores mineral reserves,
  - and provides a site for blood cell formation.
- The skeleton is divided into two parts (figure left):
  - The **axial skeleton** includes the skull, ribs, and spine.
  - The **appendicular skeleton** includes all the bones associated with the arms and legs, including bones of the shoulders, hips, hands, and feet.
- The **bones** that make up the skeletal system are living tissue. Bones are a solid network of living cells and protein fibers that are surrounded by deposits of calcium salts.
- A typical bone (figure left) is surrounded by a tough layer of connective tissue called the **periosteum**. Beneath the periosteum is a thick layer of compact bone.
  - Running through compact bone is a network of tubes called **Haversian canals**. These canals contain blood vessels and nerves.
  - Within bones are cavities that contain a soft tissue called bone marrow. **Bone marrow** can be yellow or red. Yellow marrow is fat. Red marrow produces blood cells.

Bone Structure



Armando Hasudungan
@armandohasudungan
2.29M subscribers

Skeletal System Overview

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The Skeletal System: Crash Course Anatomy & Physiology

Green, Hank. “Crashcourse.” *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

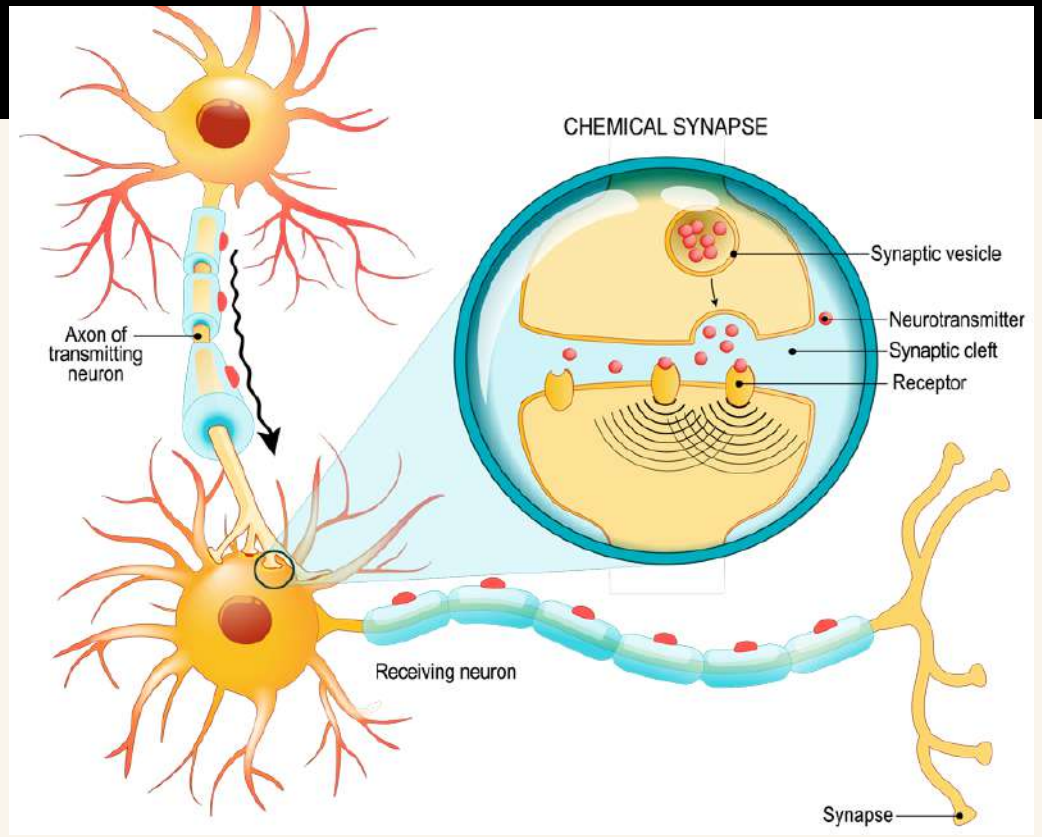
Muscular System

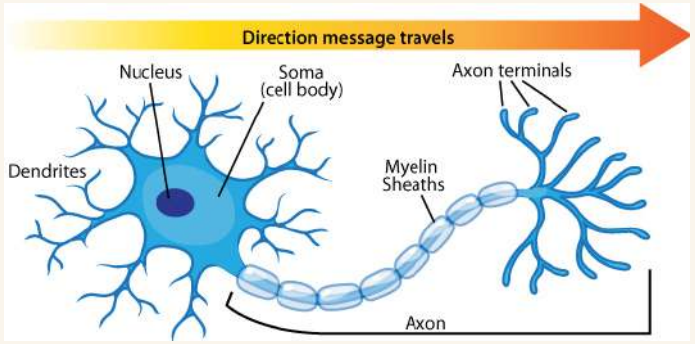
- The skeleton of an embryo is composed almost entirely of **cartilage**.
  - Cartilage is a type of connective tissue that is tough but flexible.
  - Cartilage is replaced by bone during the process of bone formation, **ossification**.
  - Ossification starts before birth and continues until adulthood.
- A place where one bone attaches to another bone is called a **joint**.
  - Joints permit bones to move without damaging each other.
    - ➔ Immovable joints, such as the joints in the skull, allow no movement.
    - ➔ Slightly movable joints, such as the joints in the spine, allow a small amount of restricted movement.
    - ➔ Freely movable joints permit movement in one or more directions. Freely movable joints are classified by the type of movement they permit. Ball-and-socket joints, such as the shoulder, allow the widest range of movement of any joint.
    - ➔ Hinge joints, such as the knee, permit only back-and-forth movement. Strips of tough connective tissue, called **ligaments**, hold bones together in a joint. The bony surfaces of the joint are covered with cartilage.
    - ➔ **Arthritis** is a disorder that involves inflammation of the joints. **Osteoporosis** is a condition in

Joints: Crash Course Anatomy & Physiology - Crash Course

Green, Hank. "Crashcourse." *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

Nervous System





- The **nervous system** controls and coordinates functions throughout the body and responds to internal and external stimuli.
- Messages carried by the nervous system are electrical signals called **impulses**.
- Cells that transmit impulses are called **neurons**.
  - A neuron has a cell body containing the **nucleus**.
  - Short branches, called **dendrites**, carry impulses toward the cell body.
  - A long fiber, called the **axon**, carries impulses away from the cell body.
  - A **myelin sheath** surrounds parts of the axon in some neurons. Impulses can jump over the myelin and travel faster.
  - A resting neuron is one that is not transmitting an impulse. At the end of the axon is a synapse.
  - A synapse is the location at which a neuron can transfer an impulse to another cell. Chemicals called **neurotransmitters** transmit impulses across the synapse.

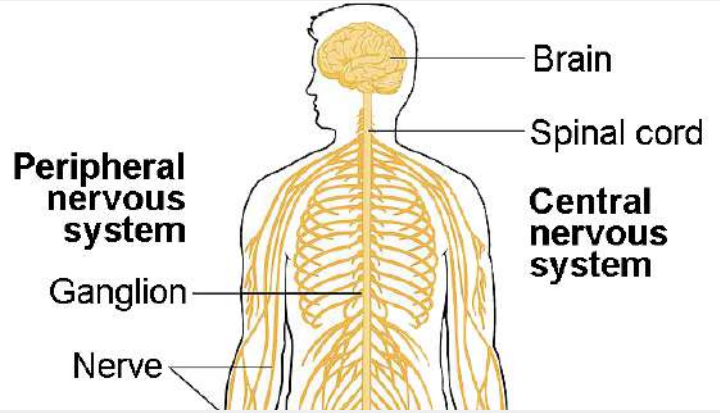
Nervous System

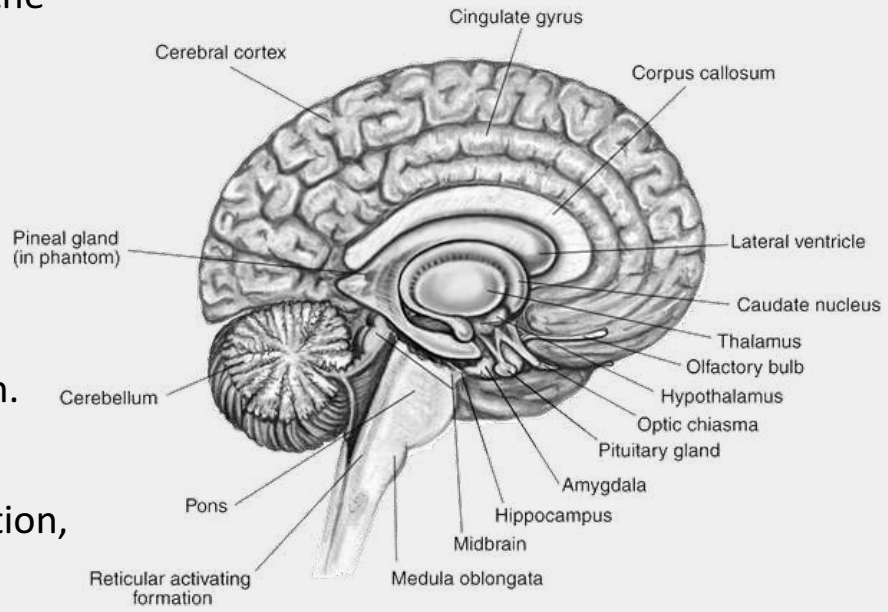
The Nervous System, Part 1: Crash Course Anatomy & Physiology

Green, Hank. "Crashcourse." *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

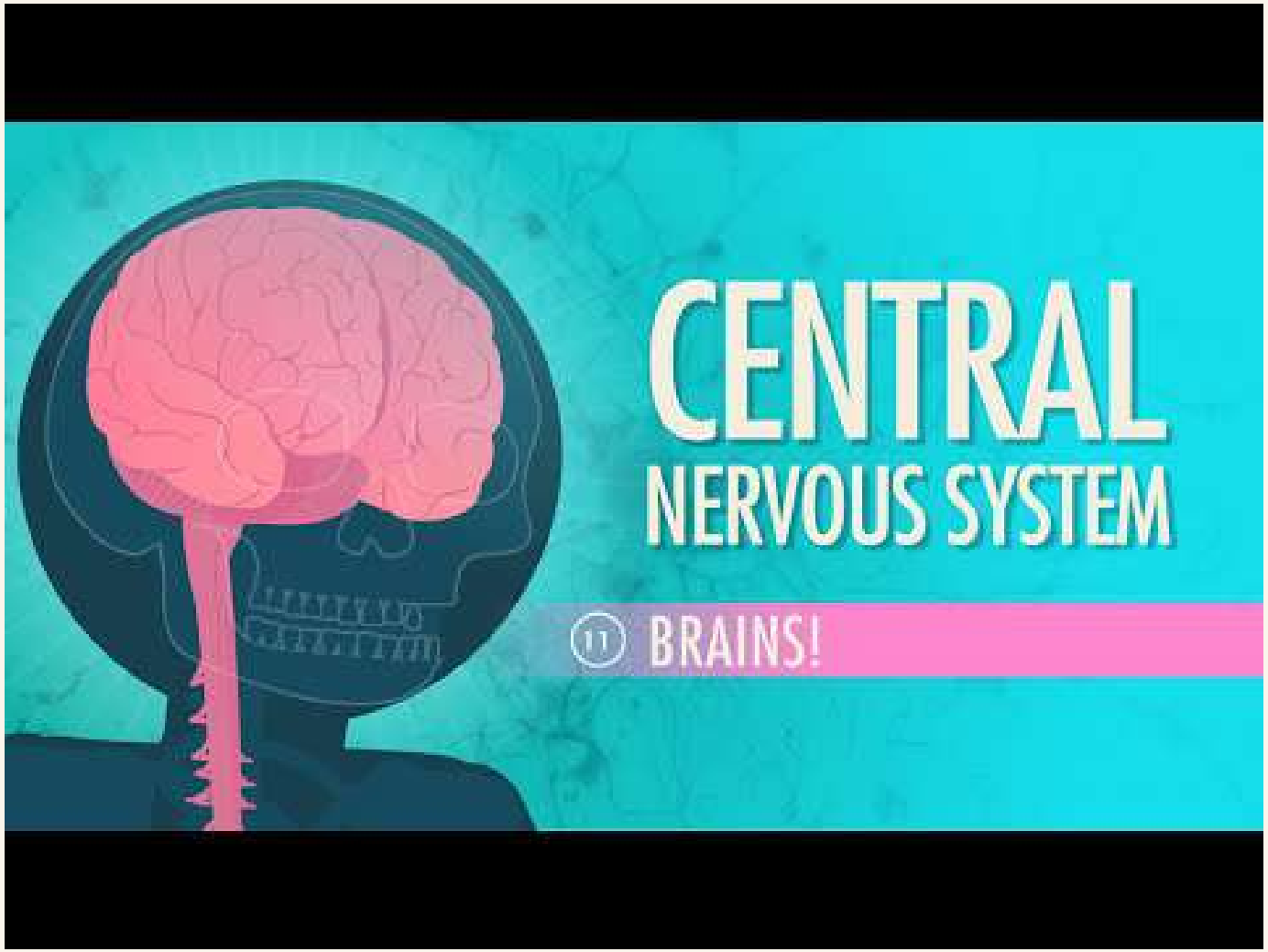
Nervous System

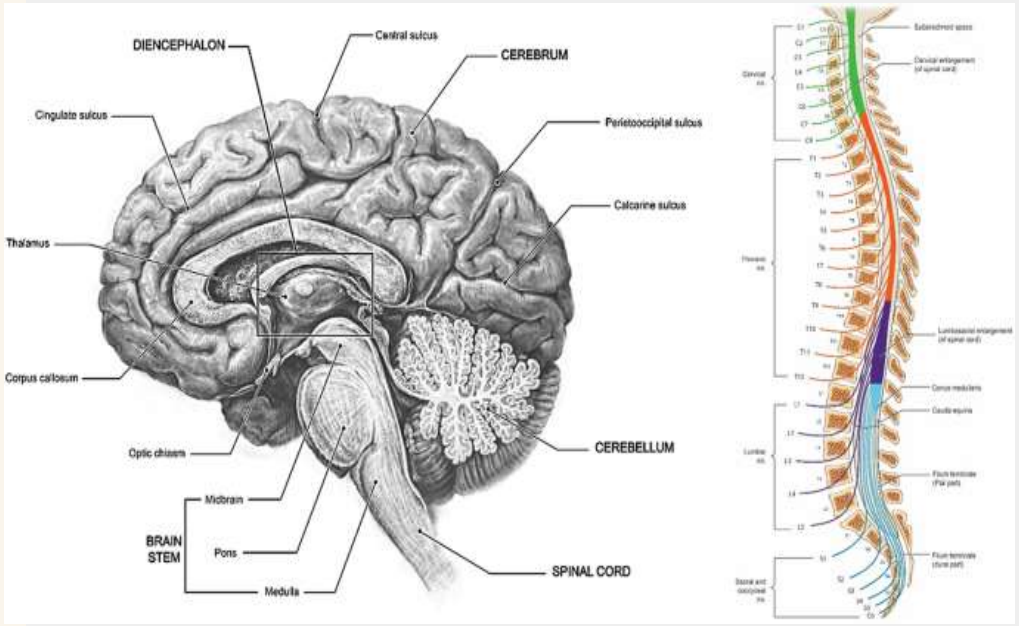
- **Divisions of the Nervous System** -
  - The **Central Nervous System (CNS)** is the control center of the body. It relays messages, processes information, and analyzes information.
    - ➔ The central nervous system consists of the brain and **spinal cord**.
    - ➔ Both are wrapped in layers of tissue called meninges. Between the meninges and nervous tissue is cerebrospinal fluid, which cushions and protects nervous tissue.
  - The **Peripheral Nervous System (PNS)** carries messages back and forth between the environment and the central nervous system.
- The **brain** is divided into several regions.
  - The **cerebrum** controls voluntary actions.
  - The **cerebellum** controls actions of the muscles.
  - The **brain stem** controls basic body functions.
  - The **thalamus** receives impulses from the senses and sends them to the cerebrum.
  - The **hypothalamus** connects the nervous and endocrine systems.
  - The **spinal cord** connects the brain and rest of the body. Certain kinds of information, including some reflexes, are processed directly in the spinal cord.





Central Nervous System



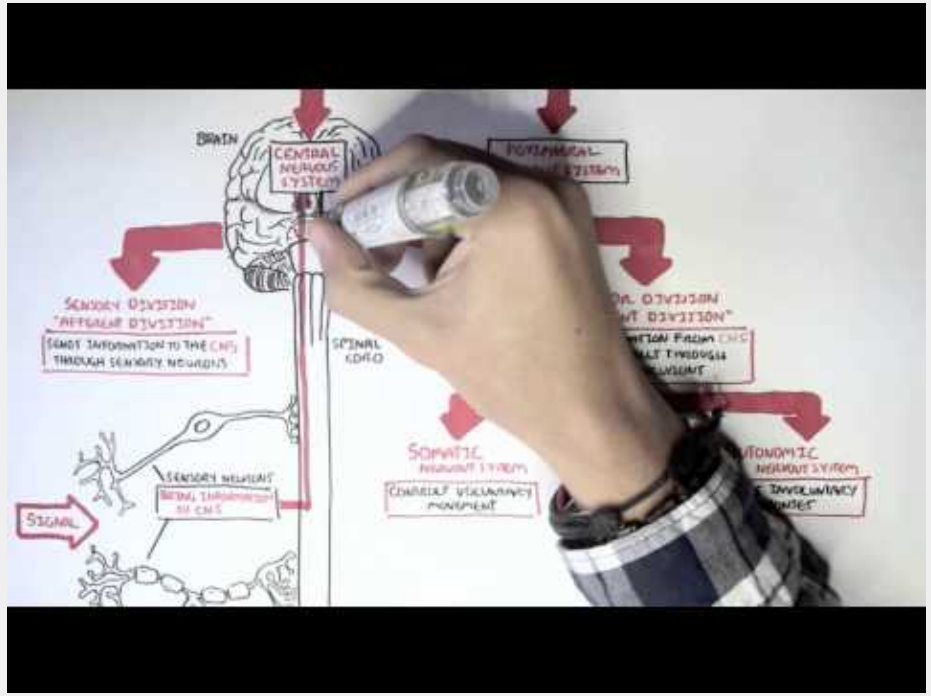


Central Nervous System: Crash Course Anatomy & Physiology

Green, Hank. "Crashcourse." *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

Peripheral Nervous System

- A reflex is a quick, automatic response to a stimulus.
- The pathway an impulse travels in a reflex is called the reflex arc.
- The PNS has two divisions.
    1. The Sensory division transmits impulses from sensory neurons to the central nervous system.
    2. The Motor division transmits impulses from the central nervous system to muscles and glands. The motor division is further divided into somatic and autonomic nervous systems.
        - ➔ The Somatic nervous system controls voluntary actions.
        - ➔ The Autonomic nervous system controls involuntary actions. The autonomic nervous system also has two divisions:
            3. The Sympathetic Nervous System is responsible for the body's response to emergency situations or the "fight or flight" response.
            4. The Parasympathetic Nervous System controls involuntary activities that are not emergencies. For example, it controls the organs of the digestive system so they can break down food eaten.



Neurology - Divisions of the Nervous System

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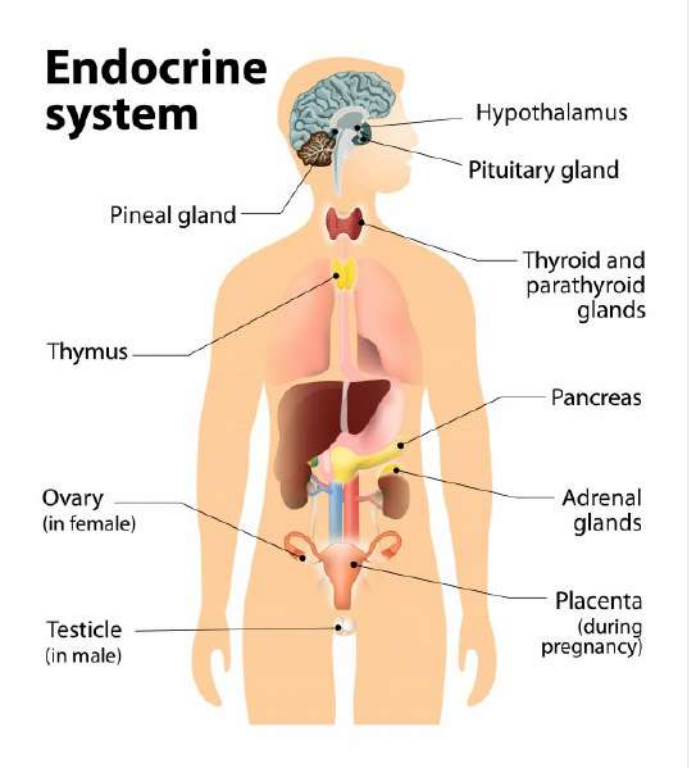
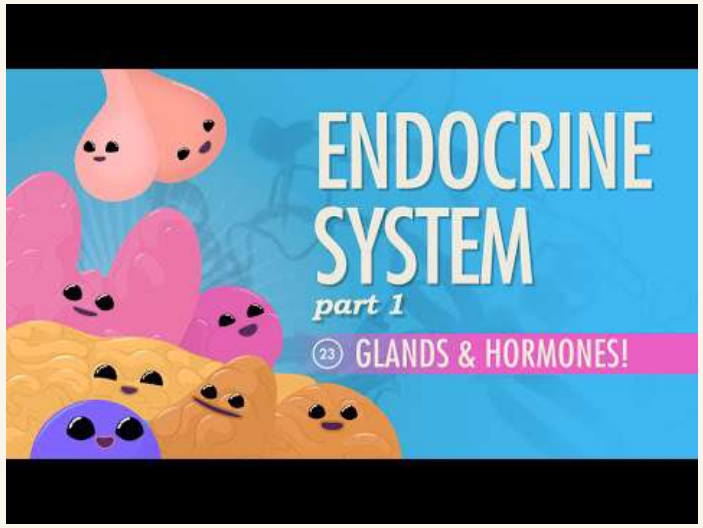
Endocrine System

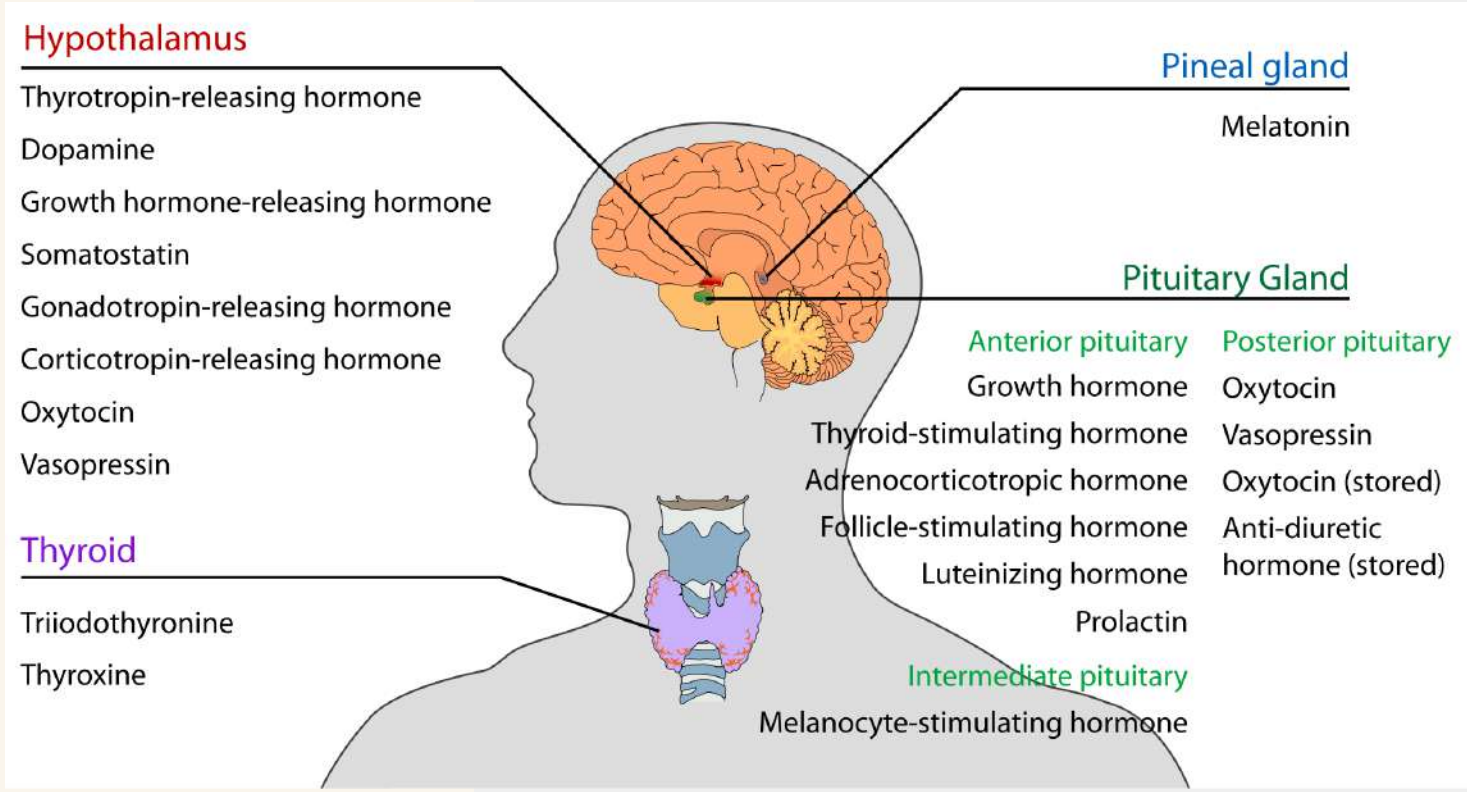
- The **endocrine system** consists of glands that release secretions into the bloodstream.
- The secretions are called **hormones**.
  - Hormones are chemicals released in one part of the body that travel throughout the body and affect cells elsewhere.
  - Bind to specific chemical receptors on cells called **target cells**.
- A **gland** is an organ that produces and releases a secretion.
  - Exocrine glands release their secretions through ducts directly to tissues and organs. There are two types of hormones.
    1. **Steroid hormones** can cross cell membranes of target cells, enter the nucleus, and turn genes on or off.
    2. **Non-steroid hormones** cannot cross cell membranes. Compounds called secondary messengers carry the messages of non-steroid hormones inside target cells.
- The endocrine system is regulated by feedback mechanisms that help maintain homeostasis. Two hormones with opposite effects may work together to maintain homeostasis. This is called **complementary hormone action.**

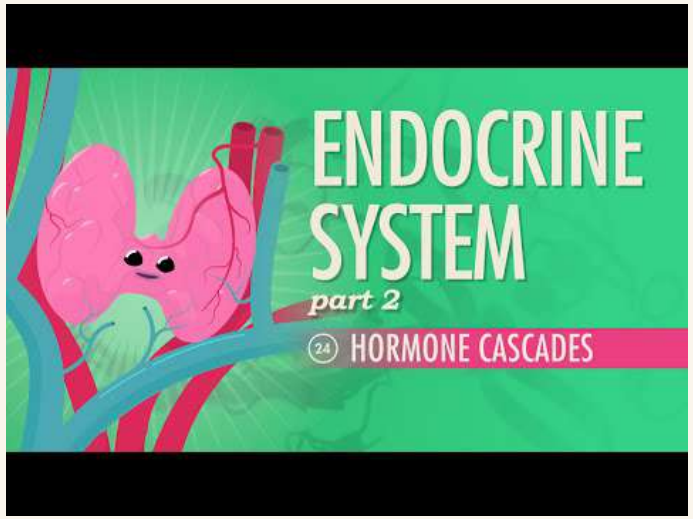


Hormones in the body



Endocrine System, Part 1 - Glands & Hormones: Crash Course



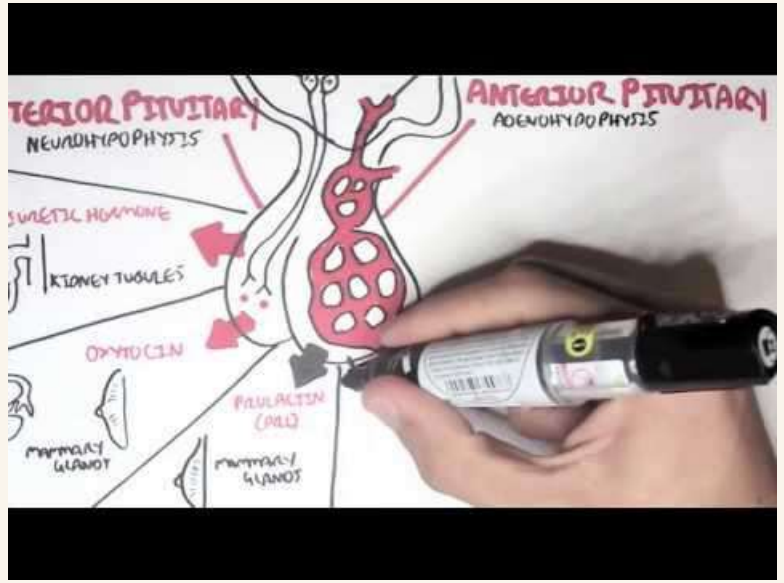


Endocrine System, Part 2 - Hormone Cascades: Crash Course

Green, Hank. "Crashcourse." *YouTube*, YouTube, https://www.youtube.com/@crashcourse.

Endocrine Glands

- **Human endocrine glands include**:
  - **the pituitary gland**
  - **Hypothalamus**
  - **thyroid gland**
  - **parathyroid glands**
  - **adrenal glands**
  - **Pancreas**
  - **and reproductive glands.**
- The nine **pituitary hormones** either directly regulate body functions or control the actions of other endocrine glands.
- Hormones from the **hypothalamus** control the pituitary gland.
- The **thyroid** gland regulates metabolism.
- Hormones produced in the **parathyroid** gland help regulate calcium levels in the blood.
- The **adrenal** gland produces hormones that help the body deal with stress.
- Insulin produced by the **pancreas** keeps the level of sugar in the blood stable (figure left). Without insulin, diabetes mellitus occurs.
- **Reproductive** glands, or gonads, produce gametes. Gonads also secrete sex hormones that produce male and female physical characteristics.



Endocrinology - Overview

Armando Hasudungan
@armandohasudungan
2.29M subscribers

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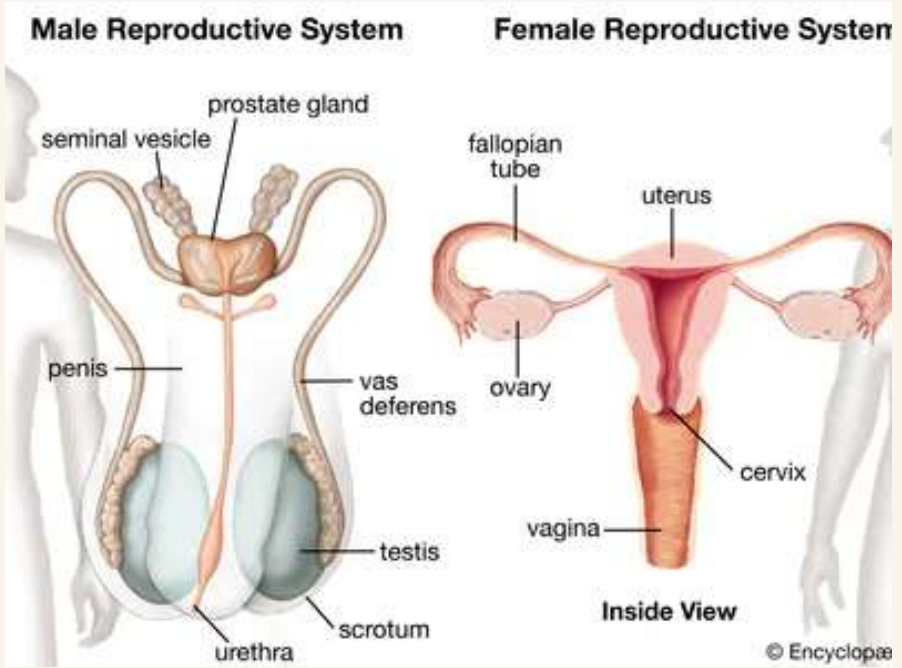
Reproductive System

- Sex hormones produced by the gonads of an embryo cause the embryo to develop into either a female or a male.
  - cause puberty to occur. **Puberty** is a period of rapid growth and sexual maturation that usually begins between ages 9 and 15. At the end of puberty, the male and female reproductive organs are fully developed and able to function.
- The main function of the **male** reproductive system is to produce and deliver sperm.
  - The main organs: of the male reproductive system are the **testes**, which are held in a sac called the scrotum. In the testes, sperm are produced in tiny tubes called seminiferous tubules. Sperm then mature in a structure known as the **epididymis**. They leave the body through a tube called the **vas deferens** and then through the **urethra**. The urethra is the tube in the penis that leads to the outside.
- The main function of the **female** reproductive system is to produce eggs and prepare the female body to nourish an embryo.
  - The main organs of the female reproductive system are the **ovaries**.



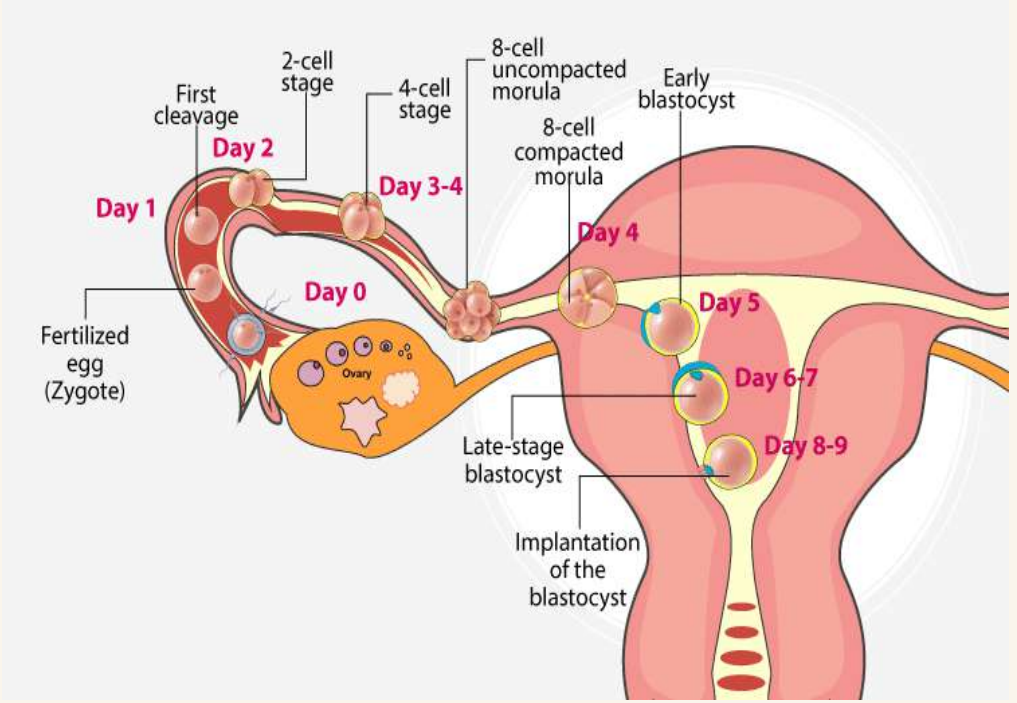
Fertilization

- Each ovary contains thousands of **follicles**.
  - ➔ A **follicle** is a cluster of cells surrounding a single egg.
  - ➔ The follicle helps the egg mature. About once a month, an egg matures and is released from the ovary. The egg moves through the Fallopian tube, where it can be fertilized if sperm are present. After a few days, the egg reaches the **uterus**. The uterus is connected to the outside of the body by a canal called the **vagina**. One egg develops each month during the menstrual cycle.
  - ➔ The cycle is controlled by hormones.

❖ Fertilization (figure below) is the process of a sperm joining an egg.

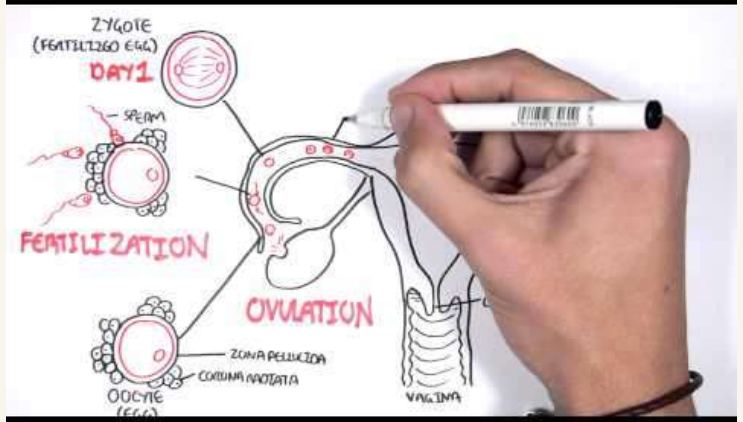
❖ A fertilized egg is called a **zygote**.

- The zygote undergoes repeated mitosis and soon develops into a hollow ball of cells called a **blastocyst**.
- About a week after fertilization, the blastocyst imbeds itself in the lining of the uterus. This is called **implantation** (figure below).
- The cells of the blastocyst begin to specialize in a process called **differentiation**. Some cells migrate to form three cell layers. This process is called **gastrulation**.

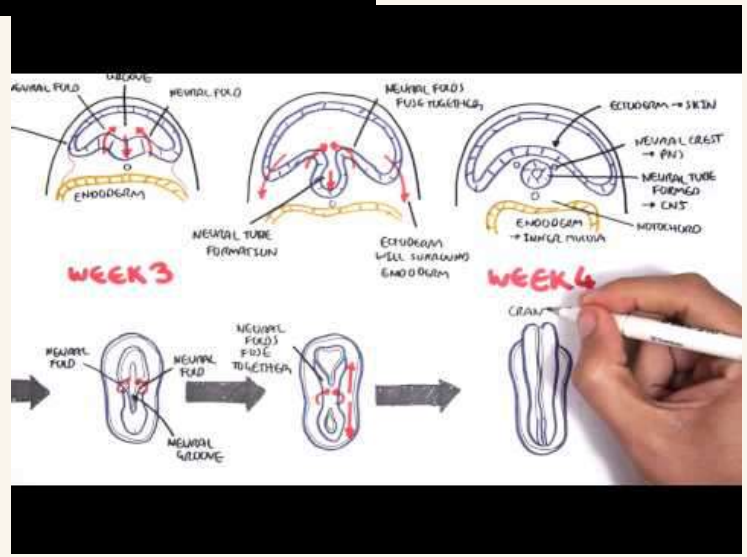


Development

- The three layers eventually develop into the different organs of the embryo.
- **Gastrulation** is followed by **neurulation**, or the development of the nervous system.
- As the embryo develops, membranes also form to protect and nourish it. One of these membranes develops into the **placenta**.
- The mother and embryo exchange gases, food, and waste products across the placenta. After eight weeks of development, the embryo is called a **fetus**.
- By the end of three months, most of the major organs are fully formed.
- During the remaining six months before birth, the organ systems mature, and the fetus grows in size and mass.
- Childbirth occurs when hormones stimulate the mother's uterus to contract. The contractions push the baby from the uterus and out through the vagina.



Embryology - Day 0 7 Fertilization, Zygote, Blastocyst



Embryology - Neurulation

Hasudungan, Armando. "Armando Hasudungan." *YouTube*, YouTube, https://www.youtube.com/@armandohasudungan/search.

	Circulatory	Respiratory	Muscular
Digestive	• molecules are broken down so they can be absorbed into the bloodstream • carries nutrients throughout the body	• Epiglottis block the windpipe when swallowing food • We need oxygen to burn energy (chemical energy to thermal energy)	• muscles push down our food (throat, peristalsis) • break down food into smaller particles (stomach) • help us eliminate waste
Nervous	• heart beat (pumps blood)/ sends blood to and from the heart • bring nutrients and oxygen to the cells • Tells waste to be eliminated from the body	• Inhale Oxygen • Exhale Carbon Dioxide • Oxygen go to the bloodstream, surrounding tissues via gas exchange	• heart (pumps blood throughout the body) • stomach (breaks down food particles) • skeletal muscles (pulls on your bones to move, prevent injury)
Skeletal	• Protects the heart • Bones produces and stores red blood cells (bone marrow) that the bloodstream takes it to the rest of the body. • Stores needed material that the blood also takes to the rest of the body (when needed)	• The bones (ribs) protect the lungs	• The bones pull on the skeletal muscles to make the body move.
Muscular	• Heart (cardiac muscle)	• Diaphragm	
Respiratory	• The exchange of oxygen and carbon dioxide – blood vessels		• Diaphragm
Excretory	• Kidneys filters blood (urea, salt, water)	• Lungs get rid of Carbon Dioxide	• Muscles release urine

	Circulatory	Respiratory	Muscular
Integumentary	• capillaries supply blood to the skin	• If you don't get enough air to your skin, it will turn blue	• Covers your muscles
Immune	• White blood cells	• Cough and sneeze help keeps germs out of your body	• Muscles can be attached: HIV/AIDS • Vaccines go into your muscles
Endocrine	• Hormones are released into the bloodstream ●	• hormones regulate you breathing ●	• Adrenaline hormones control your muscle growth • Release of glucose, so muscles can function.
Reproductive	• Carries hormones and nutrients • Blood Supply to Fetus	• Supplies Oxygen to the fetus	• Muscle Contractions for Menstruation/ childbirth

Thank you!

Do you have any questions?

matthewsimmons@hebisd.edu
817-399-3360 x-7565