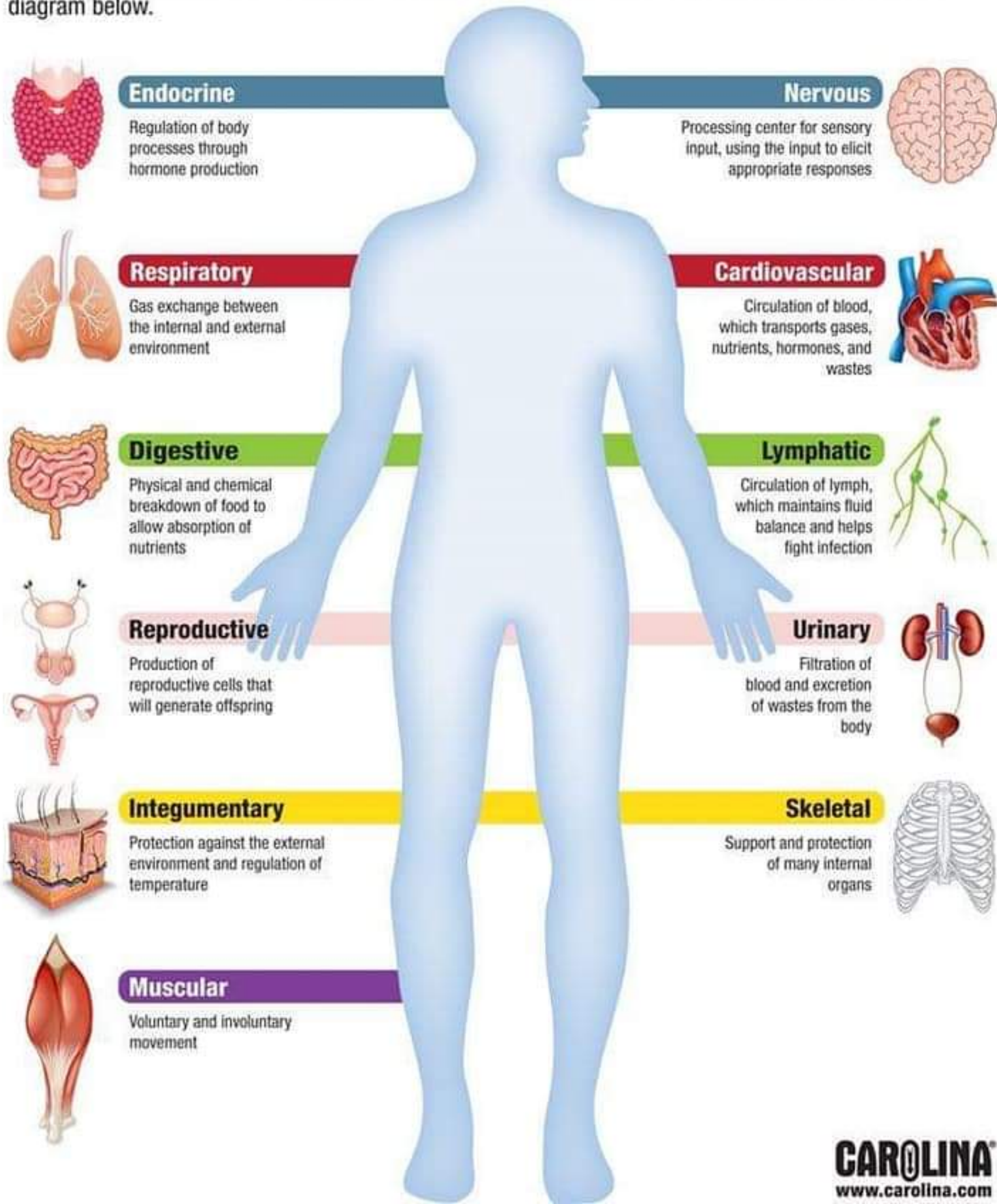


# Human Body Systems

There are 11 main systems that keep our bodies functioning. Learn the primary roles of each in the diagram below.

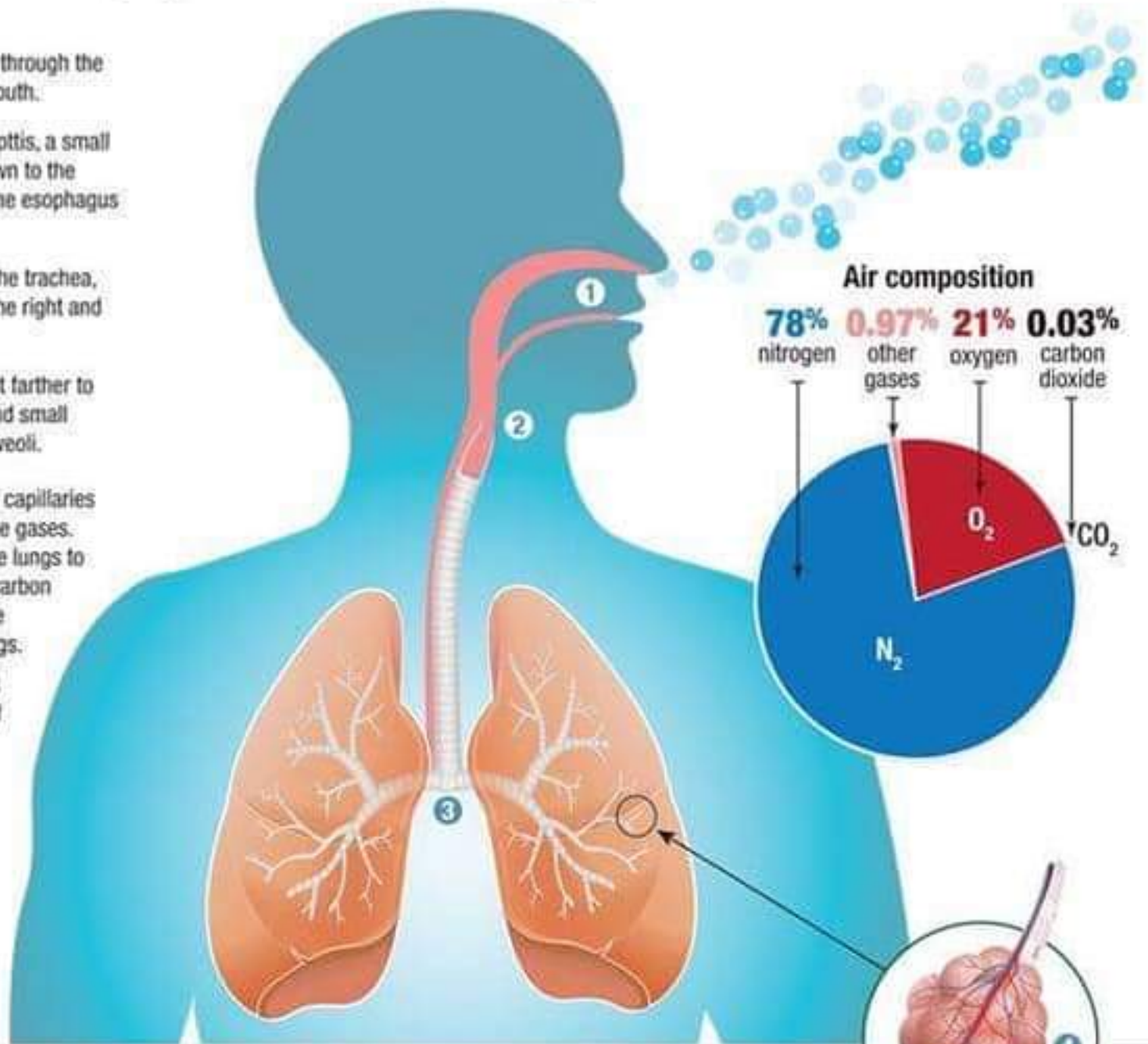


# Lungs: How Gas Exchange Works

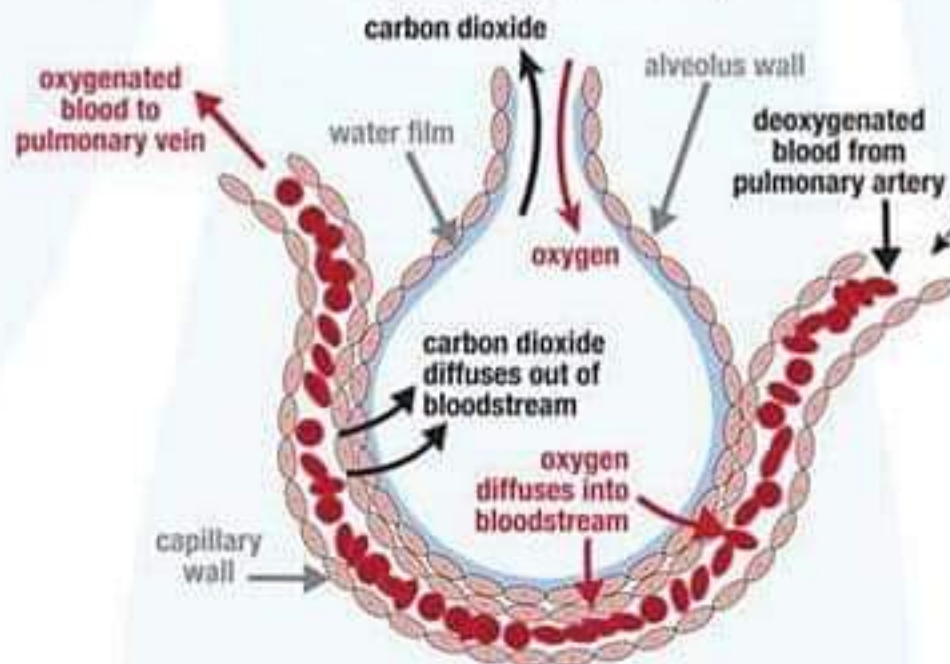
Breathing comes naturally to us, but this seemingly simple process is complex. We inhale oxygen and exhale carbon dioxide through a process known as gas exchange.

- 1 Air flows into the body through the nasal passages and mouth.
- 2 Air passes by the epiglottis, a small flap that directs air down to the lungs and food down the esophagus to the stomach.
- 3 Air then travels down the trachea, or windpipe, and into the right and left bronchi.
- 4 These tubes branch out farther to become bronchioles and small air-filled sacs called alveoli.
- 5 Around the alveoli, tiny capillaries bring blood to exchange gases. Oxygen moves from the lungs to the bloodstream, and carbon dioxide moves from the bloodstream to the lungs.

The exchange is based on the concentration of gases in the blood compared to gases in the alveolus.



## 5 Alveolus Gas Exchange



### Did you know?



Algae produce approximately **75%** of the oxygen we breathe.

# Human Body: Respiratory System

The respiratory system is responsible for gas exchange—the inhalation of oxygen ( $O_2$ ) and the exhalation of carbon dioxide ( $CO_2$ ). The lungs, conducting airways, and the diaphragm are key structures of the system.

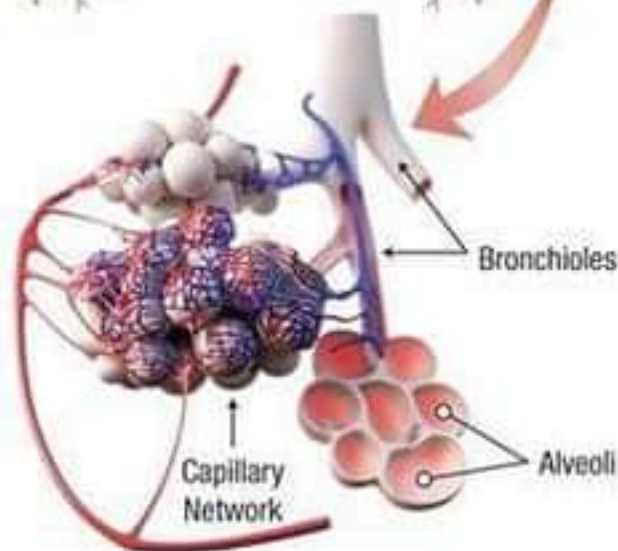
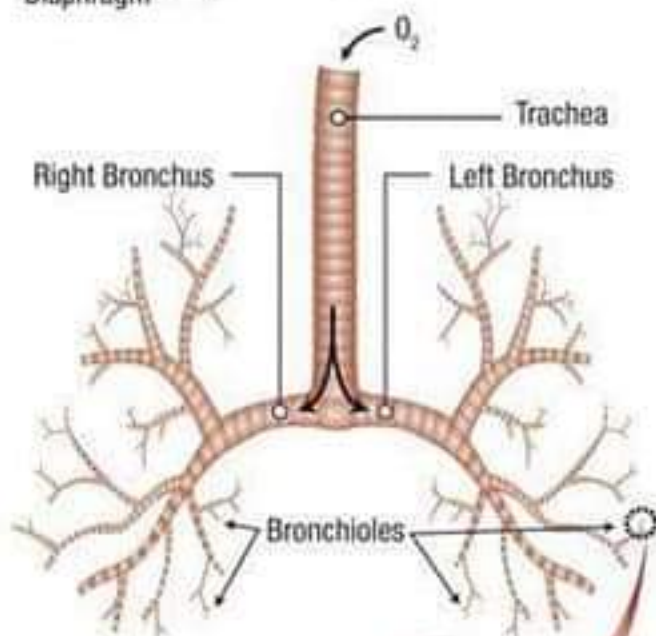
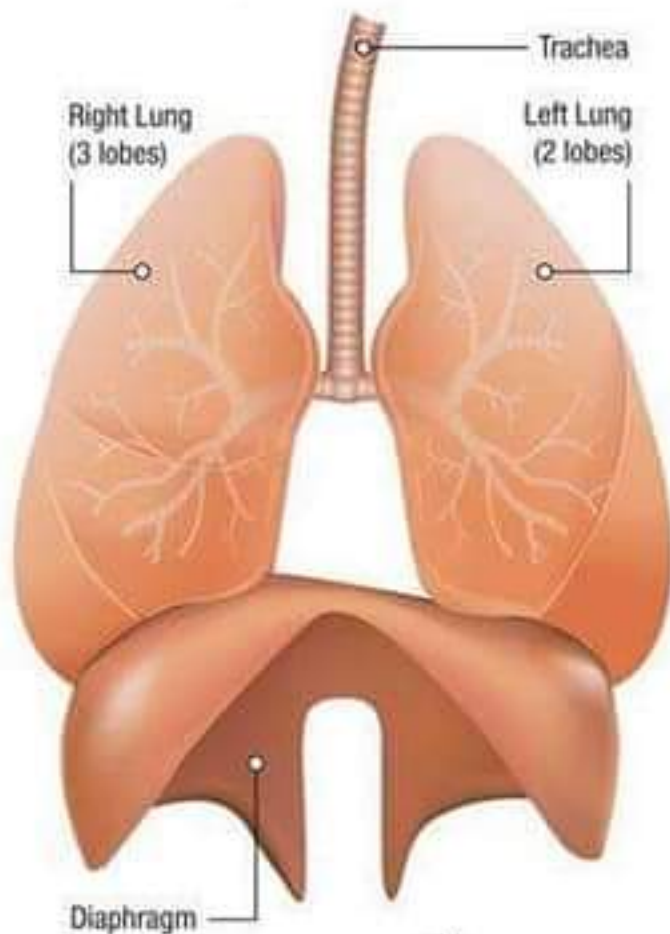
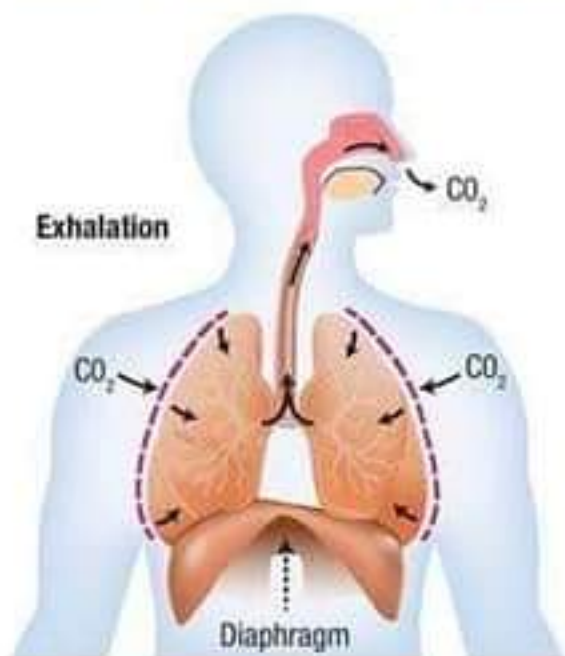
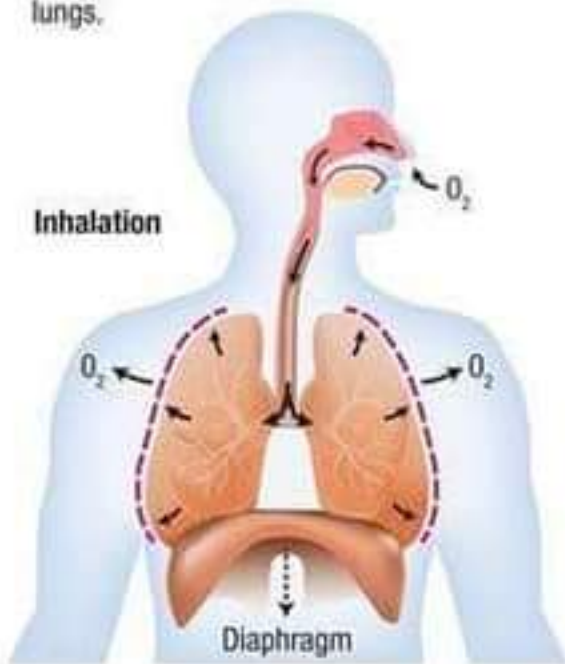
## Lungs and Diaphragm

Human lungs are sponge-like organs found in the thoracic (chest) cavity. The right lung has 3 lobes and is larger than the bilobed left lung, as the heart occupies more space on the left side.

The diaphragm is a domed, sheet-like muscle that separates the thoracic and abdominal cavities.

## Breathing

During **inhalation**, the diaphragm contracts, and air is pulled through the conducting airways into the lungs. During **exhalation**, the diaphragm relaxes, and air is pushed from the lungs.

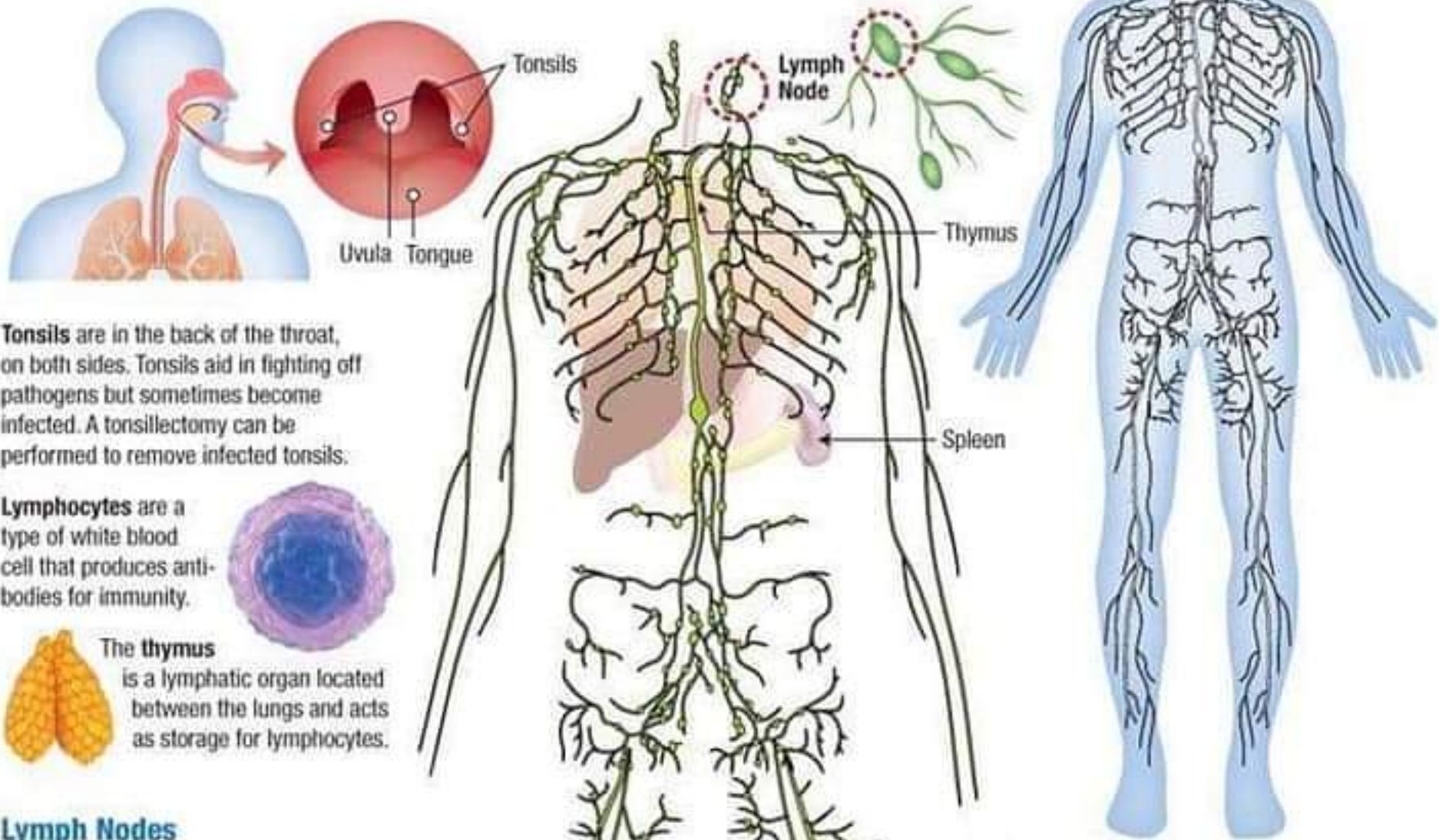


## Bronchi, Bronchioles, and Alveoli

Air enters the lungs from the trachea through the right and left bronchus. These branching airways lead to bronchioles and end in microscopic air sacs called alveoli. The alveoli are the sites of gas exchange between the cardiovascular and respiratory systems.

# Human Body: Lymphatic System

The lymphatic system plays a vital role in the body's immunity. Lymphatic vessels transport lymph, a fluid containing infection-fighting white blood cells, from body tissues into lymph ducts that drain into lymph nodes.



**Tonsils** are in the back of the throat, on both sides. Tonsils aid in fighting off pathogens but sometimes become infected. A tonsillectomy can be performed to remove infected tonsils.

**Lymphocytes** are a type of white blood cell that produces antibodies for immunity.



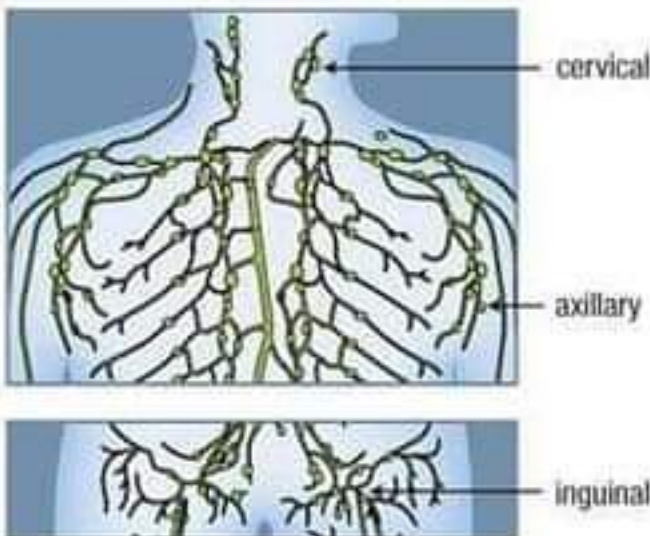
The **thymus** is a lymphatic organ located between the lungs and acts as storage for lymphocytes.



## Lymph Nodes

**Lymph nodes** are small, oval-shaped nodes that occur in clusters throughout the body. They contain lymphocytes and help defend the body against infection.

**Superficial lymph nodes** are highly concentrated in the cervical (neck), axillary (arm pit), and inguinal (groin) regions. These are palpable and are often used as indicators of infection.

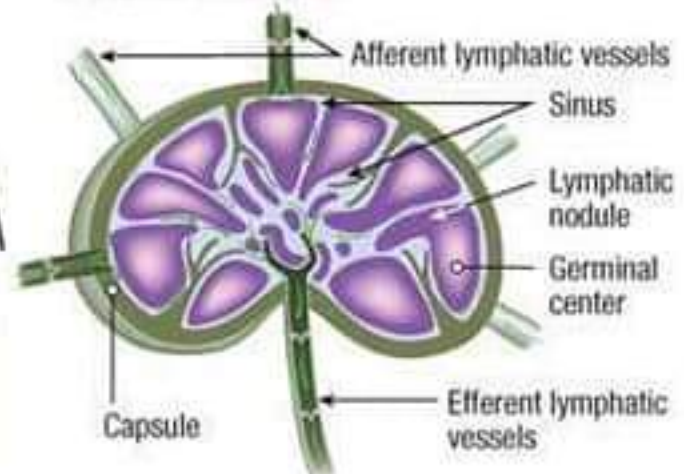


## Spleen

The spleen is a lymphatic organ located in the upper abdomen, behind the stomach. Its function is to filter blood's debris and old red blood cells. Lymphocytes are also stored here.

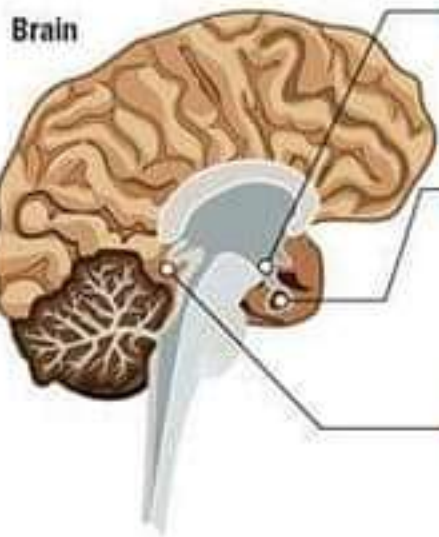


## Lymph Node Anatomy



# Human Body: Endocrine System

The endocrine system contains 9 major glands and organs that produce, store, and secrete hormones.



## 1 Hypothalamus

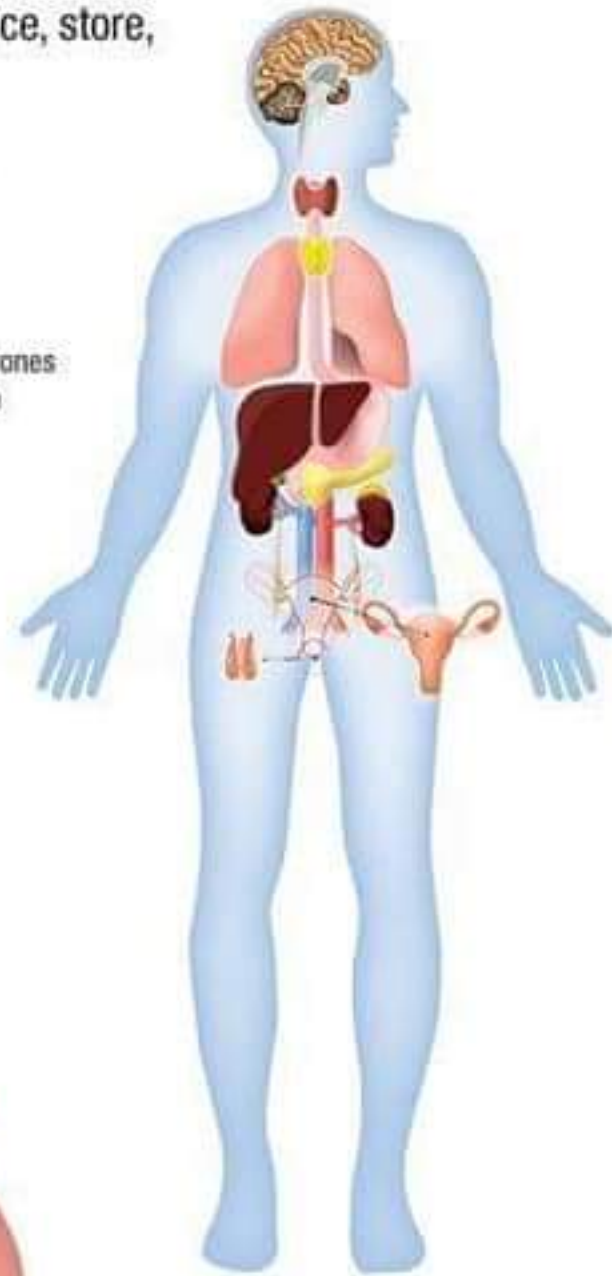
Maintains the body's homeostasis and regulates body temperature, heart rate, and blood pressure.

## 2 Pituitary Gland

Composed of 2 lobes: the anterior, which secretes hormones involved in the body's growth and development, and the posterior, which secretes hormones that increase the reabsorption of water into the kidneys.

## 3 Pineal Gland

Responsible for the production of melatonin, which plays a major role in the body's sleep-wake cycle.



## Thyroid

This butterfly-shaped gland produces 3 major hormones: calcitonin, triiodothyronine (T3), and thyroxine (T4). They help regulate the body's energy and metabolism.

## 4



## Parathyroid

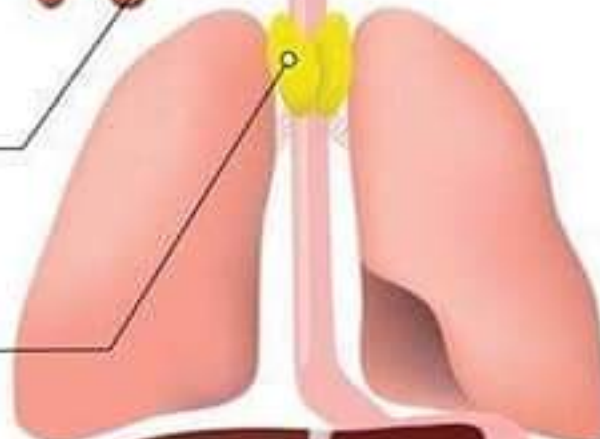
The parathyroid, also referred to as the hypophysis, secretes hormones necessary for calcium absorption.

## 5

## Thymus

The thymus controls production of T-cells (white blood cells) and plays a vital role in the body's ability to fight diseases.

## 6



## Ovaries/Testes

The male and female reproductive organs release hormones responsible for blood circulation, mental vigor, and sex drive.

## 7

**Ovary**  
Secretes estrogen and progesterone, which play a key role in the health of the female reproductive system.

**Testis**  
Secretes testosterone, which is vital for physical development, bone density, and libido in males.

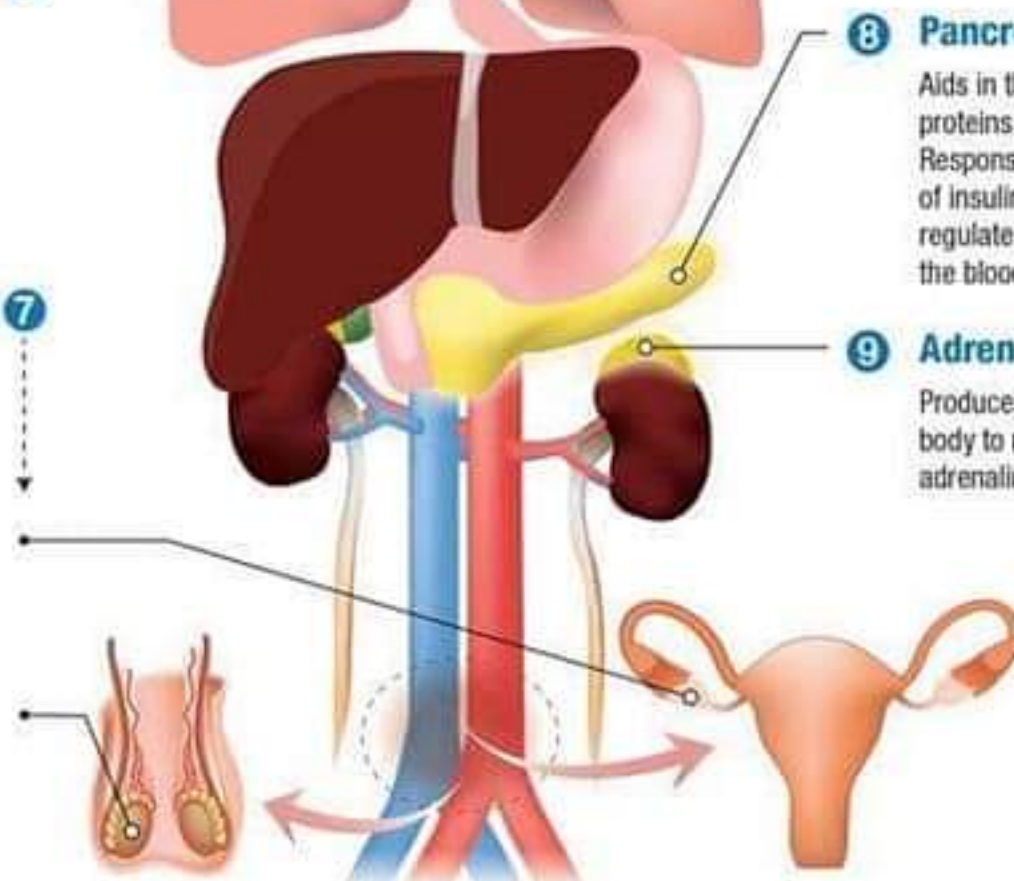
## 8

## Pancreas

Aids in the digestion of proteins, fats, and carbohydrates. Responsible for the production of insulin and glucagon, which regulate the level of glucose in the blood.

## 9 Adrenal Gland

Produces hormones that allow the body to react to stress, such as adrenaline and cortisol.

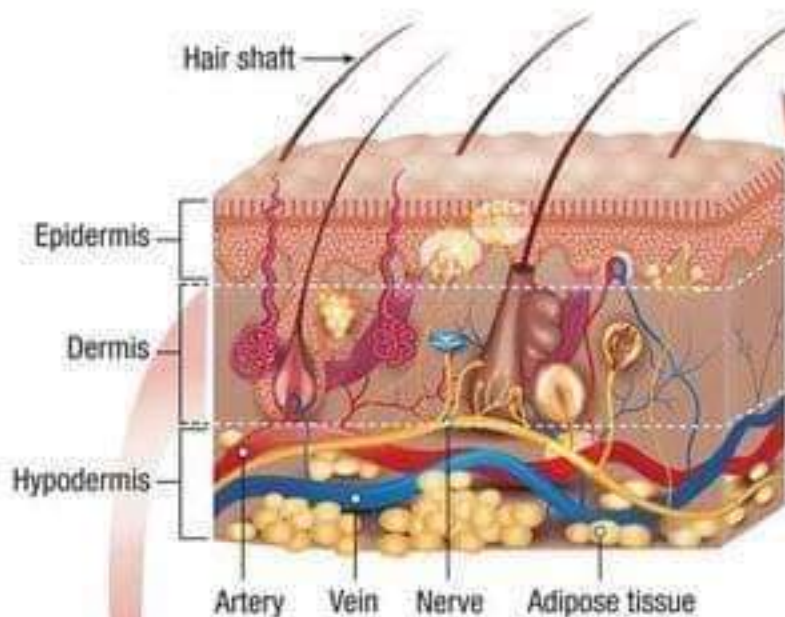


# Human Body: Integumentary System

The integumentary system protects the body from the external environment and works with other body systems to regulate internal processes. Major structures include the skin, glands, hair, and nails. The main functions of the integumentary system are protection, regulation, and sensation.

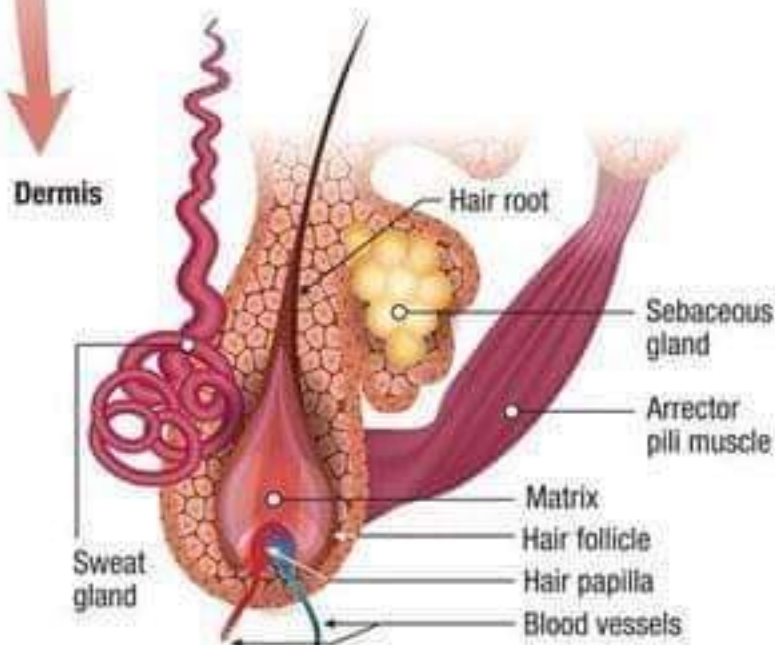
## Skin

Skin is the largest and fastest-growing organ in the body. The outermost layer, the **epidermis**, is composed of stratified squamous epithelial tissue. Below this layer is the **dermis**, which contains the cutaneous glands, hair follicles, and most of the skin's nerve endings. The **hypodermis** (subcutaneous layer) consists of loose connective and adipose tissue.



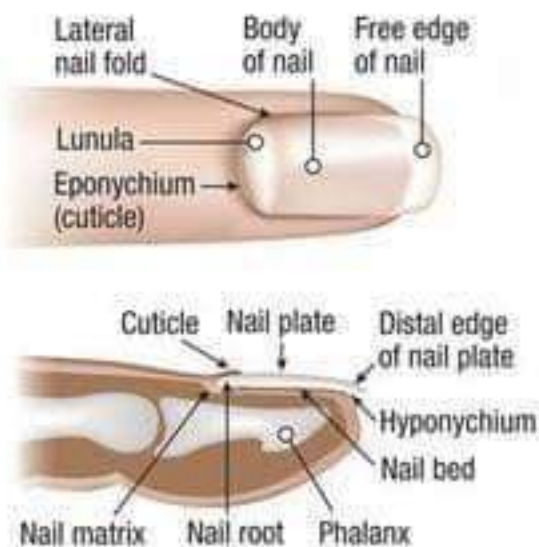
## Cutaneous Glands

Cutaneous glands within the dermis include sebaceous and sweat glands. **Sebaceous glands** secrete sebum, an oily substance that waterproofs and lubricates the skin. **Sweat glands** help cool the body through evaporation of sweat.

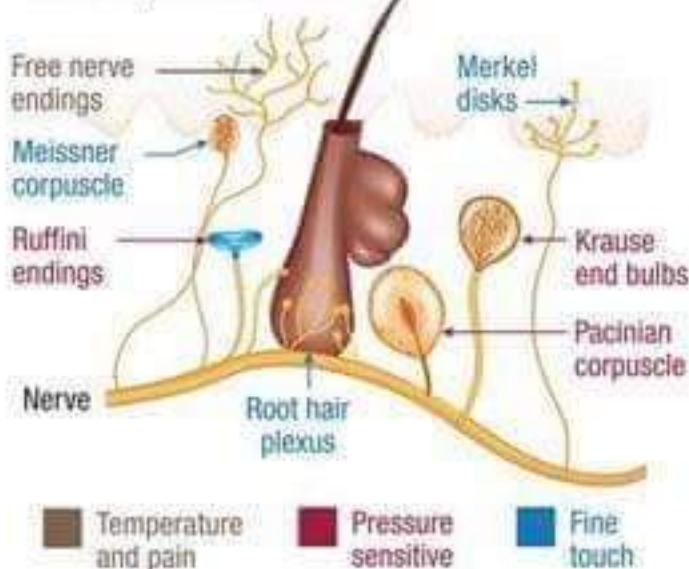


## Fingernails

Fingernails and toenails are made of densely-packed cells covered in keratin. The cuticle, found at the base of the nail, provides a barrier between the skin and the nail. The body of the nail appears pink due to numerous blood vessels in the nail bed underneath. Nails protect the fingers and toes and can be used for scratching.

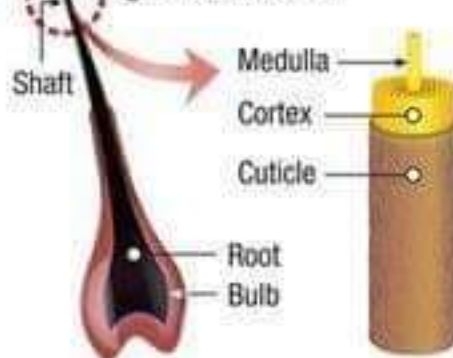


## Nerve receptors of the skin



## Hair

Hair is a pigmented filament formed by mostly keratinized cells. Human hair follicles can be divided into 3 main segments: the bulb, root, and shaft. The shaft (the visible part of hair) consists of 3 layers: the cuticle, cortex, and medulla. The cortex defines texture and contains the pigment that gives hair its color.



# Human Body: Nervous System

The nervous system is made up of the central nervous system and peripheral nervous system. These systems work together to collect and interpret data from the body's internal and external environment and control responses.

## Central Nervous System

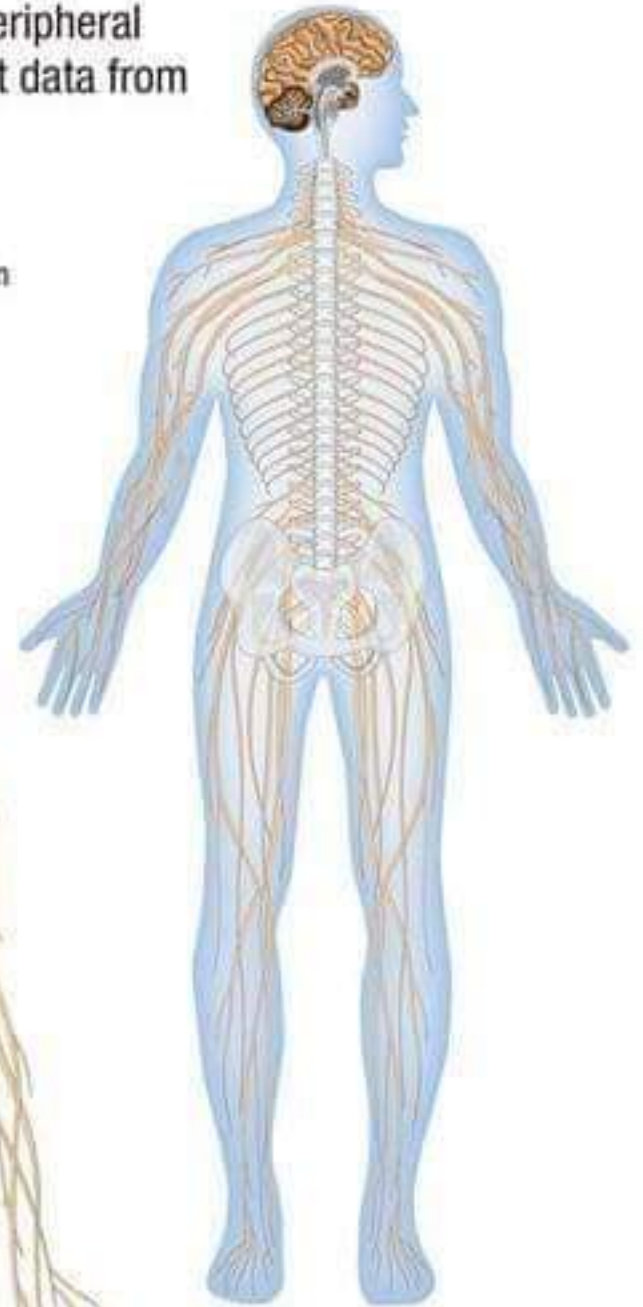
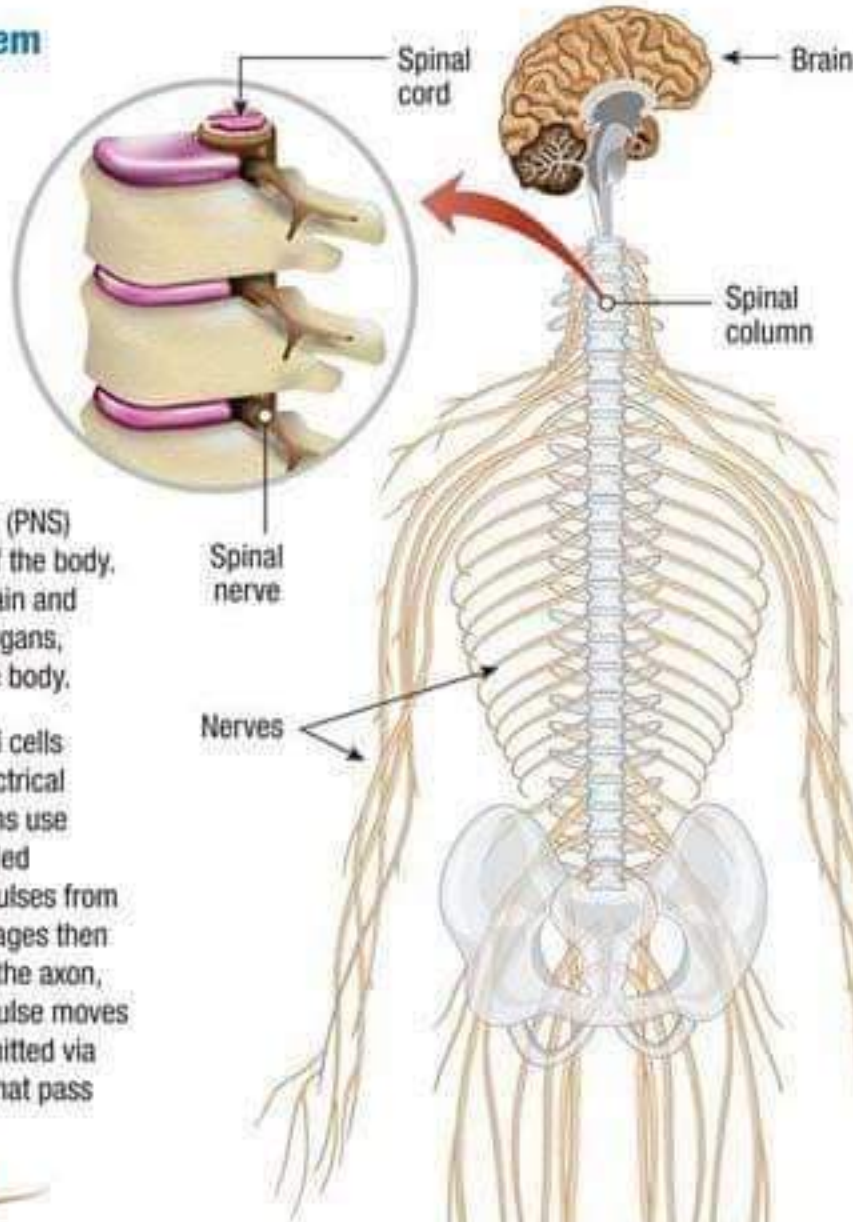
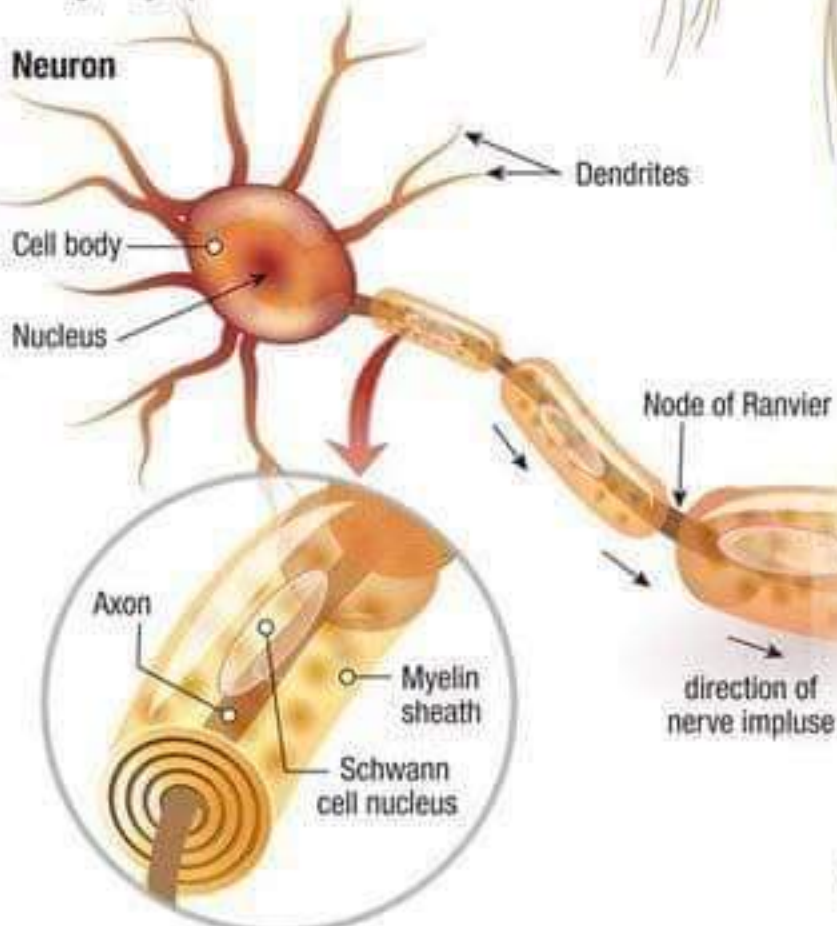
The central nervous system (CNS) manages the body's essential functions. Made up of the brain and spinal cord, the CNS receives sensory information and coordinates an appropriate response.

## Peripheral Nervous System

The peripheral nervous system (PNS) connects the CNS to the rest of the body. Nerves branch out from the brain and spinal cord, extending to the organs, muscles, and other parts of the body.

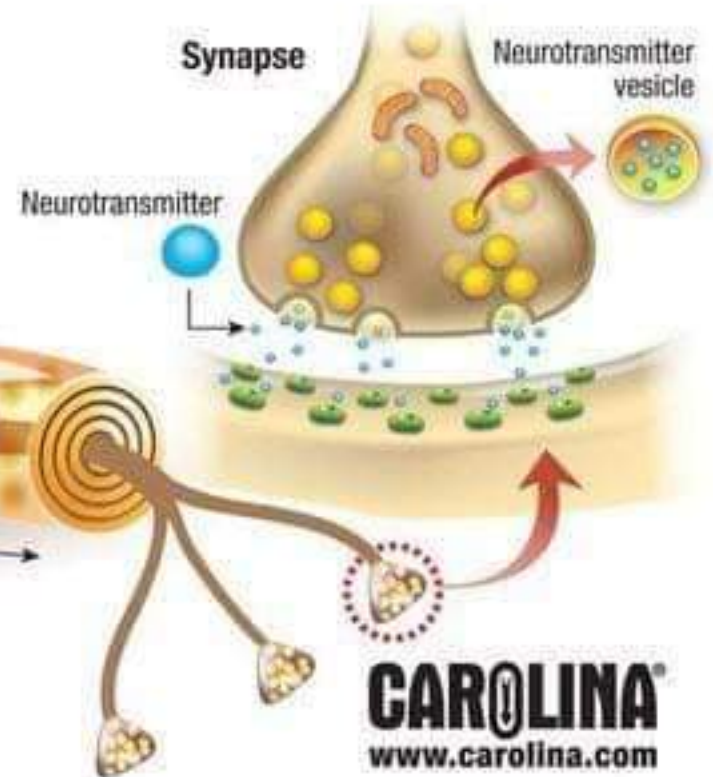
**Neurons** are highly specialized cells that transmit chemical and electrical information in the body. Neurons use short, branched extensions called dendrites to receive nerve impulses from surrounding cells. These messages then travel through the cell body to the axon, a threadlike structure. The impulse moves through the axon and is transmitted via chemical or electrical signals that pass through a synapse.

## Neuron



**Neurotransmitters** are chemicals that relay signals between neurons and bodily tissues. Neurotransmitters include adrenaline, dopamine, and endorphins.

## Synapse

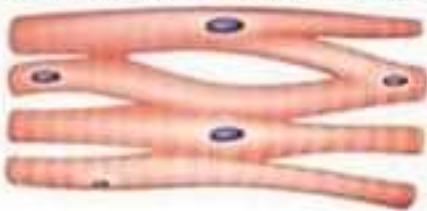


# Human Body: Muscular System

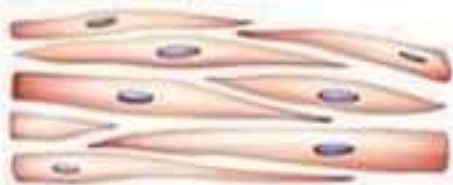
Muscles are found throughout the body. The 3 types of muscle tissue are skeletal muscle, cardiac muscle, and smooth muscle. Muscles allow the body to do everything from walking, to pumping blood, to churning food in the stomach.

## Types of Muscle Cells

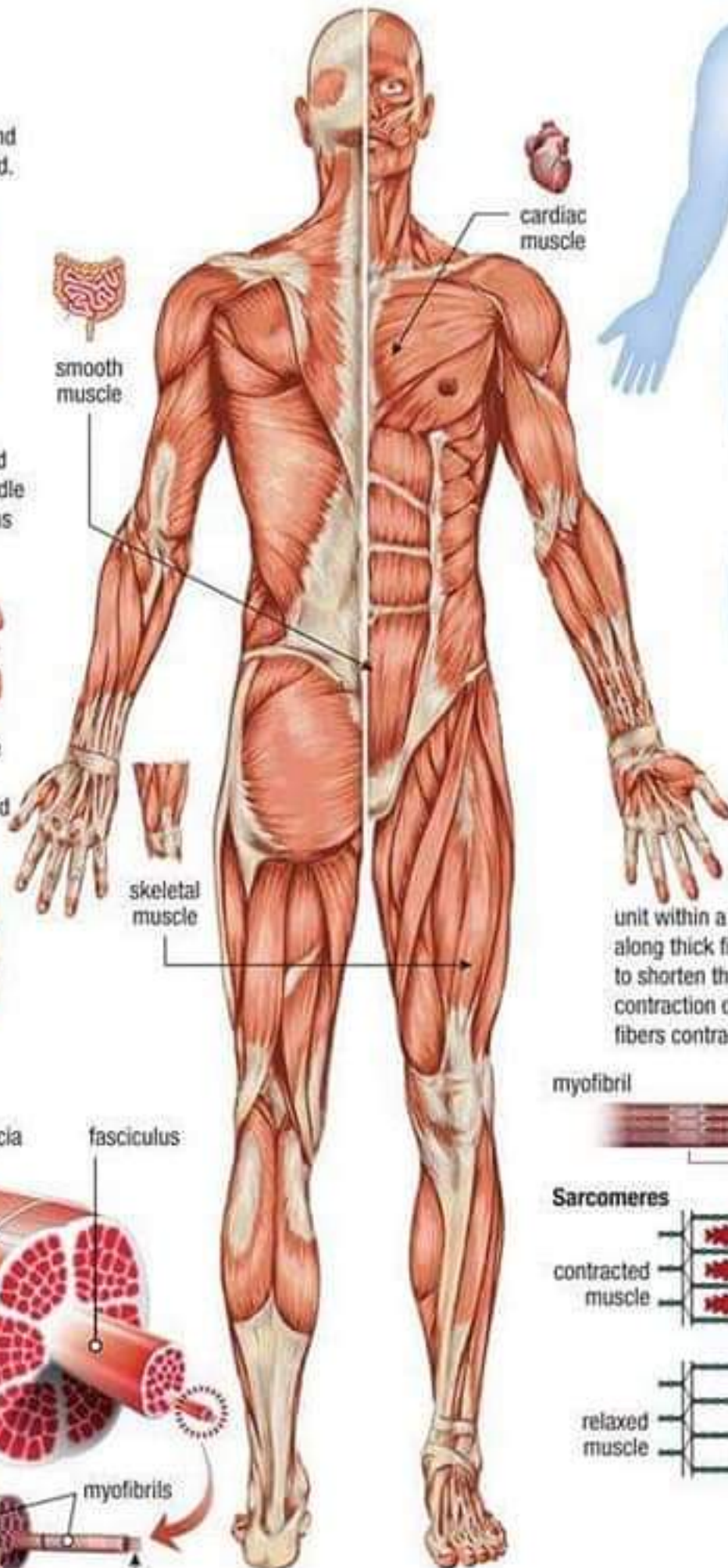
**Cardiac muscle** is an involuntary tissue located in the heart. Cardiac muscle contains intercalated discs, and the cells appear branched and striated. Each cell contains a single nucleus.



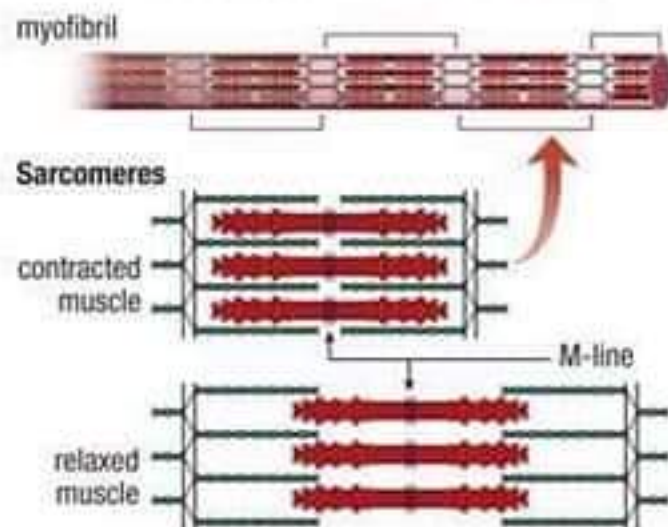
**Smooth muscle** is an involuntary tissue found in the walls of organs like the stomach, intestines, and blood vessels. The cells are wide in the middle and narrow on the ends. Each contains a single nucleus.



**Skeletal muscle** is a voluntary tissue and is commonly found attached to bone by tendons. The cells are striated and each contains multiple nuclei.



A **sarcomere** is the contractile unit within a muscle. Thin filaments are pulled along thick filaments toward the midline (M-line) to shorten the muscle fiber, resulting in a contraction of the fiber. When multiple muscle fibers contract, the entire muscle shortens.





# Human Body: Skeletal System

Made up of bone and cartilage, the human skeletal system has many important functions, including support, movement, protection of internal organs, blood cell production, and mineral storage.

## Skeleton

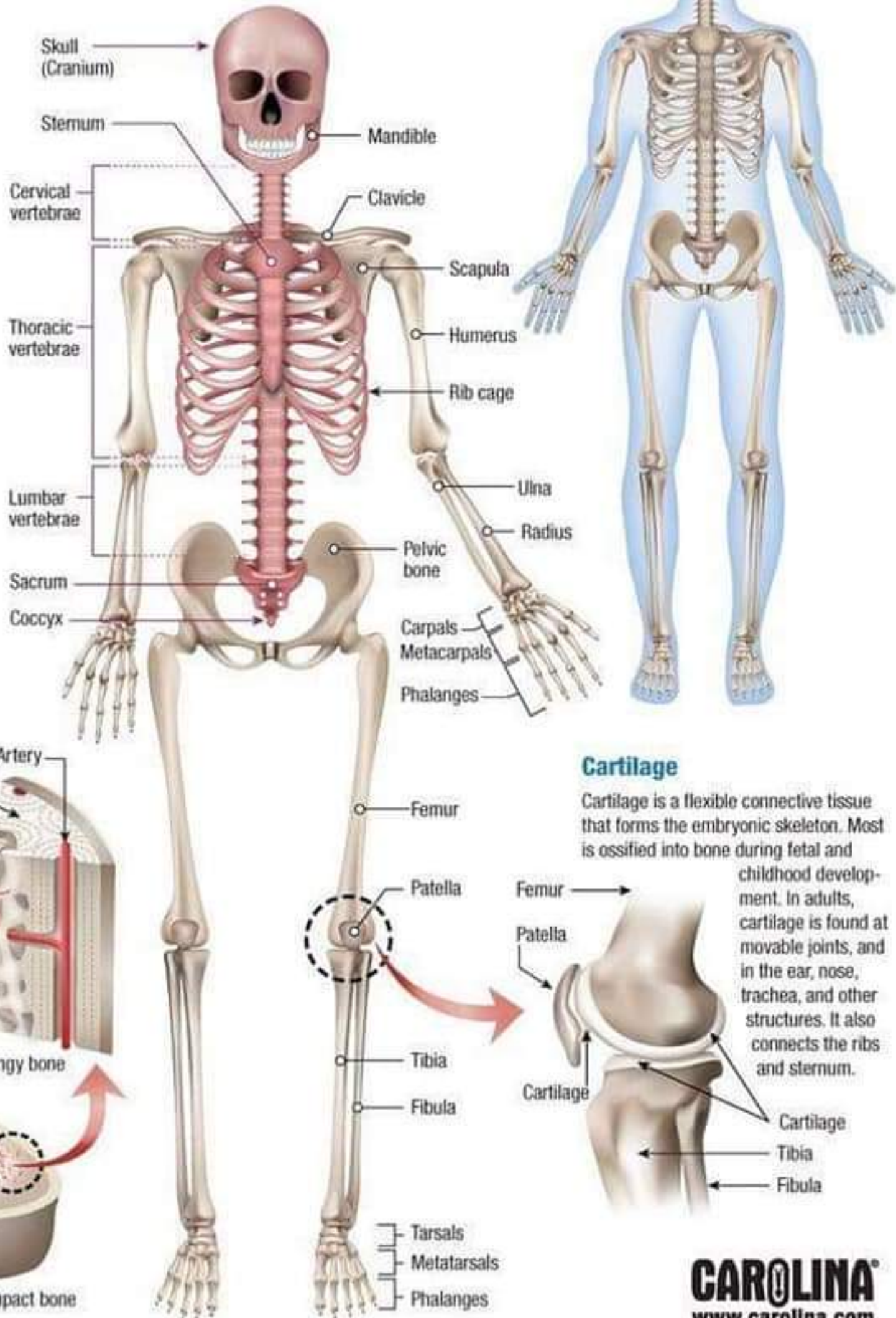
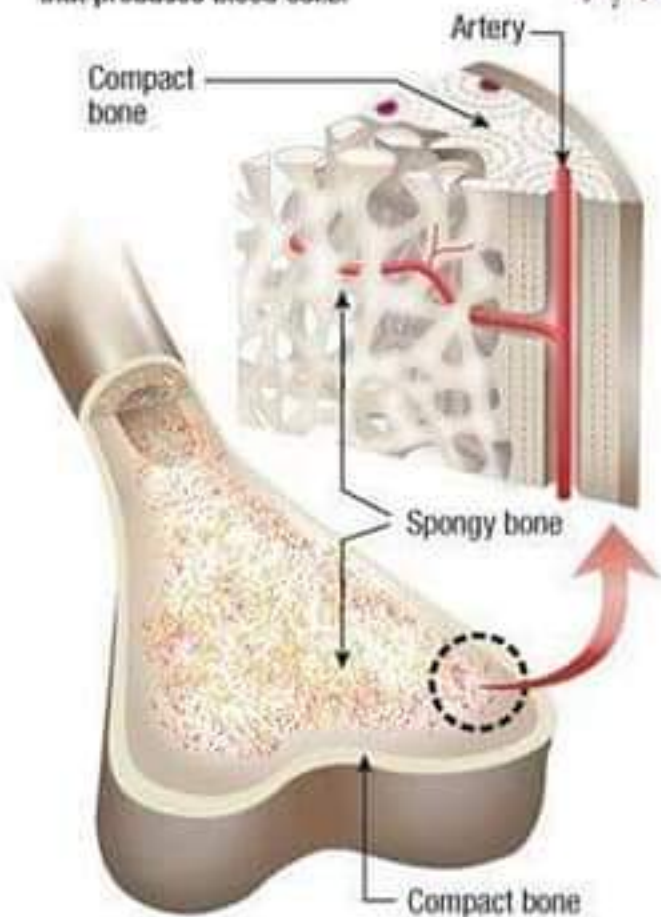
The adult human body has 206 bones and can be divided into 2 parts—the axial skeleton and the appendicular skeleton.

The **axial skeleton** (highlighted in red) includes bones of the skull, vertebral column, ribs, sternum, sacrum, and coccyx, totaling 80 bones.

The **appendicular skeleton** includes the 126 bones of the shoulders, pelvis, and upper and lower extremities.

## Bone Tissue

There are 2 types of bone tissue. **Compact bone** is hard, dense, mineralized tissue that gives bone its strength. It usually surrounds spongy bone tissue. **Spongy bone** is a porous layer of tissue that makes bone lightweight. Its spaces usually contain blood vessels and bone marrow, a soft tissue that produces blood cells.



## Cartilage

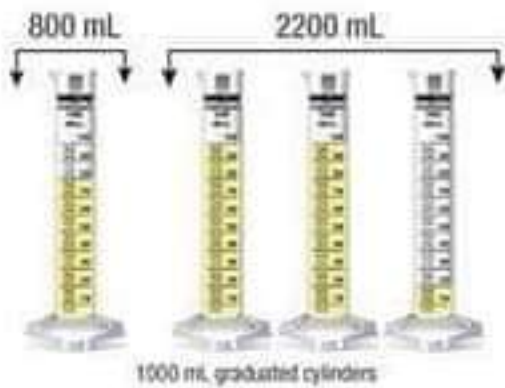
Cartilage is a flexible connective tissue that forms the embryonic skeleton. Most is ossified into bone during fetal and childhood development. In adults, cartilage is found at movable joints, and in the ear, nose, trachea, and other structures. It also connects the ribs and sternum.



# Human Body: Urinary System

The urinary system filters extra water and waste products from the blood to help maintain proper fluid balance inside the body. An elaborate system of tubes and tubules intertwines with arteries and veins within the kidneys to allow for maximum excretion of waste products, such as various salts and proteins. The ureters carry this waste to the bladder, where it is stored until excretion.

Normal daily urine output range:



## Urinary System

**Ureters** are long, thin tubes that carry urine from the kidneys (where it is produced) to the bladder.

The **bladder** is a muscular sac that stores urine.

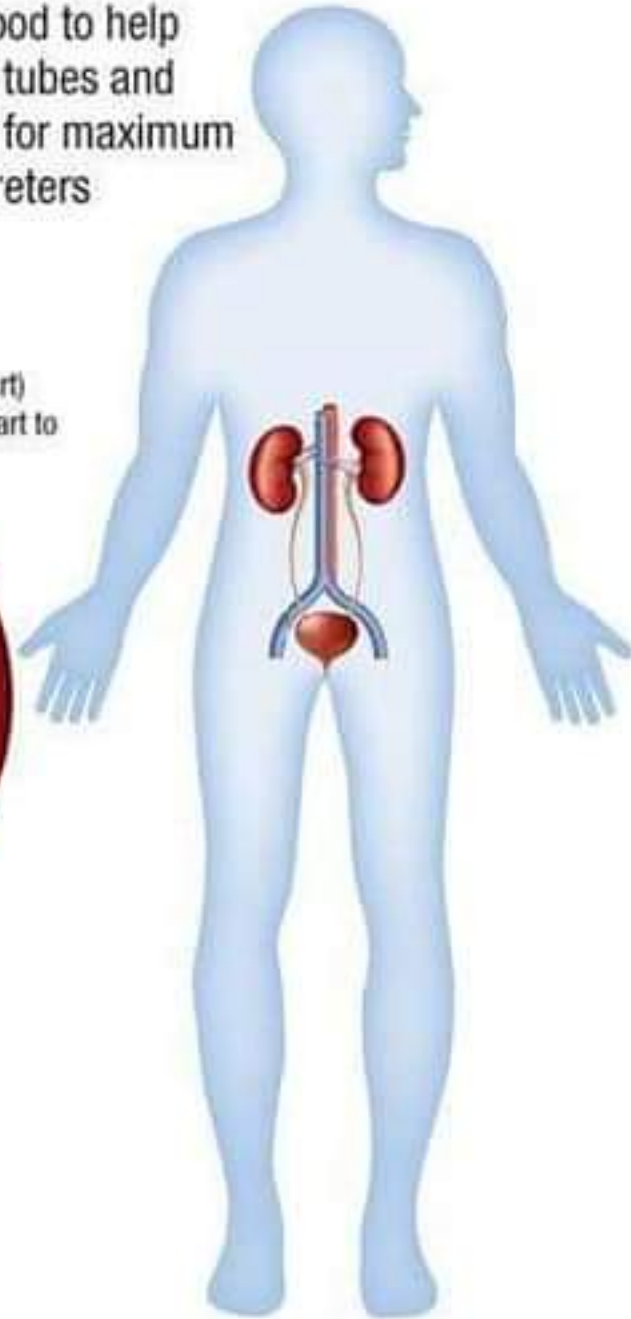
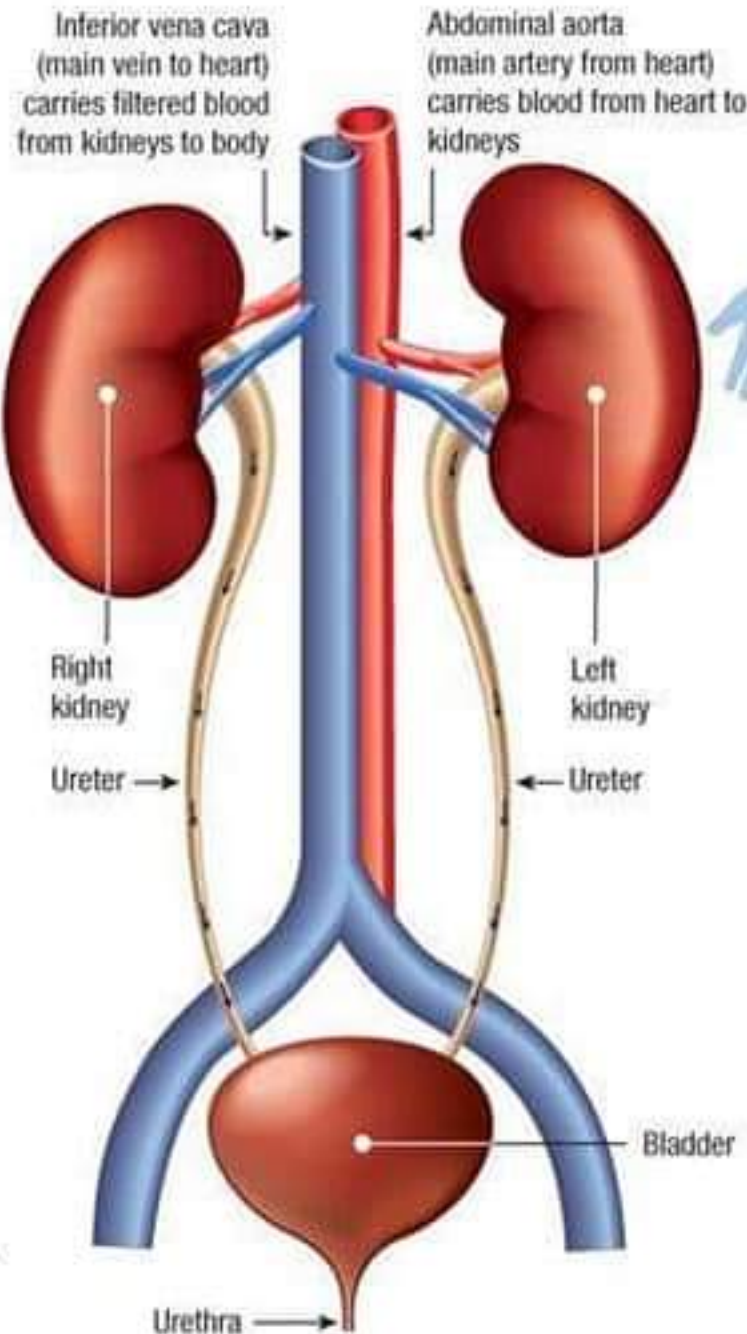
The **urethra** is a narrow tube connected to the bladder that removes urine from the body.

## Kidneys

The kidneys are found in the upper abdomen on each side of the spine. These fist-size organs filter waste products out of the bloodstream and produce urine.

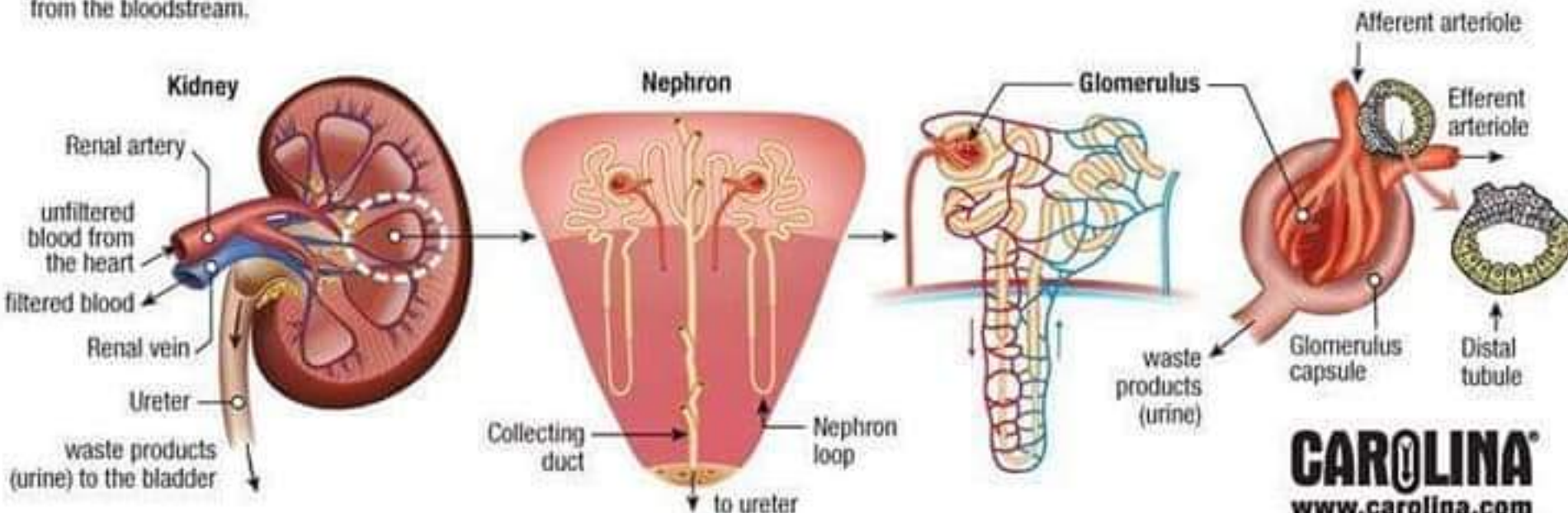
## Nephrons

Nephrons contain a network of tubes, veins, and arteries that intertwine to exchange salts, wastes, and fluids to remove them from the bloodstream.



## Glomerulus

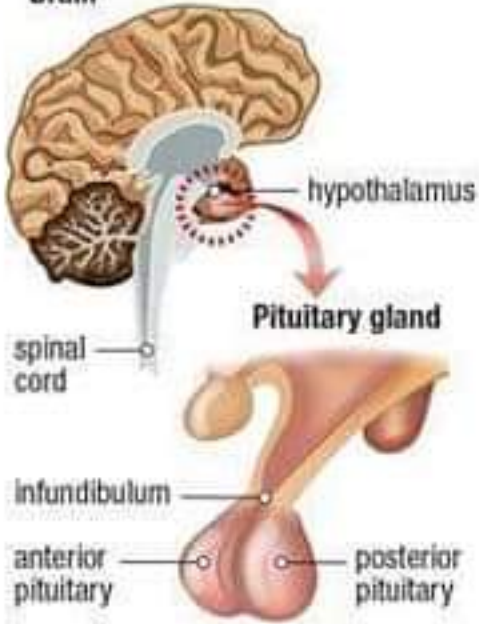
A glomerulus is a small, round pocket within the kidneys that uses concentration gradients to remove nitrogenous waste and salts from the blood vessels that pass through it.



# Human Body: Reproductive System

The male and female reproductive systems are controlled by hormones produced by the pituitary gland in the brain, and the reproductive organs themselves.

## Brain



## Pituitary Gland

The pituitary gland secretes hormones that control the reproductive organs. It signals the production of sex hormones and controls ovulation and the menstrual cycle in women.

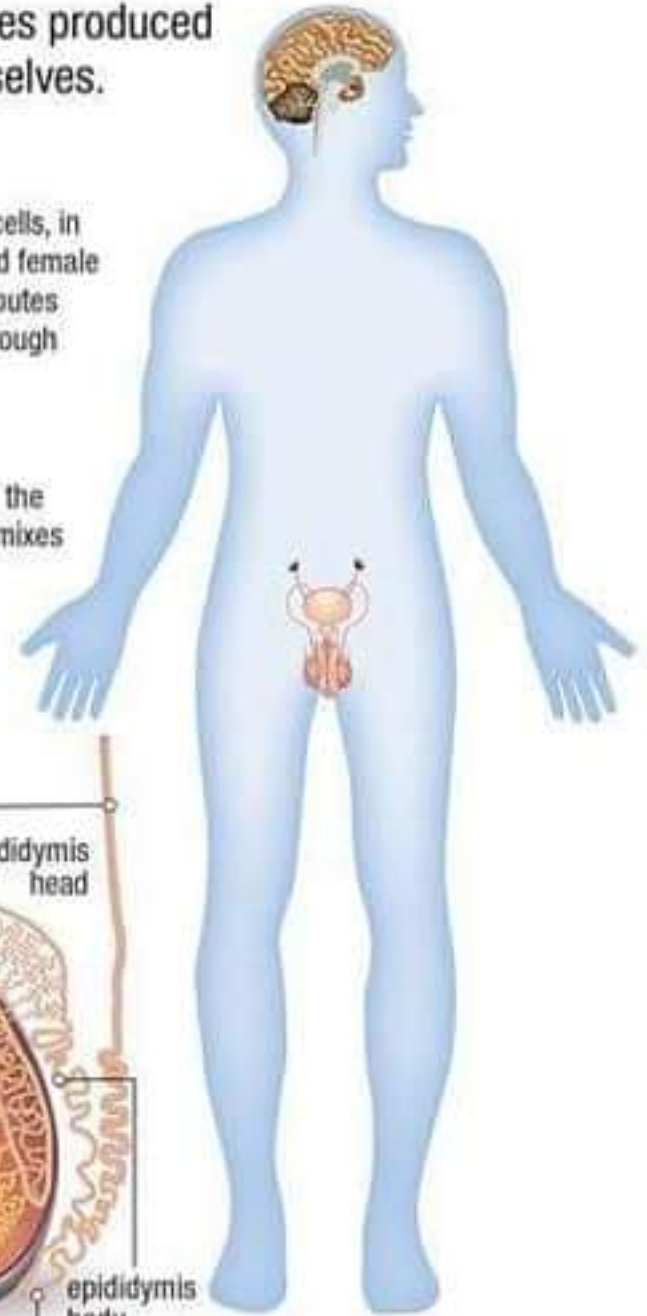
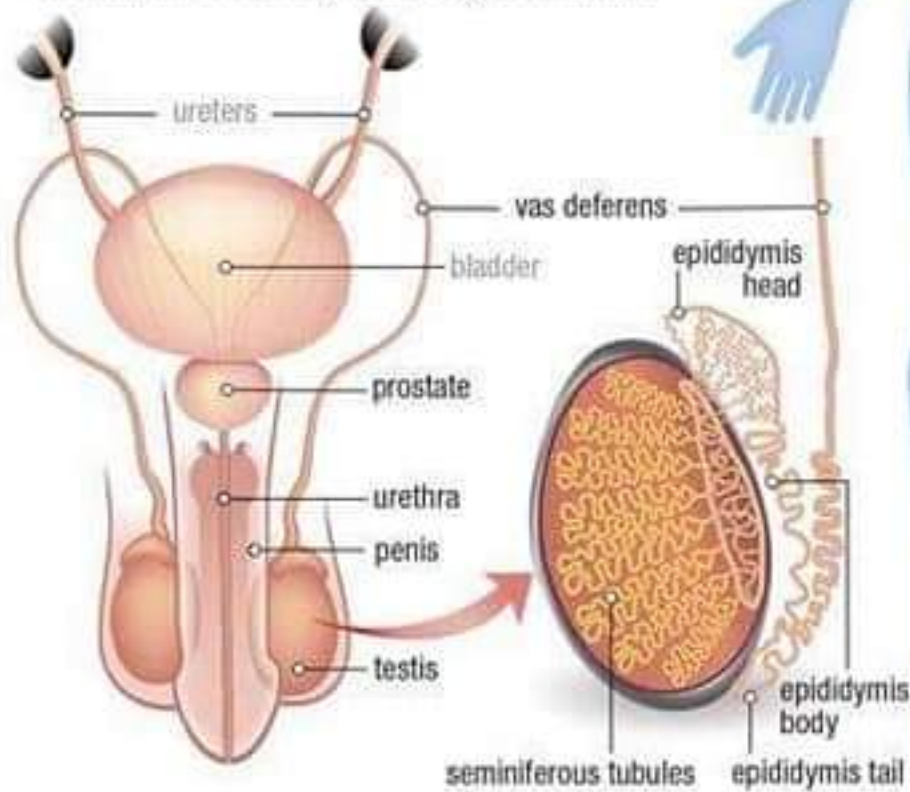


## The Reproductive Organs

These organs make, mature, and store gametes, or sex cells, in the human body. The male gametes are called sperm and female gametes are called ova or egg cells. Each gamete contributes half of an offspring's DNA, providing genetic variation through sexual reproduction.

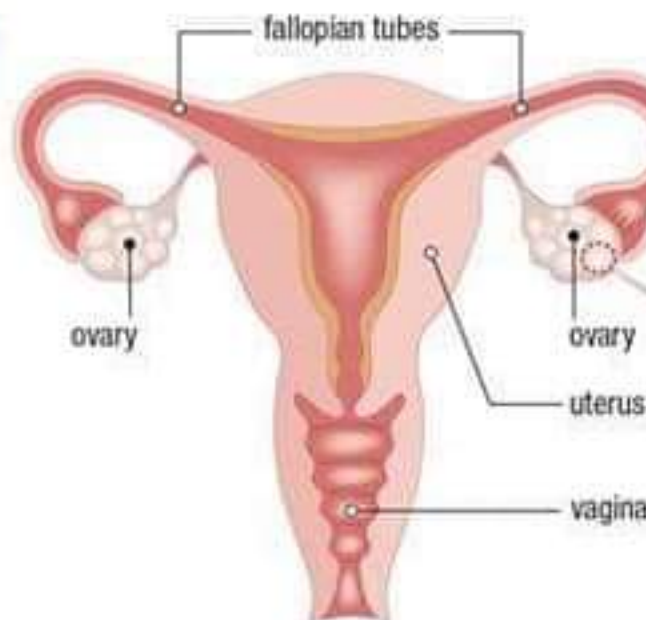
### Male reproductive system

Sperm is made in the seminiferous tubules and stored in the epididymis. It travels through the vas deferens, where it mixes with seminal fluids and passes through the urethra.

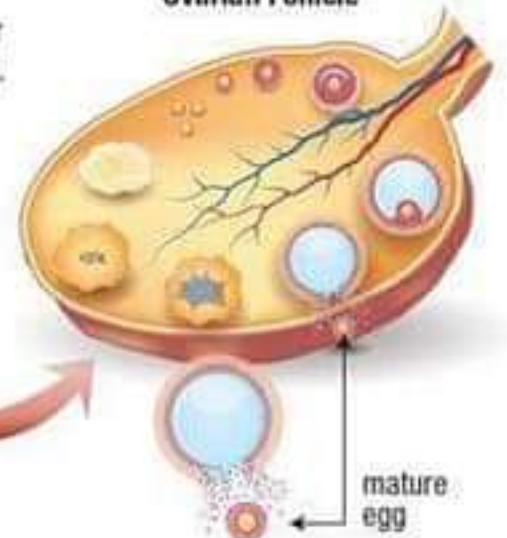


### Female reproductive system

Immature eggs are found in the ovaries where they mature and are released into the fallopian tubes. An egg travels down the tube to the uterus, where it either implants and develops into an embryo or is shed with the lining of the uterus at the end of a menstrual cycle.



### Developing Ovarian Follicle



# Human Body: Digestive System

The main functions of the digestive system are mechanical and chemical digestion, and absorption. Digestion is the process in which the body breaks food down into smaller molecules so that nutrients can be easily absorbed. The entire digestion process can take anywhere from 24 to 50 hours.

## Mouth/Esophagus

Digestion begins in the mouth through the mechanical and chemical breakdown of food. Smooth muscle tissue in the esophagus squeezes the food down toward the stomach in a process called peristalsis.

## Stomach

Mechanical and chemical digestion continues in the stomach. Smooth muscle tissue in the stomach wall squeezes and churns the material, while enzymes and chemicals are added to help further break down the food.

### Stomach structure

The internal structure of the stomach has ridges and folds called rugae. This increases the surface area within the stomach and allows it to expand to hold more food.

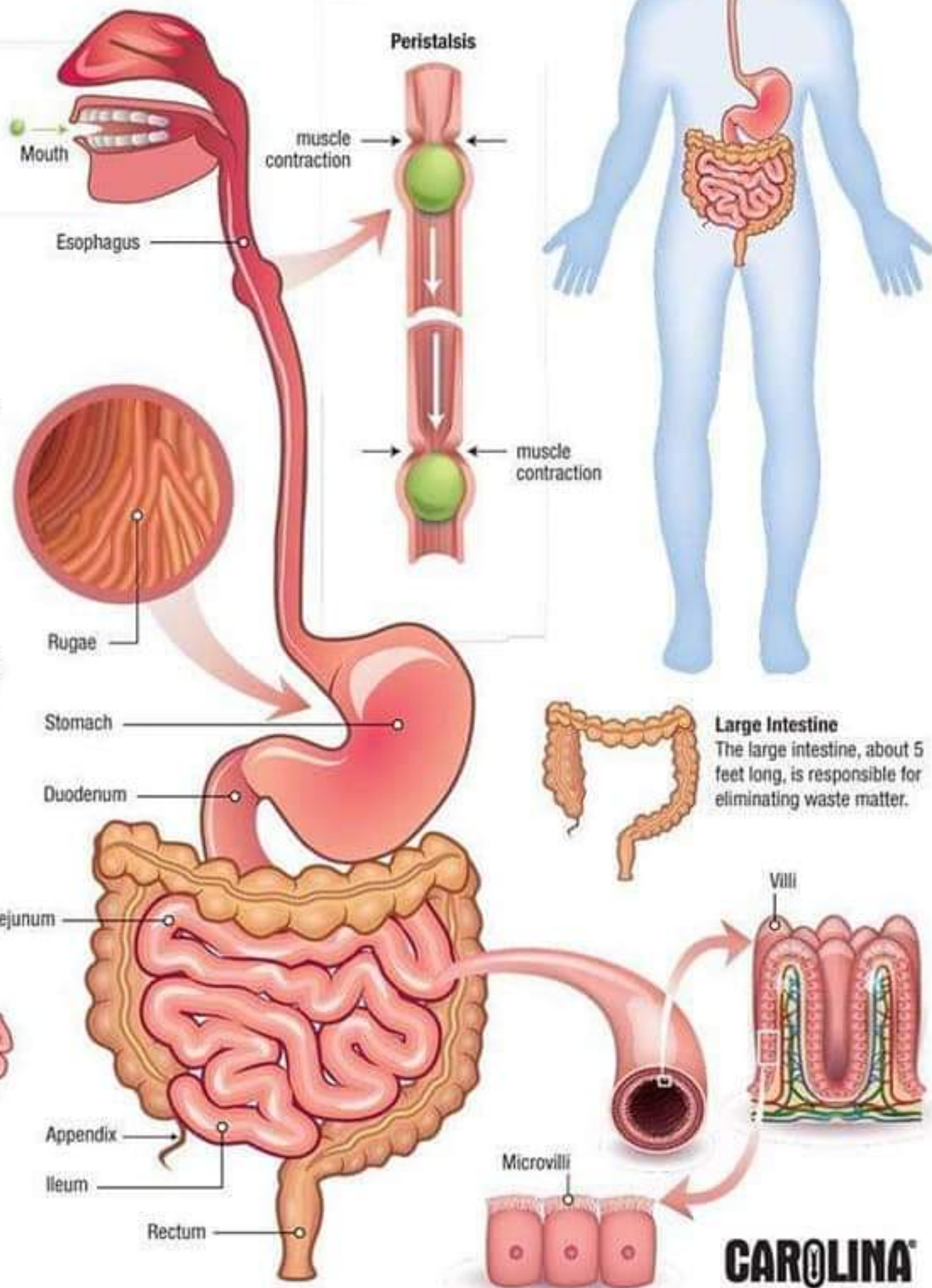
## Intestines

The small intestine and large intestine (colon) combined average 25 feet long.

### Small Intestine

The majority of absorption takes place in the small intestine, which is about 20 feet long. The small intestine has 3 sections: duodenum, jejunum, and ileum.

Finger-like extensions called villi and microvilli increase the surface area of the small intestine, allowing maximum absorption of nutrients and water.



**Large Intestine**  
The large intestine, about 5 feet long, is responsible for eliminating waste matter.