Anatomy First class

Introduction

Anatomy is the science of the structure and function of the body.

Basic anatomy is the study of the minimal amount of anatomy consistent with the understanding of the overall structure and function of the body.

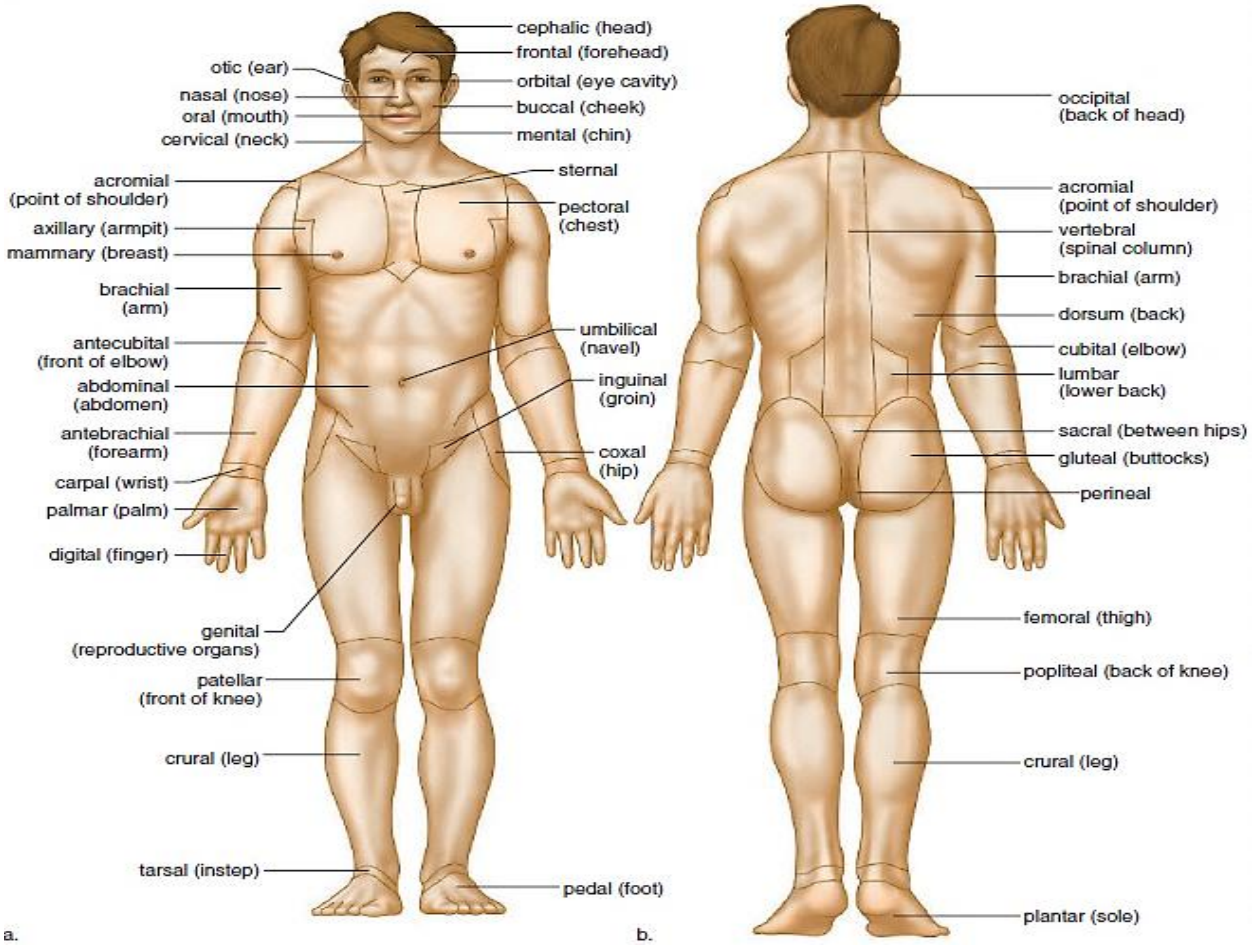
Clinical anatomy is the study of the macroscopic structure and function of the body as it relates to the practice of medicine and other health sciences.

Major Body Regions

The external anatomy and landmarks of the body is important in performing a physical examination and many other clinical procedures. For purposes of study, the body is divided into two major regions called the ***axial*** and ***appendicular regions***. Smaller areas within the major regions.

Axial Region

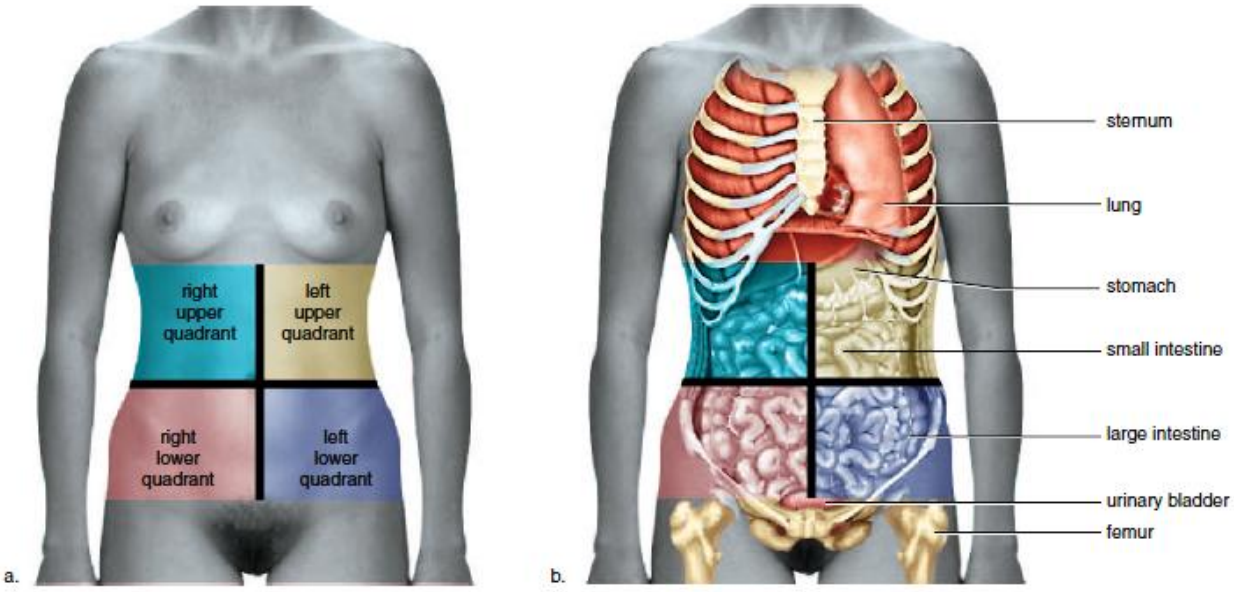
The axial region consists of the ***head, neck (cervical region)***, and ***trunk***. The trunk is further divided into the ***thoracic*** region above the diaphragm and the ***abdomin*** region and ***pelvis*** region below it.



Appendicular Region

The **appendicular region** of the body consists of the **upper limbs** and **lower limbs**. The upper limb includes the **arm** (**brachial region)**, **forearm region**, **wrist (carpal region), hand (manual region),** and **fingers (digits).** The lower limb includes the **thigh (femoral region), leg** (**crural region**), **ankle (tarsal region), foot** (**pedal region**)**,** and **toes (digits).** In strict anatomical terms, *arm* refers only to that part of the upper limb between the shoulder and elbow. *Leg* refers only to that part of the lower limb between the knee and ankle.

The **abdominopelvic** cavity is divided into four quadrants by running a transverse plane across the midsagittal plane at the point of the umbilicus (navel). Physicians commonly use these quadrants to identify the locations of patients' symptoms. The four quadrants are: ***(1) right upper quadrant, (2) left upper quadrant, (3) right lower quadrant, and (4) left lower quadrant.***



Anatomical position*:* standing erect, with face forward, arms at the sides, and palms and toes directed forward.

Directional Terms

Directional terms are used to describe the location of one body part in relation to another:

Anterior (ventral) means that a body part is located toward the front. The windpipe (trachea) is anterior to the esophagus.

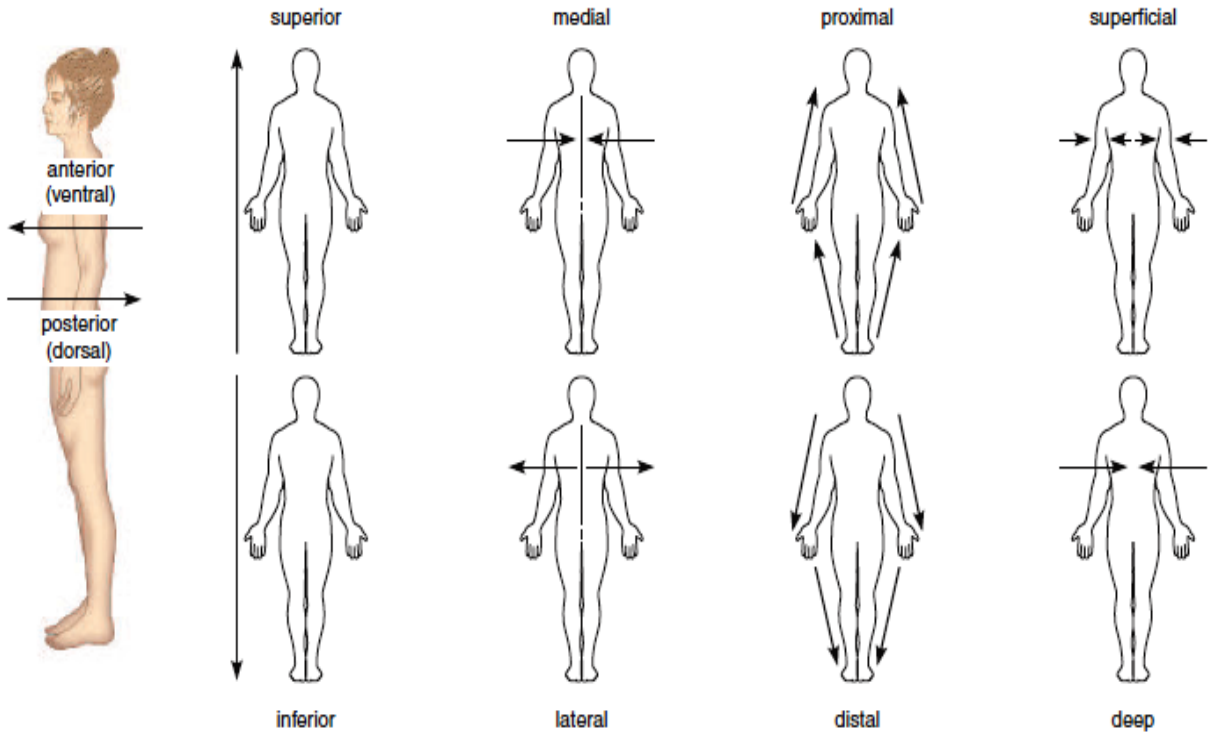
Posterior (dorsal) means that a body part is located toward the back. The heart is posterior to the rib cage.

Superior means that a body part is located above another part, or toward the head. The face is superior to the neck.

Inferior means that a body part is below another part, or toward the feet. The navel is inferior to the chin.

Medial means that a body part is nearer than another part to an imaginary midline of the body. The bridge of the nose is medial to the eyes.
Lateral means that a body part is farther away from the midline. The eyes are lateral to the nose.

Proximal means that a body part is closer to the point of attachment or closer to the trunk. The elbow is proximal to the hand.
Distal means that a body part is farther from the point of attachment or farther from the trunk or torso. The hand is distal to the elbow.
Superficial (external) means that a body part is located near the surface. The skin is superficial to the muscles.
Deep (internal) means that the body part is located away from the surface. The intestines are deep to the spine.
Central means that a body part is situated at the center of the body or an organ. The central nervous system is located along the main axis of the body.
Peripheral means that a body part is situated away from the center of the body or an organ. The peripheral nervous system is located outside the central nervous system.



Planes and Sections of the Body

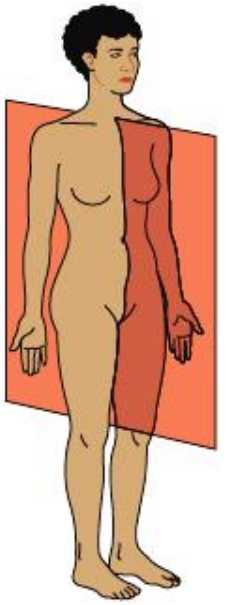
To observe the structure of an internal body part, it is customary to section (cut) the body along a plane. A plane is an imaginary flat surface passing through the body. The body is customarily sectioned along the following planes:

- **Sagittal** (median) **plane** extends lengthwise and divides the body into right and left portions. A midsagittal plane passes exactly through the midline of

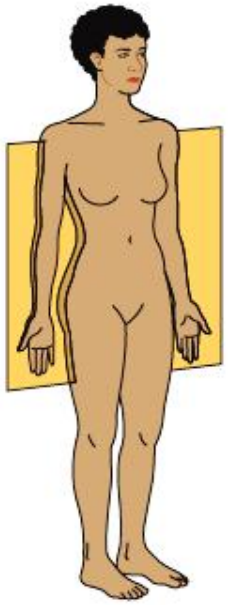
the body. Sagittal cuts that are not along the midline are called parasagittal sections.

- **Frontal** (coronal) **plane** also extends lengthwise, but it is perpendicular to a sagittal plane and divides the body or an organ into anterior and posterior portions.
- **Transverse** (horizontal) **plane** is perpendicular to the body's long axis and therefore divides the body horizontally to produce a cross section. A transverse cut divides the body or an organ into superior and inferior portions.

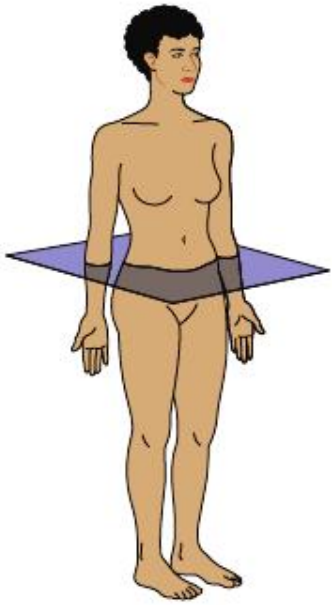
The terms ***longitudinal section*** and ***cross section*** are often applied to body parts that have been removed and cut either lengthwise or straight across, respectively.



a. Sagittal (median) plane



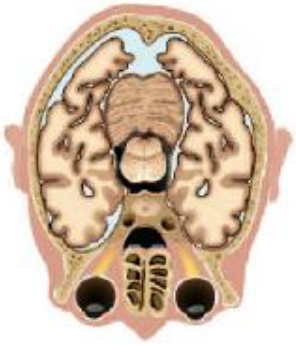
b. Frontal (coronal) plane



c. Transverse (horizontal) plane

d. Sagittal section of pelvic cavity

e. Frontal section of thoracic cavity



f. Transverse section of head at eye level

Body Cavities and Membranes

During embryonic development, the body is first divided into two internal cavities: the posterior (dorsal) body cavity and the anterior (ventral) body cavity. Each of

these major cavities is then subdivided into smaller cavities. The cavities, as well as the organs in the cavities (called the **viscera**), are lined by membranes.

Posterior (Dorsal) Body Cavity

The posterior body cavity is subdivided into two parts:

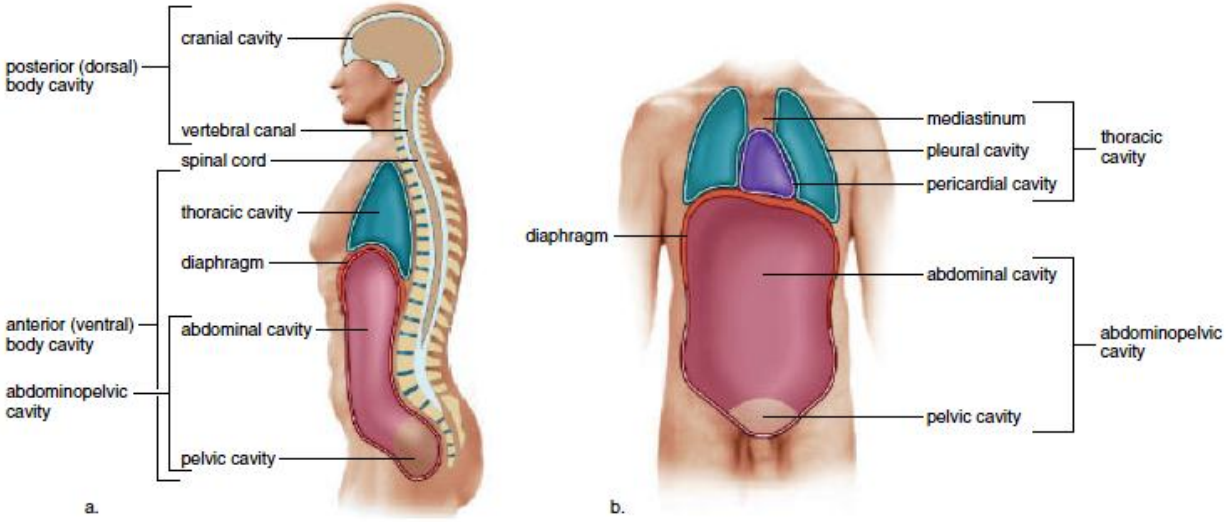
(1) The **cranial cavity**, enclosed by the bony cranium, contains the brain.

(2) The **vertebral canal**, enclosed by vertebrae, contains the spinal cord

The posterior body cavity is lined by three membranous layers called the **meninges**.

.**Anterior (Ventral) Body Cavity**

The large anterior body cavity is subdivided into the superior **thoracic cavity** and the inferior **abdominopelvic cavity**. A muscular partition called the **diaphragm** separates the two cavities. Membranes that line these cavities are called **serous membranes**. Serous fluid between the smooth serous membranes reduces friction as the viscera rub against each other or against the body wall. Your fist would be covered by one membrane (called a **visceral membrane**), and there would be a small space between this inner membrane (**visceral membrane**) and the outer membrane (called a **parietal membrane**):



<u>Thoracic Cavity</u>

The thoracic cavity is enclosed by the rib cage, and has three portions: the left, right, and medial portions. The medial portion, called the ***mediastinum,*** contains the heart, thymus gland, trachea, esophagus, and other structures. The right and left portions of the thoracic cavity contain the lungs. The lungs are surrounded by a serous membrane called the ***pleura.*** In the mediastinum, the heart is covered by the two-layered membrane called the ***pericardium***.

<u>Abdominopelvic cavity</u>

It has two portions: the superior **abdominal cavity** and the inferior **pelvic cavity.** The stomach, liver, spleen, gallbladder, and most of the small and large intestines

are in the abdominal cavity. The pelvic cavity contains the rectum, the urinary bladder, the internal reproductive organs, and the rest of the large intestine. Males have an external extension of the abdominal wall, called the **scrotum,** where the testes are found. Many of the organs of the abdominopelvic cavity are covered by the ***visceral peritoneum,*** while the wall of the abdominal cavity is lined with the ***parietal peritoneum*.**

Systems of the human Body

There are 11 major organ systems in the human body, each with specific functions, yet all are interrelated and work together to sustain life.

Integumentary System: Integument means "skin." It consists of the skin and the various accessory organs associated with it. These accessories include hair, nails, sweat glands, and sebaceous (oil) glands.

Skeletal System: forms the framework of the body and protects underlying organs such as the brain, lungs, and heart.

Muscular System: Muscles are the organs of the ***muscular system***. As muscles contract, they create the forces that produce movement and maintain posture.

Nervous System: consists of the ***brain, spinal cord, and associated nerves***. These organs work together to coordinate body activities. Nerve cells, or neurons, are specialized to transmit impulses from one point to another.

Endocrine System: This system includes all the glands that secrete chemicals called hormones. These hormones travel through the blood and act as messengers to regulate cellular activities.

Cardiovascular System: The cardiovascular system consists of the blood, heart, and blood vessels. The blood transports nutrients, hormones, and oxygen to tissue cells and removes waste products such as carbon dioxide.

Lymphatic System: The lymphatic system consists of a series of vessels that transport a fluid called lymph from the tissues back into the blood. Lymphoid organs also function in the body's defense mechanism by enhancing the activities of cells that inactivate specific pathogenic agents.

Digestive System: The organs of the digestive system include the mouth, pharynx, esophagus, stomach, small intestine, and large intestine (colon), which make up the digestive tract. Accessory organs of this system include the teeth, tongue, salivary glands, liver, gallbladder, and pancreas.

Respiratory System: The respiratory system brings oxygen, in the form of air, into the lungs, removes the carbon dioxide that is produced in metabolism.

Urinary System: The kidneys, ureters, urinary bladder, and urethra make up the urinary system. The kidneys remove various waste materials.

Reproductive System: The purpose of the reproductive system is the production of new individuals. The primary organs of the system are the gonads that produce the reproductive cells.

The body must maintain a relatively constant internal environment despite changes in external conditions. This constancy, or balance, is called **homeostasis.**

The circulatory system

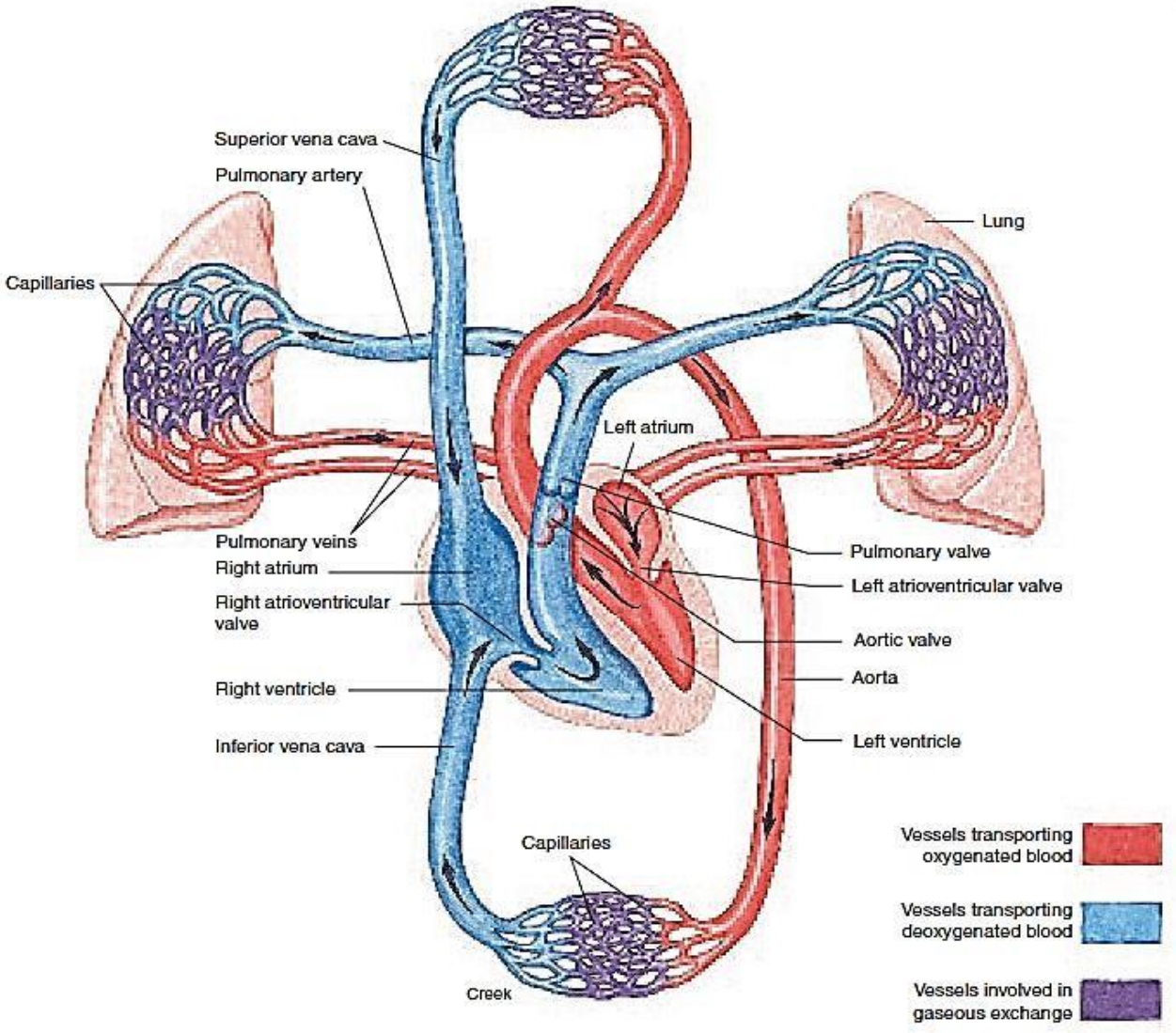
The circulatory system is divided into:

(1) **cardiovascular system,** which consists of the heart, blood vessels, and blood.

(2) **lymphatic system,** which consists of lymphatic vessels and lymphoid tissues within the spleen, thymus, tonsils, and lymph nodes.

Cardiovascular system (CVS)

The cardiovascular system which is closed system consists of : (1) the **heart**, which pumps blood so that it flows to body tissue capillaries, (2) the series of **blood vessels** through which the blood flows, there are certain blood vessels are a part of the pulmonary circuit, and others are a part of the systemic circuit and (3) **blood.**



Heart

The heart is located in the thoracic cavity between the lungs within the mediastinum (anatomical region that extends from the sternum to the vertebral column) rests on the diaphragm. It is a hollow, cone-shaped, relatively small roughly the same size as a **closed fist**. Its mass averages 250 g in adult females and 300 g in adult males. The base of the heart is superior to its apex which rests inferiorly on the diaphragm.

The heart is on a slant. About two-thirds of the mass of the heart lies to the left of the body's midline.

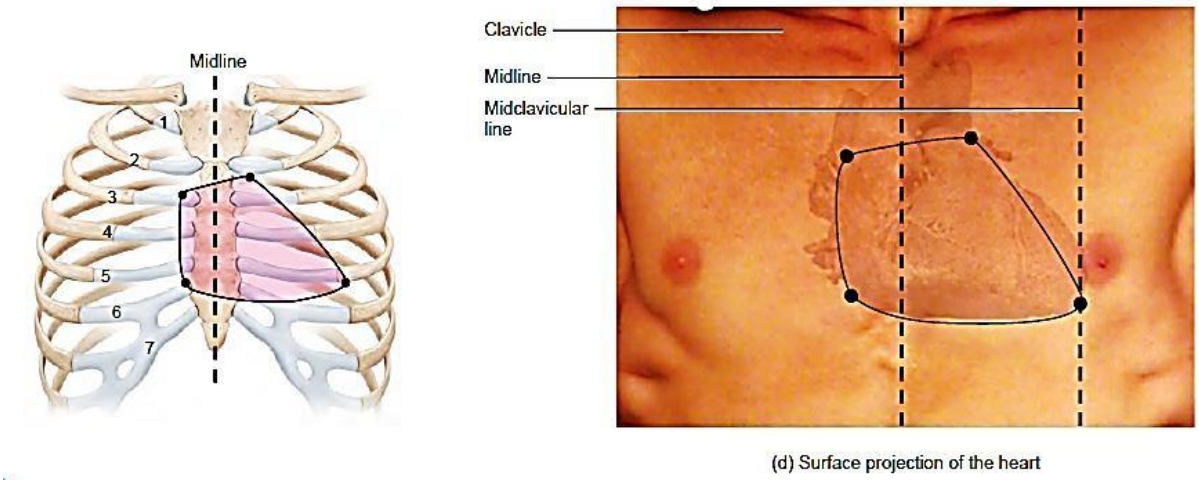
As the heart pumps the blood through the pulmonary and systemic vessels, it performs these functions:

1. Keeps O2-poor blood separate from O2-rich blood.

2. Keeps the blood flowing in one direction—blood flows away from and then back to the heart in each circuit.

3. creates blood pressure, which moves the blood through the circuits.

4. Regulates the blood supply based on the current needs of the body.



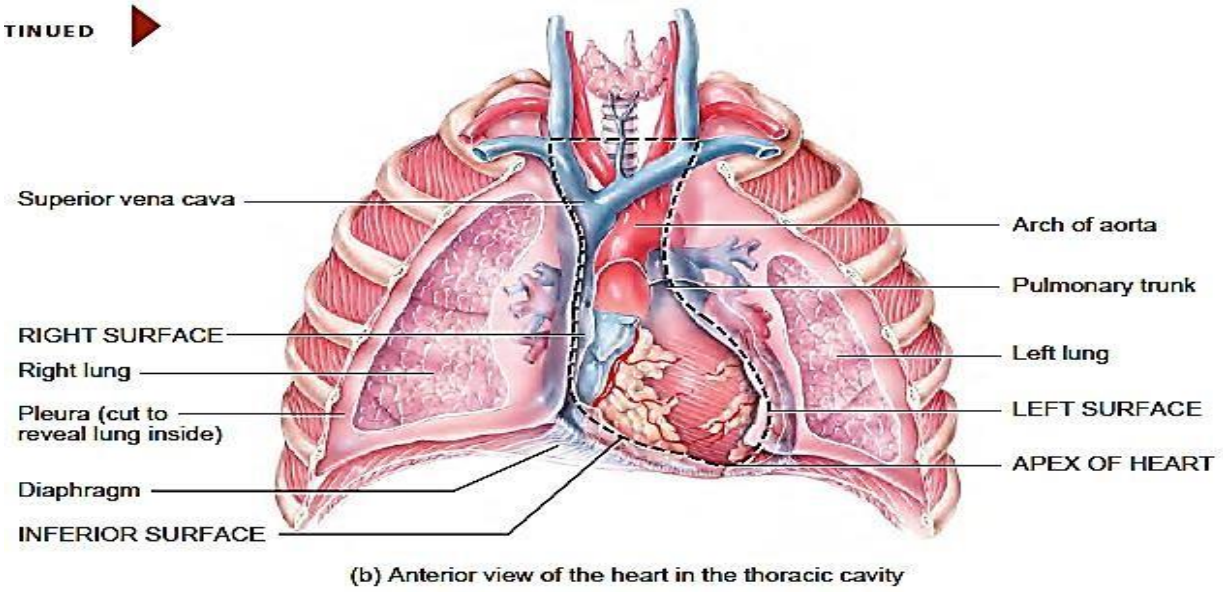
(d) Surface projection of the heart

Pericardium

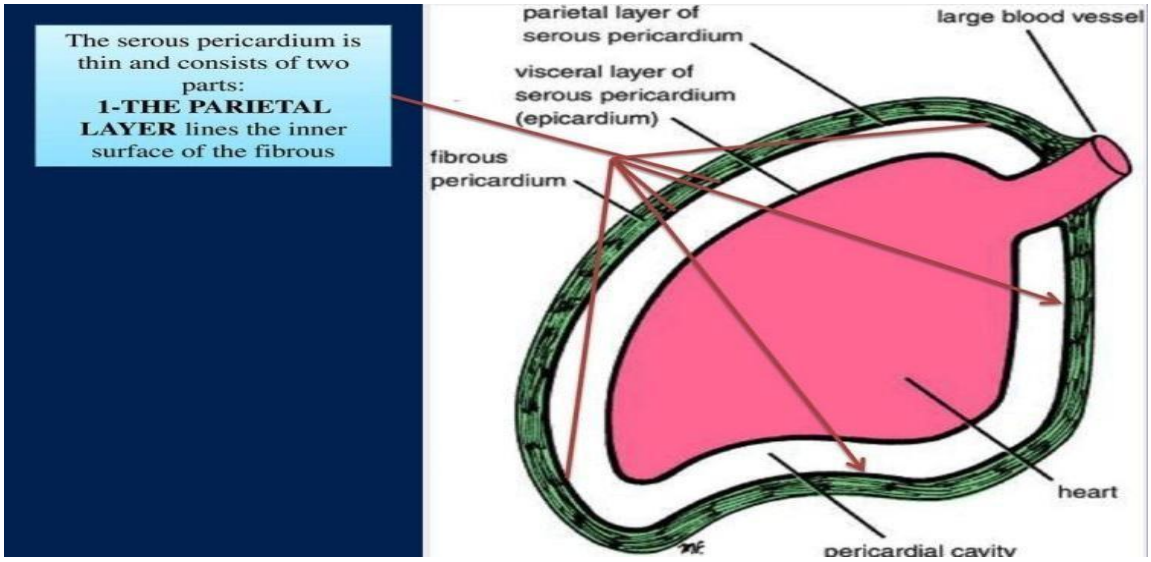
The membrane that surrounds and protects the heart is the ***pericardium*** fused with base of great vessels**.** The Function of the Pericardium: (1) Protects and anchors the heart (2) Prevents overfilling of the heart with blood (3) allows for the heart to work in a relatively friction-free environment.

The pericardium consists of two principal portions: (1) the superficial **fibrous pericardium** is composed of tough, inelastic, dense irregular connective tissue.

(2) The deeper **serous pericardium** is a thinner, more delicate membrane that forms a double layer around the heart. The outer ***parietal layer*** of the serous pericardium is fused to the fibrous pericardium. The inner ***visceral layer*** of the serous pericardium, also called the ***epicardium*** adheres tightly to the surface of the heart. Between them is a space called the pericardial cavity that contains the few milliliters of thin film of lubricating fluid called ***pericardial fluid*** reduces friction between the membranes as the heart moves.

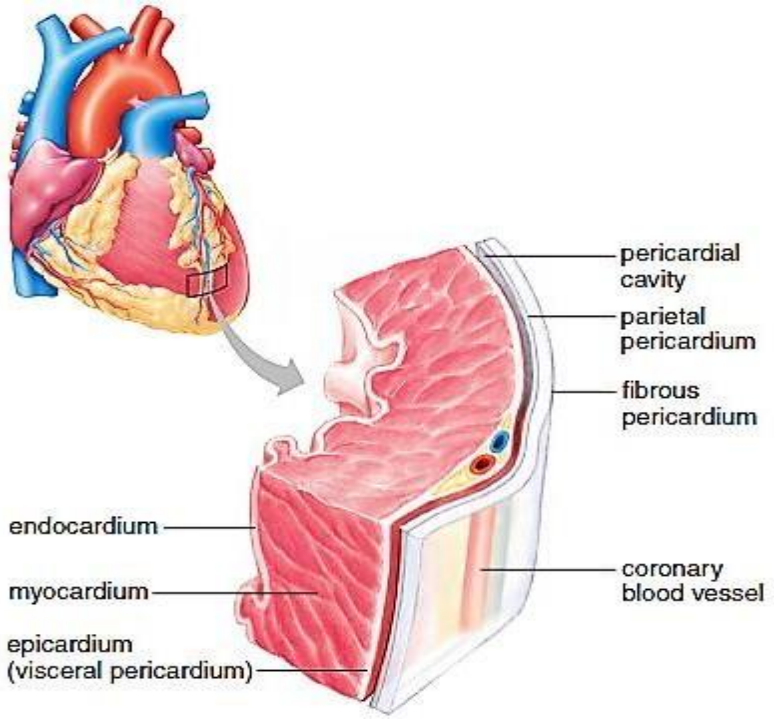


(b) Anterior view of the heart in the thoracic cavity



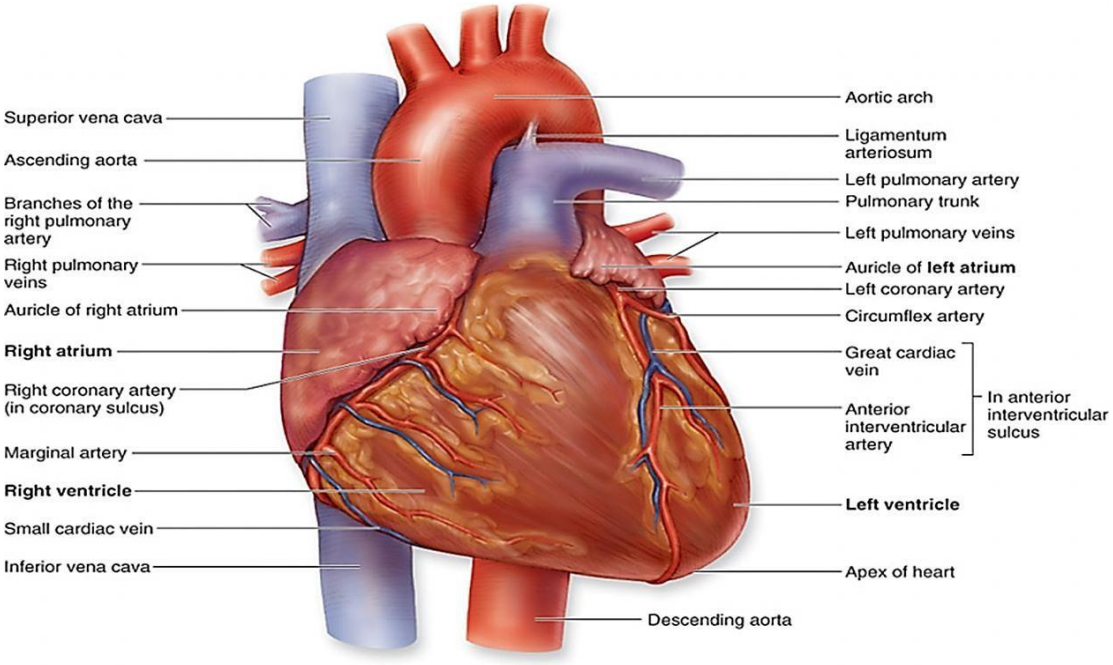
Layers of the Heart Wall

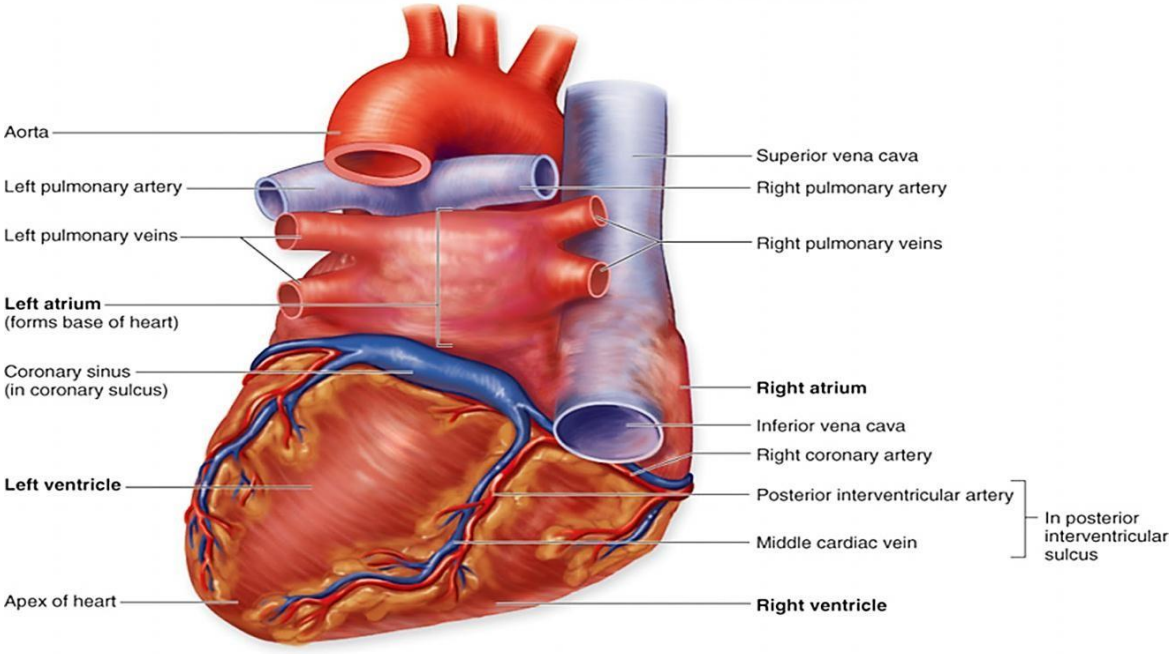
The wall of the heart consists of three layers: the ***epicardium*** (external layer), the ***myocardium*** (middle layer) composed of cardiac muscle, It's the thickest of the three layers and the ***endocardium*** (inner layer).



Chambers of the Heart

The heart has four hollow chambers: two superior ***atria*** (single atrium) and two inferior ***ventricles***. Each atrium has a wrinkled anterior pouch called an ***auricle***. Internally, the atria are separated by the ***interatrial septum,*** and the ventricles are separated by the ***interventricular septum.*** Therefore, the heart has a left and a right side. The thickness of a chamber's myocardium is suited to its function. The atria have thin walls, and they send blood into the adjacent ventricles. The ventricles are thicker, and they pump blood into blood vessels that travel to parts of the body. The left ventricle has a thicker wall than the right ventricle; the right ventricle pumps blood to the lungs, which are nearby. The left ventricle pumps blood to all the other parts of the body.





Right Atrium

The **right atrium** forms the right border of the heart. It receives blood from three veins: ***superior vena cava, inferior vena cava,*** **and** ***coronary sinus***. Veins always carry blood toward the heart. Venous blood passes from the right atrium into the right ventricle through an **atrioventricular** (**AV**) **valve.** This valve, like the other heart valves, directs the flow of blood and prevents any backflow. The AV valve also called the **tricuspid valve** because it has three cusps, or flaps.

Right Ventricle

In the **right ventricle**, the cusps of the tricuspid valve are connected to fibrous cords, called the **chordae tendineae .** The chordae tendineae in turn are connected

to the **papillary muscles**, which are conical extensions of the myocardium. Blood from the right ventricle passes through a **semilunar valve(resemble half-moons)** into the **pulmonary trunk**. This particular semilunar valve, called the **pulmonary semilunar valve,** prevents blood from flowing back into the right ventricle. The **pulmonary trunk** divides into the **left** and **right pulmonary arteries**.

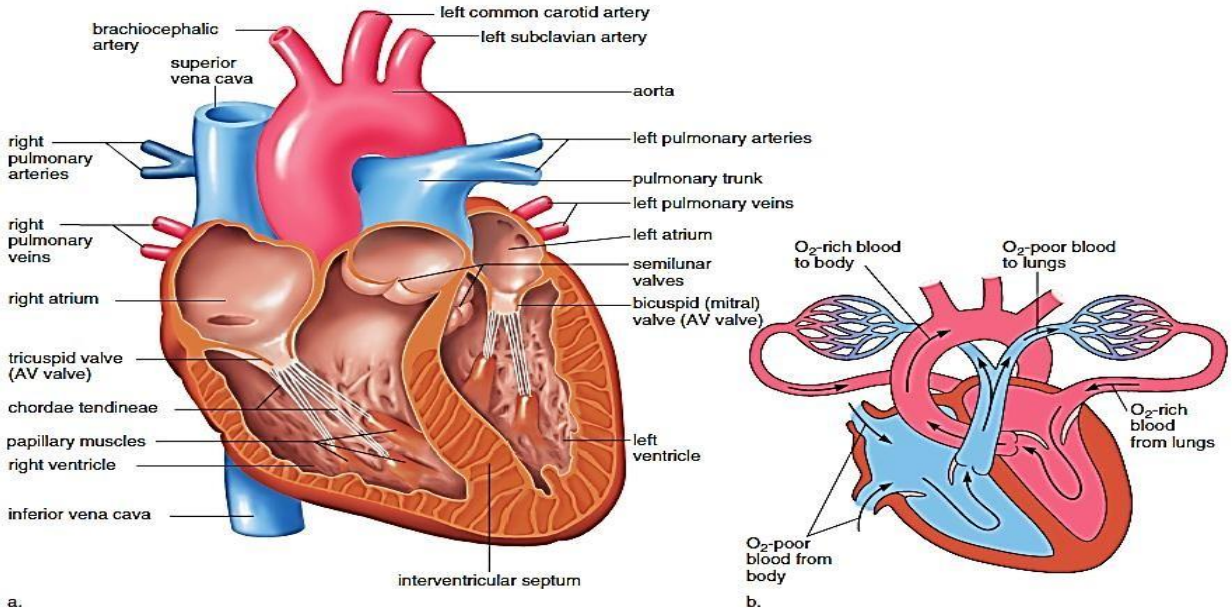
Left Atrium

At its posterior wall, the **left atrium** receives O2-rich blood from **four pulmonary veins**. Two pulmonary veins come from each lung. Blood passes from the left atrium into the left ventricle through an AV valve. The AV valve on the left side is specifically called the **bicuspid (mitral) valve** because it has two cusps.

Left Ventricle

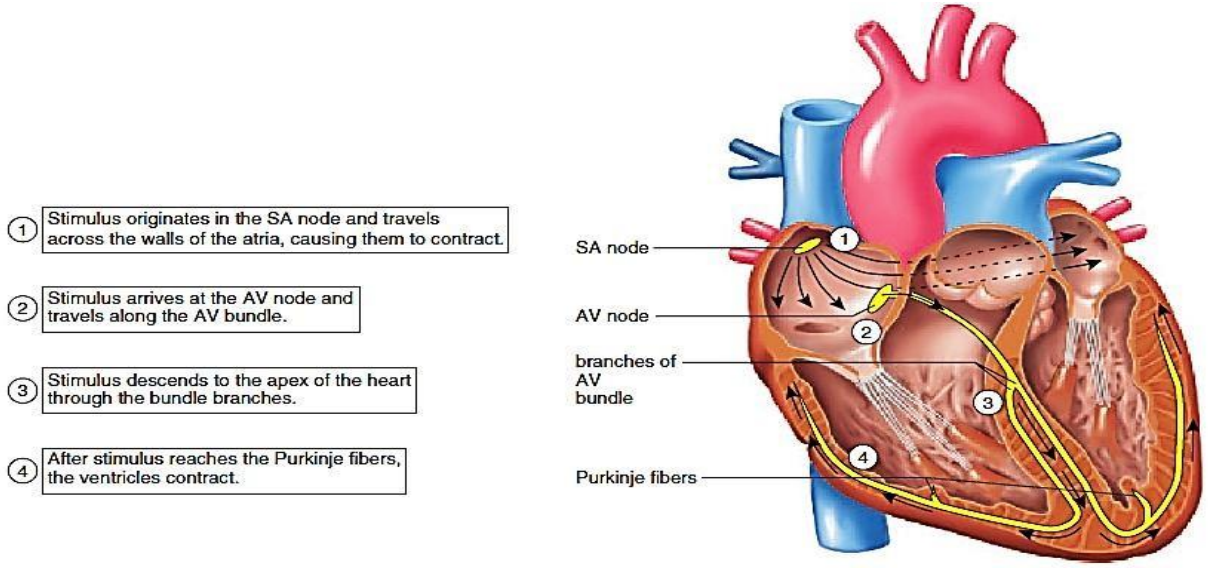
The **left ventricle** forms the apex of the heart. The cavity of the left ventricle is oval-shaped, while that of the right ventricle is crescent-shaped in transverse section. The papillary muscles in the left ventricle are quite large, and the chordae tendineae attached to the AV valve are thicker and stronger than those in the right ventricle. As mentioned, the AV valve on the left side is also called the bicuspid (or mitral) valve. Blood passes from the left ventricle through a semilunar valve into the **aorta**. This semilunar valve is appropriately called the **aortic semilunar valve.** Just beyond the aortic semilunar valve, some blood passes into the two **coronary arteries,** termed the **left** and **right coronary arteries**, blood vessels that lie on and nourish the heart itself. The aorta continues as **ascending aorta** then the **arch of the aorta** and then the **descending aorta**. The path of O2-rich blood through the heart, from the pulmonary veins to the aorta.

The heart have coronary veins are specifically called **cardiac veins.** The cardiac veins enter a **coronary sinus**, which is essentially a thin-walled vein. The **coronary sinus** enters the **right atrium**.



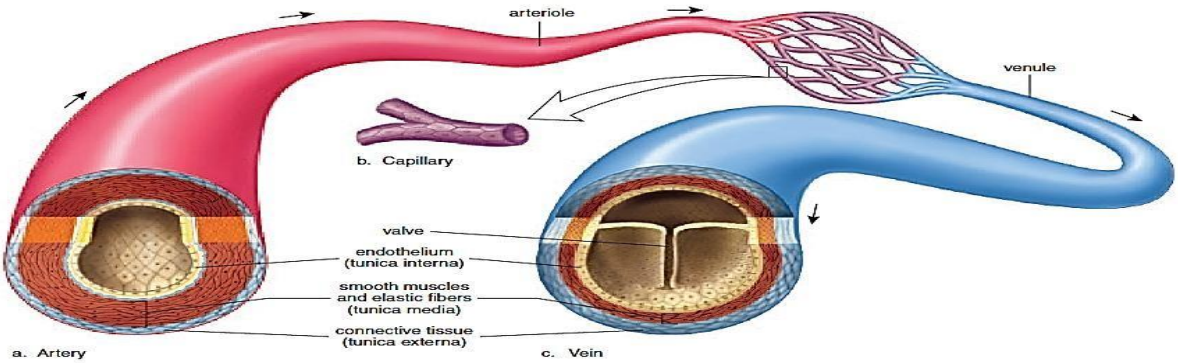
Conduction System of the Heart

The **conduction system of the heart** is a route of specialized cardiac muscle fibers that initiate and stimulate contraction of the atria and ventricles. The conduction system is said to be **intrinsic**, meaning that the heart beats automatically without the need for external nervous stimulation. The conduction system coordinates the contraction of the atria and ventricles so that the heart is an effective pump. Without this conduction system, the atria and ventricles would contract at different rates. Conduction system of the heart. **(1)** The **sinoatrial node (SA) cardiac pacemaker** sends out a stimulus, which causes the atria to contract. **(2)** When this stimulus reaches the **atrioventricular node (AV)**, it signals the ventricles to contract. **(3)** Impulses pass down the two branches of the **atrioventricular bundle (4)** and then to the **Purkinje fibers**, and thereafter, the ventricles contract.

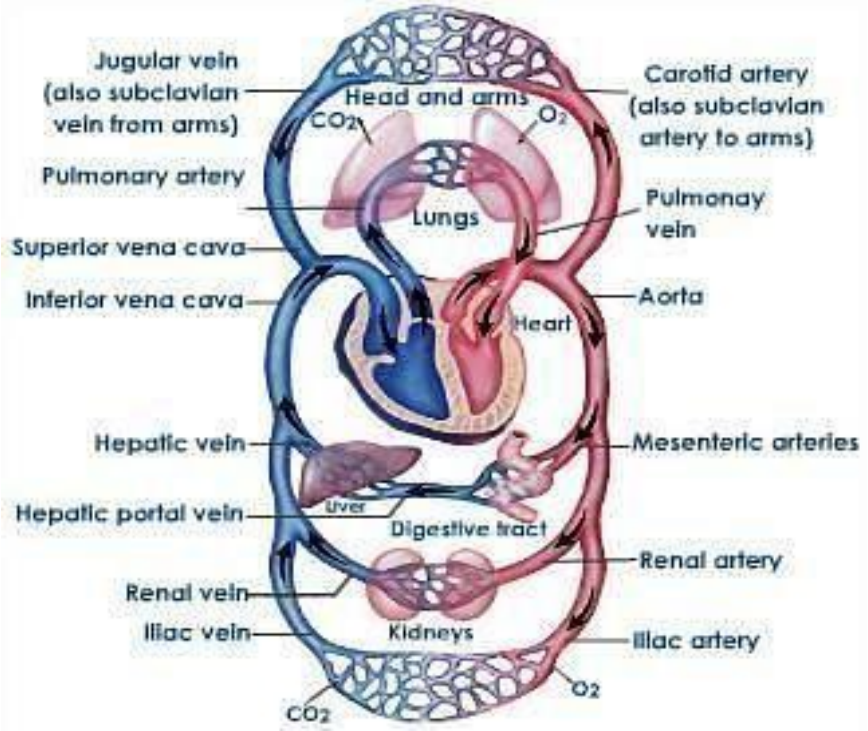


Anatomy of Blood Vessels

Blood vessels are of three types: **arteries, capillaries, and veins**. These vessels function to transport blood and its contents; Carry out exchange of gases in the pulmonary capillaries and exchange of gases plus nutrients for waste at the systemic capillaries; Regulate blood pressure; Direct blood flow to those systemic tissues that most require it at the moment.



Arteries transport blood away from the heart. Blood vessels belong to either the ***pulmonary circuit*** or the ***systemic circuit***. The path of blood through the **pulmonary circuit** can be traced as follows: deoxygenated blood from all regions of the body first collects by veins in the right atrium and then passes into the right ventricle, which pumps it into the pulmonary trunk. The pulmonary trunk divides into the **pulmonary arteries,** which in turn divide into the arterioles of the lungs. The arterioles then take blood to the pulmonary capillaries, where carbon dioxide and oxygen are exchanged. The blood then enters the pulmonary venules and flows through the **pulmonary veins** back to the left atrium. The **systemic circuit** includes all of the other arteries and veins of the body. The largest artery in the systemic circuit is the **aorta**, and the largest veins are the **superior vena cava** and **inferior vena cava.** The superior vena cava collects blood from the head, chest, and arms, and the inferior vena cava collects blood from the lower body regions. Both venae cavae enter the right atrium. The aorta and venae cavae are the major pathways for blood in the systemic system.



The Major Systemic Arteries

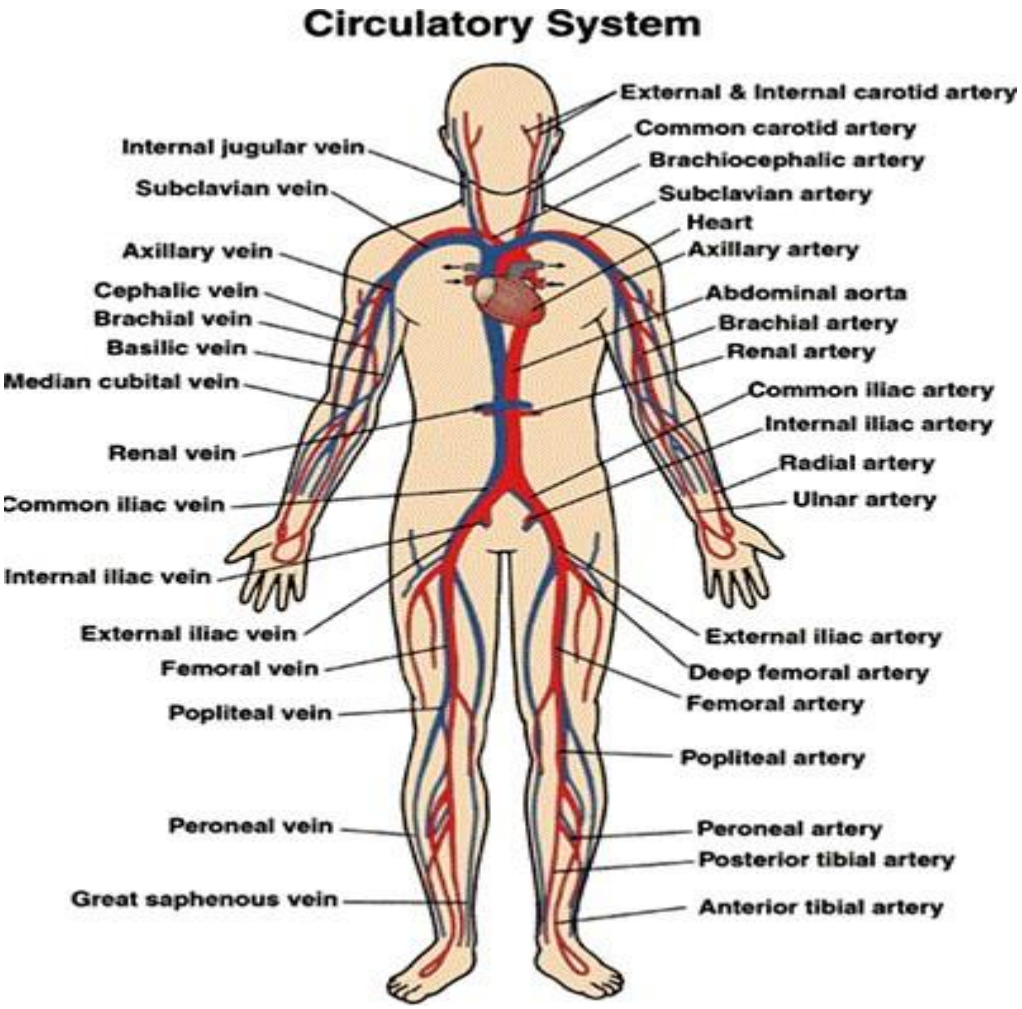
After the aorta leaves the heart, it divides into the **ascending aorta**, the **aortic arch**, and the **descending aorta**. The left and right coronary arteries, which supply blood to the heart, branch off the ascending aorta. Three major arteries branch off the aortic arch: the **brachiocephalic artery,** the **left common carotid artery,** and the **left subclavian artery.** The brachiocephalic artery divides into the **right common carotid** and the **right subclavian arteries.** These blood vessels serve the head (right and left common carotids) and arms (right and left subclavians). The descending aorta is divided into the **thoracic aorta**, which branches off to the organs within the

thoracic cavity, and the **abdominal aorta**, which branches off to the organs in the abdominal cavity. The descending aorta ends when it divides into the **common iliac arteries** that branch into the **internal iliac artery** and the **external iliac artery.** The internal iliac artery serves the pelvic organs, and the external iliac artery serves the legs.

Portion of Aorta	Major Branch	Regions Supplied
Ascending aorta	Left and right coronary arteries	Heart
Aortic arch	Brachiocephalic artery	
	Right common carotid	Right side of head
	Right subclavian	Right arm
	Left common carotid artery	Left side of head
	Left subclavian artery	Left arm
Descending aorta		
Thoracic aorta	Intercostal artery	Thoracic wall
Abdominal aorta	Celiac artery	Stomach, spleen, and liver
	Superior mesenteric artery	Small and large intestines (ascending and transverse colons)
	Renal artery	Kidney
	Gonadal artery	Ovary or testis
	Inferior mesenteric artery	Lower digestive system (transverse and descending colons, and rectum)
	Common iliac artery	Pelvic organs and legs

The Major Systemic Veins

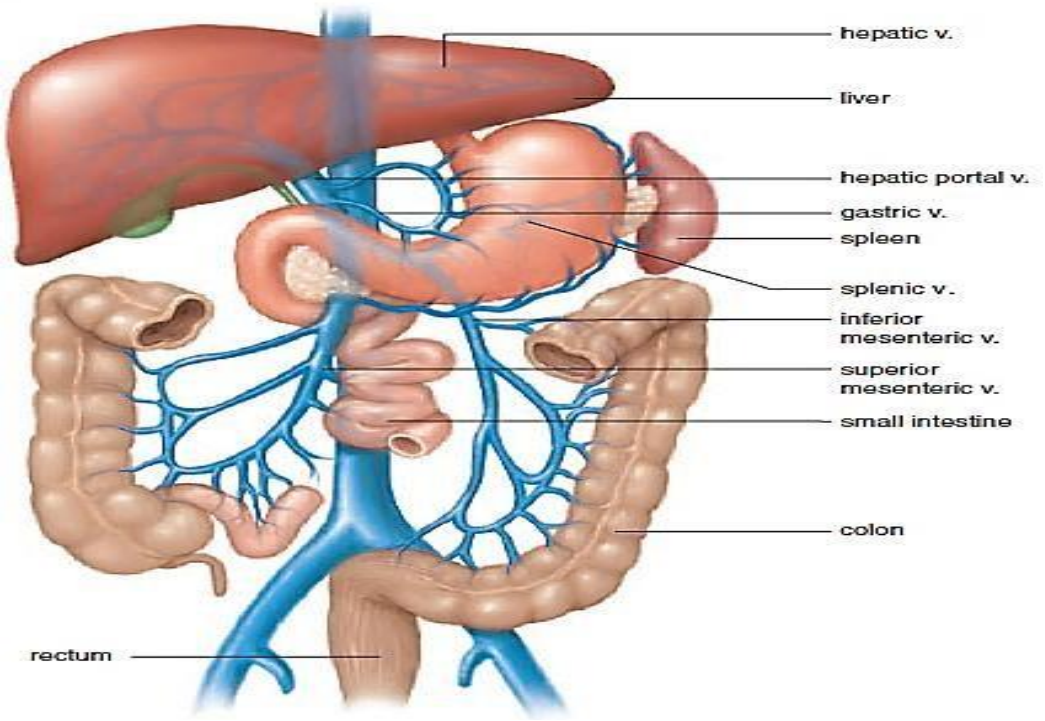
the major veins of the body. The **external** and **internal jugular veins** drain blood from the brain, head, and neck. An external jugular vein enters a **subclavian vein** that, along with an internal jugular vein, enters a **brachiocephalic vein.** Right and left brachiocephalic veins merge, giving rise to the superior vena cava. In the abdominal cavity the **hepatic portal vein** receives blood from the abdominal viscera and enters the liver. Emerging from the liver, the **hepatic veins** enter the inferior vena cava. In the pelvic region, veins from the various organs enter the **internal iliac** veins, while the veins from the legs enter the **external iliac veins.** The internal and external iliac veins become the **common iliac veins** that merge, forming the **inferior vena cava**.



Special Systemic Circulations

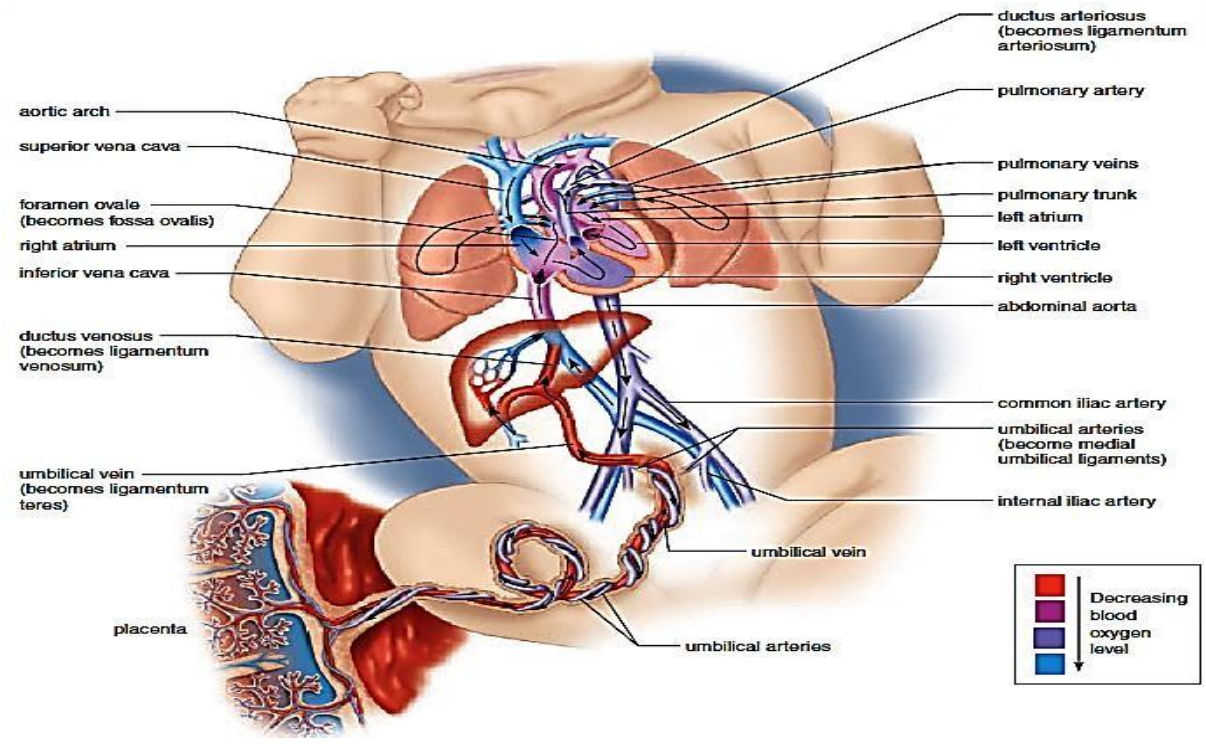
Hepatic Portal System

The **hepatic portal system** receives all of the blood draining from the abdominal digestive tract, as well as from the **pancreas**, **gallbladder,** and **spleen**. It is called a portal system because it connects capillaries of the intestines and other digestive organs to modified capillaries (**hepatic sinusoids**) of the **liver**; thus, the blood passes through two capillary beds in series before it returns to the heart.



Fetal circulation

The lungs are not functional in the fetus. The blood passes directly from the right atrium to the left atrium via the **foramen ovale** or from the right ventricle to the aorta via the pulmonary trunk through **ductus arteriosus to aorta**. The two **umbilical arteries** take fetal blood to the placenta where exchange of molecules between **fetal** and **maternal** blood takes place. Oxygen and nutrient molecules diffuse into the fetal blood, and carbon dioxide and urea diffuse from the fetal blood. The umbilical vein returns blood from the placenta to the fetus.



Lymphatic system

The lymphatic system is a network of tissues, organs, and vessels that help to maintain the body's fluid balance, this system, which is closely associated with the cardiovascular system, has three main functions that contribute to homeostasis:

1. **Fluid balance.** The lymphatic system takes up excess tissue fluid and returns it to the bloodstream.
2. **Fat absorption.** The lymphatic system absorbs fats from the digestive tract and transports them to the bloodstream. Special lymphatic capillaries called **lacteals** are located in the intestinal villi.
3. **Defense.** The lymphatic system helps defend the body against disease.

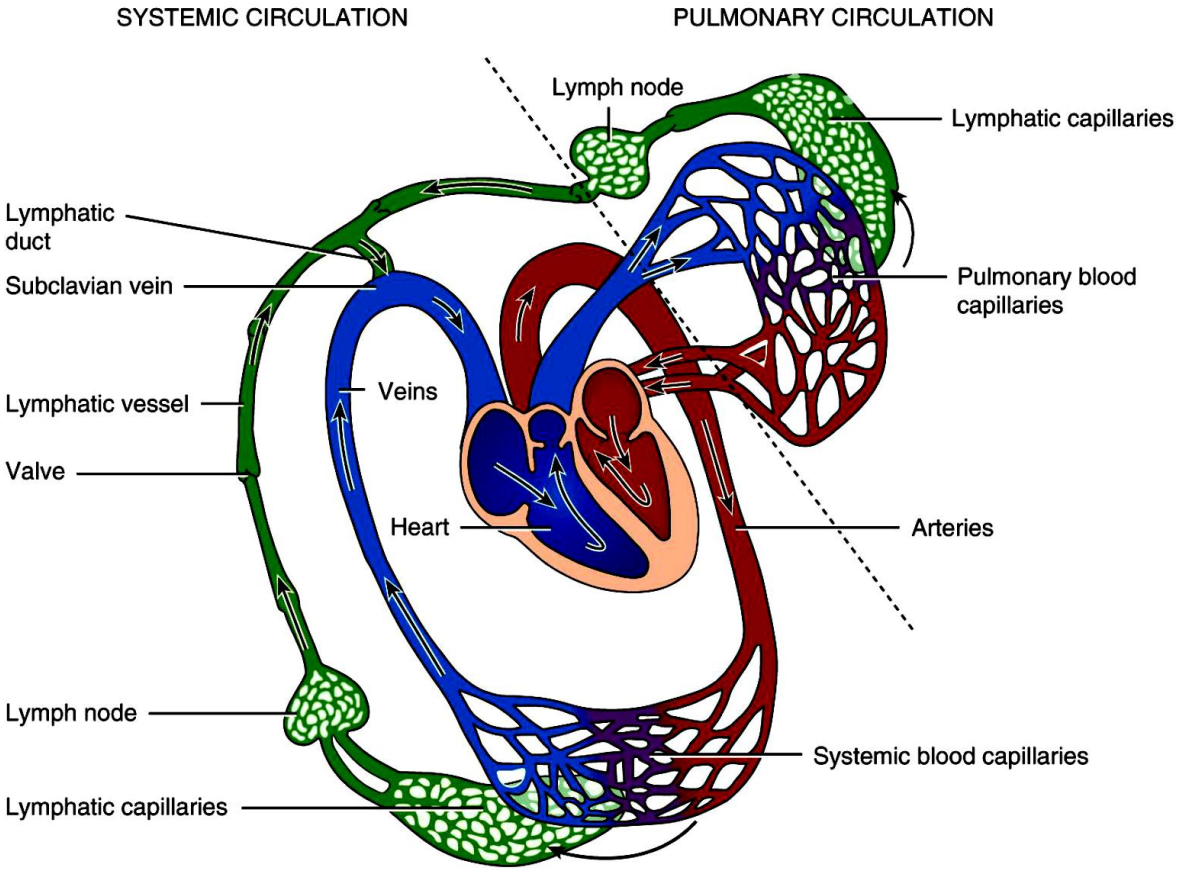


Figure 16.04 Tortora - PHA 11/e

Components of the Lymphatic System

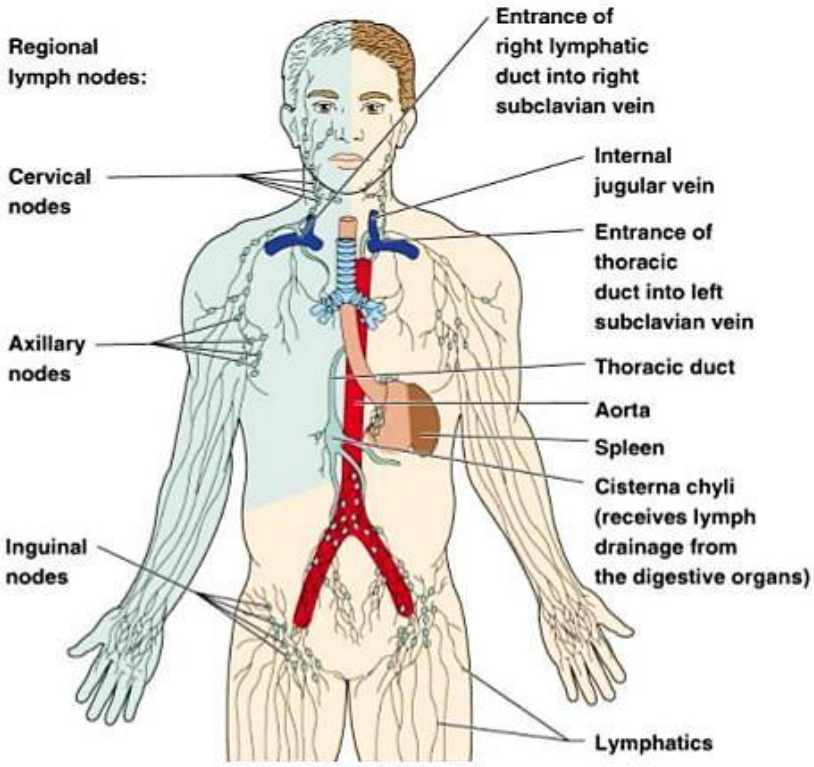
- Lymph
- Lymphatic Vessels: Lymphatic Capillaries, Lymphatic Vessels, Lymphatic Trunks and Lymphatic Ducts.
- Lymphatic Organs: Thymus, Lymph Nodes and Spleen.

Lymph is usually a clear, colorless fluid, similar to blood plasma but low in protein. It originates as tissue fluid that has been taken up by the lymphatic vessels.

Lymphatic Vessels

Lymphatic vessels form a one-way system (contain valve) that begins with lymphatic capillaries. Most regions of the body are richly supplied with lymphatic capillaries, tiny, closed-ended vessels whose walls consist of simple squamous epithelium. Lymphatic capillaries take up excess tissue fluid (lymph). The lymphatic capillaries join to form lymphatic vessels that merge before entering one of two ducts:

1. The **right lymphatic duct** is formed by the convergence of the **right jugular, subclavian**, and **bronchomediastinal trunks** in the **right side of thoracic cavity**. It receives lymphatic drainage from the **right upper limb** and **right side** of the **thorax** and **head**, and empties into the **right subclavian vein**.
2. The **thoracic duct,** on the left, is larger and longer. It begins just below the diaphragm, anterior to the vertebral column. Here, the two lumbar trunks and the intestinal trunk join and form a prominent sac called the **cisterna chyli**, named for the large amount of chyle that it collects after a meal. The thoracic duct then passes through the diaphragm with the aorta and ascends the mediastinum, adjacent to the vertebral column. As it passes through the thorax, it receives additional lymph from the **left bronchomediastinal, left subclavian,** and **left jugular trunks**, then empties into the **left subclavian vein**. Collectively, this duct therefore drains all of the body below the diaphragm, and the **left upper limb** and **left side** of the **head, neck**, and **thorax**. The construction of the larger lymphatic vessels is similar to that of cardiovascular veins, including the presence of **valves**. Lymphatic vessels is **absent** from the **central nervous system, cartilage, cornea, bone,** and **bone marrow**.



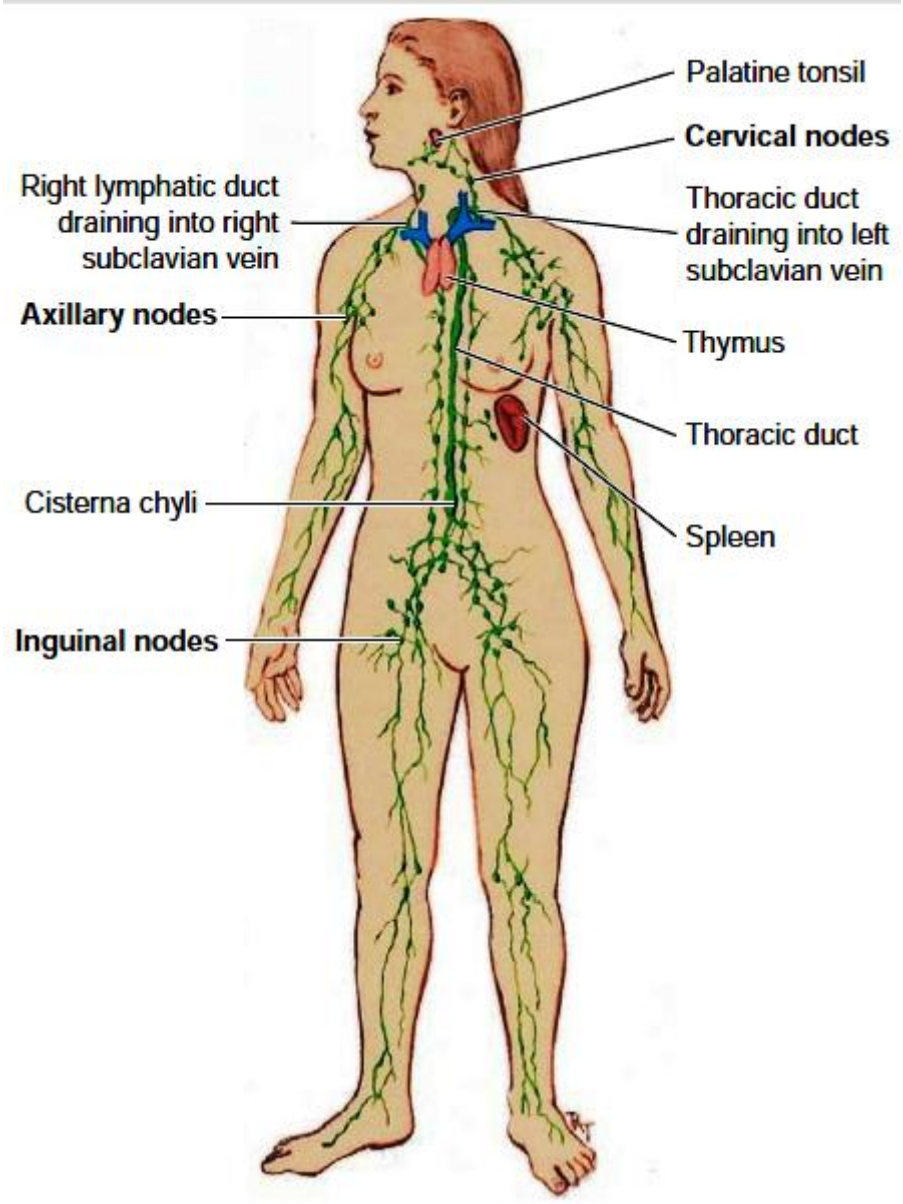
Lymph Nodes

Lymph nodes are small, bean-shaped structures that are usually less than (2.5 cm) in length. They are widely distributed throughout the body along the lymphatic pathways, where they filter the lymph before it is returned to the blood. Lymph nodes are not present in the central nervous system. There are **three superficial regions** on each side of the body where lymph nodes tend to cluster. These areas are the **inguinal nodes** in the **groin**, the **axillary nodes** in the **armpit**, and the **cervical nodes** in the **neck**. The typical lymph node is surrounded by a connective tissue **capsule** and divided into compartments called **lymph nodules.**

Lymphatic Nodules

Lymphatic nodules are egg-shaped masses of lymphatic tissue; unlike lymph nodes, they are not surrounded by a capsule. Because they are scattered throughout the **lamina propria (connective tissue)** of mucous membranes lining the **gastrointestinal, urinary, reproductive tracts** and **the respiratory airways**, lymphatic nodules in these areas are also referred to as **mucosa associated lymphatic tissue (MALT)**. Although many lymphatic nodules are small and solitary, some occur in multiple large aggregations in specific parts of

the body. Among these are the **tonsils** in the **pharyngeal region** and the **aggregated lymphatic follicles** (**Peyer's patches**) in the **ileum** of the **small intestine**. Aggregations of lymphatic nodules also occur in the **appendix**.

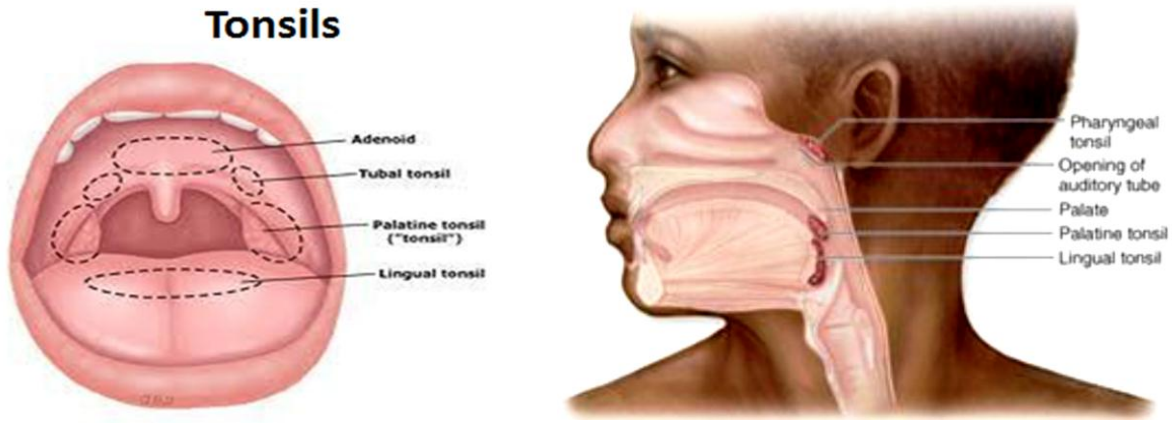


Tonsils

Tonsils are clusters of lymphatic tissue just under the mucous membranes that line the **nose, mouth,** and **throat (pharynx)**. There are **three** groups of tonsils.
1- **pharyngeal tonsils** are located near the opening of the nasal cavity into the pharynx. When these tonsils become enlarged, they may interfere with breathing and are called **adenoids**.

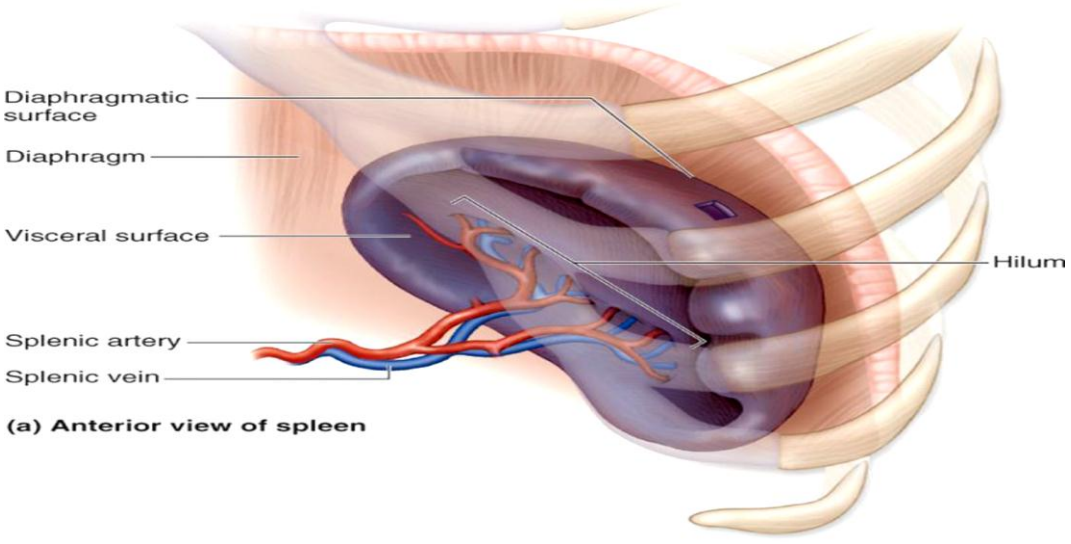
2- **palatine tonsils** are two These are located near the opening of the oral cavity into the pharynx.

3- **Lingual tonsils** are located on the posterior surface of the tongue, which also places them near the opening of the oral cavity into the pharynx. Lymphocytes and macrophages in the tonsils provide protection against harmful substances and pathogens that may enter the body through the nose or mouth.



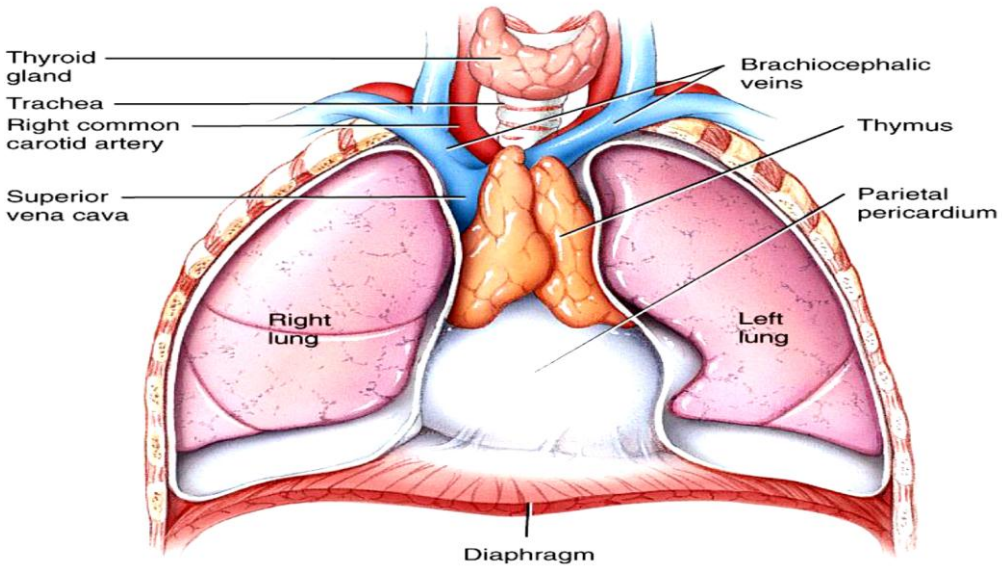
Spleen

The **spleen** is located in the upper **left abdominal cavity**, just beneath the diaphragm, and posterior to the stomach. It is similar to a lymph node in shape and structure but it is much larger. The spleen is the **largest** lymphatic organ in the body and is approximately 12 cm in length, 7 cm wide and 2.5 cm thick. It weighs about 200 g and is purplish in colour. Surrounded by a connective tissue capsule, which extends inward to divide the organ into lobules, the spleen consists of two types of tissue called **white pulp** and **red pulp**. It is in contact with the stomach, the left kidney and the diaphragm. The blood supply to the spleen enter it at hilum derives from the splenic artery and the splenic vein.



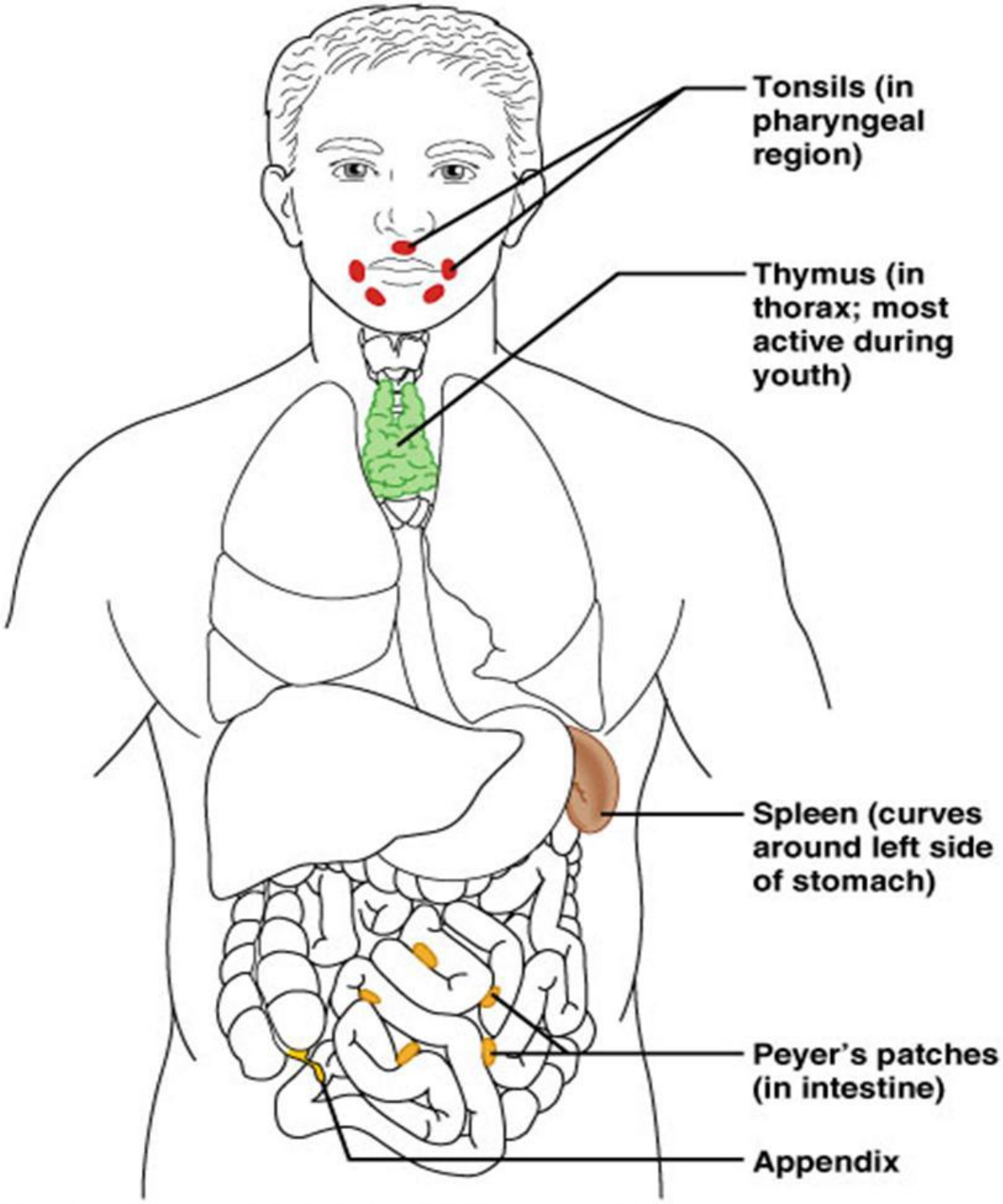
Thymus

The **thymus** is a soft organ with two lobes that is a ductless, pinkish - grey mass of lymphoid tissue located anterior to the ascending aorta and posterior to the sternum. It is relatively large in infants and children, but after puberty it begins to decrease in size so that in older adults it is quite small. The primary function of the thymus is the processing and maturation of special lymphocytes called **T lymphocytes** or **T cells**. While in the thymus, the lymphocytes do not respond to pathogens and foreign agents. The thymus also produces a hormone, **thymosin** that stimulates the maturation of lymphocytes in other lymphatic organs.



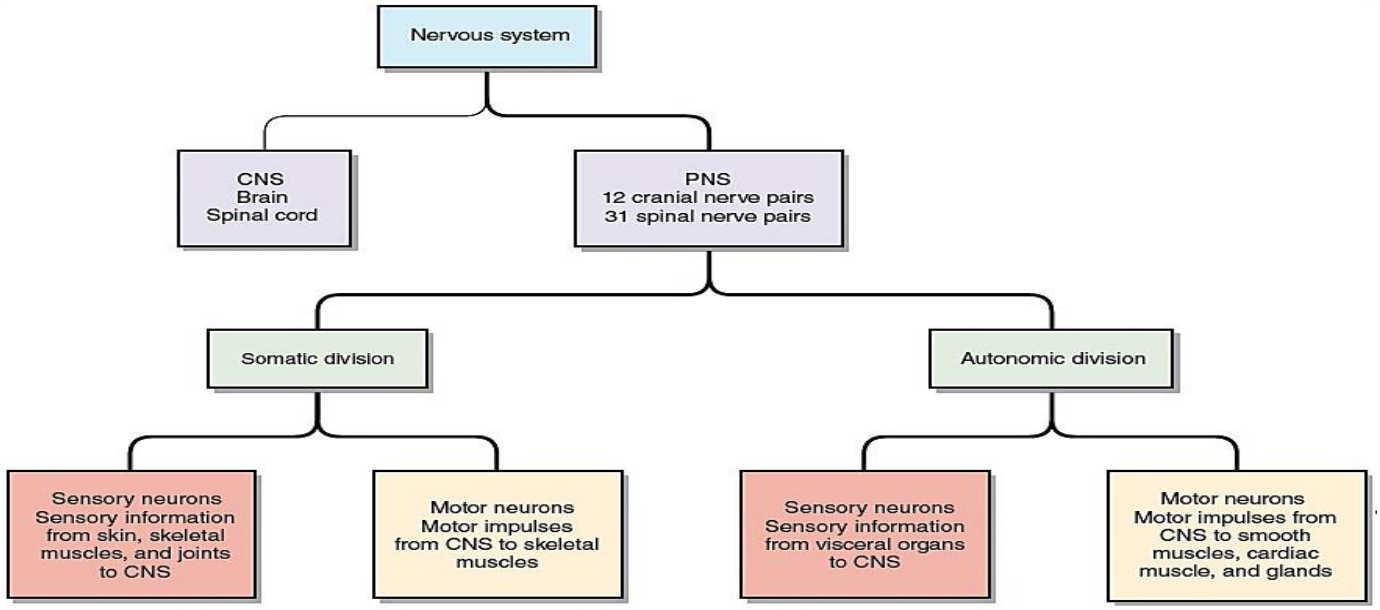
(a) Thymus of adolescent

Figure 16.05 Tortora - PHA 11/e

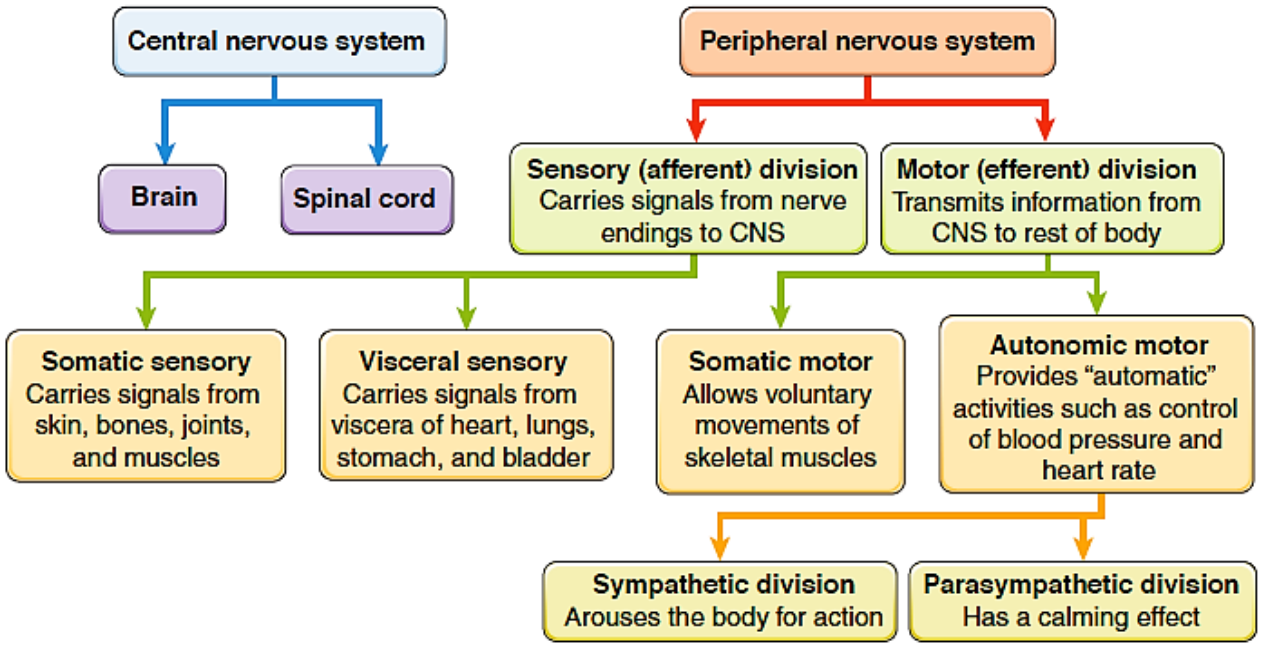


Nervous system

The nervous system is a major communicating and control system within the body. It works with the endocrine system to control many body functions. The two systems work together to maintain homeostasis. The **nervous system** includes all the **neural tissue** in the body. The nervous system can be divided into the ***central nervous system (CNS)***: made up of the **brain** and **spinal cord** and the ***peripheral nervous system (PNS)***: consisting of the **peripheral nerves** and the **ganglia** associated with them, and the ***autonomic nervous system***: consisting of the **sympathetic** and the **parasympathetic nervous systems**. Neurons (nerve cells) **cannot** regenerate if damaged.



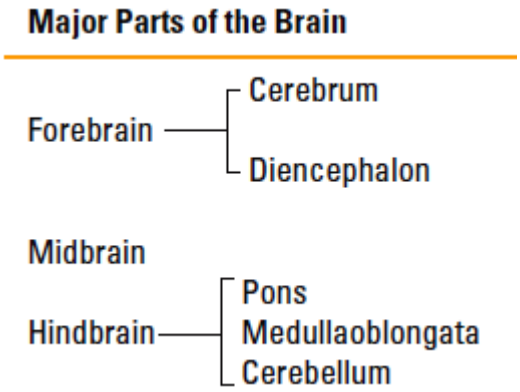
Other classification



Cenral nervous system: consist of

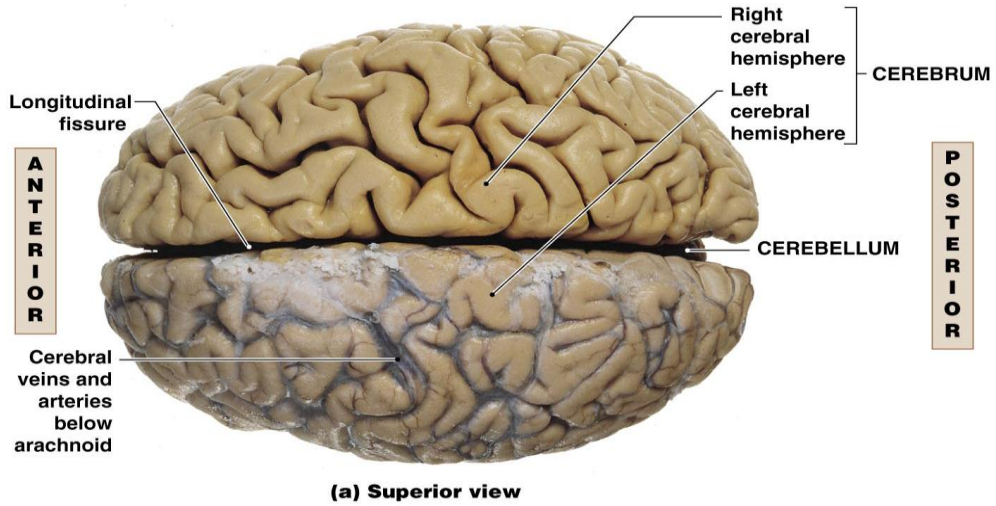
Brain

The brain is that part of the central nervous system that lies inside the cranial cavity. It is continuous with the spinal cord through the foramen magnum. The brain consists of the **cerebrum** (made up of two large cerebral hemispheres), **cerebellum**, **midbrain**, **pons**, and **medulla oblongata**. The midbrain, pons, and medulla together form the **brainstem**. The medulla is continuous below with the spinal cord.



Cerebrum

- This is the largest brain structure. superior parts of the brain Include more than half of the brain mass. It is divided into the left and right hemispheres by the **longitudinal cerebral fissure**. Each half controls the opposite side of the body. The two halves of the brain communicate through the **corpus callosum** which a bundle of nerve fibers (white matter) connecting the two sides together.

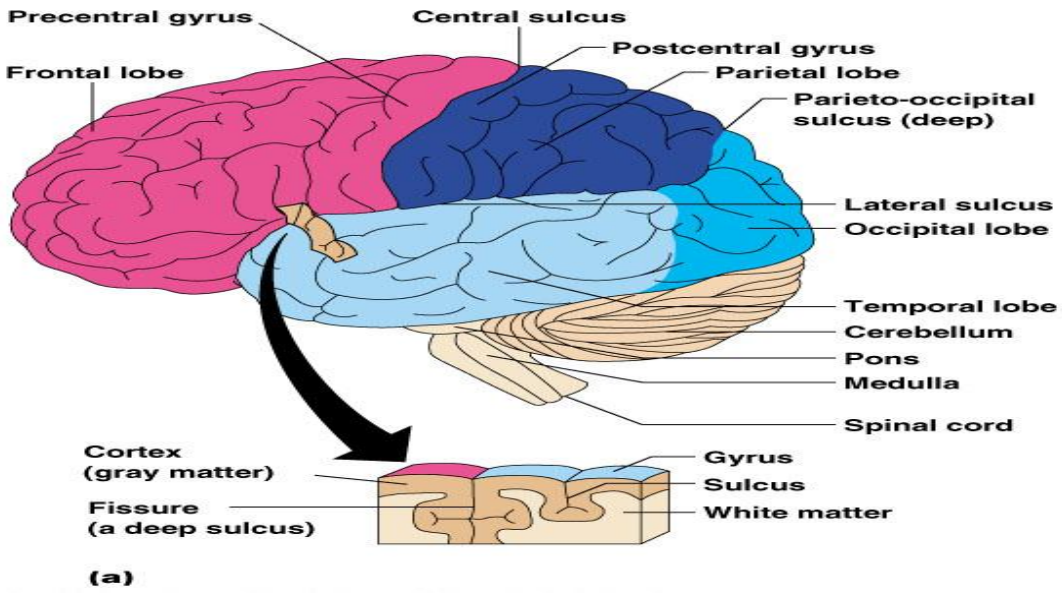


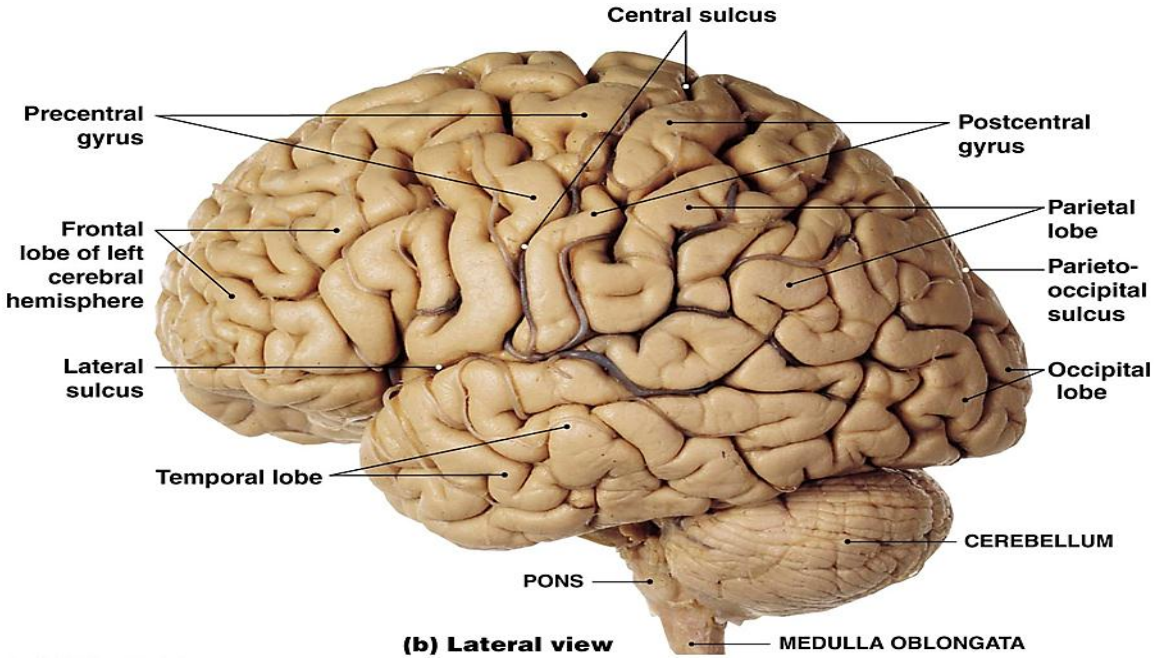
(a) Superior view

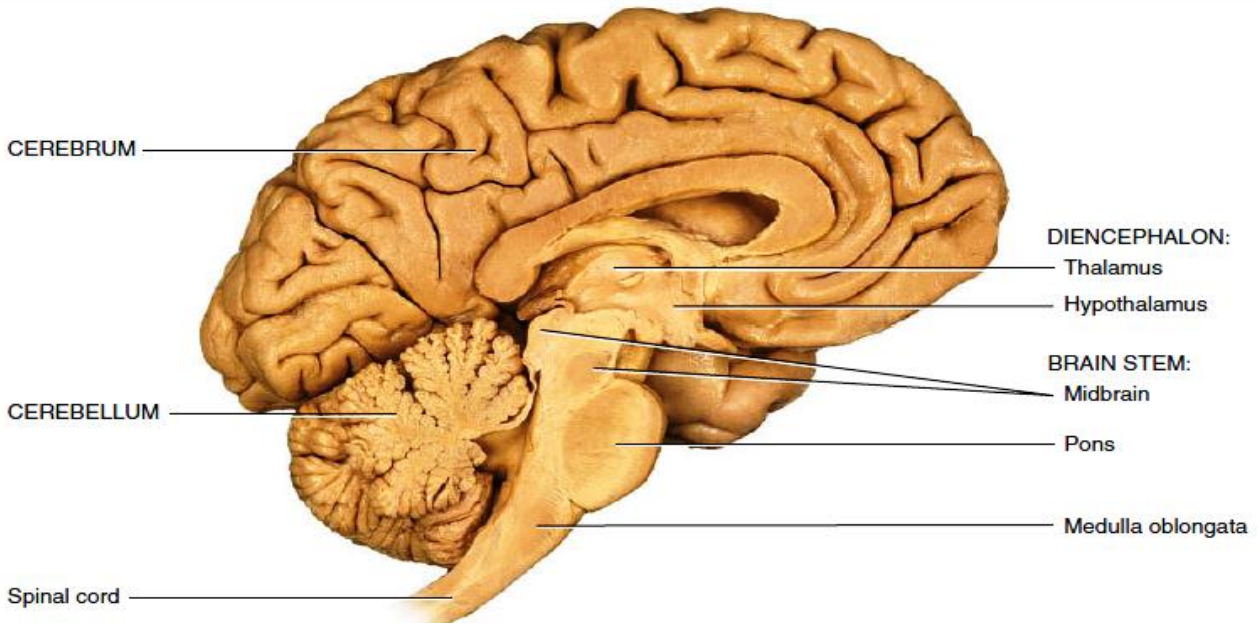
Each hemisphere of the cerebrum has outer layer is called the **cerebral cortex** and is made of grey matter (nerve cell bodies). The layers below this are **white**

matter (nerve fibers), the cerebral cortex is made of ridges (**gyri**) and grooves (**sulci**) and **Fissures** (deep grooves) divide the cerebral hemisphere into four lobes (**frontal, parietal, temporal and occipital** lobes) under bones of same name, Plus: Insula (buried deep in lateral sulcus), the main sulci and fissure are :

- ***longitudinal fissure*** separate cerebrum into right & left sides(hemisphere)
- ***Central sulcus*** separate frontal from parietal lobes
- ***Lateral sulcus*** separates temporal lobe from parietal lobe
- ***Parieto-occipital sulcus*** separate occipital from parietal lobes mainly in medial side (not seen from outside)
- ***Transverse cerebral fissure*** separates cerebral hemispheres from cerebellum.



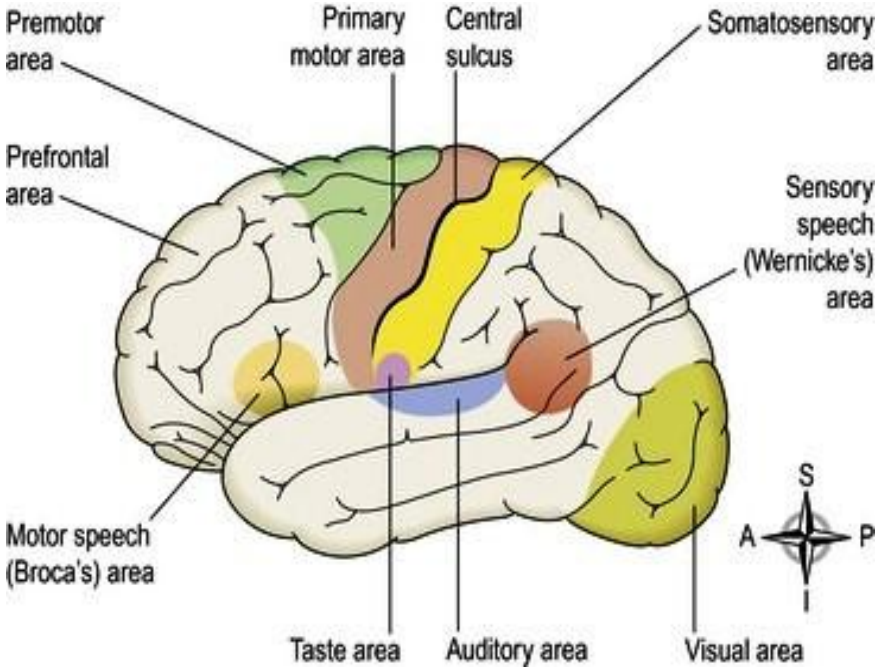




Medial view

The cerebral cortex can be divided into functional areas as follows:

- **The primary motor area**: responsible for contraction of skeletal muscles
- **The primary somatosensory(sensory) area** receives sensory information from the skin and also from proprioreceptors in skeletal muscles.
- **Broca's area** is responsible for the motor movement for produce speech.
- **The visual areas** – the primary visual area receives information from the eye.
- **The auditory areas** are associated with the interpretation of sounds.
- **The olfactory area** interprets smell information received from the nose via the olfactory nerves.
- **The gustatory area** interprets taste information.



Diencephalon

It's a part of the brain is surrounded by the cerebrum and contains three paired structures:

• **Thalamus** – acts as a relay station for sensory impulses going to the cerebral cortex for integration and motor impulses entering and leaving the cerebral hemispheres. It also has a role in memory.

• **Hypothalamus** – is closely associated with the pituitary gland and produces two hormones: antidiuretic hormone (ADH) and oxytocin. It is also the chief autonomic integration center and is part of the **limbic system** which is the **emotional brain**.

• **Epithalamus** – this structure is linked to the pineal gland which secretes the hormone melatonin responsible for sleep - wake cycles.

Brain stem

The structures that form the brain stem are involved in many activities that are essential for life. The brain stem is associated with the cranial nerves.it consist of:

• **Midbrain** – conduction pathway that connects the cerebrum with the lower brain structures and spinal cord.

• **Pons** – also a conduction pathway communicating with the cerebellum. The pons works with the medulla oblongata to control depth and rate of respiration.

• **Medulla oblongata** – relay station for sensory nerves going to the cerebrum. The medulla contains autonomic centers such as the cardiac center, the respiratory center, the vasomotor center and the coughing, sneezing and vomiting center. The medulla is also the site of decussate of the pyramidal tracts – this means that the right side of the body is controlled by the left cerebral hemisphere and vice versa.

Cerebellum

The cerebellum **coordinates** voluntary muscle movement, **balance** and **posture**. It ensures that muscle movements are smooth, coordinated and precise. It is the second-largest part of the brain, occupies the inferior and posterior aspects of the cranial cavity. Like the cerebrum, it has a highly folded surface that greatly increases the surface area of its outer gray matter cortex, allowing for a greater number of neurons and the core contains the white matter.

Cranial nerves

The human body contains **12 pairs** of cranial nerves which emerge from the brain and supply various structures most of which are associated with the head and neck except **vagus nerve**. The 12 pairs of cranial nerves differ in their functions – some are **sensory nerves**, some are **motor nerves** and some are **mixed nerves,** i.e. contain both sensory and motor nerves.

I. **Olfactory -** smell
II. **Optic -** vision
III. **Oculomotor –** supply four of the six extrinsic eye muscles
IV. **Trochlear -** extrinsic eye muscles
V. **Trigeminal -** sensory fibers to the face and motor fibers to the chewing muscles.
VI. **Abducens-** controls eye muscles that turn the eye laterally.
VII. **Facial-** facial expression.
VIII. **Vestibulocochlear-** hearing and balance.
IX. **Glosopharyngeal-** tongue and pharynx.
X. **Vagus-** parasympathetic control of heart, lungs & abdominal organs.
XI. **Accessory-** accessory part of vagus nerve, neck & throat muscles.
XII. **Hypoglossal-** moves muscles of tongue.

The meninges

The meninges cover the delicate nervous tissue, providing further protection. They also protect the blood vessels that serve nervous tissue and contain cerebrospinal fluid**(CSF)**. The meninges consist of three layers:

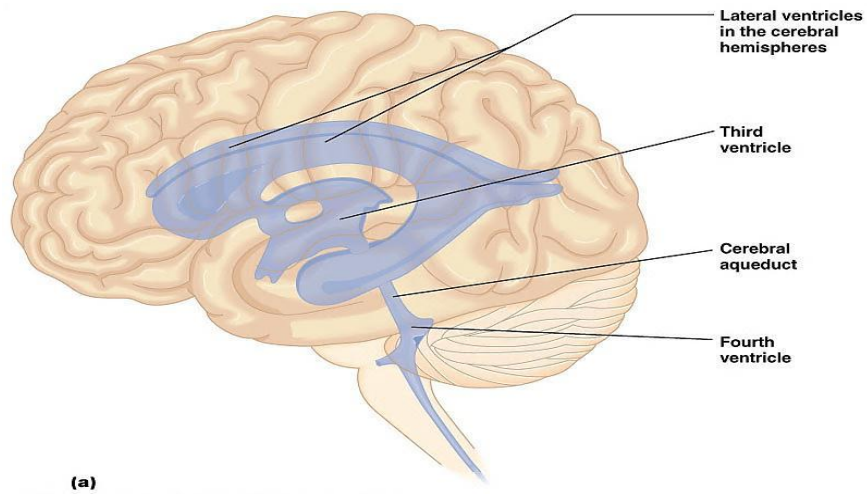
• **Dura mater** – this layer lies closest to the bone of the skull and is a double layer of tough, fibrous, connective tissue. The outer layer is called the **periosteal layer** (the spinal cord lacks this layer) and the **meningeal layer** lies closest to the brain.

• **Arachnoid mater** –The arachnoid mater is a delicate serous membrane. Between the dura mater and the arachnoid mater there is a space called the subdural space. The subarachnoid space is below the arachnoid mater and above the pia mater. The subarachnoid space contains cerebrospinal fluid and is also home to some of the larger blood vessels serving the brain.

• **Pia mater** – this is a delicate connective tissue layer that adheres tightly to the brain. It contains many tiny blood vessels that serve the brain.

Ventricles

There are four **ventricles** (cavities) in the brain contain cerebrospinal fluid (**CSF**). The paired **lateral ventricles** – one in each cerebral hemisphere, the **third ventricle** situated below this and the **fourth ventricle** located inferior to the third. The third communicate with lateral ventricles via interventicular foramen and with fourth ventricles communicate via the **cerebral equeduct** and then cerebrospinal fluid circulates through the central canal into the spinal cord.



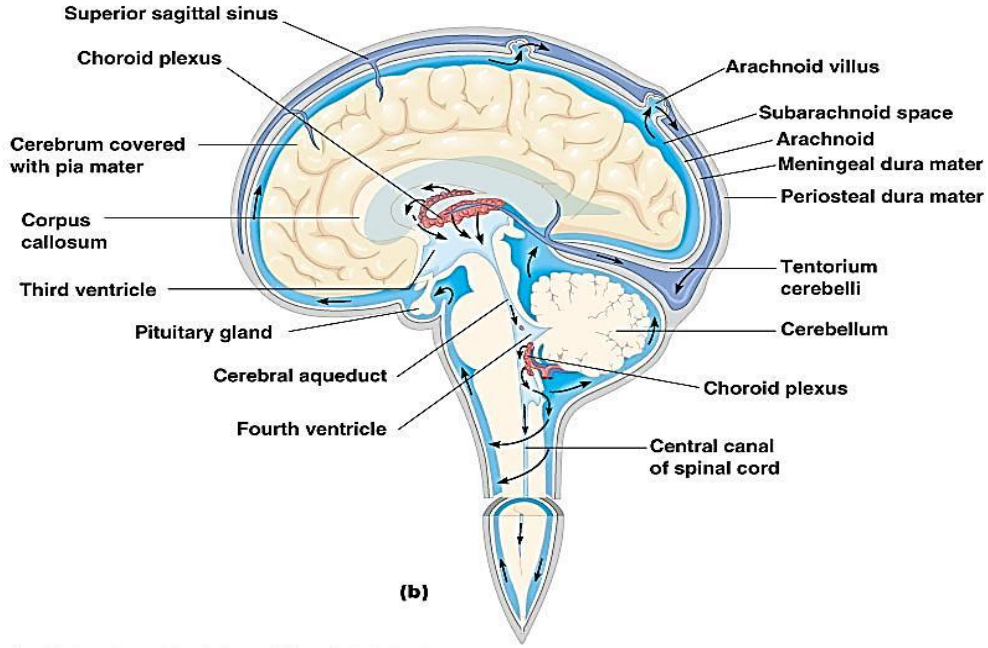
Cerebrospinal fluid (CSF)

Cerebrospinal fluid is produced by the ***choroid plexus*** in the ventricles of the brain. There is approximately 150 ml of CSF circulating around the brain, in the ventricles and around the spinal cord. It is a thin fluid similar to plasma and has several important functions:

• It is a cushion supporting the weight of the brain and protecting it from damage.

• It helps to maintain a uniform pressure around the brain and spinal cord.

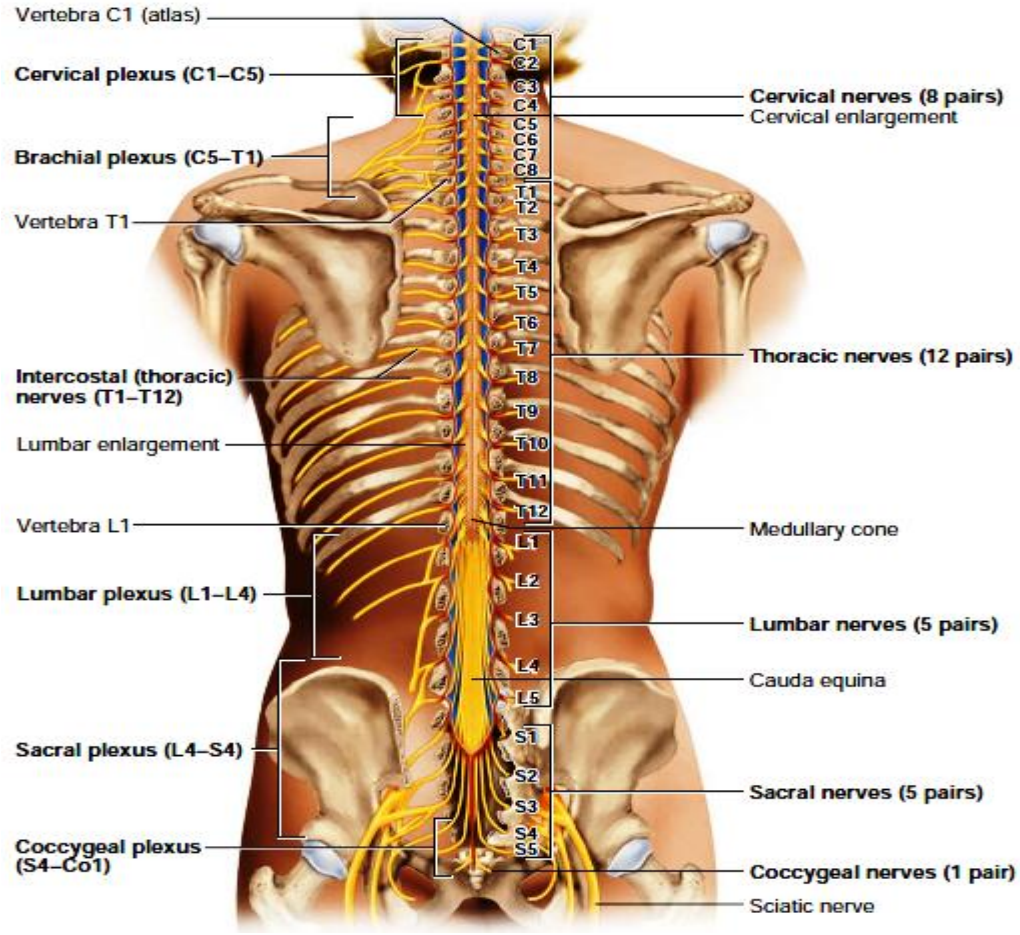
• There is a limited exchange of nutrients and waste products between neurons and CSF.



Spinal cord

The **spinal cord** is a cylinder of nervous tissue that arises from the brainstem. It passes down the vertebral canal as far as the inferior margin of the first lumbar vertebra (L1) or slightly beyond. In adults, it averages about 45 cm long and 1.8 cm thick. It occupies only the upper two-thirds of the vertebral canal. The cord exhibits longitudinal grooves on its anterior and posterior sides—the **anterior median**

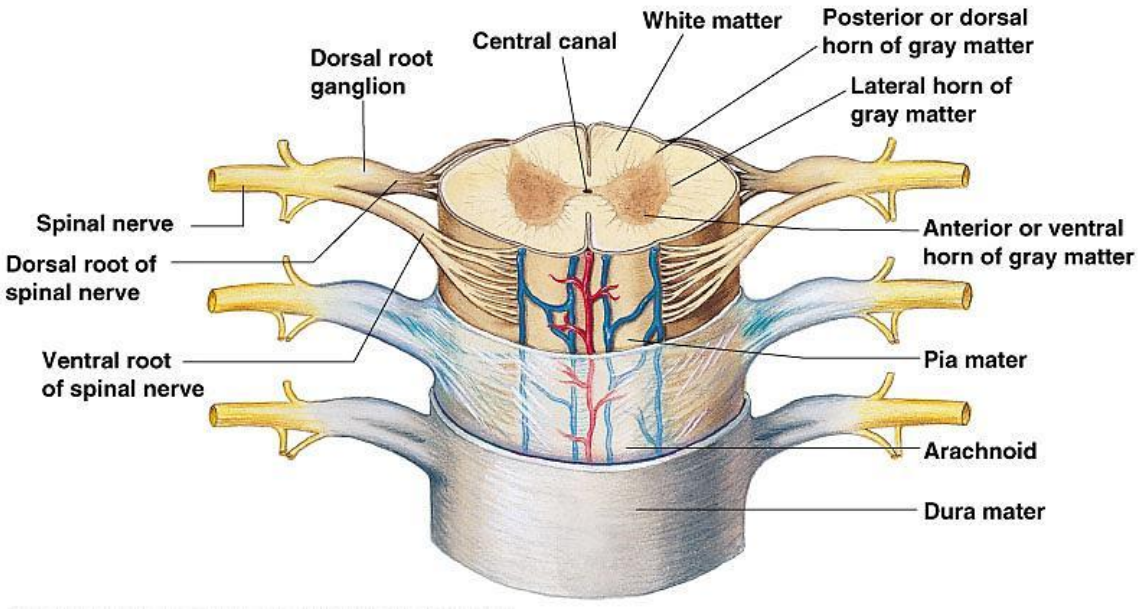
fissure and **posterior median sulcus**, respectively. The cord gives rise to 31 pairs of spinal nerves. The spinal cord is segmented into **segment** part supplied by pair of spinal nerves. The spinal cord is divided into **cervical, thoracic, lumbar,** and **sacral regions.** The cord widens at two points along its course: a **cervical enlargement** in the inferior cervical region, where it gives rise to nerves of the upper limbs; and a similar **lumbar enlargement** in the lumbosacral region, where it gives rise to nerves of the pelvic region and lower limbs. Inferior to the lumbar enlargement, the cord tapers to a point called the **medullary cone (conus medullaris).** The lumbar enlargement and medullary cone give off a bundle of nerve roots that occupy the vertebral canal after spinal cord end from L2 to S5. This bundle, named the **cauda equina** for its resemblance to a horse's tail, innervates the pelvic organs and lower limbs.



Cross-Sectional Anatomy of spinal cord

The spinal cord, like the brain, consists of two kinds of nervous tissue called **gray** and **white matter**. **Gray matter** that looks somewhat **H-shaped** in cross sections, it consists mainly of two **posterior** (**dorsal) horns give posterior sensory rootles of spinal nerves contain sensory ganglia** and two wider **anterior** (**ventral) horns give anterior motor rootles of spinal nerves**. In the **thoracic** and **lumbar** regions,

an additional **lateral horn** is visible on each side of the gray matter. It contains neurons of the **sympathetic nervous system**. The right and left sides of the gray matter are connected by a **gray commissure** that **i**n the middle of it **central canal** filled with **CSF**. **Gray matter** has dull color because it contains little myelin and it contains the neurons. **White matter** contains an abundance of myelinated axons, which give it a bright, pearly white appearance, it is composed of bundles of axons, called **tracts** that carry signals from one part of the CNS to another.



Spinal nerves

There are **31 pairs** of spinal nerves attached to the spinal cord within the human body which are named and numbered according to the region and level of the vertebral column from which they emerge.

- **8 cervical**
- **12 thoracic**
- **5 lumbar**
- **5 sacral**
- **1 coccygeal**

***Peripheral nervous system* PNS**

PNS can be divided into two subcategories: the **afferent peripheral system**, which consists of afferent or **sensory** neurons that convey information from receptors in the periphery of the body to the spinal cord and then to brain, and the **efferent peripheral system**, which consists of efferent or **motor** neurons that convey information from the brain and spinal cord to the muscles and glands. There is also a **Mixed nerves** which contain both sensory and motor fibers found specially in spinal nerve of spinal cord.

The autonomic nervous system

The autonomic nervous system (ANS) plays a major role in the maintenance of homeostasis by regulating the body's automatic, involuntary functions and in common with the rest of the nervous system. However, its structure is unique in that it is divided into two, namely the ***sympathetic division*** and the ***parasympathetic division*****.** These two divisions have several common features:

• They innervate all internal organs.
• They utilize two motor neurons and one ganglion to transmit an action potential.
• They function automatically and usually in an involuntary manner.

Sympathetic division (fight or flight)

The sympathetic division includes nerve fibers that arise from the **12 thoracic** and **first two lumbar** segments of the spinal, hence it is also referred to as the ***thoracicolumbar*** division. The sympathetic division takes control of many internal organs when a stressful situation occurs.

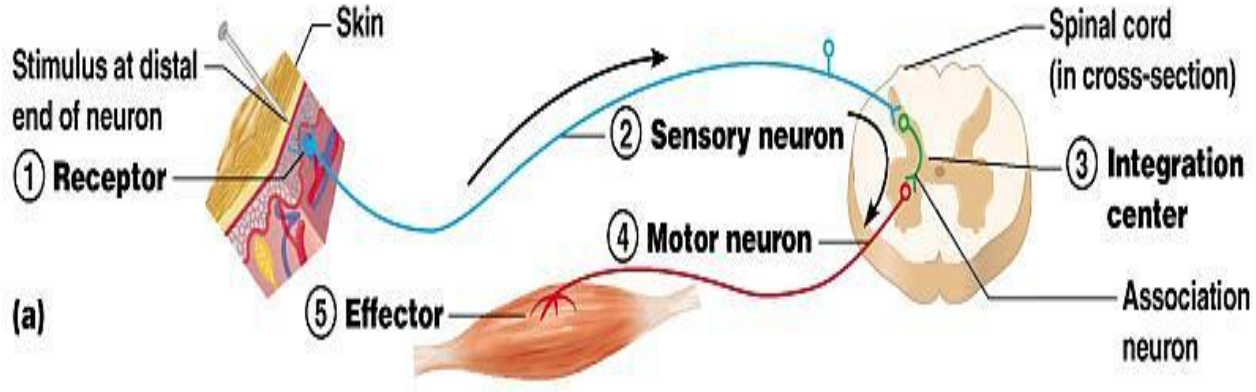
Parasympathetic division (rest and digest)

The parasympathetic division includes fibers that arise from the lower end of the spinal cord **2^{nd}, 3^{rd}, 4^{th} sacral spinal nerves** and **several cranial nerves** and – hence it is often referred to as the ***craniosacral*** division. The parasympathetic division is most active when the body is at rest.

The Reflex Arc

Reflex – rapid and involuntary responses to stimuli

Reflex arc – In most reflex arcs the sensory neuron connects to motor neurons through **association neurons** (**interneurons**) in the spinal cord. That's mean direct route from a sensory neuron, to an interneuron, to an effector organ without send to brain.



Respiratory system

The **respiratory system** is an organ system specialized to follow function provide oxygen to the blood and remove carbon dioxide from it , filters inspired air, produces sound, contains receptors for smell, rids the body of some excess water and heat, helps regulate blood pH. The respiratory system consists of two parts: (1) the **upper respiratory system** includes the nose, nasal cavity, pharynx, and associated structures; (2) the **lower respiratory system** includes the larynx, trachea, principle bronchi and lungs. Also part of the respiratory system is the pleural membranes and the respiratory muscles that form the chest cavity: that are diaphragm and intercostal muscles.

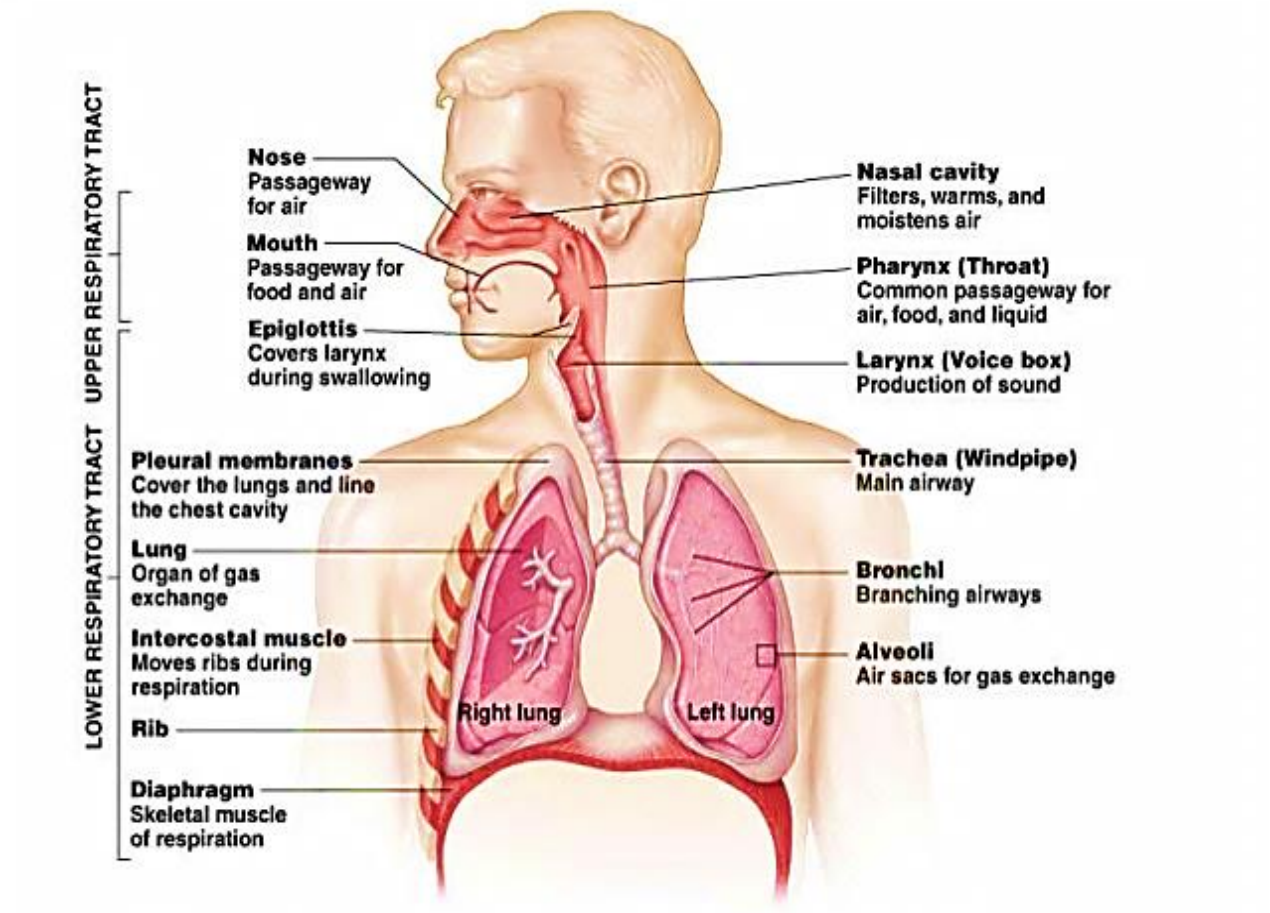
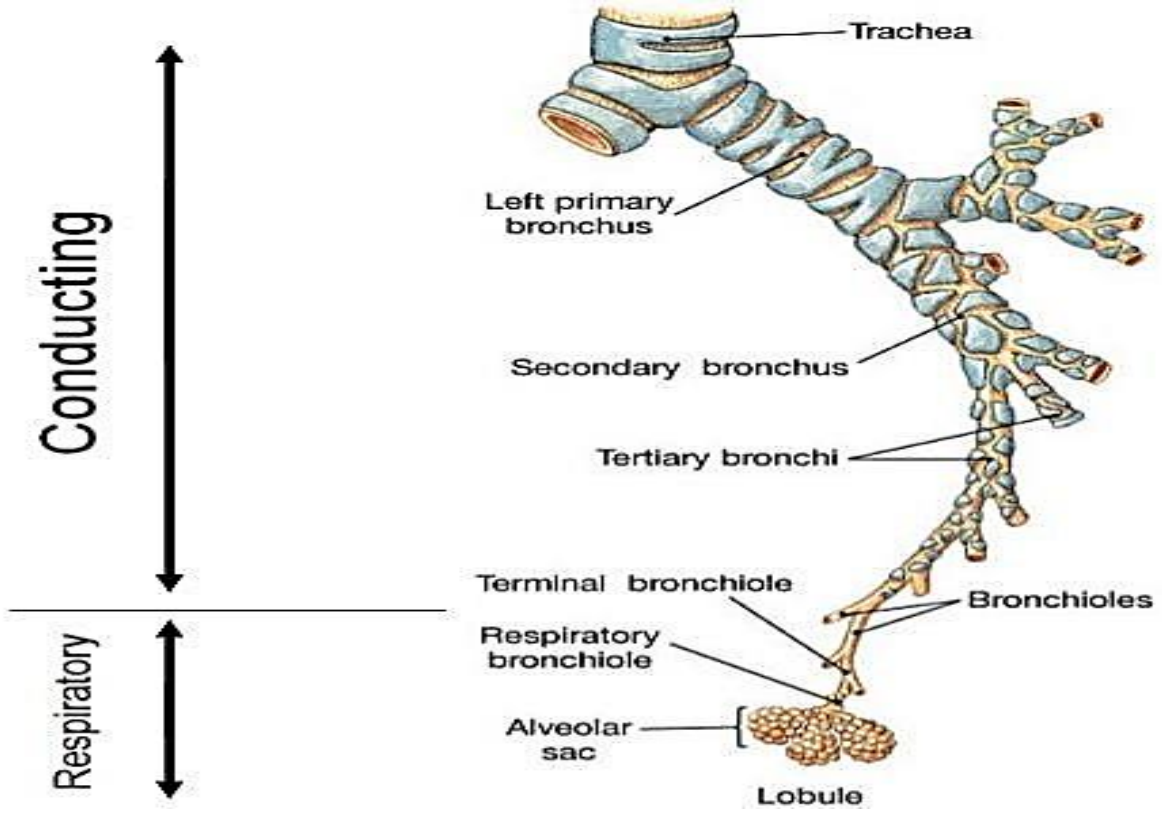


Figure: Upper and Lower Respiratory Systems.

Functionally, the respiratory system also consists of two parts. (1) The **conducting zone** consists of a series of interconnecting cavities and tubes both outside and within the lungs. These passageways include the nose, nasal cavity, pharynx, larynx,

trachea, bronchi, bronchioles, and terminal bronchioles; their function is to filter, warm, and moisten air and conduct it into the lungs. (2) The **respiratory zone** consists of tubes and tissues within the lungs where gas exchange occurs. These tubes and tissues include the respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli, and are the main sites of gas exchange between air and blood.

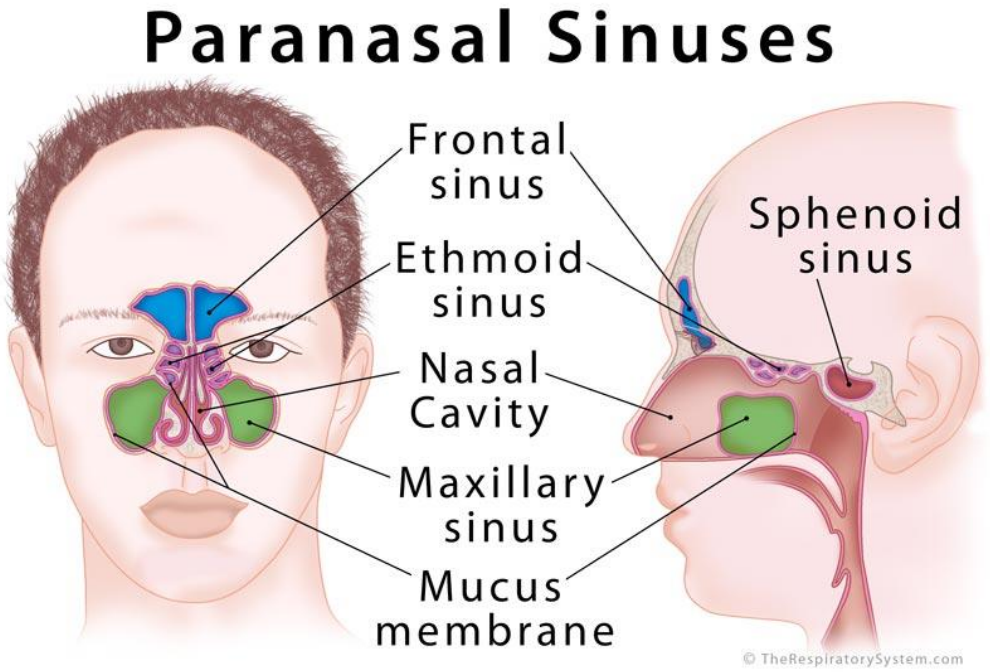


Nasal cavity

Air usually enters and leaves the respiratory system through the **nose**, which is made of bone and cartilage covered with skin. First opening inside are the nostrils are contain hair which help block the entry of dust. The two **nasal cavities** are within the skull, separated by the **nasal septum** form the medial wall. Three shelf-like bones called **conchae** project from the lateral wall of each nasal cavity. **Conchae** provide more flat space for storage, the conchae increase the surface area of the nasal mucosa and open beneath it paranasal air sinus.

In the upper nasal cavities are the **olfactory receptors**, which detect vaporized chemicals that have been inhaled (smell).

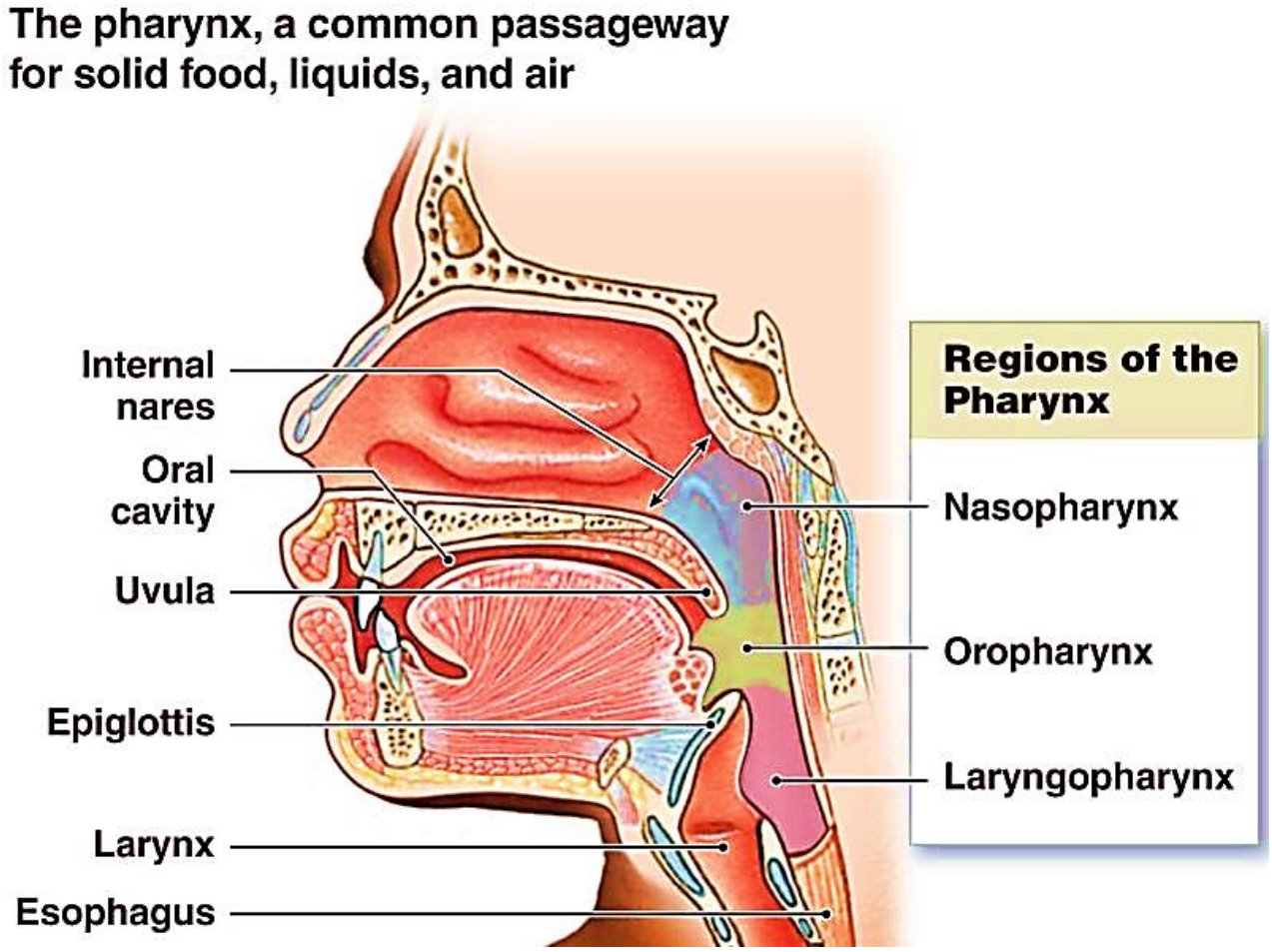
- **Paranasal air sinuses**, within the four bones of the skull there are three paired cavities in the **maxillae, frontal, ethmoid bones**, and one in **sphenoid bone**. These sinuses are lined with ciliated epithelium, and the mucus produced drains into the nasal cavities. The functions of the paranasal sinuses are to lighten the skull and provide resonance (more vibrating air) for the voice.

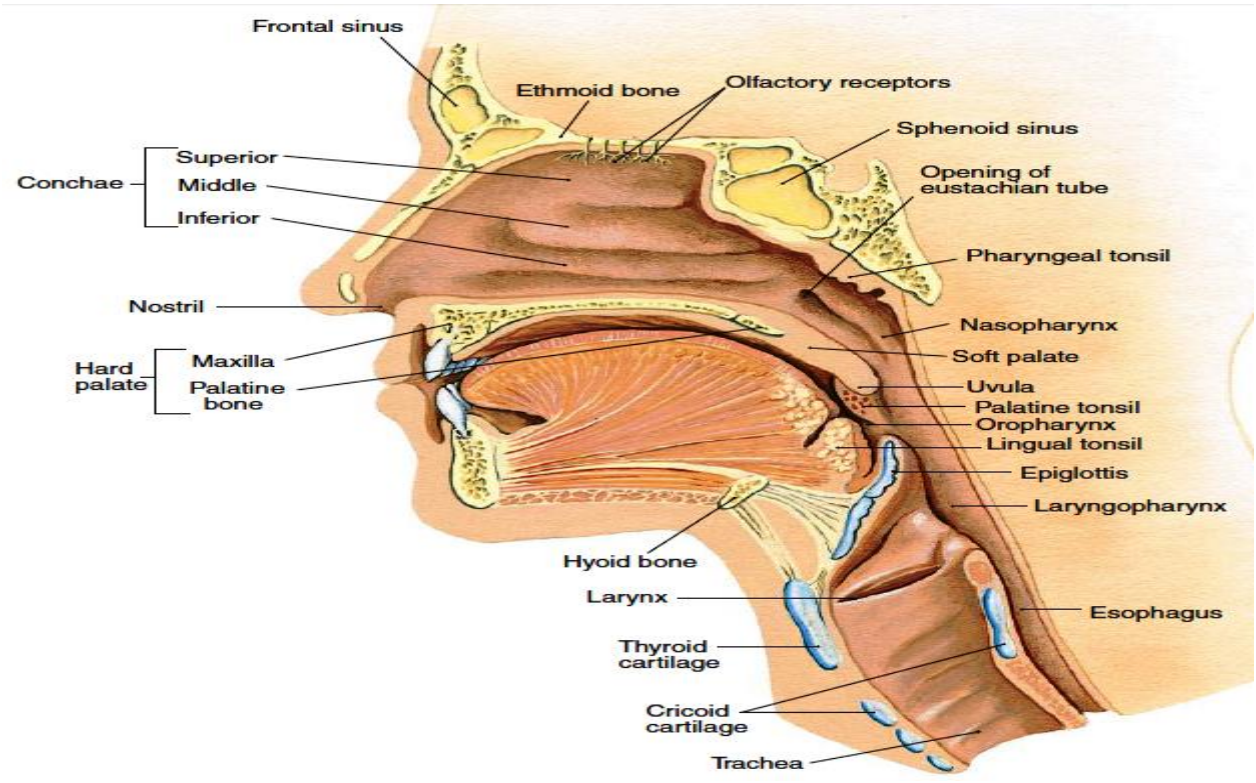


PHARYNX

The **pharynx** is a muscular tube posterior to the nasal and oral cavities and anterior to the cervical vertebrae. The pharynx may be divided into three parts: the **nasopharynx**, **oropharynx**, and **laryngopharynx**. The uppermost portion is the **nasopharynx**, which is behind the nasal cavities. The **soft palate** is elevated during swallowing to block the nasopharynx and prevent food or saliva from going up rather than down. The uvula is the free hanging part of the soft palate you can see at the back of the throat. Opening into the nasopharynx are the two eustachian tubes, which extend to the middle ear cavities. The purpose of the eustachian tubes is to permit air to enter or leave the middle ears, allowing the eardrums to vibrate properly. The nasopharynx is a passageway for air only, but the remainder of the pharynx serves as both an air and food passageway. The **oropharynx** is behind the mouth; its mucosa is stratified squamous epithelium, continuous with that of the oral

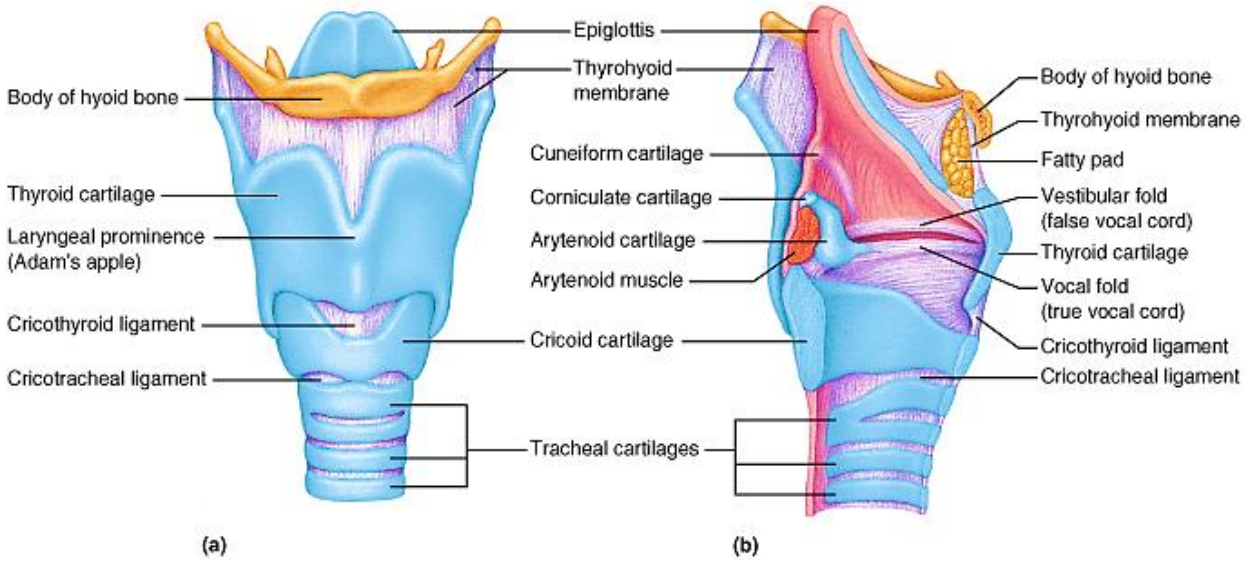
cavity. On its lateral walls are the **palatine tonsils**, also lymph nodules. The **laryngopharynx** is the most inferior portion of the pharynx. It opens anteriorly into the larynx and posteriorly into the esophagus.





LARYNX

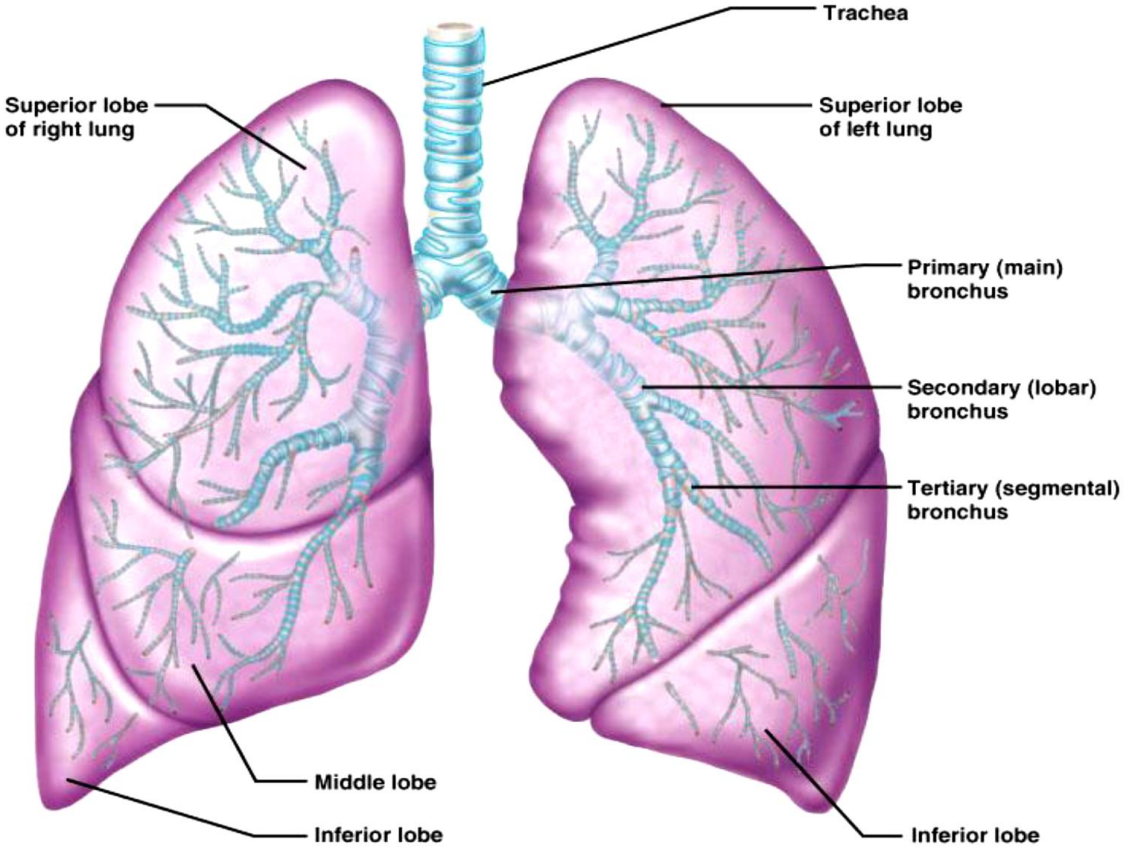
The **larynx** is often called the **voice box**, a name that indicates one of its functions, which is speaking. The other function of the larynx is to be an air passageway between the **pharynx** and the **trachea**. Air passages must be kept open at all times, so the larynx is made of **nine** pieces of cartilage connected by ligaments. Cartilage is a firm yet flexible tissue that prevents collapse of the larynx. The wall of the larynx is composed of nine pieces of cartilage. Three occur singly (**thyroid cartilage, epiglottis,** and **cricoid cartilage**), and three occur in pairs (**arytenoid**, **cuneiform**, and **corniculate cartilages**) all are **hyaline cartilages** except epiglottis is **elastic cartilage**. The largest cartilage of the larynx is the **thyroid cartilage,** which you can feel on the anterior surface of your neck (**Adam's apple**). The mucous membrane lining the larynx forms two pairs of folds: a superior pair called the **vestibular folds** (**false vocal cords**) and an inferior pair called simply **the vocal folds (true vocal cords)**.



TRACHEA and BRONCHIAL TREE

The **trachea or windpipe** is about (10 to 13 cm) long and extends from the **larynx** to the **primary bronchi**; it is anterior to the **esophagus**. The wall of the trachea contains **16 to 20 C-shaped pieces of cartilage**, which keep the trachea open. The posterior gaps in these incomplete cartilage rings are lined by **trachealis muscle**, to permit the expansion of the esophagus when food is swallowed.

The right and left **principle(primary) bronchi** are the branches of the trachea that enter the **lungs**. Their structure is just like that of the trachea, with C-shaped cartilages. Within the lungs, each primary bronchus branches into **secondary (lobar)bronchi** leading to the **lobes** of each lung (**three in right lung, two in left lung**) then branching into **(tertiary or segmental)brnchi**. The further branching of the bronchial tubes is often called the **bronchial tree**. Imagine the trachea as the trunk of an upside-down tree with extensive branches that become smaller and smaller; these smaller branches are the **bronchioles** . The cartilage becomes patchy and smaller and there is no cartilage is present in the walls of the **bronchioles**. The smallest bronchioles terminate in clusters of **alveoli**, the air sacs of the lungs.

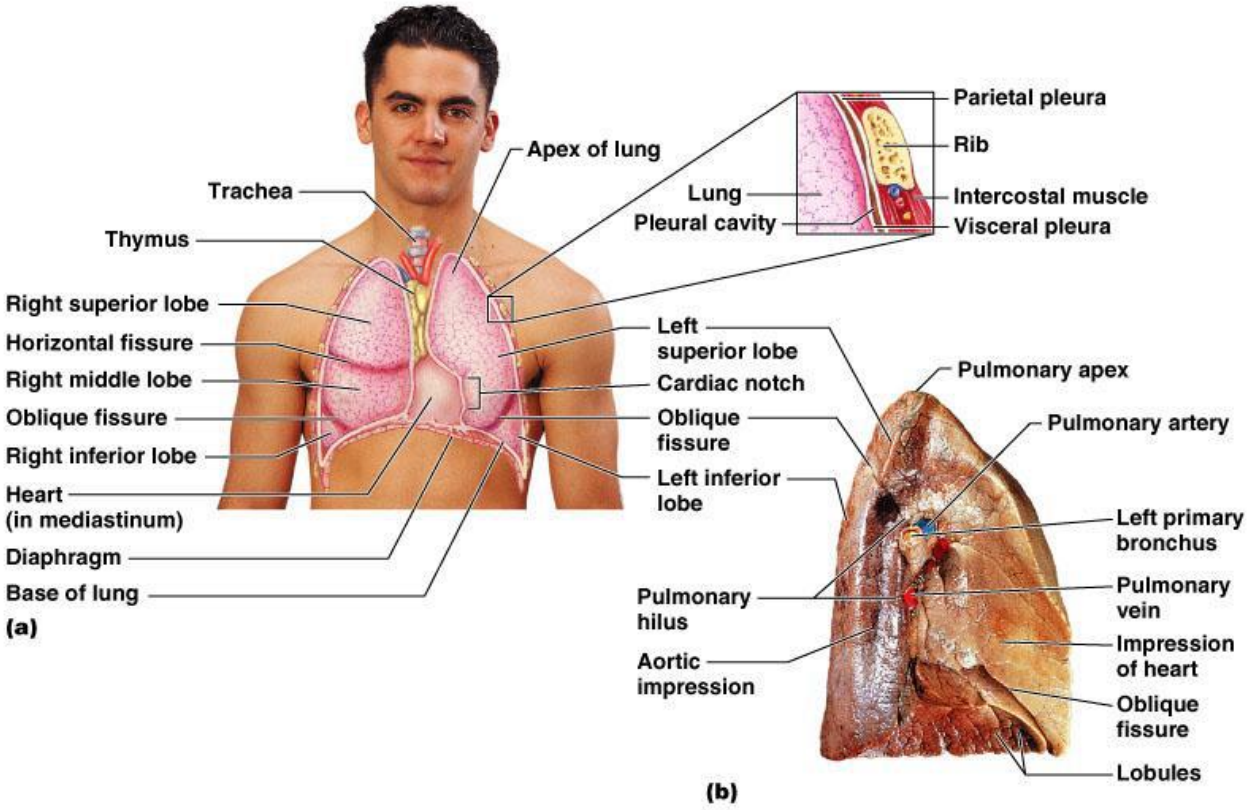


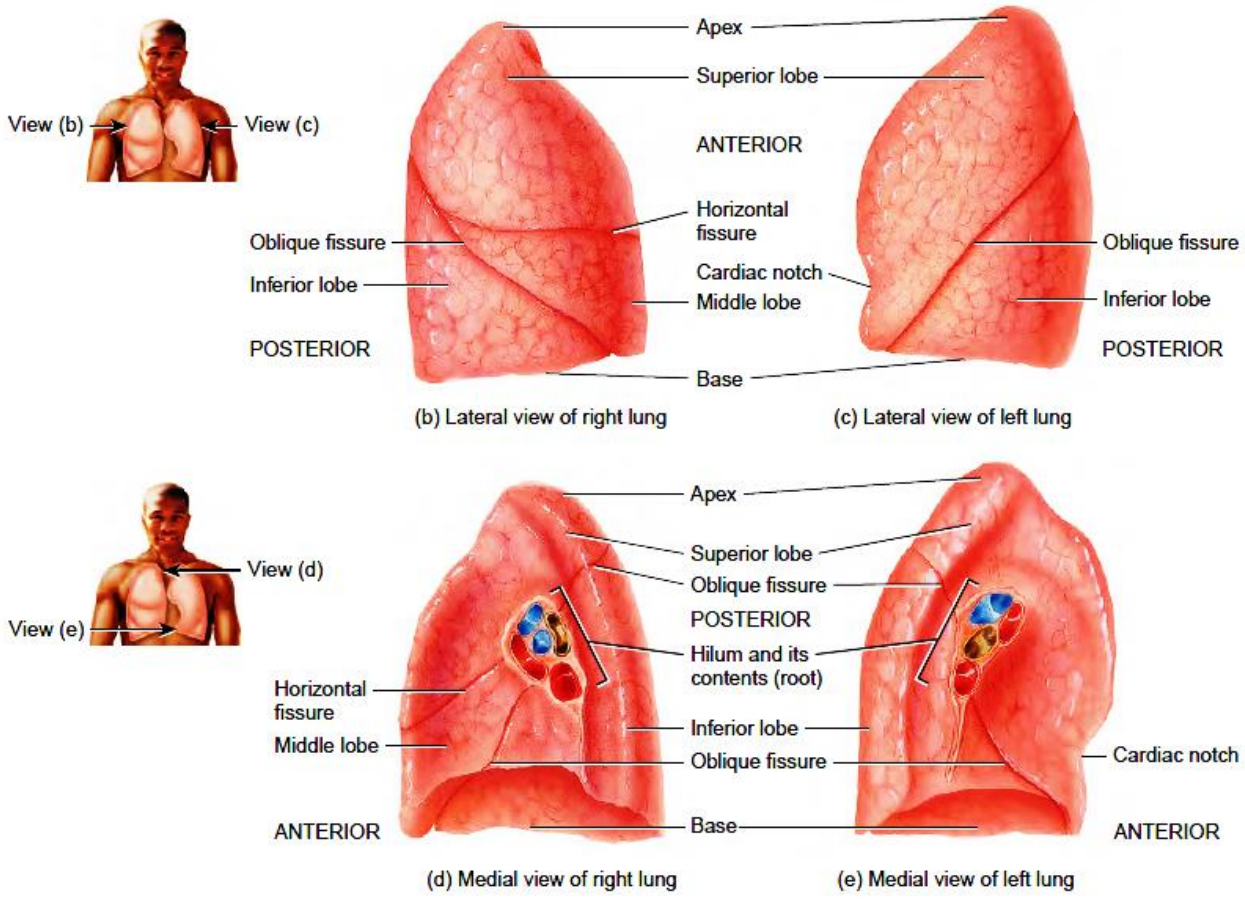
LUNGS AND PLEURAL MEMBRANES

The **lungs** are located on either side of the heart in the thoracic cavity and are encircled and protected by the **rib cage**. The base of each lung rests on the **diaphragm** below; the apex (superior tip) is at the level of the **clavicle**. On the medial surface of each lung is an indentation called the **hilus** also called roots of the lungs, where the **primary bronchus** and the **pulmonary artery** and **veins**, **bronchial artery** enter the lung. **Left lung** is divided into **two lobes** by **oblique fissure** and it's **smaller** than the right lung. Medially, the left lung also contains a

concavity called the **cardiac notch**, which accommodates the apex of the **heart**. **Right lung** is divided into **3 lobes** by **oblique** and **horizontal fissure** and it's located more superiorly in the body due to liver on right side.

The pleural membranes are the serous membranes of the thoracic cavity. It consist of two layers, **parietal pleura** line the chest wall, and the **visceral pleura** are on the surface of the lungs. Between the pleural membranes is pleural space filled with serous fluid, which prevents friction and keeps the two membranes together during breathing.





Blood Supply to the Lungs

The lungs receive blood via two sets of arteries: **(1) pulmonary arteries** deliver Deoxygenated blood passes through the pulmonary trunk, which divides into a left pulmonary artery that enters the left lung and a right pulmonary artery that enters the right lung. Return of the oxygenated blood to the heart occurs by way of the four pulmonary veins, which drain into the left atrium. **(2) Bronchial arteries**, which branch from the **aorta**, deliver oxygenated blood to the lungs. This blood mainly passes to the bronchi, the connective tissue of the lung, and the visceral pleura. Connections do exist between branches of the bronchial arteries and branches of the pulmonary arteries; most blood returns to the heart via pulmonary veins. Some blood, however, drains into bronchial veins and returns to the heart via the superior vena cava.

The nerve supply of the lungs is derived from the pulmonary plexus, located anterior and posterior to the roots of the lungs. The pulmonary plexus is formed by branches of the vagus (X) nerves and sympathetic trunks.

Lymph Drainage

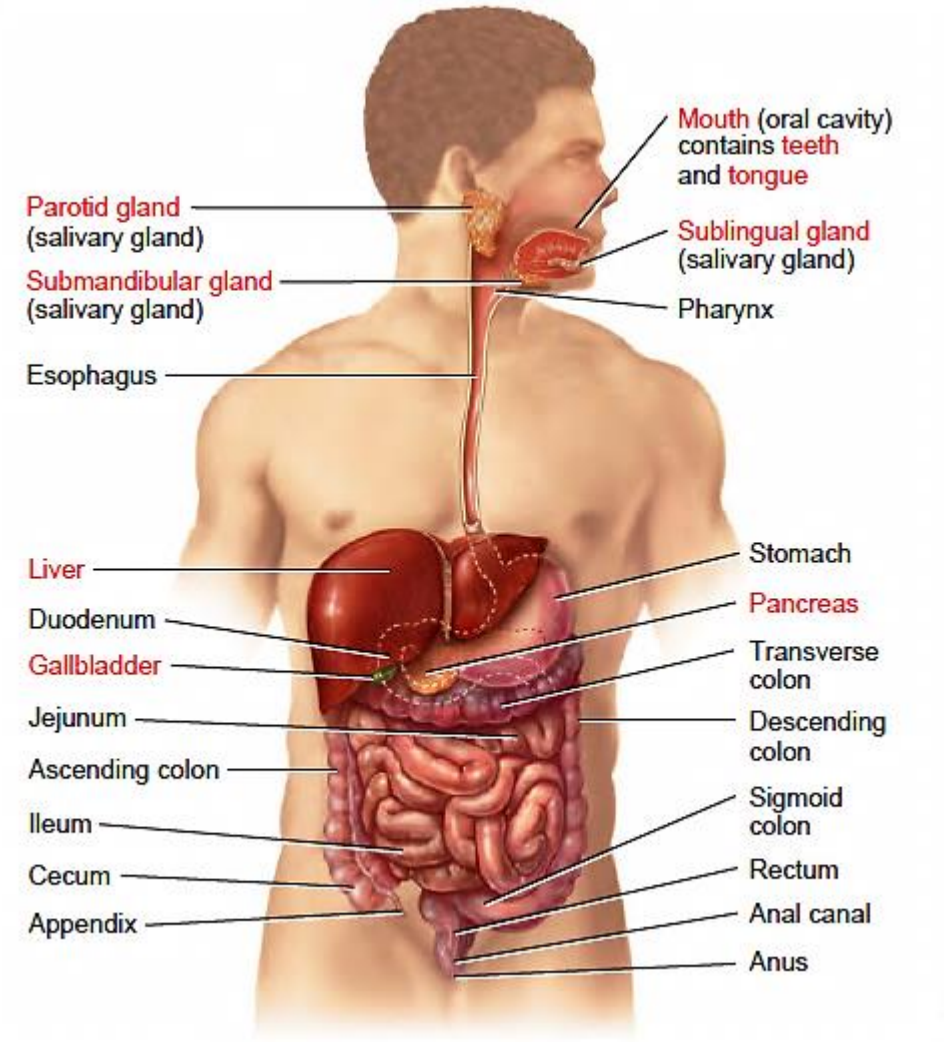
Lymph draining by tow plexus of lymph vessels; the **superficial** (**subpleural**) **plexus and deep plexus.** All the lymph of lung leaves the hilum and drains into the tracheobronchial nodes and then into the **bronchomediastinal lymph trunks**.

The digestive system

The digestive system is composed of two groups of organs: the **gastrointestinal tract** (**GIT**) and the **accessory digestive organs**.

The **gastrointestinal tract** (**GIT**), or alimentary canal, is a continuous tube that extends from the mouth to the anus through the head, neck, thoracic and abdominopelvic cavities. Organs of the gastrointestinal tract include the **mouth**, **pharynx**, **esophagus**, **stomach**, **small intestine**, and **large intestine**. The length of the GIT is variable about **5 –7** meters.

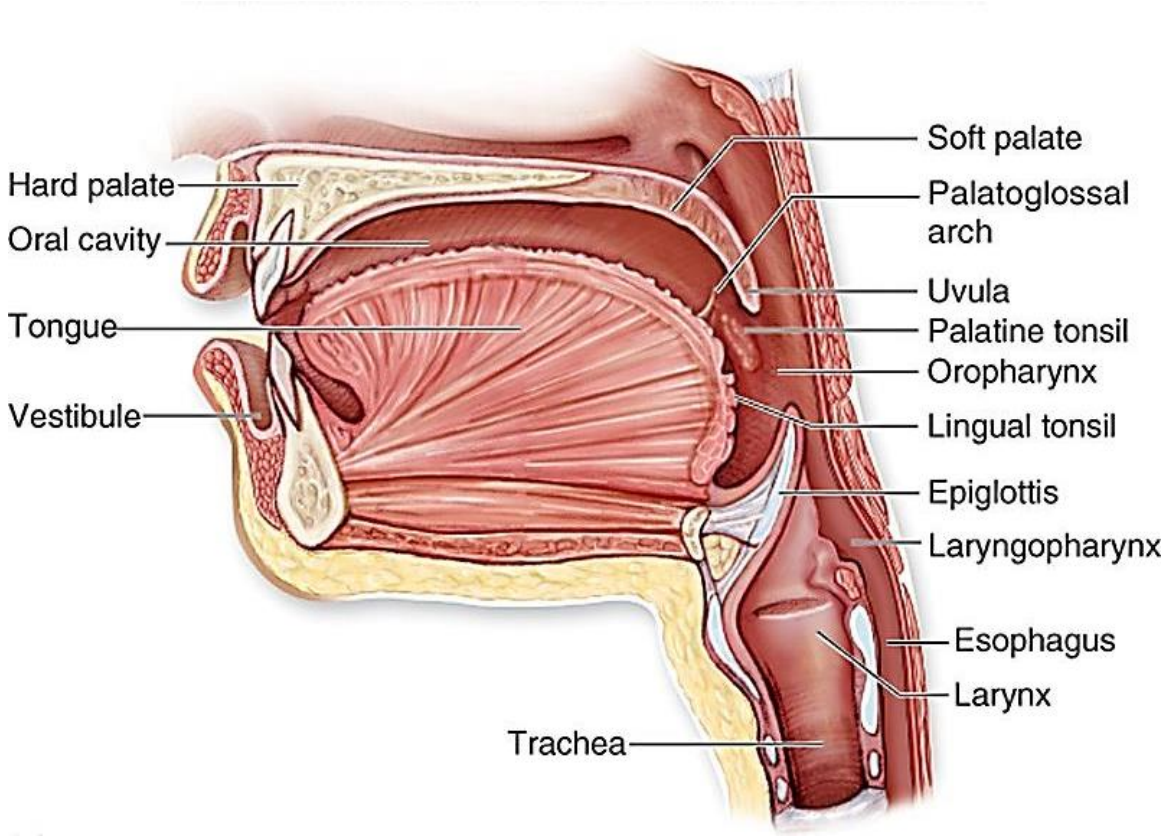
The **accessory digestive organs** include the **teeth**, **tongue**, **salivary glands**, **liver**, **gallbladder**, and **pancreas**. Teeth aid in the physical breakdown of food, and the tongue assists in chewing and swallowing.



The **mouth**, also referred to as the **oral** or **buccal cavity,** is formed by the cheeks laterally, hard and soft palates superiorly, and tongue inferiorly. The **cheeks** are covered externally by skin and internally by a mucous membrane,

The **lips** or **labia** are fleshy folds surrounding the opening of the mouth. They contain the orbicularis oris muscle and are covered externally by skin and internally by a mucous membrane.

The **oral vestibule** of the oral cavity is the space bounded externally by the cheeks and lips and internally by the gums and teeth. The **oral cavity proper** is the space that extends from the gums and teeth to the **oropharyngeal isthmus**, the opening between the oral cavity and the oropharynx.



Tongue

The **tongue** is an accessory digestive organ composed of skeletal muscle covered with mucous membrane. Together with its associated muscles, it forms the floor of the oral cavity. The dorsum and lateral surfaces of the tongue are covered with **papillae**. Many papillae contain taste buds, the receptors for gustation (taste). As their name are, **Fungiform papillae, Vallate papillae, Foliate papillae, Filiform papillae.**

The **palate** is a wall or septum that separates the oral cavity from the nasal cavity, and forms the roof of the mouth. Consist of:

- **Hard palate**–the anterior two-thirds of the palate are formed by the maxillae and palatine bones and are covered by a mucous membrane.
- **Soft palate**, which forms the posterior portion of the roof of the mouth, is an arch-shaped muscular partition between the oropharynx and nasopharynx that is lined with mucous membrane.

Hanging from the free border of the soft palate is a finger-like muscular structure called the **uvula.**

Lateral to the base of the uvula are two muscular folds that run down the lateral sides of the soft palate:

(1) anteriorly, the **palatoglossal arch** extends to the side of the base of the tongue

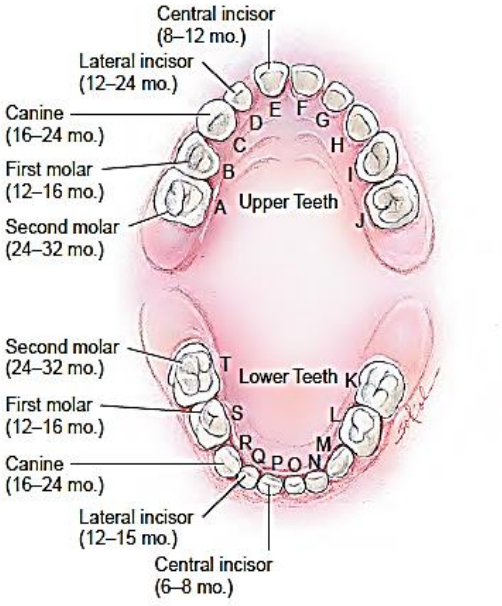
(2) posteriorly, the **palatopharyngeal arch** extends to the side of the pharynx.

The palatine tonsils are situated between the arches, and the lingual tonsils are situated at the base of the tongue. At the posterior border of the soft palate, the mouth opens into the oropharynx through the fauces (oropharyngeal isthmus).

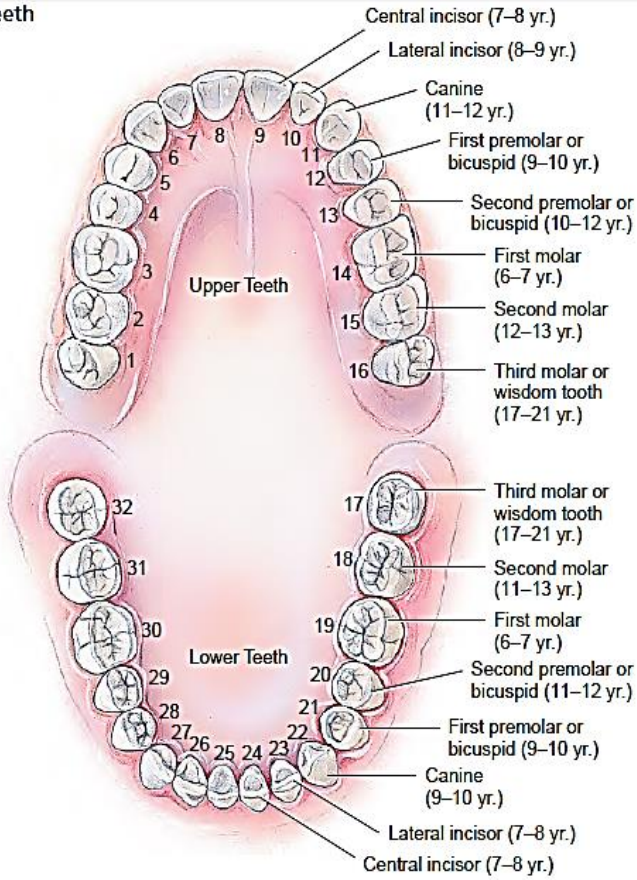
Teeth

The **teeth**, or **dentes**, are accessory digestive organs located in sockets of the alveolar processes of the mandible and maxillae. The alveolar processes are covered by the **gingivae**, or **gums**, which extend slightly into each socket to form the **gingival sulcus**

There are 20 teeth in a complete deciduous set and 32 teeth in a complete permanent set.



(a) Deciduous (primary) dentition; teeth designated by letters (with times of eruption)

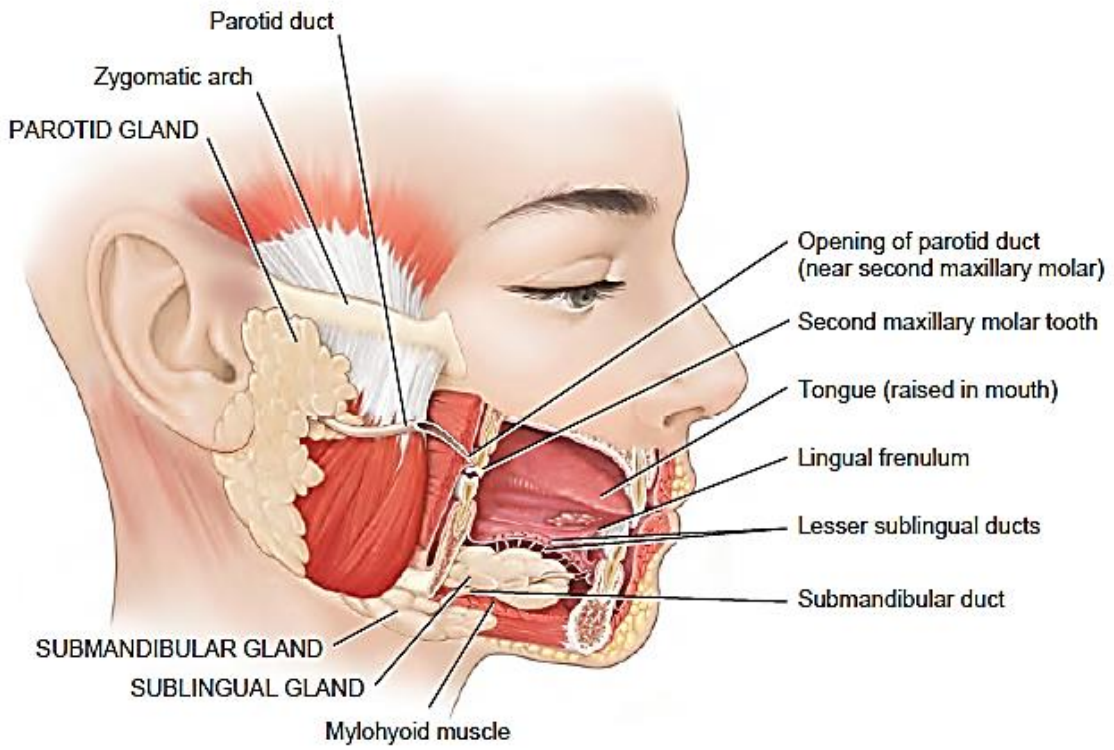


(b) Permanent (secondary) dentition; teeth designated by numbers (with times of eruption)

Salivary Glands

Salivary gland is a gland that releases a secretion called **saliva** into the oral cavity. Ordinarily, just enough saliva is secreted to keep the mucous membranes of the mouth and pharynx moist and to cleanse the mouth and teeth.

- The **parotid glands (largest Salivary gland)** are located inferior and anterior to the ears, between the skin and the masseter muscle. Each secretes saliva into the oral cavity via a **parotid duct** that pierces the buccinators muscle to open into the vestibule opposite the second maxillary (upper) molar tooth.
- The **submandibular glands** found in the floor of the oral cavity beneath the base of the tongue, their ducts, the **submandibular ducts**, run under the mucosa on either side of the midline of the floor of the mouth and enter the oral cavity proper.
- The **sublingual glands** are superior to the submandibular glands. Their ducts, the **lesser sublingual ducts,** open into the floor of the mouth in the oral cavity proper.



(a) Location of salivary glands

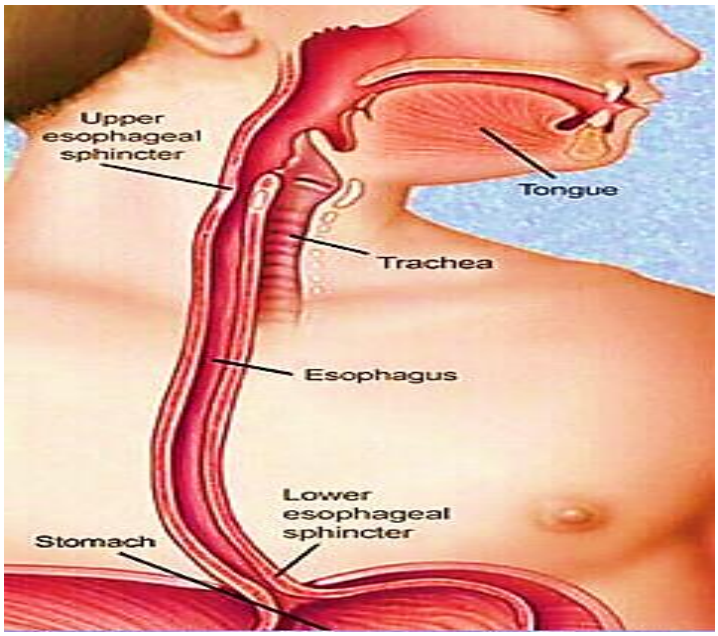
Pharynx

The pharynx (throat) is a funnel-shaped tube that extends from the internal nares to the esophagus posteriorly and the larynx anteriorly. The pharynx is composed of skeletal muscle and lined by mucous membrane. **Nasopharynx** functions only in respiration, but the **oropharynx** and **laryngopharynx** have both digestive and respiratory functions. Swallowing is a mechanism that moves food from the mouth to the stomach.

Esophagus

The esophagus is a **25** cm long collapsible muscular tube that lies posterior to the trachea. It begins at the inferior end of the laryngopharynx, passes through the inferior aspect of the neck, enters the mediastinum and descends anterior to the vertebral column, pierces the diaphragm through an opening called the esophageal hiatus, and ends in the superior portion of the stomach. The esophagus secretes mucus and

transports food into the stomach. The passage of food from the laryngopharynx into the esophagus is regulated at the entrance to the esophagus by a sphincter called the upper esophageal sphincter or pharyngoesophageal sphincter. The wall muscles of the superior third of the esophagus is skeletal muscle, the intermediate third is skeletal and smooth muscle, and the inferior third is smooth muscle. Food is pushed through the esophagus by a progression of involuntary coordinated contractions and relaxations of the circular and longitudinal layers of the muscularis called **peristalsis**.



Peritoneum

The **peritoneum** is a thin serous membrane that lines the walls of the abdominal and pelvic cavities and clothes the viscera. The peritoneum can be regarded as a balloon against which organs are pressed from outside. Thus it consists of:

- **parietal peritoneum** lines the walls of the abdominal and pelvic cavities
- **Visceral peritoneum** covers the organs.

The potential space between the parietal and visceral layers, which is in effect the inside space of the balloon, is called the peritoneal cavity. In males, this is a closed cavity, but in females, there is communication with the exterior through the uterine tubes, the uterus, and the vagina.

Between the parietal peritoneum and the fascial lining of the abdominal and pelvic walls is a layer of connective tissue called the extraperitoneal tissue; in the area of the Kidneys, this tissue contains a large amount of fat, which supports the kidneys.

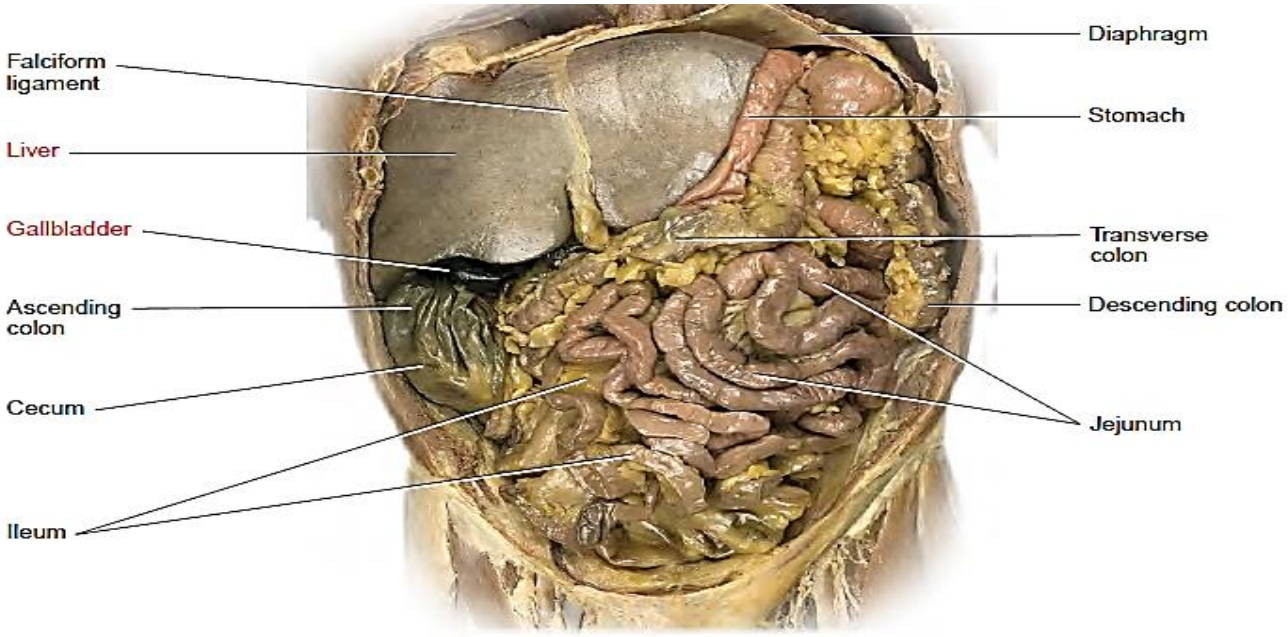
peritoneal cavity is the largest cavity in the body and is divided into two parts:

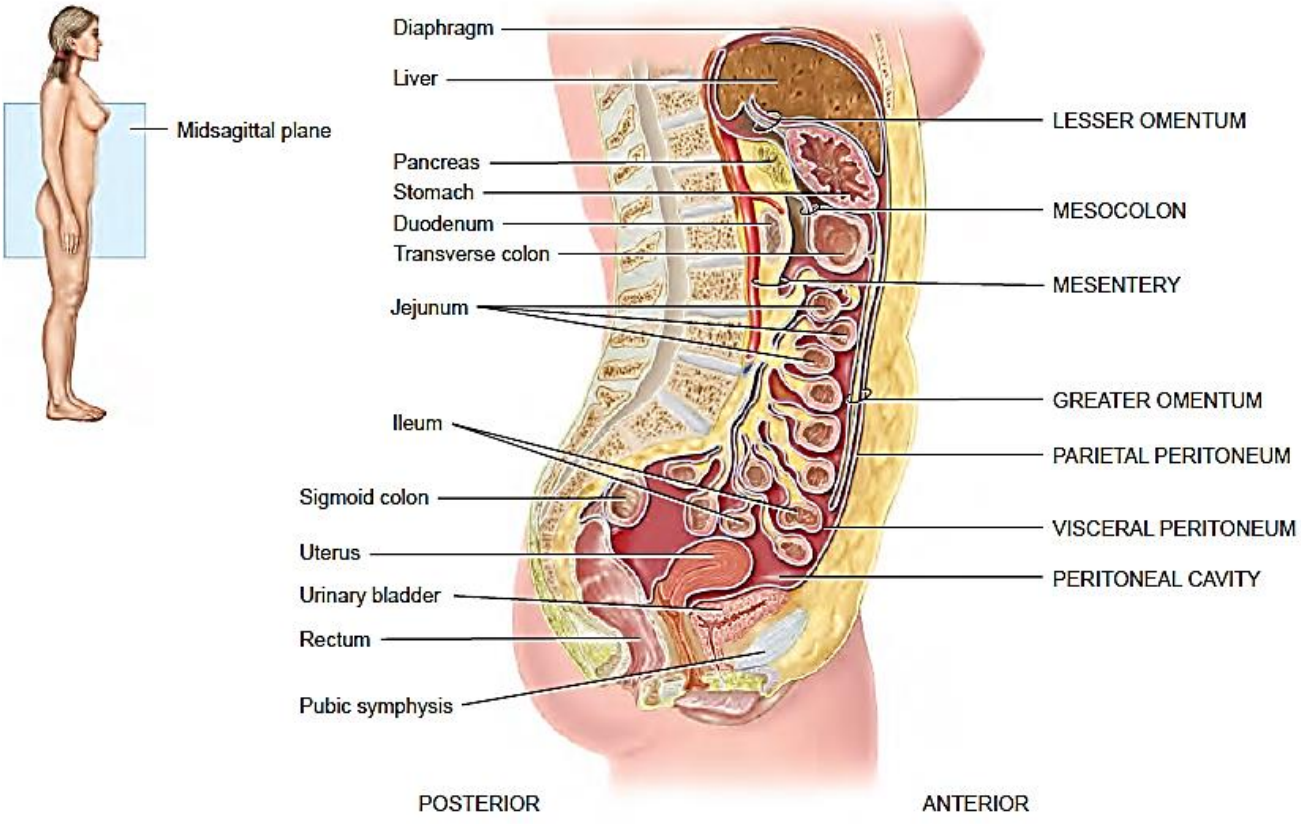
- **The greater sac** is the main compartment and extends from the diaphragm down into the pelvis.
- **The lesser sac** is smaller and lies behind the stomach.

The greater and lesser sacs are in free communication with one another through an oval window called the opening of the lesser sac, or the epiploic foramen.

The peritoneum secretes a small amount of serous fluid, the peritoneal fluid, which lubricates the surfaces of the peritoneum and allows free movement between the viscera. The terms **intraperitoneal** and **retroperitoneal** are used to describe the relationship of various organs to their peritoneal covering.

- **Intraperitoneal** when it is almost totally covered with visceral peritoneum. The stomach, jejunum, ileum, and spleen are good examples.
- **Retroperitoneal** organs lie behind the peritoneum and are only partially covered with visceral peritoneum. The pancreas, Kidney, the ascending and descending parts of the colon are examples of retroperitoneal organs.





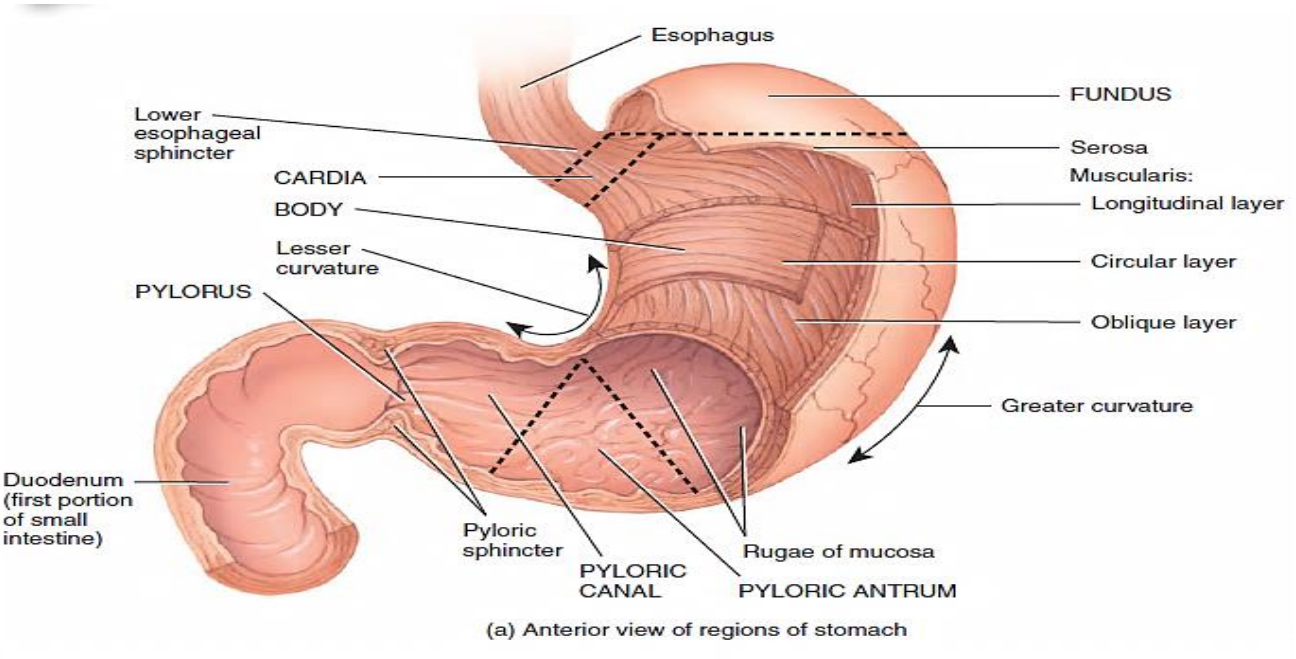
Stomach

The stomach is typically a J-shaped enlargement of the GI tract directly inferior to the diaphragm in the epigastric, umbilical, and left lower quadrant regions of the abdomen. The stomach has anterior and posterior surface and concave medial border of the stomach is called the **lesser curvature**, and the convex lateral border is called the **greater curvature**. The stomach connects the esophagus to the duodenum, the first part of the small intestine; it functions as a mixing area and holding reservoir.

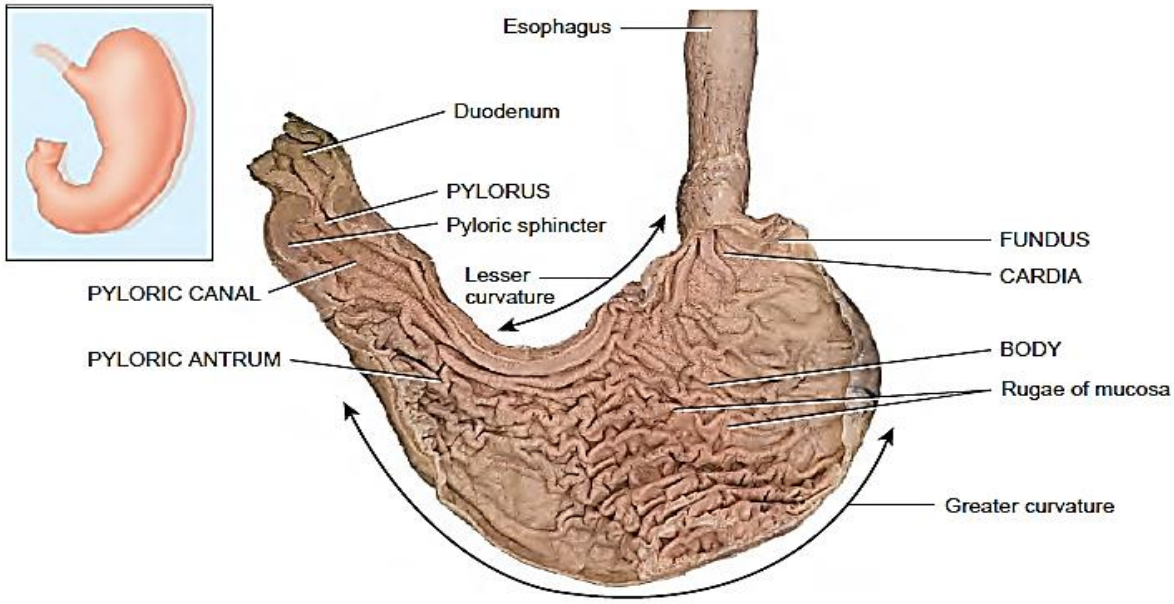
The stomach has four main regions:

- **Cardiac** surrounds the opening of the esophagus into the stomach.
- **Fundus** rounded dome shape superior portion.
- **Body** (**corpus**) it is the large central portion of the stomach and it is found left to the cardiac and Inferior to the fundus.
- **Pyloric** part is divisible into three regions. The first region, the pyloric antrum, connects to the body of the stomach. The next region, the pyloric canal, leads to the third region, the pyloric sphincter which in turn connects to the duodenum.

When the stomach is empty, the mucosa lies in large folds, called **rugae**, which can be seen with the unaided eye. The pylorus communicates with the duodenum of the small intestine via a smooth muscle sphincter called the **pyloric sphincter** (valve).



(a) Anterior view of regions of stomach



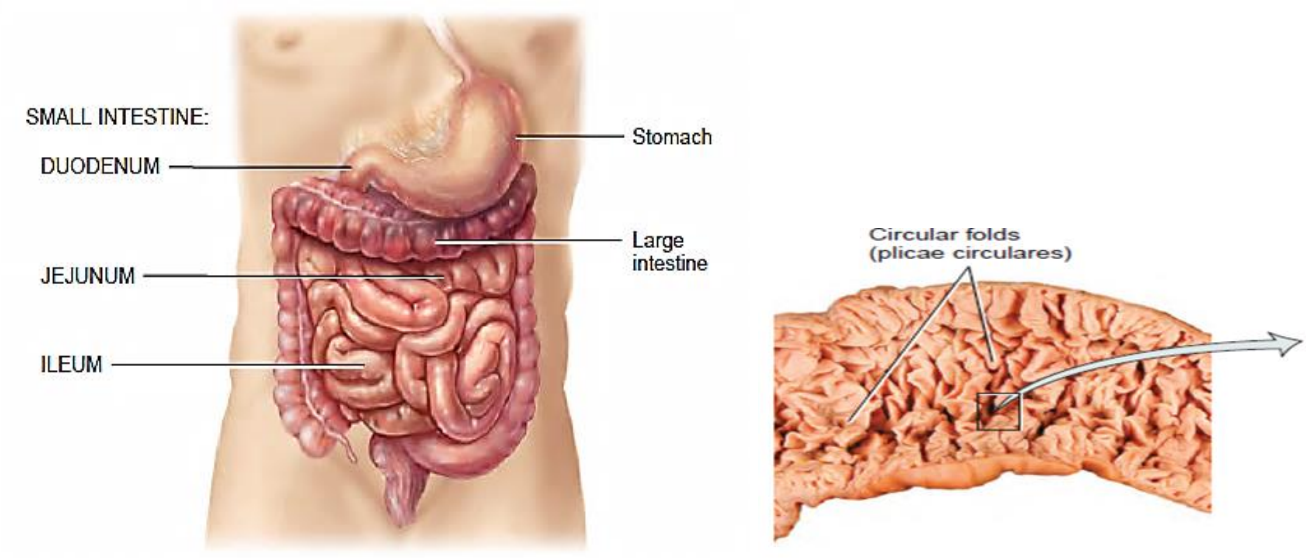
(b) Anterior view of internal anatomy

Small intestine

Most digestion and absorption of nutrients occur in a long tube called the small intestine. Because of this, its structure is specially adapted for this function. Its length

alone provides a large surface area for digestion and absorption, and that area is further increased by circular folds called **plicae circulars, villi, and microvilli**. The small intestine begins at the pyloric sphincter of the stomach, coils through the central and inferior part of the abdominal cavity, and eventually opens into the large intestine. It averages **2.5 cm** in diameter; its length is about **3 m** in a living person and about **6.5** m in a cadaver due to the loss of smooth muscle tone after death. It is divided into three regions.

- **Duodenum** first part of the small intestine, it is the shortest region, and is retroperitoneal. It starts at the pyloric sphincter of the stomach and is in the form of a C-shaped tube that extends about **25 cm** until it merges with the next section, called the jejunum.
- **Jejunum** it is the next portion, is about **1m** long, and extends to the ileum. The jejunum is mostly in the left upper quadrant (**LUQ**).
- **Ileum** it is final and longest region of the small intestine, the, measures about **2 m** and joins the large intestine at a smooth muscle sphincter called the **ileocecal sphincter (valve)**. The ileum is mostly in the right lower quadrant (**RLQ**).



The **plicae circulars** are folds of the mucosa and submucosa permanent ridges, which are about 10 mm long, begin near the proximal portion of the duodenum and

end at about the midportion of the ileum. It with Villi and microvilli increase the surface area of the small intestine for digestion and absorption.

The two types of movements of the small intestine

- **Segmentations** are localized, mixing contractions that occur in portions of the intestine distended by a large volume of chyme.
- **Peristalsis** called migrating motility begins in the lower portion of the stomach and pushes chyme forward along a short stretch of small intestine.

Large intestine

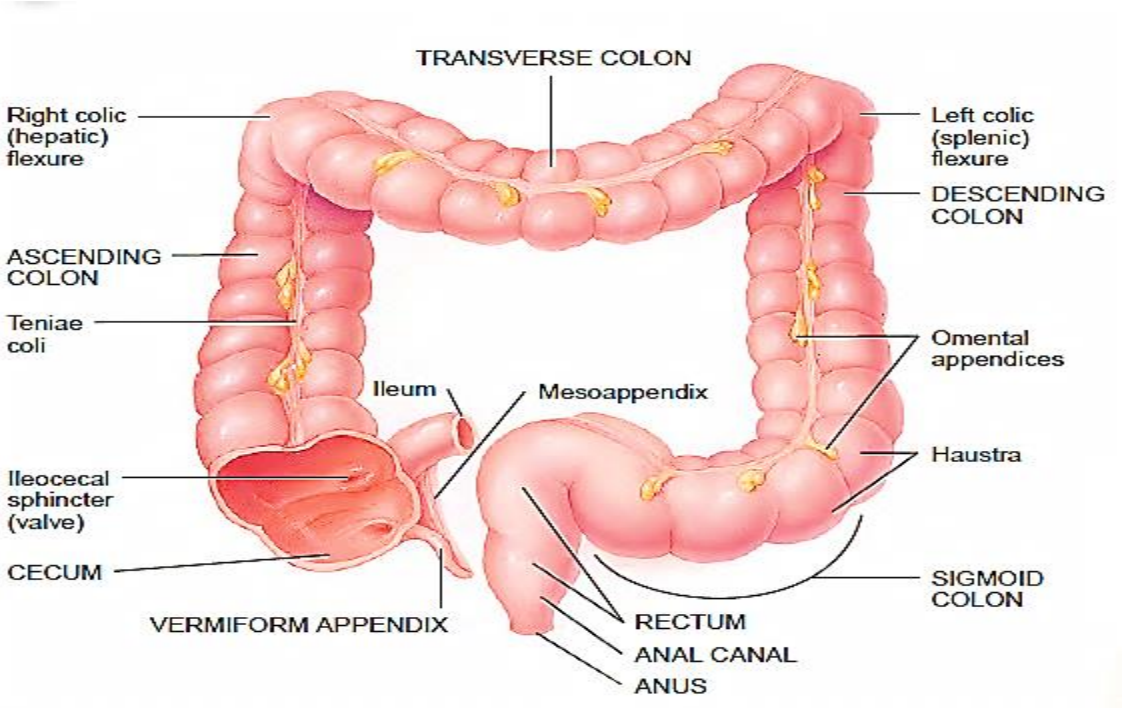
It is the terminal portion of the GI tract and as chyme moves through the large intestine, bacteria act on it and water, ions, and vitamins are absorbed. As a result, feces are formed and then eliminated from the body. The large intestine is about **1.5 m** long and **6.5 cm** in diameter in living humans and cadavers, extends from the ileum to the anus. Structurally, the four principal regions of the large intestine are found:

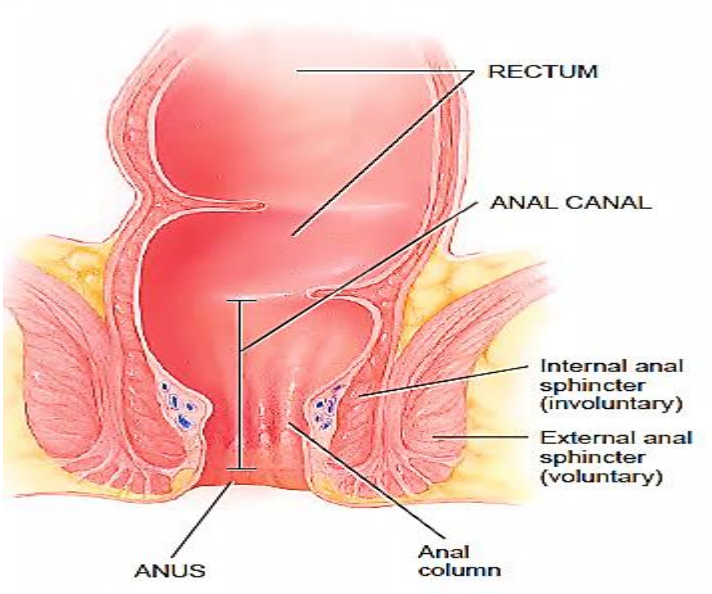
- **Cecum** a small pouch about **6 cm** long. Attached to the cecum is a twisted, coiled tube, measuring about 8 cm in length, called the **appendix**. The mesentery of the appendix, called the mesoappendix attaches the appendix to the inferior part of the mesentery of the ileum.
- **Colon** it is a long tube, which is divided into **ascending, transverse, descending,** and **sigmoid** portions. Both the ascending and descending colon are retroperitoneal; the transverse and sigmoid colon are intraperitoneal. The ascending colon ascends on the right side of the abdomen, reaches the inferior surface of the liver, and turns abruptly to the left to form the right colic (**hepatic**) flexure. The colon continues across the abdomen to the left side as the transverse colon. It curves beneath the inferior end of the spleen on the left side as the left colic (**splenic**) flexure and passes inferiorly to the level of the left iliac crest as the descending colon. The sigmoid colon begins near the left iliac crest, projects

medially to the midline, and terminates as the rectum at about the level of the third sacral vertebra.

- **Rectum** The rectum, approximately 15 cm in length, lies anterior to the sacrum and coccyx.
- **Anal canal**. The terminal of the large intestine is called the anal canal 2–3 cm .The mucous membrane of the anal canal is arranged in longitudinal folds called **anal columns** that contain a network of arteries and veins. The opening of the anal canal to the exterior, called the **anus**, is guarded by an **internal anal sphincter** of smooth muscle (**involuntary**) and an **external anal sphincter** of skeletal muscle (**voluntary**). Normally the anus is closed except during the elimination of feces.

Ascending colon and **descending colon** are retroperitoneal, while the remaining parts of the colon and **cecum** are attached to the posterior abdominal wall by their **mesocolon** that a double layer of peritoneum connecting the parietal peritoneum to the visceral peritoneum that contains the vascular and nervous supply to the organs

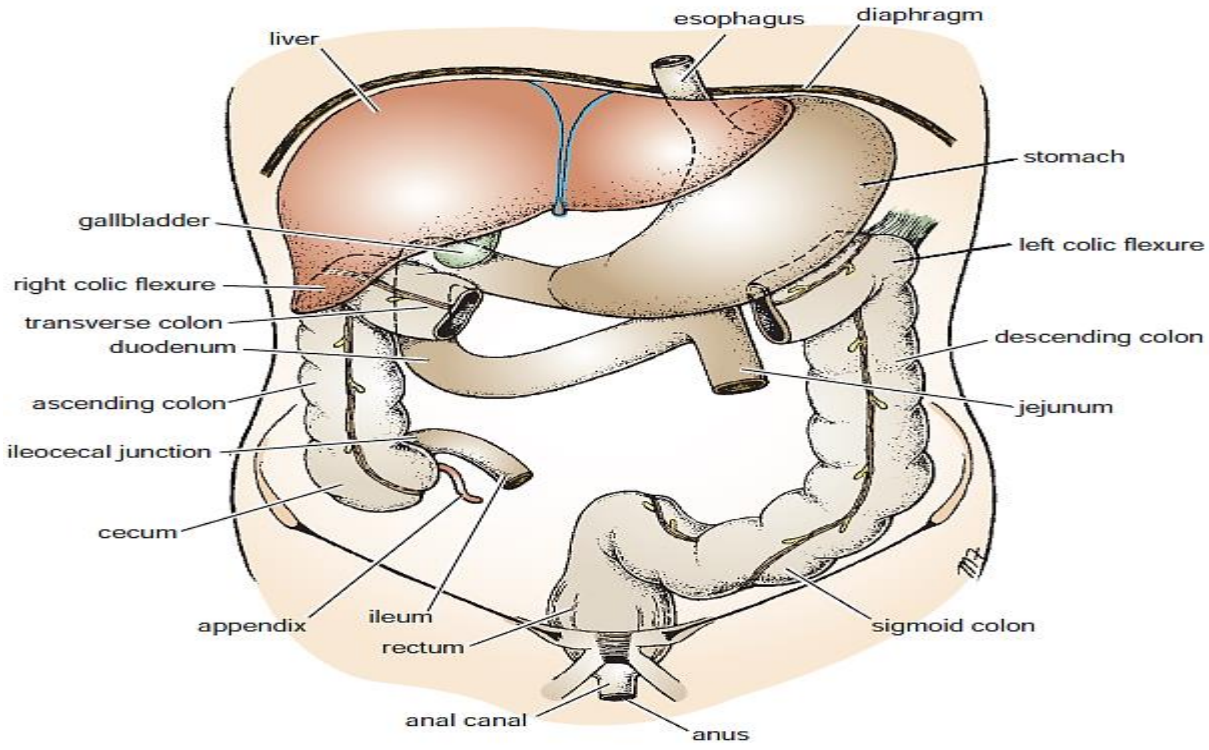




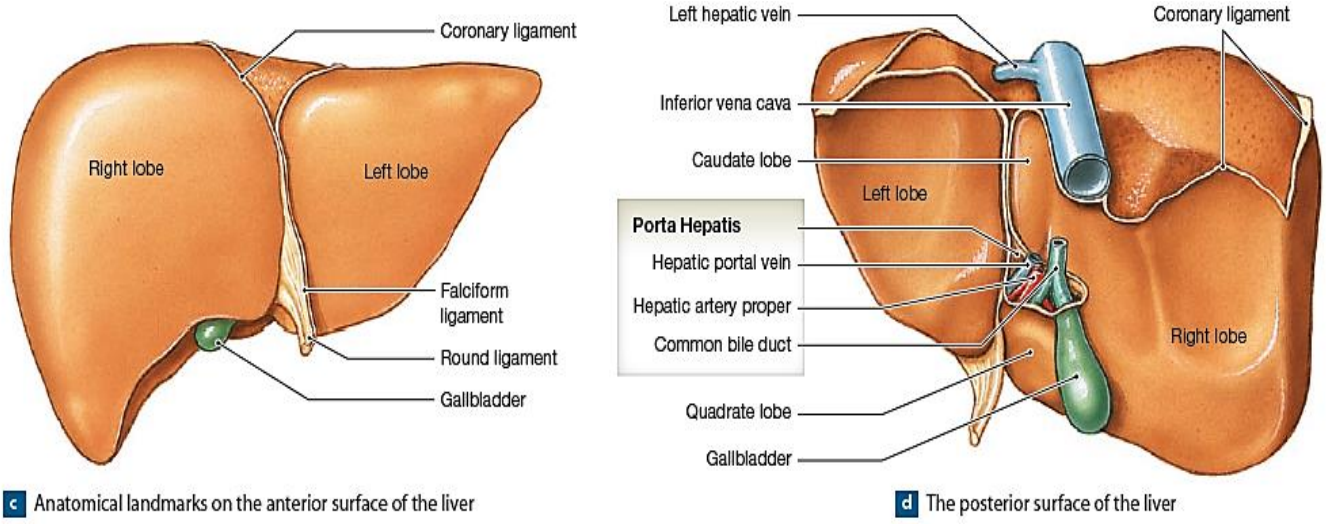
The accessory digestive organs

Liver

The liver is the largest internal organ and heaviest gland of the body, weighing about 1.4 kg in an average adult; it is second organ in size after the skin. The liver is inferior to the diaphragm and occupies most of the right upper quadrant and part of the epigastric regions of the abdominopelvic cavity.



The liver is almost completely covered by visceral peritoneum and is completely covered by a capsule composed of dense irregular connective tissue that lies deep to the peritoneum. The liver is divided into two principal lobes a large **right lobe** and a smaller **left lobe** by the **falciform ligament** that a mesenteric fold extend from the parietal peritoneum of the diaphragm and anterior abdominal wall to the visceral peritoneum of the liver.



c Anatomical landmarks on the anterior surface of the liver

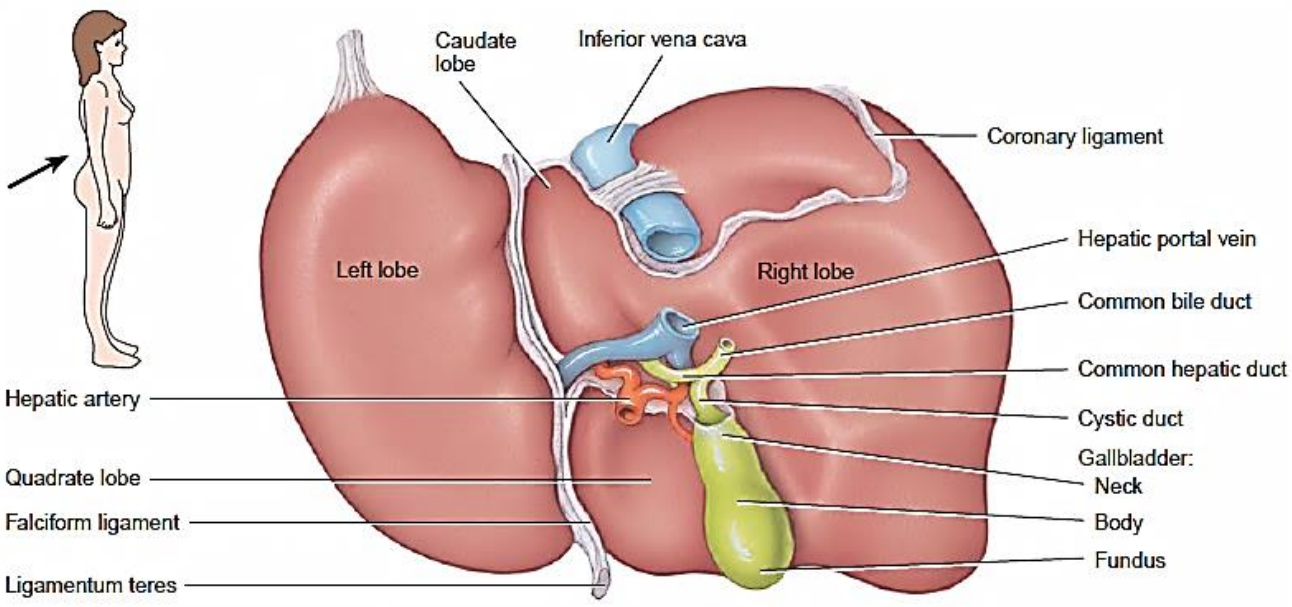
d The posterior surface of the liver

The **right lobe** is considered by many anatomists to include an inferior **quadrate lobe** and a posterior **caudate lobe**. However, on the basis of internal morphology (primarily the distribution of blood vessels), the quadrate and caudate lobes more appropriately belong to the left lobe. The **falciform ligament** extends from the undersurface of the diaphragm between the two principal lobes of the liver to the superior surface of the liver, helping to suspend the liver in the abdominal cavity. The free inferior border of the falciform ligament is the **ligamentum teres** (**round ligament**) is a fibrous cord that is a remnant of the umbilical vein of the fetus; it extends from the liver to the umbilicus. The **right and left coronary ligaments** are narrow extensions of the parietal peritoneum that suspend superiorly the liver from the diaphragm. The **porta hepatis (hilum of the liver)** is found on the posteroinferior surface and lies between the caudate and quadrate lobes; in it lie the

right and left hepatic ducts, right and left branches of hepatic artery, portal vein, sympathetic and parasympathetic nerve fibers and few hepatic lymph nodes.

The **gallbladder** is a pear-shaped sac that is located on the inferior surface of the liver. It is 7–10 cm long and part of it typically hangs below the anterior inferior margin of the liver.

The parts of the gallbladder are the broad **fundus**, which projects downward beyond the inferior border of the liver; the central portion, called the **body**; and a tapered portion called the **neck**. The body and neck project superiorly.

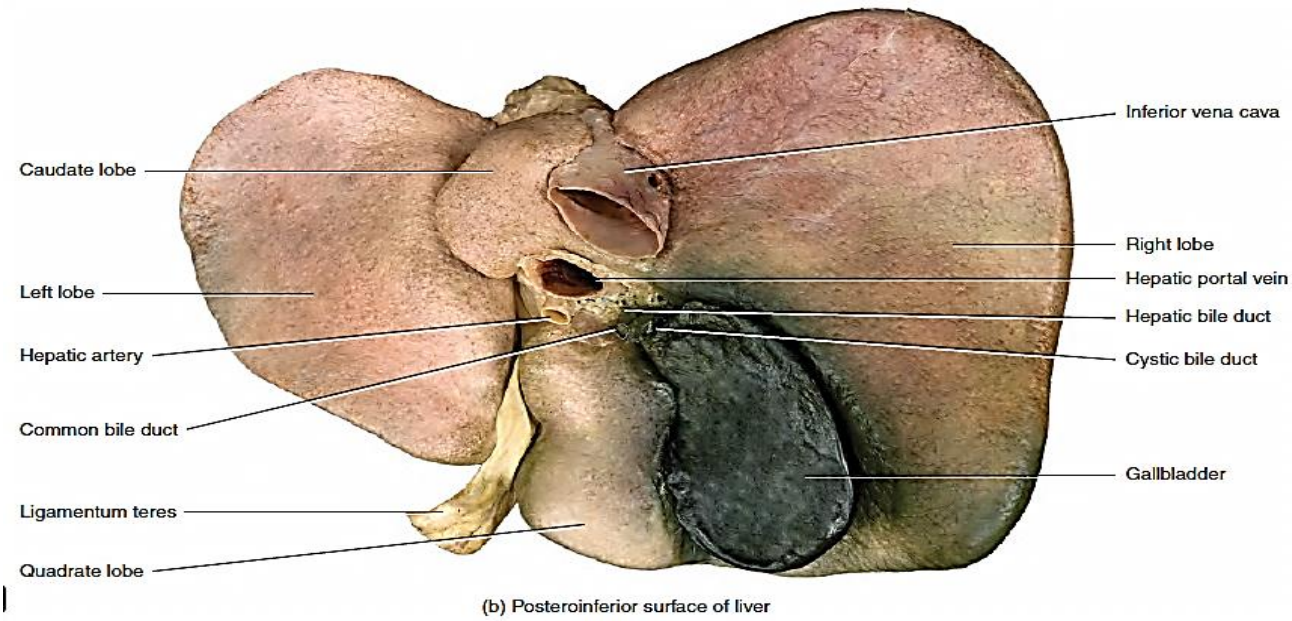


PATH OF BILE FLOW FROM THE LIVER INTO THE DUODENUM

Hepatocytes → Bile canaliculi → Small bile ducts → Right and left hepatic ducts →

Common hepatic duct → Common bile duct (or cystic duct for storage in gallbladder) →

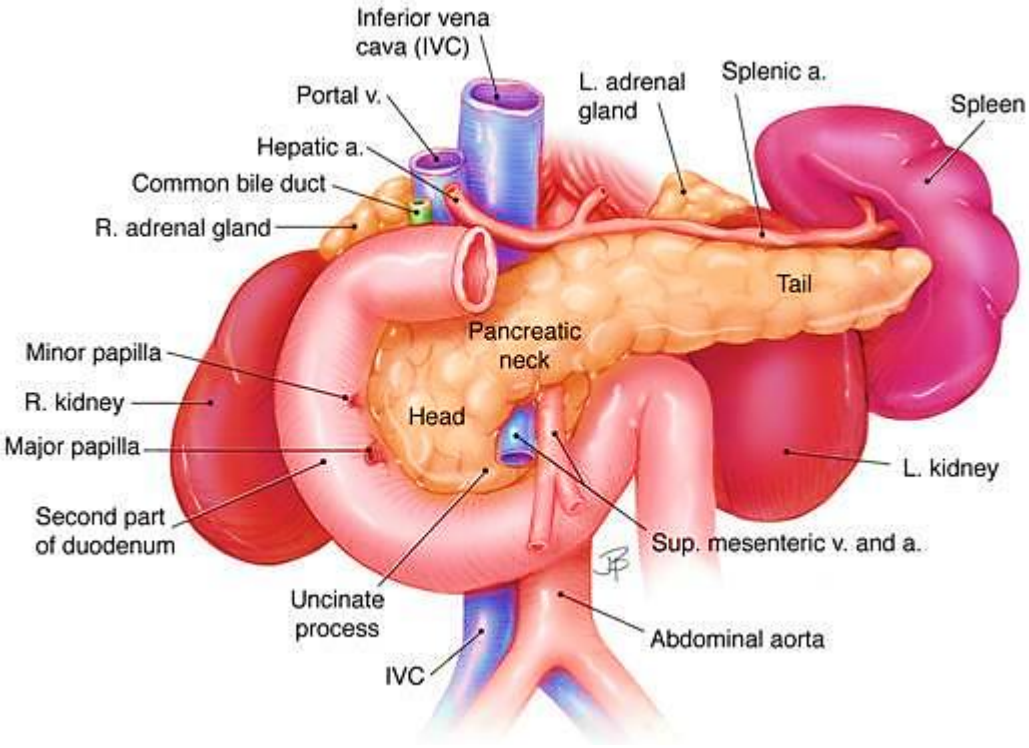
Hepatopancreatic ampulla (ampulla of Vater)



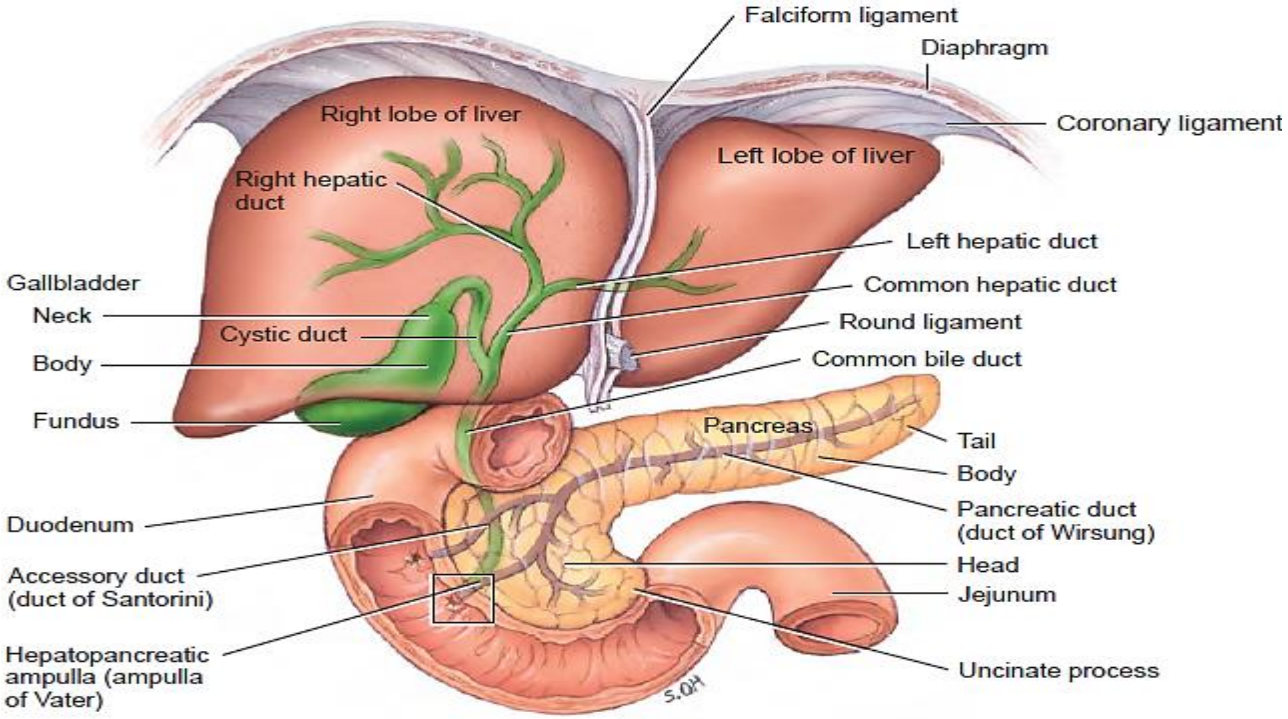
(b) Posteroinferior surface of liver

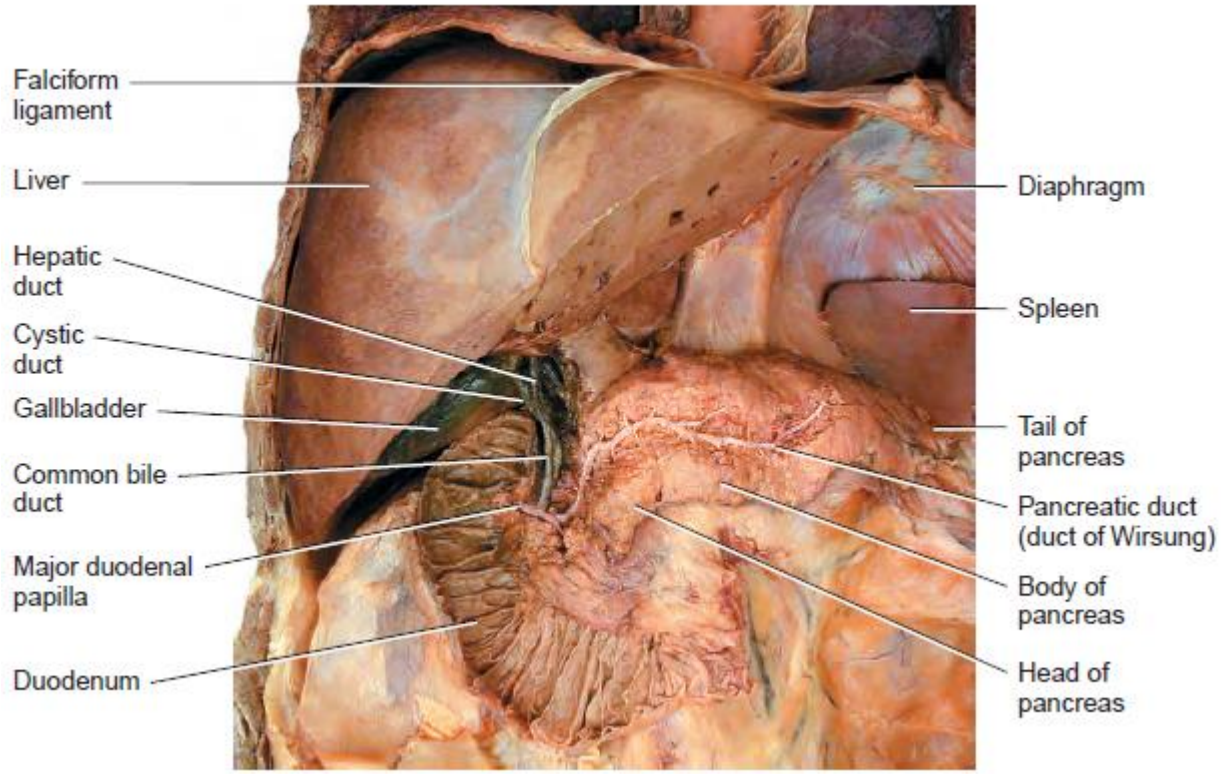
Pancreas

The pancreas is a retroperitoneal gland that is about 12–15 cm long and 2.5 cm thick lies posterior to the greater curvature of the stomach. The pancreas consists of a **head**, a **body**, and a **tail**. The head is the disc shape expanded portion of the organ enclosed by the curve of the duodenum. Projecting from the lower portion of the head is the hook like **uncinate process** that arches behind the superior mesenteric artery and vein, encircling them with pancreatic tissue. Superior to and to the left of the head are the central body and the tapering tail.



Pancreatic secretions pass from the secreting cells into small ducts that ultimately unite to form two larger ducts that convey the secretions into the duodenum of the small intestine. The larger of the two ducts is called the **pancreatic duct**. In most people, the pancreatic duct joins the common bile duct from the liver and gallbladder and enters the duodenum as a dilated common duct called the **hepatopancreatic ampulla (ampulla of Vater)**. The ampulla opens onto an elevation of the duodenal mucosa, the **major duodenal papilla** that lies about 10 cm inferior to the pyloric sphincter of the stomach. The smaller of the two ducts, the accessory duct, leads from the pancreas and empties into the duodenum about 2.5 cm superior to the hepatopancreatic ampulla.

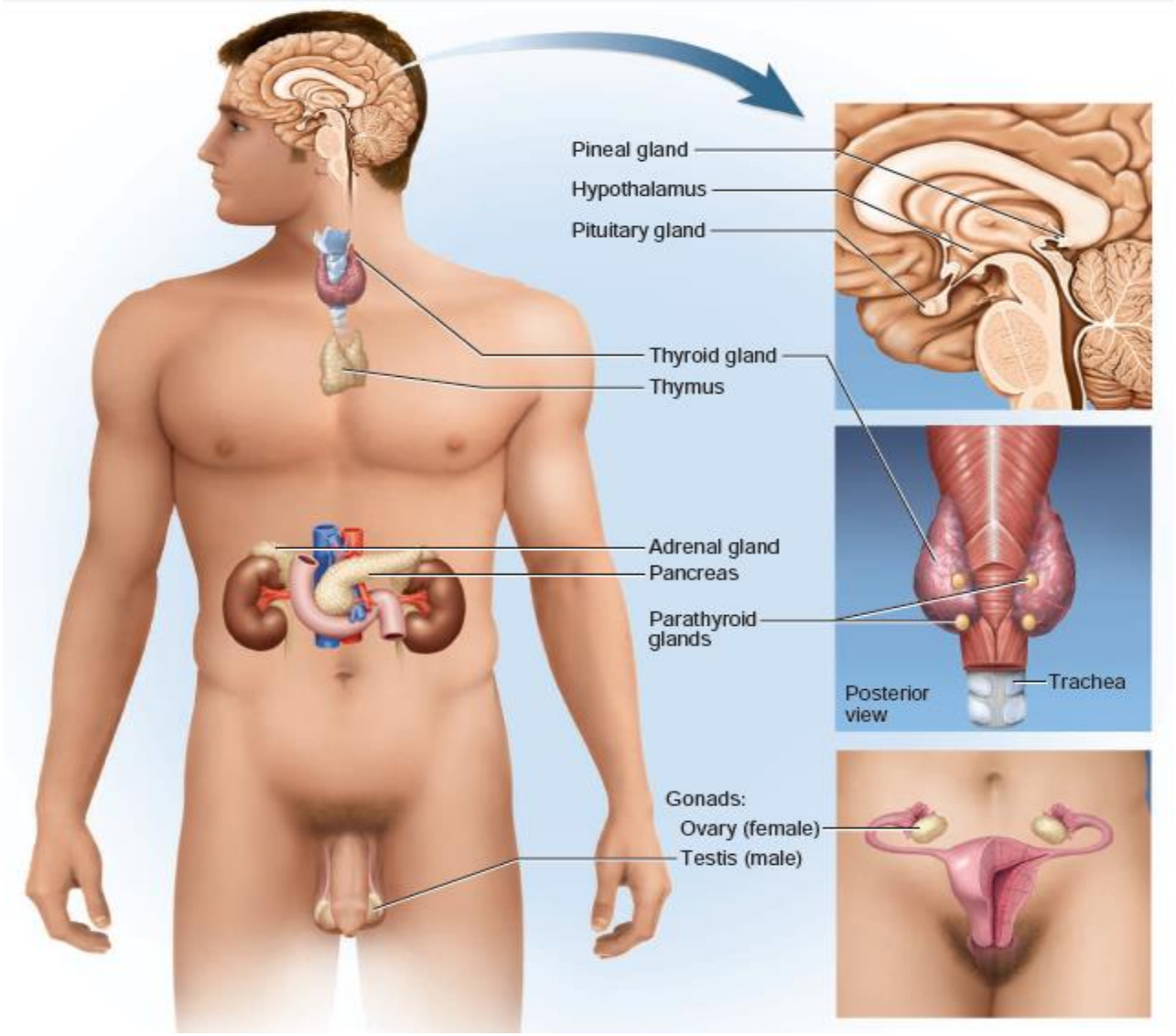

Falciform ligament
Diaphragm
Coronary ligament
Right lobe of liver
Left lobe of liver
Right hepatic duct
Left hepatic duct
Gallbladder
Common hepatic duct
Neck
Cystic duct
Round ligament
Body
Common bile duct
Fundus
Pancreas
Tail
Body
Pancreatic duct (duct of Wirsung)
Duodenum
Head
Accessory duct (duct of Santorini)
Jejunum
Hepatopancreatic ampulla (ampulla of Vater)
Uncinate process
S.OH


Falciform ligament
Liver
Diaphragm
Hepatic duct
Spleen
Cystic duct
Gallbladder
Tail of pancreas
Common bile duct
Pancreatic duct (duct of Wirsung)
Major duodenal papilla
Body of pancreas
Duodenum
Head of pancreas

The endocrine anatomy

The endocrine glands constitute the endocrine system. In contrast to exocrine glands, endocrine glands are **ductless**; they secrete specific chemicals called **hormones** directly into the blood or surrounding interstitial fluid. The blood then transports these hormones to specific sites called target cells, where they perform precise functions.

The endocrine system functions closely with the nervous system in regulating and integrating body processes and maintaining homeostasis. The nervous and endocrine systems are closely coordinated in autonomically controlling the functions of the body. Three endocrine glands are located within the cranial cavity, where certain structures of the brain routinely stimulate or inhibit the release of hormones. Likewise, certain hormones may stimulate or inhibit the activities of the nervous system.



Glands of the Endocrine System

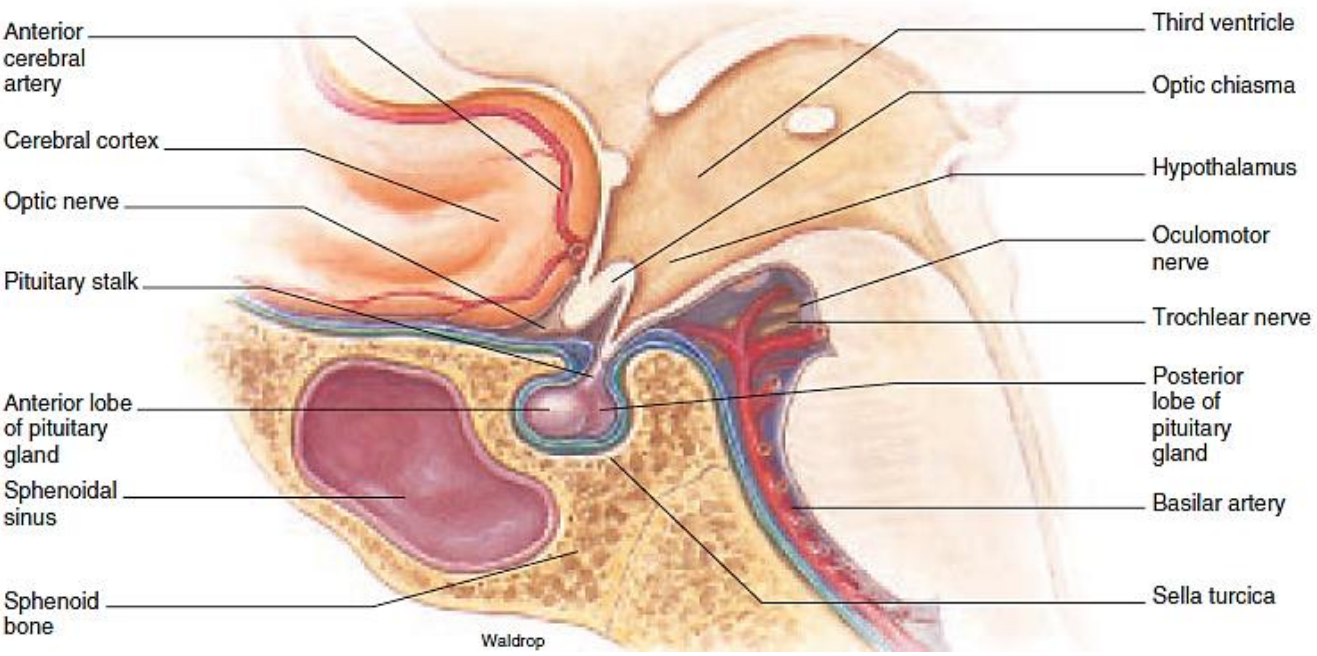
The endocrine glands are distribute throughout the body. The pituitary gland, the hypothalamus, and the pineal gland are associated with the brain within the cranial cavity. The thyroid gland and parathyroid glands are located in the neck. The adrenal glands and pancreas are located within the abdominal region. The gonads (ovaries) of the female are located within the pelvic cavity, whereas the gonads (testes) of the male are located in the scrotum. The pancreas and gonads are frequently classify as mixed glands because they have exocrine as well as endocrine functions.

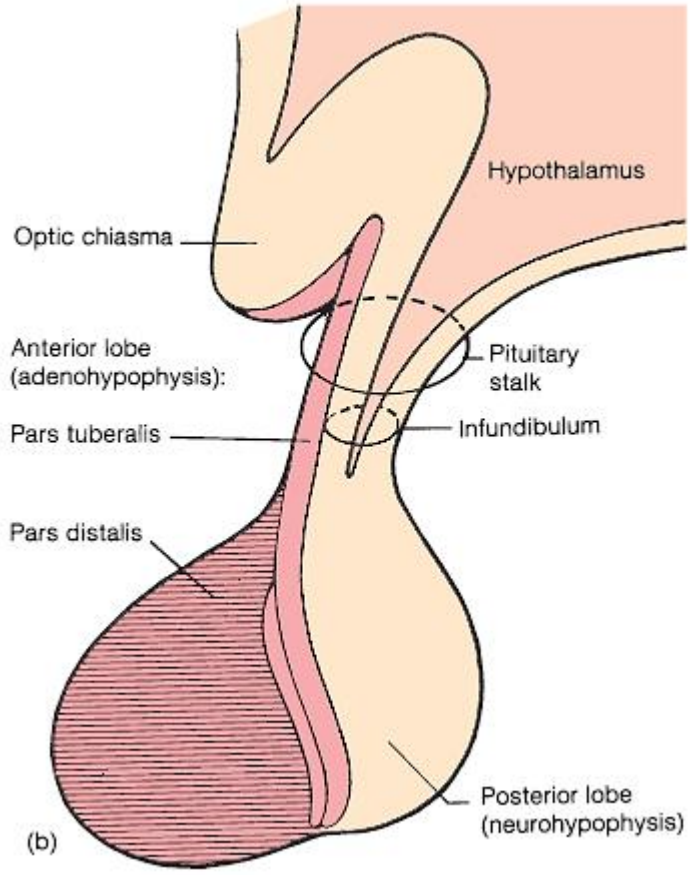
In addition to the glands just mentioned, several others may be consider part of the endocrine system because they have endocrine functions. These include the thymus, located in the lower median neck region; the stomach; the kidneys; the mucosal cells of the duodenum; and the placenta, associated with the fetus.

Hormones are specific organic substances that act as the chemical messengers of the endocrine system. The three basic kinds of hormones (proteins, steroids, and amines) are derived either from amino acids or cholesterol.

Pituitary gland

The pituitary gland or **cerebral hypophysis** is located on the inferior aspect of the brain in the region of the diencephalon and is attached to the brain by astructure called the pituitary stalk. The pituitary is a rounded, pea-shaped gland measuring about **1.3** cm in diameter. It is covered by the dura mater and is supported by the sella turcica of the sphenoid bone. The pituitary gland is structurally and functionally divided into an **anterior lobe**, or **adenohypophysis**, and a **posterior lobe** called the **neurohypophysis**. The adenohypophysis consists of two parts in adults: (1) the **pars distalis** (***anterior pituitary***) is the bulbar portion, and (2) the **pars tuberalis** is the thin extension in contact with the infundibulum. A **pars intermedia,** is a strip of tissue between the anterior and posterior lobes, exists in the fetus.


Anterior cerebral artery
Cerebral cortex
Optic nerve
Pituitary stalk
Anterior lobe of pituitary gland
Sphenoidal sinus
Sphenoid bone
Third ventricle
Optic chiasma
Hypothalamus
Oculomotor nerve
Trochlear nerve
Posterior lobe of pituitary gland
Basilar artery
Sella turcica
Waldrop


Hypothalamus
Optic chiasma
Anterior lobe (adenohypophysis):
Pituitary stalk
Pars tuberalis
Infundibulum
Pars distalis
Posterior lobe (neurohypophysis)
(b)

Pituitary Hormones

1. **Growth hormone (GH).** Growth hormone, or ***somatotropin*** regulates the rate of growth of all body cells and promotes mitotic activity.
2. **Thyroid-stimulating hormone (TSH).** TSH, frequently called thyrotropin, regulates the hormonal activity of thethyroid gland.
3. **Adrenocorticotropic hormone (ACTH)**. ACTH promotes normal functioning of the adrenal cortex. It also acts on all body cells by assisting in the breakdown of fats.
4. **Follicle-stimulating hormone (FSH)**. In males, FSH stimulates the testes to produce sperm. In females, FSH regulates the monthly development of the follicle and egg. It also stimulates the secretion of the female sex hormone estrogen.
5. **Luteinizing hormone (LH)**. LH works with FSH, and together they are referred to as gonadotrophins, which mean their target cells are located within the gonads or reproductive organs.
6. **Prolactin**. Prolactin is secreted in both males and females, but it functions primarily in females after parturition.
7. **Melanocyte-stimulating hormone (MSH)**. The exact action of MSH in humans is unknown, but it can cause darkening of the skin by stimulating the dispersion of melanin granules within melanocytes.
8. **Oxytocin**. Oxytocin is produce by specialize cells in the hypothalamus then store in neurosecretory vesicles in neurohypophysis to release from it. Influences physiological activity in the female reproductive system. It is release near the end of gestation and causes uterine contractions during labor.
9. **Antidiuretic hormone (ADH)**. ADH is similar to oxytocin in its site of production and release. The major function of ADH is to inhibit the formation of urine in the kidneys, or more specifically, to reduce the amount of water excreted from the kidneys.

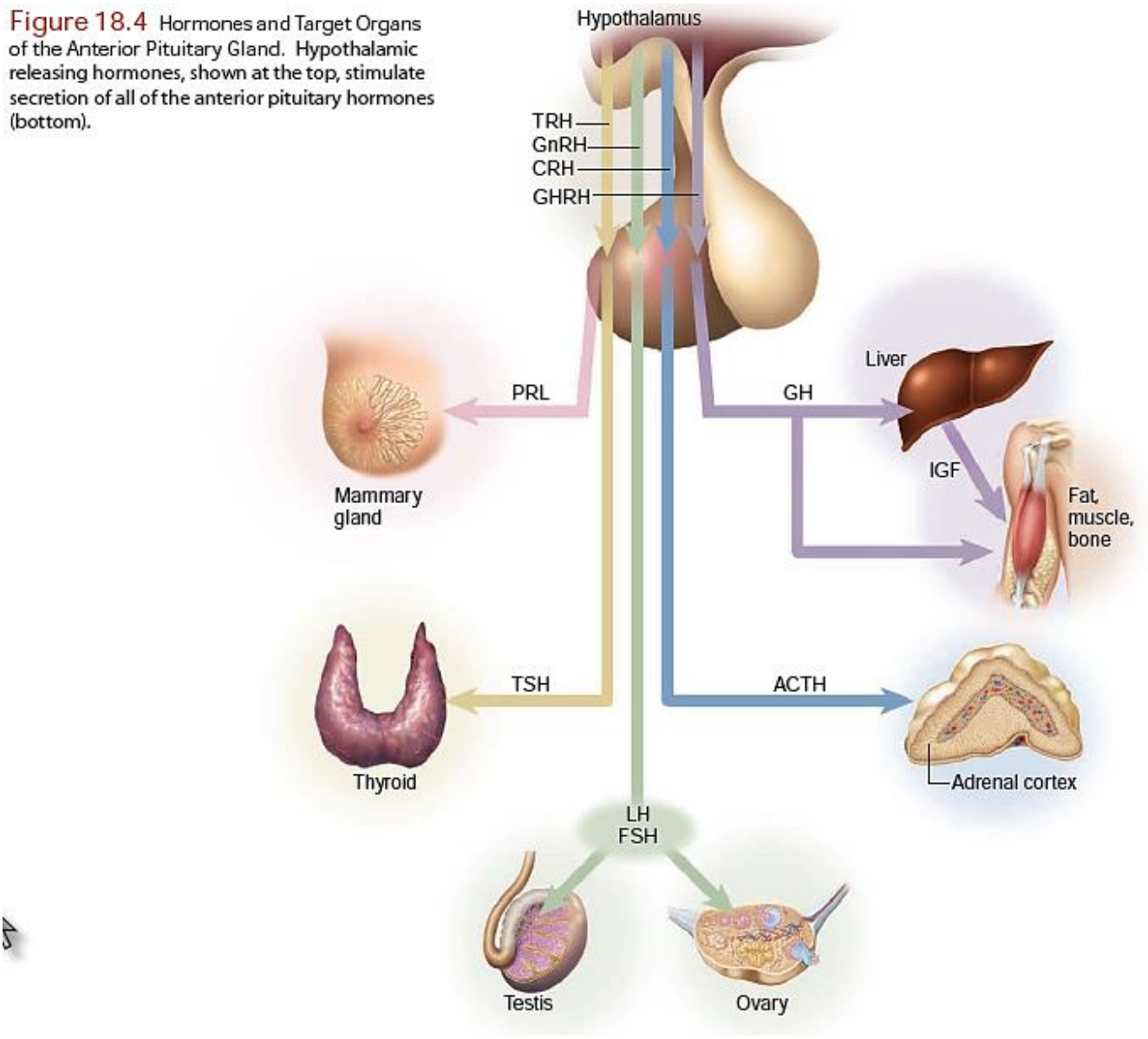


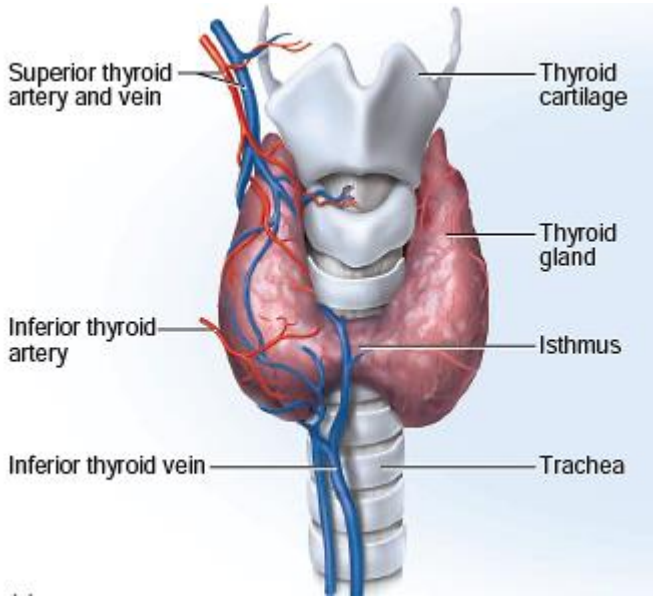
Figure 18.4 Hormones and Target Organs of the Anterior Pituitary Gland. Hypothalamic releasing hormones, shown at the top, stimulate secretion of all of the anterior pituitary hormones (bottom).

Thyroid Gland

The **thyroid gland** is located in the neck, just below the larynx. Its two lobes, each about 5 cm long, are positioned on either lateral side of the trachea and connected anteriorly by a bridge of tissue called the **isthmus.** The thyroid is the largest of the endocrine glands, weighing between 20 and 25 g.

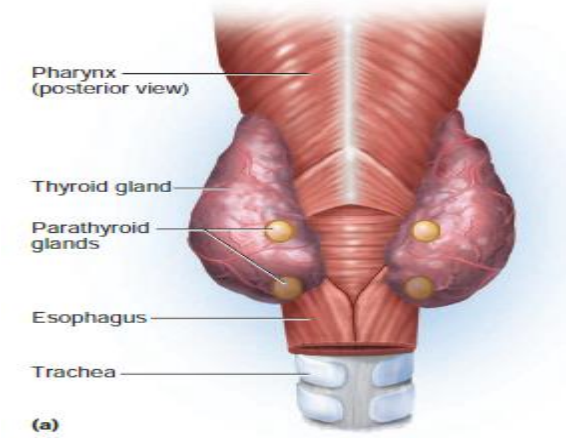
The thyroid gland produces two major hormones plays a major role in the metabolism, growth and development of the human body: thyroxine (T4) and triiodothyronine (T3),

and the minor hormone calcitonin (thyrocalcitonin) which that stimulates deposition of calcium from the blood into the bones. The release of thyroxine and triiodothyronine are controlled by the hypothalamus and by the TSH secreted from the adenohypophysis of the pituitary gland.



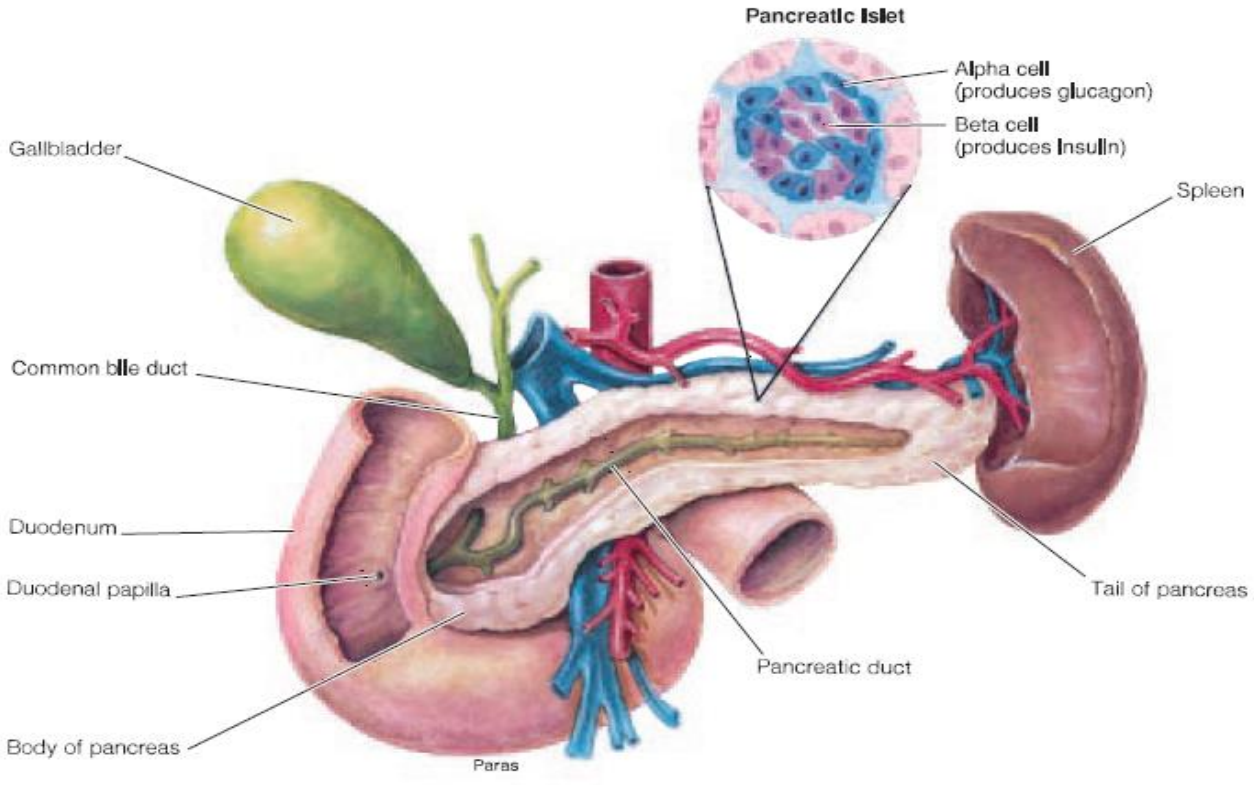
Parathyroid Glands

The small, flattened tow pair **parathyroid glands** are embedded in the posterior surfaces of the lateral lobes of the thyroid gland. There are usually four parathyroid glands: a superior and an inferior pair. Each parathyroid gland is a small yellowbrown body 3–8 mm long, 2–5 mm wide and about 1.5 mm thick. The parathyroid glands secrete one hormone called parathyroid hormone (PTH). This hormone promotes a rise in blood calcium levels by acting on the bones, kidneys, and small intestine; thus, it opposes the effects of calcitonin, released by the thyroid gland.



Pancreas

Pancreas is both an endocrine and an exocrine gland. The endocrine portion of the pancreas consists of scattered clusters of cells called **pancreatic islets** (**islets of Langerhans**). These endocrine structures are most common in the body and tail of the pancreas and mainly consist of two types of secretory cells called **alpha** cells and **beta** cells.

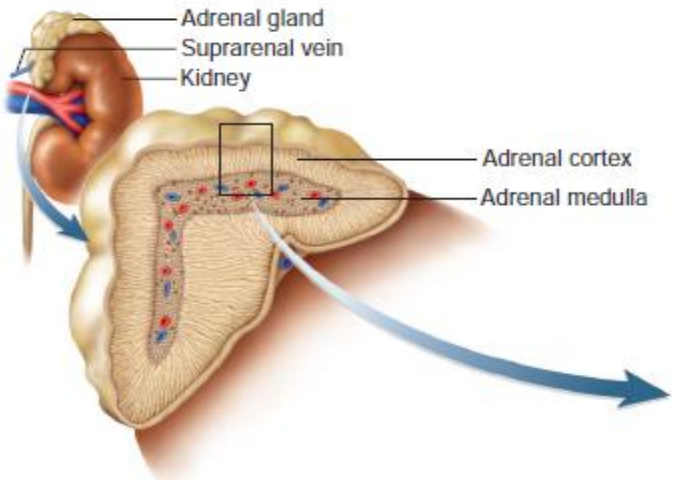


The endocrine function of the pancreas is to produce and secrete the hormones **glucagon** and **insulin**. The alpha cells of the pancreatic islets secrete glucagon and the

beta cells secrete insulin. Glucagon stimulates the liver to convert glycogen into glucose, which causes the blood glucose level to rise. Insulin has a physiological function opposite to that of glucagon: it decreases the level of blood sugar. Insulin promotes the movement of glucose through cell membranes, especially in muscle and adipose cells. As the glucose enters the cells, the sugar level of the blood decreases. Failure of beta cells to produce insulin causes the common hereditary disease **diabetes mellitus**.

Adrenal Glands

The **adrenal glands (suprarenal glands)** are paired organs that cap the superior borders of the kidneys. The adrenal glands, along with the kidneys, are retroperitoneal and are embedded against the muscles of the back in a protective pad of fat. Each of the pyramid-shaped adrenal glands is about 50 mm long, 30 mm wide, and 10 mm thick. Each consists of an outer adrenal cortex and inner adrenal medulla that functionally act as separate glands. Over 30 hormones have been identified as being produced by the adrenal cortex. These hormones called corticosteroids or corticoids, for short. The adrenal corticoids grouped into three functional categories: **mineralocorticoids, glucocorticoids,** and **gonadocorticoids**.



Gonads

The **gonads** are the male and female primary sex organs. The male gonads called **testes** and the female gonads called **ovaries.** The gonads mixed glands in that they produce both sex hormones and sex cells or **gametes.**

- ***Testes***

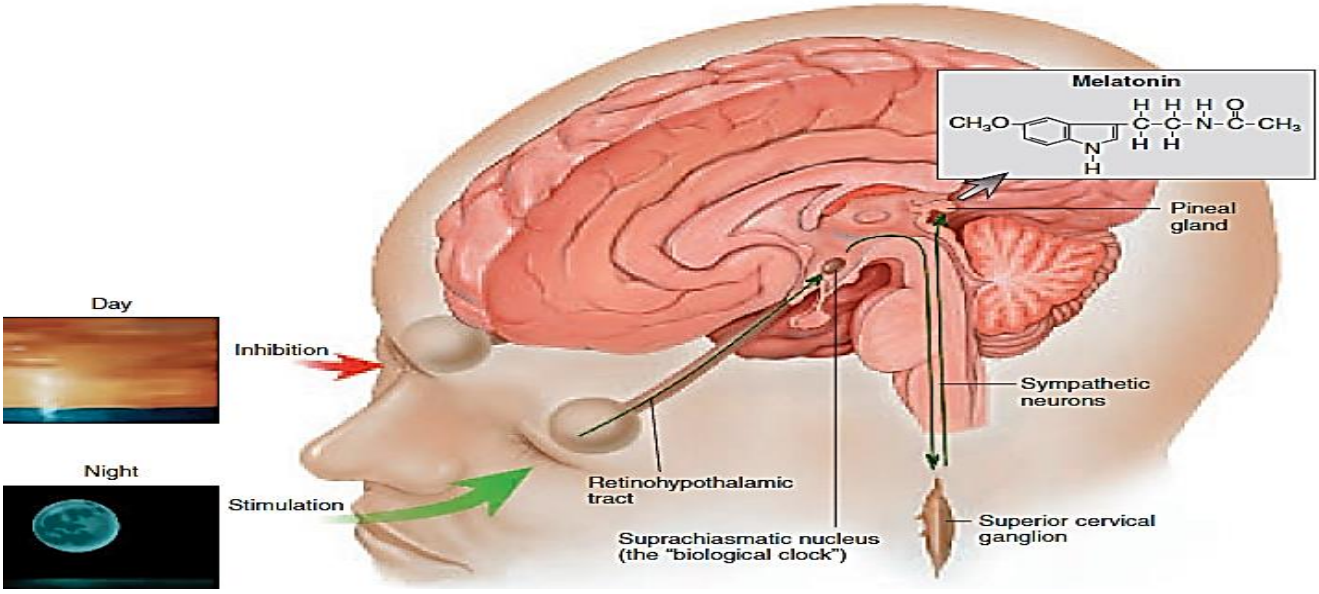
The **interstitial cells of Leydig (Leydig cells)** of the testes produce and secrete the male sex hormone **testosterone**. Testosterone controls the development and function of the male secondary sex organs: the penis, accessory glands, and ducts. It also promotes the male secondary sex characteristics and somewhat determines the sex drive.

- ***Ovaries***

The endocrine function of the ovaries is the production of the female sex hormones, **estrogens** and **progesterone**. Estrogens produced in the **ovarian** (**graafian**) **follicles** and **corpus luteum** of the ovaries, they also produced in the **placenta**, **adrenal cortex**, and even in the **testes** of the male. **Estrogens** are responsible for (1) development and function of the secondary sex organs, (2) menstrual changes of the uterus, (3) development of the female secondary sex characteristics, and (4) regulation of the sex drive. Progesterone is produce by the corpus luteum and placenta is primarily associated with pregnancy in preparing the uterus for implantation and preventing abortion of the fetus.

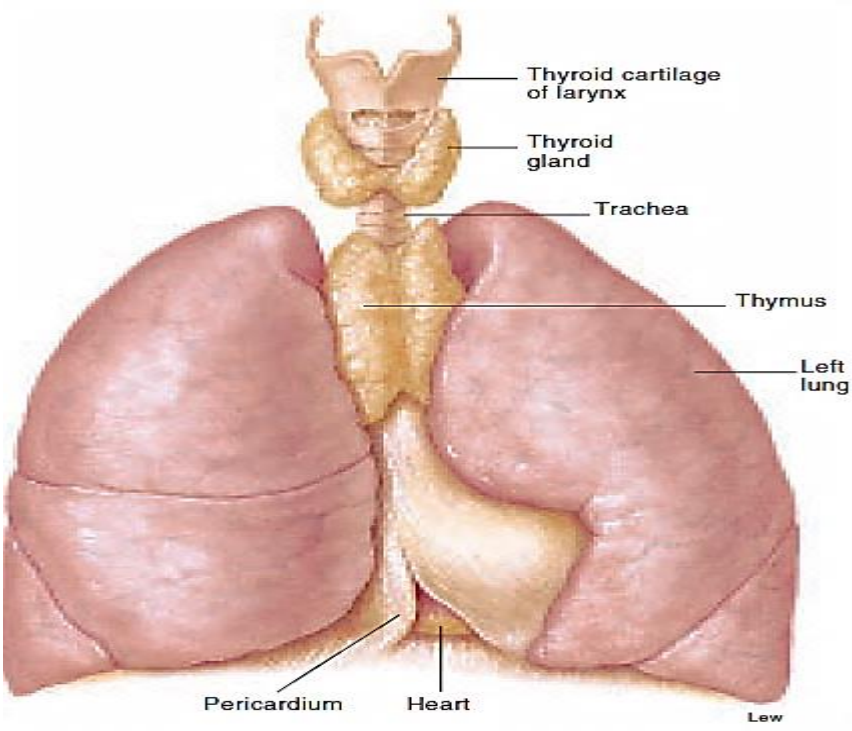
Pineal Gland

The small, cone-shaped **pineal gland** (**pineal body**) is located in the roof of the third ventricle, where it encapsulated by the meninges covering the brain. In a child, the pineal gland weighs about 0.2 g and is 5–8 mm long and 9 mm wide. It begins to regress in size at about the age of **7y**, and in the adult, it appears as a thickened strand of fibrous tissue. The function of the pineal gland in humans secretion of its principal hormone, **melatonin**, antioxidant and responsible for follows a circadian (daily) rhythm tied to daily and seasonal changes in light.



Thymus

The **thymus** is a bilobed organ positioned in the upper mediastinum, in front of the aorta and behind the manubrium of the sternum. It is relatively large in newborns and children and then sharply regresses in size after puberty. Besides decreasing in size, the thymus of adults becomes infiltrate with strands of fibrous and fatty connective tissue. The principal function of the thymus is associated with the lymphatic system in maintaining body immunity through the maturation and discharge of a specialized group of lymphocytes called **T cells**. The thymus also secretes a hormone called **thymosin**, which is believe to stimulate the T cells after they leave the thymus.



Stomach and Small Intestine

Certain cells (enteroendocrine cells) of the mucosal linings of the stomach and small intestine secrete hormones that promote digestive activities. Coordinate the activities of different regions of the GI tract and the secretions of pancreatic juice and bile in conjunction with regulation by the autonomic nervous system.

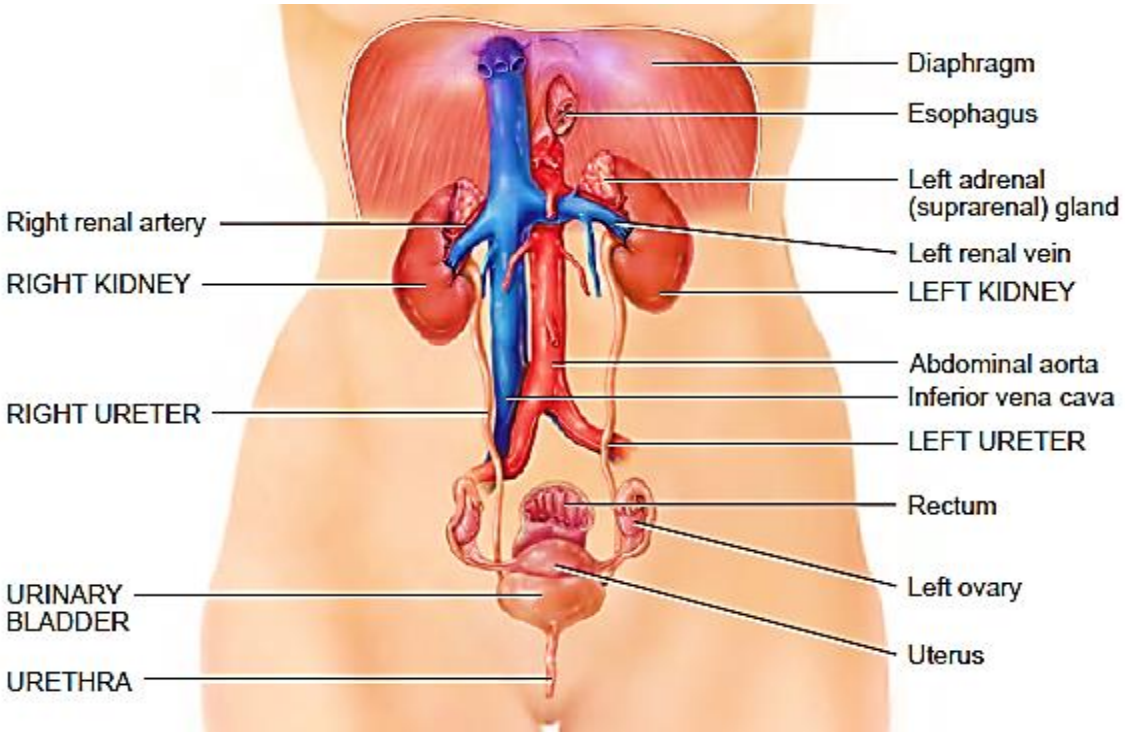
Placenta

The **placenta** is the organ responsible for nutrient and waste exchange between the fetus and the mother. The placenta is also an endocrine gland; it secretes large amounts of estrogens and progesterone, as well as a number of polypeptide and protein hormones that are similar to some hormones secreted by the anterior pituitary called **human chorionic gonadotrophin (hCG),** which is similar to LH, and **somatomammotrophin,** which is similar in action to growth hormone and prolactin. Detection of hCG in urine is an indication of pregnancy and is the basis of home pregnancy tests.

The urinary system

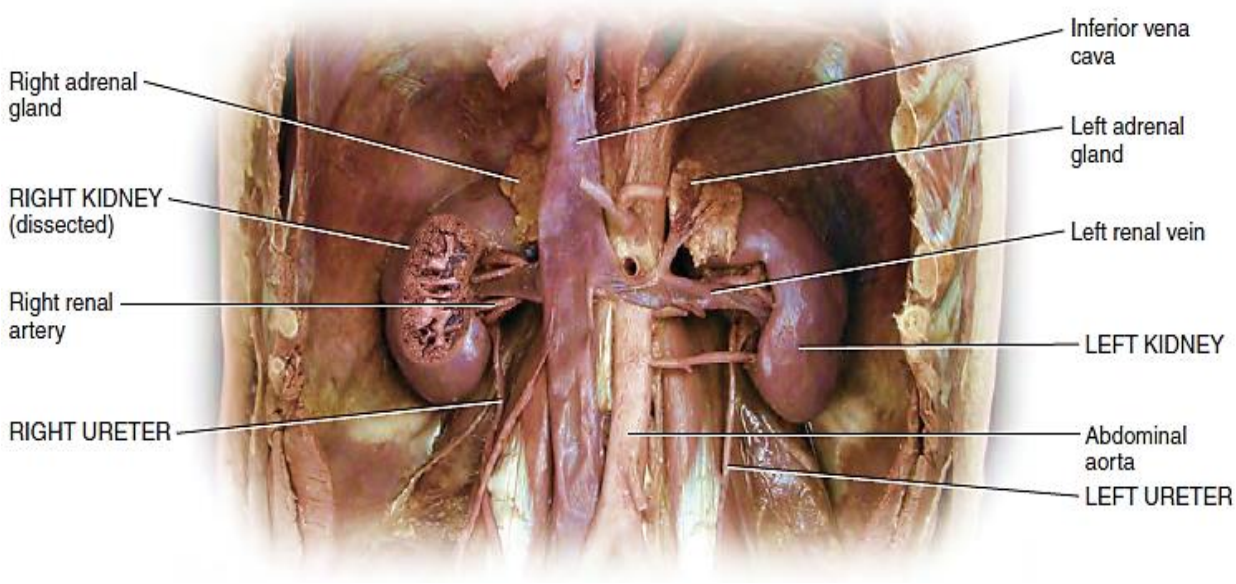
The urinary system consists of two kidneys, two ureters, one urinary bladder, and one urethra. Like the respiratory and digestive systems, the urinary system forms an extensive area of contact with the cardiovascular system. After the kidneys filter blood plasma, they return most of the water and solutes to the bloodstream. The remaining water and solutes constitute urine, which passes through the ureters and is stored in the urinary bladder until it is removed from the body through the urethra.

The kidneys do the major functional work of the urinary system. The other parts of the system are mainly passage ways and storage areas. Functions of the kidneys include the following: Regulation of blood ionic composition, blood pH, blood volume, blood glucose level and enzymatic regulation of blood pressure also maintenance of blood osmolarity and Production of hormones and finally excretion of wastes and foreign substances.

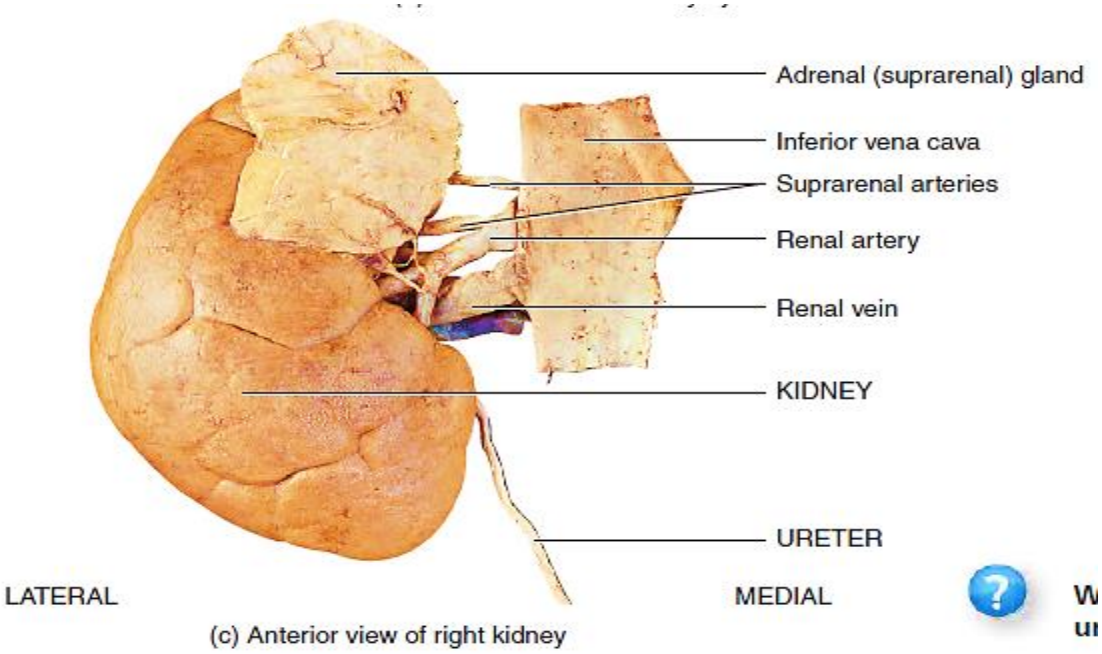


Kidney

The paired kidneys are reddish, bean-shaped organs located just above the waist on each side of spine between the peritoneum and the posterior wall of the abdomen (retroperitoneal). The kidneys are located between the levels of the last thoracic and third lumbar vertebrae, a position where they are partially protected by ribs 11 and 12. The right kidney is slightly lower than the left because the liver occupies considerable space on the right side superior to the kidney.



With contraction of the diaphragm during respiration, both kidneys move downward in a vertical direction by as much as (2.5 cm). A typical kidney in an adult is 10–12 cm long, 5–7 cm width, and 3cm thick and has a mass of 125–170 g. The each of kidney have anterior and posterior surface, also have lateral convex and medial concave borders. On the medial concave border of each kidney faces the vertebral column is a vertical slit that is bounded by thick lips of renal substance and is called the hilum. The hilum extends into a large cavity called the renal sinus. The hilum transmits, from the front backward, the renal vein, two branches of the renal artery, the ureter, and the third branch of the renal artery (VAUA). Lymph vessels and sympathetic fibers also pass through the hilum.



(c) Anterior view of right kidney

The kidneys have the following coverings:

■ **Fibrous capsule**: This surrounds the kidney and is closely applied to its outer surface.

■ **Perirenal fat**: This covers the fibrous capsule.

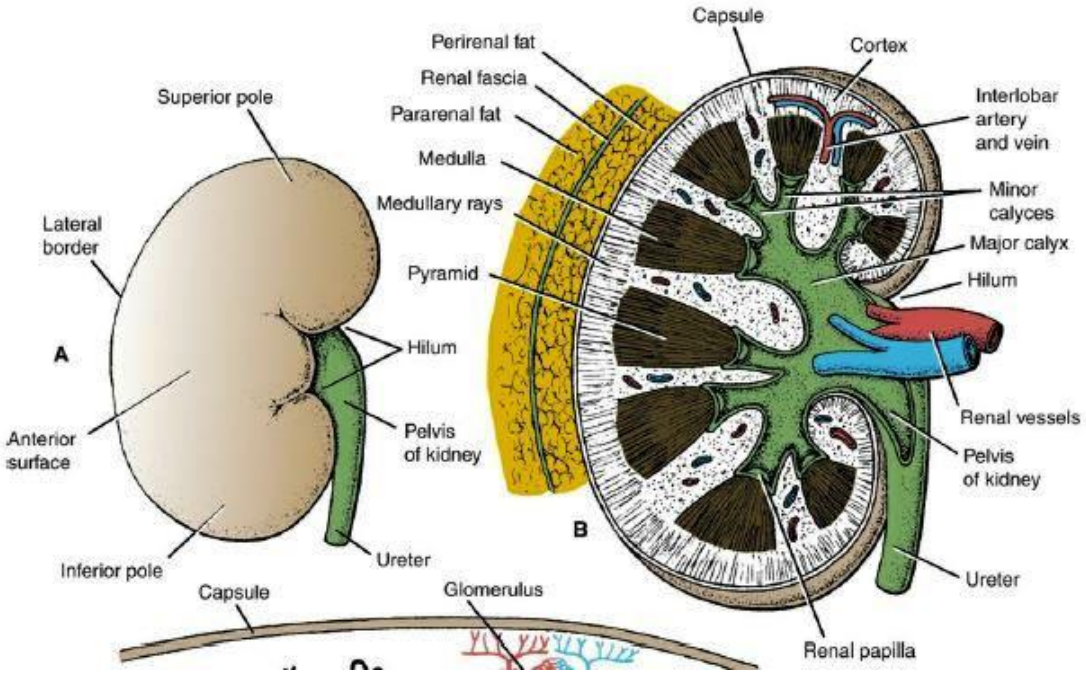
■ **Renal fascia**: This is a condensation of connective tissue that lies outside the perirenal fat and encloses the kidneys and suprarenal glands; it is continuous laterally with the fascia transversalis that lining the abdominal cavity.

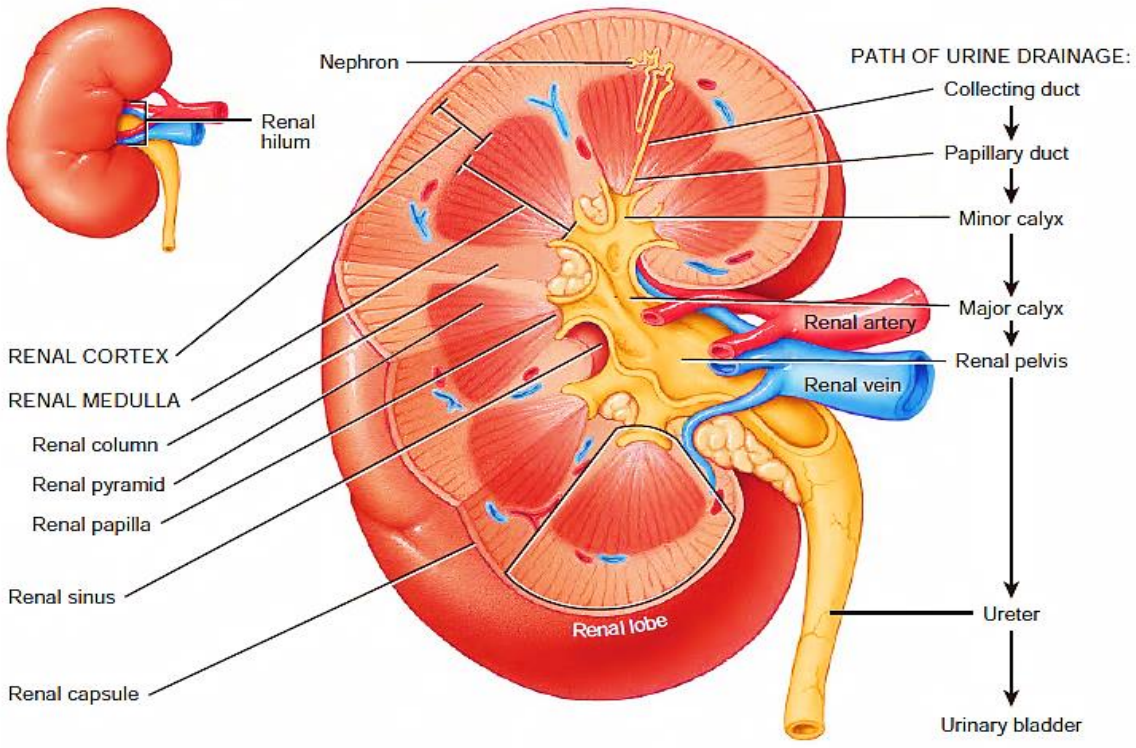
■ **Pararenal fat**: This lies external to the renal fascia and is often in large quantity. It forms part of the retroperitoneal fat.

Internal Anatomy of the Kidneys

Each kidney has a dark brown outer **cortex** and a light brown inner **medulla**. The medulla is composed of about a dozen renal pyramids, each having its base oriented toward the cortex and its apex, the renal papilla, projecting medially. The cortex extends into the medulla between adjacent pyramids as the **renal columns**. Extending from the bases of the renal pyramids into the cortex are striations known as **medullary rays**. The renal sinus, which is the space within the hilum, contains the upper expanded end of the ureter, the renal pelvis, which divides into two or three **major calyces**, each of which divides into two

or three **minor calyces**. Each minor calyx is indented by the apex of the renal pyramid, called the renal papilla. The functional units of the kidney about 1 million microscopic structures called nephrons.





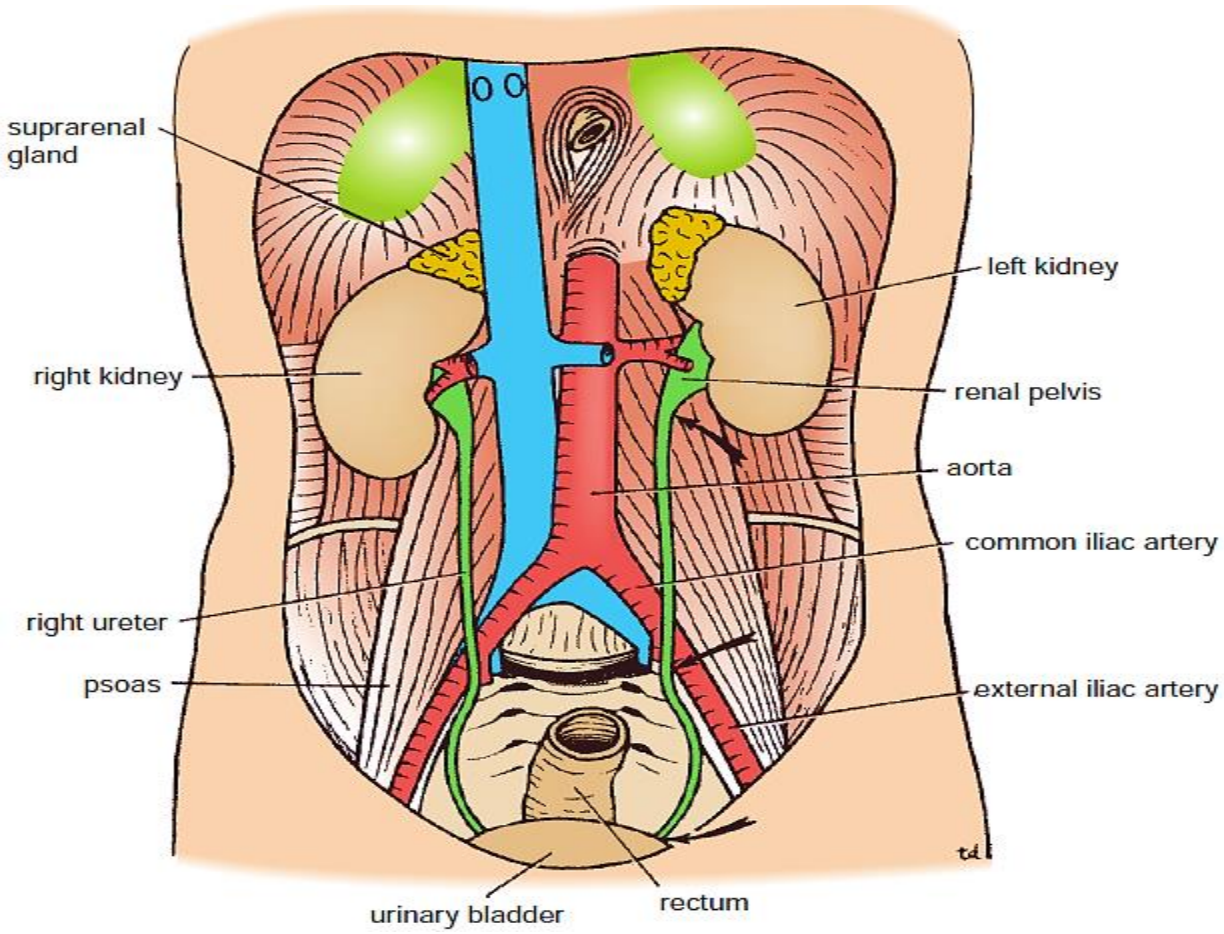
(a) Anterior view of dissection of right kidney

Ureters

Each of the two ureters transports urine from the renal pelvis of one kidney to the urinary bladder. Ureters are muscular tubes that extend from the kidneys to the posterior surface of the urinary bladder. The urine is propelled along the ureter by peristaltic contractions of the muscle coat, assisted by the filtration pressure of the glomeruli.

Like the kidneys, the ureters are retroperitoneal. Each ureter measures about (25 cm) long and having three constrictions along its course: where the renal pelvis joins the ureter, where it is kinked as it crosses the pelvic brim, and where it pierces the bladder wall. The renal pelvis is the funnel-shaped expanded upper end of the ureter. It lies within the hilum of the kidney and receives the major calyces. The ureter emerges from the hilum of the kidney and runs vertically downward behind the parietal peritoneum (adherent to it) on the psoas muscle, which separates it from the tips of the transverse processes of the lumbar vertebrae. It enters the pelvis by crossing the bifurcation of the common iliac artery in front of the sacroiliac joint. The ureter then runs down on the lateral wall of the pelvis to the region of the ischial spine and turns forward to enter the superiolateral angle of the bladder. The vas deferens crosses over the ureter near the ureter's termination (remember: water under the bridge). The ureter passes obliquely through the wall of the bladder for about (1.9 cm) before opening into the bladder.

There is no anatomical valve at the opening of each ureter into the urinary bladder, there is a physiological one that is quite effective. As the urinary bladder fills with urine, pressure within it compresses the oblique openings into the ureters and prevents the backflow of urine.



Urinary Bladder

The urinary bladder is situated immediately behind the pubic bones within the pelvis. It stores urine and in the adult has a maximum capacity of about 500mL. The bladder has a strong muscular wall. Its shape and relations vary according to the amount of urine that it contains. The empty bladder in the adult is pyramidal shape, having an apex, base, neck, superior surface, and two inferolateral surfaces, it lies entirely within the pelvis; as the bladder fills, its superior wall rises up into the hypogastric region.

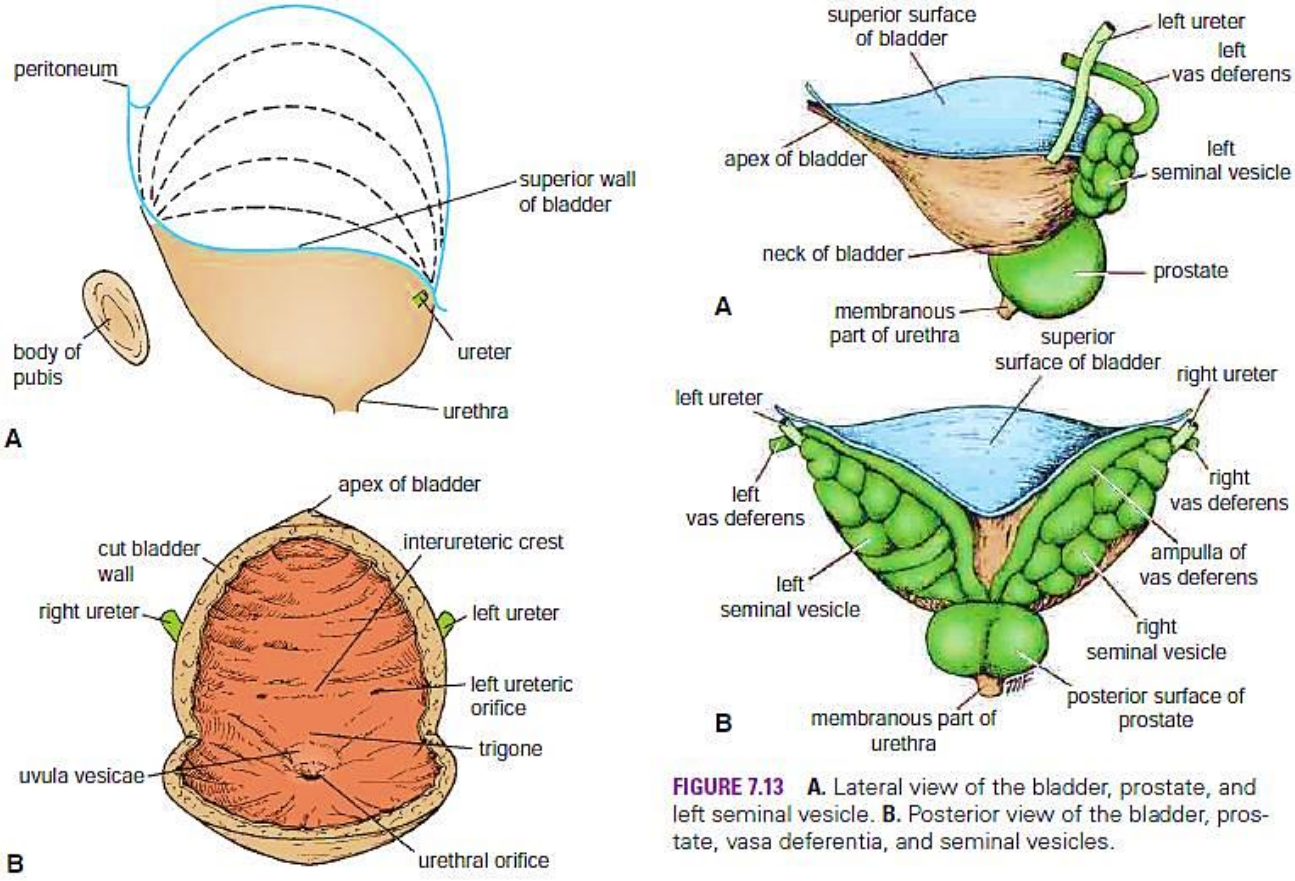
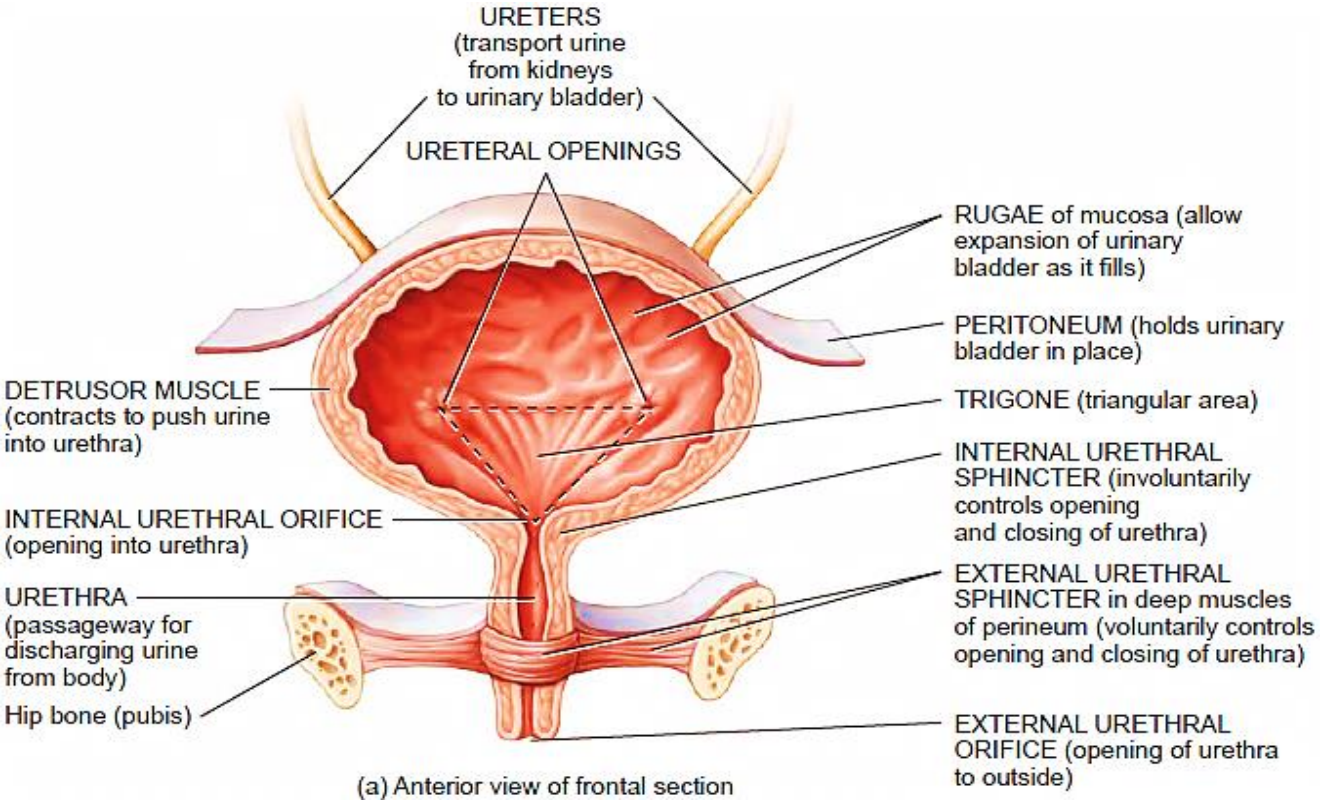


FIGURE 7.13 **A.** Lateral view of the bladder, prostate, and left seminal vesicle. **B.** Posterior view of the bladder, prostate, vasa deferentia, and seminal vesicles.

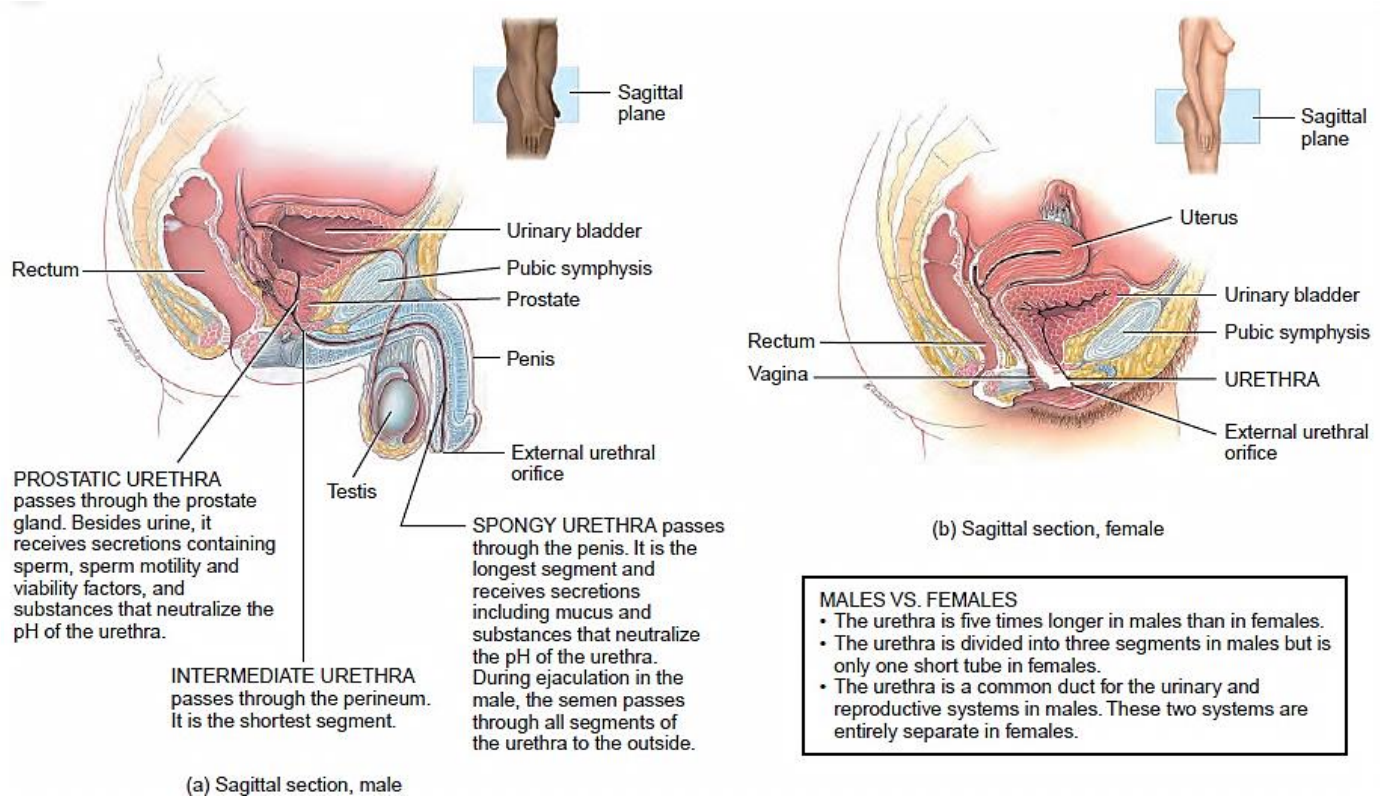


(a) Anterior view of frontal section

In the floor of the urinary bladder is a small triangular area called the **trigone**. The two posterior corners of the trigone contain the two ureteral openings; and anterior corner contain the internal urethral orifice. Because its mucosa is firmly bound to the muscularis, the trigone has a smooth appearance. The urinary bladder wall containing muscles called the **detrusor muscle**, which consists of three layers of smooth muscle fibers: the inner longitudinal, middle circular and outer longitudinal layers. Around the opening to the urethra the circular fibers thickening form an internal urethral sphincter; inferior to it is the external urethral sphincter, which is composed of skeletal muscle. Discharge of urine from the urinary bladder, called micturition, is also known as urination or voiding.

Urethra

It is a small tube leading from the internal urethral orifice in the floor of the urinary bladder to the exterior of the body. In both males and females, the urethra is the terminal portion of the urinary system and the passage way for discharging urine from the body; in males it discharges semen as well. In males, its length and passage through the body are considerably different from females. The male urethra first passes through the prostate, then through the deep perineal muscles, and finally through the penis, a distance of about 20 cm. Several glands and other structures associated with reproduction deliver their contents into the male urethra. In females, the urethra lies directly posterior to the pubic symphysis directed obliquely inferiorly and anteriorly, and has a length of 4 cm. The opening of the urethra to the exterior called the external urethral orifice, is located between the clitoris and the vaginal opening.



Blood Supply of kidney

The renal artery arises from the abdominal aorta at the level of the second lumbar vertebra which divides into five segmental arteries that enter the kidney hilum and distributed to different segments or areas of the kidney and gives lobar arteries, which gives off two or three interlobar arteries which run toward the cortex on each side of the renal pyramid. At the junction of the cortex and the medulla, the interlobar arteries give off the arcuate arteries, which arch over the bases of the pyramids. The arcuate arteries give off several interlobular arteries which gives afferent glomerular arterioles of glomerular tuff.

The renal vein emerges from the hilum in front of the renal artery and drains into the inferior vena cava.

Lymph Drainage of kidney

Lymph drains to the lateral aortic lymph nodes around the origin of the renal artery.

Nerve Supply of kidney

The nerve supply is the renal sympathetic plexus. The afferent fibers that travel through the renal plexus enter the spinal cord in the 10th, 11th, and 12th thoracic nerves.

Reproduction system anatomy

Reproduction system anatomy are produce germ cells called gametes and hormones. After the male gamete (sperm cell) and female gamete (secondary oocyte) which everyone contains one set of chromosomes unites in event called fertilization to form zygote contains double set of chromosomes from parent. Males and females have anatomically distinct reproductive organs that are adapted for producing gametes, facilitating fertilization, and in females, sustaining the growth of the embryo and fetus.

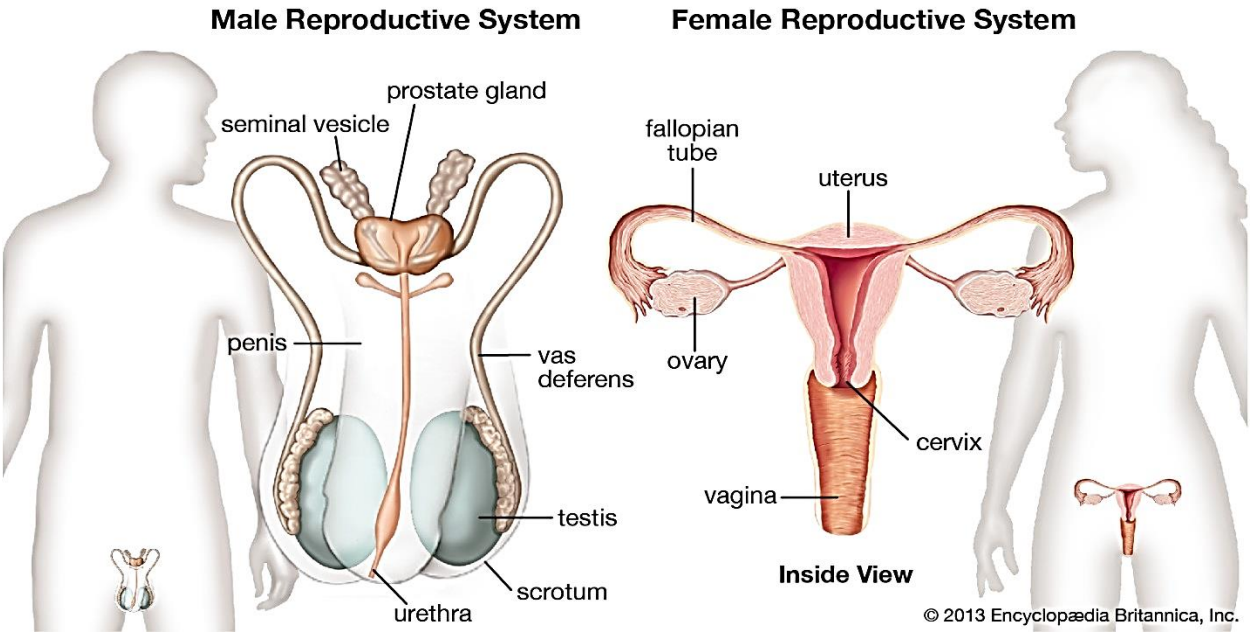
The male and female reproductive organs are consist of:

(a) The gonads **testes** in males and **ovaries** in females produce gametes and secrete sex hormones.

(b) Various **ducts** that store and transport the gametes.

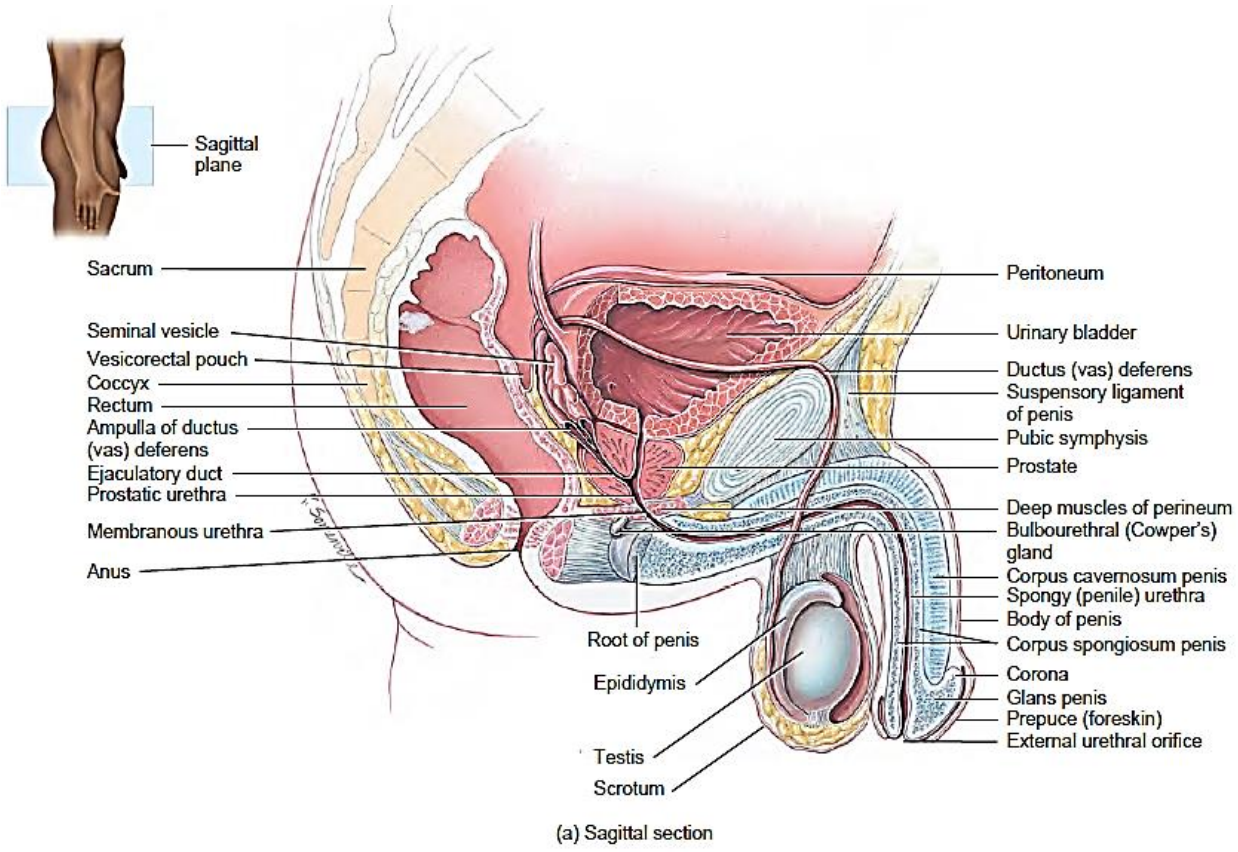
(c) The **accessory sex glands** produce substances that protect the gametes and facilitate their movement.

Finally, **supporting structures**, such as the penis in males and the vagina in females, assist the delivery of gametes, and the uterus in females assists in the growth of the embryo and fetus during pregnancy.



MALE REPRODUCTIVE SYSTEM

The organs of the **male reproductive system** include the testes (male gonads), a system of ducts (including the epididymis, ductus deferens, ejaculatory ducts, and urethra), accessory sex glands (seminal vesicles, prostate, and bulbourethral glands), and several supporting structures, including the scrotum and the penis.



(a) Sagittal section

The **scrotum**, externally separated into two lateral portions by a median ridge called the **raphe**. Internally, the **scrotal septum** divides the scrotum into two sacs, each containing a single testis. The septum made up of a subcutaneous layer and smooth muscle fibers called the **dartos muscle**.

Testes

The **testes**, or **testicles**, are paired oval glands in the scrotum, which looks like a single pouch of skin hangs from the root (attached portion) of the penis. Each testis (singular) measuring about 5cm long and 2.5 cm in diameter and weight 10‑15 grams. The testes develop near the kidneys, in the posterior portion of the abdomen, and usually begin descent into the scrotum through the inguinal canals (passageways in the lower anterior abdominal wall; during the end of the seventh month of fetal development. The testes are partially cover by a serous membrane called the **tunica vaginalis** derived from the peritoneum. Internal to the tunica vaginalis, the testis is surround by a white fibrous capsule called the **tunica albuginea**; it extends inward, forming septa that divide each testis into a series of internal compartments called **lobules**. Each of the 200‑300 lobules contains one to three tightly coiled tubules called the **seminiferous tubules**, where sperm are produce by process called **spermatogenesis.**

Reproductive System Ducts in Males

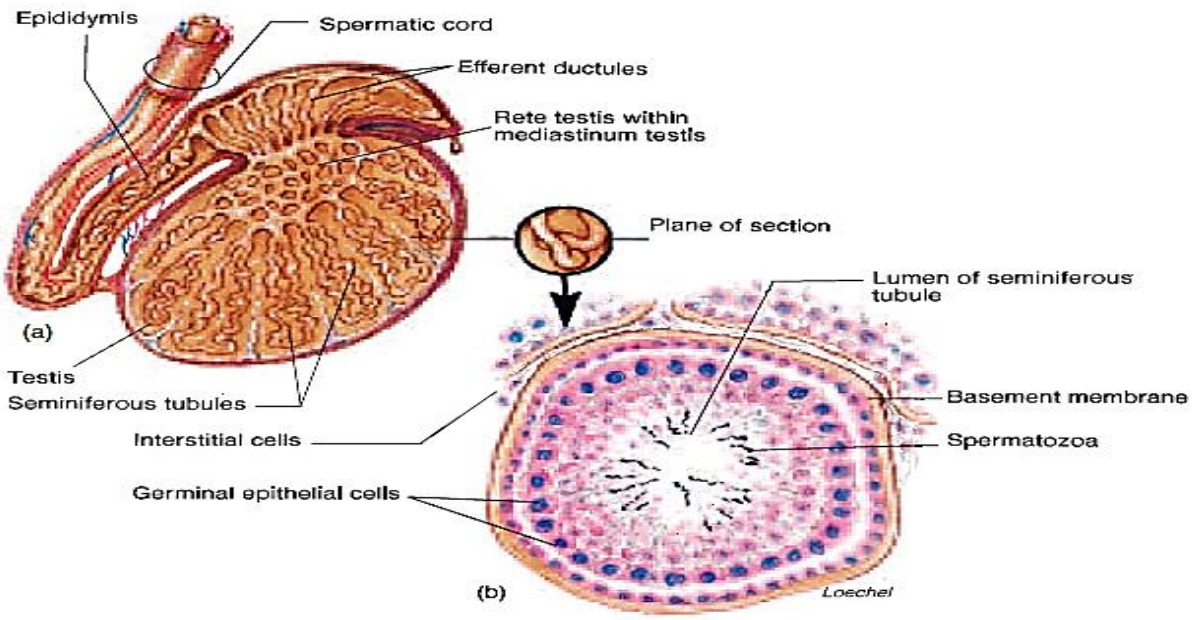
The spermatic ducts store spermatozoa and transport them from the testes to the urethra and the accessory reproductive glands provide additives to the spermatozoa in the formation of semen.

- ***Epididymis***

The **epididymis** is a comma shaped organ about (4 cm) long that lies along the posterior border of each testis. Each of epididymis consists mostly of the tightly coiled ductus epididymis and have larger superior portion of the epididymis called the head where the efferent ducts from the testis join the s epididymis and body is the narrow midportion and the tail is the smaller inferior portion(contains spermatozoa in their final stages of maturation) which continues as the ductus (vas) deferens.

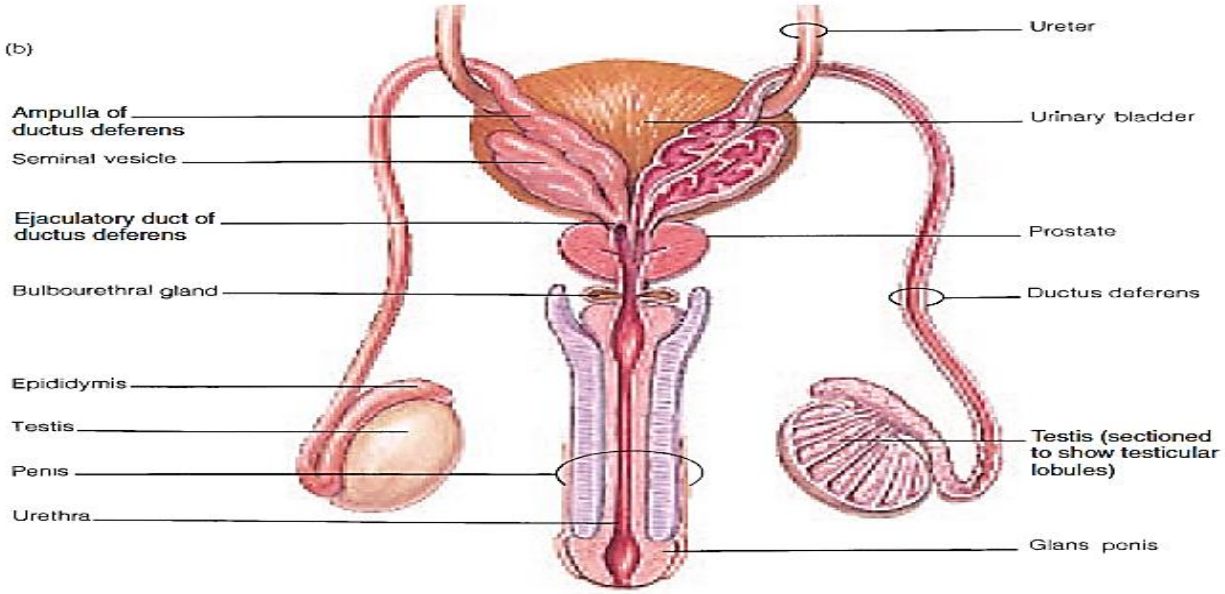
Ductus Deferens

The **ductus deferens** is a fibromuscular tube that conveys spermatozoa from the epididymis to the ejaculatory duct. Also called the *vas deferens*, it exits the scrotum as it ascends along the posterior border of the testis and penetrates the inguinal canal to enter the pelvic cavity, and passes to the side of the urinary bladder on the medial side of the ureter. The **ampulla** of the ductus deferens is the terminal portion that joins the ejaculatory duct. Much of the ductus deferens is located within a structure known as the **spermatic cord**.



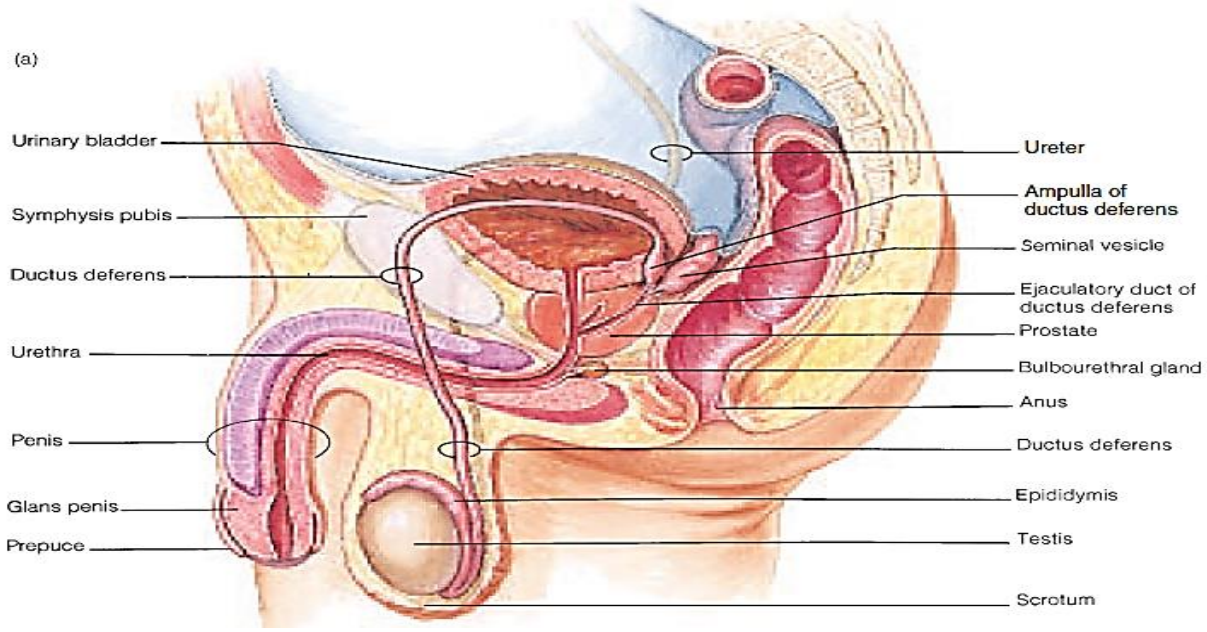
Ejaculatory Duct

The ejaculatory duct is about 2 cm long and is formed by the union of the ampulla of the ductus deferens and the duct of the seminal vesicle. The ejaculatory duct then pierces the capsule of the prostate on its posterior surface and continues through this gland. Both ejaculatory ducts receive secretions from the seminal vesicles and then eject the spermatozoa with its additives into the prostatic urethra to be mixed with secretions from the prostate.



Accessory Reproductive Glands

The accessory reproductive glands of the male include the ***seminal vesicles***, the ***prostate***, and the ***bulbourethral (Cowper's) glands***. The contents of the seminal vesicles and prostate mixed with the spermatozoa during ejaculation to form ***semen (seminal fluid)***. The fluid from the bulbourethral glands is released in response to sexual stimulation prior to ejaculation.



Urethra

The **urethra** of the male serves as a common tube for both the urinary and reproductive systems. However, urine and semen cannot pass through simultaneously because the nervous reflex during ejaculation automatically inhibits micturition. The male urethra is about 20 cm long, and S-shaped because of the shape of the penis. it is divided into three regions:

1. The **prostatic part of the urethra** is the 2.5-cm proximal portion that passes through the prostate. The prostatic urethra receives drainage from the small ducts of the prostate and the two ejaculatory ducts.
2. The **membranous part of the urethra** is the 0.5-cm portion that passes through the urogenital diaphragm. The external urethral sphincter muscle is located in this region.
3. The **spongy part of the urethra** is the longest portion about 15 cm long, extending from the outer edge of the urogenital diaphragm to the external urethral orifice on the glans penis, this portion is surround by erectile tissue as it passes through the corpus spongiosum of the penis. The paired ducts from the bulbourethral glands attach to the spongy part of the urethra near the urogenital diaphragm.

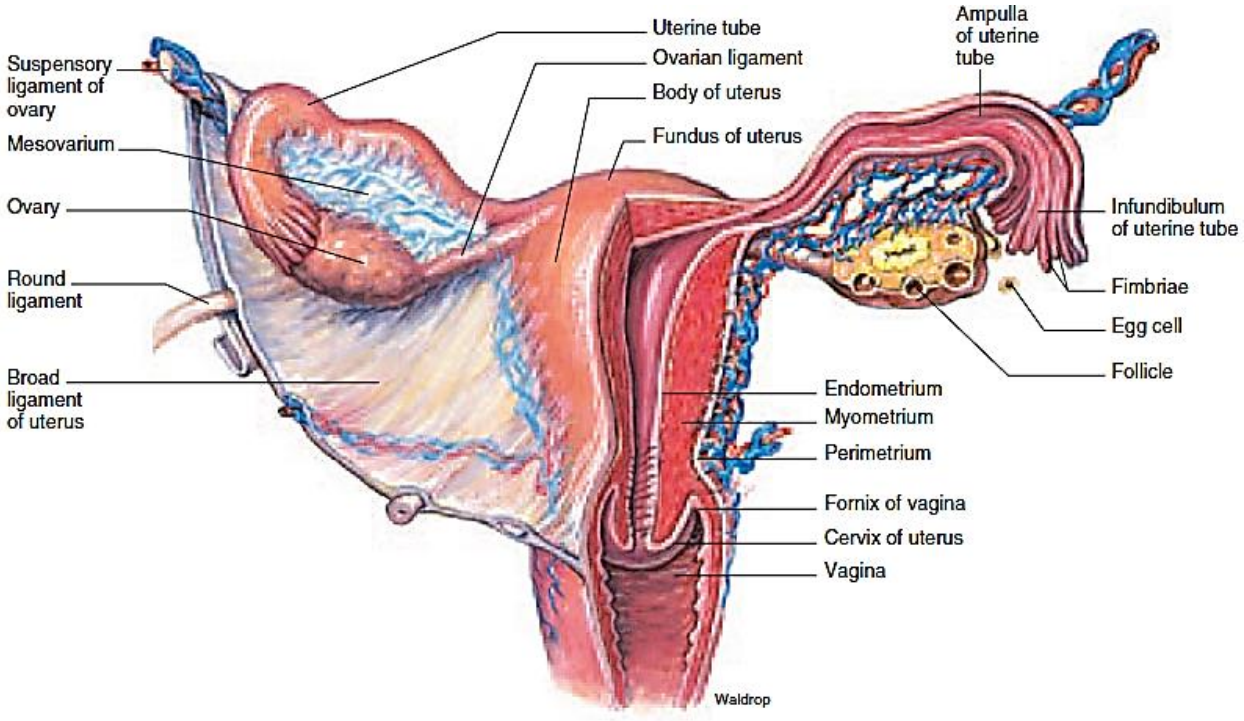
The penis, which divided into a proximal part **root**, which is attach to the pubic arch; an elongated tubular **body or shaft** and a distal part cone-shaped **glans penis**.

THE FEMALE REPRODUCTIVE SYSTEM

Ovaries

Ovaries are paired primary sex organs of the female that produce **gametes**, or **ova**, and the sex hormones, **estrogens** and **progesterone**. The ovaries of a sexually mature female are solid, ovoid structures. The color and texture of the ovaries vary according to the age and reproductive stage of the female. On the medial portion of

each ovary is a **hilum**, which is the point of entrance for ovarian vessels and nerves. The lateral portion of the ovary is positioned near the open end of the uterine tube. The paired ovaries are positioned in the upper pelvic cavity, one on each lateral side of the uterus. Each ovary is situated in a shallow depression of the pelvic wall called **ovarian fossa,** and anchored by several membranous attachments; the **broad ligament** is the parietal peritoneum that supports the uterine tubes and uterus, the **mesovarium** is a posterior extension of the broad ligament that attaches to ovary, the **ovarian ligament** that is anchored ovary to the uterus and a **suspensory ligament** which is connect ovary to the pelvic wall contains blood and lymphatic vessels and nerves of ovary.



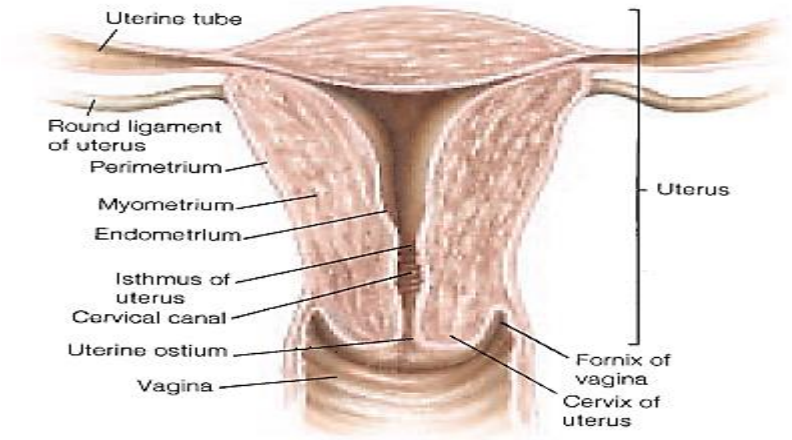
Uterine Tubes

The paired **uterine tubes,** also known as the ***fallopian tubes,* or *oviducts***, transport oocytes from the ovaries to the uterus. Each uterine position is between the folds of the broad ligament of the uterus. The funnel shape, open-ended portion of the

uterine tube, the **infundibulum**, lies close to the ovary but is not attach. A number of fingerlike processes called **fimbriae** project from the margins of the infundibulum over the lateral surface of the ovary. Wavelike movements of the fimbriae sweep an ovulated oocyte into the lumen of the uterine tube. From the infundibulum, the uterine tube extends medially and inferiorly to open into the cavity of the uterus. The **ampulla of the uterine tube** is its longest and widest portion and site of fertilization.

Uterus

The uterus receives fertilized oocyte and provides a site for implantation. Prenatal development continues within the uterus until gestation is completed at which time the uterus plays an active role in the delivery of the baby. The uterus is inverted hollow pear shape with a thick muscular wall. It is located near the floor of the pelvic cavity, anterior to the rectum and posterosuperior to the urinary bladder. Although the shape and position of the uterus changes dramatically during pregnancy. The anatomical regions of the uterus include the uppermost dome-shaped portion superior to the entrance of the uterine tubes, called the **fundus of the uterus;** the enlarged main portion, called the **body of the uterus;** and the inferior constricted portion opening into the vagina, called the **cervix of the uterus**.

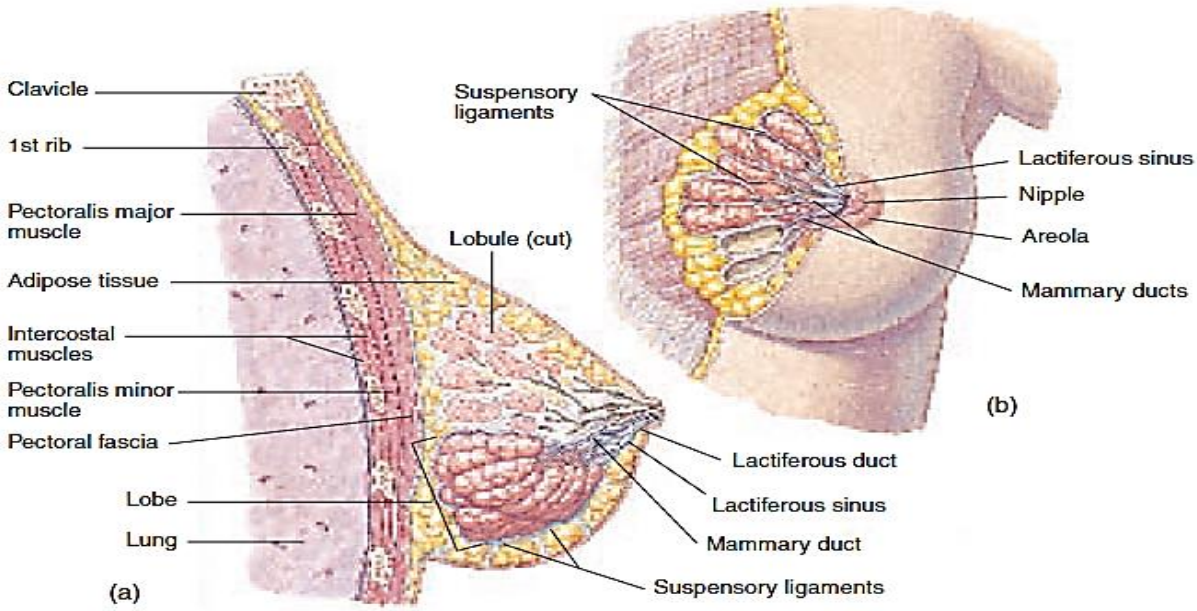


Vagina

The **vagina** is the tubular, fibromuscular organ that receives sperm through the urethra of the erect penis during coitus. It also serves as the birth canal during parturition and provides for the passage of menses to the outside of the body. The exterior opening of the vagina at its lower end called the vaginal orifice. The external genitalia of the female are referred to collectively as the **vulva**.

Mammary glands

Mammary glands are modified sweat glands located in the **breast** which a part of the integumentary system. In function, however, these glands are associated with the reproductive system because they secrete milk for the nourishment of the young. The size and shape of the breasts vary considerably from person to person in accordance with genetic differences, age, percentage of body fat and pregnancy. Each it is positioned over 2 - 6 ribs. Each mammary gland is composed of 15 to 20 **lobes** that is subdivide into **lobules** that contain the glandular **mammary alveoli**. The **nipple** is a cylindrical projection from the breast that contains some erectile tissue. A circular pigmented **areola** surrounds the nipple.


Clavicle
1st rib
Pectoralis major muscle
Adipose tissue
Intercostal muscles
Pectoralis minor muscle
Pectoral fascia
Lobe
Lung
(a)
Lobule (cut)
Suspensory ligaments
Lactiferous duct
Lactiferous sinus
Mammary duct
Suspensory ligaments
Suspensory ligaments
Lactiferous sinus
Nipple
Areola
Mammary ducts
(b)