UNIT-3

Regional Anatomy: - The study of anatomy based on the region or divisions of the body and emphasizing the relations between various structures in that region.

Cardiovascular System (Heart and Blood Vessels)

The cardiovascular system is responsible for **transporting blood, oxygen, nutrients, and waste products** throughout the body.

1. Components

1. **Heart** – the muscular pump.
    - **Location:** In the thoracic cavity, between the lungs, behind the sternum.
    - **Structure:** 4 chambers:
        - Right atrium → receives deoxygenated blood
        - Right ventricle → pumps blood to lungs
        - Left atrium → receives oxygenated blood from lungs
        - Left ventricle → pumps blood to body
    - **Valves:** Ensure unidirectional flow
        - Tricuspid (RA→RV), Pulmonary (RV→Lungs), Mitral (LA→LV), Aortic (LV→Aorta)
    - **Circuits:**
        - Pulmonary circulation → heart ↔ lungs
        - Systemic circulation → heart ↔ rest of the body
2. **Blood Vessels**
    - **Arteries:** carry blood away from the heart (usually oxygenated)
    - **Veins:** carry blood toward the heart (usually deoxygenated)
    - **Capillaries:** small vessels for exchange of oxygen, nutrients, and waste

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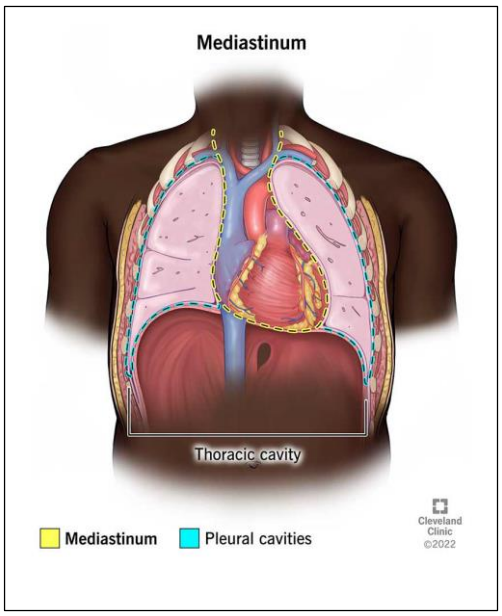
□ Mediastinum

The **mediastinum** is the central compartment of the thoracic cavity, **between the lungs**, containing the heart, great vessels, oesophagus, trachea, thymus, and nerves.

Function of Mediastinum

- Protects and supports vital organs
- Allows movement and expansion of the lungs and heart
- Serves as a conduit for blood vessels, nerves, and airways



Anatomy of the mediastinum

Your mediastinum is located in the middle of your chest between your lungs. Mediastinum means “midway” in Latin. Its boundaries are as follows:

- The superior (upper) border is the root (base) of your neck.

- The inferior (lower) border is your diaphragm. This muscle separates your thoracic cavity from your abdominal cavity.
- The anterior (front) border is your sternum (breastbone).
- The posterior (back) border is your spine.
- The lateral (at each side) borders are the pleural sacs that surround your left lung and right lung.

Component	Location	Function
Heart	Middle of thoracic cavity	Pumps blood through pulmonary & systemic circuits
Arteries	From heart to body	Carry oxygenated blood (except pulmonary arteries)
Veins	To heart	Carry deoxygenated blood (except pulmonary veins)
Capillaries	Throughout tissues	Exchange oxygen, nutrients, waste
Mediastinum	Between lungs, central thorax	Houses heart, vessels, trachea, oesophagus; supports & protects organs

Pericardium - is a double-layered sac that surrounds the heart externally. It is a double-walled sac-like structure; hence, it is also called the pericardial sac.

Pericardium Location: The pericardium is located in the thoracic cavity, behind the sternum, and just ahead of the spine. It externally encloses the heart and the roots of the aorta, the main pulmonary vein, the main pulmonary artery, and the two vena cava.

Pericardium Structure

- The pericardium is mainly made of outer fibrous and elastic connective tissue and inner mesothelial cells.
- Anatomically, the pericardium is divided into two layers, the **fibrous pericardium** and the **serous pericardium**. Its thickness varies from region to region and is usually about 1.5 to 2.0 mm thick.

a. Fibrous Pericardium

It is the relatively inelastic outer tough layer made of connective tissues with collagen and elastin fibers.

This layer provides toughness and structural support to the pericardium. It is connected to the central tendon of the diaphragm.

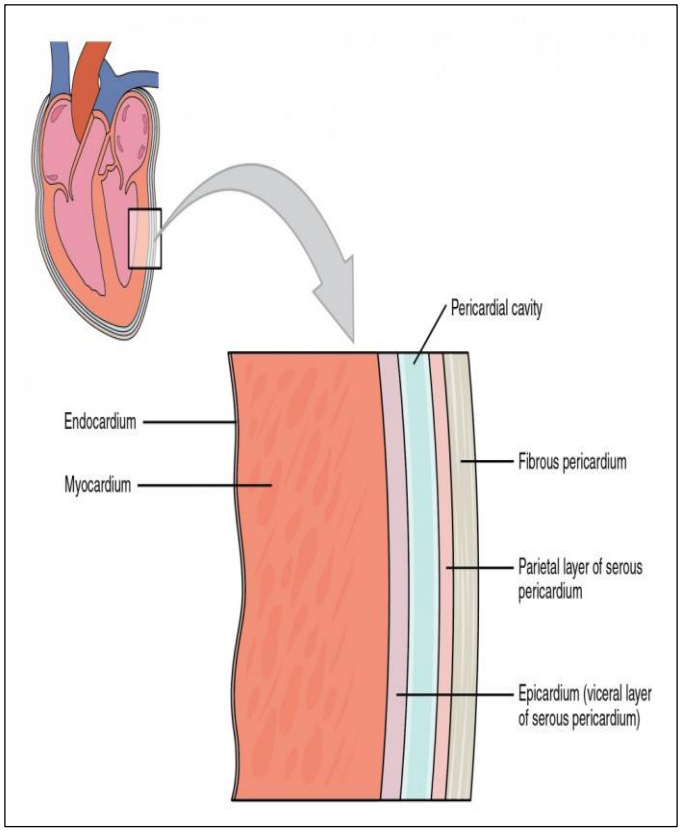
b. Serous Pericardium

Endocardium - The endocardium is the inner lining of the heart wall. It is composed of simple squamous epithelium and loose connective tissue. Provides a smooth lining for efficient blood flow and plays a role in regulating myocardial contractions.

Myocardium - The myocardium forms the bulk of the heart wall and consists of involuntary striated cardiac muscle.
It is the contractile layer responsible for generating force to pump blood throughout the body.

Epicardium -The **epicardium** is the outermost layer of the heart wall and is equivalent to the visceral layer. It is composed of loose connective tissue and fat, and is lined externally by simple squamous epithelial cells (**mesothelium**).Serves as a protective outer covering. Secretes pericardial fluid, which lubricates the heart within the pericardial cavity. Reduces friction during cardiac contractions

It is the inner thin double-layered membrane directly in contact with the heart. It is primarily composed of mesothelial cells with numerous microvilli and cilia.



1. Parietal Serous Pericardium

It is the outer layer of the serous pericardium that lines the fibrous pericardium and marks the outer boundary of the pericardial cavity.

2. Visceral Serous Pericardium

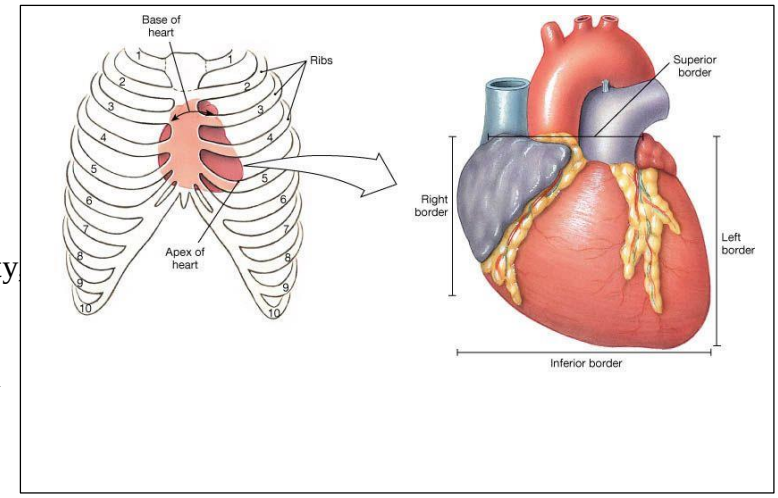
It is the inner thin mesothelial cell monolayer that adheres firmly to the epicardium.

3. Pericardial Cavity

In between the parietal and the visceral layers of the serous pericardium, there is a fluid-filled space called the pericardial cavity. It contains up to 50 mL of serous fluid, called the pericardial fluid.

Functions of the Pericardium

- ✓ Protect the Heart.
- ✓ Provide the heart stability.
- ✓ It limits the hearts motion.
- ✓ Prevent expansion of the heart.



❖ The heart is positioned in the thoracic cavity within mediastinum, behind sternum, between lungs two thirds to the left of the midline and one third to the right. It is roughly cone shaped weighs about 230-350grams.

POSITION OF THE HEART

Location:

- The heart is a muscular, cone-shaped organ located in the thoracic cavity.
- Lies in the mediastinum, between the two lungs.
- It rests on the diaphragm.

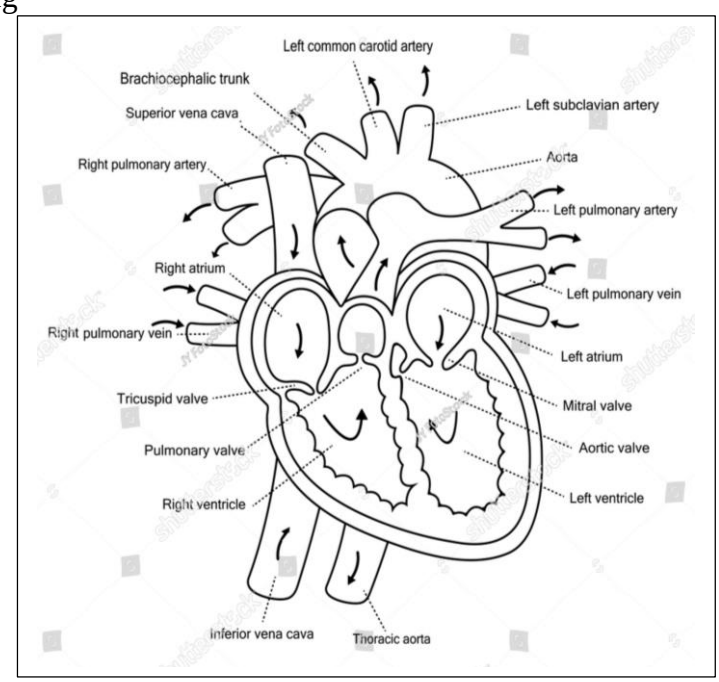
Orientation:

The heart is tilted obliquely:

Base: Directed upwards, backwards, and to the right.
Apex: Directed downwards, forwards, and to the left, lying at the 5th intercostal space, about 9 cm from the midline (can be felt during apex beat).

Relations:

- **Anteriorly (front):** Sternum and costal cartilages.
- **Posteriorly (back):** Esophagus, descending
- aorta, and vertebral column.
- **Laterally:** Lungs (covered by pleura).
- **Inferiorly:** Diaphragm.



SHAPE AND SIZE OF THE HEART
Shape:
The heart is roughly conical (cone-shaped).
It has:
A base (broad, upper part)
An apex (narrow, lower pointed end)

Size and Weight:

- **Adult size:** About the size of a **closed fist**.
- **Weight:**
  - Males ≈ 280–340 g
  - Females ≈ 230–280 g

PARTS OF THE HEART (EXTERNAL & INTERNAL STRUCTURE)

A. External Features

The heart is divided by grooves and sulci into four chambers.
Grooves/Sulci: Coronary sulcus (atrioventricular groove): Encircles the heart and separates the atria from the ventricles.
Anterior interventricular sulcus: Marks the division between the right and left ventricles on the front surface.
Posterior interventricular sulcus: Same division on
the back surface.

Major Blood Vessels Connected:

- Aorta – carries oxygenated blood from the left ventricle to the body.
- Pulmonary artery – carries deoxygenated blood from the right ventricle to the lungs.
- Pulmonary veins – carry oxygenated blood from the lungs to the left atrium.
- Superior and inferior vena cava – bring deoxygenated blood from the body to the right atrium.

B. Internal Structure (Four Chambers)

The heart has four chambers – two atria (upper chambers) and two ventricles (lower chambers).

1. Right Atrium (RA)

Receives deoxygenated blood from Superior vena cava (from upper body), Inferior vena cava (from lower body) and Coronary sinus (from heart wall).
The interatrial septum separates it from the left atrium.

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2. Right Ventricle (RV)

Pumps deoxygenated blood into the pulmonary artery → lungs.
The tricuspid valve guards the opening between right atrium and ventricle.
Papillary muscles connect to valve flaps via chordae tendineae to prevent valve prolapse.
Pulmonary semilunar valve at the exit to pulmonary artery.

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3. Left Atrium (LA)

Receives oxygenated blood from the lungs via four pulmonary veins.
Separated from the right atrium by the interatrial septum.
Connected to the left ventricle via bicuspid (mitral) valve.

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4. Left Ventricle (LV)

Pumps oxygenated blood to the body via the aorta.
Bicuspid (mitral) valve guards the opening from the left atrium.
The wall of the left ventricle is much thicker (≈3x) than the right ventricle (to generate higher pressure).
Aortic semilunar valve at the beginning of the aorta.

VALVES OF THE HEART

Valve	Location	Function
Tricuspid valve	Between right atrium & right ventricle	Prevents backflow into RA
Pulmonary semilunar valve	At the opening of pulmonary artery	Prevents backflow into RV
Bicuspid (Mitral) valve	Between left atrium & left ventricle	Prevents backflow into LA
Aortic semilunar valve	At the opening of aorta	Prevents backflow into LV

CIRCULATION THROUGH THE HEART

Deoxygenated blood → right atrium → tricuspid valve → right ventricle→ pulmonary valve → pulmonary artery → lungs (for oxygenation)Oxygenated blood → pulmonary veins → left atrium → mitral valve → left ventricle→ aortic valve → aorta → body tissues.

WALLS OF THE HEART

Epicardium – Outer layer (visceral pericardium)
Myocardium – Middle muscular layer (thickest, responsible for contraction)
Endocardium – Inner smooth lining (forms valves and chambers)

The **cardiac conduction system** is a collection of nodes and specialised conduction cells that initiate and co-ordinate contraction of the heart muscle. It consists of:

- **Sinoatrial Node**

The sinoatrial (SA) node is a collection of specialised cells (pacemaker cells), and is located in the upper wall of the right atrium, at the junction where the superior vena cava enters.
These pacemaker cells can spontaneously generate electrical impulses. The wave of excitation created by the SA node spreads via gap junctions across both atria, resulting in atrial contraction (atrial systole) – with blood moving from the atria into the ventricles.
The rate at which the SA node generates impulses is influenced by the autonomic nervous system:
Sympathetic nervous system – increases firing rate of the SA node, and thus increases heart rate.
Parasympathetic nervous system – decreases firing rate of the SA node, and thus decreases heart rate.

- **Atrioventricular Node**

After the electrical impulses spread across the atria, they converge at the atrioventricular node – located within the atrioventricular septum, near the opening of the coronary sinus.
The AV node acts to delay the impulses by approximately 120ms, to ensure the atria have enough time to fully eject blood into the ventricles before ventricular systole.
The wave of excitation then passes from the atrioventricular node into the atrioventricular bundle.

- **Atrioventricular Bundle**

The atrioventricular bundle (bundle of His) is a continuation of the specialised tissue of the AV node, and serves to transmit the electrical impulse from the AV node to the Purkinje fibres of the ventricles.
It descends down the membranous part of the interventricular septum, before dividing into two main bundles:
Right bundle branch – conducts the impulse to the Purkinje fibres of the right ventricle
Left bundle branch – conducts the impulse to the Purkinje fibres of the left ventricle.

- **Purkinje Fibres**

The Purkinje fibres (sub-endocardial plexus of conduction cells) are a network of specialised cells. They are abundant with glycogen and have extensive gap junctions.
These cells are located in the subendocardial surface of the ventricular walls, and are able to rapidly transmit cardiac action potentials from the atrioventricular bundle to the myocardium of the ventricles
This rapid conduction allows coordinated ventricular contraction (ventricular systole) and blood is moved from the right and left ventricles to the pulmonary artery and aorta respectively.

The following **sequence of electrical events** occurs during one full contraction of the heart muscle:

- An excitation signal (an action potential) is created by the sinoatrial (SA) node.
- The wave of excitation spreads across the atria, causing them to contract.
- Upon reaching the atrioventricular (AV) node, the signal is delayed.

- It is then conducted into the bundle of His, down the interventricular septum.
- The bundle of His and the Purkinje fibres spread the wave impulses along the ventricles, causing them to contract.

Heart blood supply

- Arteries: The right and left coronary arteries branch from the aorta to supply the heart muscle.
- Right Coronary Artery (RCA): Supplies the right atrium, right ventricle, and the bottom part of the left ventricle.
- Left Coronary Artery (LCA): Divides into the left anterior descending (LAD) artery (supplies the left ventricle and interventricular septum) and the circumflex artery (LCx) (supplies the left atrium and the lateral and posterior walls of the left ventricle).
- Veins: Cardiac veins collect deoxygenated blood and drain into the coronary sinus, which empties into the right atrium.
- Great Cardiac Vein: Collects blood from the left ventricle and joins the coronary sinus.
- Middle Cardiac Vein: Drains the right ventricle and empties into the coronary sinus.
- Small Cardiac Vein: Drains the right ventricle and SA node, also draining into the coronary sinus.
- Anterior Cardiac Veins: Drain the anterior wall of the right ventricle directly into the right atrium.

Heart Nerve Supply

The heart is supplied by both sympathetic and parasympathetic nerves, which are part of the autonomic nervous system and form the cardiac plexus. Sympathetic nerves, primarily from the accelerans nerve, increase heart rate and contractility by releasing norepinephrine, while the parasympathetic nervous system, via the vagus nerve, slows the heart rate by releasing acetylcholine. The heart also has an intrinsic nervous system within its walls that interacts with these external signals.

Parasympathetic innervation

1. Vagus nerve: The parasympathetic supply comes primarily from the vagus nerve, which originates in the medulla oblongata.
2. Neurotransmitter: It releases acetylcholine at the nerve endings.
3. Effect: Acetylcholine acts on muscarinic (M2) receptors in the heart muscle cells to decrease heart rate and contractility.
4. Synapse: Preganglionic fibers synapse with intrinsic ganglia in the heart's epicardium, and postganglionic neurons then directly innervate the myocardium.

Sympathetic innervation

1. Cardiac nerves: Sympathetic fibers travel through cardiac nerves arising from the sympathetic trunk.
2. Neurotransmitter: The primary neurotransmitter released is norepinephrine.
3. Effect: Norepinephrine binds to beta-adrenergic receptors on the heart muscle cells, leading to increased contractility and heart rate by increasing calcium influx.
4. Synapse: Most postganglionic sympathetic fibers directly synapse with the heart muscle cells.

Intrinsic and afferent innervation

- Intrinsic system: The heart has its own intrinsic nerve supply, or intracardiac nervous system, located within its walls. This system integrates with the extrinsic nerves and is important for maintaining adequate cardiac output.
- Afferent fibers: Sensory, or afferent, fibers are also part of the cardiac plexus. They carry information from receptors in the heart to the central nervous system about blood pressure and chemistry. These fibers also transmit pain signals, which can be "referred" to other parts of the body.

Blood vessels are distributed throughout the body via the aorta, which branches to supply arteries to different regions like the head, arms, and legs, while the superior and inferior vena cava collect deoxygenated blood from these regions back to the heart. Major arteries like the carotid and subclavian arteries supply the head, neck, and arms, while the iliac and femoral arteries supply the pelvis and legs. Veins follow a similar distribution, collecting blood from the body and returning it to the heart, such as the superior vena cava from the upper body and the inferior vena cava from the lower body.

Head, Neck, and Arms
Arteries: The carotid and vertebral arteries supply the brain, head, face, and neck. The subclavian arteries provide blood to the head, neck, and arms. The axillary artery continues into the arm as the brachial artery, supplying the upper limb.
Veins: The superior vena cava collects blood from the head, neck, and arms, returning it to the heart.

Trunk (Thorax, Abdomen, and Pelvis)
Arteries: The aorta runs through the chest and abdomen, branching to supply these regions. Specific arteries include the coronary arteries for the heart, and various arteries that branch to supply the abdominal organs and pelvis.
Veins: The inferior vena cava collects blood from the abdomen and pelvis. Veins draining the trunk include the common iliac, internal iliac, lumbar, renal, and hepatic veins.

Legs and Pelvis
Arteries: The iliac arteries supply blood to the pelvis. The femoral artery continues from the iliac artery to supply the legs.
Veins: The inferior vena cava collects blood from the legs and pelvis.

Other vessels
Capillaries: These are the smallest blood vessels and are found in almost every tissue, connecting the arteries and veins. Their thin walls allow for the exchange of gases, nutrients, and waste products between the blood and body tissues.

The **respiratory system's blood supply** is dual, provided by the pulmonary circulation for gas exchange and the bronchial circulation for nourishing the airways. The pulmonary arteries carry deoxygenated blood from the heart to the alveoli for oxygenation, while bronchial arteries supply oxygenated blood to the lung tissue, pleura, and airways. Oxygenated blood returns to the heart via the pulmonary veins.

Pulmonary circulation

- Pulmonary arteries: These arteries carry deoxygenated blood from the right ventricle of the heart to the lungs. They branch into a network of capillaries that surround the alveoli, where gas exchange occurs.
- Pulmonary veins: After gas exchange, the oxygenated blood leaves the lungs through the pulmonary veins, which return it to the left atrium of the heart.

Bronchial circulation

- Bronchial arteries: These arteries branch directly from the aorta and deliver oxygenated blood to the lung tissue itself, including the airways (bronchi and bronchioles), the pleura, and supporting connective tissues.
- Bronchial veins: The venous drainage from the bronchial circulation returns to the systemic circulation, typically draining into the azygos vein on the right and the accessory hemiazygos vein or left superior intercostal vein on the left.

The **respiratory system's nerve supply** comes from the pulmonary plexuses, which are formed by sympathetic and parasympathetic nerves from the vagus nerve and sympathetic trunks, and the phrenic nerves, which control the diaphragm. The phrenic nerves are essential for the physical act of breathing by controlling the diaphragm's contraction, while the pulmonary plexuses regulate the airways, controlling smooth muscle and secretions.

Autonomic (involuntary) control

• Pulmonary plexuses: These nerve networks surround the lungs and branch off to follow the bronchial and vascular pathways.
• Parasympathetic innervation: Branches from the vagus nerve cause bronchoconstriction (narrowing of the airways), stimulate bronchial gland secretion, and cause vasodilation of pulmonary blood vessels.
• Sympathetic innervation: Branches from the sympathetic trunks cause bronchodilation (widening of the airways), vasoconstriction of pulmonary blood vessels, and inhibit alveolar gland secretion.
• Control center: The respiratory center in the brainstem (pons and medulla oblongata) controls the basic rhythm of breathing, receiving input from chemoreceptors and other sensory information. [1]

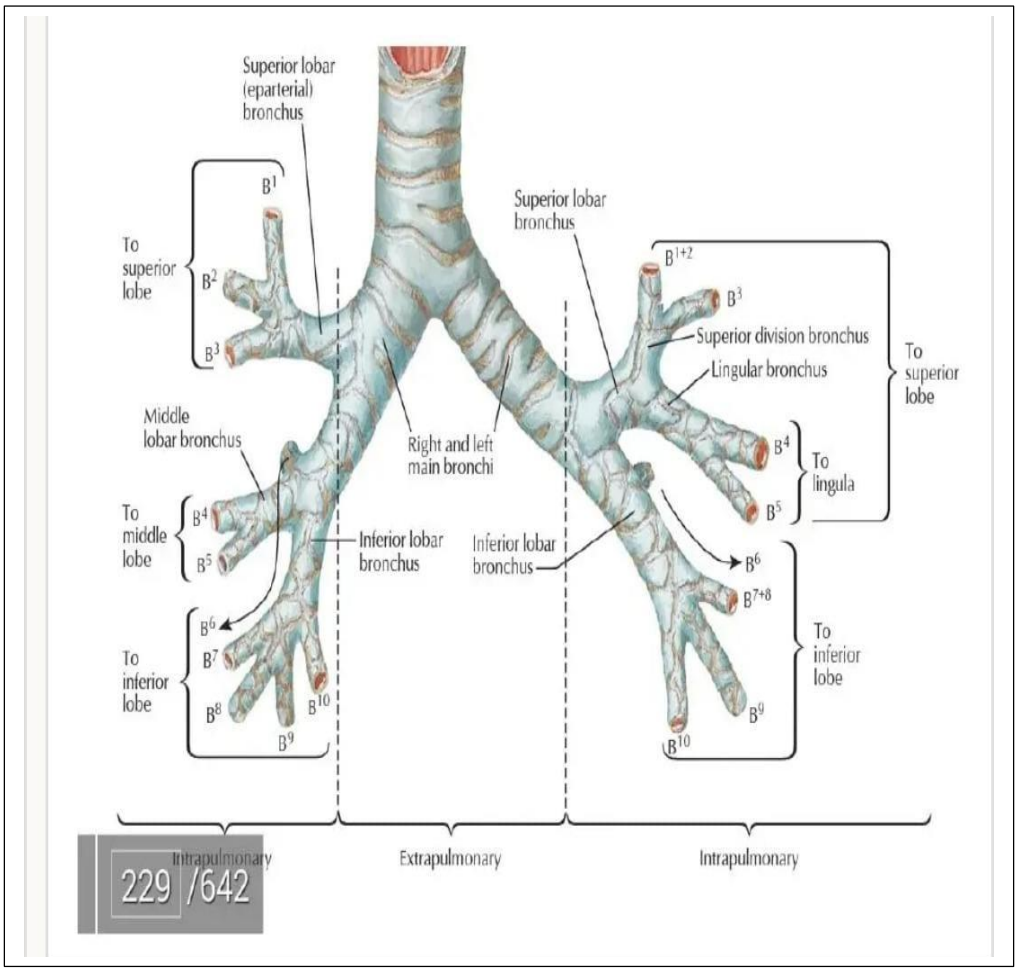
Motor and sensory innervation of the diaphragm

• Phrenic nerves: These are the primary motor nerves to the diaphragm, the main muscle of respiration.
• They send signals that cause the diaphragm to contract and flatten, expanding the chest cavity to allow inhalation.
• They also provide sensory information (touch, pain, etc.) from the diaphragm and surrounding tissues.
• Location: There are two phrenic nerves, a left and a right, which start in the neck and run down through the chest to the diaphragm.

Each of the tertiary bronchi serves a specific bronchopulmonary segment. These segments each have their own artery. Thus, each bronchopulmonary segment is supplied by a segmental bronchus, and two arteries, a pulmonary artery and a bronchial artery which run together through the center of the segment. Veins and lymphatics drain along the edges.

There are 10 bronchopulmonary segments in the right lung (3 in superior lobe, 2 in middle lobe, 5 in inferior lobe) and 9 segments on the left (4 in upper lobe, 5 in lower lobe).

Right lung, superior lobe
Apical segment
Posterior segment
Anterior segment
Right lung, middle lobe
Lateral segment
Medial segment
Right lung, inferior lobe
Superior segment (Fowler)
Medial basal segment
Anterior basal segment
Lateral basal segment
Posterior basal segment
Left lung, superior lobe
Apicoposterior segment
Anterior segment
Superior lingular segment
Inferior lingular segment
Left lung, inferior lobe
Superior segment (Fowler)
Medial basal segment
Anterior basal segment
Lateral basal segment
Posterior basal segment



The **diaphragm's** origin is from the xiphoid process, lower ribs, and lumbar vertebrae; it inserts into the central tendon. Its primary action is respiration, as the phrenic nerves (C3-C5) cause it to contract, increasing the thoracic cavity volume for inhalation. Key openings include the caval opening (for the inferior vena cava), the esophageal hiatus (for the esophagus and vagus nerves), and the aortic opening (for the aorta and thoracic duct).

Origin
• Sternal part: Posterior surface of the xiphoid process
• Costal part: Inner surfaces of the lower six costal cartilages and adjacent parts of the lower sixth ribs
• Lumbar part: Vertebral column via the right and left crura (muscles from the lumbar vertebrae)

Insertion - Central tendon, which is partially fused with the fibrous pericardium

Nerve Supply

• Motor: Phrenic nerves (C3-C5)
• Sensory: Phrenic nerves for the central tendon, and the lower six or seven intercostal nerves for the peripheral parts

Action
• Inhalation: Contracts and flattens, moving inferiorly to increase the vertical diameter of the thoracic cavity, drawing air into the lungs
• Other: Increases abdominal pressure to aid in urination, defecation, and vomiting

Openings in the diaphragm

Caval Opening at vertebra level T8, passing through Inferior vena cava
Esophageal Hiatus at vertebra level T10 passing through Esophagus and vagus nerves
Aortic Opening at vertebra level T12 passing through Aorta and thoracic duct

The external intercostals elevate the ribs for inspiration, originating from the inferior border of the rib above and inserting on the superior border of the rib below, innervated by intercostal nerves. The internal and innermost intercostals depress the ribs for forced expiration, originating from the costal groove of the rib above and inserting on the rib below, and are also innervated by intercostal nerves. Accessory muscles like the sternocleidomastoid and scalenes assist in deep breathing by elevating the ribs.
Intercostal muscles

External Intercostals origins from Inferior border of one rib, insertion from Superior border of the rib below, Intercostal nerves (anterior rami of spinal nerves T1-T11) and Elevates the ribs, increasing thoracic volume during inspiration.
Internal Intercostals oigins from Costal groove of one rib insertion from the Superior border of the rib below, Intercostal nerves, Depresses the ribs, decreasing thoracic volume during forced expiration.

Accessory muscles of respiration

- Sternocleidomastoid origins from Clavicle and sternum insertion from Mastoid process of the temporal bone, Spinal accessory nerve (Cranial Nerve XI), Elevates the sternum and clavicle, especially during deep or forced inspiration.
- Scalene muscles origins from Cervical vertebrae insertion from First two ribs, Branches from the cervical spinal nerves, Elevate the first two ribs, increasing thoracic volume.
- Pectoralis major origins from Humerus insertion from the Clavicle, sternum, and ribs, Brachial plexus nerves, Elevates the ribs and sternum during deep inspiration
- Serratus anterior origins from Ribs 1-8 insertion from Medial border of the scapula, Long thoracic nerve, Fixes the scapula, allowing for labored breathing

The peritoneum is a serous membrane lining the abdominal cavity, with the parietal peritoneum lining the walls and the visceral peritoneum covering the organs. Folds of the peritoneum, such as the mesentery and omentum, support organs and carry blood vessels. The peritoneum's functions include lubricating organs for free movement, supporting

organs in place, providing a pathway for blood and lymphatic vessels, and a role in immune response and fat storage.

• Parietal Peritoneum: The outer layer that lines the inner surface of the abdominal and pelvic walls. It is sensitive to pain, pressure, and temperature.
• Visceral Peritoneum: The inner layer that folds over to cover the surface of most abdominal organs, like the stomach and intestines. It is less sensitive to pain but can detect stretch and chemical irritation.

Folds of the Peritoneum
These are double folds of the peritoneum that suspend organs and help hold them in place:
• Mesentery: Supports the small intestine and provides a passage for blood vessels and nerves.
• Omentum: A fold that hangs from the stomach; the greater omentum drapes over the intestines, while the lesser omentum connects the stomach and liver.
• Ligaments: Connect organs to each other or to the abdominal wall, such as the hepatogastric ligament, which is part of the lesser omentum and connects the liver to the stomach.

Functions of the Peritoneum
• Lubrication: Secretes a serous fluid that reduces friction between moving organs.
• Support: Suspends organs in place via folds like the mesentery.
• Immune Response: The omentum contains immune cells to help fight infection and inflammation.
• Fat Storage: Stores fat for insulation and energy.
• Nutrient Absorption: Plays a role in the absorption of nutrients from the digestive system.

Stomach
Location: Upper left quadrant of the abdomen, below the diaphragm.
Size: Varies significantly depending on contents, with an average capacity of 1.5 liters in adults. Measures approximately 10-12 inches (25-30 cm) long.
Shape: A distensible, J-shaped muscular bag.
Features: Divided into four regions (cardia, fundus, body, and pylorus); the inner lining has folds called rugae that allow it to expand.
Blood Supply: Arterial supply comes from branches of the celiac trunk, including the left gastric, splenic, and common hepatic arteries.
Nerve Supply: Innervated by both sympathetic (celiac plexus) and parasympathetic (vagus nerve) systems.
Functions: Temporary food storage, mechanical breakdown of food, chemical digestion of proteins using stomach acid and enzymes, microbial defense, and production of intrinsic factor for vitamin B12 absorption.

Liver
Location: Upper right quadrant of the abdominal cavity, beneath the diaphragm, and on top of the stomach and intestines.
Size: Largest solid organ in the body, weighing about (1.5 kg) in adults.
Shape: Cone or wedge-shaped and dark reddish-brown.

Features: Consists of four lobes (right, left, caudate, quadrate) and thousands of smaller functional units called lobules.
Blood Supply: Has a dual blood supply: oxygenated blood from the hepatic artery and nutrient-rich blood from the hepatic portal vein.
Nerve Supply: Innervated by the hepatic plexus.
Functions: Metabolism, detoxification of blood, production of proteins for blood clotting, regulation of blood sugar levels, and bile production.

Spleen
Location: Upper left quadrant of the abdomen, posterior to the stomach and inferior to the diaphragm.
Size: Roughly the size of a clenched fist, measuring about 12 cm long and weighing around 150 grams in adults.
Shape: Wedge-shaped, soft, and highly vascular.
Features: Enclosed by a weak fibroelastic capsule. Contains red pulp for filtering blood and white pulp for immune response.
Blood Supply: Primarily supplied by the splenic artery, a branch of the celiac trunk. Venous drainage is via the splenic vein.
Nerve Supply: Innervated by autonomic nerves from the celiac plexus.
Functions: Filters blood, removes old red blood cells, stores platelets, plays a role in immune responses by housing lymphocytes, and, in fetuses, is a site of hematopoiesis.

Pancreas
Location: Lies transversely in the retroperitoneum (behind the stomach) in the upper abdomen, extending from the duodenum on the right to the spleen on the left.
Size: Spongy, lobulated gland about 6 inches (12-15 cm) long.
Shape: Described as a flat pear or a fish extended horizontally.
Features: Divided into a head, neck, body, and tail. It is a mixed gland with both exocrine and endocrine components.
Blood Supply: Receives a rich blood supply from branches of both the celiac artery and the superior mesenteric artery, via the splenic, superior pancreaticoduodenal, and inferior pancreaticoduodenal arteries.
Nerve Supply: Innervated by the celiac plexus.
Functions: Exocrine function involves secreting digestive enzymes into the duodenum; endocrine function involves releasing hormones (insulin, glucagon) into the bloodstream to regulate blood sugar levels.

Kidney
Location: Paired organs located in the retroperitoneal space, just below the rib cage on either side of the spine (T12 to L3 vertebrae).
Size: Approximately the size of a fist, measuring about 10-12 cm in length.
Shape: Bean-shaped with a convex lateral border and a concave medial border.
Features: Covered by a tough fibrous capsule. Internally, it has an outer cortex and an inner medulla containing millions of functional units called nephrons.
Blood Supply: Highly vascular, receiving blood from the renal artery (a direct branch of the aorta).
Nerve Supply: Innervated by the renal plexus.

Functions: Filters blood to remove waste products and excess water to produce urine, regulates electrolyte and acid-base balance, controls blood pressure, and produces hormones like erythropoietin and calcitriol.

Urinary Bladder
Location: Located in the pelvis, behind the pubic bone. It lies in the extraperitoneal space.
Size: A normal adult bladder can store up to 500-600 mL of urine.
Shape: Triangle-shaped when empty, becoming oval/spherical as it fills.
Features: A hollow, muscular organ with a lining of transitional epithelium that allows it to stretch. It has a fundus, body, apex, and neck region.
Blood Supply: Arterial supply comes from branches of the anterior trunk of the internal iliac arteries, primarily the superior and inferior vesical arteries.
Nerve Supply: Innervated by nerves from the hypogastric and pelvic plexuses, which alert a person when it's time to urinate.
Functions: A temporary reservoir for storing urine before it is expelled from the body through the urethra.

Small Intestine
Location: Extends from the stomach to the large intestine, filling much of the central and lower abdominal cavity.
Size: A long, coiled tube averaging 6 to 7 meters (about 20 feet) in length.
Shape: Tubular structure divided into three parts: duodenum, jejunum, and ileum.
Blood Supply: Supplied by the superior mesenteric artery (SMA) and its branches.
Nerve Supply: Extrinsic innervation from the vagus nerve (parasympathetic) and thoracic splanchnic nerves (sympathetic).
Functions: Primary site for chemical digestion and absorption of nutrients, water, and vitamins into the bloodstream.

Large Instestine
Location: Loops around the small intestine, from the right hip area, across the abdomen, and down the left side to the rectum/anus.
Size: Shorter than the small intestine, about 1 to 1.5 meters (5-6 feet) long, but larger in diameter (about 3 inches).
Shape: Characterized by the teniae coli (muscle bands) and haustra (pouches), giving it a segmented appearance.
Blood Supply: Supplied by the superior mesenteric artery (SMA) and the inferior mesenteric artery (IMA) and their branches.
Nerve Supply: Innervated by sympathetic and parasympathetic nerves via the mesenteric plexuses.
Functions: Absorbs remaining water and electrolytes, converts indigestible food matter into feces, and stores waste until elimination.

Gallbladder
Location: Nestled in a shallow fossa on the inferior surface of the right lobe of the liver in the upper right abdomen.
Size: Small, pear-shaped organ typically 3-4 inches (7-10 cm) long, with a capacity of 30-50 mL of bile.

Shape: Pear-shaped (piriform).
Features: Connected to the common hepatic duct by the cystic duct. Its wall contains a muscular layer for contraction and a mucosal lining with folds that allow for expansion and concentration of bile.
Blood Supply: The main arterial supply is the cystic artery, which is usually a branch of the right hepatic artery.
Nerve Supply: Receives parasympathetic nerve supply from the right vagus nerve and sympathetic supply from the celiac plexus (T7-T9 segments).
Functions: Stores and concentrates bile produced by the liver, releasing it into the small intestine to aid in the digestion and absorption of fats.

The male and female pelvis have different shapes, sizes, and features to accommodate their reproductive roles: the female pelvis is wider, shallower, and more rounded to allow for childbirth, while the male pelvis is narrower, taller, and heart-shaped. Both are supplied by the internal iliac arteries, but the female pelvis also receives blood from the ovarian and uterine arteries, which are crucial for the uterus, while the male pelvis lacks this direct blood supply for reproductive organs. Both are innervated by the sacral and pudendal plexuses, but the female reproductive organs receive additional innervation via the hypogastric plexuses.
Position: The pelvis is a bowl-shaped structure that connects the spine to the legs, situated below the abdominal cavity.
Shape: The female pelvis is adapted for childbirth and is generally wider, shallower, and more rounded than the male pelvis, which is taller, narrower, and more compact.
Size
Female: Wider and larger overall, with a wider subpubic angle (pubic arch), a larger pelvic inlet, and a wider pelvic outlet.
Male: Taller, narrower, and more compact, with a smaller pelvic inlet and a narrower pelvic outlet.
Blood Supply
Female: The internal iliac arteries are a major source of blood supply, along with the ovarian and uterine arteries, which are crucial for supplying the uterus, ovaries, and fallopian tubes.
Male: The major source of blood supply is the internal iliac arteries; however, the testicular arteries do not enter the lesser pelvis.
Nerve Supply
Both: The pelvic region is innervated by nerves from the sacral plexus and the pudendal nerve, which arise from the sacral and coccygeal plexuses.
Female: In addition to the sacral and pudendal nerves, female reproductive organs receive autonomic innervation from sympathetic fibers that exit at the T10–L2 levels to form the superior hypogastric plexus, which then divides to form the right and left hypogastric nerves. Parasympathetic fibers from the S2–S4 levels also contribute to the inferior hypogastric plexus.
Male: The male pelvic reproductive organs also have sympathetic innervation, which originates from the T10–L2 levels and forms the hypogastric plexuses

Hypothalamus and Pituitary Gland
Position: The hypothalamus is in the lower central part of the brain; the pituitary is a small, pea-sized gland at the base of the brain, connected by a stalk (infundibulum).

Shape/Size: Hypothalamus is a region of the brain. Pituitary is pea-sized.
Function:
Hypothalamus: Links the nervous and endocrine systems, producing hormones (e.g., TRH, GnRH, oxytocin, ADH) that control the pituitary gland.
Pituitary: Often called the "master gland" as it secretes multiple hormones (GH, TSH, ACTH, FSH, LH, prolactin, ADH, oxytocin) that regulate other endocrine glands and body functions.
Blood Supply: Supplied by branches of the internal carotid arteries, primarily the superior and inferior hypophyseal arteries, forming a complex hypophyseal portal system connecting the hypothalamus and anterior pituitary.
Nerve Supply:
Anterior pituitary: Primarily connected to the hypothalamus by the hypophyseal portal blood system, not direct nerve supply for hormone release regulation.
Posterior pituitary: Directly connected via the hypothalamohypophyseal nerve tract, an extension of hypothalamic neurons.

Thyroid Glands
Position: Located in the anterior lower part of the neck, below the larynx, surrounding the trachea.
Shape/Size: Butterfly-shaped, consisting of two lobes connected by a narrow isthmus. Each lobe is about 5 cm long, 3 cm wide, and 2 cm thick in adults.
Function: Produces thyroid hormones (T3 and T4) which regulate metabolism, growth, and development, and calcitonin, which helps regulate blood calcium levels.
Blood Supply: Highly vascularized, supplied by the superior thyroid artery (branch of the external carotid artery) and the inferior thyroid artery (branch of the thyrocervical trunk).
Nerve Supply: Autonomic nervous system innervation (parasympathetic from the vagus nerve, sympathetic from cervical ganglia) modulates blood flow, but does not control hormone production, which is hormonally regulated.

Parathyroid Glands
Position: Usually four small glands located on the posterior surface of the thyroid gland, within its capsule.
Shape/Size: Small, typically pea-sized (though variable); superior glands are more constant in position, inferior ones vary.
Function: Secrete parathyroid hormone (PTH) in response to low blood calcium levels to increase serum calcium (by affecting bones, kidneys, and intestines).
Blood Supply: Primarily from branches of the inferior thyroid artery, though supply can be variable, including contributions from the superior thyroid artery.
Nerve Supply: Supplied by thyroid branches of the cervical sympathetic ganglia; nerves are believed to be vasomotor (regulating blood flow), not secretomotor.

Adrenal Glands
Position: Paired glands located in the abdomen, on the superior poles of each kidney.
Shape/Size: The right is pyramidal, the left is semilunar or crescent-shaped. Each gland weighs about 5 grams in adults.
Function:
Cortex: Produces steroid hormones: mineralocorticoids (aldosterone for salt/water balance), glucocorticoids (cortisol for metabolism and immune response), and androgens.

Medulla: Produces catecholamines (epinephrine and norepinephrine) for the "fight-or-flight" response.
Blood Supply: Rich blood supply from three sources: the superior adrenal arteries (from the inferior phrenic artery), the middle adrenal artery (from the abdominal aorta), and the inferior adrenal artery (from the renal artery).
Nerve Supply: Innervated by the celiac plexus and greater splanchnic nerves; preganglionic sympathetic fibers synapse directly onto the medullary chromaffin cells to stimulate hormone release.

Pancreatic Islets (Islets of Langerhans)
Position: Located within the pancreas, an organ situated posterior to the stomach in the upper abdomen.
Shape/Size: Small clusters of endocrine cells scattered throughout the exocrine pancreatic tissue; they make up only 1-2% of the total pancreas mass.
Function: Secrete hormones directly into the bloodstream: insulin (lowers blood glucose) and glucagon (raises blood glucose) to regulate blood sugar.
Blood Supply:
Arterial Supply: Via branches of the splenic artery, superior mesenteric artery, and common hepatic artery, which supply the whole pancreas.
Venous Drainage: Veins drain into the hepatic portal vein, allowing hormones like insulin and glucagon to go directly to the liver.
Nerve Supply: Innervated by both sympathetic and parasympathetic divisions of the autonomic nervous system via the celiac plexus.

Ovaries and Testes
Position:
Ovaries**:** Located in the female pelvis, on either side of the uterus.
Testes: Located in the male scrotum.
Shape/Size: Ovaries are oval-shaped, typically about 3-5 cm long. Testes are oval-shaped, about 4-5 cm long.
Function:
Ovaries: Produce eggs (ova) and female sex hormones (estrogen and progesterone).
Testes: Produce sperm and male sex hormones (testosterone).
Blood Supply:
Ovaries/Testes: Supplied by the gonadal arteries (ovarian/testicular arteries), which branch directly from the abdominal aorta.
Nerve Supply: Innervation comes from the ovarian/testicular plexuses, with both sympathetic and parasympathetic fibers.

Pineal Glands
Position: A tiny gland in the brain, beneath the back part of the corpus callosum, superior to the cerebellum.
Shape/Size: Small, pinecone-shaped; typically 5-8 mm long.
Function: Produces and releases melatonin, which regulates the body's sleep-wake cycles (circadian rhythm).
Blood Supply: Has a very rich blood supply, primarily from the posterior cerebral artery's choroidal branches.

Nerve Supply: Innervation is mainly sympathetic from the superior cervical ganglia, with some parasympathetic input.

Thymus
Position: Located in the upper part of the chest (thorax), behind the sternum and between the lungs.
Shape/Size: Bilobed organ; relatively large in infants and children, but shrinks (atrophies) significantly after puberty.
Function: Essential for the development and maturation of T-lymphocytes (a type of white blood cell) which are crucial for the immune system.
Blood Supply: Primarily supplied by branches of the internal thoracic arteries, and also branches from the inferior thyroid and intercostal arteries.
Nerve Supply: Branches from the vagus nerve and the sympathetic trunks.