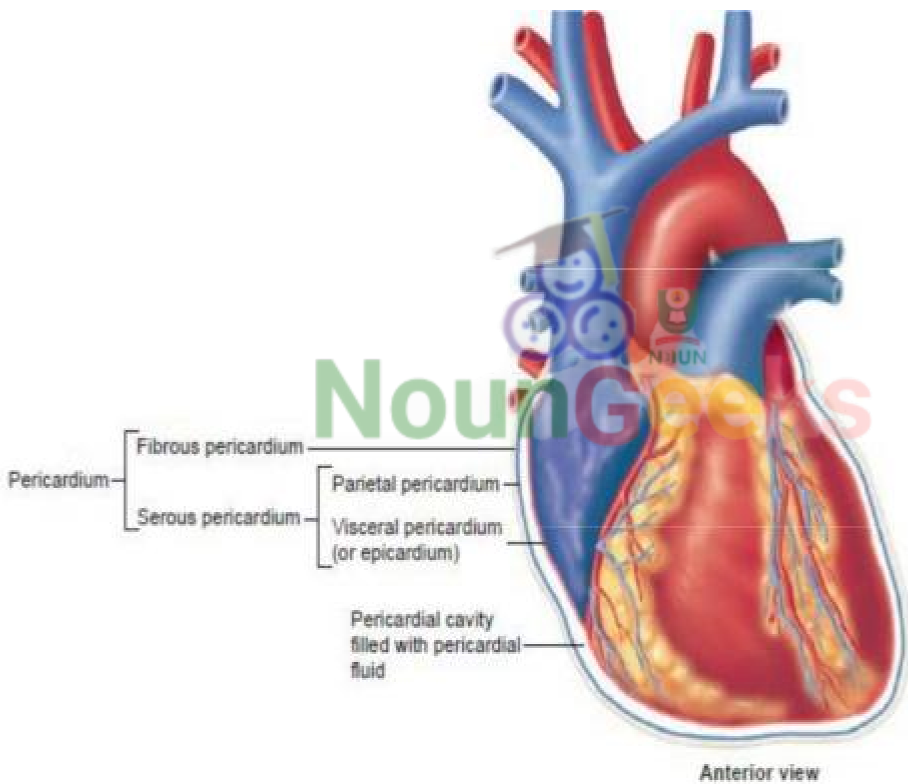
The Pericardium

The pericardium is a protective sheath that encloses the heart, it has two parts: the fibrous pericardium and the serous pericardium.



Fibrous pericardium

The pericardium has an outer single-layered fibrous sac that encloses the heart and the roots of the great vessels, fusing with the adventitia of these vessels. Its broad base overlies the central tendon of the diaphragm, with which it is inseparably blended, both being derived from the septum transversum.

Serous pericardium

A serous layer lines the inside of the fibrous pericardium, where it is reflected around the roots of the great vessels to cover the entire surface of the heart, where it forms the **epicardium**.

Between these parietal and visceral layers there are two sinuses: the transverse sinus and the oblique sinus of the pericardium.

Nerve supply

The fibrous pericardium is supplied by the phrenic nerve. The parietal layer of serous pericardium that lines it is similarly innervated, but the visceral layer on the heart surface is insensitive. Pain from the heart (angina) originates in the muscle or the vessels and is transmitted by sympathetic nerves. The pain of pericarditis originates in the parietal layer only, and is transmitted by the phrenic nerve.

Pericardial drainage

A needle inserted in the angle between the xiphoid process and the left seventh costal cartilage and directed upwards at an angle of 45, towards the left shoulder, passes through the central tendon of the diaphragm into the pericardial cavity. The creation of a small pericardial window surgically through the same route, or through the anterior end of the fourth intercostal space, provides more effective drainage.

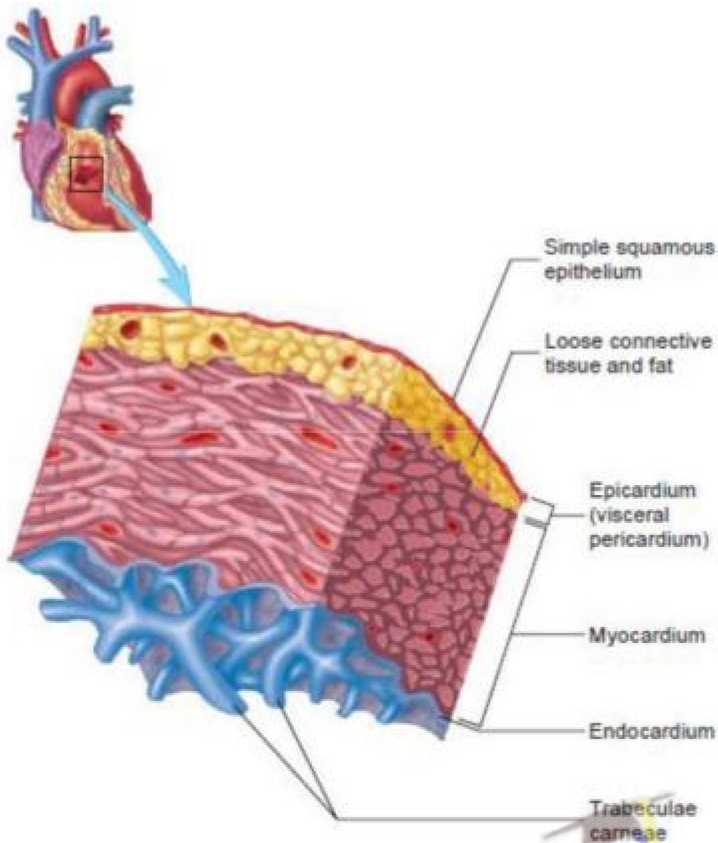
Gross anatomy of the heart

The heart, slightly larger than a clenched fist, is a double, self-adjusting suction and pressure pump, the parts of which work in unison to propel blood to all parts of the body. The right side of the heart (right heart) receives poorly oxygenated (venous) blood from the body through the SVC and IVC and pumps it through the pulmonary trunk and arteries to the lungs for oxygenation. The left side of the heart (left heart) receives well-oxygenated (arterial) blood from the lungs through the pulmonary veins and pumps it into the aorta for distribution to the body.

Chambers of the heart

The heart has **four chambers**: right and left atria and right and left ventricles. The atria are receiving chambers that pump blood into the ventricles (the discharging chambers). The synchronous pumping actions of the heart's two atrioventricular (AV) pumps (right and left chambers) constitute the cardiac cycle. The cycle begins with a period of ventricular elongation and filling (diastole) and ends with a period of ventricular shortening and emptying (systole).

Two heart sounds are heard with a stethoscope: a lub (1st) sound as the blood is transferred from the atria into the ventricles and a dub (2nd) sound as the ventricles expel blood from the heart. The heart sounds are produced by the snapping shut of the one-way valves that normally keep blood from flowing backward during contractions of the heart.

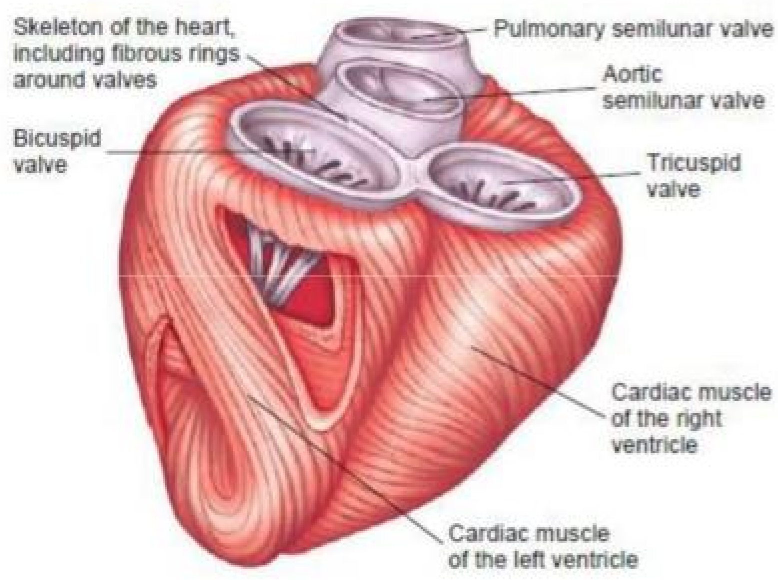


Wall of the heart

Contraction of the heart

The walls of the heart consist mostly of myocardium, especially in the ventricles. When the ventricles contract, they produce a wringing motion because of the double helical orientation of the cardiac muscle fibers. This motion initially ejects the blood from the ventricles as the outer (basal) spiral contracts, first narrowing and then shortening the heart, reducing the volume of the ventricular chambers. Continued sequential contraction of the inner (apical) spiral elongates the heart, followed by widening as the myocardium briefly relaxes, increasing the volume of the chambers to draw blood from the atria.

The muscle fibers are anchored to the fibrous skeleton of the heart. This is a complex framework of dense collagen forming four fibrous rings (L. anulifibrosi) that surround the orifices of the valves, a right and left fibrous trigone (formed by connections between rings), and the membranous parts of the interatrial and interventricular septa.



Demarcations

Externally, the atria are demarcated from the ventricles by the coronary sulcus (atrioventricular groove), and the right and left ventricles are demarcated from each other by anterior and posterior interventricular (IV) sulci (grooves). The heart appears trapezoidal from an anterior or posterior view, but in three dimensions it is shaped like a tipped-over pyramid with its apex (directed anteriorly and to the left), a base (opposite the apex, facing mostly posteriorly), and four sides.

The apex of the heart:

- Is formed by the inferolateral part of the left ventricle.
- Lies posterior to the left 5th intercostal space in adults, usually approximately 9 cm (a hand's breadth) from the median plane.
- Remains motionless throughout the cardiac cycle.
- Is where the sounds of mitral valve closure are maximal (apex beat); the apex underlies the site where the heartbeat may be auscultated on the thoracic wall.

The base of the heart:

- Is the heart's posterior aspect (opposite the apex).
- Is formed mainly by the left atrium, with a lesser contribution by the right atrium.

- Faces posteriorly toward the bodies of vertebrae T6-T9 and is separated from them by the pericardium, oblique pericardial sinus, esophagus, and aorta.
- Extends superiorly to the bifurcation of the pulmonary trunk and inferiorly to the coronary sulcus.

- Receives the pulmonary veins on the right and left sides of its left atrial portion and the superior and inferior venae cavae at the superior and inferior ends of its right atrial portion.

The four surfaces of the heart are the:

- Anterior (sternocostal) surface, formed mainly by the right ventricle.
- Diaphragmatic (inferior) surface, formed mainly by the left ventricle and partly by the right ventricle; it is related mainly to the central tendon of the diaphragm.
- Right pulmonary surface, formed mainly by the right atrium.
- Left pulmonary surface, formed mainly by the left ventricle; it forms the cardiac impression in the left lung.

The heart appears trapezoidal in both anterior and posterior views.

The four borders of the heart are the:

- Right border (slightly convex), formed by the right atrium and extending between the SVC and the IVC.

- Inferior border (nearly horizontal), formed mainly by the right ventricle and slightly by the left ventricle.

- Left border (oblique, nearly vertical), formed mainly by the left ventricle and slightly by the left auricle.

- Superior border formed by the right and left atria and auricles in an anterior view; the ascending aorta and pulmonary trunk emerge from this border and the SVC enters its right side. Posterior to the aorta and pulmonary trunk and anterior to the SVC, this border forms the inferior boundary of the transverse pericardial sinus.

- The pulmonary trunk, approximately 5 cm long and 3 cm wide, is the arterial continuation of the right ventricle and divides into right and left pulmonary arteries. The pulmonary trunk and arteries conduct low-oxygen blood to the lungs for oxygenation.

Vasculature of heart

The blood vessels of the heart comprise the coronary arteries and cardiac veins, which carry blood to and from most of the myocardium. The endocardium and some subendocardial tissue located immediately external to the endocardium receive oxygen and nutrients by diffusion or microvasculature directly from the chambers of the heart. The blood vessels of the heart, normally embedded in fat, course across the surface of the heart just deep to the epicardium. Occasionally, parts of the vessels become embedded within the myocardium. The blood vessels of the heart are affected by both sympathetic and parasympathetic innervation.

Arterial supply of heart.

The coronary arteries, the first branches of the aorta, supply the myocardium and epicardium. The right and left coronary arteries arise from the corresponding aortic sinuses at the proximal part of the ascending aorta, just superior to the aortic valve, and pass around opposite sides of the pulmonary trunk.

Venous drainage of the heart

The heart is drained mainly by veins that empty into the coronary sinus and partly by small veins that empty into the right atrium. The coronary sinus, the main vein of the heart, is a wide venous channel that runs from left to right in the posterior part of the coronary sulcus. The coronary sinus receives the great cardiac vein at its left end and the middle cardiac vein and small cardiac veins at its right end. The left posterior ventricular vein and left marginal vein also open into the coronary sinus.

Lymphatic drainage of the heart.

Lymphatic vessels in the myocardium and subendocardial connective tissue pass to the subepicardial lymphatic plexus. Vessels from this plexus pass to the coronary sulcus and follow the coronary arteries. A single lymphatic vessel, formed by the union of various lymphatic vessels from the heart, ascends between the pulmonary trunk and left atrium and ends in the inferior tracheobronchial lymph nodes, usually on the right side.

Innervation of the heart.

The heart is supplied by autonomic nerve fibers from the cardiac plexus, which is often quite artificially divided into superficial and deep portions. This nerve network is most commonly described as lying on the anterior surface of the bifurcation of the trachea (a respiratory structure), since it is most commonly observed in dissection after removal of the ascending aorta and the bifurcation of the pulmonary trunk. However, its primary relationship is to the posterior aspect of the latter two structures, especially the ascending aorta.

Functions of blood

The total blood volume in the average adult is about 4–5 L in females and 5–6 L in males. Blood makes up about 8% of the total weight of the body. An average-sized adult contains approximately5 litres of blood. However, blood volume varies from person to person depending on the person‘s size, the amount of adipo se tissue, and the concentrations of certain ions in the blood.

The heart pumps blood through blood vessels, which extend throughout the body. Blood helps maintain homeostasis in several ways:

Transport of gases, nutrients, and waste products. Oxygen enters blood in the lungs and is carried to cells. Carbon dioxide, produced by cells, is carried in the blood to the lungs, from which it is expelled. Th e blood transports ingested nutrients, ions, and water from the digestive tract to cells, and the blood transports the waste products of cells to the kidneys for elimination.

Transport of processed molecules. Many substances are produced in one part of the body and transported in the blood to another part, where they are modified. For example, the precursor to vitamin D is produced in the skin (see chapter 5) and transported by the blood to the liver and then to the kidneys for processing into active vitamin D. Active vitamin D is transported in the blood to the small intestines, where it promotes the uptake of calcium.

Composition of blood

Blood is a type of connective tissue consisting of cells and cell fragments surrounded by a liquid matrix. The cells and cell fragments are the **formed elements,** and the liquid is the **plasma**.

The formed elements make up about 45%, and plasma makes up about 55% of the total blood volume.

The percentage of red blood cells in a sample of blood is referred to as **hematocrit.** A healthy person normally has a hematocrit level of about 45%. Most of the cells are red blood cells, and only about 1% are white blood cells and platelets. The rest of blood (approximately 55%) is plasma.

Plasma

Plasma is a pale yellow fluid that consists of about 91% water; 7% proteins; and 2% other substances, such as ions, nutrients, gases, and waste products. Plasma proteins include albumin, globulins, and fibrinogen. **Albumin** makes up 58% of the plasma proteins. Although the osmotic pressure of blood results primarily from sodium chloride, albumin makes an important contribution. The water balance between blood and tissues is determined by the movement of water into and out of the blood by osmosis. **Globulins** account for 38% of the plasma proteins. Some globulins, such as antibodies and complement, are part of the immune system.

Other globulins and albumin function as transport molecules because they bind to molecules, such as hormones, and carry them in the blood throughout the body. Some globulins are clotting factors, which are necessary for the formation of blood clots. **Fibrinogen** is a clotting factor that constitutes 4% of plasma proteins. Activation of clotting factors results in the conversion of fibrinogen into **fibrin**, a threadlike protein that forms blood clots.

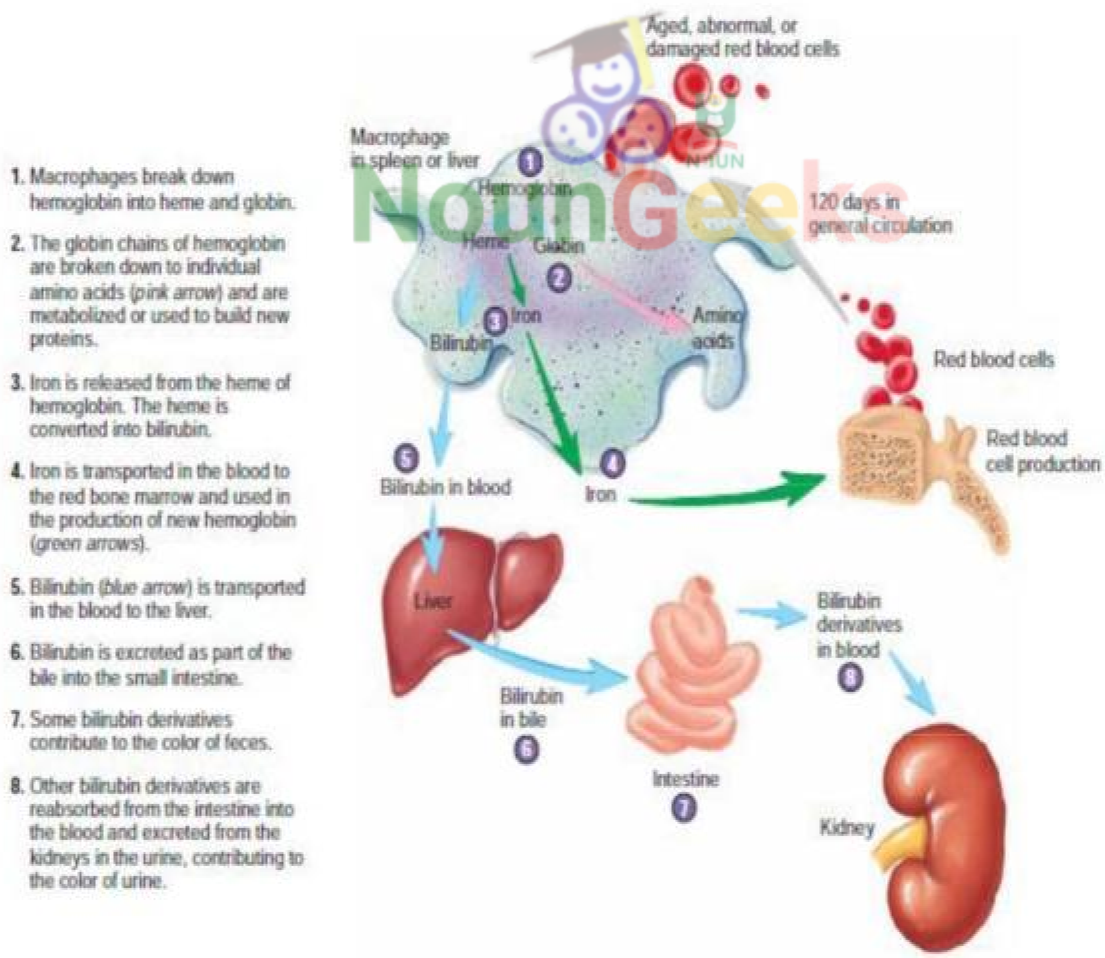
Serum is plasma without the clotting factors. Nutrients in plasma include amino acids, glucose, nucleotides, and lipids that have all been absorbed from the digestive tract. Because lipids are not water soluble and because plasma is mostly water, lipids must combine with molecules called **lipoproteins** to be transported. The different types of lipoproteins are **chylomicrons,** very low density lipoproteins (VLDL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL).

Red Blood Cells

Red blood cells, called **erythrocytes,** are biconcave-shaped cells that are small enough to pass through capillaries. Mature red blood cells do not contain nuclei because they must lose their nuclei in order to make room for a pigment called hemoglobin. Hemoglobin's function is to carry oxygen. Hemoglobin that carries oxygen is called **oxyhemoglobin** and is bright red in colour; hemoglobin carries carbodioxide is called **deoxyhemoglobin** and has a darker red color.

A red blood cell count is the number of red blood cells in one cubic millimeter of blood (a cubic millimeter of blood is roughly 20 drops of blood). This count is normally between 4 million and 6.5 million red blood cells. Because the function of a red blood cell is to transport oxygen throughout the body, low count reflects a decreased ability to carry oxygen. This condition is known as **anaemia.**

When red blood cells age, macrophages in the liver and spleen destroy them. When a red blood cell is destroyed, a pigment called **biliverdin** is released from the cell. The liver usually converts biliverdin into an orange-colored pigment called **bilirubin.**



Bilirubin is used to make bile, which is needed for the digestion of fats. However, sometimes bilirubin is not used to make bile; instead, it persists in the bloodstream. This causes a person‘s skin to appear yellowish, which is a condition known as **jaundice.**

During development, red blood cells are made in the fetal yolk sac, the liver, and the spleen. However, once a baby is born, most red blood cells are produced in red bone marrow by cells called **hemocytoblasts.** The average life span of a red blood cell is only about 120 days, so red bone marrow is constantly making new cells.

Leukocytes (white blood cells)

The leukocytes, also called white blood cells, are the mobile units of the body‘s protective system. They are formed partially in the bone marrow (granulocytes and monocytes and a few lymphocytes) and partially in the lymph tissue (lymphocytes and plasma cells). After formation, they are transported in the blood to different parts of the body where they are needed. The real value of the white blood cells is that most of them are specifically transported to areas of serious infection and inflammation, thereby providing a rapid and potent defense against infectious agents. As we see later, the granulocytes and monocytes have a special ability to "seek out and destroy" a foreign invader.

White blood cells, which are called **leukocytes,** are divided into two categories: granulocytes and agranulocytes. **Granulocytes** have granules in their cytoplasm and include neutrophils, eosinophils, and basophils. **Agranulocytes** do not have granules in their cytoplasm and include monocytes and lymphocytes.

Vascular Spasm

Vascular spasm is an immediate but temporary constriction of a blood vessel resulting from a contraction of smooth muscle within the wall of the vessel. This constriction can close small vessels completely and stop the flow of blood through them. Damage to blood vessels can activate nervous system reflexes that cause vascular spasms.

Platelet Plugs

A **platelet plug** is an accumulation of platelets that can seal up a smallbreak in a blood vessel. Platelet plug formation is very important in maintaining the integrity of the circulatory system because small tears occur in the smaller vessels and capillaries many times each day, and platelet plug formation quickly closes them.

Functions of the lymphatic system

The lymphatic system represents an accessory route through which fluid can flow from the interstitial spaces into the blood. Most important, the lymphatics can carry proteins and large particulate matter away from the tissue spaces, neither of which can be removed by absorption directly into the blood capillaries. This return of proteins to the blood from the interstitial spaces is an essential function without which we would die within about 24 hours.

Anatomy of the diaphragm

Diaphragm is a muscular and tendinous sheath that closes the opening between thorax and abdomen and is pierced by structures that pass between these two regions of the body.

Origin of diaphragm:

The origin of the diaphragm can be divided into three parts.

Sternal part: It consists of small left and right strips that arise from the posterior surface of the xiphoid process.

Costal part: It consists of six slips that arise from the lower six ribs (rib 7 to rib 12) and their costal cartilages.

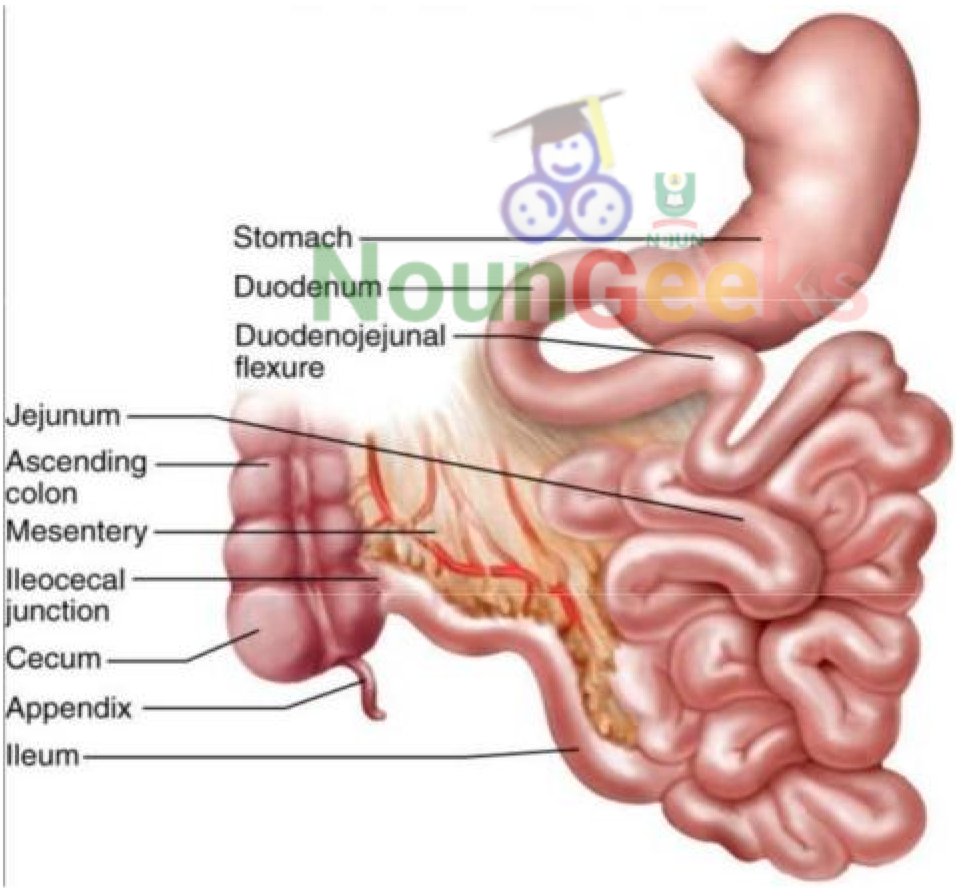
Vertebral part: It arises by means of vertical columns, also known as crura, and from the arcuate ligaments.

Crura**:** The right crus arises from the bodies of first three lumbar vertebrae and their intervertebral discs. The left crus, on the other hand, arises from the bodies of first two lumbar vertebrae.

The gross anatomy of the small intestine

The small intestine is a convoluted tube, extending from the pylorus to the colic valve, where it ends in the large intestine. It is contained in the central and lower part of the abdominal cavity, and is surrounded above and at the sides by the large intestine; a portion of it extends below the superior aperture of the pelvis and lies in front of the rectum. It is in relation, in front, with the greater omentum and abdominal parietes, and is connected to the vertebral column by a fold of peritoneum, the mesentery.

The small intestine is divisible into three portions: the duodenum, the jejunum, and the ileum.



The nerve supply to the small intestine

The nerves -of the small intestines are derived from the plexuses of **sympathetic nerves** around the superior mesenteric artery. From this source they run to the **myenteric plexus** (Auerbach's plexus) of nerves and gangliasituated between the circular and longitudinal muscular fibers from which the nervous branches are distributed to the muscular coats of the intestine.

From this a secondary plexus, the plexus of the **submucosa** (Meissner's plexus) is derived, and is formed by branches which have perforated the circular muscular fibers. This plexus lies in the submucous coat of the intestine; it also contains ganglia from which nerve fibers pass to the muscularis mucosæ and to the mucous membrane. T he nerve bundles of the submucous plexus are finer than those of the myenteric plexus.