



Case 1 Trigger 1: Shape of My Heart

Block 4 Module 2

EMBRYOLOGY OF THE HEART AND BLOOD VESSELS

- The cardiovascular system is the first major system to function in the embryo.
- The primordial heart and vascular system appears in the middle of the third week
- The CVS is derived mainly from:
 - Splanchnic mesoderm which forms the primordium of the heart
 - Paraxial and lateral mesoderm near the otic placodes from which the internal ears develop
 - Neural crest cells from the region between the otic vesicles and the caudal limits of the third pair of somites
- These sources will produce respectively:
 - The endocardium and the cardiac mesenchymal cells which produce the valvular tissue of the heart
 - The myocardium, including the conducting tissue of the heart, and the specific matrix proteins associated with the developing heart, i.e. the cardiac jelly
 - The aorticopulmonary septum and the media of the great vessels, and, possibly contributes to the conducting tissue of the heart.
- The heart begins to beat at 22 - 23 days
- Blood flow begins during the fourth week and can be visualized by Doppler ultrasonography.
- Three paired veins drain into the tubular heart of a 4-week-old embryo:
 - Vitelline veins**
 - return poorly oxygenated blood from the yolk sac;
 - Umbilical veins**
 - carry well-oxygenated blood from the chorionic villi of the embryonic placenta; only the left umbilical vein persists.
 - Common cardinal veins**
 - return poorly oxygenated blood from the body of the embryo.
- Transformation of the umbilical veins may be summarized as follows:
 - The right umbilical vein and the caudal part of the left umbilical vein between the liver and the sinus venosus degenerate.
 - The persistent caudal part of the left umbilical vein becomes the umbilical vein, which carries all the blood from the placenta to the A large venous shunt - the ductus venosus - develops within the liver and connects the umbilical vein with the inferior vena cava (IVC).
 - The ductus venosus forms a bypass through the liver, enabling most of the blood from the placenta to pass directly to the heart without passing through the capillary networks of the liver.

- The cardinal veins constitute the main venous drainage system of the embryo (see Figs. 13-2 and 13-4A). The anterior and posterior cardinal veins, the earliest veins to develop, drain cranial and caudal parts of the embryo, respectively. They join the common cardinal veins, which enter the sinus venosus.

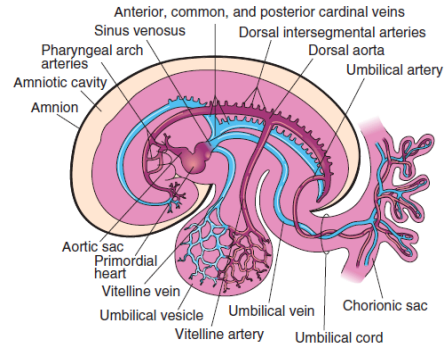


FIGURE 13-2 Drawing of the embryonic cardiovascular system (approximately 26 days), showing vessels on the left side. The umbilical vein carries well-oxygenated blood and nutrients from the chorionic sac to the embryo. The umbilical arteries carry poorly oxygenated blood and waste products from the embryo to the chorionic sac (outermost embryonic membrane).

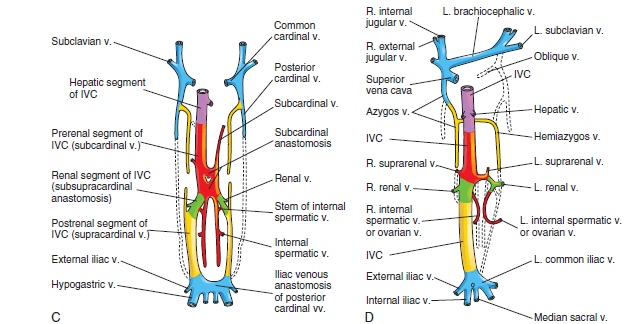
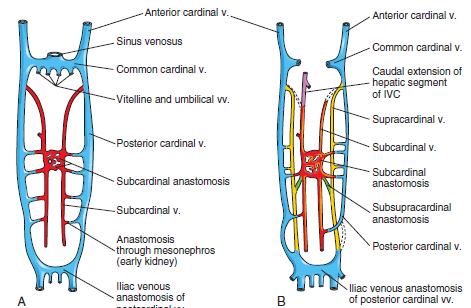


FIGURE 13-4 Illustrations of the primordial veins of bodies (trunks) of embryos (ventral views). Initially, three systems of veins are present: the umbilical veins from the chorion, vitelline veins from the umbilical vesicle, and cardinal veins from the body of the embryos. Next the subcardinal veins appear, and finally the supra-cardinal veins develop. A, At 6 weeks. B, At 7 weeks. C, At 8 weeks. D, Adult. This drawing illustrates the transformations that produce the adult venous pattern. IVC, Inferior vena cava; L, left; R., right; v., vein; vv., veins. (Modified from Arey LB: Developmental anatomy, revised ed 7, Philadelphia, 1974, Saunders.)

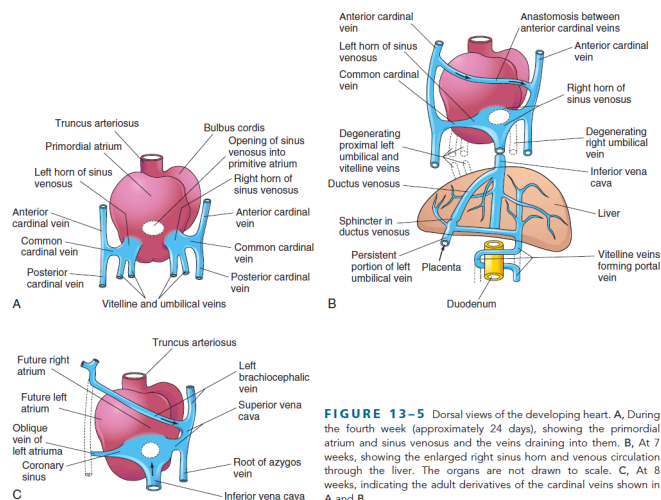


FIGURE 13-5 Dorsal views of the developing heart. A, During the fourth week (approximately 24 days), showing the primordial atrium and sinus venosus and the veins draining into them. B, At 7 weeks, showing the enlarged right sinus horn and venous circulation through the liver. The organs are not drawn to scale. C, At 8 weeks, indicating the adult derivatives of the cardinal veins shown in A and B.

- During the eighth week, the **anterior cardinal veins** are connected by an anastomosis (see Fig. 13-5A and B), which shunts blood from the left to the right anterior cardinal vein. This anastomotic shunt becomes the **left brachiocephalic vein** when the caudal part of the left anterior cardinal vein degenerates (see Figs. 13-4D and 13-5C). The **superior vena cava (SVC)** forms from the right anterior cardinal vein and the right common cardinal vein.
- The **posterior cardinal veins** develop primarily as the vessels of the **mesonephroi** (interim kidneys) and largely disappear with these transitory kidneys. The only adult derivatives of these veins are the root of the azygos vein and common iliac veins (see Fig. 13-4D). The subcardinal and supra-cardinal veins gradually

develop and replace and supplement the posterior cardinal veins (see Fig. 13-4A to D).

- The **subcardinal veins** appear first (see Fig. 13-4A). They are connected with each other through the **subcardinal anastomosis** and with the posterior cardinal veins through the mesonephric sinusoids. The subcardinal veins form the stem of the left renal vein, the suprarenal veins, the gonadal veins (testicular and ovarian), and a segment of the IVC (see Fig. 13-4D). The subcardinal veins become disrupted in the region of the kidneys (see Fig. 13-4C). Cranial to this region, they are united by an anastomosis that is represented in the adult by the azygos and hemiazygos veins (see Figs. 13-4D and 13-5C). Caudal to the kidneys, the left supracardinal vein degenerates; however, the right supracardinal vein becomes the inferior part of the IVC (see Fig. 13-4D).
- The IVC forms during a series of changes in the primordial veins of the trunk that occur as blood, returning from the caudal part of the embryo, is shifted from the left to the right side of the body. The IVC is composed of four main segments (Fig. 13-4 C):
 - A hepatic segment derived from the hepatic vein (proximal part of right vitelline vein) and hepatic sinusoids
 - A prerenal segment derived from the right subcardinal vein
 - A renal segment derived from the subcardinal-supracardinal anastomosis
 - A postrenal segment derived from the right supracardinal vein
- The superior vena cava (SVC) is derived from the right anterior cardinal vein and the right common cardinal vein.

DERIVATIVES OF THE PHARYNGEAL ARCH ARTERIES

- The pharyngeal arch arteries arise from the aortic sac and terminate in the dorsal aorta. There are six pairs of aortic arches:
 - Derivatives of the first pair
 - Maxillary arteries - supply the ears, teeth, and muscles of the eye and face
 - External carotid arteries
 - Derivatives of the second pair
 - Stapedial arteries - small vessels that run through the ring of the stapes, a small ear bone
 - Derivatives of the third pair
 - Common carotid arteries - supply structures in the head.
 - Internal carotid arteries - supply the ears, orbits, brain and its meninges.
 - Derivatives of the fourth pair
 - Arch of the aorta - formed partly by the fourth aortic arch. The proximal part of the arch develops from the aortic sac and the distal part is derived from the left dorsal aorta (Fig. 13-39 C)
 - Right subclavian artery - its proximal part is derived from the right: fourth pharyngeal arch artery while the distal part is derived from the right dorsal aorta and right seventh intersegmental artery.
 - Derivatives of the fifth pair
 - In 50% of embryos the fifth pair are rudimentary vessels that soon degenerate, leaving no vascular derivatives. In other embryos, these arteries do not develop.
 - Derivatives of the sixth pair
 - The left sixth aortic arch develops as follows:
 - ❖ (1) Proximal part of the left pulmonary artery - derived from the proximal part of the arch.
 - ❖ (2) Ductus arteriosus - a prenatal shunt and derived from the distal part of the arch which passes from the left pulmonary artery to the dorsal aorta.
 - The right sixth aortic arch develop as follows:
 - ❖ Proximal part of the right pulmonary artery - derived from the proximal part of the arch.

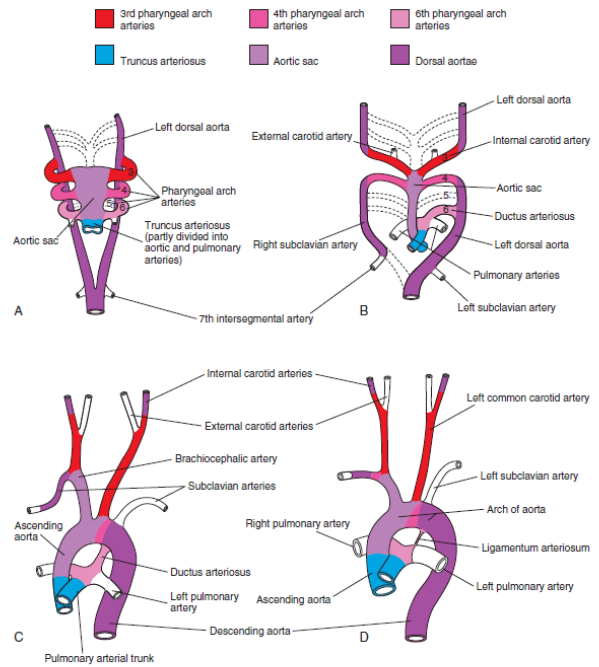


FIGURE 13-39 Schematic drawings illustrating the arterial changes that result during transformation of the truncus arteriosus, aortic sac, pharyngeal arch arteries, and dorsal aortae into the adult arterial pattern. The vessels that are not colored are not derived from these structures. A, Pharyngeal arch arteries at 6 weeks; by this stage, the first two pairs of arteries have largely disappeared. B, Pharyngeal arch arteries at 7 weeks; the parts of the dorsal aortae and pharyngeal arch arteries that normally disappear are indicated with broken lines. C, Arterial arrangement at 8 weeks. D, Sketch of the arterial vessels of a 6-month-old infant. Note that the ascending aorta and pulmonary arteries are considerably smaller in C than in D. This represents the relative flow through these vessels at the different stages of development. Observe the large size of the ductus arteriosus in C and that it is essentially a direct continuation of the pulmonary trunk. The ductus arteriosus normally becomes functionally closed within the first few days after birth. Eventually the ductus arteriosus becomes the ligamentum arteriosum, as shown in D.

DERIVATIVES OF LYMPH SACS AND DUCTS

- There are six primary lymph sacs at the end of the embryonic period (Fig. 13-54 A)
 - Two jugular lymph sacs near the junction of the subclavian veins with the anterior cardinal veins (the future internal jugular veins)
 - Two iliac lymph sacs near the junction of the iliac veins with the posterior cardinal veins
 - One retroperitoneal lymph sac in the root of the mesentery on the posterior abdominal wall
 - One cisterna chyli located dorsal to the retroperitoneal lymph sac
- Two large channels (right and left thoracic ducts) connect the jugular sacs with the cisterna chyli.

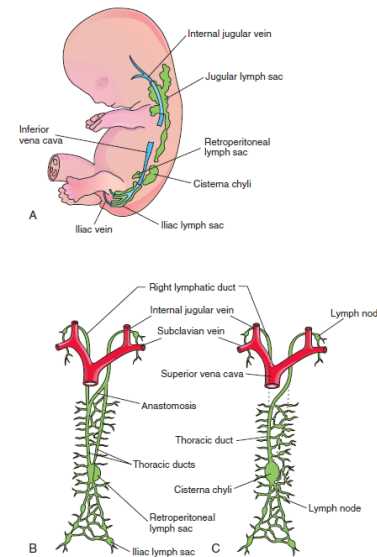


FIGURE 13-54 Development of lymphatic system. A, Left side of a 7.5-week embryo showing the primary lymph sacs. B, Ventral view of the lymphatic system at 9 weeks showing the paired thoracic ducts. C, Later in the fetal period, illustrating formation of the thoracic duct and right lymphatic duct.

- The thoracic duct develops from:
 - The caudal part of the right thoracic duct
 - The anastomosis between the thoracic ducts and the cranial part of the left thoracic duct.
- The right lymphatic duct is derived from the cranial part of the right thoracic duct (Fig. 14-54 C). The thoracic duct and the right

lymphatic duct connect with the venous system at the angle between the internal jugular and subclavian veins.

- The superior part of the embryonic cisterna chili persists, and in the adults, cisterna chyli is about 5 cm long and 6 mm wide.

FUNCTIONS OF THE HEART

- The heart is actually 2 separate pumps
 - Right heart that pumps blood through the lungs
 - Left heart that pumps blood through the peripheral organs

LOCATION OF THE HEART

- It is located between the lungs and lies within the pericardium in the middle mediastinum

ANATOMICAL RELATIONSHIPS

- In front:
 - It is separated from the sternum by the remains of the thymus gland above and is covered by the margins of the lungs specially the left.
- Behind:
 - It rests upon the bronchi, the esophagus and the descending aorta.
- Laterally:
 - It is covered by the pleurae and is related to the inner surface of the lungs, the phrenic nerve and pericardiophrenic vessels.
- The base is attached to the central tendon and to the left of the muscular respiratory diaphragm.

PERICARDIUM

- Pericardium is a fibroserous sac that encloses the heart and the roots of the great vessels.
- Functions:
 - To restrict excessive movements of the heart as a whole.
 - To serve as a lubricated container in which the different parts of the heart can contract.
- Location:
 - Lies within the middle mediastinum, posterior to the body of the sternum and the second to the sixth costal cartilages

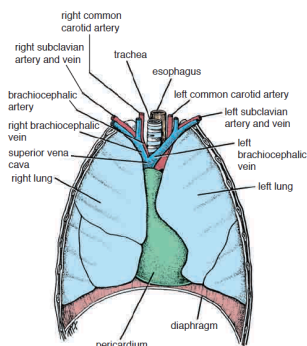


FIGURE 3.30 The pericardium and the lungs exposed from in front.

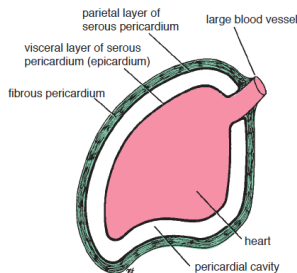


FIGURE 3.31 Different layers of the pericardium.

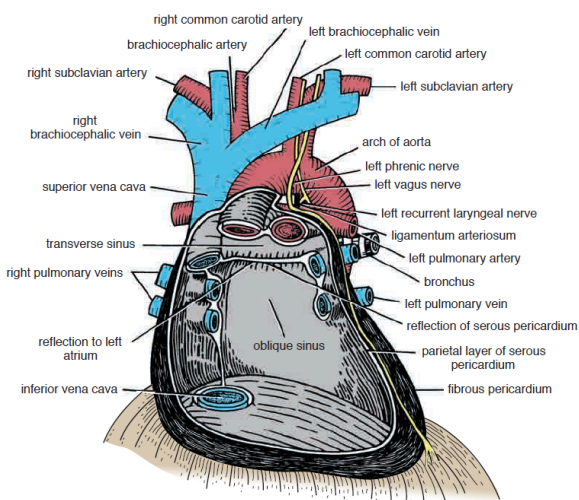


FIGURE 3.32 The great blood vessels and the interior of the pericardium.

COMPONENTS OF THE PERICARDIUM

- **Fibrous Pericardium**
 - The strong fibrous part of the sac.
 - It is firmly attached below the central tendon of the diaphragm.
 - It fuses with the outer coats of the great blood vessels passing through it, namely, the aorta, pulmonary trunk, superior and inferior vena cava, and pulmonary veins.
 - It is attached in front to the sternum by the, sternopericardial ligaments.
- **Serous Pericardium**
 - Has 2 layers:
 - **Parietal Layer**
 - ❖ lines the fibrous pericardium and is reflected around the roots of the great vessels to become continuous with the visceral layer that closely covers the heart.
 - **Visceral Layer**
 - ❖ closely applied to the heart and is often called the epicardium.
- **Pericardial cavity**
 - Slit like space between the parietal and visceral layers containing a small amount of tissue fluid, the pericardial fluid, which acts as a lubricant to facilitate movements of the heart.

PERICARDIAL SINUSES

- **Oblique Sinus**
 - a recess formed by the reflection of the serous pericardium around the large veins found on the posterior surface of the heart.
- **Transverse Sinus**
 - a short passage that lies between the reflection of serous pericardium around the aorta and pulmonary trunk and the reflection around the large veins located on the posterior surface of the heart.

GREAT BLOOD VESSELS AT THE BASE OF THE HEART

Aorta

- **Ascending Aorta**
 - lies behind the right half of sternum at the level of the sternal angle
 - begins at the base of left ventricle, gives off 2 branches right and left coronary arteries.
- **Aortic Arch**
 - continuation of ascending AORTA
 - lies behind the manubrium sternae
 - Branches:
 - Brachiocephalic artery
 - ❖ Right Subclavian artery
 - ❖ Right common carotid artery
 - Left common carotid artery
 - ❖ Left subclavian artery
 - Descending thoracic aorta
 - lies at T4-T12
 - Branches:
 - ❖ Posterior intercostal arteries
 - ❖ Subcostal arteries
 - ❖ Pericardial arteries
 - ❖ Bronchial arteries
 - ❖ Esophageal arteries
 - ❖ Mediastinal arteries
 - ❖ Phrenic arteries

Pulmonary Trunk

- Conveys blood from the right ventricle to the lungs
- Branches:
 - Right and Left Pulmonary Arteries

LARGE VEINS OF THE THORAX

- Brachiocephalic veins:
 - Right
 - Left: formed by the union of subclavian and internal jugular veins
- Superior vena cava
 - Formed by the union of brachiocephalic veins.
- Azygos veins
- Inferior vena cava
- Pulmonary veins

BORDERS AND SURFACES OF THE HEART

SURFACES

- **Posterior Surface (Base of the Heart)**
 - Formed mainly by the left atrium, into which open the 4 pulmonary veins.
 - It lies opposite the apex.
- **Sternocostal Surface (Anterior)**
 - formed mainly by the right atrium and right ventricle.
- **Diaphragmatic Surface (Inferior)**
 - formed mainly by the right and left ventricles and the inferior surface of the right atrium into which the IVC opens.
- **Apex of the Heart**
 - formed by the left ventricle, is directed downward, forward, and to the left.
 - It lies at the level of the fifth) left intercostals space, 3 ½ inches (9 cm) from the midline.

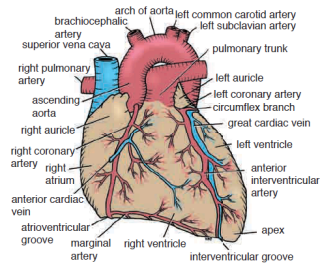


FIGURE 3.34 The anterior surface of the heart and the great blood vessels. Note the course of the coronary arteries and the cardiac veins.

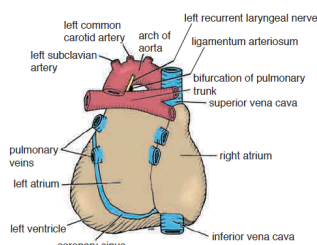


FIGURE 3.35 The posterior surface, or the base, of the heart.

BORDERS

- **Superior Border**
 - Formed by the roots of the great blood vessels, extend from a point on the second left costal cartilage ½ inch (1.3 cm) from the edge of the sternum to a point on the third right costal cartilage ½ inch (1.3 cm) from the edge of the sternum.
- **Left Border**
 - formed by the left ventricle, extends from a point on the second left costal cartilage ½ inch (1.3 cm) from the edge of the sternum to the apex of the heart.
- **Inferior Border**
 - formed by the right ventricle and the apical part of the left ventricle, extends from the sixth-costal cartilage ½ inch (1.3 cm) from the sternum to the apex

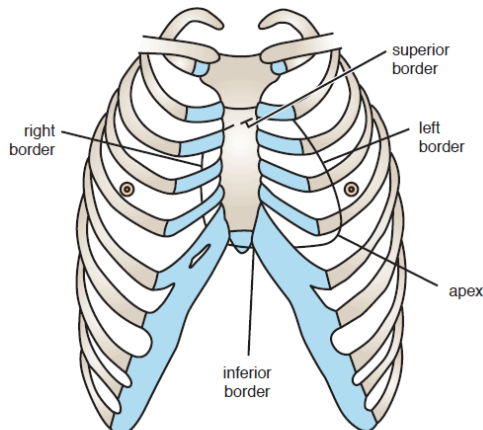


FIGURE 2.26 Surface markings of the heart.

CHAMBERS OF THE HEART

MAIN CHAMBERS

- Right and Left Atrium
- Right and Left Ventricle

ANATOMICAL FEATURES OF THE MAIN CHAMBERS

Right Atrium

- **Auricle**
 - a small outpouching, conical in shape, presents at the internal surface muscular ridges called musculi pectinati which end behind on a smooth vertical ridge - crista terminalis which is indicated externally as sulcus terminalis.
- **Sinus Venosus**
 - principal cavity situated posteriorly
 - **Fossa Ovalis**
 - located on the atrial septum
 - a shallow depression which is the remnant of the foramen ovale
- **Openings in the right atrium:**
 - SVC (Superior Vena Cava)
 - opens in the upper part, no valve
 - IVC (inferior Vena Cava)
 - opens in the lower part, guarded by eustachian valves
 - Coronary sinus
 - opens between IVC and A-V opening, guarded by Thebesian valve.
 - Right atrio-ventricular opening
 - lies anterior to IVC opening, guarded by tricuspid valve
 - Many small orifices of veins

Left Atrium

- Similar to right atrium, smaller in size, thicker wall, longer narrow auricle.
- **Openings:**
 - 4 pulmonary veins, no valves
 - Left AV opening guarded by mitral valve

Right and Left Ventricles

- **Trabeculae carneae**
 - muscular bundles in the internal ventricular wall.
- **Papillary muscles**
 - conical projections whose bases are attached to the ventricular wall.
- **Chordae tendinae**
 - fibrous chords extending from the apices of the papillary muscles to the cusps of the tricuspid and mitral valves.
- **Right Ventricle:**
 - Moderator band
 - attached to the ventricular wall at their ends
 - Infundibulum
 - Funnel shaped structure below the pulmonary orifice.
 - **Openings:**
 - Right Atrio-ventricular opening
 - ❖ guarded by the tricuspid valve consisting of 3 cusps: anterior, septal and posterior or inferior.
 - Pulmonary
 - ❖ guarded by a pulmonary valve consisting of 3 semilunar cusps.
- **Left Ventricle:**
 - 3x thicker than the right so has more trabeculae carneae
 - aortic vestibule - part below the aortic orifice
 - 2 large papillary muscles
 - **Openings:**
 - Left atrio-ventricular
 - ❖ guarded by the mitral valve consisting posterior cusps, anterior and posterior
 - Aortic
 - ❖ guarded by aortic semilunar valves similar in structure to pulmonary valve.

SEPTUM

- Structure that divides the heart into 4 chambers
- The **atrioventricular septum** separates the atrium from the ventricles.
- The **atrial septum** separates the right and left atrium.
- The **interventricular septum** separates the right and left ventricles.

ATRIOVENTRICULAR OPENINGS

- **Right Atrium**
 - Superior vena cava (SVC)
 - opens in the upper part no valve
 - Inferior vena cava (IVC)
 - opens in the lower part, guarded by Eustachian valve.
 - Coronary sinus
 - opens between IVC and A-V opening, guarded by Thebesian valve
 - Right atrioventricular opening
 - lies anterior to IVC opening, guarded by tricuspid valve
 - Many small orifices of veins
- **Left Atrium**
 - 4 pulmonary veins, no valves
 - Left AV opening guarded by the mitral valve
- **Right Ventricle**
 - Right atrioventricular opening
 - Guarded by the tricuspid valve consisting of 3 cusps: anterior, septal, and posterior or inferior
 - Pulmonary orifice
 - Guarded by aortic semilunar valves similar in structure to pulmonary valve
- **Left Ventricle**
 - Left atrioventricular opening
 - Guarded by the mitral valve consisting of 2 cusps, anterior and posterior
 - Aortic orifice
 - Guarded by aortic semilunar valves similar in structure to pulmonary valve.

LOCATION OF VALVES

CLINICAL LOCATION

- Clinical Valve Areas
 - Areas where the different heart sounds are best heard
 - **Mitral Area:**
 - ❖ at and around the cardiac apex (over the apex of the left ventricles)
 - **Tricuspid Area:**
 - ❖ at or near the lower left sternal border (over the right ventricle)
 - **Pulmonic Area:**
 - ❖ 2nd and 3rd left interspace close to the sternum (upward along the pulmonary area)
 - **Aortic Area:**
 - ❖ 2nd right interspace (upward along the aorta)

ANATOMICAL LOCATION

- **Tricuspid Valve:**
 - Right half of the sternum opposite the 4th ICS
- **Mitral Valve:**
 - Left half of the sternum opposite 4th left costal cartilage
- **Pulmonary Valve:**
 - Medial end of the 3rd left costal cartilage and adjoining part of sternum
- **Aortic Valve:**
 - Left half of the sternum opposite the 3rd ICS

CORONARY CIRCULATION

RIGHT CORONARY ARTERY

- Arises from the anterior aortic sinus of the ascending aorta
- Runs forward between the pulmonary trunk and right auricle then descends in the right AV groove then it goes to the inferior border of the heart posteriorly to anastomose with the left coronary artery.

- Branches:
 - **Right Conus Artery**
 - supplies the anterior surface of the pulmonary conus (infundibulum of the right ventricle) and the upper part of the anterior wall of the right ventricle
 - **Anterior Ventricular Branches**
 - 2 or 3 in number, supply the anterior surface of the right ventricle
 - Marginal branch
 - ❖ the largest and runs along the lower margin of the costal surface to reach the apex.
 - **Posterior Ventricular Branches**
 - usually 2 in number
 - supply the diaphragmatic surface of the right ventricle,
 - **Posterior Interventricular (Descending) Artery**
 - runs toward the apex in the posterior interventricular groove.
 - It gives off branches to the right and left ventricles, including its inferior wall.
 - It supplies branches to the posterior part of the ventricular septum but not to the apical part.
 - ❖ A large septal branch supplies the AV node.
 - ❖ In 10% of individuals this artery (post interventricular artery) is replaced by a branch from the left coronary artery.
 - **Atrial Branches**
 - supply the anterior and lateral surfaces of the right atrium
 - One branch supplies the posterior surface of both the right and left atria.
 - ❖ The artery of the SA node supplies the node and the left and right atria; in 35% of individuals, it arises from the left coronary artery.

LEFT CORONARY ARTERY

- Usually larger than the right coronary artery, supplies the major part of the heart, including the greater part of the left atrium, left ventricle and ventricular septum.
- It arises from the left posterior aortic sinus of the ascending aorta and passes forward between the pulmonary trunk and the left auricle, then enters the atrioventricular groove and divides into branches:
 - **Anterior Interventricular (Descending) Branch**
 - runs downward in the anterior interventricular groove to the apex of the heart and enter the posterior interventricular groove and anastomose with the terminal branches of the right coronary artery. It supplies the right and left ventricles with numerous branches that also supply the anterior part of the ventricular septum.
 - **Left diagonal artery**
 - ❖ may arise directly from the trunk of the left coronary artery.
 - **Left Conus Artery**
 - ❖ supplies the pulmonary conus.
 - **Circumflex Artery**
 - the same size as the anterior interventricular artery.
 - Winds around the left margin of the heart in the atrioventricular groove.
 - ❖ **Left Marginal Artery**
 - a large branch that supplies the left margin of the left ventricle down to the apex.
 - ❖ **Anterior Ventricular and Posterior Ventricular Branches**
 - Supply the left ventricle
 - ❖ **Atrial Branches**
 - Supply the left atrium

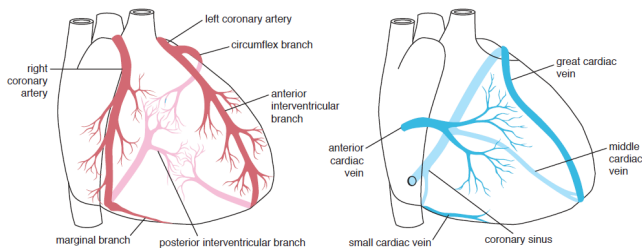


FIGURE 3.41 Coronary arteries and veins.

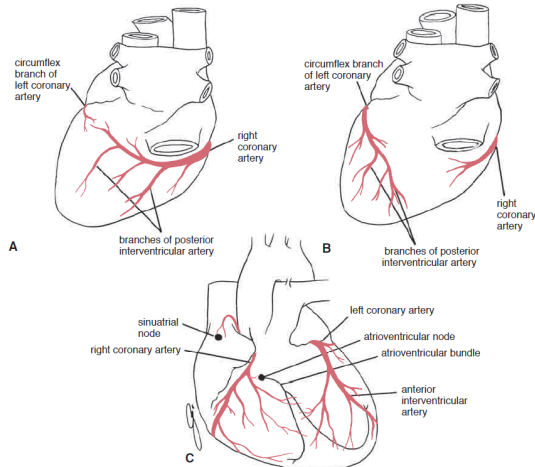


FIGURE 3.42 A. Posterior view of the heart showing the origin and distribution of the posterior interventricular artery in the right dominance. B. Posterior view of the heart showing the origin and distribution of the posterior interventricular artery in the left dominance. C. Anterior view of the heart showing the relationship of the blood supply to the conducting system.

SUMMARY OF OVERALL ARTERIAL SUPPLY TO THE HEART IN MOST INDIVIDUALS

The **right coronary artery** supplies all of the right ventricle (except for the small area to the right of the anterior interventricular groove), the variable part of the diaphragmatic surface of the left ventricle, the posteroinferior third of the ventricular septum, the right atrium and the part of the left atrium, and the sinoatrial node and the atrioventricular node and bundle. The LBB also receives small branches.

The **left coronary artery** supplies most of the left ventricle, a small area of the right ventricle to the right of the interventricular groove, the anterior two-thirds of the ventricular septum, most of the left atrium, the RBB, and the LBB.

VENOUS DRAINAGE CORONARY SINUS

- Drains blood to the right atrium from the whole heart (including its septa) except the anterior region of the right ventricle and small, variable parts of both atria and left ventricle.
- It is about 2-3 cm long, lying posterior in the coronary sulcus (atrioventricular groove) between the left atrium and ventricle
- It opens into the right atrium between the opening of the inferior vena cava and the right atrioventricular orifice, and its opening is guarded by an endocardial fold (semilunar valve of the coronary sinus)

Tributaries:

- **Great Cardiac Vein**
 - begins at the cardiac apex, ascends in the anterior interventricular sulcus to the coronary sulcus and follows this to the left and round posterior to the heart to enter the coronary sinus at its origin. It receives tributaries from the left atrium and both ventricles, including the large left marginal vein ascending the left aspect ('obtuse border') of the heart.
- **Small Cardiac Vein**
 - lies posterior in the coronary sulcus between the right atrium and ventricle and opens into the coronary sinus near its atrial end. It receives blood from the back of the right atrium and

- **Middle Cardiac Vein**
 - beginning at the cardiac apex, it runs back in near its atrial interventricular groove to end in the coronary sinus near its atrial end.
- **Posterior Vein of the Left Ventricle**
 - found on the diaphragmatic surface of the left ventricle a little left of the middle cardiac vein
 - it usually opens into the center of the coronary sinus but sometimes into the great cardiac vein
- **Oblique Vein of the Left Atrium**
 - descends obliquely on the back of the left atrium to join the coronary sinus near its end; it is continuous above with the ligament of the left vena cava; the two structures are remnants of the left common cardinal vein.
- All veins except the oblique vein of the left atrium have valves on their orifices.

ANTERIOR CARDIAC VEIN

- Drain an anterior part of the right ventricle and a region around the right cardiac border when the right marginal vein join this group, ending principally in the right atrium.
- There are usually 2 or 3, sometimes even 5, they ascend in subepicardial tissue to cross the right part of the atrioventricular sulcus, passing deep or superficial to the right coronary artery. They end in the right atrium, near the sulcus, separately or in variable combinations.

VENAE CORDIS MINIMAE (THEBESIIUS' VEINS)

- Opens into the right atrium and ventricle and, to a lesser extent, the left atrium and sometimes left ventricle.

NERVE SUPPLY OF THE HEART

- **Cardiac plexus** situated below the arch of the aorta.
 - The sympathetic supply arises from the cervical and upper thoracic portions of the sympathetic trunks.
 - The parasympathetic supply comes from the vagus nerve.
- The postganglionic sympathetic fibers terminate on the sinoatrial and atrioventricular nodes, on cardiac muscle fibers, and on the coronary arteries. Activation of these nerves result in
 - Cardiac acceleration
 - Increased force of contraction of cardiac muscle
 - Dilatation of the coronary arteries
- The postganglionic parasympathetic fibers terminate on the sinoatrial and atrioventricular nodes, cardiac muscle fibers, and on the coronary arteries. Activation of these nerves result in:
 - Reduction in the rate and force of contraction of the heart
 - Constriction of the coronary arteries

CARDIAC SKELETON

- The cardiac skeleton is a chondroid tissue that serves as a central support of the heart. It provides attachment for the cardiac muscles. It is made up of the following parts:
 - **Annuli Fibrosi**
 - firm connective tissue made up of elastic fibers found around AV openings and openings of blood vessels that spring from the heart.
 - **Trigona Fibrosa**
 - triangular fibrous tissue in between the right & the left atria.
 - **Septum Membranaceum**
 - found in the superior part of the inter-ventricular septum and connects it to the trigona fibrosa.

LAYERS OF THE WALL OF THE HEART

- Endocardium
 - Innermost layer
 - Endothelium
 - Layer of flattened cells which form a long tubule
 - Sub-endothelial Layer
 - Contains nerves and blood vessels, fibroblasts, collagen, and elastic fibers
 - Subendocardial Layer
 - Main mass of the endocardium
 - Contains Purkinje fibers

- Myocardium
 - Middle and thickest layer made up of cardiac muscle
- Epicardium
 - Outermost layer composed of mesothelium and areolar tissue. Forms the visceral layer of the pericardium

HISTOLOGIC FEATURES

CARDIAC MUSCLE

- Independent of nervous stimulation
- Long and branching with end-to-end attachment (intercalated disc)
- One nucleus at main segment
- Myofibrils in parallel bundles
- Fainter and closer cross striations

PURKINJE FIBERS

- Specialized for conduction impulses
- Bigger but shorter, more sarcoplasm but fewer myofibrils
- Cross striations are fainter
- Nuclei fewer, larger and paler