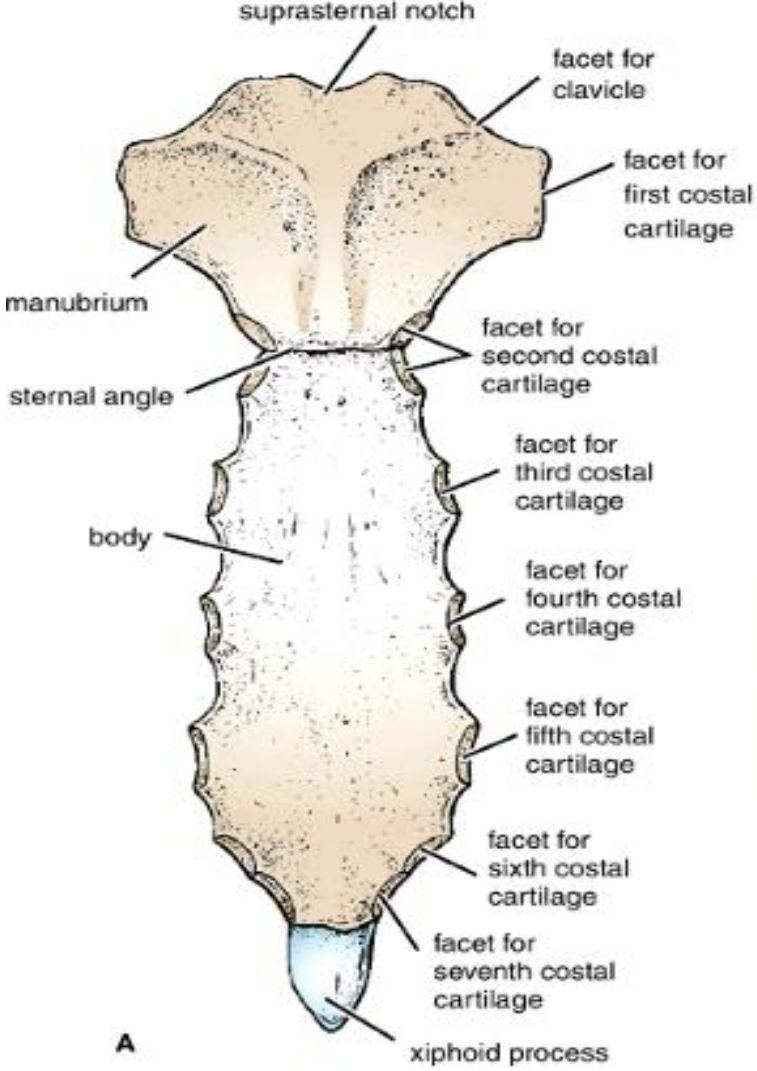
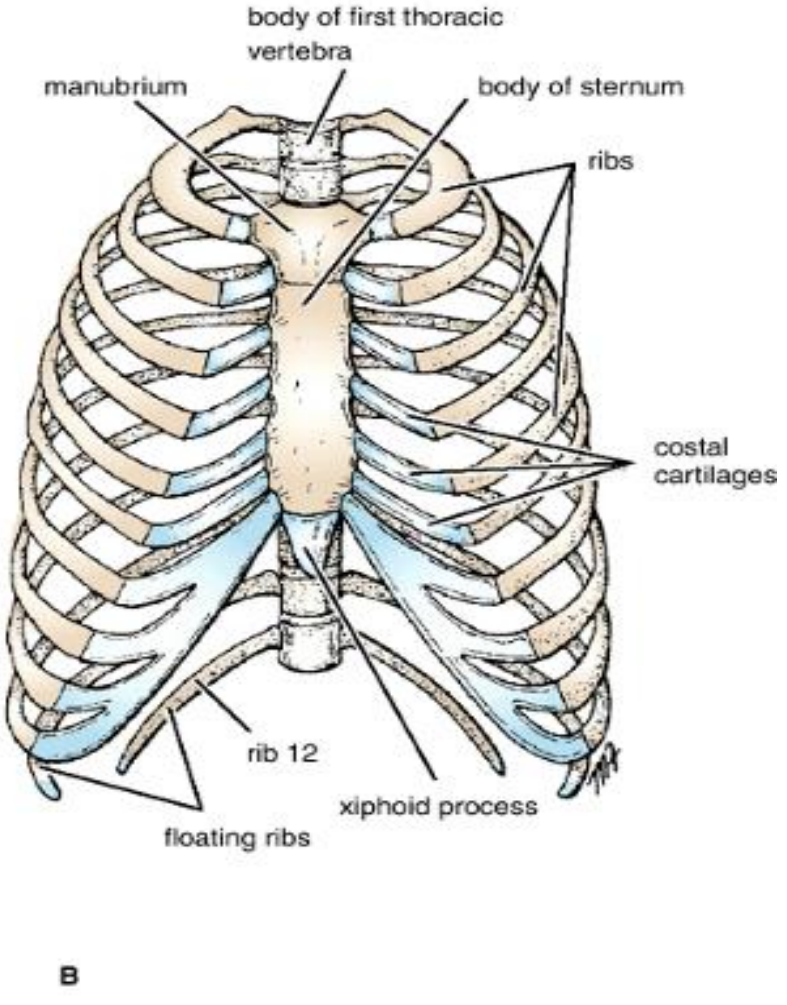
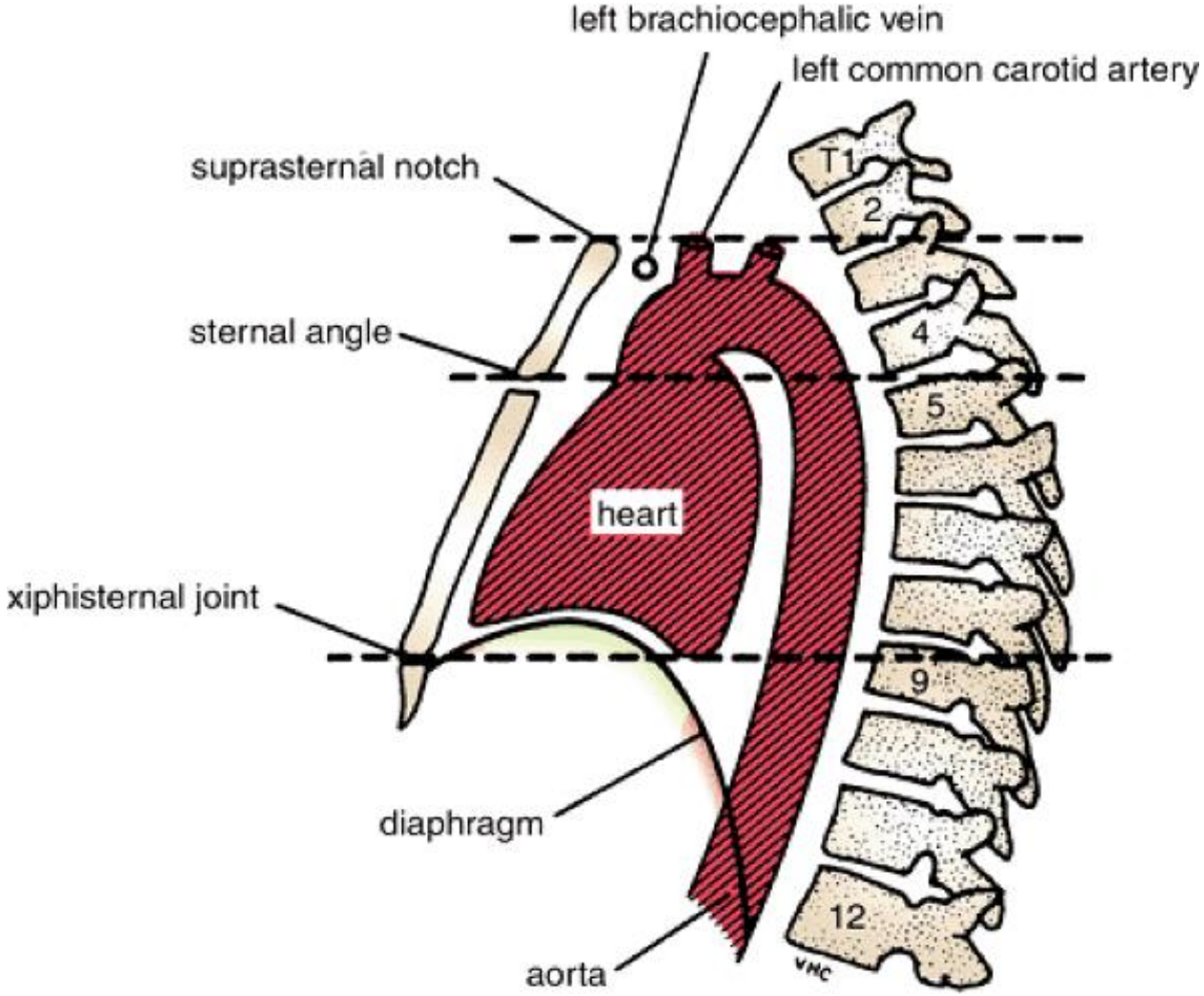

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

A. Anterior view of the sternum.
B. Sternum, ribs, and costal cartilages forming the thoracic skeleton.





Lateral view of the thorax showing the relationship of the surface markings to the vertebral levels.



Nipple

The nipple usually lies in the fourth intercostal space about 4 in. (10 cm) from the midline. In the female, its position is not constant.

Apex Beat of the Heart

The apex of the heart is formed by left ventricle. The apex beat can usually be felt by placing the flat of the hand on the chest wall over the heart.

The apex beat is normally found in the fifth left intercostal space 3.5 in. (9 cm) from the midline.

Lines of Orientation

Midsternal line: Lies in the median plane over the sternum.

Midclavicular line: Runs vertically downward from the midpoint of the clavicle.

Anterior axillary line: Runs vertically downward from the anterior axillary fold.

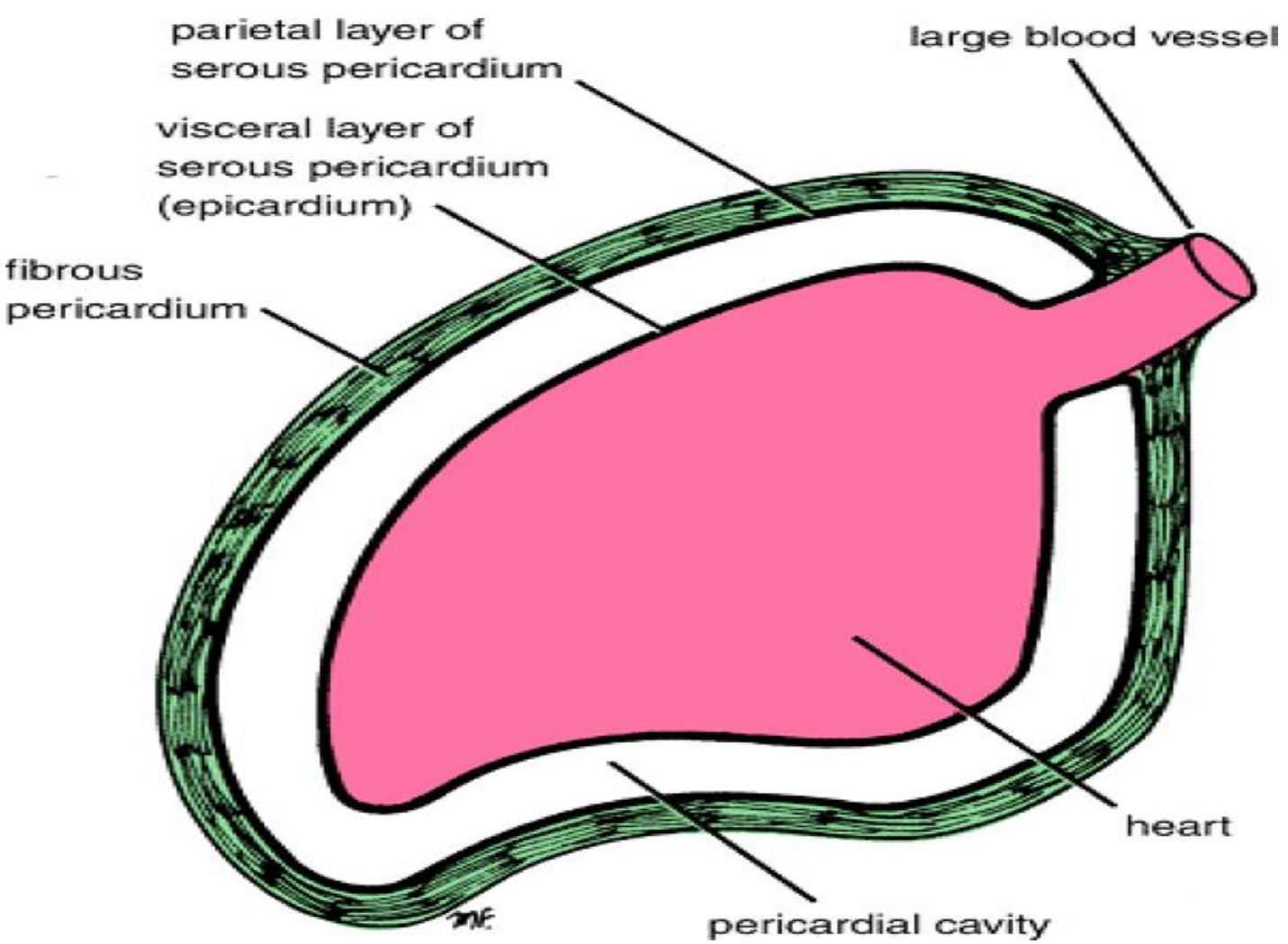
Posterior axillary line: Runs vertically downward from the posterior axillary fold

Midaxillary line: Runs vertically downward from a point situated midway between the anterior and posterior axillary folds

STERNAL ANGLE

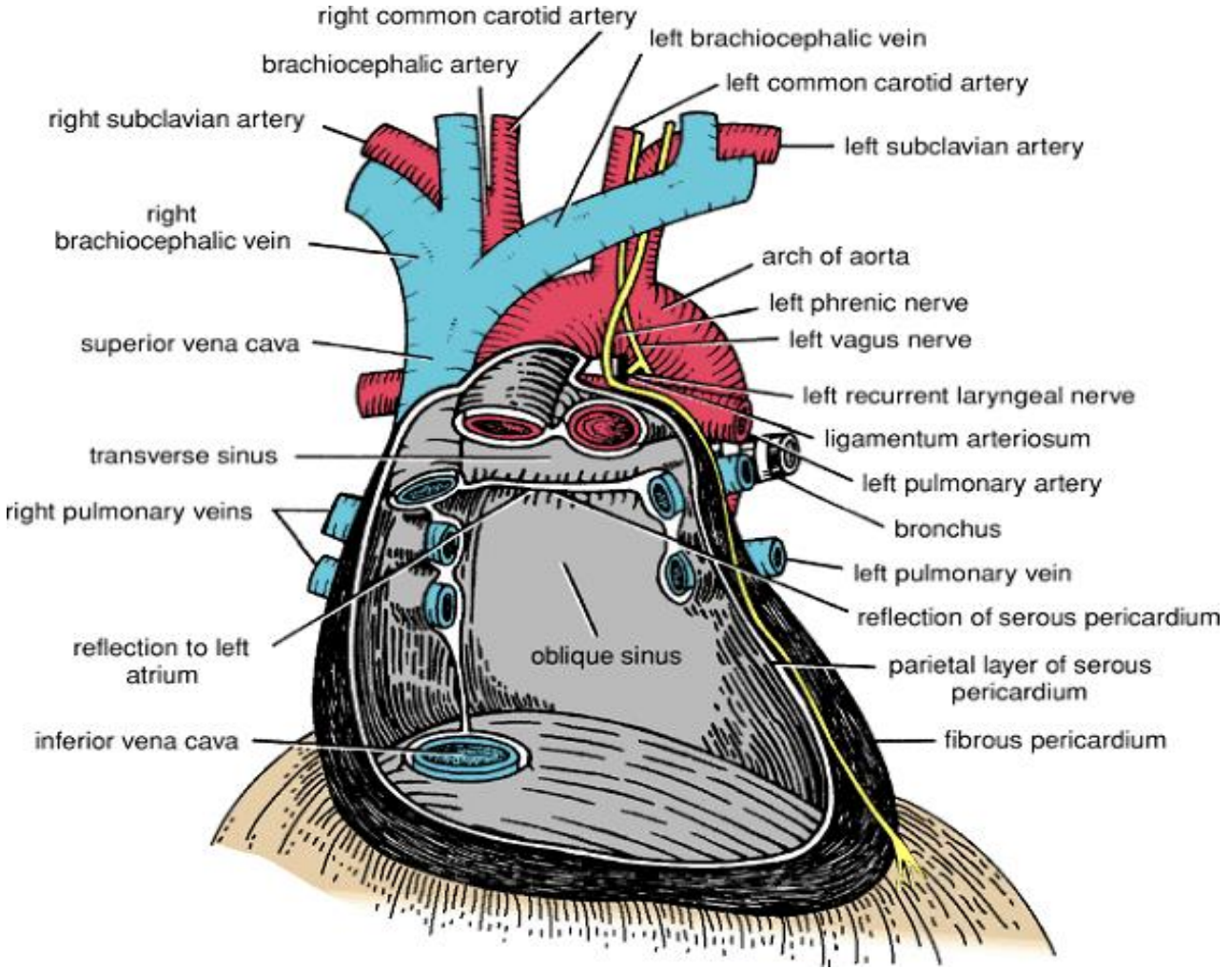
1. Mediastinum
2. Thoracic duct shift to left
3. Trachea divide
4. End of SV
5. Ligamentum arteriosum
6. Loop of RLN around aortic arch
7. Arch of aorta

Different layers of the pericardium.



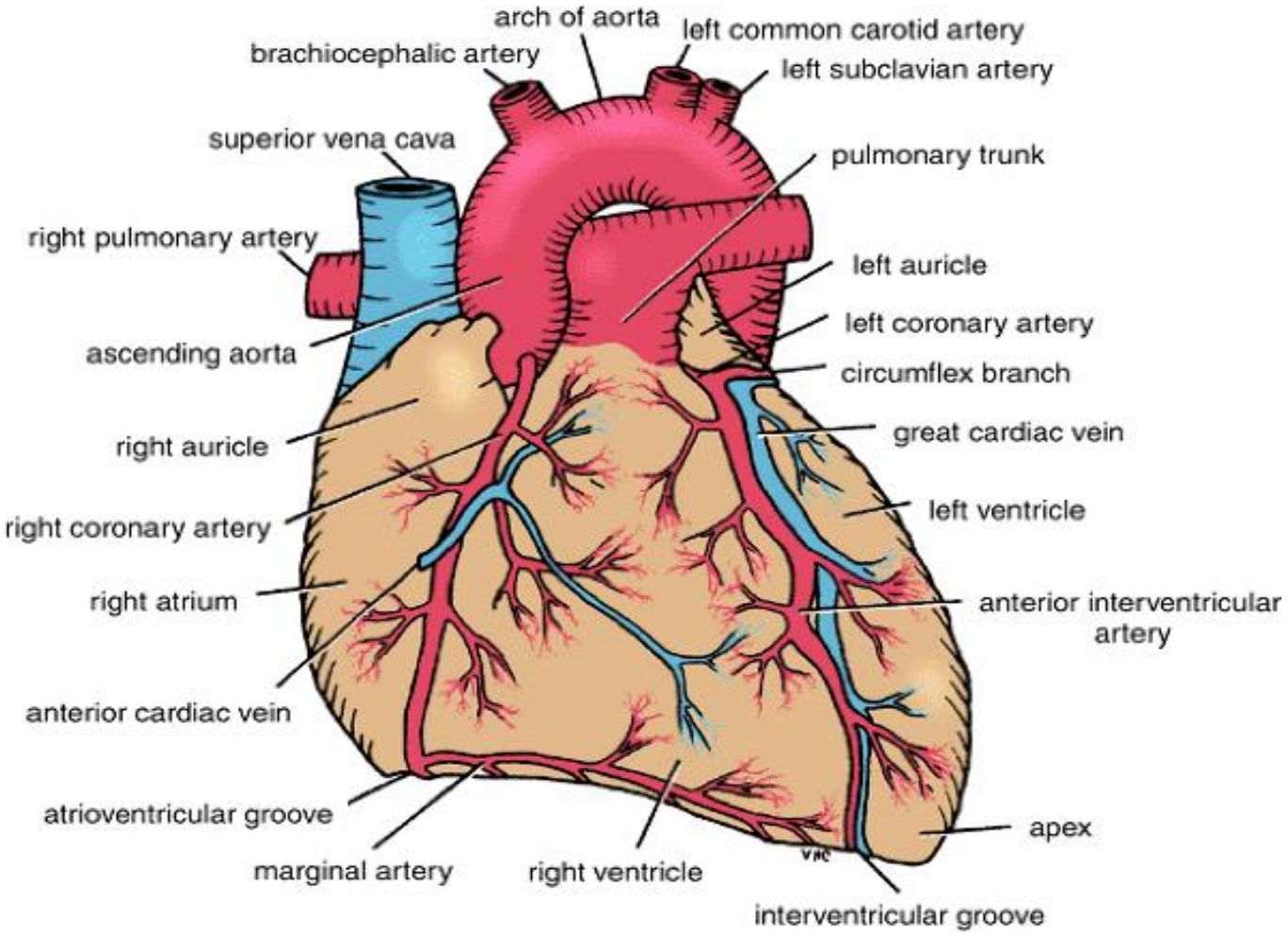
Pericardial Sinuses

On the posterior surface of the heart, the reflection of the serous pericardium around the large veins forms a recess called the **oblique sinus** . Also on the posterior surface of the heart is the **transverse sinus**, which is a short passage that lies between the reflection of serous pericardium around the aorta and pulmonary trunk and the reflection around the large veins.



Heart

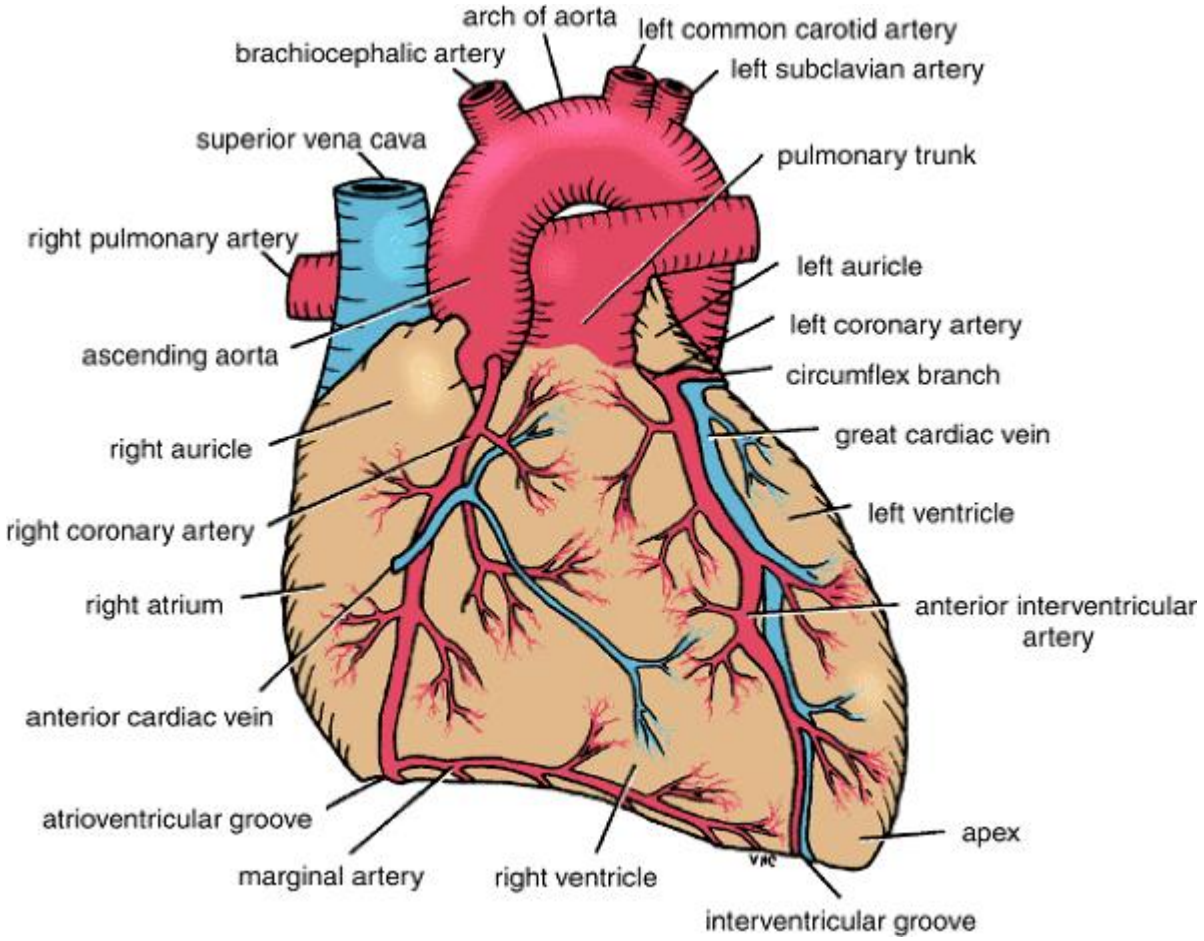
The heart is a hollow muscular organ that is somewhat pyramid shaped and lies within the pericardium in the mediastinum. It is connected at its base to the great blood vessels but otherwise lies free within the pericardium.



Surfaces of the Heart

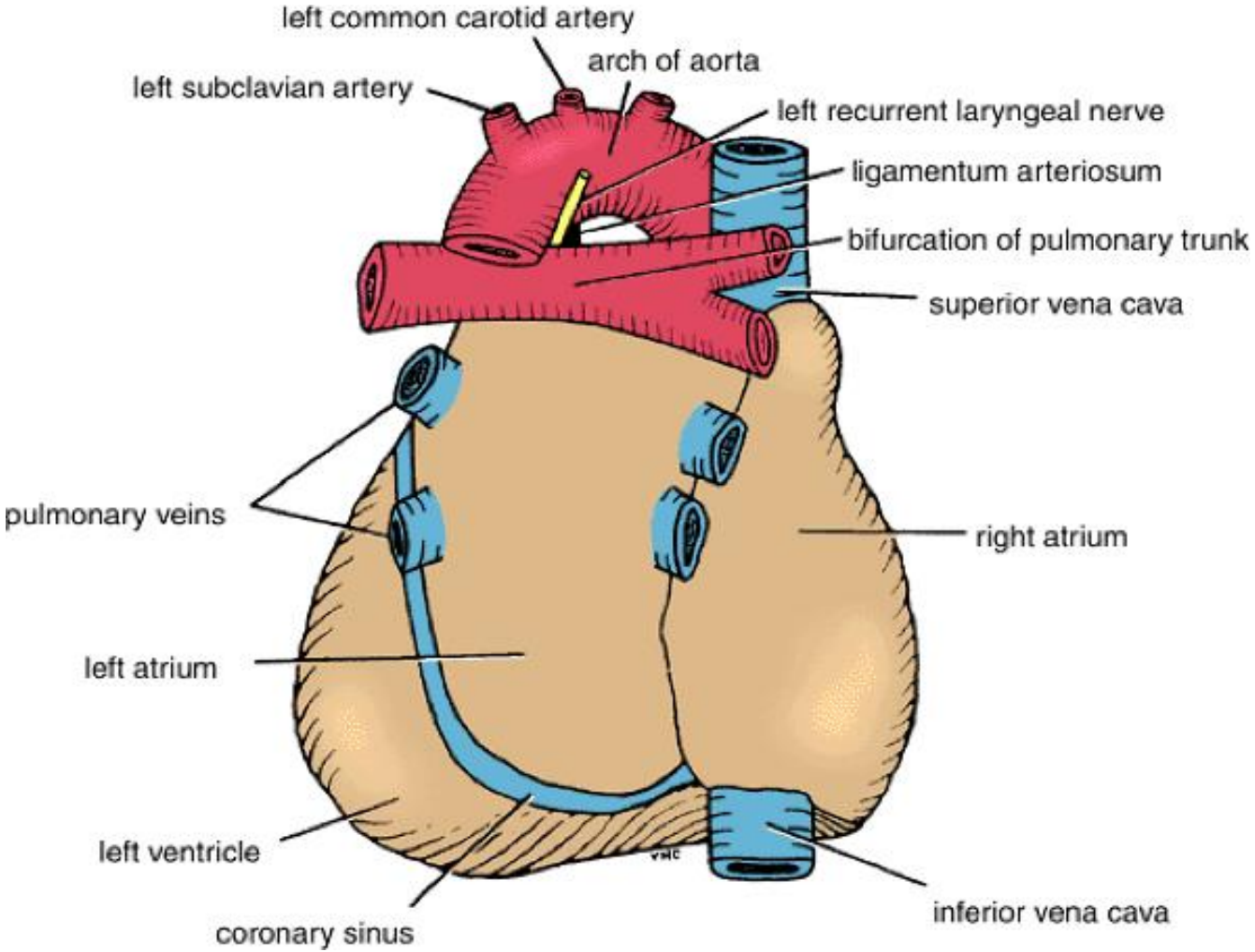
The heart has three surfaces: sternocostal (anterior), diaphragmatic (inferior), and a base (posterior). It also has an apex, which is directed downward, forward, and to the left.

The **sternocostal surface** is formed mainly by the right atrium and the right ventricle, which are separated from each other by the vertical atrioventricular groove . The right border is formed by the right atrium; the left border, by the left ventricle and part of the left auricle. The right ventricle is separated from the left ventricle by the anterior interventricular groove.



The **diaphragmatic surface** of the heart is formed mainly by the right and left ventricles separated by the posterior interventricular groove. The inferior surface of the right atrium, into which the inferior vena cava opens, also forms part of this surface.

The **base of the heart**, or the posterior surface, is formed mainly by the left atrium, into which open the four pulmonary veins. The base of the heart lies opposite the apex.

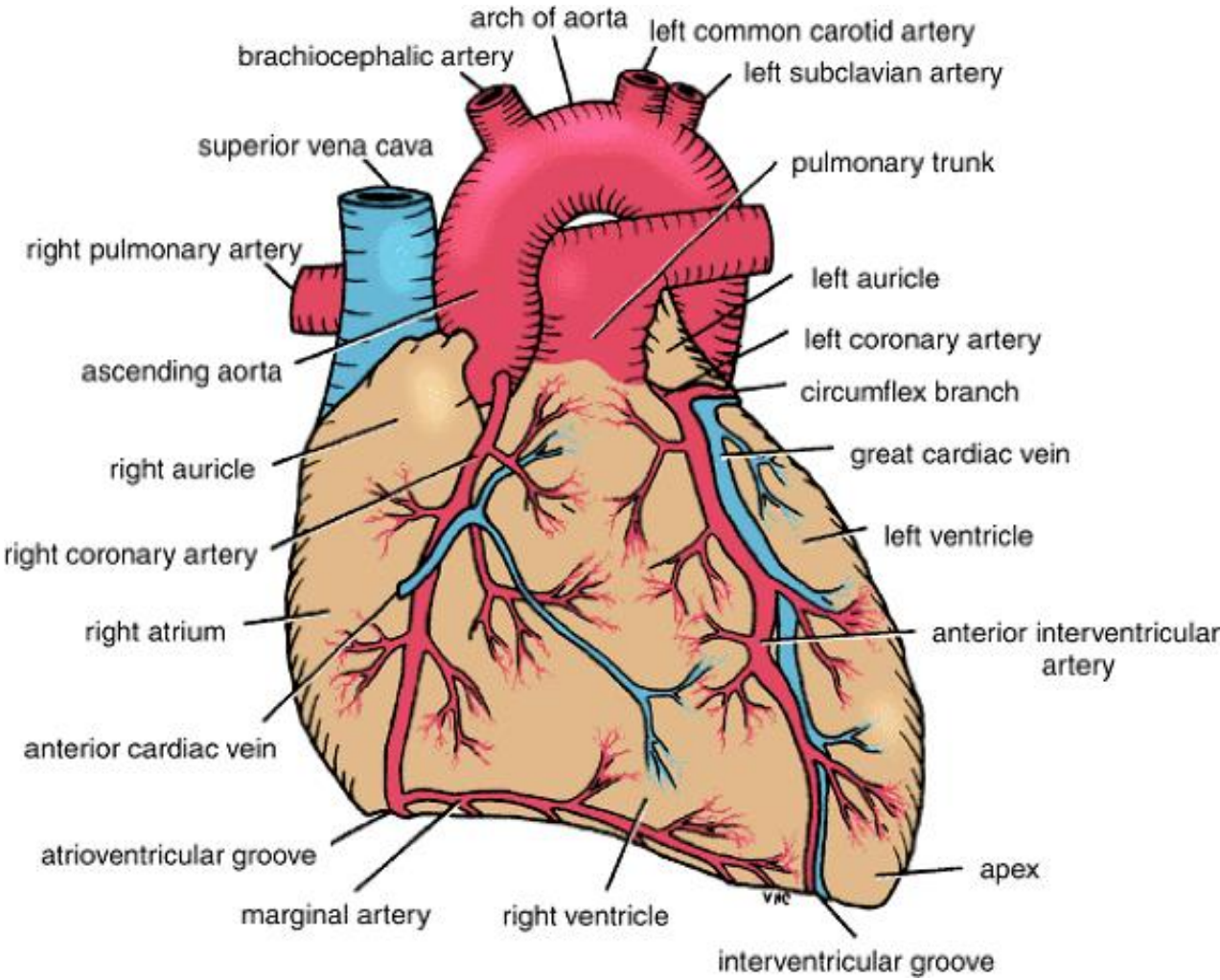


The **apex of the heart**, formed by the left ventricle, is directed downward, forward, and to the left. It lies at the level of the fifth left intercostal space,

3.5 in. (9 cm)

from the midline. In the region of the apex, the apex beat can usually be seen and palpated in the living patient.

Note that the base of the heart is called the base because the heart is pyramid shaped; the base lies opposite the apex. The heart does not rest on its base; it rests on its diaphragmatic (inferior) surface.

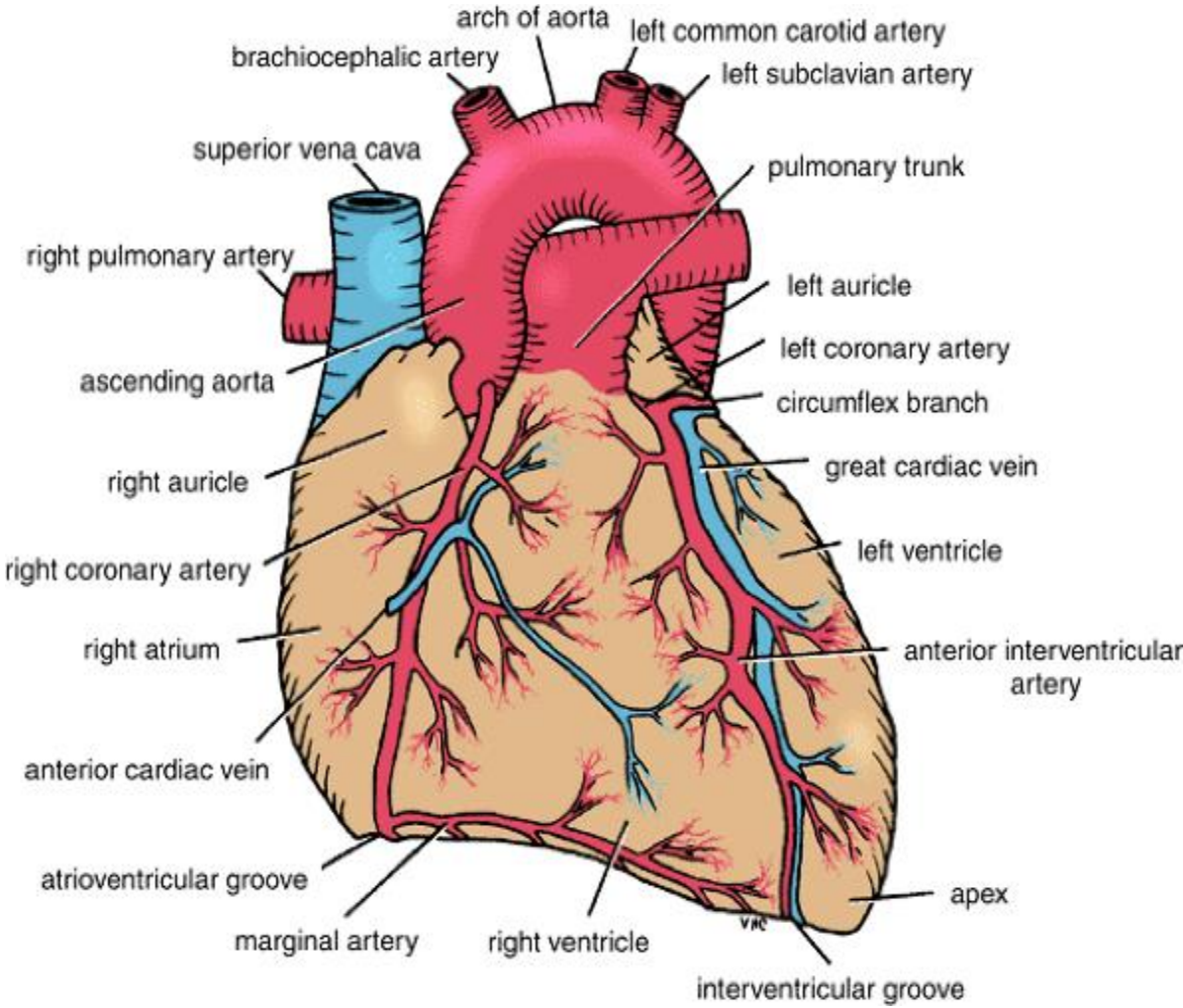


Borders of the Heart

The right border is formed by the right atrium; the left border, by the left auricle; and below, by the left ventricle. The lower border is formed mainly by the right ventricle but also by the right atrium; the apex is formed by the left ventricle. The Rt and Lt atria forms superior border.

Chambers of the Heart

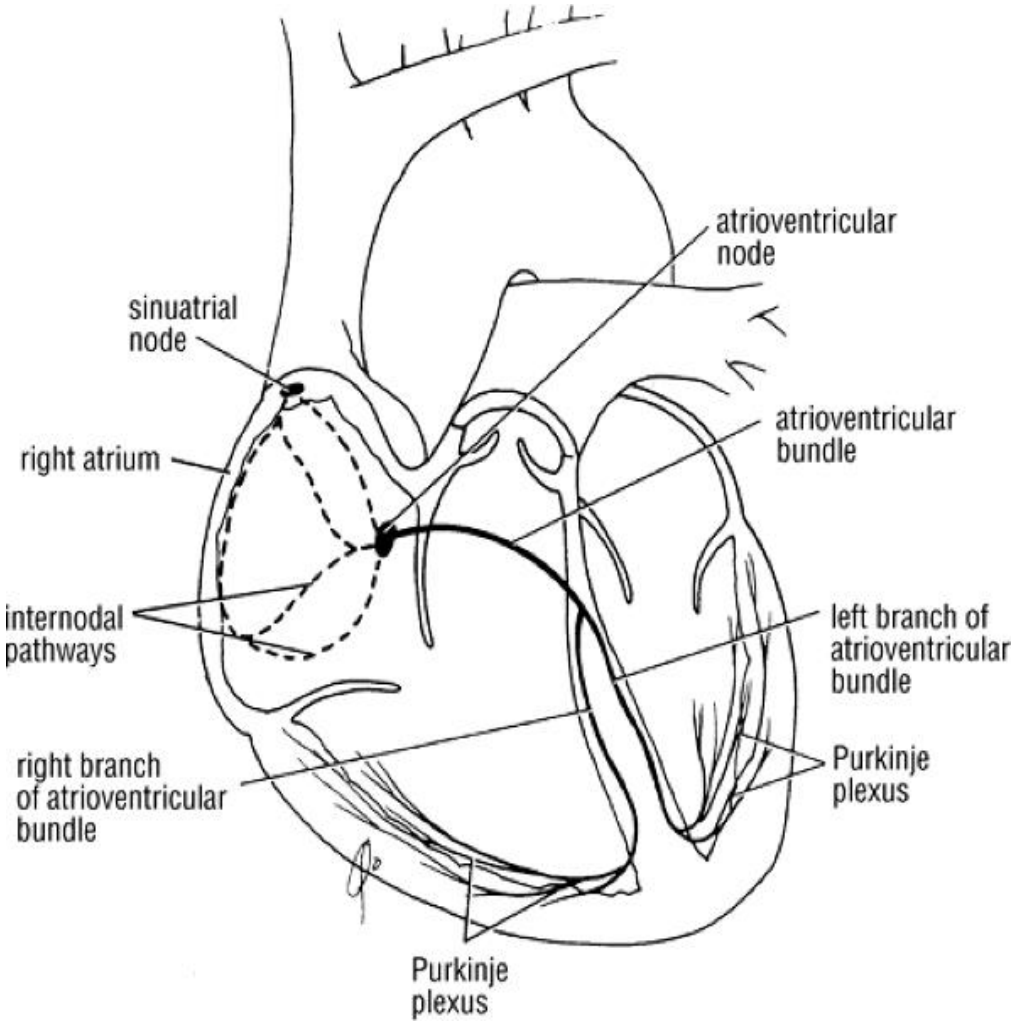
The heart is divided by vertical septa into four chambers: the right and left atria and the right and left ventricles. The right atrium lies anterior to the left atrium, and the right ventricle lies anterior to the left ventricle.
The walls of the heart are composed of cardiac muscle, the **myocardium;** covered externally with serous pericardium, the **epicardium;**and lined internally with a layer of endothelium, the **endocardium.**



Conducting System of the Heart

The normal heart contracts rhythmically at about 70 to 90 beats per minute in the resting adult.

The conducting system of the heart consists of specialized cardiac muscle present in the **sinuatrial node**, the **atrioventricular node**, the **atrioventricular bundle** and its right and left terminal branches, and the subendocardial plexus of **Purkinje fibers** (specialized cardiac muscle fibers that form the conducting system of the heart).



Surface Anatomy of the Heart Valves

The surface markings of the heart valves are as follows:

- The **tricuspid valve** lies behind the right half of the sternum opposite the fourth intercostal space.
- The **mitral valve** lies behind the left half of the sternum opposite the fourth costal cartilage.
- The **pulmonary valve** lies behind the medial end of the third left costal cartilage and the adjoining part of the sternum.
- The **aortic valve** lies behind the left half of the sternum opposite the third intercostal space.

Auscultation of the Heart Valves

It is important for a physician to know where to place the stethoscope on the chest wall so that he or she will be able to hear sounds produced at each valve with the minimum of distraction or interference.

- The **tricuspid valve** is best heard over the right half of the lower end of the body of the sternum.
- The **mitral valve** is best heard over the apex beat, that is, at the level of the fifth left intercostal space, 3.5 in. (9 cm) from the midline.
- The **pulmonary valve** is heard with least interference over the medial end of the second left intercostal space.
- The **aortic valve** is best heard over the medial end of the second right intercostal space.

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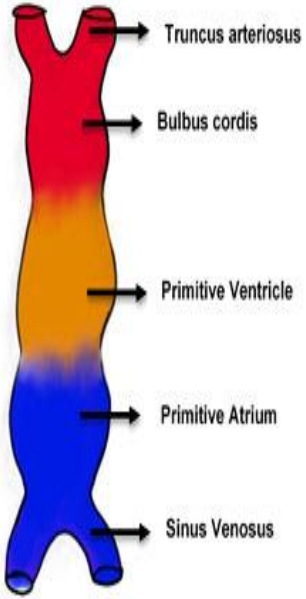

Figure 1A. The heart tube

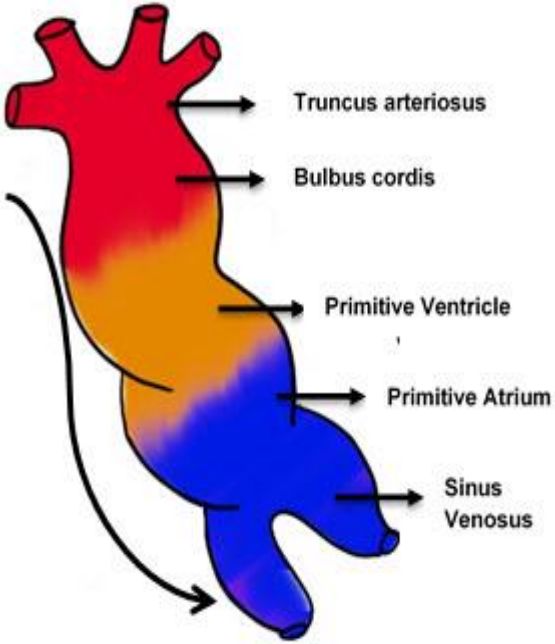

Figure 1B. Cardiac looping

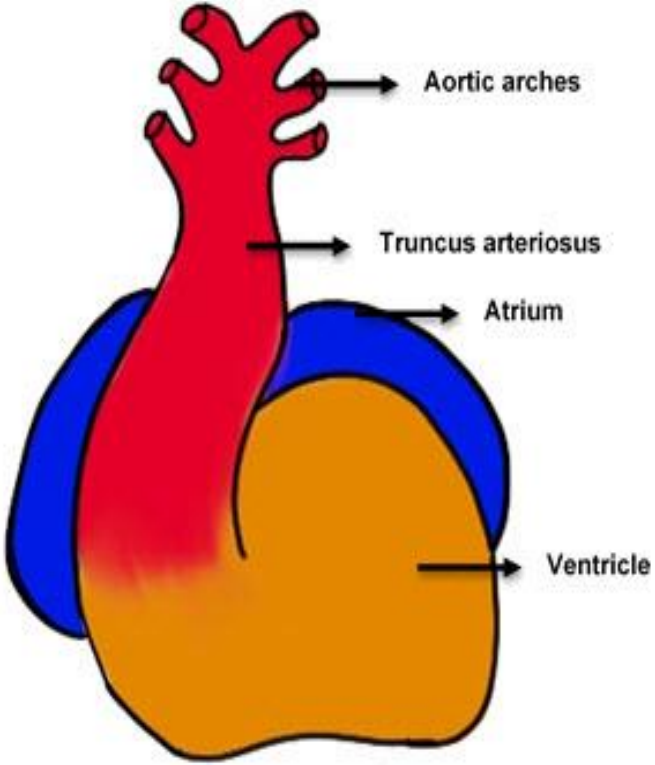

Figure 1C. Fetal heart

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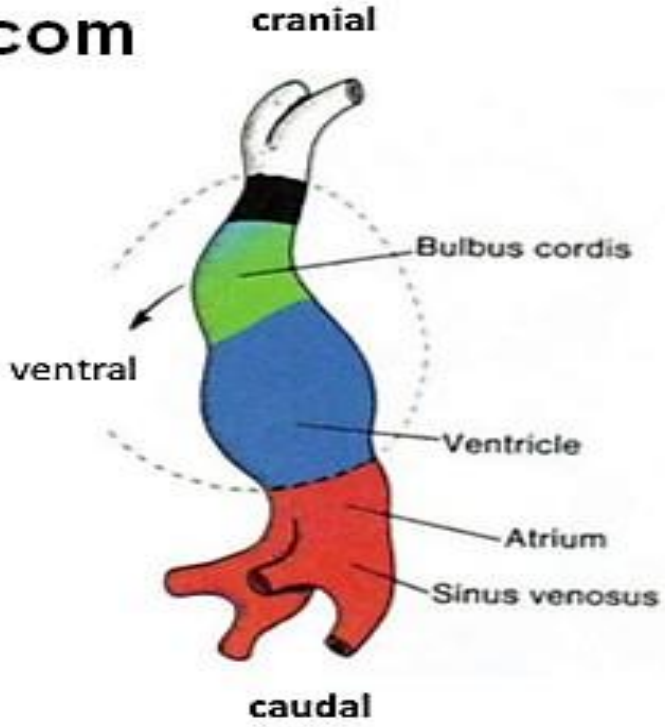
Truncus arteriosus

Bulbus cordis

Primitive ventricle

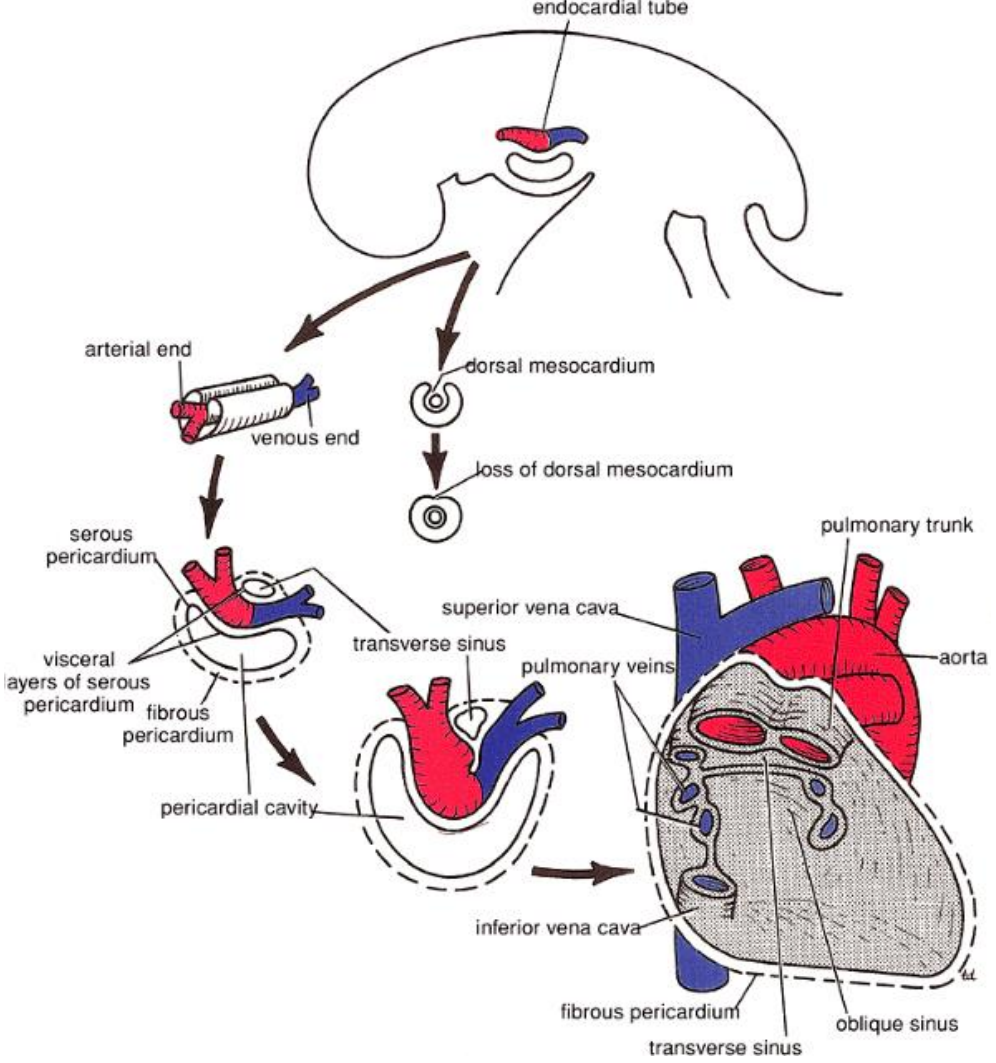
Primitive atria

Sinus venosus

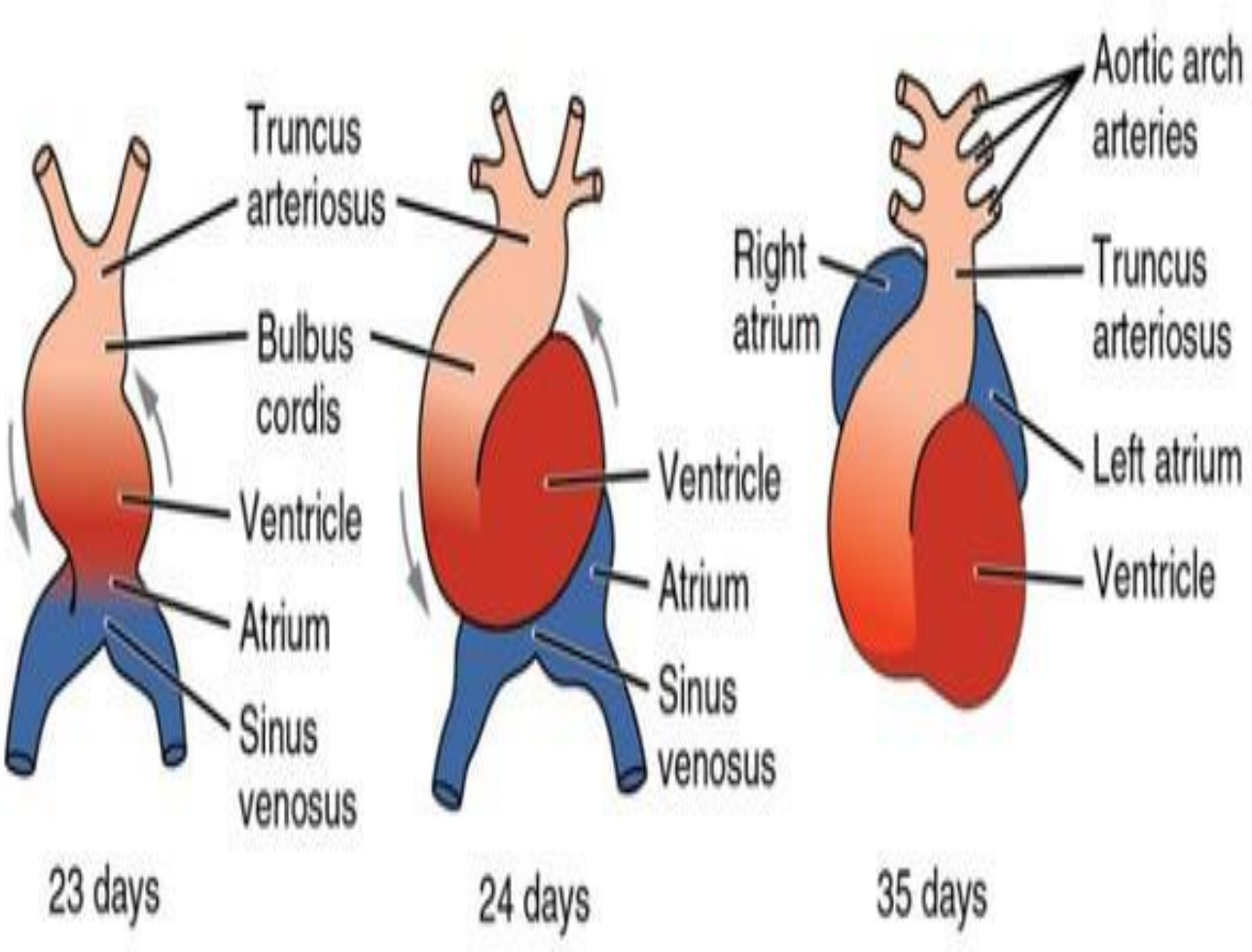


CVS DEVELOPMENT

The entire cardiovascular system—heart, blood vessels, and blood cells—originates from the mesodermal germ layer. Induction of the cardiogenic region is initiated by anterior endoderm underlying prospective heart cells. Although initially paired, by the 22nd day of development, the two tubes form a single, slightly bent heart tube consisting of an inner endocardial tube and a surrounding myocardial mantle.

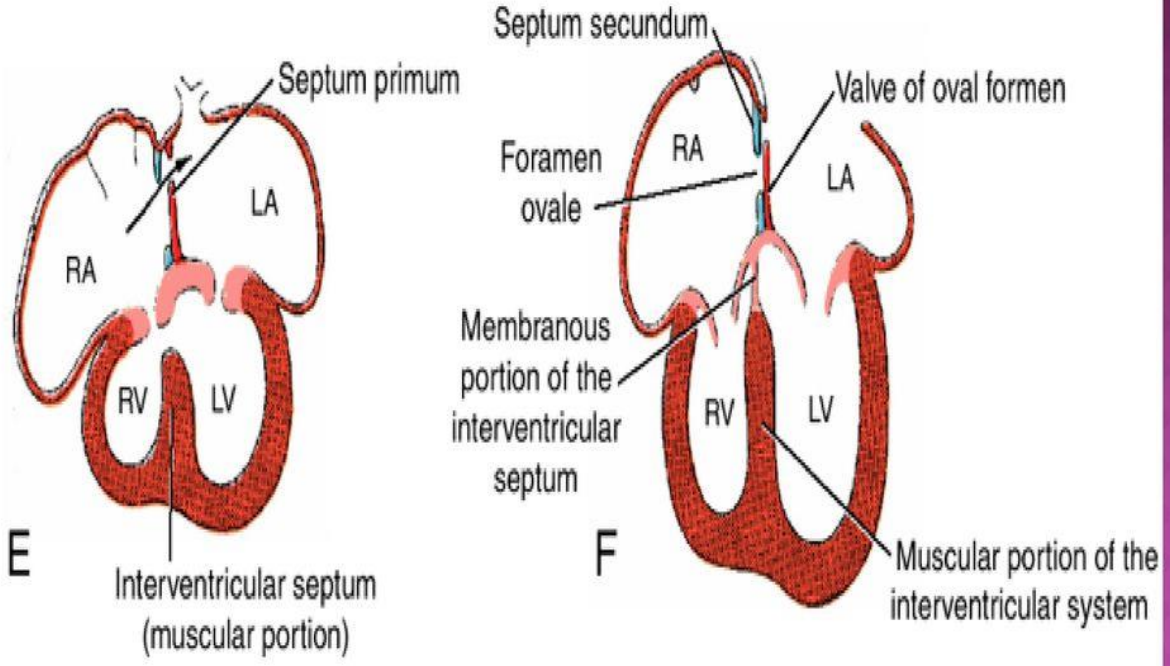


The caudal end of this tube forms atrial structures. During the 4th to 7th weeks, the heart undergoes looping followed by septation into a typical four chambered structure.



Septum formation in the heart in part arises from development of endocardial cushion tissue in the atrioventricular canal (atrioventricular cushions) and in the conotruncal region (conotruncal swellings). Because of the key location of cushion tissue, many cardiac malformations are related to abnormal cushion morphogenesis.

Septum Formation in the Ventricles



Septum Formation in the Atrium. The septum primum, a sickle-shaped crest descending from the roof of the atrium, begins to divide the atrium in two but leaves a lumen, the ostium primum, for communication between the two sides.

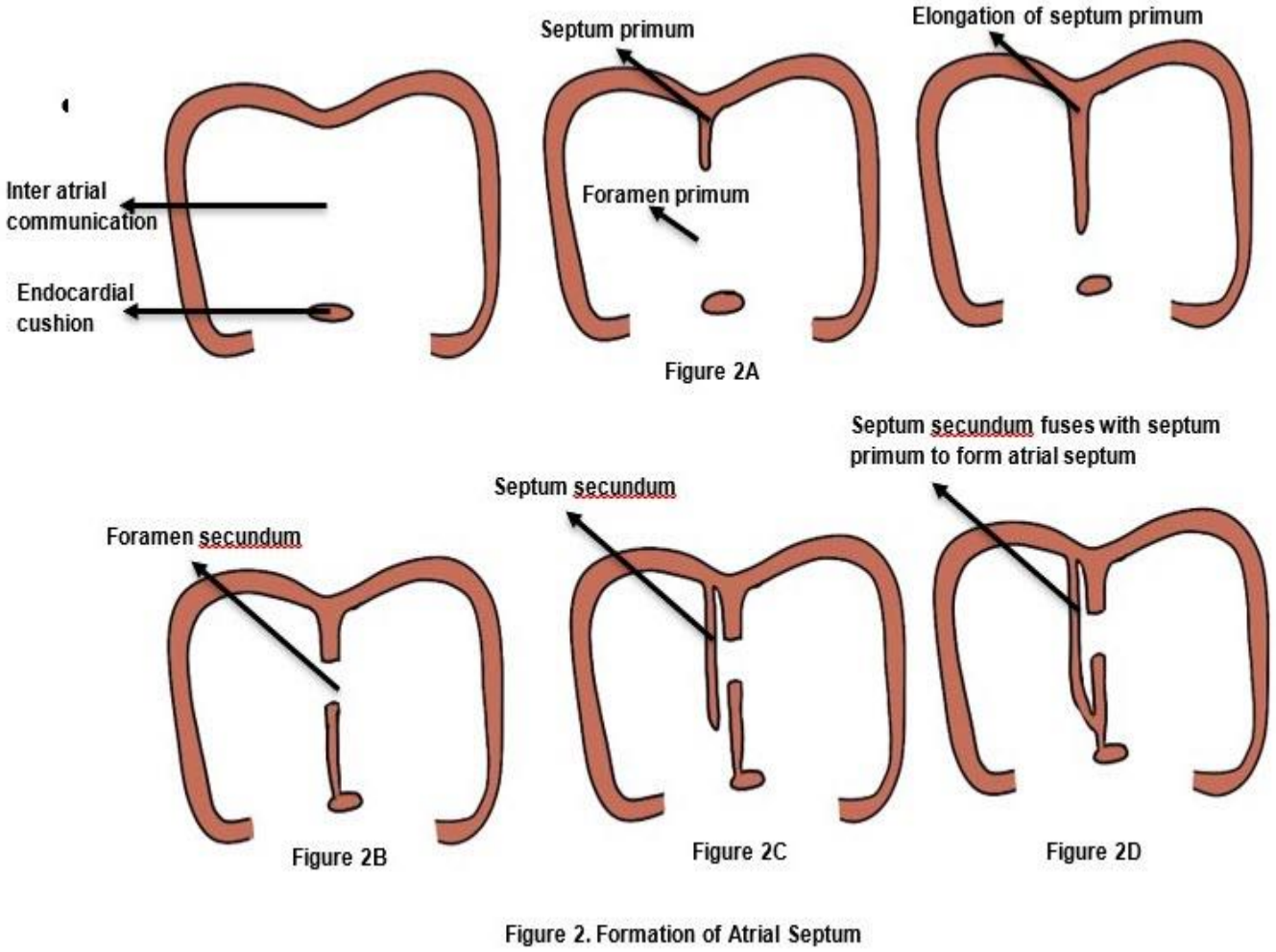
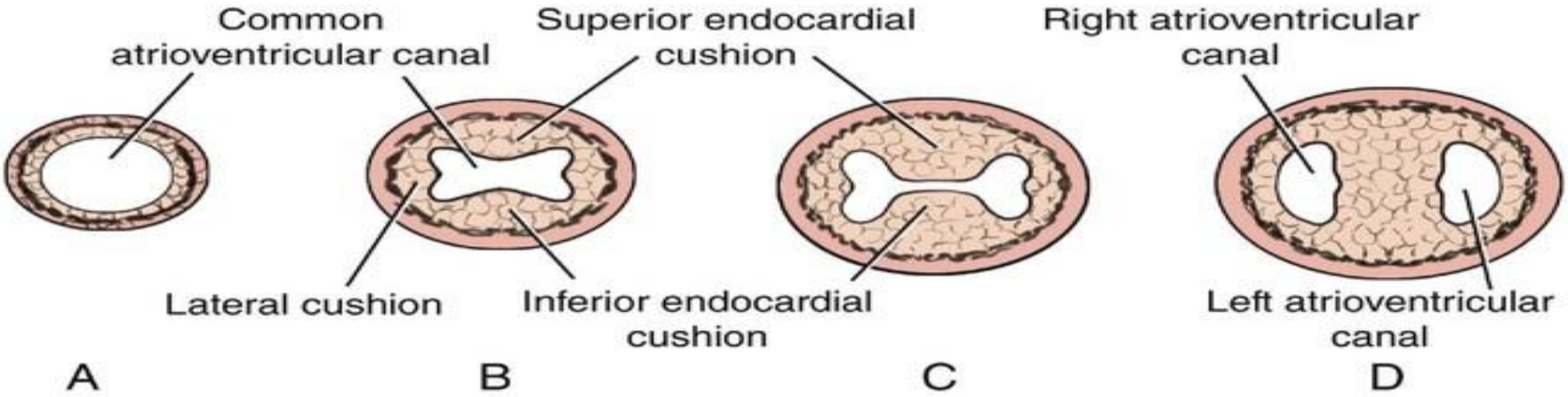


Figure 2. Formation of Atrial Septum

Later, when the ostium primum is obliterated by fusion of the septum primum with the endocardial cushions, the ostium secundum is formed by cell death that creates an opening in the septum primum. Finally, a septum secundum forms, but an interatrial opening, the oval foramen, persists. Only at birth, when pressure in the left atrium increases, do the two septa press against each other and close the communication between the two.

Abnormalities in the atrial septum may vary from total absence to a small opening known as probe patency of the oval foramen.

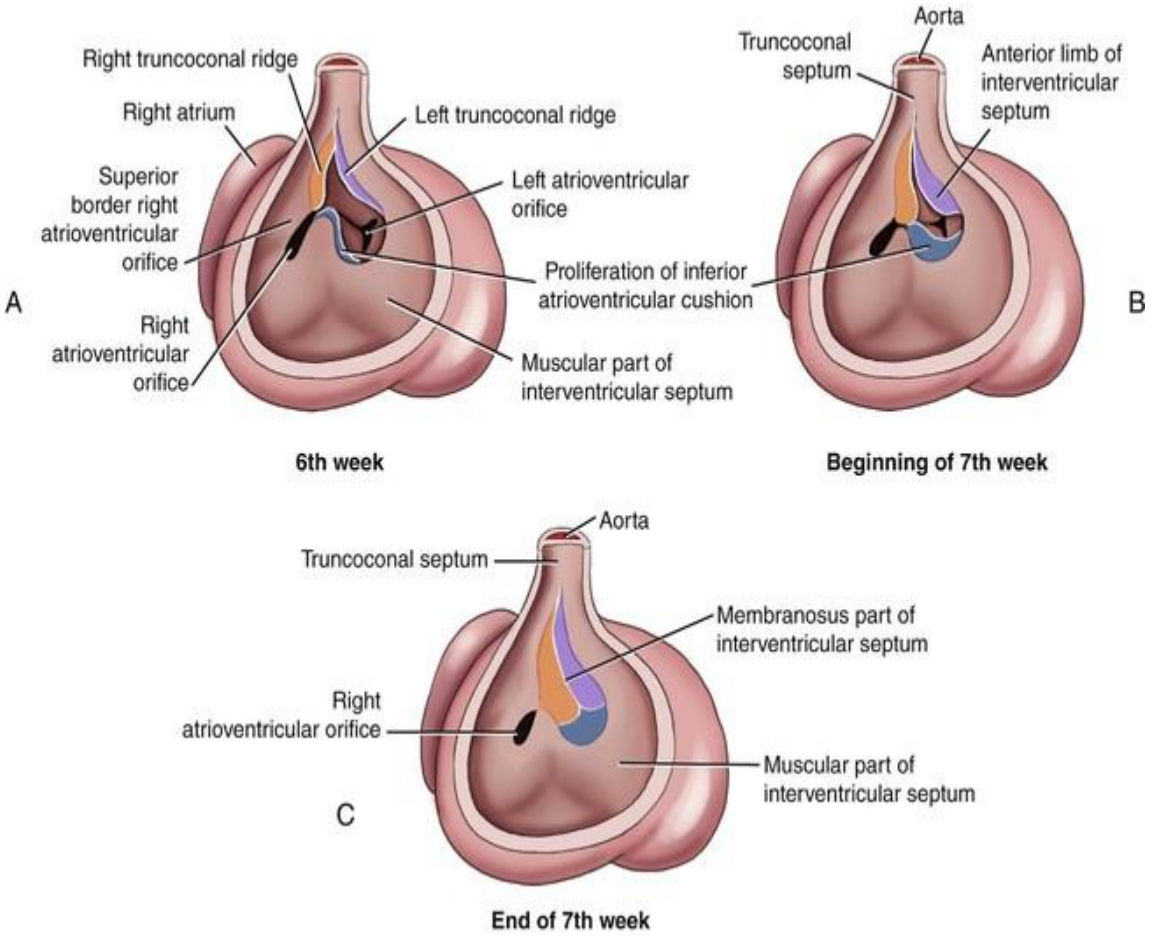
Septum Formation in the Atrioventricular Canal. Four endocardial cushions surround the atrioventricular canal. Fusion of the opposing superior and inferior cushions divides the orifice into right and left atrioventricular canals. Cushion tissue then becomes fibrous and forms the mitral (bicuspid) valve on the left and the tricuspid valve on the right. Persistence of the common atrioventricular canal and abnormal division of the canal are well-known defects.



Septum Formation in the Ventricles. The interventricular septum consists of a thick

1. Muscular part and a thin
2. Membranous portion formed by

(a) an inferior endocardial atrioventricular cushion,
(b) the right conus swelling, and
(c) the left conus swelling.



Septum Formation in the Bulbus.

The bulbus is divided into

(a) the truncus (aorta and pulmonary trunk), The truncus region is divided by the spiral aorticopulmonary septum into the two main arteries.

(b) The conus (outflow tract of the aorta and pulmonary trunk), and

(c) The trabeculated portion of the right ventricle.

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The conus swellings divide the outflow tracts of the aortic and pulmonary channels and with tissue from the inferior endocardial cushion, close the interventricular foramen. Many vascular abnormalities, such as transposition of the great vessels and pulmonary valvular atresia, result from abnormal division of the conotruncal region; their origin may involve neural crest cells that contribute to septum formation in the conotruncal region.

The aortic arches lie in each of the five pharyngeal arches. Four important derivatives of the original aortic arch system are

(a) the carotid arteries (third arches);
(b) the arch of the aorta (left fourth aortic arch);
(c) the pulmonary artery (sixth aortic arch), which during fetal life is connected to the aorta through the ductus arteriosus; and
(d) the right subclavian artery formed by the right fourth aortic arch, distal portion of the right dorsal aorta, and the seventh intersegmental artery .
(e) Left subclavian artery is formed from seventh intersegmental artery .

The most common vascular aortic arch abnormalities include (a) open ductus arteriosus and coarctation of the aorta (Fig. 12.37) and (b) persistent right aortic arch and abnormal right subclavian artery (Figs. 12.38 and 12.39), both causing respiratory and swallowing complaints. The vitelline arteries initially supply the yolk sac but later form the celiac, superior mesenteric, and inferior mesenteric arteries, which supply

The paired umbilical arteries arise from the common iliac arteries. After birth, the distal portions of these arteries are obliterated to form the medial umbilical ligaments, whereas the proximal portions persist as the internal iliac and vesicular arteries.

Venous System.

Three systems can be recognized:

(a) the vitelline system, which develops into the portal system;

(b) the cardinal system, which forms the caval system; and

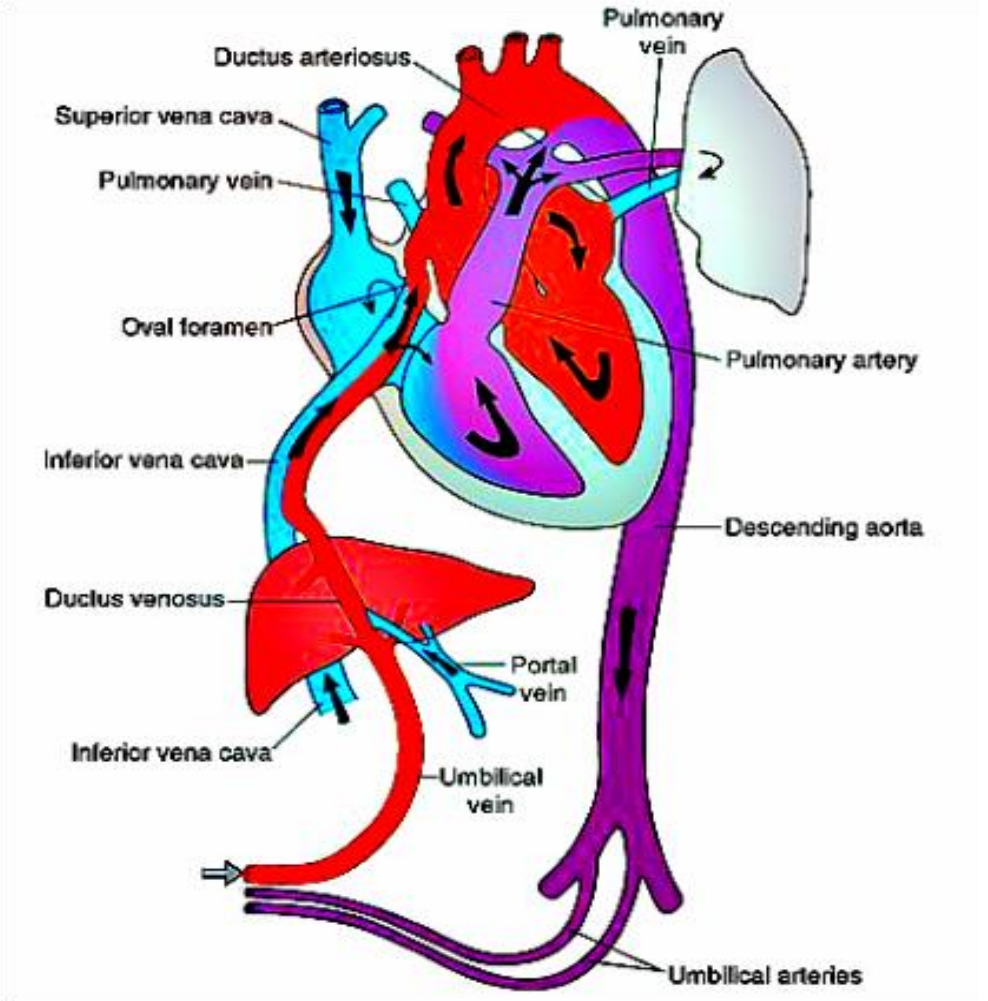
(c) the umbilical system, which disappears after birth.

The complicated caval system is characterized by many abnormalities, such as double inferior and superior vena cava and left superior vena cava.

Changes at Birth.

During prenatal life, the placental circulation provides the fetus with its oxygen, but after birth, the lungs take on gas exchange. In the circulatory system, the following changes take place at birth and in the first postnatal months:

(a) the ductus arteriosus closes;
(b) the oval foramen closes;
(c) the umbilical vein and ductus venosus close and remain as the ligamentum teres hepatis and ligamentum venosum; and
(d) the umbilical arteries form the medial umbilical ligaments.

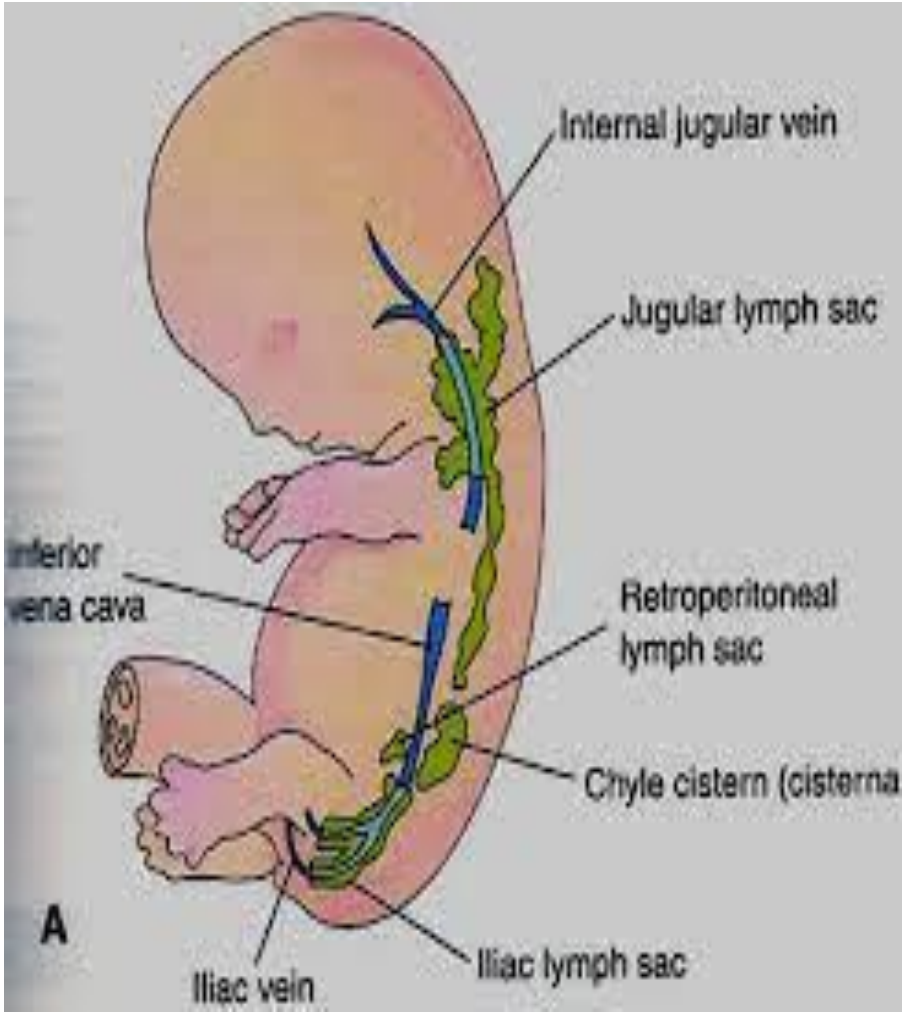


Lymphatic System.

The lymphatic system develops later than the cardiovascular system, originating from the endothelium of veins as six sacs:

1. Two jugular, 2. Two iliac,
3. One retroperitoneal, 4. One cisterna chyli.

Numerous channels form to connect the sacs and provide drainage from other structures. Ultimately, the thoracic duct forms from anastomosis of the right and left thoracic ducts, the distal part of the right thoracic duct, and the cranial part of the left thoracic duct. The right lymphatic duct develops from the cranial part of the right thoracic duct.



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