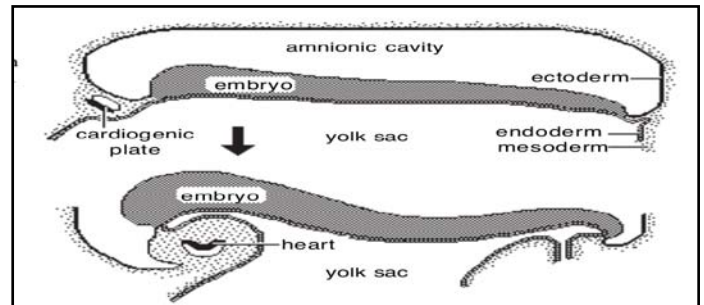


Development of Cardiovascular system

- The cardiovascular system develops very early (about week-3)
- Heart: Beginning as a simple tube, the heart undergoes differential growth into a four chambered structure.

Formation of a Tubular Heart:

- From cardiogenic plate (splanchnic mesoderm situated anterior to the embryo)
- The cardiogenic plate moves ventral to the pharynx as the head process grows upward and outward.
- Bilateral endocardial tubes meet at the midline & fuse into a single endocardial tube, the future heart.
- Endocardial tube (Splanchnic mesoderm surrounding the tube forms cardiac muscle cells)



Primitive Heart Regions:

Differential growth of the endocardial tube establishes five primitive heart regions:

- **Truncus arteriosus:** the output region of the heart. It will develop into the ascending aorta and pulmonary trunk.
- **Bulbus cordis:** a bulb-shaped region destined to become right ventricle.
- **Ventricle:** an enlargement destined to become the left ventricle.
- **Atrium:** a region that will expand to become both right and left auricles.
- **Sinus venosus:** a paired region into which veins drain. The left sinus venosus becomes the coronary sinus; the right is incorporated into the wall of the right atrium.

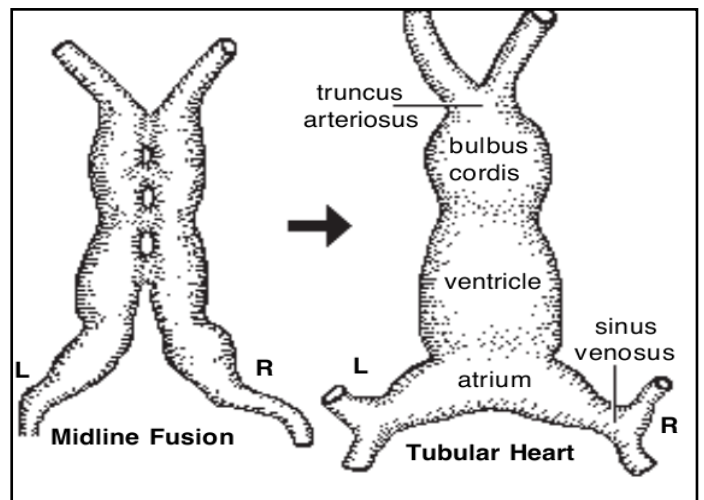


Fig.1 Formation of tubular heart

Forming a Four-Chambered Heart:

The following are six stages of the development of four-chambered heart:

1. Endocardial tube lengthens and loops on itself this puts the bulbus cordis (right ventricle) beside the ventricle (left ventricle) and the atrium dorsal to the ventricle.
2. Venous return is shifted to the right side
3. Atrio-ventricular opening is partitioned:
4. Right & left ventricles formed
5. Right and left atria divided by a septum
6. Aorta and pulmonary trunk formed

****Fetal circulation, shunts and changes after birth- Please see the angiology lecture.****

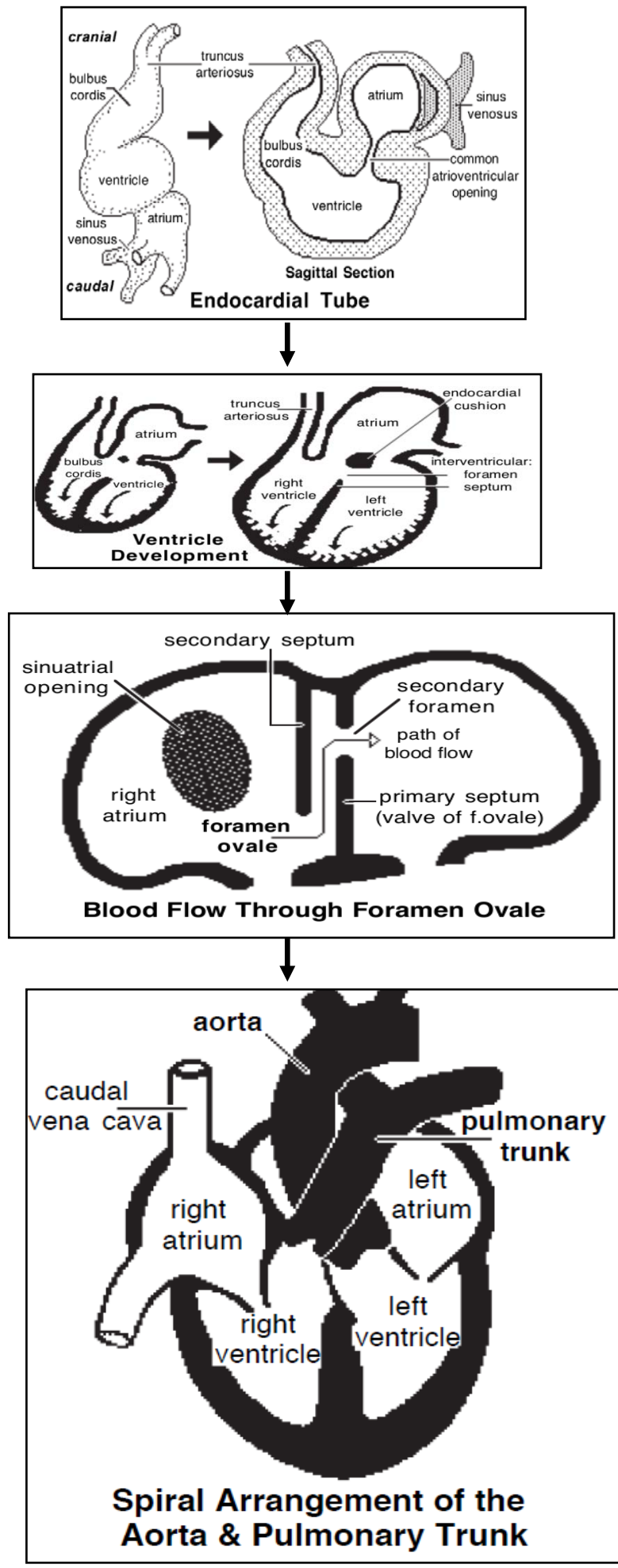


Fig.2 Stages of Four chambered heart development

Fetal circulation:

Throughout entire gestation period, the fetus depends on the dam for nutrients, water, oxygen needed for growth and elimination of carbon dioxide and other waste products. In this period, fetus gets oxygenated blood and nutrients from dam via placenta.

In the fetal life, lungs remain solid or collapsed and functionally inactive. So in fetus blood is oxygenated in the placenta.

- Before birth umbilical vein enter into the fetus through umbilicus. Then umbilical vein enter liver of fetus.
- In liver, most of the blood flows through the ductus venosus directly into the caudal venacava. A smaller amount enters the liver sinusoids and mixes blood from portal circulation. A sphincter is present in the ductus venosus which regulates flow of blood through the liver sinusoids.
- After a short course in the caudal venacava it enters right atrium. 80% of the blood of caudal venacava enters left atrium through oval foramen, located at the atrial septum. A small amount of blood remains in the right atrium. Here it mixes with the deoxygenated blood returning from the head and arms via cranial venacava.
- From the left atrium, where it mixes with the small amount of deoxygenated blood returning from the lungs, blood enters the left ventricle and ascending aorta. Deoxygenated blood from the cranial venacava enters right atrium then right ventricle and then pulmonary circulation. During fetal life 80-90% of blood of the pulmonary trunk passes directly into the descending aorta via ductus arteriosus and remaining blood enter the lung.
- After systemic circulation via descending aorta blood flows toward placenta, via two umbilical arteries for purification.

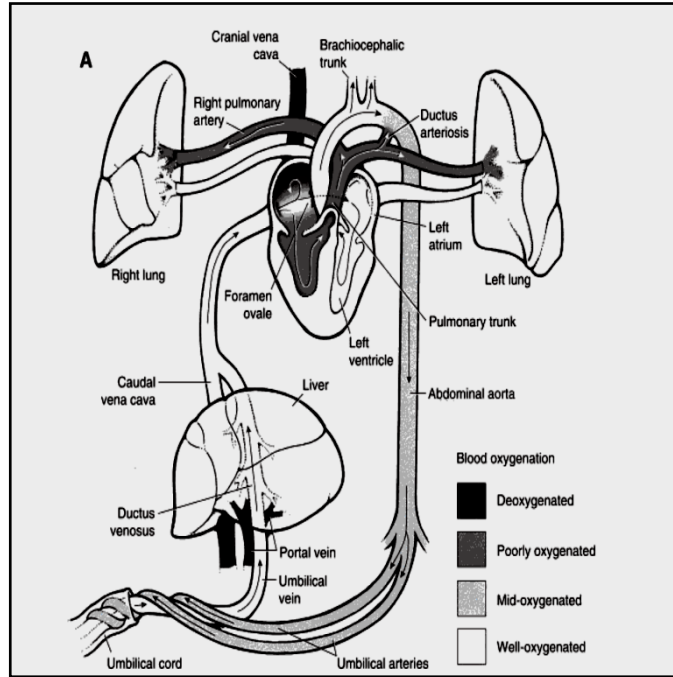


Fig. Fetal Circulation

Circulatory changes at birth:

Following changes occur in the vascular system after birth.

1. Closure of the umbilical arteries: form round ligament of liver in postnatal life.
2. Closure of the umbilical vein: form round ligament of urinary bladder in postnatal life.
3. Ductus venosus: form ligamentum venosum
4. Ductus arteriosum: forms ligamentum arteriosum
5. Foramen ovale/oval foramen: forms fossa ovale.

Shunts of fetal circulation:

There are two bypasses or shortcuts or shunts in the fetal circulation. These bypasses are:

- Foramen ovale: which connects the right and left atria.
- Ductus arteriosus-which connect the pulmonary artery and aorta.