UNIVERSITY OF BASRAH

AL-ZAHRAA MEDICAL COLLEGE

Ministry of higher Education
and Scientific Researches

The module: Cardiovascular system

Session 3, Lecture 1

Duration : 1 hr

Early Development of the Cardiovascular System P II

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As in work book

For more discussion, questions or cases need help please post to the session group

Learning outcomes:

1-Relate the anatomy of the adult heart to embryonic structures . (LO1)

2-Describe the process of septation (Formation of the inter-atrial and inter-ventricular septum). (LO2)

3-Understand the principles of the fetal circulation

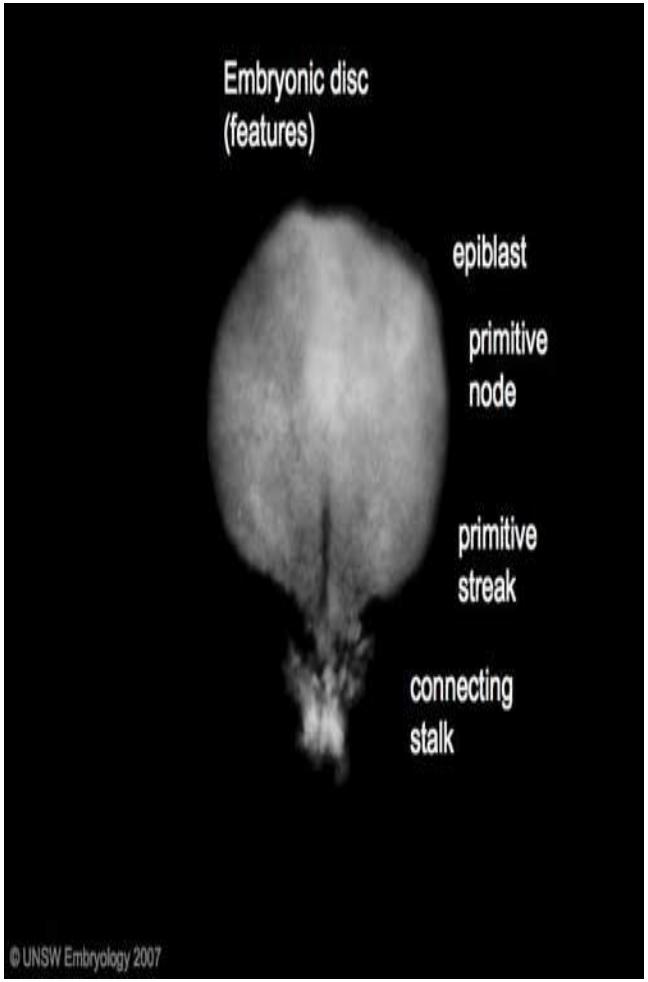
- Fate of the fetal shunts. (LO3)

Development of the heart

- -At the middle of 3rd week
- **Progenitor heart cells** lie in the epiblast adjacent to cranial end of the primitive streak

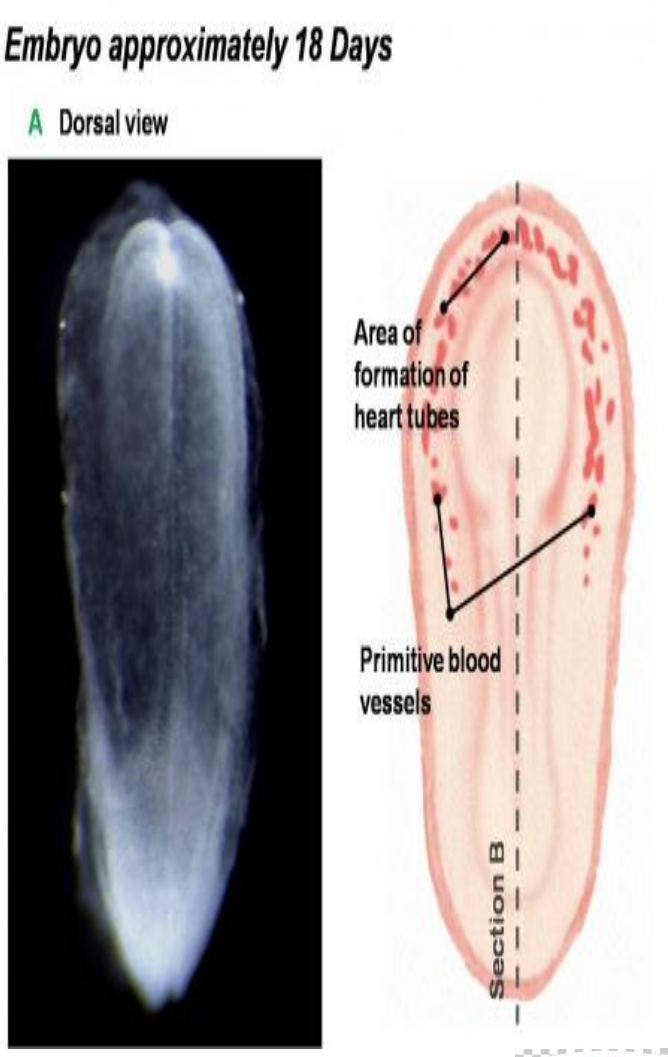
Then **migrate** Into splanchnic layer of lateral plate mesoderm to form **Horse-shoe cluster of cells** called **primary heart field (PHF)** cranial to neural tube

- **16-18days**
- PHF form atria, LV, and most of RV



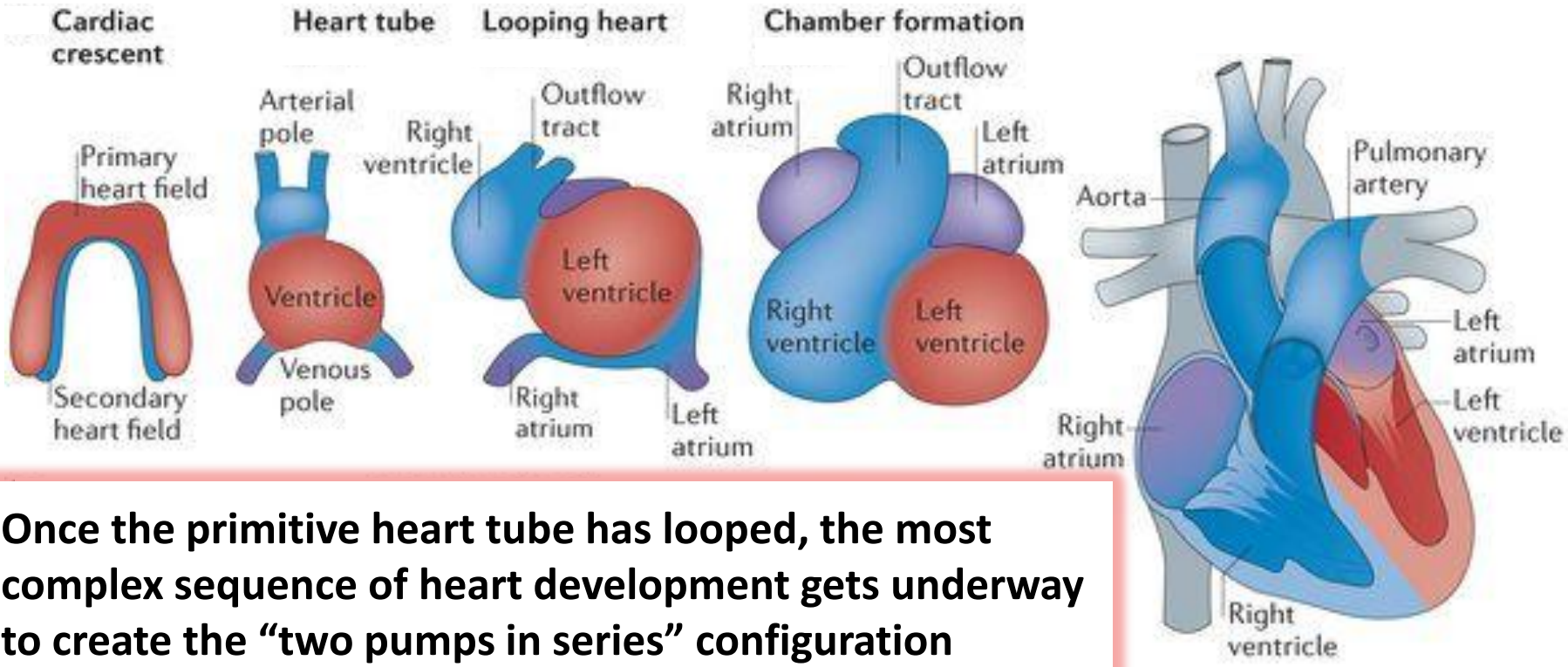
Development of the heart

- The remainder of RV, outflow tract (conus cordis, truncus arteriosus) are derived from **secondary heart field (SHF)**
- At **(20-21 days)** from migrated blood cells
- The process controlled by **Signaling pathway**
- The intraembryonic cavity overlap the cardiogenic area forming the **pericardium**
- At cardiogenic area other blood islands migrate bilaterally to form parallel pair of long vessels closed at midline forming **dorsal aorta**



Embryonic vs. adult heart structures

(LO1)

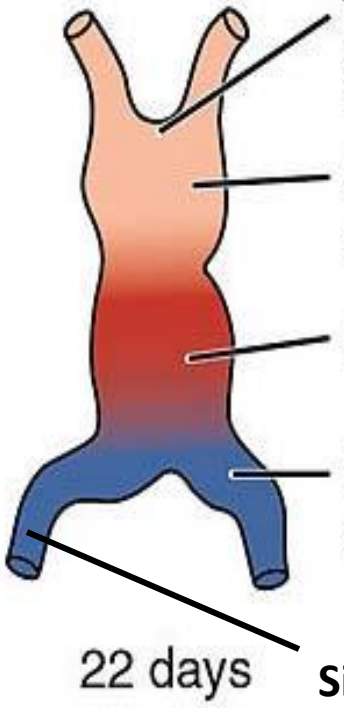


Once the primitive heart tube has looped, the most complex sequence of heart development gets underway to create the "two pumps in series" configuration required.

Therefore in the process of septation the primitive heart tube becomes divided into chambers and the outflow tract is subdivided into pulmonary trunk and aorta.

Embryonic vs. adult heart structures

(LO1)



-Ascending aorta
-Pulmonary trunk

-Smooth part of right ventricle (conus arteriosus).
-Smooth part of left ventricle(aortic vestibule).

-Trabeculated part of right and left ventricles

-Trabeculated part of right and left atria

-Smooth part of right atrium (Sinus venarum)
-coronary sinus
-oblique vein of left atrium

The process of septation

(LO2)

In the process of septation the primitive heart tube becomes divided into chambers and the outflow tract is subdivided into pulmonary trunk and aorta.

Firstly, the junction between the atrium and ventricle becomes constricted creating a narrow channel called the atrio-ventricular canal.

This narrowing provides a framework by which the inter-atrial and inter-ventricular septa are formed.

Septum formation

(LO2)

The major septa of the heart are formed between the 27th and 37th days of development, when the embryo grows in length from 5 mm to approximately 16 to 17 mm.

Method of formation of septum

1. two actively growing masses of tissue that approach each other until they fuse, dividing the lumen into two separate canals.
2. active growth of a single tissue mass that continues to expand until it reaches the opposite side of the lumen

Process of septation

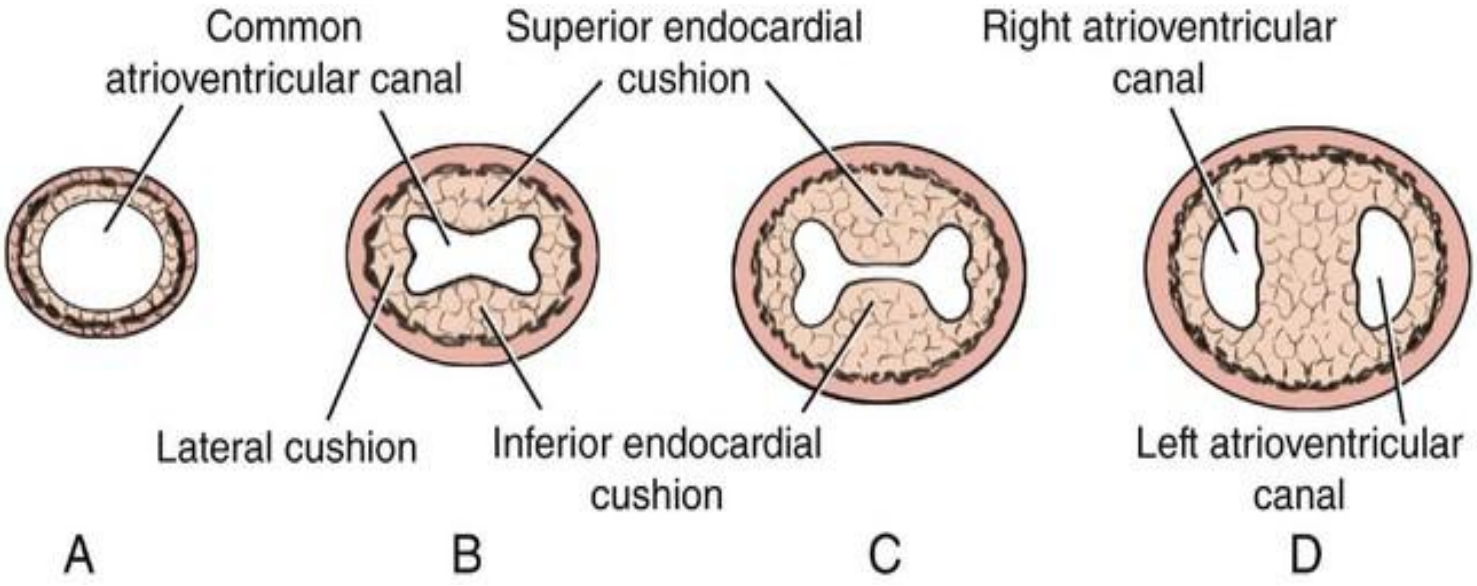
(LO2)

- Formation of such tissue masses depends on synthesis and deposition of **extracellular matrices and cell proliferation**.
- The masses, known as **endocardial cushions**, develop in the atrioventricular and conotruncal regions. In these locations, they assist in formation of the atrial and ventricular septi

The process of septation

(LO2)

Endocardial cushions form in the region of the atrio-ventricular canal and provide a platform toward which the septa grow inferiorly (inter – atrial) or superiorly (inter – ventricular), dividing the heart into left and right sides.



Process of septation

(LO2)

Because of their key location, **abnormalities** in endocardial cushion formation may cause **cardiac malformations**, including atrial and ventricular septal defects (VSDs) and defects involving the great vessels (i.e., transposition of the great vessels, common truncus arteriosus, and tetralogy of Fallot).

Process of septation

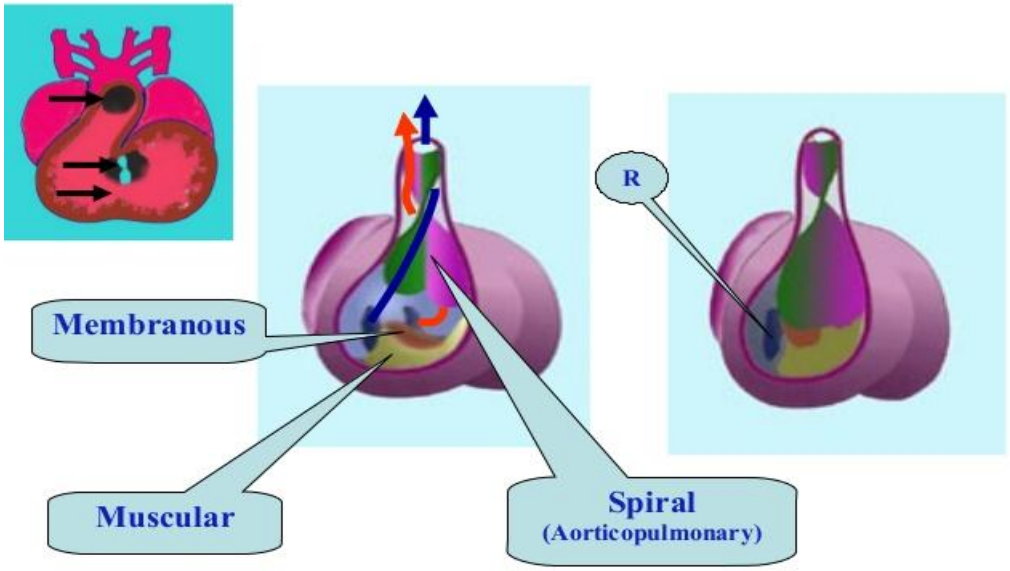
(LO2)

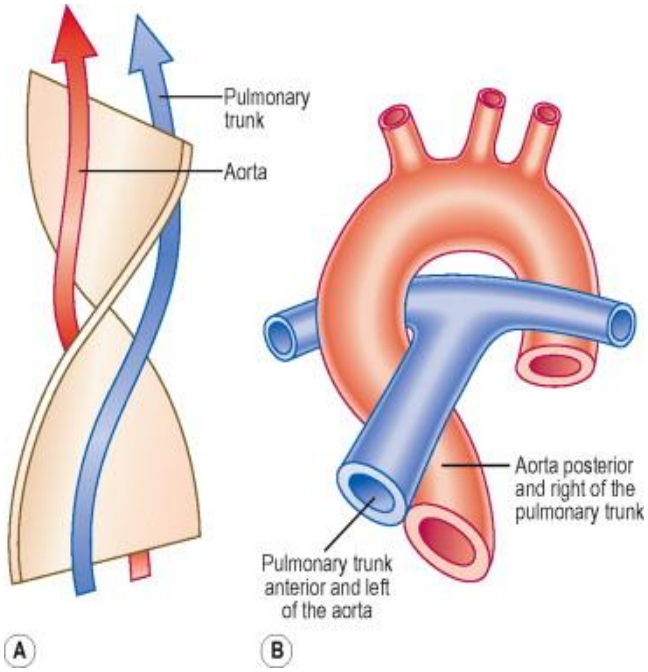
3. a narrow strip of tissue in the wall of the atrium or ventricle should fail to grow while areas on each side of it expand rapidly, **a narrow ridge** forms between the two expanding portions
When growth of the expanding portions continues on either side of the narrow portion, the two walls approach each other and eventually merge, forming a septum

The process of septation

(LO2)

Endocardial cushions forming in the truncus arteriosus contribute to the formation of a spiral septum dividing the outflow into pulmonary trunk and aorta.



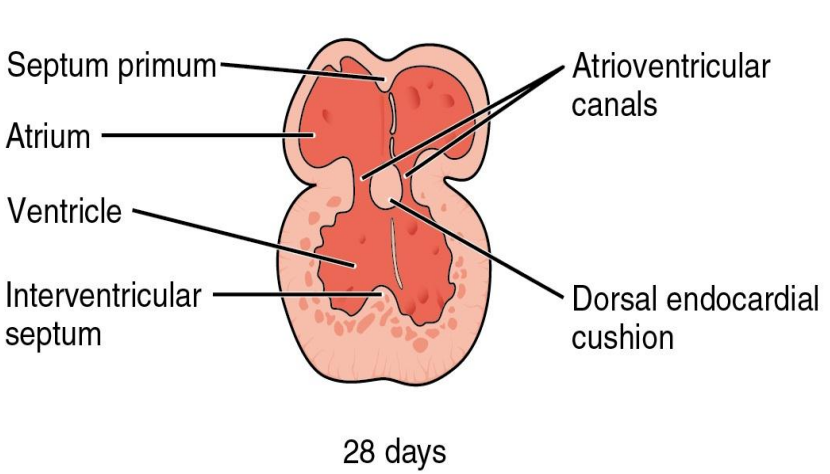


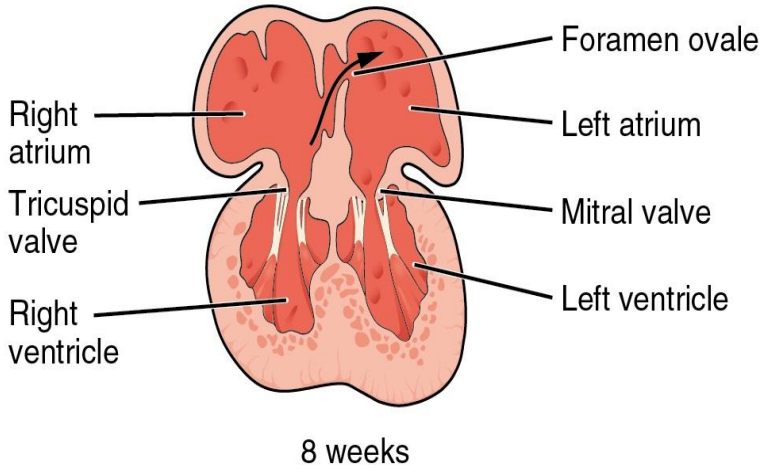
The process of septation

(LO2)

Atrial septation is complicated by the fact that the circulatory needs of the embryo/fetus are different to those of the adult. Thus a right – to – left shunt (the foramen ovale) must be maintained during life in utero, but this must be instantly sealable at birth.

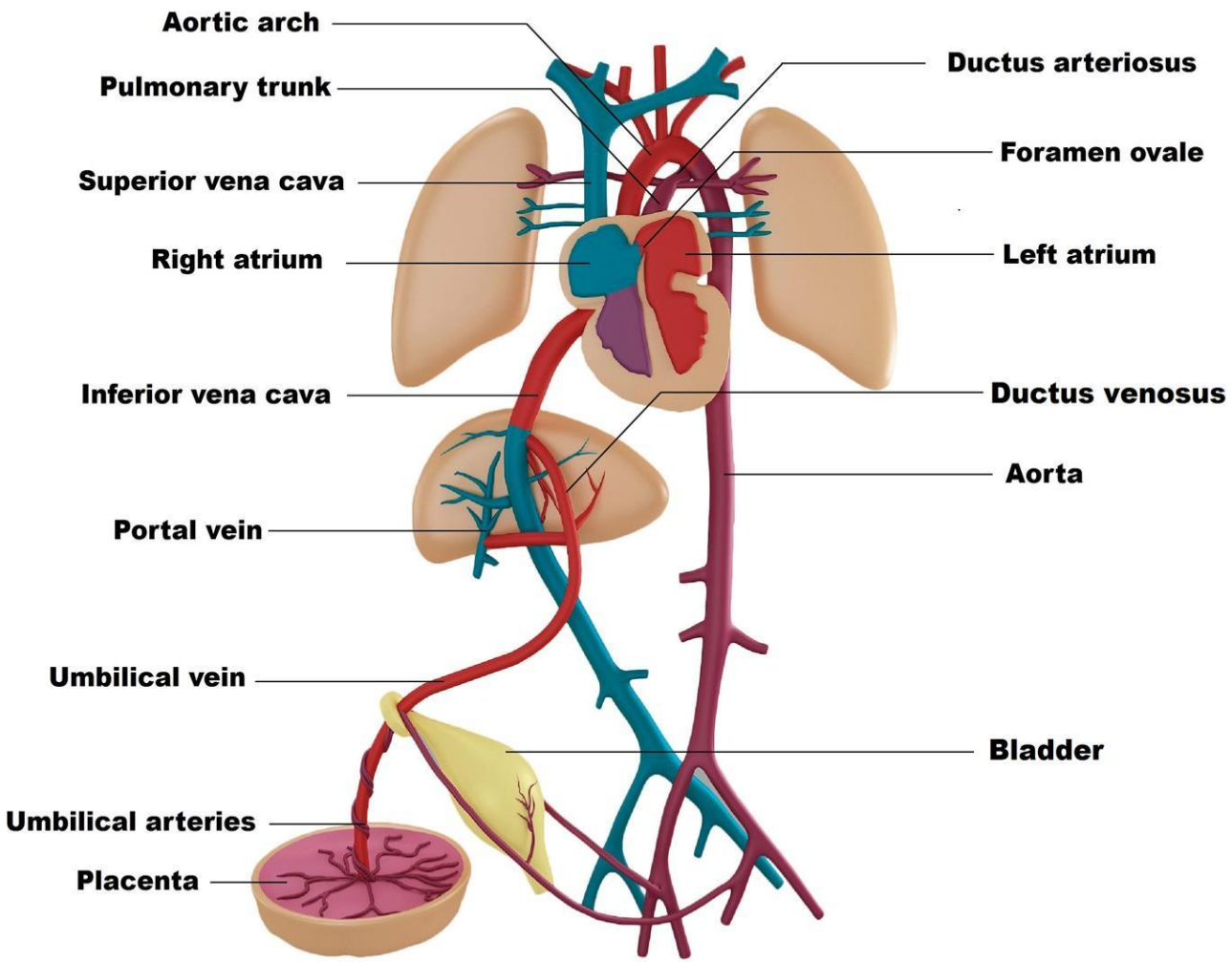
Partitioning of the heart into four chambers





(LO3)

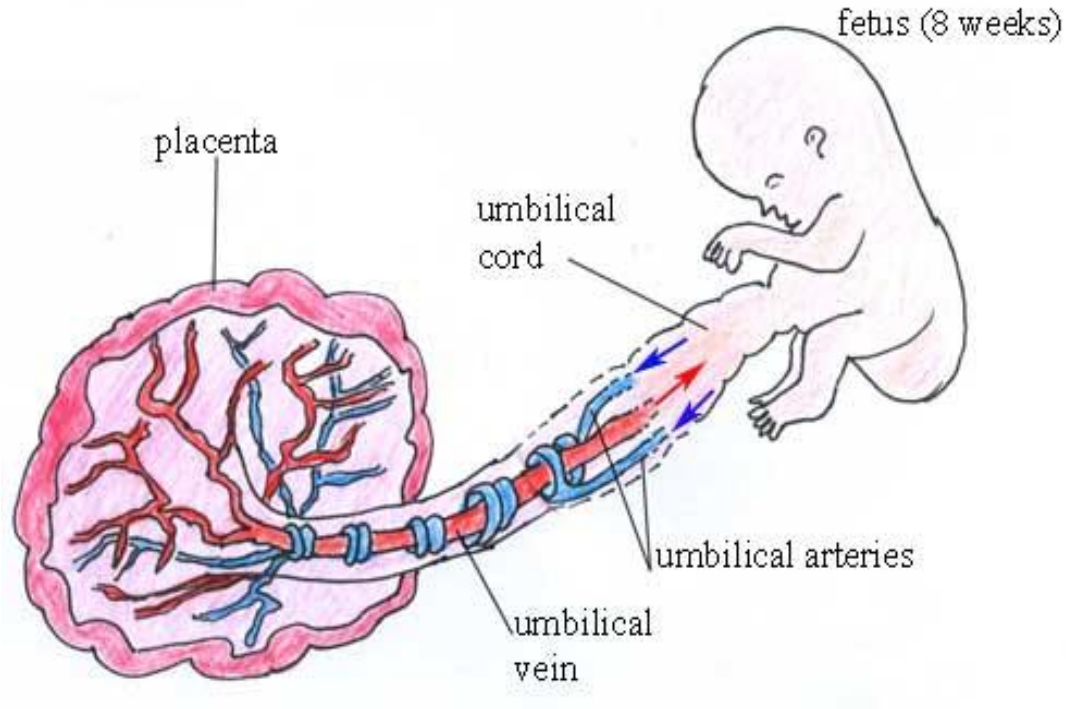
Fetal Circulation



Fetal circulation

(LO3)

- **Umbilical vein**
  - **returns 80% saturated blood from the placenta to the fetus**
- **Umbilical arteries**
  - **carry mainly deoxygenated blood back to the placenta for oxygenation**



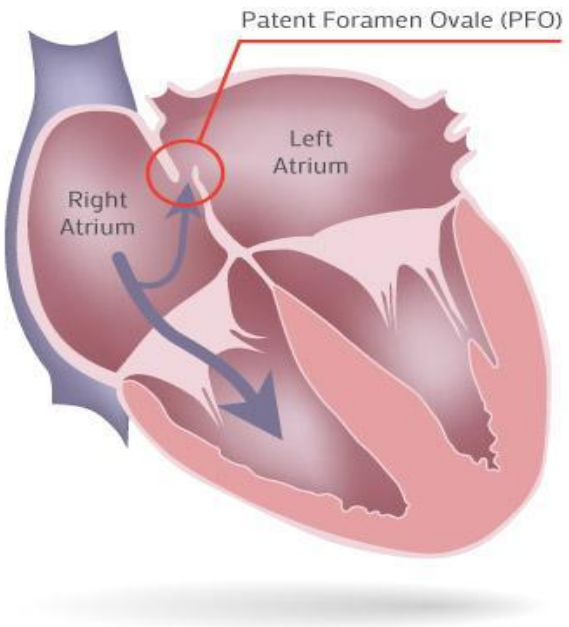
Fetal circulation

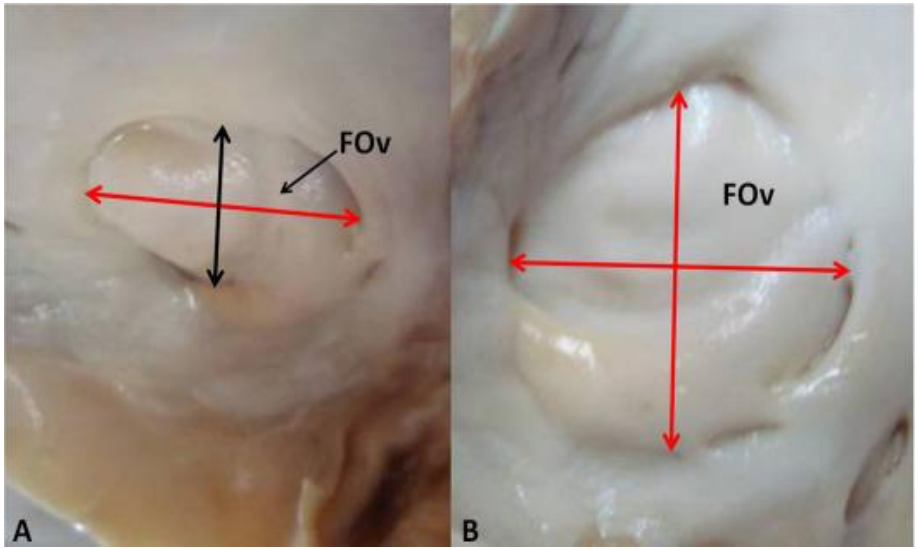
(LO3)

Foramen ovale

-Due to the increased pulmonary resistance, oxygenated blood entering the right atrium is diverted from the lungs through the foramen ovale into the left atrium to deliver oxygenated blood to the body.

-Closes after birth due to increased left atrial pressure and becomes fossa ovalis.





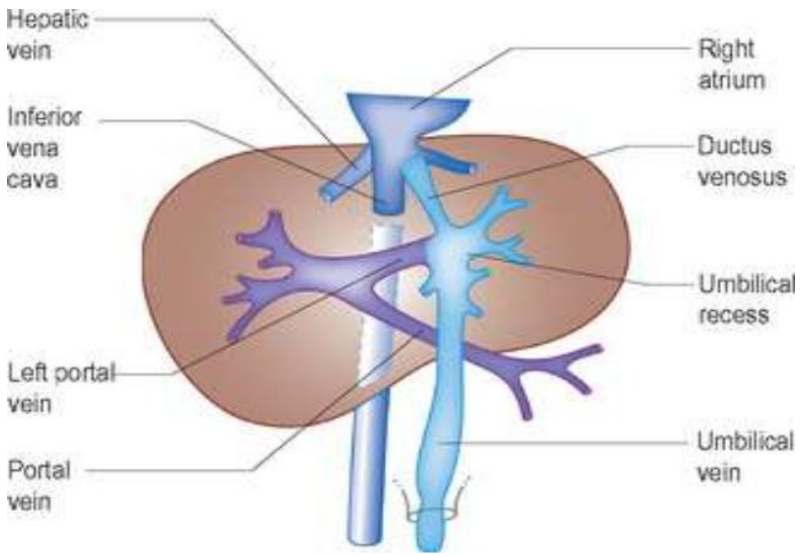
Fetal circulation

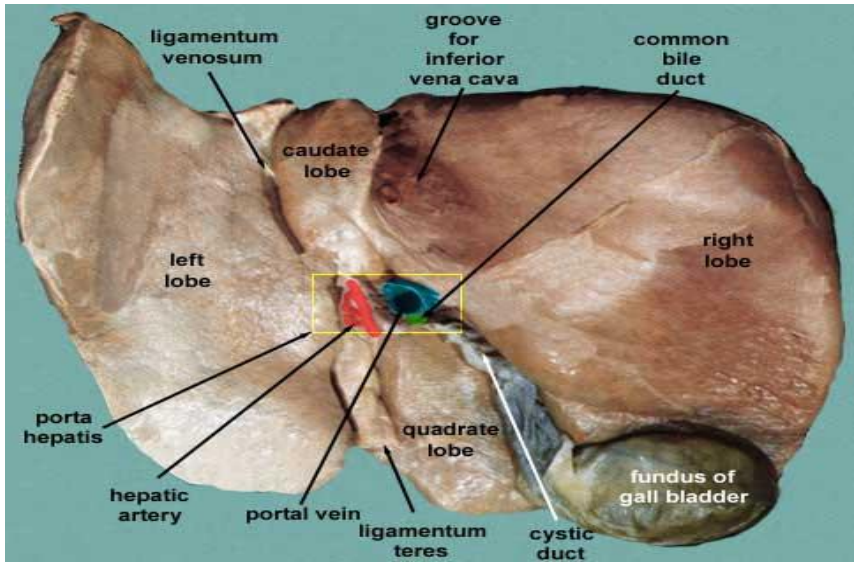
(LO3)

Ductus venosus

-Oxygenated blood returning from the placenta via the umbilical vein is shunted away from the liver via the ductus venosus to the IVC

-Becomes ligamentum venosum upon closure at birth





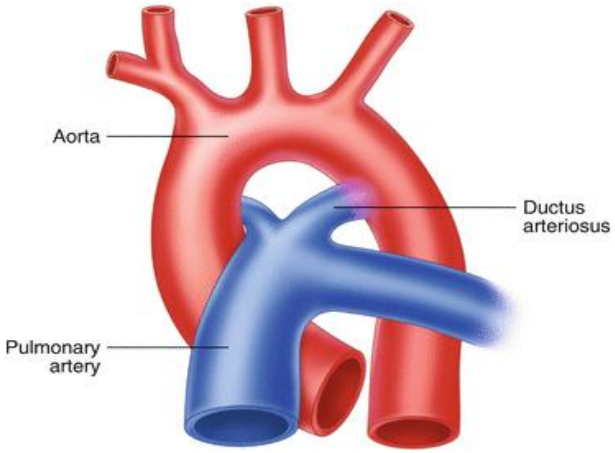
Fetal circulation

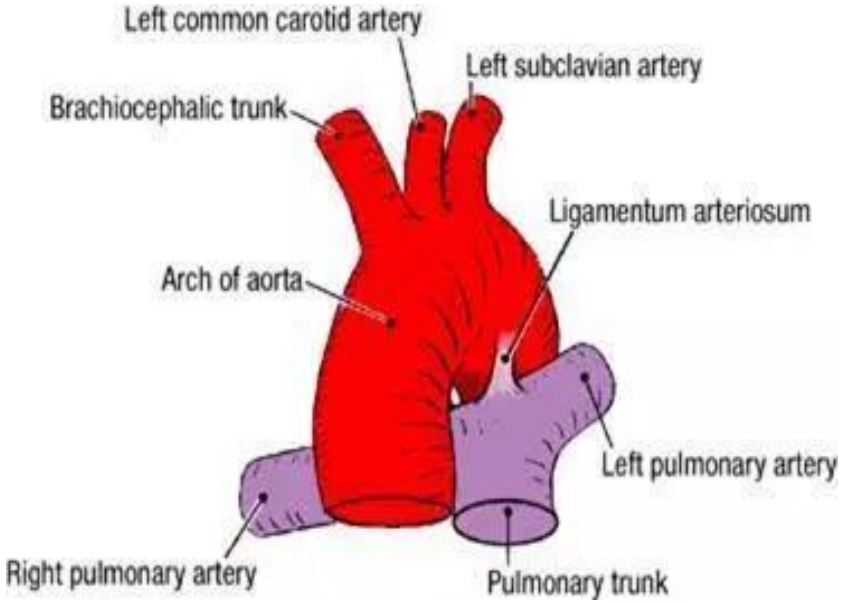
(LO3)

Ductus arteriosus

-Connects pulmonary artery to aortic arch deoxygenated blood that enters the right ventricle to be pumped through the pulmonary arteries is mostly diverted from the lungs to the body into the aortic arch via the ductus arteriosus

-Becomes ligamentum arteriosum upon closure at birth





Fetal circulation

(LO3)

Infant's first breath

After the first breath:

-Pulmonary resistance ↓ causing ↓ in right atrial pressure.

-↑ venous return to left atria causes ↑ pressure resulting in closure of foramen ovale.

-↑ in O2 tension leads to ↓ in prostaglandin production resulting in closure of ductus arteriosus.

-Indomethacin, an NSAID, closes ductus arteriosus.

-Prostaglandins keeps ductus arteriosus open.

(LO3)

Fetal Circulation