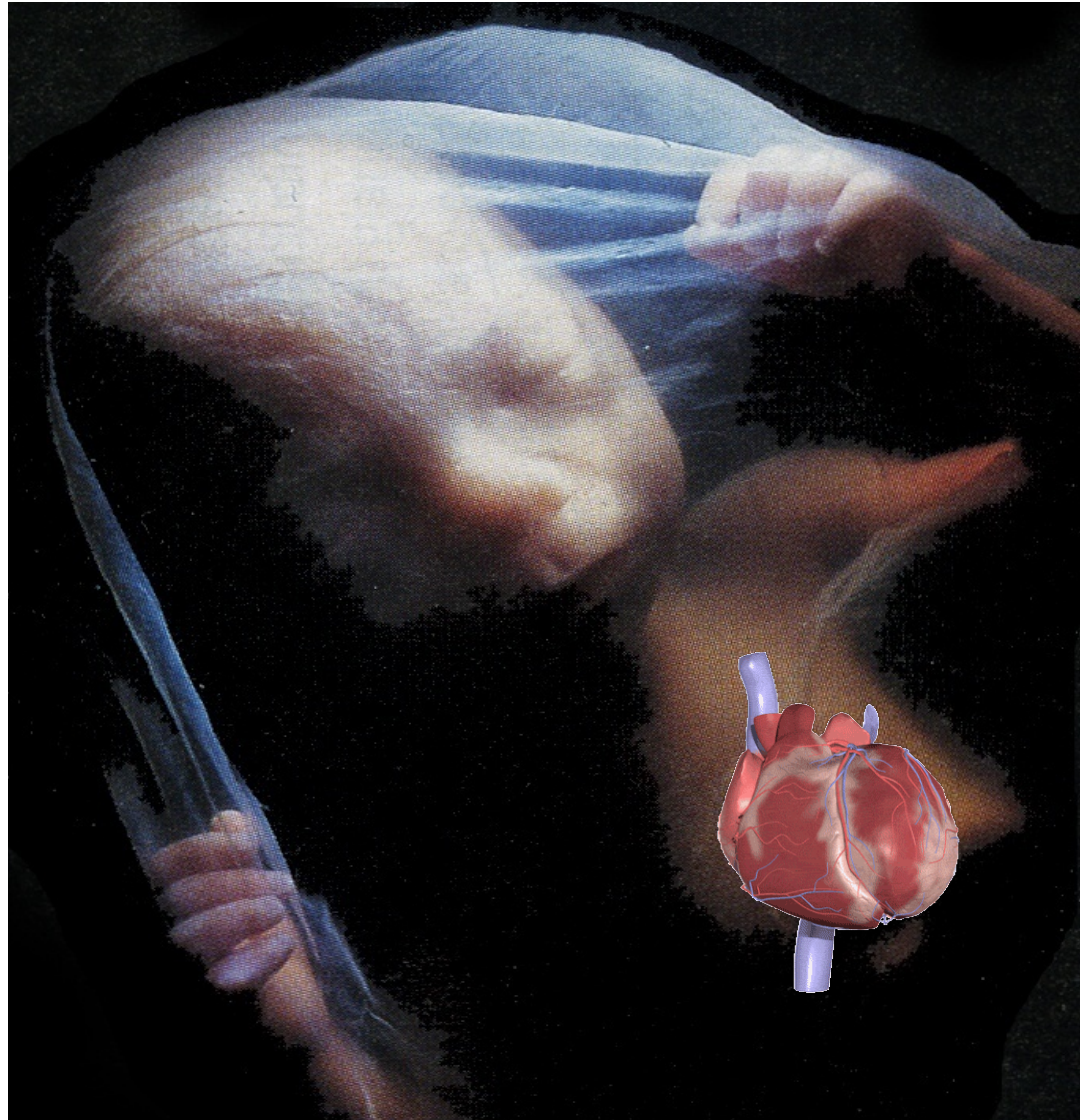


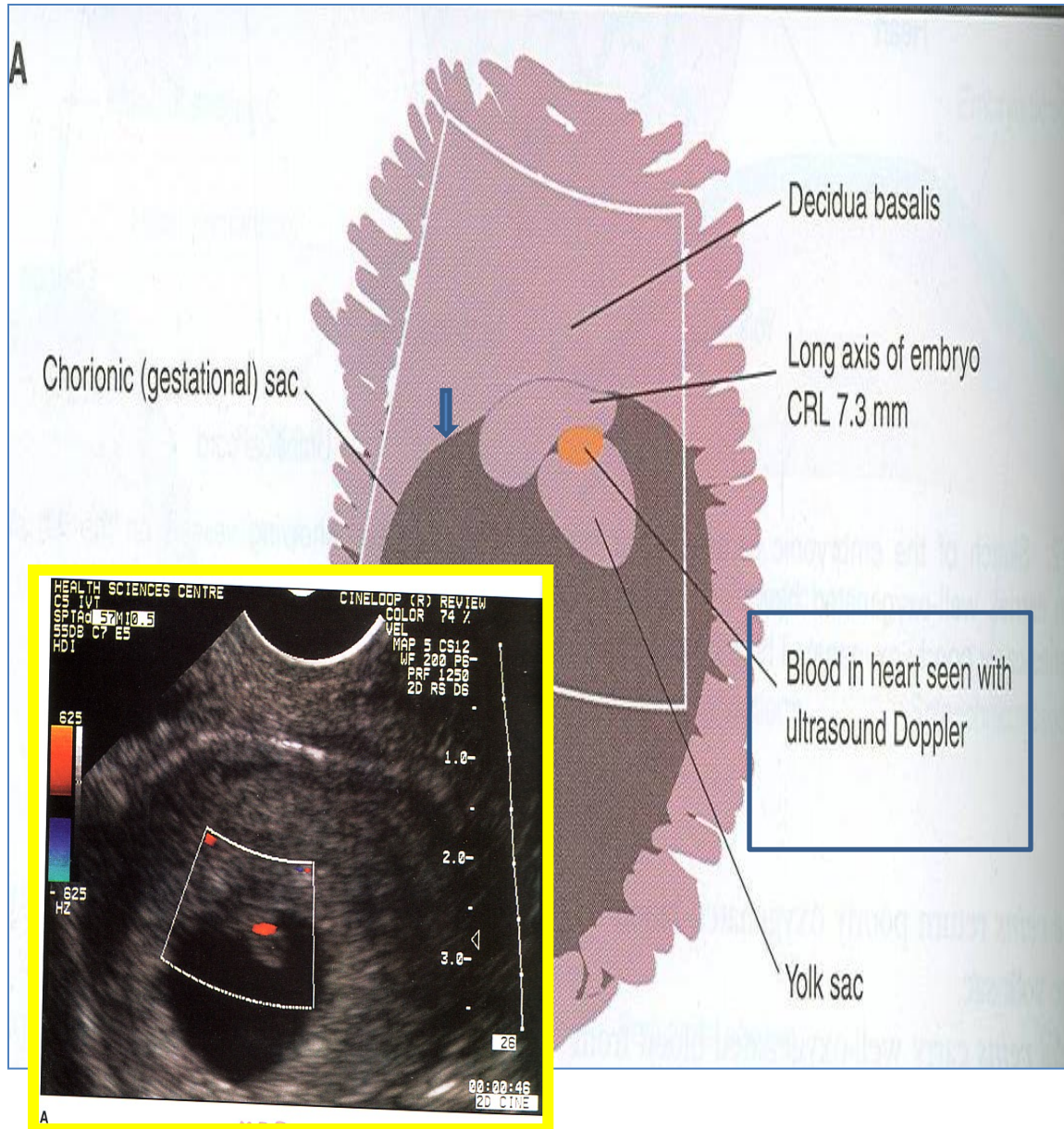
DEVELOPMENT OF HEART

Prof. Saeed Abuel Makarem
Dr. Jamila El Medany



Objectives

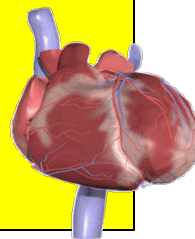
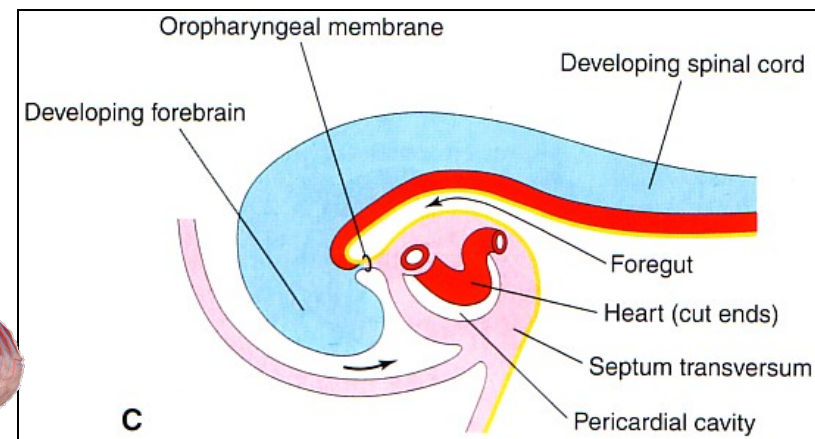
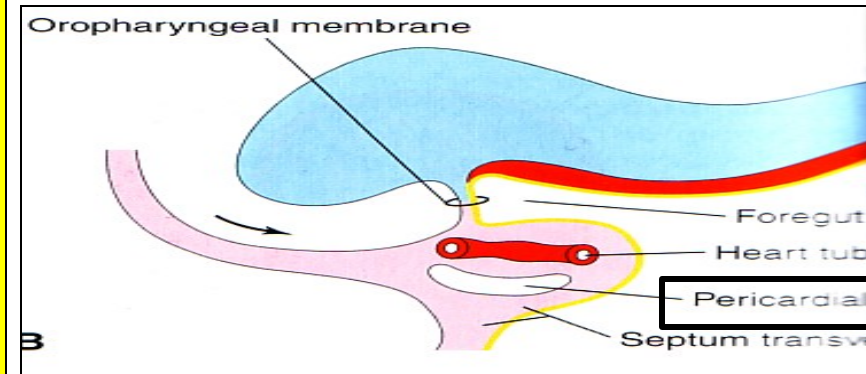
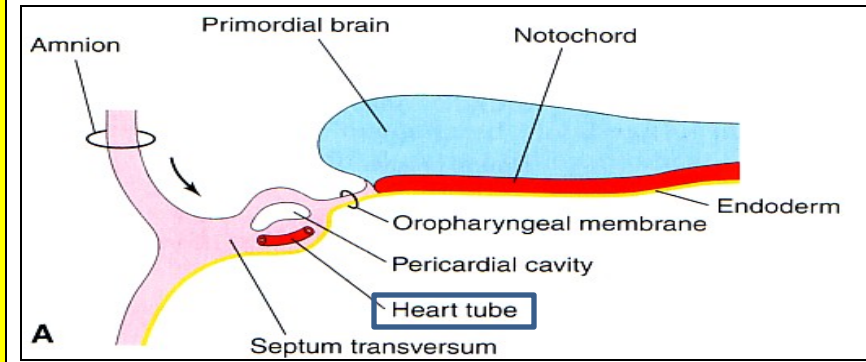
- **By the end of this lecture the student should be able to:**
- Describe the formation, site, and union divisions of the heart tubes.
- Describe the formation and fate of the sinus venosus.
- Describe the partitioning of the common atrium and common ventricle.
- Describe the partitioning of the truncus arteriosus.
- List the most common cardiac anomalies.



- The **CVS** is the first major system to function in the embryo.
- The heart begins to beat at (22nd – 23rd) days.
- Blood flow begins during the beginning of the fourth week and can be visualized by **Ultrasound Doppler**

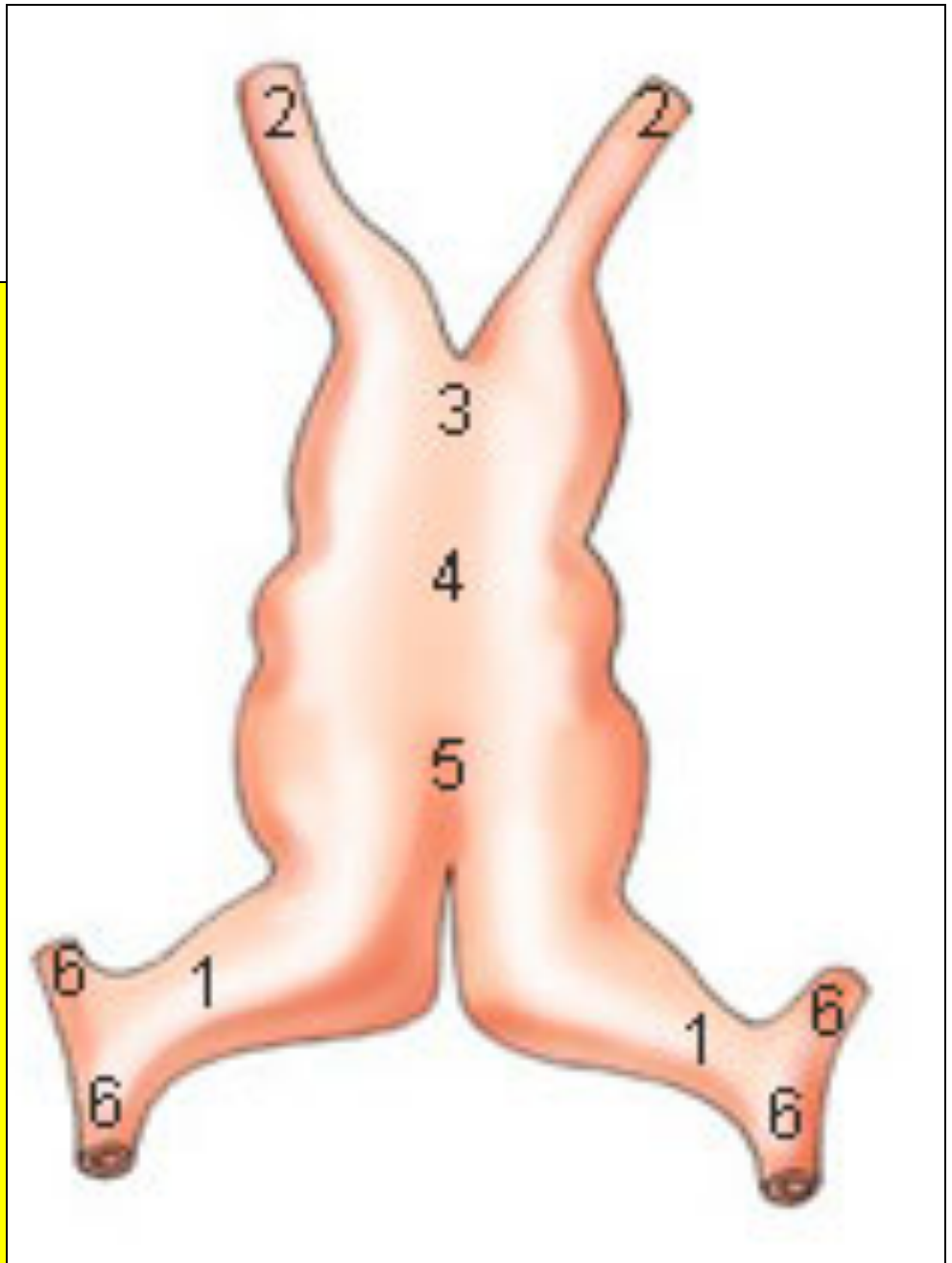
FORMATION OF THE HEART TUBE

- The heart is the first functional organ to develop.
- It develops from **Splanchnic Mesoderm** in the wall of the yolk sac (**Cardiogenic Area**): **Cranial to the developing Mouth & Nervous system** and **Ventral to the developing Pericardial sac**.
- The heart primordium is first evident at **day 18** (as an **Angioblastic cords** which soon canalize to form the 2 heart tubes).
- As the **Head Fold** completed, the developing heart tubes change their **position** and become in the **Ventral** aspect of the embryo, **Dorsal** to the developing Pericardial sac.



Development of the Heart tube

- After **Lateral Folding** of the embryo, the 2 heart tubes **approach each other and fuse** to form a **single Endocardial Heart tube** within the pericardial sac.
- Fusion of the two tubes occurs in a **Craniocaudal** direction.



What is the shape of the Heart Tube?

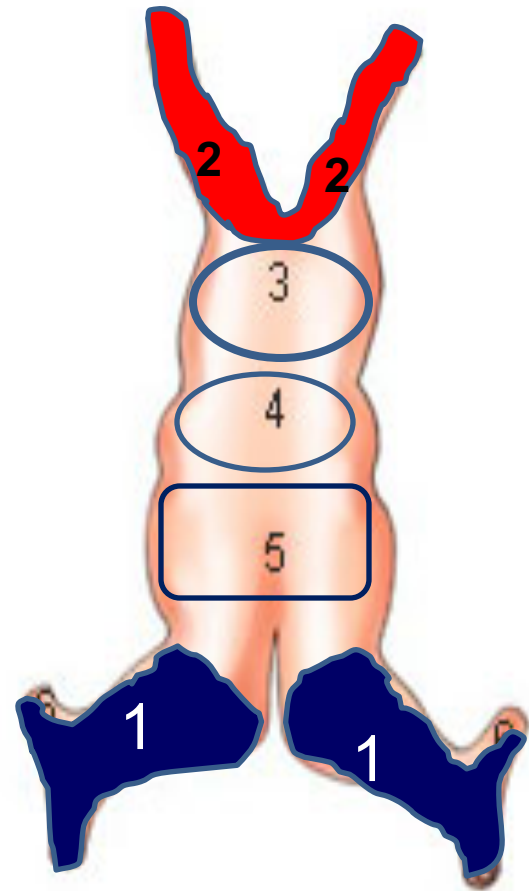
- The heart tube grows faster than the pericardial sac, so it shows **5** alternate dilations separated by constrictions.

- These are:

- Sinus Venosus.**
- Truncus Arteriosus.**
- Bulbus Cordis.**
- Common Ventricle.**
- Common Atrium.**

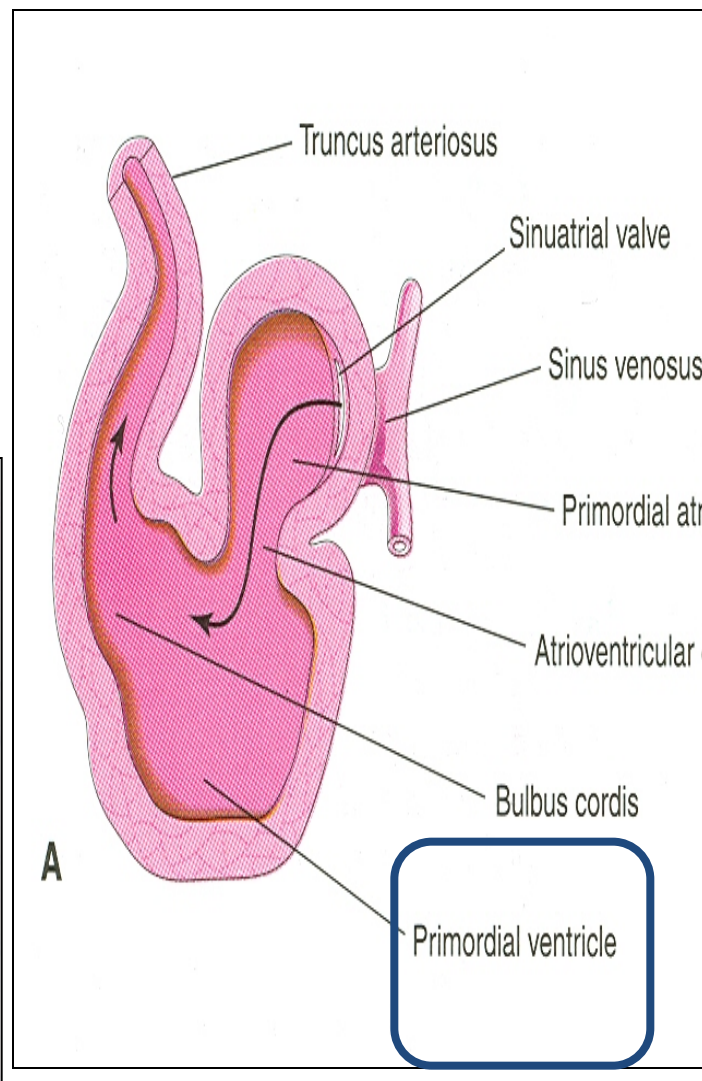
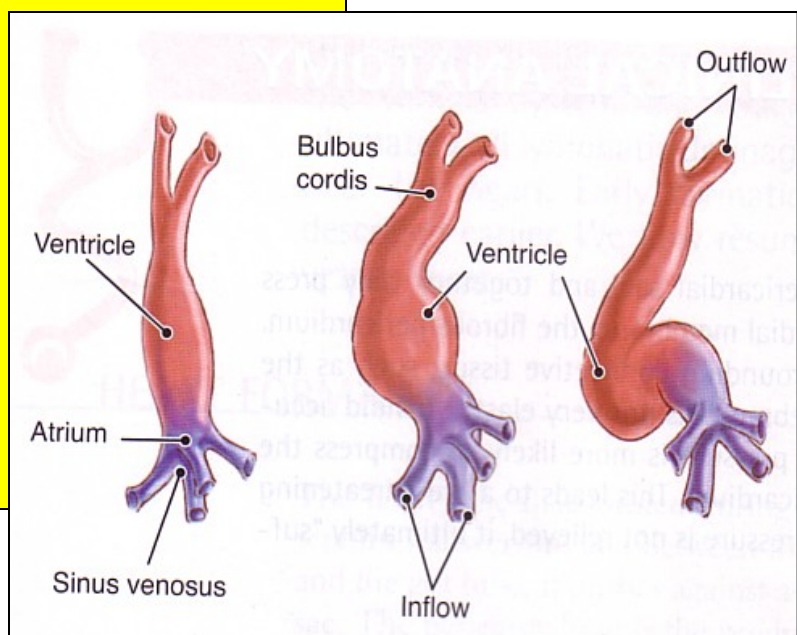
The endocardial heart tube has 2 ends:

- Venous end (Caudal): Sinus Venosus.**
- Arterial end (Cranial): Truncus arteriosus**

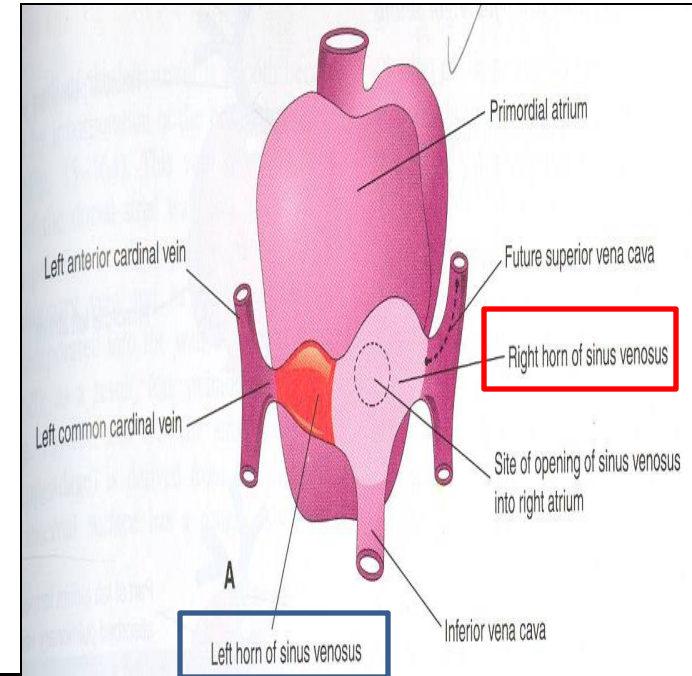
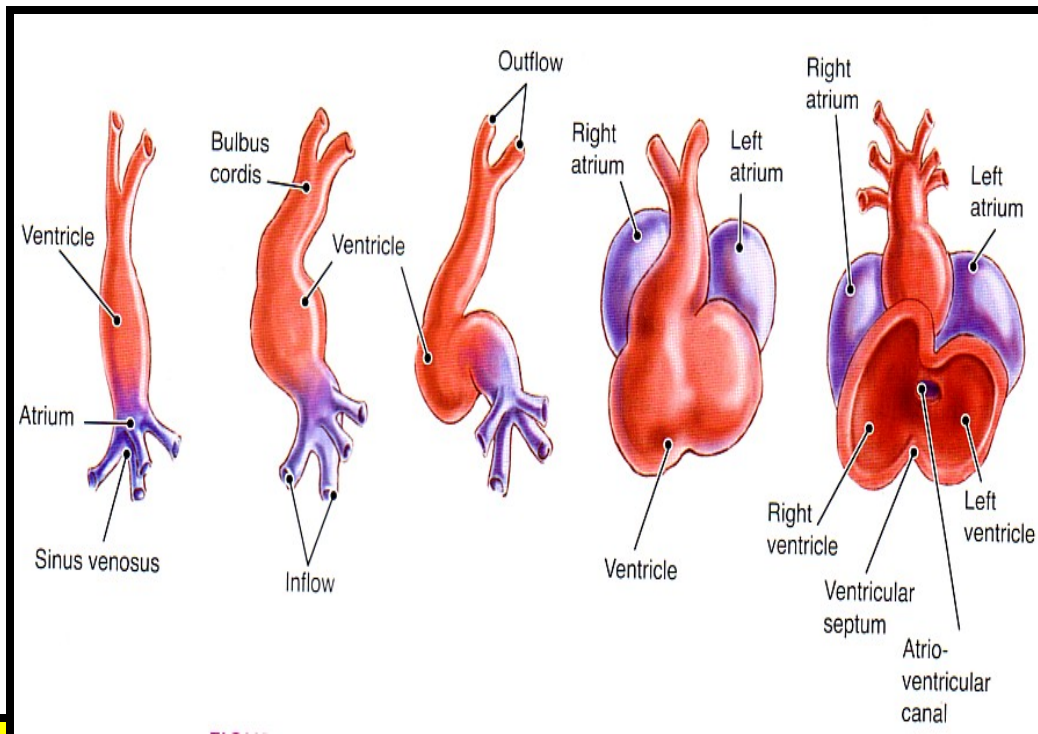


U-SHAPED HEART TUBE

- Bulbus cordis and ventricle grow faster than other regions.
- So the heart bends upon itself, forming
- The **U-shaped heart tube**, (**Bulboventricular loop**).

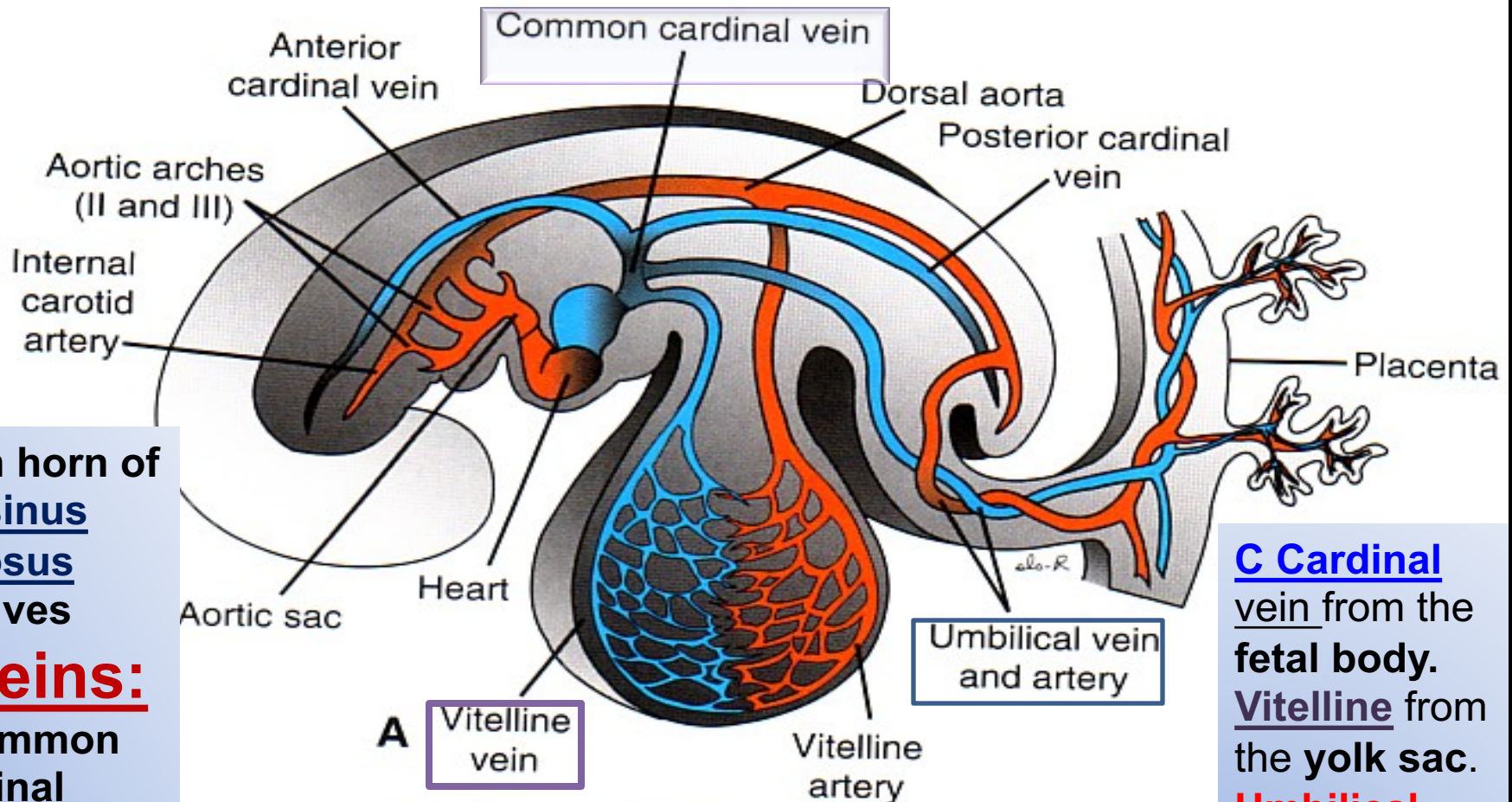


S-Shaped Heart Tube



- As the heart tube develops it bends, upon itself and forms S shaped heart tube:
SO, the Atrium and Sinus venosus become **Cranial** in position & **Dorsal** to the **Truncus arteriosus, Bulbus cordis, and Ventricle**.
- By this stage the sinus venosus (opens in the dorsal surface of the atrium) has developed **2** lateral expansions, (**Horns**): Right and Left

Veins Draining into Sinus Venosus



Each horn of the sinus venosus receives

3 veins:

1. Common cardinal
2. Vitelline
3. Umbilical

A

Vitelline vein

Vitelline artery

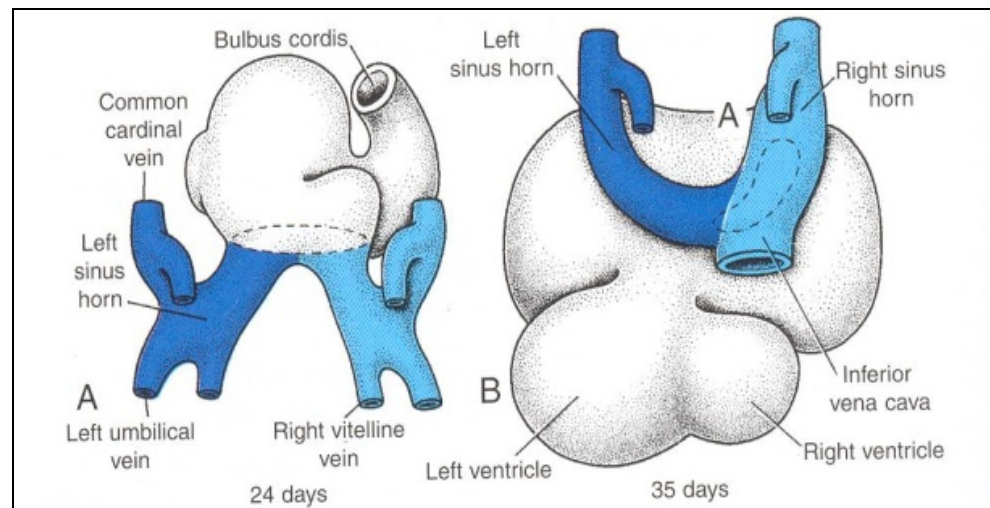
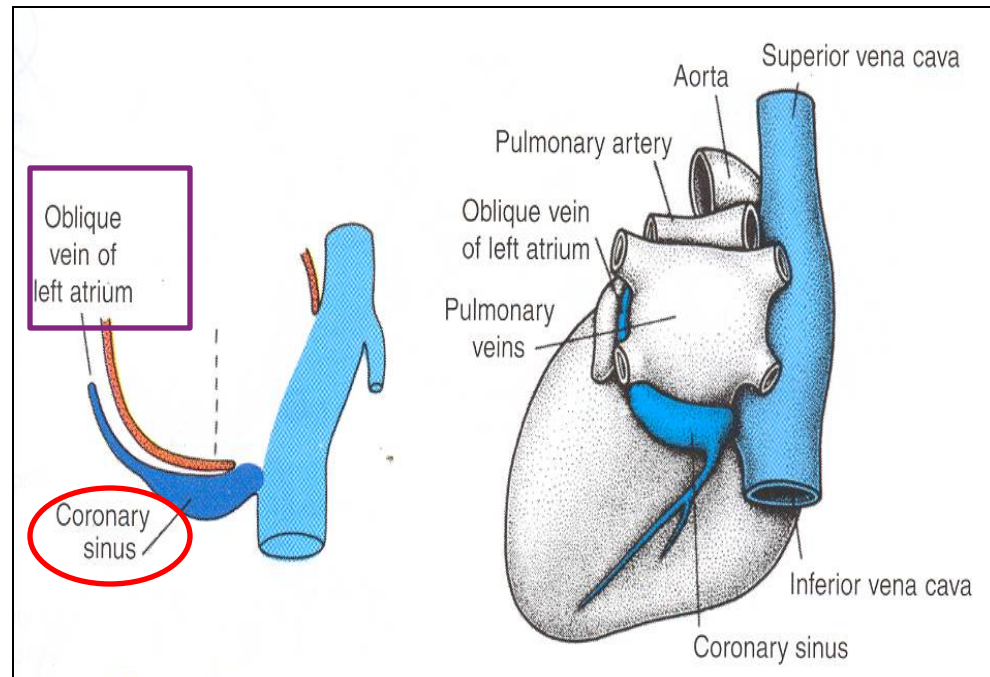
Umbilical vein and artery

Each vessel is paired at this stage (not illustrated)

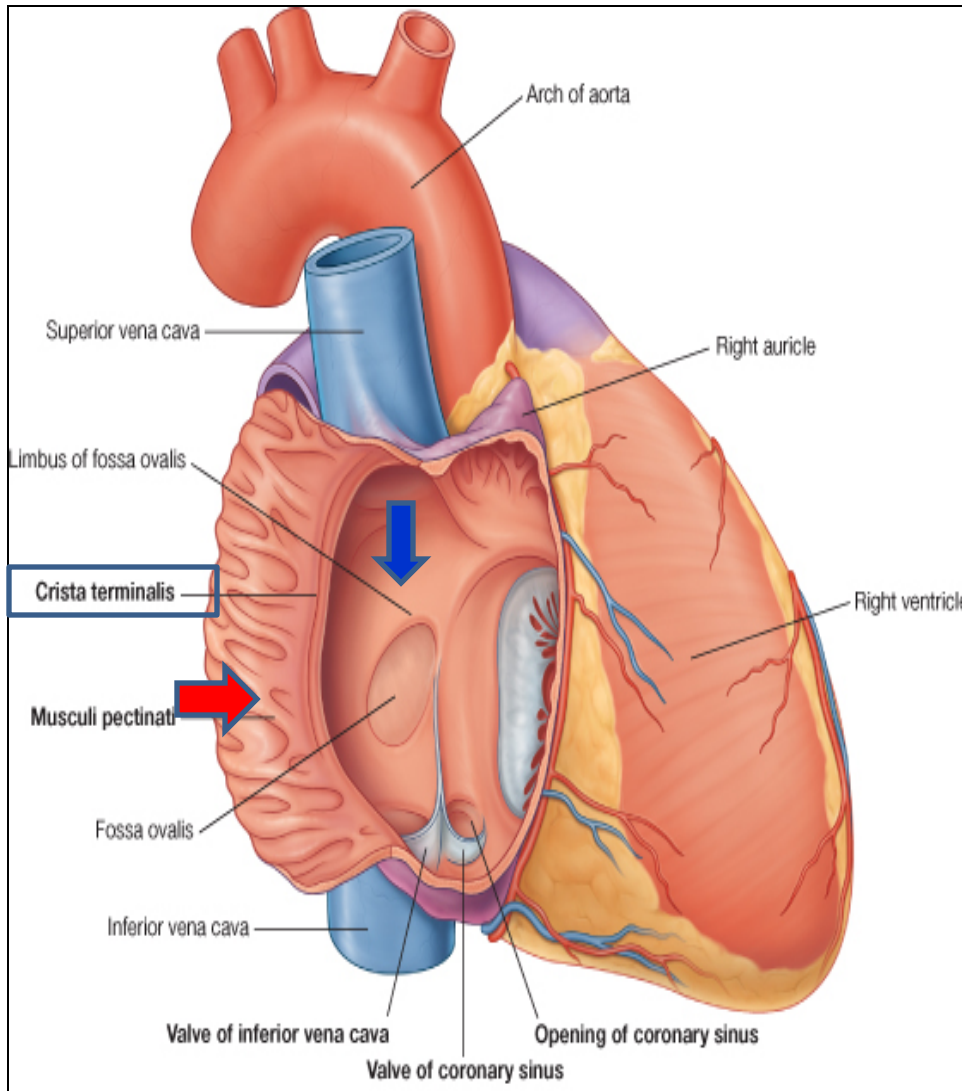
C Cardinal vein from the fetal body. Vitelline from the yolk sac. Umbilical from the placenta.

Fate of Sinus Venosus

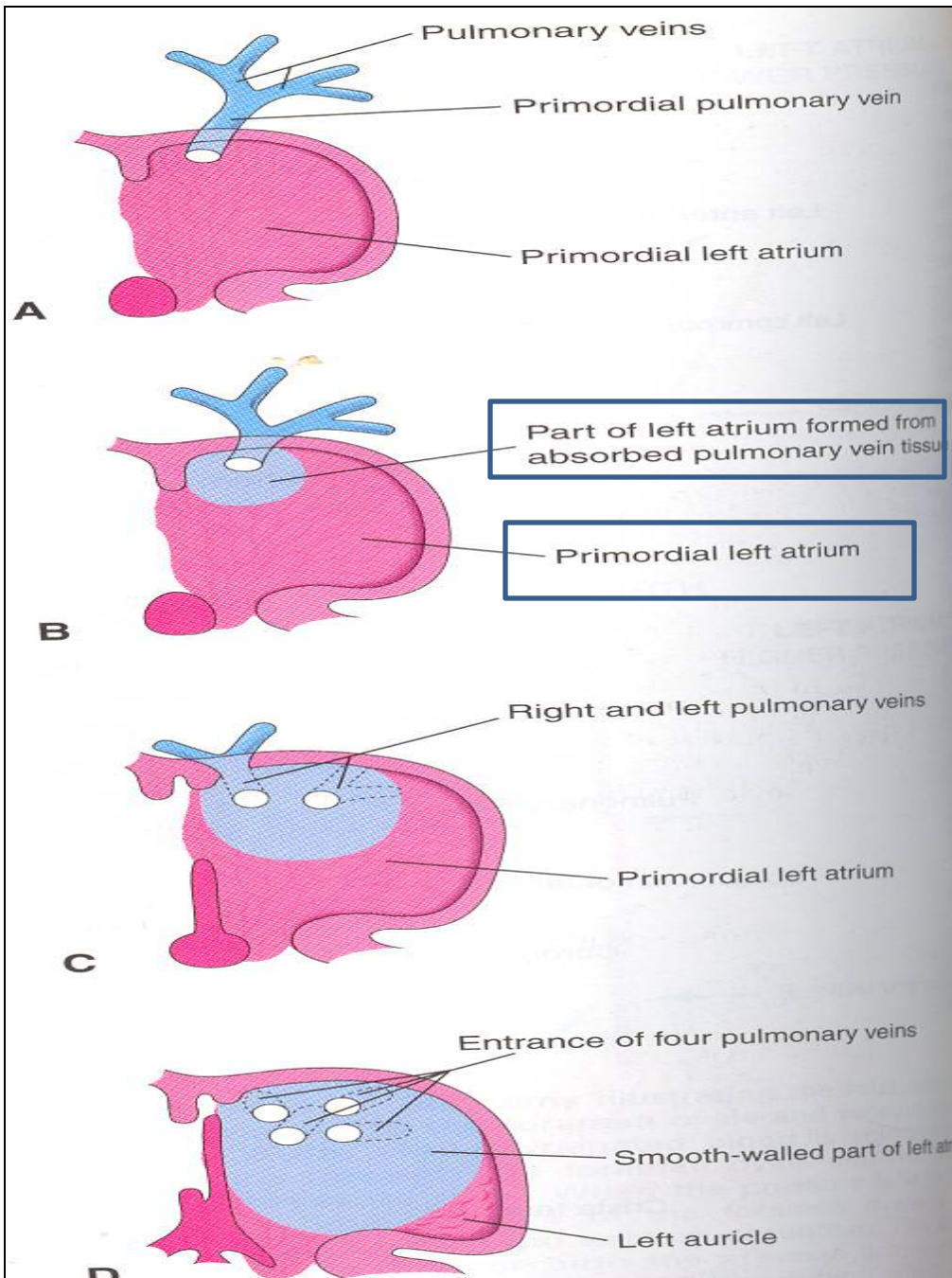
- The **Right Horn** forms the smooth posterior part of the right atrium.
- The **Left Horn and Body** atrophy and form the **Coronary Sinus**.
- The Left Common cardinal vein forms the **Oblique Vein of the Left Atrium**.



Right Atrium



- The right horn of the sinus venosus forms the smooth posterior part of the right atrium.
- Rough Trabeculated anterior part (musculi pectinati) of the right atrium is derived from the primordial common atrium.
- These two parts are demarcated by the **crista terminalis** internally and **sulcus terminalis** externally.



Left Atrium

- ***Rough Trabeculated part:*** derived from the common primordial atrium.
- ***The smooth part:*** derived from the absorbed ***Pulmonary Veins.***

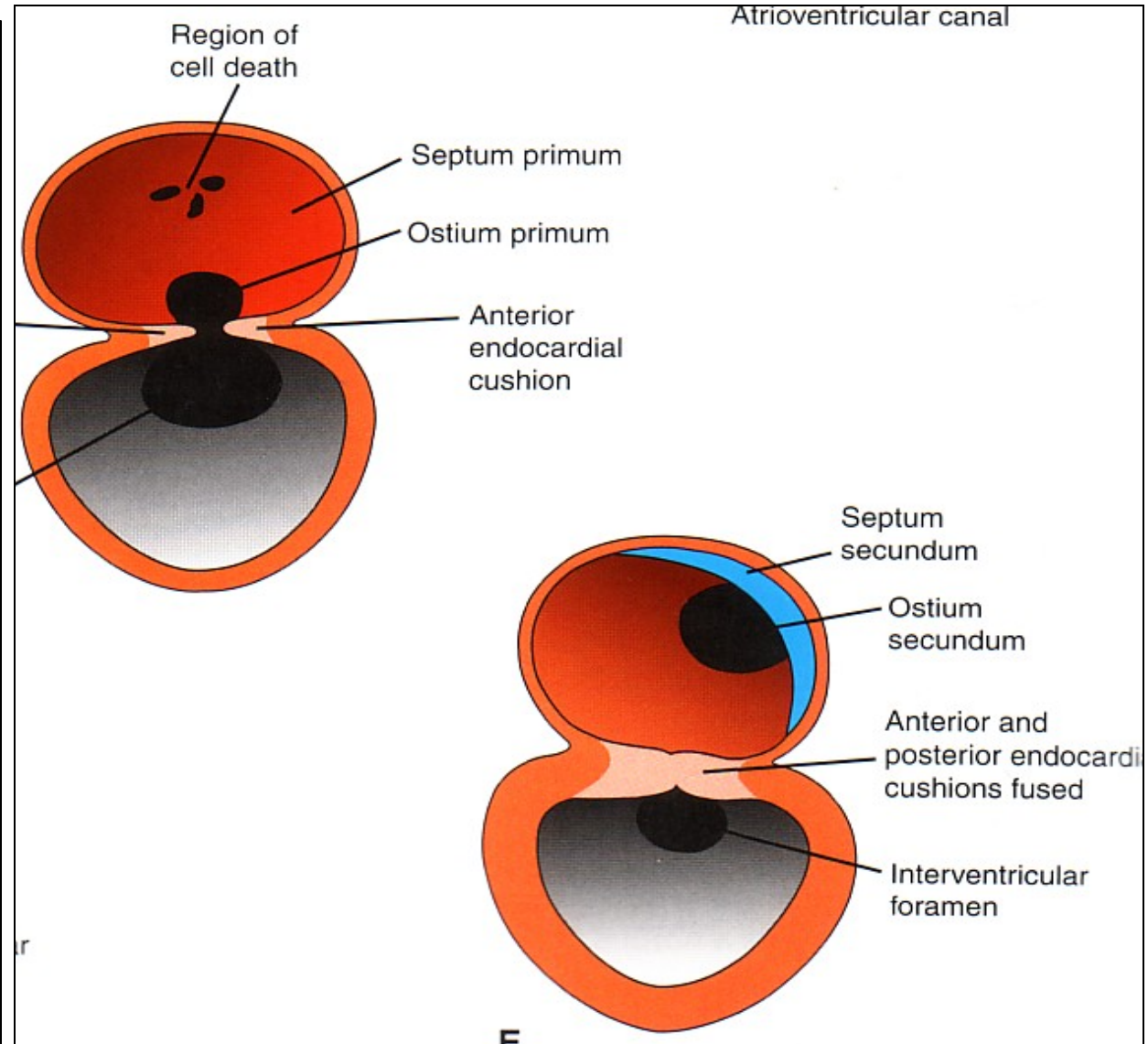
Partitioning of Primordial Heart

Partitioning of:

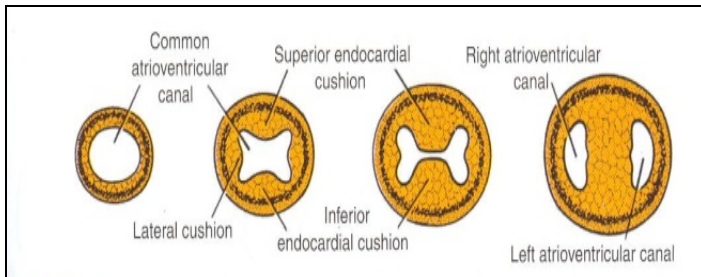
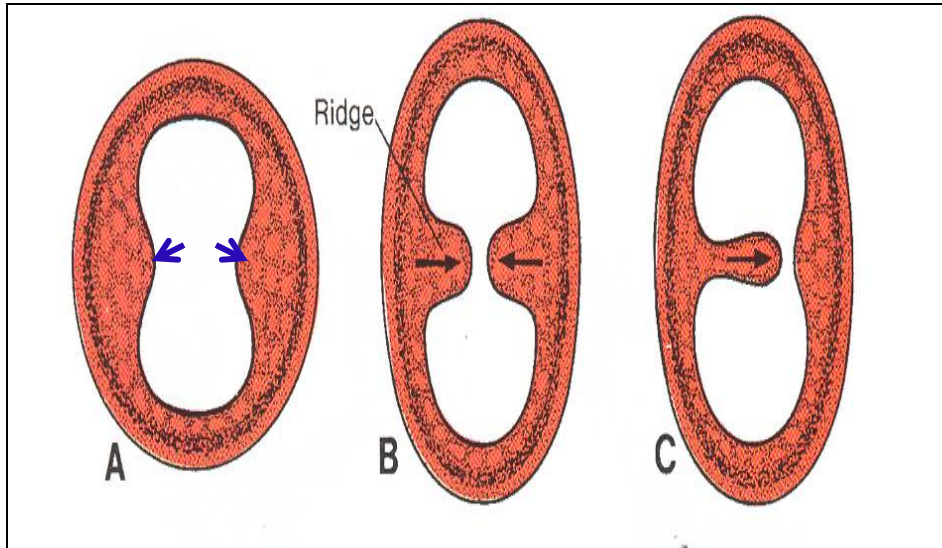
- 1- Atrioventricular canal.
- 2- Common atrium.
- 3- Common ventricle.
- 4- Truncus arteriosus & Bulbus cordis.

It begins by the middle of 4th week.

It is completed by the end of 5th week.



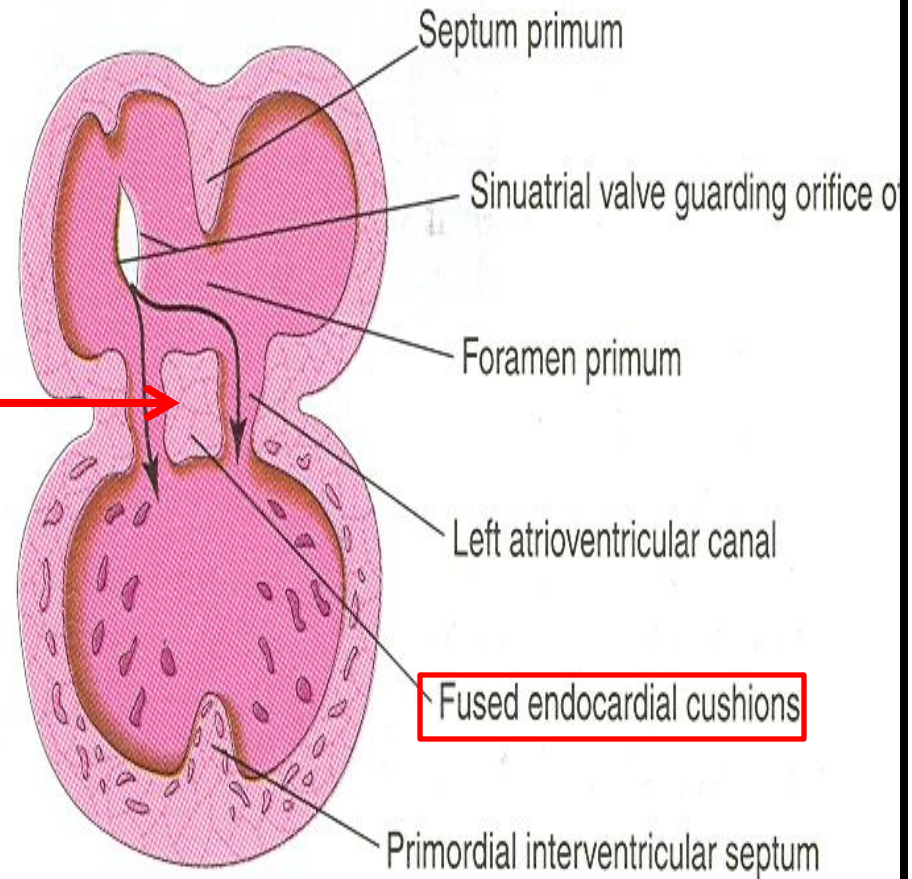
Endocardial Cushions



- They appear around the middle of the **4th week** as **Mesenchymal Proliferation**
They participate in formation of :
 - (1) **A.V canals and valves.**
 - (2) **Atrial septa.**
 - (3) **Membranous part of Ventricular septum.**
 - (4) **Aortic and Pulmonary channels (Spiral septum).**

Partitioning of the atrioventricular canal

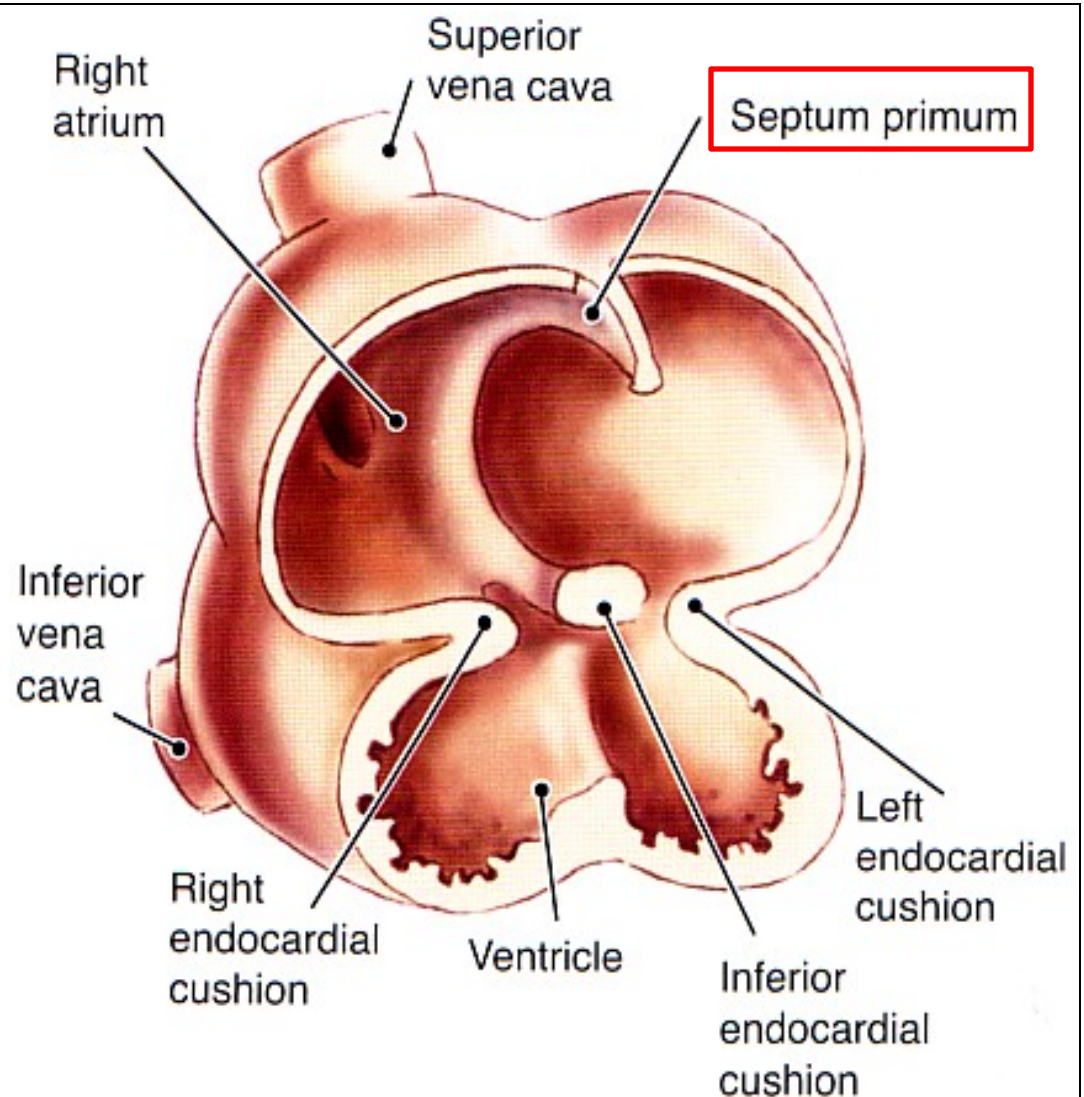
- **Two** Endocardial Cushions are formed on the dorsal and ventral walls of the AV canal.
- The AV endocardial cushions approach each other and fuse to form the **Septum Intermedium**.
- Dividing the AV canal into right & left canals.
- These canals partially separate the primordial atrium from the ventricle.



Partition of the Common Atrium

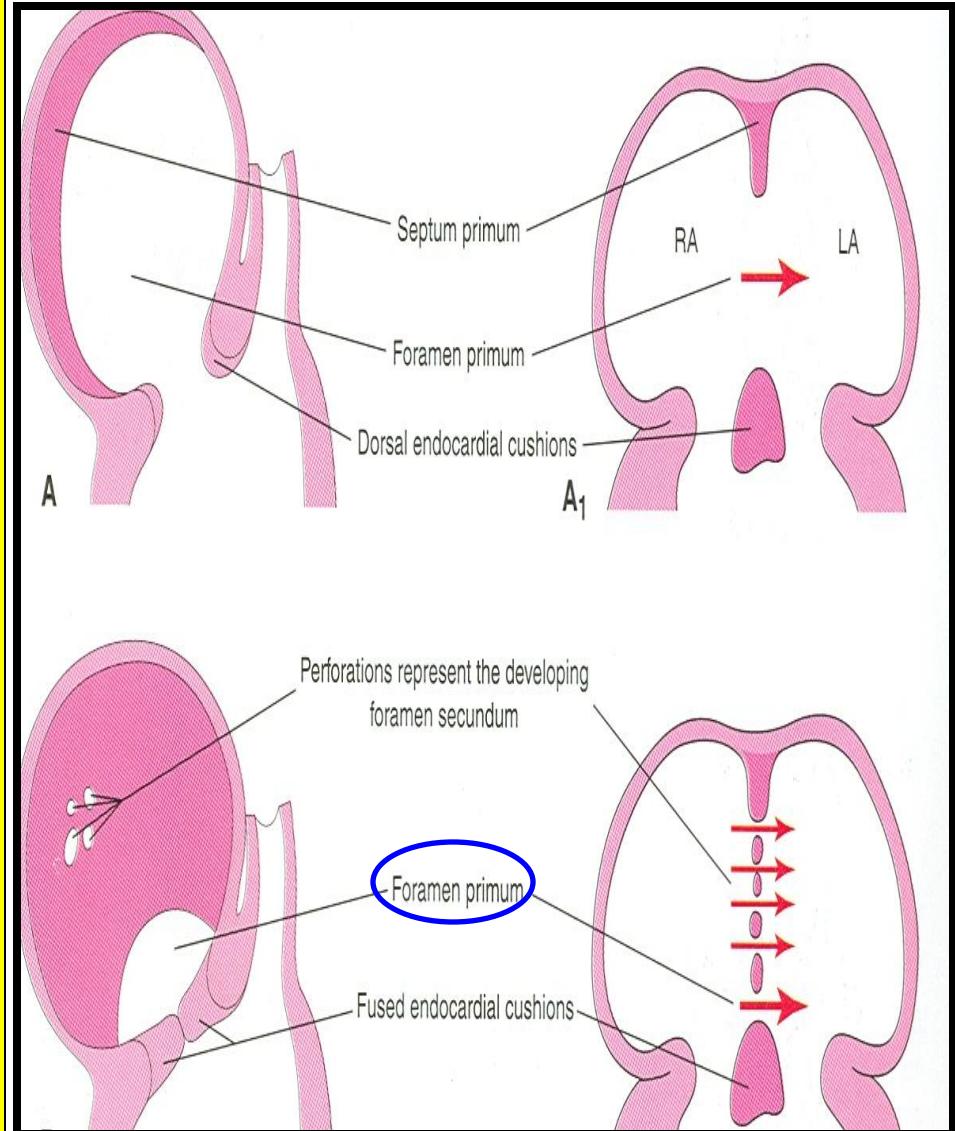
Septum Primum

- It is sickle-shaped septum that grows from the roof of the common atrium towards the fusing endocardial cushions (**septum intermedium**)
- So it divides the common atrium into right & left halves.



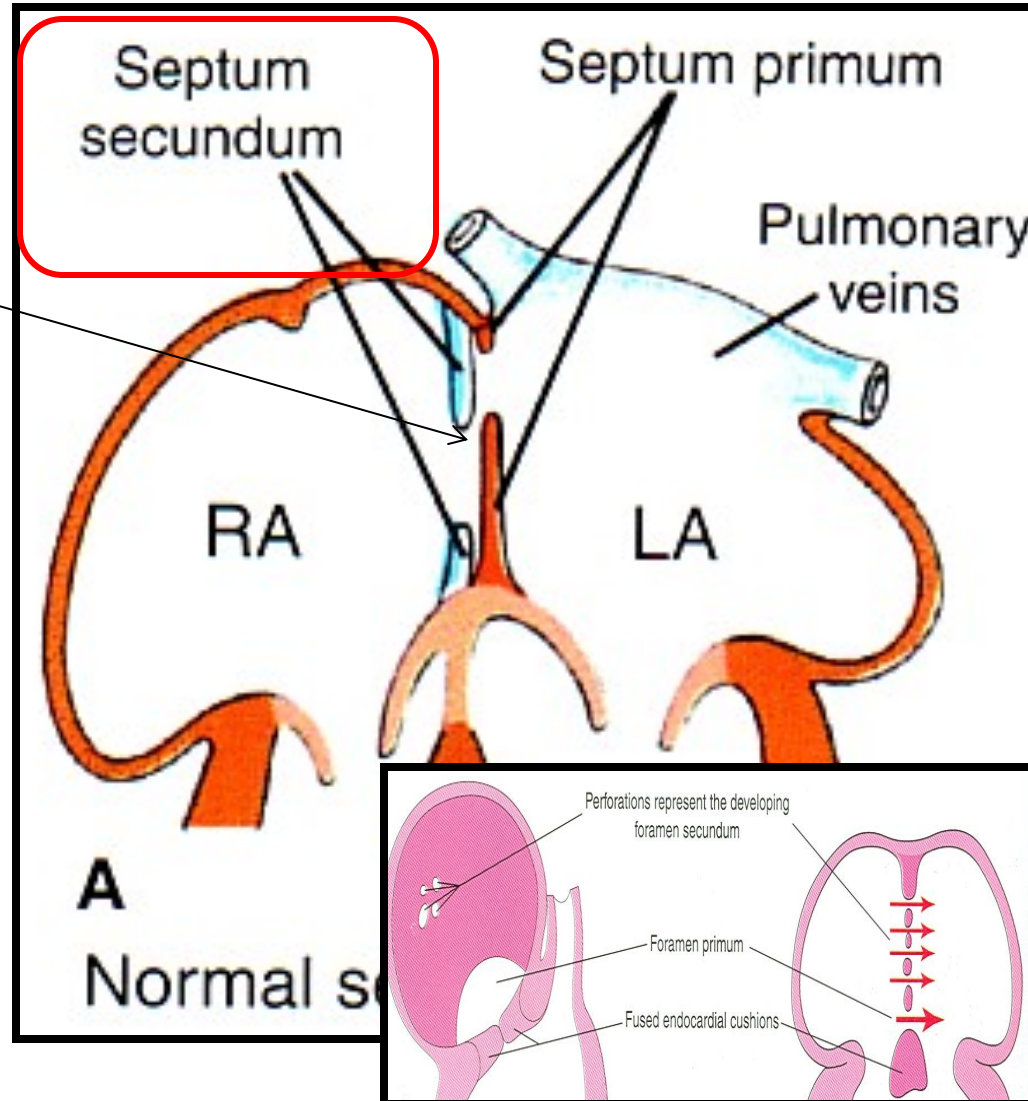
- The two ends of septum primum reach to the growing endocardial cushions before its central part.
- Now the septum primum bounds a foramen called **ostium primum**.
- It serves as a shunt, enabling the oxygenated blood to pass from right to left atrium.
- The **ostium primum** become smaller and disappears as the septum primum fuses completely with the septum intermedium to form the **AV septum**.

Ostium Primum

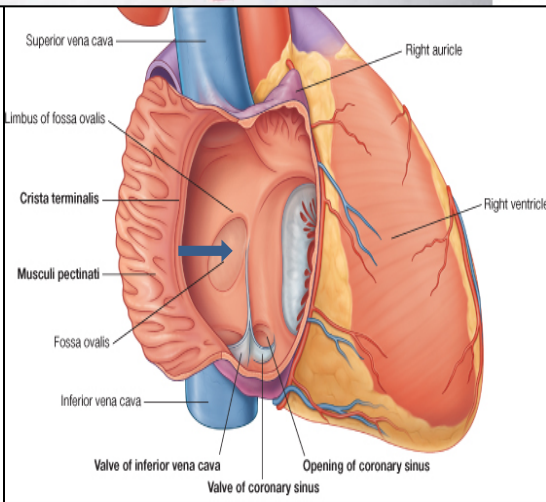
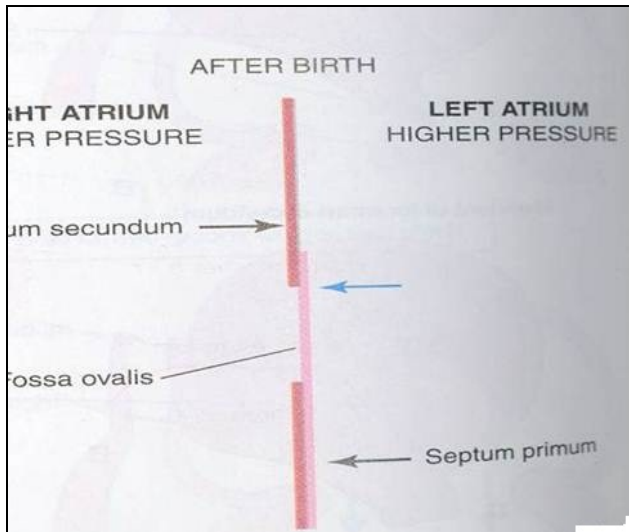


- The upper part of septum primum that is attached to the roof of the common atrium shows gradual resorption forming an opening called **ostium secundum**.
- Another septum descends on the right side of the septum primum called **Septum Secundum**.
- It forms an incomplete partition between the two atria.
- Consequently a valvular oval foramen forms, (**Foramen Ovale**)

Septum Secundum



Fate of foramen Ovale

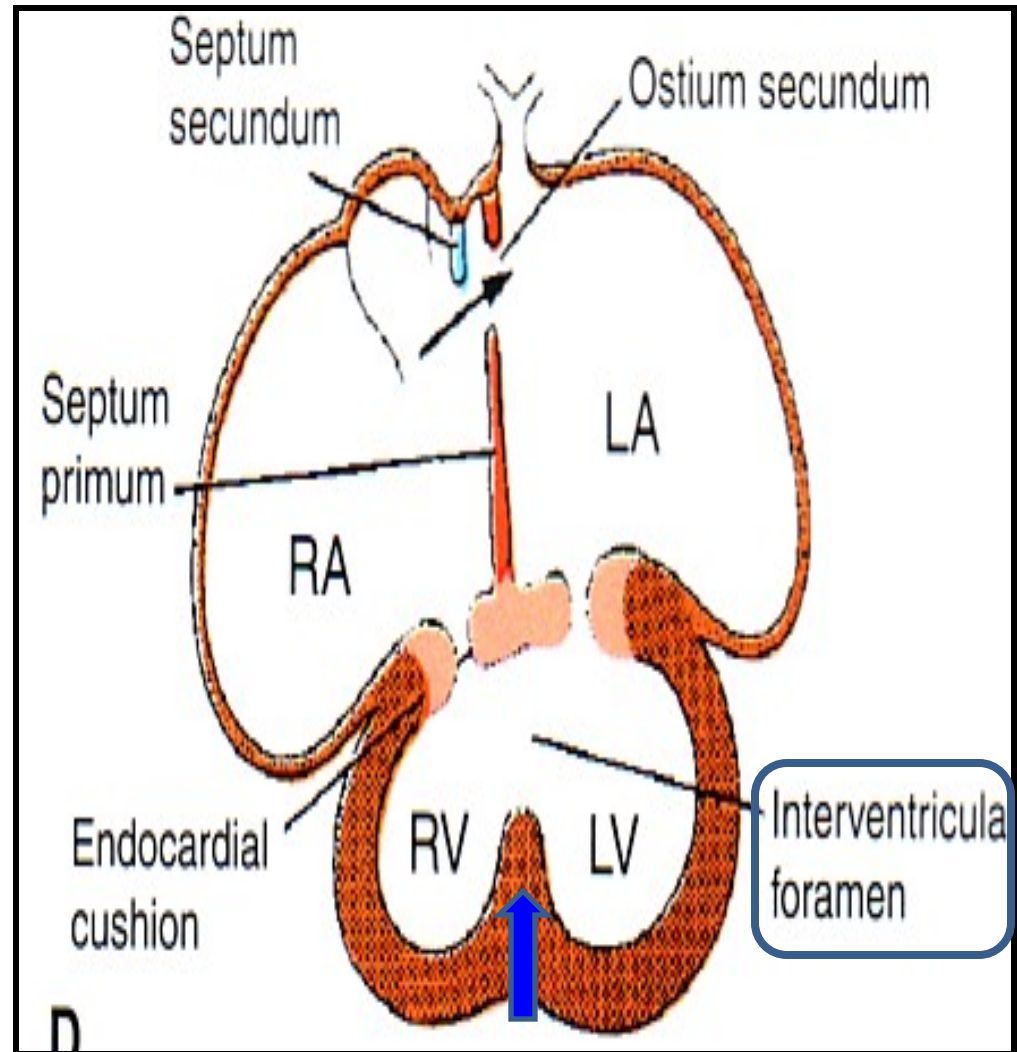


- At birth when the lung circulation begins, the pressure in the left atrium increases.
- The valve of the foramen ovale is pressed against the septum secundum and obliterates the foramen ovale.
- Its site is represented by the **Fossa Ovalis:**
- Its **floor** represents the persistent part of the **septum primum**.
- Its **limbus (anulus)** is the lower edge of the **septum secundum**.

Partitioning of Primordial Ventricle

Muscular part of the interventricular septum:
Division of the primordial ventricle is first indicated by a **median muscular ridge, the primordial interventricular septum.**

- It is a thick crescentic fold which has a concave upper free edge.
- This septum bounds a temporary connection between the two ventricles called **Interventricular foramen.**



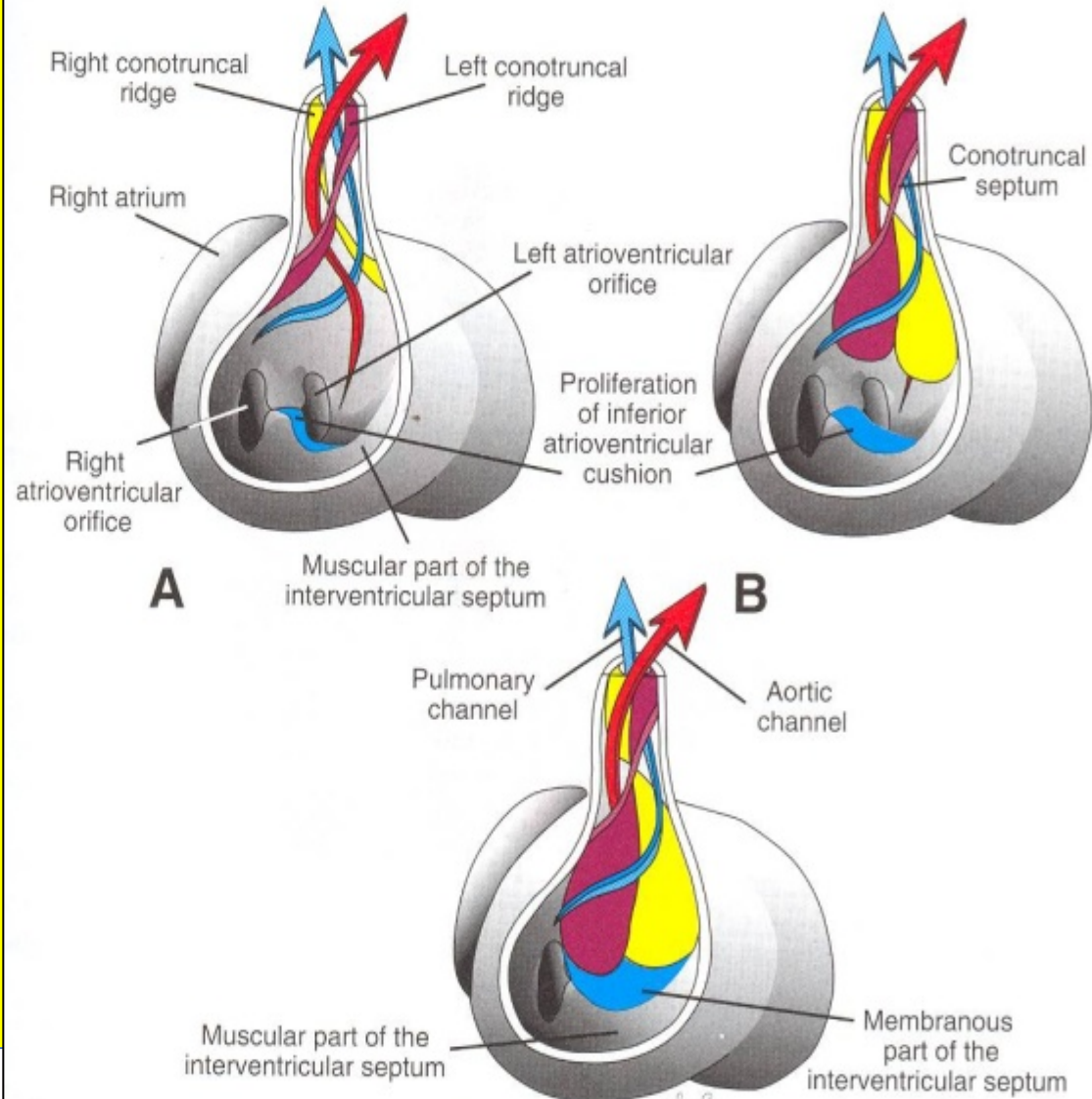
Interventricular Septum

The Membranous part

of the IV septum:

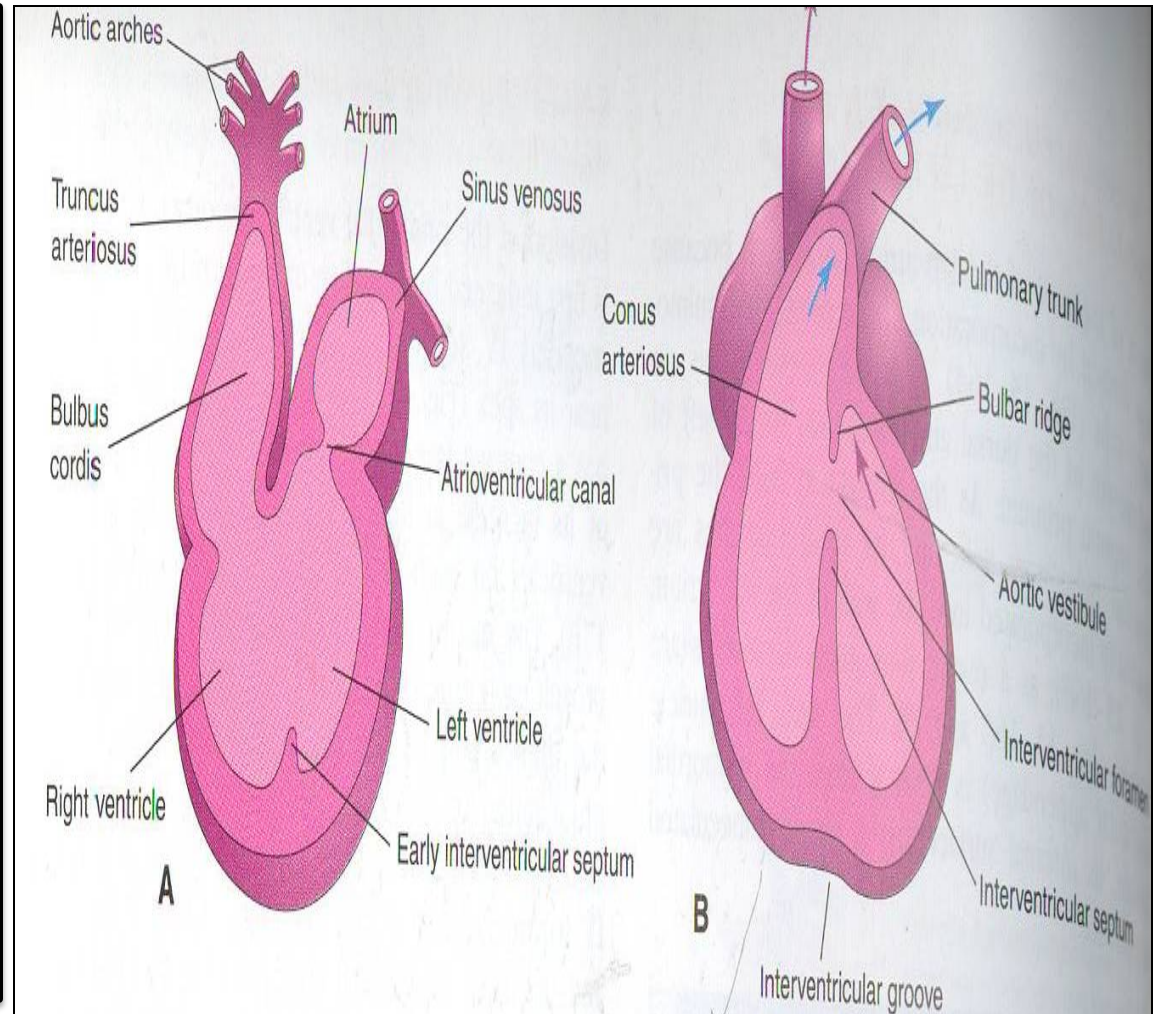
derived from

- 1- A tissue extension from the right side of the **Endocardial Cushion**.
- 2- **Aorticopulmonary septum**.
- 3- Thick **Muscular part** of the IV septum.

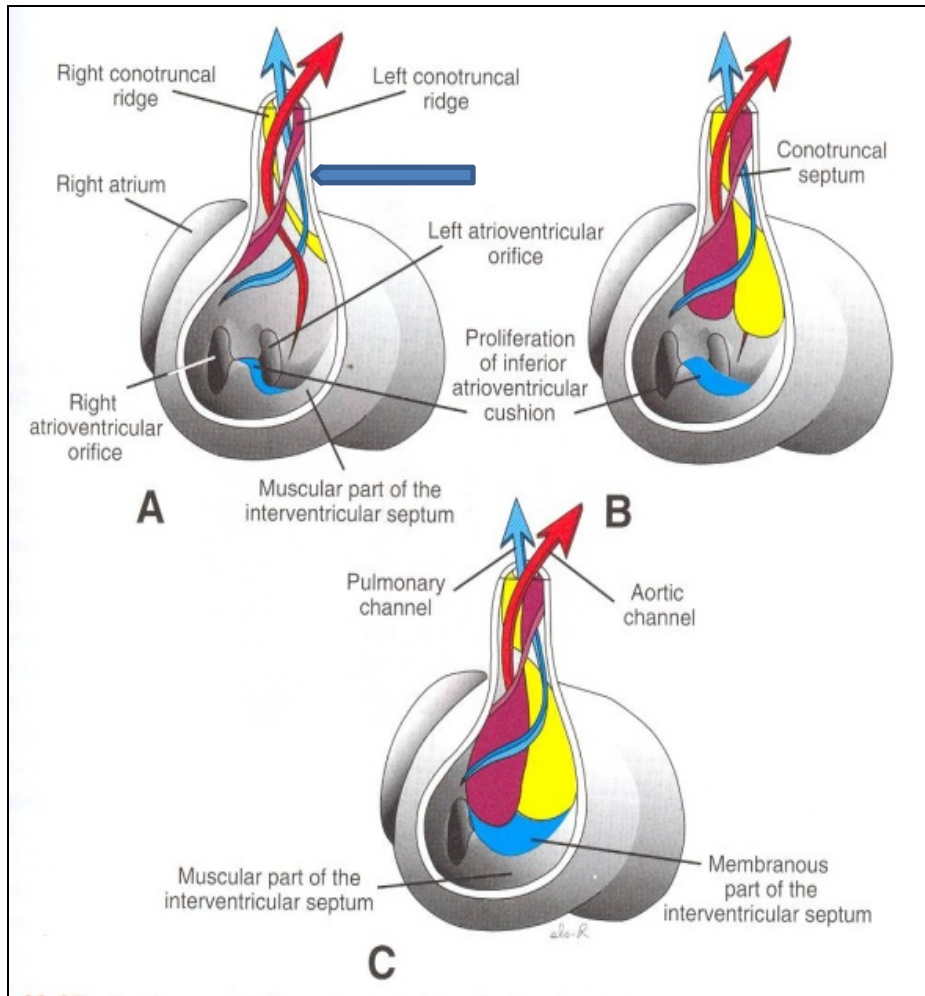


BULBUS CORDIS

- The bulbus cordis forms the smooth upper part of the two ventricles.
- **Right Ventricle:**
- **Conus Arteriosus or (Infundibulum)** which leads to the pulmonary trunk.
- **Left ventricle:**
- **Aortic Vestibule** leading to ascending aorta.

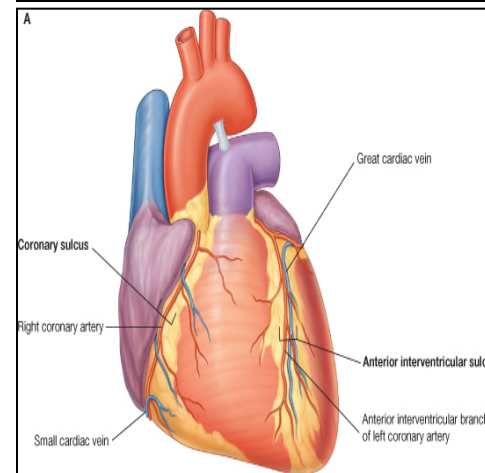
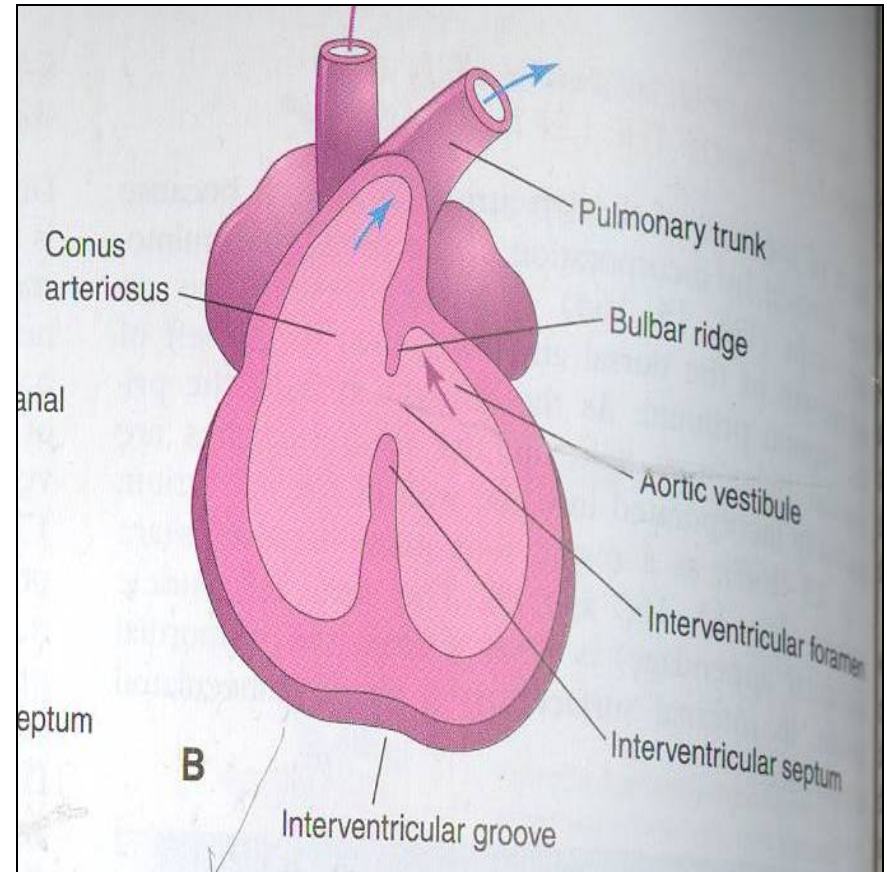


Partition of Truncus Arteriosus

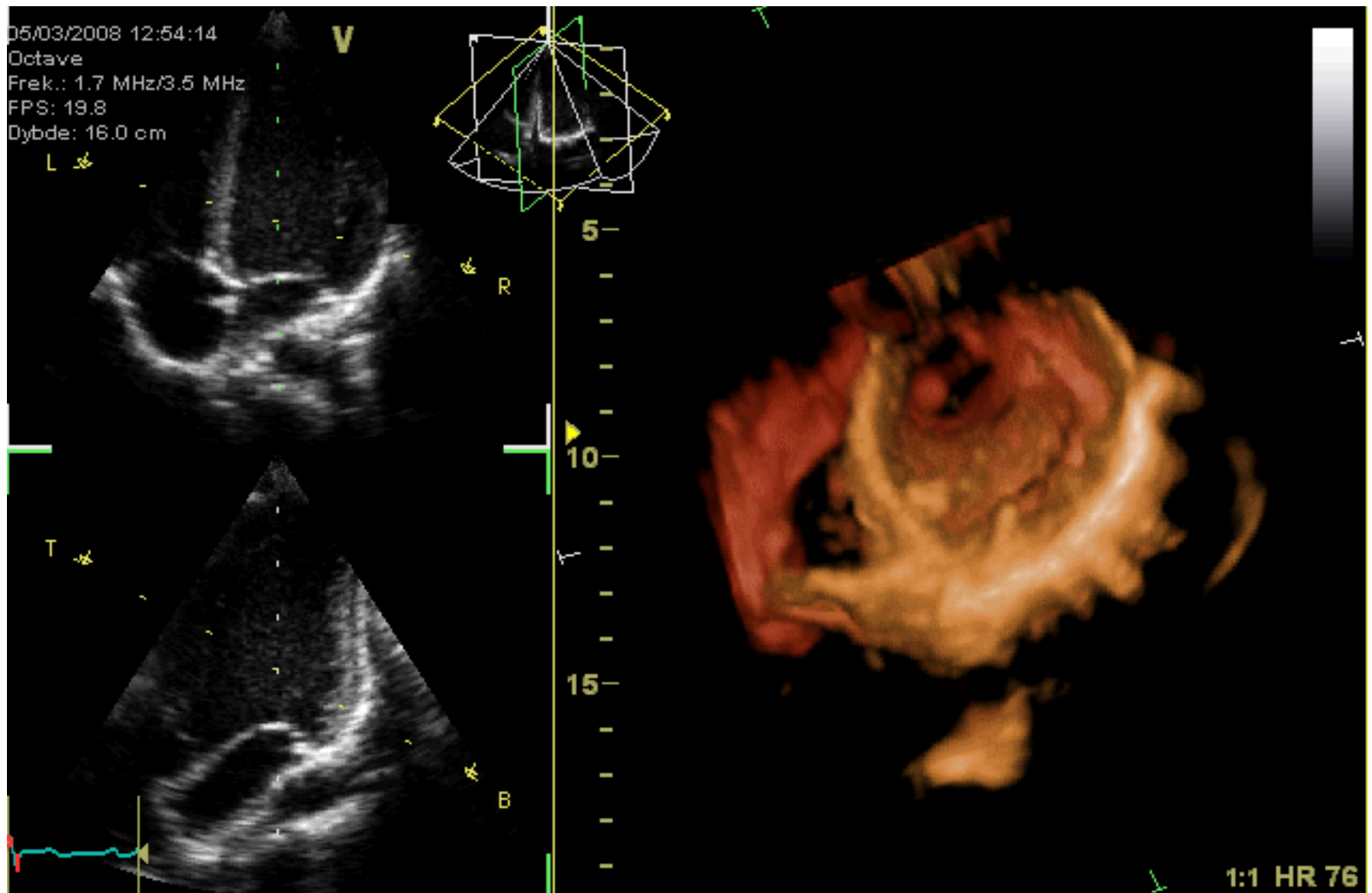


- In the **5th week**, proliferation of mesenchymal cells (**Endocardial Cushions**) appear in the wall of the **truncus arteriosus**, they form a **Spiral Septum**:
- A. It divides the **Lower part of the TA** into **Right & Left parts**
- B. It divides the **Middle part of TA** into **Anterior & Posterior parts**.
- C. It divides the **Upper part of the TA** into **Left & Right parts**.

- This explains the origin of pulmonary trunk from R ventricle & ascending aorta from L ventricle & their position to each other.

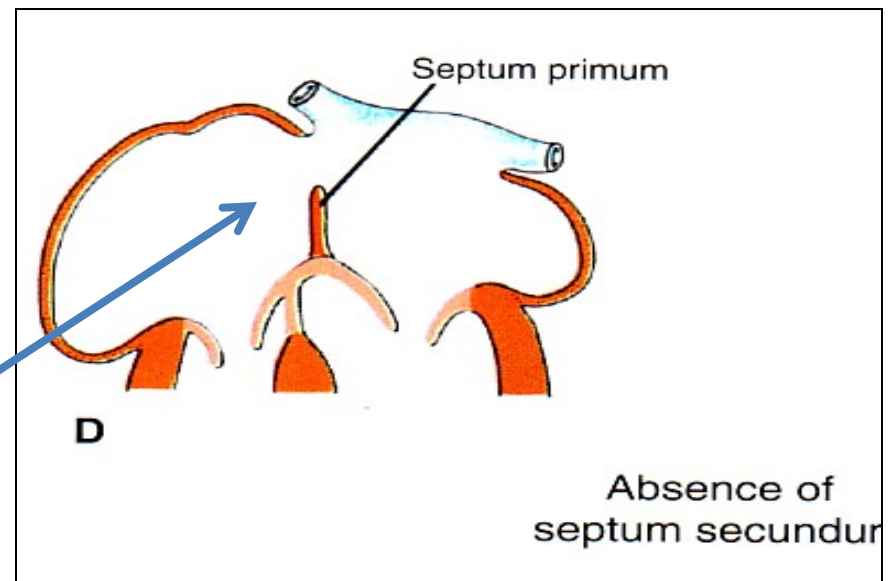
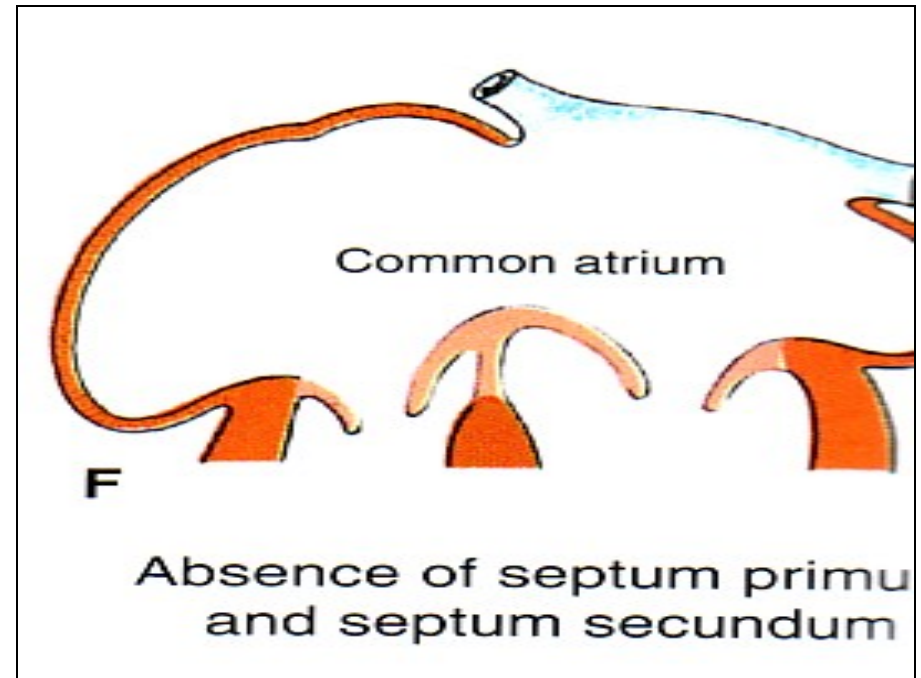


MAJOR CARDIAC ANOMALIES



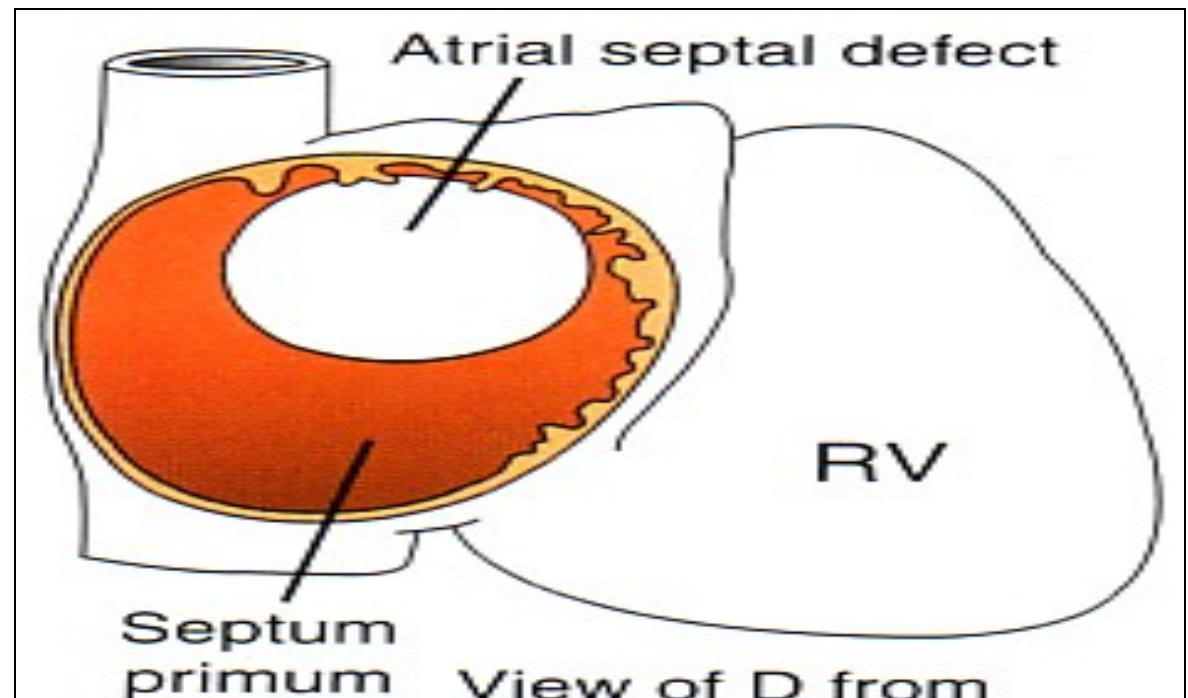
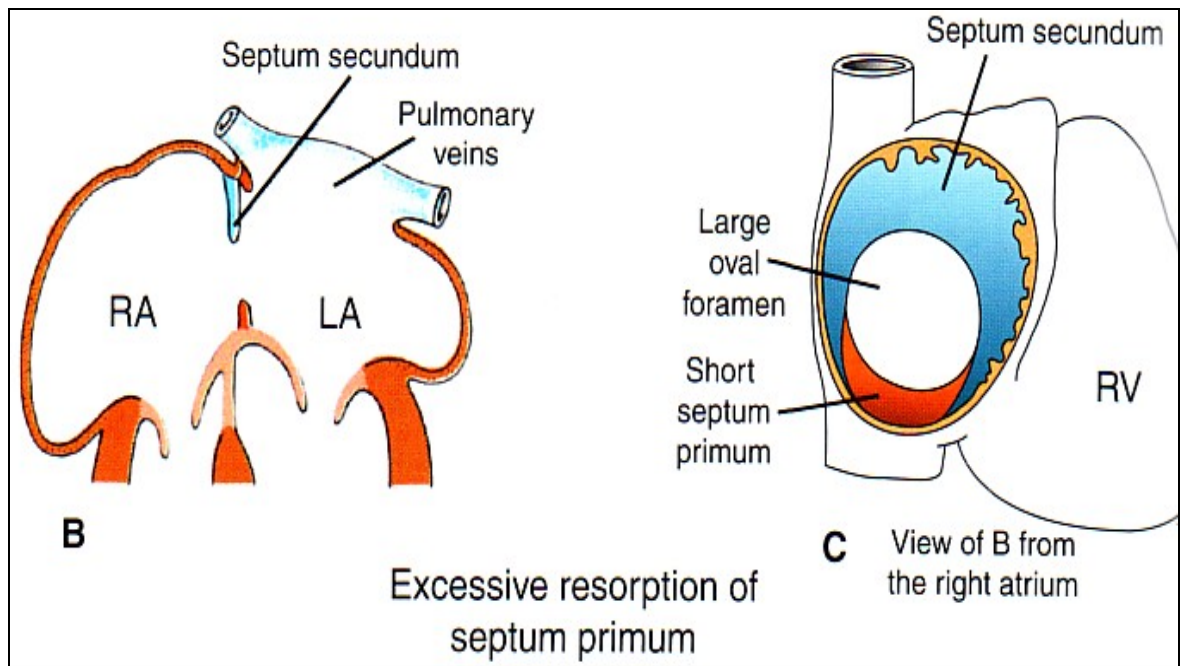
Atrial Septal Defects (ASD)

- **Types :**
- 1. Absence of both septum primum and septum secundum, leads to **Common Atrium.**
- 2. Absence of **Septum Secundum**



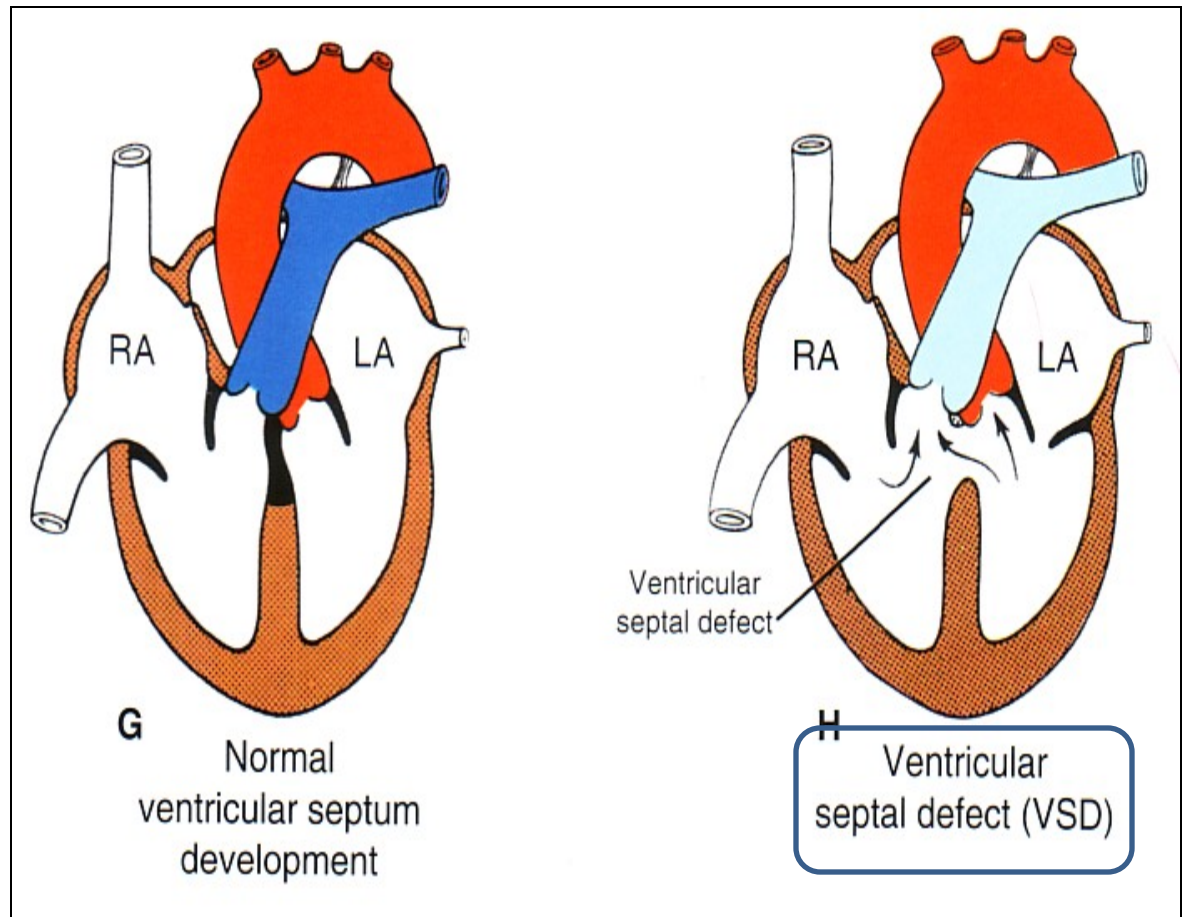
3. Large (**Patent**) **foramen ovale**

: Excessive
resorption of
septum primum



VENTRICULAR SEPTAL DEFECT (VSD)

- **Roger's disease**
- Absence of the ***Membranous*** part of interventricular septum (**persistent IV Foramen**).
- Usually accompanied by other cardiac defects.

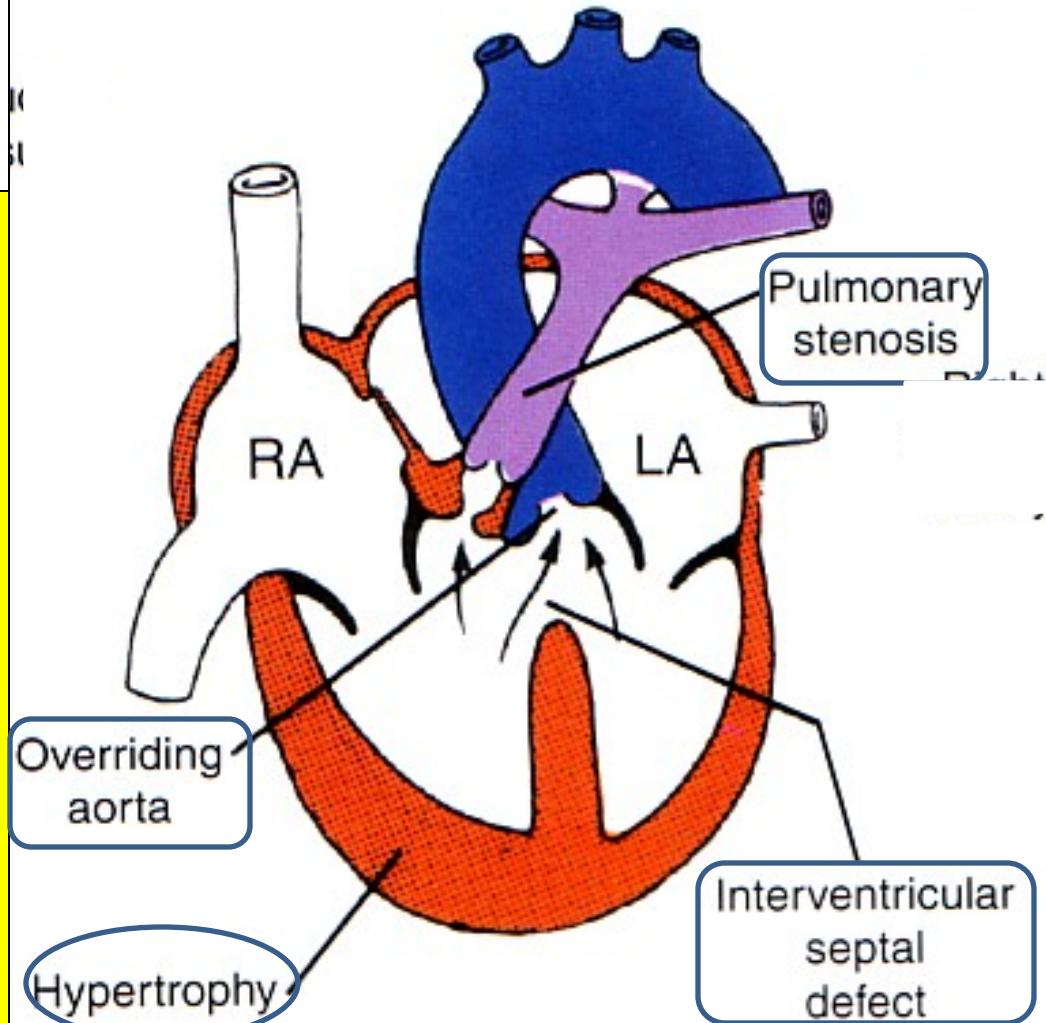




Blue
Baby

- **Falot's Tetralogy:**
- **1-VSD.**
- **2- Pulmonary stenosis.**
- **3-Overriding of the aorta**
- **4- Right ventricular hypertrophy.**

TETRALOGY OF FALLOT

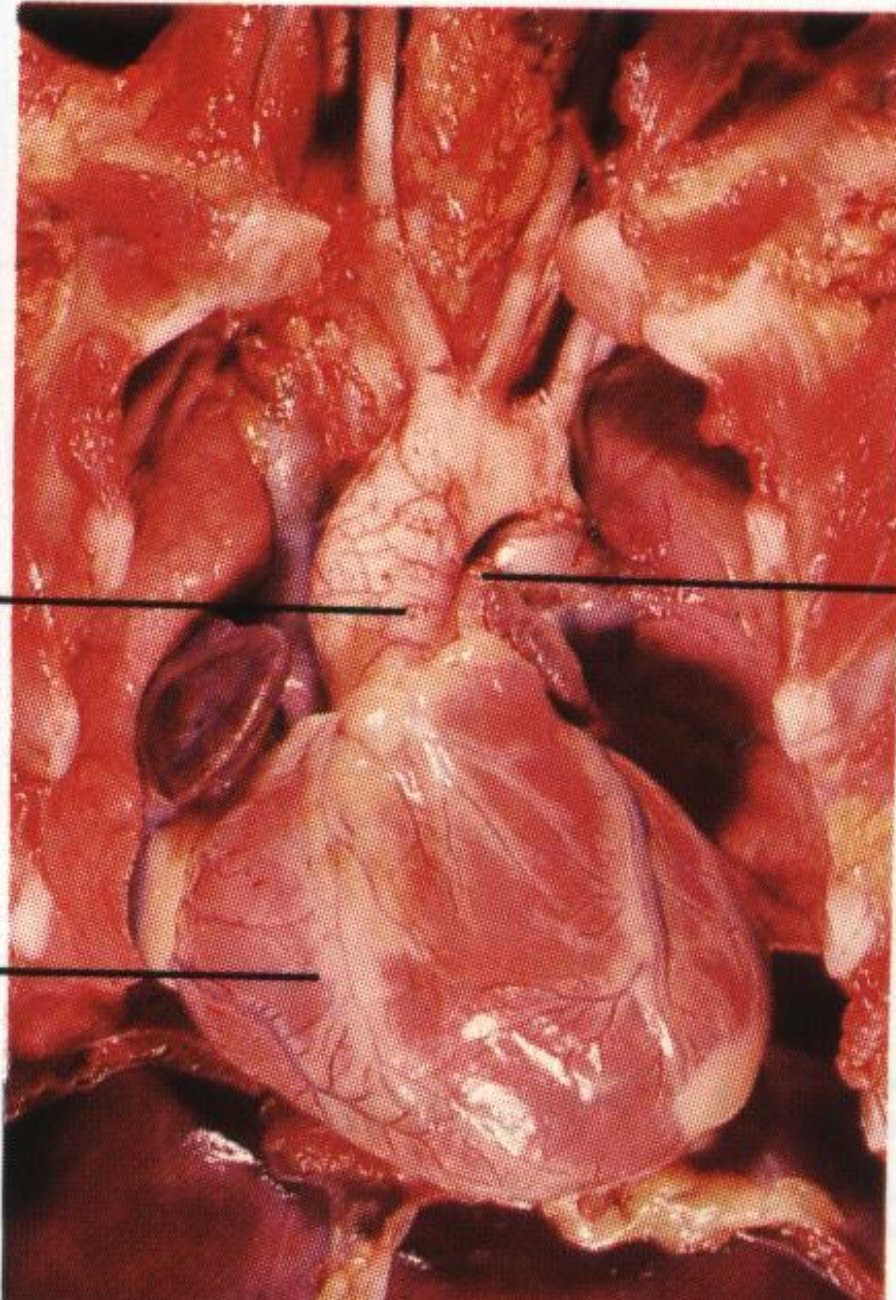


Tetralogy of

TETRALOGY OF FALLOT

Overriding aorta

Enlarged right ventricle

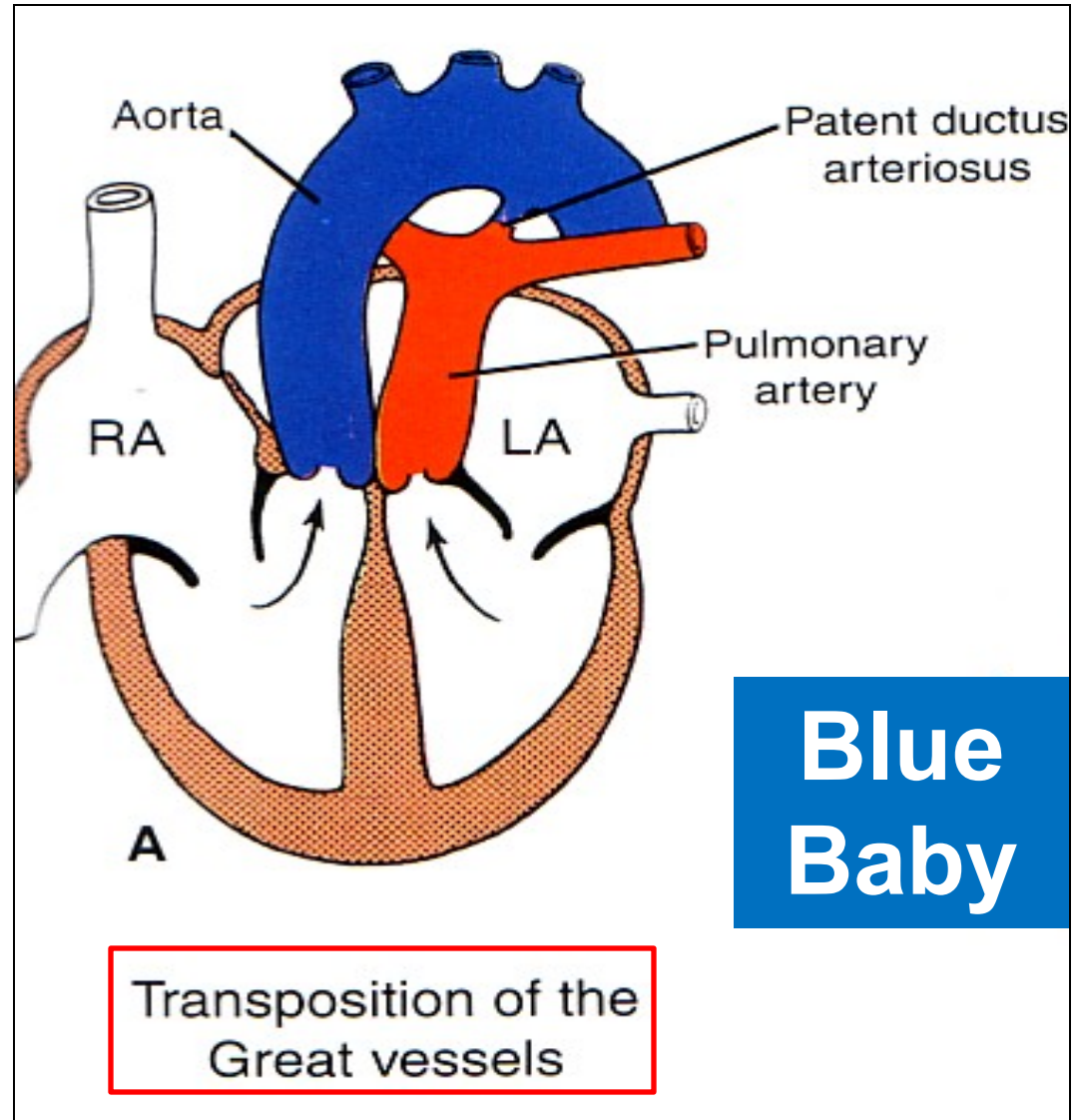


Stenotic pulmonary trunk

Blue Baby

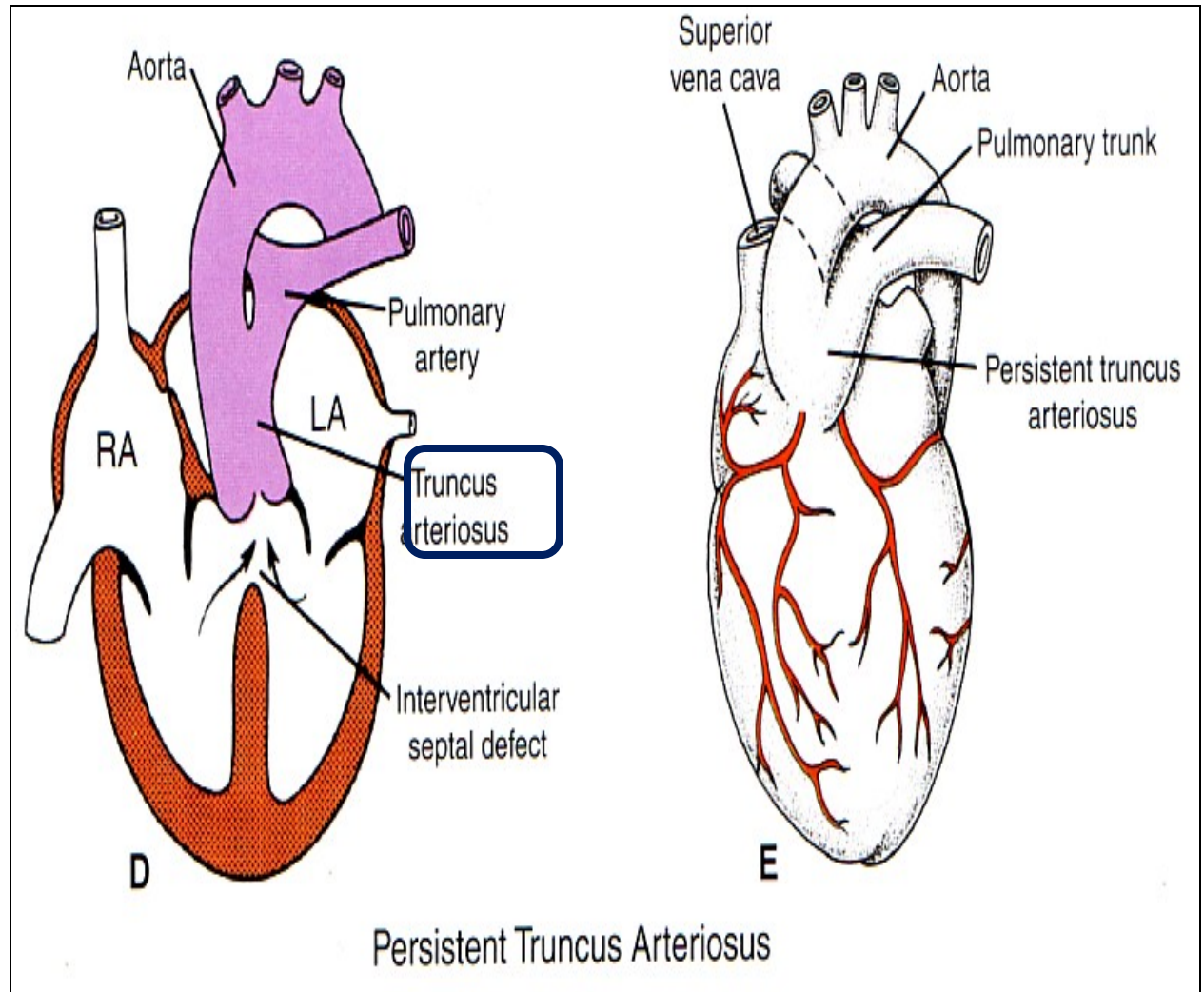
TRANSPOSITION OF GREAT ARTERIES (TGA)

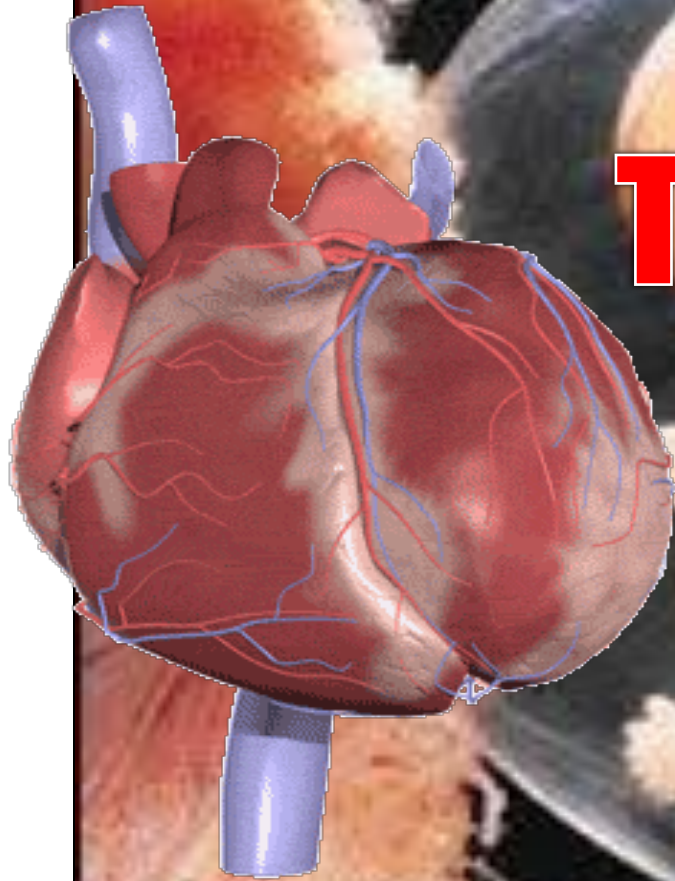
- **TGA** is due to **abnormal rotation or malformation of the aortopulmonary septum**, so the right ventricle joins the aorta, while the left ventricle joins the pulmonary artery.
- It is one of the most common causes of cyanotic heart disease in the newborn
- Often associated with ASD or VSD



Persistent Truncus Arteriosus

- It is due to **failure of the development of aorticopulmonary (spiral) septum.**
 - It is usually accompanied with VSD.
- It forms a single arterial trunk arising from the heart and supplies the systemic, pulmonary & coronary circulations.**





THANK YOU

