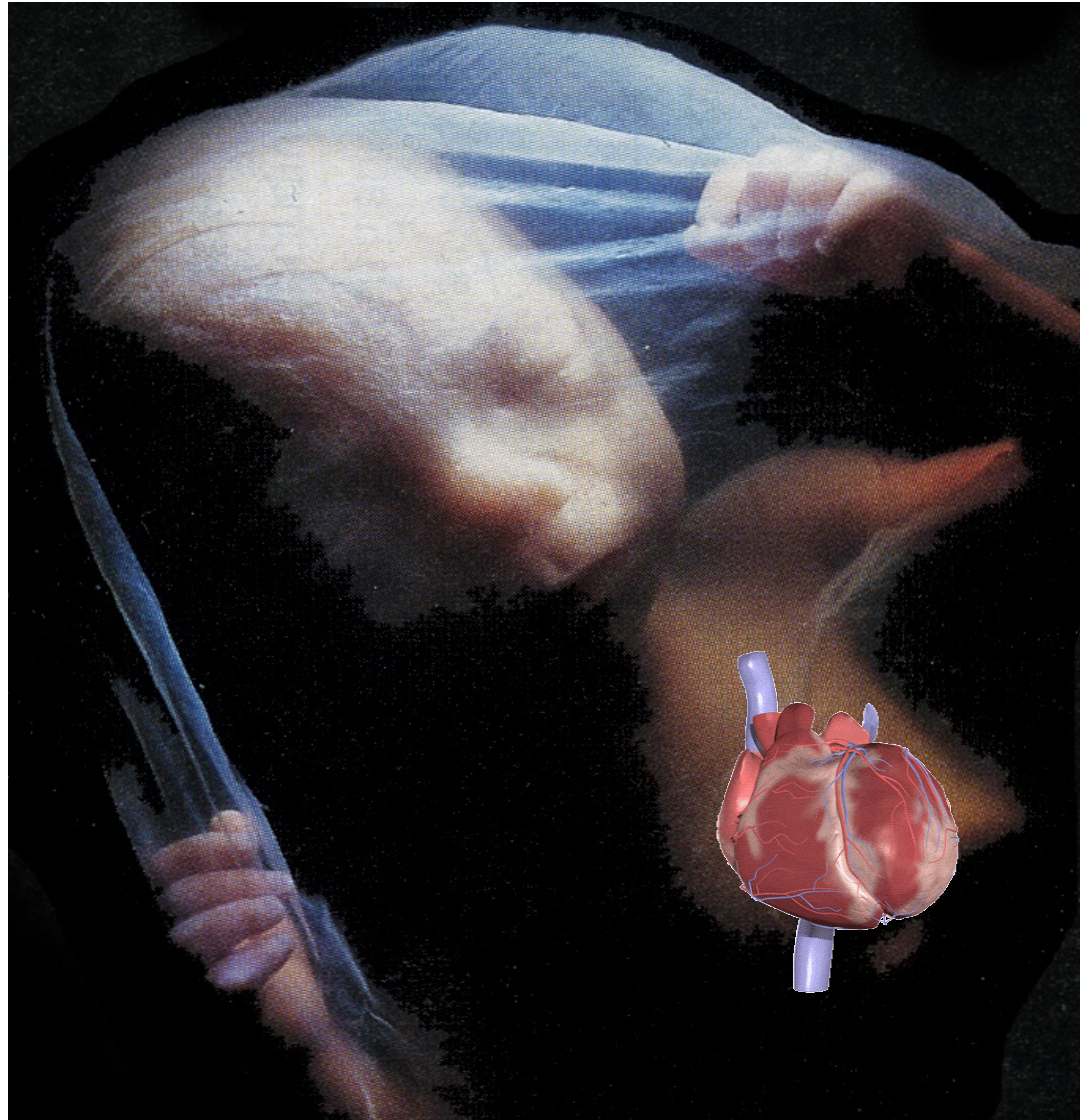


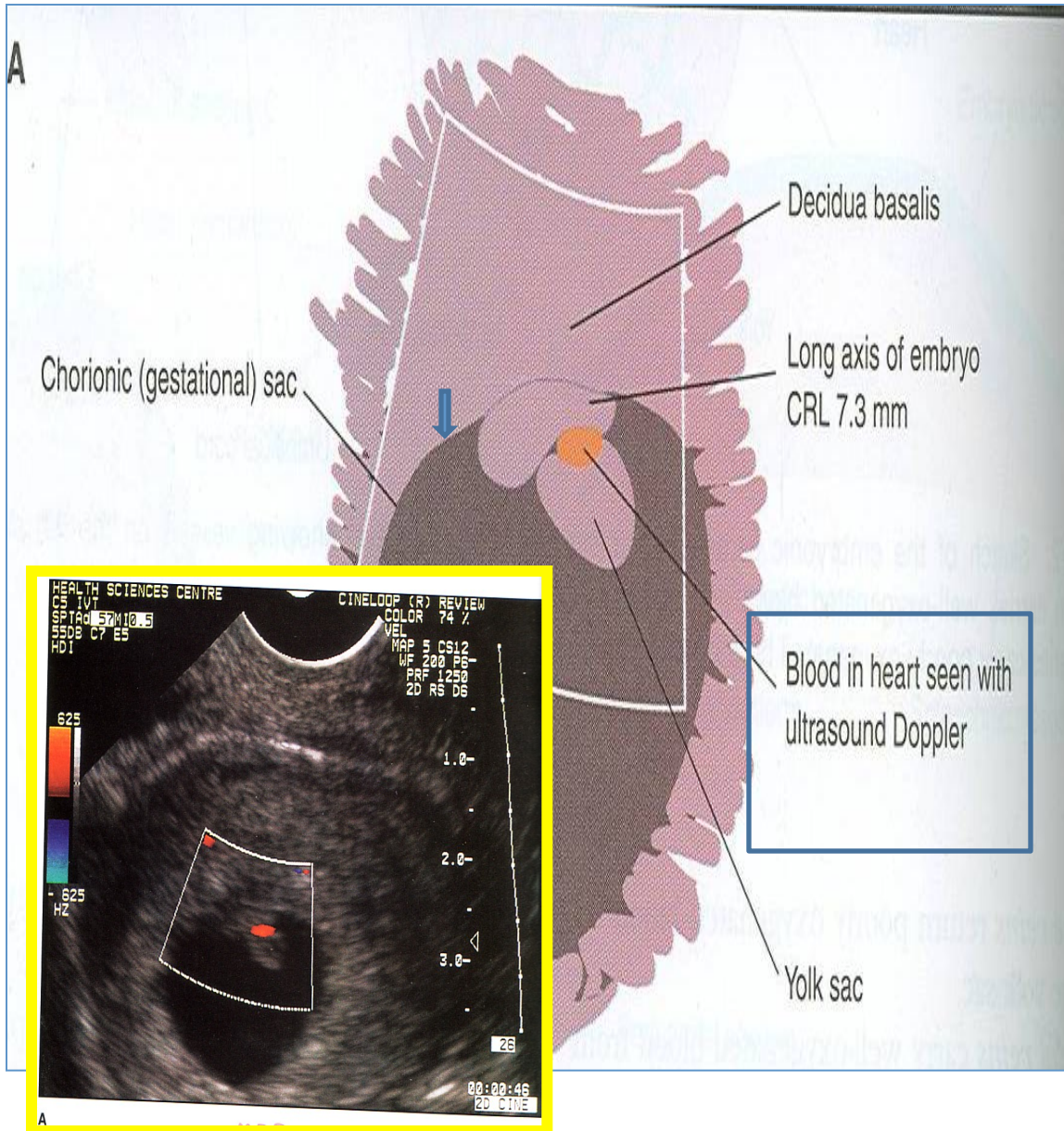
# DEVELOPMENT OF HEART

Prof. Saeed Abuel Makarem  
Dr. Jamila El Medany

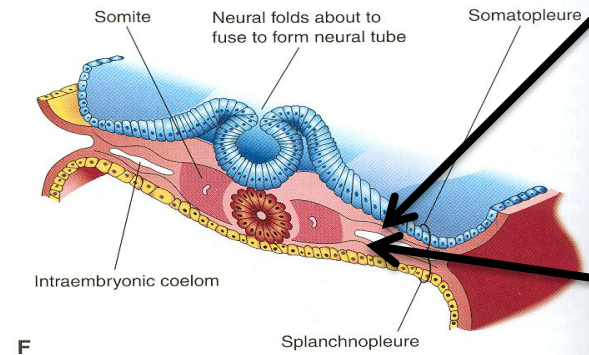
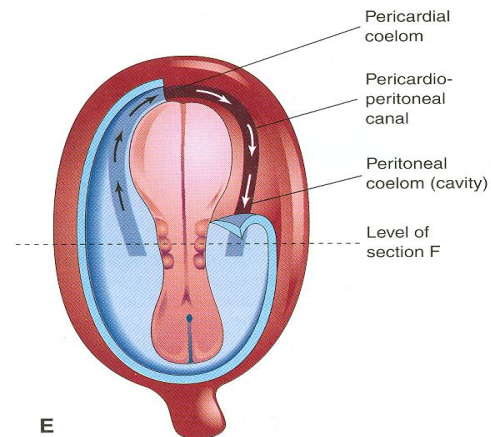
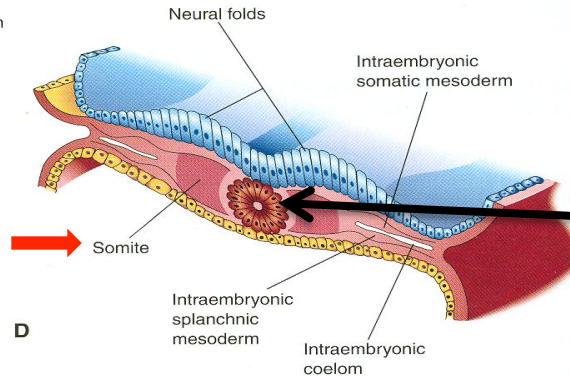
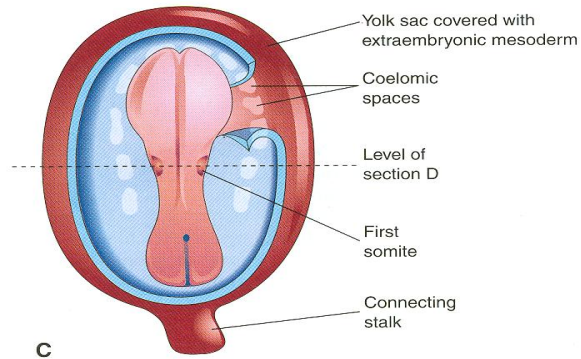
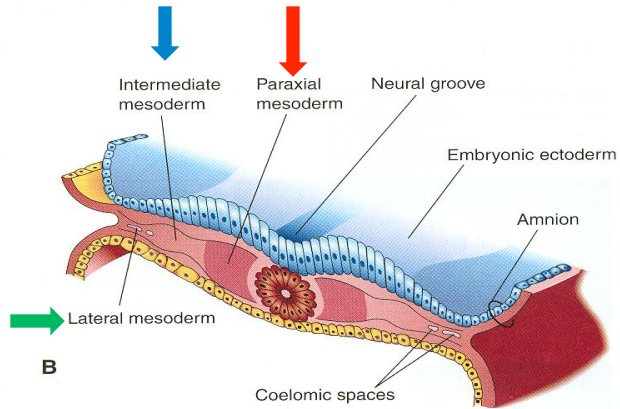
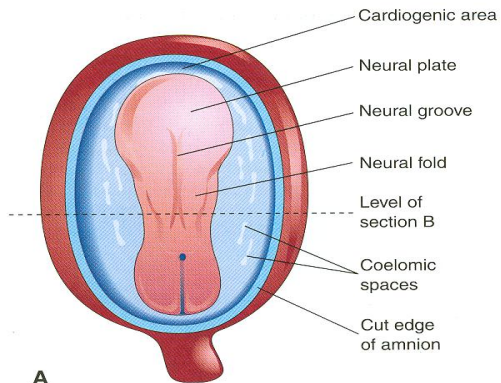


# Objectives

- **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**



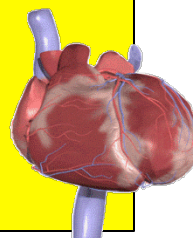
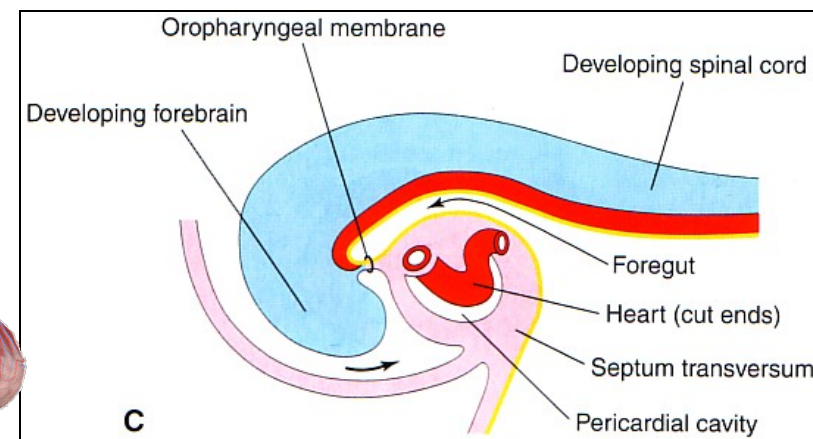
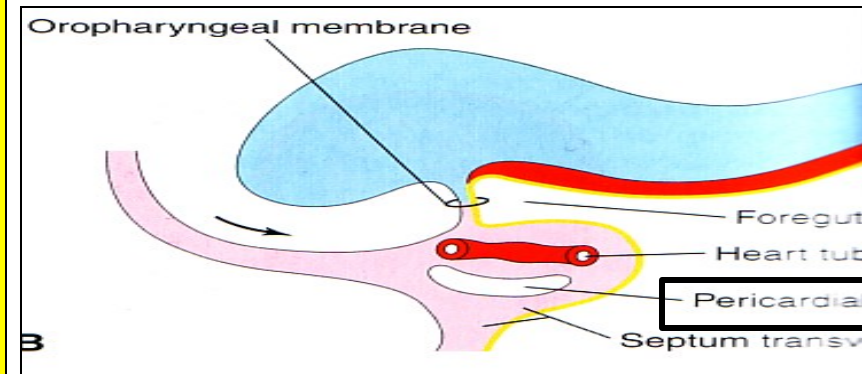
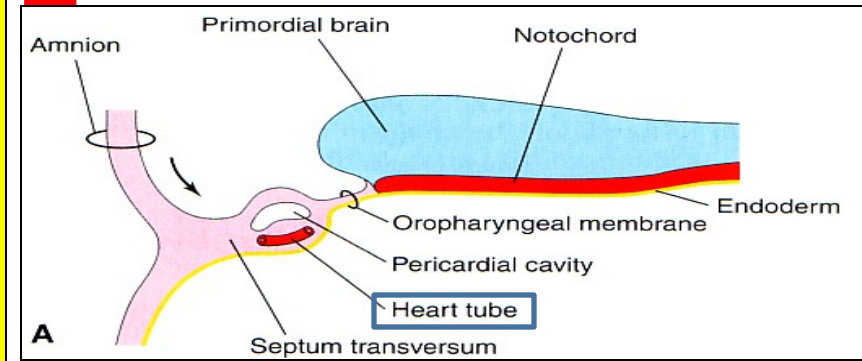
**Notochord:**  
stimulates neural tube formation

**Somatic mesoderm**

**Splanchnic mesoderm**

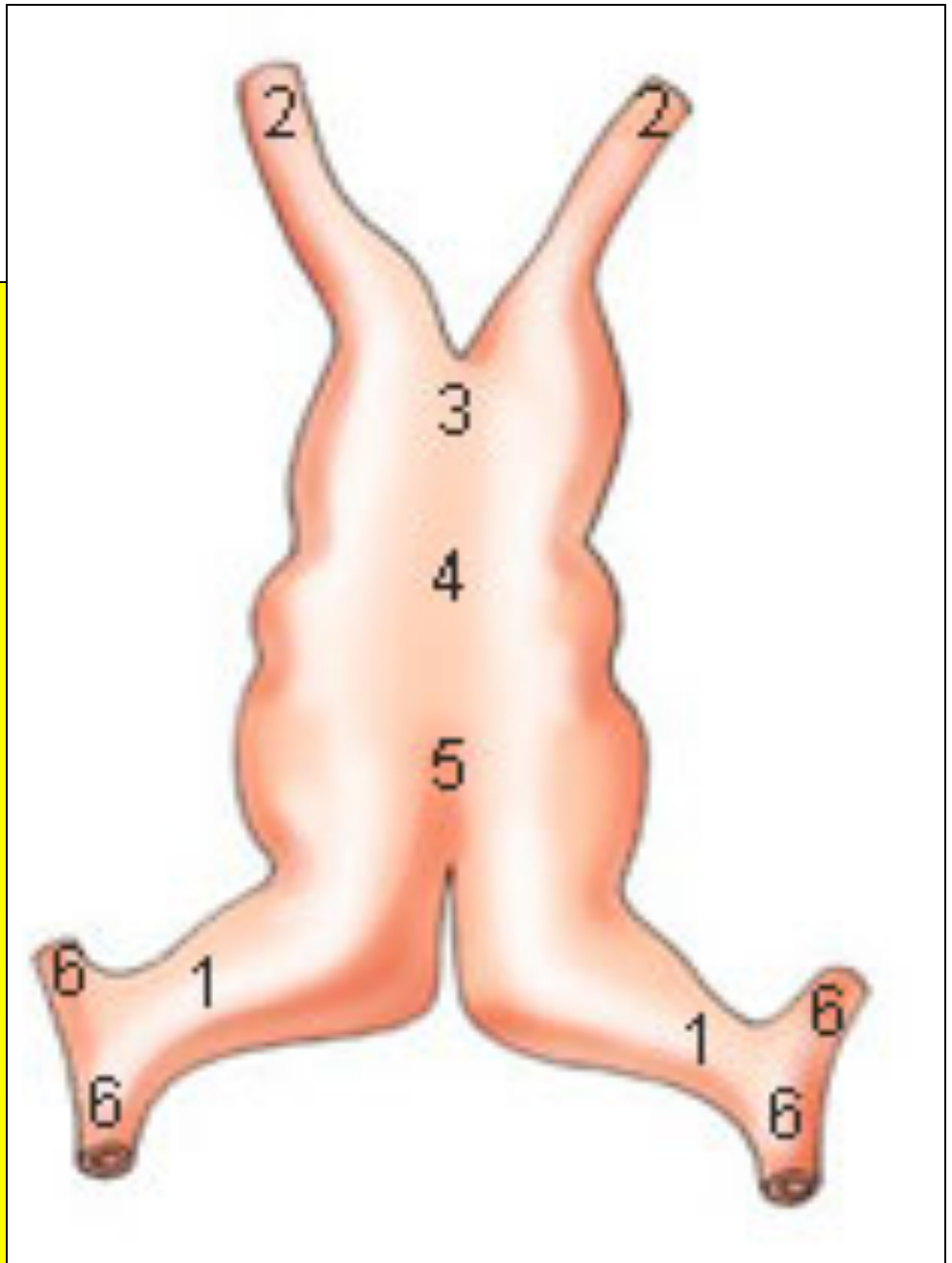
# FORMATION OF THE HEART TUBE

- 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?

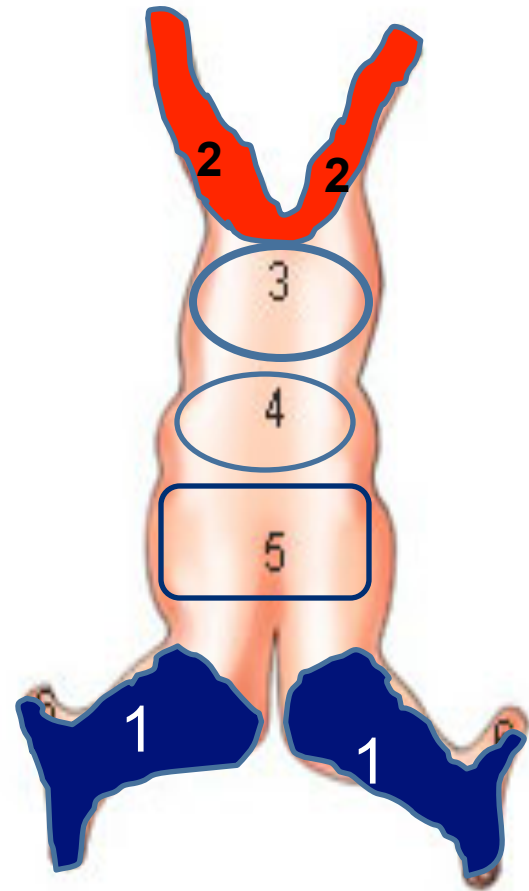
- The heart tube grows faster than the pericardial sac, so it shows **5** alternate dilations separated by constrictions.

- These are:

1. Sinus Venosus.
2. Truncus Arteriosus.
3. Bulbus Cordis.
4. Common Ventricle.
5. Common Atrium.

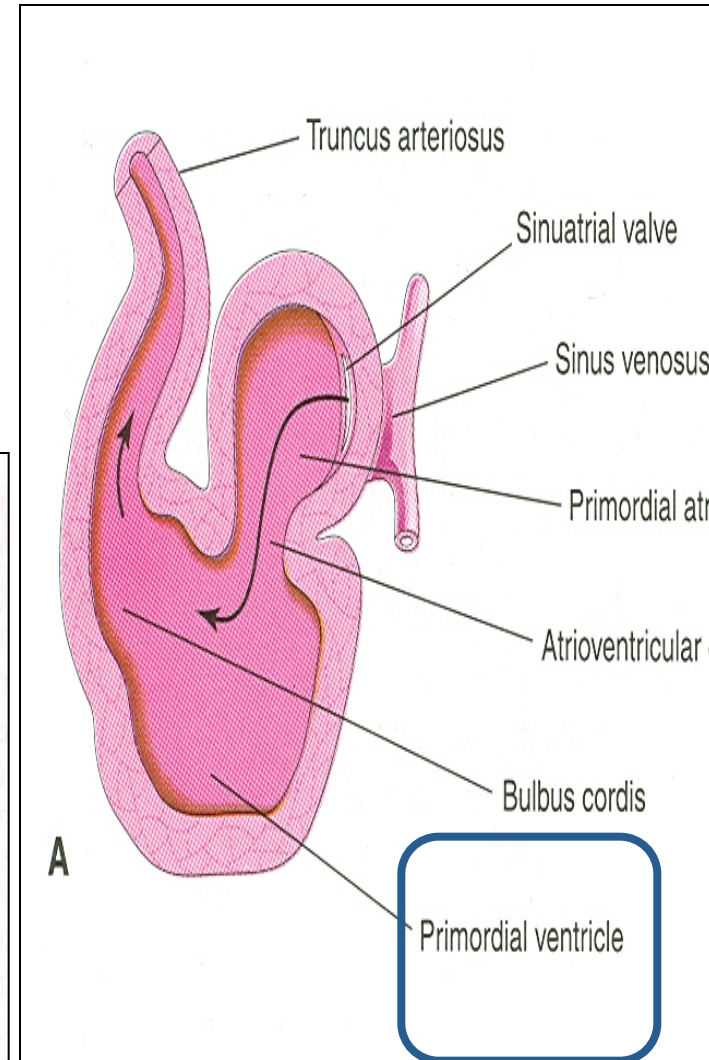
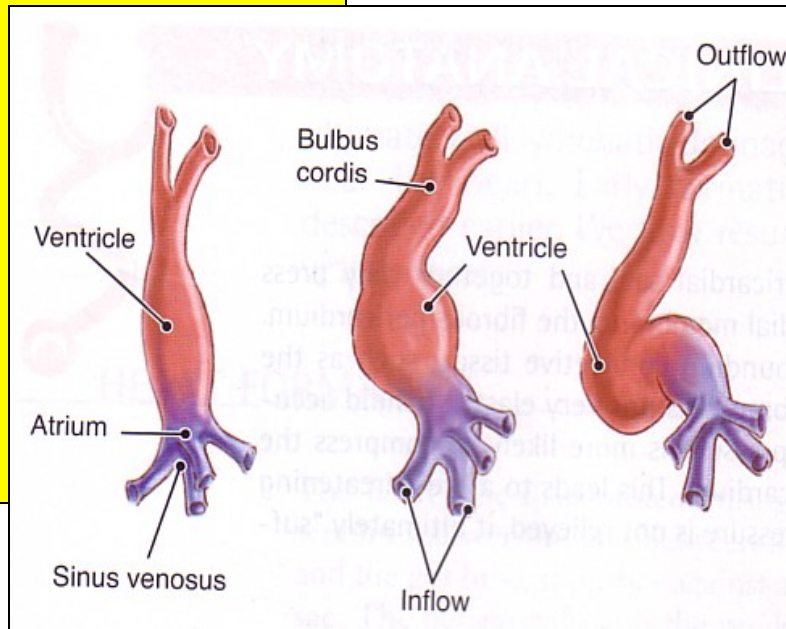
The endocardial heart tube has 2 ends:

1. Venous end (Caudal): Sinus Venosus.
2. Arterial end (Cranial): Truncus arteriosus



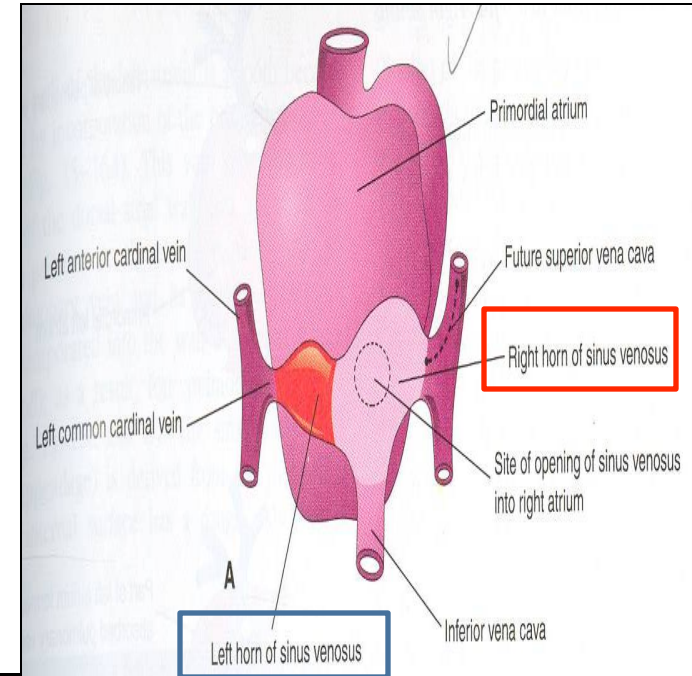
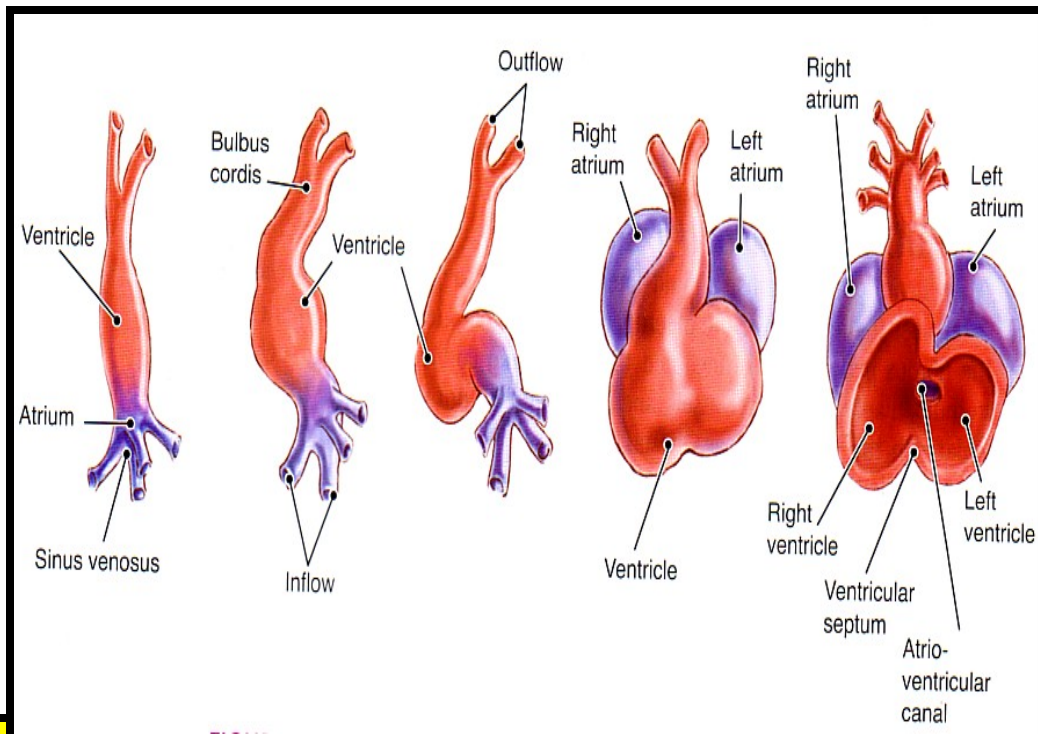
# U-SHAPED HEART TUBE

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



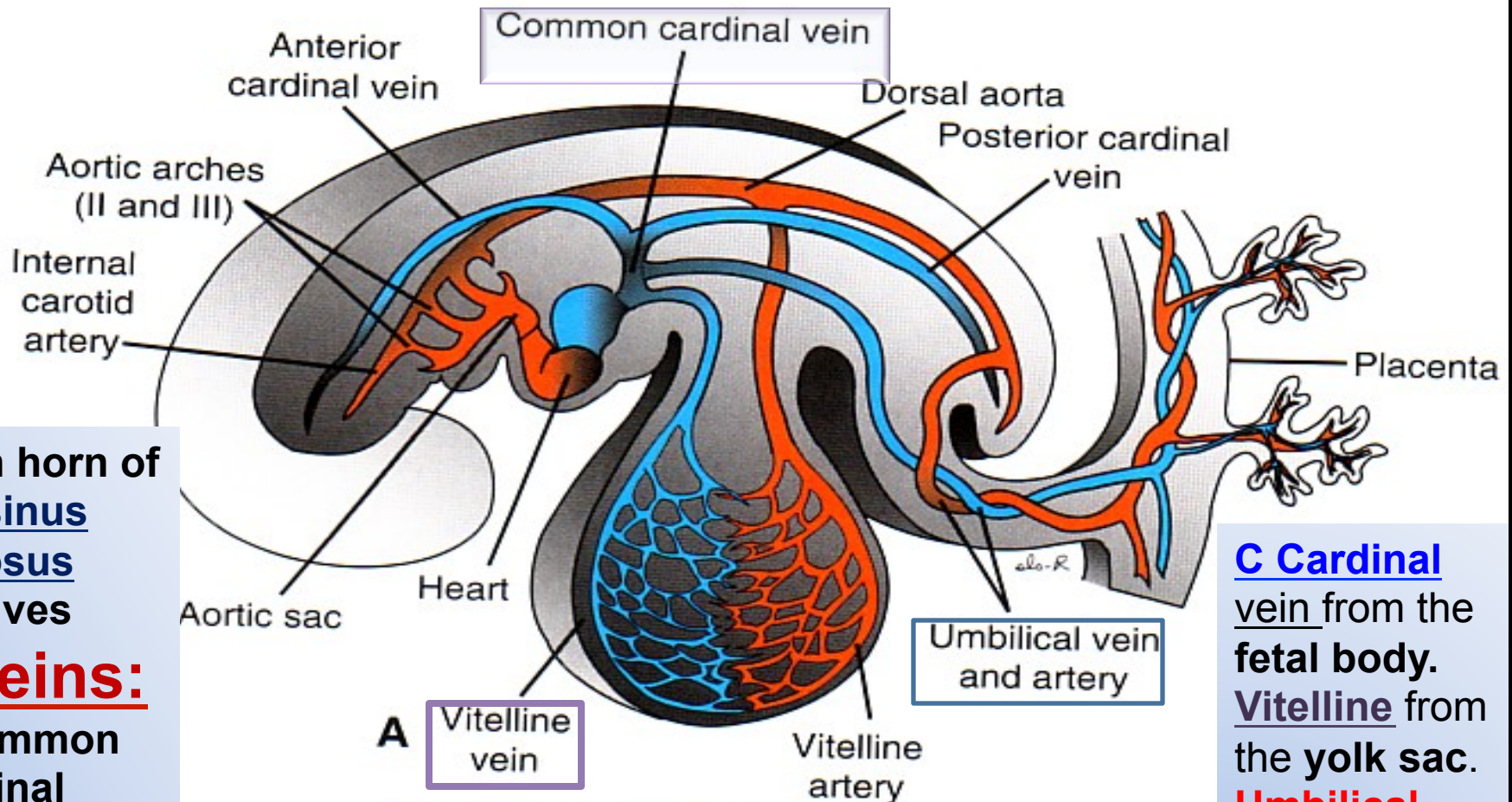


# S-Shaped Heart Tube



- 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

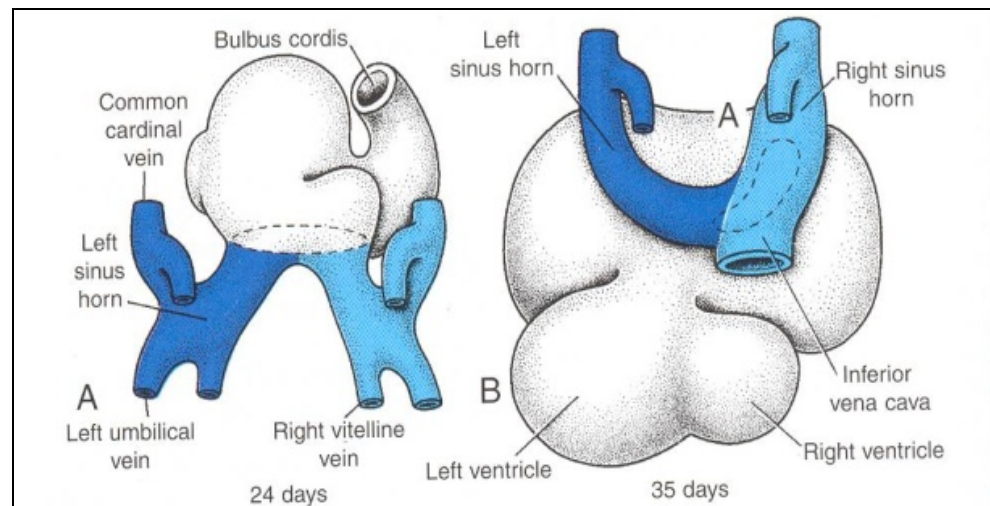
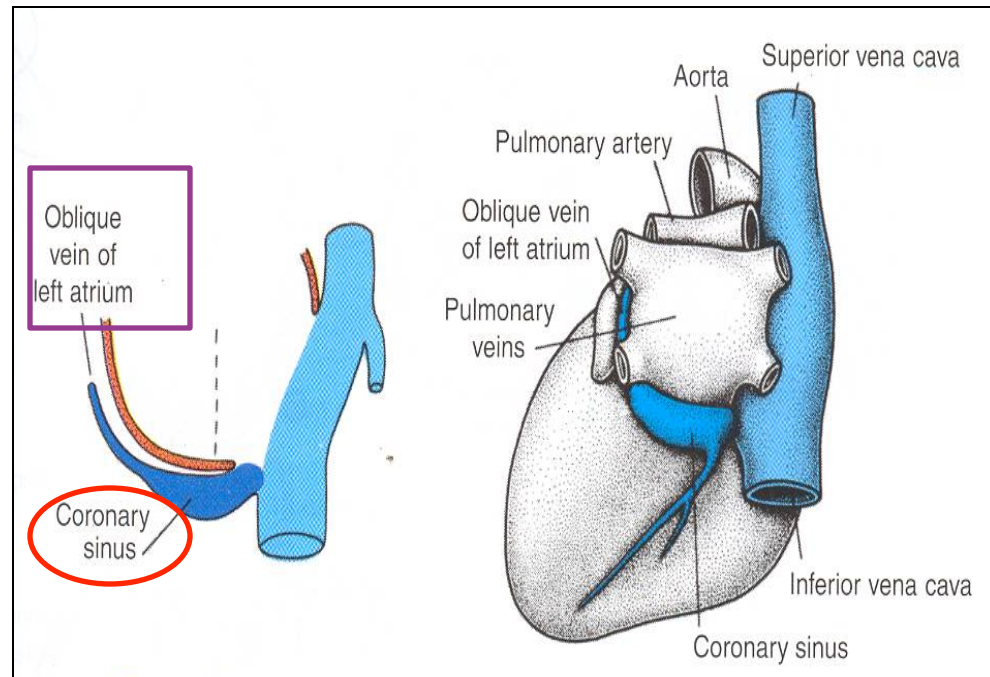
A

Each vessel is paired at this stage (not illustrated)

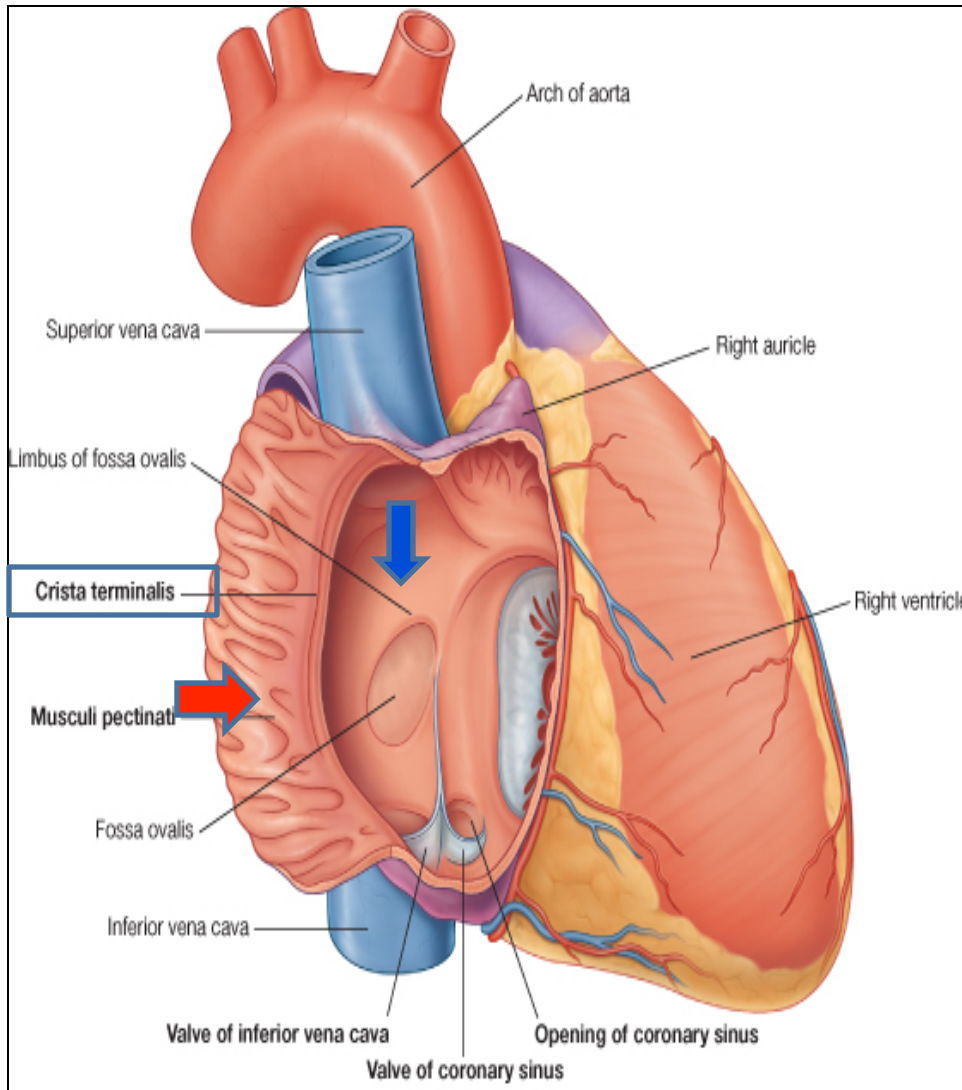
**C Cardinal vein** from the fetal body.  
**Vitelline** from the yolk sac.  
**Umbilical** from the placenta.

# Fate of Sinus Venosus

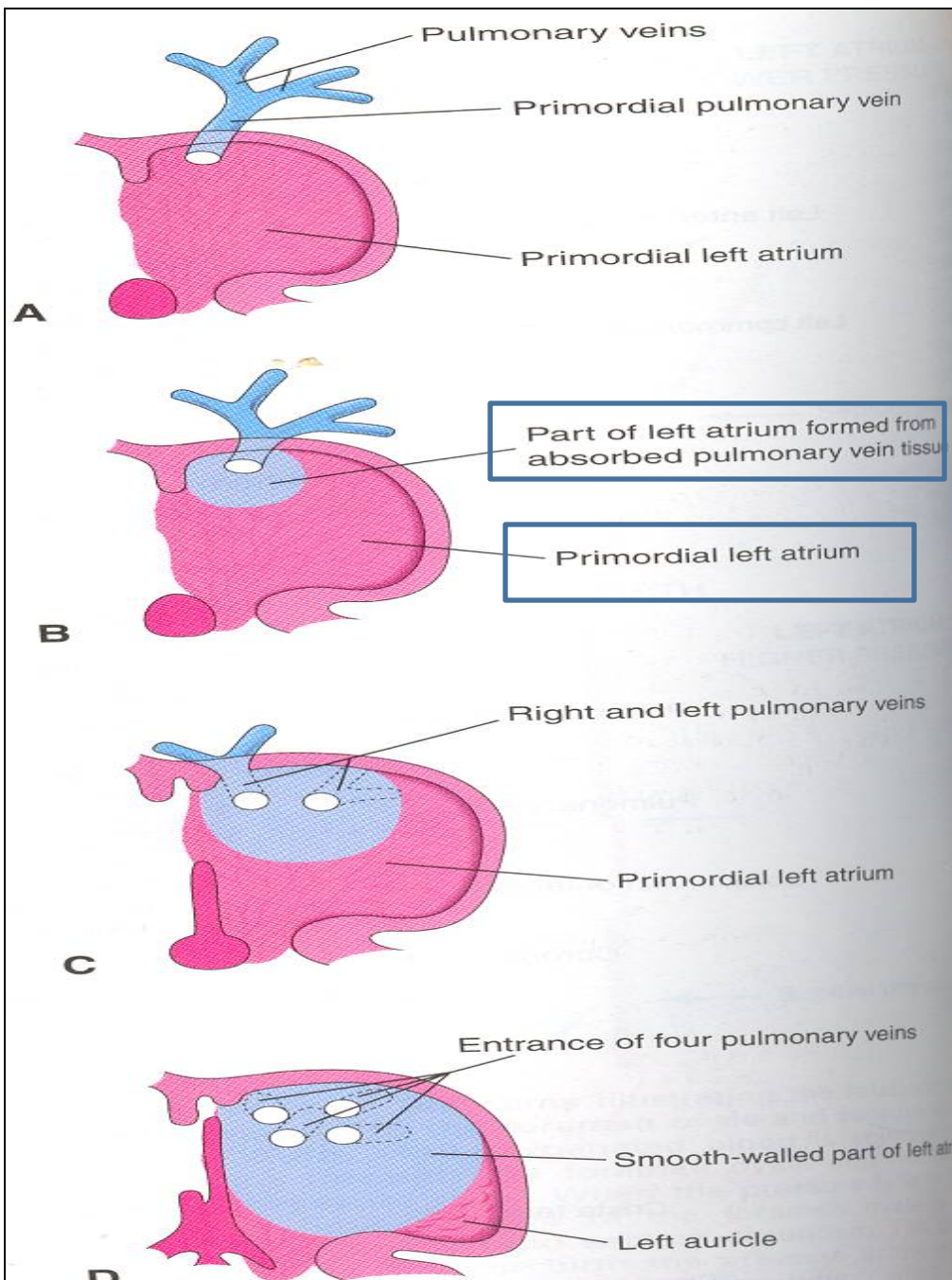
- The **Right Horn** forms the smooth posterior part of the right atrium.
- The **Left Horn and Body** atrophy and form the **Coronary Sinus**.
- The **Left Common cardinal vein** forms the **Oblique Vein of the Left Atrium**.



# 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.***

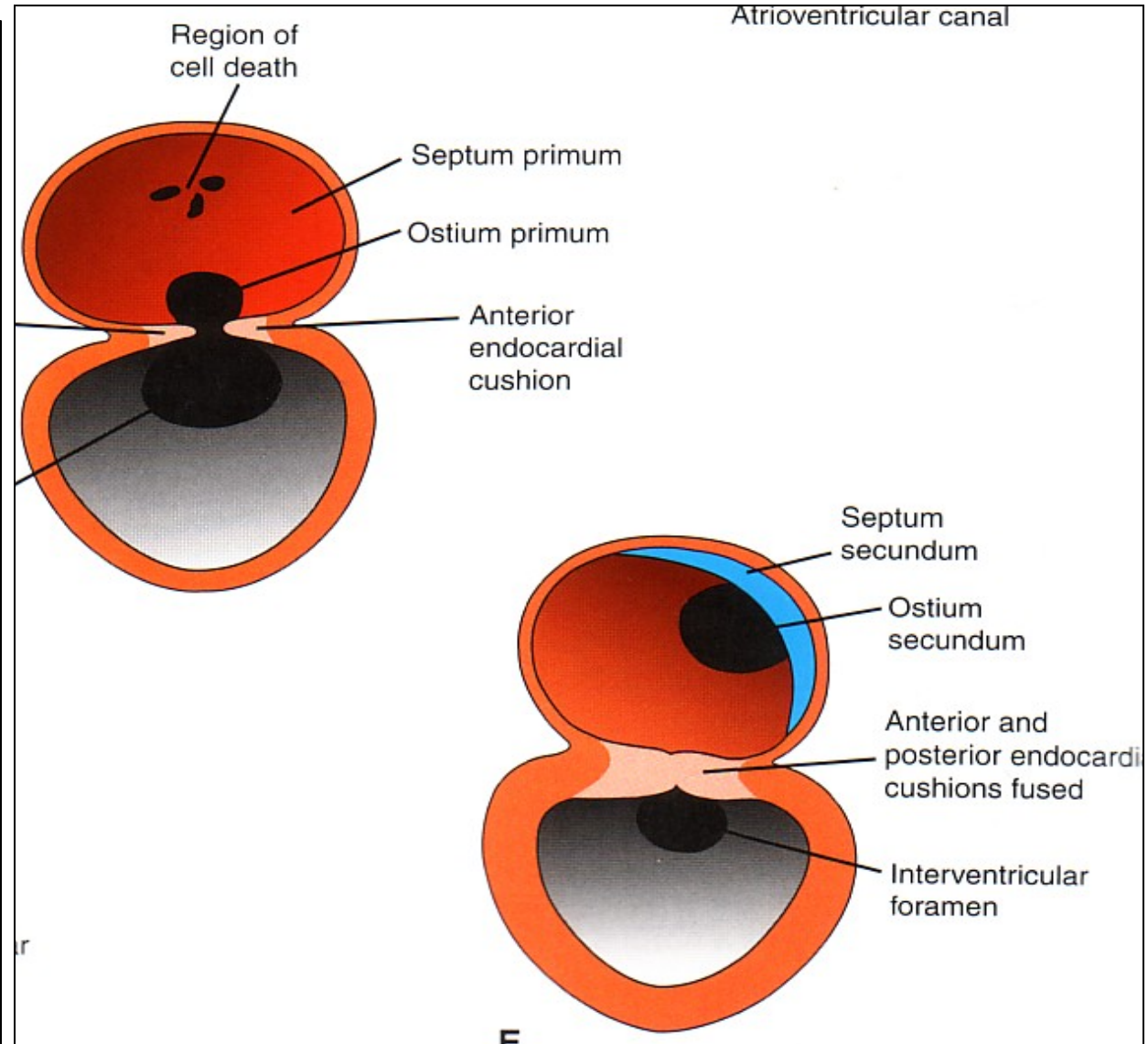
# Partitioning of Primordial Heart

## Partitioning of:

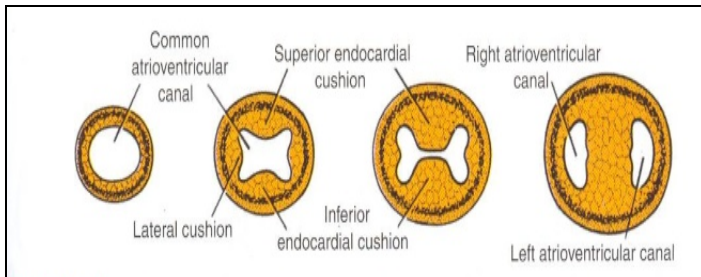
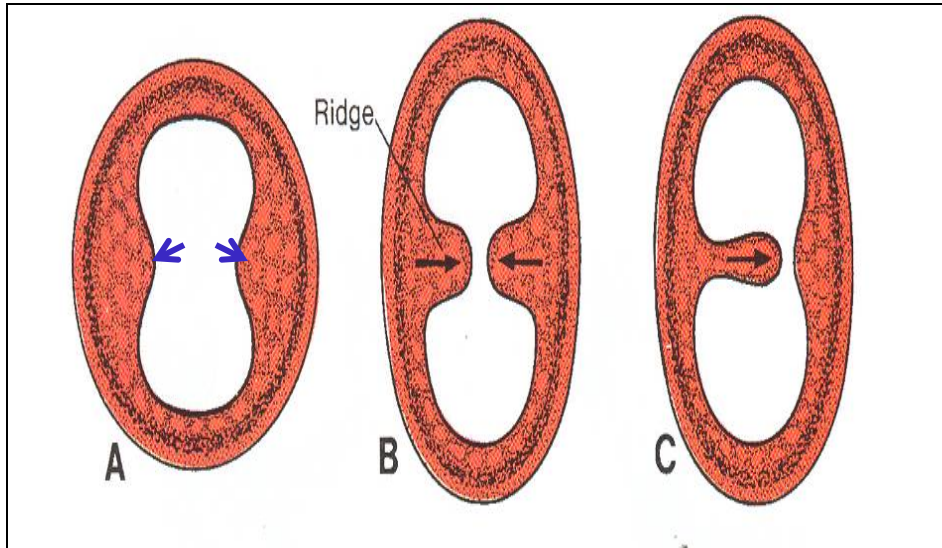
- 1- Atrioventricular canal.
- 2- Common atrium.
- 3- Common ventricle.
- 4- Truncus arteriosus & Bulbus cordis.

It begins by the middle of 4<sup>th</sup> week.

It is completed by the end of 5<sup>th</sup> week.



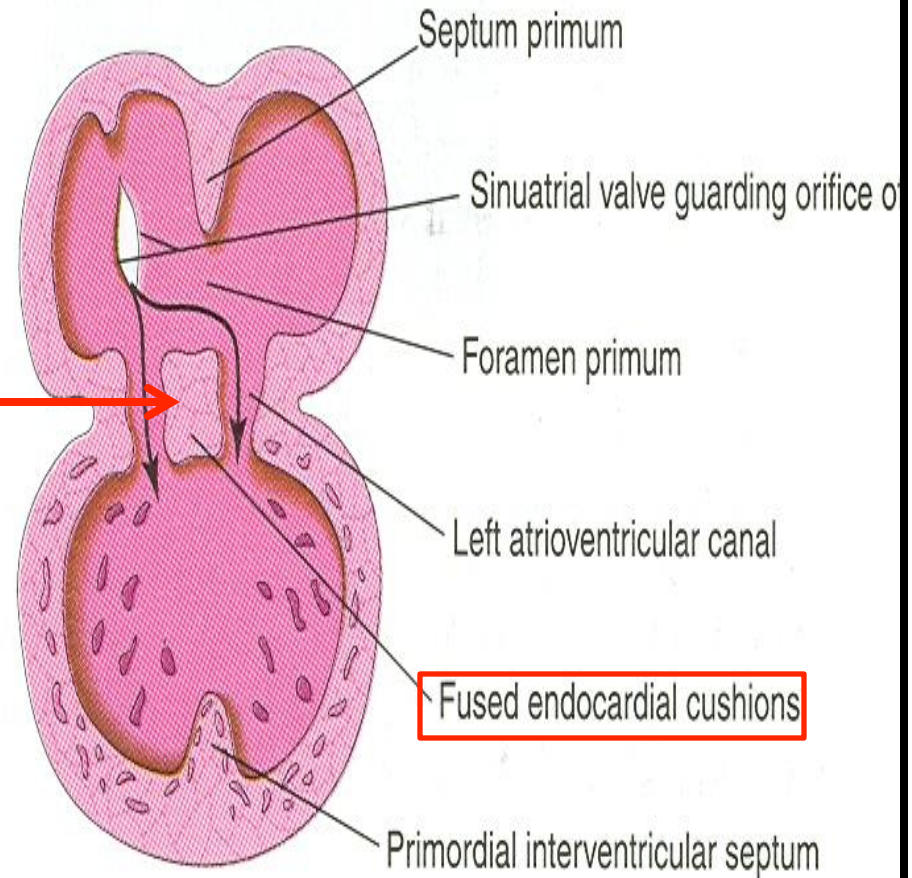
# Endocardial Cushions



- They appear around the middle of the **4<sup>th</sup> 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.

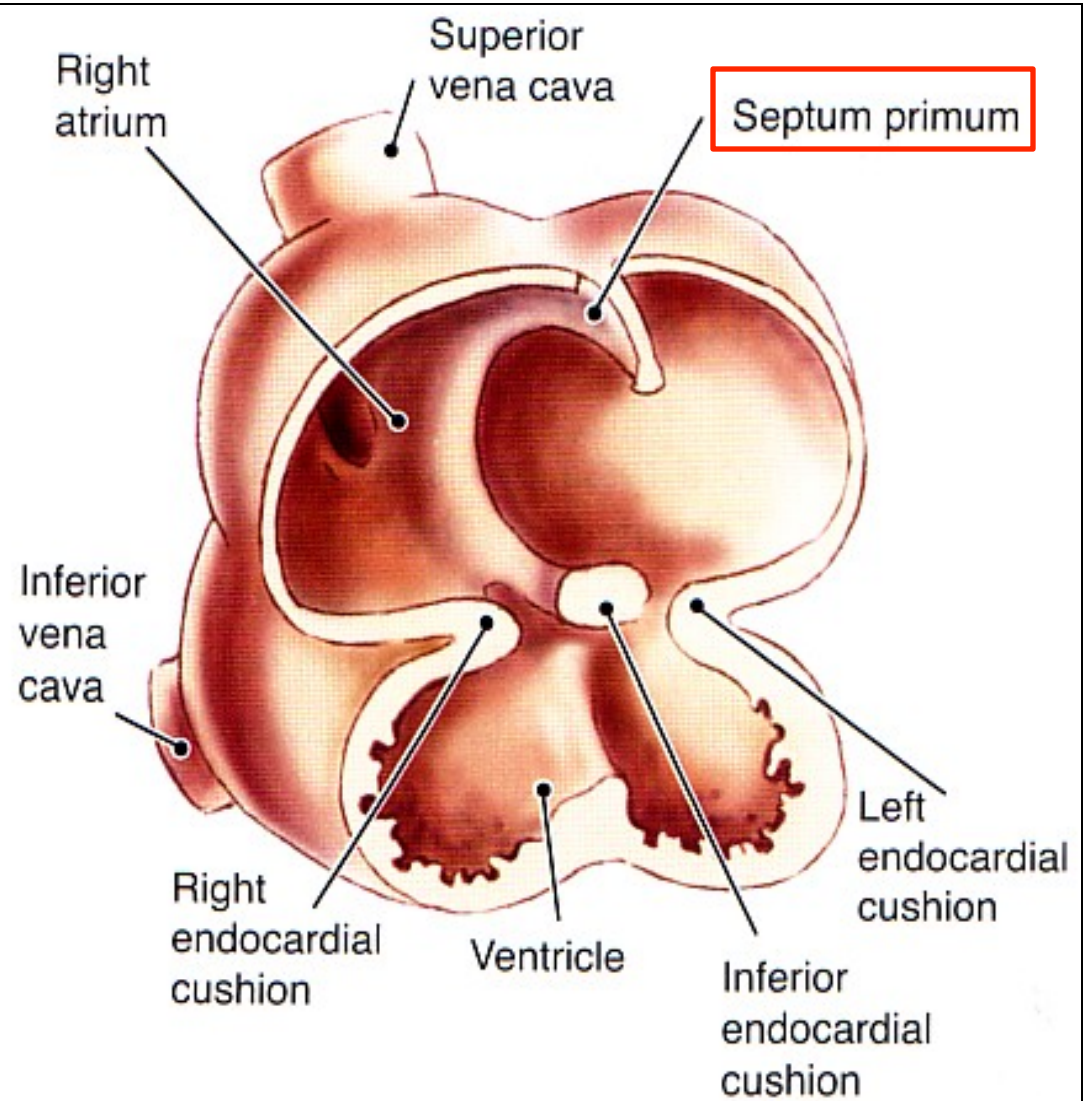




# Partition of the Common Atrium

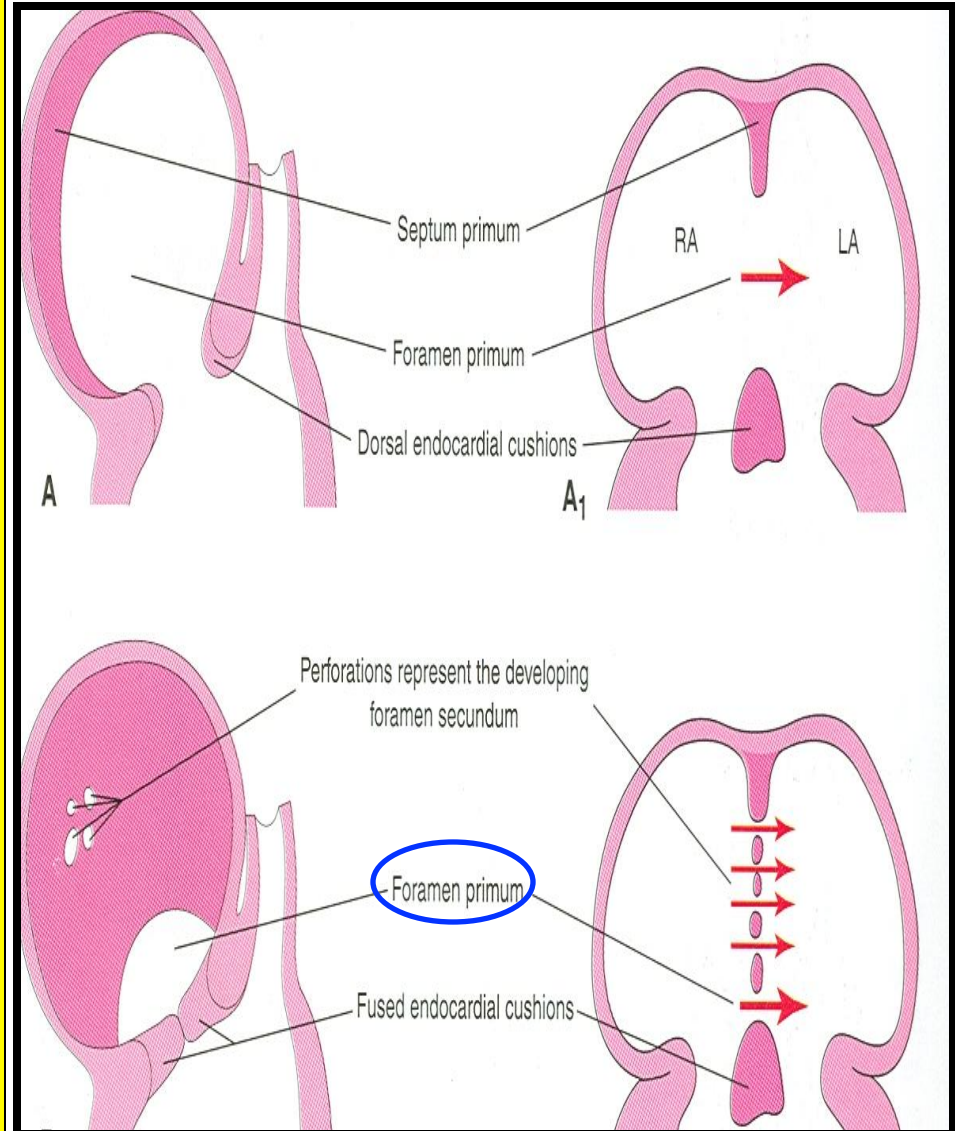
## Septum Primum

- 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.



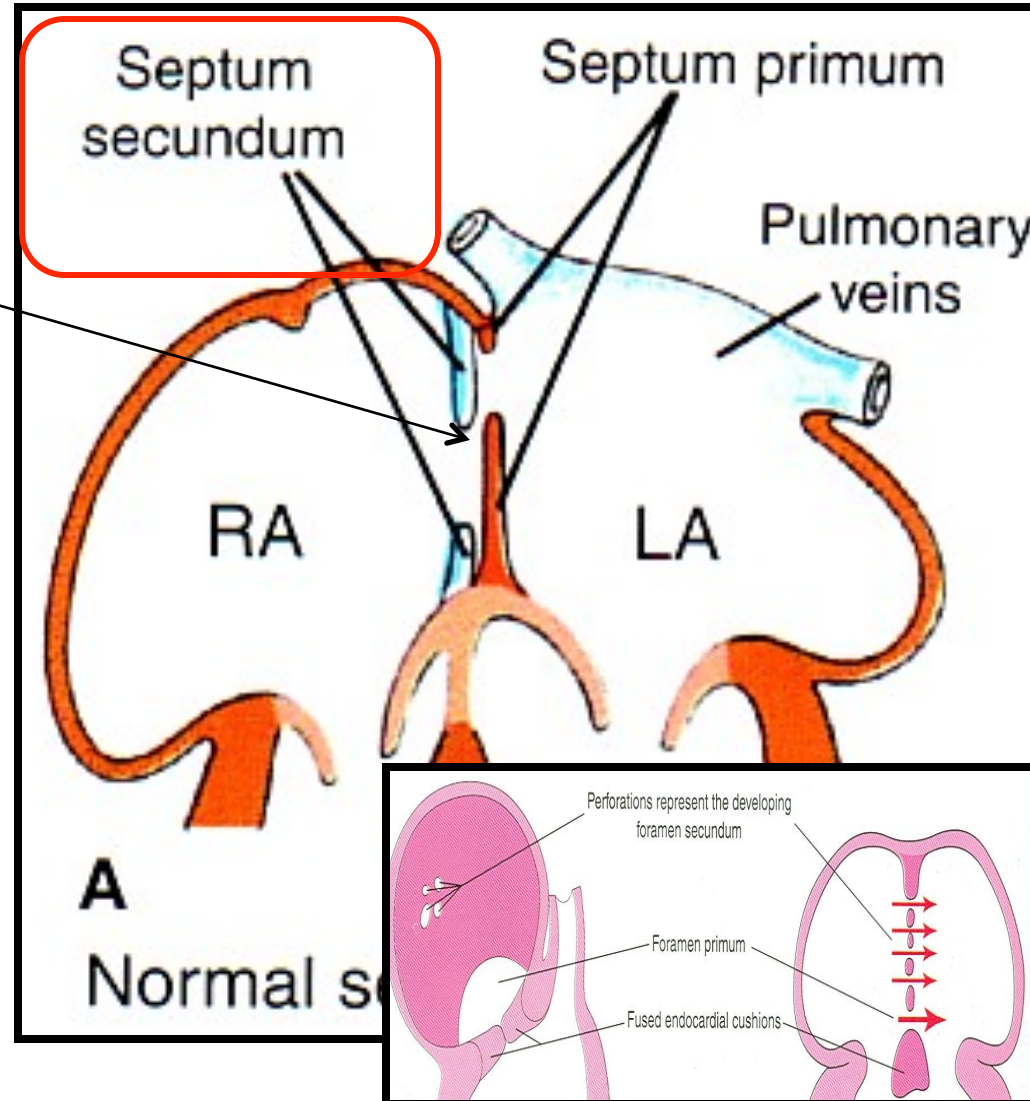
- The two ends of septum primum reach to the growing endocardial cushions before its central part.
- Now the septum primum bounds a foramen called ostium primum.
- It serves as a shunt, enabling the oxygenated blood to pass from right to left atrium.
- The **ostium primum** become smaller and disappears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

# Ostium Primum

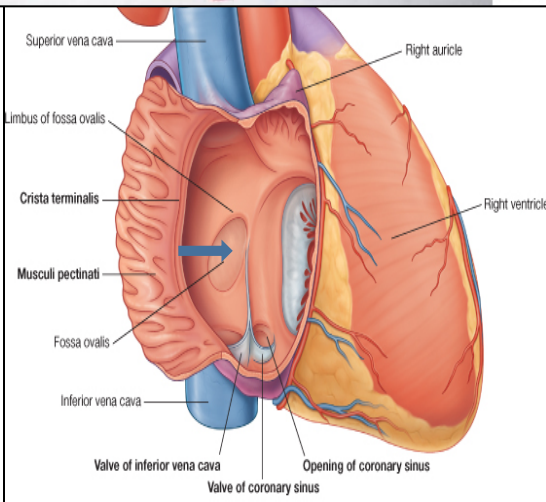
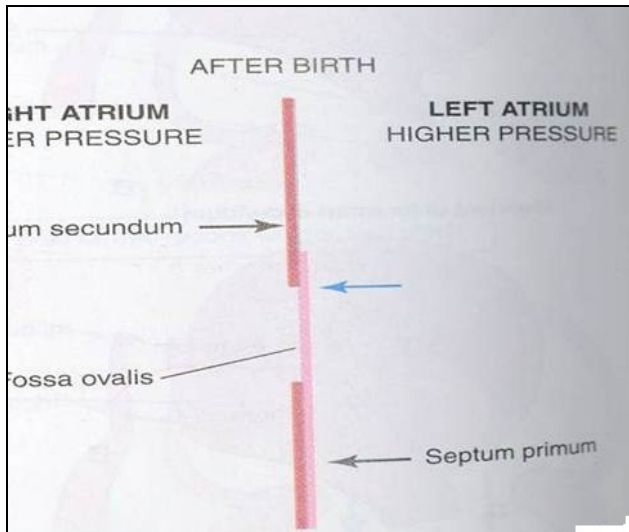


- The upper part of septum primum that is attached to the roof of the common atrium shows gradual resorption forming an opening called ostium secundum.
- Another septum descends on the right side of the septum primum called Septum Secundum.
- It forms an incomplete partition between the two atria.
-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

# Septum Secundum



# Fate of foramen Ovale



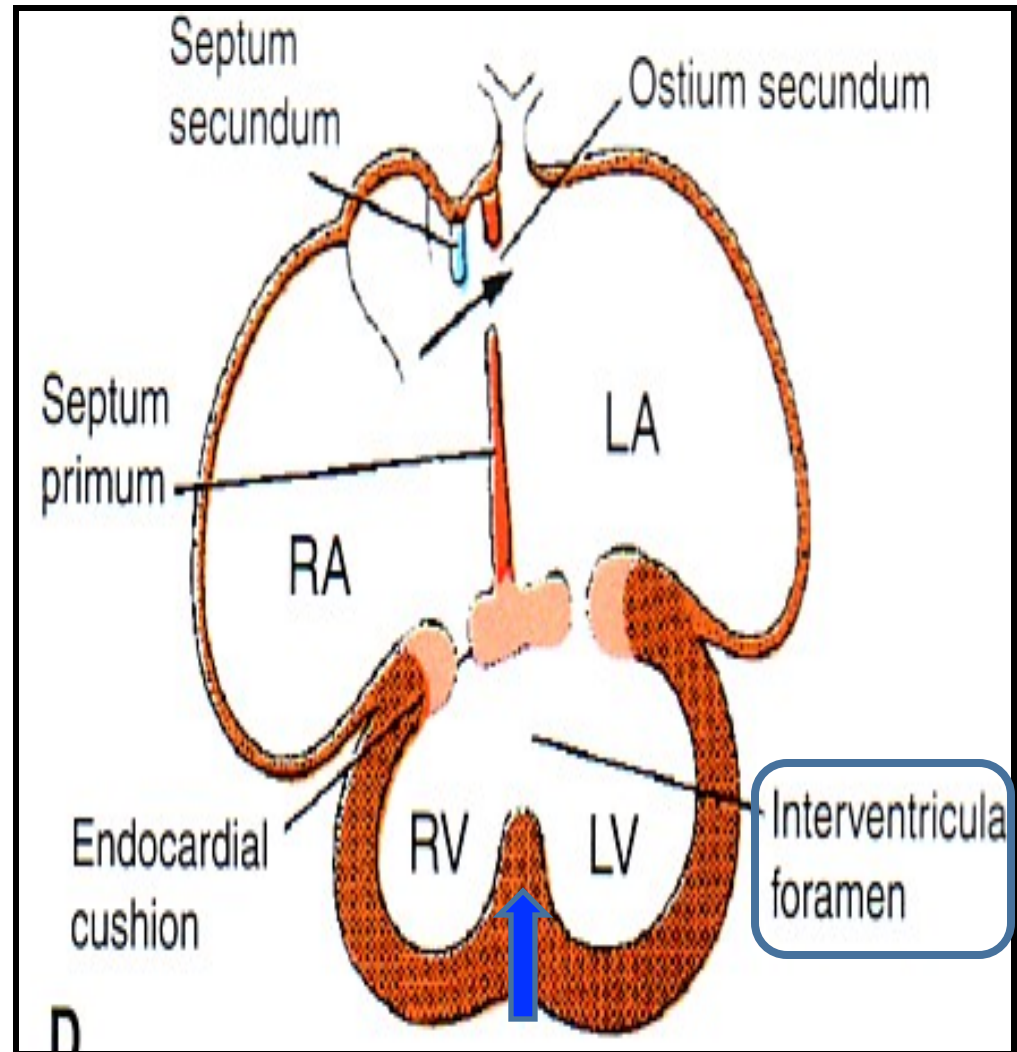
- At birth when the lung circulation begins, the pressure in the left atrium increases.
- The valve of the foramen ovale is pressed against the septum secundum and obliterates the foramen ovale.
- Its site is represented by the **Fossa Ovalis**:
- Its **floor** represents the persistent part of the **septum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

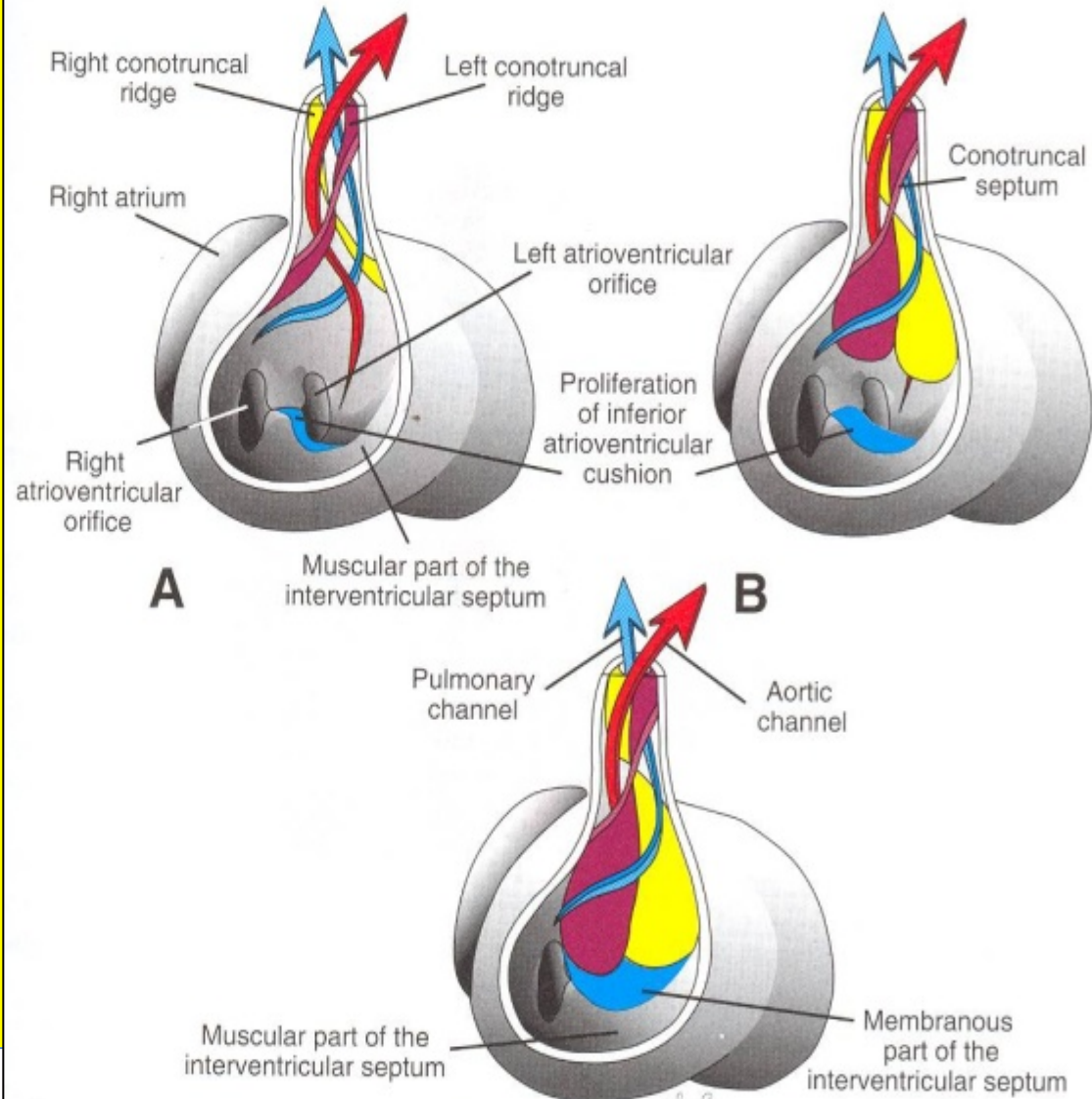
## The Membranous

part

of the IV septum:

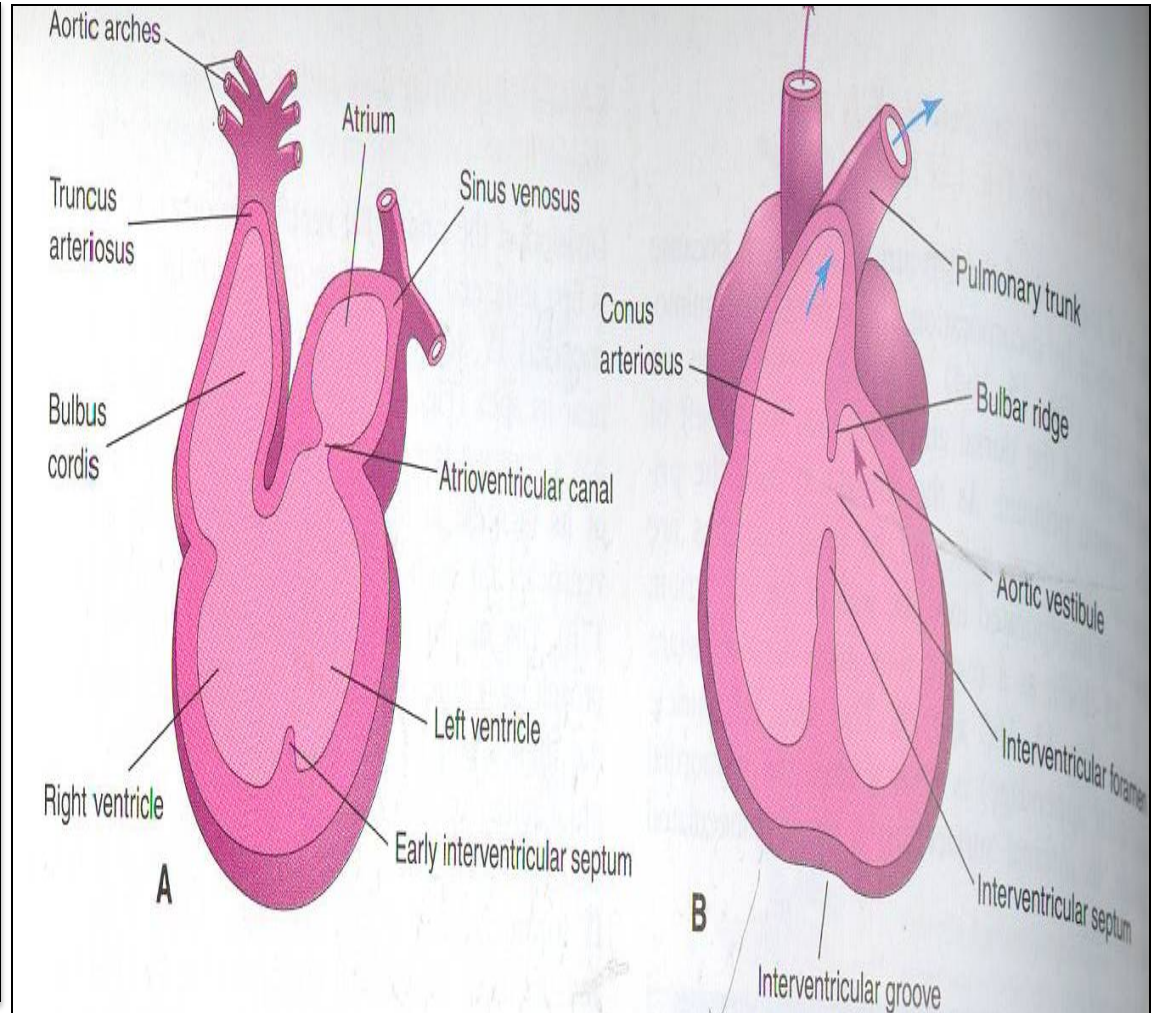
derived from

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

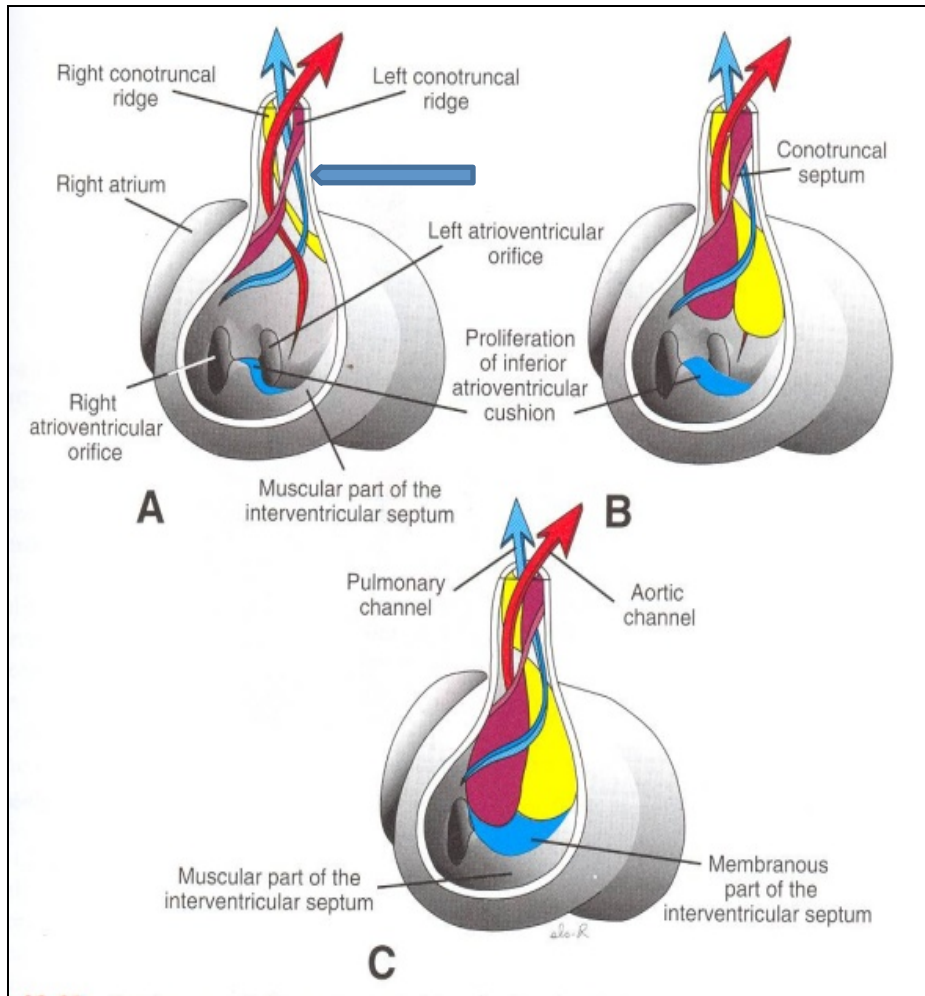


# BULBUS CORDIS

- 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.



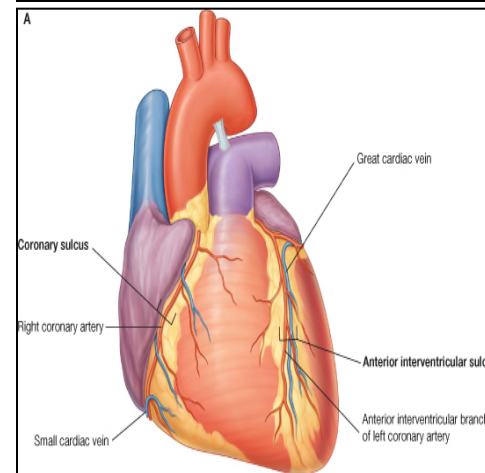
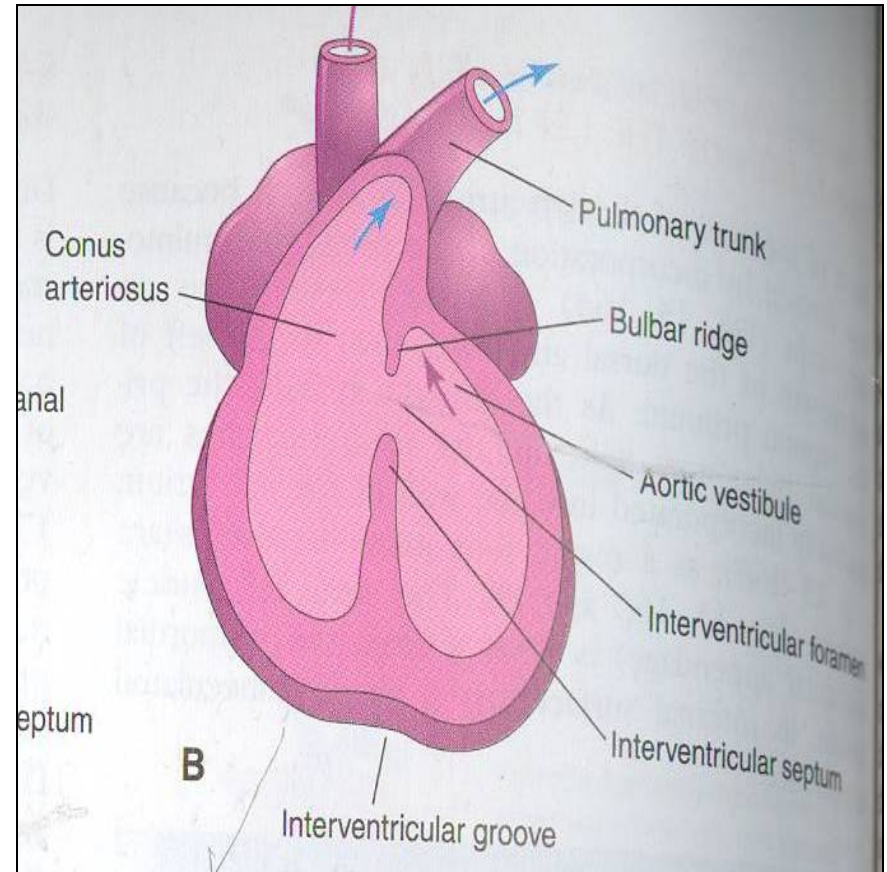
# Partition of Truncus Arteriosus



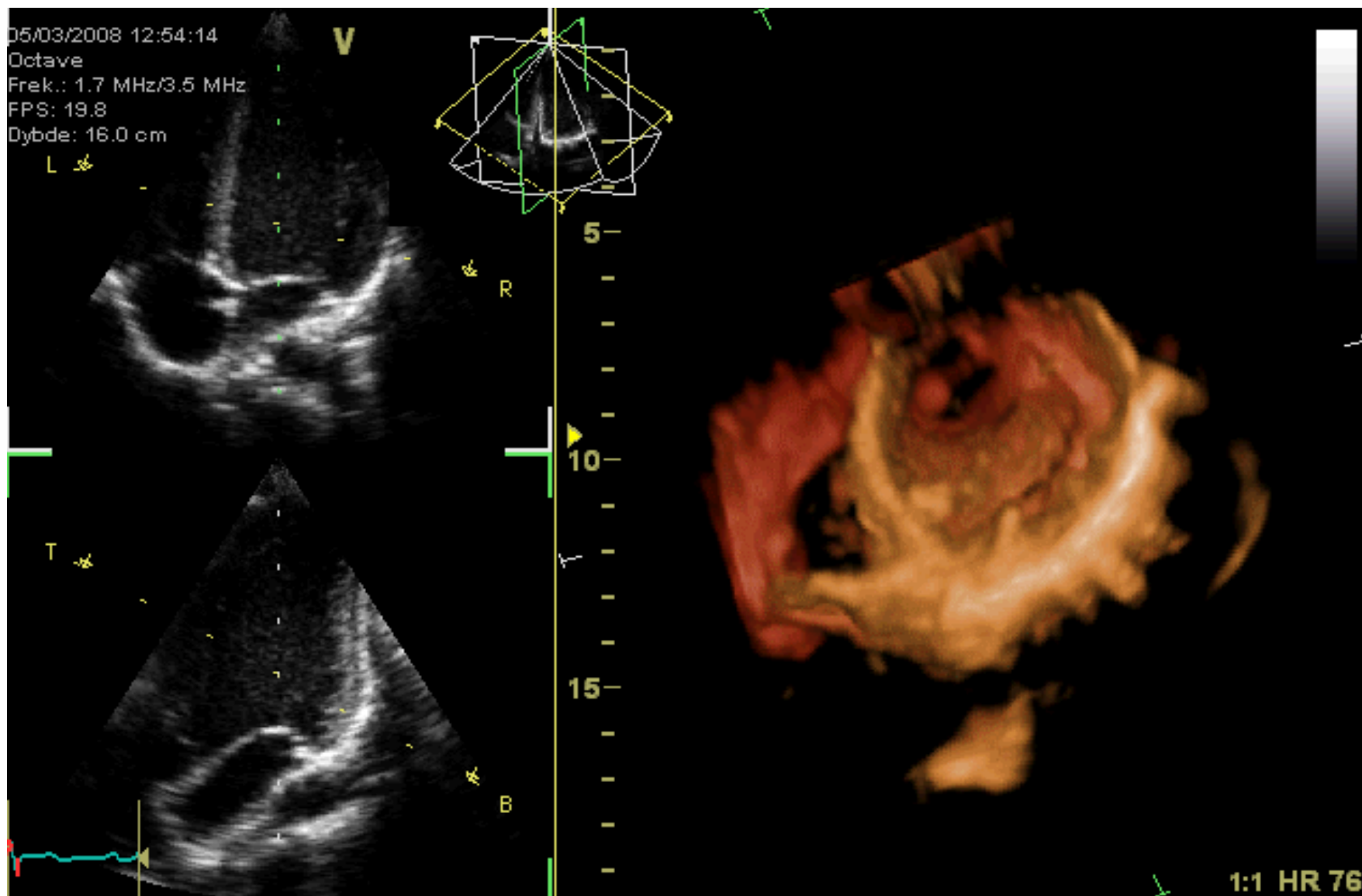
- In the **5<sup>th</sup> week**, proliferation of mesenchymal cells (**Endocardial Cushions**) appear in the wall of the **truncus arteriosus**, they form a **Spiral Septum**:
- A. It divides the **Lower part** of the TA into **Right & Left parts**
- B. It divides the **Middle part** of TA into **Anterior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

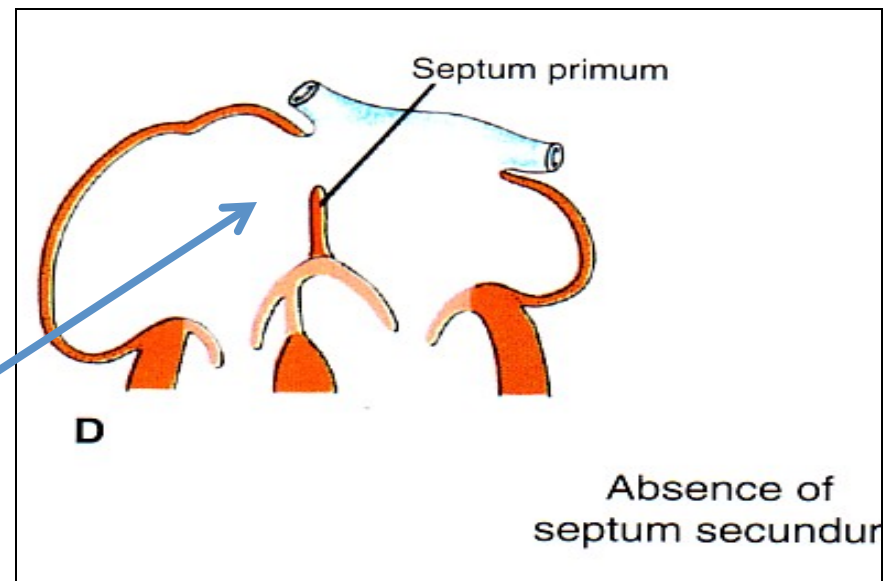
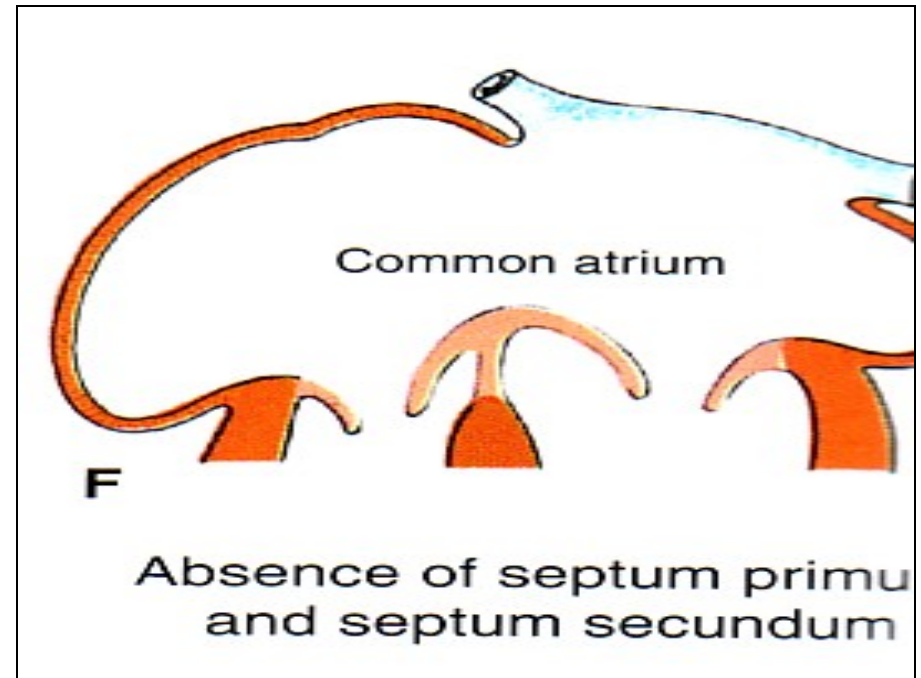


# MAJOR CARDIAC ANOMALIES

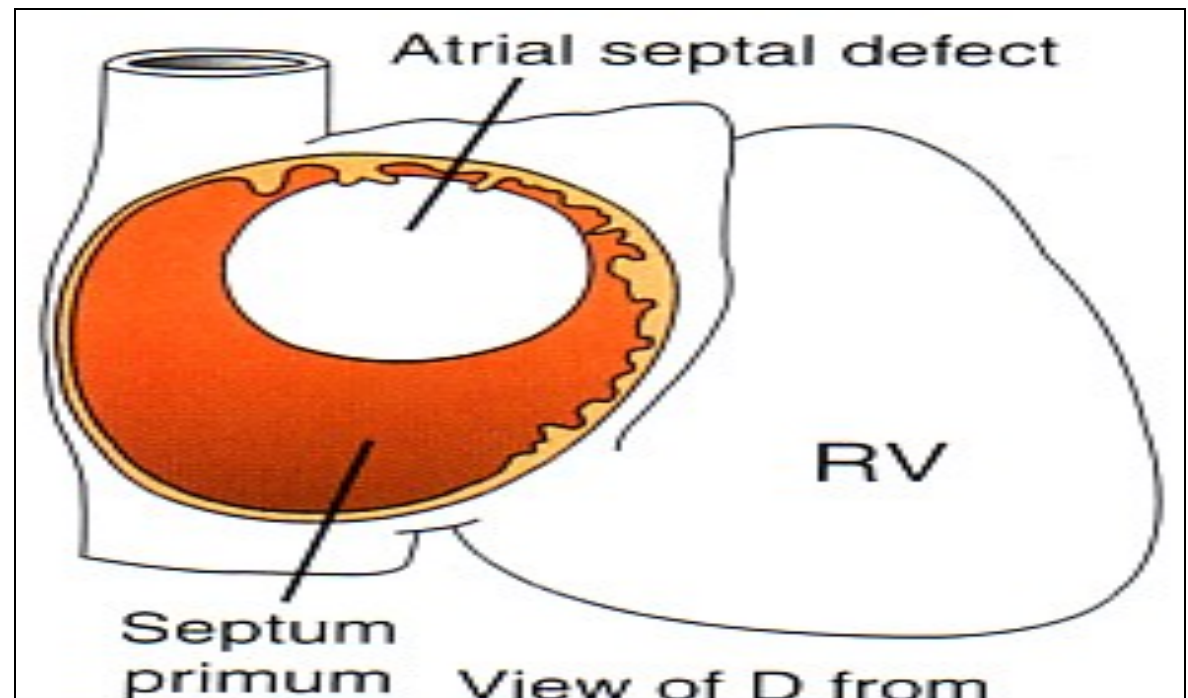
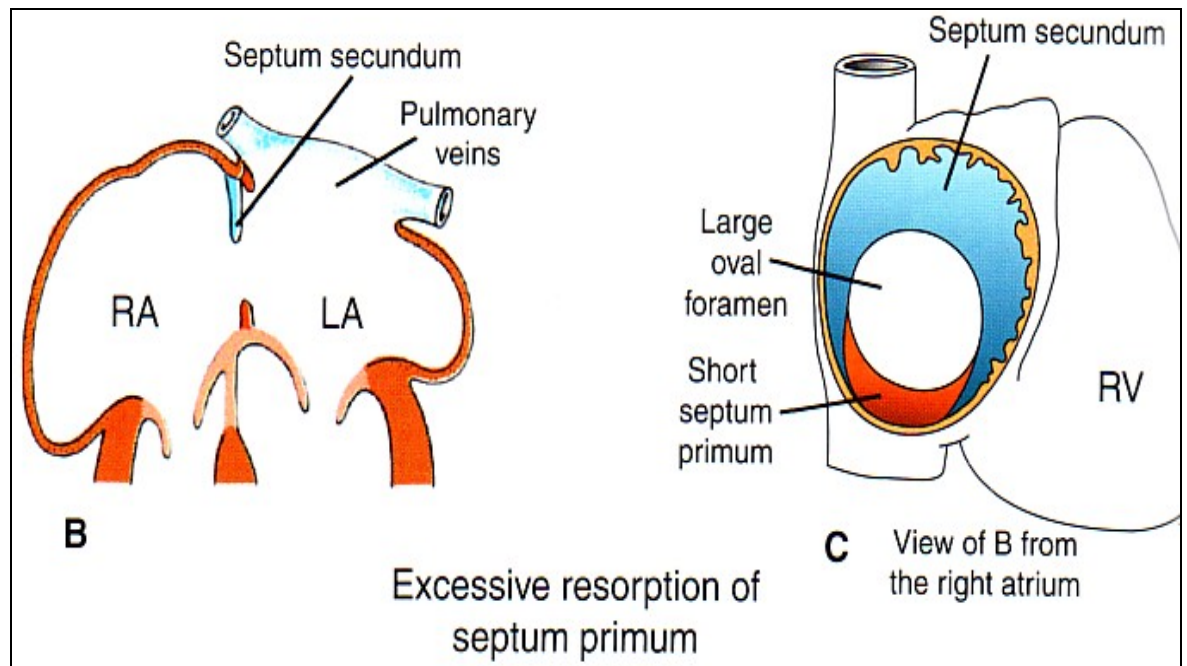


# Atrial Septal Defects (ASD)

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

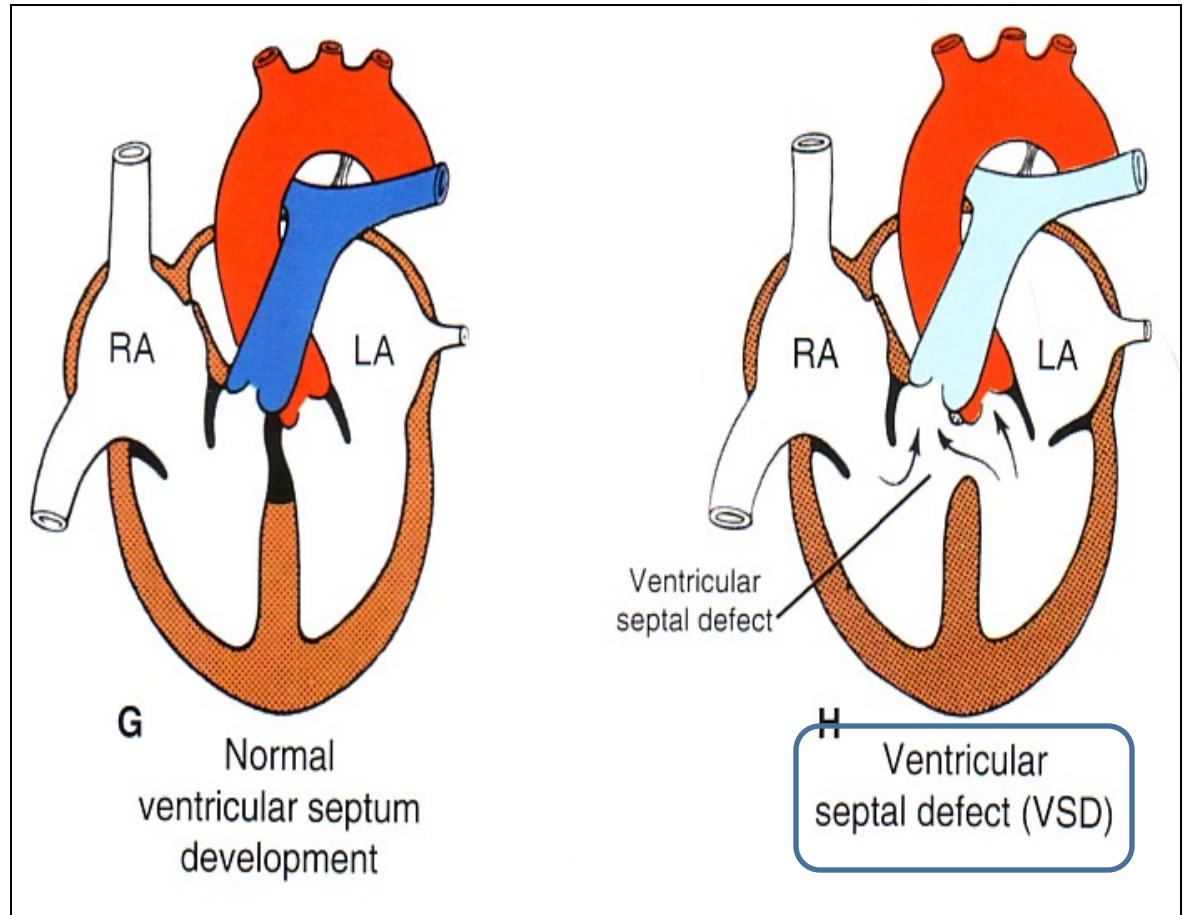


**3. Large  
(Patent)  
foramen  
ovale : Excessive  
resorption of  
septum primum**



# VENTRICULAR SEPTAL DEFECT (VSD)

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

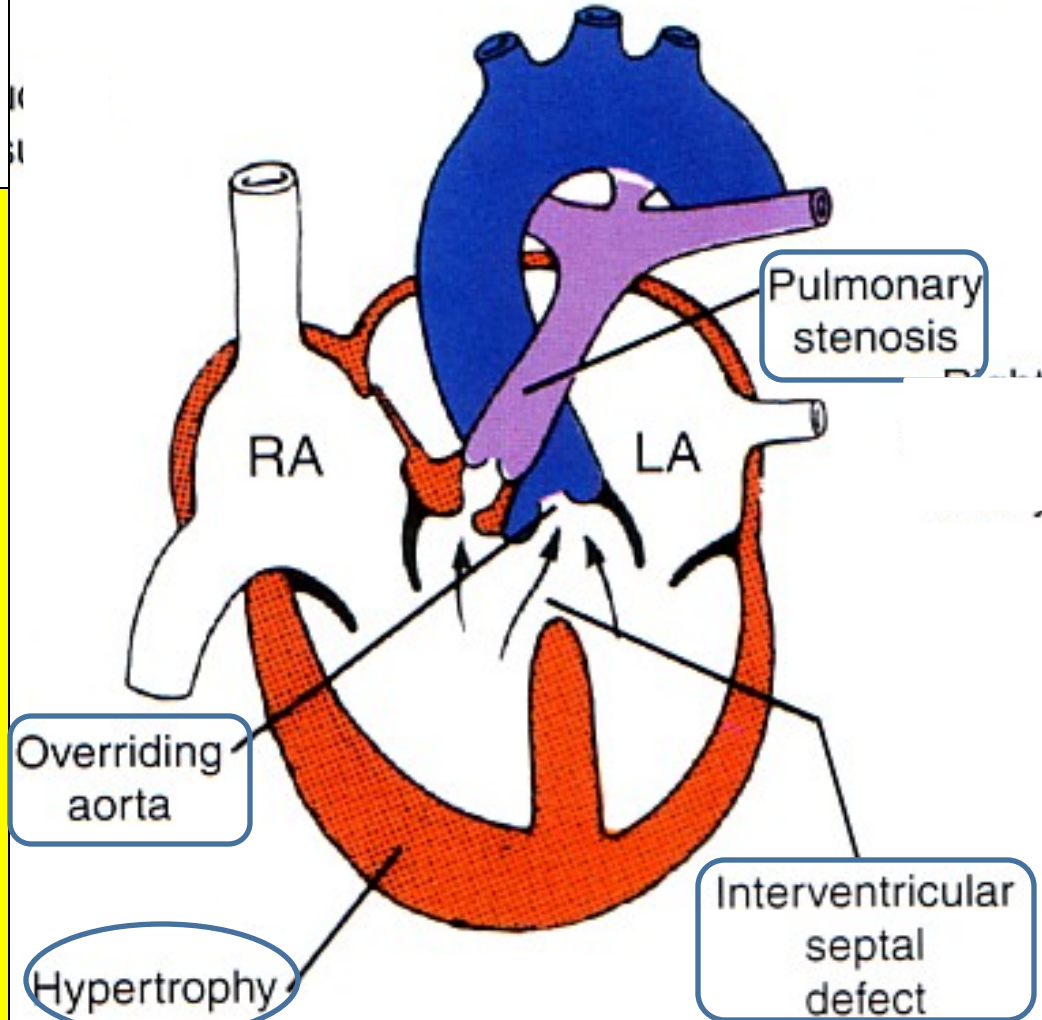




Blue  
Baby

# TETRALOGY OF FALLOT

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

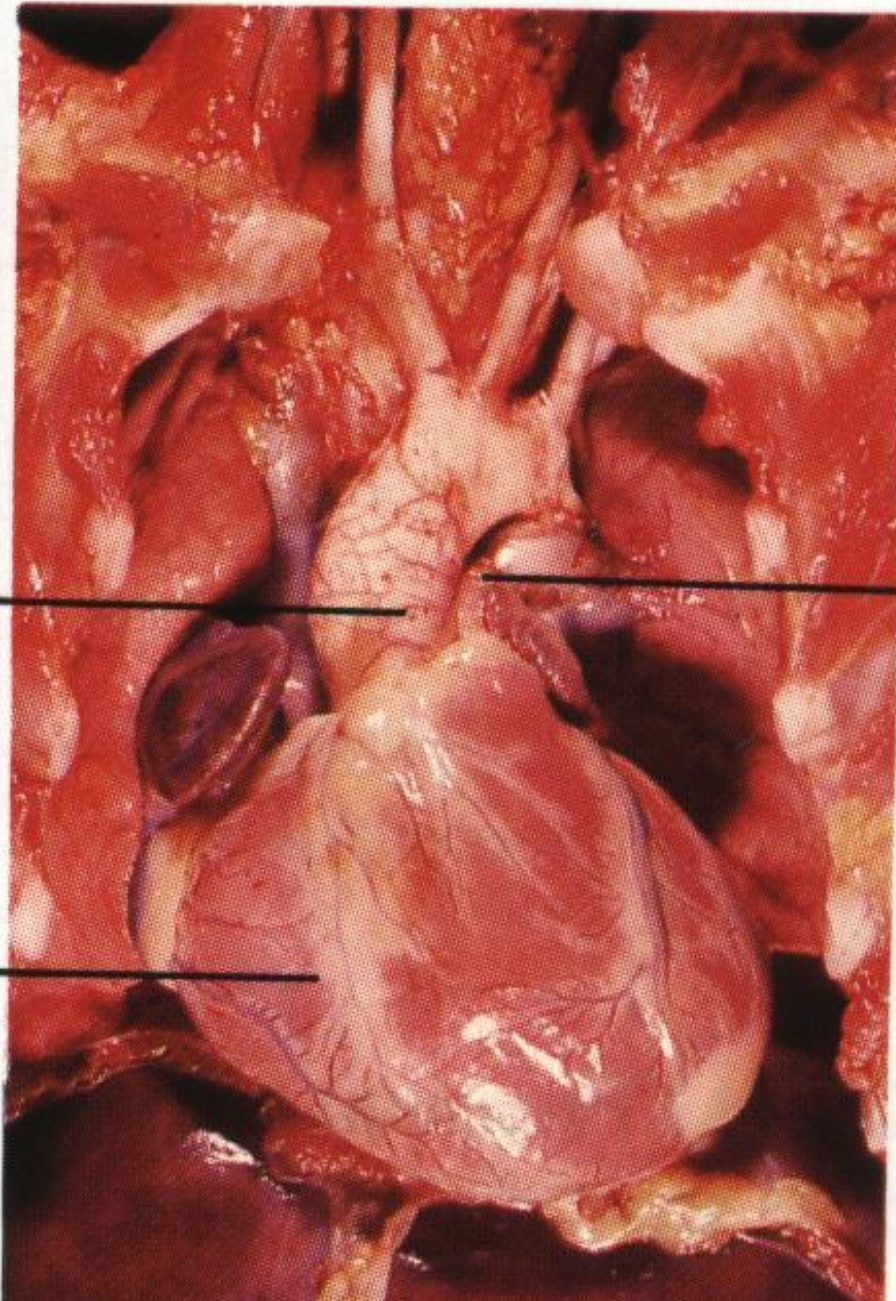


Tetralogy of

# TETRALOGY OF FALLOT

Overriding aorta

Enlarged right ventricle

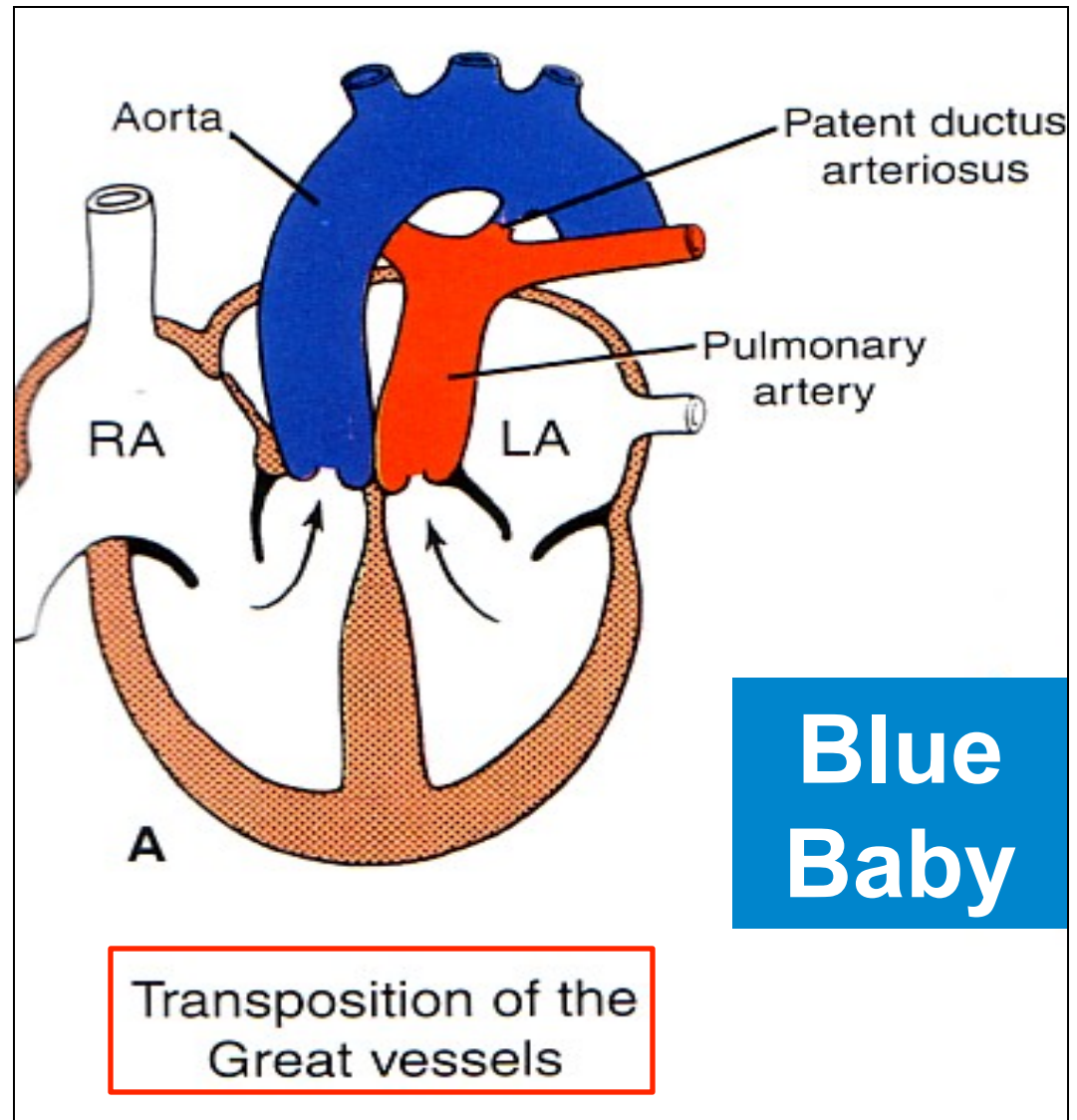


Stenotic pulmonary trunk

**Blue Baby**

# TRANSPOSITION OF GREAT ARTERIES (TGA)

- **TGA** is due to abnormal rotation or malformation of the aorticopulmonary 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

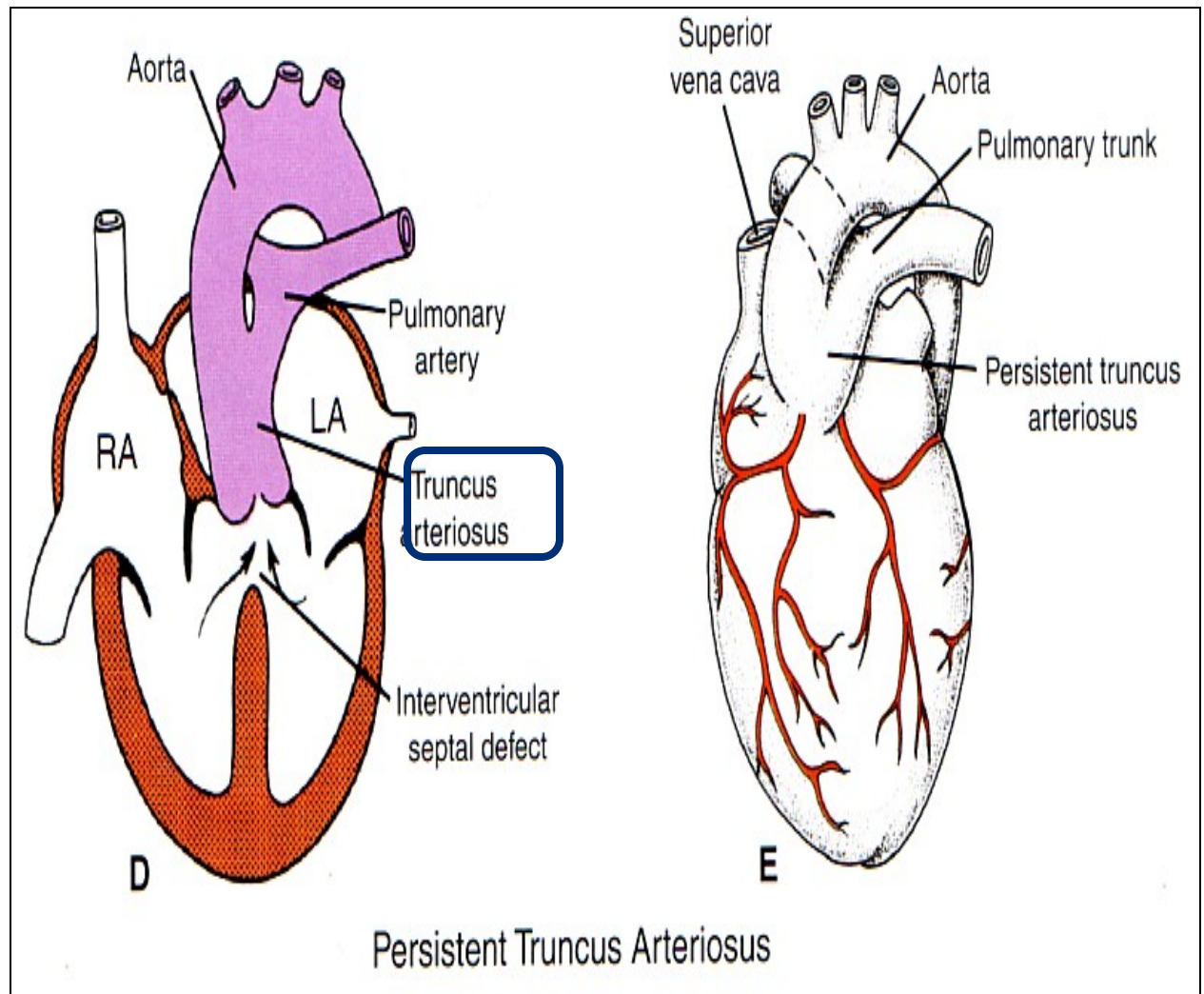


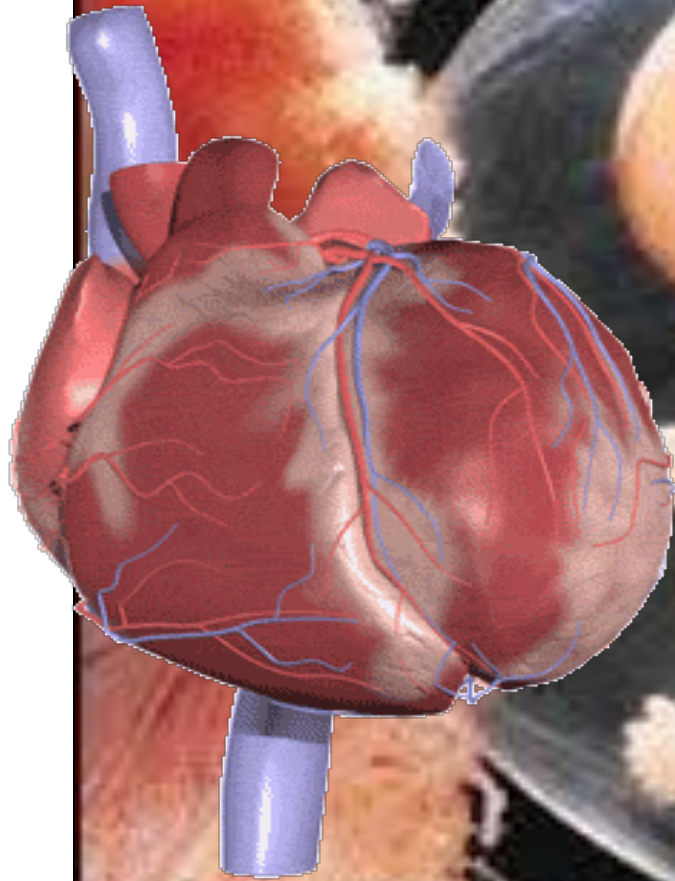


# Persistent Truncus Arteriosus

- 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**

