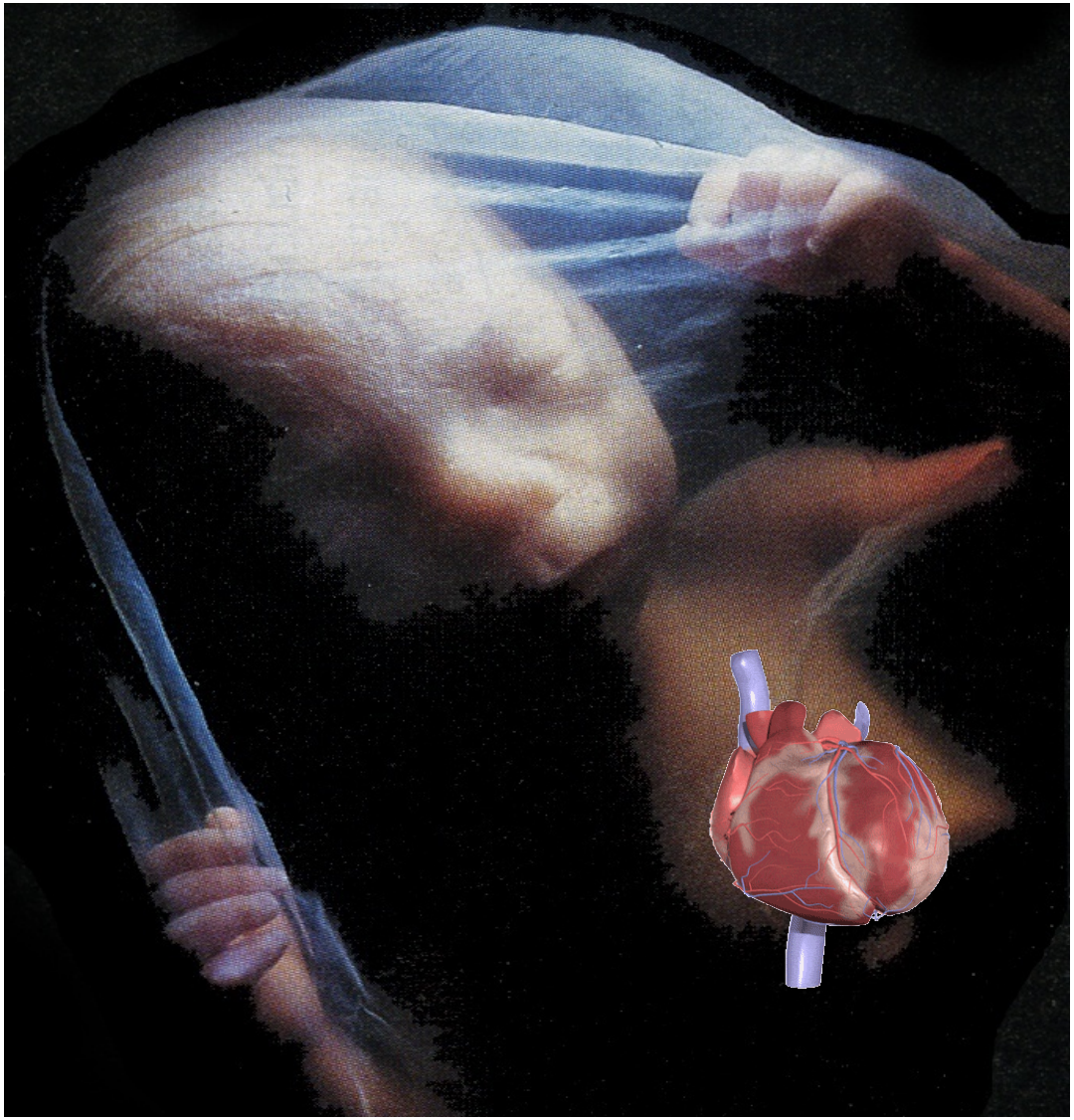
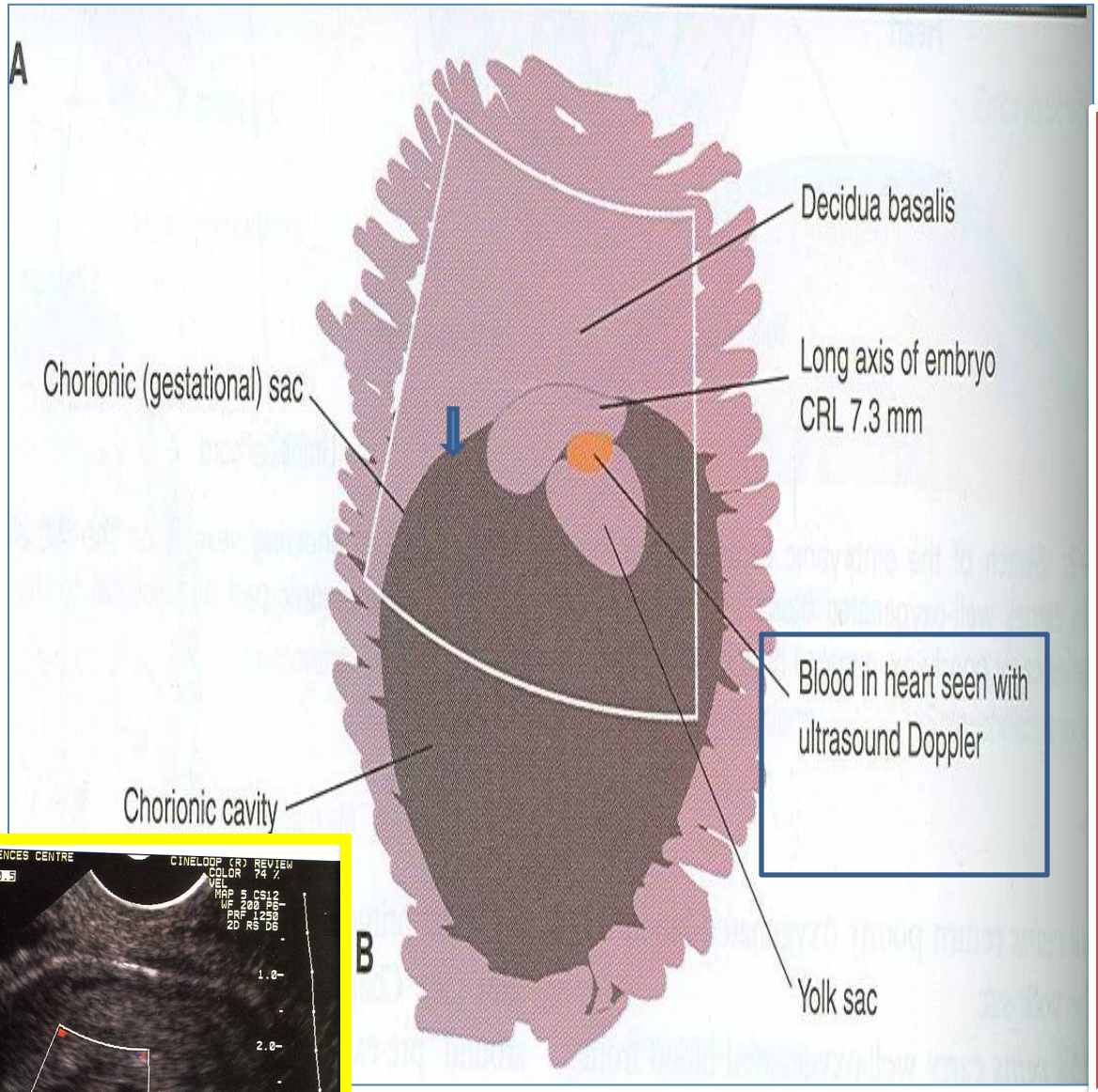
DEVELOPMENT OF HEART

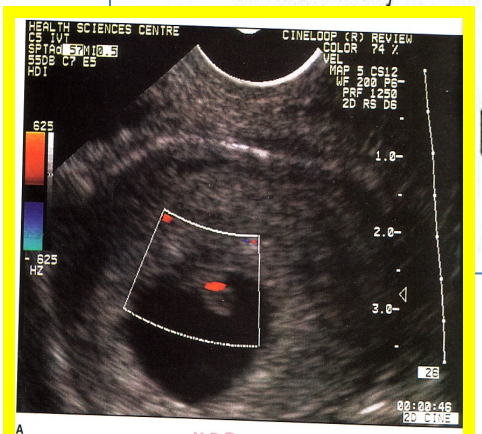


Prof. Saeed Abuel Makarem
Dr. Jamila El Medany

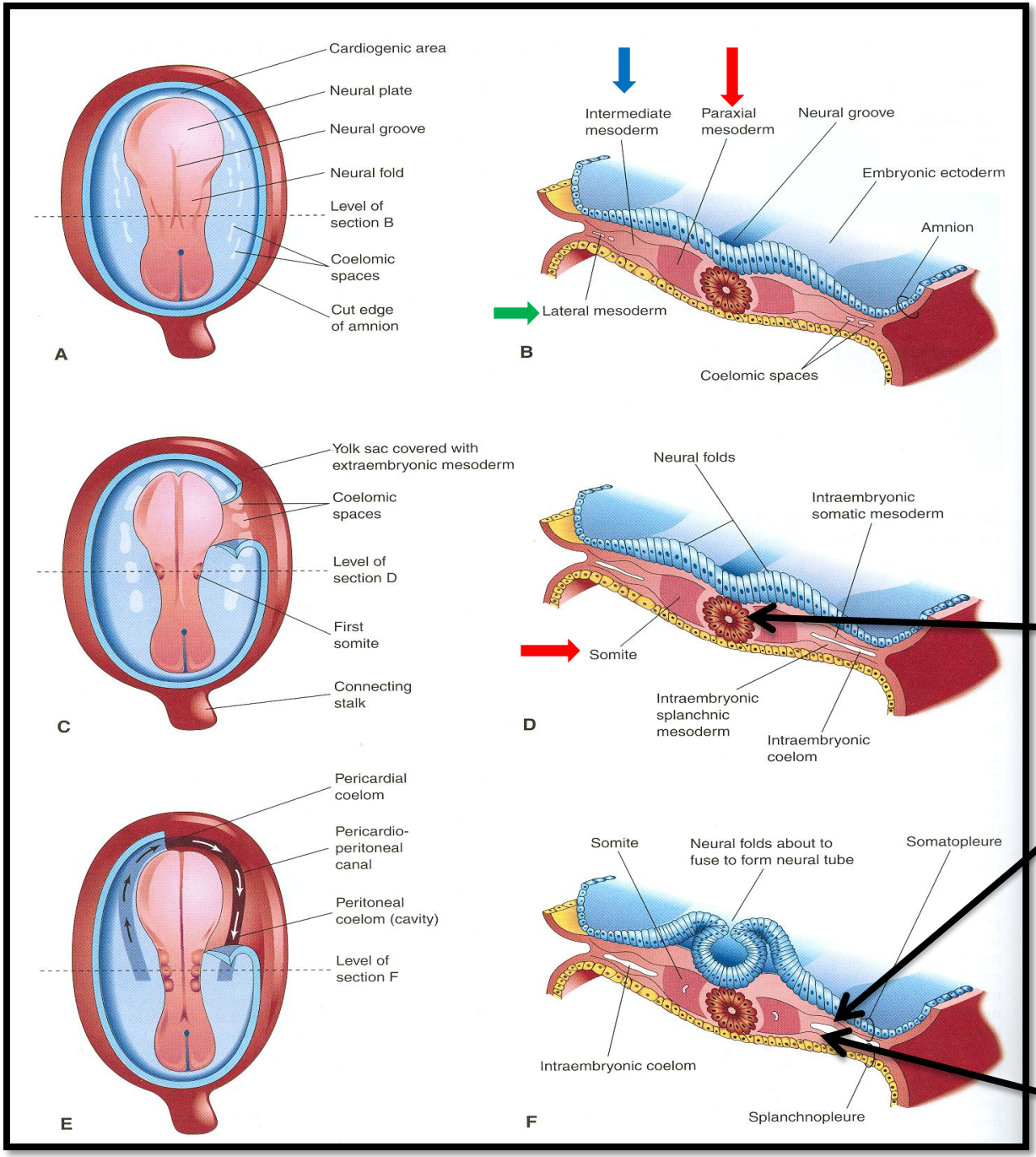
Objectives

- **By the end of this lecture the student should be able to:**
- Describe the formation, sit, union divisions of the 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**



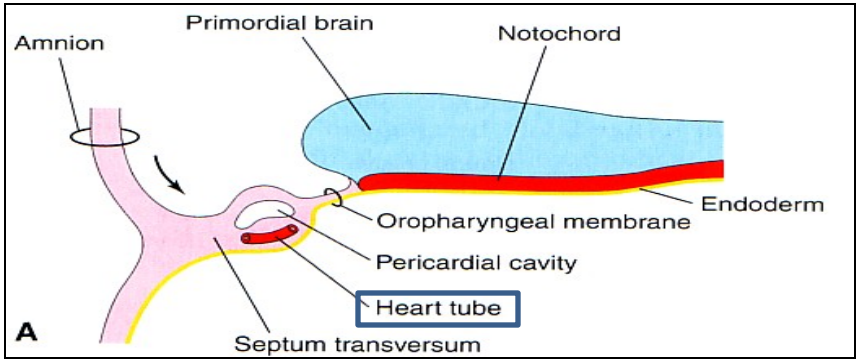
Notochord:
stimulates neural tube formation

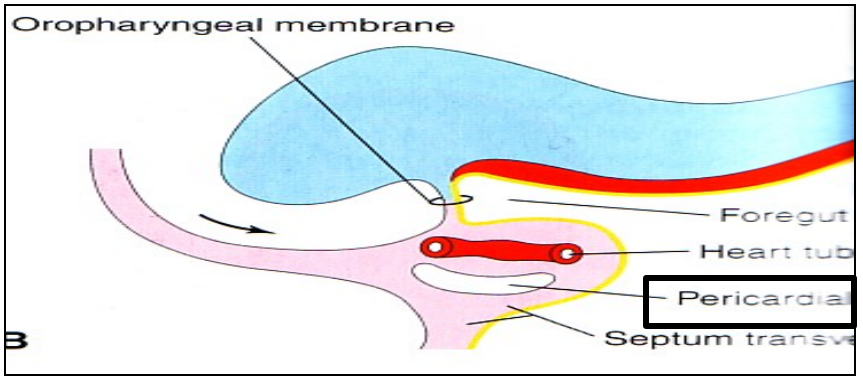
Somatic mesoderm

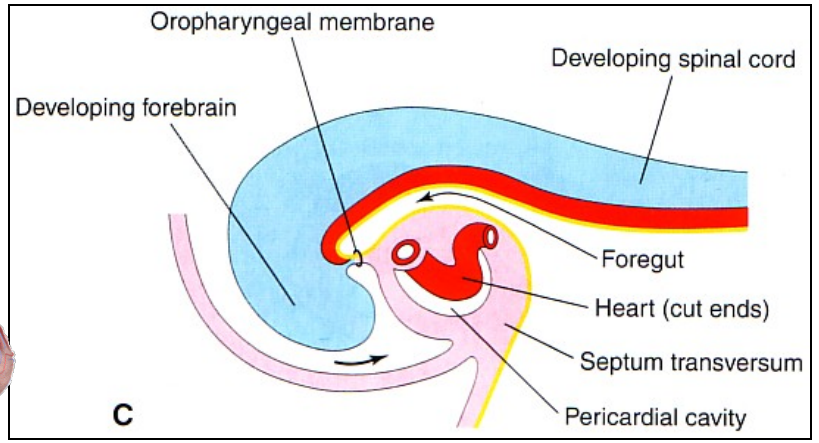
Splanchnic mesoderm

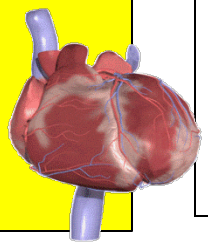
FORMATION OF THE HEART TUBE

- 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 Angioplastic 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.**
- .



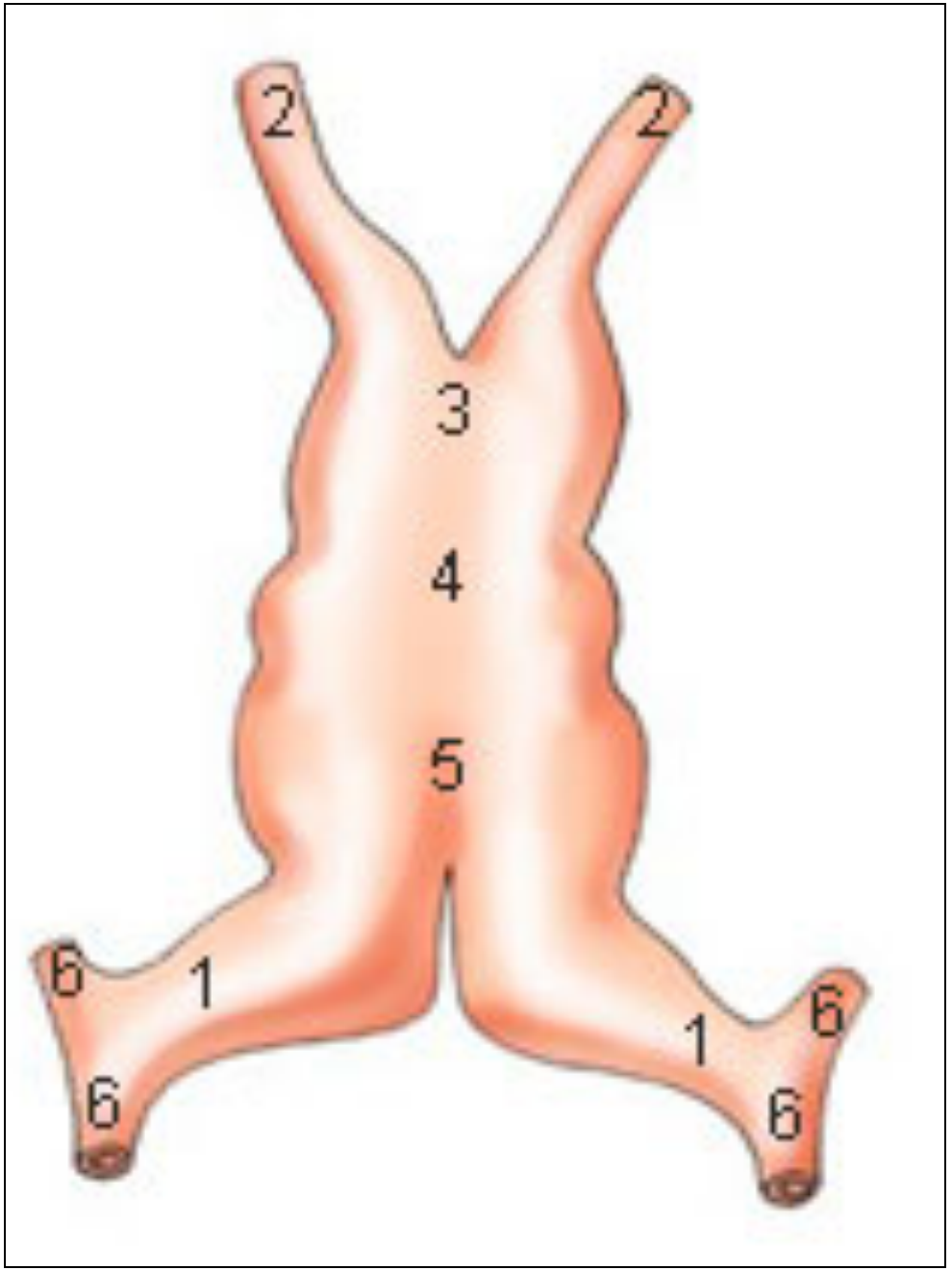






Development of the Heart tube

- 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.

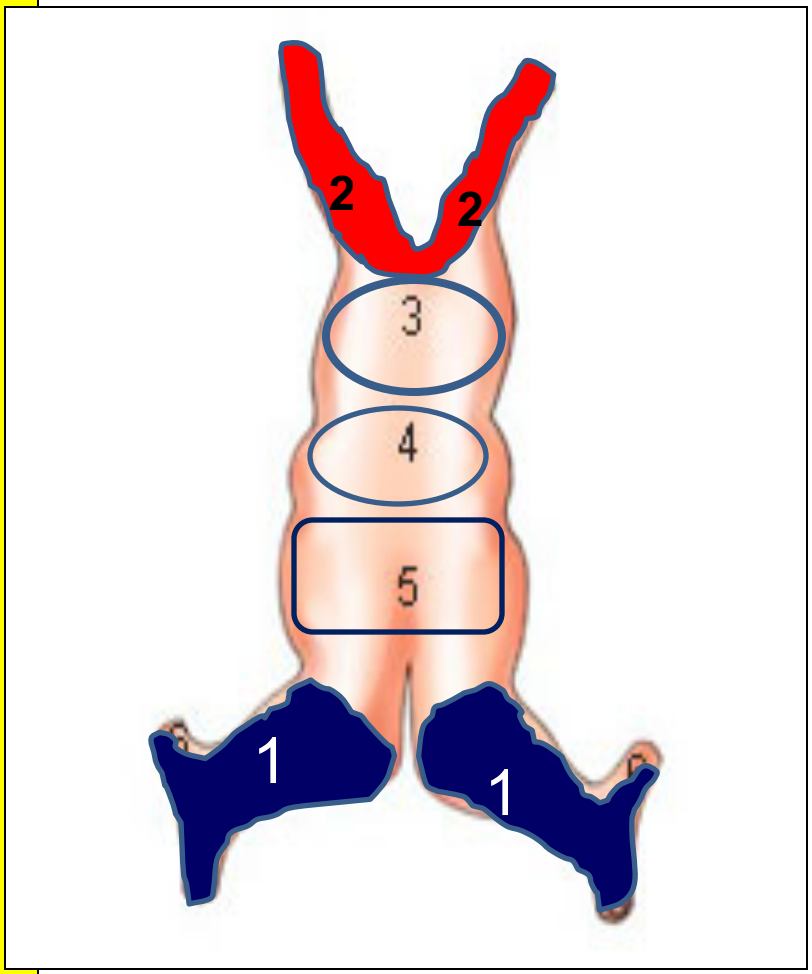


What is the shape of the Heart Tube?

- 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.**

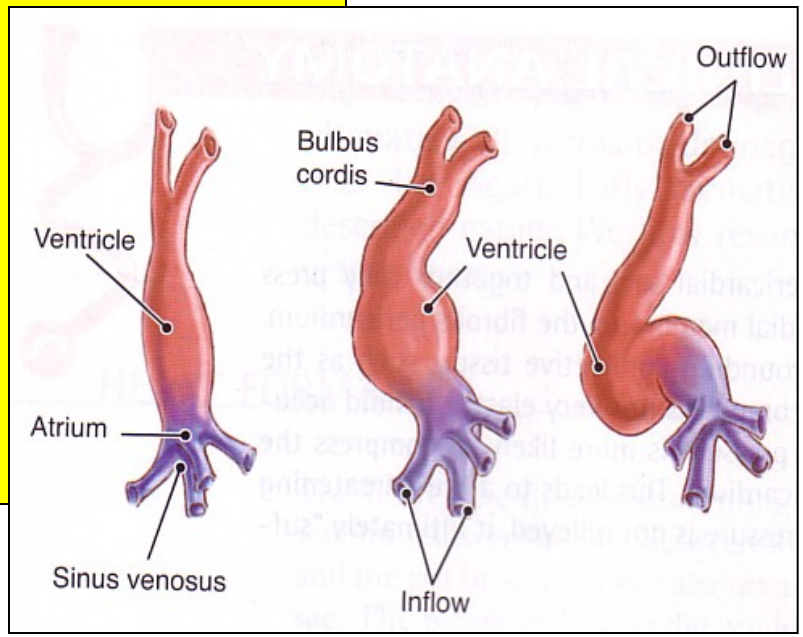
The endocardial heart tube has 2 ends:

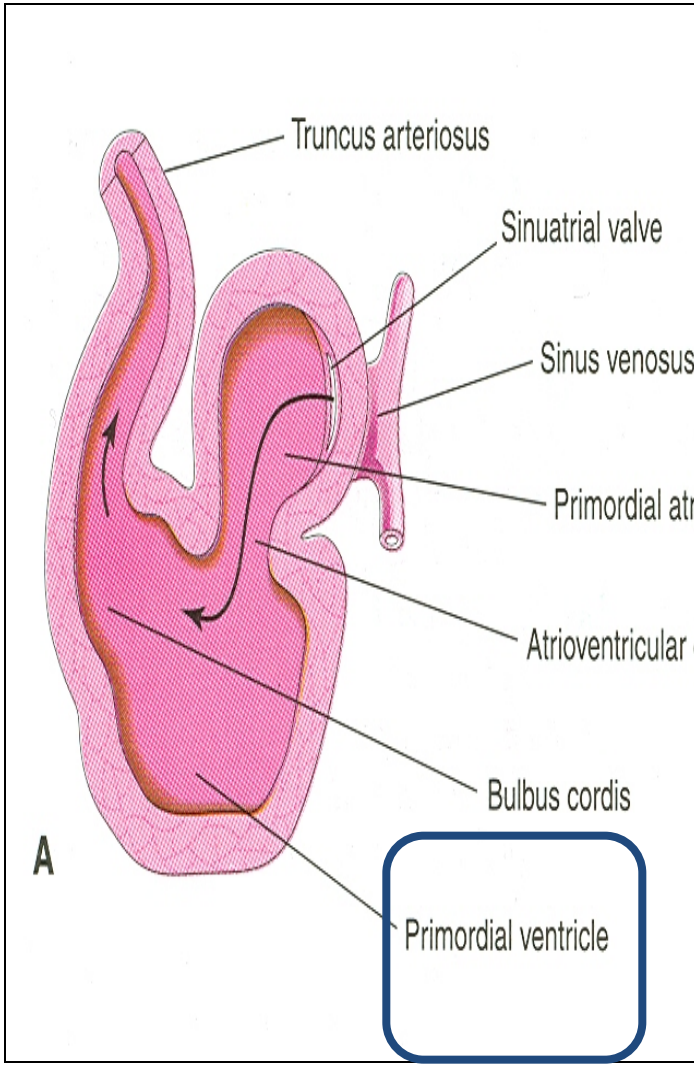
1. **Venous end (Caudal): Sinus Venosus.**
2. **Arterial end (Cranial): Truncus arteriosus**



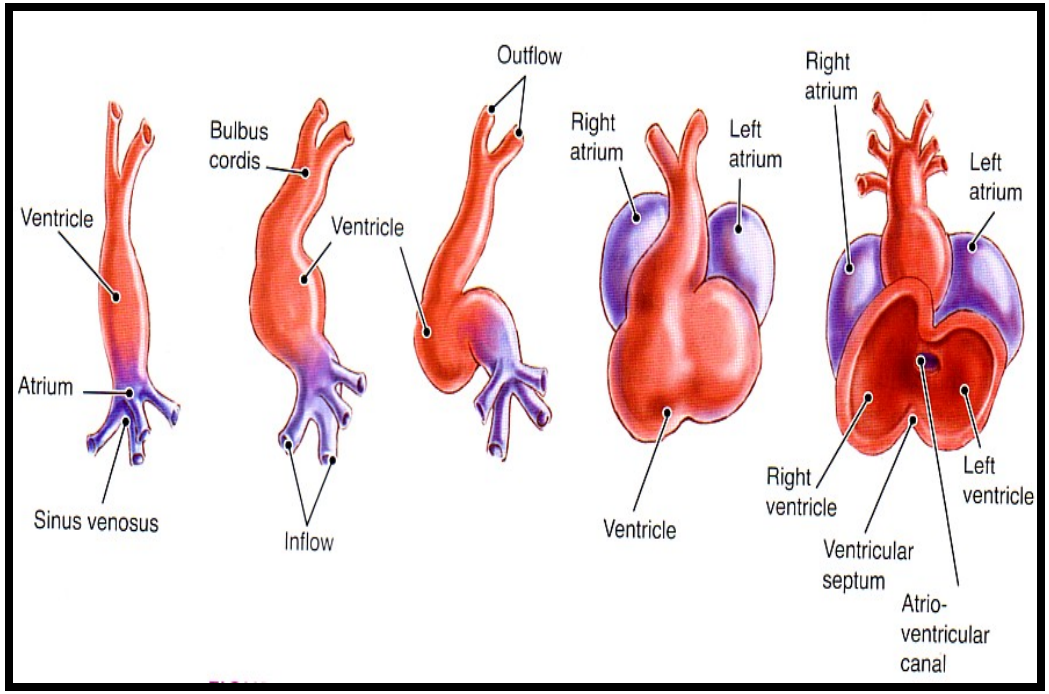
U-SHAPED HEART TUBE

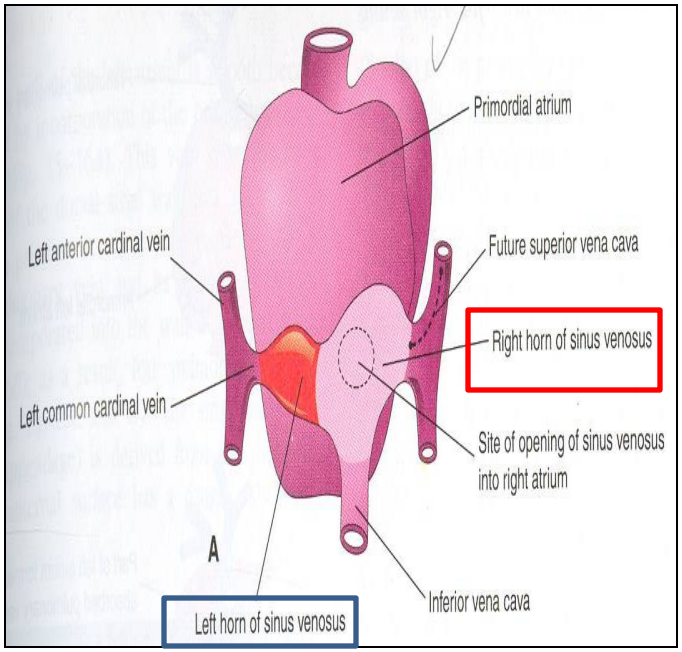
- Bulbus cordis and ventricle grow faster than other regions.
- So the heart bends upon itself, forming
- **The U-shaped heart tube, (Bulboventricular loop).**





S-Shaped Heart Tube



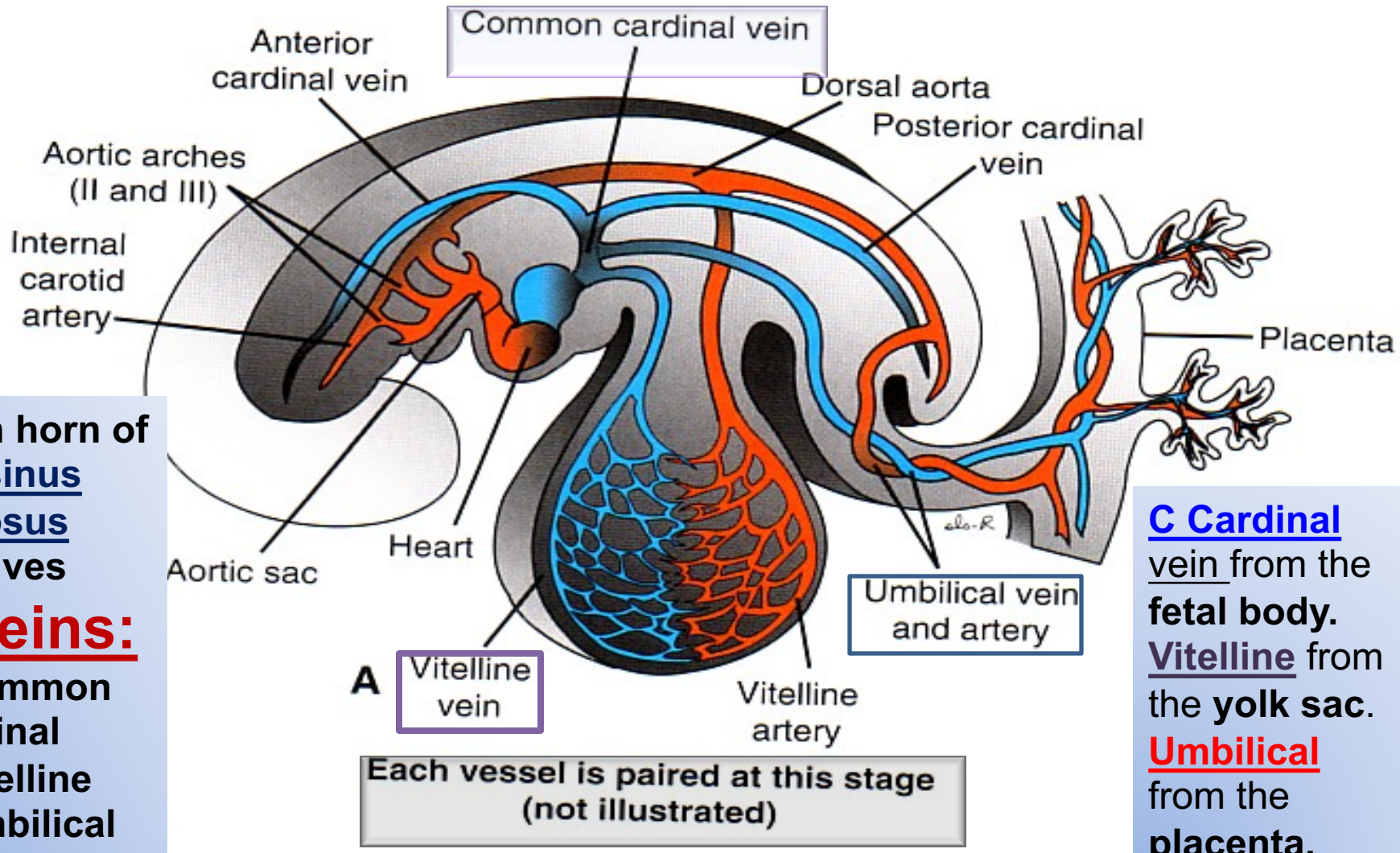


- As **the heart** tube develops it bends**, upon itself and forms S shaped heart tube**:

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

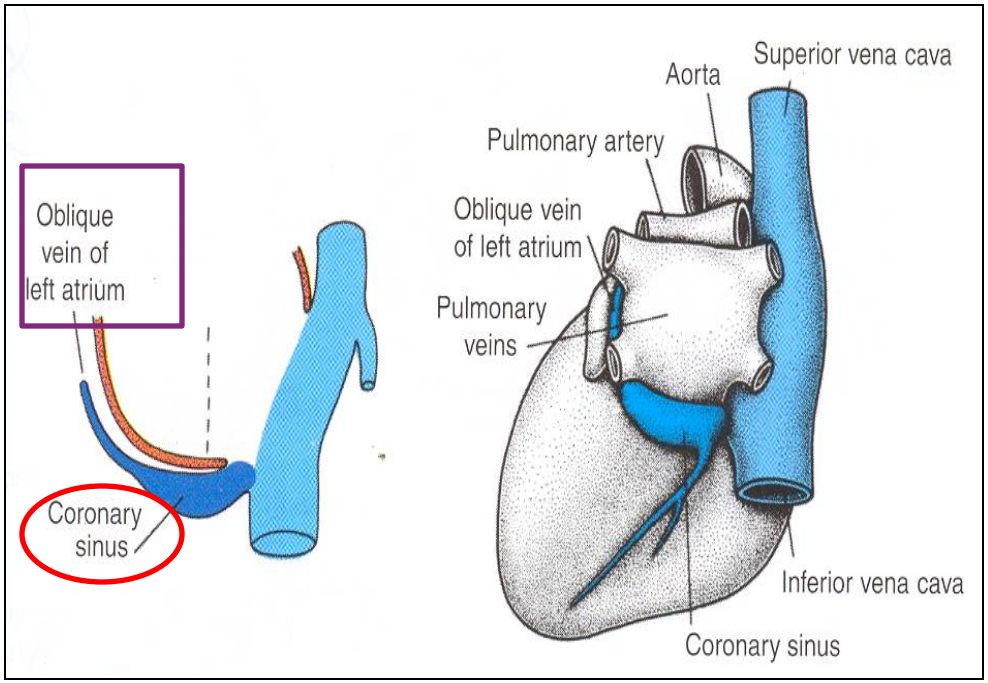
3 veins:

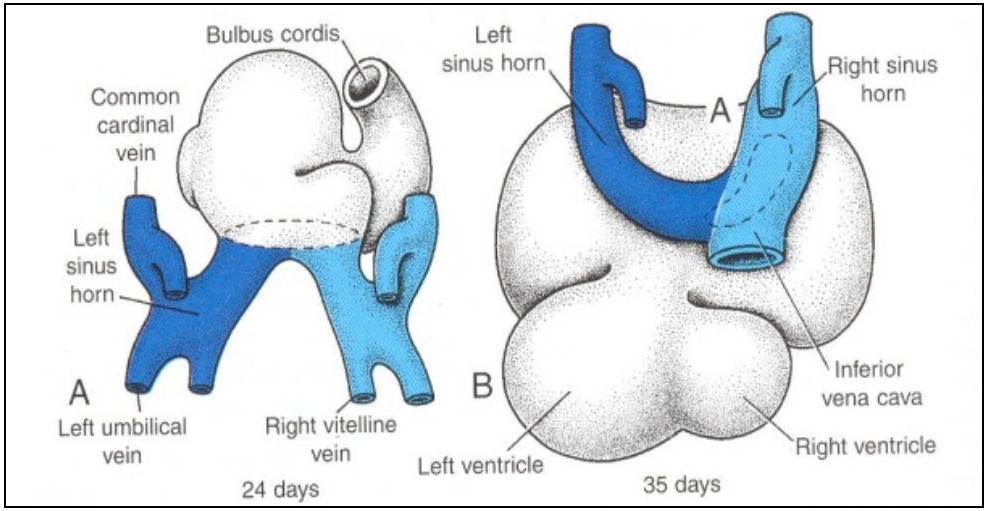
1.Common cardinal
2.Vitelline
3.Umbilical

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

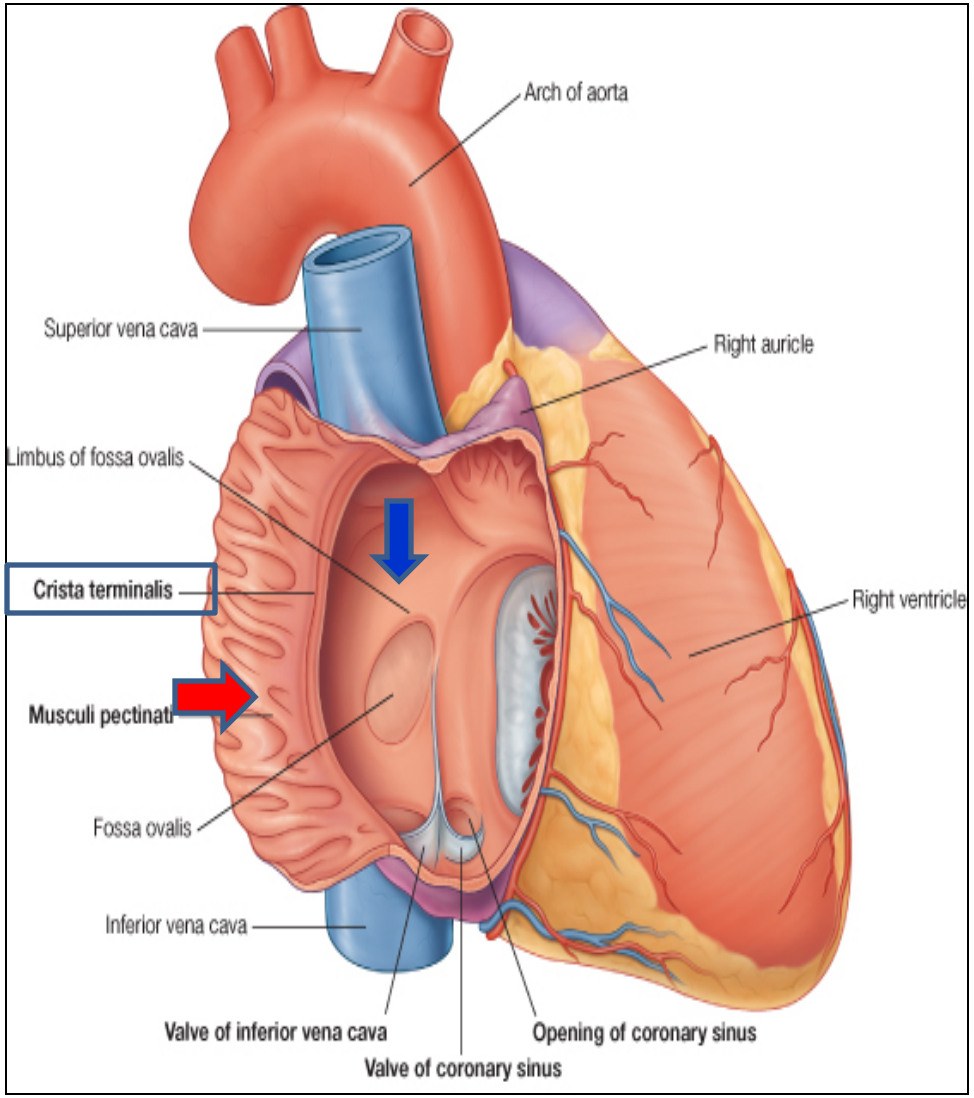
Fate of Sinus Venosus

- 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.**

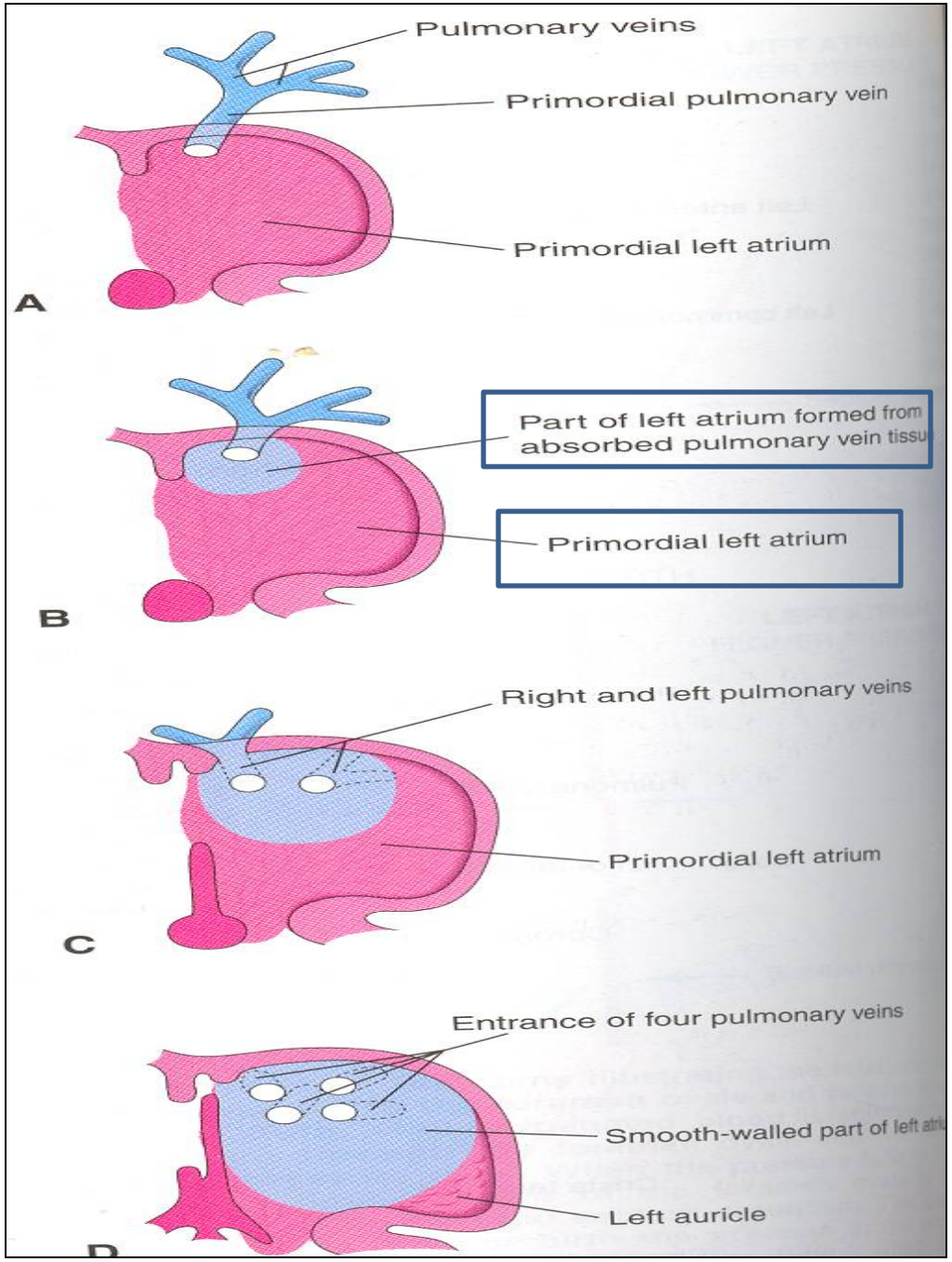




Right Atrium



- **The right horn** of the sinus venosus forms the **smooth posterior part** of the right atrium.
- **Rough Trabeculated** anterior part **(musculi pec**tanti) 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.

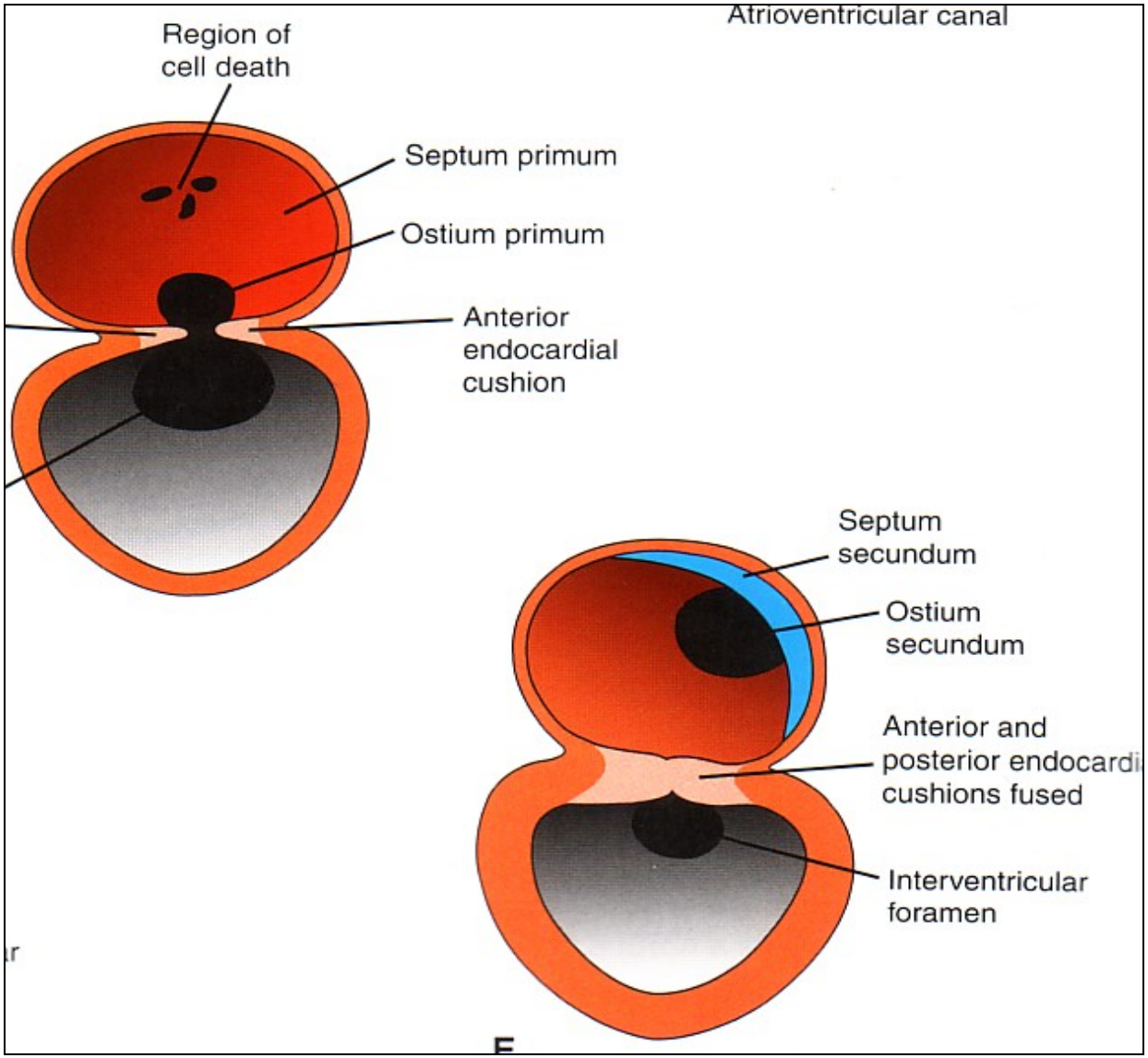
2- Common atrium.

3- Common ventricle.

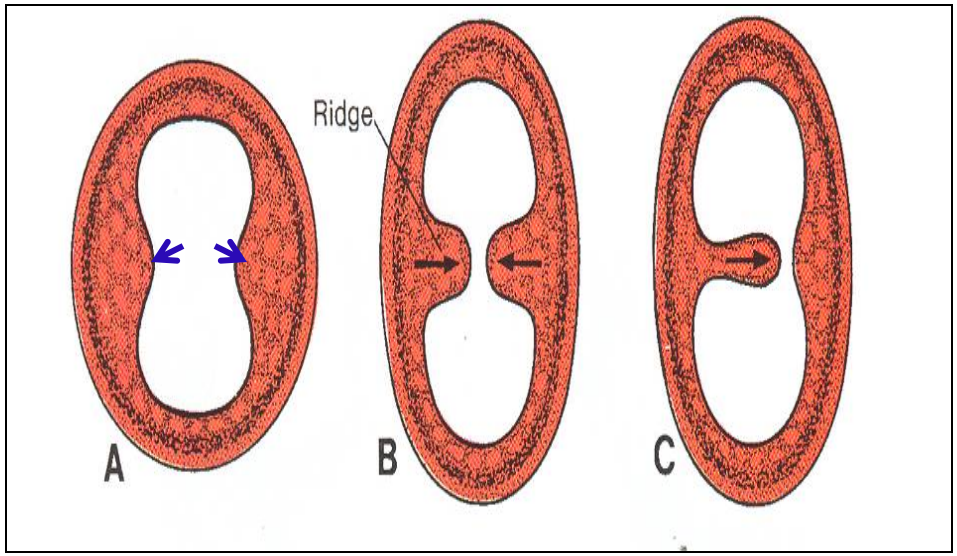
4- Truncus arteriosus & Bulbus cordis.

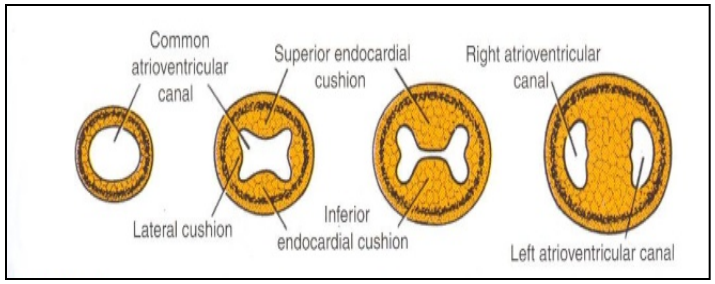
It **begins** by the **middle of 4th week.**

It is **completed by the end of 5th week.**



Endocardial Cushions

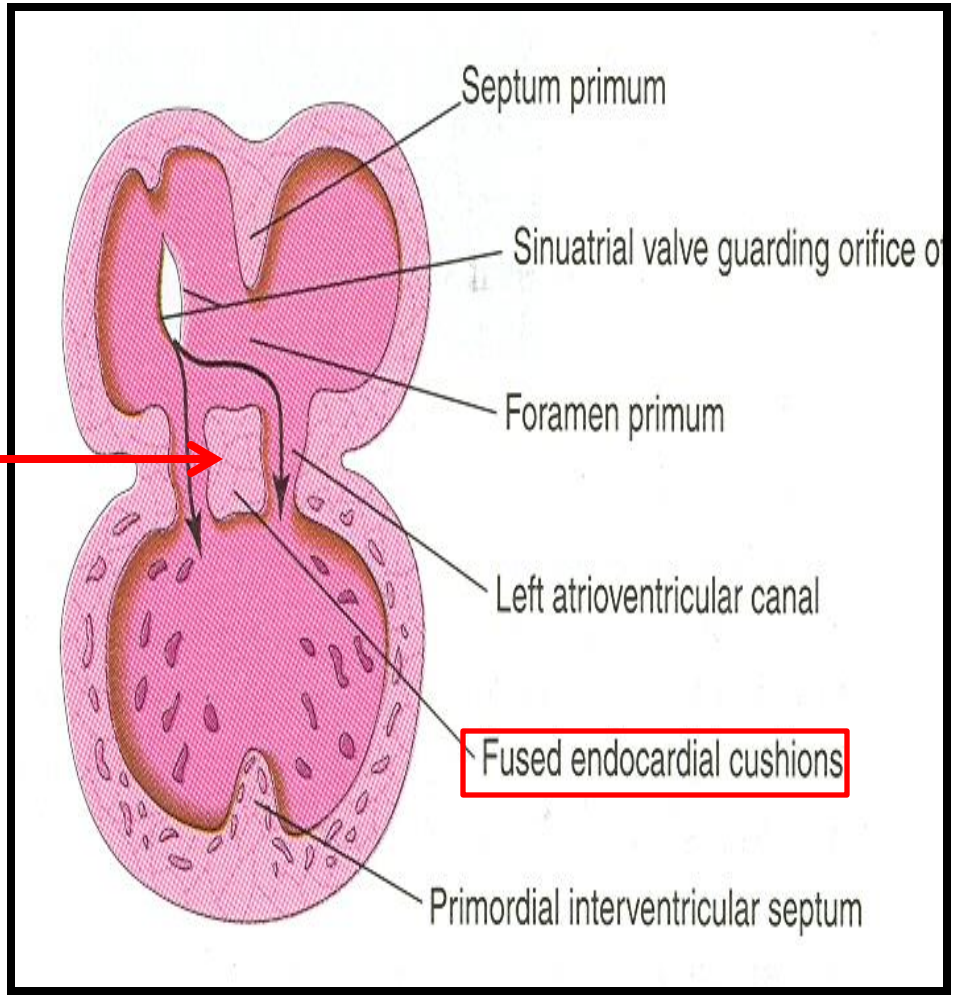




- They appear around the middle of the **4th week** as **Mesenchymal Proliferation** They participate in formation of :
- **(1) A.V canals and valves.**
- **(2) Atrial septa.**
- **(3) Membranous part of Ventricular septum.**
- **(4) Aortic and Pulmonary channels (Spiral septum).**

Partitioning of the atrioventricular canal

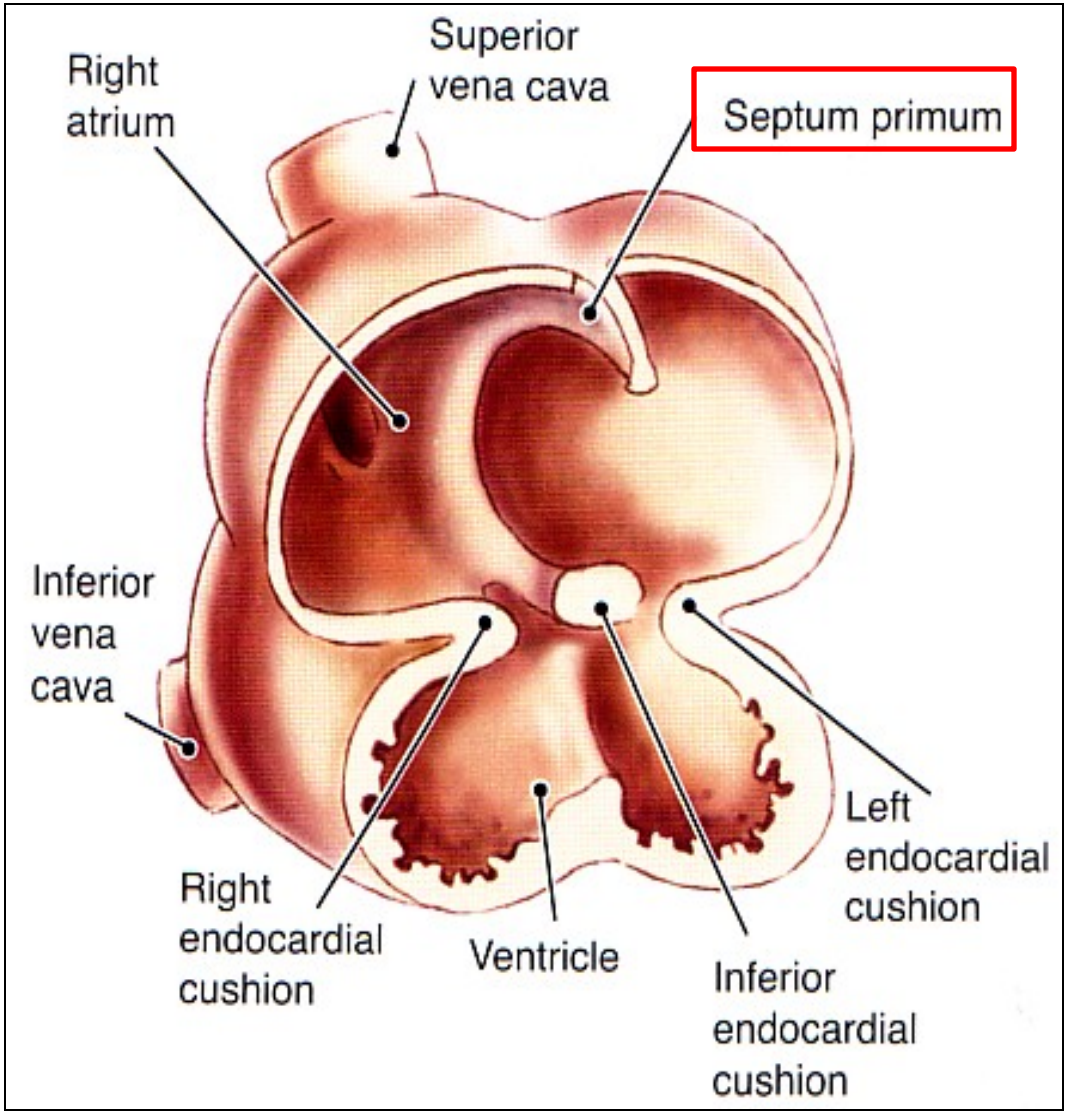
- **Two** Endocardial Cushions are formed on the dorsal and ventral walls of the AV canal.
- The AV endocardial cushions approach each other and fuse to form the **Septum Intermedium.**
- Dividing the AV canal into right & left canals.
- These canals partially separate the primordial atrium from the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



Partition of the Common Atrium

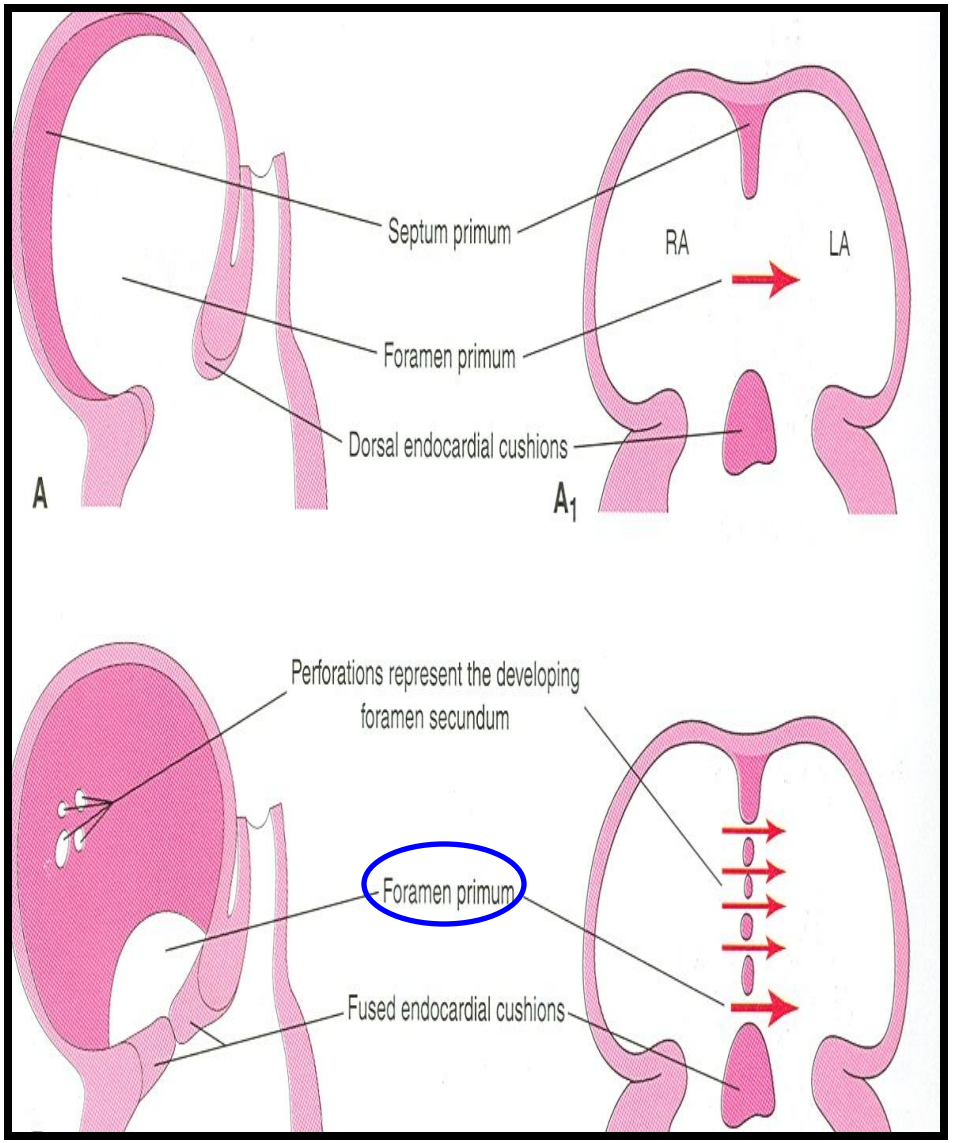
Septum Primum

- 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.



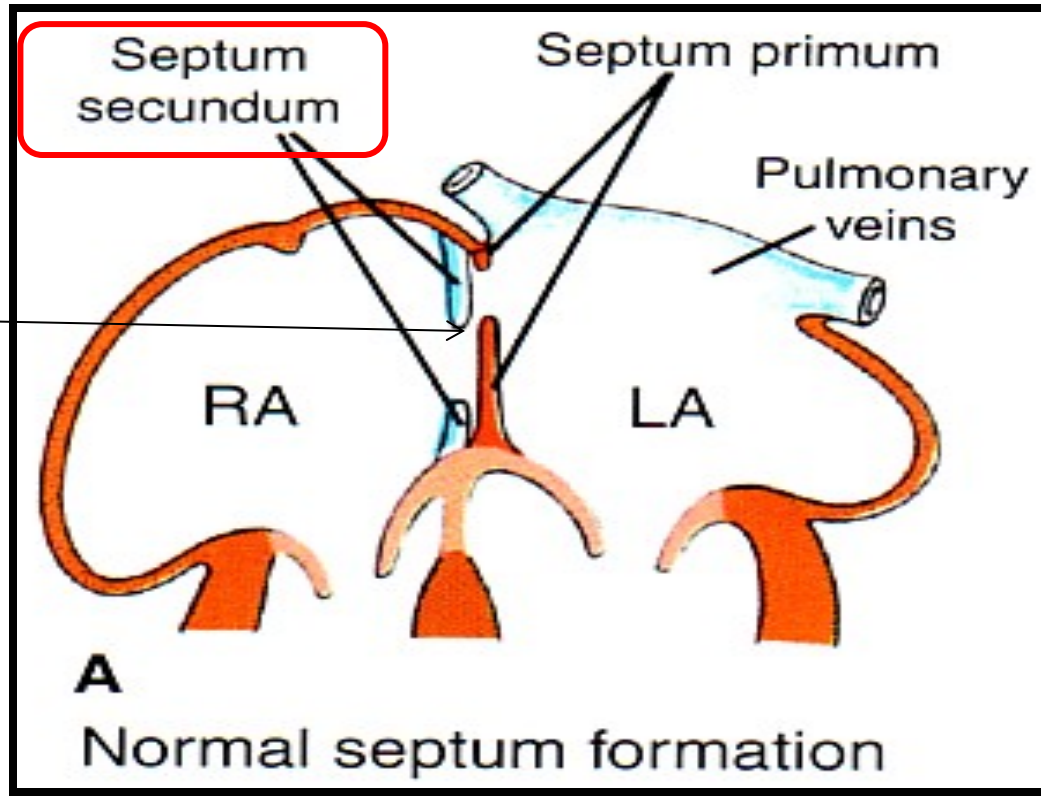
Ostium Primum

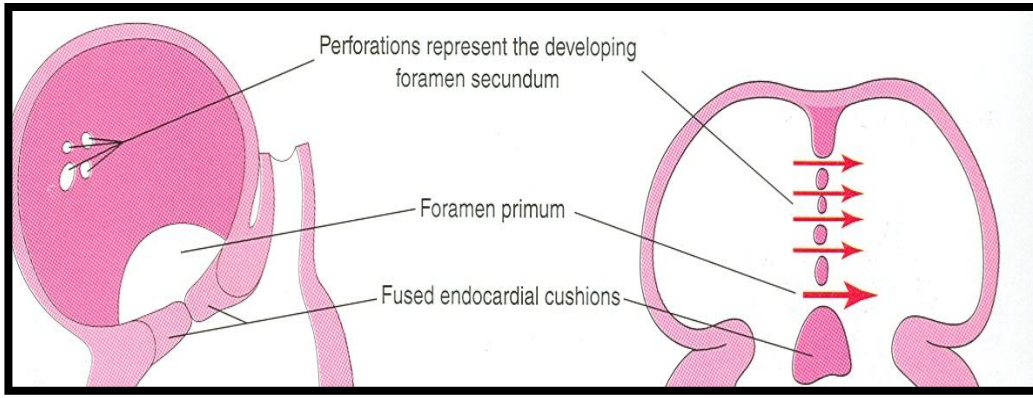
- The two ends of septum primum reach to the growing endocardial cushions before its central part.
- Now the septum primum bounds a foramen called **ostium primum.**
- It serves as a shunt, enabling the oxygenated blood to pass from right to left atrium.
- The **ostium primum** become smaller and disappears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



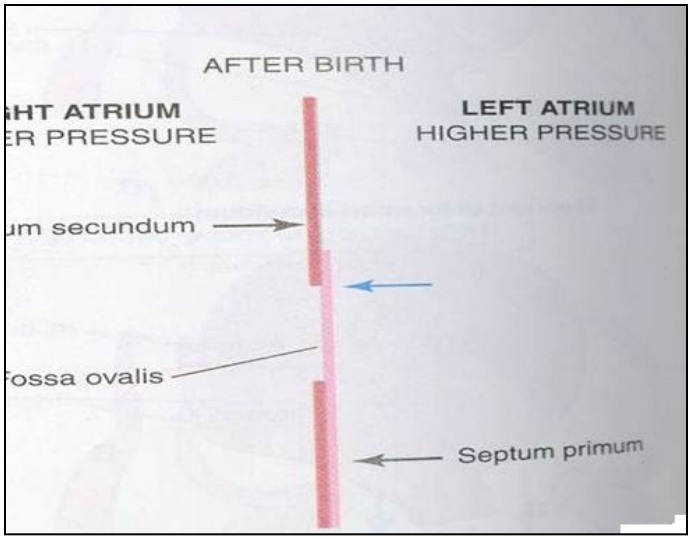
Septum Secundum

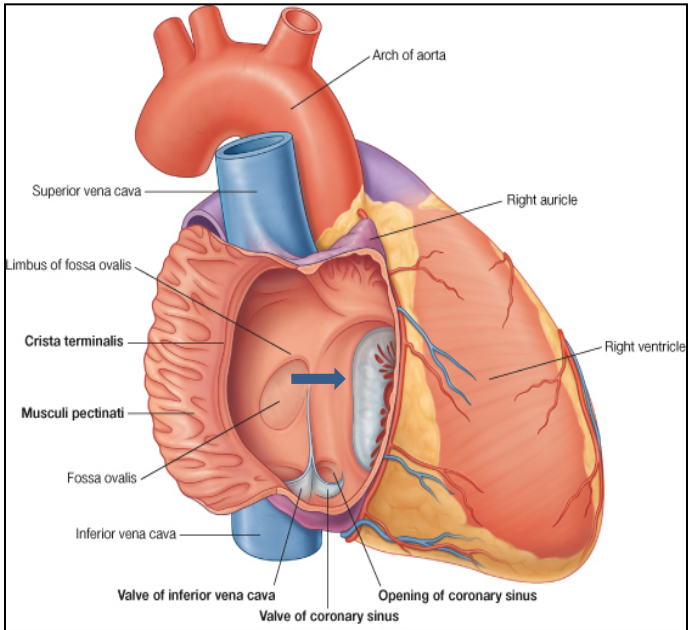
- The upper part of septum primum that is attached to the roof of the common atrium shows gradual resorption forming an opening called **ostium secondum**.
- Another septum descends on the right side of the septum primum called **Septum Secundum**.
- It forms an incomplete partition between the two atria.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





Fate of foramen Ovale





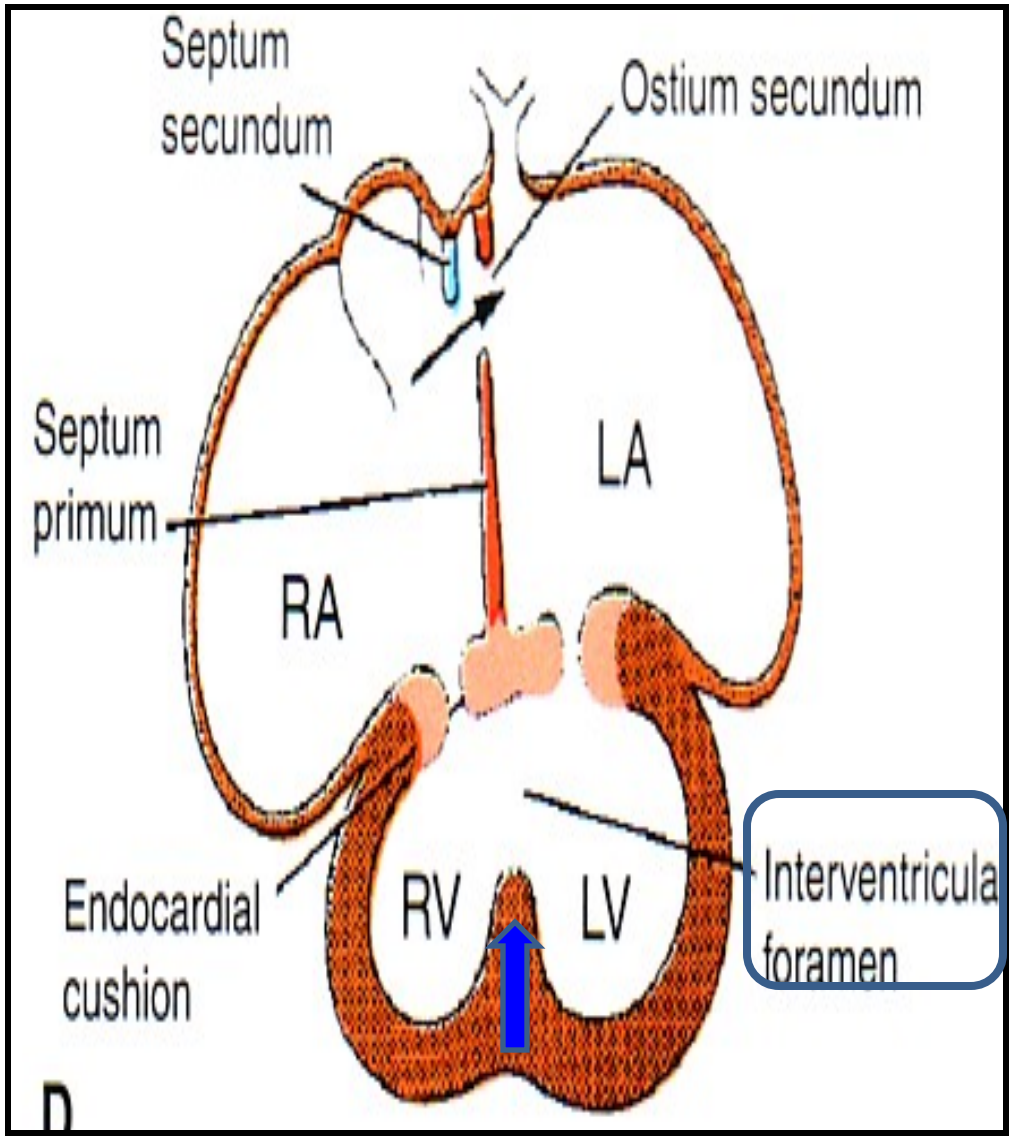
- At birth when the lung circulation begins, the pressure in the left atrium increases.
- The valve of the foramen ovale is pressed against the septum secundum and obliterates the foramen ovale.
- Its site is represented by the **Fossa Ovalis:**
- Its **floor** represents the persistent part of the **septum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

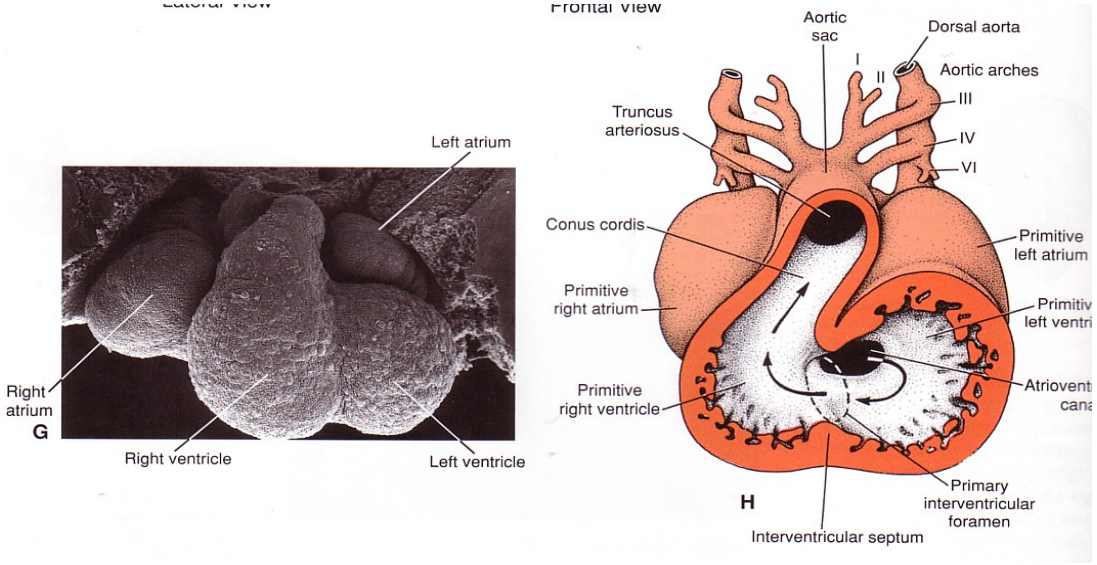
The Membranous part of the IV septum:

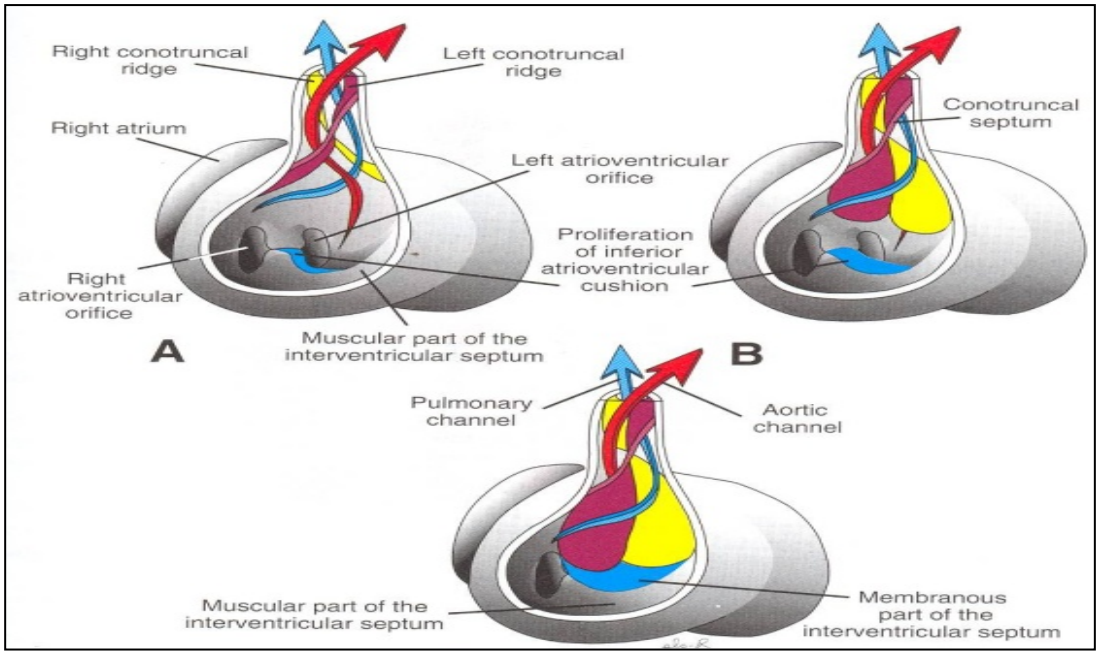
derived from

1- A tissue extension from the right side of the **Endocardial Cushion**.

2- **Aorticopulmonary septum**.

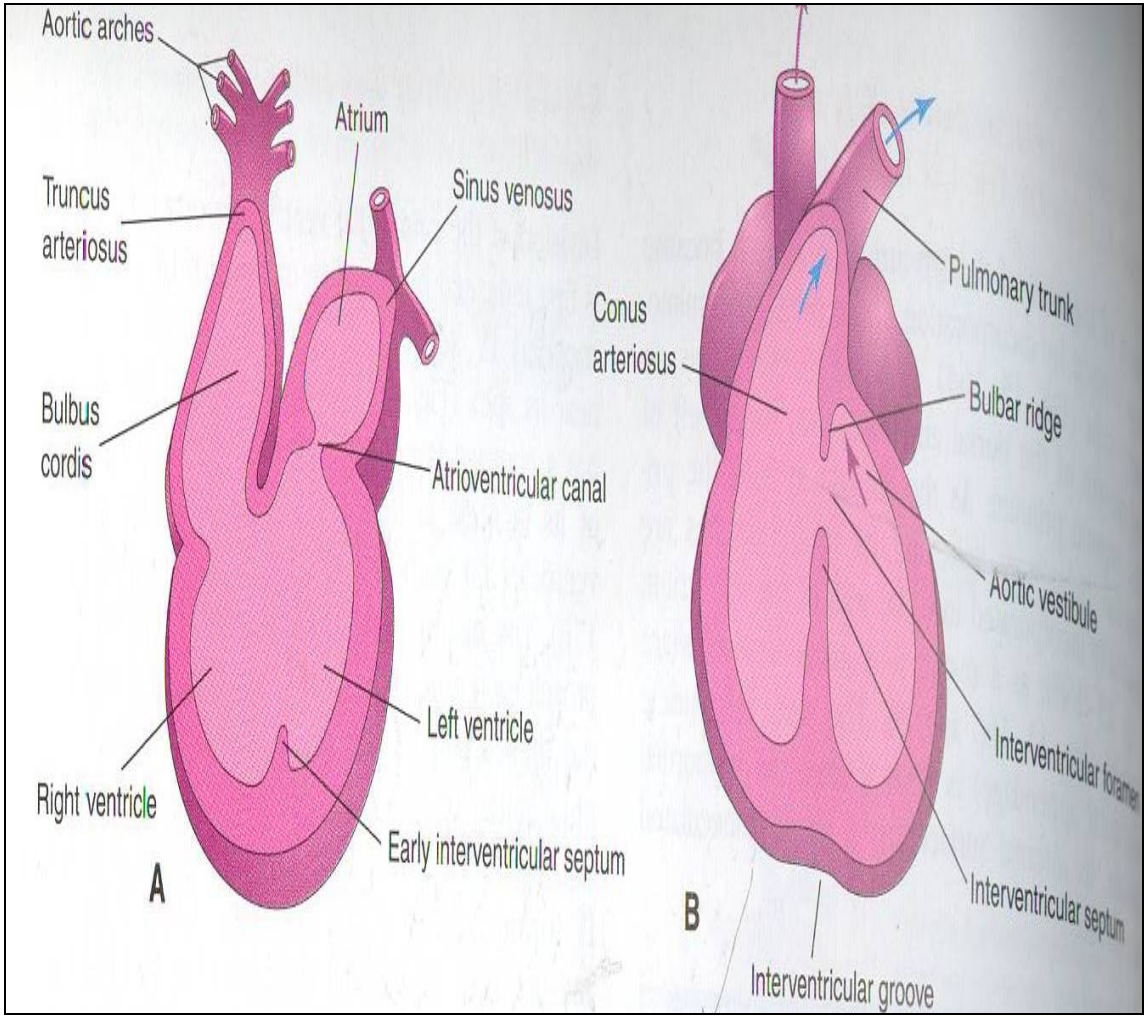
3- Thick **Muscular part of the IV septum**.



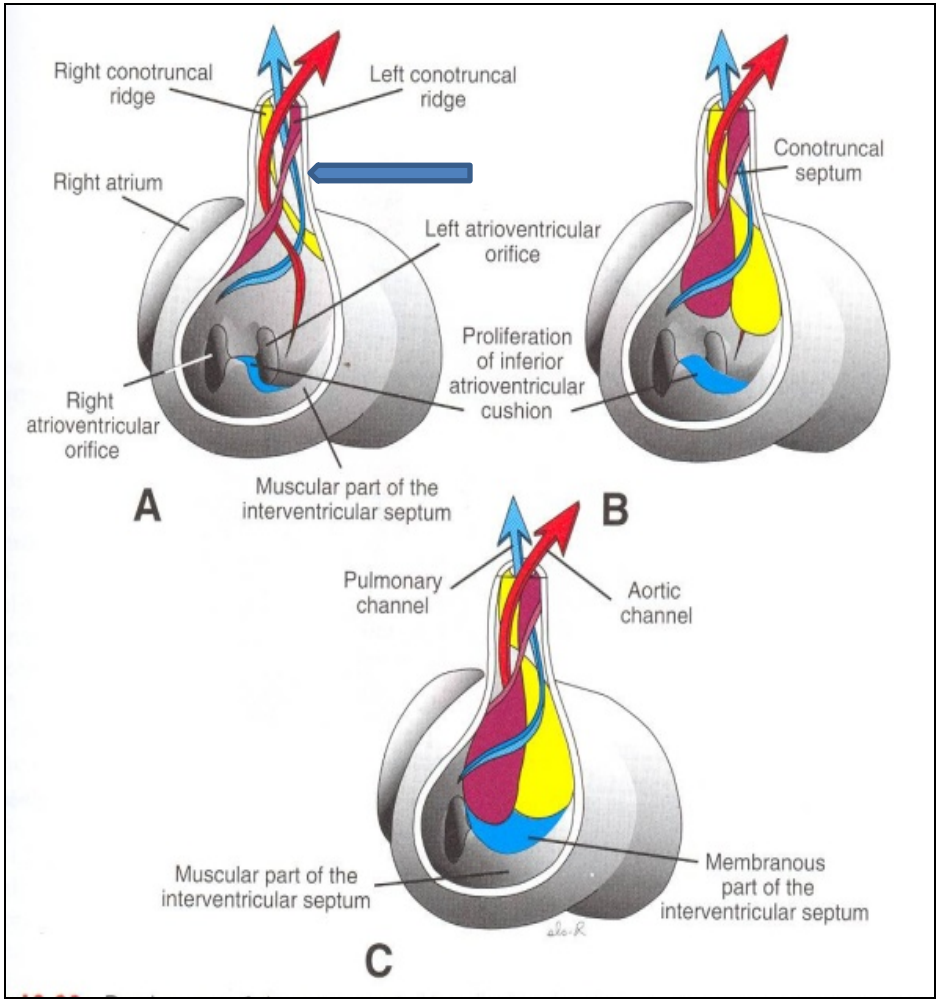


BULBUS CORDIS

- **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.**

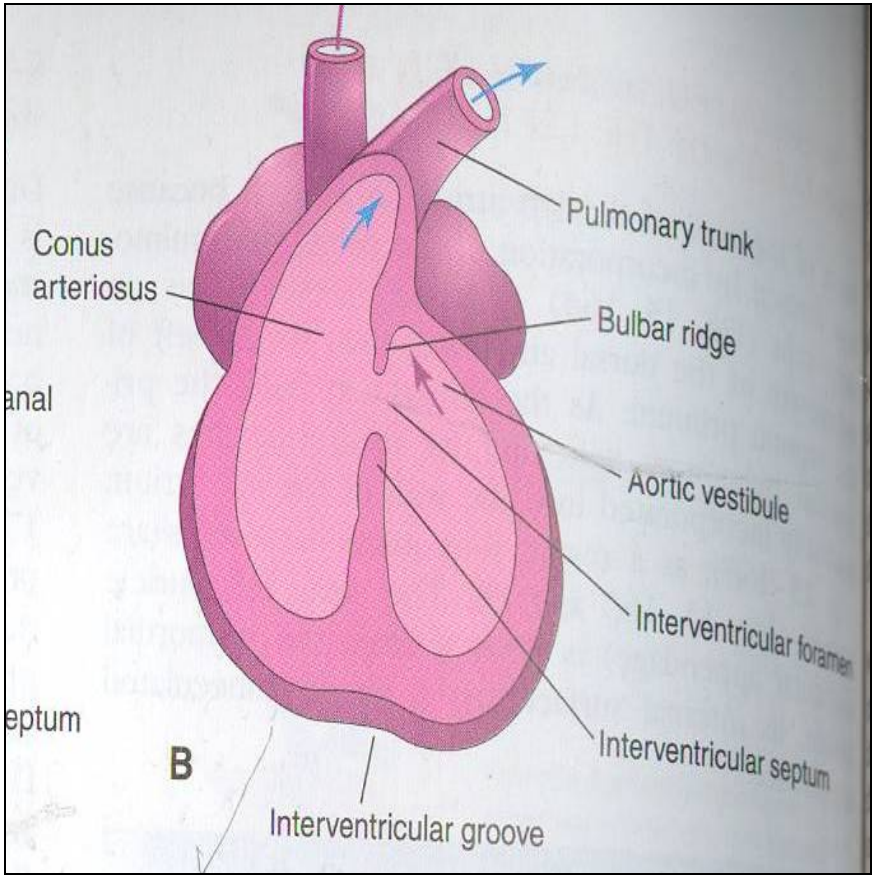


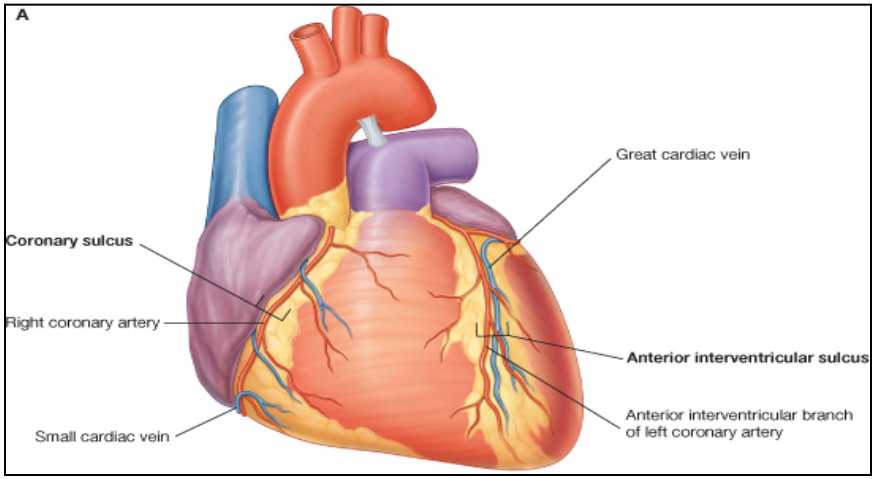
Partition of Truncus Arteriosus



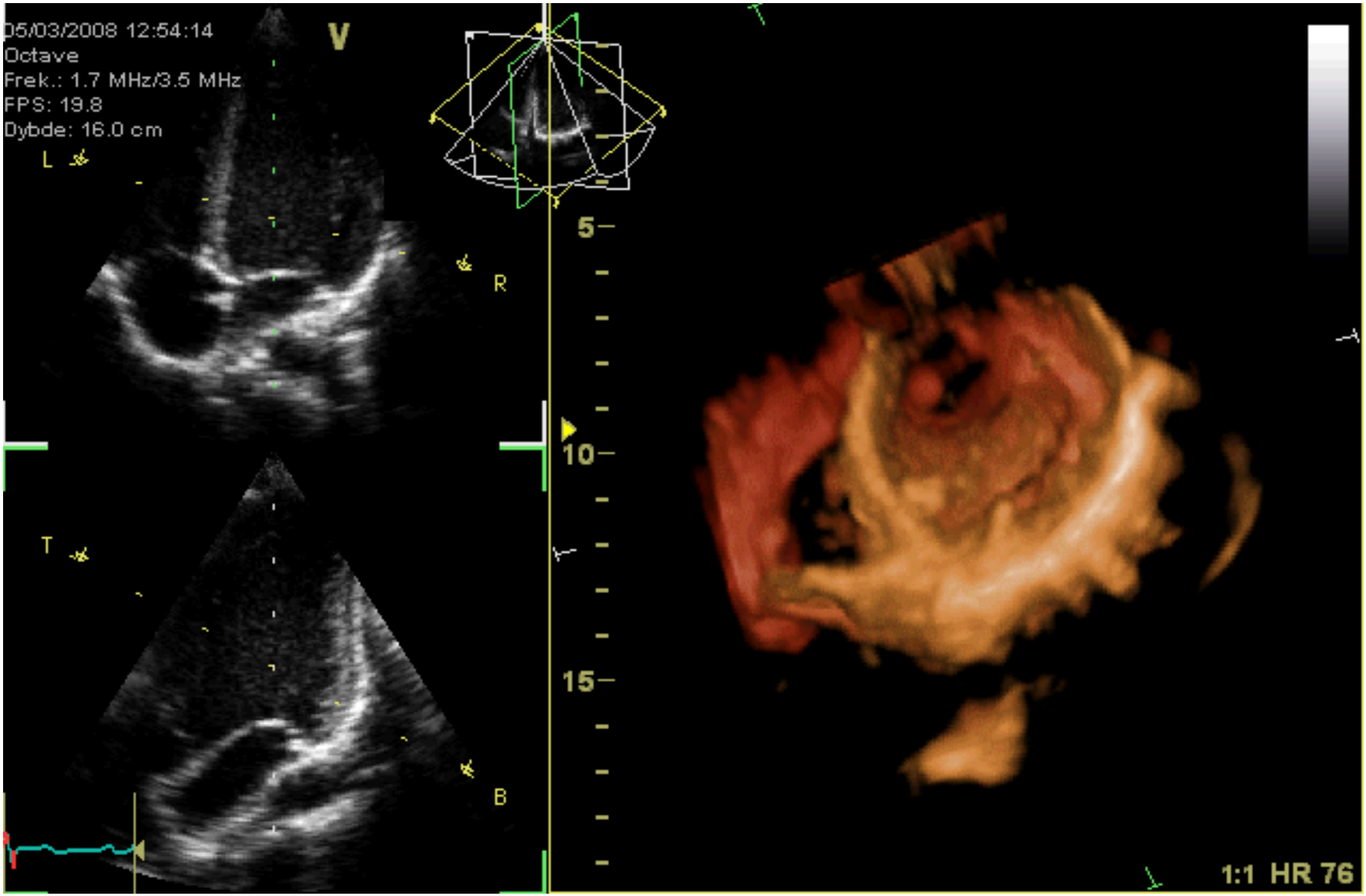
- In the **5th week**, proliferation of mesenchymal cells **(Endocardial Cushions)** appear in the wall of the **truncus arteriosus** ,they form a **Spiral Septum:**
- A. It divides **the Lower part of the T A into Right & Left parts**
- B. It divides the **Middle part of TA into Anterior & Posterior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



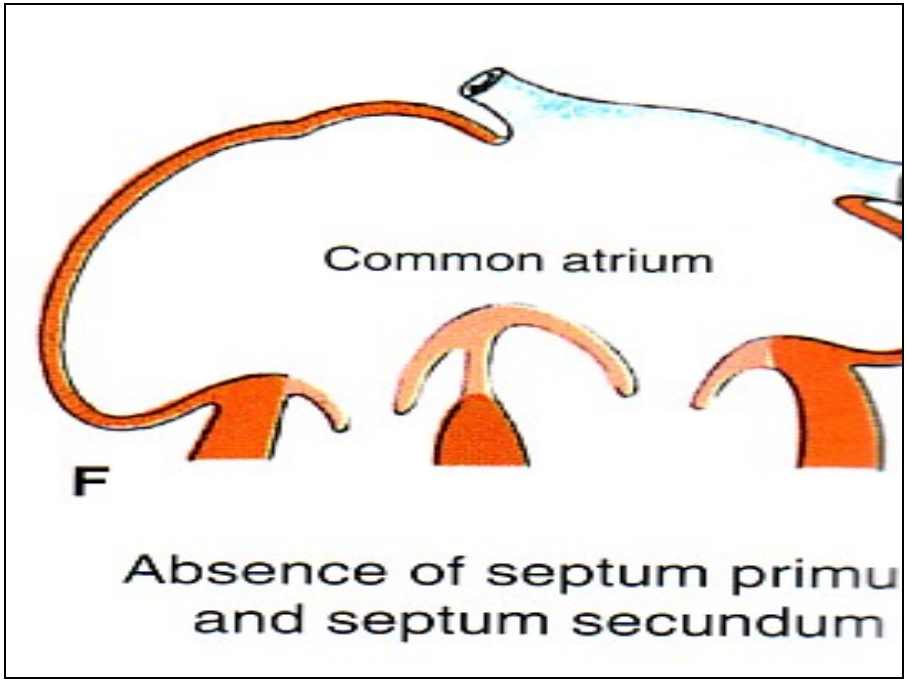


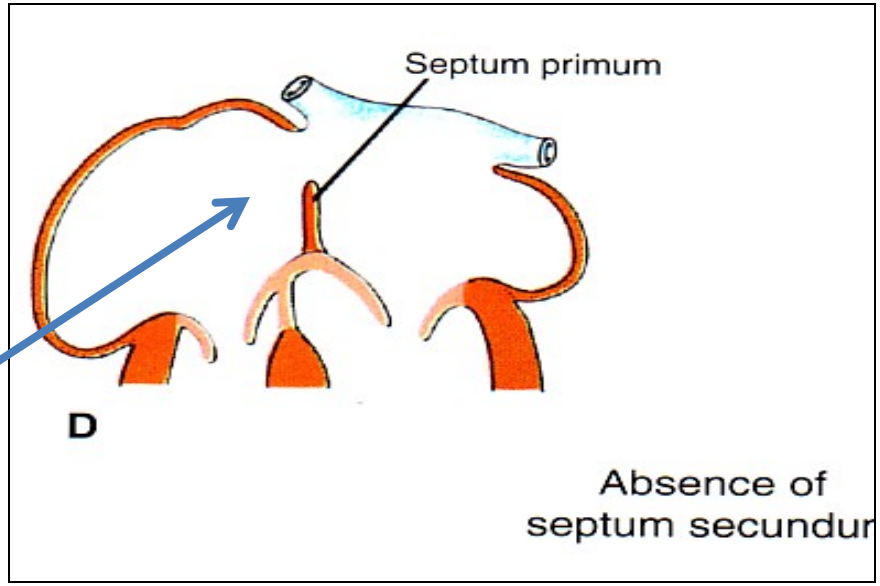
MAJOR CARDIAC ANOMALIES



Atrial Septal Defects (ASD)

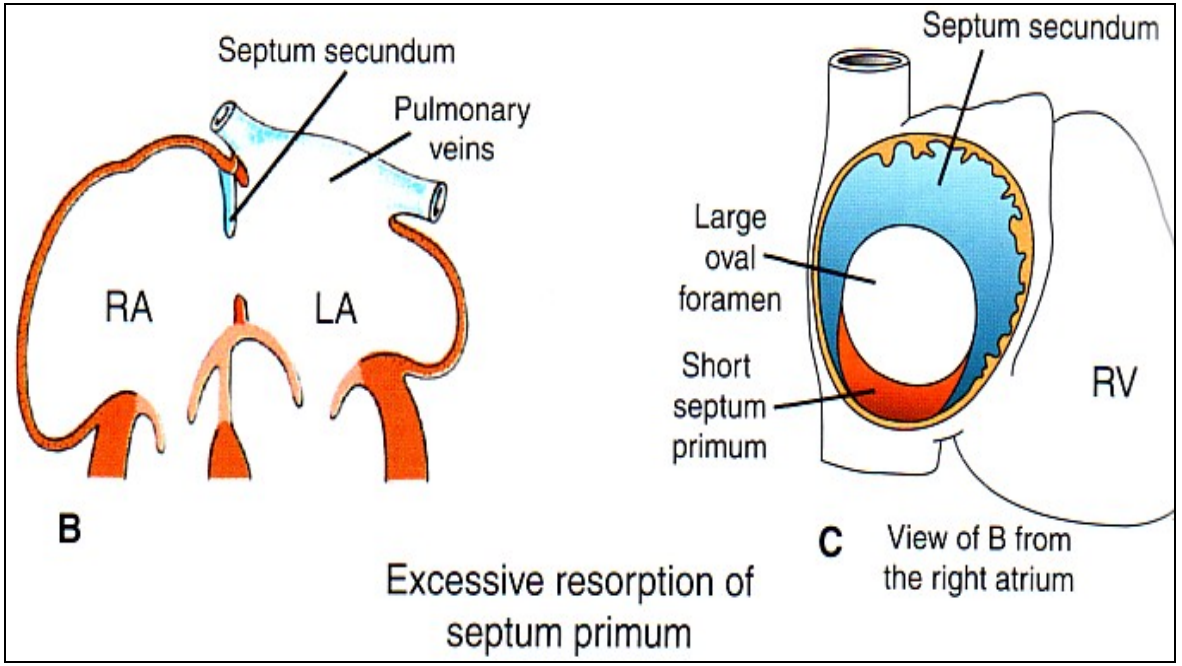
- **Types :**
- 1. Absence of both septum primum and septum secundum, leads to **Common Atrium.**
- 2. Absence of **Septum Secundum**

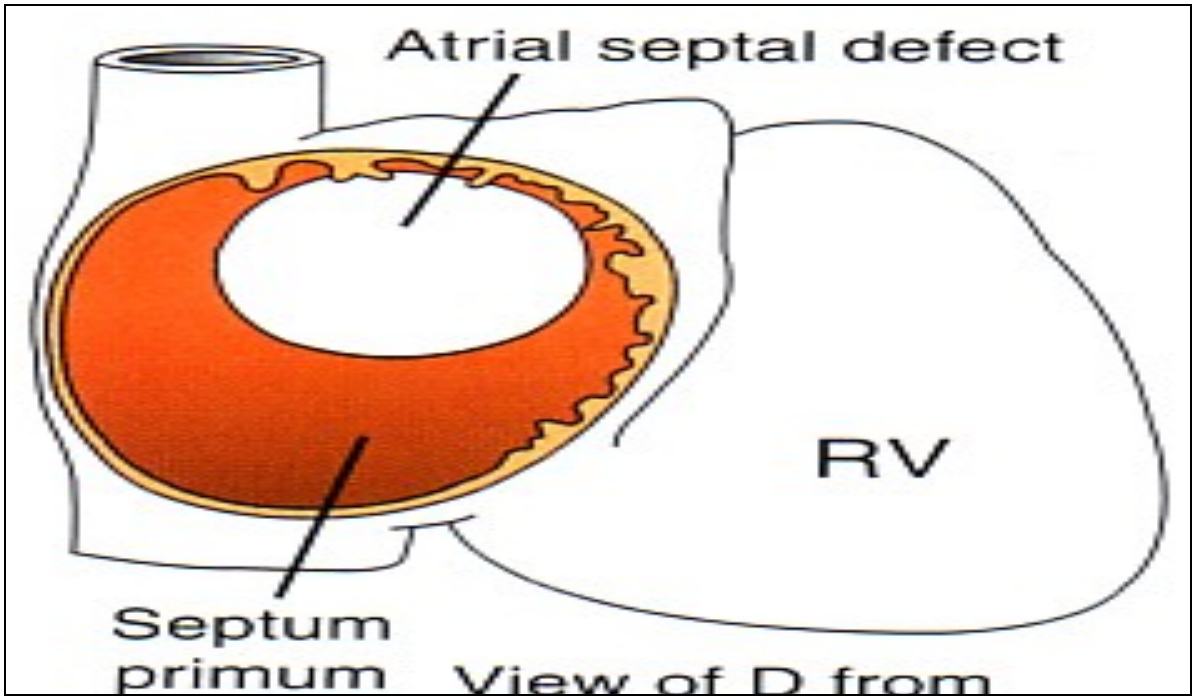




3. Large (Patent) foramen ovale

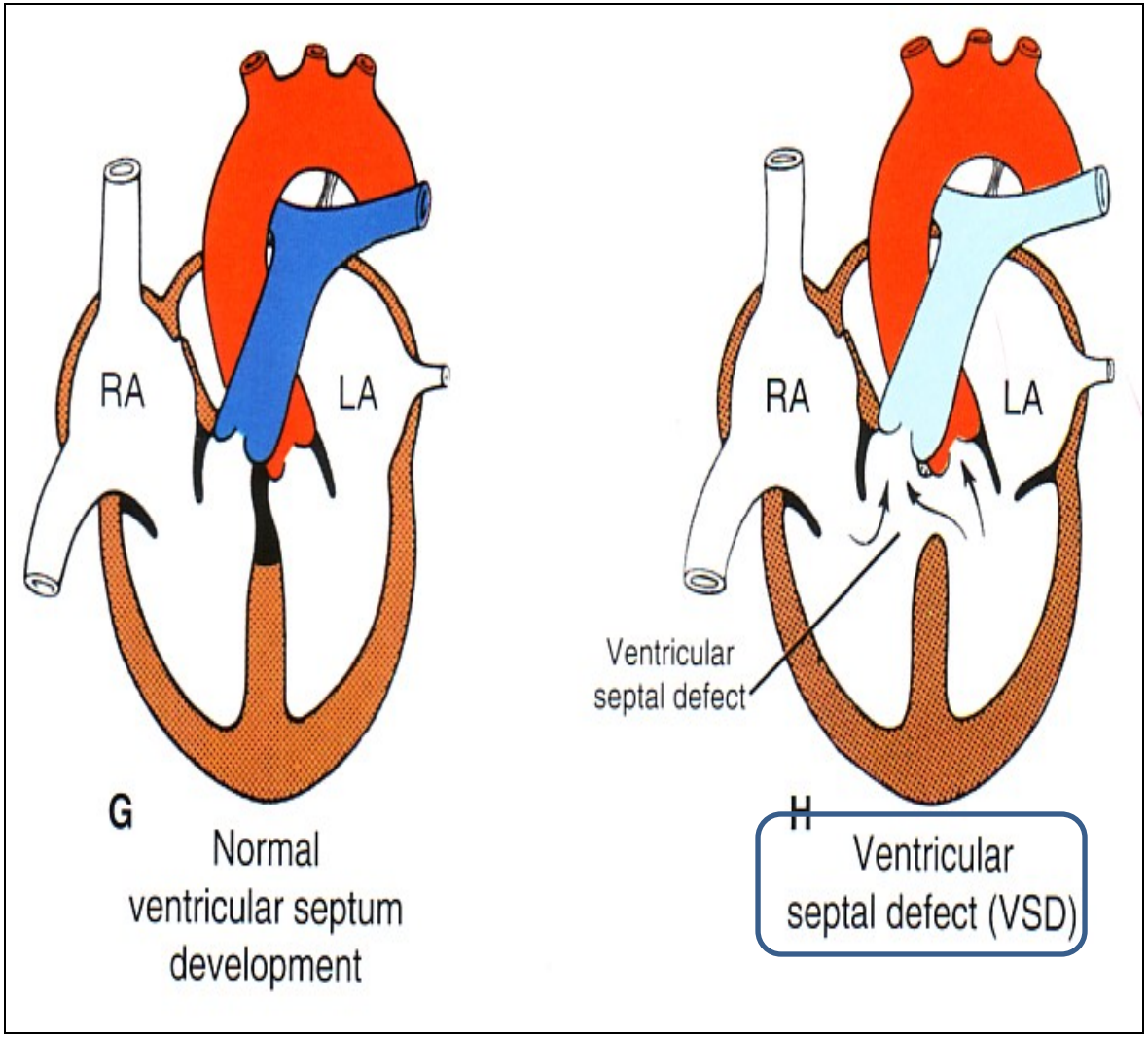
: Excessive resorption of septum primum





VENTRICULAR SEPTAL DEFECT (VSD)

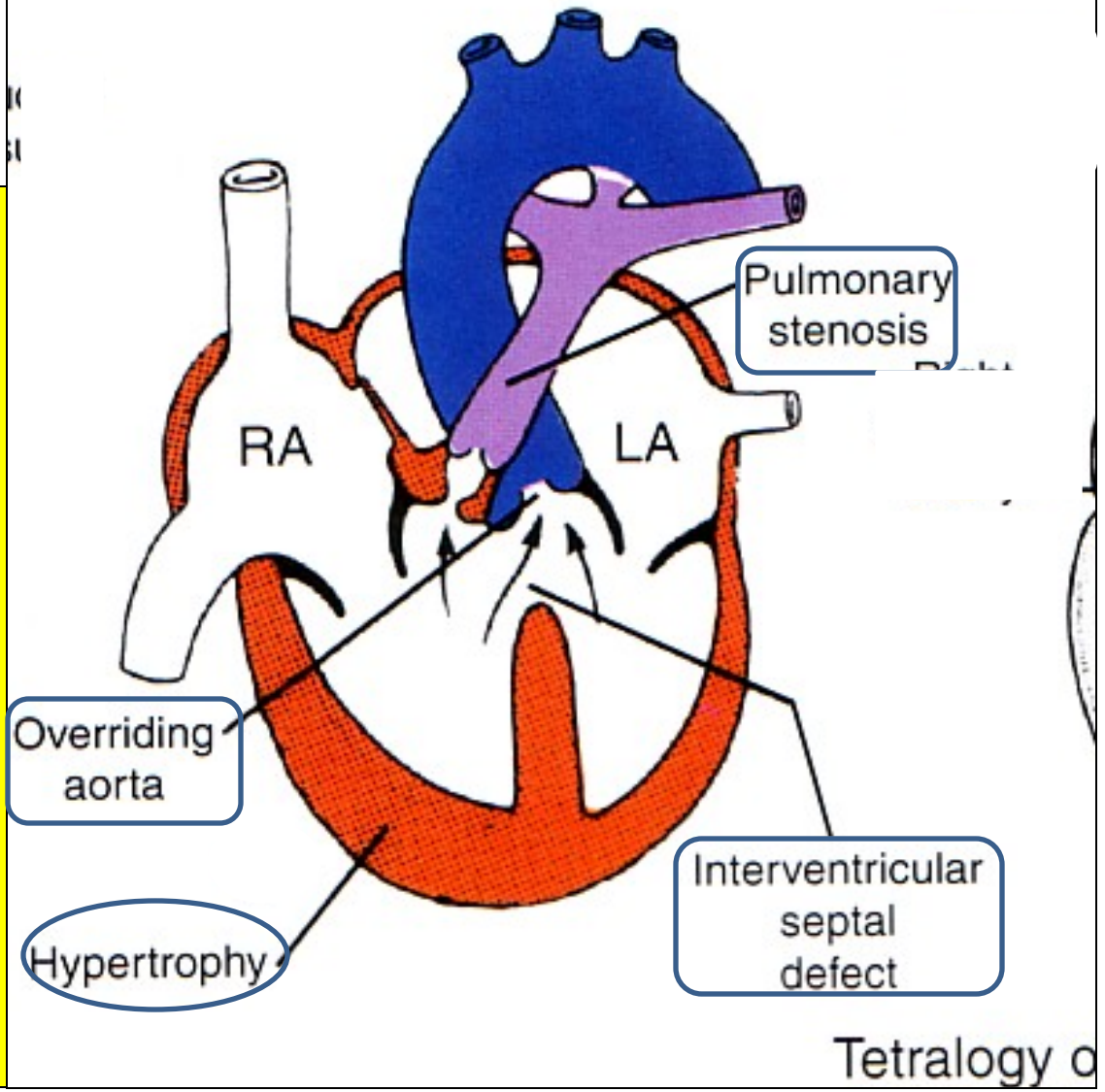
- **Roger's disease**
- Absence of the ***Membranous*** part of interventricular septum **(persistent IV Foramen).**
- Usually accompanied by other cardiac defects.



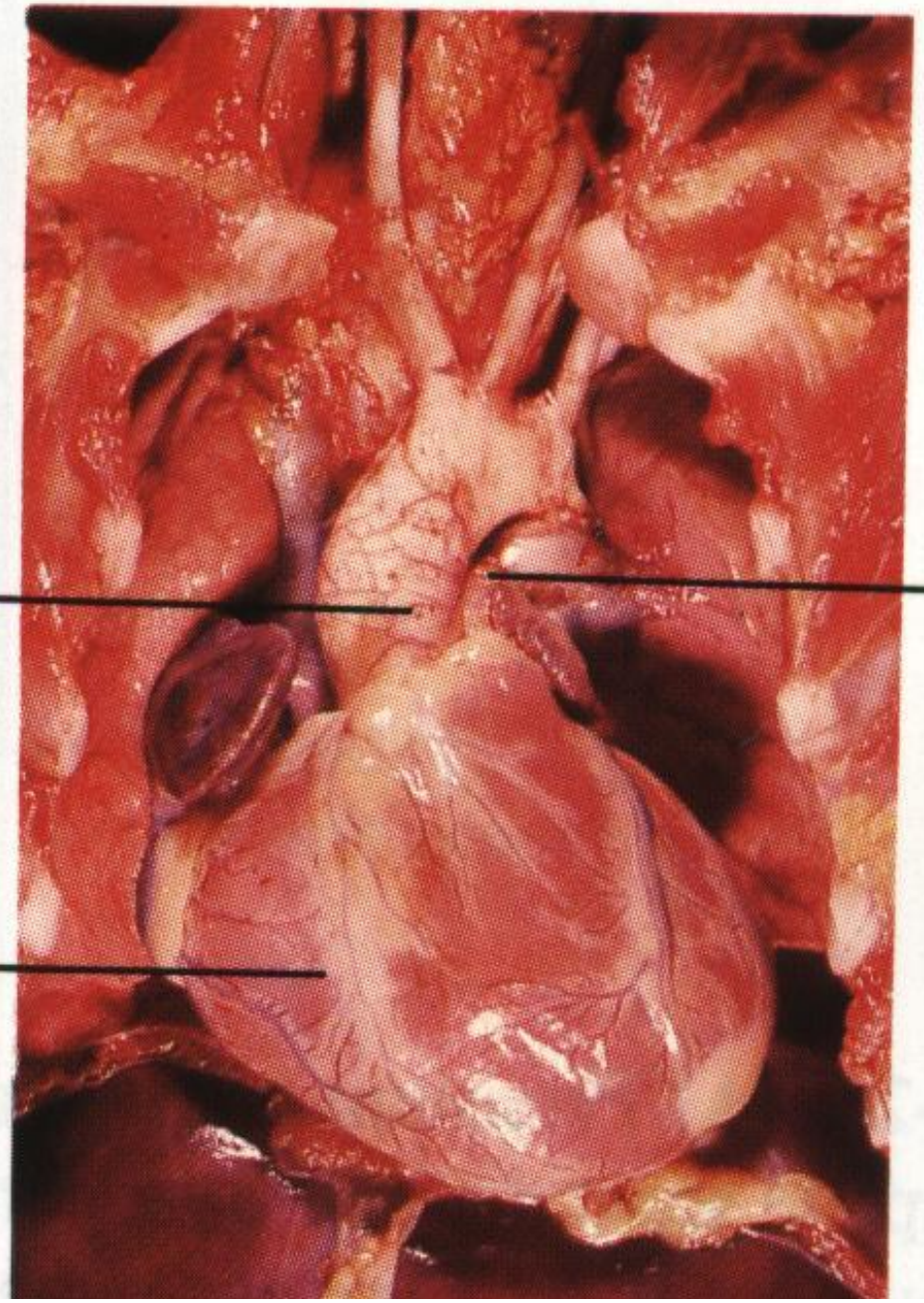
TETRALOGY OF FALLOT

Blue Baby

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



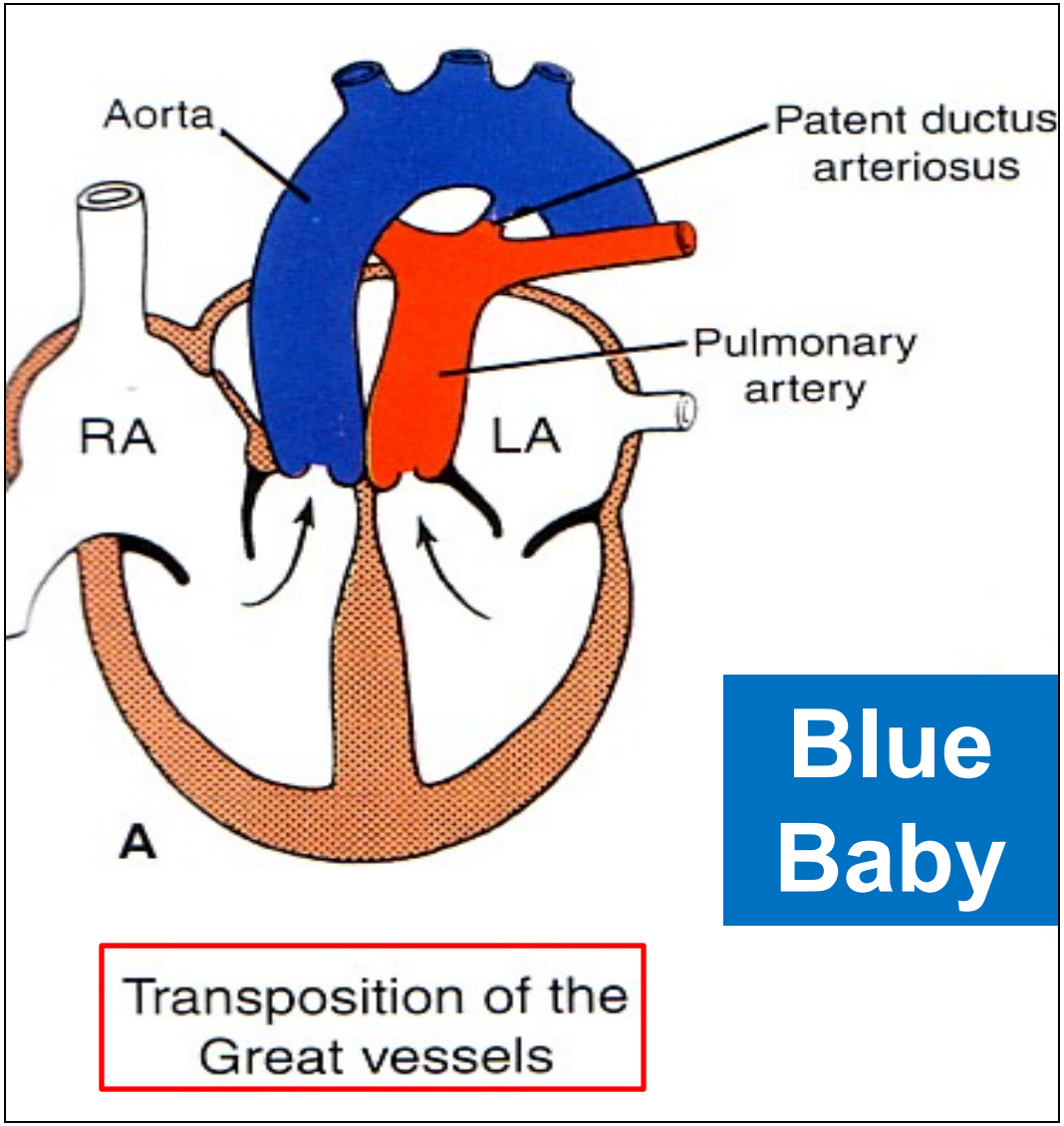
TETRALOGY OF FALLOT



Blue Baby

TRANSPOSITION OF GREAT ARTERIES (TGA)

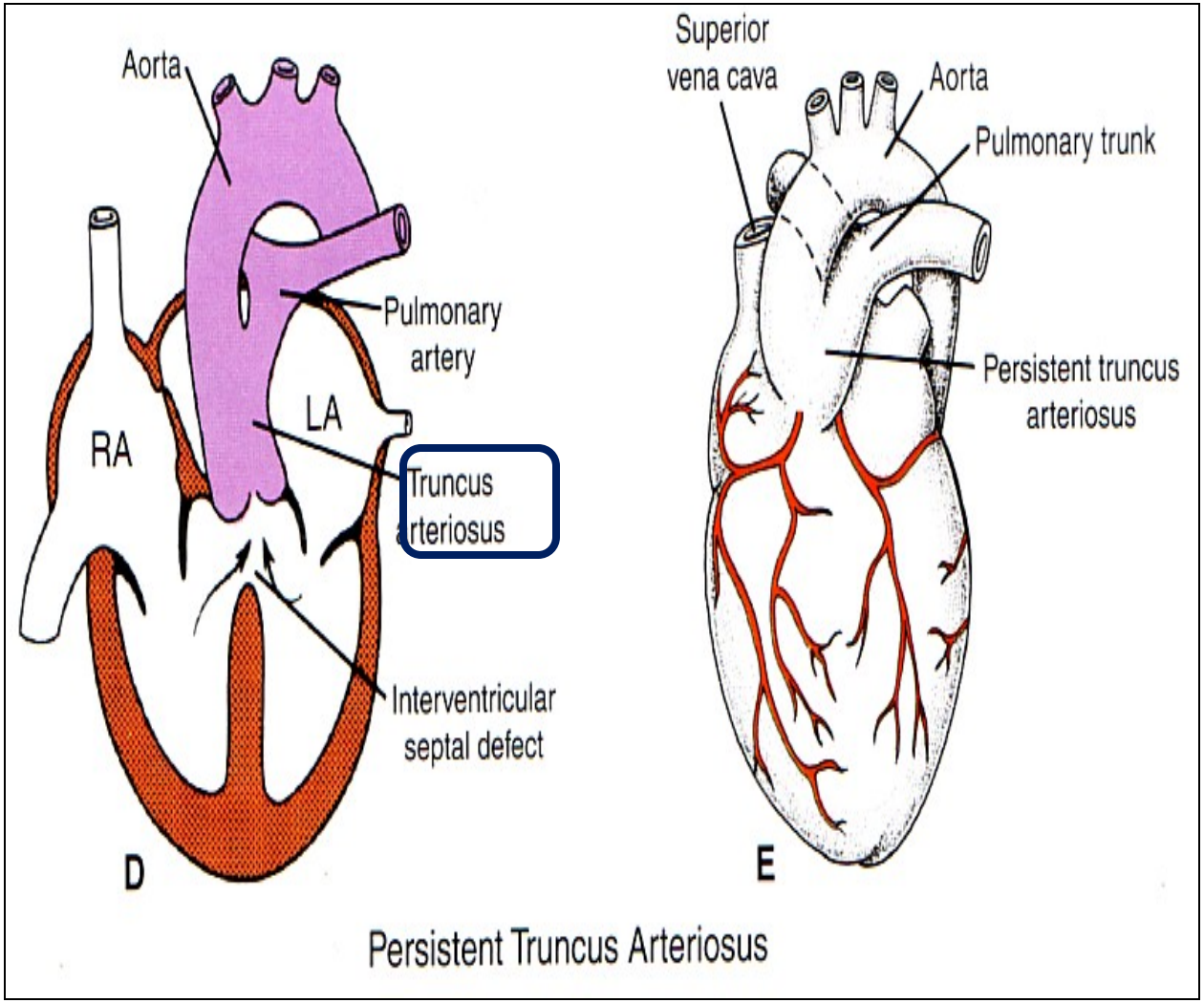
- TGA is due to **abnormal rotation or malformation of the aorticopulmonary septum**, so the right ventricle joins the aorta, while the left ventricle joins the pulmonary artery.
- It is one of the most common causes of cyanotic heart disease in the newborn
- Often associated with ASD or VSD



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