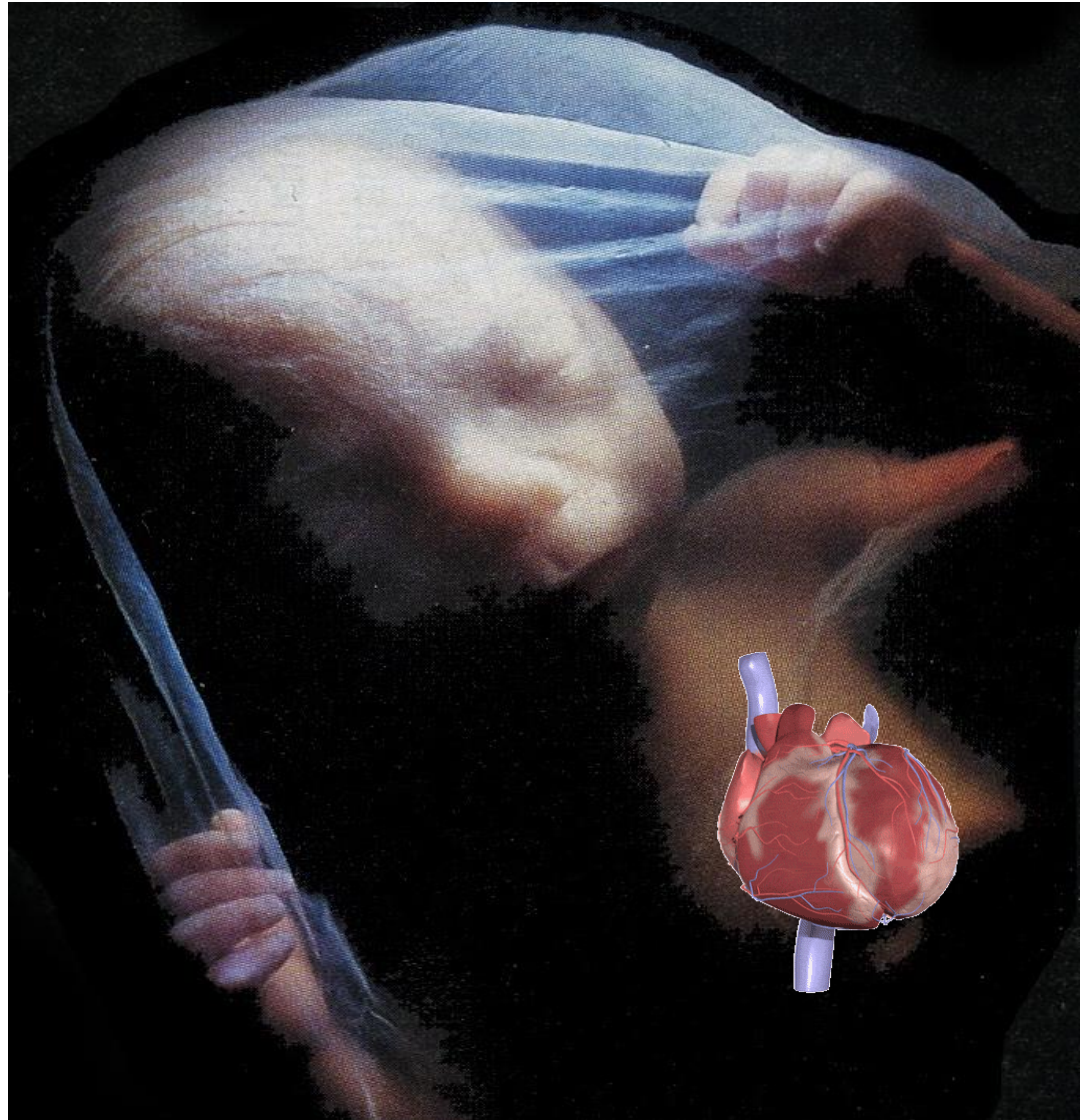


# HEART DEVELOPMENT



PROF. Saeed Abuel Makarem

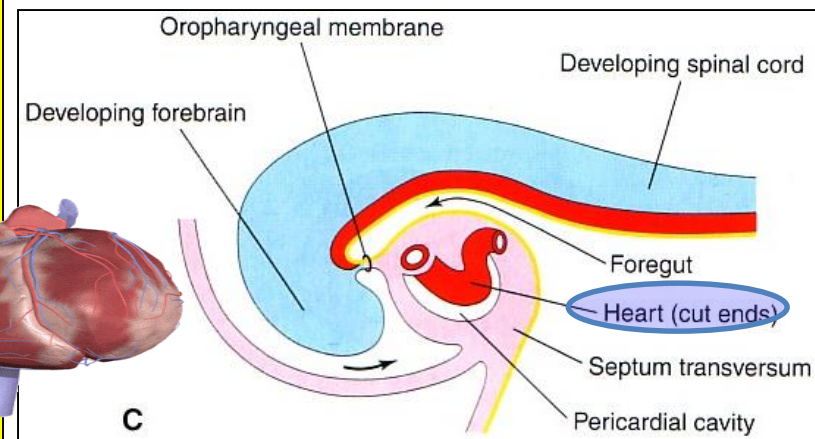
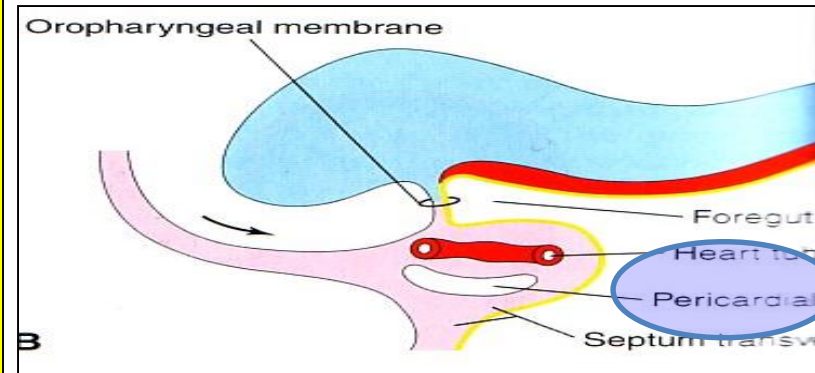
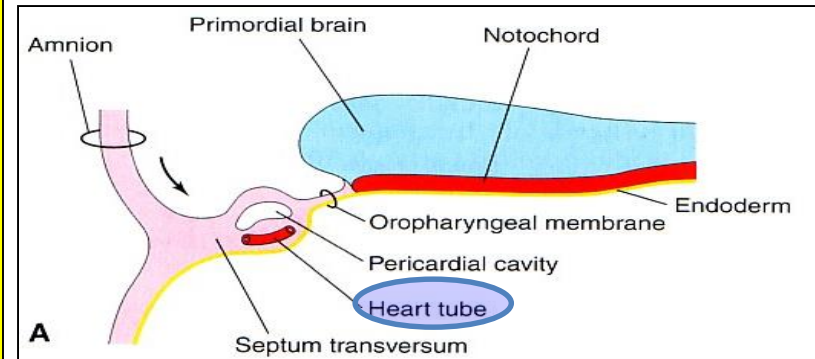
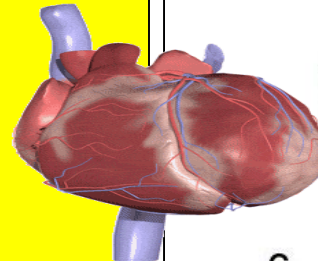
# Objectives

## By the end of the lecture you should be able to:

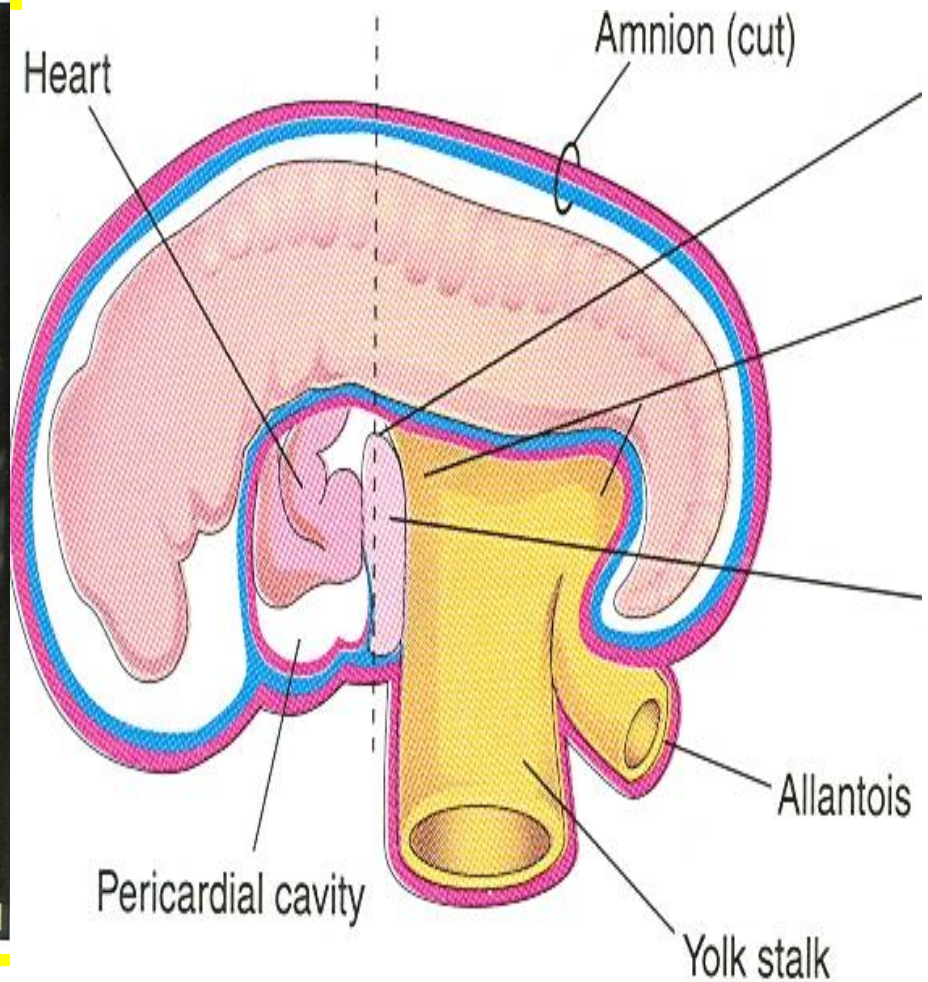
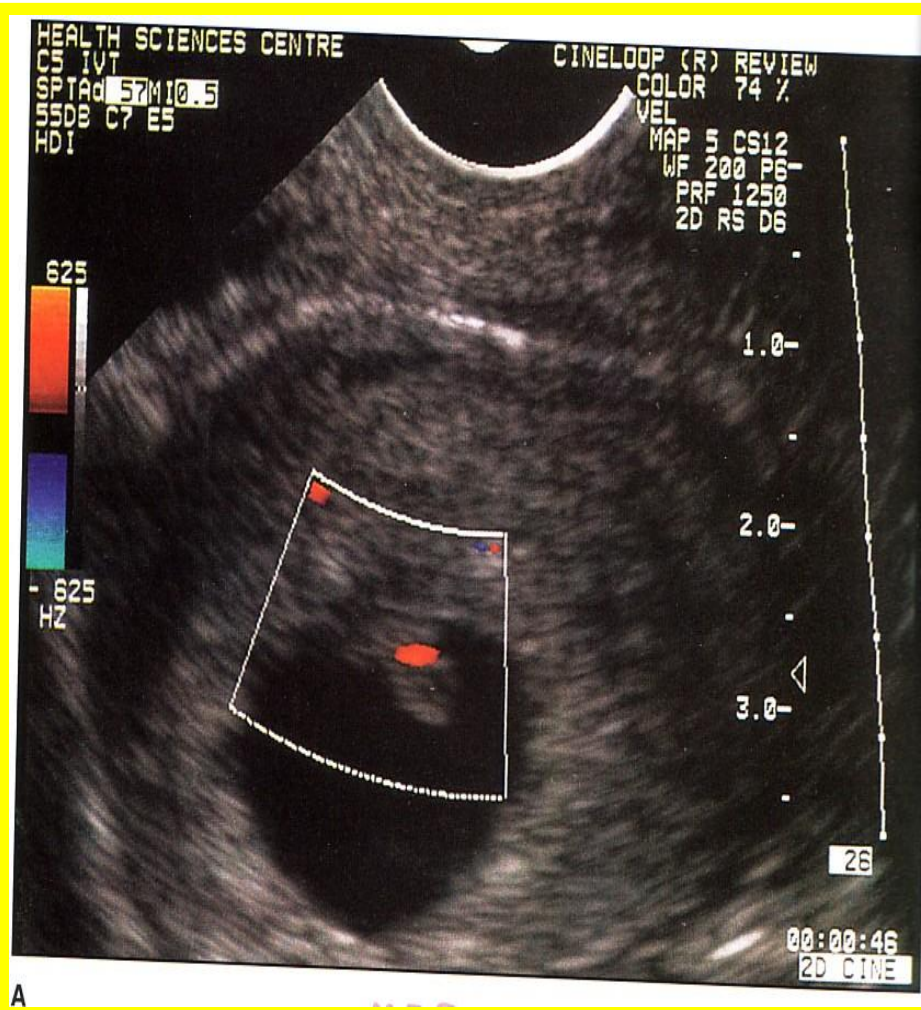
- Describe the embryology of the heart tube: (site of formation, union, and division).
- Describe the formation and fate of the **sinus venosus**.
- Describe the formation of the **interatrial and the interventricular septae**.
- Describe the formation of the **two atria and the two ventricles**.
- Describe the partitioning of the **truncus arteriosus** and formation of the **aorta** and **pulmonary trunk**.
- List the most common cardiac anomalies.

# FORMATION OF THE HEART TUBE

- The heart is the **first functional** organ to develop.
- It develops from **splanchnic mesoderm** (cardiogenic area), cranial to the developing mouth and brain.
- At first it lies ventral to the developing pericardial sac.
- The heart primordium is first evident **at 18 days** (as an angioplastic cords which soon canalize to form the 2 heart tubes).
- After completion of the head fold, the developing heart tubes lie in the ventral aspect of the embryo and dorsal to the developing pericardial sac.
- **After lateral folding** of the embryo
- **The 2** heart tubes fuse together to form a **single endocardial heart tube**.
- It begins to beat **at 22 to 23 days**.



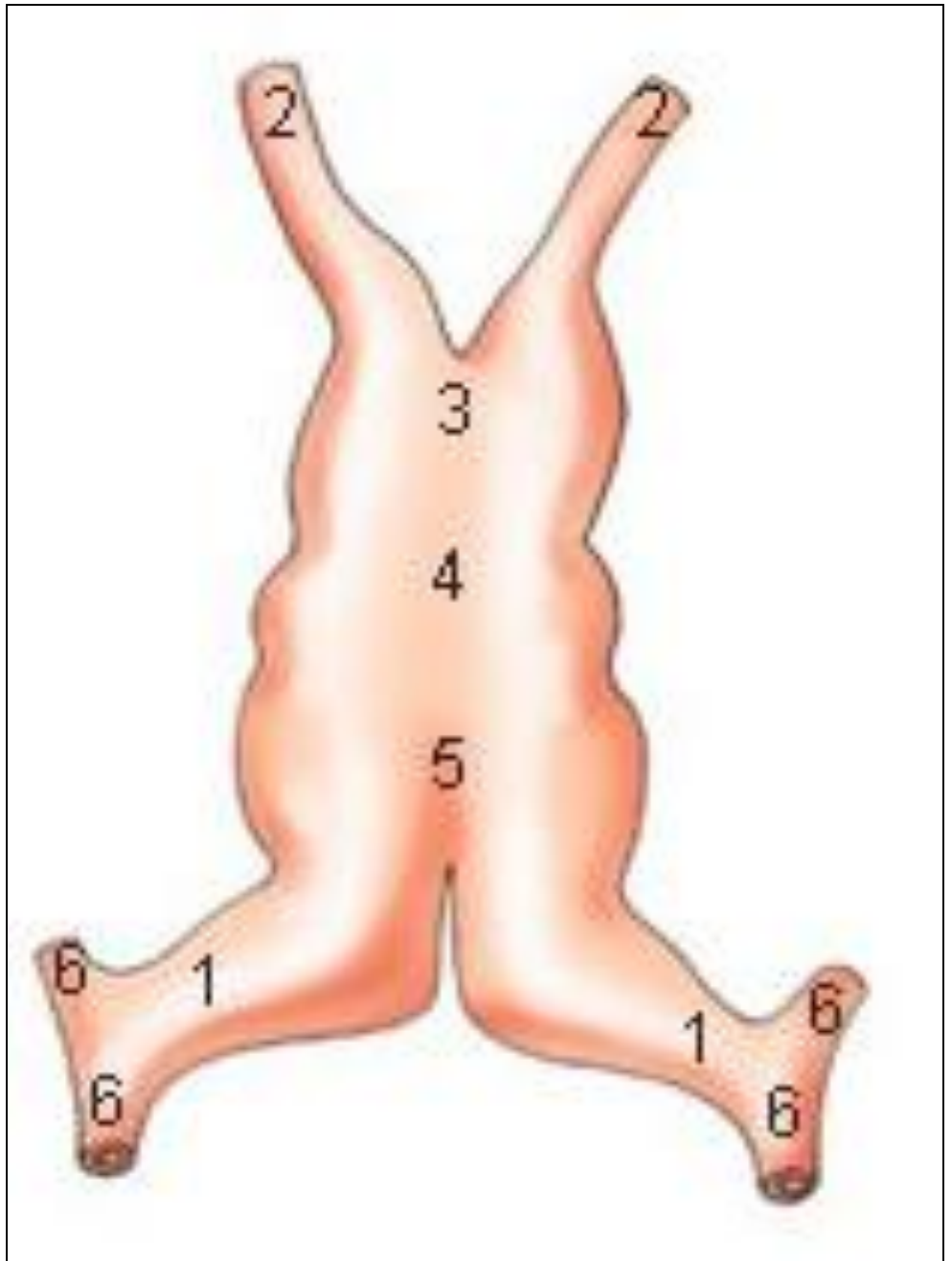




Blood **flow** begins during the beginning of the **fourth week** and can be visualized by **Ultrasound Doppler**.

# Development of the Heart tube

- After lateral folding of the embryo, the 2 heart tubes approach each other and fuse together in a craniocaudal direction to form a **single endocardial heart tube** within the pericardial sac.



## What is the fate of the Heart Tube?

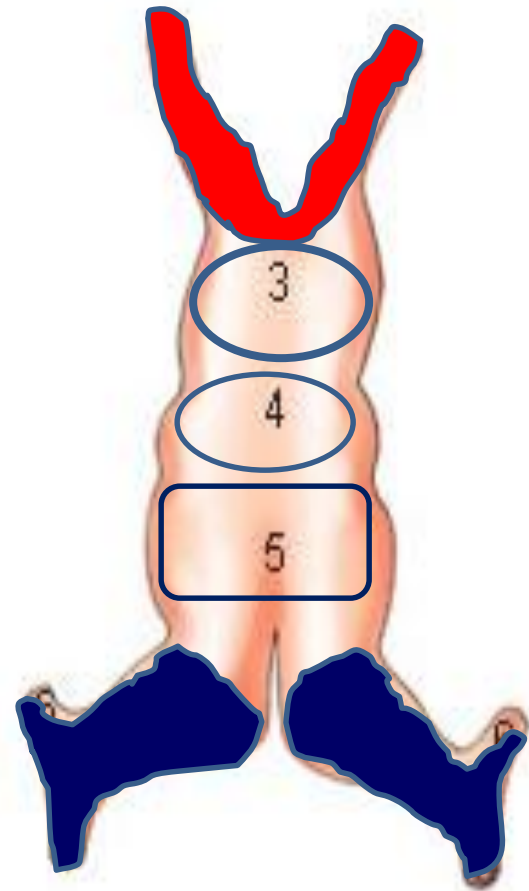
- The heart tube grows faster than the pericardial sac, so it shows **5 dilations separated by constrictions.**

- These are:

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

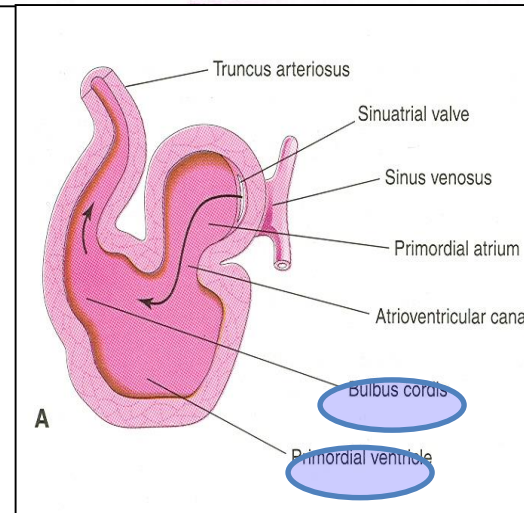
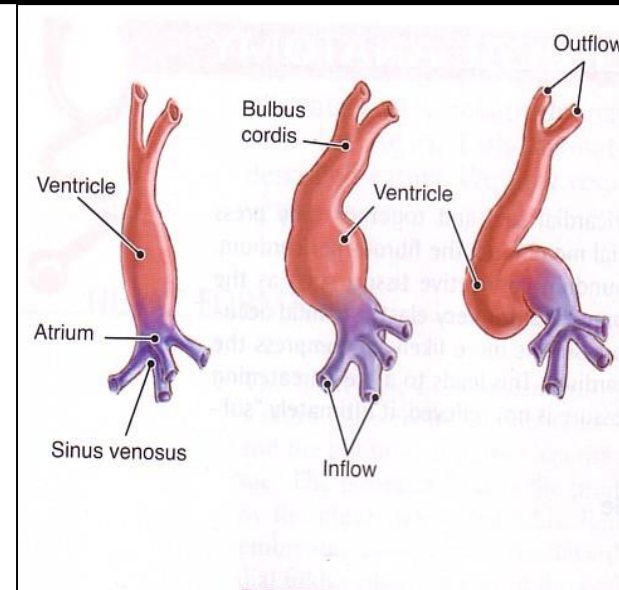
The endocardial heart tube has 2 ends:

1. Venous end; Sinus Venosus.
2. Arterial end; Truncus arteriosus.



# U-SHAPED HEART TUBE

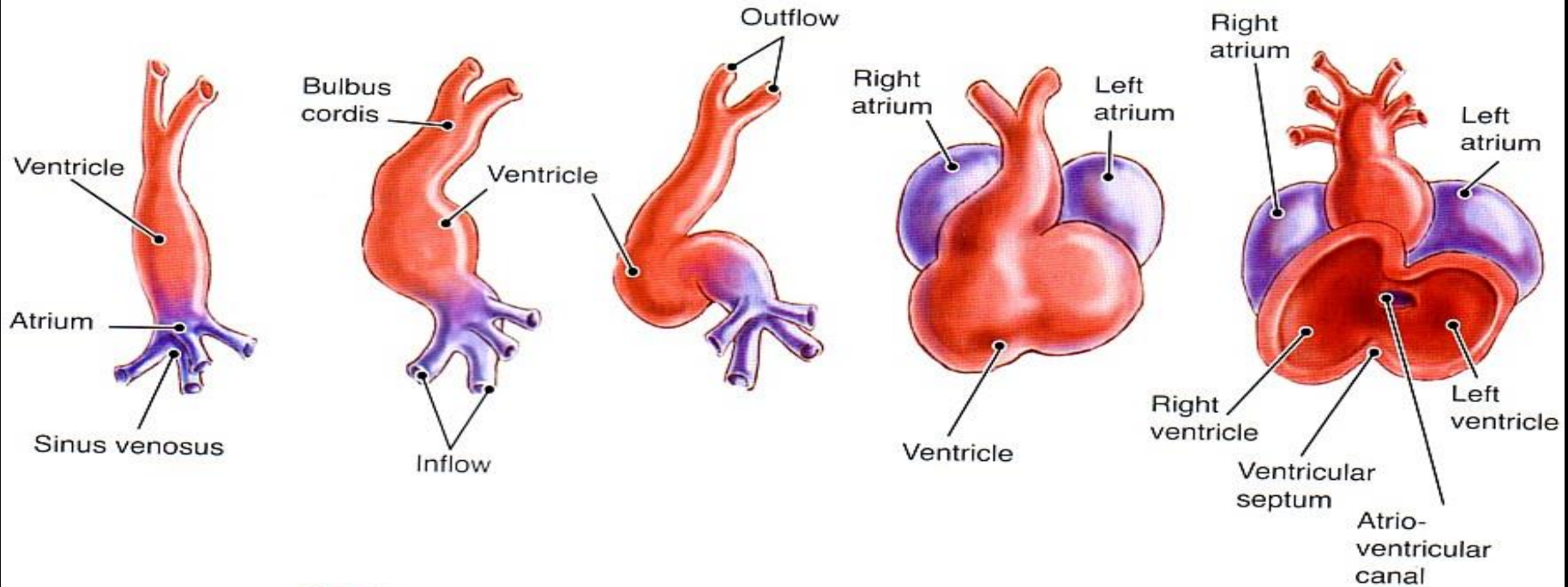
- Bulbus cordis and common ventricle grow faster than the other chambers.
- So the heart bends upon itself, forming what is called:
- The U-shaped heart tube, or **(Bulboventricular loop)**.



**Bulboventricular loop**



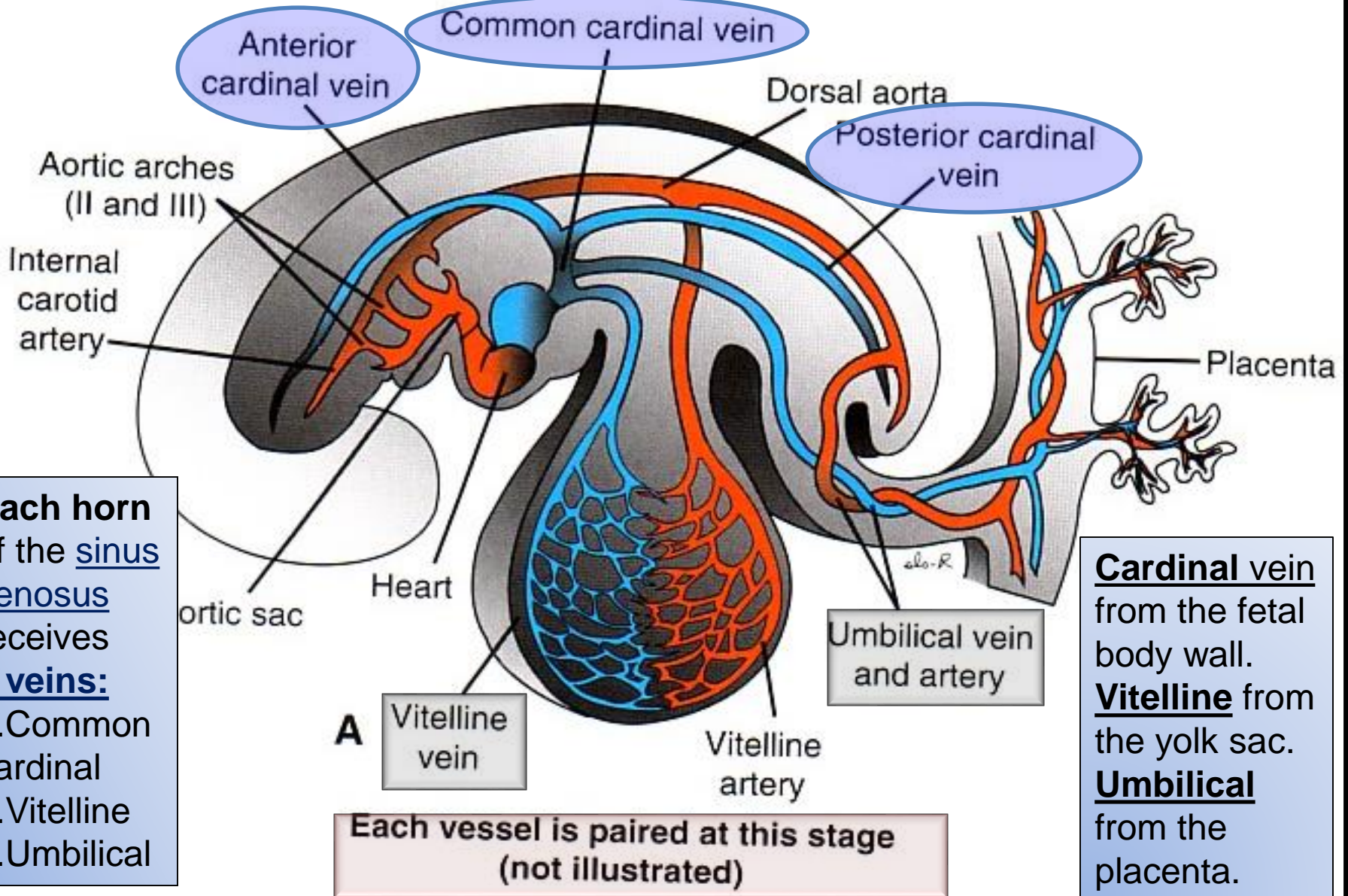
# Loop formation Or S-Shaped Heart Tube



- **With further development the heart tube bends, upon itself:**  
**SO, the atrium and sinus venosus become dorsal to the truncus arteriosus, bulbus cordis, and ventricle.**
- By this stage the sinus venosus has developed **2** lateral expansions, called the **2 horns** ( right and left horns) and a central body.

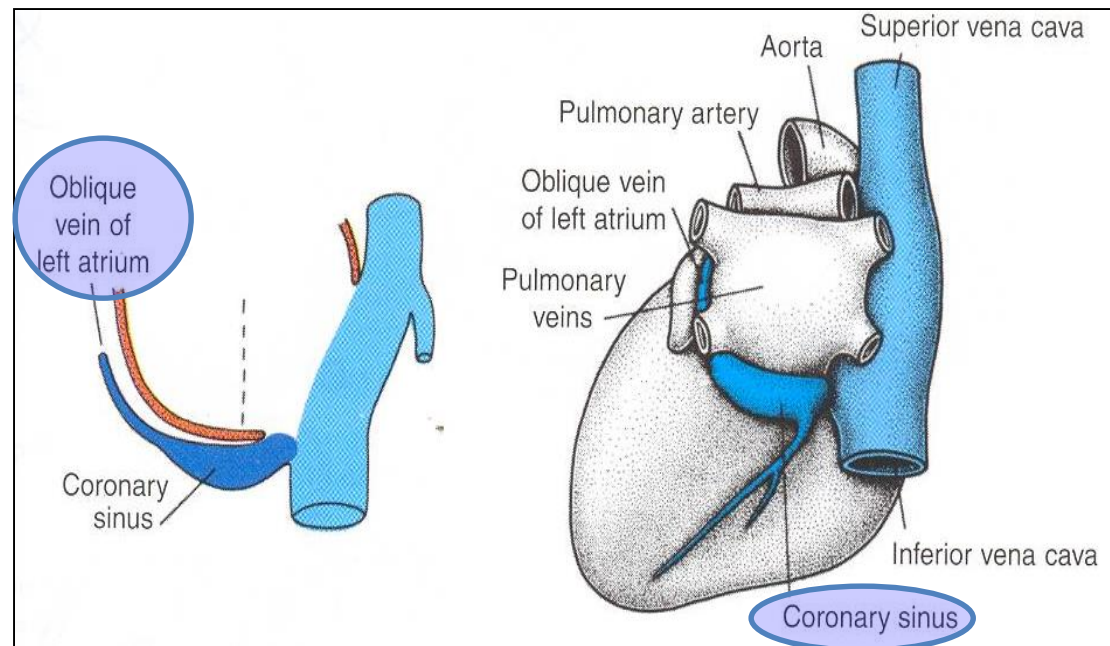
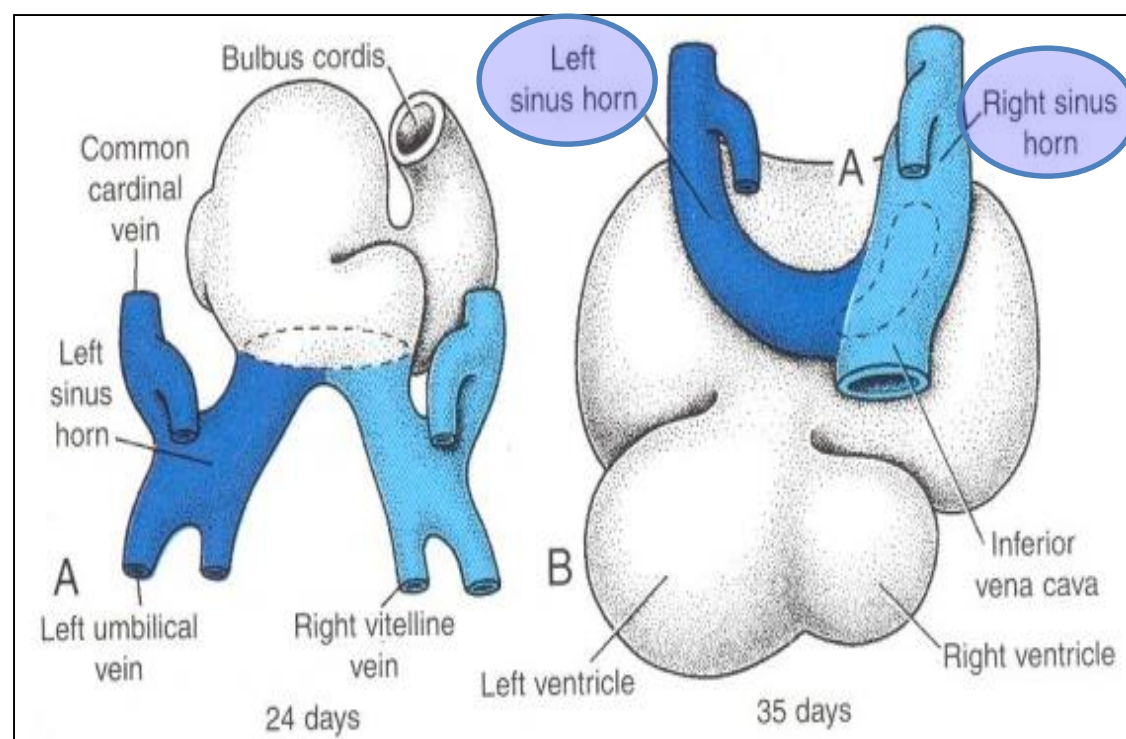


# Veins Associated With Heart Development



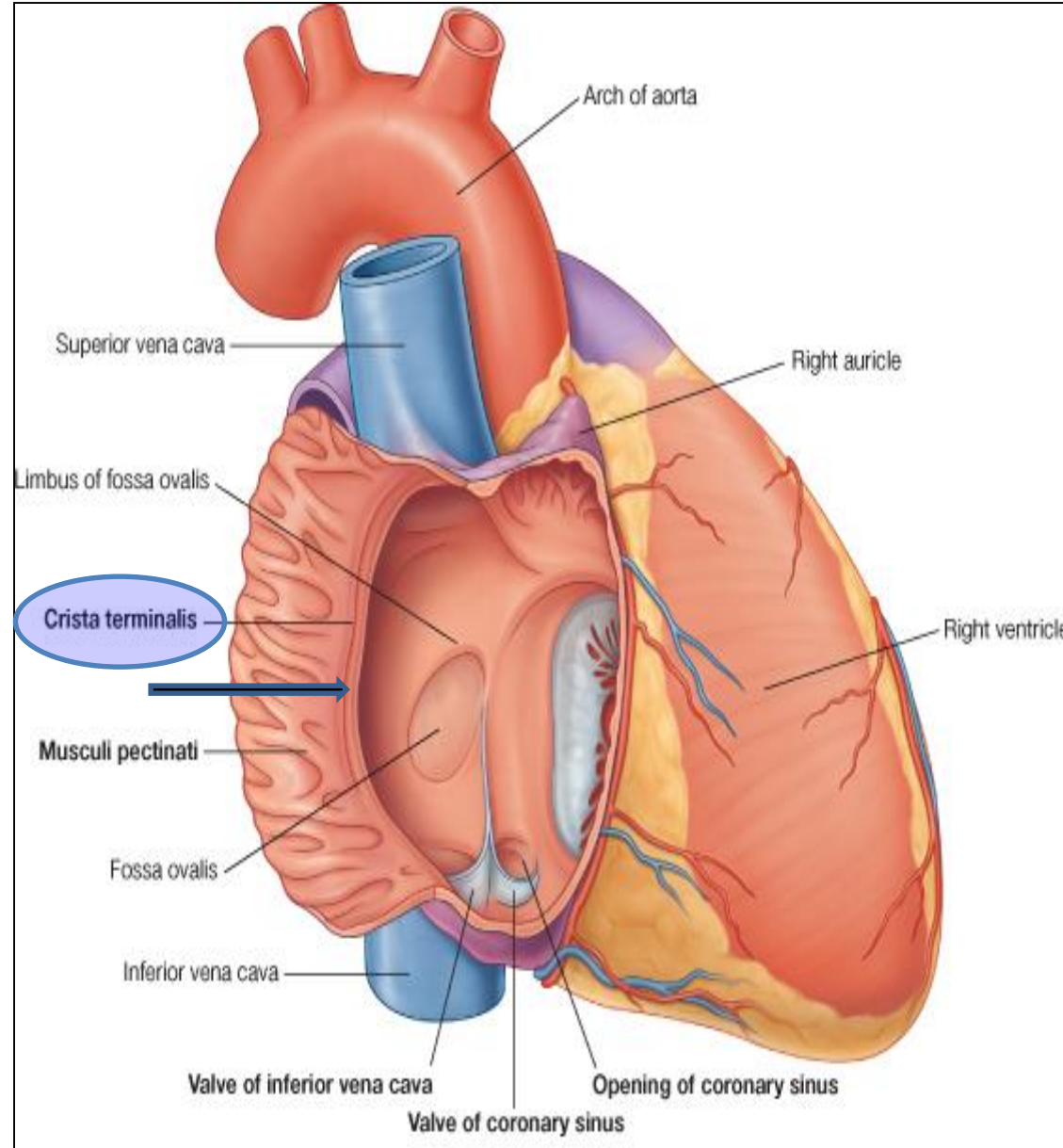
# Fate of Sinus Venosus

- The right horn of the sinus venosus forms the **smooth posterior wall of the right atrium**.
- The left horn and the **body** of the sinus venosus **atrophy** and form the **coronary sinus**.
- The **left common cardinal vein** forms the **oblique vein of the left atrium**.

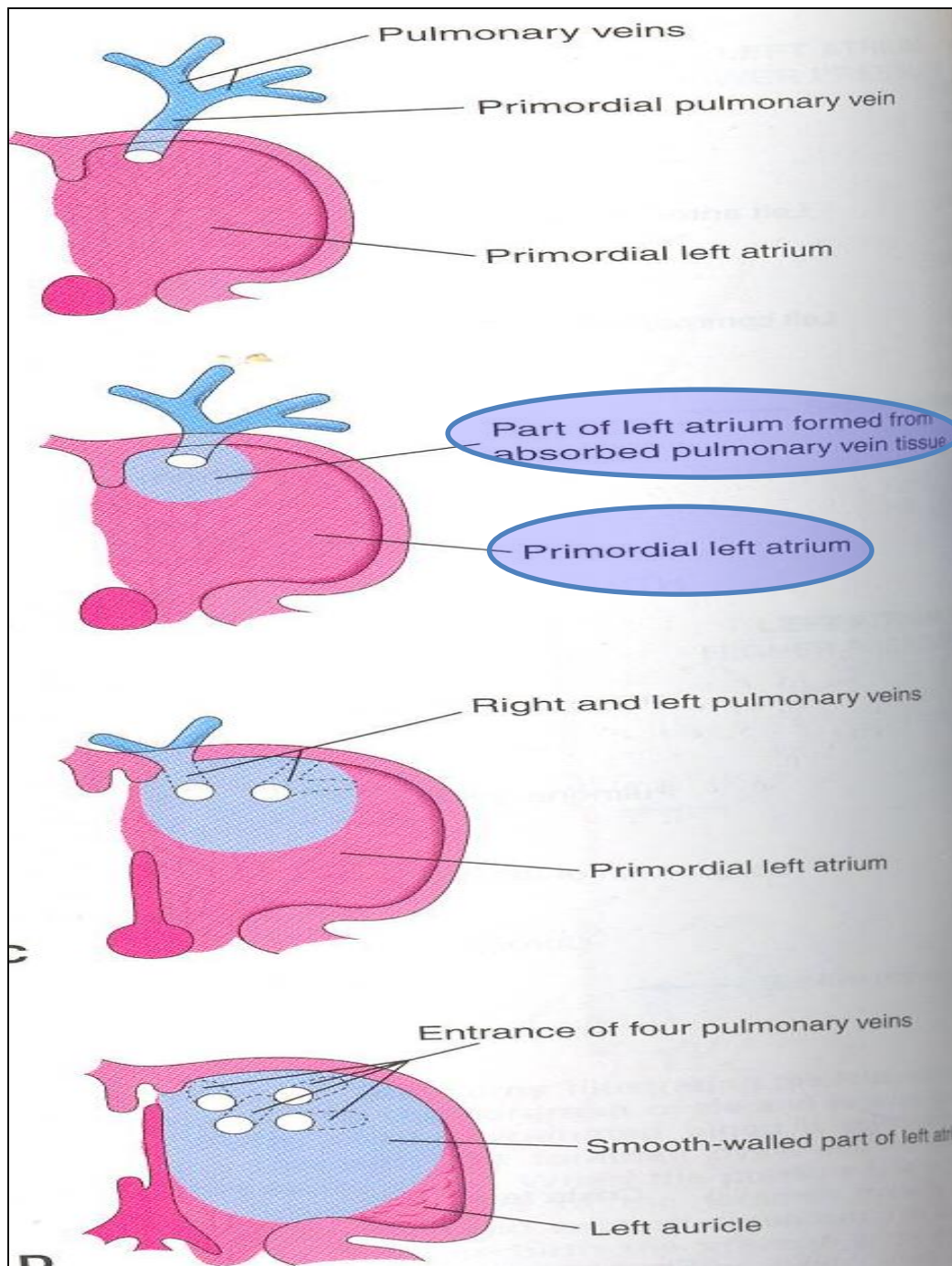




# Right Atrium



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



# Left Atrium

- **Rough Trabeculated part of left atrium is** derived from the primitive or common primordial atrium.
- **The smooth part is** derived from the absorbed part of the **Pulmonary Veins**.



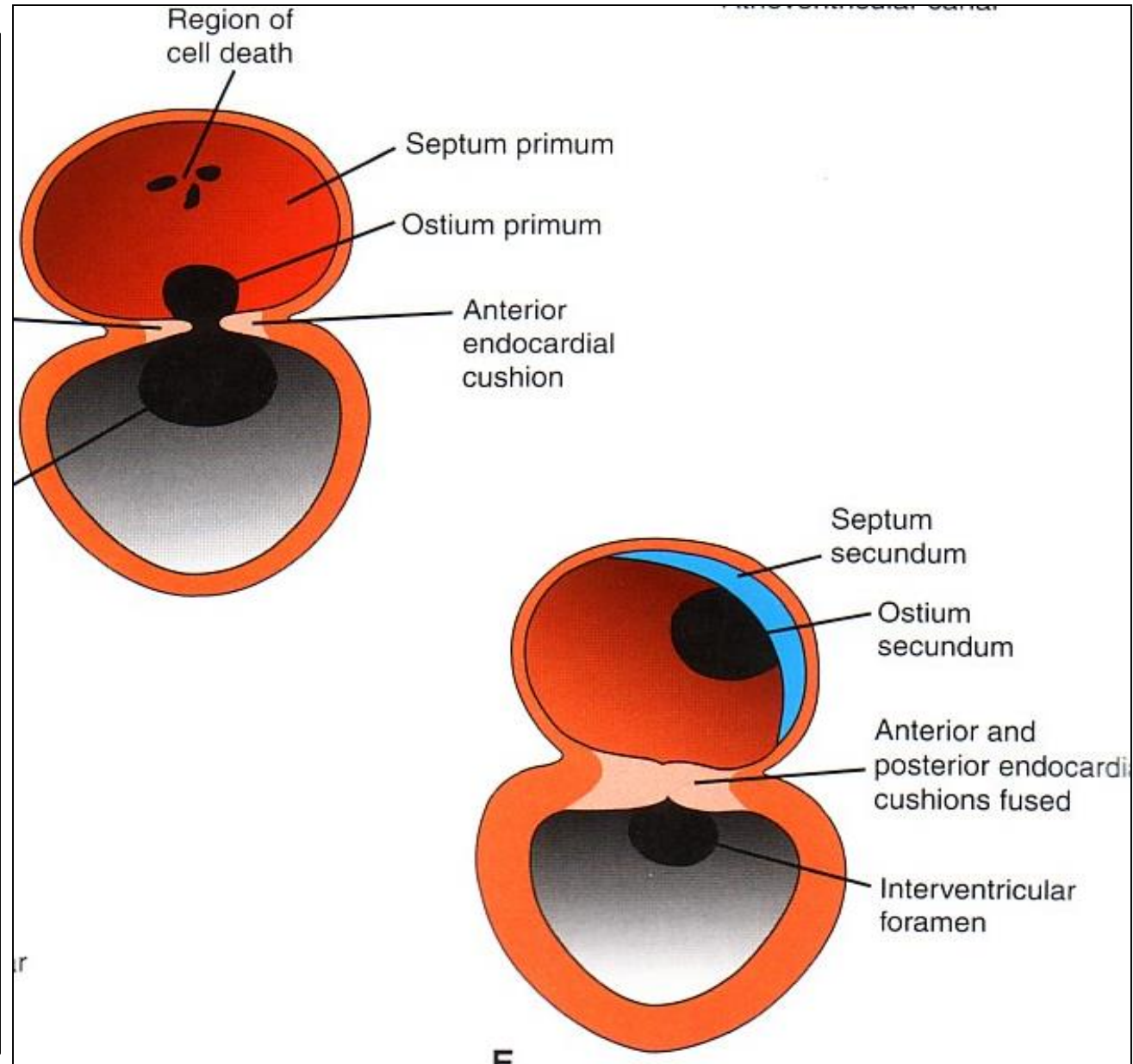
# Partitioning of Primordial Heart

## Partitioning of:

- 1- Atrioventricular canal.
- 2- Common atrium.
- 3- Common ventricle.
- 4- Bulbus cordis.
- 5- **Truncus Arteriosus.**

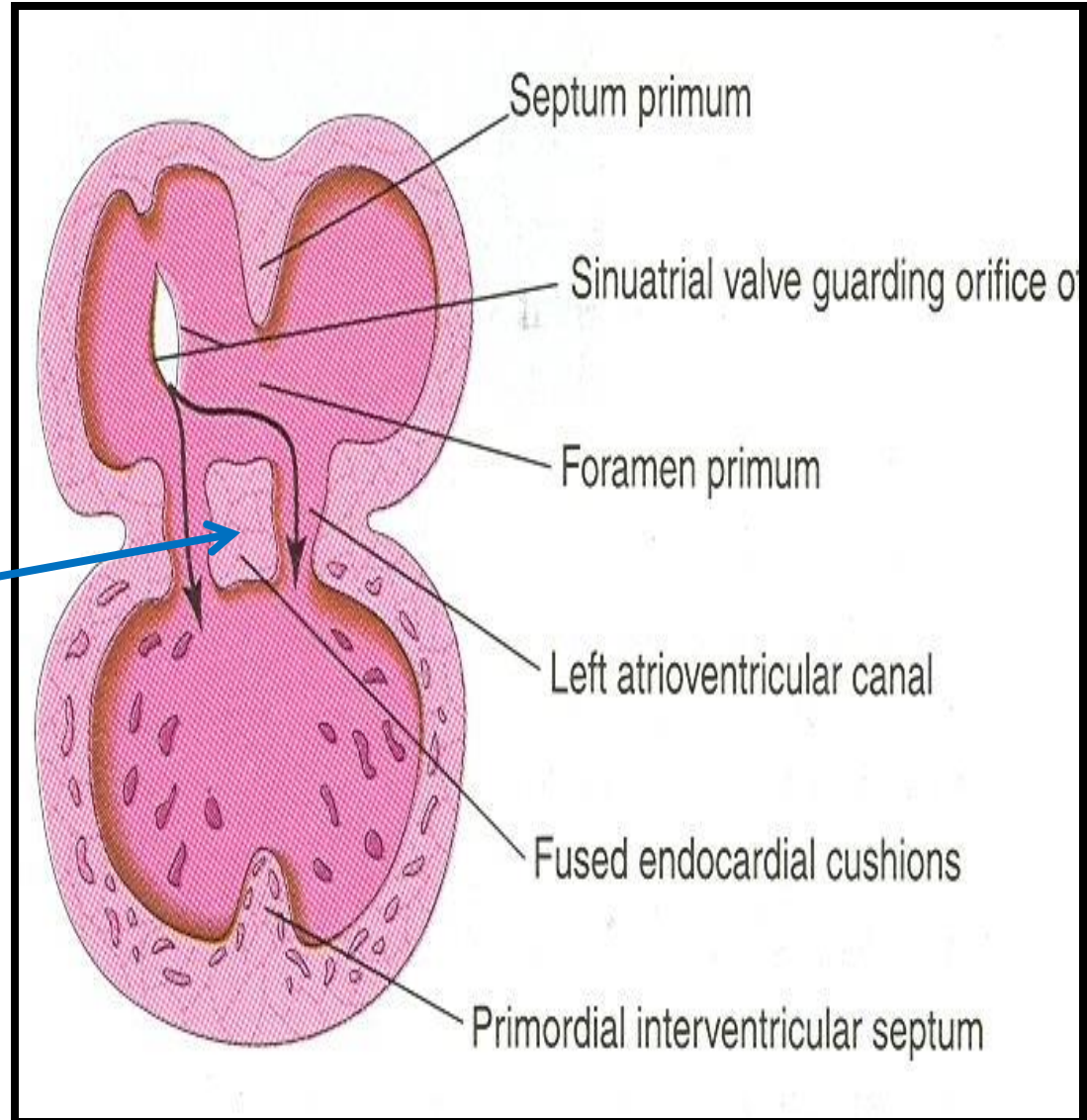
It begins by the middle of 4<sup>th</sup> week.

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



# Partitioning of the **atrioventricular** canal

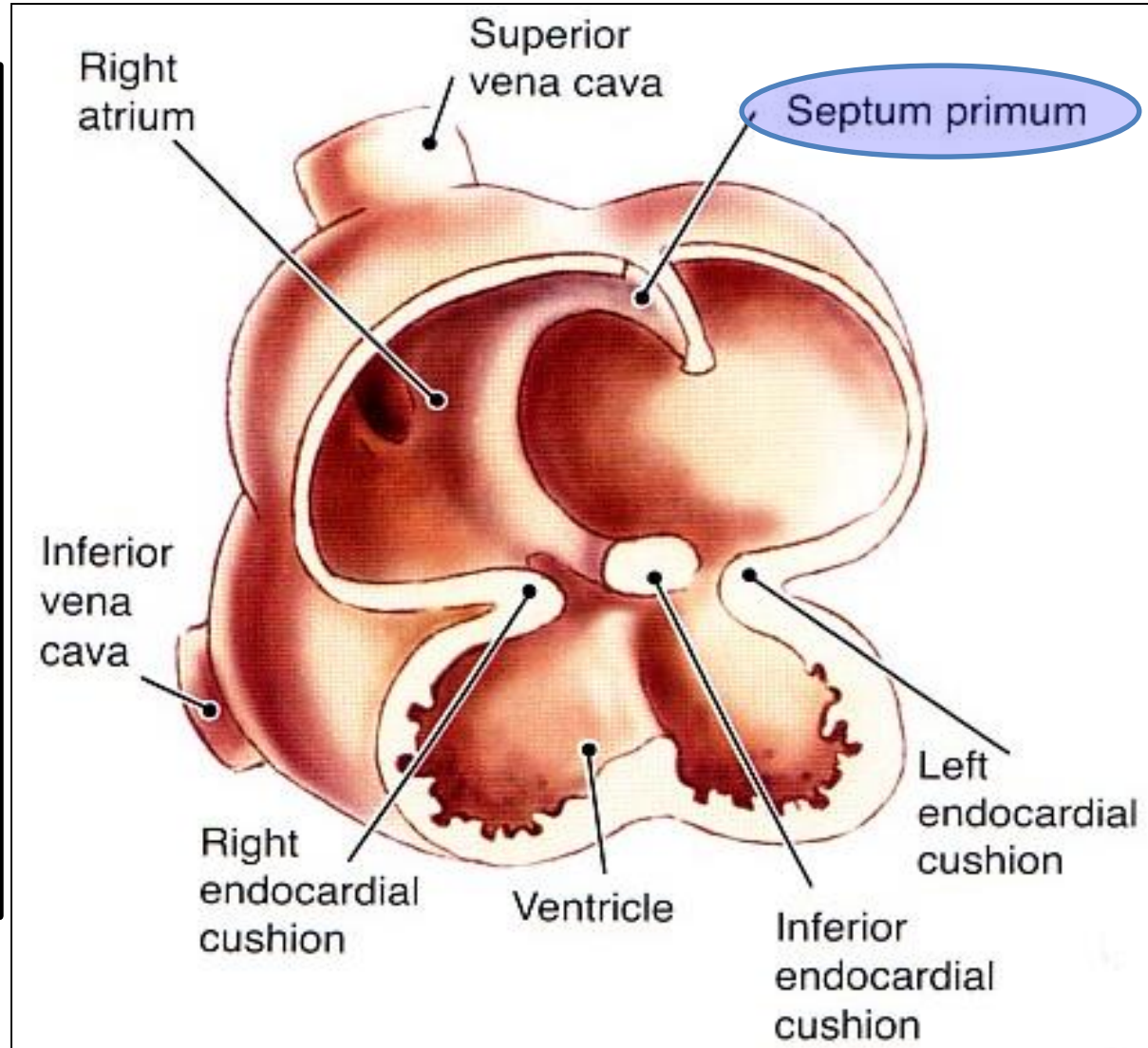
- **Two** anterior and posterior (ventral & dorsal) subendocardial cushions are formed on walls of the AV canal.
- The **AV** subendocardial cushions approach each other and fuse together to form the **septum intermedium**.
- Dividing the AV canal into right & left canals.
- These canals partially connect the primordial atrium and primordial ventricle.



# Partition of the common atrium

## Septum Primum

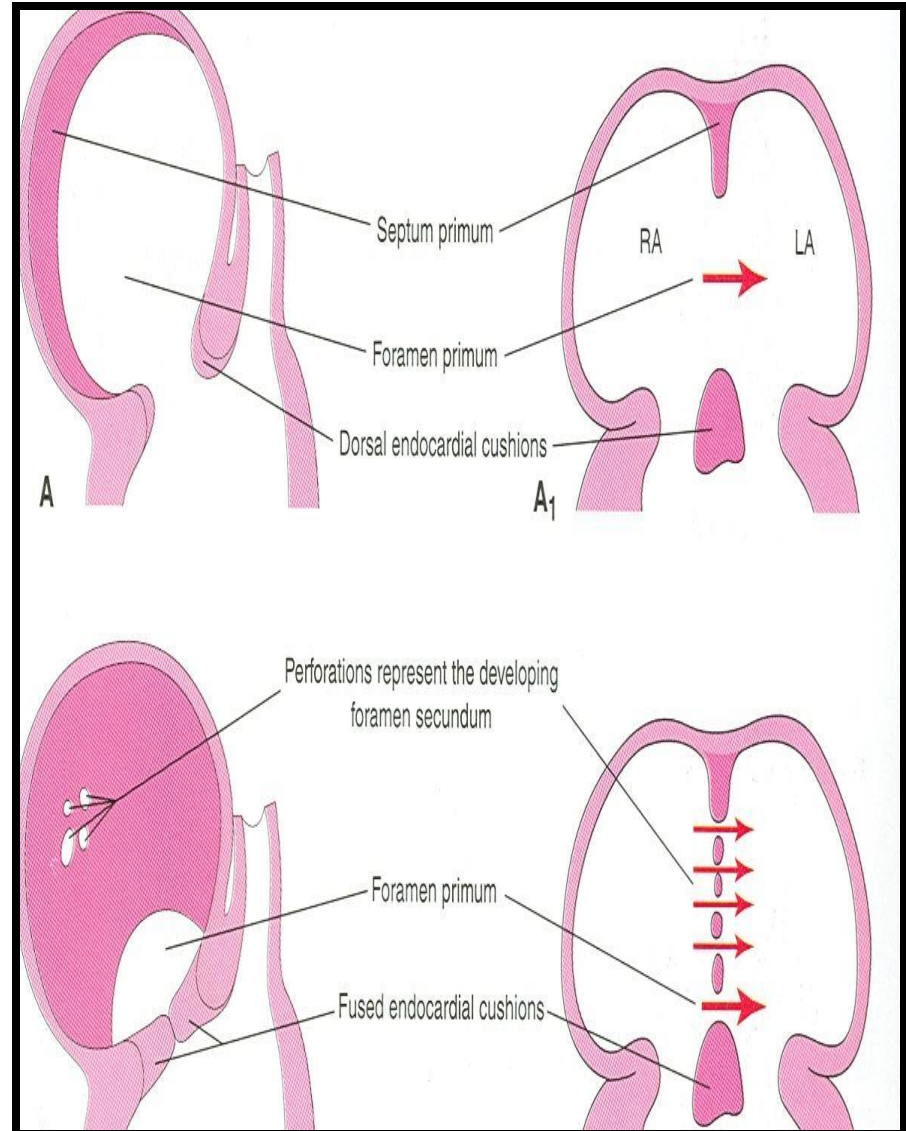
- A sickle-shaped septum grows from the roof of the common atrium towards the septum intermedium.
- So the common atrium is divided into right & left halves.





- **At first** the two ends of the septum primum reach to the growing subendocardial cushions before its central part.
- So the septum primum bounds a foramen at this stage called **ostium primum**.
- It serves as a shunt, enabling the oxygenated blood to pass from right atrium to left atrium.
- The **ostium primum** become smaller and disappears as the septum primum fuses completely with subendocardial cushions (septum intermedium) to form the interatrial septum.

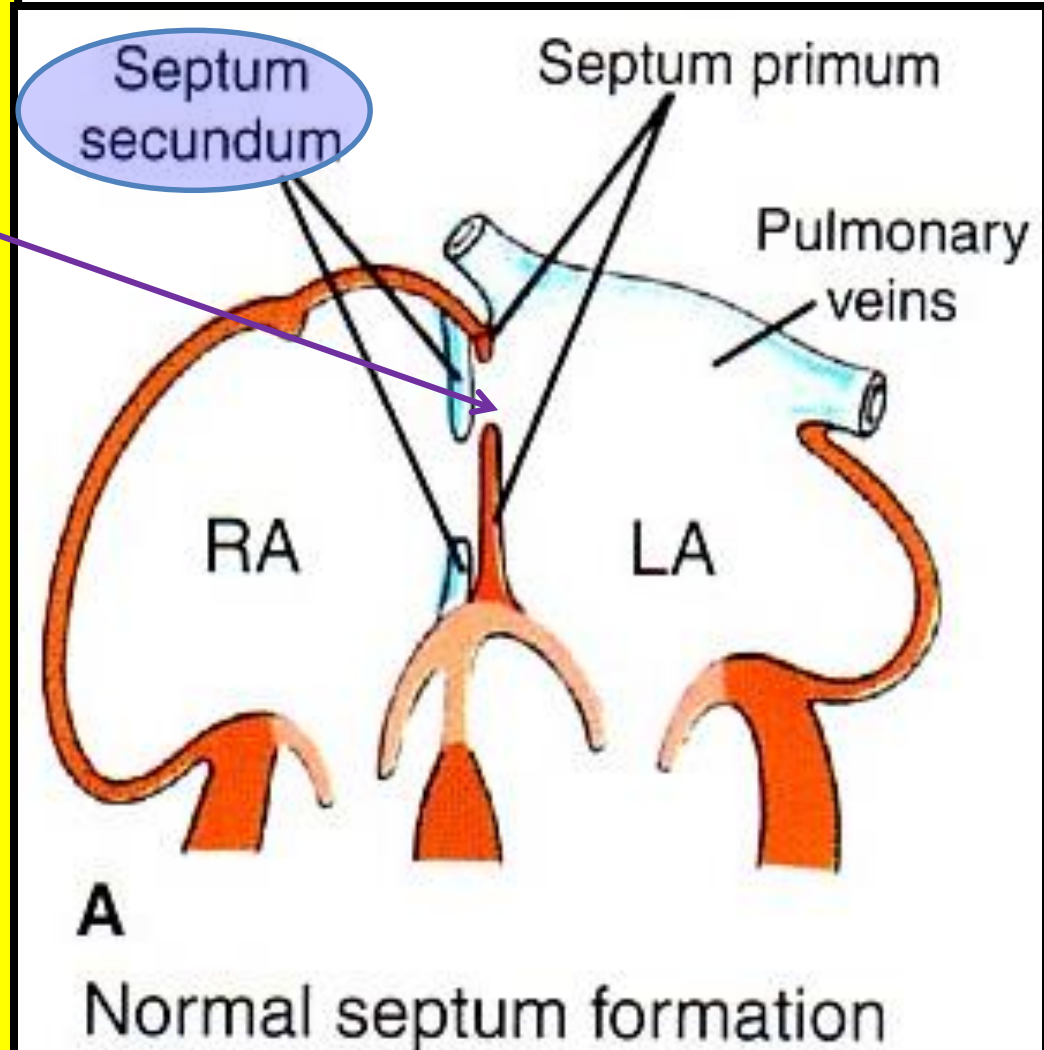
# Ostium Primum



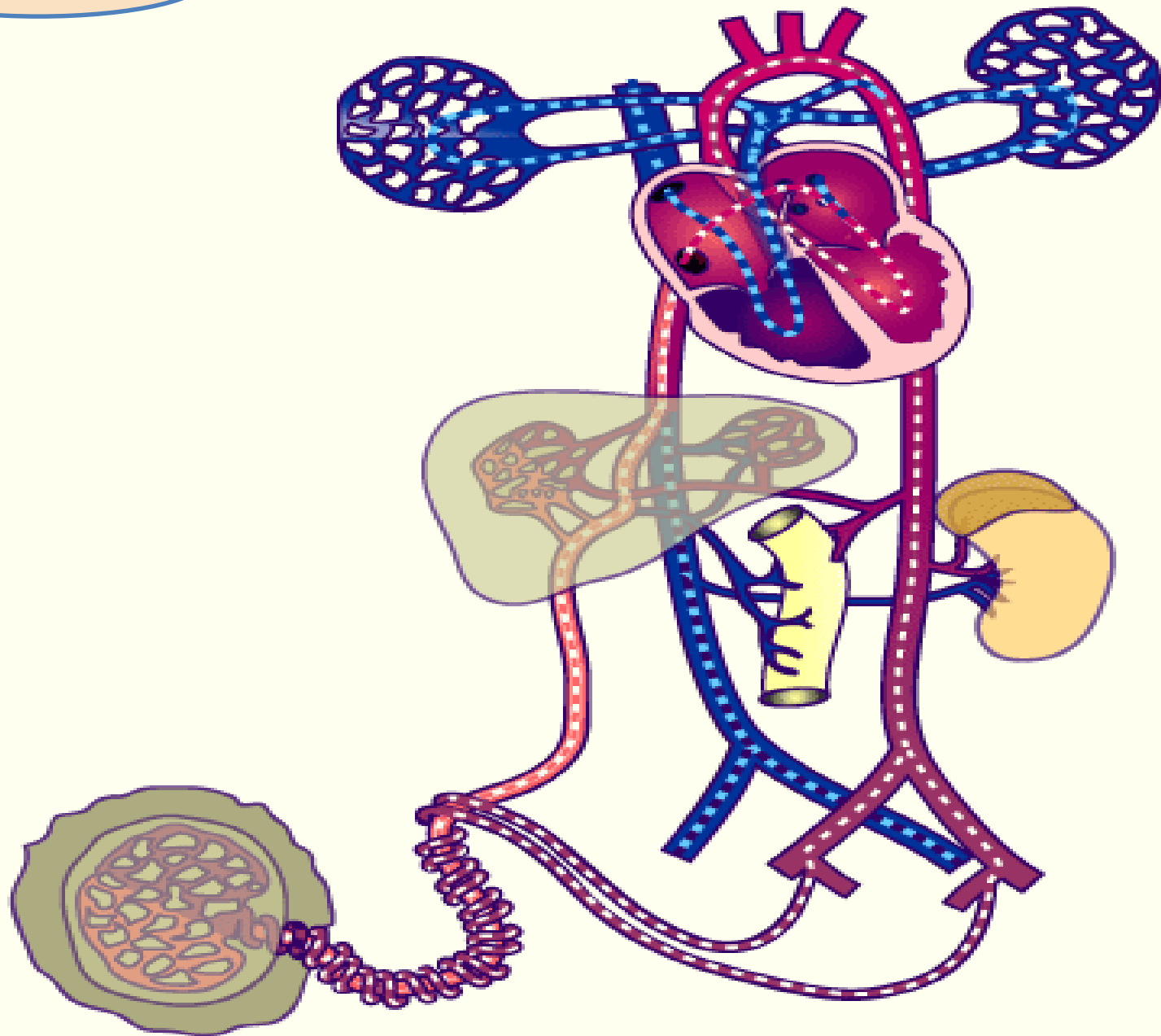


- The upper part of septum primum that is attached to the roof of the common atrium shows gradual resorption forming a new opening called **ostium secundum**.
- Another septum descends on the right side of the septum primum called **septum secundum**.
- It forms an incomplete partition between the two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

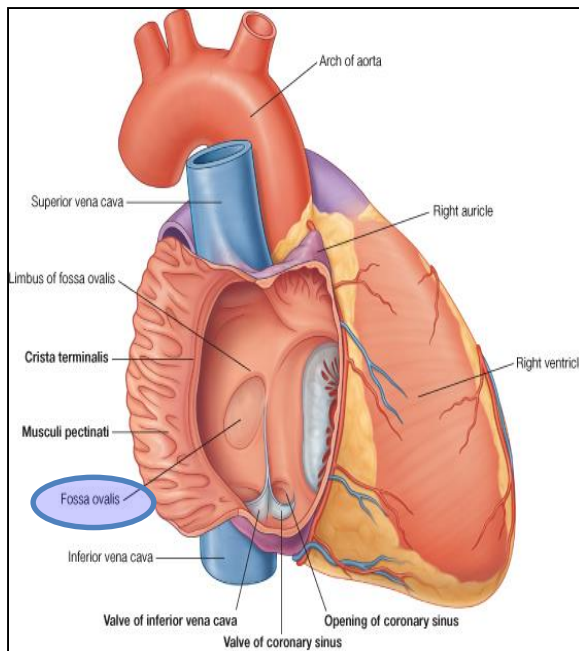
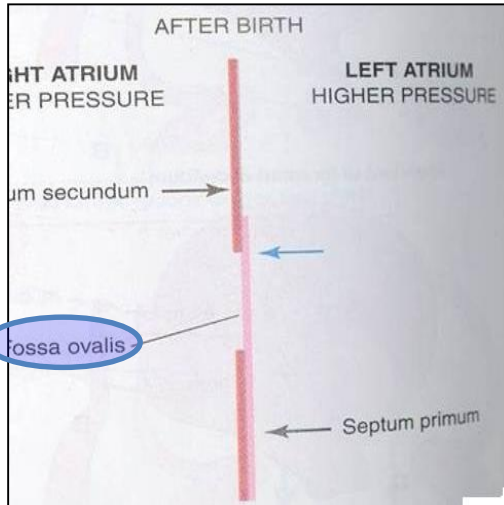
## Septum Secundum



before birth



# Fate of foramen Ovale

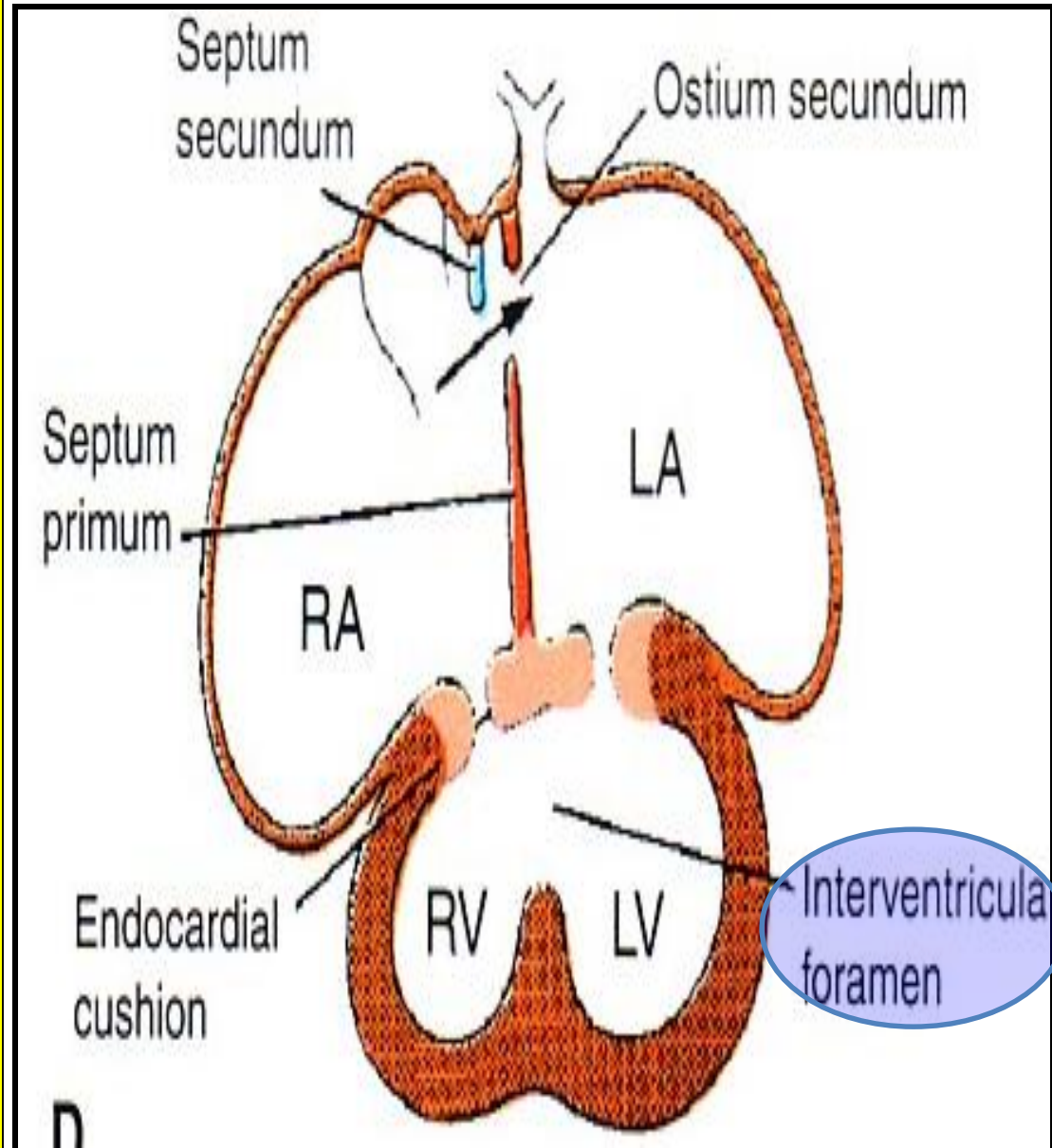


- At birth when the lungs inflated and pulmonary circulation begins the pressure in the left atrium increases and exceeds that of the right atrium.
- So the two **septae** oppose each other and fuse together.
- Its site is represented in adult by the **Fossa Ovalis**.
- The septum primum forms the **floor of the fossa ovalis**.
- The septum secundum forms the margin of the fossa ovalis which is called the **limbus** ovalis or (annulus) ovalis.

# 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 **(IVF) interventricular foramen**.

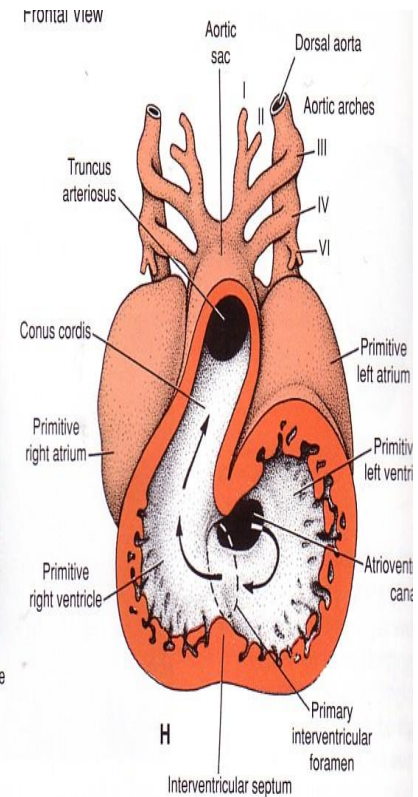
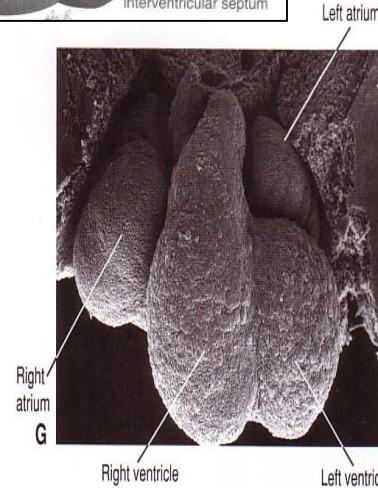
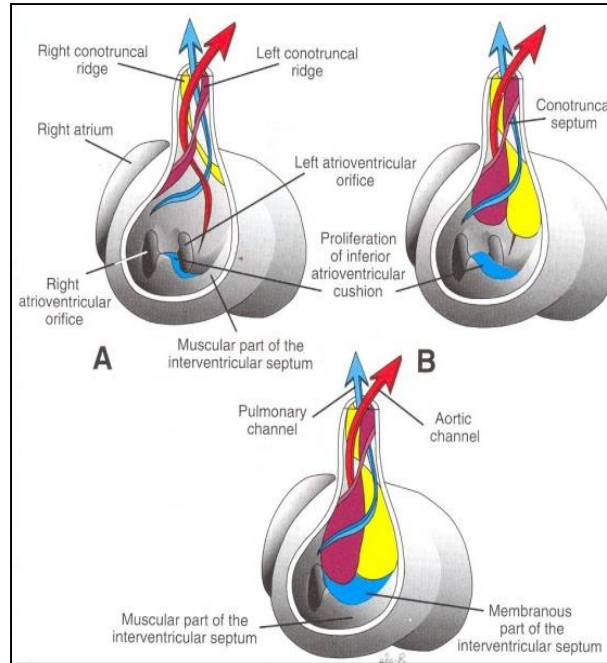




# Interventricular Septum

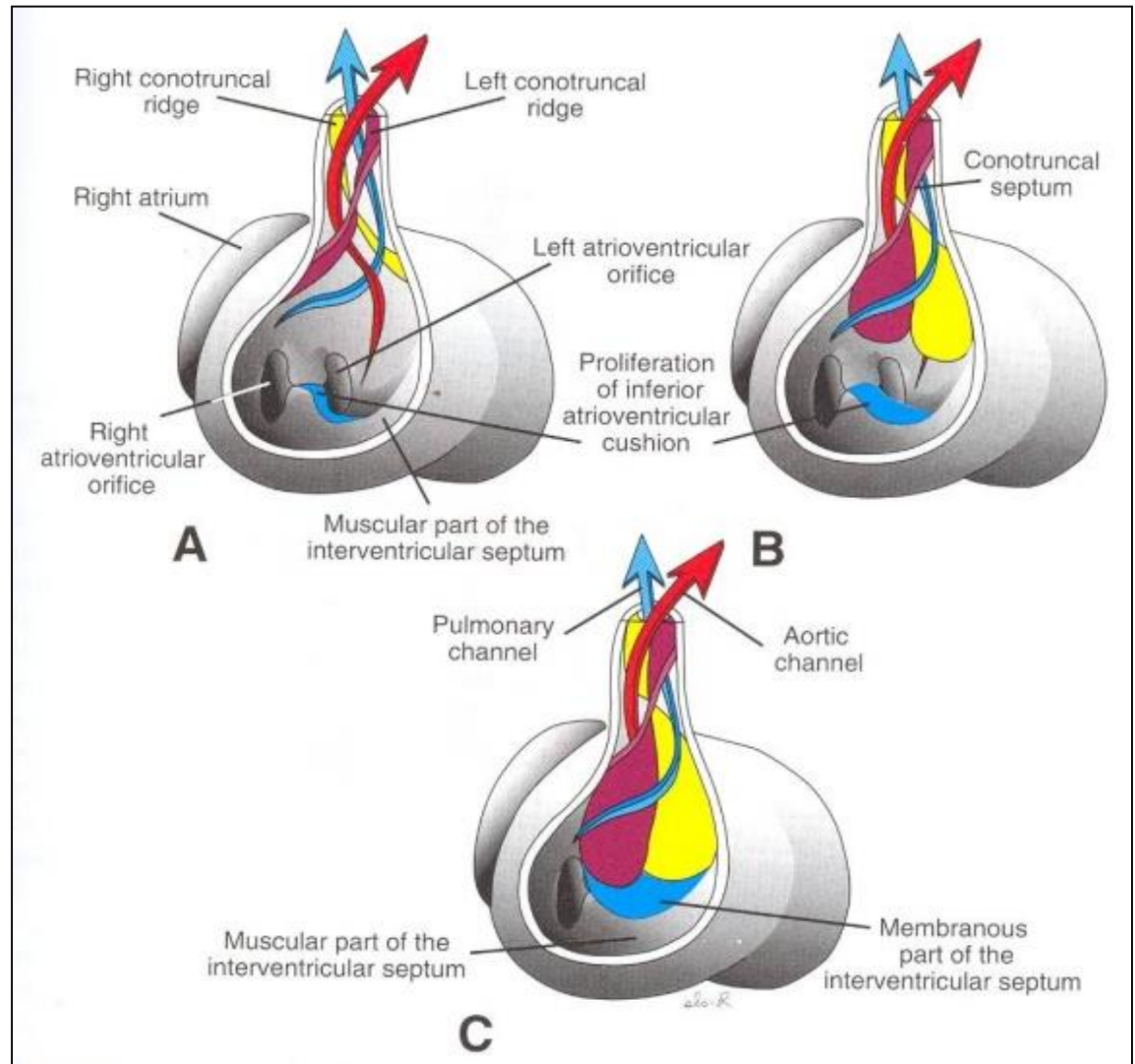
The membranous part of the IV septum is derived from:

- 1- A tissue extension from the endocardial cushion.
- 2- **Aorticopulmonary septum.**
- 3- Muscular part of the IV septum.

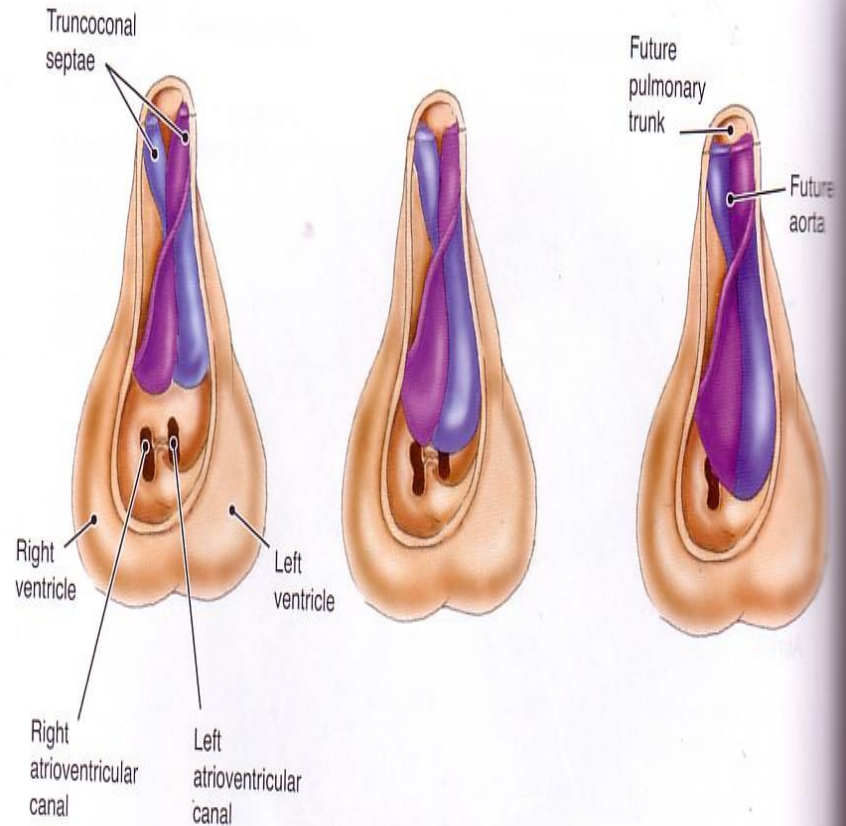
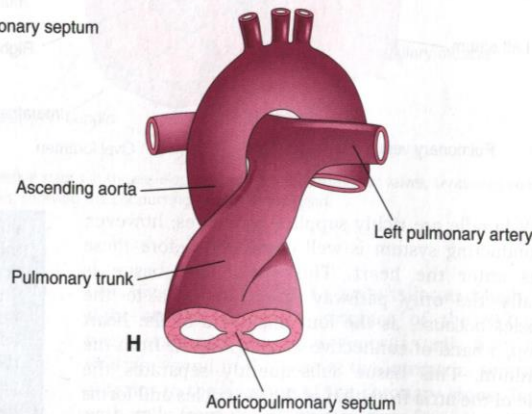
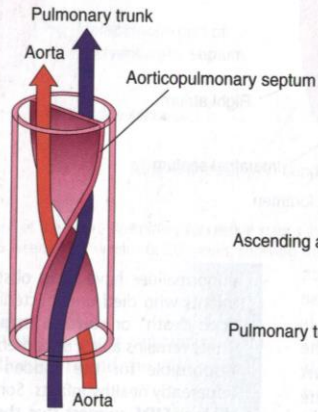
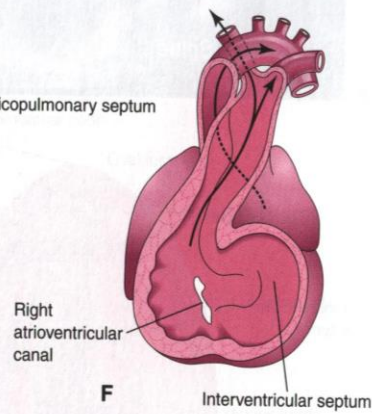
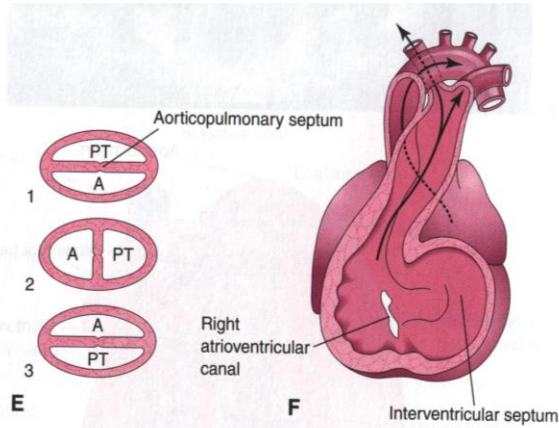
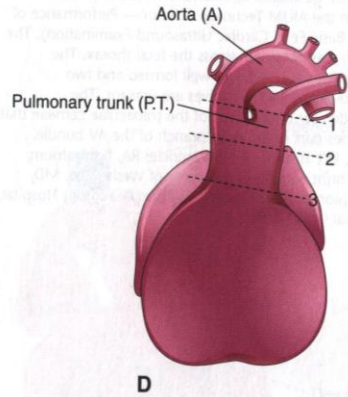


# Spiral Aorticopulmonary Septum

- A spiral septum develops in the **Truncus arteriosus** dividing it into **aorta** and **pulmonary trunk**.
- So, now the **pulmonary artery** joins the **right ventricle** while the **aorta** joins the **left ventricle**.



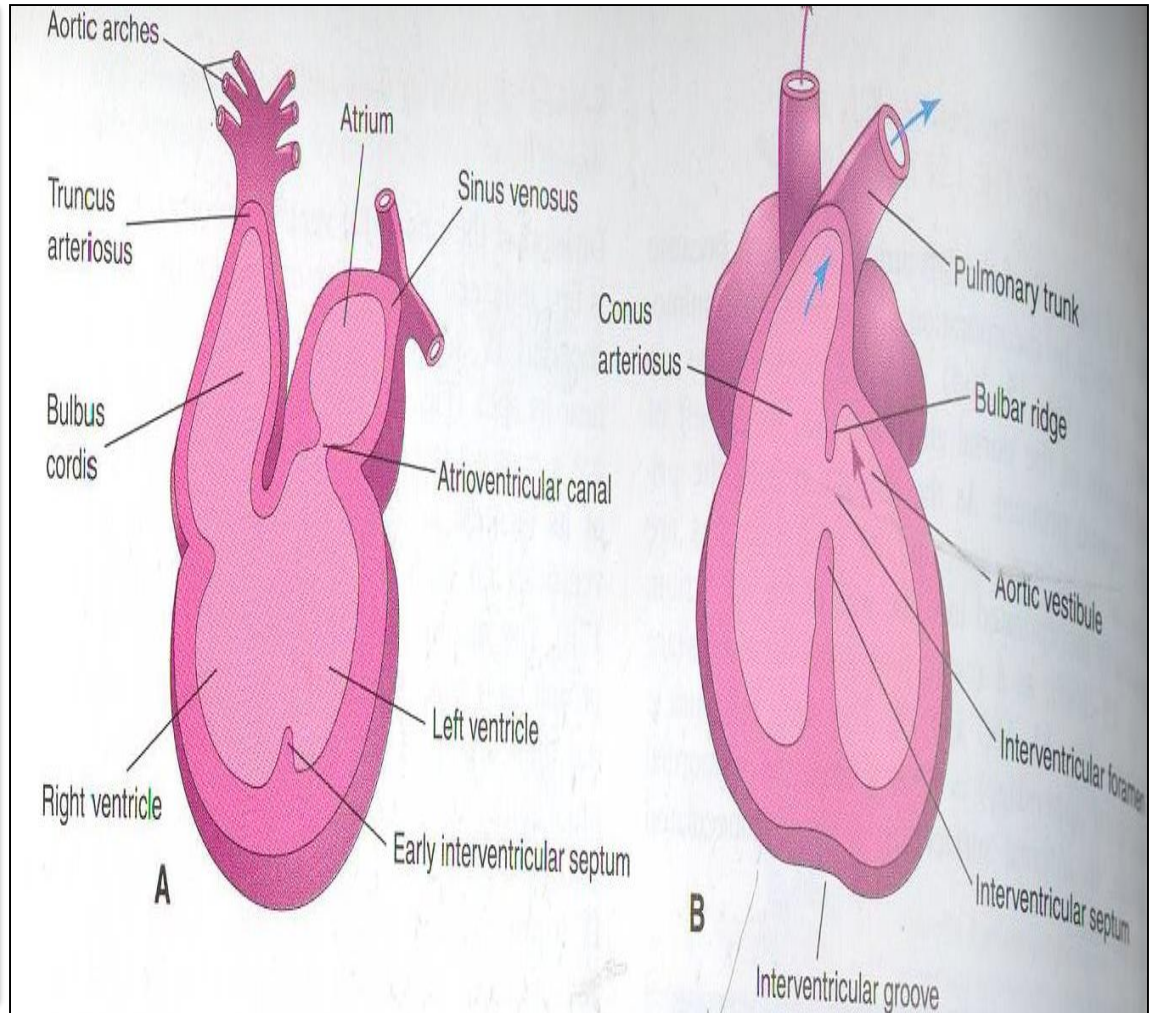
# Spiral Aorticopulmonary Septum





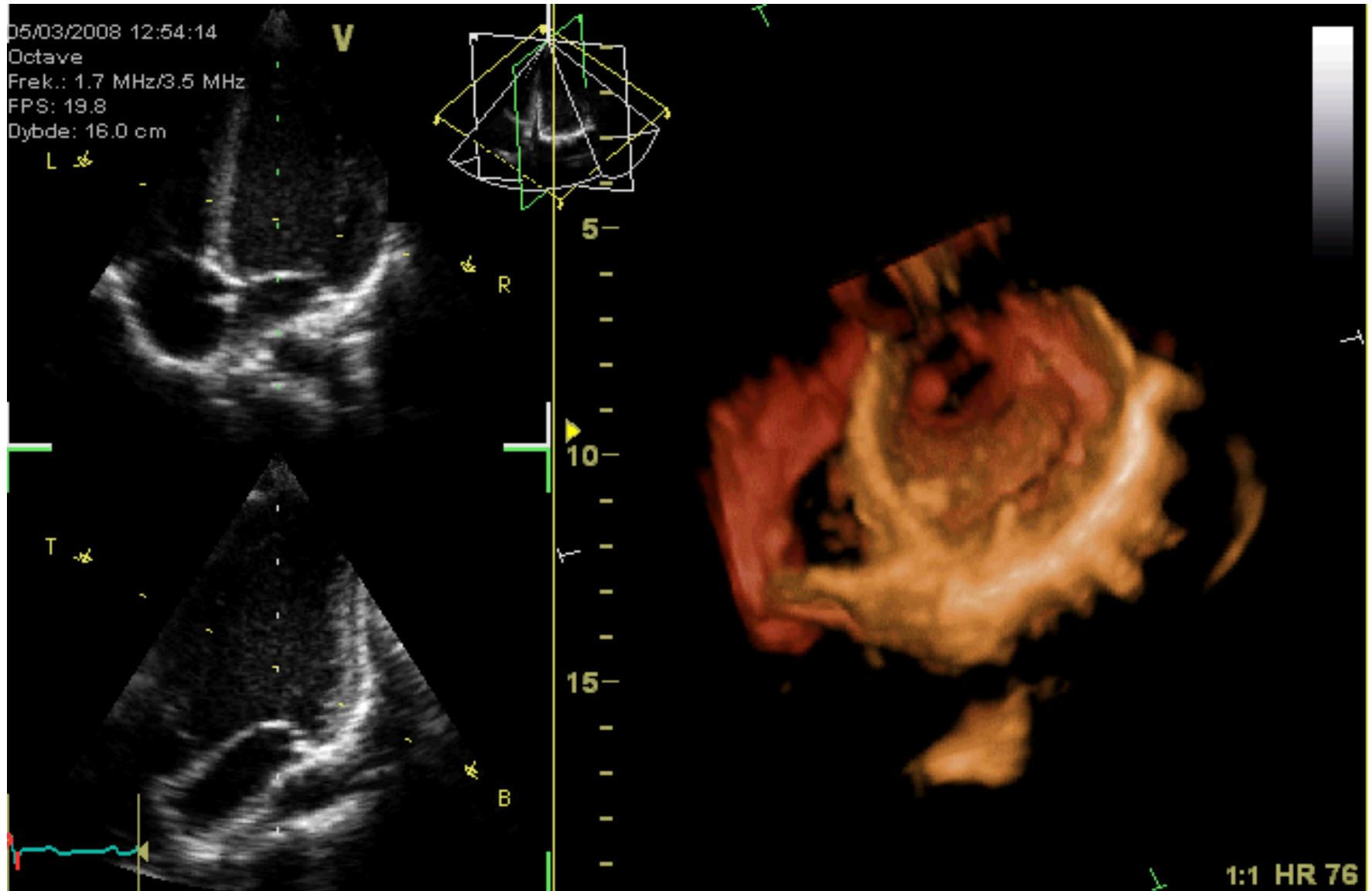
# BULBUS CORDIS

- **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.



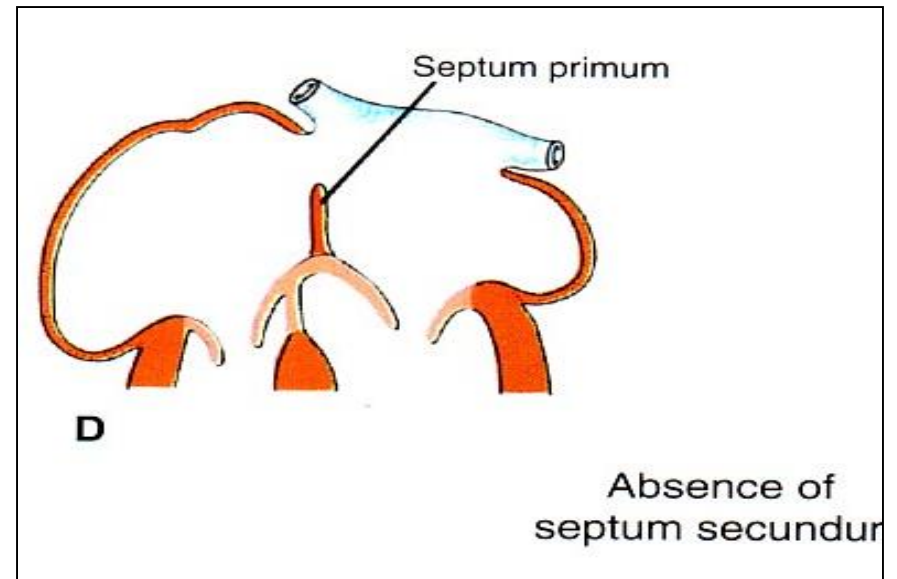
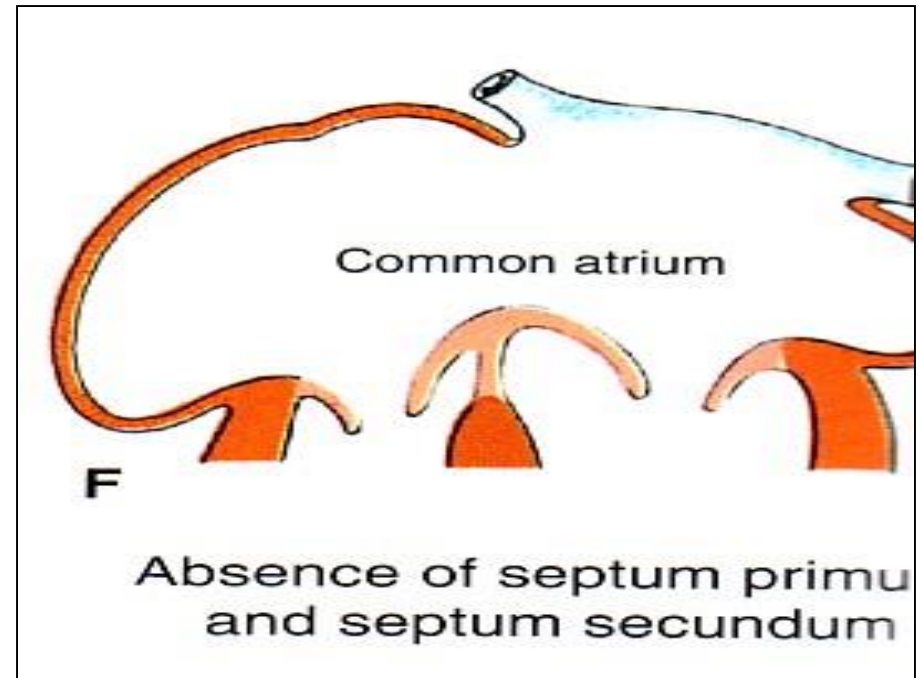


# MAJOR CARDIAC ANOALIES

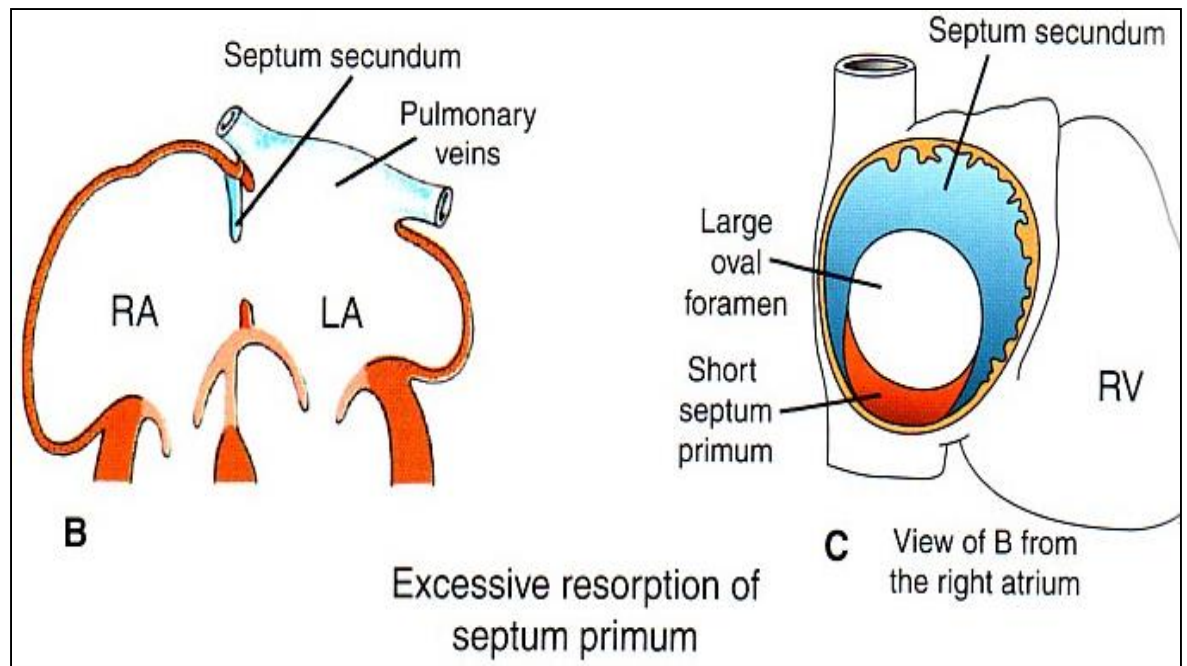


# Atrial Septal Defects (ASD)

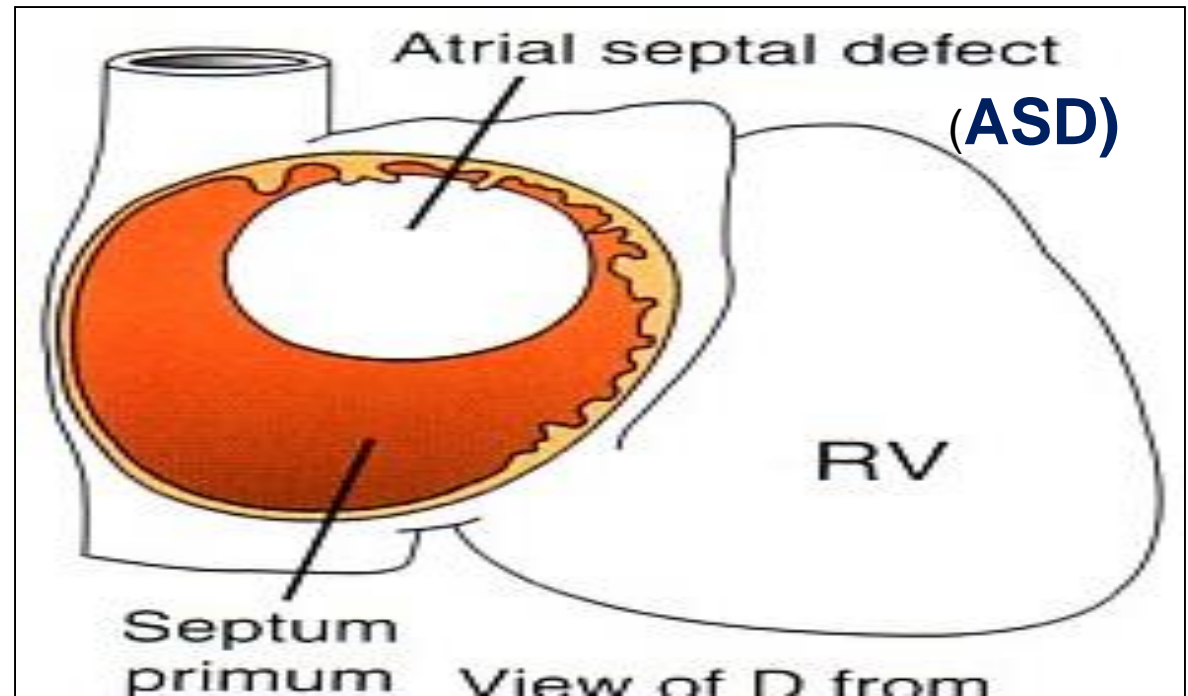
- Absence of septum primum and septum secundum, leads to common atrium.
- Absence of Septum Secundum



**Excessive  
resorption of  
septum primum  
(ASD)**

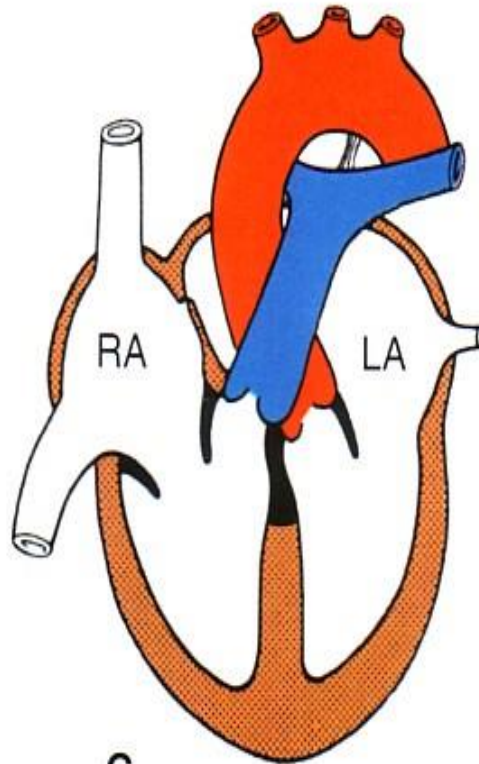


**Patent  
foramen  
ovale**

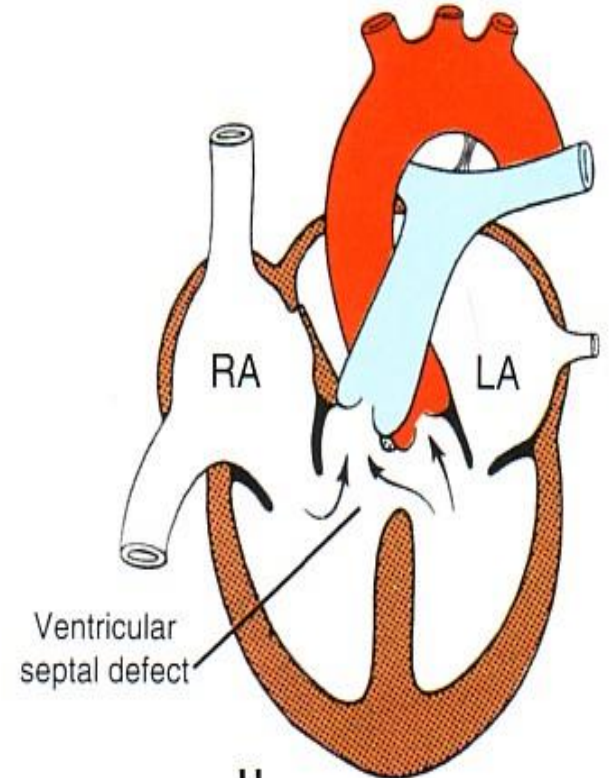


# VENTRICULAR SEPTAL DEFECT (VSD)

- **Roger's disease**
- Absence of the *membranous* part of the interventricular septum.
- **Usually accompanied by other cardiac defects.**



G  
Normal  
ventricular septum  
development



H  
Ventricular  
septal defect (VSD)

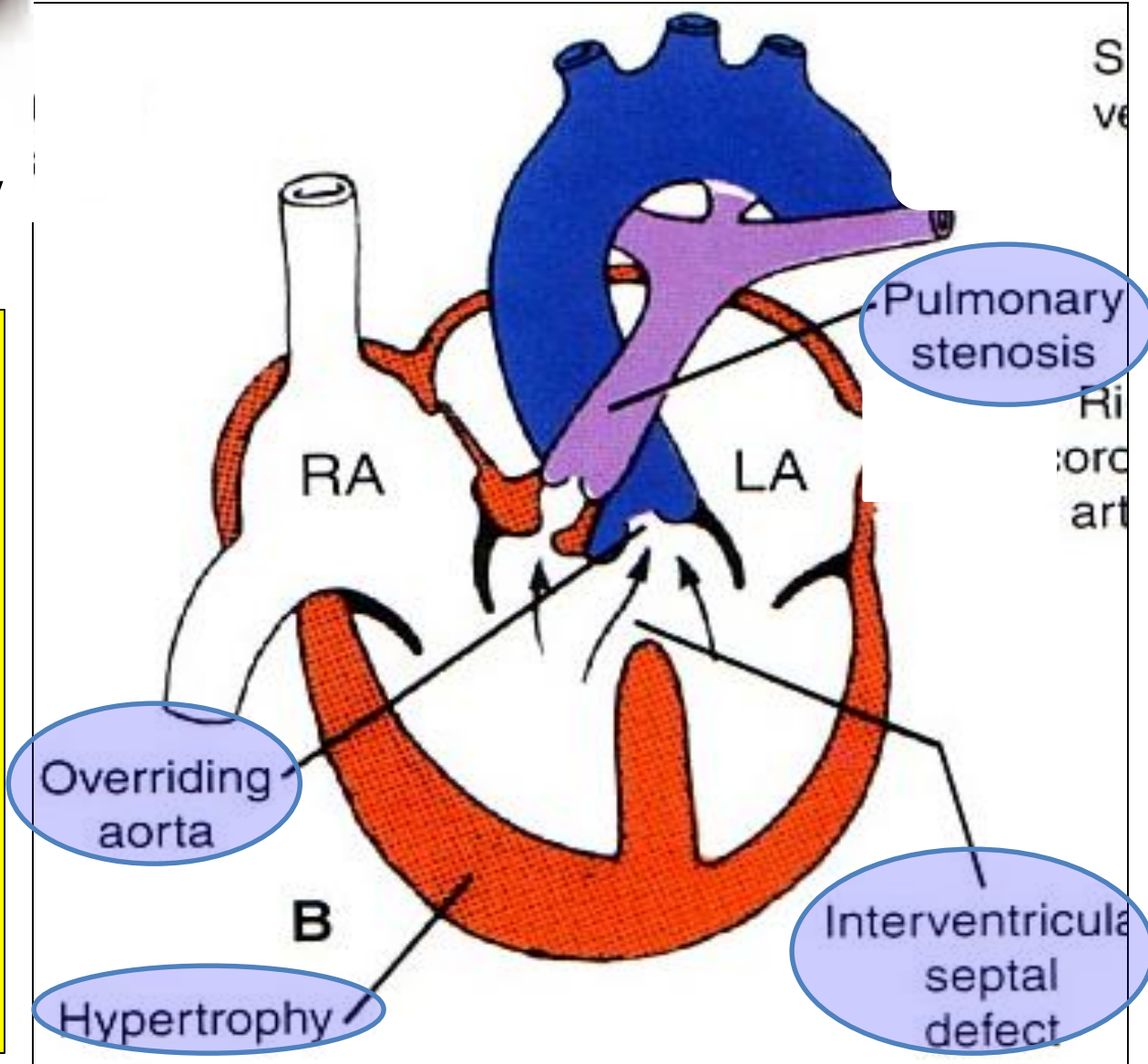




**Blue  
Baby**

# FALLOT TETRALOGY

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

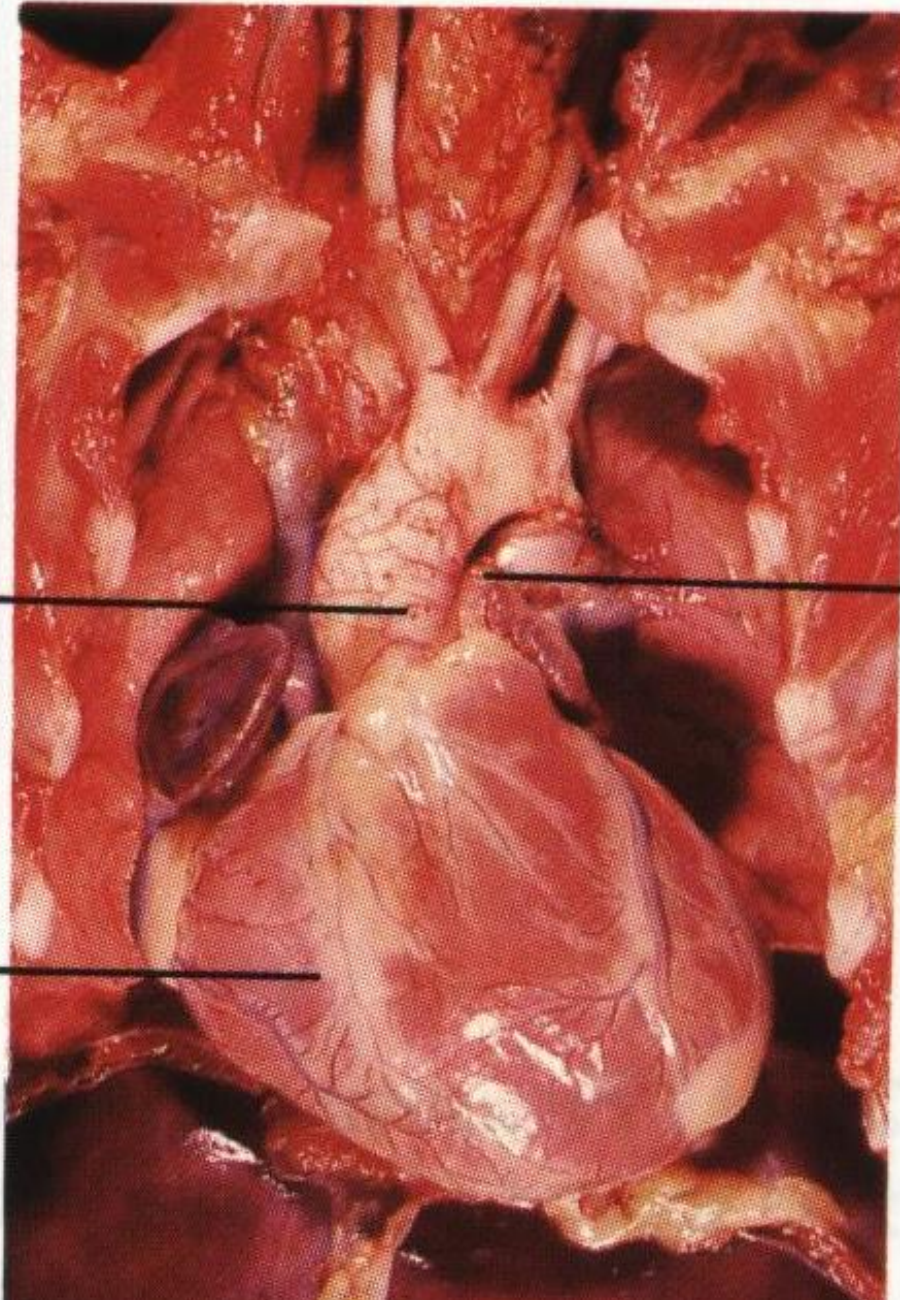


# TETRALOGY OF FALLOT

VSD

Overriding aorta

Enlarged right ventricle



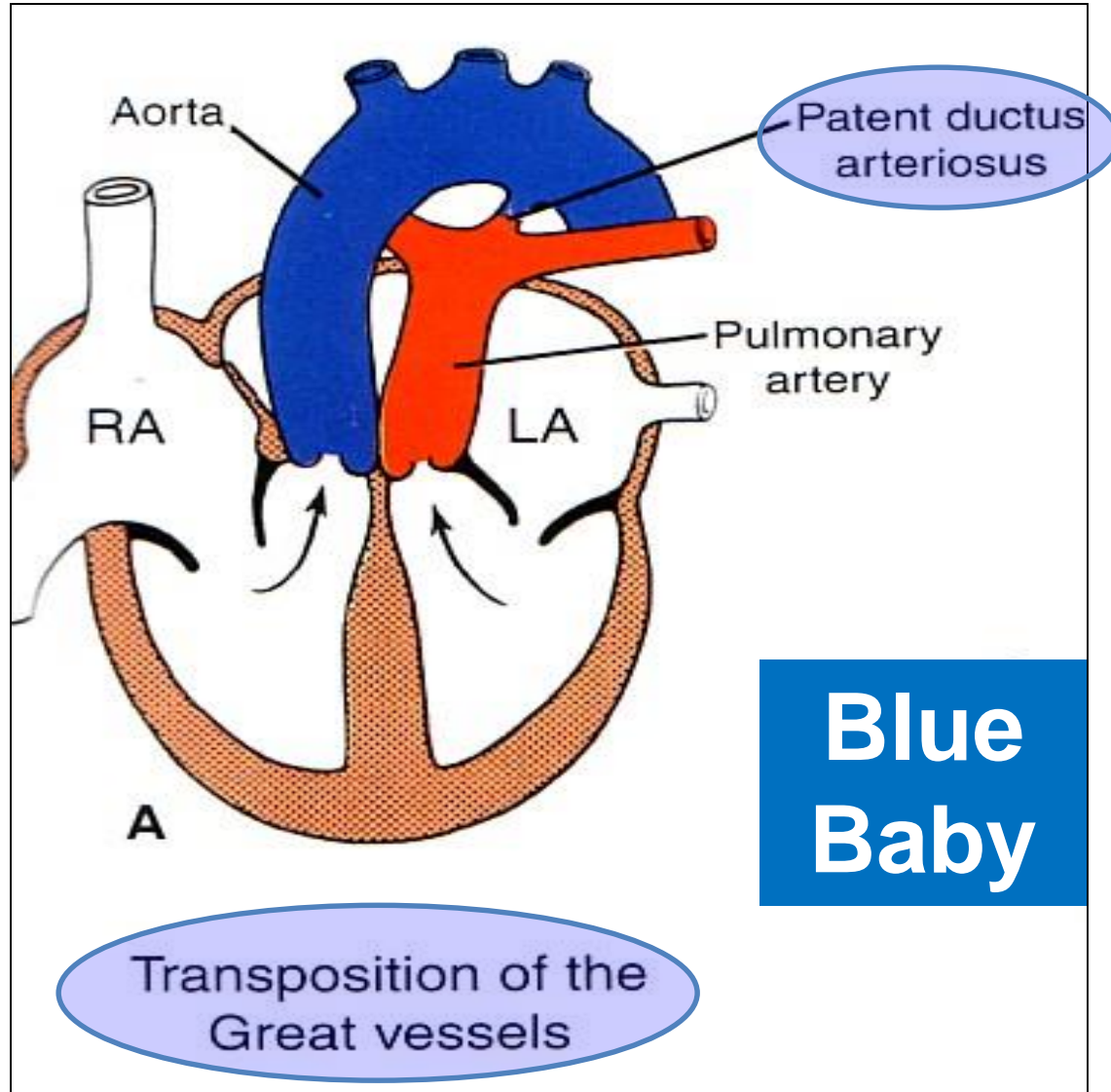
Stenotic pulmonary trunk

**Blue Baby**



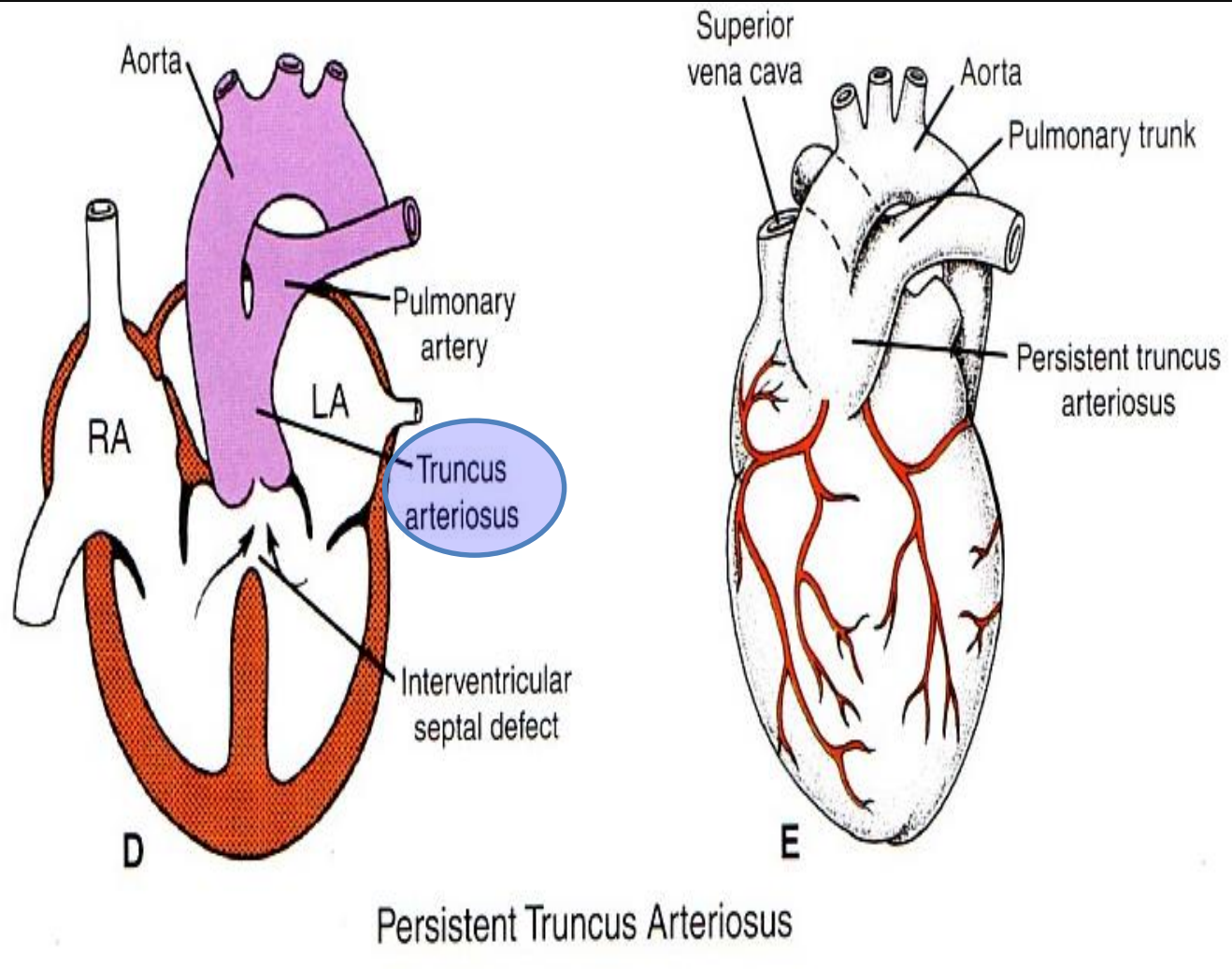
# (TGA) TRANSPOSITION OF GREAT ARTERIES

- **TGA** is due to malformation OR abnormal rotation of the aorticopulmonary (spiral) septum.
- **So** the right ventricle joins the aorta, while the left ventricle joins the pulmonary artery.
- One of the most common cause of [cyanotic heart disease](#) in the newborn.
- Often associated with ASD or VSD or PDA.



# Persistent Truncus Arteriosus

- It is due to failure of the development of the aorticopulmonary (spiral) septum.
- It is usually accompanied with VSD.





# Test your knowledge!

**1. Which of the following clinical signs would be most obvious on examination of a patient with fallot tetralogy?**

- A. Pulmonary hypertension.
- B. Diffuse rach.
- C. Lack of femoral pulse.
- D. Cyanosis.

**2. The conus arteriosus is derived from which of the following?**

- A. Truncus arteriosus.
- B. Bulbus cordis.
- C. Common ventricle.
- D. Sinus venosus.



**THANK  
YOU  
AND  
GOOD  
LUCK**