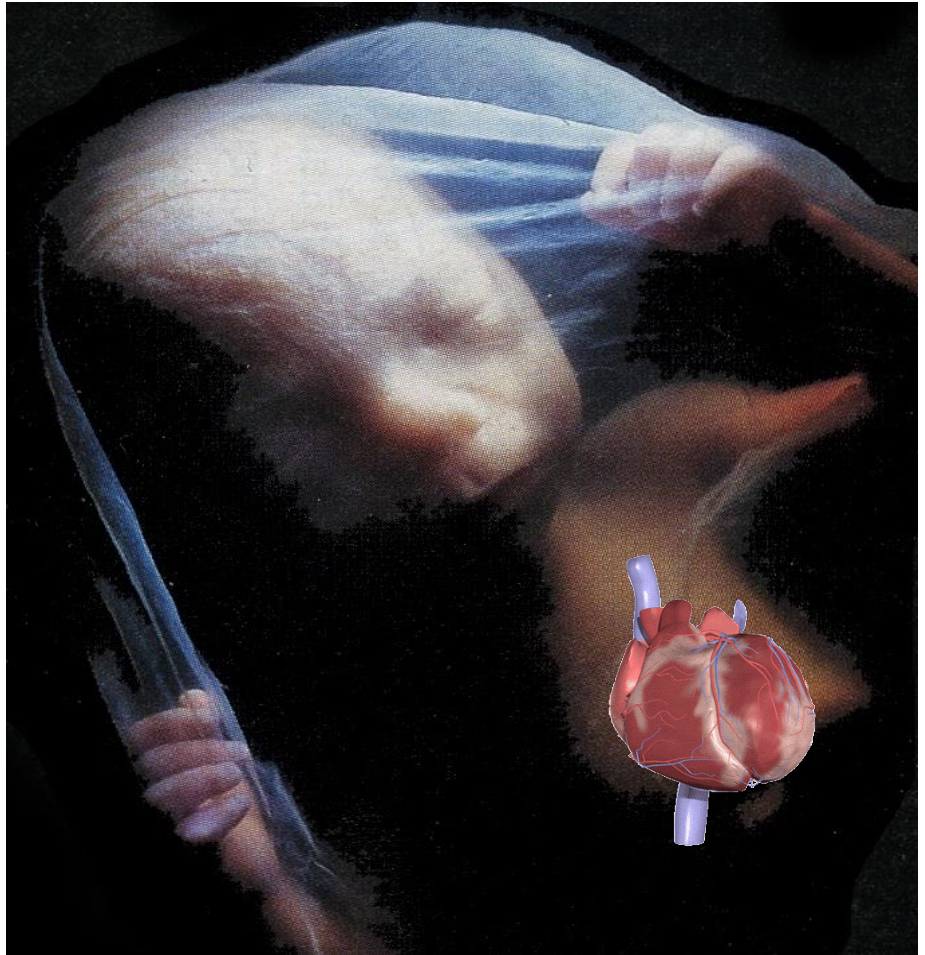


HEART DEVELOPMENT



PROF. Saeed Abuel Makarem

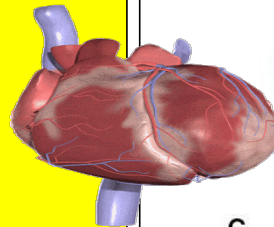
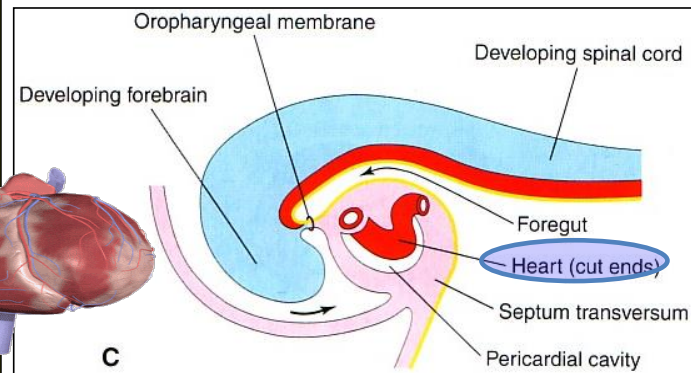
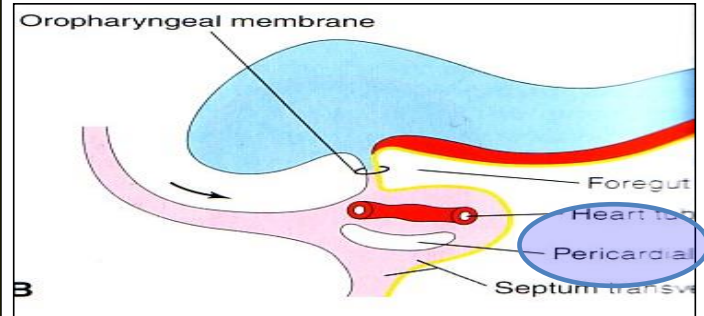
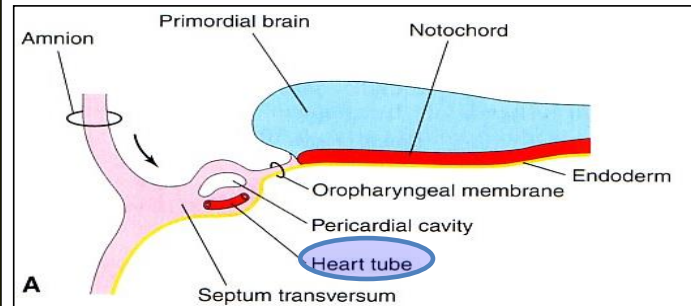
Objectives

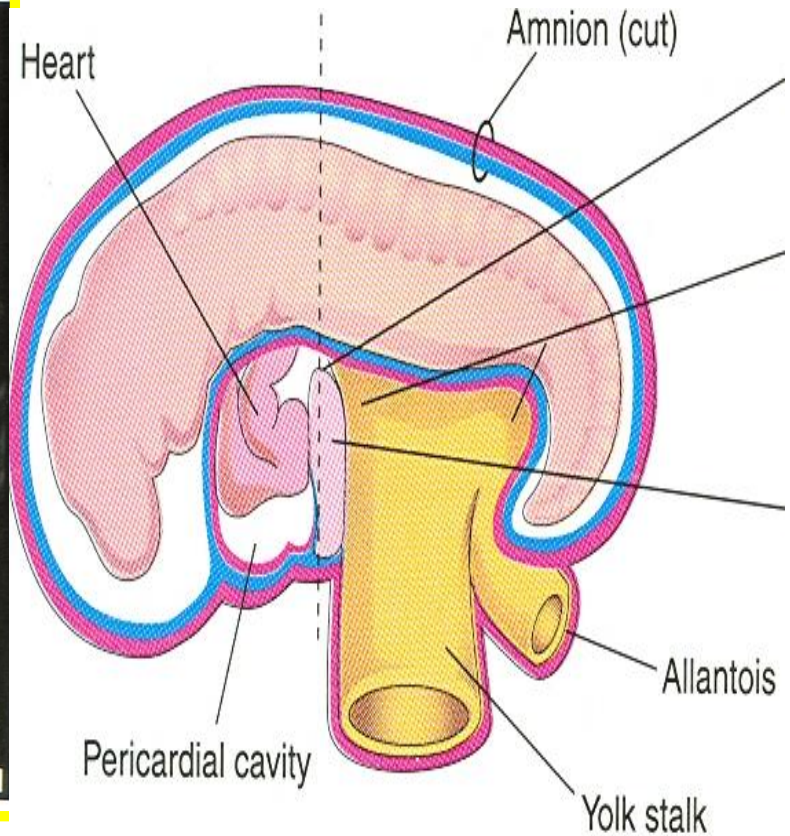
By the end of the lecture you should be able to:

- 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**.

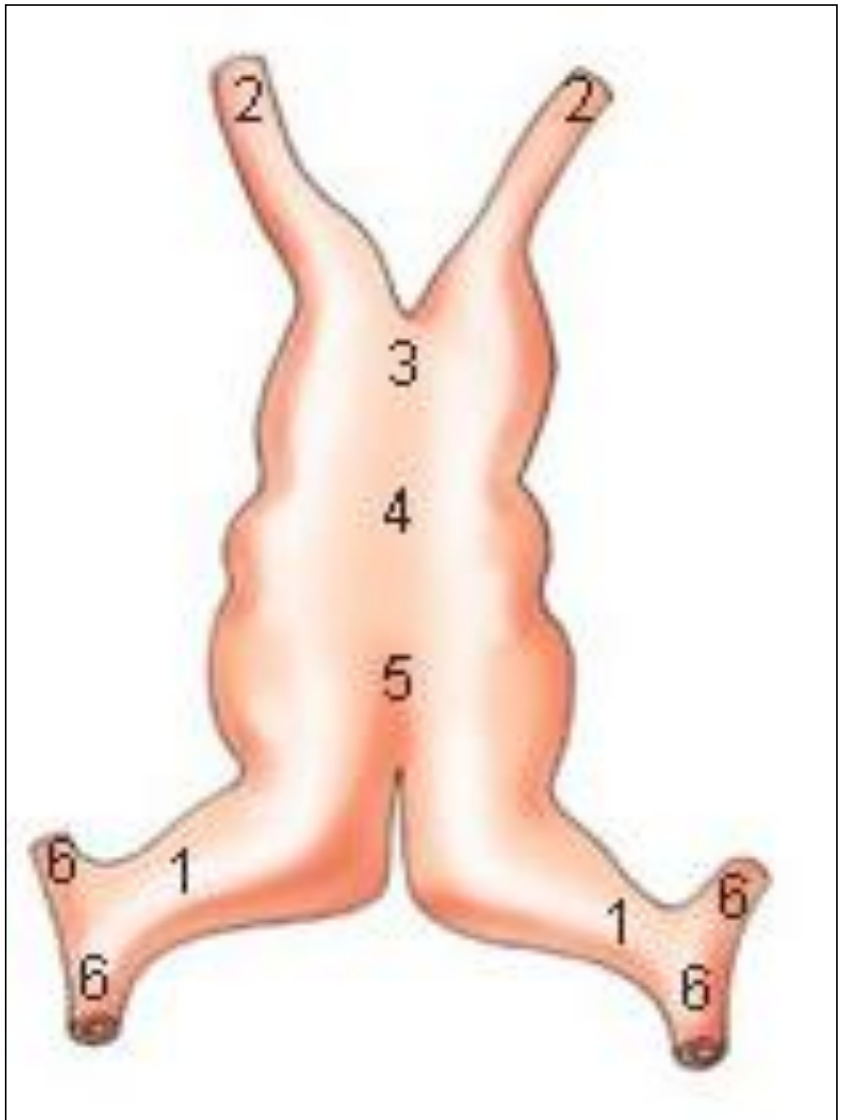




Blood **flow** begins during the beginning of the fourth week and can be visualized by **Ultrasound Doppler**.

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?

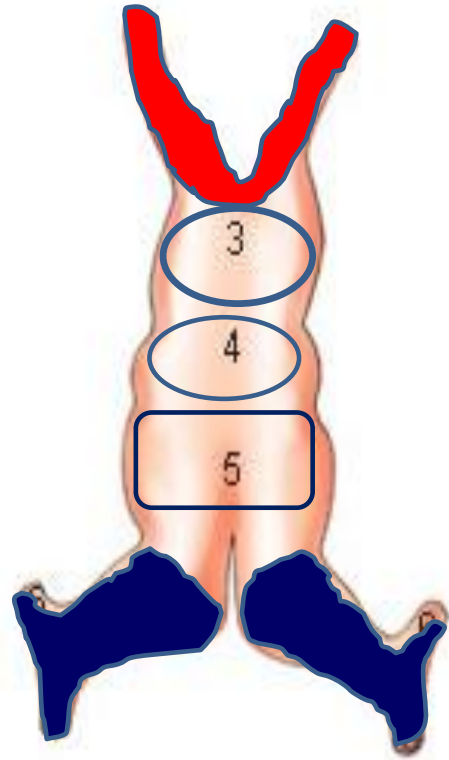
- The heart tube grows faster than the pericardial sac, so it shows **5 dilations separated by constrictions.**

- These are:

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

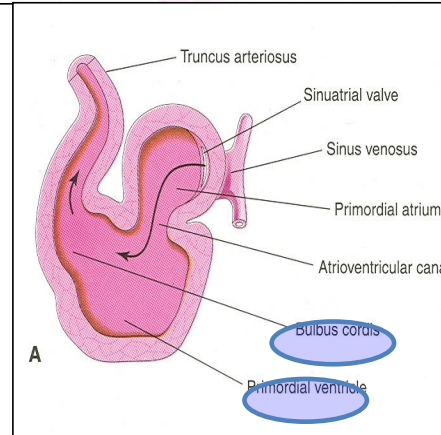
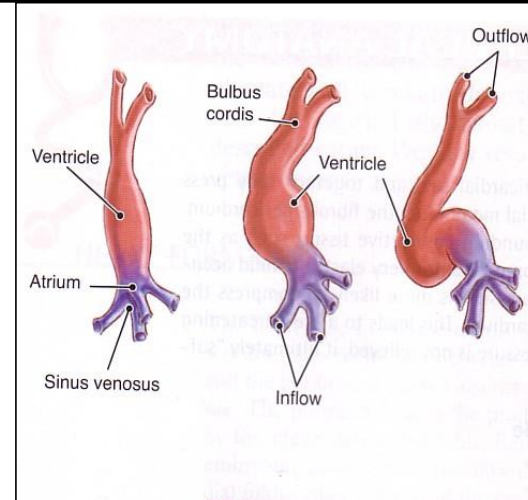
The endocardial heart tube has 2 ends:

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



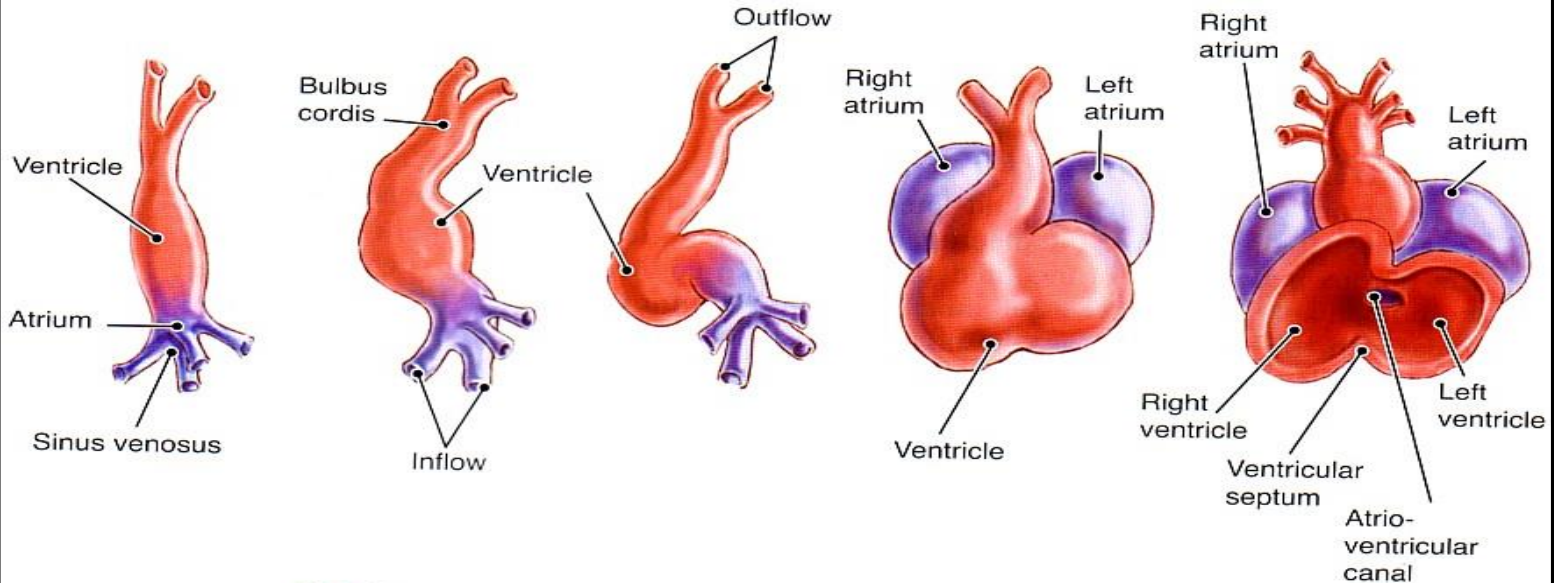
U-SHAPED HEART TUBE

- 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)**.



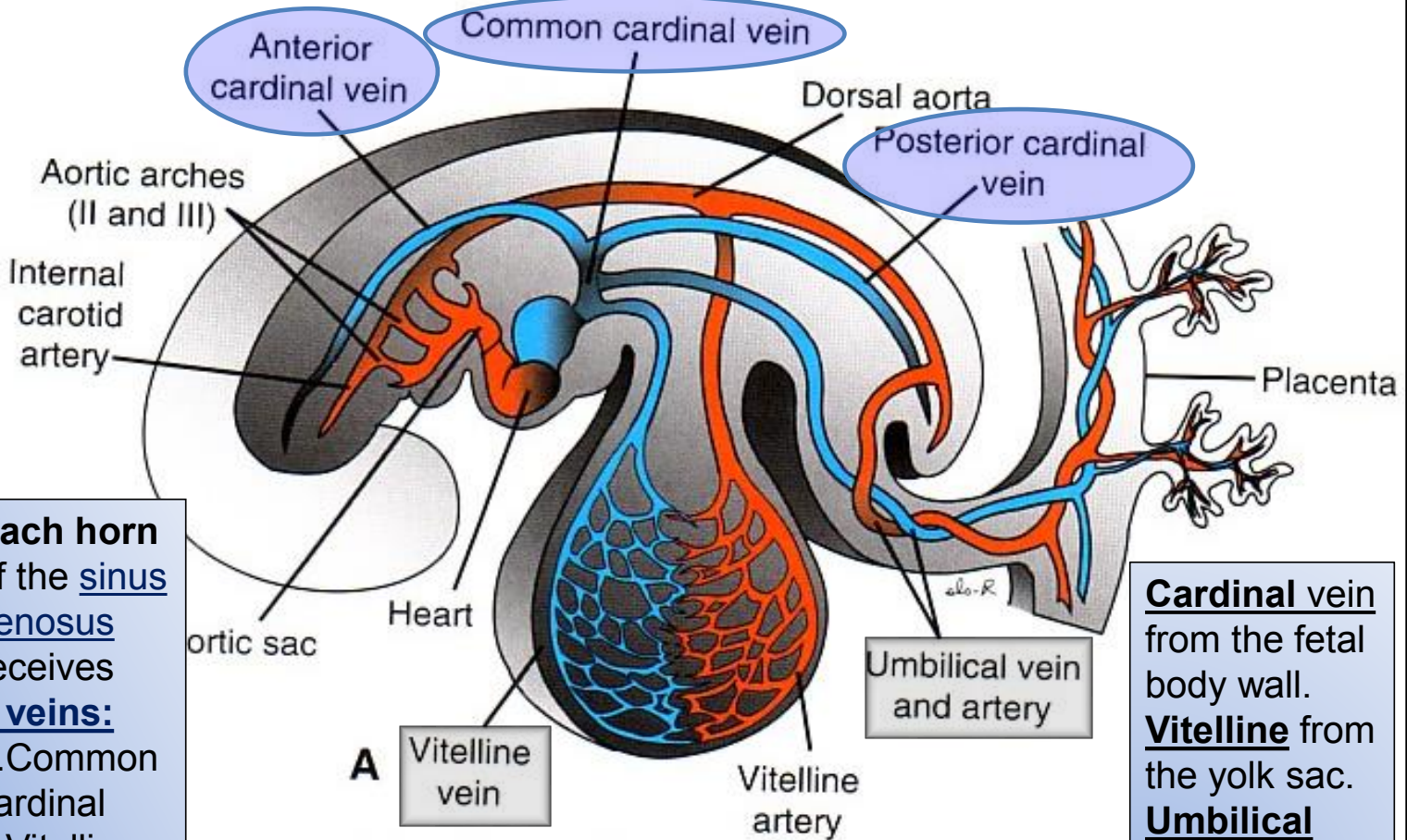
Bulboventricular loop

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



Each horn of the sinus venosus receives **3 veins:**

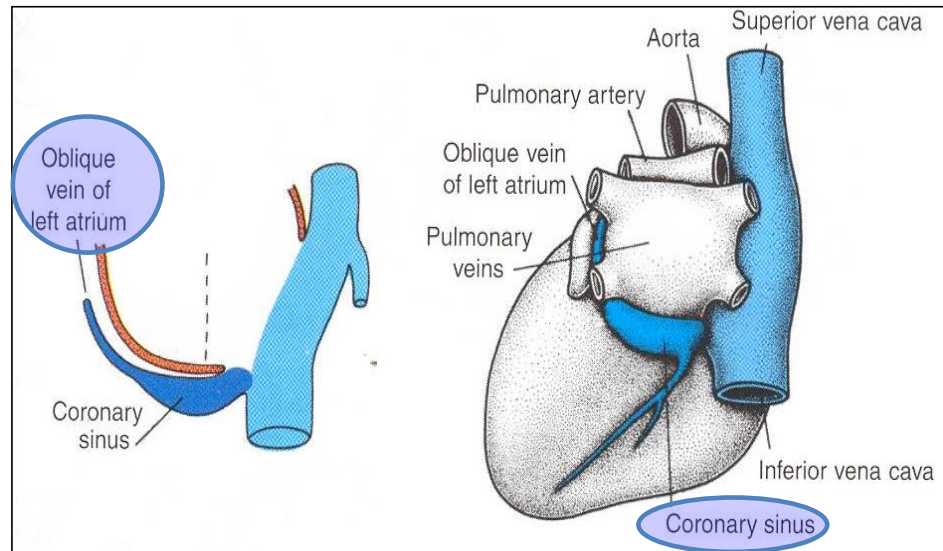
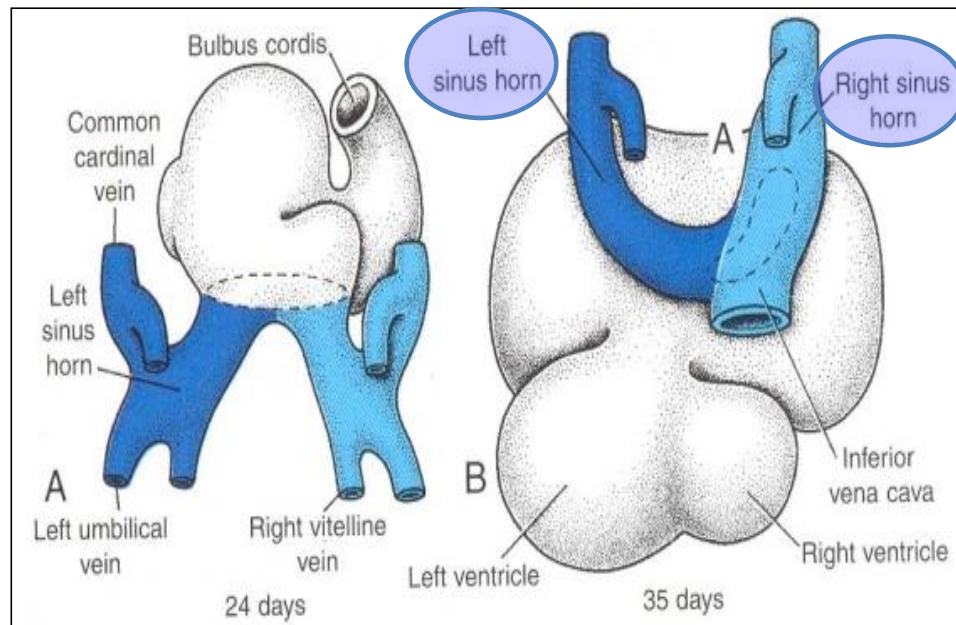
1. Common cardinal
2. Vitelline
3. Umbilical

Each vessel is paired at this stage (not illustrated)

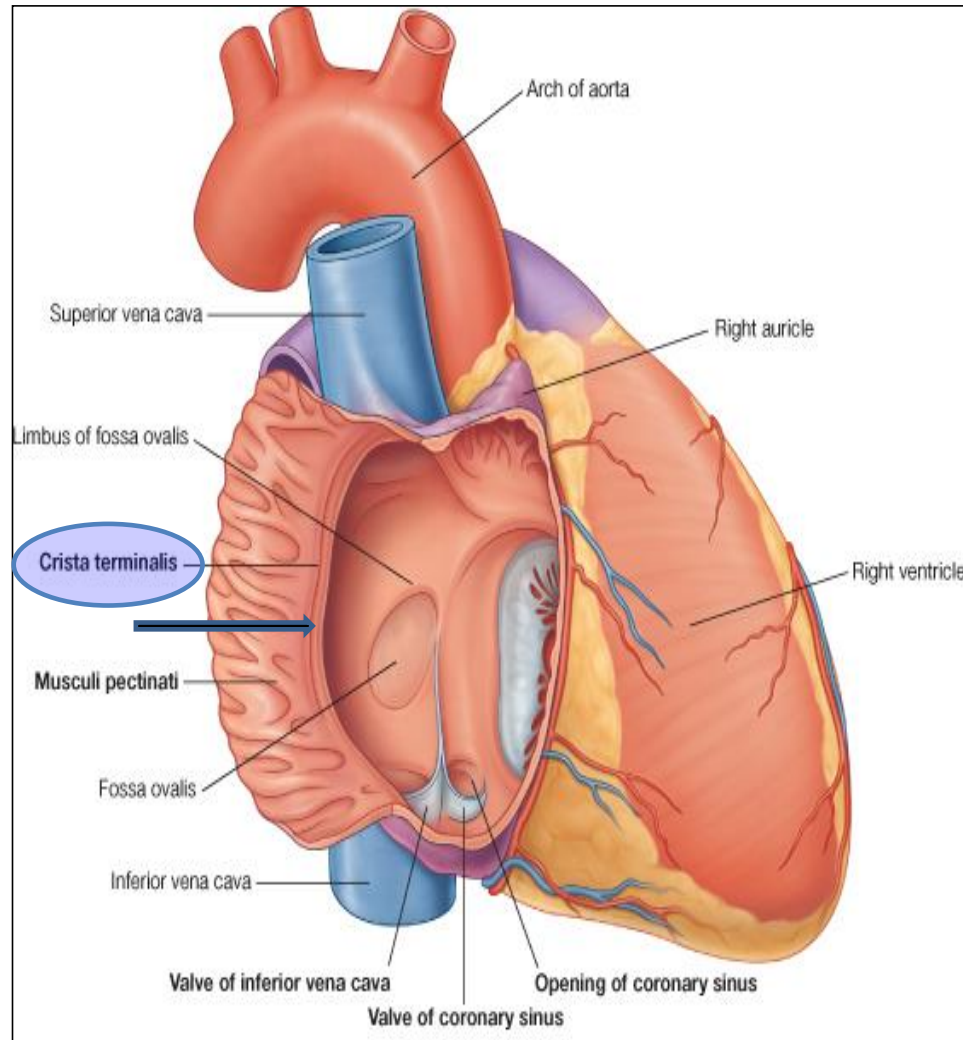
Cardinal vein from the fetal body wall.
Vitelline from the yolk sac.
Umbilical from the placenta.

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**.

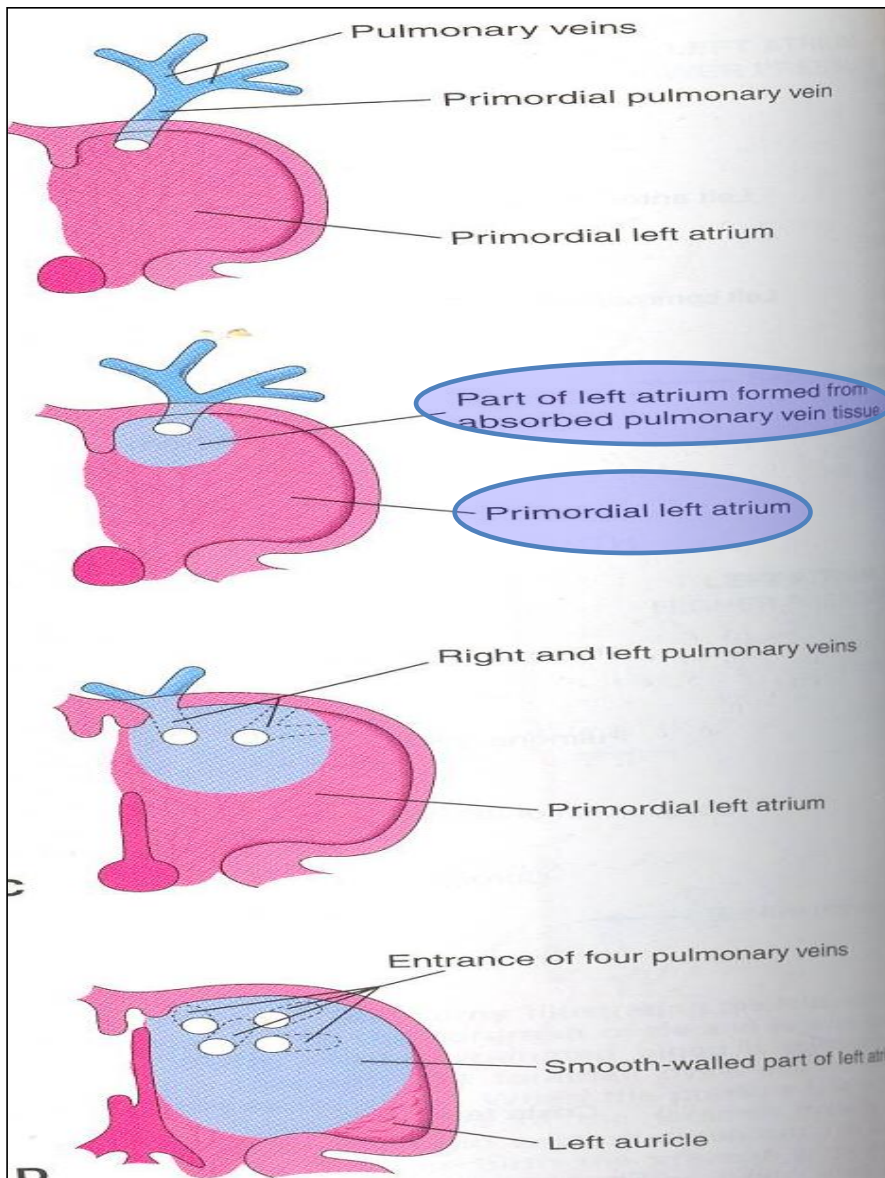


Right Atrium



- 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***.

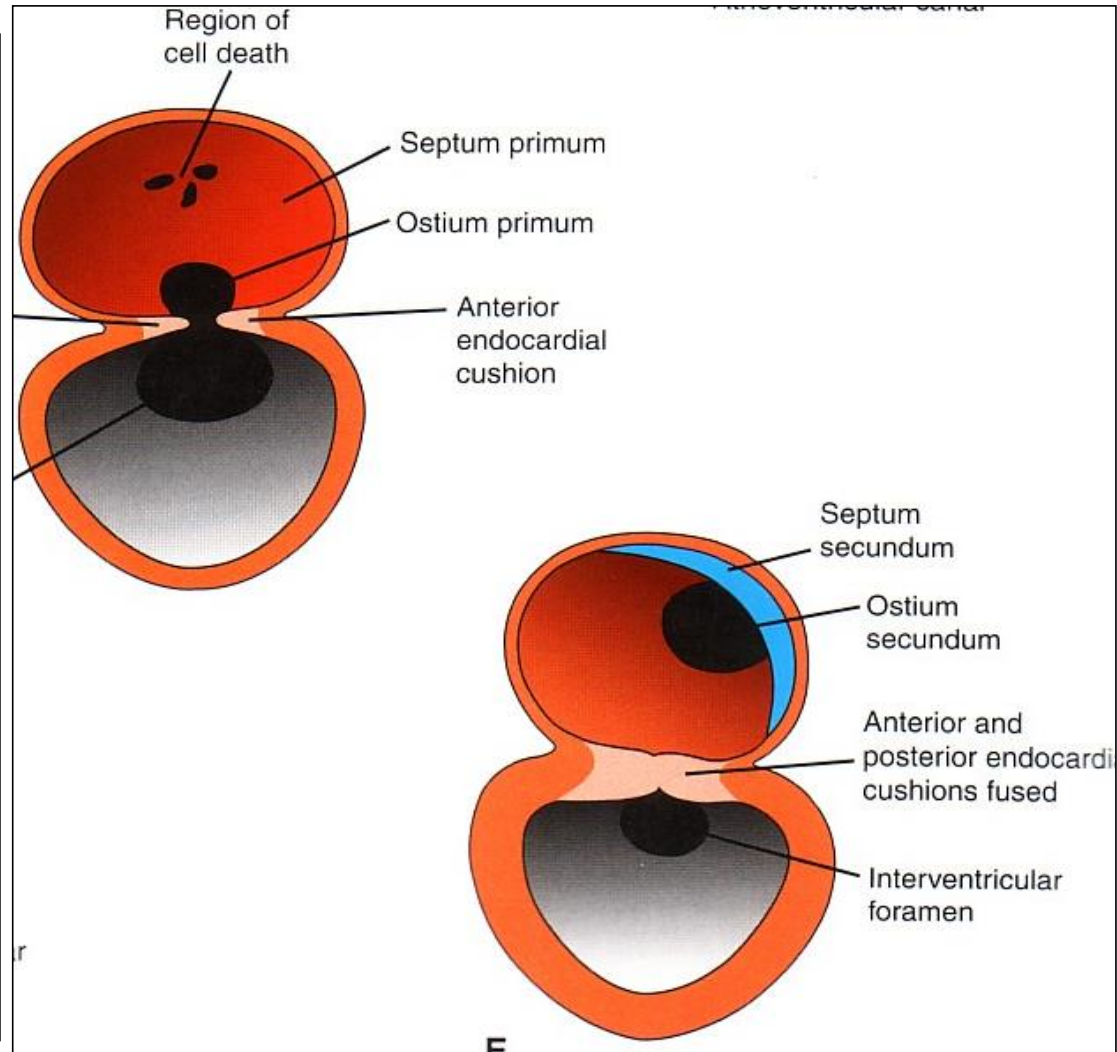
Partitioning of Primordial Heart

Partitioning of:

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

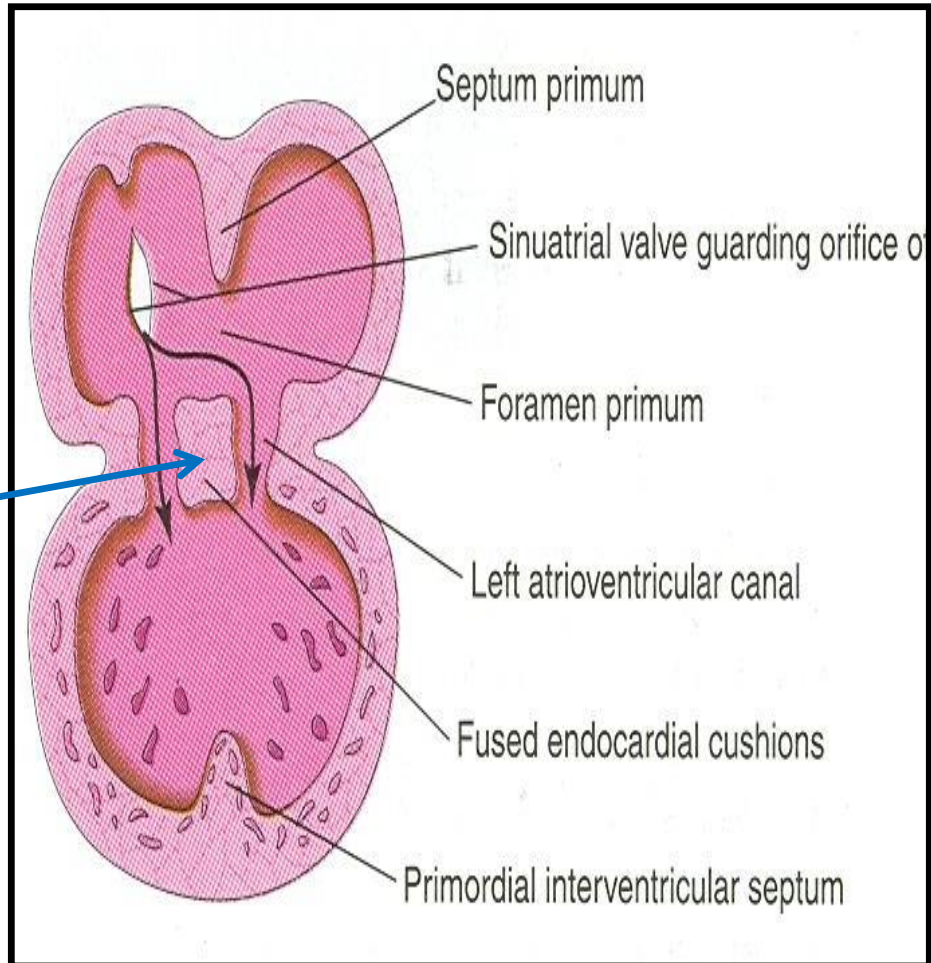
It begins by the middle of 4th week.

It is completed by the end of 5th week.



Partitioning of the **atrioventricular** canal

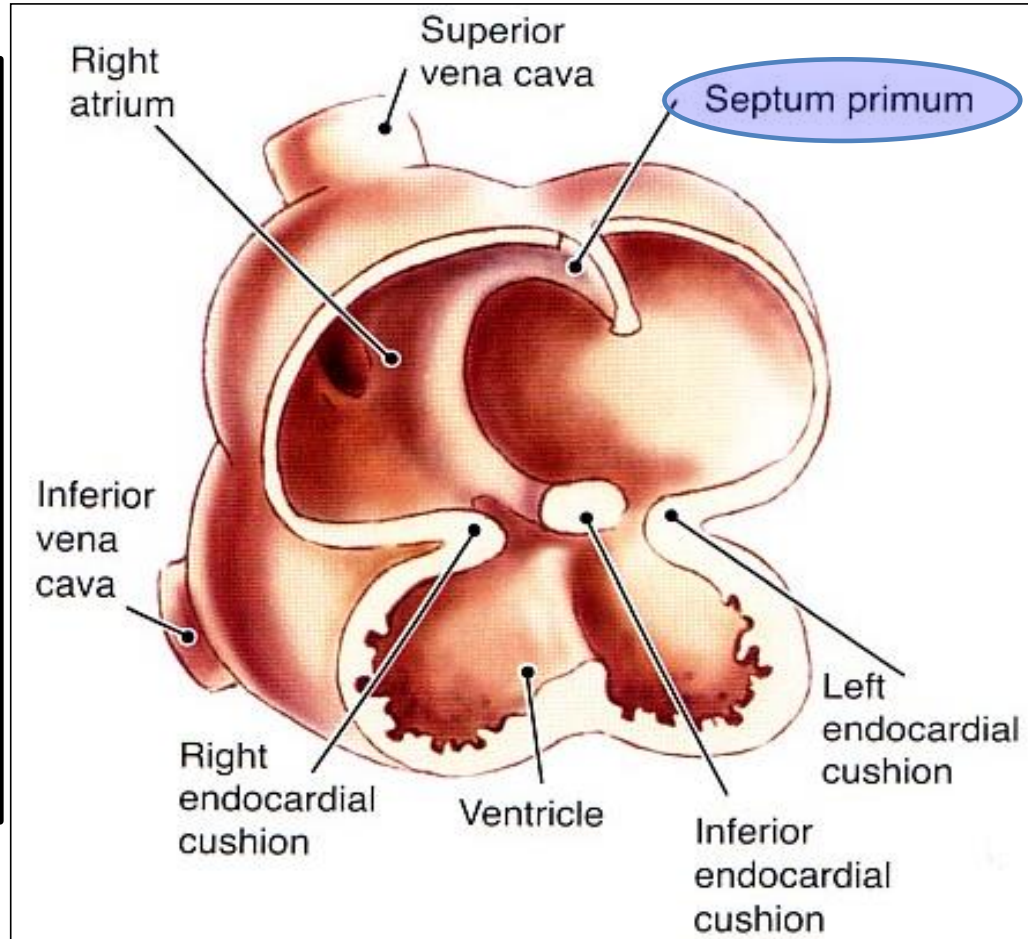
- **Two** anterior and posterior (ventral & dorsal) subendocardial cushions are formed on walls of the AV canal.
- The **AV** subendocardial cushions approach each other and fuse together to form the **septum intermedium**.
- Dividing the AV canal into right & left canals.
- These canals partially connect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



Partition of the common atrium

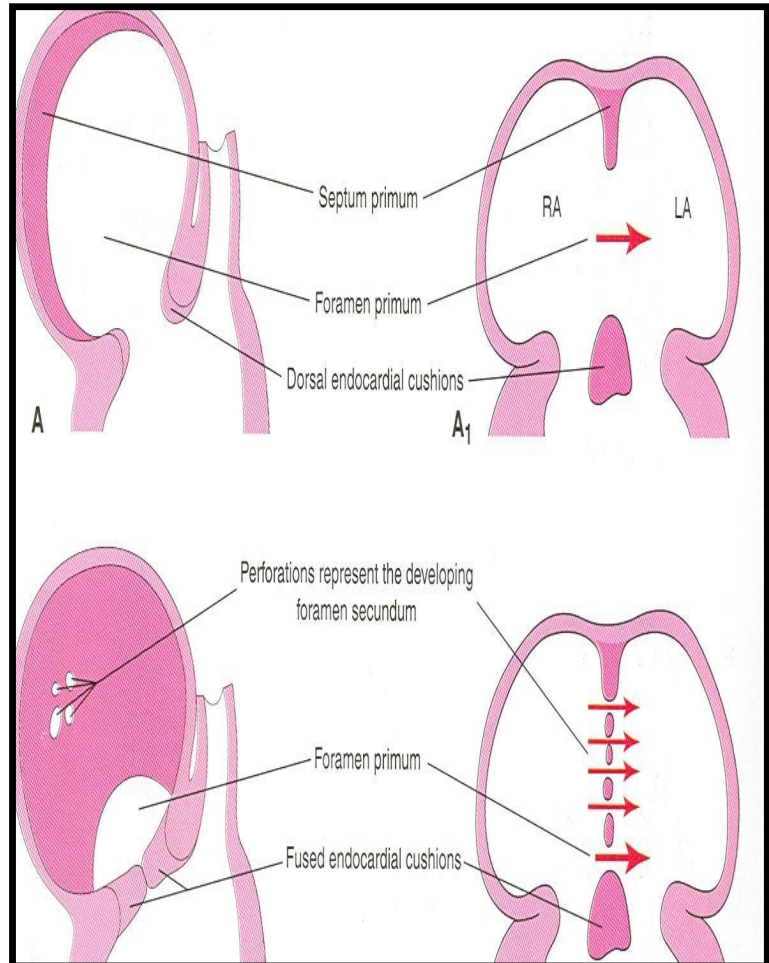
Septum Primum

- 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.



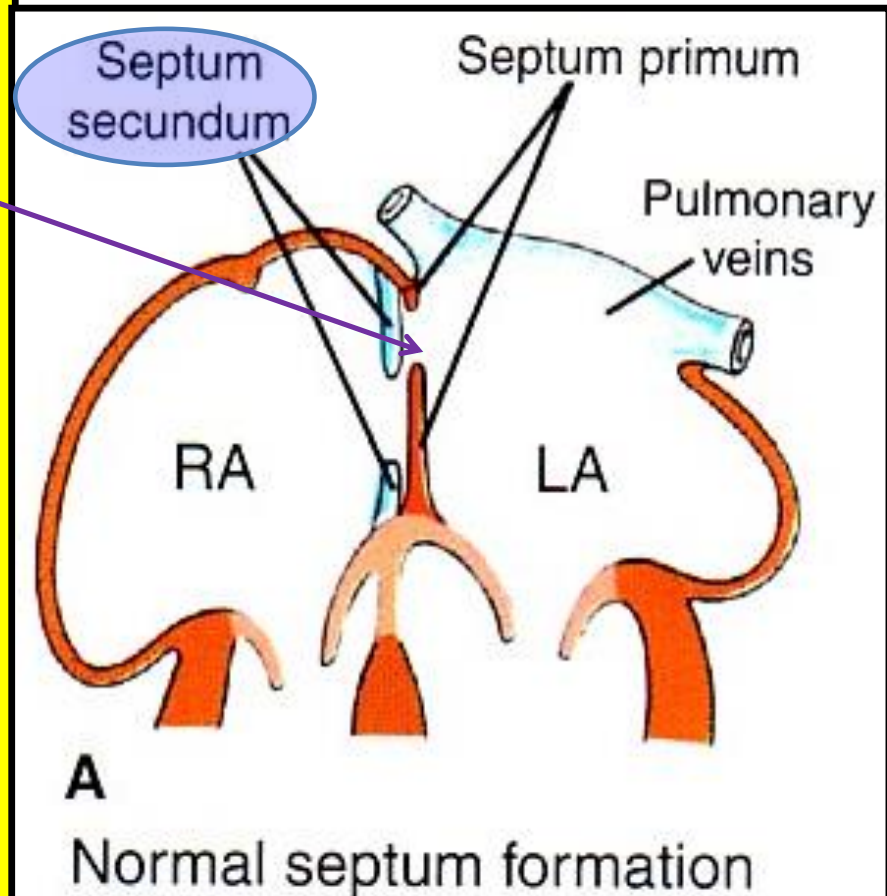
- **At first** the two ends of the septum primum reach to the growing subendocardial cushions before its central part.
- So the septum primum bounds a foramen at this stage called **ostium primum**.
- It serves as a shunt, enabling the oxygenated blood to pass from right atrium to left atrium.
- The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

Ostium Primum

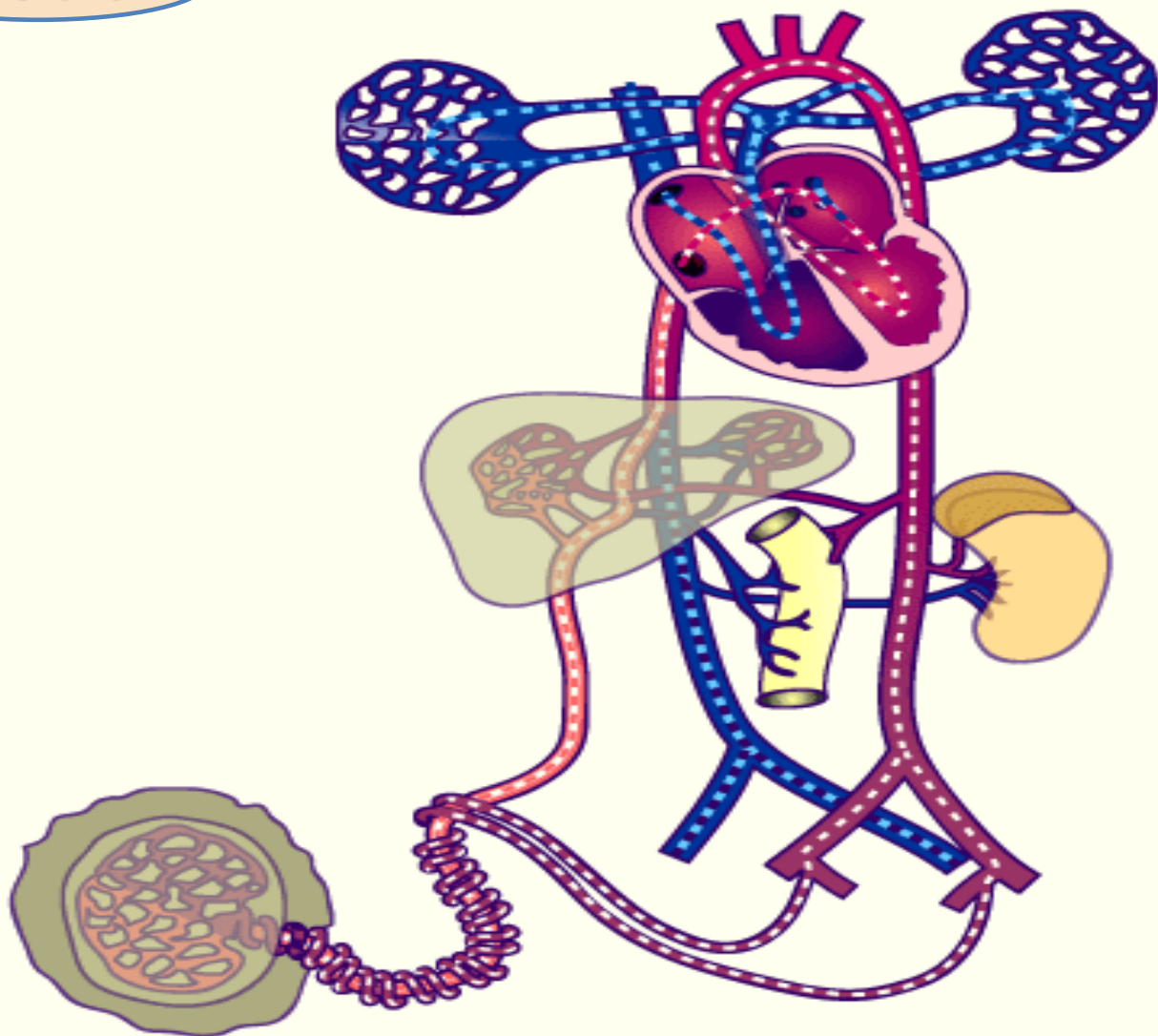


- The upper part of septum primum that is attached to the roof of the common atrium shows gradual resorption forming a new opening called **ostium secundum**.
- Another septum descends on the right side of the septum primum called **septum secundum**.
- It forms an incomplete partition between the two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

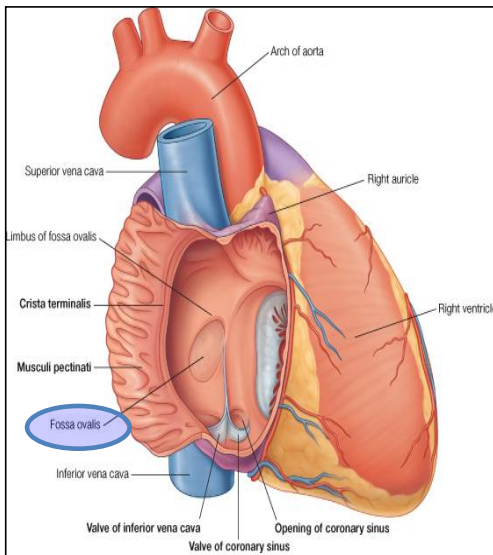
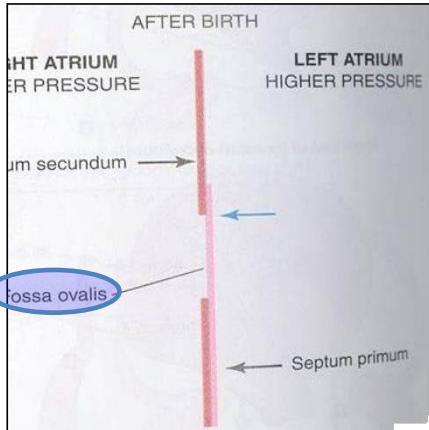
Septum Secundum



before birth



Fate of foramen Ovale

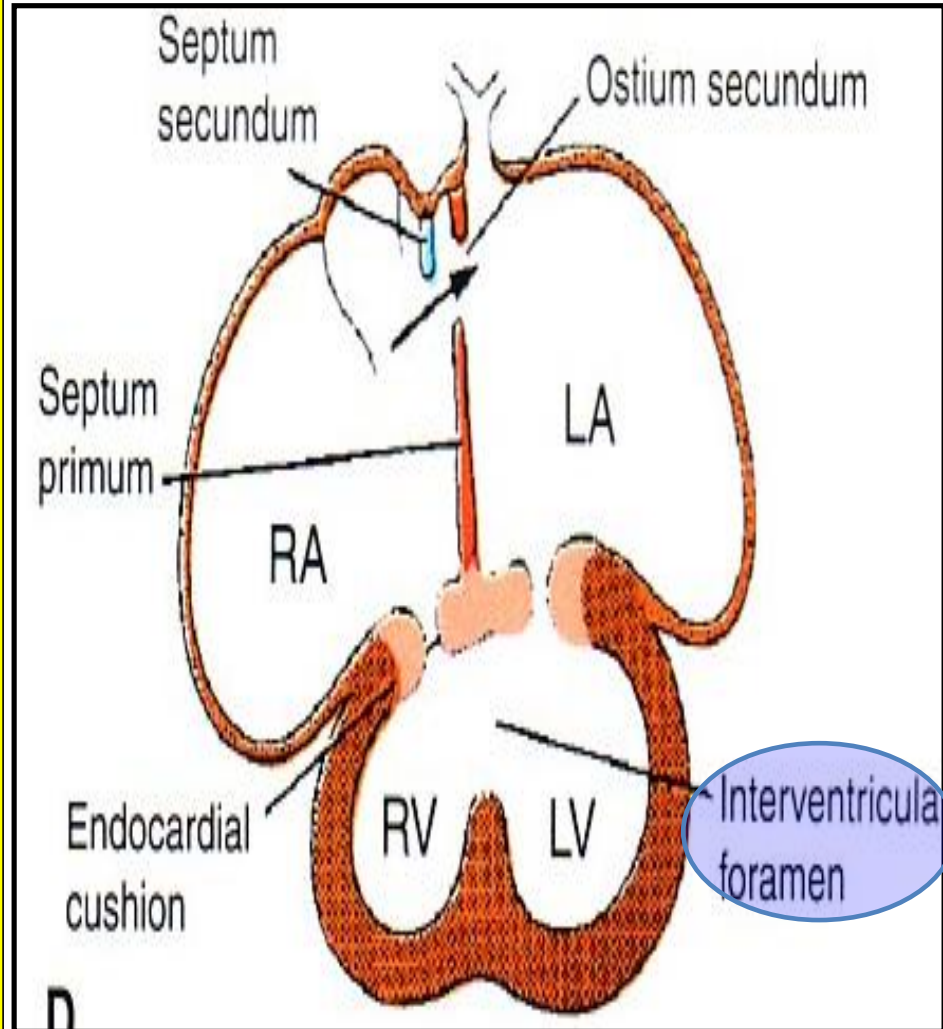


- At birth when the lungs inflated and pulmonary circulation begins the pressure in the left atrium increases and exceeds that of the right atrium.
- So the two **septae** oppose each other and fuse together.
- Its site is represented in adult by the **Fossa Ovalis**.
- The septum primum forms the **floor** 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.

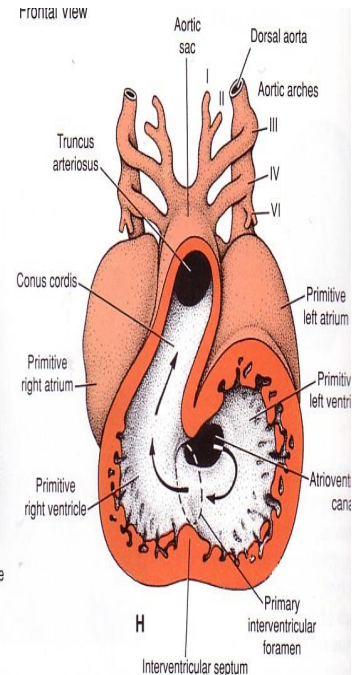
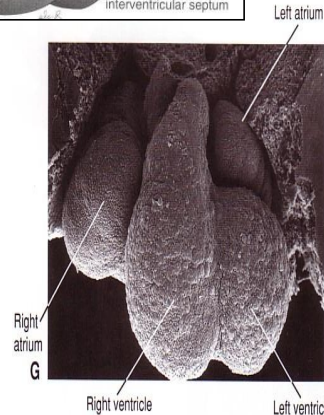
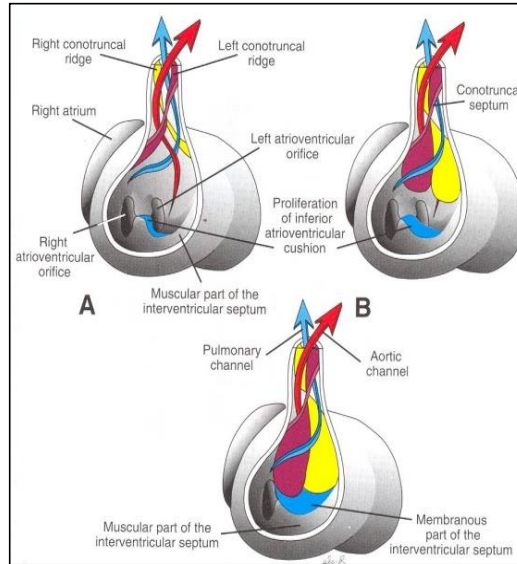
- Division of the primordial ventricle is first indicated by a median muscular ridge, the **primordial interventricular septum**.
- It is a thick **crescentic** fold which has a concave upper free edge.
- This septum bounds a temporary connection between the two ventricles called (**IVF**) **interventricular foramen**.



Interventricular Septum

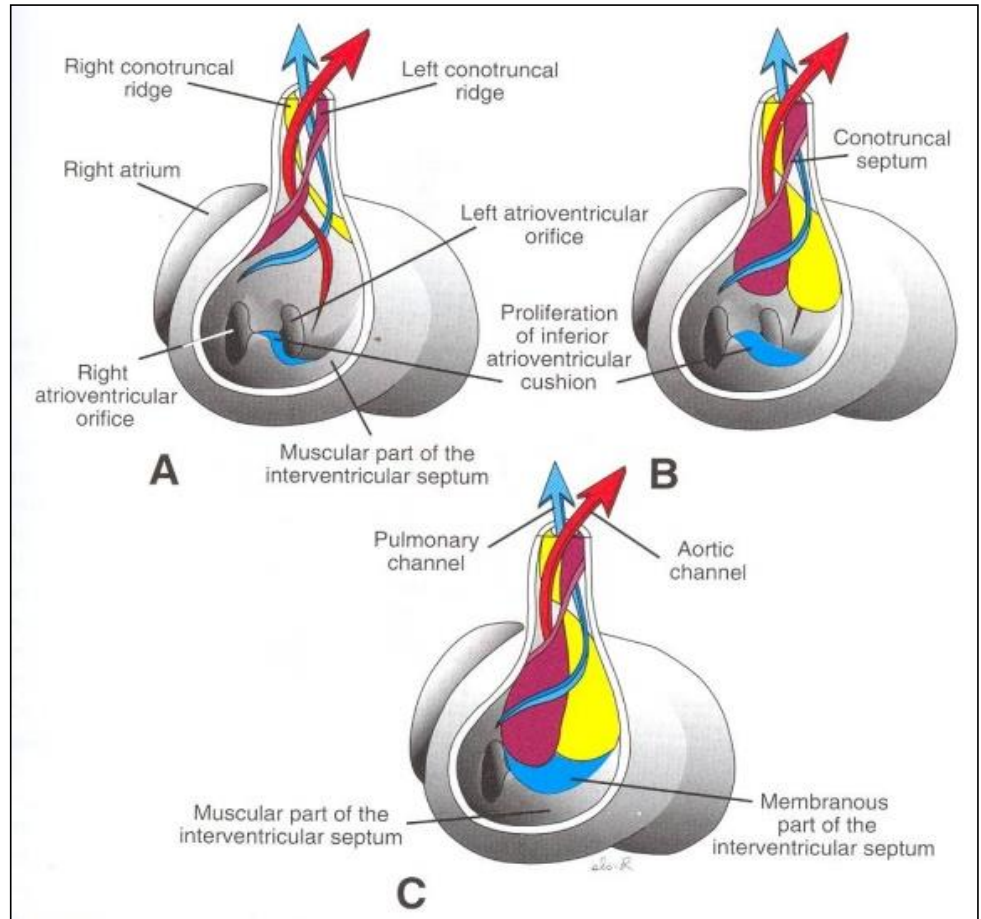
The membranous part of the IV septum is derived from:

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

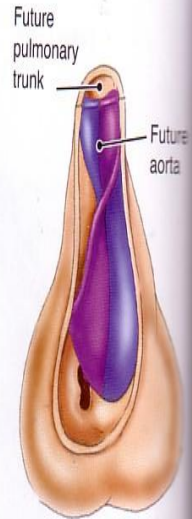
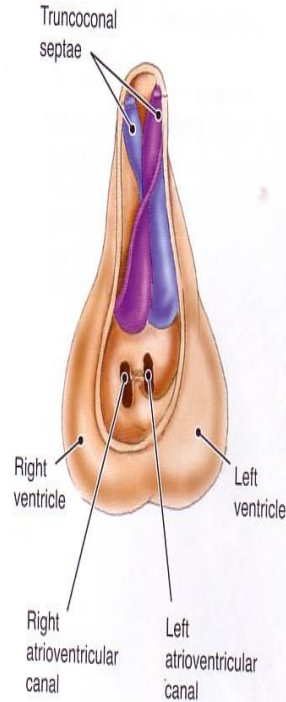
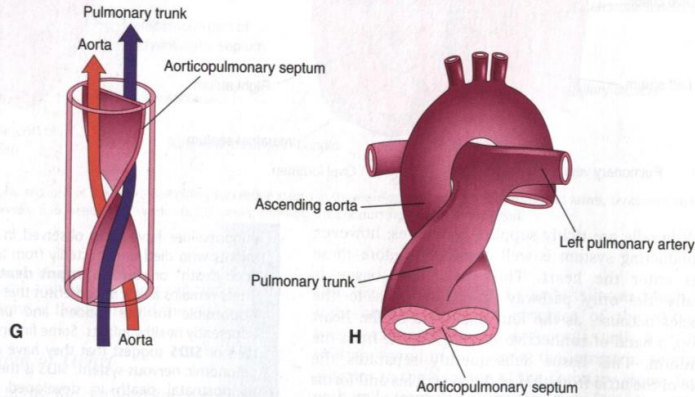
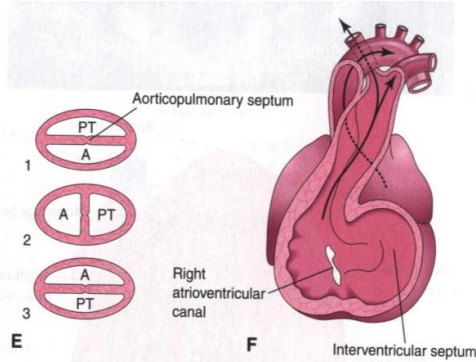
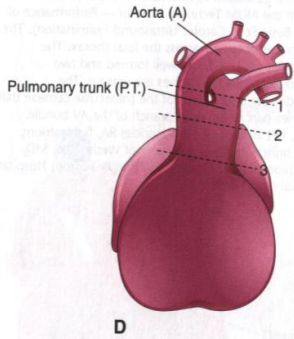


Spiral Aorticopulmonary Septum

- 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**.

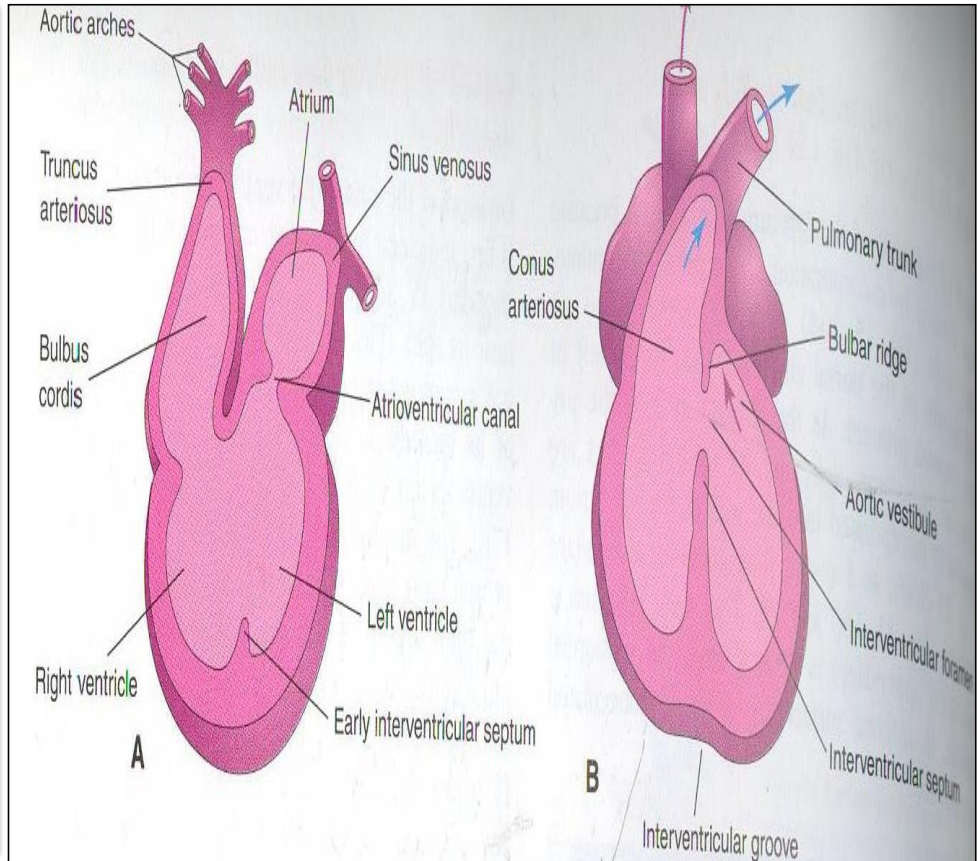


Spiral Aorticopulmonary Septum

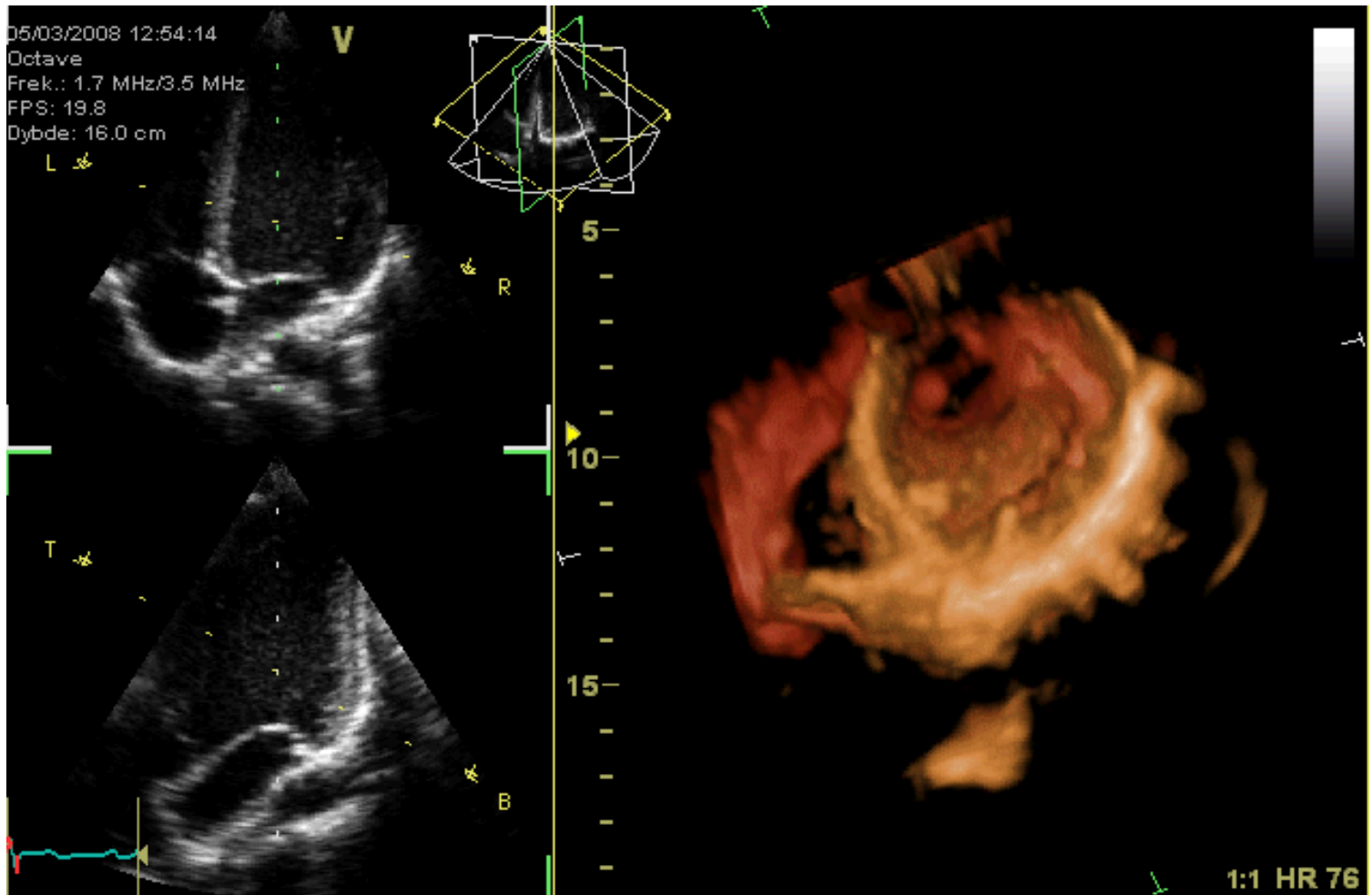


BULBUS CORDIS

- 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.

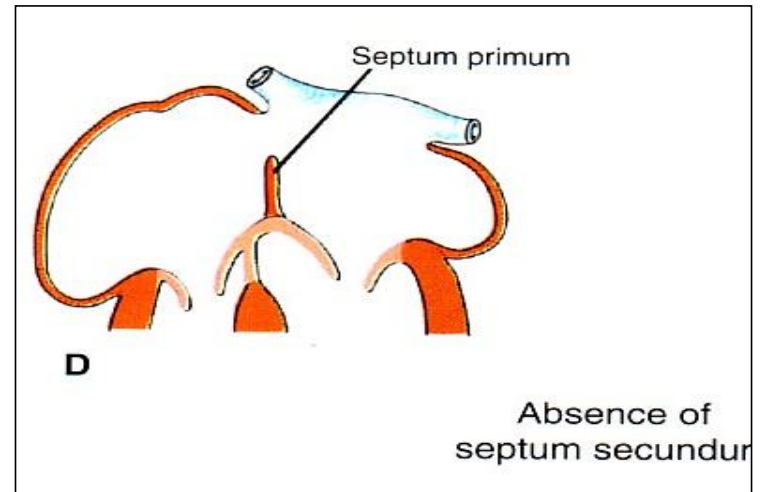
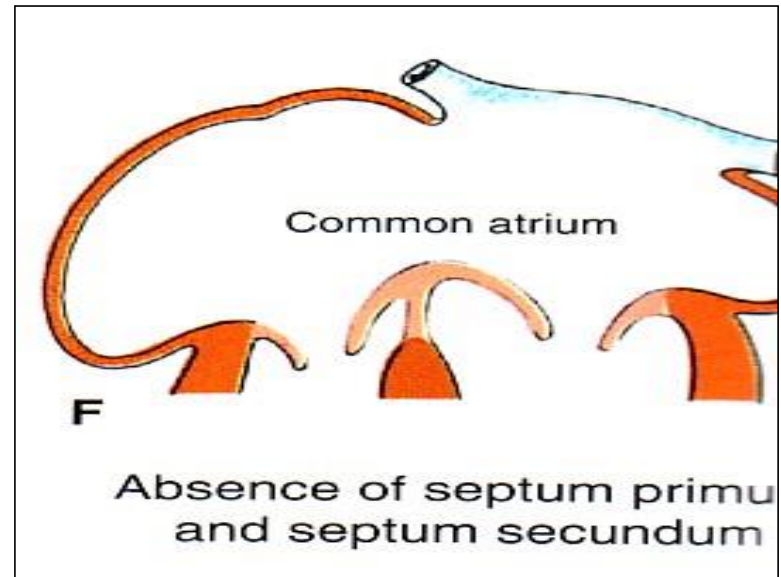


MAJOR CARDIAC ANOALIES

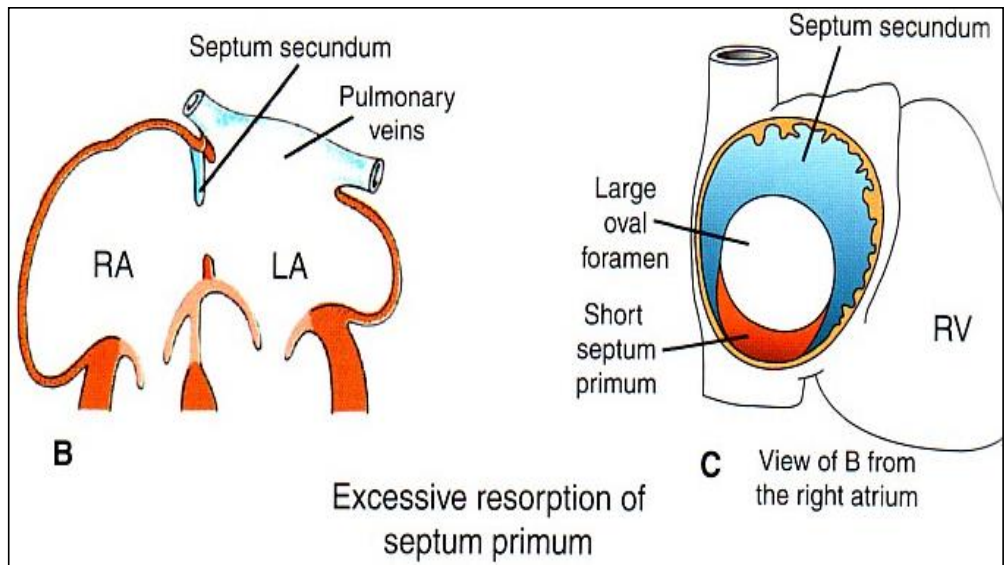


Atrial Septal Defects (ASD)

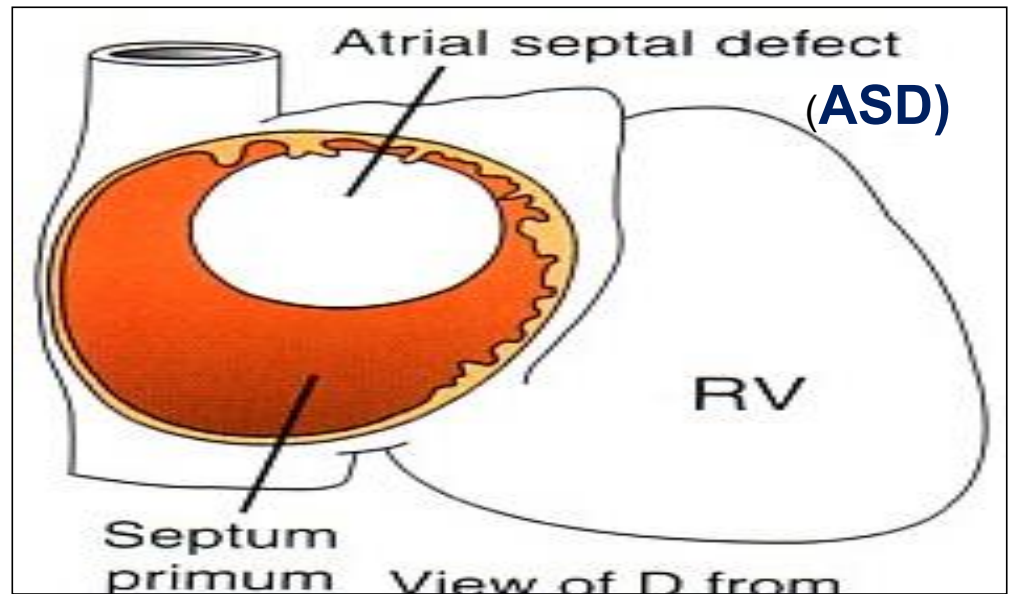
- Absence of septum primum and septum secundum, leads to common atrium.
- Absence of Septum Secundum



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

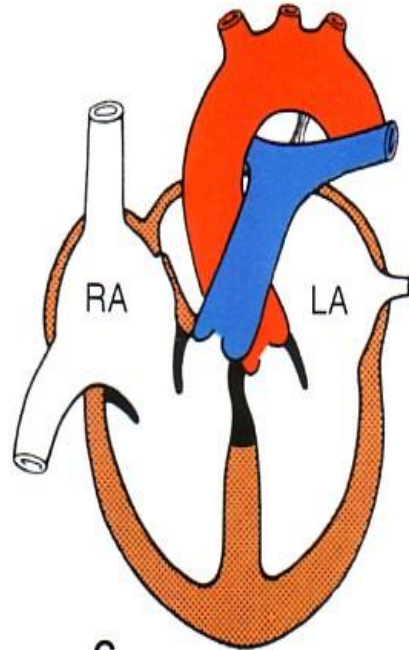


**Patent
foramen
ovale**

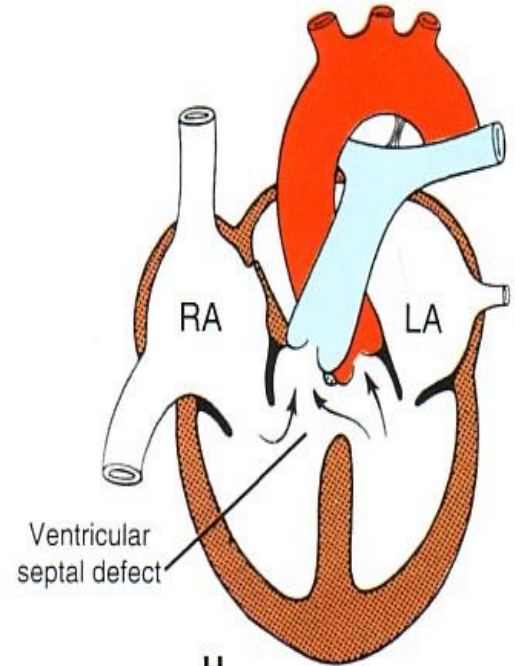


VENTRICULAR SEPTAL DEFECT (VSD)

- **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)

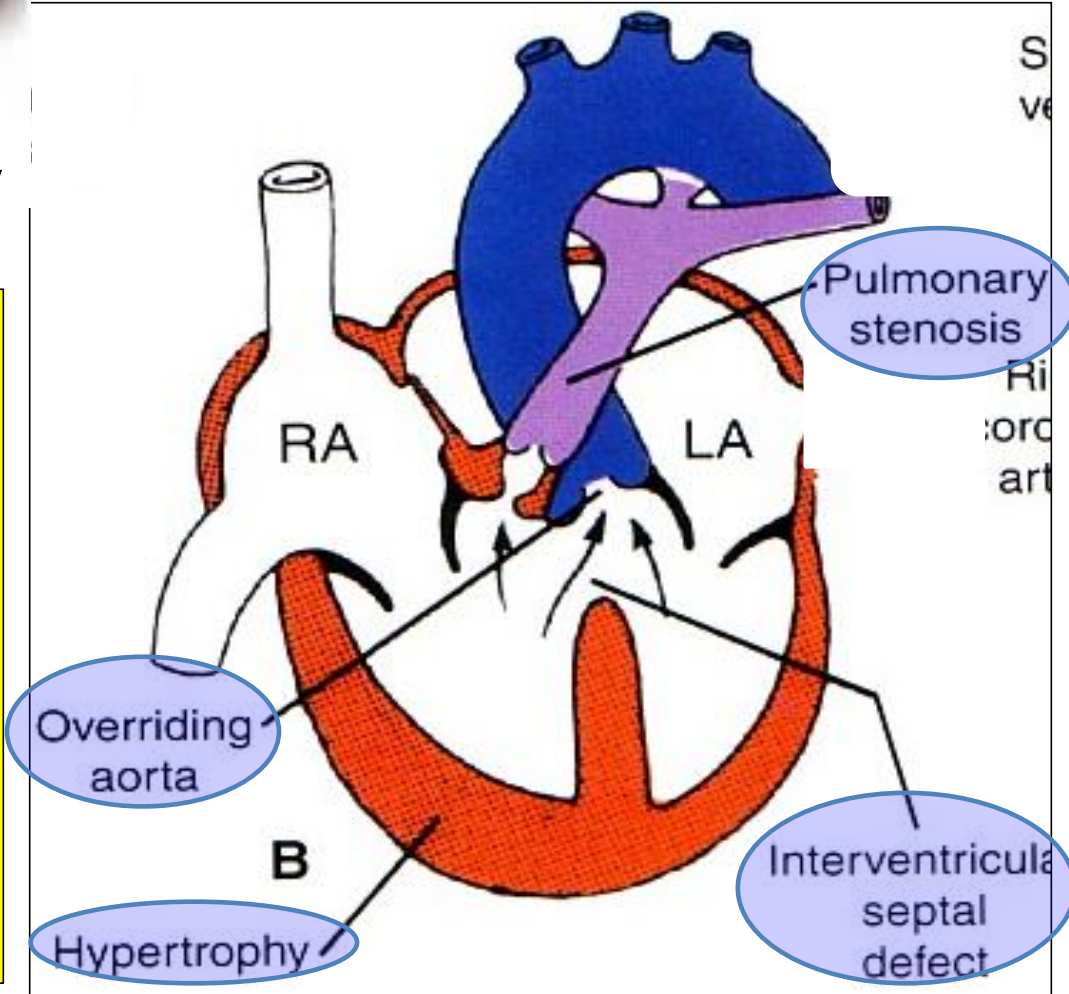


**Blue
Baby**

FALLOT TETRALOGY

• Fallot's Tetralogy:

- 1-VSD.
- 2- Pulmonary stenosis.
- 3-Overriding of the aorta
- 4- Right ventricular hypertrophy.

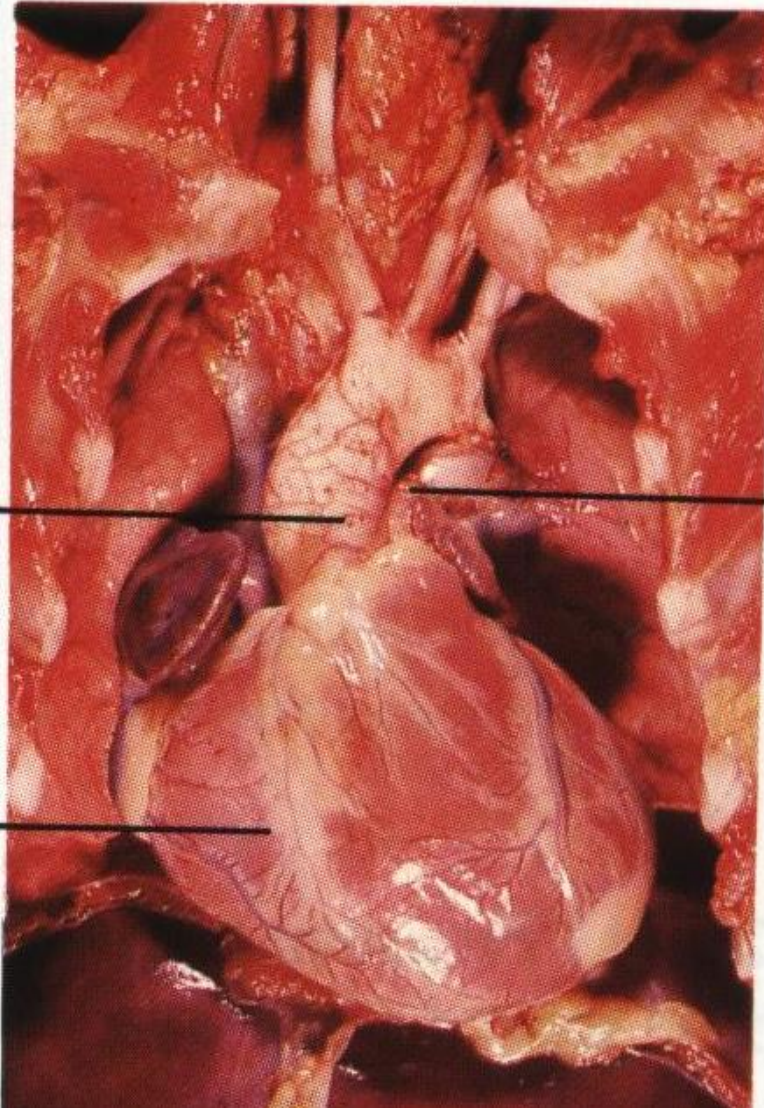


TETRALOGY OF FALLOT

VSD

Overriding aorta

Enlarged right ventricle

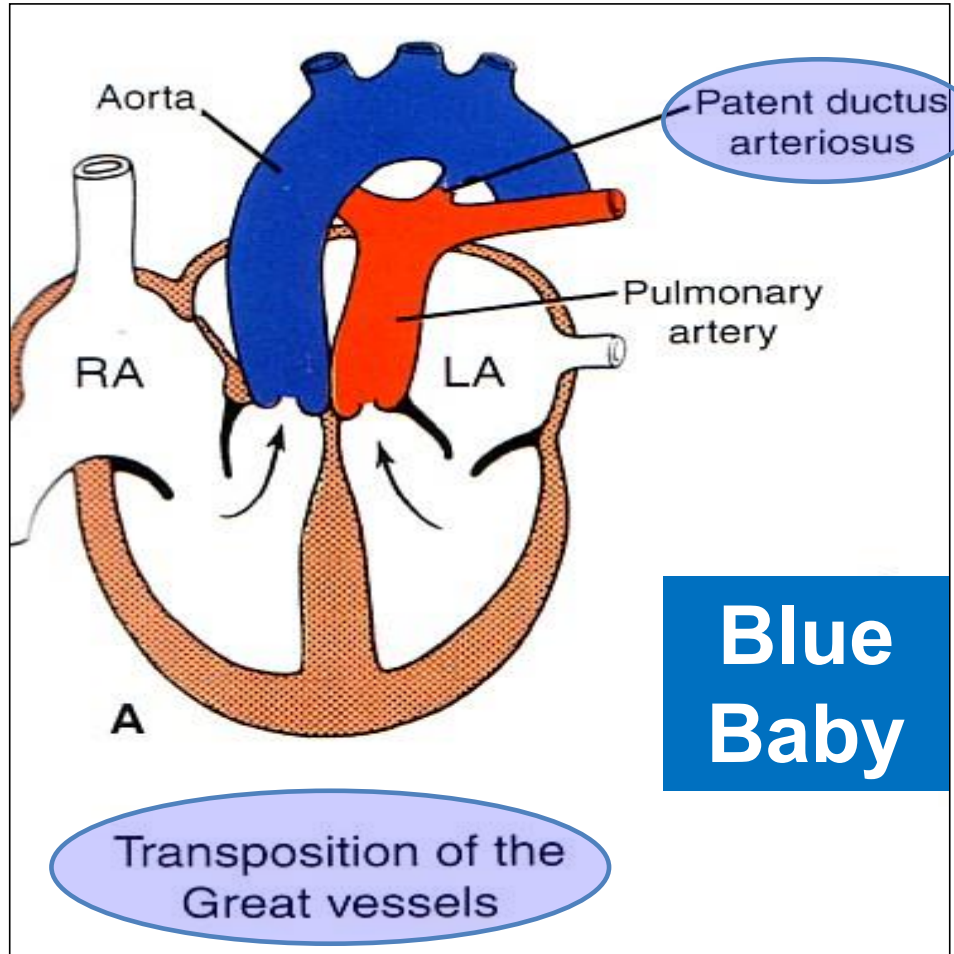


Stenotic pulmonary trunk

Blue Baby

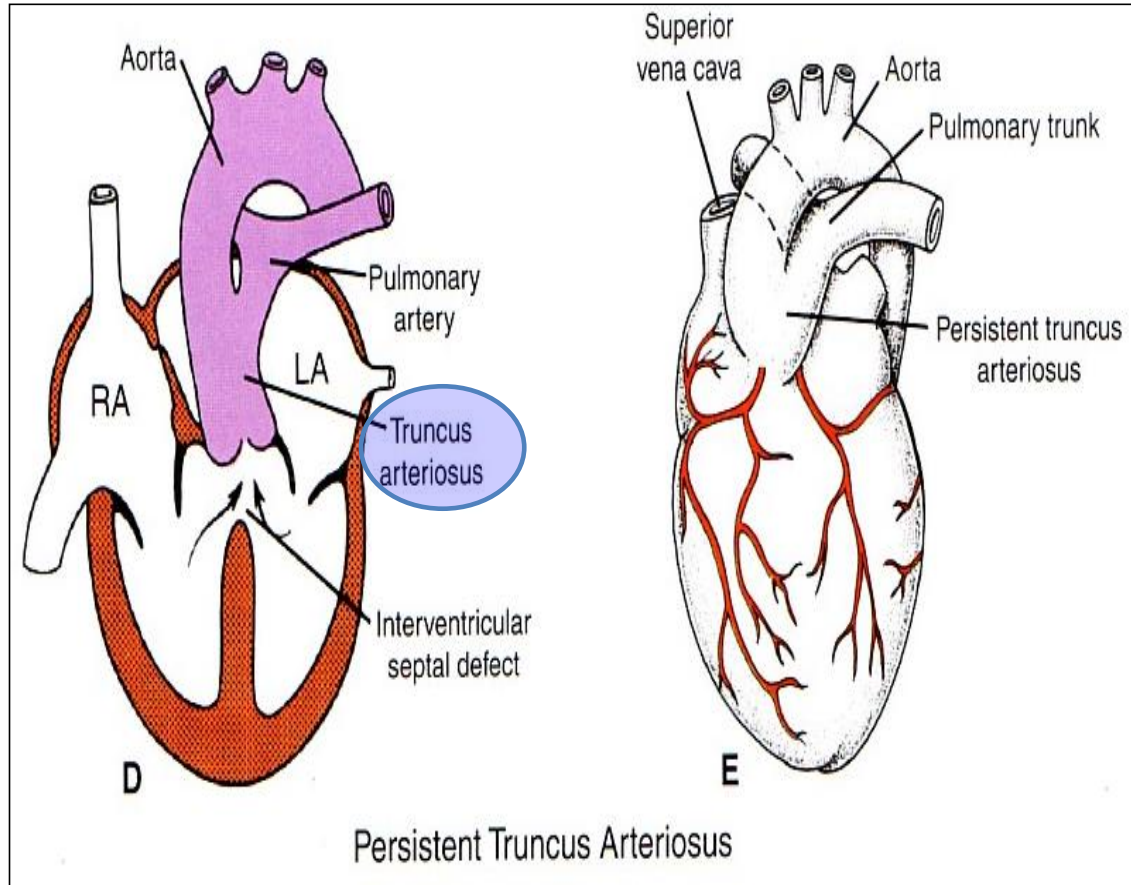
(TGA) TRANSPOSITION OF GREAT ARTERIES

- **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.



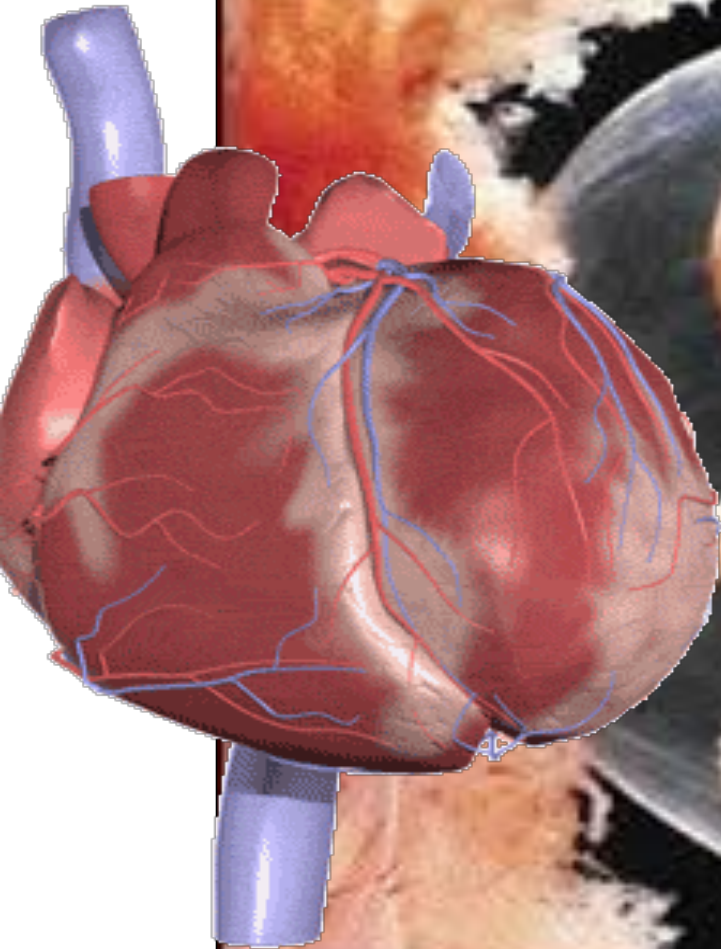
Test your knowledge!

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**

