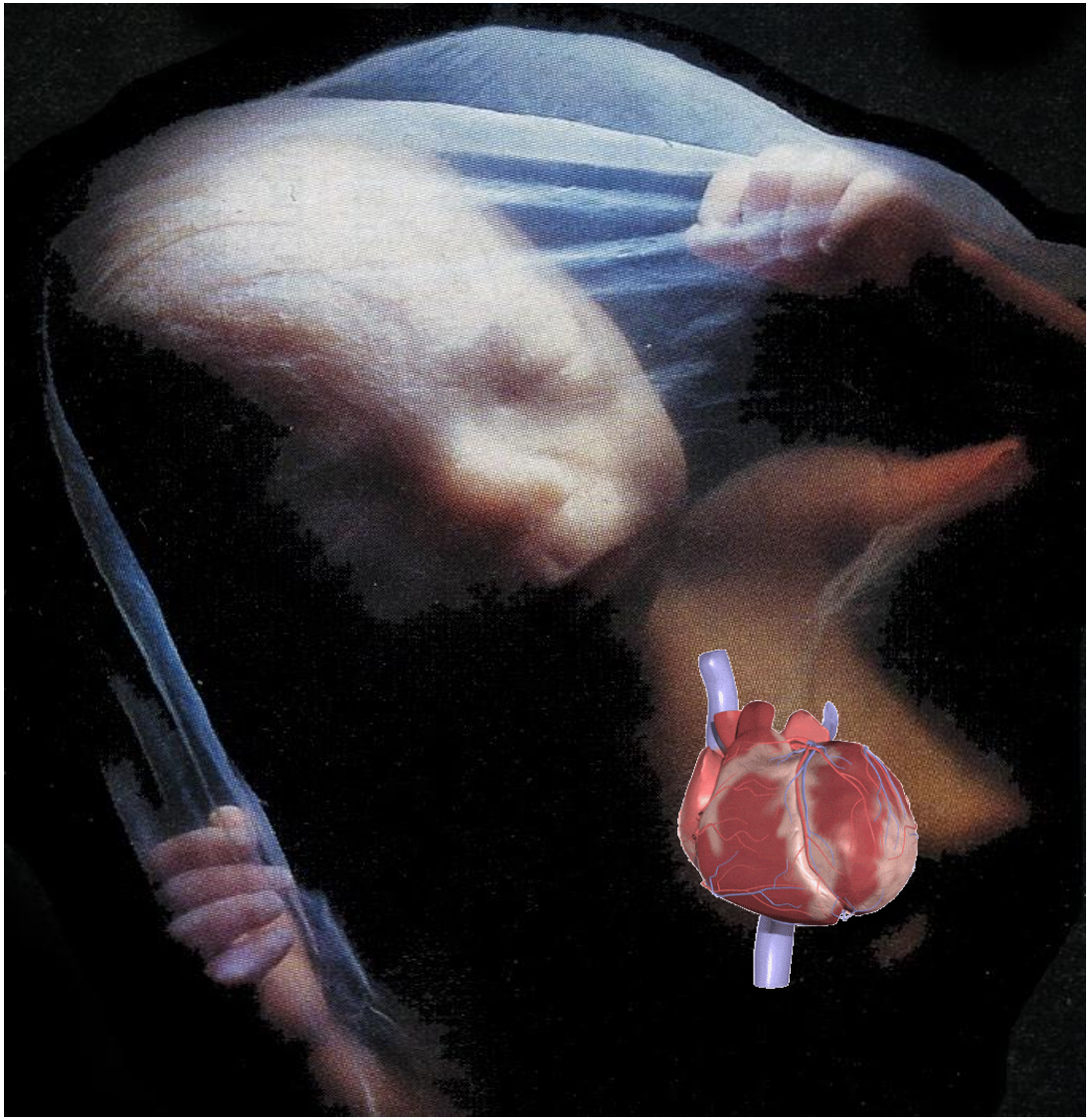
HEART DEVELOPMENT



PROF. SAEED ABUEL MAKAREM

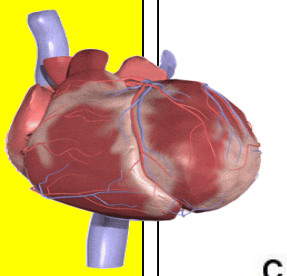
OBJECTIVES

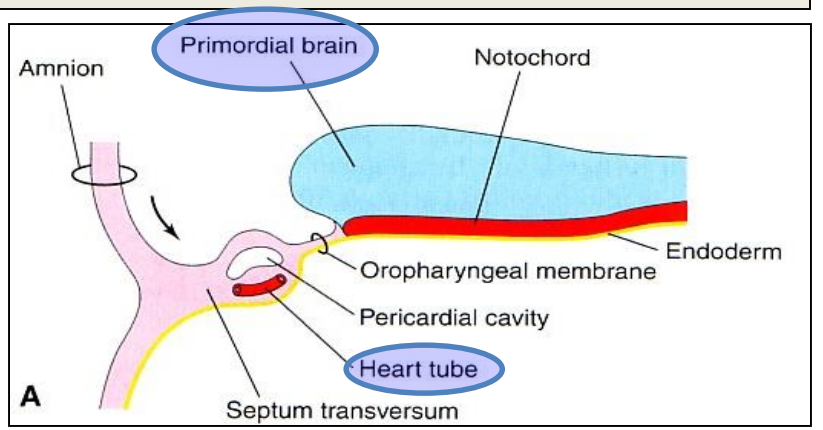
By the end of the lecture you should be able to describe:

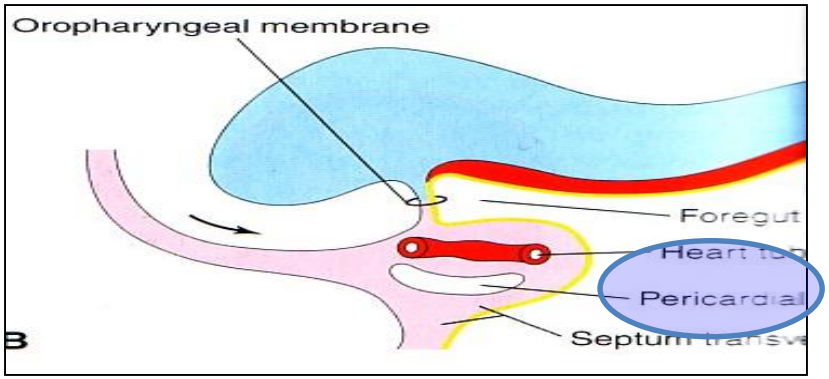
- The site, formation, union, and division of the of the heart tube.
- The formation and fate of the **sinus venosus**.
- The formation of **interatrial and interventricular septae.**
- The formation of the two atria and the two ventricles.
- The partitioning of the **truncus arteriosus** and formation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

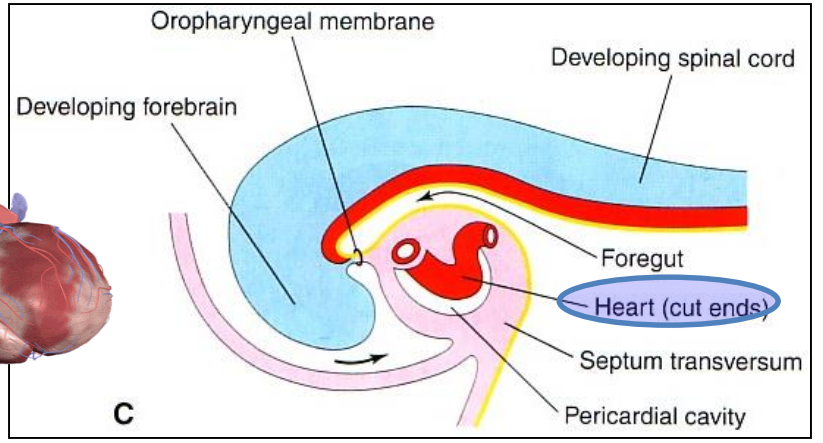
FORMATION OF THE HEART TUBE

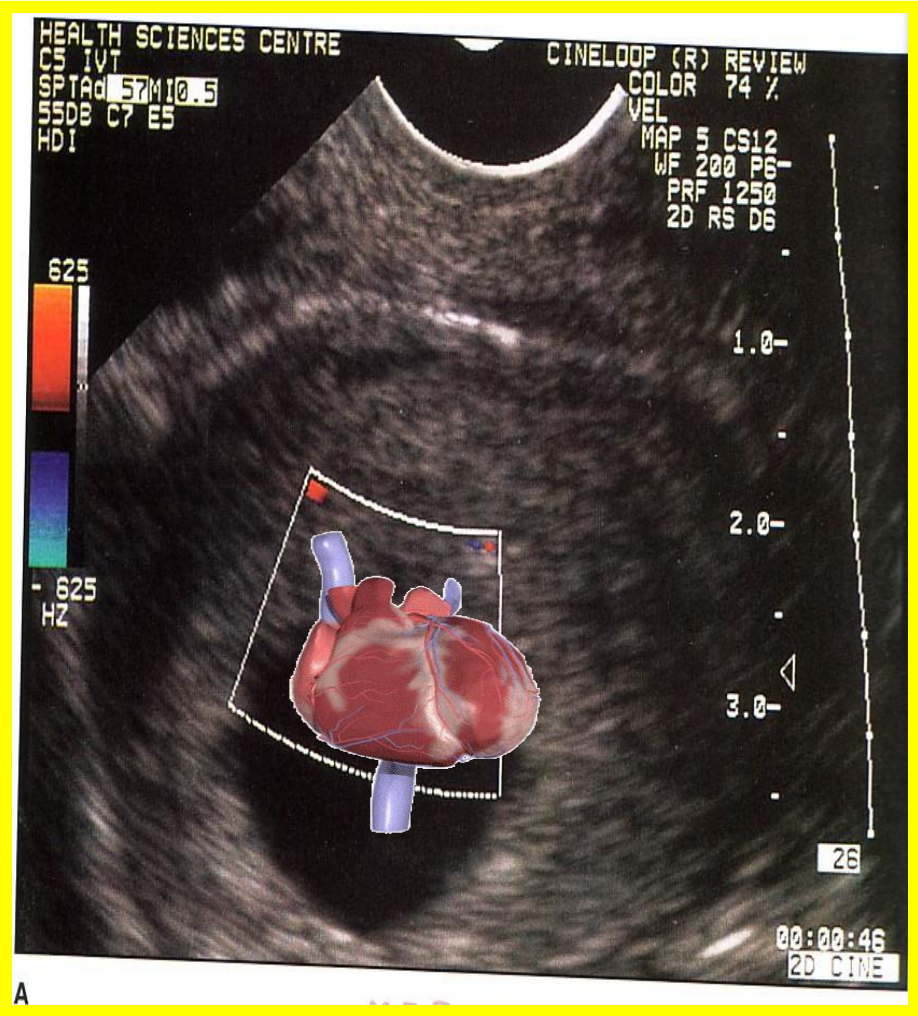
- The heart is the **first functional** organ to develop.
- It develops from **splanchnic mesoderm** (cardiogenic area), cranial to the developing mouth and nervous system.
- It lies ventral to the developing pericardial sac.
- The heart primordium is **first** evident **at 18 days** (as an angioplastic 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***.

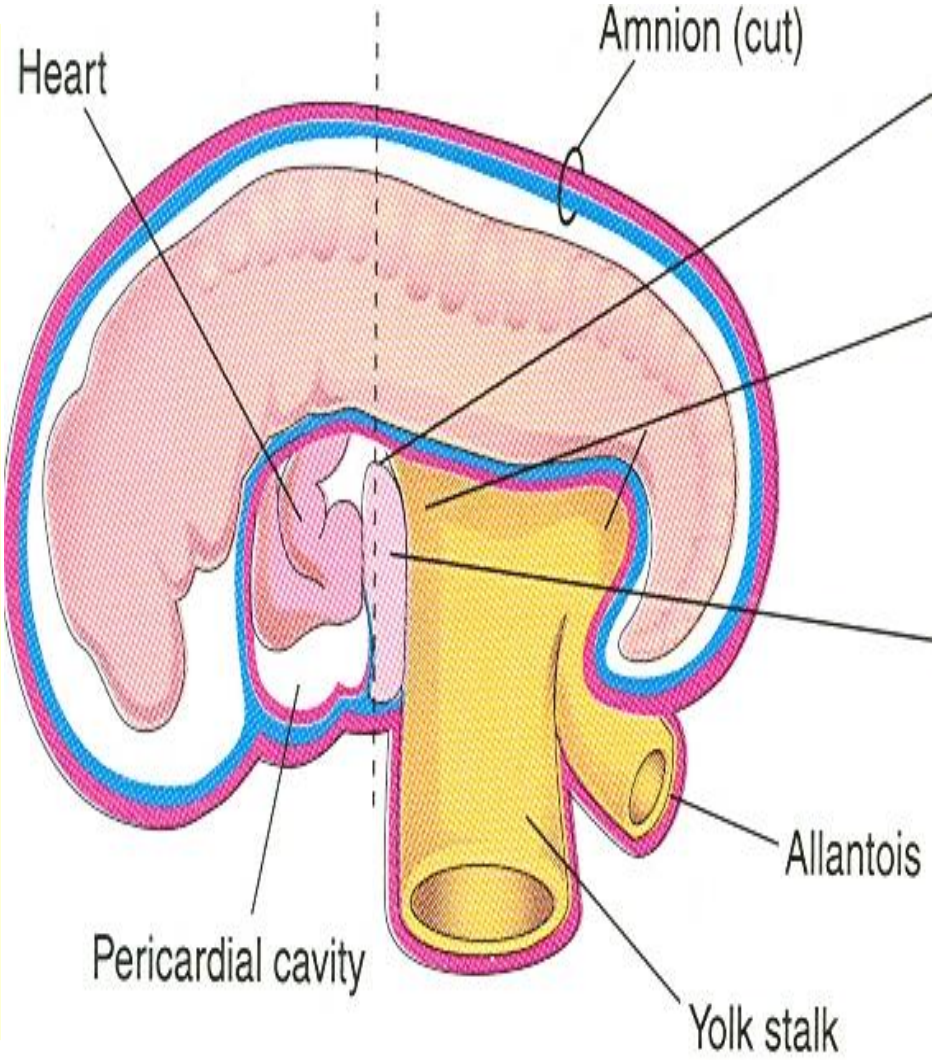








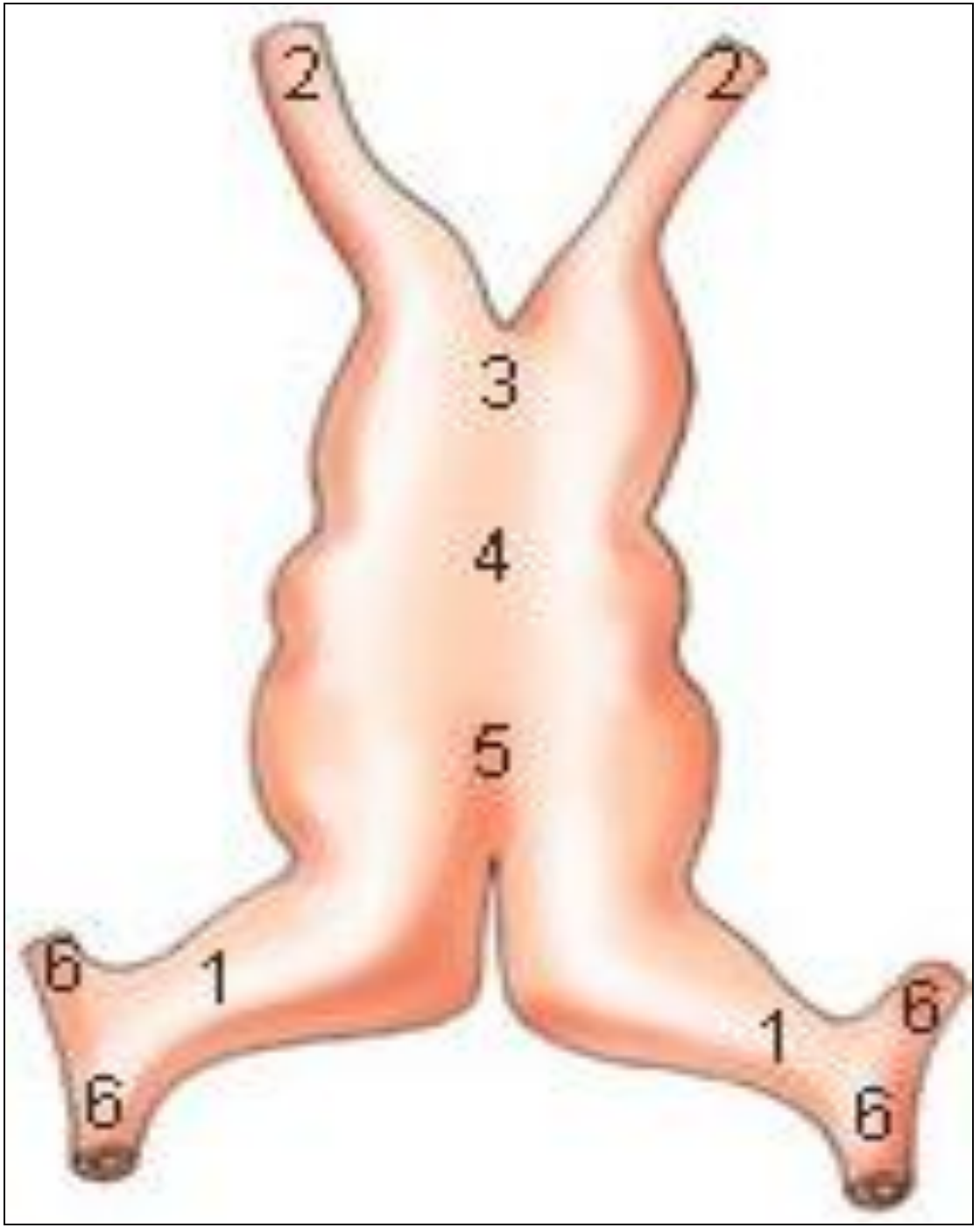




Blood **flow** begins during the beginning of **4th week** **(22 or 23 day)** and can be visualized by **Ultrasound Doppler.**

Development of the Heart tube

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



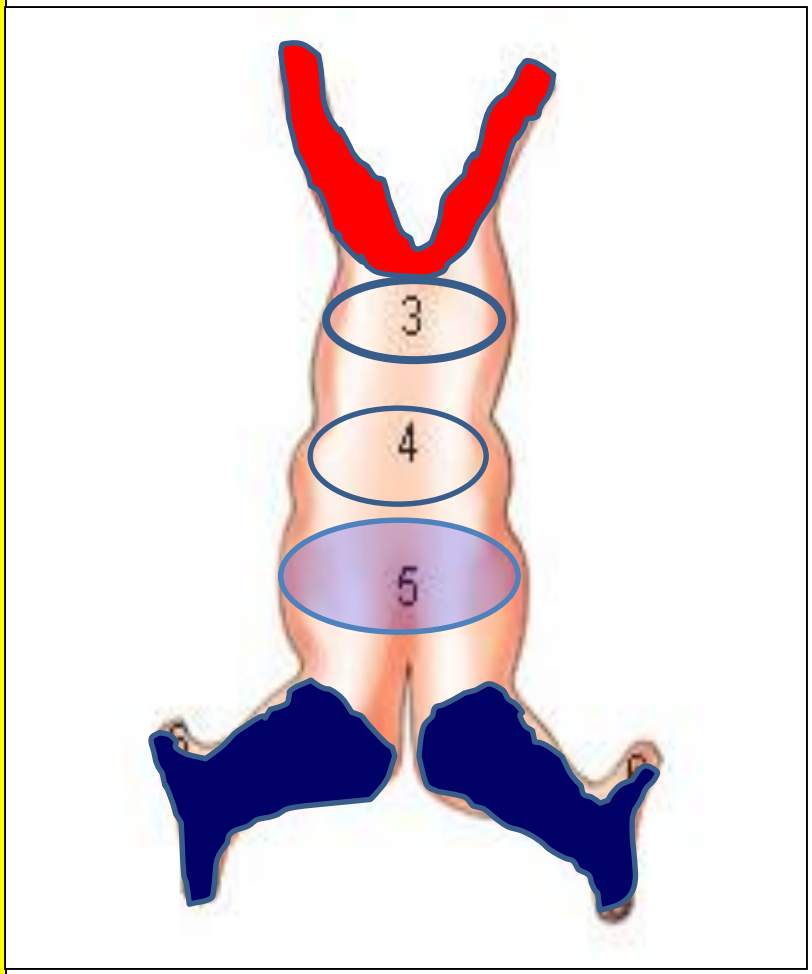
What is the fate of the Heart Tube?

- 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.**

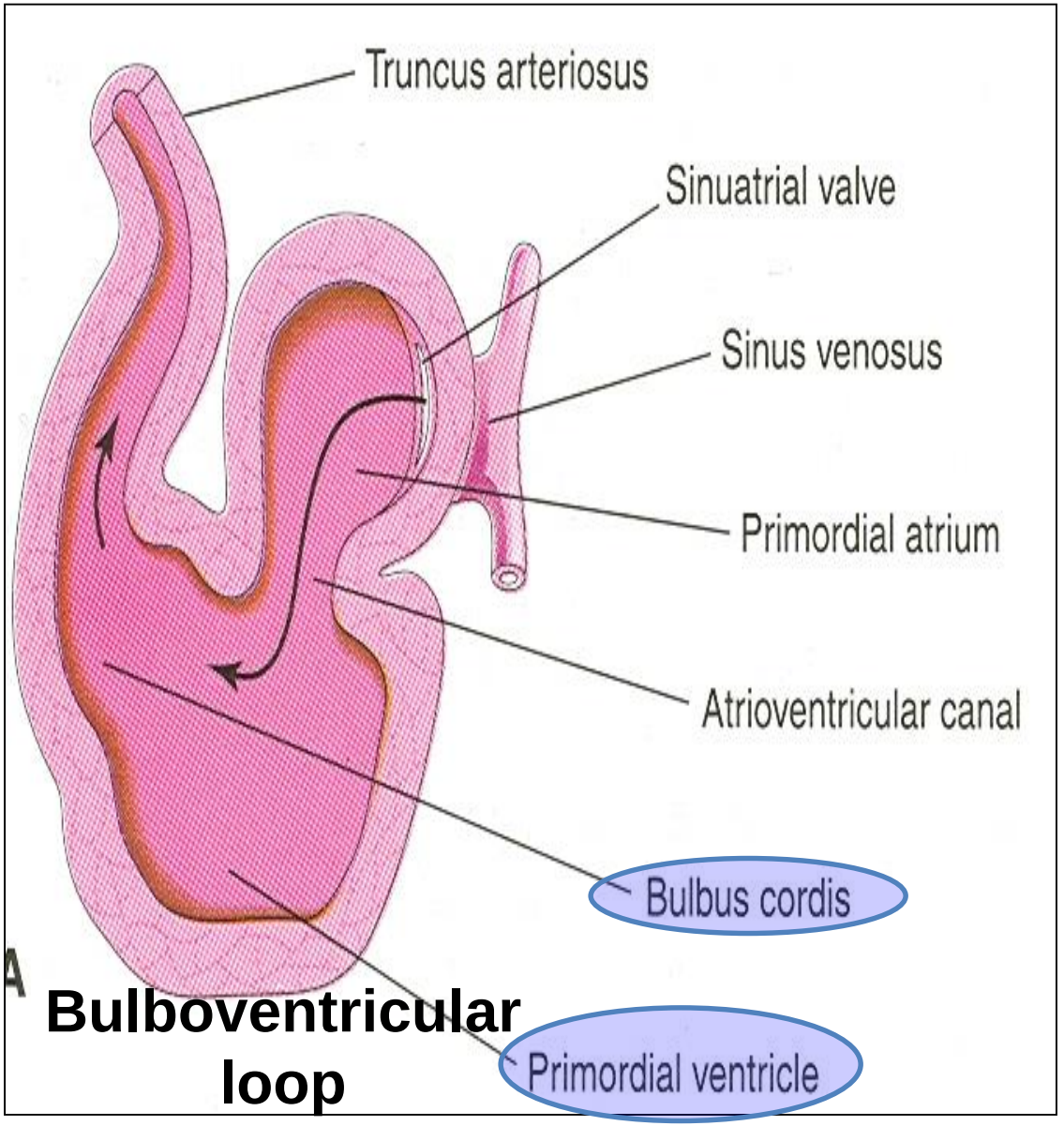
The endocardial heart tube has 2 ends:

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

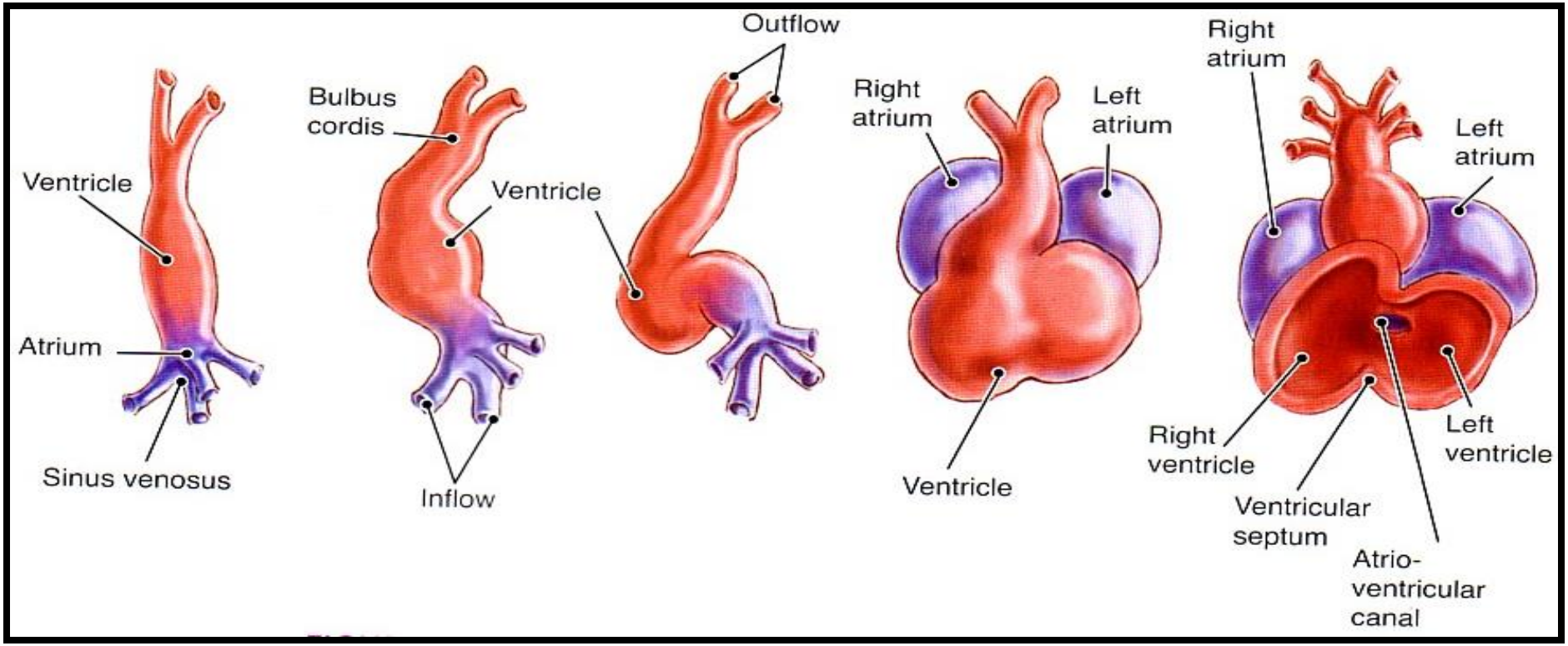


U-SHAPED HEART TUBE

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



Loop formation Or S-Shaped Heart Tube

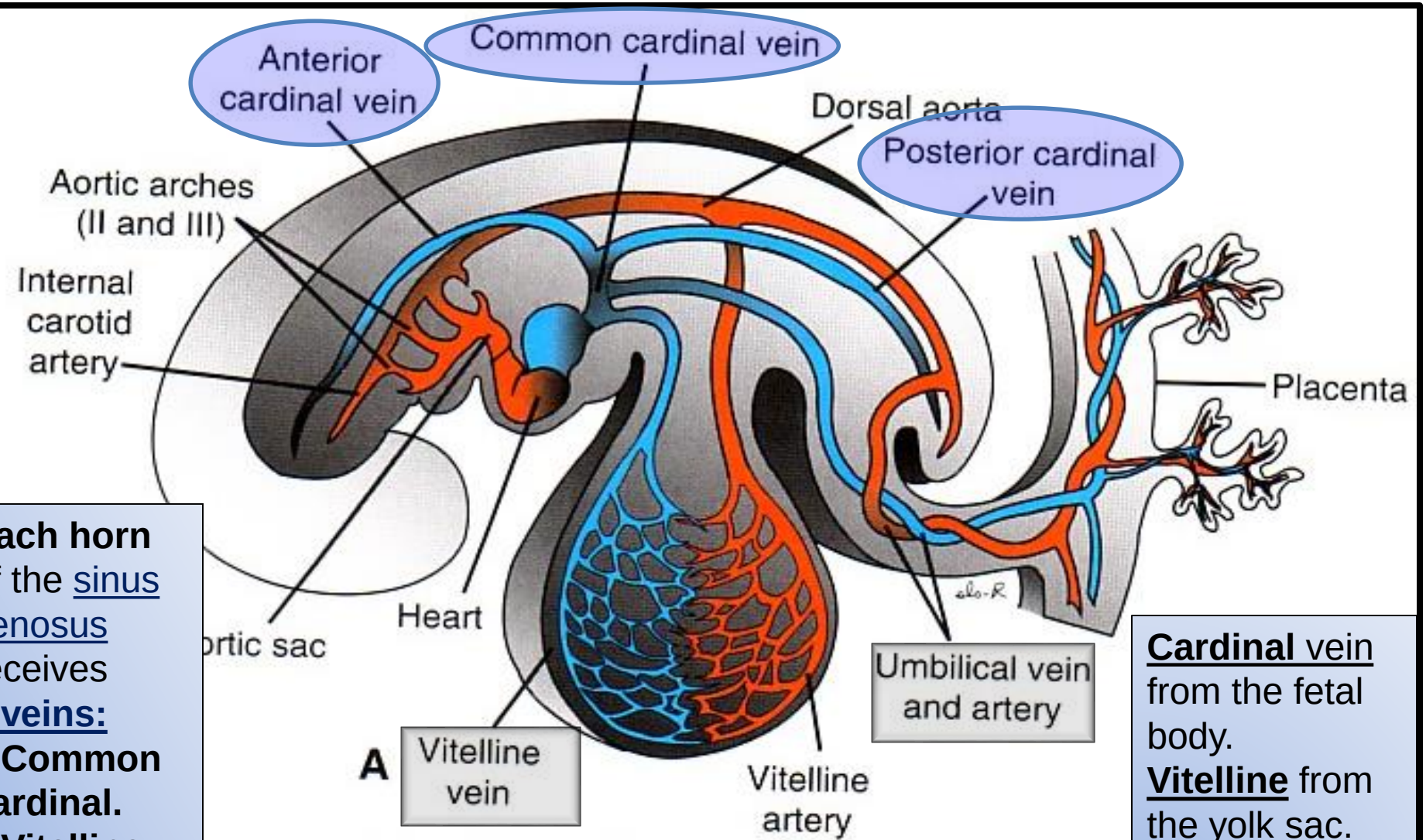


- **With** further development **the heart** tube bends**, upon itself**:

SO, the atrium and sinus venosus become dorsal to the truncus arteriosus, bulbus cordis, and ventricle.

- By this stage the sinus venosus has developed into a body and **2** lateral expansions, called the **2 horns** (right and left horns).

Veins Associated With Heart Development



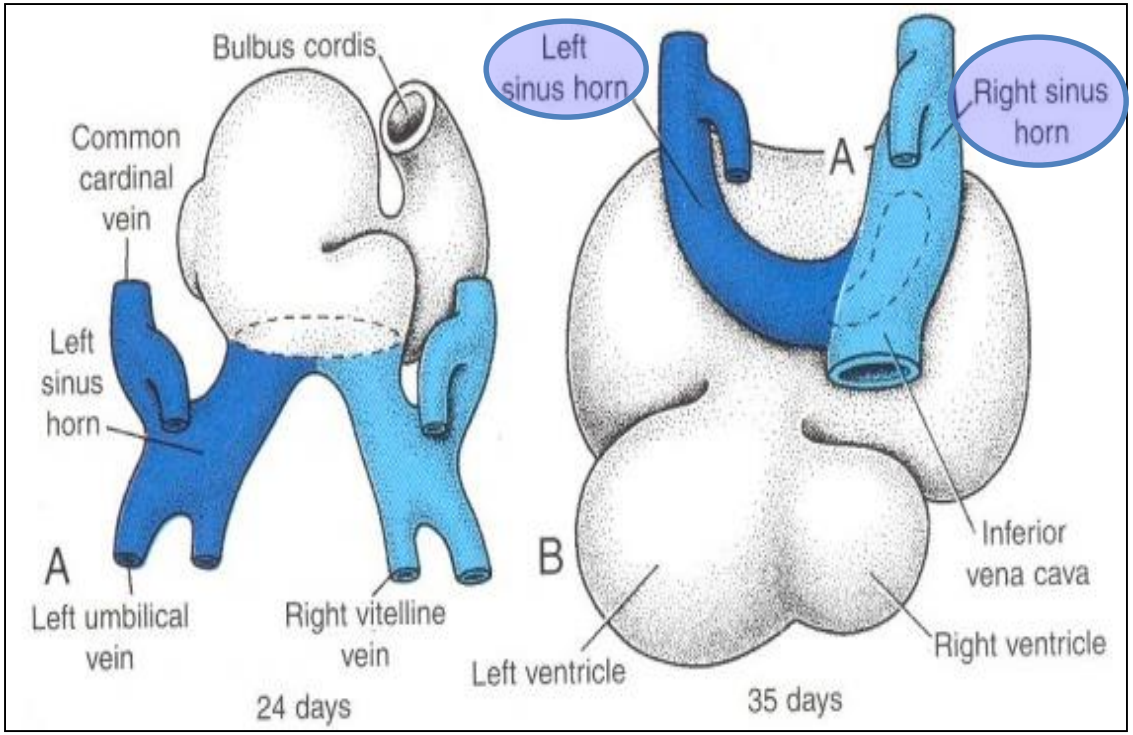
Each horn of the sinus venosus receives **3 veins:**

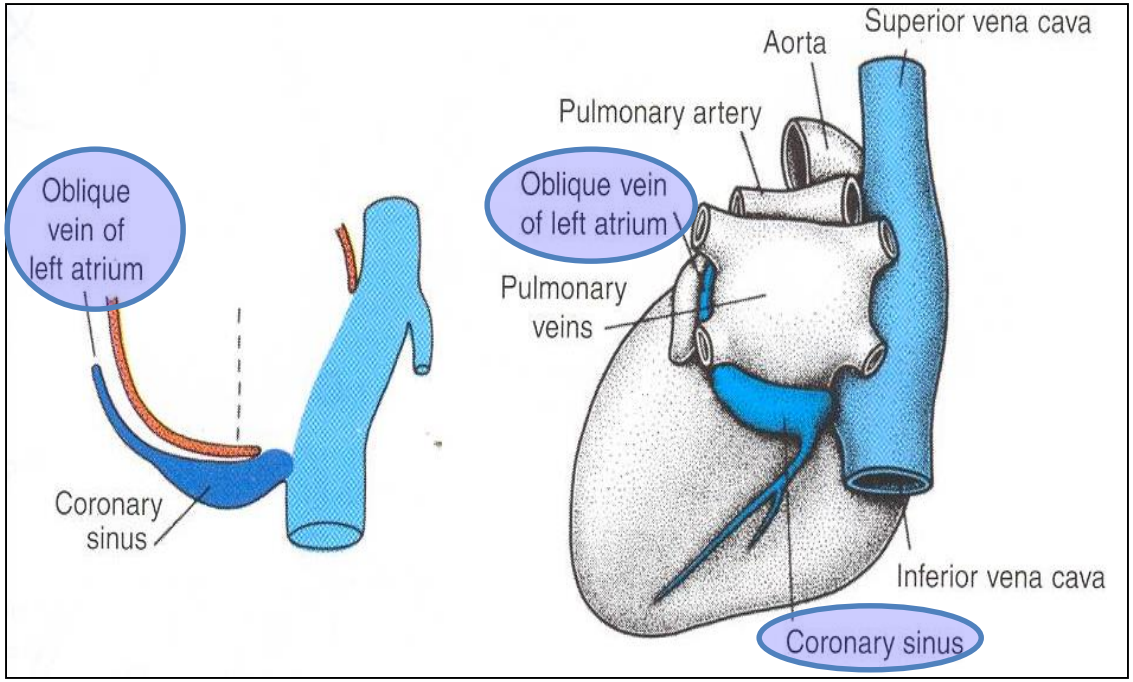
1.Common cardinal.
2.Vitelline.
3.Umbilical.

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

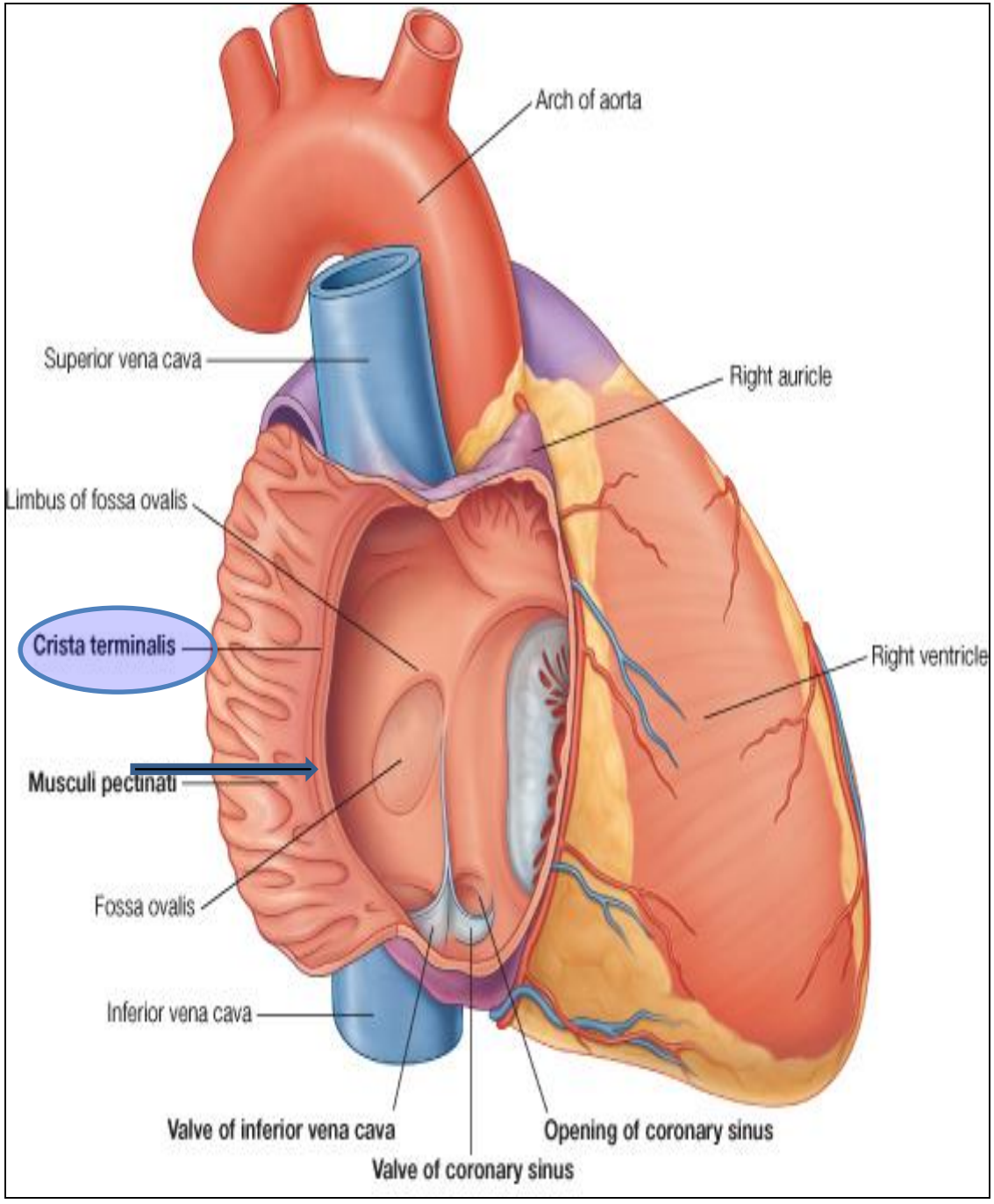
Fate of Sinus Venosus

- 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**.

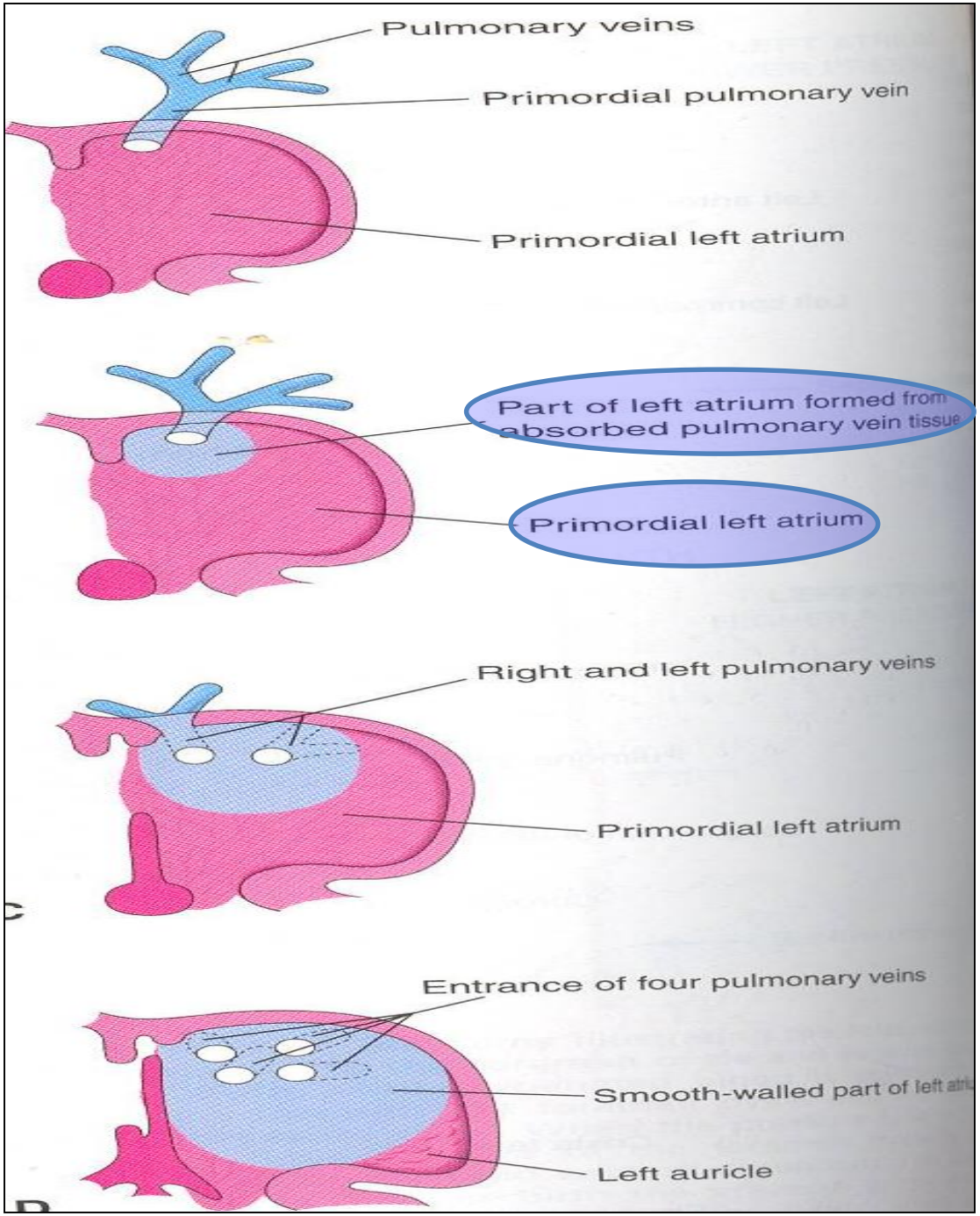




Right Atrium



- 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:*** derived from the primitive or common primordial atrium.
- ***The smooth part:***

derived from the absorbed part of the *Pulmonary Veins*.

Partitioning of Primordial Heart

Partitioning of:

1- **Atrioventricular canal.**

2- **Common atrium.**

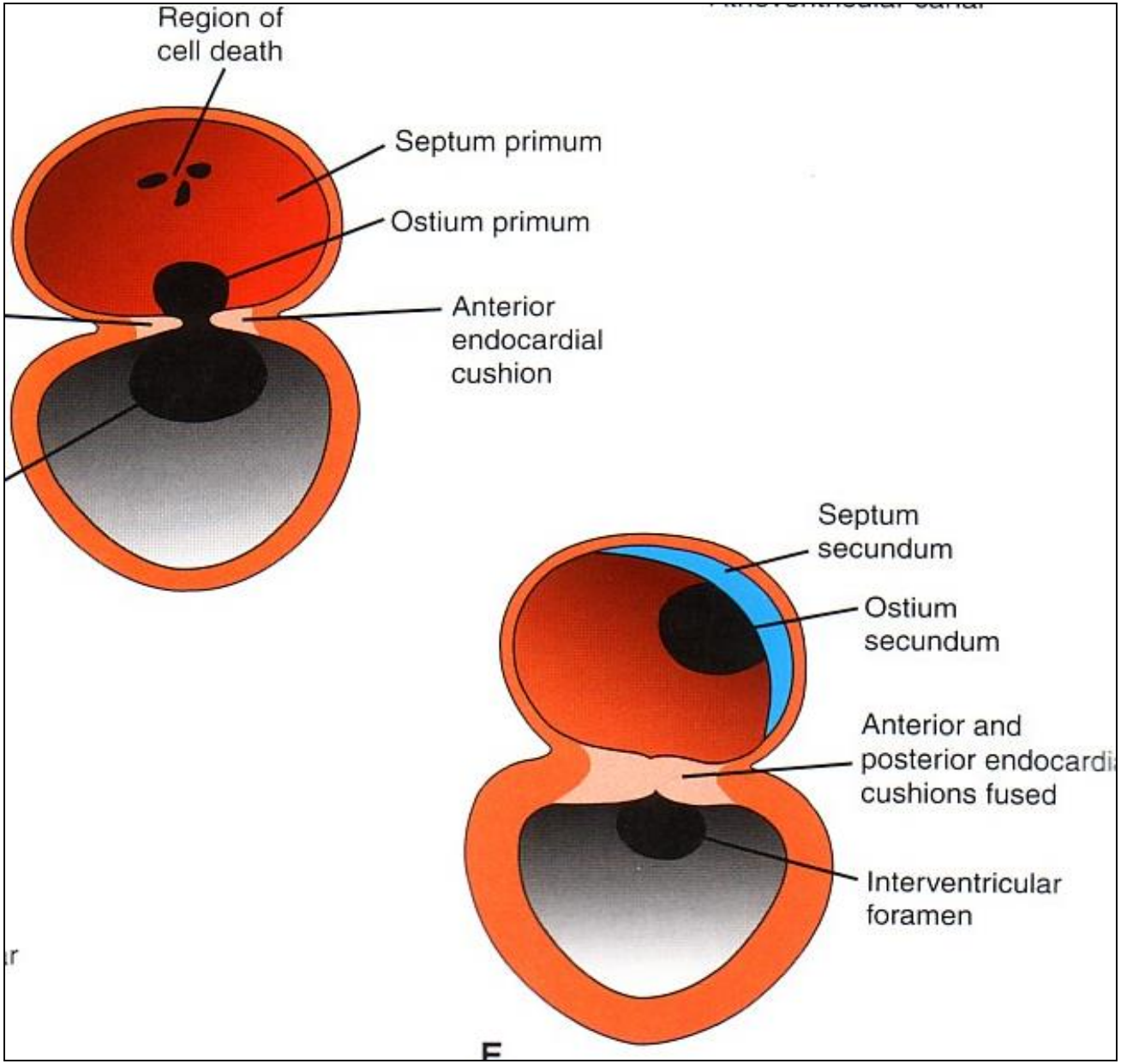
3- **Common ventricle.**

4- **Bulbus cordis.**

5- **Truncus Arteriosus.**

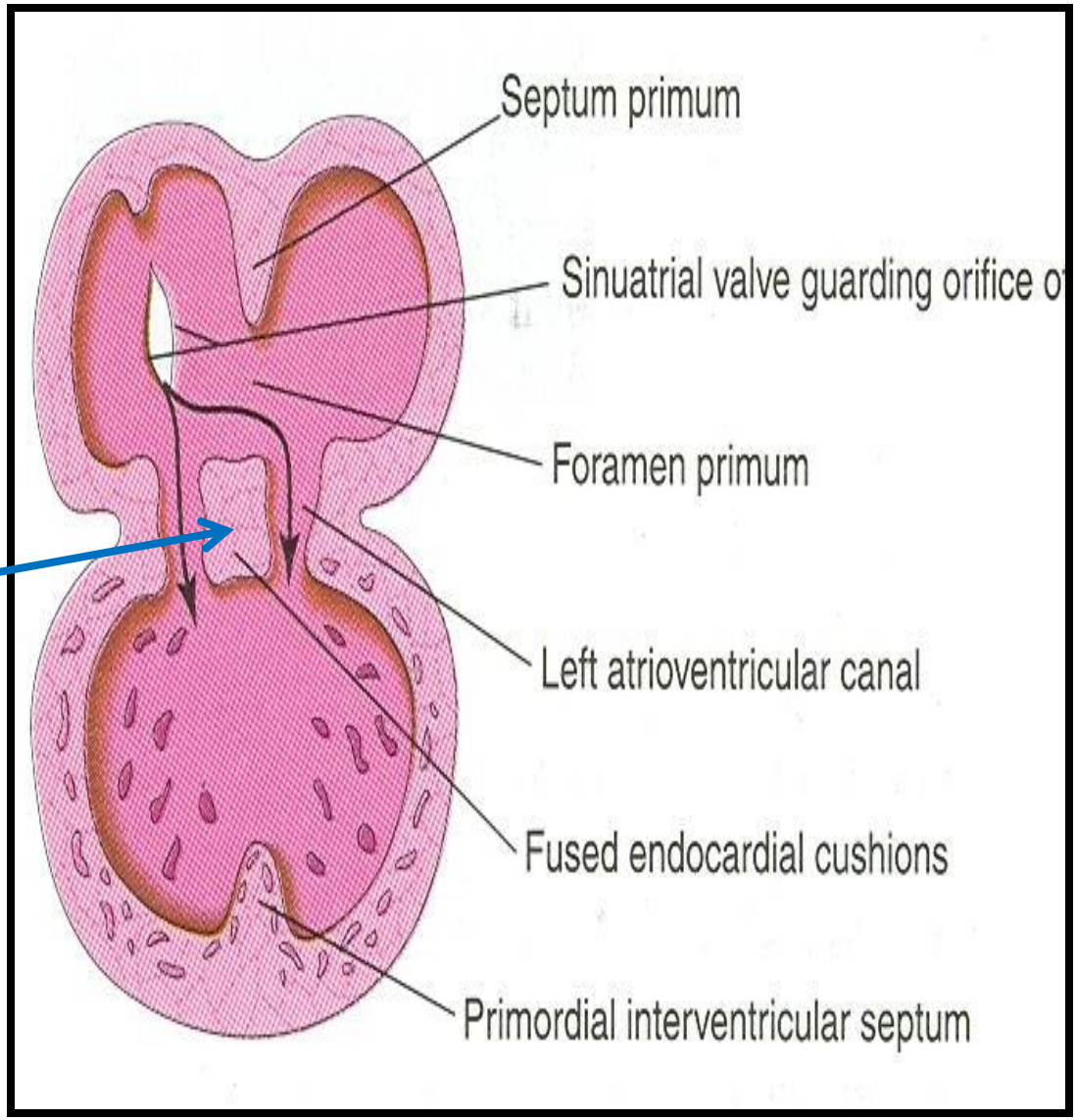
It begins by the **middle** of **4th** week.

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



Partitioning of the atrioventricular canal

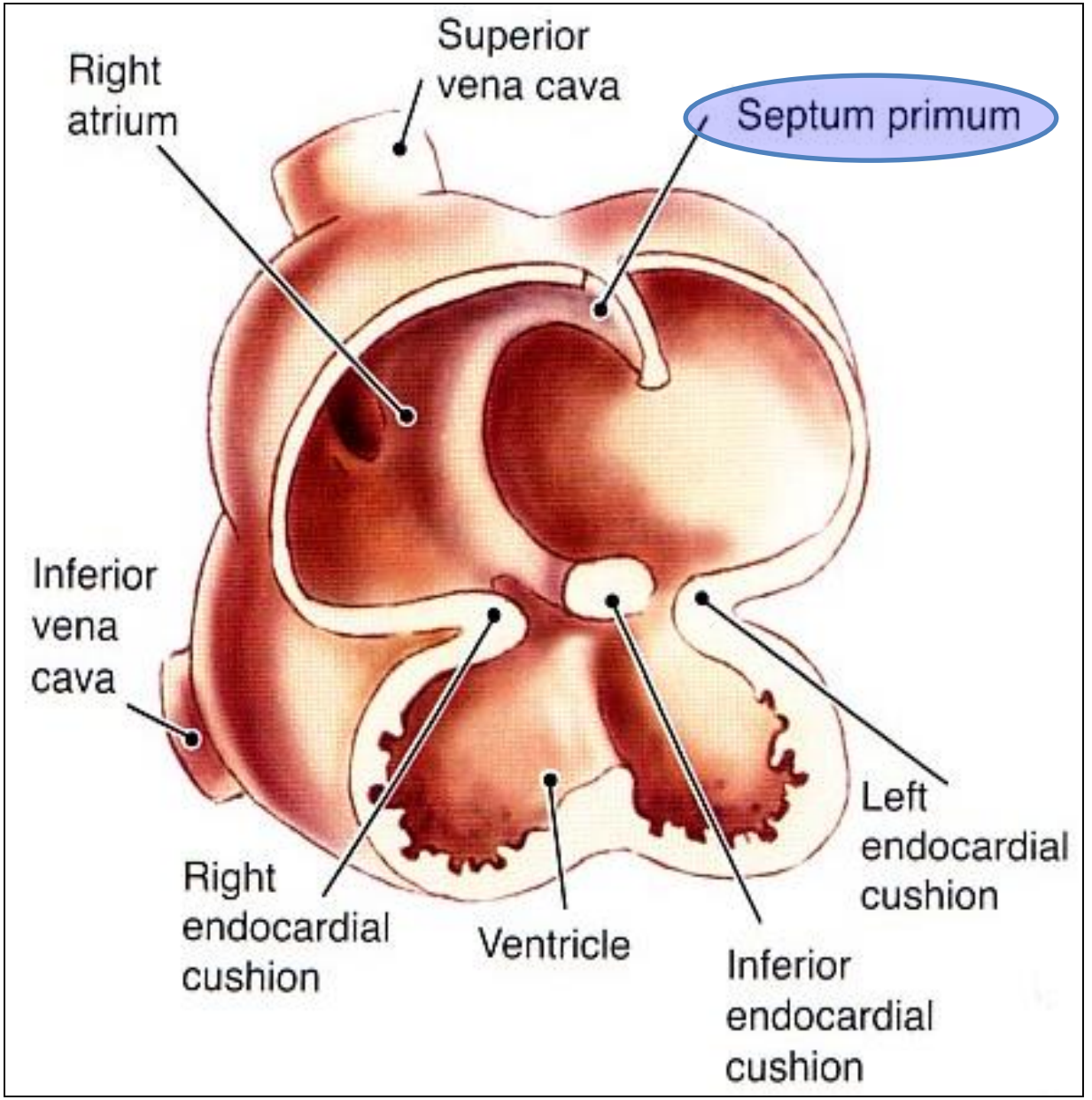
- **Two** anterior and posterior (ventral & dorsal) subendocardial cushions are formed on walls of the AV canal.
- The AV subendocardial cushions approach each other and fuse together to form the **septum intermedium.**
- Dividing the AV canal into right & left canals.
- These canals partially connect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



Partition of the common atrium

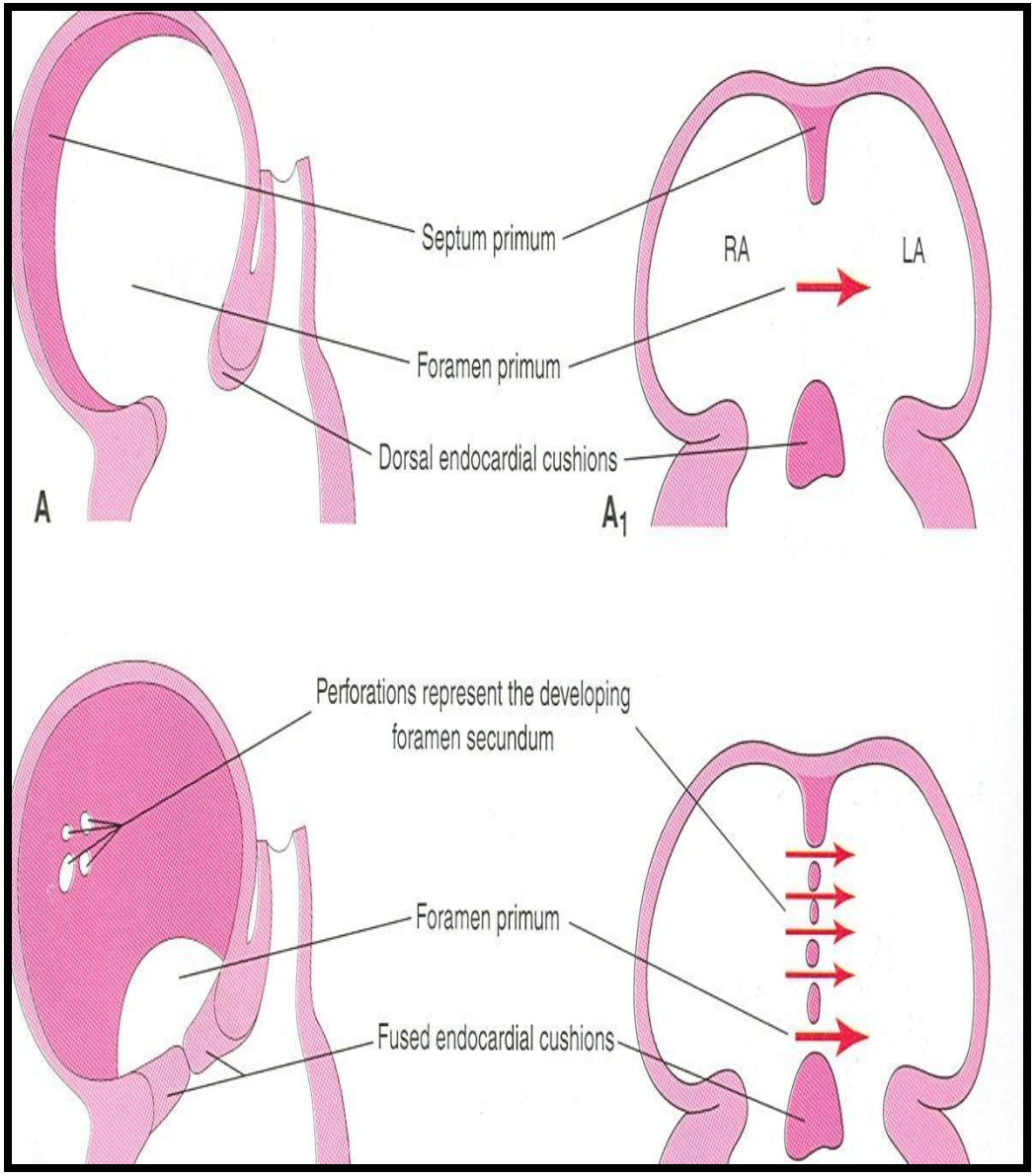
Septum Primum

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



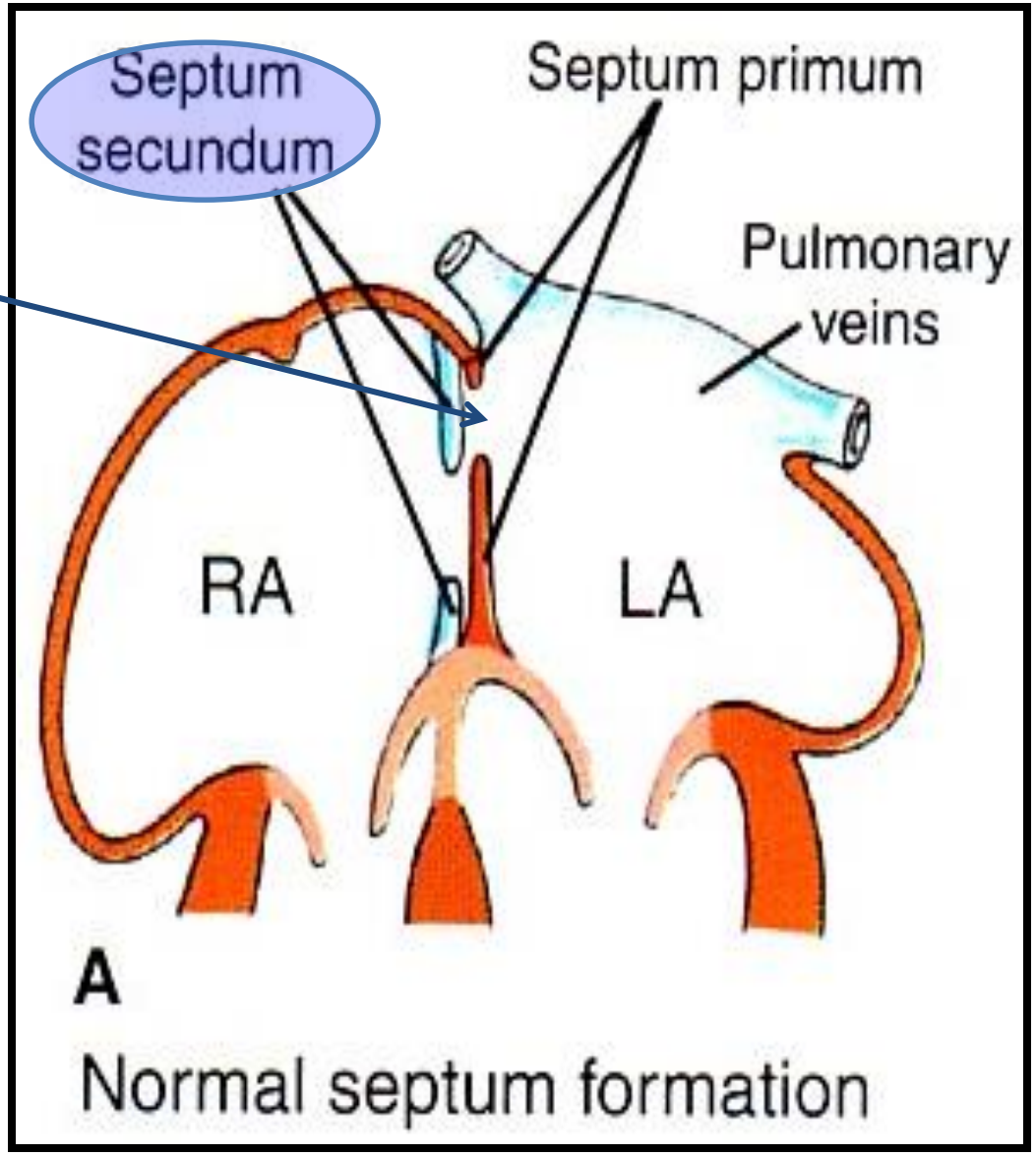
Ostium Primum

- **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 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 completely fused with subendocardial cushions (septum intermedium) to form the interatrial septum.

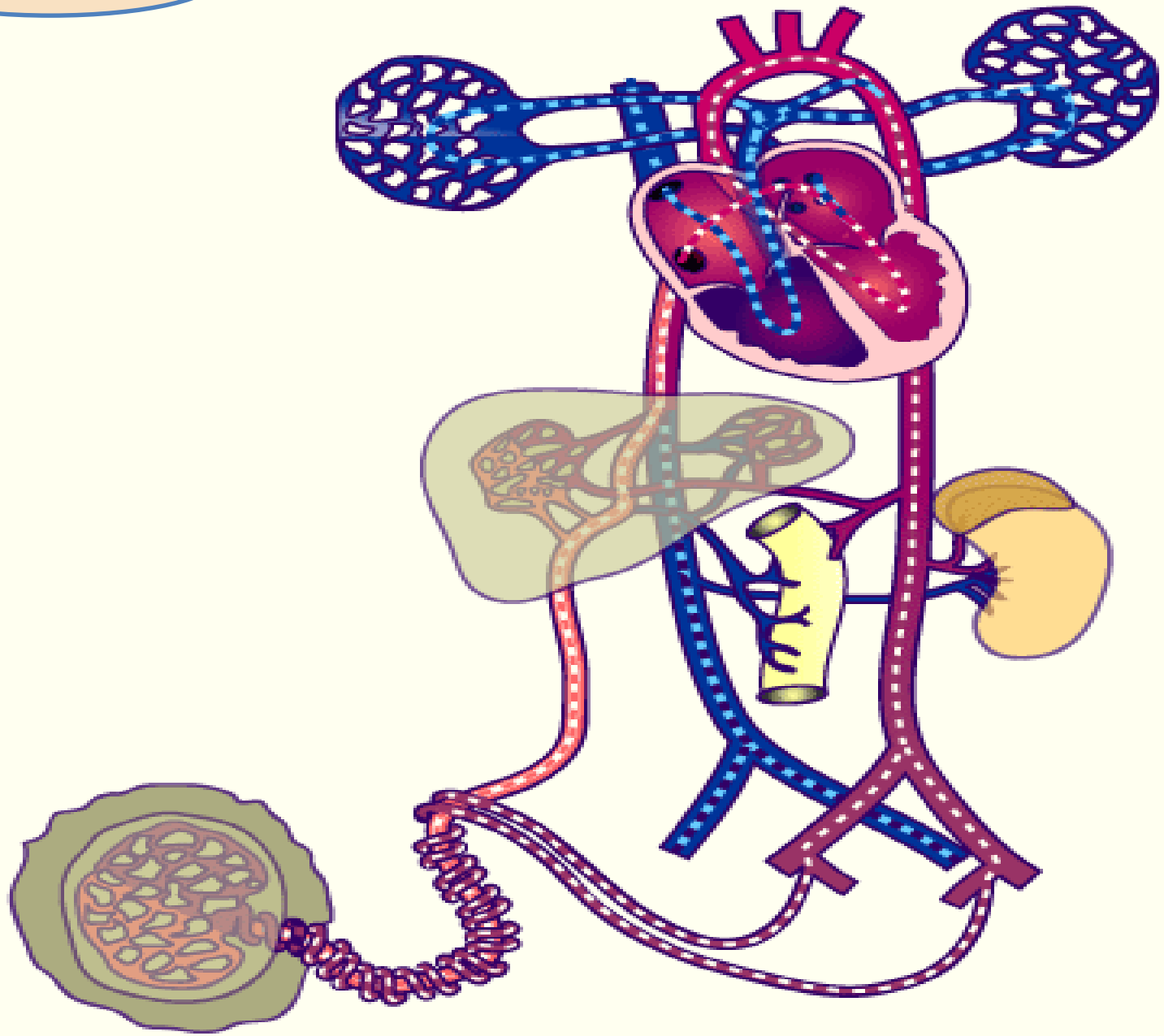


Septum Secundum

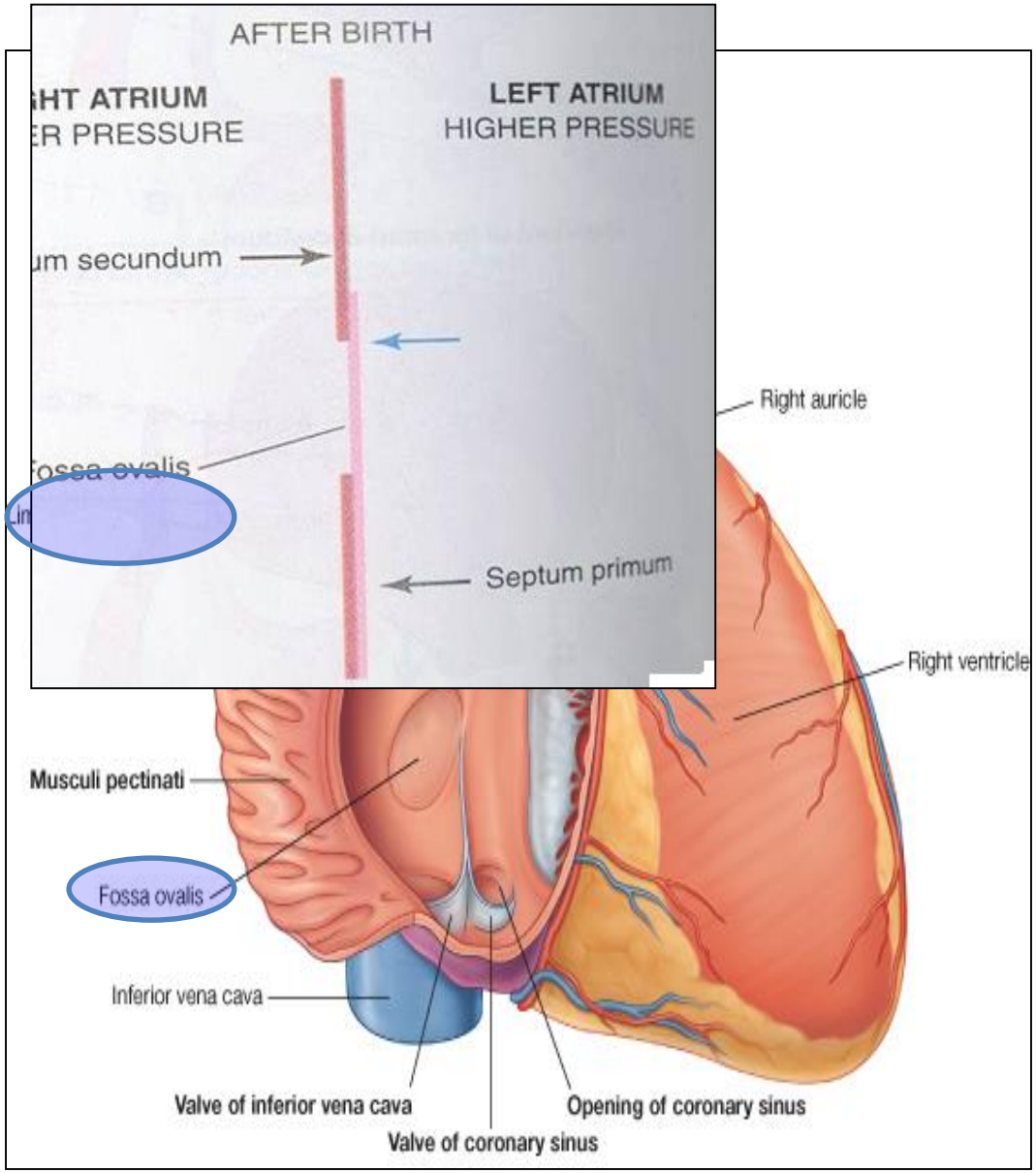
- The upper part of septum primum that is attached to the roof of the common atrium shows gradual resorption forming an opening called **ostium secundum.**
- Another septum descends on the right side of the septum primum called **septum secundum**.
- It forms an incomplete partition between the two atria.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



before birth



Fate of foramen Ovale

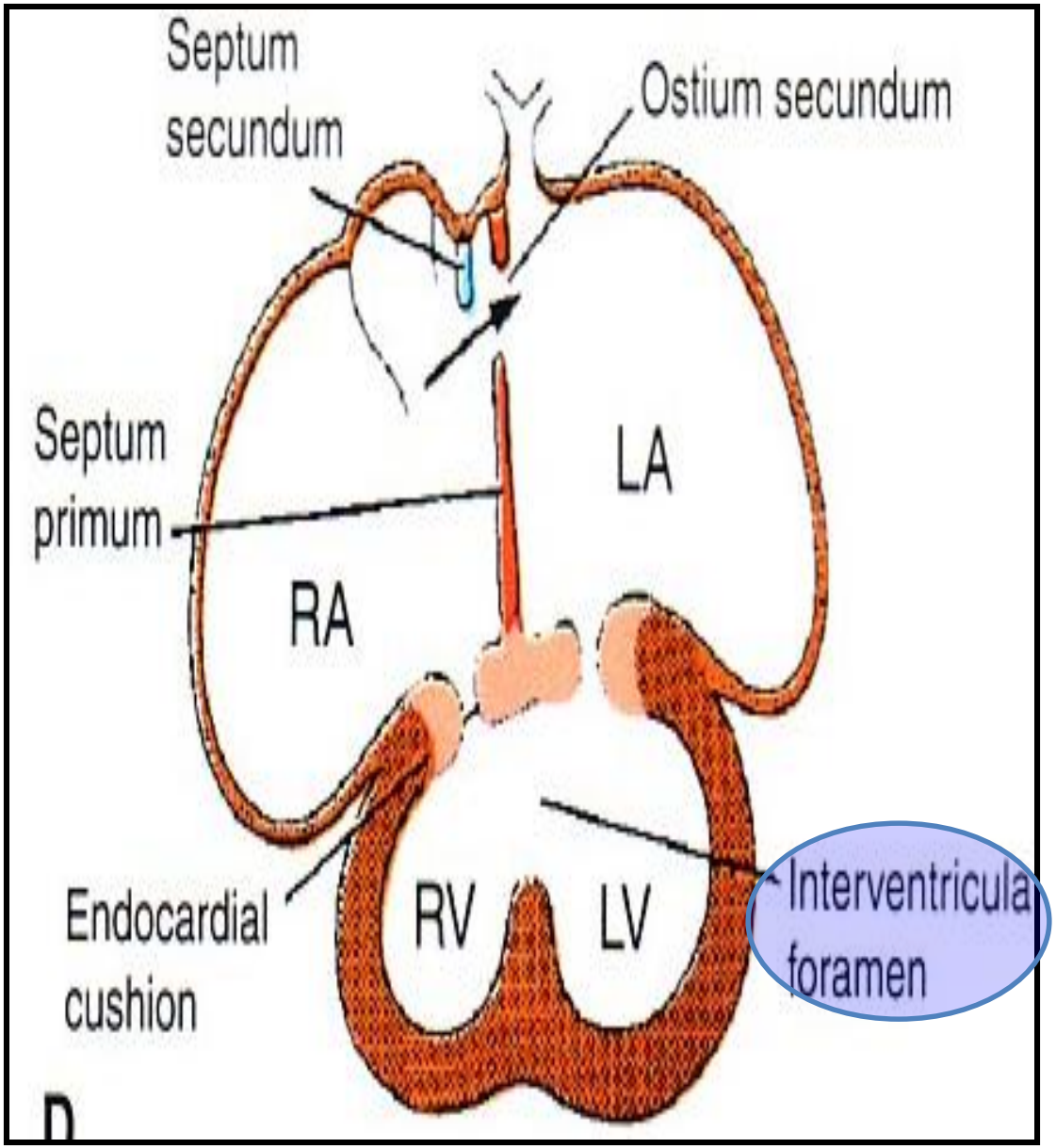


- At birth when the lungs inflated and pulmonary circulation begins the pressure in the left atrium increases and exceeds that of the right atrium.
- So the two septae oppose each other.
- Its site is represented by the **Fossa Ovalis.**
- The septum primum forms the **floor of the fossa ovalis.**
- The septum secondum 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 **2** ventricles called **interventricular foramen, (IVF).**



Interventricular Septum

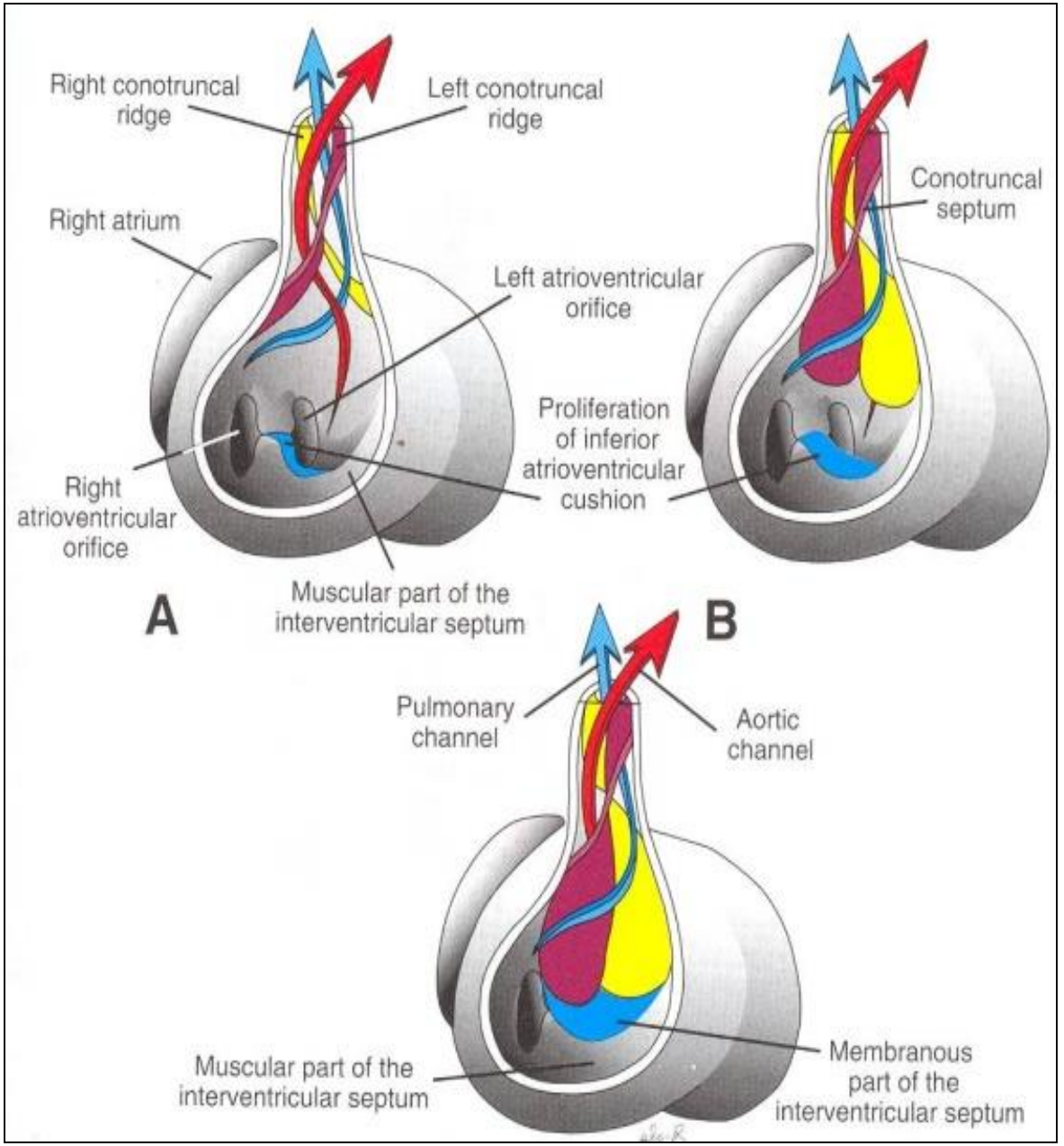
Membranous part of IV septum:

It is derived from:

1- A tissue extension from the right side of the endocardial cushion.

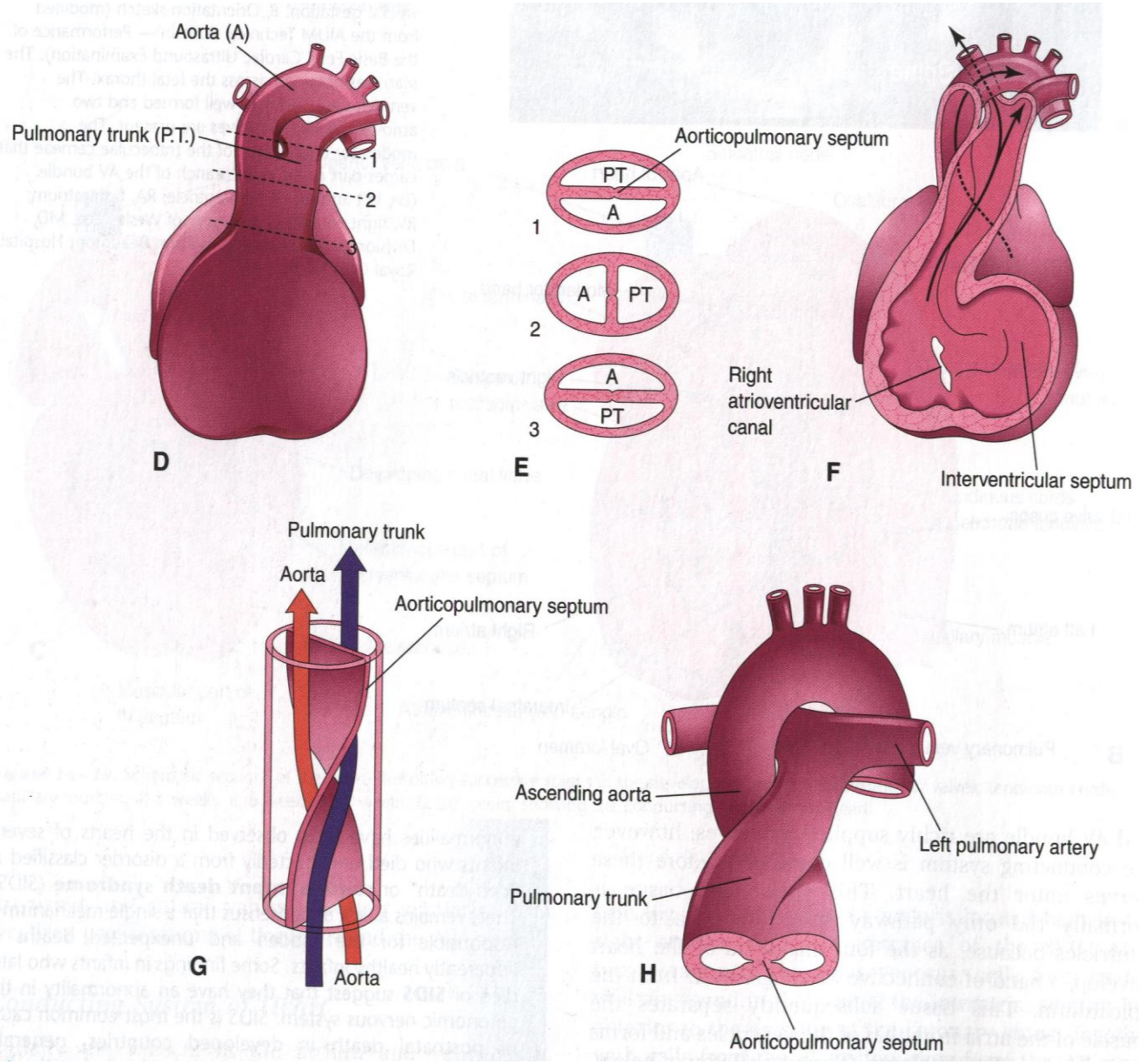
2- Aorticopulmonary septum.

3- Thick muscular part of IV septum.



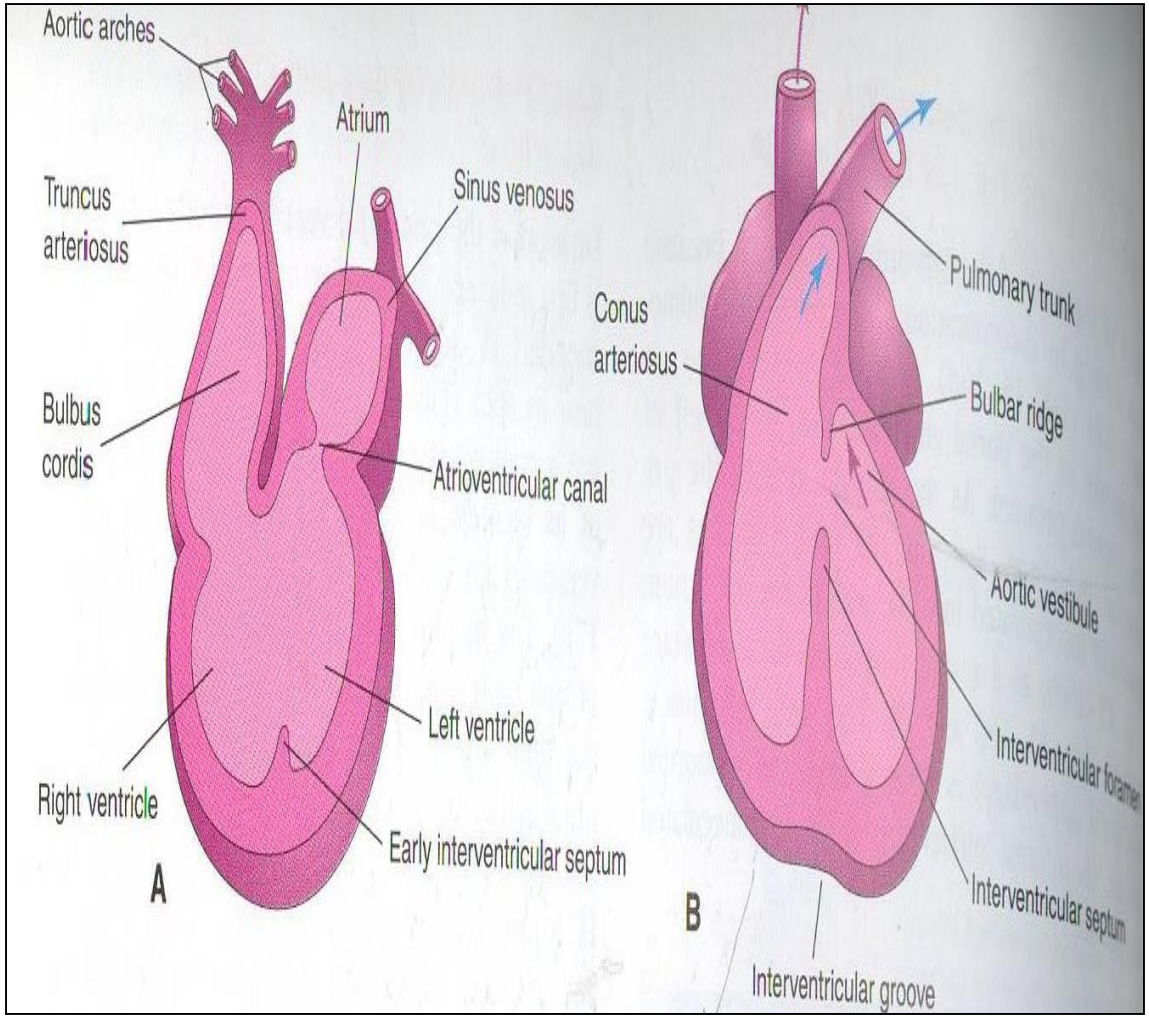
Spiral Aorticopulmonary Septum

- 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.**

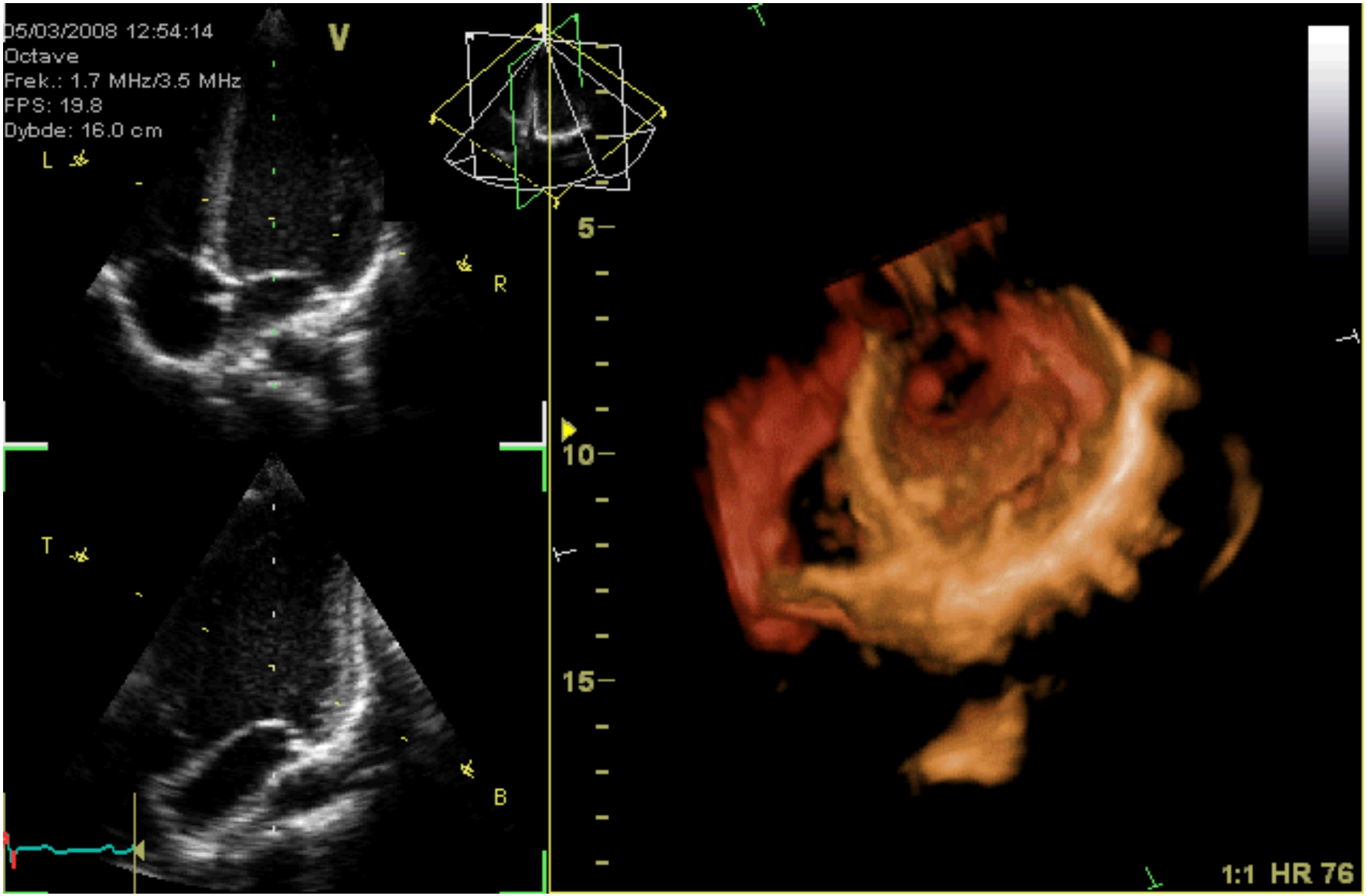


BULBUS CORDIS

- **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.**

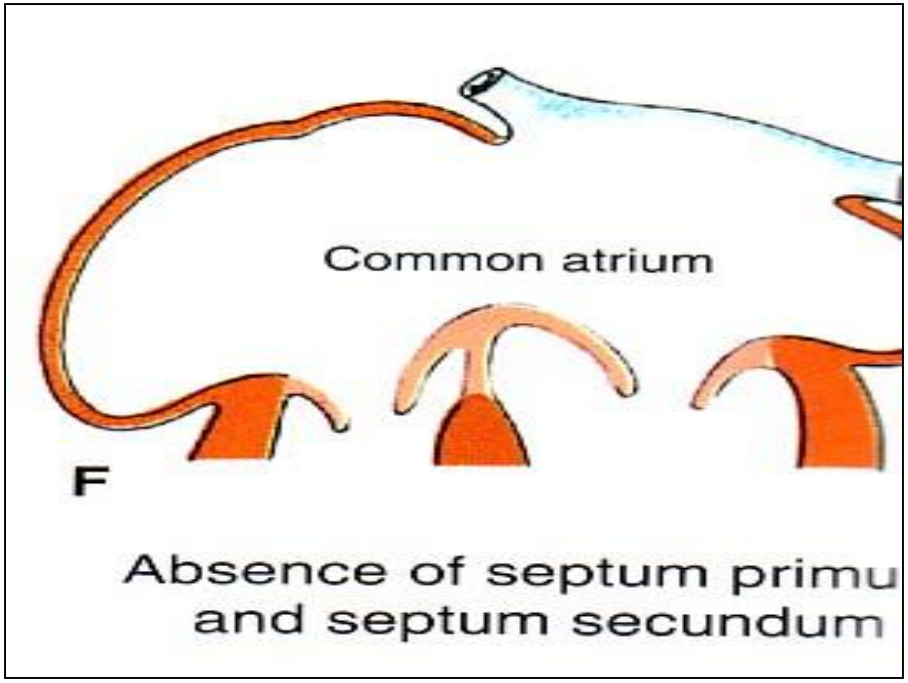


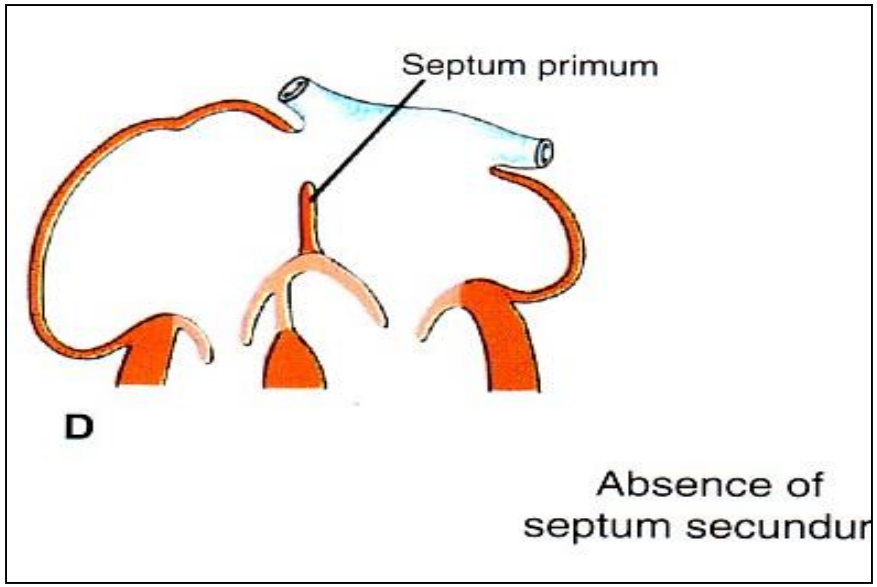
MAJOR CARDIAC ANOALIES



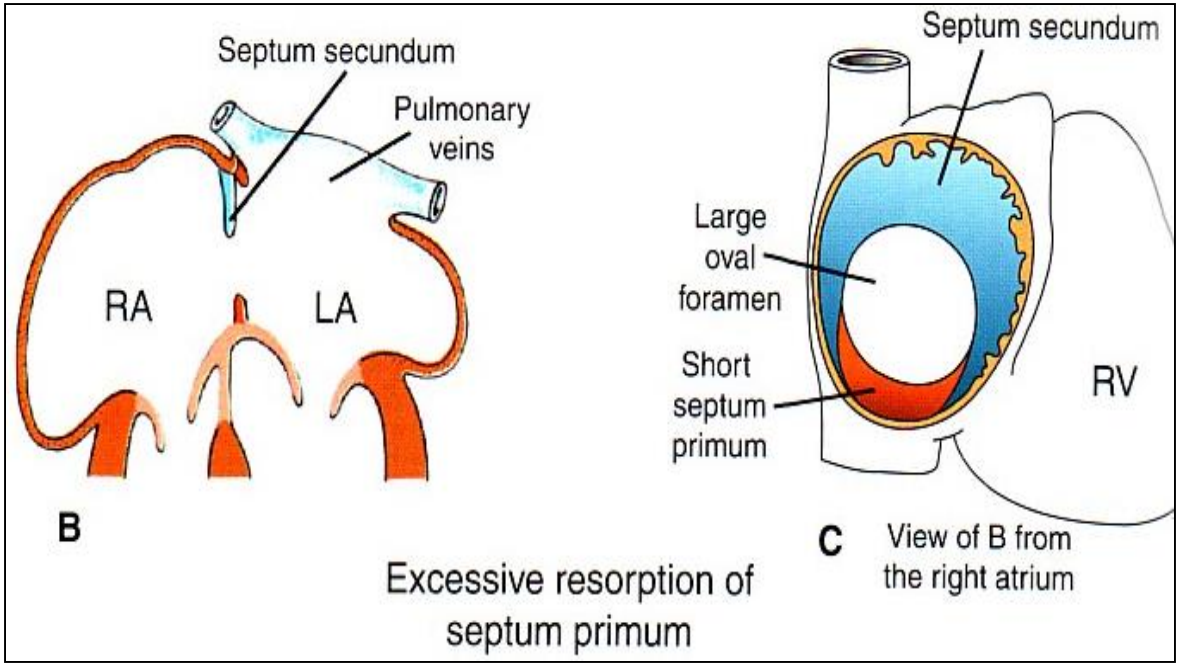
Atrial Septal Defects (ASD)

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

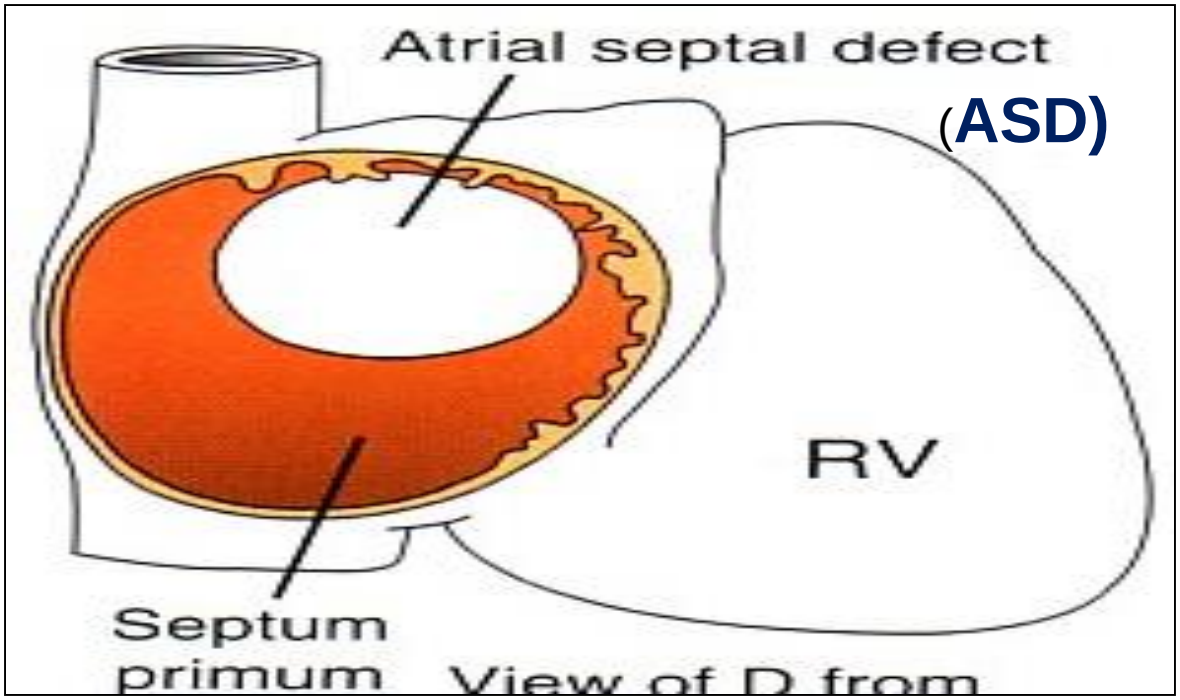




Excessive resorption of septum primum (ASD)

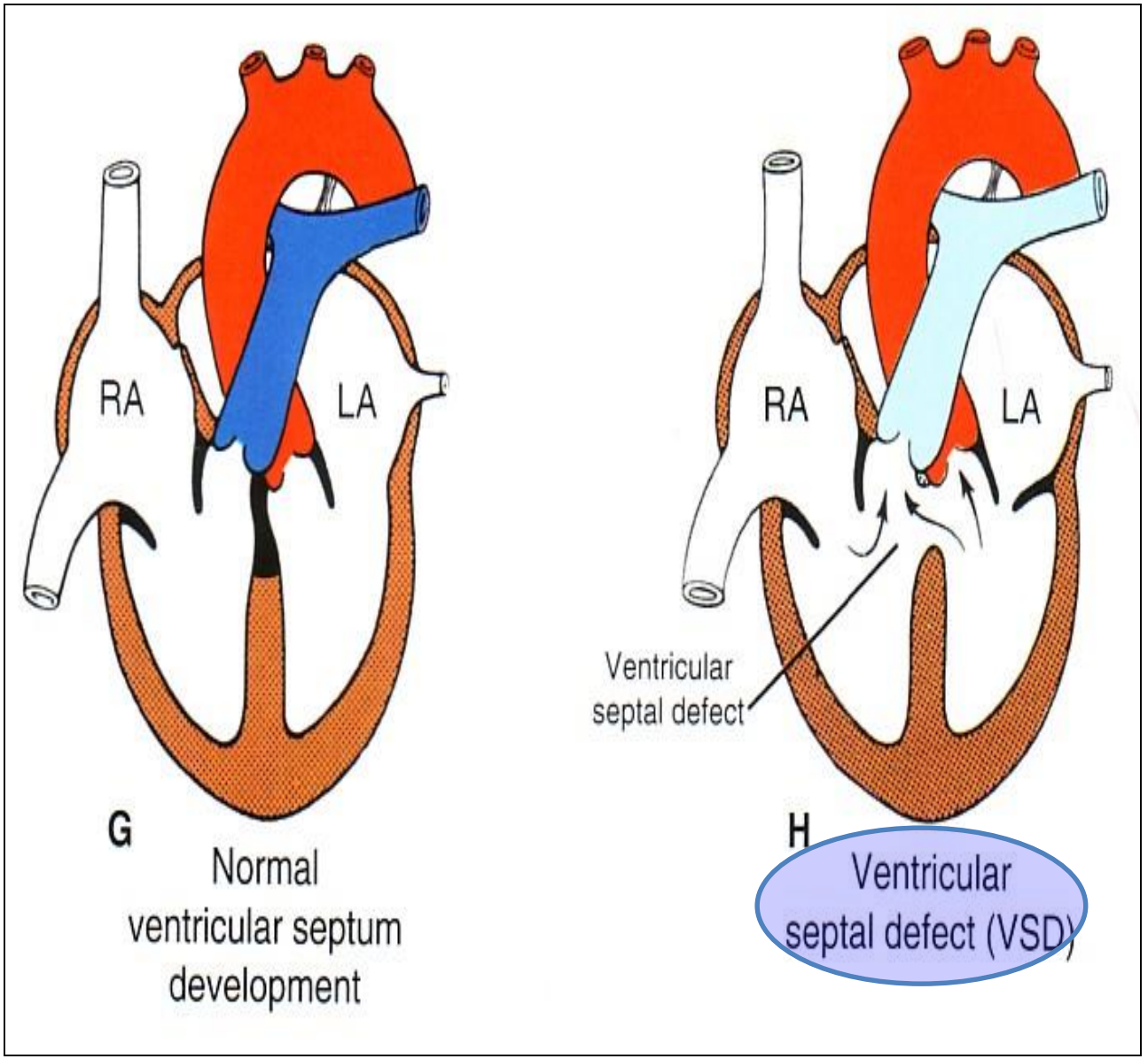


Patent foramen ovale



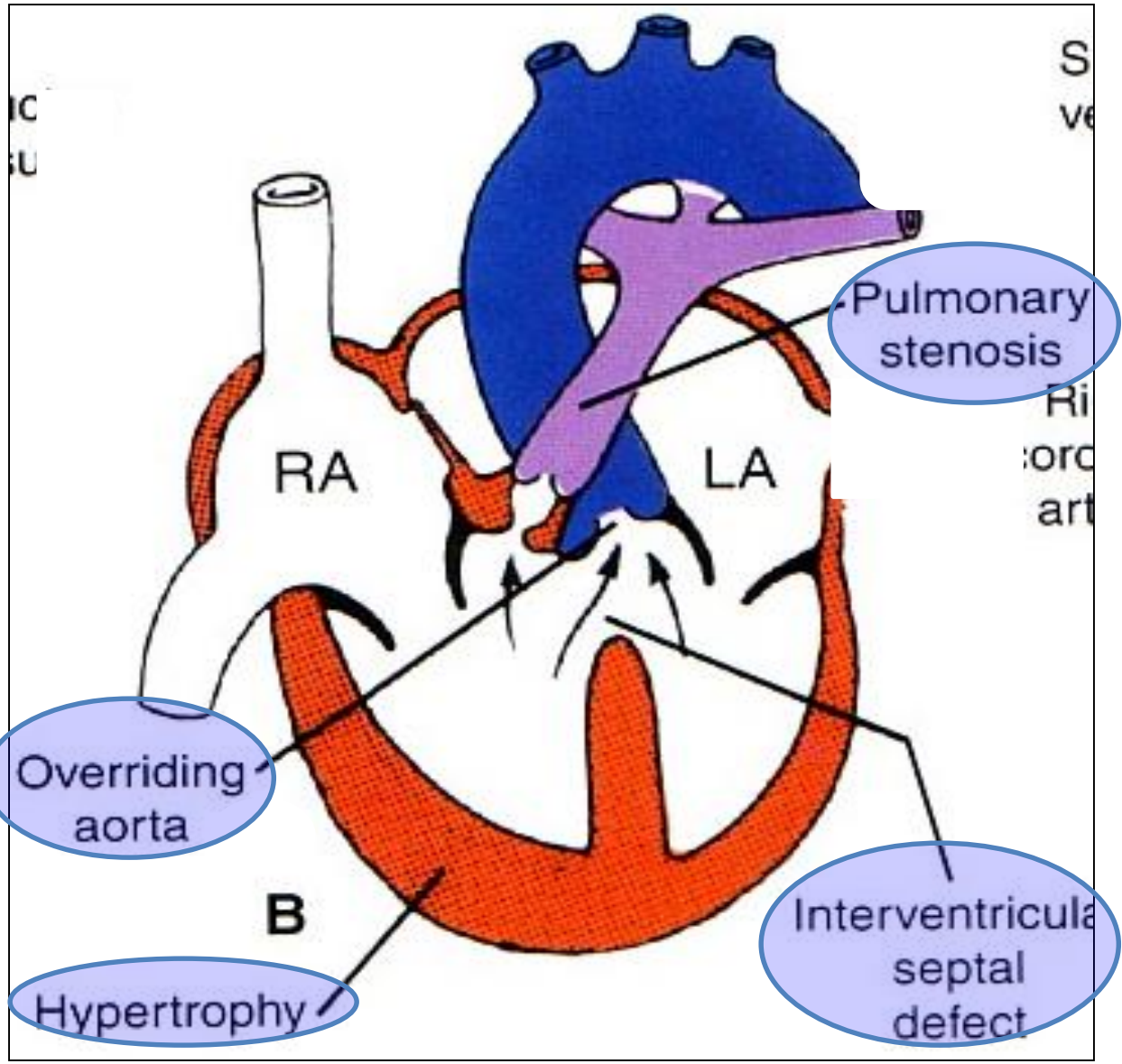
VENTRICULAR SEPTAL DEFECT (VSD)

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

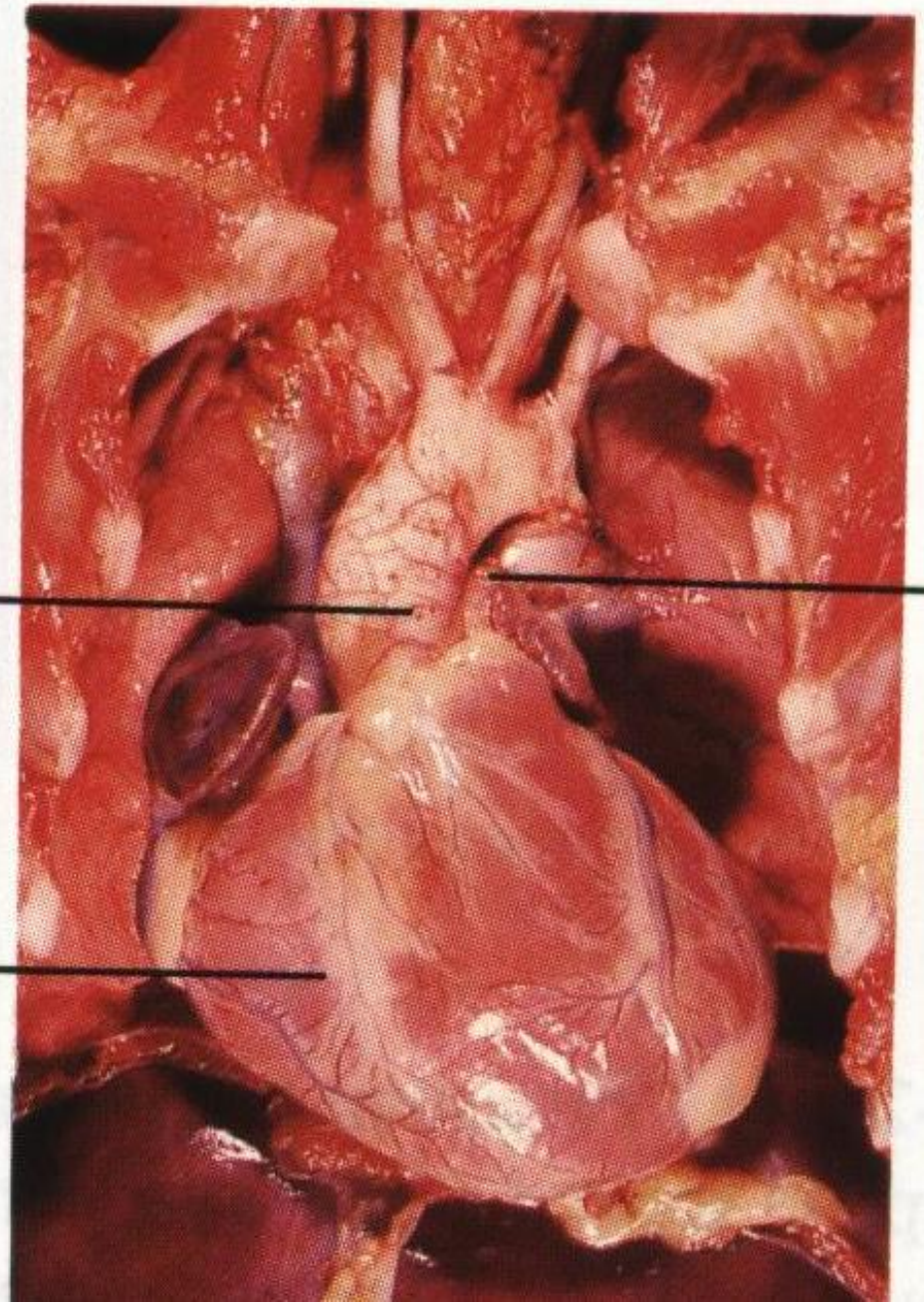


TETRALOGY OF FALLOT

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



TETRALOGY OF FALLOT



Overriding aorta

Stenotic pulmonary trunk

Enlarged right ventricle

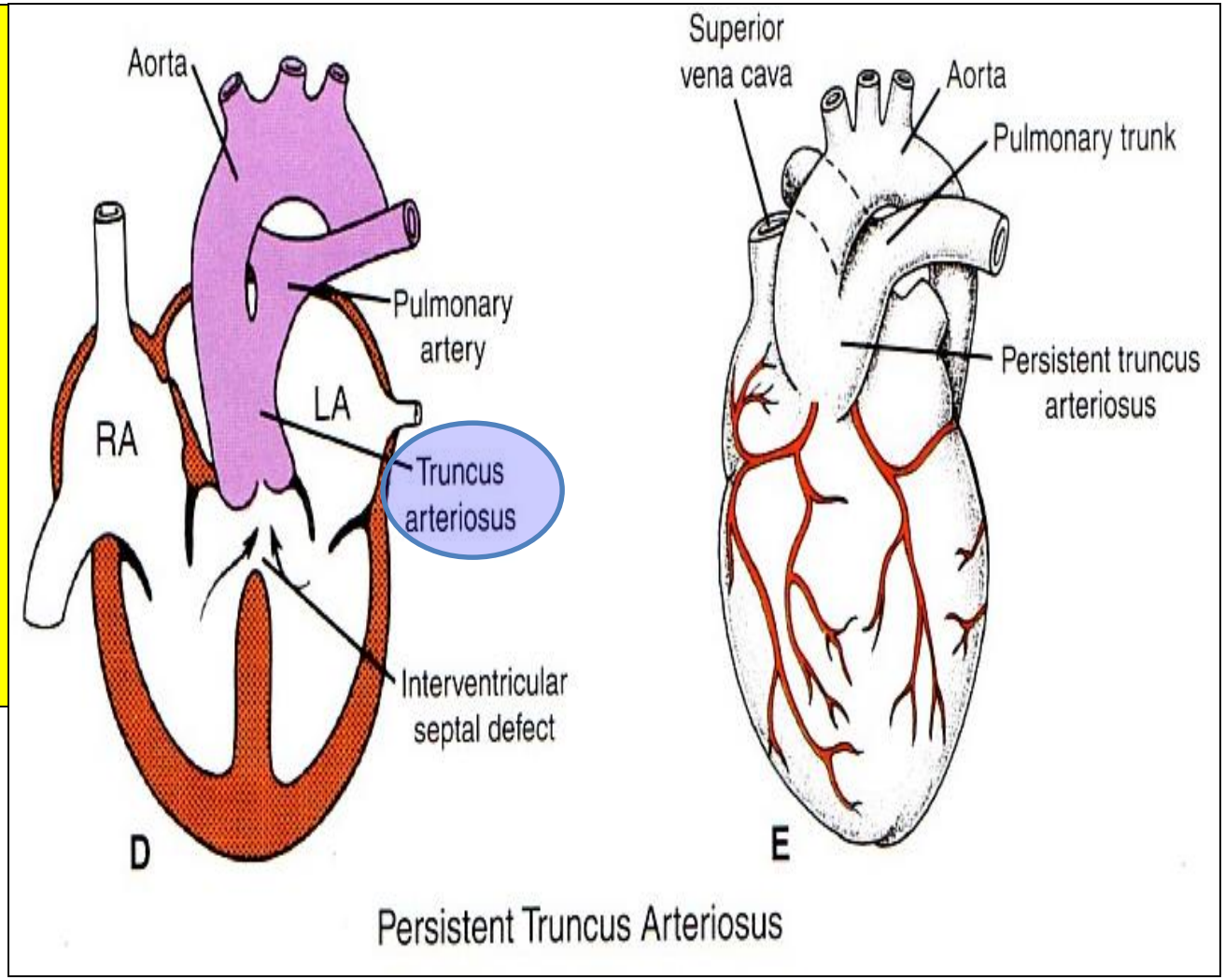
Blue Baby

(TGA) TRANSPOSITION OF GREAT ARTERIES

- **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.
- 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.

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AND GOOD
LUCK