

Done by: *maya. alrefae*  
 Corrected by: *Tasnim. ahmed*

the development of heart

① \* the heart development starts in middle of the third week

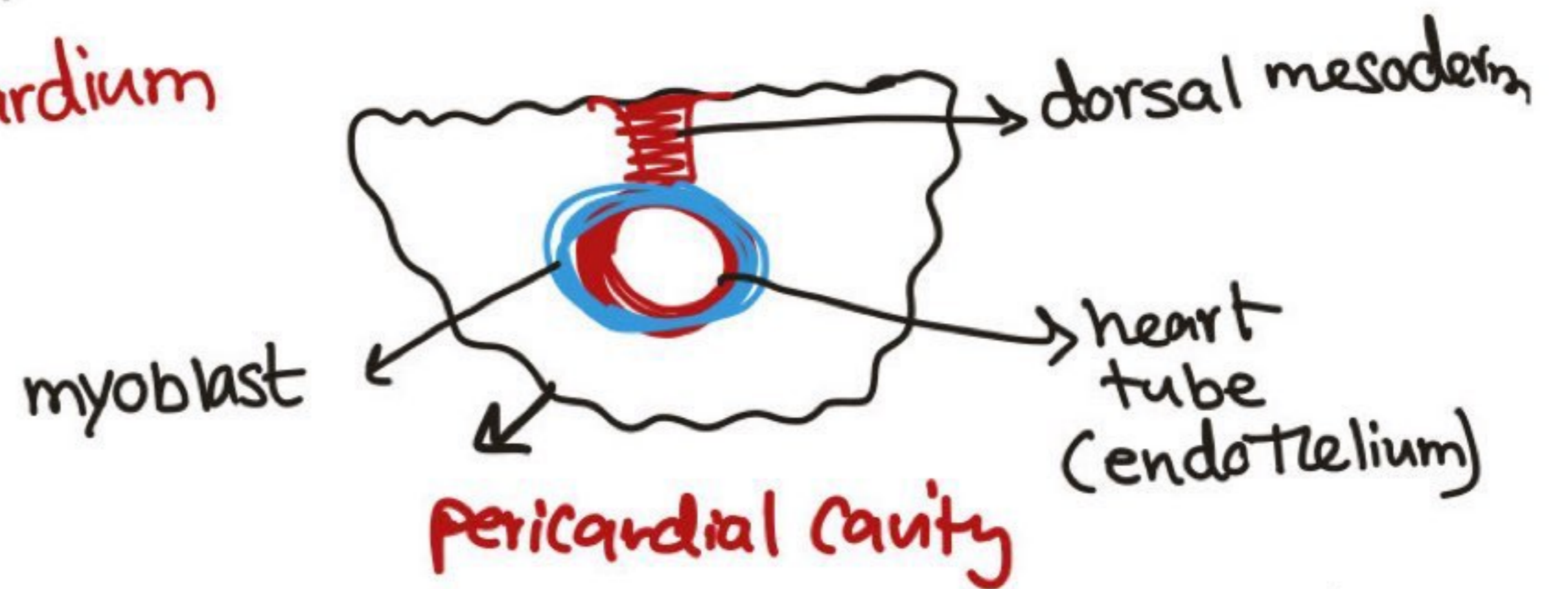
② \* the heart develops in splanchnic layer of lateral plate of mesoderm (where contains Cardiac Progenitor cells)

doctro don't mention this

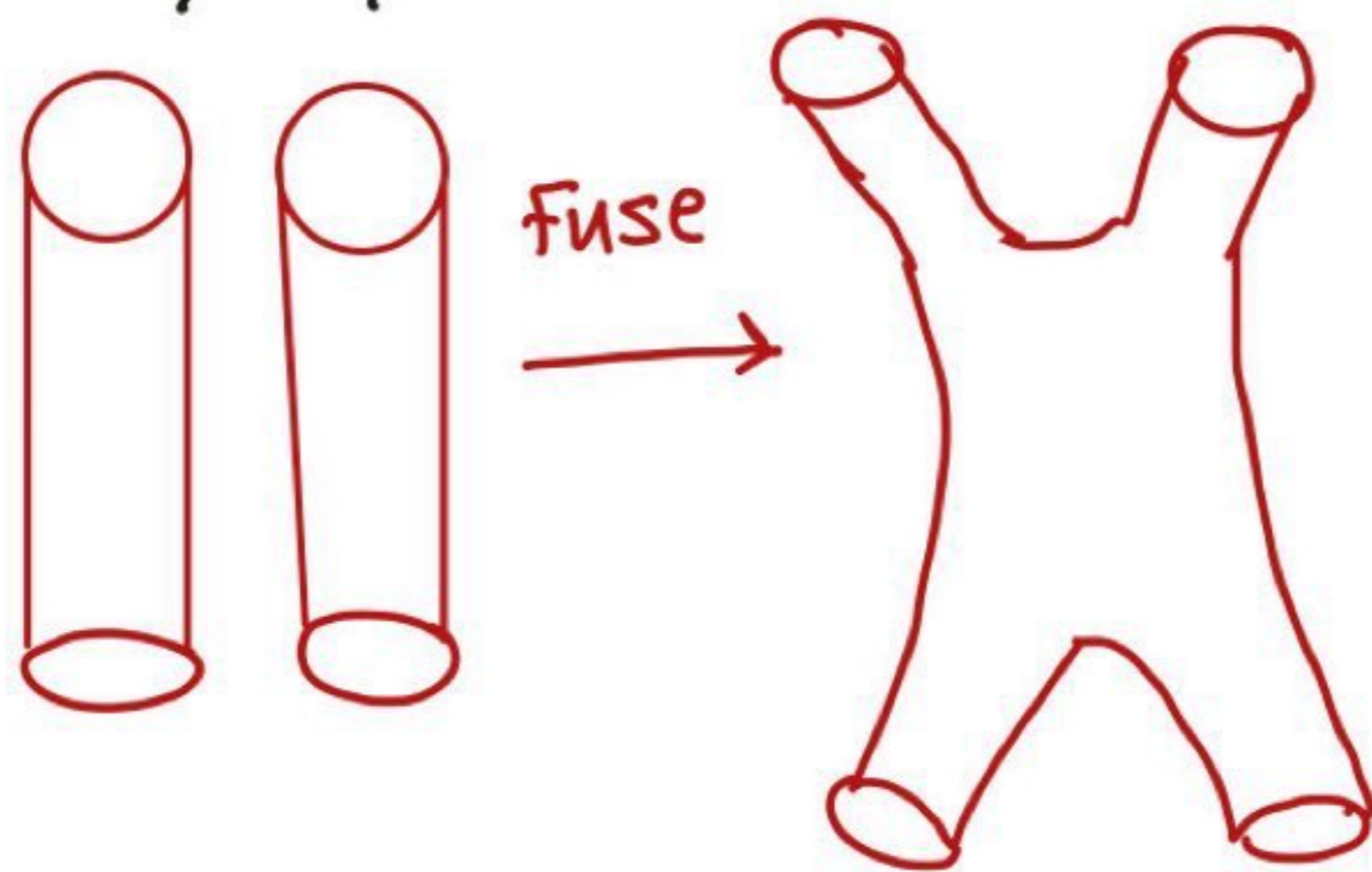
③ \* endoderm secrete growth factor to mesoderm (VEGFs) to divide and give Angioblast (vessels + Heart) + Hemoblastic cell (blood cells)

④ \* two heart vessels develop in mesoderm and during folding two heart vessels fuse to give single endocardial tube + one pericardial cavity

⑤ \* Some mesoderm connect pericardial cavity with Heart tube forming dorsal mesocardium



⑤ \* single endocardial tube is lined by endothelial and surrounds by myoblast



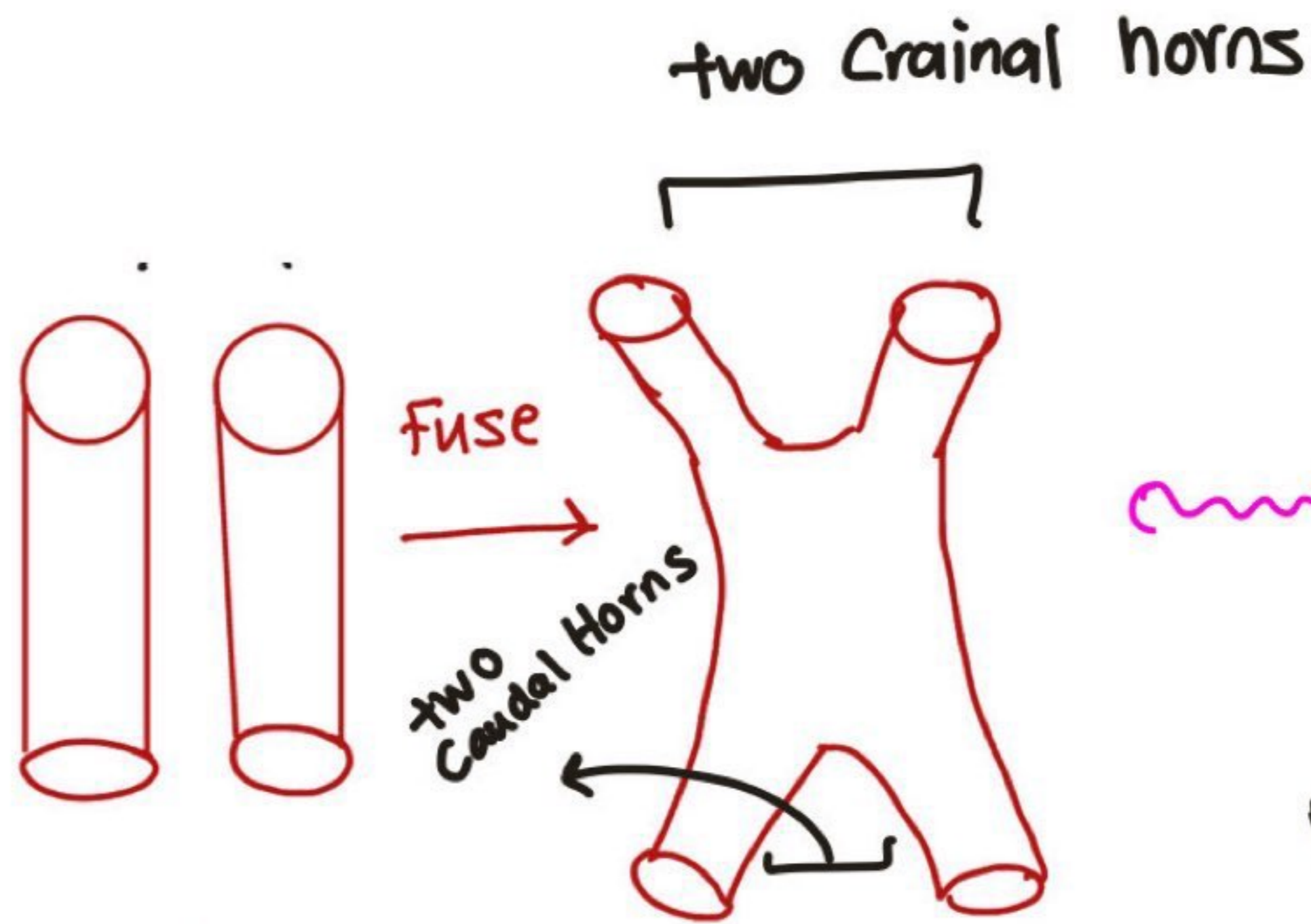
\* the heart develops crainally to caudally

يبقى ذن الرأس حتى ما يدخل على ال chest

So cardiogenic field lies cephalic to oropharyngeal membrane + neural plate  
 يكون رأسي (فوق) ال دماغ + العفم

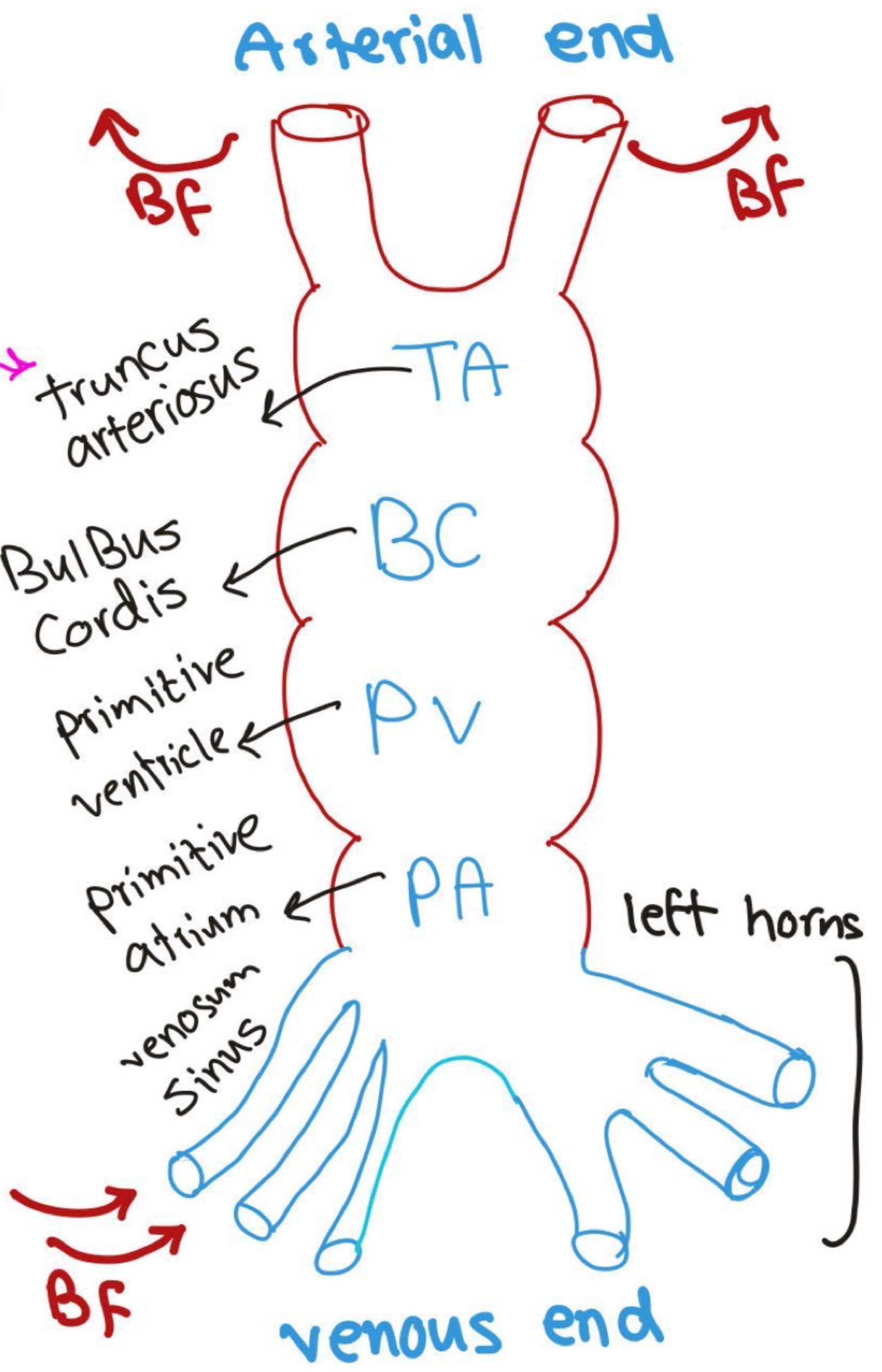
on fourth week due to cephalic fold + lateral fold the two endocardial tubes moves to future thoracic cavity + meet in middle line.



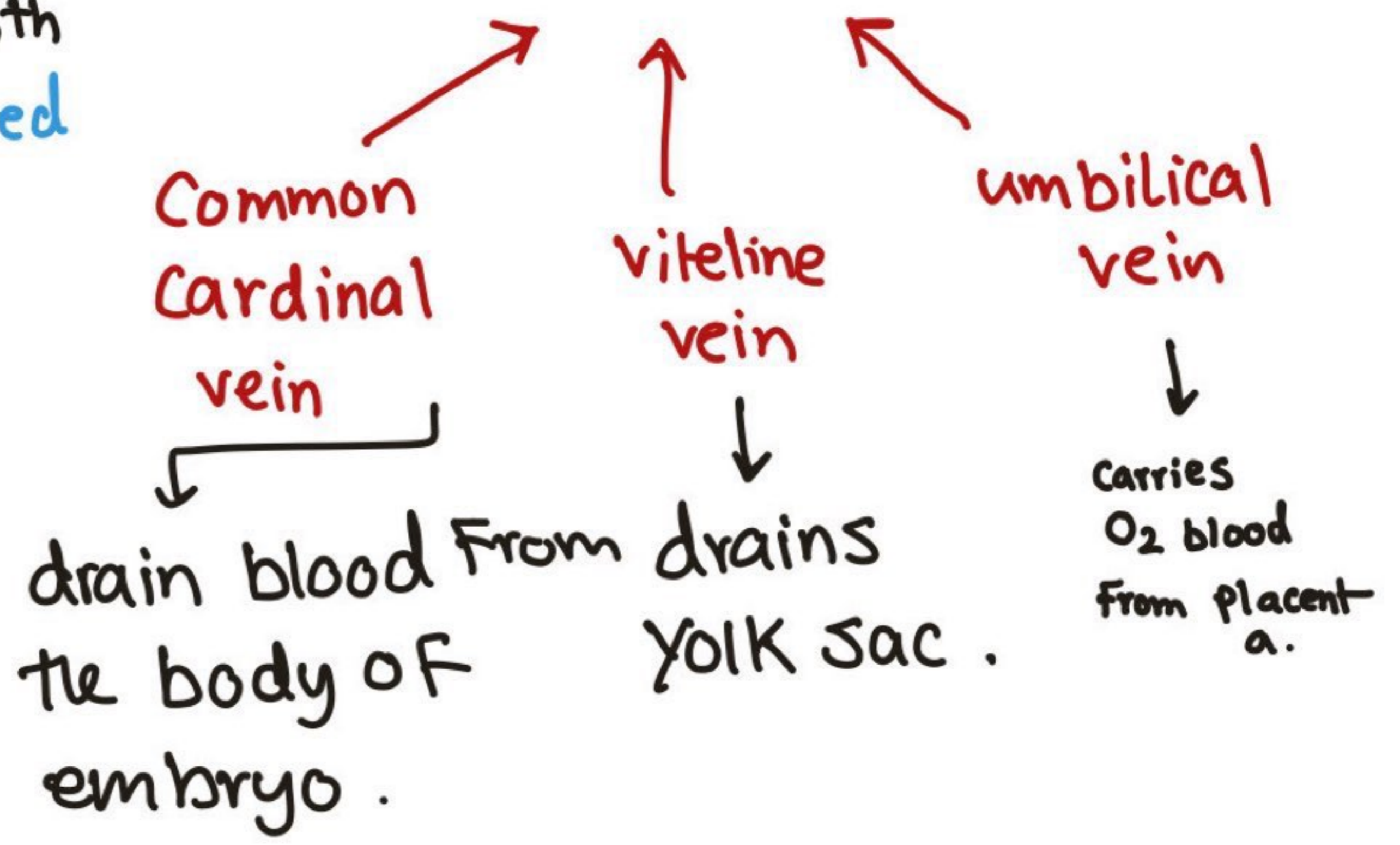


On 19<sup>th</sup> Day the endocardial tube is changed into 2 endocardial tubes which are connected to the 2 primitive aorta.

1. **Sinus venosus** consists of a small central part receiving 2 (left and right) sinus horns.
2. **Primitive atrium.**
3. **Primitive ventricle** separated from the atrium by the atrio-ventricular sulcus.
4. **Bulbus cordis** separated from the ventricle by the bulboventricular sulcus.

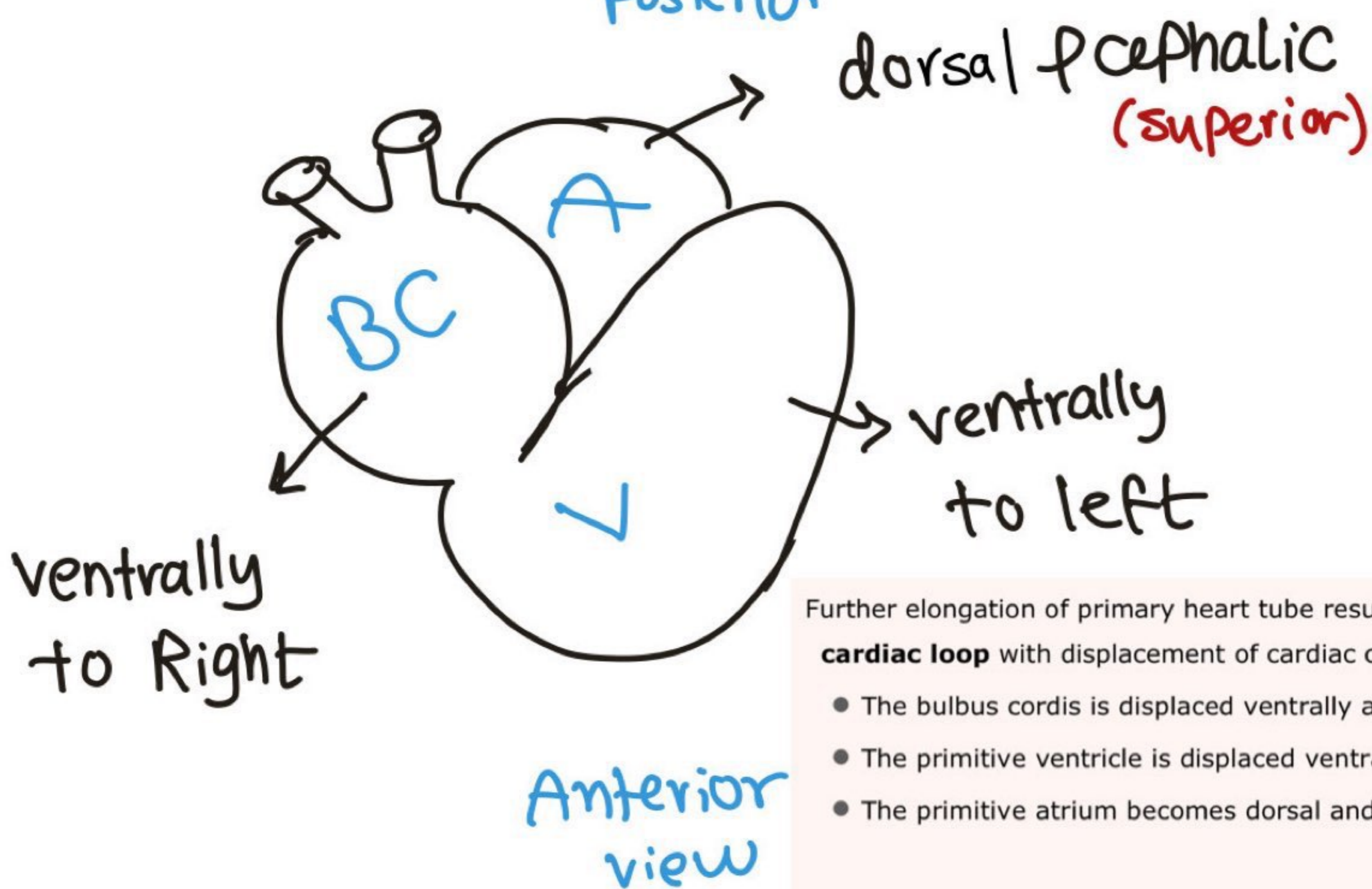
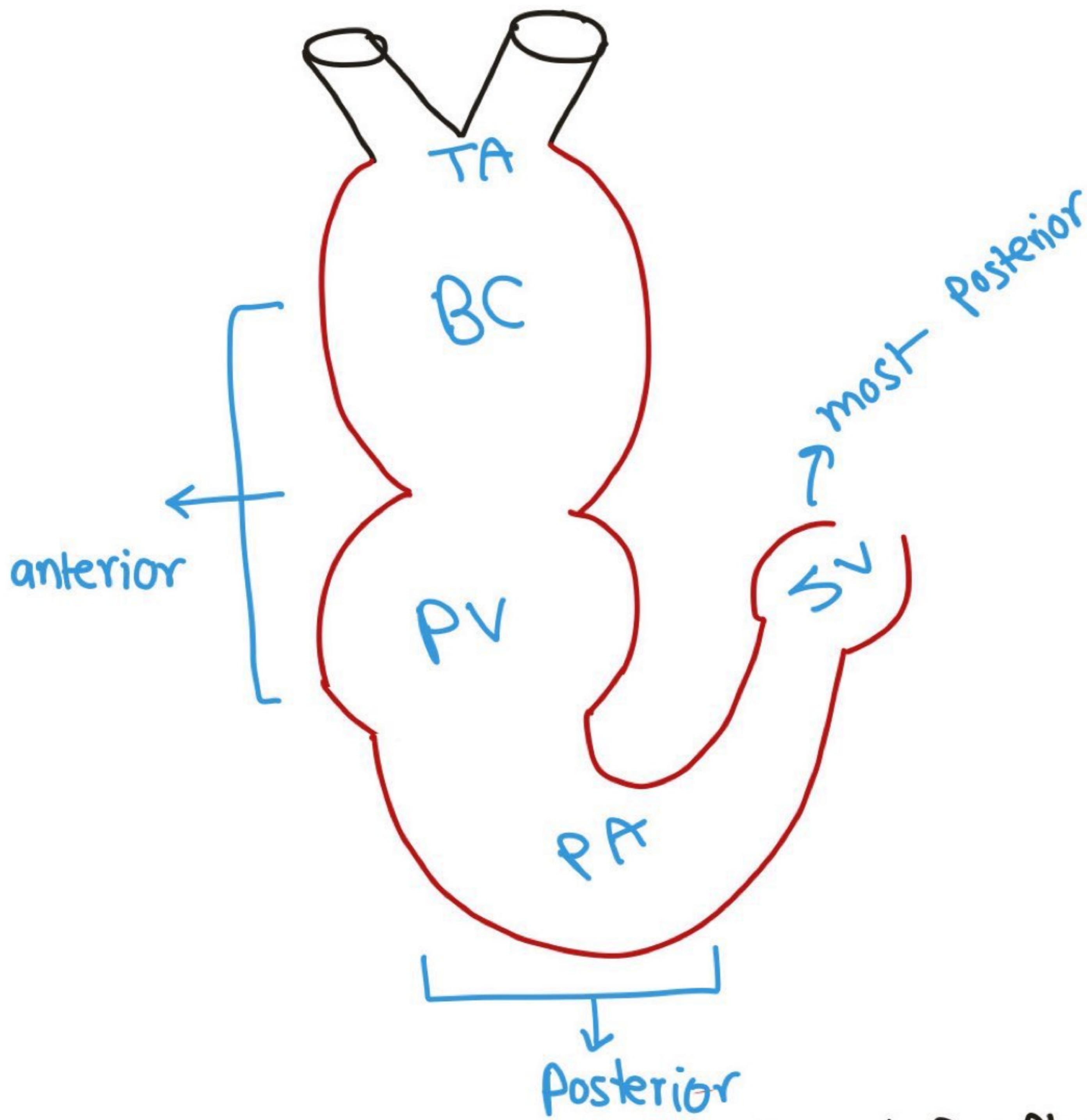


- \* **Bulbus cordis** ⇒ Form smooth outflow of ventricle (connected to arterial end that's why)
- \* **Primitive ventricle** ⇒ Form trabecular part of ventricle
- \* **Primitive atrium** ⇒ Form rough part of atrium
- \* **Sinus venosum** ⇒ Form smooth part of atrium.
- \* **Sinus venosum** most caudal part.





Cardial looping ⇒ formation of S-shaped



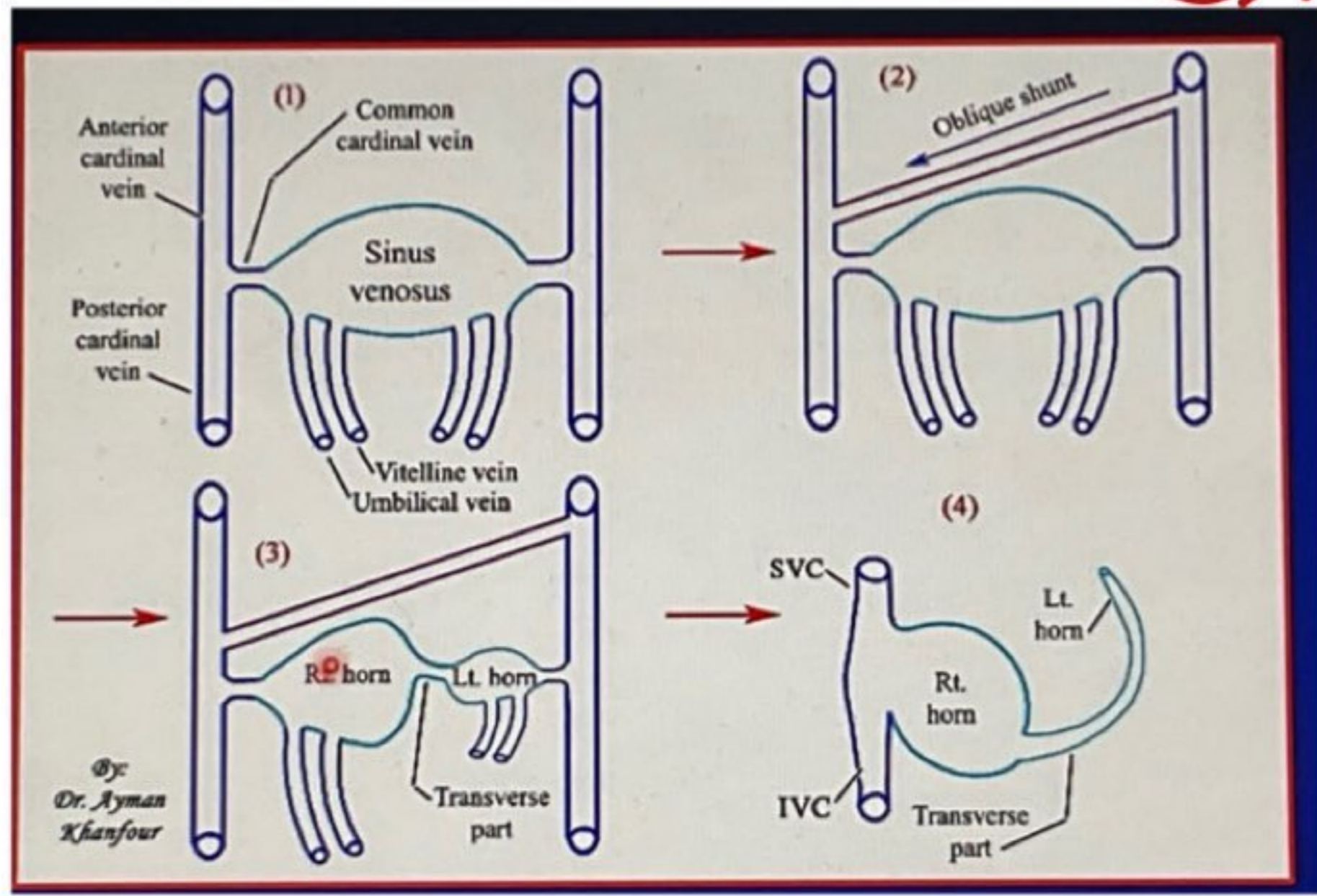
Further elongation of primary heart tube results in its folding and formation of **S** shaped cardiac loop with displacement of cardiac chambers as follows :

- The bulbus cordis is displaced ventrally and to the right.
- The primitive ventricle is displaced ventrally and to the left of primitive atrium
- The primitive atrium becomes dorsal and cephalic .



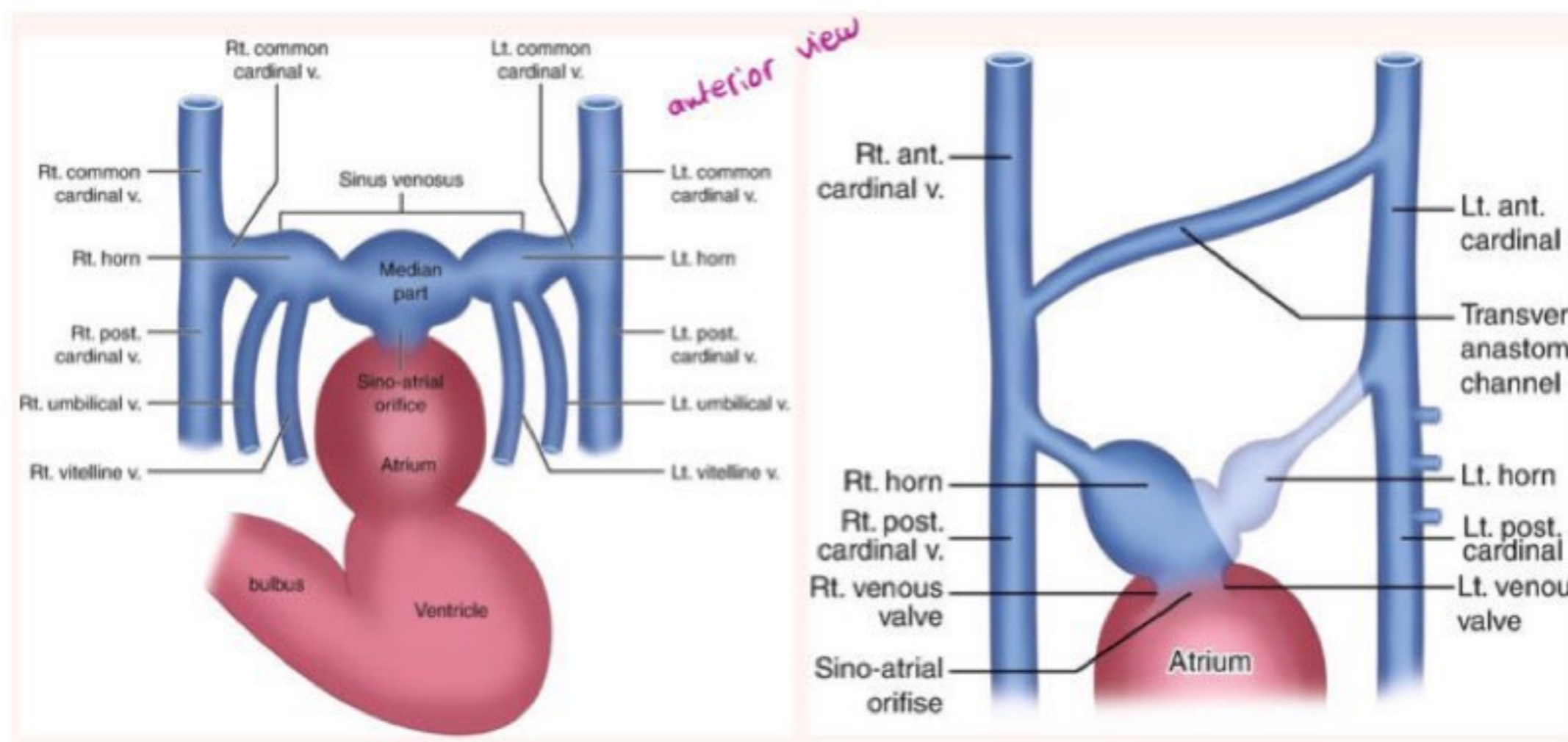
# Sinus venosum

\* it has two horns ↻ Right  
↻ left

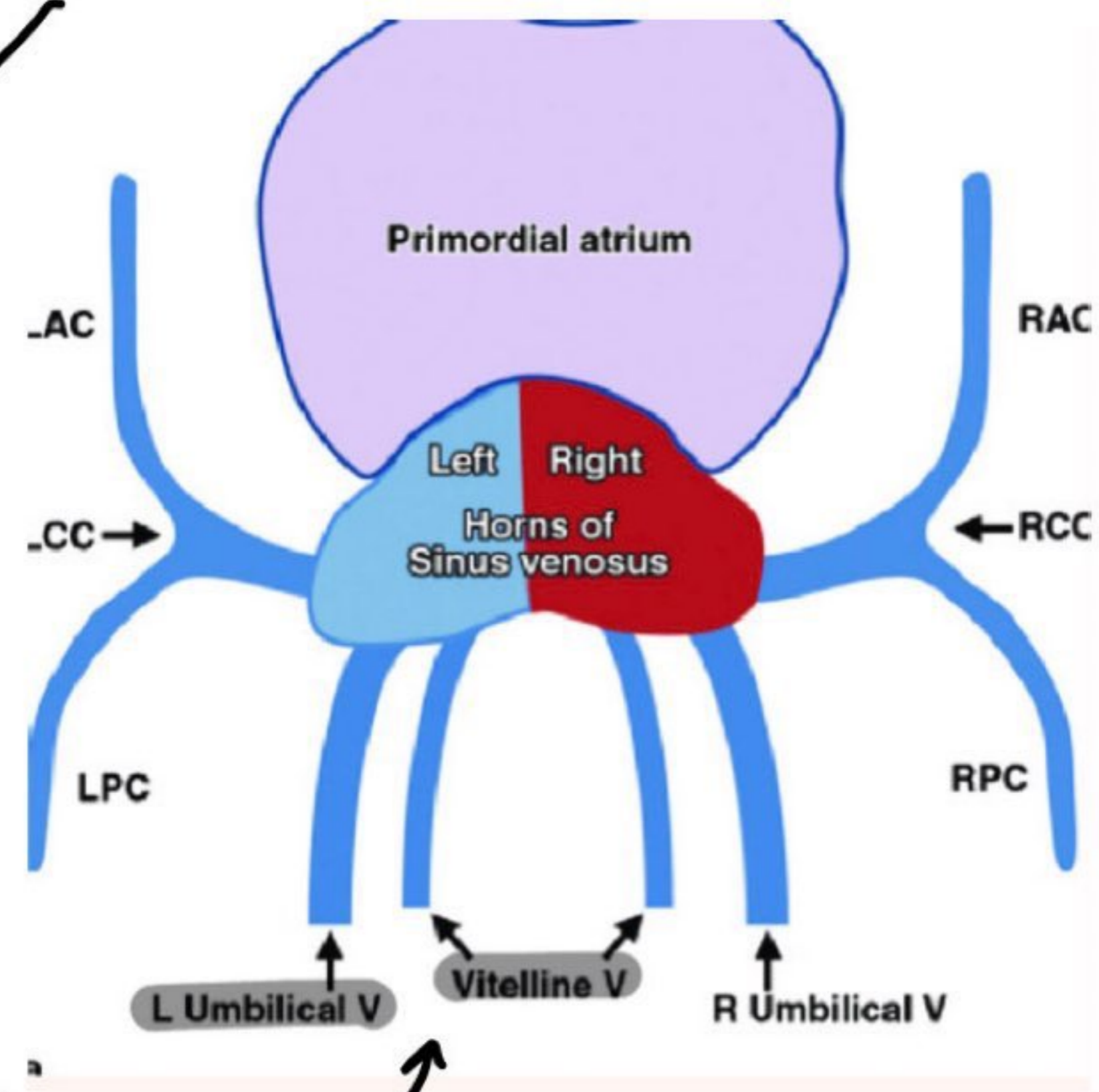


\* because of oblique shunt  
(transverse anastomoses)  
between **Right** anterior cardinal veins  
= left = " "

- ① venous blood from left to Right so Right horn grow & left horn diminishes in size
- ② left vitelline & left umbilical lose their connection with the left sinus venosus.

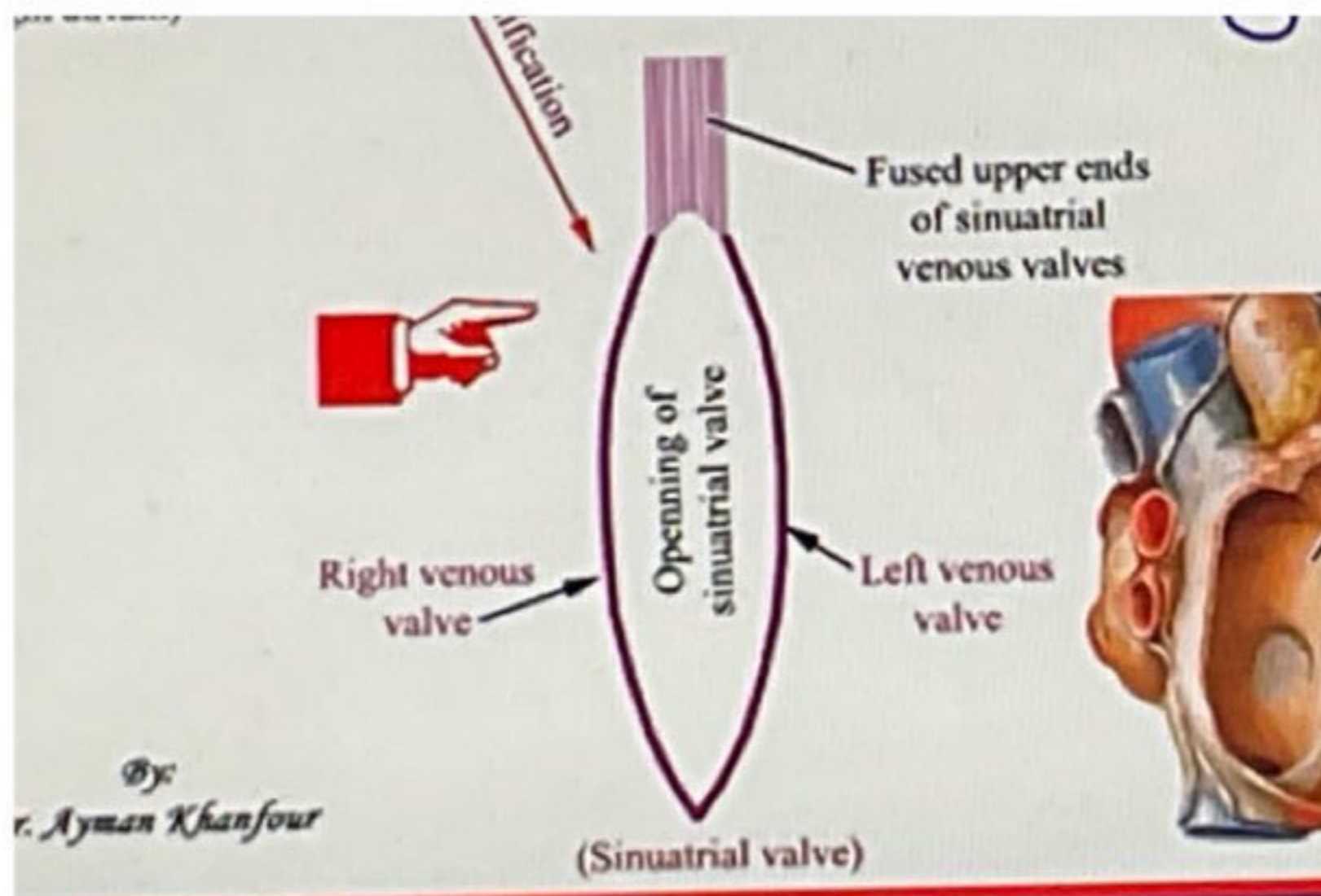
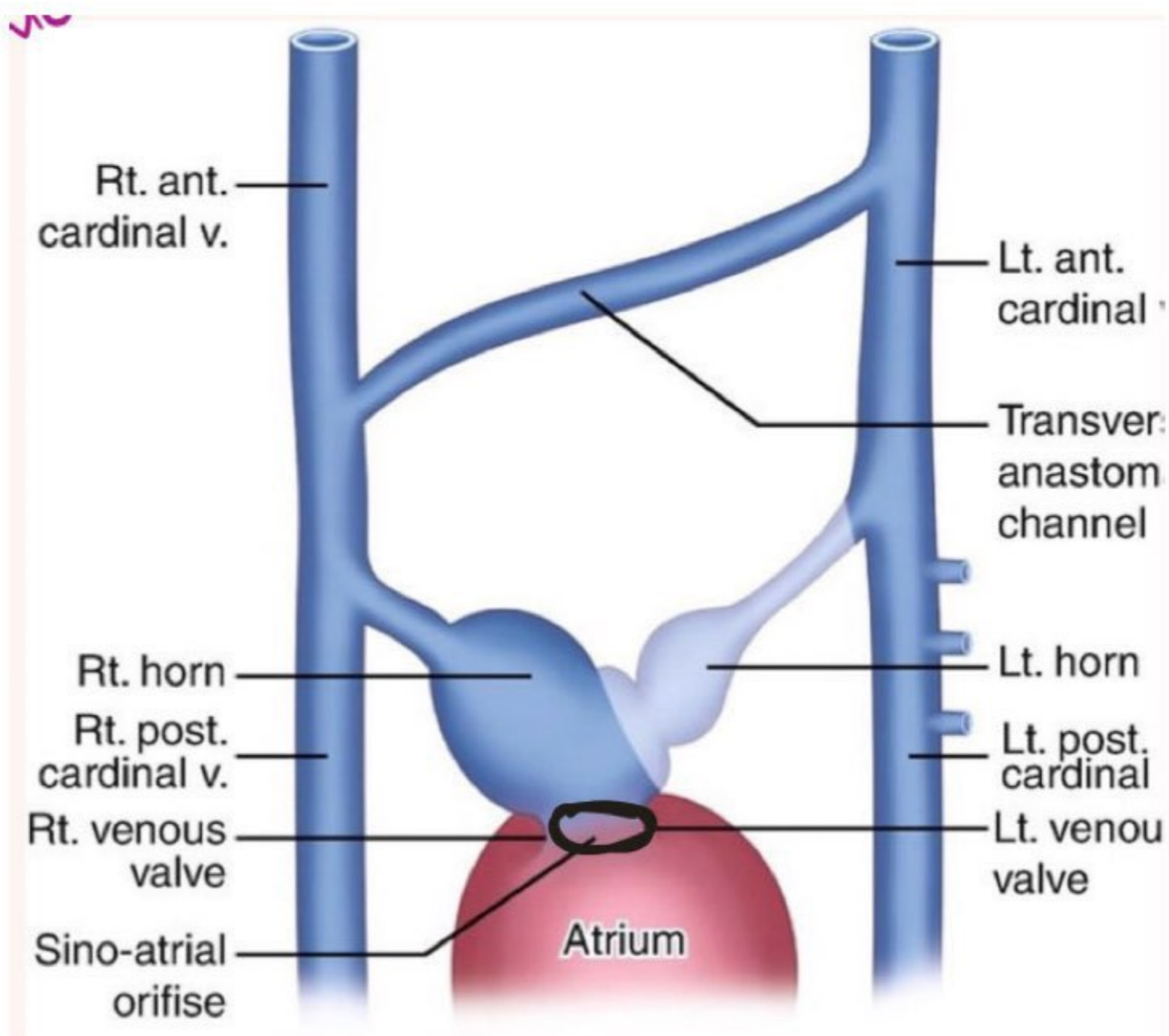


- left sinus horn diminishes and form Coronary sinus
- Right sinus horn + central part of sinus venosus form Sinus venarum (smooth posterior part of Right atrium).





## Sinuatrial valve



\* Sino-atrial orifice between Right horn of sinus venosum & Right atrium

\* it has two valve ↗ Right  
↘ left

\* left & right valve fuse to form Septum primum

\* left valve & septum primum fuse with Interatrial septum

\* Right venous valve

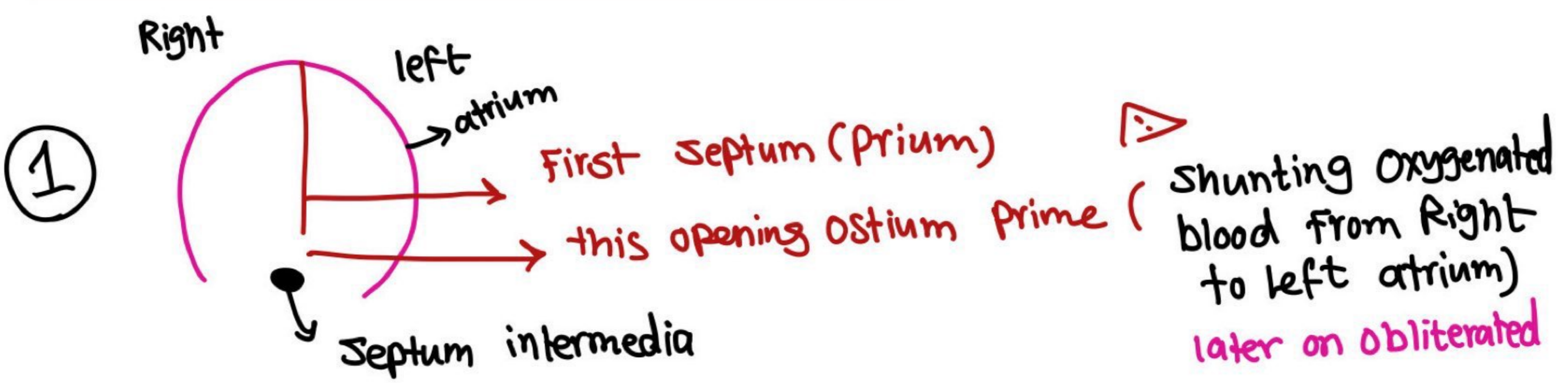
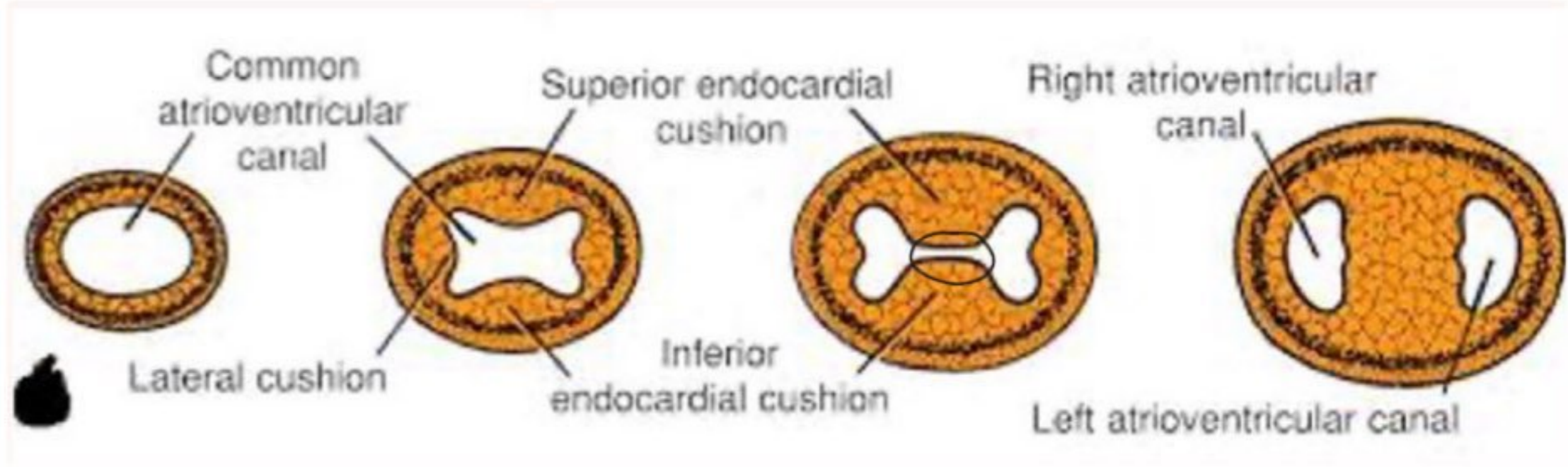
① Cranial part ⇒ form Crista terminalis

② Caudal part ⇒ valve of coronary sinus + valve of IVC



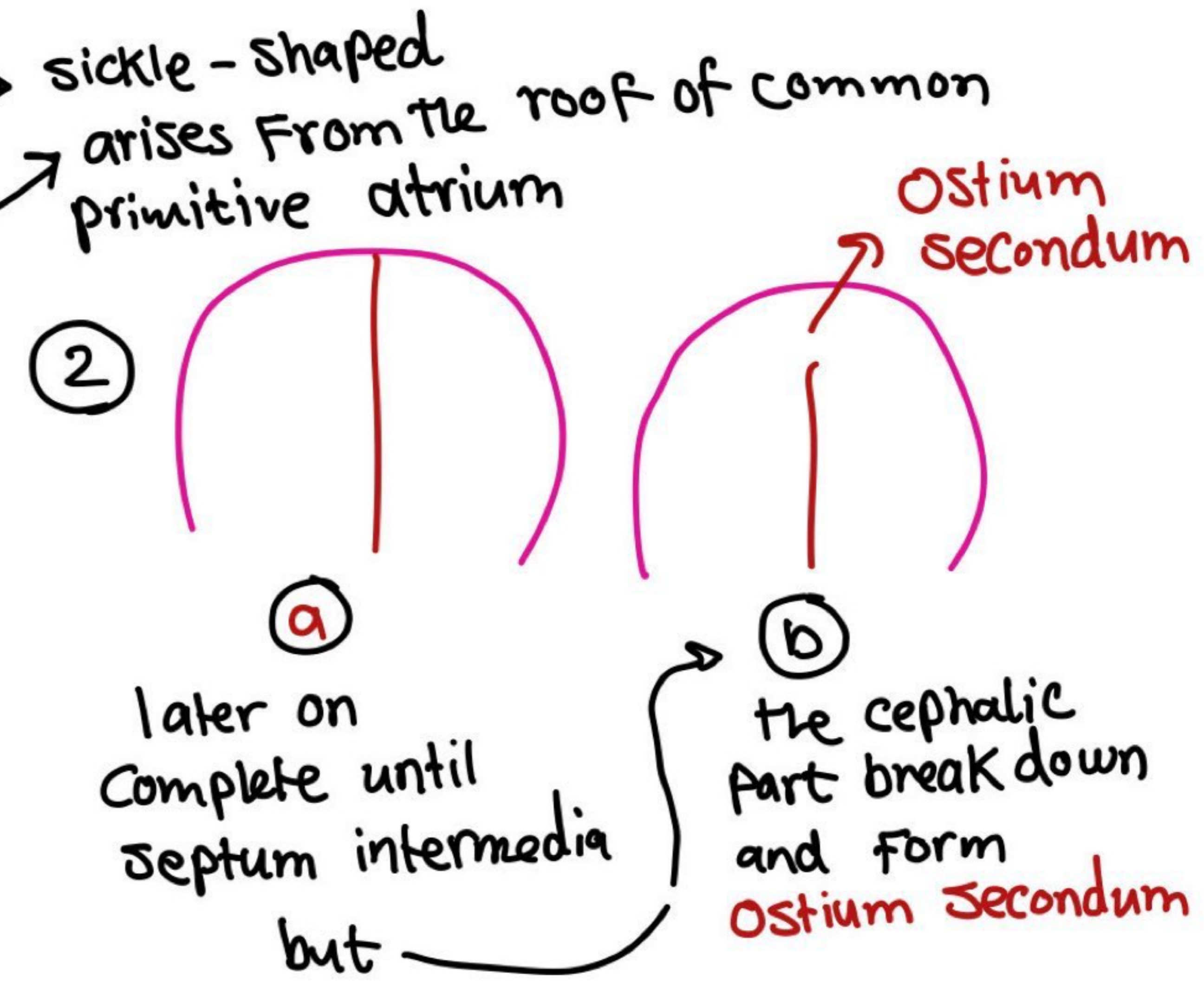
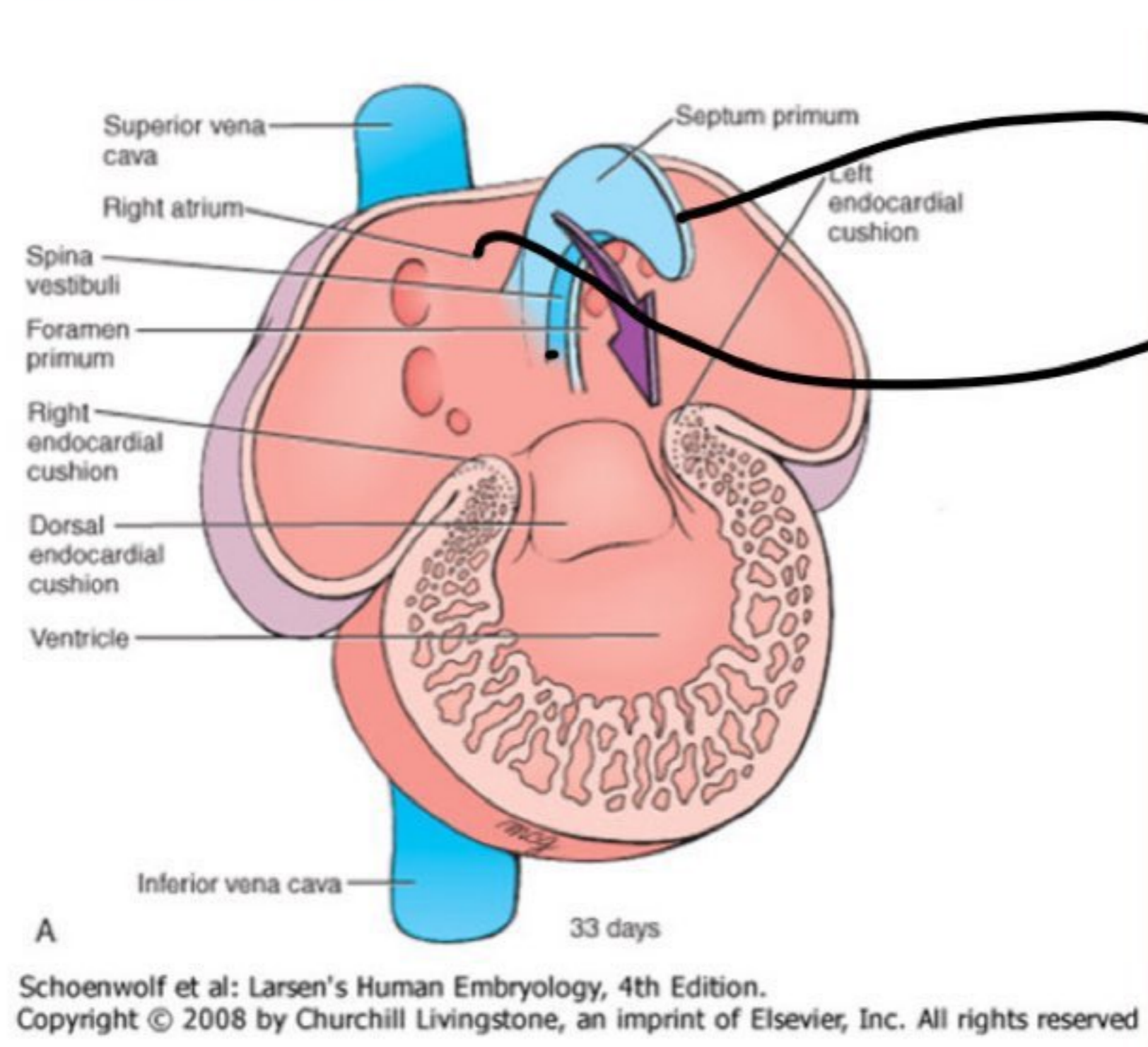
# Lecture 2

\* between atrium & ventricle (atrio-ventricular orifice)  
 \* ventral & dorsal cushions fuse together and form **Septum intermedium**  
 which divide the atrioventricular into **Right** & **Left**



### A. Septum primum :

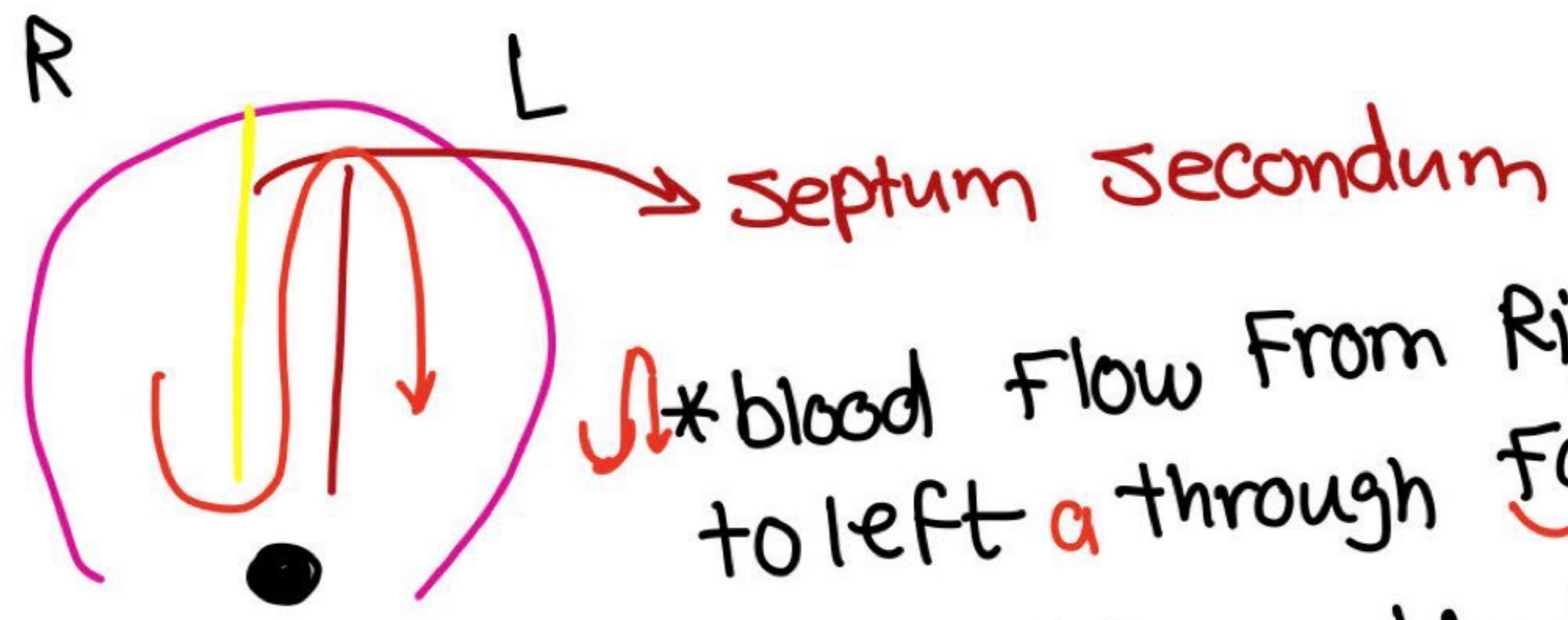
- It is sickle-shaped having caudal **crescentic border** ending in ventral & dorsal **horns**.
- It arises from the **roof** of the common primitive atrium and **descends** in the direction of the **endocardial cushions** of the atrio-ventricular canal.
- The septum primum **divides** the cavity of the primitive atrium **incompletely** into right and left halves because its caudal border is still **separated** from the endocardial cushions by gap called the **ostium primum**.



**Ostium secundum + Ostium primum From septum primum**



a=atrium



\*Foramen ovale: between septum secundum & septum primum.

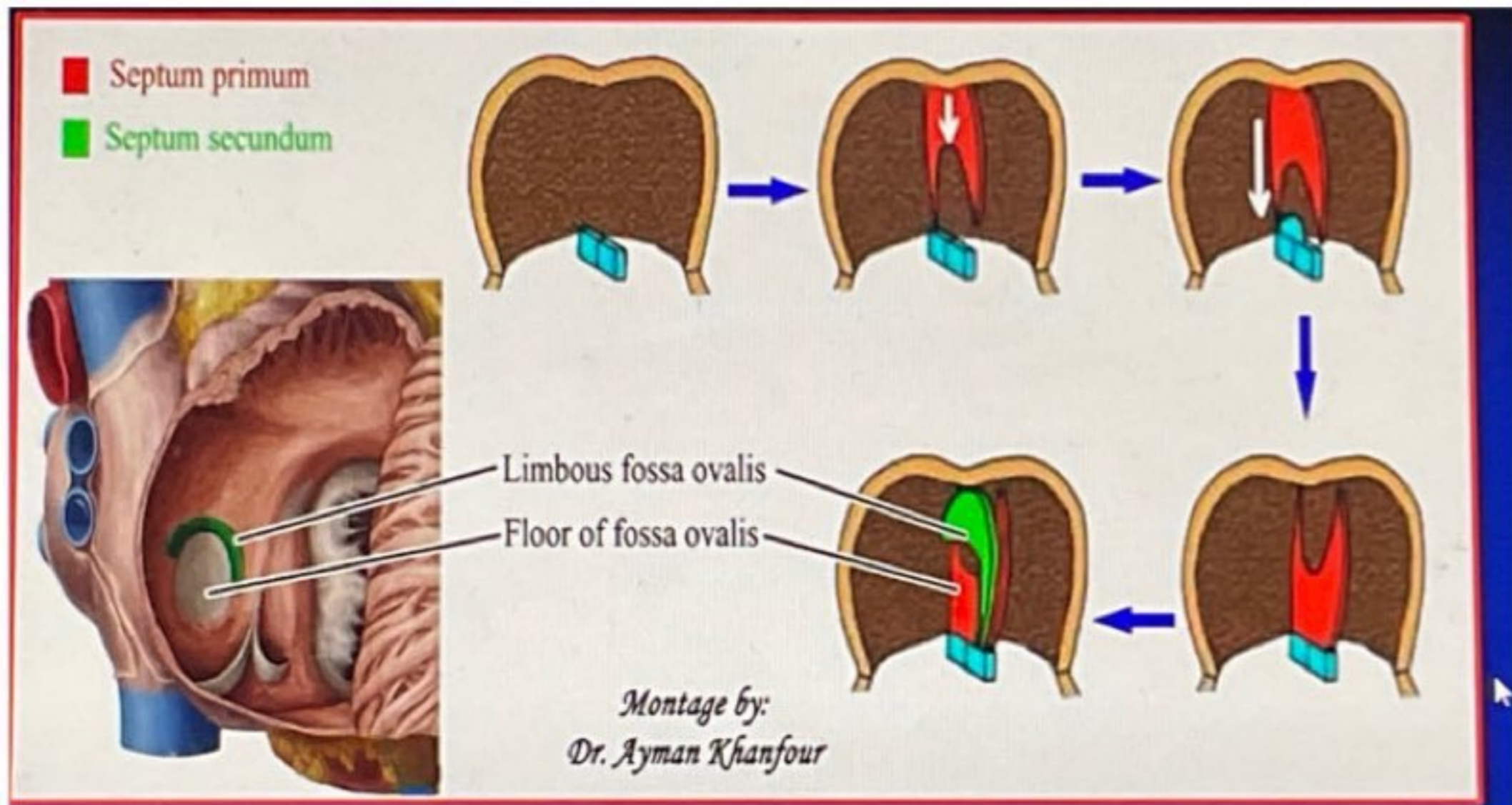
\* blood flow from Right a to left a through foramen ovale

\* after delivery blood return from pulmonary veins carry oxygenated blood to left atrium ↑ increase pressure in left side close foramen ovale due to

Fusion between septum secundum & septum primum.

Later on life, complete fusion between the septum primum and septum secundum occur to form the interatrial septum which is formed of :

- \* **Septum primum** : form the lower part of interatrial septum with formation of fossa ovalis .
- \* **Septum secundum** : form the upper part of interatrial septum.
- \* **The free caudal edge** of the septum secundum form annulus ovalis . ★

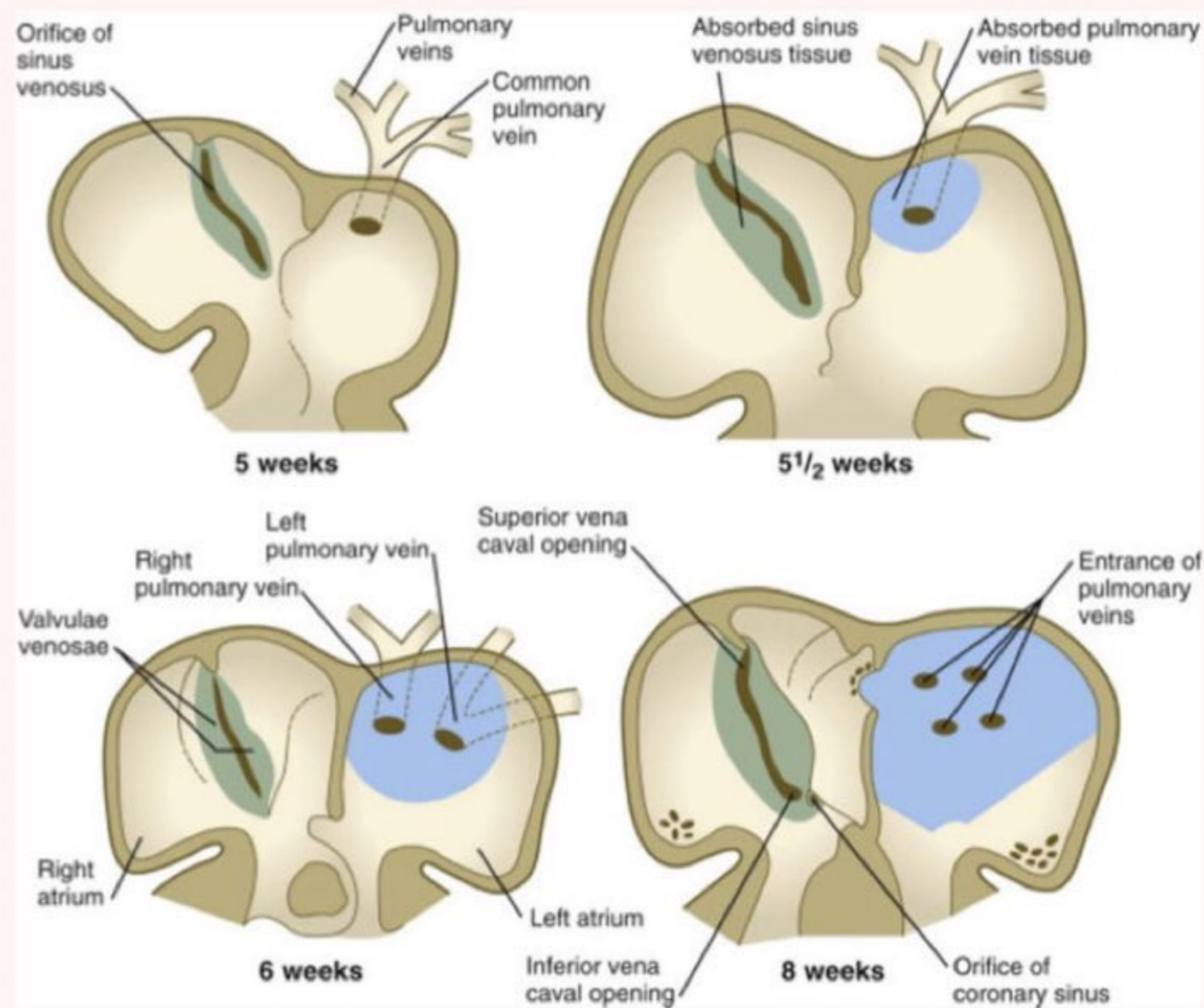


- Fossa ovalis → Septum primum  
 - annulus ← " → septum secundum

- ⊗ The edge of the septum primum that forms the lower boundary of the foramen secundum is thin and mobile like a flap **valve**
- ⊗ When blood tends to flow from the right to the left atrium, this thin flap moves away and there is no obstruction to blood flow.
- ⊗ However, when there is a tendency for blood to flow from left to right this flap comes into apposition with the septum secundum and closes the opening.

→ valve of septum primum will facilitate movement of blood from Right to left (NO obstruction) but IF blood from left to Right close septum secundum and obstructs the blood.





**Absorption of the pulmonary vein into the left atrium**

**Embryological components of each atrium**

Components of the right atrium	Components of the left atrium
(1) The right 1/2 of the common primitive atrium (forms the anterior rough part + Right auricle).	(1) The left 1/2 of the common primitive atrium (forms the left auricle).
(2) The absorbed central part & right horn of sinus venosus (forms the posterior smooth part).	(2) The absorbed pulmonary vein and its tributaries (forms the posterior smooth part).
(3) The absorbed right atrioventricular canal	(3) The absorbed left atrioventricular canal

(postnatal shunt)

From left to right

↳ acynotic  
(Non-cynatoic)

→ O<sub>2</sub> more than CO<sub>2</sub>

From Right to left

(cynotic)  
CO<sub>2</sub> more than O<sub>2</sub>

• Cynotic → ↓O<sub>2</sub>

□ \* ASD [Atrial septal defect]

- more common in female than male
- result in left-right shunt (non-cynotic)
- IF it's small clinical symptoms delayed as late as age 30
- Atrial septal formed by septum secundum or septum primum so defect of it meaning either the problem in septum primum or septum secundum { secundum is most common type }



## 2-Atrial Septal Defects Atrial septal defect (ASD)

- ✳ It is more common in female than in male
- ✳ ASDs result in **left -to-right shunting** and are **non-cyanotic conditions**.
- ✳ This ASD results in variable openings between the right and left atria in the central part of the atrial septum **above the** limbus.
- ✳ **Secundum-type ASD is the most common ASD** It is caused by either an excessive resorption of the Septum primum or an underdevelopment and reduced size of the Septum Secundum or both.
- ✳ If the ASD is small, clinical symptoms may be delayed as late as age 30

- Septum primum → over degeneration
- Septum secundum → underdevelopment

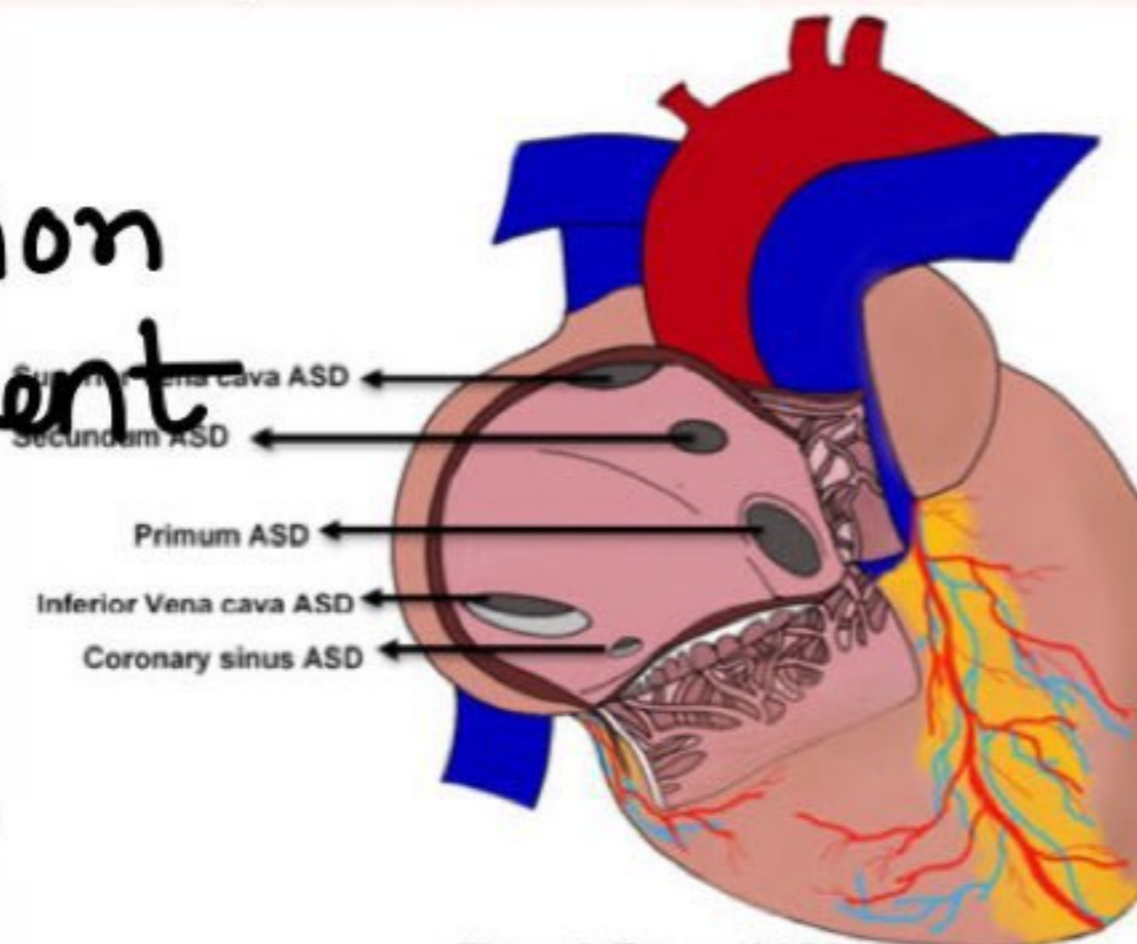


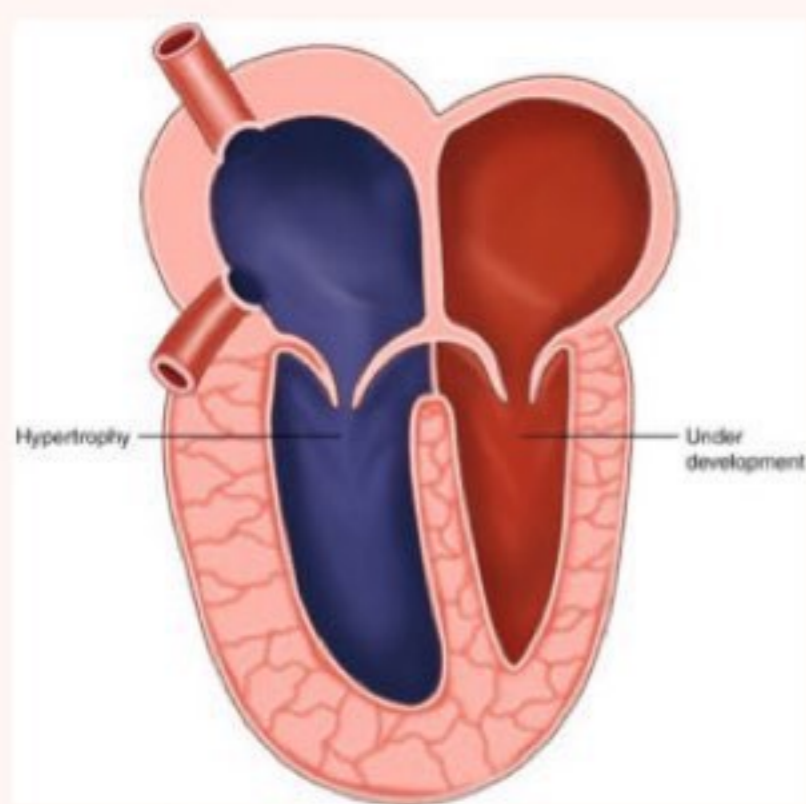
Figure 3. Types of ASD

- [2] ✳ premature closure of Foramen ovale: **اتسقى قبل الولادة**
- Results:**
- ① Hypertrophy of Right atrium & Right ventricle (high pressure on it)
  - ② underdevelopment of left atrium & left ventricle
- ⇒ it leads to **Death**

### 1- Premature closure of foramen ovale:

**Character:** premature closure of foramen ovale in the intrauterine life due to excessive descent of septum secundum and fusion with septum intermedium .

**Results:** hypertrophy of right atrium and right ventricle with underdevelopment of left atrium & left ventricle. It leads to the death.



- [3] probe potent Foramen Ovale:
- not closure by very small opening blood can't pass between atria + in larger defects surgery may be required.

- [4] Failure of formation of interatrial septum:
- the heart composed of 3 Chamber → 2 ventricle  
 → common atrium



Cause: Failure of separation of 2 atria.

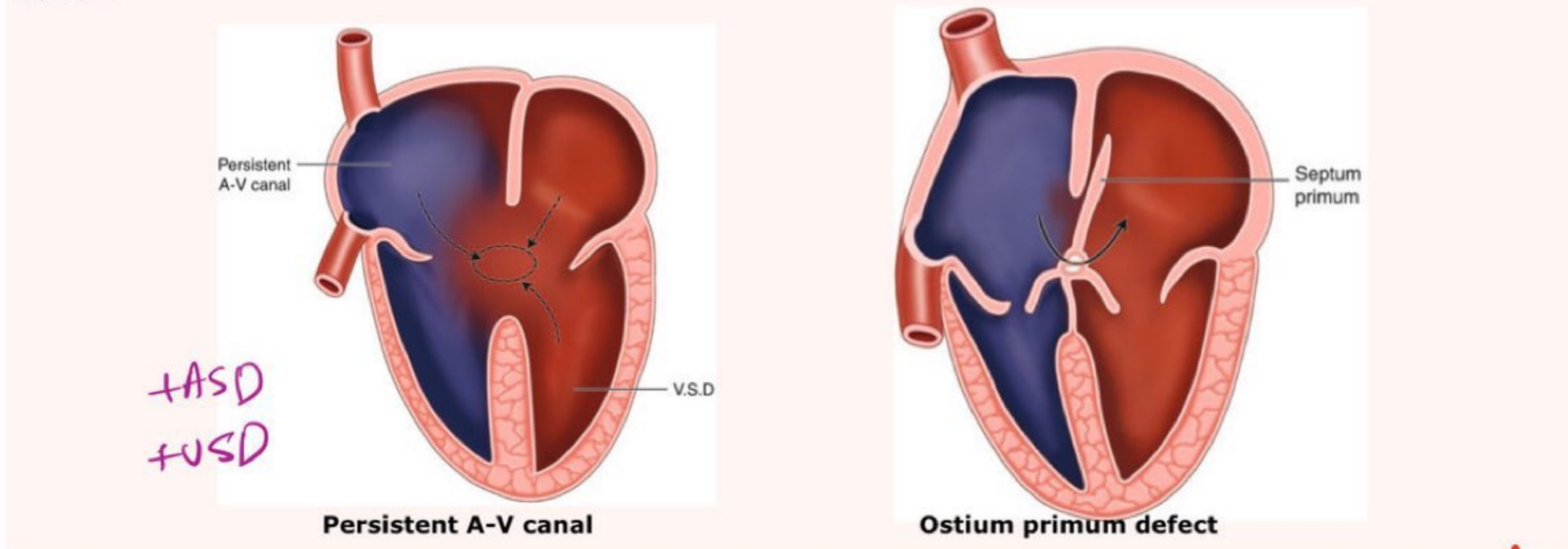
5) Persistent AV-canal:

- Complete failure of fusion of ventral & dorsal endocardial cushions in AV canal.

1- Persistent A-V canal:

This anomaly is usually accompanied by atrial septal defect and ventricular septal defect.

Cause: complete failure of fusion of the ventral and dorsal endocardial cushions in the A-V canal.



6) tricuspid atresia: narrowing of tricuspid usually accompanied by Patent Foramen ovale + (ASD) (VSD)

Hypertrophy of left ventricle & underdevelopment of Right ventricle.

لأن كمية الدم قليلة أو معدومة لست؟ لأن من راحة الله يكون عندنا

ASD يعني ال Blood يعني من ال R.atrium

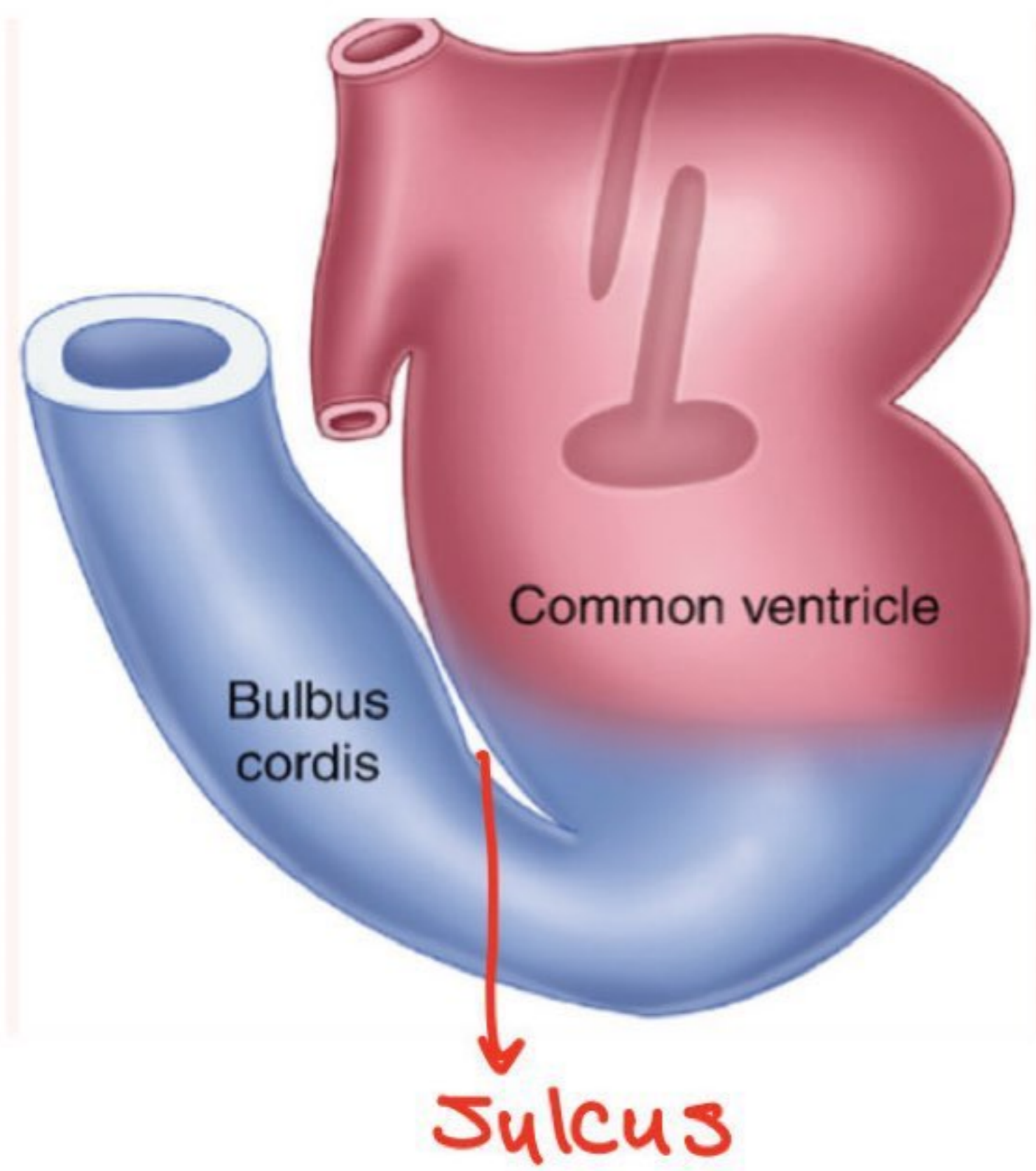
يصب بال left atrium مباشرة فيصير عليه load

+ أن ال pulmonary veins يصبوا بال left atrium

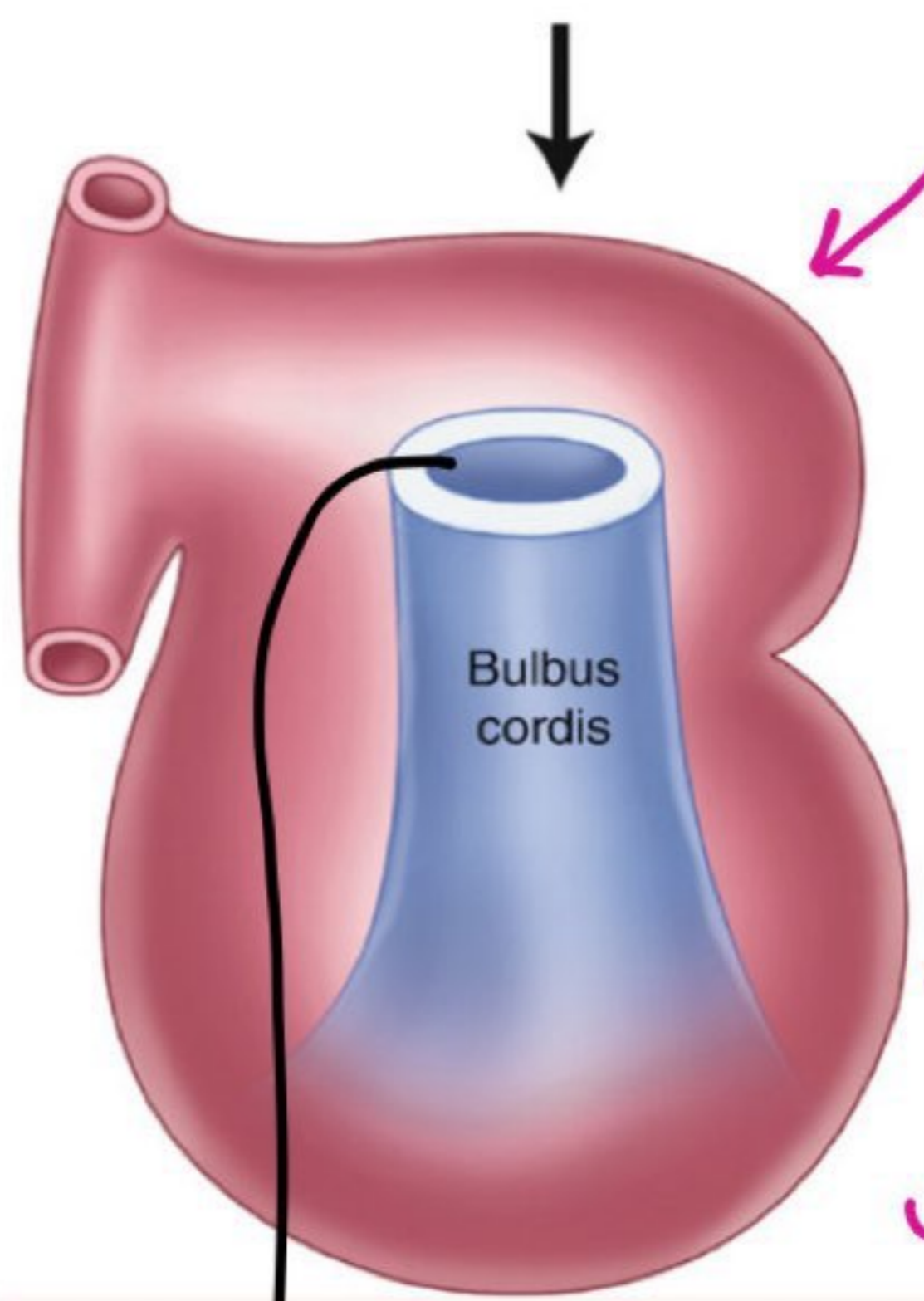
load (high pressure) → Hypertrophy of left ventricle and left atrium



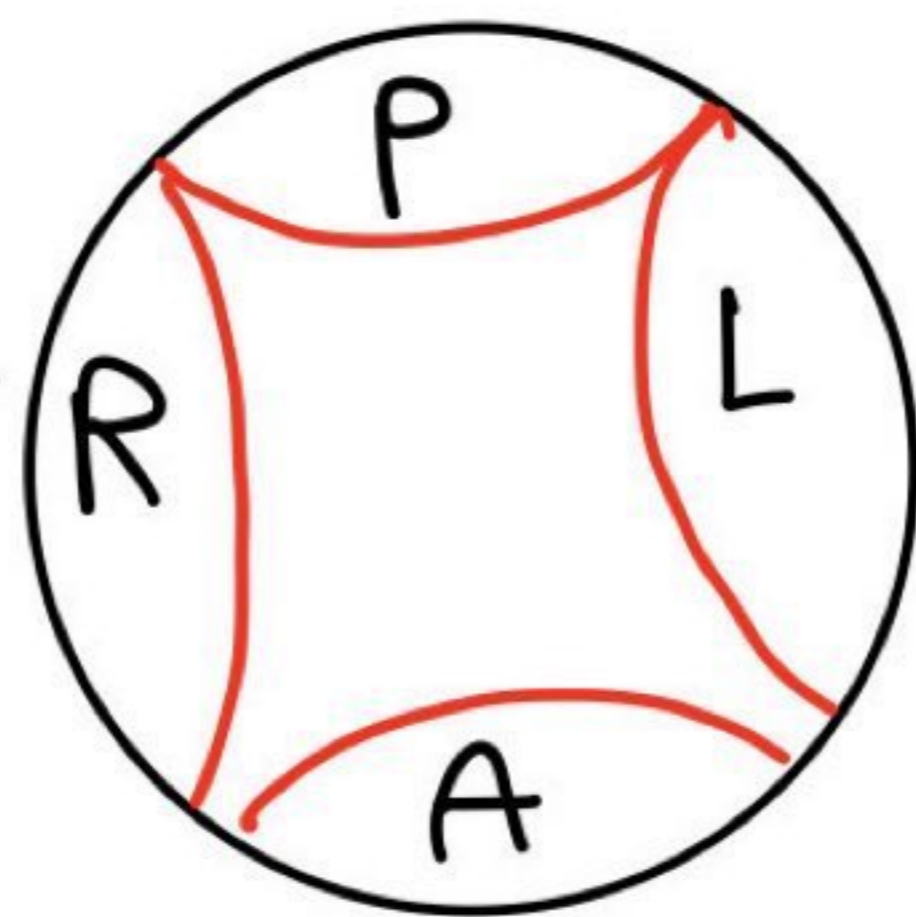
### lecture 3



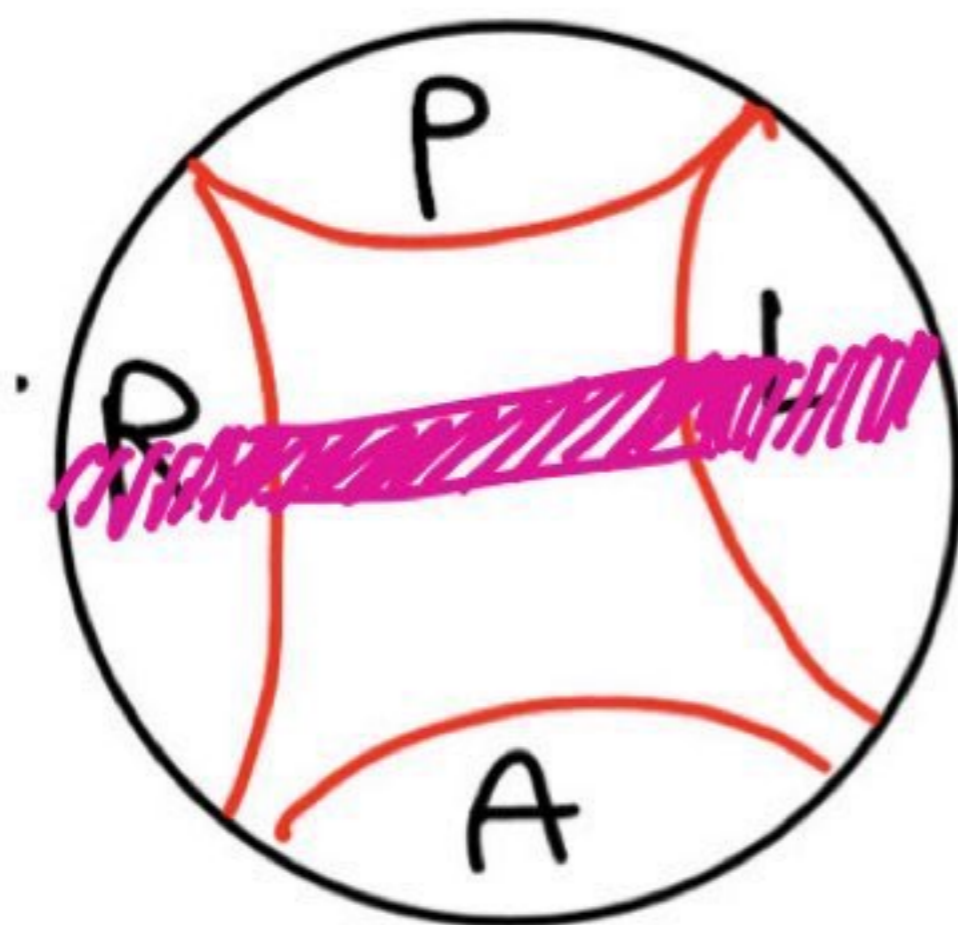
- Bulbus Cordis lies on Right side OF the primitive ventricle with a deep sulcus separating two structure
- the Sulcus becomes obliterated and the bulbus Cordis moves to left side to lie in front of Common primitive ventricle.



proximal part of bulbus cordis becomes absorbed inside primitive ventricle to form common bulboventricular chamber.

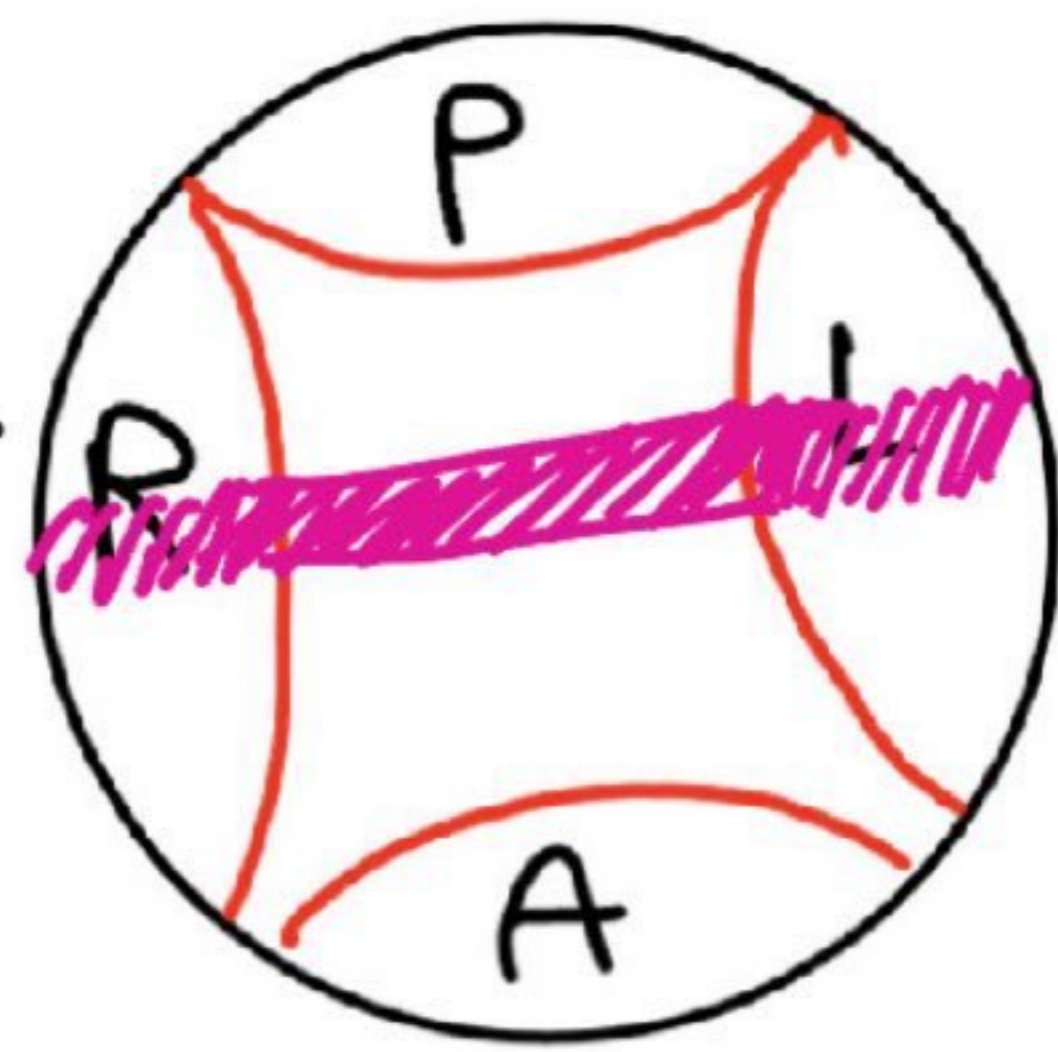


\* Four endocardial Cushions (A, P, R, L) developed in distal part of Bulbus cordis



\* a ridge developed in the middle of each lateral cushions these ridges will fuse to form a complete septum "distal bulbar septum"





\* this distal bulbar septum will divide the cranial end of bulbus cordis in two orifice:

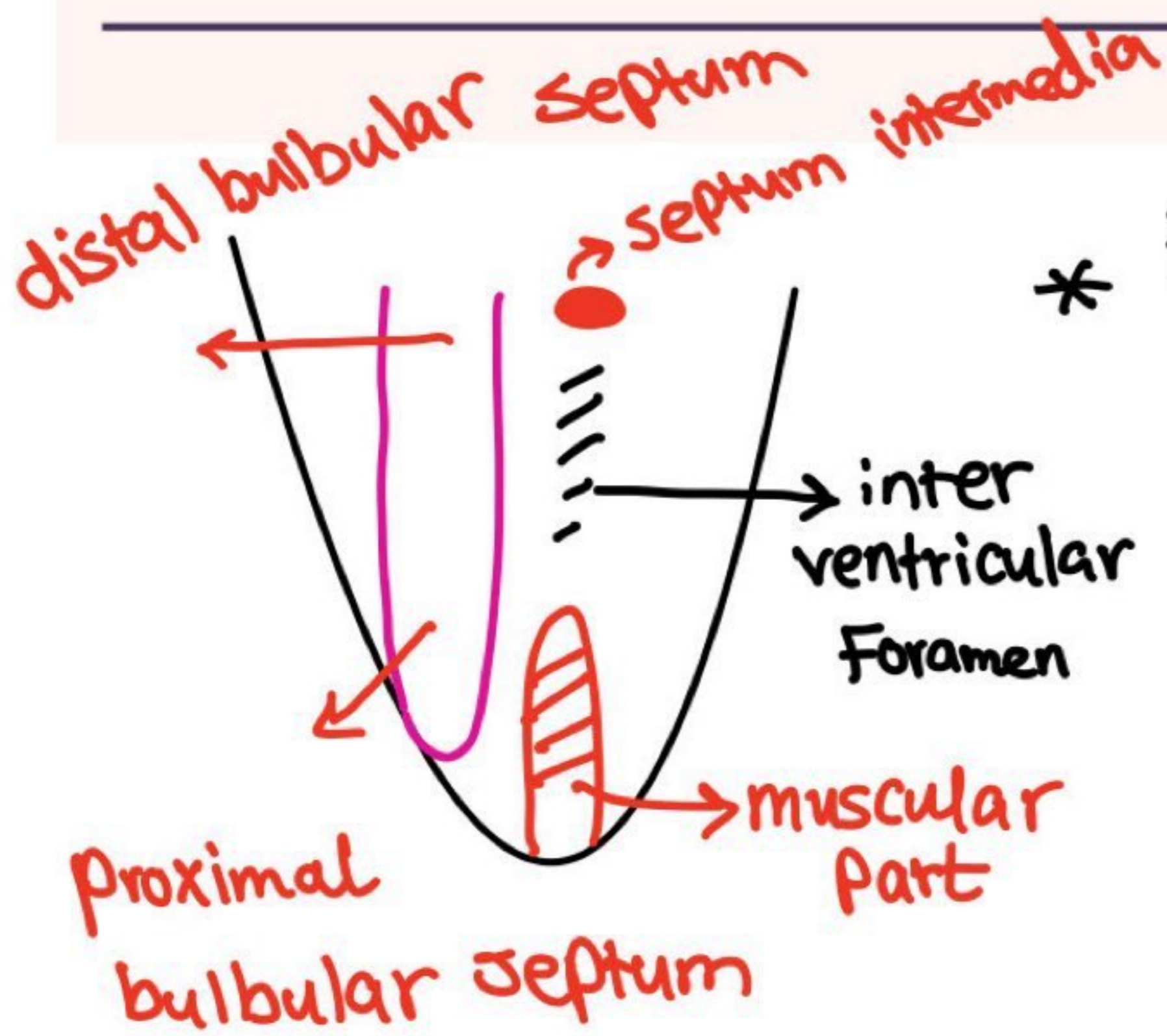
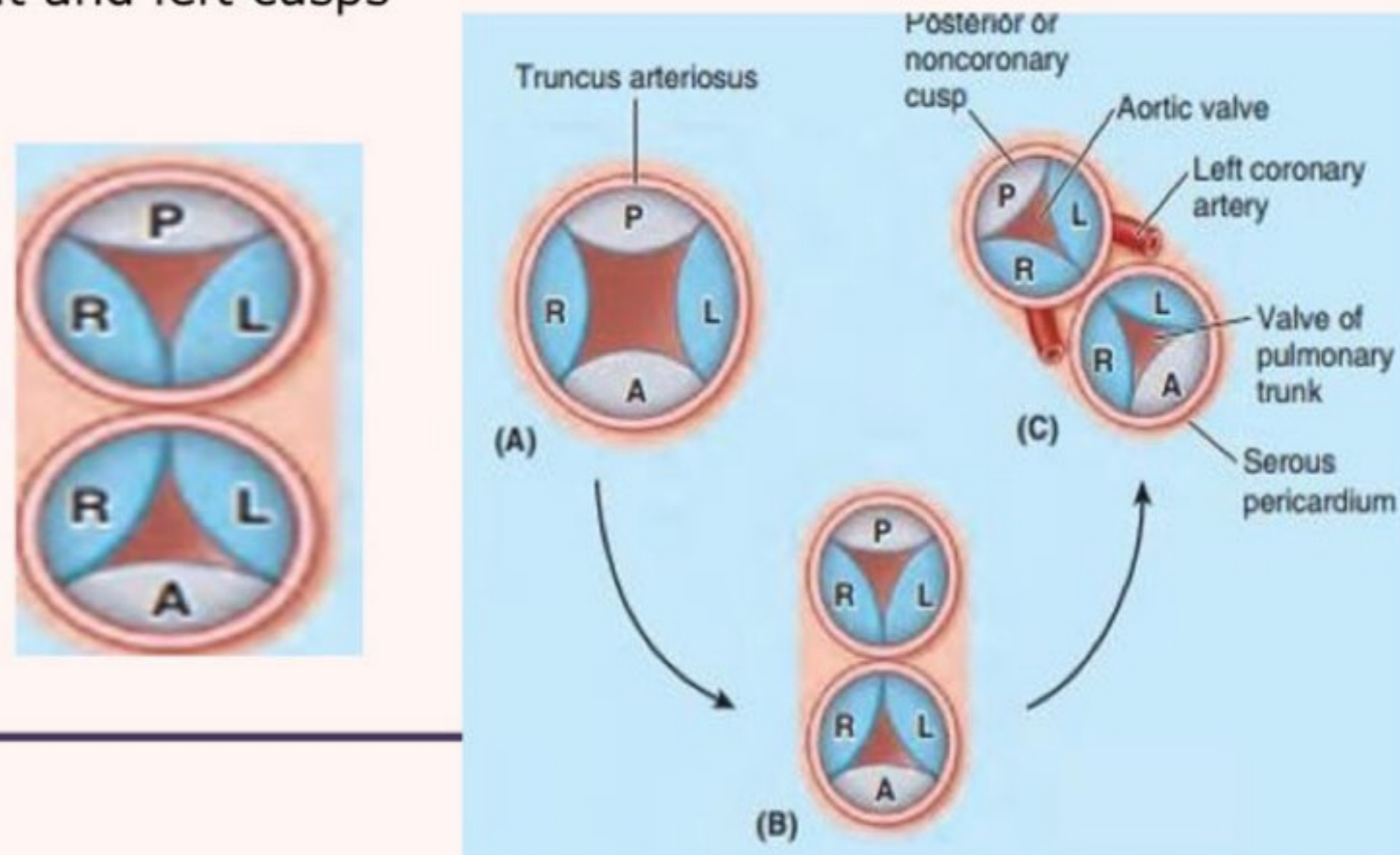
- ① pulmonary orifice anteriorly
- ② aortic orifice posteriorly

4- The distal bulbar septum will divide the cranial end of bulbus cordis into into two orifices: The pulmonary orifice **anteriorly** and The aortic orifice **posteriorly**

6- The cusps of the pulmonary valve are one anterior and two posterior but as a result of rotation of the vessels the two cusps become one anterior, right and left cusps

7- The cusps of the aortic valve are two anterior and one posterior but as a result of rotation of the vessels one cusp becomes one anterior posterior right and left cusps

} rotation

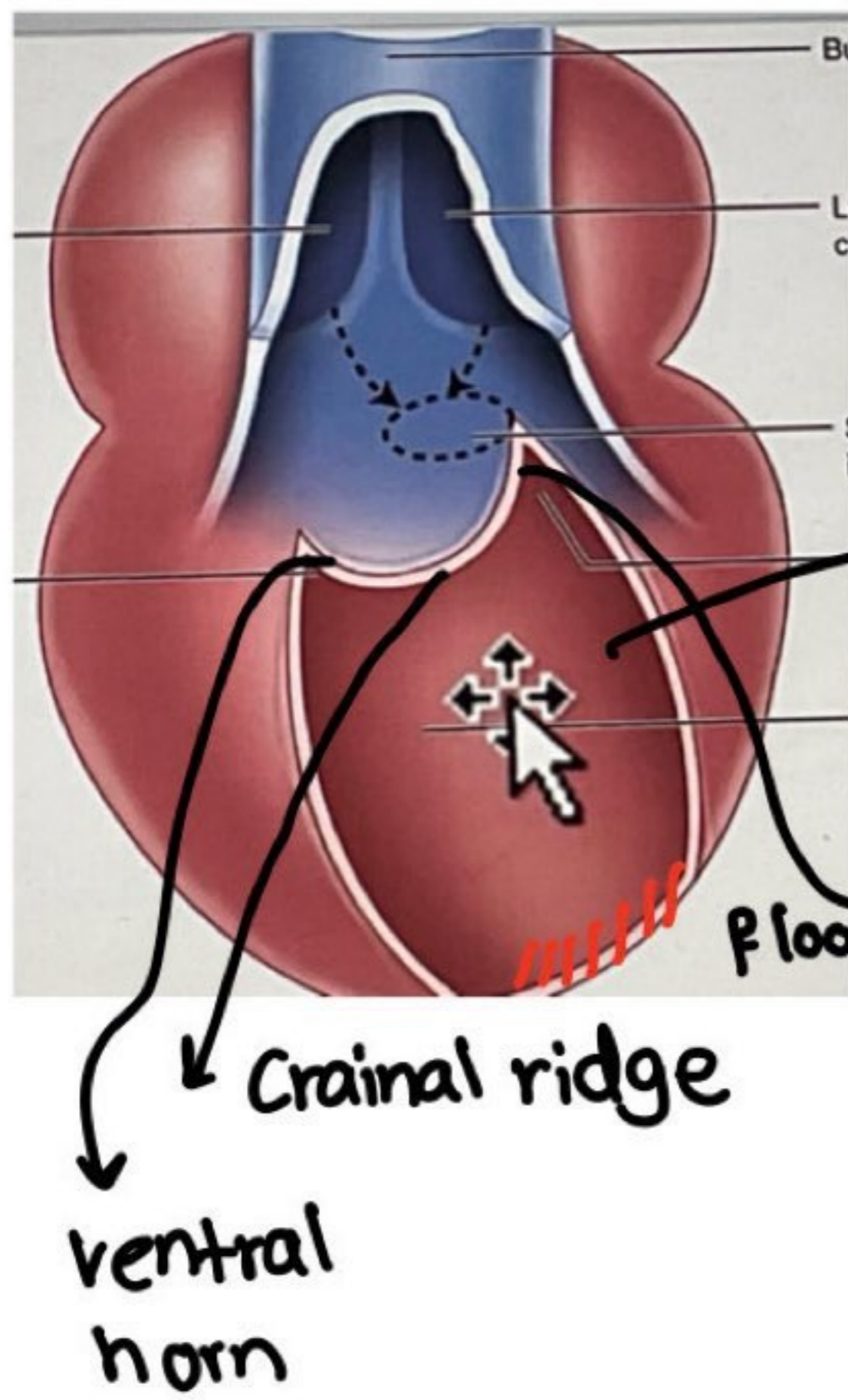


\* Function of proximal bulbar septum:

- ① closing the interventricular foramen
- ② forms smooth outflow parts of Right ventricle **Infundibulum** of pulmonary trunk (conus arteriosus) and left ventricle **vestibule** of aorta



2] Formation of IVS ↪ muscular part  
↪ membrane part



**muscular part:**

• develop from the floor of bulboventricular chamber as a **Crescent-shaped ridge** with a **Concave free Cranial border** with ventral & dorsal horns. ↗ sickle shape

• there is a **crescent shaped Interventricular Foramen** between free edge of Interventricular Septum and septum intermedia.

**membranous part:**

this part develops by the end of 7<sup>th</sup> week to close the Interventricular Foramen

\* developed from 3 structures:

- ① the muscular ventricular septum
- ② Atrio-ventricular endocardial cushions (septum intermedia)
- ③ Right & left Bulbar Ridges

**III) Absorption of the proximal portion of bulbus cordis (conus cordis)**

- The conus cordis is absorbed into the ventricles forming the **outflow tracts of the both ventricles**:
- The part absorbed into the Right ventricle will form the **infundibulum of pulmonary trunk**.
- The part absorbed into the left ventricle will form the **vestibule of the aorta**.

**SOURCES OF THE VENTRICLES :**

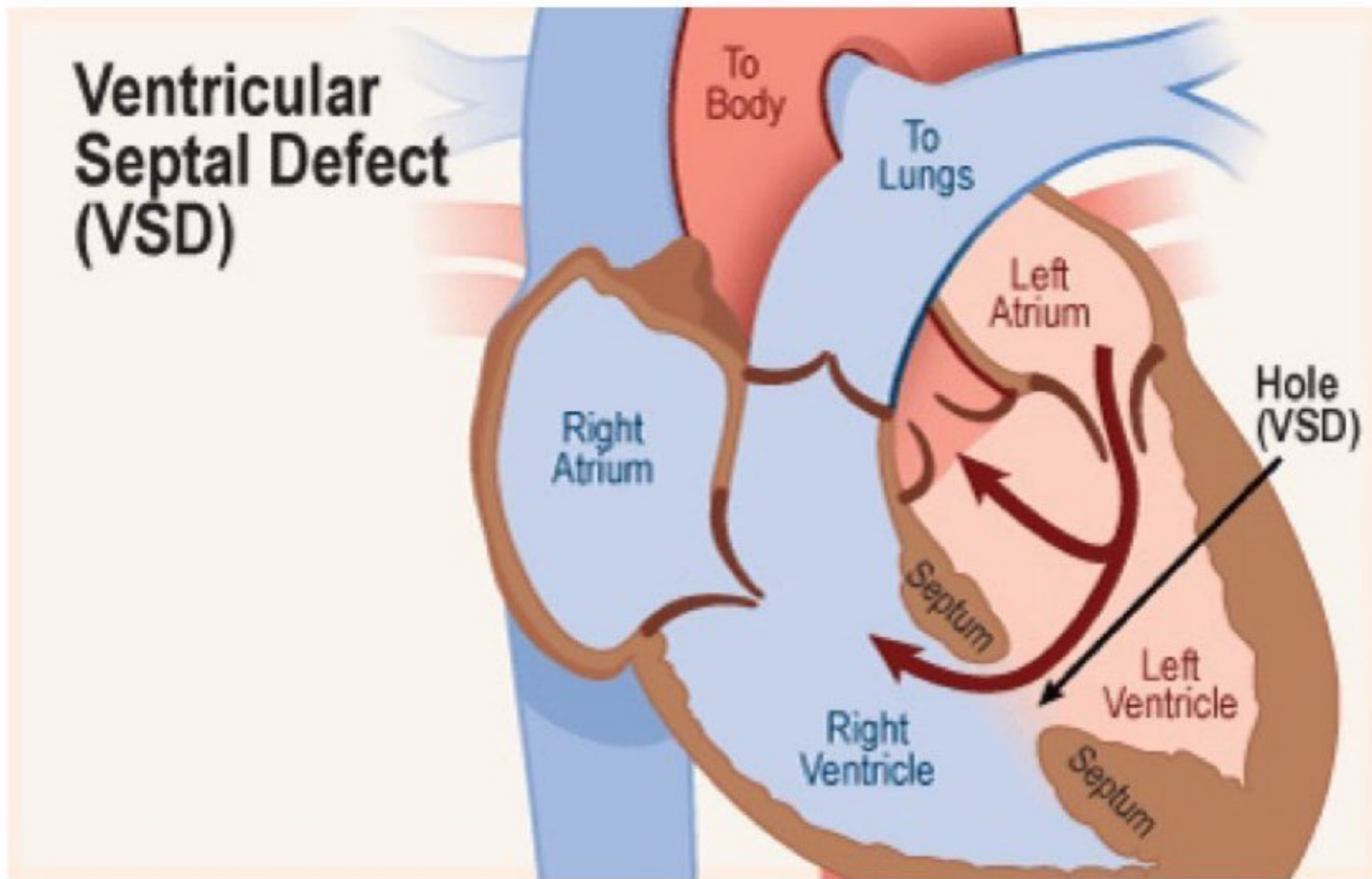
1. **Primitive ventricle:** It gives rise to ★

- Trabeculated part of the right ventricle.
- Trabeculated part of the left ventricle.

2. **Bulbus cordis:**

- The proximal-portion part (conus cordis) forms the outflow tracts of both ventricles
- Infundibulum (conus arteriosus) on the right ventricle OR aortic vestibule of the left ventricle





- \* ventricular septal defect (VSD)
- . more common in male > female
- . defect may occur in muscular or membranous part
- . the whole IV septum may be absent.
- . result in left - right shunt (non-cyanotic) but causes increased blood flow and pressure to the lungs { pulmonary hypertension }

↓

Pulmonary resistance > Systemic resistance

↓

Cause **Right - to left (Cyanotic)**

at this stage the condition is called Eisenmenger complex

\* ⚠️ ركزوا بالأول لأنه من اليسار لليمن لأنه صبغي الضغط أعلى باليسار يسارياً لأنه الـ Pulmonary بصيق وبصير عندي ضغط أعلى باليمن بصير الـ Shunt من اليمن لليمن بصير Cyanotic.