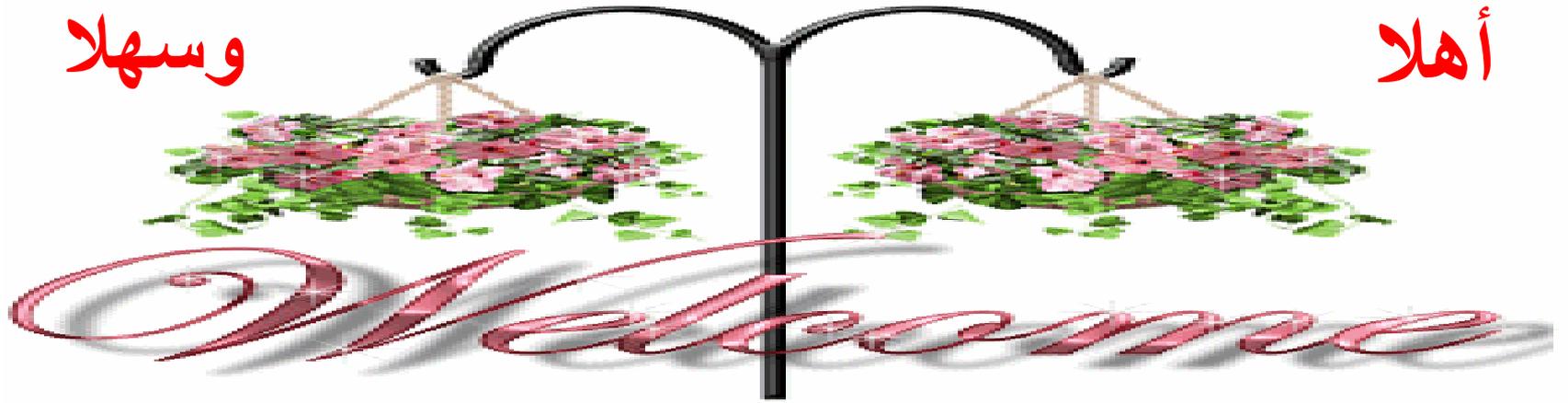


أهلا

وسهلا

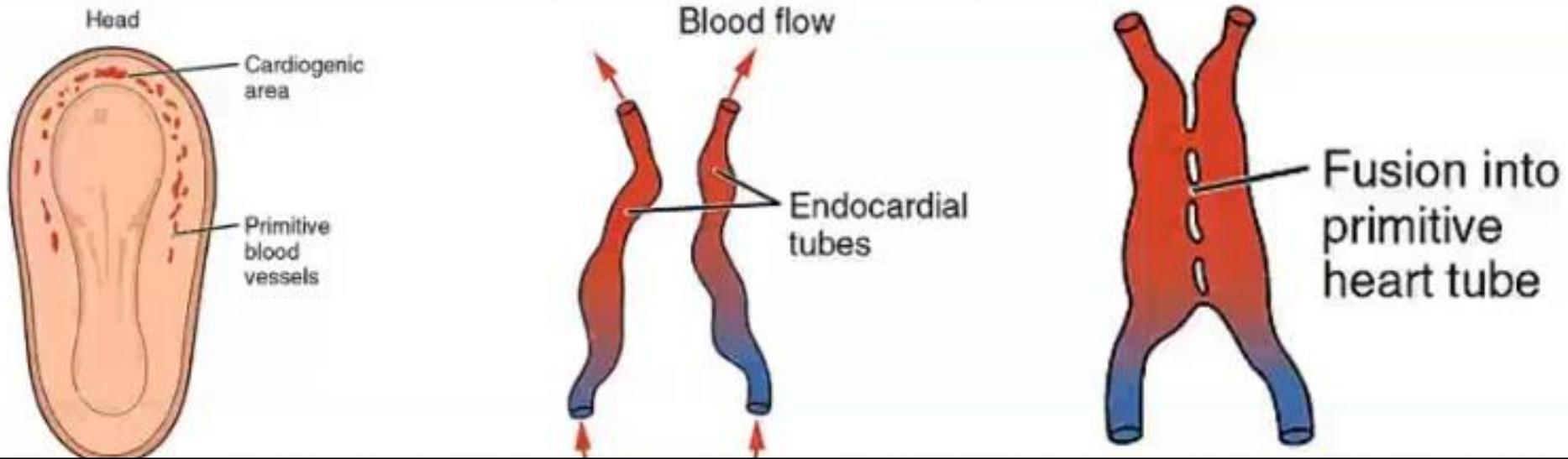


الأستاذ الدكتور / يوسف حسين

أستاذ التشريح وعلم الأجنة

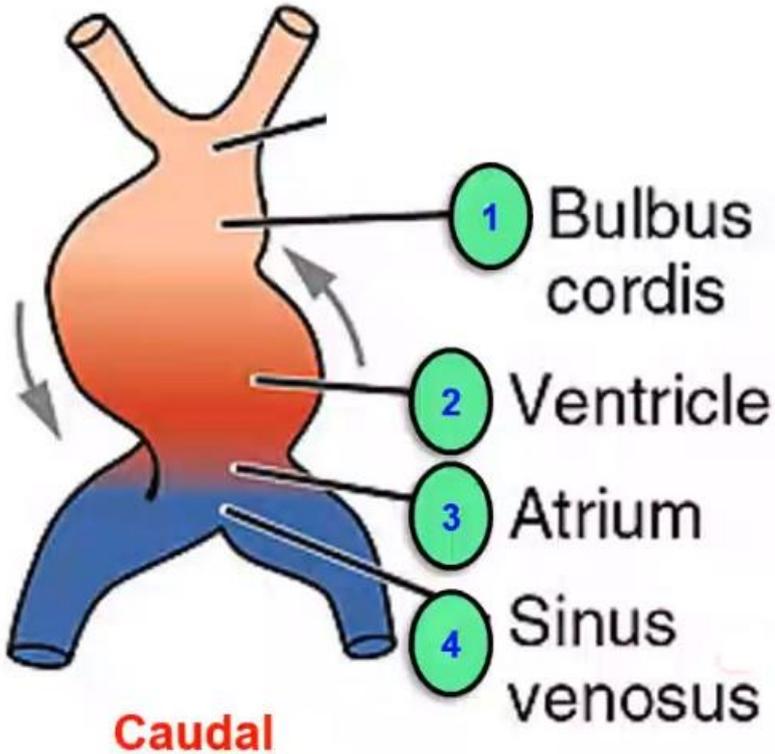
كلية الطب – جامعة الزقازيق- مصر
دكتورة من جامعة كولونيا المانيا
د. يوسف حسين (استاذ التشريح)

Development of the heart



• DEVELOPMENT OF THE HEART TUBE

- The **vascular system** (heart and blood vessels) as well as blood elements are **mesodermal in origin**.
 - The **angioblasts** (vascular **mesodermal cells**) condensed and form clusters of cells called **blood islands**.
 - The blood islands in the cardiogenic area of the **embryonic disc** forms **two endocardial heart tubes** while in the rest of the embryonic regions forms **primitive blood vessels**.
- ** **After lateral folding of the embryonic disc**, The 2 endocardial heart tubes fuse forming a **single endocardial heart tube**.

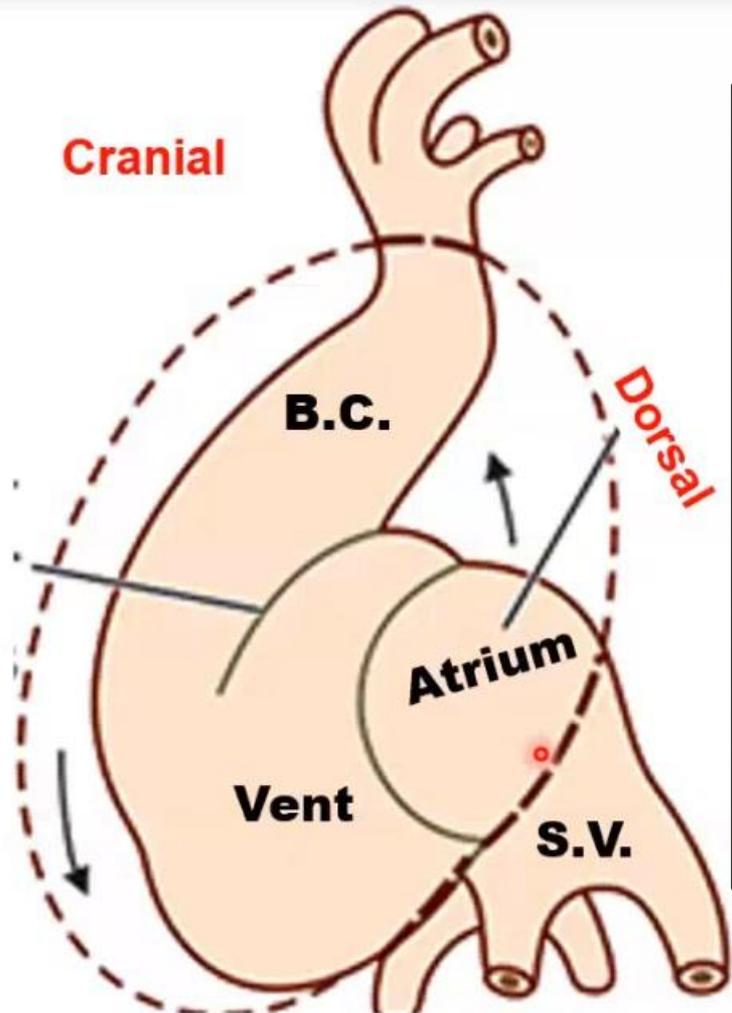


** Differentiation of the heart tube

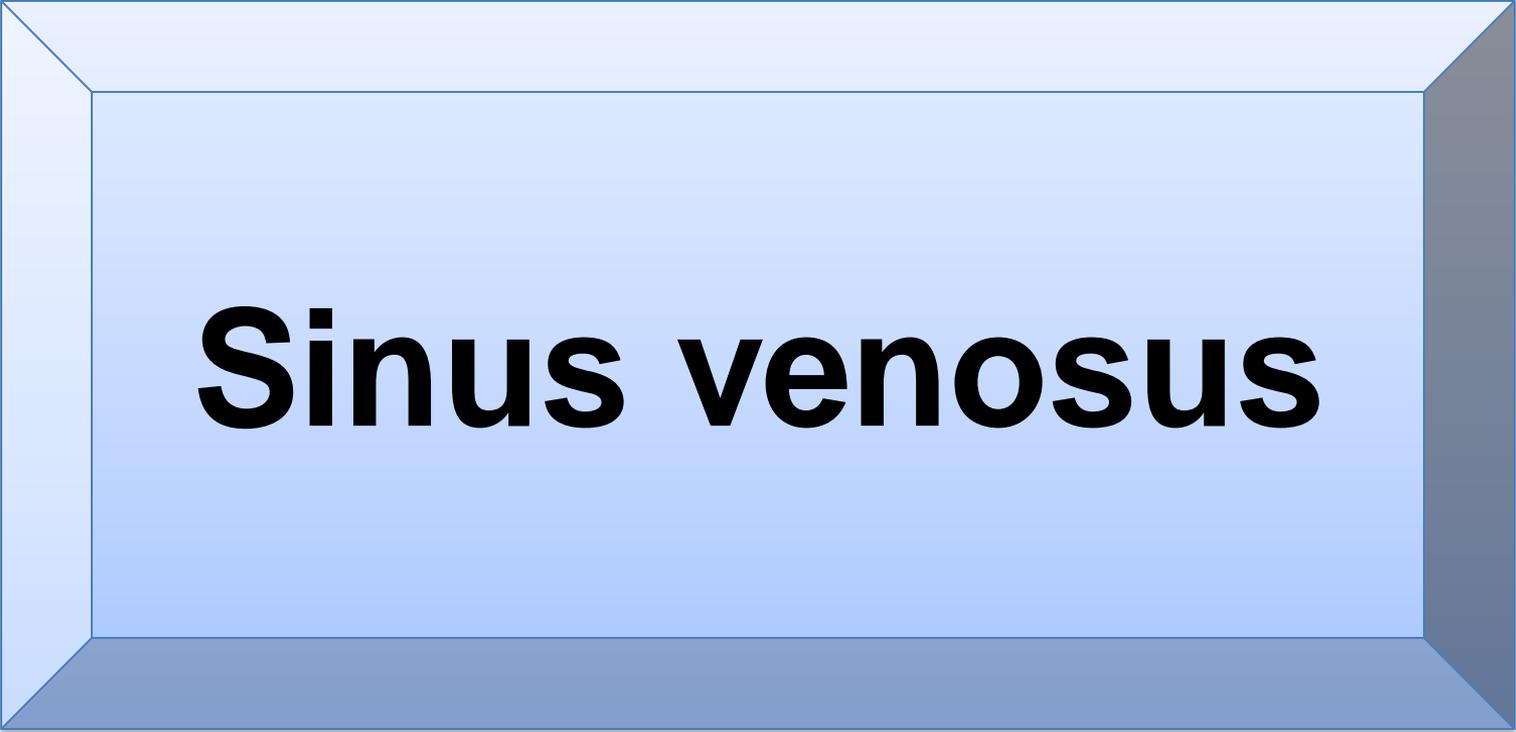
- Unequal growth of the heart tube leads to the formation of **4 dilated sacs**: separated from each other by narrow constrictions.
- The sacs arranged as follows:
 1. **Bulbus cordis (most cranially).**
 2. **Primitive ventricle.**
 3. **Primitive atrium.**

- The atrium and ventricle are connected by **atrioventricular canal.**

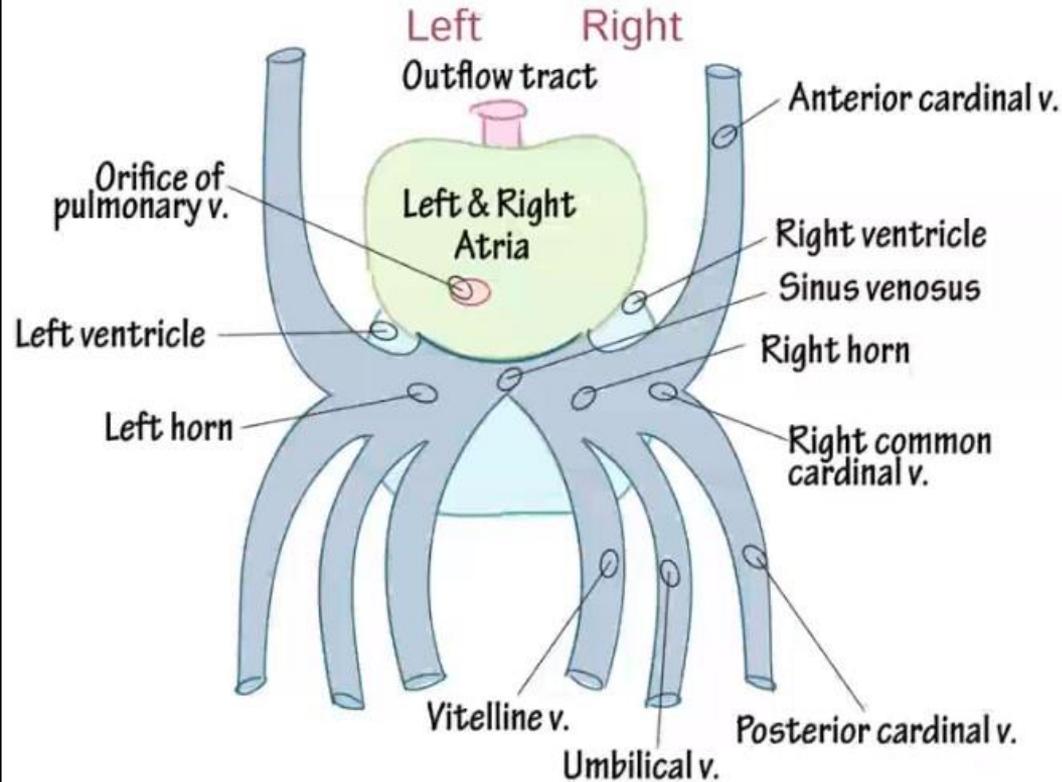
 4. **Sinus venosus (most caudally)**



- * Rapid growth of the heart tube than the pericardium resulted in dorsal folding of the heart tube on itself forming **S-shaped loop**. This will result in the following:
- 1- The primitive atrium** lies cranial and dorsal to the primitive ventricle
 - 2- The bulbus cordis** lies cranial to the primitive ventricle and ventral to the primitive atrium.
 - 3- The sinus venosus** lies caudal to the primitive atrium and dorsal to the primitive ventricle.



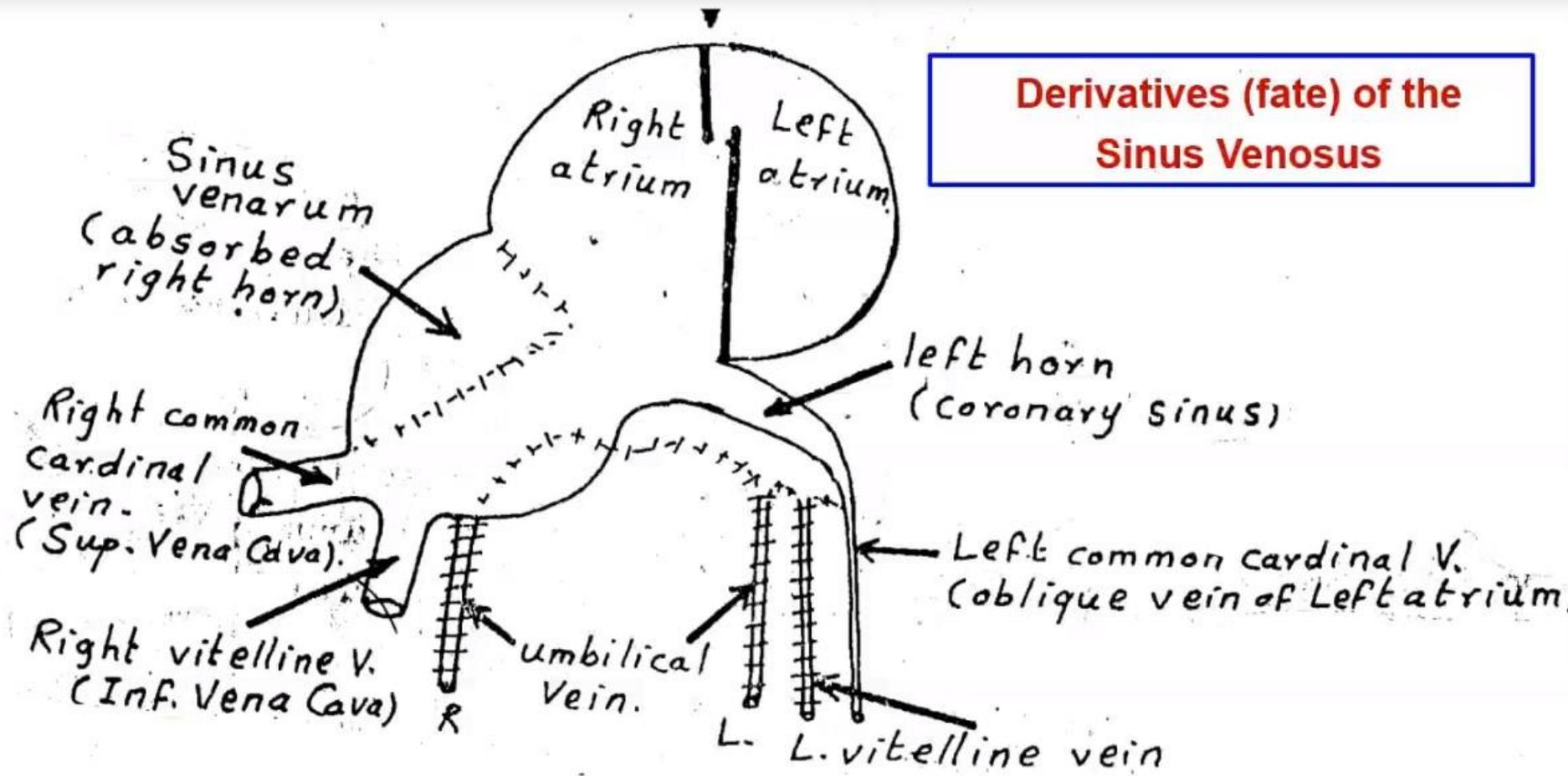
Sinus venosus



Derivatives (fate) of the Sinus Venosus

- The sinus venosus is formed of a body and **2 horns** (right and left).
- Each horn receives 3 veins:
 - 1. Umbilical vein** carried oxygenated blood from the **placenta**.
 - 2. Vitelline vein** drains blood from the **yolk sac**.
 - 3. Common cardinal vein** drains blood from the **body** of the embryo.

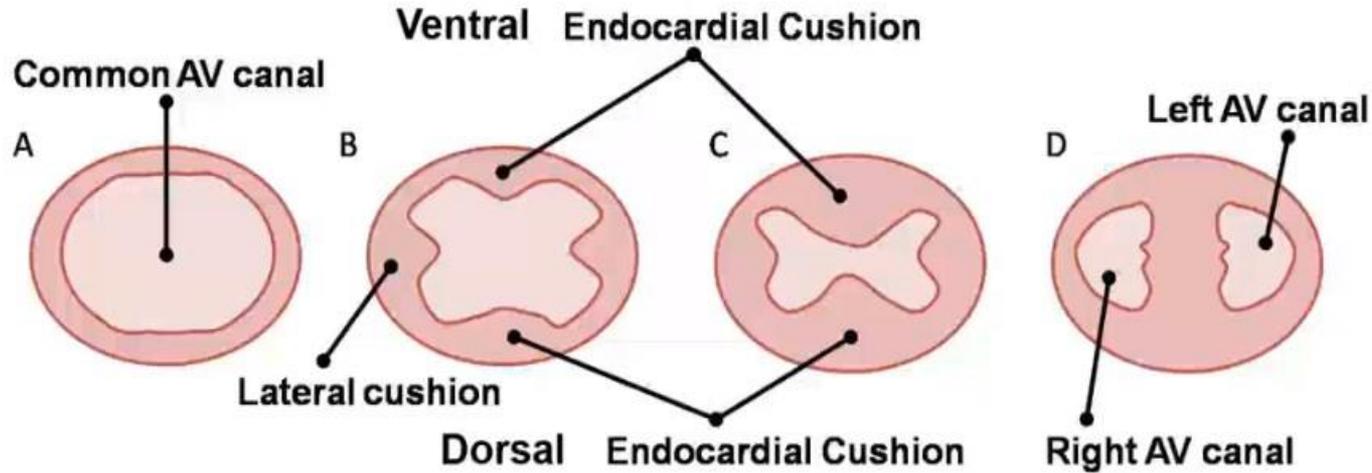
Derivatives (fate) of the Sinus Venosus



Derivatives (fate) of the Sinus Venosus

	right side	left side
Horn	Smooth posterior part of the right atrium	coronary sinus
Common cardinal vein	lower part of the superior vena cava	oblique vein of the left atrium
Vitelline vein	suprahepatic part of the inferior vena cava	Degenerated
Umbilical vein	Degenerated	After labor forms ligamentum teres of the liver

Changes of the atrioventricular canal



- **Atrioventricular septum;**

- Ventral and dorsal endocardial swellings develop in the atrioventricular canal.
- They enlarged and fused with each other forming the atrioventricular septum dividing the canal into right and left atrioventricular canals.
- **The upper part** is added into the developing **atria** while the **lower part** is added into the **developing ventricles**



Primitive atrium

جانبي

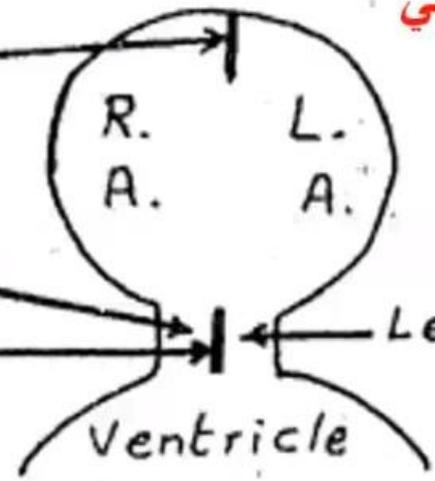
امامي خلفي



Septum primum.

Ventricle

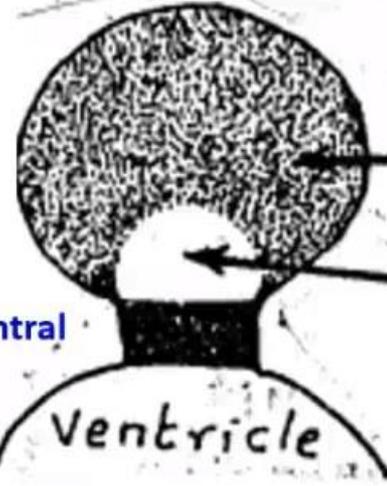
Right A-V. canal
A.V. septum.



Ventricle

Lef A-V. canal

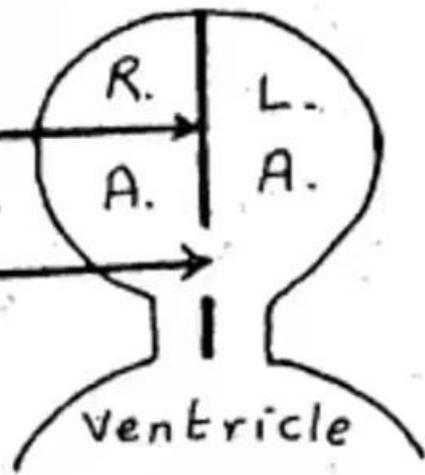
(a)



Sep-um primum.

Ostium primum.

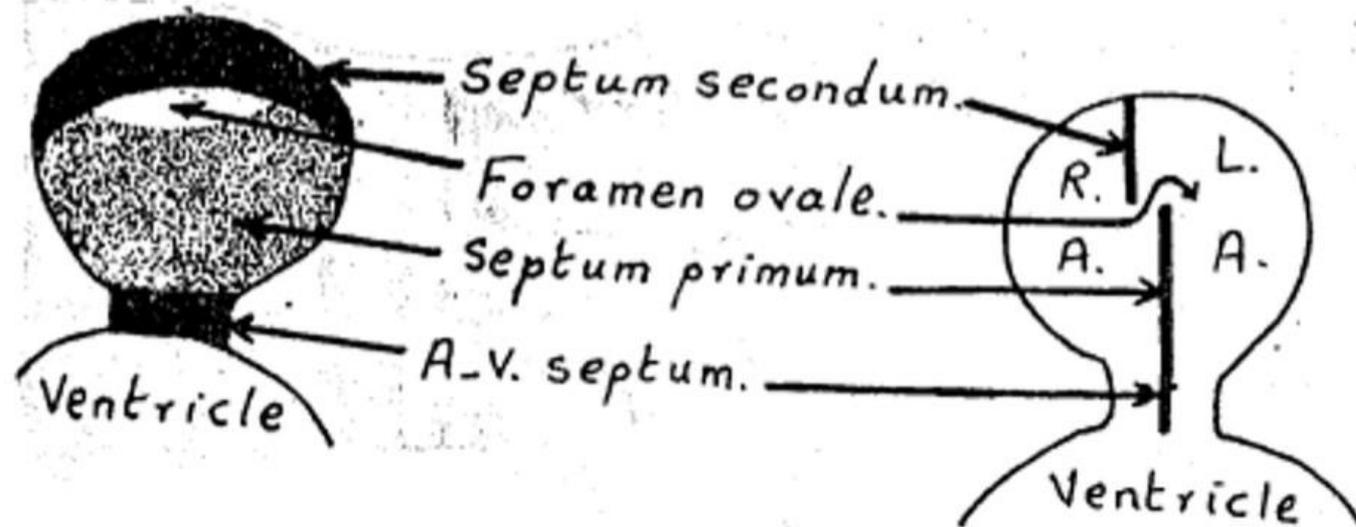
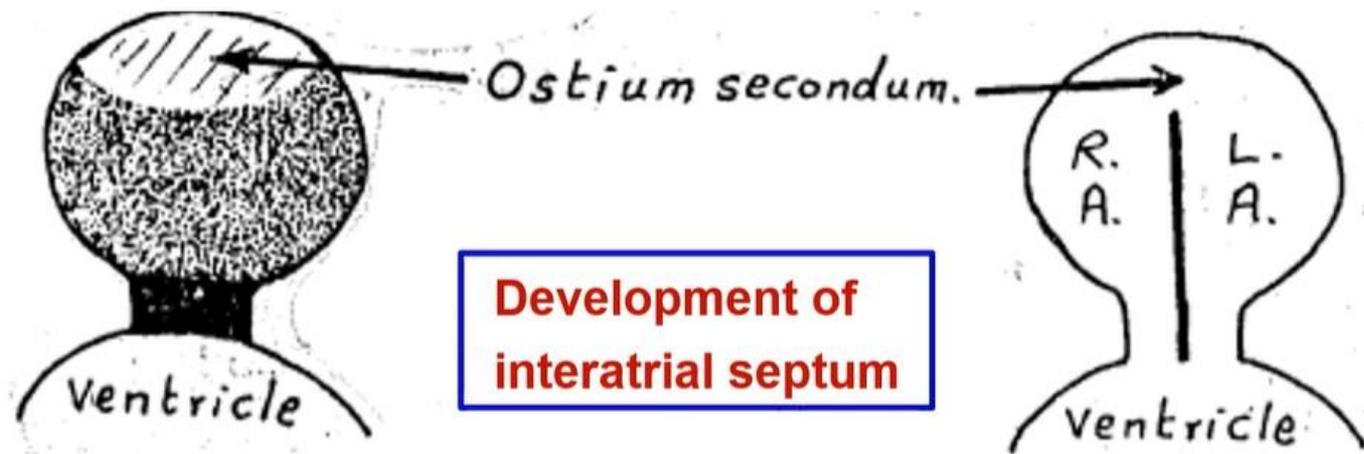
Ventricle

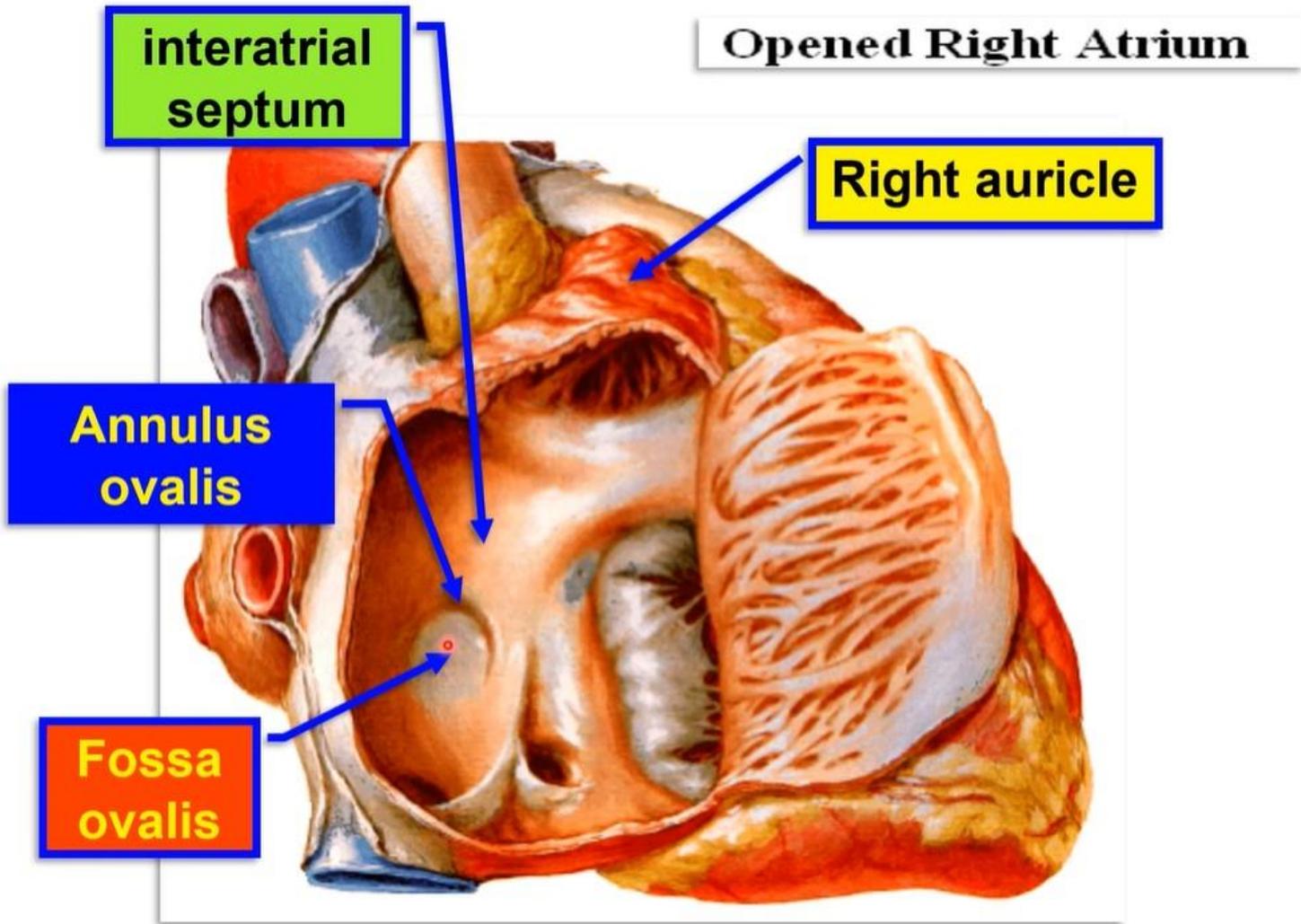


Ventricle

(b)

Development of interatrial septum





• Development of the inter-atrial septa

- It divides the common atrium into right and left atria as follows:

1- Septum primum;

- A sickle shaped septum descends from the roof of the common atrium and grows towards the atrioventricular canal.
- The anterior and posterior ends of the septum reach the atrioventricular septum before the central part. As a result, a temporary opening called **ostium primum** between the lower end of the septum primum and atrioventricular septum.
- **Before closure** of the ostium primum, another foramen appears by breaking of the upper part of the septum primum called **ostium secundum**.
- Both ostium primum and ostium secundum are necessary to passage of blood from the right atrium to left atrium during foetal life.

2- Septum secundum;

- Another sickle-shaped septum descends from the roof of the atrium to the **right side of the septum primum** till covers the ostium secundum.
- The gap between the lower edge of the septum secundum and upper edge of the septum primum is called **foramen ovale**. This foramen allows the passage of blood from the right atrium to the left atrium.
- **After birth**, the foramen ovale is closed by the apposition of the 2 septa; the septum primum forms the floor of the fossa ovalis and the lower edge of the septum secundum forms the annulus ovalis

Development of the atrium

- Two expansions from the primitive atrium around the bulbus cordis forming the right and left auricles.

- **The definitive right and left atria are developed from**

Right atrium	Left atrium
<ol style="list-style-type: none">1. Right 1/2 of primitive atrium2. Right 1/2 of A-V canal3. Absorbed right horn of sinus venosus forming smooth posterior part which receives openings of the SVC, IVC and coronary sinus	<ol style="list-style-type: none">1. Left 1/2 of primitive atrium2. Left 1/2 of A-V canal3. Absorbed common pulmonary vein forms smooth part, as a result; the 4 pulmonary veins open separately into the left atrium.

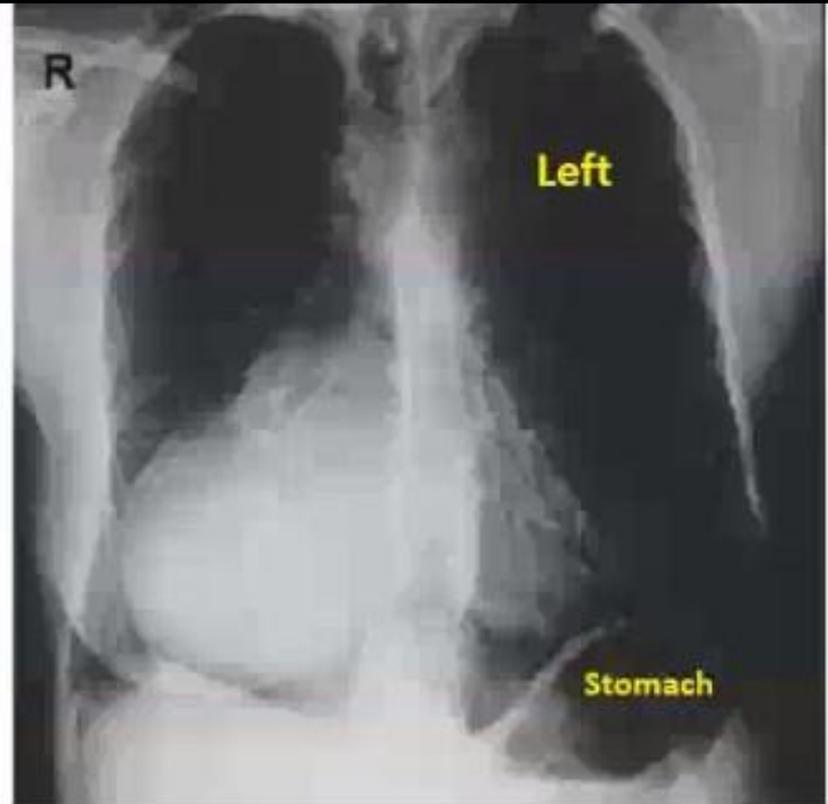
Congenital anomalies of the heart

Ectopic cordis: The costal surface of the heart is exposed to the surface due to defect in the sternum

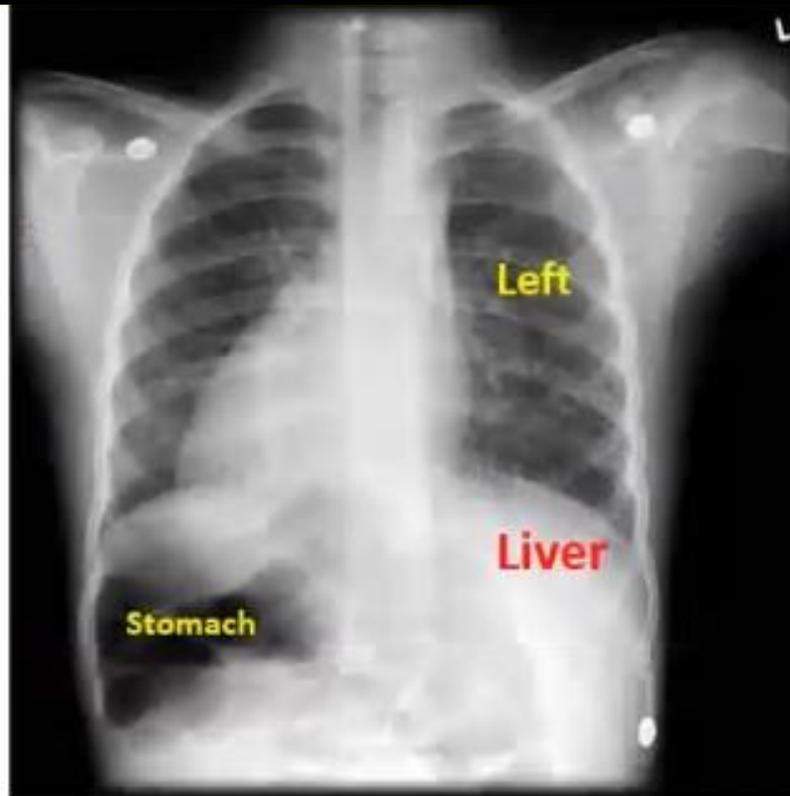


Dextrocardia: the apex of the heart is directed to the **right** side with partial **situs inversus**

- **Situs inversus is a congenital condition in which the organs in the chest and abdomen are reversed or mirrored from their normal positions.**
-Partial or complete



Dextrocardia: the apex of the heart is directed to the **right** side with complete **situs inversus**



- **Congenital anomalies of the interatrial septa**

1- Common atrium: due to failure of development of the interatrial septum.

2- Patent ostium primum: incomplete descend of the septum primum to close the ostium primum.

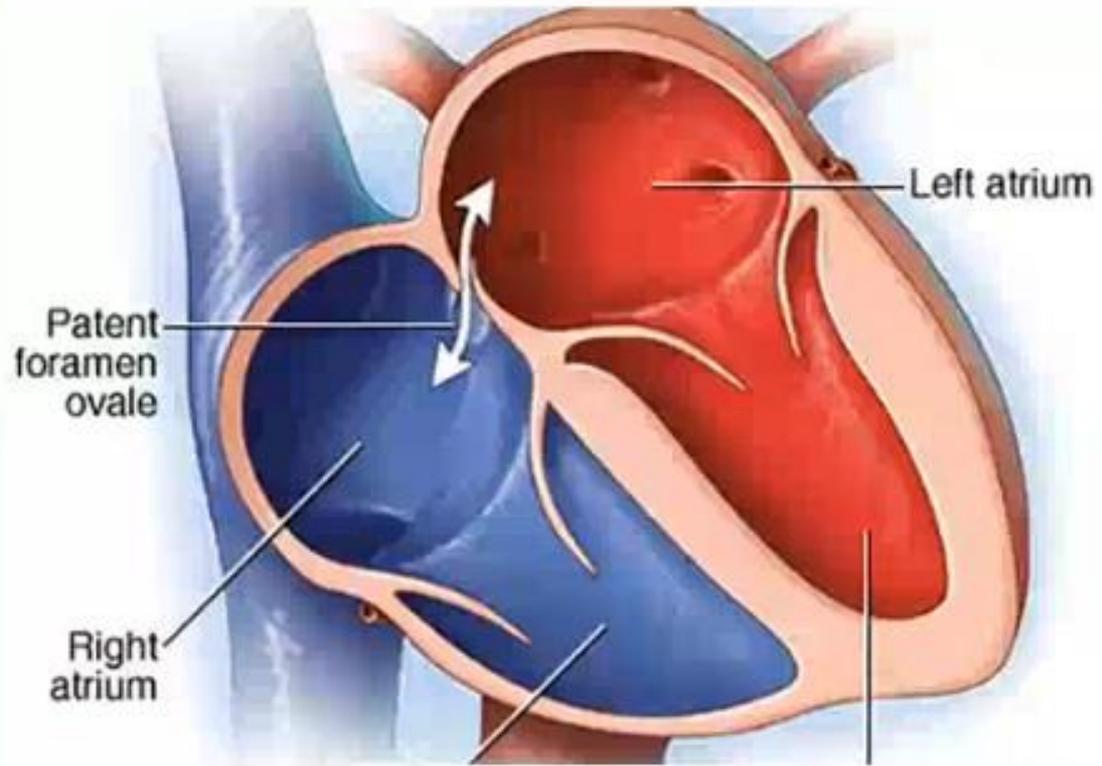
3- Patent ostium secundum: failure of development of the septum secundum or excessive breaking down of the septum primum.

4- Patent foramen ovale:

failure of closure of the foramen ovale after birth.

- This leads to shunt of the blood from the left to the right atrium with the result of right atrium enlargement.

5- Premature closure of the foramen ovale: leading to hypertrophy of the right atrium and ventricle





Bulbus cordis

* **The proximal part:** is absorbed and added to the ventricle.

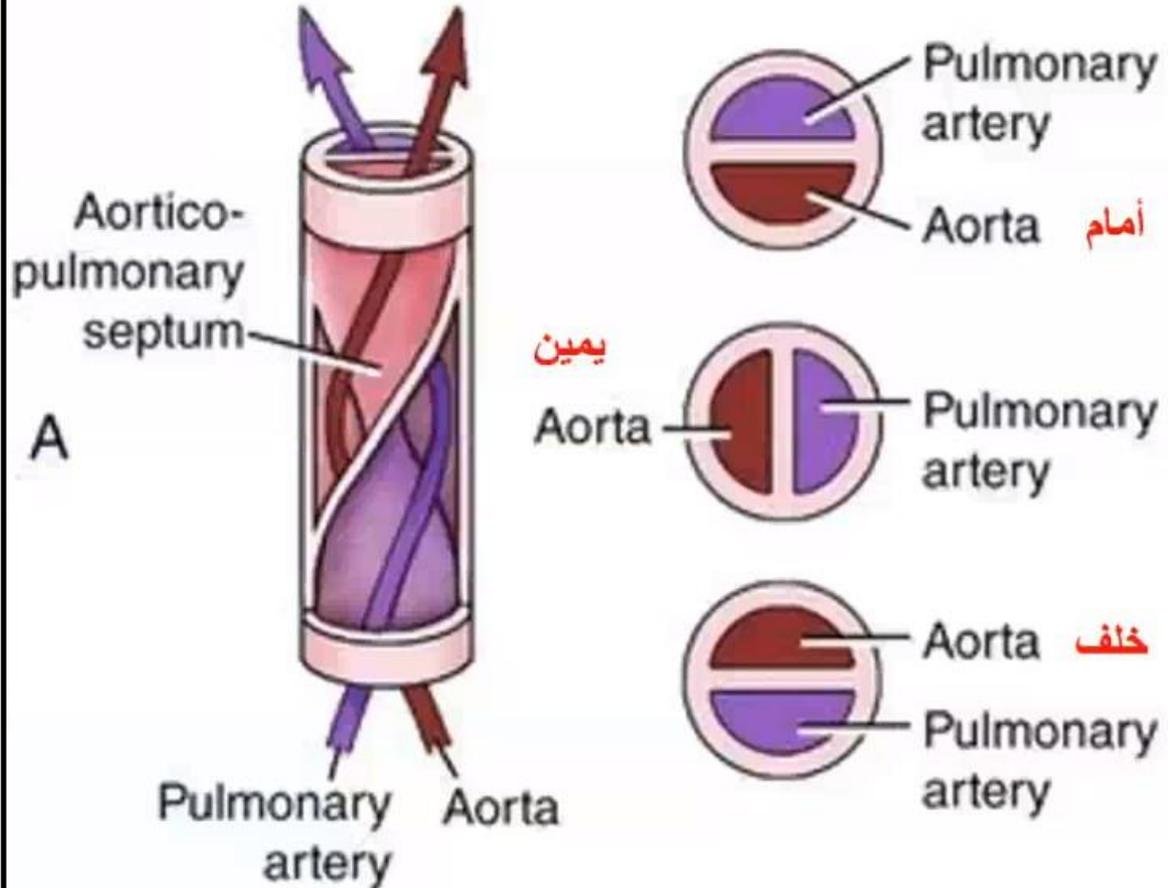
* **The distal part [truncus arteriosus]:** is divided into aorta and pulmonary trunk by a **bulbar (spiral) septum**. The lower end of the septum descends towards the inter-ventricular septum. **It rotates in a clock-wise direction**

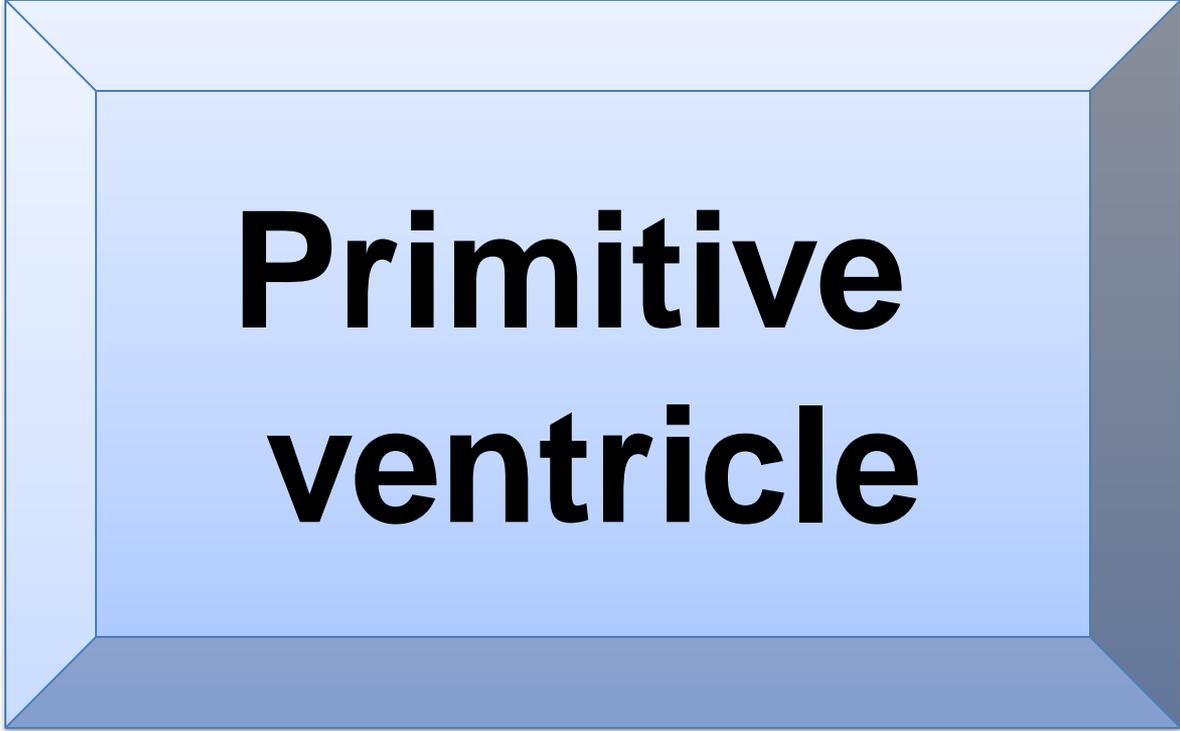
1. In the upper part: The septum is **transverse**. The **aorta** lies **in front** of the pulmonary trunk.

2. In the middle part: the septum is **antero-posterior**. The **aorta** lies to the **right side** of the pulmonary trunk.

3. In the lower part: The septum is **transverse**. The **aorta** lies **behind** the pulmonary trunk. **SO**, the aorta opens into the left ventricle and pulmonary trunk open into the R.V

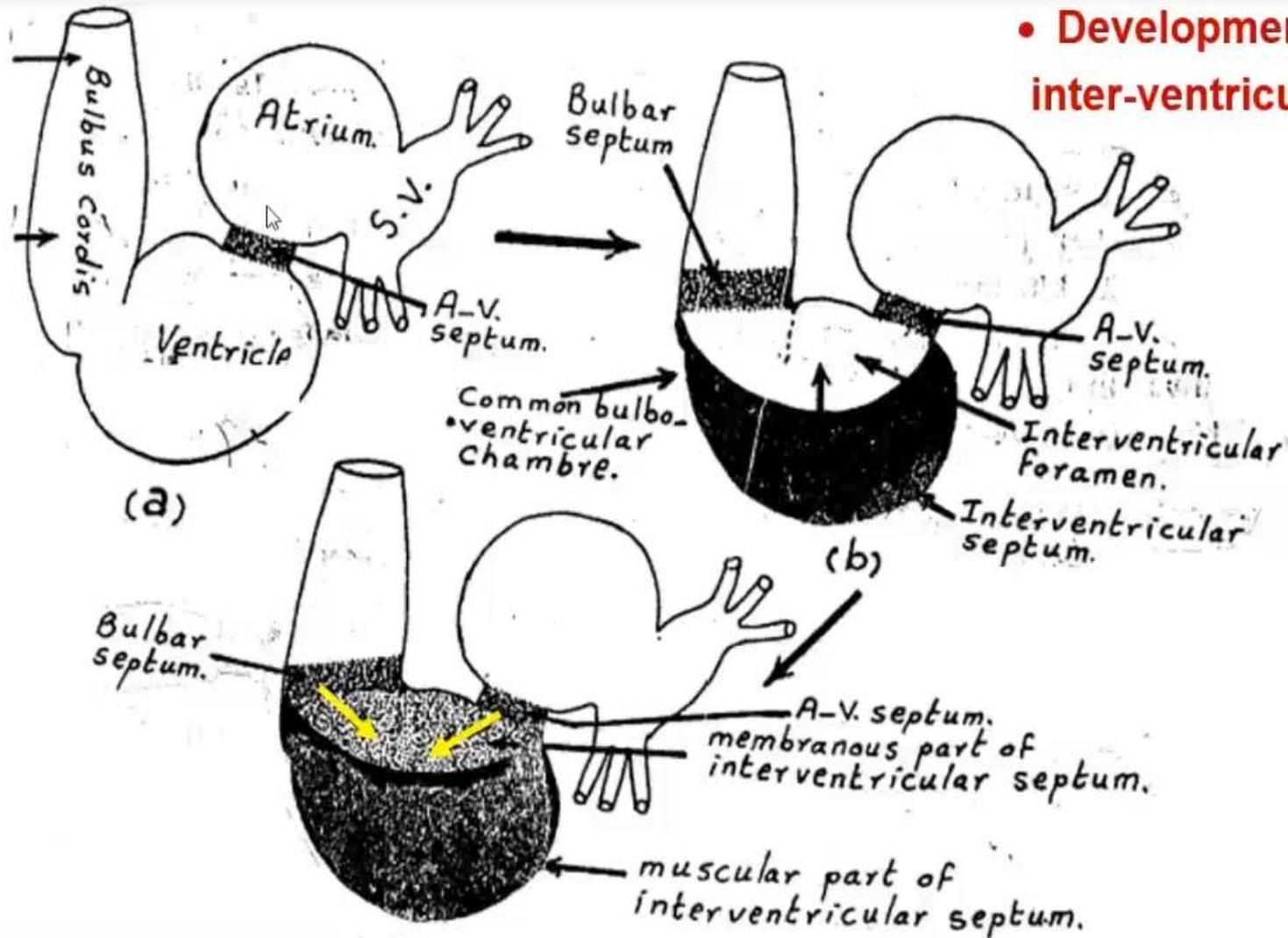
Development of the bulbus cordis





**Primitive
ventricle**

• Development of the inter-ventricular septa



Development of the definitive ventricles

- The proximal part of the bulbus cordis and the lower part of the atrioventricular canal are absorbed into the primitive ventricle forming a **common bulboventricular chamber**.

1) The absorbed bulbus cordis gives also rise to the smooth outflow parts of the definitive ventricles (**infundibulum** of the right ventricle and **vestibule** of the left ventricle).

2) The absorbed atrioventricular canal forms the part of the ventricles at the atrioventricular opening.

3) The **primitive ventricle** forms the **rough part** of the ventricular cavities.

□ It is divided into 2 parts, right and left ventricles by the inter-ventricular septum.

- **Development of the interventricular septa**

1- Muscular part of the septum:

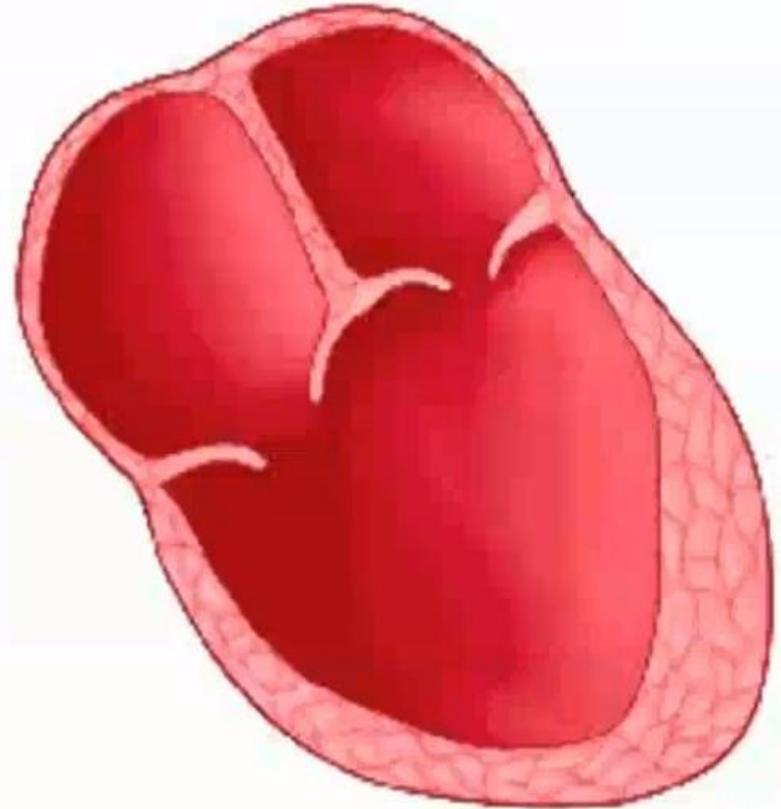
- A sickle-shaped septum developed from the floor of the common ventricular chamber.
- It ascends upward towards the bulbar septum and atrioventricular septum leaving an opening called **interventricular foramen** connecting the two ventricles and forms **muscular** part of interventricular septum.

2- Bulbar septum and **atrioventricular septum** descends **downward to** meet the upper margin of muscular part forming **membranous part of the interventricular septum.**

- **Congenital anomalies of the ventricle**

- **Cor bilocular:** the heart consists of one atrium and one ventricle due to failure of development of the septa.
- **Cor trilocular,** the heart consists of 21 atria and one ventricle due to absent of the interventricular septum.

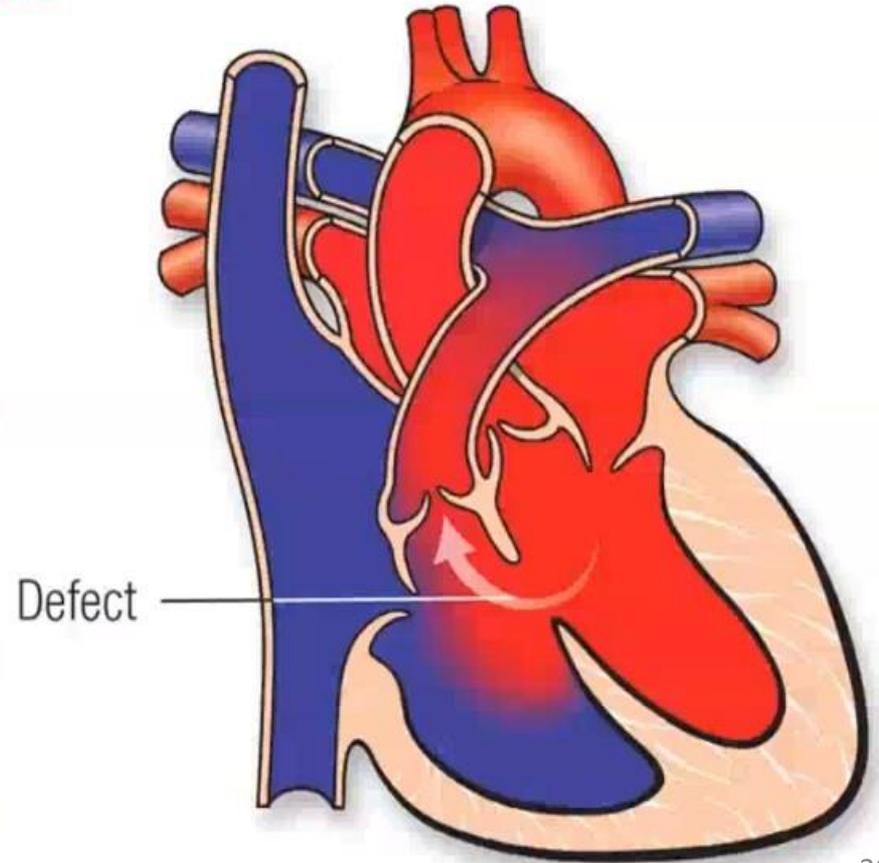
Cor trilocular



- **Congenital anomalies of the ventricle**

- **Ventricular septal defect** (VSD= Rogers' syndrome): due to failure of development of the membranous part of the interventricular septum.
 - It allows the passage of the blood from the left ventricle to the right ventricle leading to **cyanosis**.

Ventricular Septal Defect

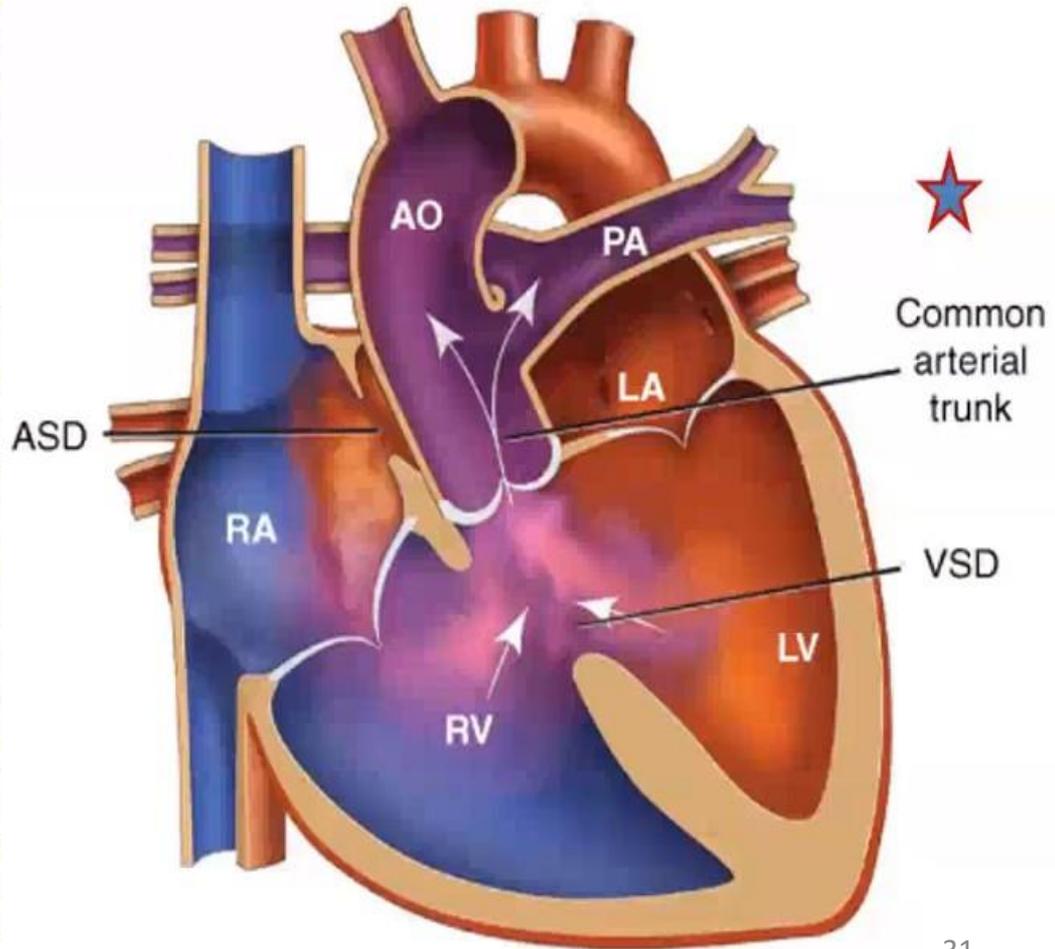


Anomalies of the bulbar septum

Persistent bulbus cordis (common arterial trunk):

due to failure of development of the bulbar septum and so the great vessels arise as a common trunk and receives blood from both ventricles

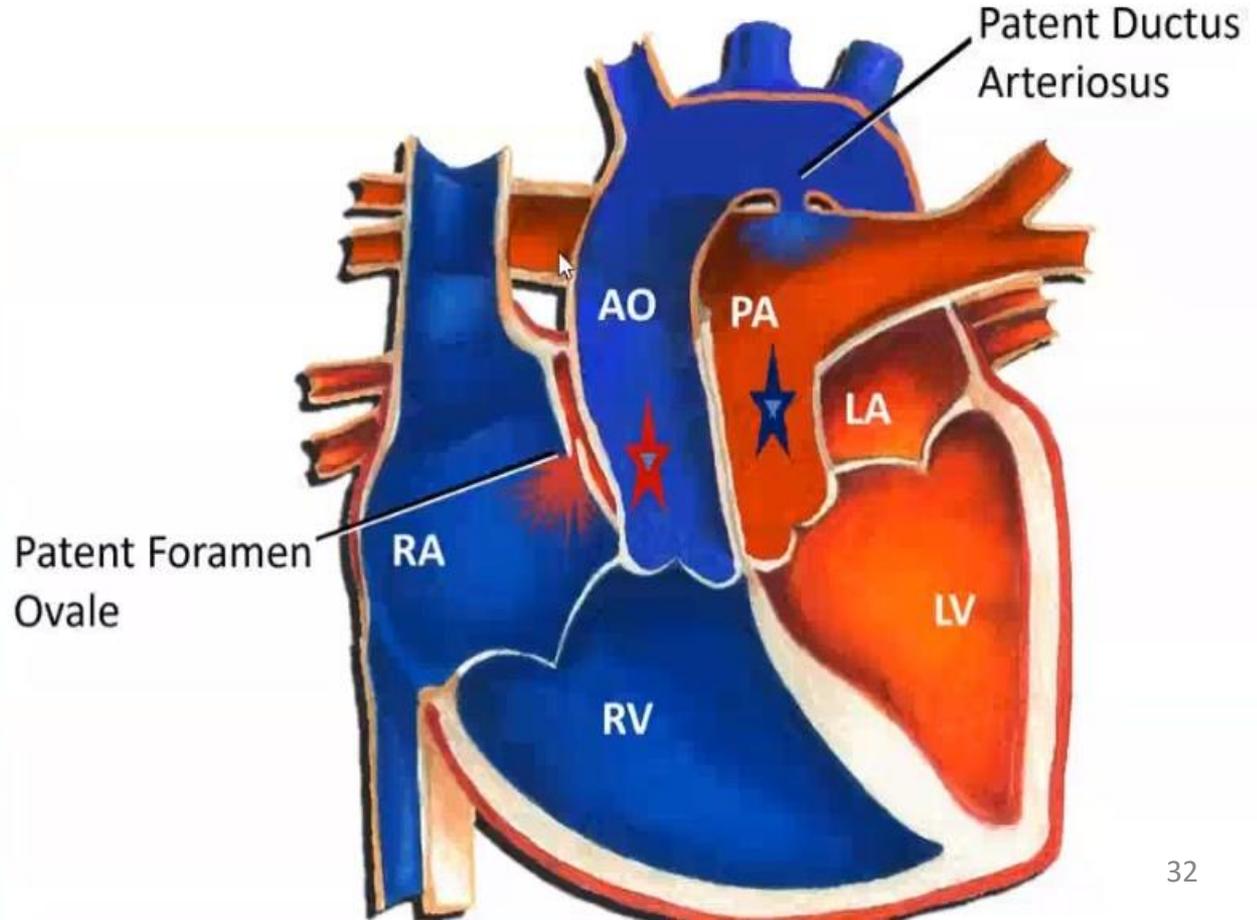
(Ventricular Septal Defect).



- **Transposition of the great vessels**

- Aorta arises from the right ventricle while the pulmonary trunk arises from the left ventricle due to **reversed rotation of the bulbar septum**

Transposition of the Great Arteries



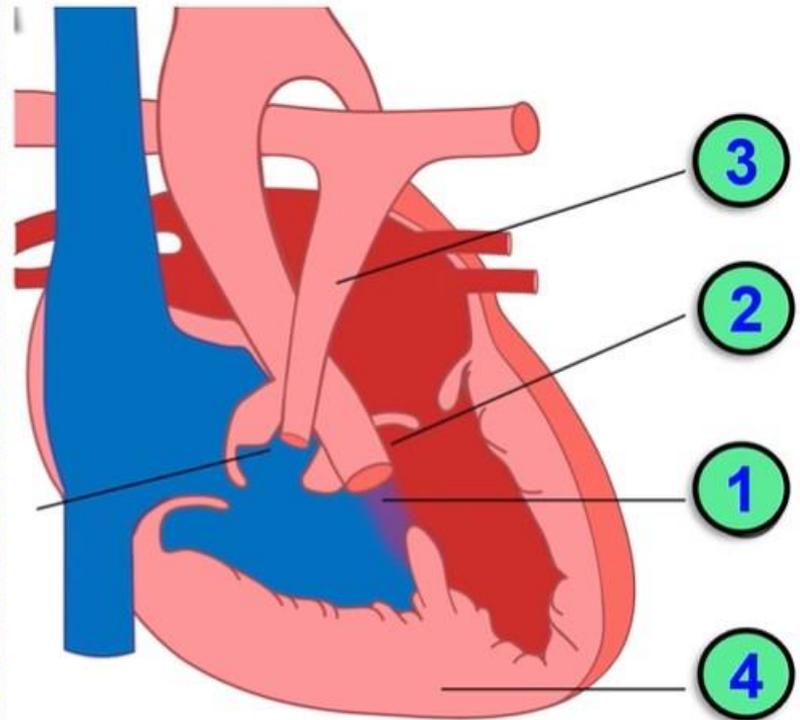
• Fallot's tetralogy

- It is caused by

- 1) Anterior displacement of the bulbar septum.
- 2) Failure of development of the membranous septum.

- It consists of:

- 1- **Ventricular septal defect** [VSD] due to failure of development of the membranous part of the interventricular septum
- 2- **Overriding of the aorta** (the aorta arises from the 2 ventricles due to anterior displacement of the bulbar septum).
- 3- **Pulmonary stenosis.**
- 4- **Right ventricular hypertrophy.**



Eisenmenger's syndrome: as Fallot's tetralogy **without** pulmonary stenosis.

