

LECTURE

#1

EMBRYOLOGY

19

Development of the heart





TABLE OF CONTENTS

Objectives	2
HEART TUBE	3
VEINS ASSOCIATED WITH HEART DEVELOPMENT AND FATE OF SINUS VENOSUS	5
LEFT & RIGHT ATRIUM	6
PARTITIONING OF PRIMORDIAL HEART	7
PARTITIONING OF THE TRUNCUS ARTERIOSUS	11
MAJOR CARDIAC ANOMALIES	12
DATE/EVENT SUMMEAY	15
MULTIPLE CHOICES QUESTIONS	16
ADDITIONAL LINKS	17

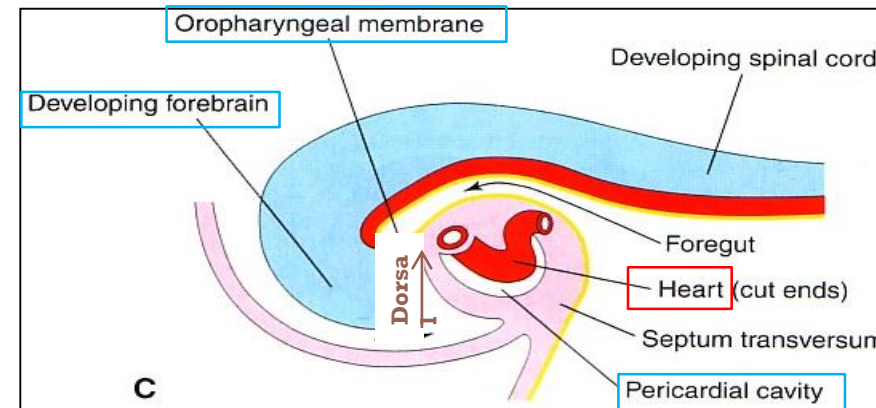
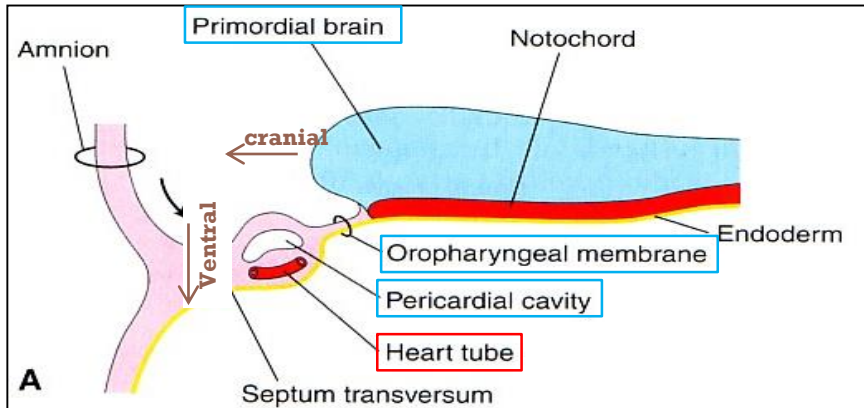
OBJECTIVES

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

- ❖ Describe the **Formation, Site, Union, Division of the heart tube.**
- ❖ 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

- It's the first functional organ to develop.
- **Origin:** cardiogenic area of splanchnic mesoderm
- The heart primordium can be seen at **18 days** as an angioplastic cords which will be canalized to form the 2 heart tubes.
- It begins cranial to the developing mouth & nervous system and ventral to the developing pericardial sac (as in A) , after the head fold completed the developing heart tubes lie in the ventral aspect of the embryo dorsal to the developing pericardial sac. (as in C)



- It begins to beat at **22 to 23 days**.
- Blood flow begins during **the beginning of the fourth week**.
- can be visualized by **Ultrasound Doppler**

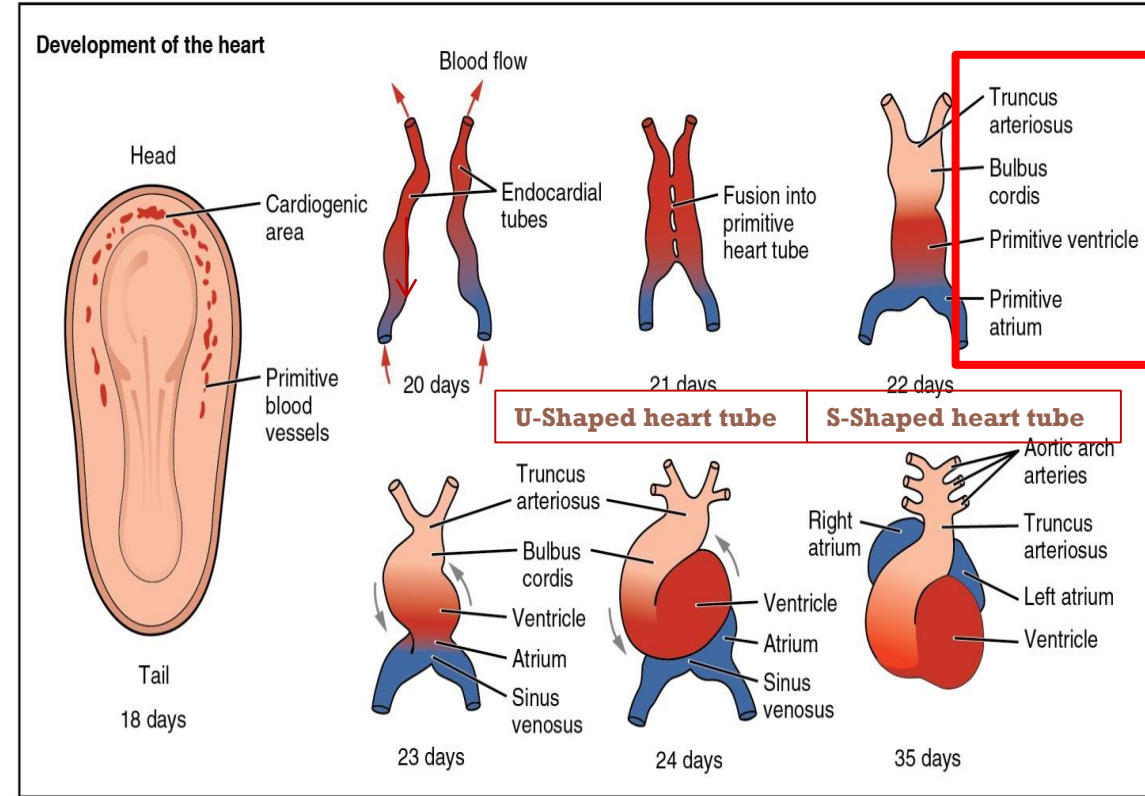


#DEVELOPMENT OF THE HEART TUBE

- the 2 heart tubes approach each other After lateral folding of the embryo and fuse to form a single endocardial heart tube within the pericardial sac.
- The fusing occurs in a **craniocaudal** ↓ direction.
- The heart tube grows faster than the pericardial sac, so it shows 5 alternate dilations separated by 4 constrictions:

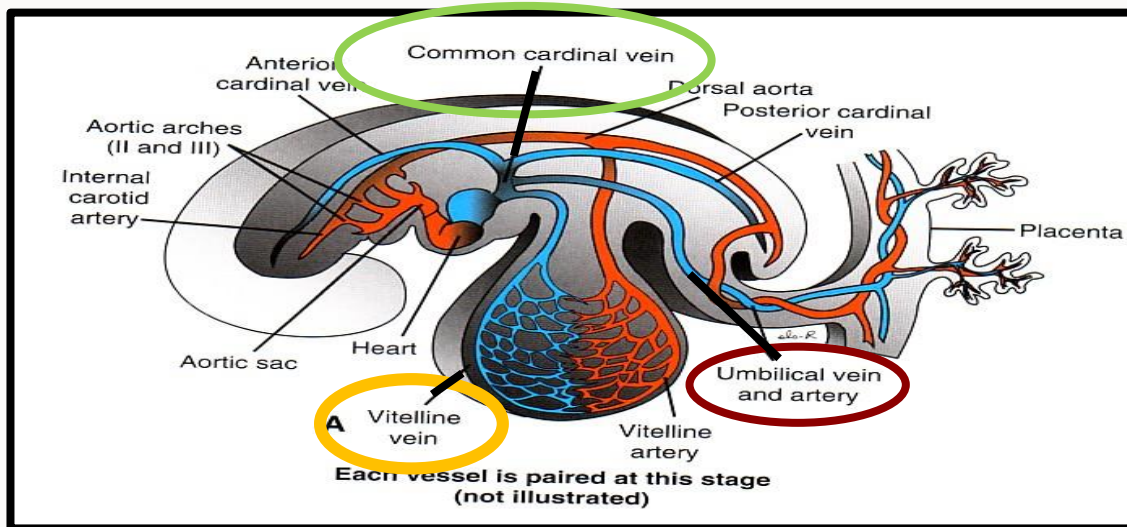
- * **Sinus venosus, the venous end** * **Truncus Arteriosus, the Arterial end**
- * **Common Ventricle.** * **Common Atrium.**
- * **Bulbus Cordis. (the smooth part of the ventricles)**

- The U-shaped heart tube (bulboventricular loop) forms as a result of Bulbus cordis and ventricle growing faster than other regions.
- As the heart tube more develops it bends upon itself so the atrium and sinus venosus become dorsal to the truncus arteriosus, bulbus cordis, and ventricle, and this is called Loop formation Or S-Shaped Heart Tube.

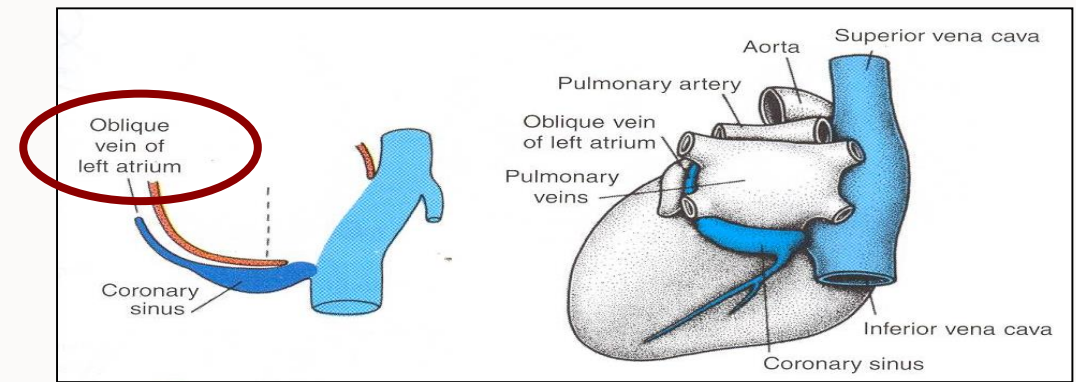


#VEINS ASSOCIATED WITH HEART DEVELOPMENT AND FATE OF SINUS VENOSUS

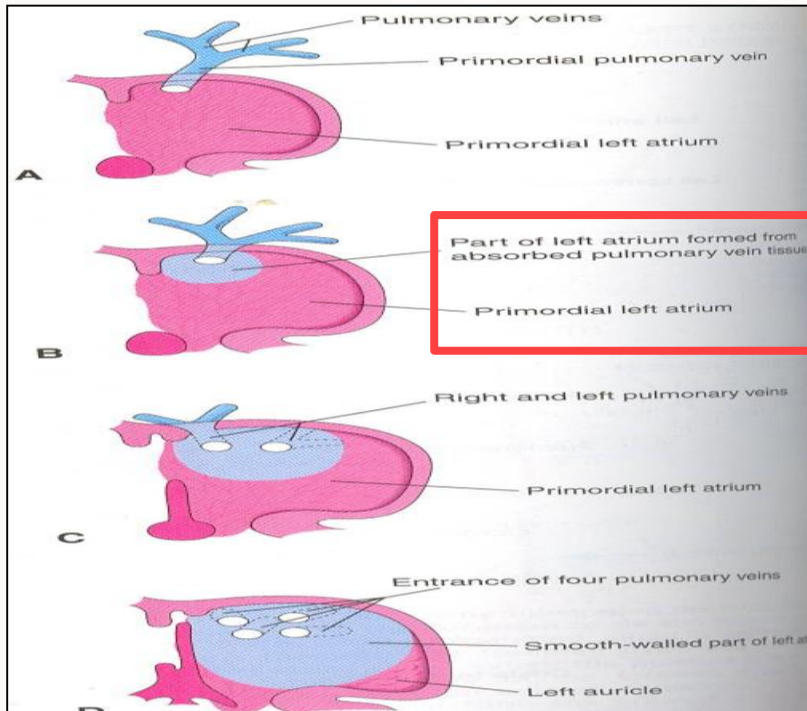
- By this stage the sinus venosus has developed **2 lateral** expansions, (Horns) : **right and left horns** (each horn will receive 3 veins)
 - Each sinus venosus' horn receives 3 veins:
 - 1) **The Cardinal** vein from the fetal body.
 - 2) **The Vitelline** vein from the yolk sac.
 - 3) **The Umbilical** vein from the placenta.



<ul style="list-style-type: none"> • Left common cardinal vein <p>Forms the oblique vein of the left atrium</p>	<ul style="list-style-type: none"> • Left horn and body <p>Atrophy and form the coronary sinus</p>	<ul style="list-style-type: none"> • Right horn <p>Forms the smooth posterior wall of the right atrium</p>
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#LEFT ATRIUM:



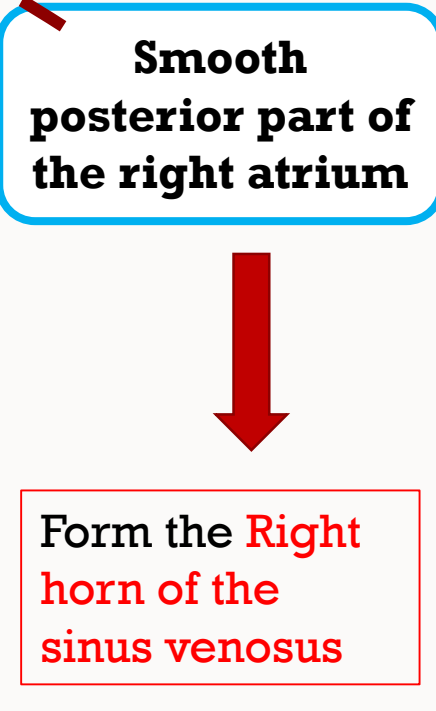
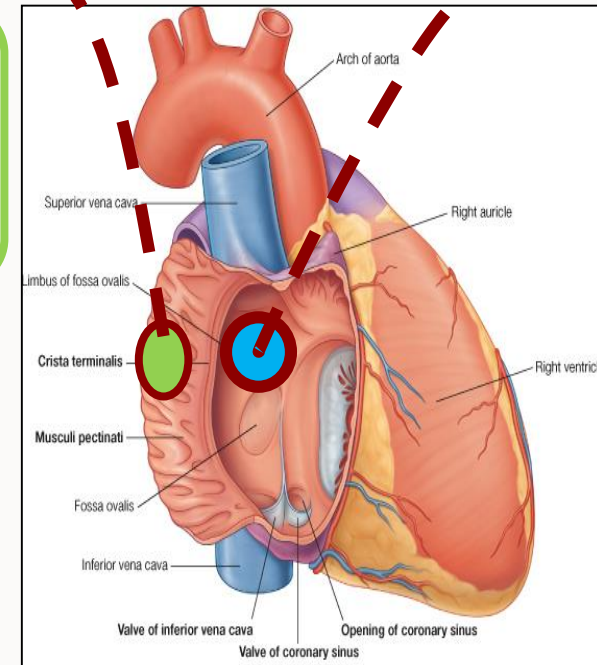
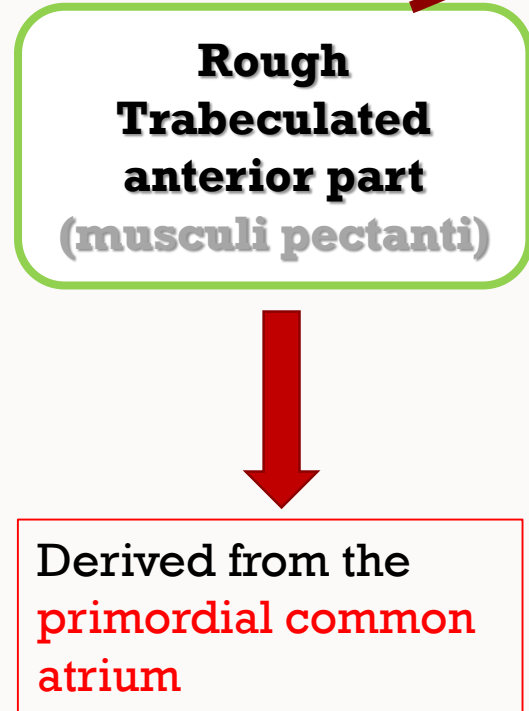
✓ Smooth part:

Derived from the **absorbed Pulmonary Veins**

✓ Rough Trabeculated part:

Derived from the **common primordial atrium**.

#RIGHT ATRIUM:



- These two parts are demarcated by the **crista terminalis** (internally), and **sulcus terminalis** (externally).



#PARTITIONING OF PRIMORDIAL HEART:

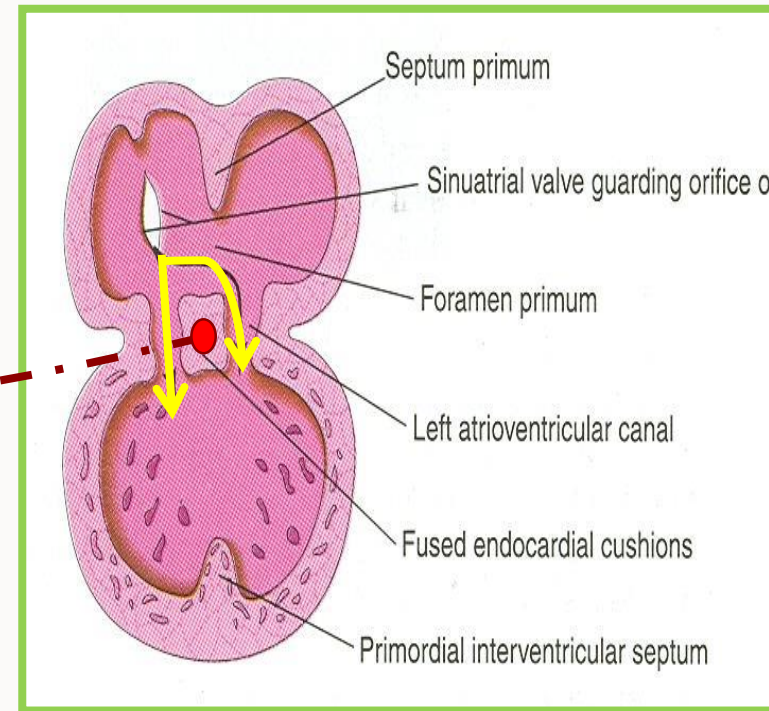
❖ The partitioning **begins** by the middle of **4th week**. It is **completed** by the end of **5th week**.

It occurs to 4 different structures :

- 1) Atrioventricular canal.**
- 2) Common atrium.**
- 3) Common ventricle.**
- 4) Truncus arteriosus & Bulbus cordis.**

#1) PARTITIONING OF ATRIOVENTRICULAR CANAL :

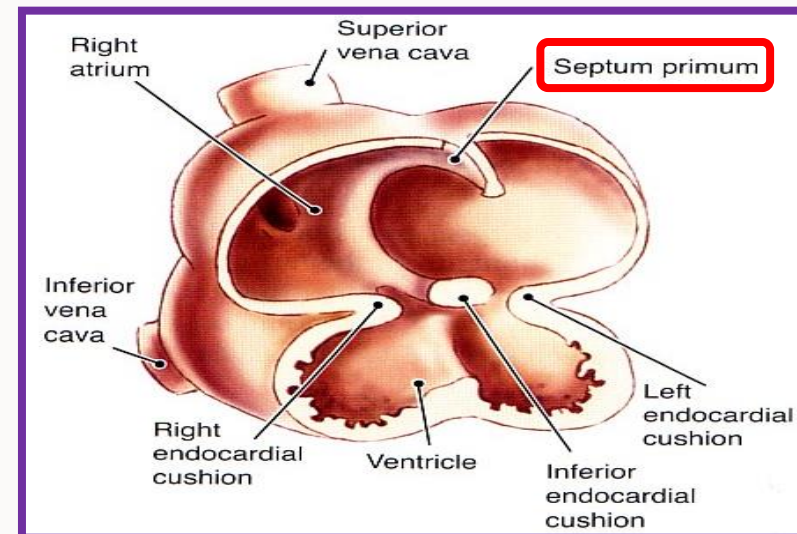
- **Two** endocardial cushions are formed on the **dorsal** and **ventral** walls of the AV canal.
- The AV endocardial cushions approach each other and fuse to form the **septum intermedium**. *Dividing the AV canal into right & left canals (2 Arrows).*
- These canals partially separate the primordial atrium from the ventricle.



#2) PARTITIONING OF THE COMMON ATRIUM:

➤ Septum Primum:

- It is sickle- shaped septum that grows from the roof of the common atrium towards the fusing endocardial cushions (septum intermedium).
- it divides the common atrium into right & left halves.





➤ Ostium Primum:

Ostium: an opening into a vessel or cavity of the body.

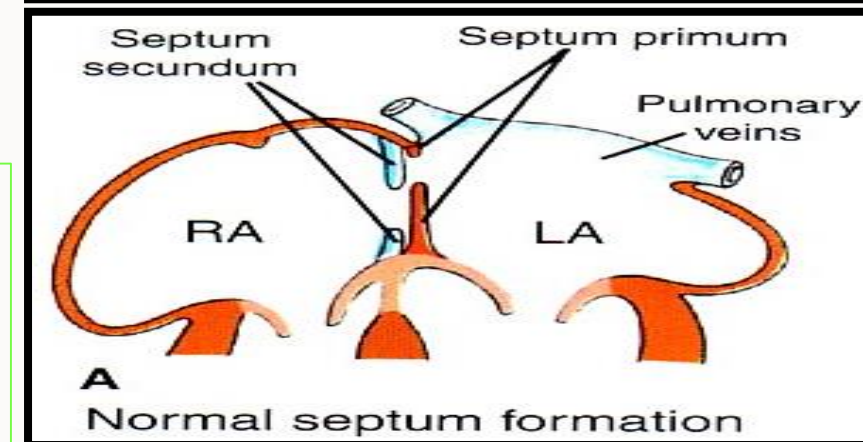
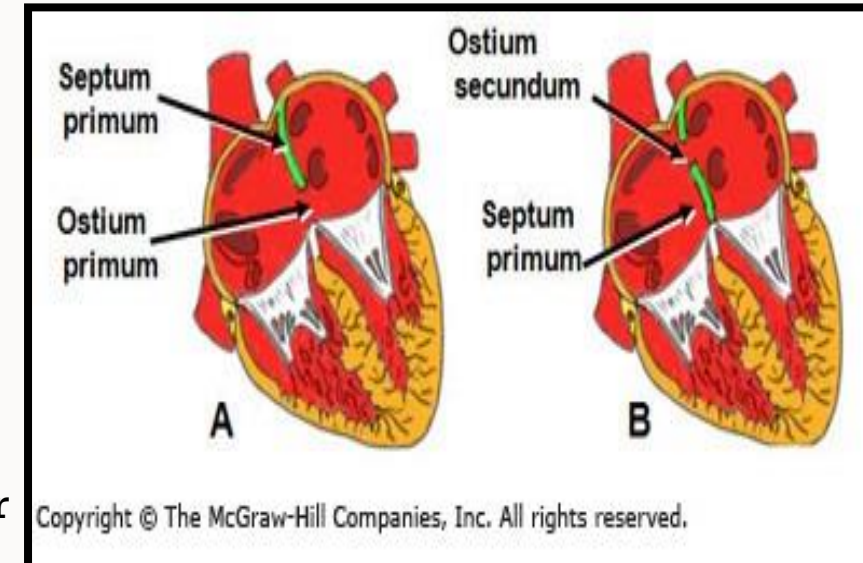
- The two ends of septum primum reach to the growing endocardial cushions before its central part.
- Now the septum primum bounds (surrounds) a foramen called **ostium primum**.
- Function** of this foramen: It serves as a shunt, enabling the oxygenated blood to pass from right to left atrium.
- Fate of ostium primum: It become smaller and disappears as the septum primum fuses completely with the septum intermedium to form the AV septum.

➤ Septum Secundum:

- On the upper part of **septum primum**, a small openings are seen and fuse together to form an opening called **Ostium secundum**. This foramen has a specific septum called **septum secundum**.
- It forms **an incomplete** partition between the two atria.
- Consequently a valvular oval foramen forms, (**foramen ovale**).

✓ Fate of foramen Ovale:

- At birth when the lung circulation begins, **the pressure in the left atrium increases**.
- The valve of the foramen ovale is pressed against the septum secundum and obliterates the foramen ovale.
- Its site is represented by the **Fossa Ovalis**
- Its **floor** represents the persistent part of the septum primum.
- Its **limbus** (anulus) is the lower edge of the septum secundum



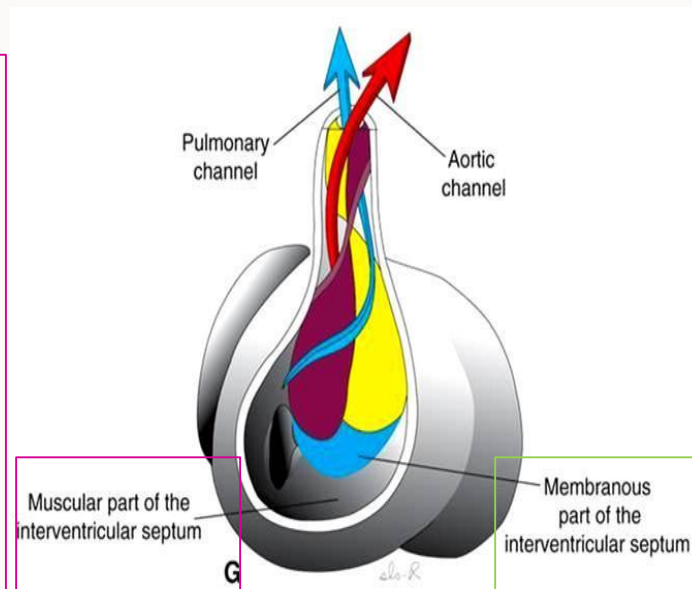
#3) PARTITIONING OF PRIMORDIAL VENTRICLE:

The interventricular is divided into

The Muscular part

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 **Interventricular foramen** (Because the muscular part can't reach to the cushions).

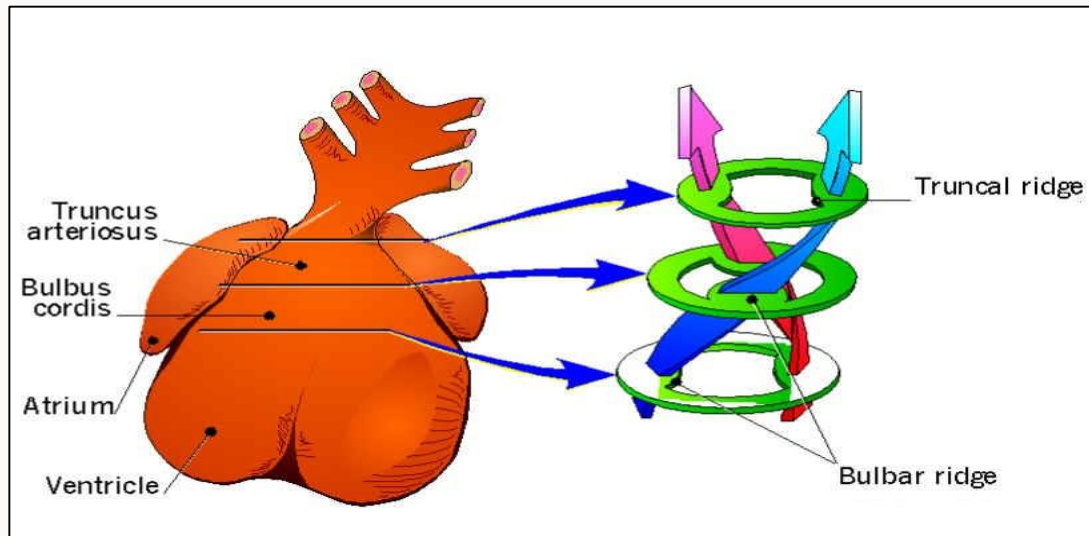


The Membranous part

It is derived from 3 parts :

- 1) A tissue extension from the right side of the endocardial cushion.
- 2) **Aorticopulmonary** septum.
- 3) Thick muscular part of the IV septum.

#SPIRAL AORTICOPULMONARY SEPTUM:



-A spiral septum develops in the **truncus arteriosus** dividing it into **aorta** and **pulmonary trunk** (that's why it is called Aorticopulmonary septum).

- ✓ The septum divides the upper and lower part **vertically** (Right & Left).
- ✓ It deviates in the middle part **Horizontally** (dividing aorta and pulmonary trunk into anterior & posterior parts).

#BULBUS CORDIS:

The bulbus cordis forms the smooth upper part of the two ventricles. :


In the left ventricle:

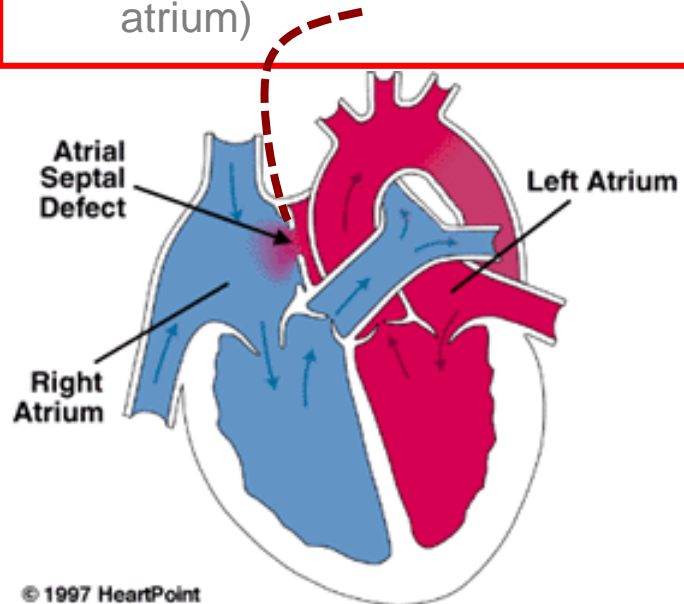
It forms the **aortic Vestibule** which leads to the aorta.

In the right Ventricle:

It forms the **Conus Arteriosus or (Infundibulum)** which leads to the pulmonary trunk.

1) Atrial septal defects (ASD):

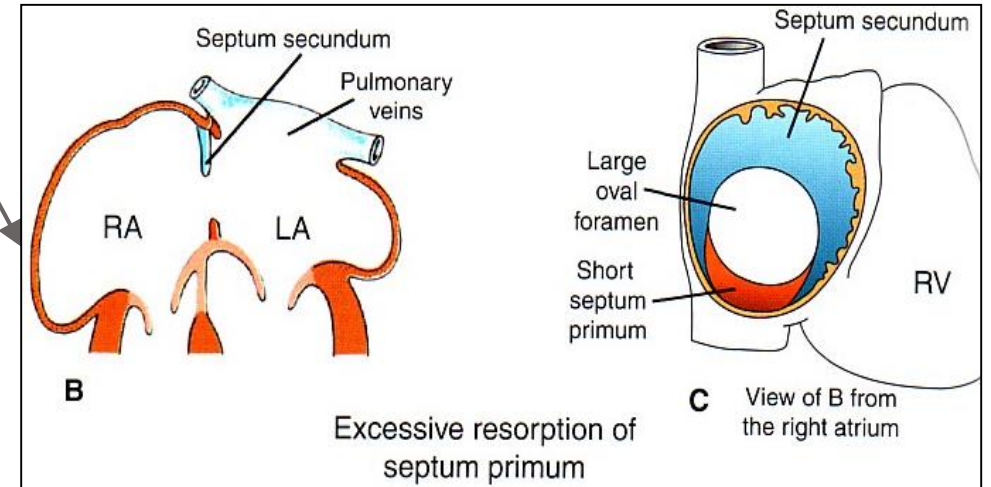
- a) Absence of septum primum and septum secundum, leads to common atrium.
- b) Excessive resorption of septum primum
- c) Patent foramen ovale 
- d) Absence of septum secundum (causes mixture of blood between the two atrium)



#MAJOR CARDIAC ANOMALIES

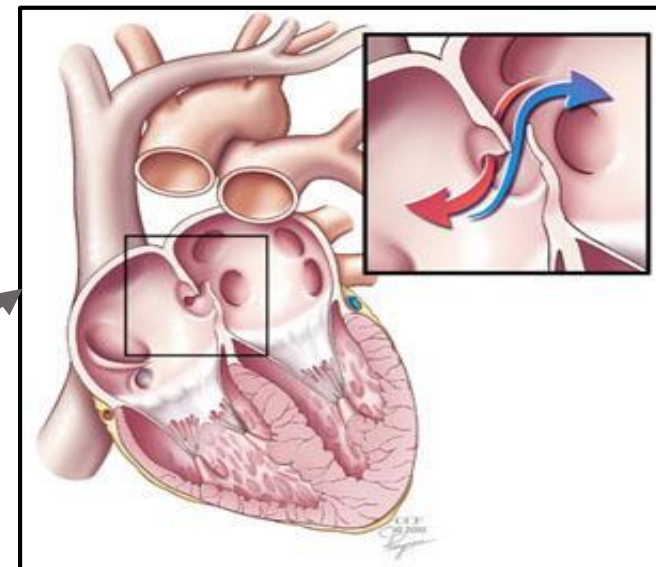
❖ Excessive resorption of septum primum

(Large foramen ovale)



❖ Patent foramen ovale

No closing of foramen ovale
It can be **Asymptomatic**.



2) VENTRICULAR SEPTAL DEFECT (VSD):



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

Children with Tetralogy of Fallot exhibit bluish skin during episodes of crying or feeding.

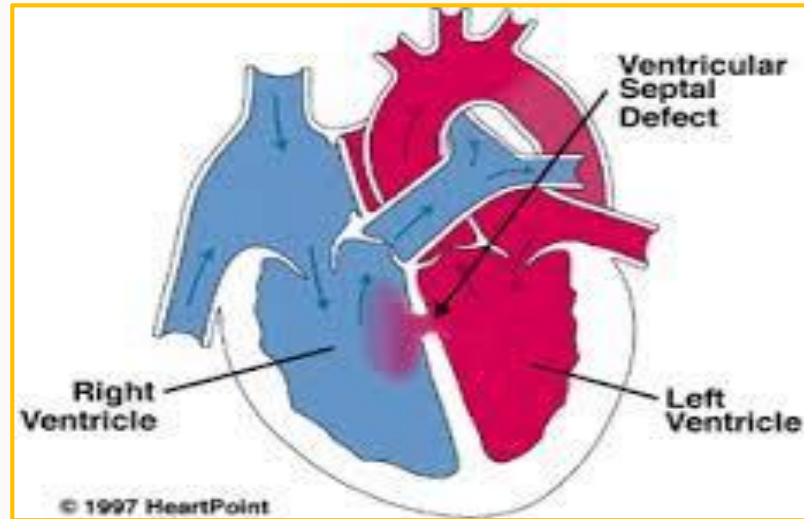
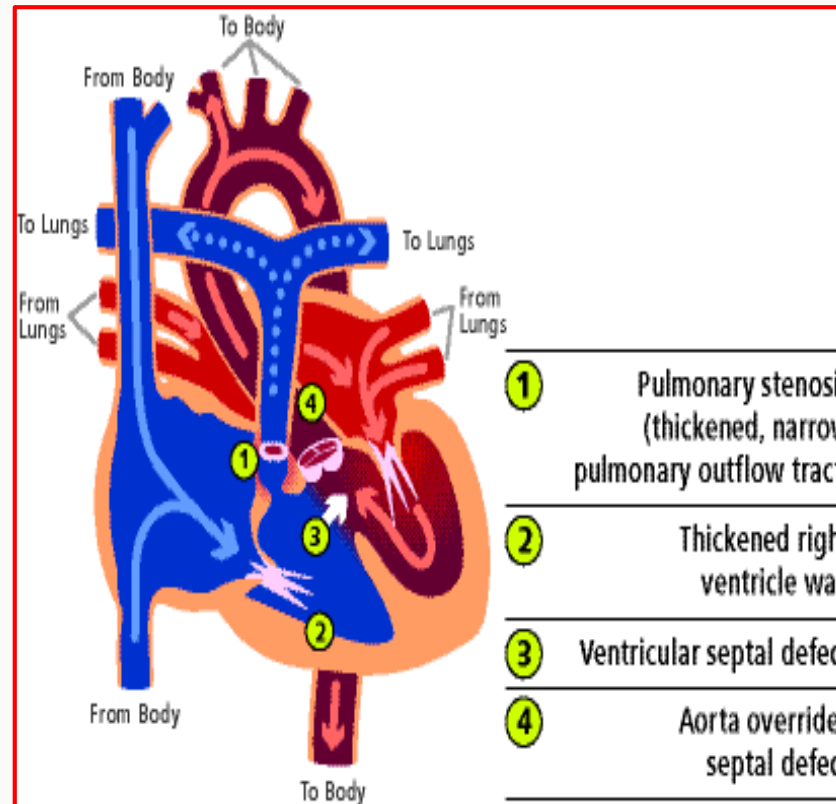


ADAM.

((Blue baby))

3) TETRALOGY OF FALLOT:

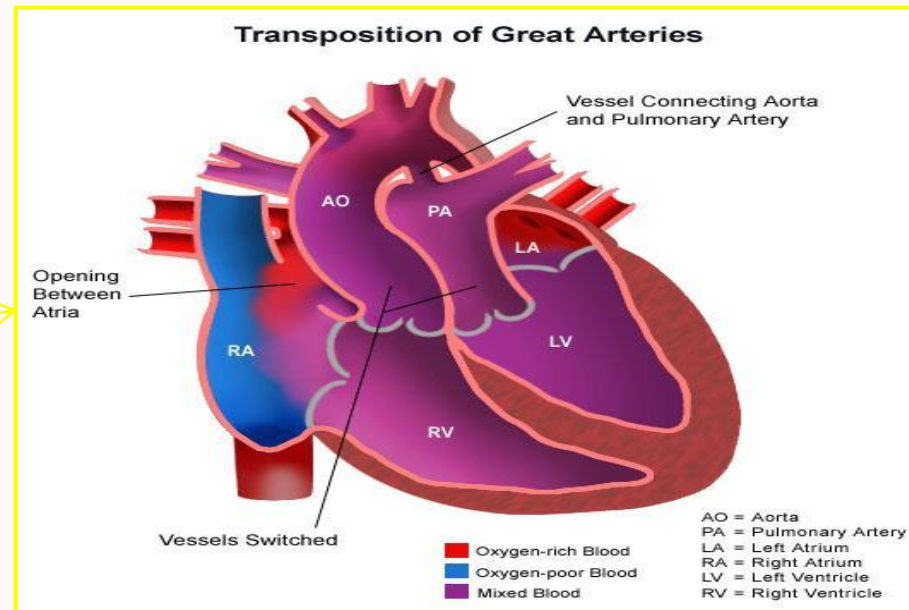
1. Pulmonary stenosis.
2. Right ventricular hypertrophy.
- 3- VSD (absent of membrane IV septum)
- 4-Overriding of the aorta



4) (TGA) OR TRANSPOSITION OF GREAT ARTERIES:

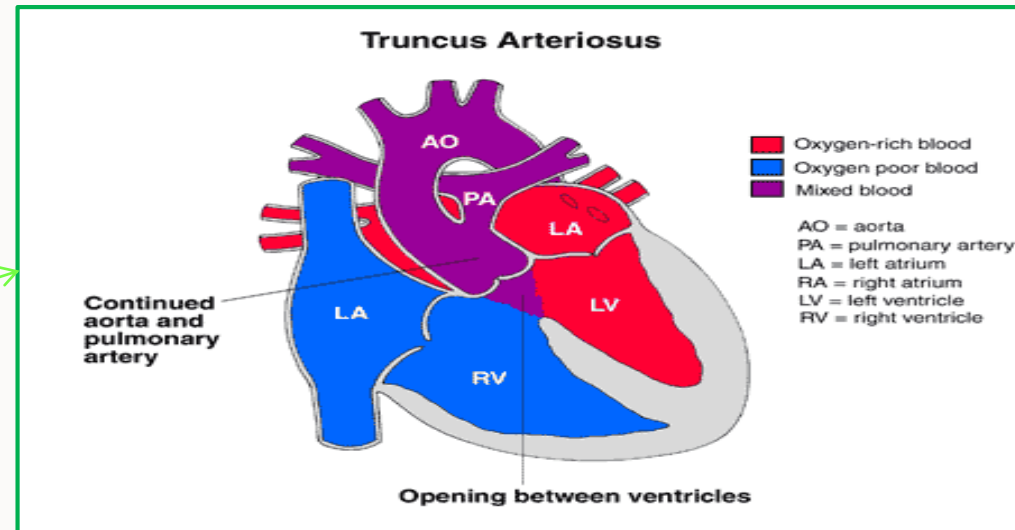


- TGA is due to abnormal rotation or malformation of the **aortopulmonary septum**, so the right ventricle joins the aorta, while the left ventricle joins the pulmonary artery.
- It is one of the most common cause of **cyanotic heart disease** in the newborn.
- Often associated with ASD or VSD.



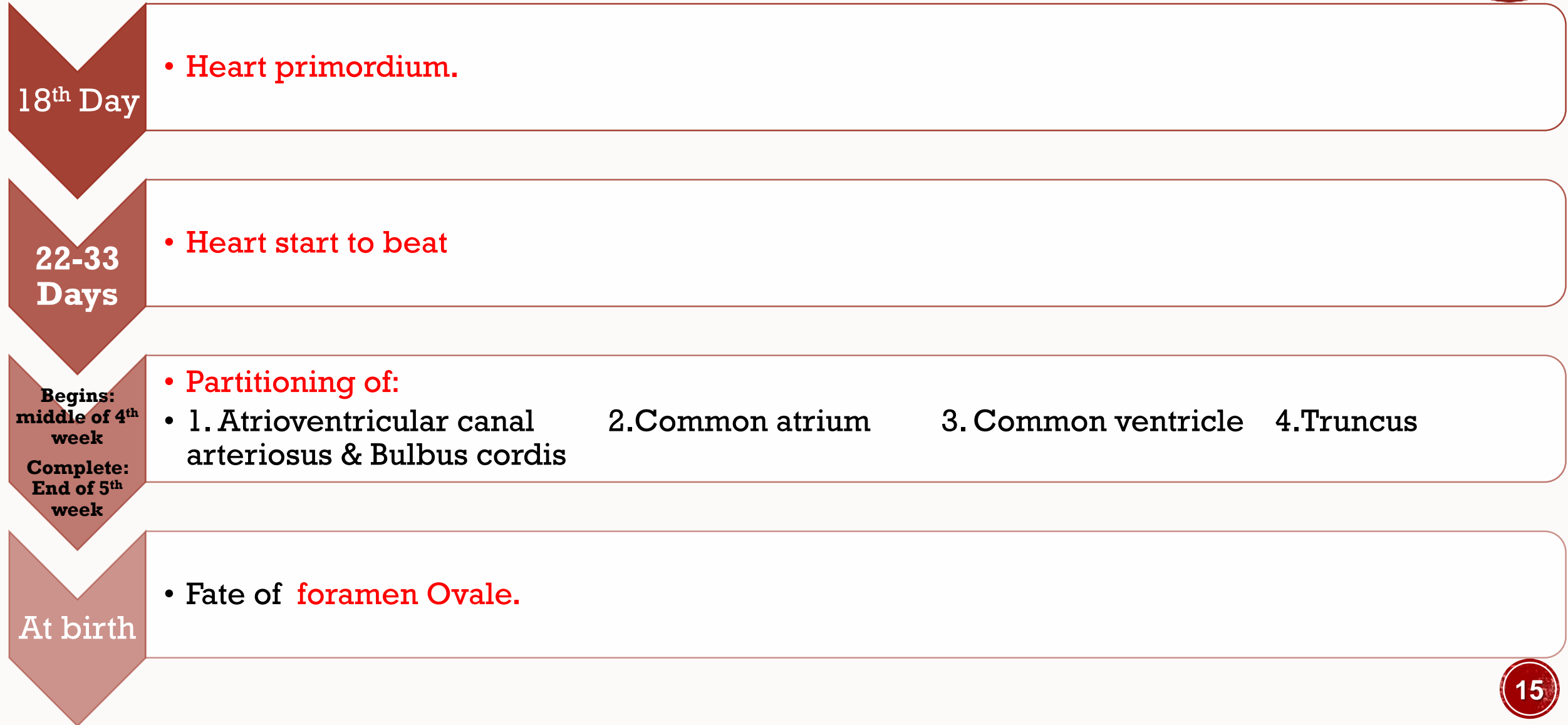
5) Persistent Truncus Arteriosus:

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





#DATE/EVENT SUMMERY:





MULTIPLE CHOICES QUESTIONS

1. First heart beat starts at:

- a. Fourth Week.
- b. 18th Day.
- c. At 22 to 23th day.
- d. Begins at the middle of the 4th week.

2. The right horn of sinus venosus forms :

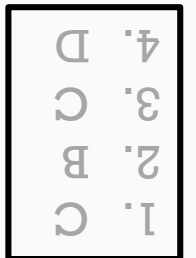
- a. The Rough Anterior wall of the right atrium.
- b. The smooth Posterior wall of the right atrium.
- c. Atrophy and forms coronary sinus
- d. The oblique vein

3. The Bulbus cordis:

- a. Begins by the 3rd week and completed by 5th week.
- b. Begins by the 3rd week and completed by 4th week.
- c. Begins by the 4th week and completed by 5th week.
- d. Begins by the 4th week and completed by 6th week.

4. Which of the follow is NOT part of TETRALOGY OF FALLOT:

- a. Pulmonary stenosis
- b. Overriding of the aorta
- c. Thicked right ventricle wall
- d. ASD





HELPFUL LINKS:

- **Heart embryology video:**
<http://www.youtube.com/watch?v=5DIUk9IXUaI>
- **Development of heart:**
<http://www.youtube.com/watch?v=OArR67aFze0>
- **Easy Ways to Remember Heart Embryology derivatives:**
<http://www.youtube.com/watch?v=YxPp67XluQA>



QUIZ LINK:

- **Development of the heart:**
<http://www.onlineexambuilder.com/development-of-the-heart/exam-19456>



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