

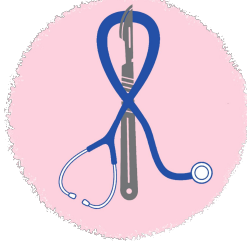


MED441
KING SAUD UNIVERSITY



Embryology
441

Revised & Reviewed
by:
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Faye Wael Sendi



The Development of the heart



Color index:

- Main text
- **Important**
- In male's slides only
- In female's slides only
- Extra information, explanation
- Doctors notes



Editing file CVS

Objectives

01. The formation and fate of the sinus venosus.

02. The site, formation, union, and division of the of the heart tube.

03. The formation of interatrial and interventricular septae.

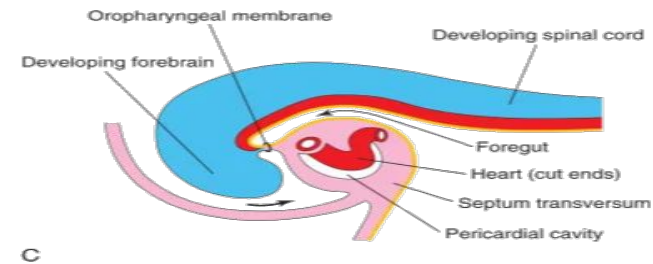
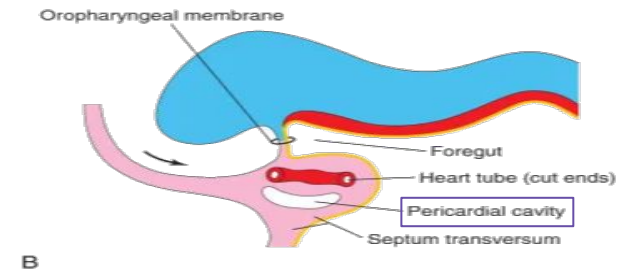
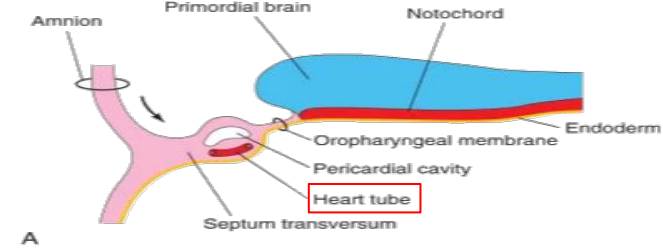
04. The formation of the two atria and the two ventricles.

05. The partitioning of the truncus arteriosus and formation of the aorta and pulmonary trunk.

06. The most common cardiac anomalies.

Formation of the heart tube:

- The heart is the **first functional** organ to develop.
- The heart begins to beat at 22nd – 23rd days. **week 3**
- Blood flow begins during the beginning of the **4th week** and can be visualized by **Ultrasound Doppler**.
- It develops from **splanchnic mesoderm** in the wall of the yolk sac (**Cardiogenic Area**):
- **Cranial**: to the developing mouth & nervous system.
- **Ventral**: to developing pericardial sac.
- The heart primordium is first evident at 18 days.
- (as an **Angioplasmic cords** which soon canalize to form the 2 heart tubes).



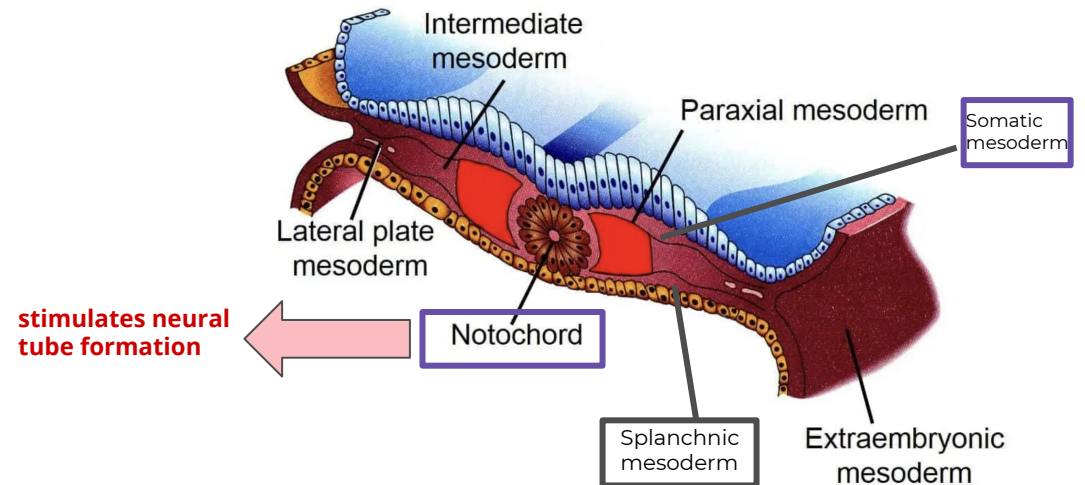
At this stage **2 folding** are going to occur:

As the **head folding** complete

the developing heart tubes change their position and become in the **Ventral** aspect of the embryo, **Dorsal** to the developing Pericardial sac.

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?



Fusion of the two tubes occurs in a craniocaudal direction.

The heart tube grows faster than the pericardial sac, so it shows 5 alternate dilations separated by constrictions. These are :

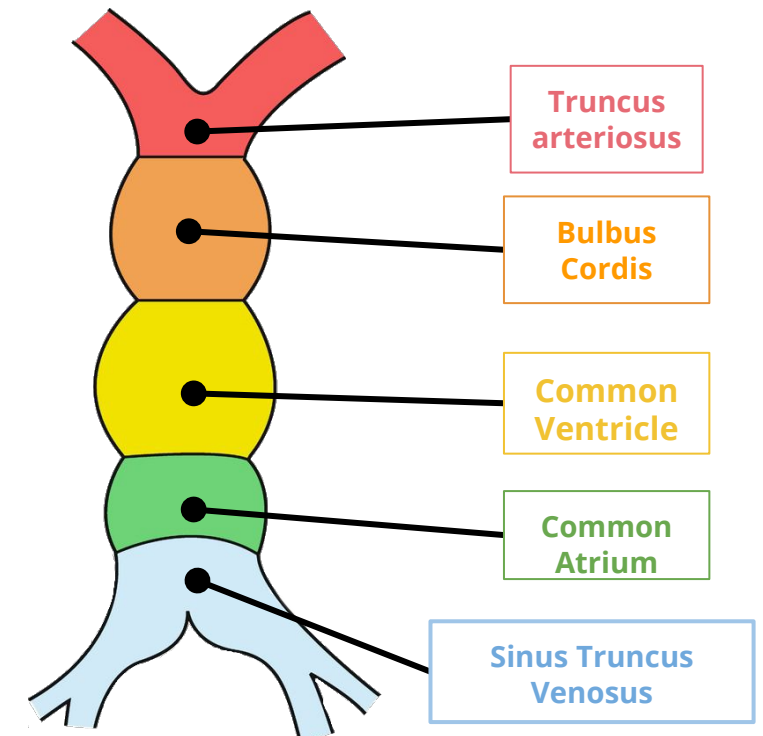
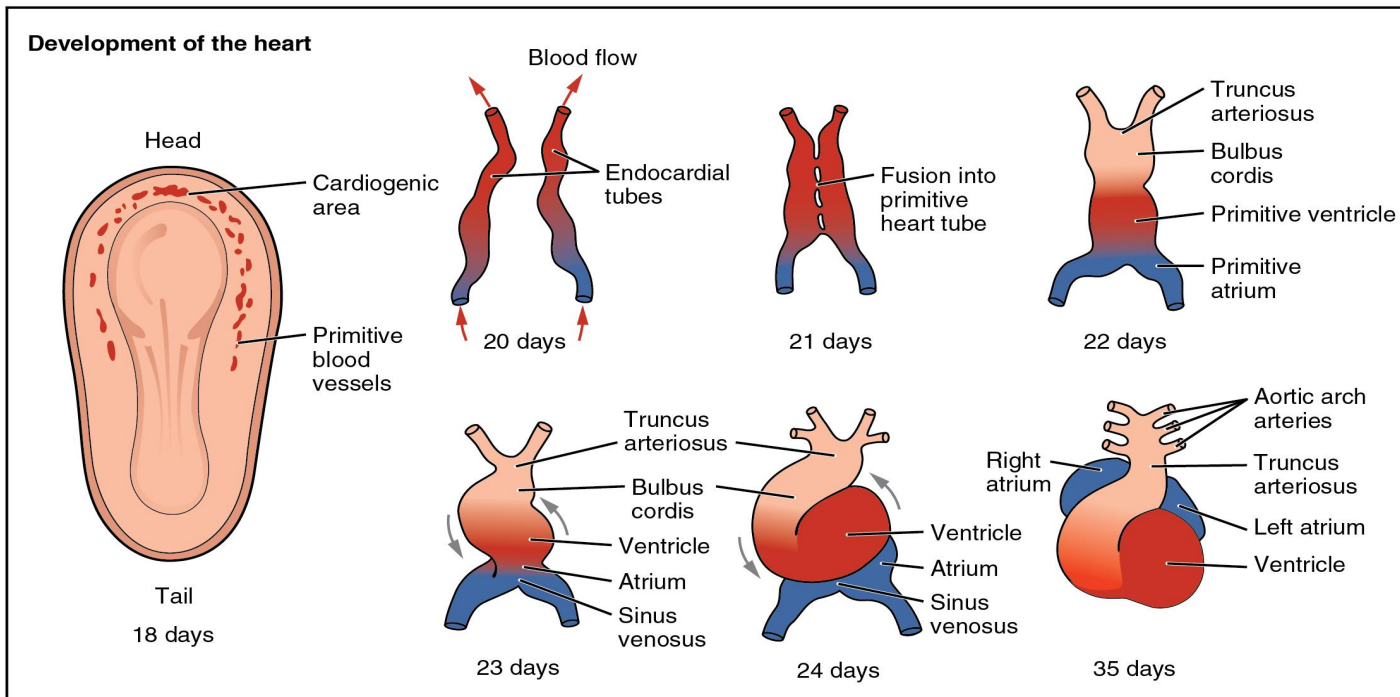
1 Sinus Truncus Venosus

2 Common Atrium

3 Common Ventricle

4 Bulbus Cordis

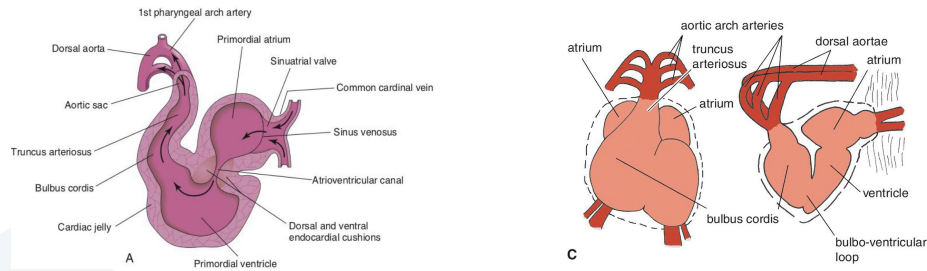
5 Truncus arteriosus (Arterial end)



The Shape of the Heart Tube

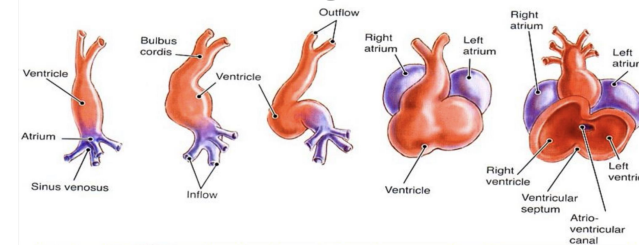
U -Shaped Heart Tube

- **Bulbus cordis** & **ventricle** grow faster than other regions.
- So the heart bends upon itself, forming the U-shaped heart tube (Bulboventricular loop).



S -Shaped Heart Tube

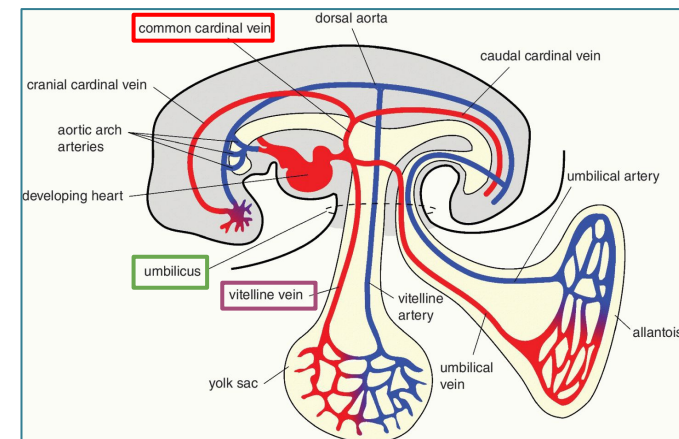
- As the heart tube develops it bends, upon itself and forms S shaped heart tube: SO, the **Atrium** & **Sinus venosus** become **Cranial in position** & Dorsal to the **Truncus arteriosus**, **Bulbus cordis**, & **Ventricle**.
- By this stage the **sinus venosus** (opens in the dorsal surface of the **atrium**) has developed 2 lateral expansions, (Horns) :Right and Left



Veins Draining into Sinus Venosus

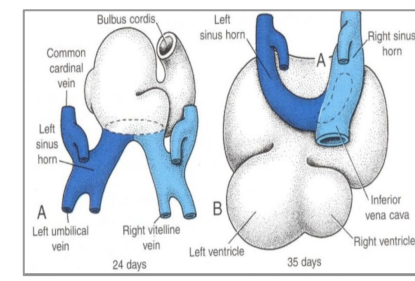
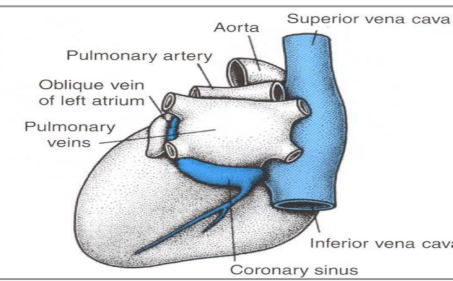
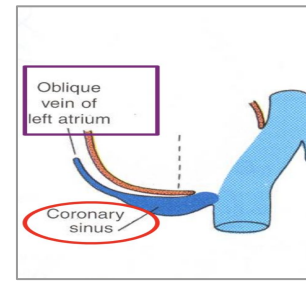
Each horn of the sinus venosus receives 3 veins :

1. **Common cardinal vein** (from the fetal body)
2. **Vitelline** (from the yolk sac)
3. **Umbilical** (from the placenta)



Fate of Sinus Venosus

- The **Right Horn** forms the : smooth posterior part of the right atrium.
- The **Left Horn** and **Body** atrophy and form the: **Coronary Sinus**.
- The **Left Common cardinal vein** form : the **Oblique Vein** of the **Left Atrium**.



Right Atrium

- The smooth posterior part (**blue arrow**) derived from The right horn of the **sinus venosus** .
- Rough Trabeculated anterior part (**red arrow, muscoli pectanti**) of the right atrium is derived from the **primordial common atrium**.
- These two parts are demarcated by the: crista terminalis (internally) and sulcus terminalis (externally)

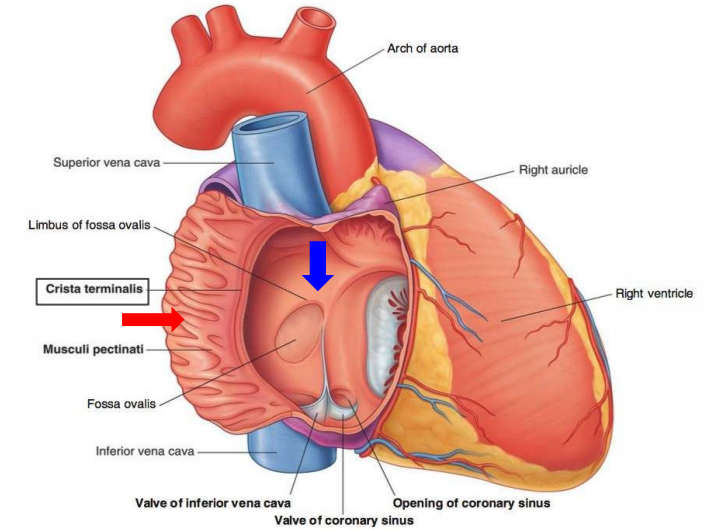
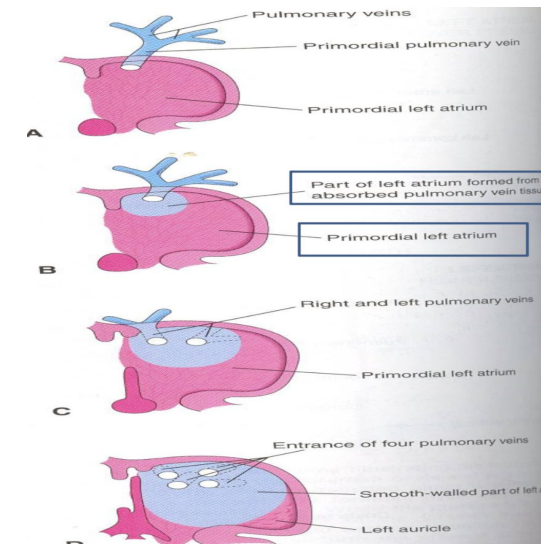


Fig. 3.63 Internal view of right atrium.

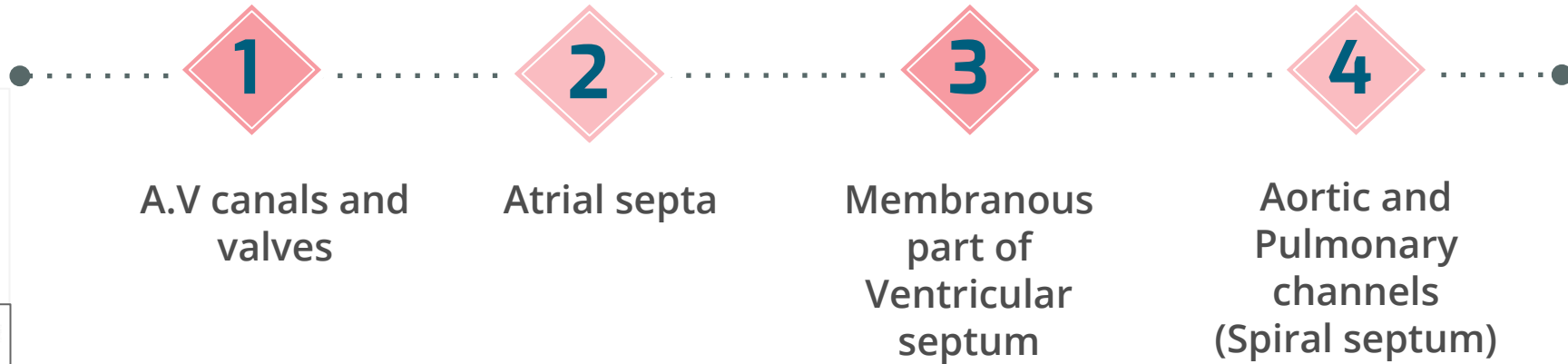
Left Atrium

- The smooth part: derived from the absorbed **Pulmonary Veins**.
- Rough Trabeculated part: is derived from the **primordial primordial common atrium**.

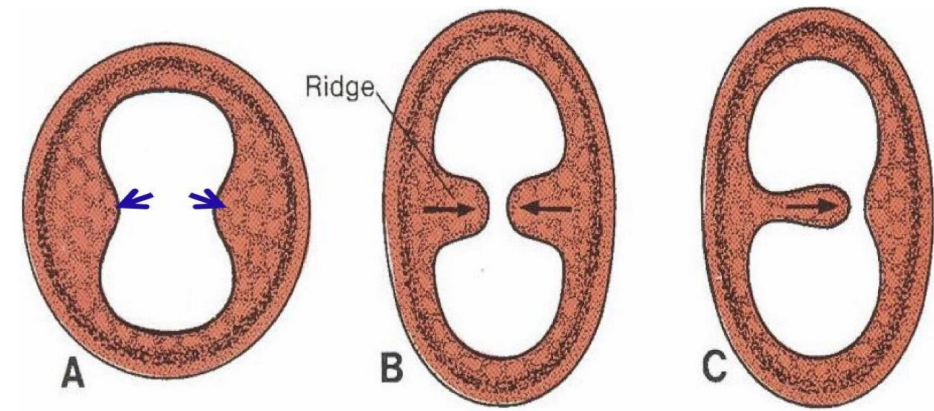
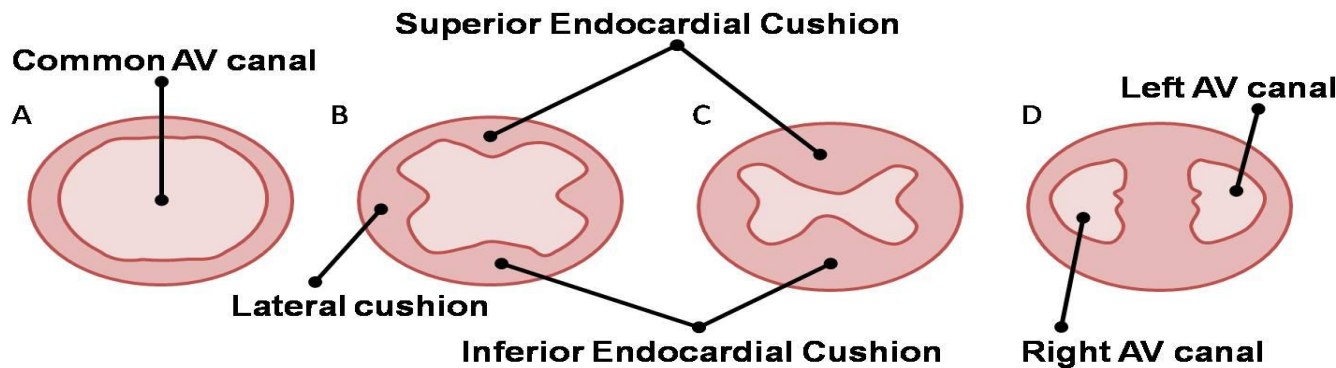
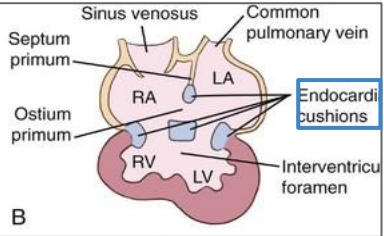


Endocardial Cushions

- They appear around the middle of the **4th week** as Mesenchymal Proliferation. They participate in formation of:



Endocardial cushions, or atrioventricular cushions, refer to a subset of cells in the development of the heart that play a vital role in the proper formation of the heart septa.



Partitioning of Primordial Heart

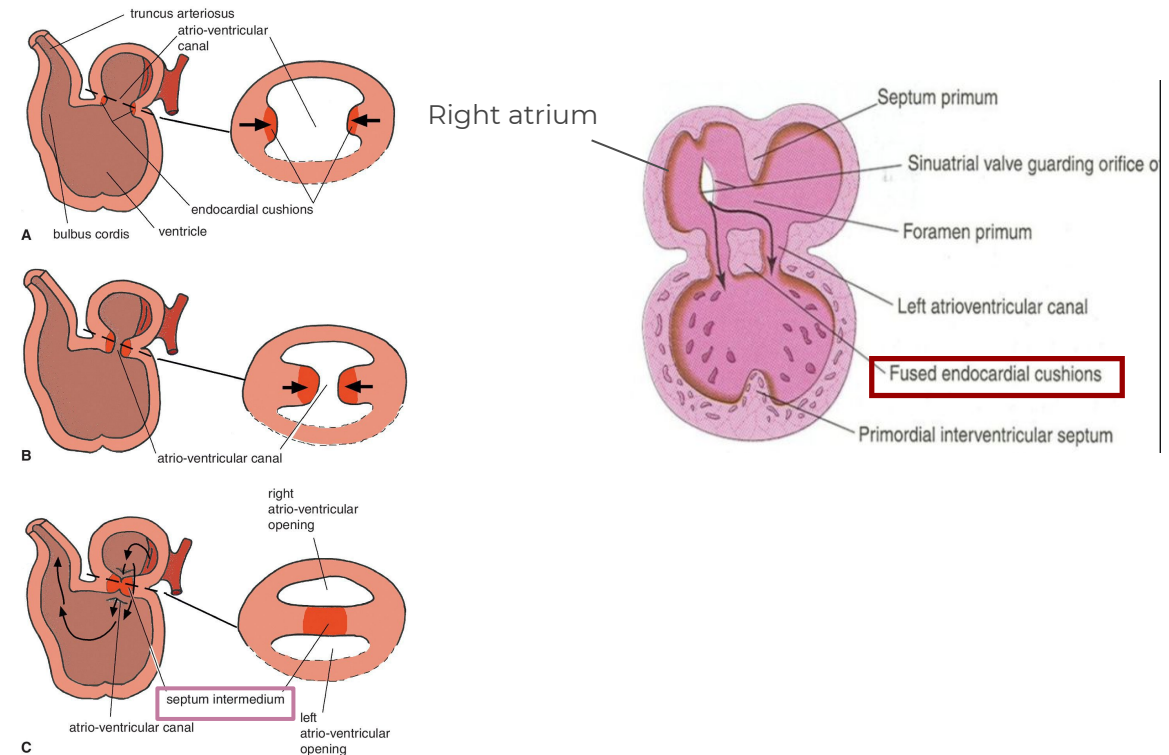
Partitioning begins by the middle of **4th week** , It is completed by the end of **5th week**. **1 week and a half**

Partitioning of



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.
- These canals partially **separate** the primordial atrium from the ventricle .

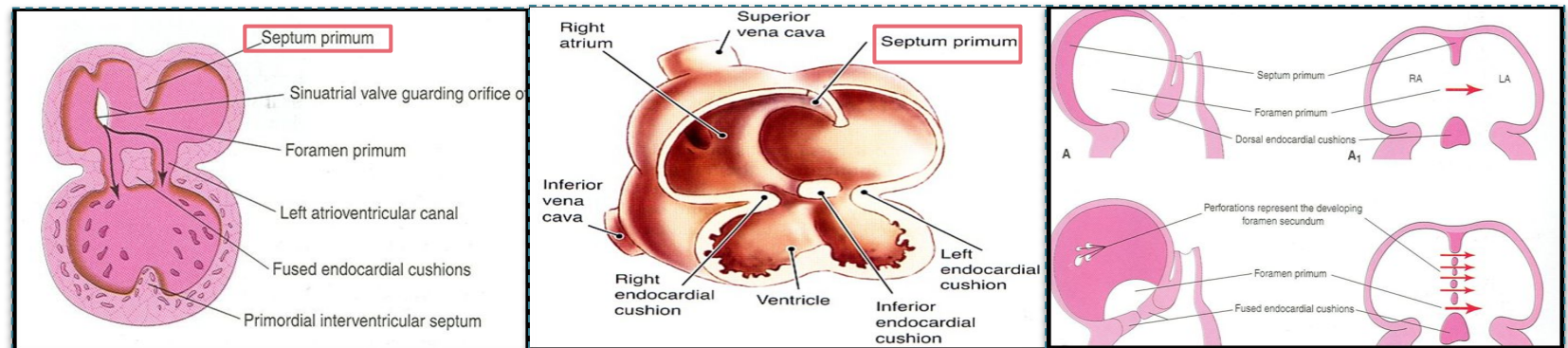


2- Partition of the Common Atrium

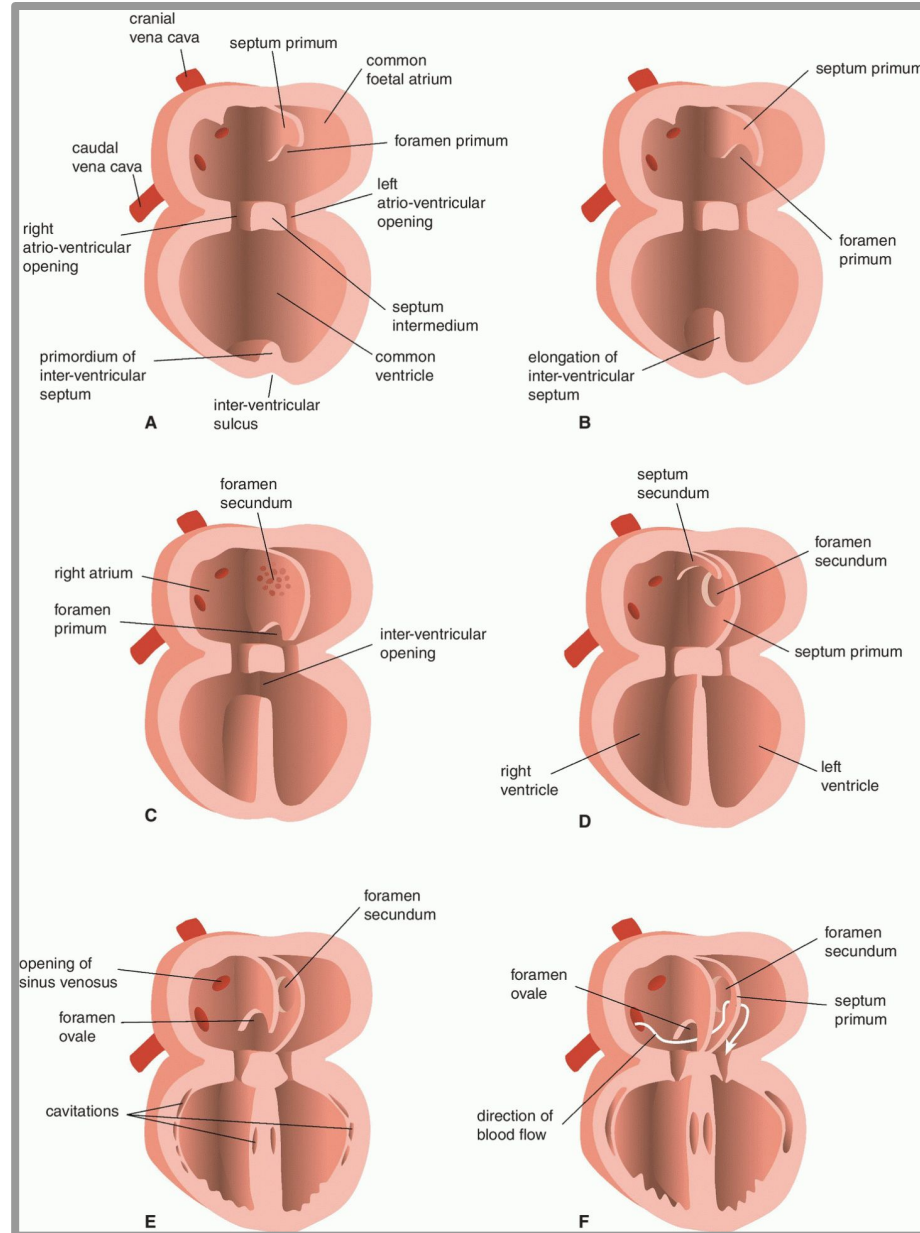
Characteristics	Septum Primum	Ostium Primum	Septum Secundum
Features	Sickle-shaped	Formed when Septum Primum bounds a foramen	Descends on the Right side of the septum
Function	Dividing the Common Atrium into Right & Left halves	Enabling the oxygenated blood to pass from Right to Left Atrium (as a Shunt)	Forming an incomplete partition between the two Atria
Course	Grows from the roof of the common Atrium towards the fusing Endocardial cushions (Septum intermedium) (Comes from above)	Become Smaller and smaller and disappears as the septum primum fuses completely with the septum intermedium (to form the AV septum)	Consequently a valvular oval foramen forms (Foramen Ovale) At this stage, blood can flow from the RA to the LA ONLY (one direction)

The Two Ends of Septum Primum reach to the growing Endocardial cushions before its central part

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**

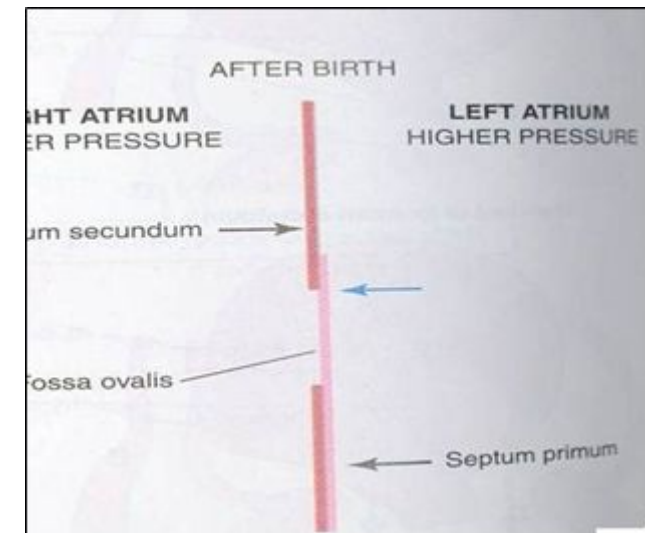
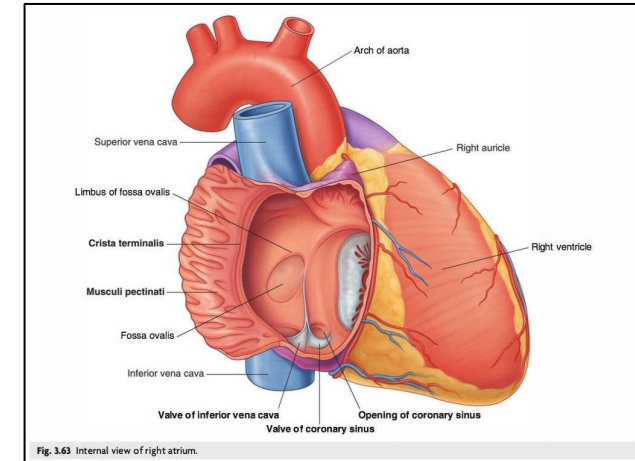


Partition of the Common Atrium



Fate of Foramen Ovale

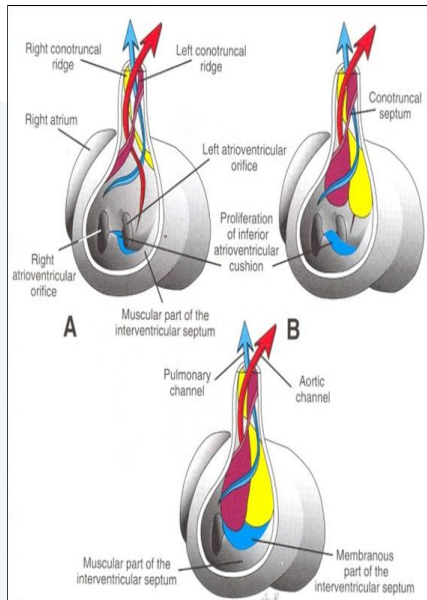
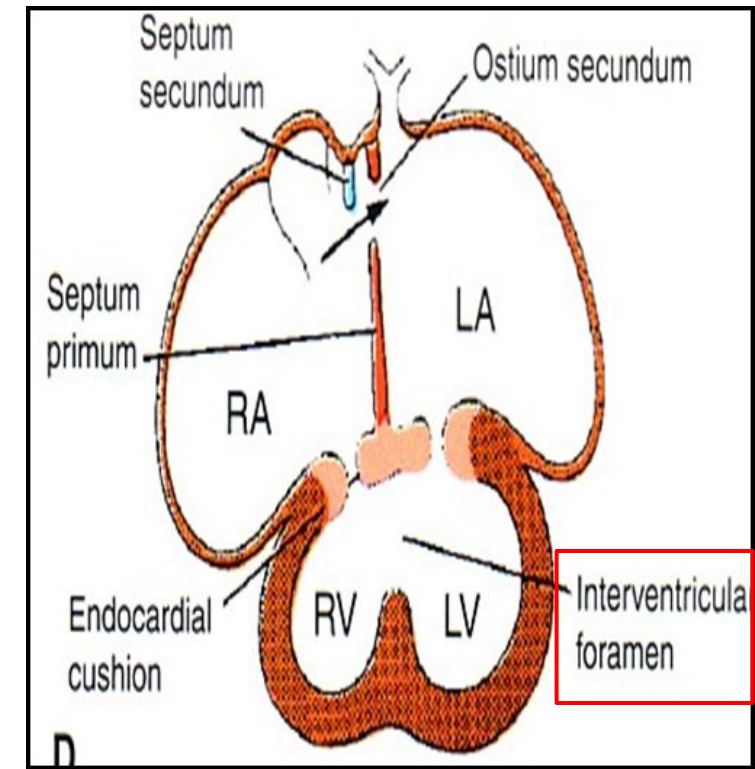
- At birth when the lungs inflated and pulmonary circulation begins the pressure in the left atrium **increase** and **exceeds that of the right atrium**
- The Valve of the foramen ovale is pressed against the septum secundum and obliterates the foramen ovale so the two septae oppose each other
- Its site is represented by the **Fossa Ovalis**
- Its floor represent the persistent part of the **septum primum**
- Its limbus (annulus) is the lower edge of the **Septum Secundum**
- **This opening is closed after birth**



3- Partition of the Primordial Ventricle

“**Muscular** part of the interventricular septum (IV)”:

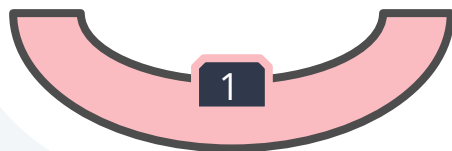
- Division of the primordial ventricle is first indicated by a median muscular ridge, the primordial interventricular septum.
- It is a thick crescentic fold which has a concave upper free edge.
- This septum bounds a temporary connection between the two ventricles called **Interventricular foramen(IVF)**.



Interventricular septum

The membranous part of the IV septum is derived from:

A tissue extension from the right side of the **Endocardial cushion**



Aorticopulmonary Septum



Thick **Muscular** part of the IV



Spiral Aorticopulmonary Septum

Spiral septum develops in the **Truncus arteriosus**

Dividing it into

Aorta

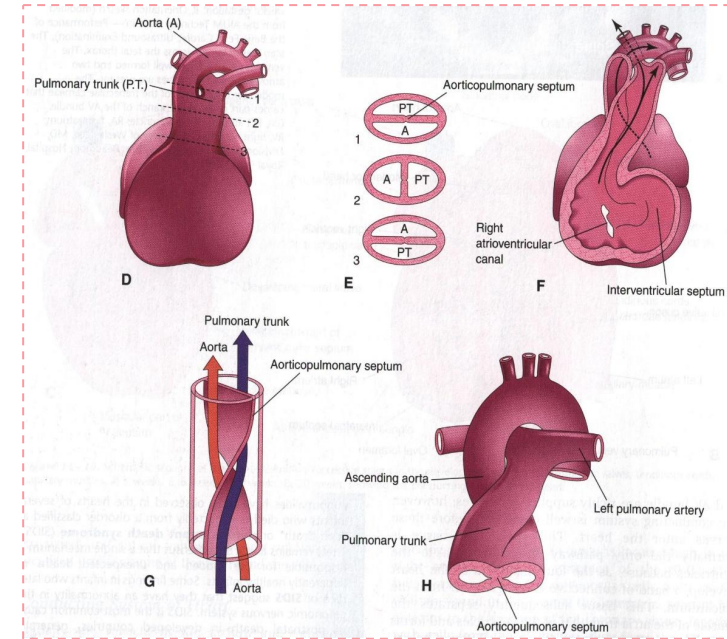
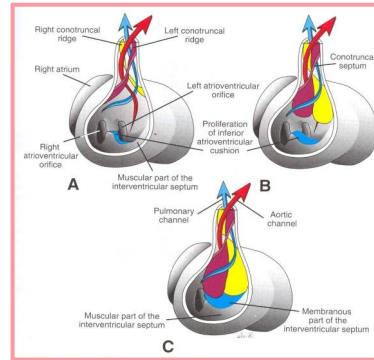
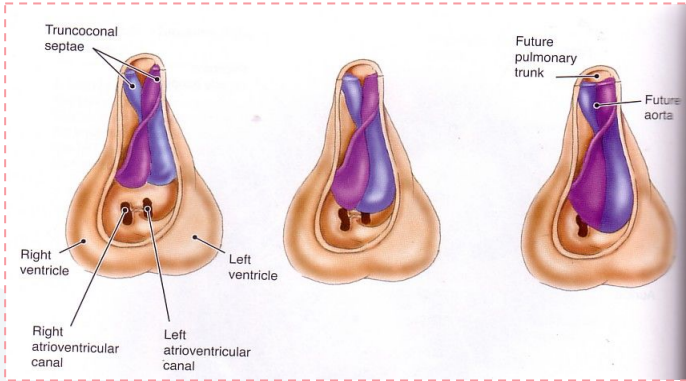
Pulmonary Trunk

Joins to

Left Ventricle

Joins to

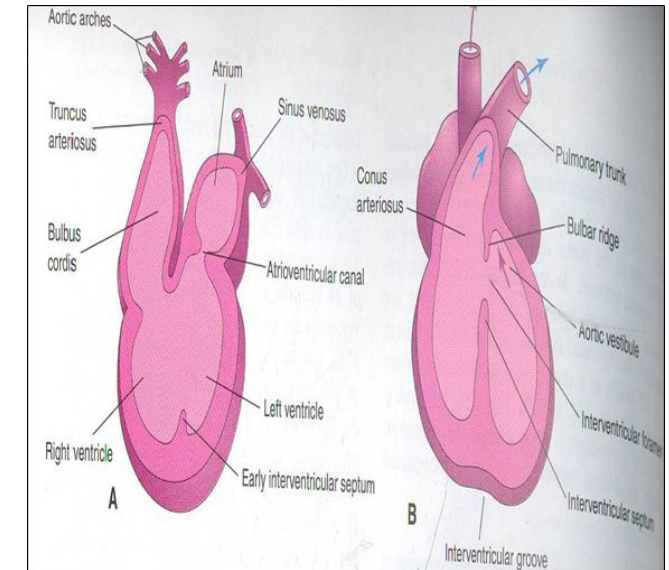
Right Ventricle



4- Bulbus Cordis

The Bulbus cordis **forms** the smooth upper part of the **two ventricles**

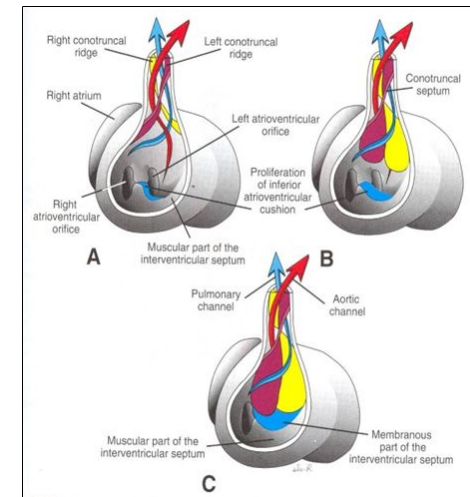
Right Ventricle	Left Ventricle
Conus Arteriosus or (Infundibulum): <u>Leads to Pulmonary Trunk</u>	Aortic Vestibule: <u>Leads to Ascending Aorta</u>



5- Partition of Truncus Arteriosus (TA)

- In the **5th week**, proliferation of mesenchymal cells (**Endocardial Cushions**) appear in the wall of the **truncus arteriosus**, they form a **Spiral Septum**:
 - It divides the **Lower** part of the TA into **Right & Left parts**
 - It divides the **Middle** part of TA into **Anterior & Posterior parts**.
 - It divides the **Upper** part of the TA into **Left & Right parts**
- This explains the origin of pulmonary trunk from R ventricle & ascending aorta from L ventricle & their position to each other

Female's slides only



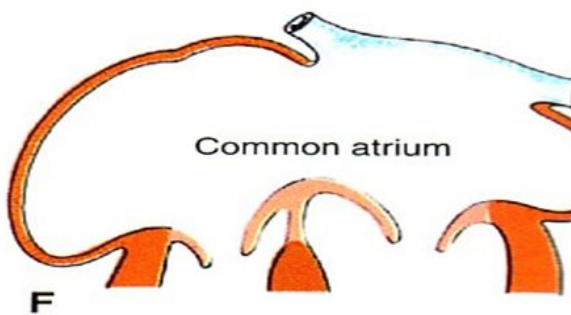
Major cardiac Abnormalities

1- Atrial Septal Defects (ASD)

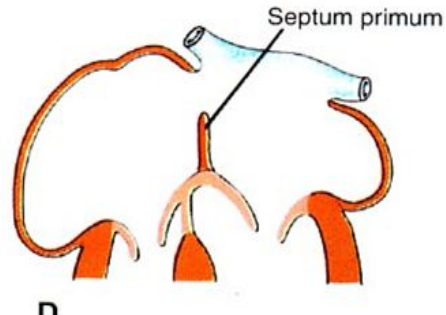
A - Absence of both septum primum and septum secundum, leads to Common Atrium

B - Absence of Septum Secundum

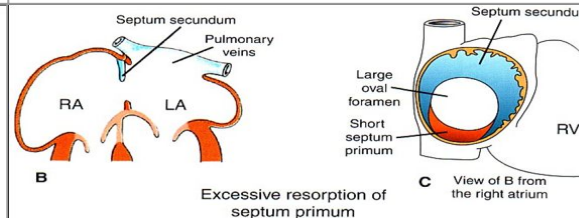
C - Large (Patent) foramen ovale : Excessive resorption of septum primum



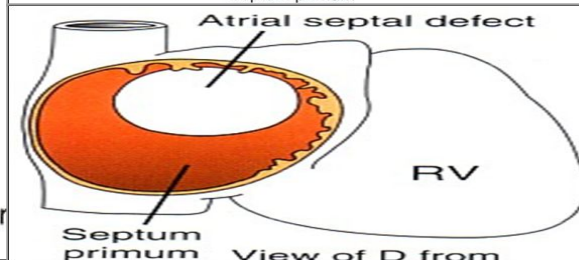
Absence of septum primum and septum secundum



Absence of septum secundum



Excessive resorption of septum primum

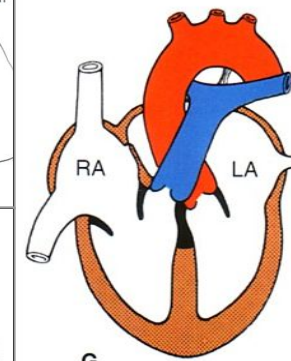


View of D from

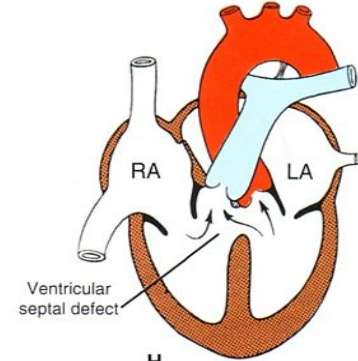
2- Ventricular septal defect (VSD)

Roger's disease

- Absence of the Membranous part of interventricular septum (persistent IV Foramen)
- A congenital defect in the septum that separates the ventricles of the heart.
- Usually accompanied by other cardiac defects.



Normal ventricular septum development



Ventricular septal defect (VSD)

Tetralogy of Fallot (blue baby → Cyanosis)

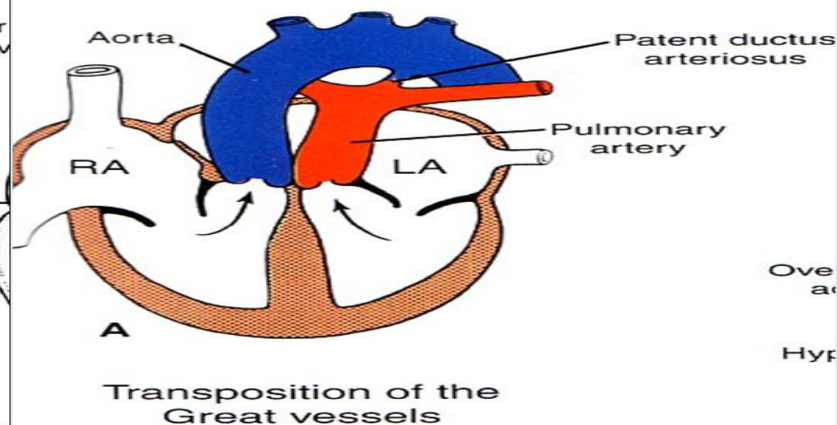
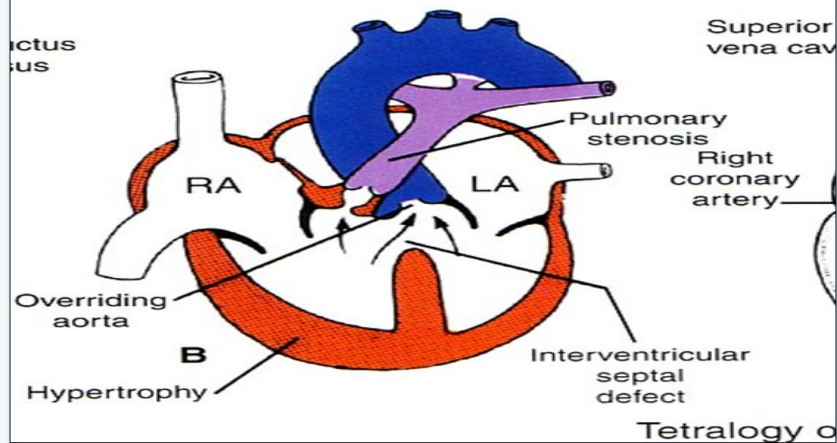
Include four heart malformation present together:

- Ventricular septal defect (VSD)
- Pulmonary stenosis
- Right ventricular hypertrophy
- Overriding of aorta

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

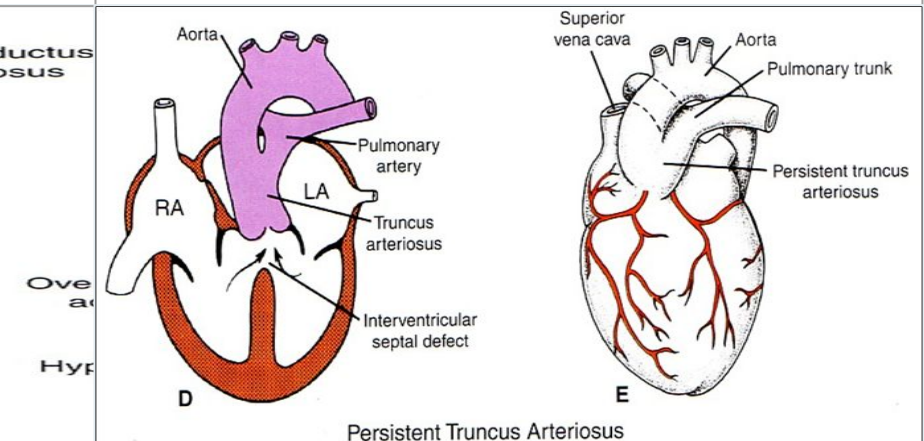


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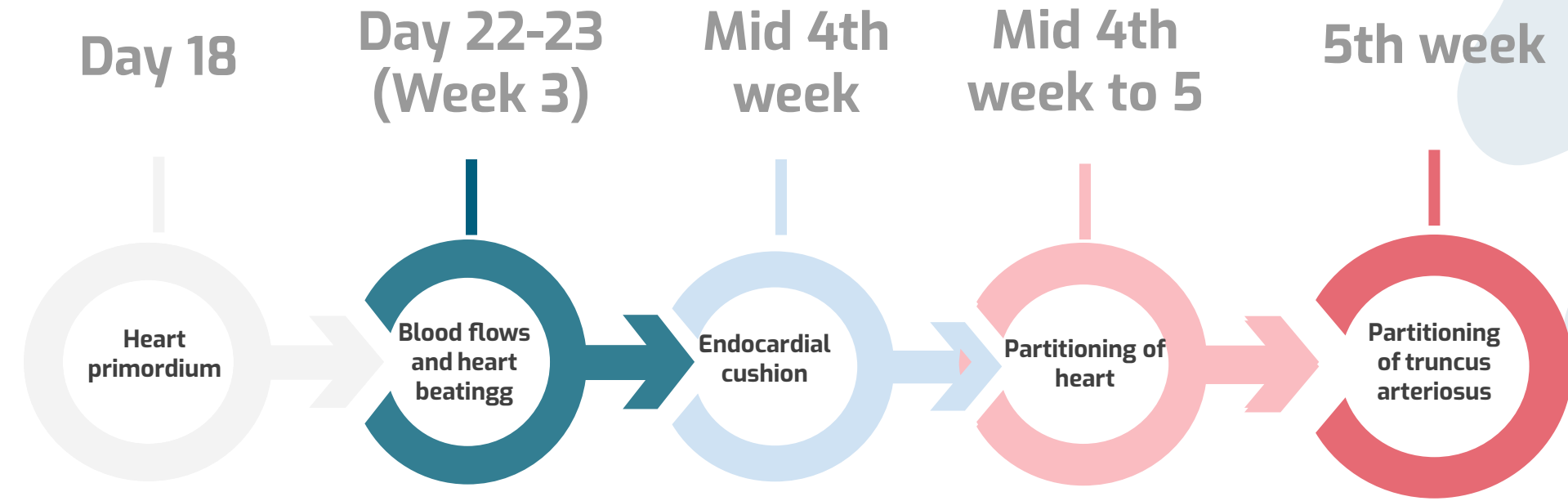
Persistent truncus arteriosus

- It is Due to failure of the development of the aorticopulmonary (Spiral) septum ما اكتمل انفصال الشرايين فالدم
- It is usually accompanied with ventricular septal defect (VSD)
- It forms a single arterial trunk arising from the heart and supplies the systemic , pulmonary and coronary circulations



Summary

“Special thanks to the team 437”



TEST YOUR SELF!

1) list all types of partitioning which take place during the formation of the heart ?

A: 1- atrioventricular canal
2- common atrium
3- common ventricle
4- bulbus cordis
5- truncus arteriosus

2) the spiral septum divides the truncus arteriosus into 2 parts, list them and mention the importance of each one ?

A:
1- pulmonary trunk: artery joins the right ventricle
2- the aorta joins the left ventricle

THANK YOU !

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