

The Development of the heart

Editing file

Cardiovascular block-Anatomy-Lecture 2



Objectives

Color guide :

Only in boys slides in **Green**

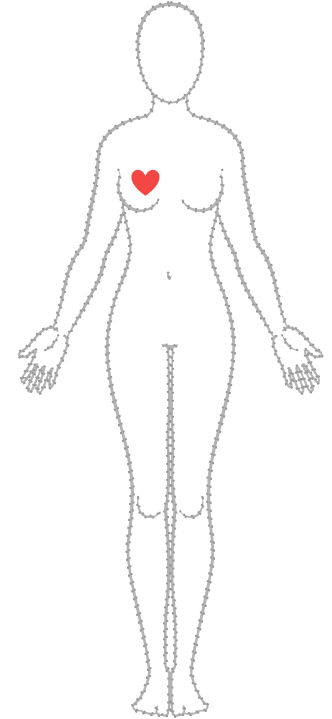
Only in girls slides in **Purple**

important in **Red**

Notes in **Grey**

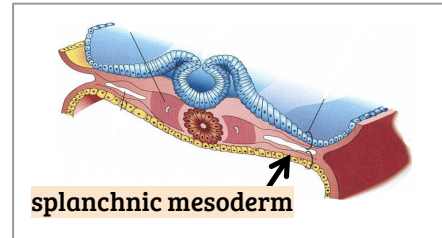
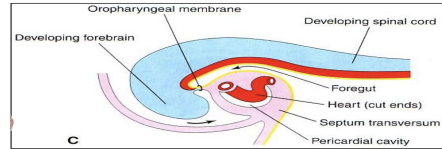
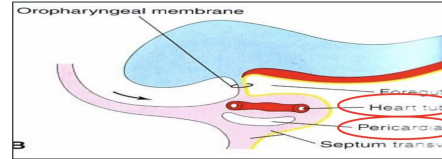
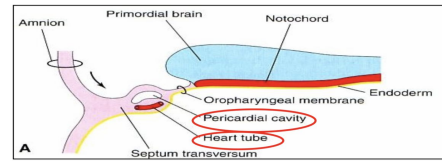
By the end of the lecture you should be able to describe:

- 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 **CVS** is the first major system to function in the embryo.
- The heart is the **first functional** organ to develop.
- 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	After lateral folding of the embryo
<p>the developing heart tubes lie in the ventral aspect of the embryo and dorsal to the developing pericardial sac (remember that it was on the ventral aspect before the folding).</p>	<p>the 2 heart tubes approach each other and fuse in a <u>craniocaudal</u> direction (from above to below) to form a single endocardial heart tube within the pericardial sac</p>

The heart begins to beat at
→ (22nd- 23rd) days.

Blood flow begins during the beginning of the
→ **4th week** (can be visualized by **Ultrasound Doppler**)

What is the fate of the Heart Tube?

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

These are:

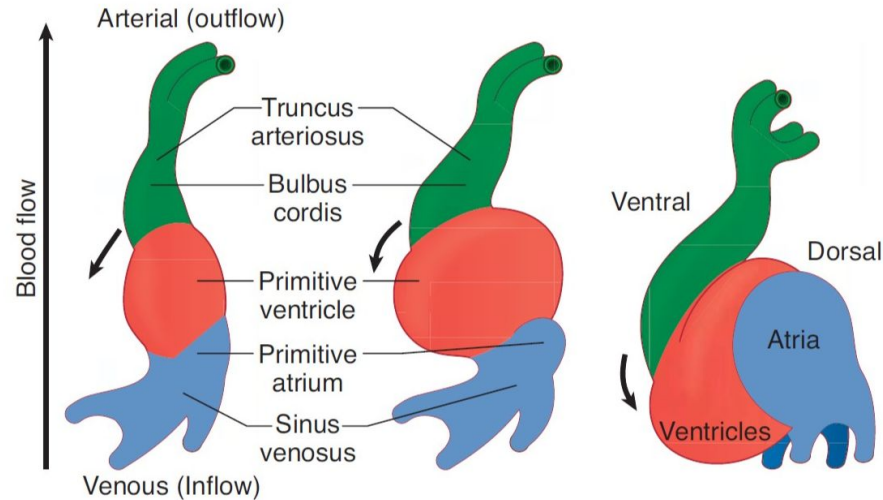
1- Sinus Venosus
(Venous end)

2- Common Atrium

3- Common Ventricle

4- Bulbus Cordis

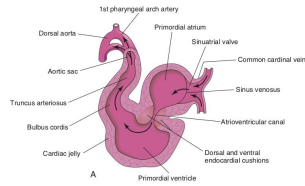
5- Truncus arteriosus
(Arterial end)



The Shape of the Heart Tube

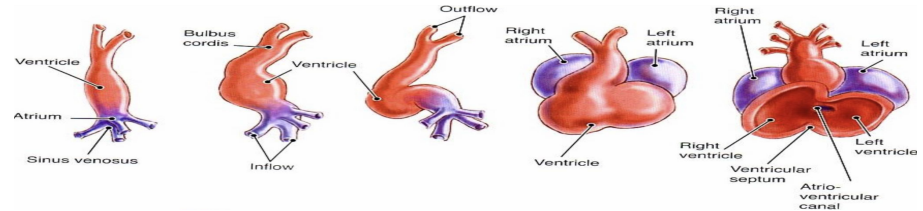
U-Shaped Heart Tube

- **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

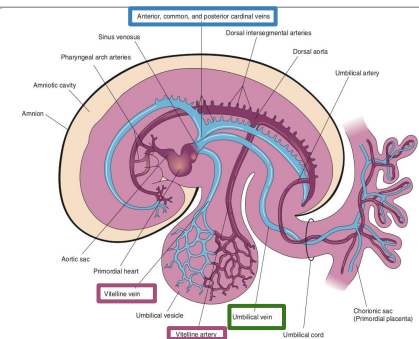
- As the heart tube develops it bends, upon itself and forms S shaped heart tube: SO, the **Atrium** & **Sinus venosus** become **Cranial** in position & **Dorsal** to the **Truncus arteriosus**, **Bulbus cordis**, & **Ventricle**.
- By this stage the **sinus venosus** (opens in the **dorsal** surface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



Veins Draining into Sinus Venosus

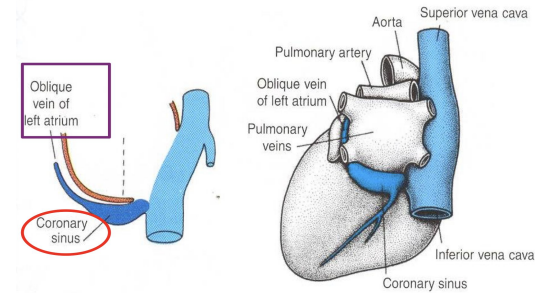
Each horn of the sinus venosus receives 3 veins:

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



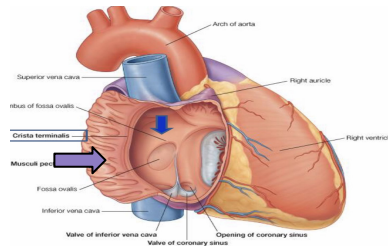
Fate of Sinus Venosus:

- The **Right Horn** form → 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**.



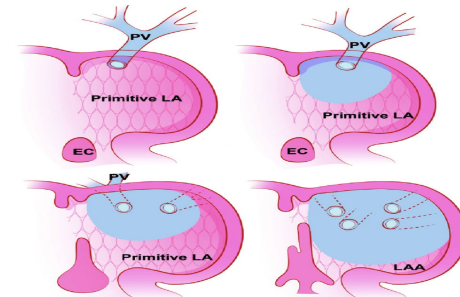
Right Atrium

- **The smooth posterior part (blue arrow)** derived from **The right horn** of the sinus venosus
- **Rough Trabeculated anterior part (purple arrow)** (musculi pectinati) 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.



Left Atrium

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

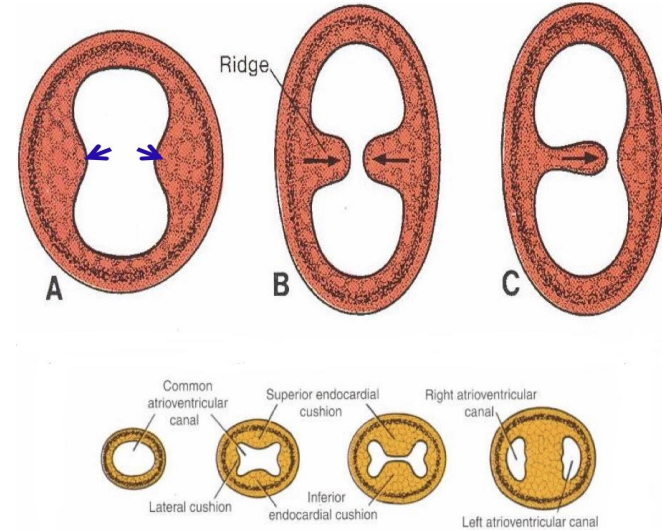


Endocardial Cushions:

- They appear around the middle of the **4th week** as Mesenchymal Proliferation.

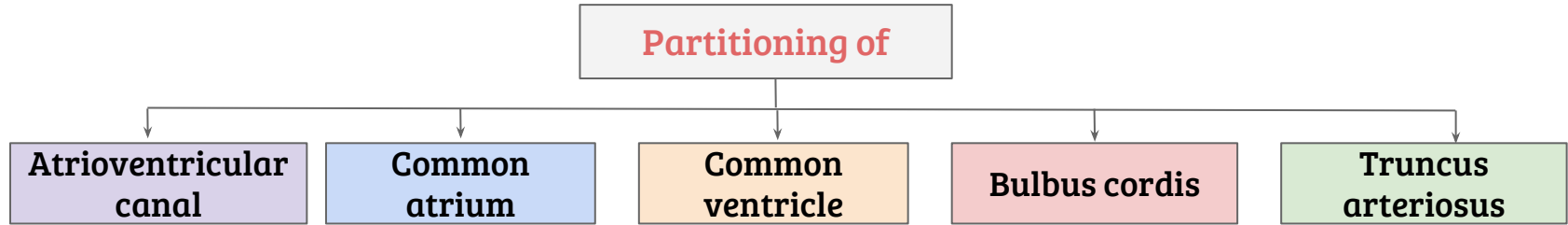
They participate in formation of:

1. A.V canals and valves.
2. Atrial septa.
3. Membranous part of Ventricular septum.
4. Aortic and Pulmonary channels (Spiral septum).



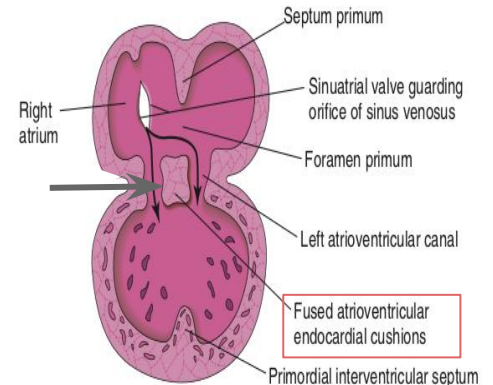
Partitioning of Primordial Heart:

Partitioning begins by the middle of **4th week**. It is completed by the end of **5th week**.



1- Partitioning of Atrioventricular canal :

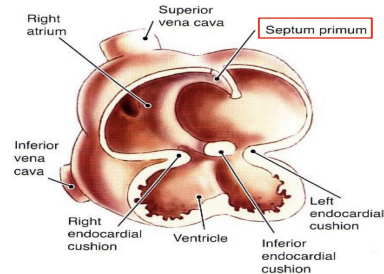
- **Two** Endocardial Cushions are formed on the dorsal and ventral walls of the AV canal.
- The AV endocardial cushions approach each other and fuse to form the **Septum Intermedium**
- Dividing the AV canal into right & left canals.
- These canals partially separate the primordial atrium from the ventricle.



2- Partition of the Common Atrium:

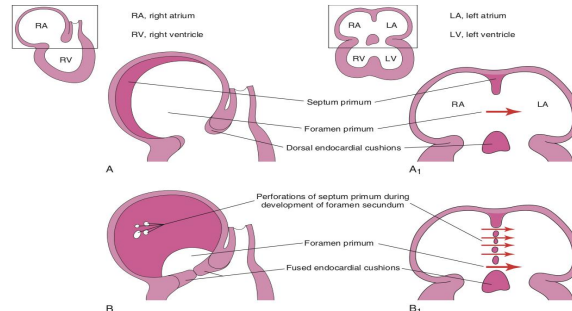
Septum Primum

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



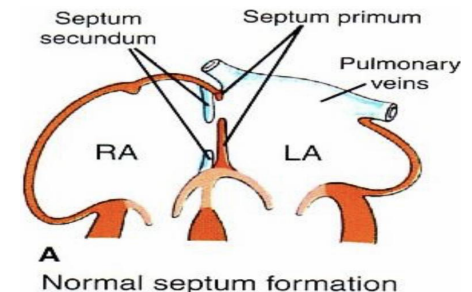
Ostium Primum

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



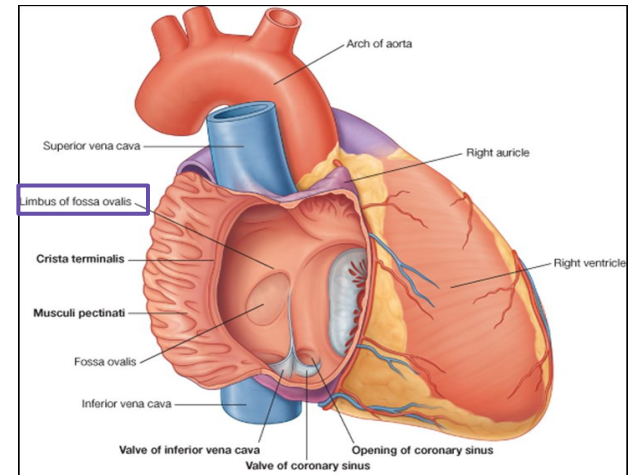
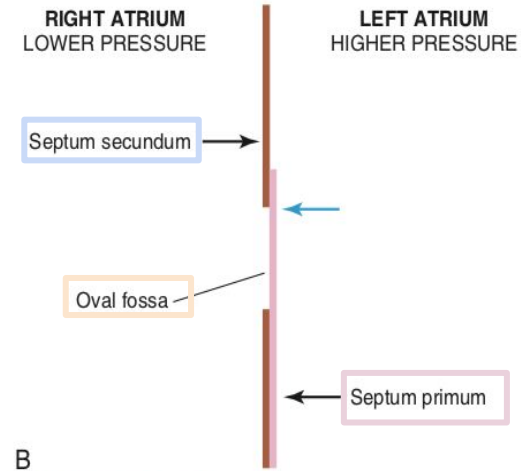
Septum Secundum

- 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 oval foramen forms, (**Foramen Ovale**)



Fate of foramen ovale

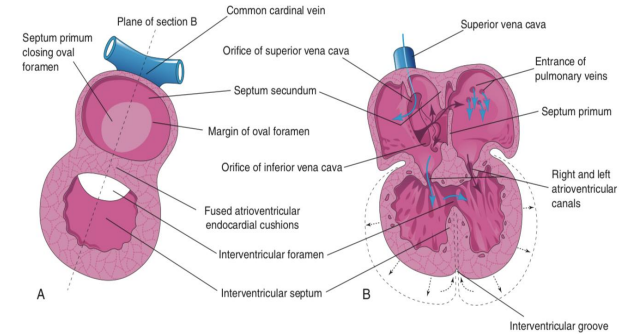
- **At birth** when the lungs inflated and pulmonary circulation begins the pressure in the **left atrium** increases and exceeds that of the right atrium.
- The valve of the foramen ovale is pressed against the **septum secundum** and obliterates the foramen ovale, So the two septae oppose each other.
- Its site is represented by the **Fossa Ovalis**.
- The **septum primum** forms \gg the **floor** of the fossa ovalis
- The **septum secundum** forms the **margin** of the fossa ovalis which is called the limbus ovalis or annulus ovalis.



3- Partitioning of Common Ventricle:

It is a **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** (left ventricle) upper free edge. (right ventricle is convex)
- ❖ This septum bounds a temporary connection between the two ventricles called (IVF) interventricular foramen.



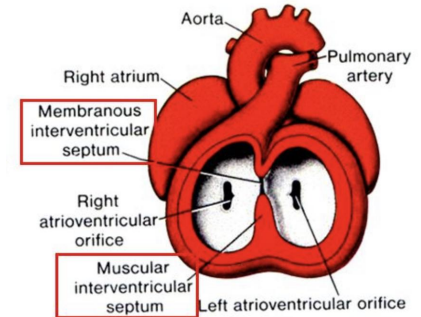
Interventricular Septum

The membranous part of the IV septum is derived from:

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

2. Aorticopulmonary septum.

3. Thick **muscular** part of the IV septum.



4- Bulbus Cordis:

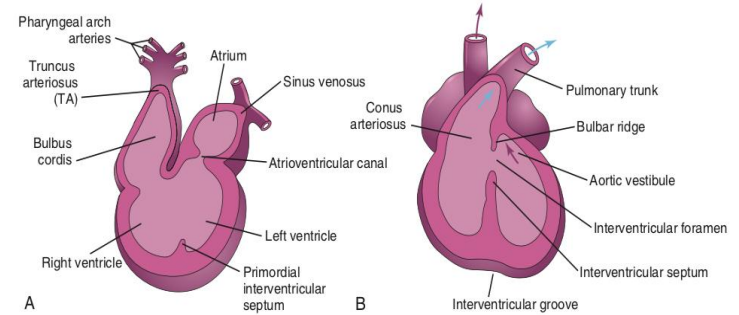
The bulbus cordis forms the smooth upper part of the two ventricles.

Right Ventricle

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

Left ventricle

Aortic Vestibule: leading to
ascending aorta.



5-Partition of Truncus Arteriosus:

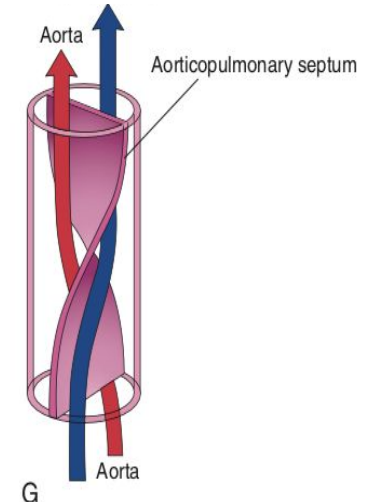
In the **5th week**, proliferation of mesenchymal cells (**Endocardial Cushions**) appear in the wall of the **truncus arteriosus**, they form a **Spiral Septum**.

It divides the lower, middle & upper parts of TA into:

- A. **Lower** :Right & Left parts
- B. **Middle** :Anterior & Posterior parts.
- C. **Upper** :Left & Right parts.

A spiral septum develops in the **Truncus arteriosus** dividing it into:

Pulmonary trunk	Aorta
pulmonary artery joins the right ventricle	the aorta joins the left ventricle



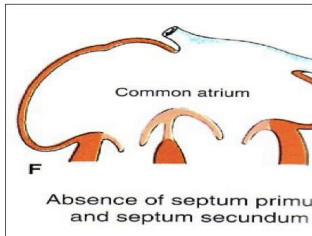
- This explains the origin of pulmonary trunk from RV & ascending aorta from LV & their position to each other.

Major cardiac anomalies

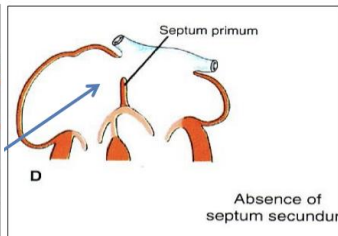
Atrial Septal Defects (ASD)

3 Types

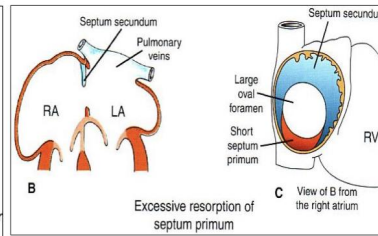
1. Absence of both septum primum and septum secundum, leads to common atrium.



2. Absence of Septum Secundum



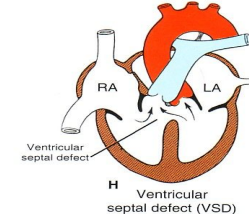
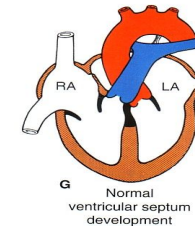
3. Large (Patent) foramen ovale: Excessive resorption of septum primum



Ventricular septal defect (VSD)

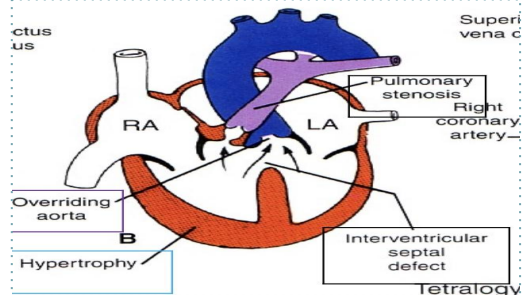
Roger's disease:

- Absence of the **membranous** part of interventricular septum (persistent IV foramen)
(There is an open space between the two ventricles, which lead to mix of Venous and arterial blood)
- Usually accompanied by other cardiac defects.



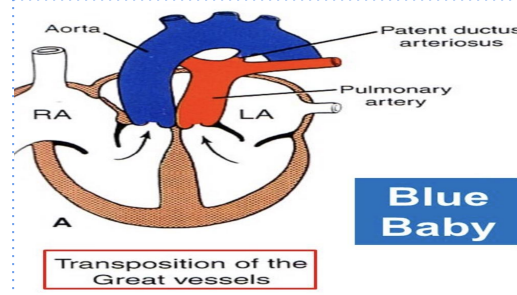
TETRALOGY OF FALLOT

- Includes four heart malformations present together:
 - Ventricular Septal Defect (VSD)**
(Absence of the membranous part)
 - Pulmonary stenosis** (narrowing of pulmonary valves, so the aorta will be larger than pulmonary)
 - Right ventricular hypertrophy**
 - overriding of aorta** (blood enters the aorta from both ventricles).



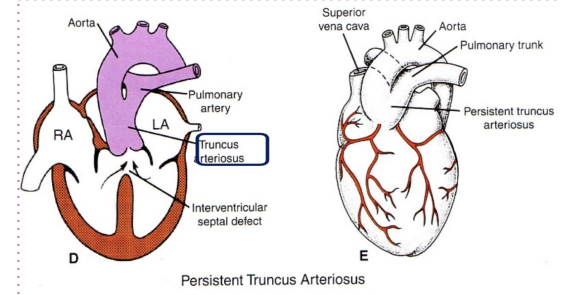
Transposition of great arteries(TGA)

- 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 (blue baby).
- Often associated with **ASD** (atrial septal defect) or **VSD** (ventricular septal defect).



Persistent truncus arteriosus

- It is due** to failure of the development of the aorticopulmonary (spiral) septum.
- 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



MCQs

Question 1: which mesodermal layer give rise to endocardial heart tubes ?

- A. Paraxial mesoderm
- B. Somatic Mesoderm
- C. Intermediate Mesoderm
- D. Splanchnic Mesoderm

Question 2: the embryo cardinal venous vessels which drain into the sinus venosus are:

- A. anterior cardinal veins
- B. posterior cardinal veins
- C. common cardinal veins
- D. superior cardinal veins

Question 3: which part of the primitive heart tube gives rise to the Spiral Septum.

- A. bulbus cordis
- B. truncus arteriosus
- C. primitive ventricle
- D. sinus venosus

Question 4: what cardiac malformation causes the aorta to arise from right ventricle and the pulmonary trunk to arise from left ventricle?

- A. transposition of the great vessels
- B. persistent truncus arteriosus
- C. ventricular septal defect
- D. atrial septal defect

Question 5: Which one of the following is NOT part of TETRALOGY OF FALLOT ?

- A- Pulmonary stenosis
- B- Overriding of the aorta
- C- Thickened of right ventricle wall
- D- ASD

Question 6: what is the Roger's disease?

- A- Pulmonary stenosis
- B- Right ventricular hypertrophy
- C- Overriding of the aorta
- D- Absence of the membranous part of interventricular septum

Question 7: witch of the flowing septums form the floor of the fossa ovalis?

- A- septum primum.
- B- septum secundum.
- C- subendocardial cushions.
- D- septum intermedium.

Question 8: the U shaped heart tube is caused by the growth of 2 of the dilations faster than the others which two are they?

- A- Common Ventricle and Bulbus Cordis.
- B- Bulbus Cordis and Truncus Arteriosus.
- C- Truncus Arteriosus and Common Atrium.
- D- Common Atrium and Common Ventricle..

Team members

Boys team:

- Faisal Alqifari
- Salman Alagla
- Ziyad Al-jofan
- Ali Aldawood
- Khalid Nagshabandi
- Omar Alammari

Team leaders

- Abdulrahman Shadid
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- Taif Alotaibi
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- Amirah Al-Zahrani
- Alhanouf Al-haluli
- Sara Al-Abdulkarem
- Rawan Al Zayed
- ★ Renad Al Haqbani
- ★ Nouf Al Humaidhi
- Jude Al Khalifah
- ★ Nouf Al Hussaini
- Alwateen Al Balawi
- Rahaf Al Shabri
- Danah Al Halees
- Rema Al Mutawa
- Amirah Al Dakhilallah
- Maha Al Nahdi
- Ghaida Al Braithen

THANKS!



Anatomy team
med 438

Contact us:

