**Embryology**

**Cardiovascular System**

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**Establishment of Cardiogenic Field**

The vascular system appears in the middle of the third week. Cardiogenic progenitor cells lie in the ectoderm, immediately lateral to primitive streak. Cells reside in the splanchnic layer of the lateral plate mesoderm, they are induced by the underlying pharyngeal endoderm to form **cardiac myoblasts**. Blood islands also appear in this mesoderm, where they will form blood cells and vessels by the process of **vasculogenesis.** With time, the islands unite and form a horseshoe-shaped endothelial-lined tube surrounded by myoblast. This region is known as the **cardiogenic field**, the intraembryonic cavity over it later develops into the pericardial cavity. In addition the blood islands appear bilaterally, parallel and close to the midline of the embryonic shield. These islands form a pair of longitudinal vessels, **the dorsal aortae**.

**Formation and position of the heart tube**

The horseshoe-shaped area expand to form the future outflow tract and ventricular regions. Thus the heart becomes a continuous expanded tube consisting of an inner endothelial lining and an outer myocardial layer. It receive venous drainage at it’s caudal pole and begins to pump blood out of the first aortic into dorsal aorta at it’s cranial pole. The developing heart tube bulges more and more into the pericardial cavity. Initially, the tube remains attached to the dorsal side of the pericardial by a fold of mesodermal tissue, **the dorsal mesocardium**. No ventral mesoderm is ever formed. The dorsal mesocardium disappear, creating the transverse pericardial sinus, connects both sides of the pericardial cavity. The heart is now suspended in the cavity by blood vessels at it’s cranial and caudal poles. During this events the myocardium thickens and secrets a thick layer of extracellular matrix, rich in hyaluronic acid, that separates it from the endothelium. In addition, mesothelial cells from the region of the sinus venous migrate over the heart to form the **epicardium.**

**Thus the heart tube consists of three layers:**

**1**-Endocardium, forming the internal endothelial lining of the heart.

**2**-The myocardium, forming the muscular wall.

**3**-The epicardium, or visceral pericardium, covering the outside of this tube. This outer layer is responsible for formation of the coronary arteries, including their endothelial lining and smooth muscle.

**Formation of cardiac loop**

The heart contonous to elongate and bend on day 23. The cephalic portion of the tube bends ventrally, caudally, and to the right. The atrial (caudal) portion shifts dorsocranially and to the left. This bending creats the **cardiac loop**. It is complete by day 28. While the cardiac loop is forming, local expansions become visible throughout the length of the tube. The atrial portion, initially a paired structure outside the pericardial cavity, forms a **common atrium** and is incorporated into the pericardial cavity. The atrioventricular junction narrow and forms the atrioventricular canal, which connects the common atrium and the early embryonic ventricle. The bulbus cordis is narrow except for it’s proximal third. This portion will form the trabeculated part of the **right ventricle**. The midportion, the conus cordis, will form the outflow tracts of both ventricles. The distal part of the bulbus, the **truncus arteriosus**, will form the roots and proximal portion of the **aortae and pulmonary artery**. The junction between the ventricle and the bulbus cordis, externally indicated by the **bulboventricular sulcus**, remains narrow. It is called primary **interventricular foramen**. Thus the cardiac tube is organized by regions along it’s craniocaudal axis from the contruncus to the right ventricle to the left ventricle to the atrial region respectively.

At the end of loop formation, the smooth-walled heat tube begins to form primitive trabeculate in two sharply defined areas just proximal and to the primary interventricular foramen. The bulbus temporarily smooth walled. The primitive ventricle, which is now trabeculated, is called the **primitive left ventricle.** The trabeculated proximal third of the bulbus cordis may called the **primitive right ventricle**. The conotruncal portion of the heart tube, initially on the right side of the pericardial cavity, shifts gradually to a more medial position. This change in position is the result of formation of two transverse dilations of the atrium, bulging on each side of the bulbus cordis.

**Abnormalities of cardiac loop**

1-Dextracordia, in which the heartlies on the right side of the thorax instead of the left, is caused because the heart loops to the left instead of the right.

2-Ventricular septa defect, occurs in the membranous (perimembranous) rather than muscular internentricular septum, males more frequent than female, perimembranous defects are located close to the aortic and tricuspid valves and adjacent to atrioventricular conduction bundle.

3-Atrial septal defects, are agroup of common congenital anomalies defects occuring more in females, patent foramen ovale-allows a continuation of the atrial shunting of blood in 25% of people a probe patent foramen ovale allowing a probe to bepassed from one atria to the other exists.

4-Tetralogy of fallot,common developmental cardiac defect. This syndrome consists of number of cardiac defects possibly stremming from abnormal crest cell migration, ventricular septal defect with pulmonary stenosis or atresia, dextroposition of aorta and hypertrophy of right ventricle.

**Congenital heart disease refers to a range of possible heart defects including**

**1-Aortic valve stenosis**

Aortic valve stenosis is a serious type of congenital heart defect.

In aortic valve stenosis, the aortic valve that controls the flow of blood out of the main pumping chamber of the heart (the left ventricle) to the body's main artery (the aorta) is narrowed. This affects the flow of oxygen-rich blood away from the heart, towards the rest of the body, and may result in the left ventricle muscle thickening because the pump has to work harder.

**2-Coarctation of the aorta**

Coarctation of the aorta (CoA) is where the main artery (the aorta) has a narrowing, which means that less blood can flow through it.

CoA can occur by itself or in combination with other types of heart defects – such as a ventricular septal defect or a type of defect known as a patent ductus arteriosus.

The narrowing can be severe and will often require treatment shortly after birth.

**3-Patent ductus arteriosus**

As a baby develops in the womb, a blood vessel called the ductus arteriosus connects the pulmonary artery directly to the aorta. The ductus arteriosus diverts blood away from the lung (which isn't working normally before birth) to the aorta.

A patent ductus arteriosus is where this connection doesn't close after birth as it's supposed to. This means that extra blood is pumped into the lungs, forcing the heart and lungs to work harder.

**4-Pulmonary valve stenosis**

Pulmonary valve stenosis is a defect where the pulmonary valve, which controls the flow of blood out of the right heart pumping chamber (the right ventricle) to the lungs, is narrower than normal. This means the right heart pump has to work harder to push blood through the narrowed valve to get to the lungs.

**5-Septal defects**

A septal defect is where there's an abnormality in the wall (septum) between the main chambers of the heart. The two main types of septal defect are outlined below.

6-**Tricuspid atresia**

Tricuspid atresia is where the tricuspid heart valve hasn't formed properly. The tricuspid valve separates the right-sided collecting chamber (atrium) and pumping chamber (ventricle). Blood can't flow properly between the chambers, which causes the right pumping chamber to be underdeveloped.

**7-Tetralogy of Fallot**

Tetralogy of Fallot is a rare combination of several defects.

The defects making up tetralogy of Fallot are:

**ventricular septal defect** – a hole between the left and right ventricle

**pulmonary valve stenosis** – narrowing of the pulmonary valve

**right ventricular hypertrophy** – where the muscle of the right ventricle is thickened

**overriding aorta** – where the aorta isn't in its usual position coming out of the heart

As a result of this combination of defects, oxygenated and non-oxygenated blood mixes, causing the overall amount of oxygen in the blood to be lower than normal. This may cause the baby to appear blue (known as cyanosis) at times.



