

Fetal circulation: During development there are three circuits:

- Vitelline circuit: fetus - Yolk sac
- Placental circuit: Fetus - Placenta(mother)
- Fetal circuit: Within the fetus

Heart development:

- Anterior migration of mesoderm during gastrulation creates the heart field/cardiac crescent rostrally, give rise to heart tube
- Cardiac crescent give rise to three populations: anterior outlet, middle ventricular chambers, posterior inlet.
- Anterior-posterior folding and bilateral folding
- Day-21: merges the two endocardial tubes, bring it under the forebrain and foregut.
- Day-22: Formation of truncus arteriosus, bulbus cordis, primitive ventricles and, primitive atrium sinus venosus
- Day-23: Folding of the primitive heart tube, inlet becomes rostral-posterior to the outlets
- Day-35: Folding complete, septation occurs simultaneously with folding.

Sinus Venosus development:

- Sinus venosus contains left and right horns, each connected to the three veins from the posterior region, 1 anterior:
 - Vitelline vein
 - Umbilical vein
 - Posterior cardinal vein
 - Anterior cardinal vein
- During development, left side vessel gradually degenerates, converging to the RHS superior and inferior vena cava.
- The sinus merges into the atrium:
 - In the right atrium, sinus merge with atrial wall, contributing to smooth part of the wall, boundary marked by crista terminalis.
 - In the left atrium, branching pulmonary veins merge into atrial wall, from 1 inlet -> 4 inlets

Atrioventricular canal division

- Formation of endocardial cushions: superior/inferior, as well as two lateral cushions.
- Endocardial cushions divide the atrioventricular canal into left and right, contribute to formation of atrioventricular valve leaflets.

Atria division:

- Formation of septum primum from atrium to meet the endocardial cushion at the AV canal. Before complete closure, Foramen primum allows bloodflow from R-L atrium
- Septum primum fuse with endocardial cushions, apoptosis cause formation of septum secundum
- Septum secundum form right of septum primum, incomplete merging with endocardial cushion form foramen ovale.
- During development, blood pass from R-L atrium via the unidirectional valve-like structure.

Ventricles division

- Atrioventricular canal formed by the endocardial cushion initially on the left, gradually shift to the middle
- Merging of the superior and inferior endocardial cushion lead to L/R separation of the AV canal.
- inferior - superior growth of muscular interventricular septum separate the two ventricles

Outflow tract separation

- Neural crest cells from the pharyngeal region migrate and invade the outflow tract, give rise to pairs of bulbar ridges and truncal ridges
- Spiral growth and fusion of the pairs of ridges separate the outflow tract.
- Fusion of the ridges with endocardial cushions and interventricular septum lead to separation of tract and fully separation of ventricles.

Bloodflow during development:

- Inferior Vena Cava carries oxygenated blood from the placenta:
 - Enters right atrium
 - Enter Left atrium via foramen ovale
 - Enter left ventricle via bicuspid valve
 - Pumped into the aorta, supply coronary + brachiocephalic arteries first before mixing (oxygenated blood for the brain)
- Superior Vena Cava carries deoxygenated blood from the brain:
 - Enters right atrium
 - Inlet position and momentum cause flow towards right ventricle through tricuspid valve.
 - Pumped into pulmonary artery, through ductus arteriosus into aortic arch, bypassing the developing lungs
- After the child is born, lungs become active, bloodflow into the lungs and return into the heart increase pressure in left atrium, shuts the septum primum against foramen ovale. Foramen ovale becomes fossa ovalis.
- Failure to close foramen ovale leads to interatrial foramen, can be caused by short septum/ foramen too big.

Precardial mesoderm: Form the epicardium (pericardium layers) and endocardium (heart chamber lining)

Precardial mesoderm also differentiate into two heart fields: First heart field and second heart field (2nd heart field contribute to formation of myocardium).

Heart position move from cervical level to thoracic level during development

Umbilical veins bypass the liver into the heart, circulation lost after born.

Vitelline circulation becomes the hepatic circuit during development

Fetal circuits

Primitive heart tube development

Sinus Venosus changes

AV separation

Atrial separation

Ventricular separation

Outflow duct separation

Heart progenitor

Changes during development.

Lined area for notes.