Fetal Circulation

Umbilical cord:

At term about 50 cm long 2 cm in diameter, contain :

- 2 umbilical arteries: return non-oxygenated blood, fecal waste, CO2 to placenta
- 1umbilical vein: brings oxygenated blood and nutrients to the fetus

There is no nerve in cord or placenta .The arteries are spiral and give a cord-like shape. The vessels are packed and protected by a viscous fluid which is Wharton Jelly.

Shunts in fetal circulation

- The fetal circulation is quite different from that of adult & characterized by 4 shunts which ensure that the best oxygenated blood from the placenta is delivered to the fetal brain thses are:
- Umblical circulation.
- Ductus venosus
- Foramen ovale
- Ductus arteriosus

Anatomy and Physiology

- The **umblical arteries** arise from the caudal end of the dorsal aorta & carry deoxygenated blood from fetus to placenta for gas & nutrient exchange. .
- Oxygenated blood is returned to the fetus via the **umbilical vein** to the fetal liver.

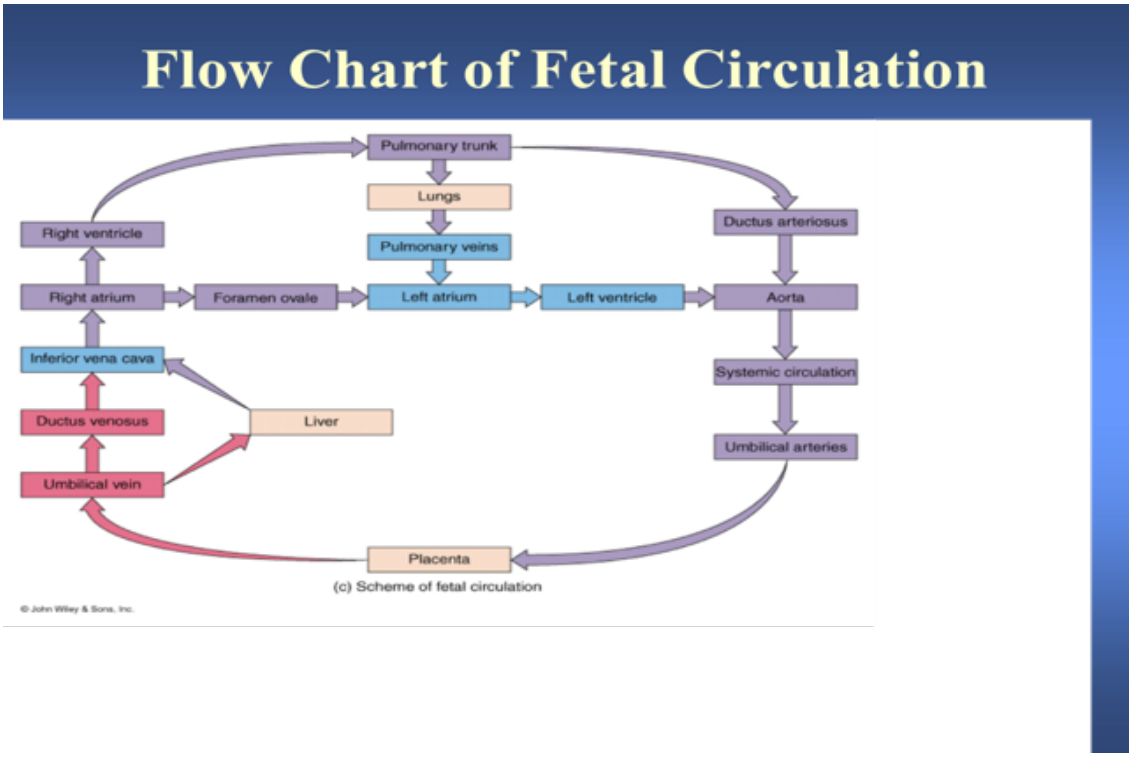
Fetal Circulation

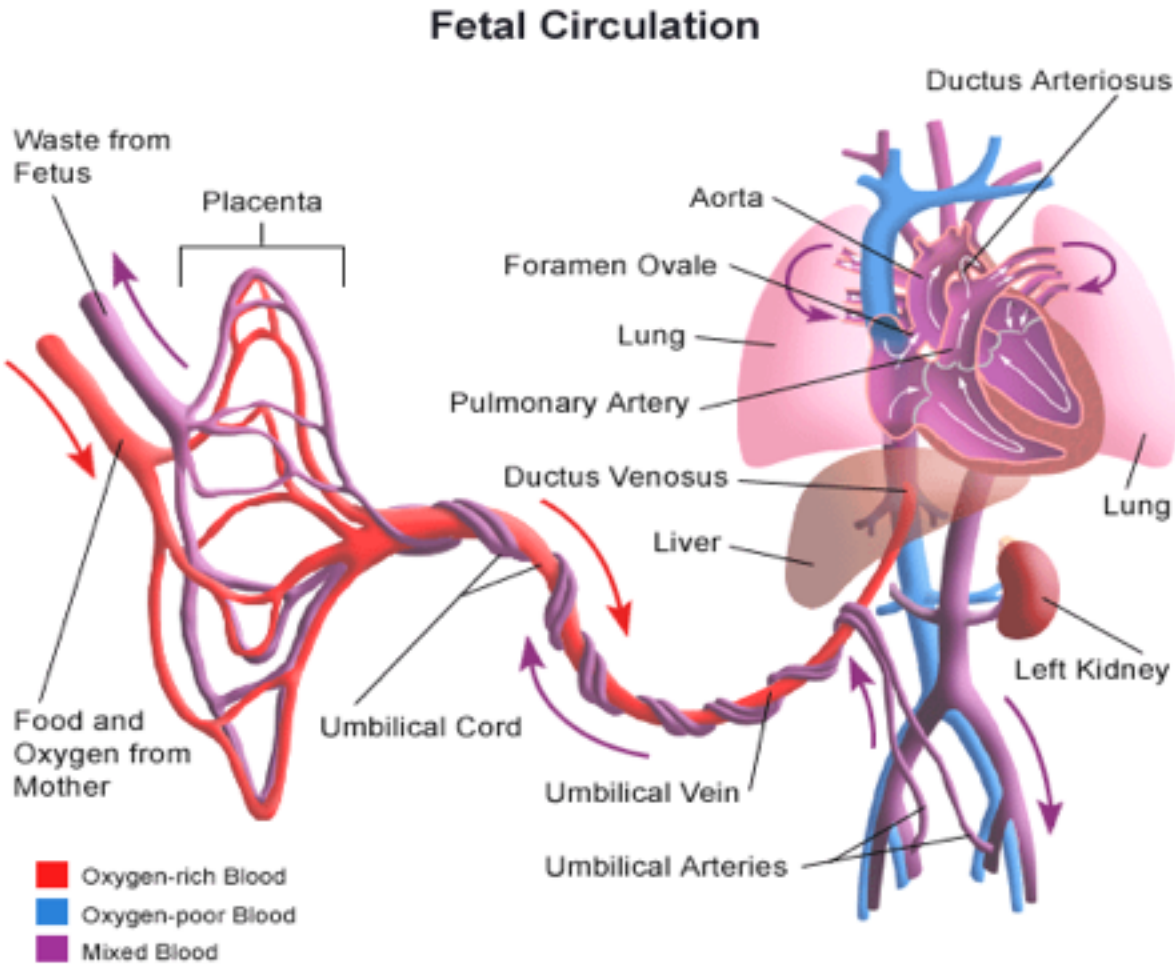
- Small amount of blood routed to growing liver
- But the bulk passes through the **ductus venosis** to by pass the liver & joins the **inferior vena cava** as it enters **the Rt atrium.**
- Ductus Venosis is a narrow vessel & high blood velocities are generated within it .This streaming of blood together with the crista dividens in Rt atrium prevents mixing of oxygenated Bd from ductus venosus with desaturated Bd from IVC.

- IVC empties into the **right atrium** of the heart
  - The ductus venosus stream then passes to the **left atrium** through the **foramen ovale (**Small physiological defect in the atrial septum)
- Completely bypasses the non-functioning lungs
- Blood continues journey to the **left ventricle** blood is then pumped into the **aorta**
- About 50% of blood is circulated to the upper extremities
- The remainder passes down the aorta to mix with Bd of reduced oxygen saturation from **Rt ventricle** via **the ductous arteriosus**
- Deoxygenated Bd returning from the head & lower body flows to the **Rt atrium**
- From the right atrium, the blood goes to the **right ventricle** then to the **pulmonary arteries**

- Pulmonary arteries
  - Small amount goes to the maturing lungs
- Rest of blood is shunted away from lungs by **ductous arteriosus** back to descending aorta
- By this means the desaturated blood from Rt Vt passes down the aorta to enter the two **umbilical arteries** to the **placenta** for reoxygenation.

- Prior to birth, the ductus arteriosus remains patent due to the production of PG E2& prostacyclin , which act as vasodilators & its premature closure has been reported with the administration of cyclooxygenase inhibitors.





Conversion of Fetal to Infant Circulation

At birth

- Clamping the cord shuts down low-pressure system & causes cessation of flow in ductus venosus,a fall in pressure in the Rt atrium &closure of foramen ovale.
- Ventilation of the lungs opens the pulmonary circulation,with a rapid fall in pulmonary vascular resistance.
- More heavily oxygenated blood passing through the ductus arteriosus with the fall in pulmonary vascular resistance, causes it's constriction & functional closure within a few days of birth.
- Occasionally, this transition from fetal to adult circulation is delayed (persistent fetal circulation), resulting in Lt-to-Rt shunting of blood from the aorta through the ductus arteriosus to the lungs.

This delay in closure of ductus arteriosus is seen in commonly premature infants & results in congestion of pulmonary circulation & reduction in Bd flow to GIT tract & brain & implicated in the pathogenesis of necrotizing enterocolitis & intra ventricular haemorrhge.

What happens to these special structures after birth?

- Umbilical arteries atrophy
- Umbilical vein becomes part of the fibrous support ligament for the liver
- The foramen ovale, ductus arteriosus, ductus venosus atrophy and become fibrous ligaments

Post natal changes

Gas exchange function is transferred from placenta to the lungs.

Separation of systemic and pulmonary circulations

- Increased metabolism to maintain body temperature and hence increased cardiac output.
- Change from right to left shunting to left to right blood flow

Overview of Conversion

- Umbilical cord is clamped
- Closure of ductus venosus
- Decreased pressure in Rt atrium
- Closure of foramen ovale
- Loss of placenta also leads to

- First breath
- Lungs expand and fluid is expelled
- Decreased pulmonary resistance
- Increased systemic resistance
- Increased O2 levels in pulmonary circulation
- Closure of the ductus arteriosus

Fetal vs. Infant Circulation

Fetal	**Infant**
Low pressure system	High pressure system
Right to left shunting	Left to right blood flow
Lungs non-functional	Lungs functional
Increased pulmonary resistance	Decreased pulmonary resistance
Decreased systemic resistance	Increased systemic resistance