

Route of Fetal Circulation

Blood rich in oxygen returns to the fetus from the placenta in the umbilical vein. Most of this blood enters a direct passageway through the liver, the ductus venosus, and joins venous blood in the caudal or inferior vena cava returning from the posterior parts of the fetus. The entrance of the caudal vena cava into the right atrium is situated in such a way that most of this blood passes through a valved opening, the Foramen Ovale, in the interatrial septum and enters the left atrium. This blood which has the highest oxygen concentration of blood in the fetus has bypassed the lungs. It is pumped by the left ventricle into the arch of the aorta, and much of it leaves through the first branches of the aorta to the head and shoulders.

Oxygen poor blood returns from the front of the body in the cranial or superior vena cava. Its entrance into the right atrium is positioned in such a way that this blood, together with a small admixture of blood from the caudal vena cava, enters the right ventricle to be pumped towards the lungs.

Fetal lungs are collapsed and offer a higher resistance to blood passage than the systemic circuit, so most of this blood flows through the open ductus arteriosus to join the aorta caudal to its branches to the head and shoulders. A mixed blood is distributed to the rest of the body and by the umbilical arteries to the placenta.

Shunts present in fetal circulation

Although an adult mammal has no shunts between the systemic and pulmonary circuits, a fetal circulation does, for the placenta and not the lungs is the site of gas exchange. Shunts found in fetal circulation are:

1. **DUCTUS VENOSUS**- Blood rich in oxygen returns to the fetus from the placenta in the umbilical vein. Most of the blood enters a direct passageway, through the liver known as Ductus Venosus. In the liver approximately half the blood from umbilical vein enters the sinusoids of the liver and other half bypasses the liver via the Ductus Venosus and enters the hepatic vein.
2. **FORAMEN OVALE**-Within the heart the inter atrial septum is incomplete. The Foramen Ovale, an opening between right and left atria, allows most blood entering the right atrium to flow directly to the left atria without first passing through the lungs. Thus, the Foramen

Oval directs most blood away from the non-functional lungs and into the systemic circulation.

3. **DUCTUS ARTERIOSUS**-About 90% of the blood that reaches the pulmonary artery bypasses the lung via the Ductus Arteriosus and is diverted instead to the dorsal aorta. Fetal lungs are collapsed and offer a high resistance to blood passage than the systemic circuit. So most blood flows through Ductus Arteriosus to join the dorsal aorta and mixed blood is distributed to rest of the body and via umbilical artery reaches the

NOTE: Near the end of gestation, the mammalian fetus has a specialized and complex circulatory system. Blood entering the right atrium is a mixture of deoxygenated blood (from liver, pre cava, post cava and coronary sinus) and oxygenated blood from the placenta (via the umbilical vein and Ductus Venosus). However, even with the mixing in the right atrium, oxygenated blood from the placenta tends to be shunted through the Foramen Ovale to the left Atrium. From the left atrium it flows in turn to the left ventricle, the dorsal aorta, the carotids and to the head. Therefore, the fetal brain preferentially receives blood that is higher in oxygen partial pressure compared to blood sent to organs elsewhere in the body.

Since pulmonary resistance is high, pressures are higher on the right side of the heart than on the left side. This pressure difference and the one-way action of the Foramen Ovale ensures that blood flows from the right to the left atrium.

In addition to diverting most of the blood from the lungs, these shunts provide both ventricles with sufficient volume of blood to pump, so that their musculature can develop normally. The Ductus Arteriosus is sometimes described as the exercise channel of the right ventricle because it permits the ventricle to pump considerable blood even though little of it can go through the lungs. Similarly, the Foramen Ovale is the exercise channel of the left Ventricle, for it provides the left Ventricle with a reasonable volume of blood and compensates for the small amount of blood that returns from the lungs.

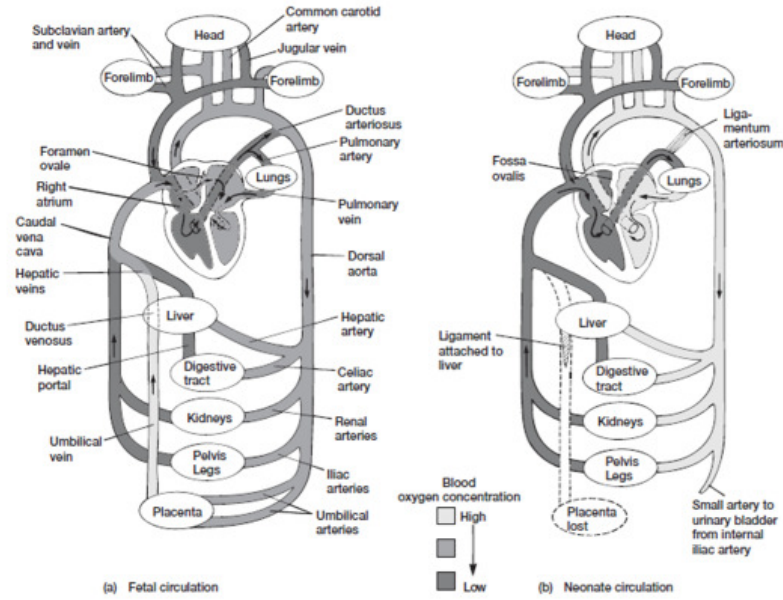


FIGURE 12.42 Mammalian (eutherian) circulatory changes at birth. (a) Fetal circulation. Because the lungs are nonfunctional, uptake of oxygen and nutrients occurs through the placenta. The ductus venosus is a liver bypass. The foramen ovale and ductus arteriosus are lung bypasses. (b) Neonatal circulation. Following birth, the lungs become functional, the placenta departs, and the ductus venosus, foramen ovale, and ductus arteriosus close.