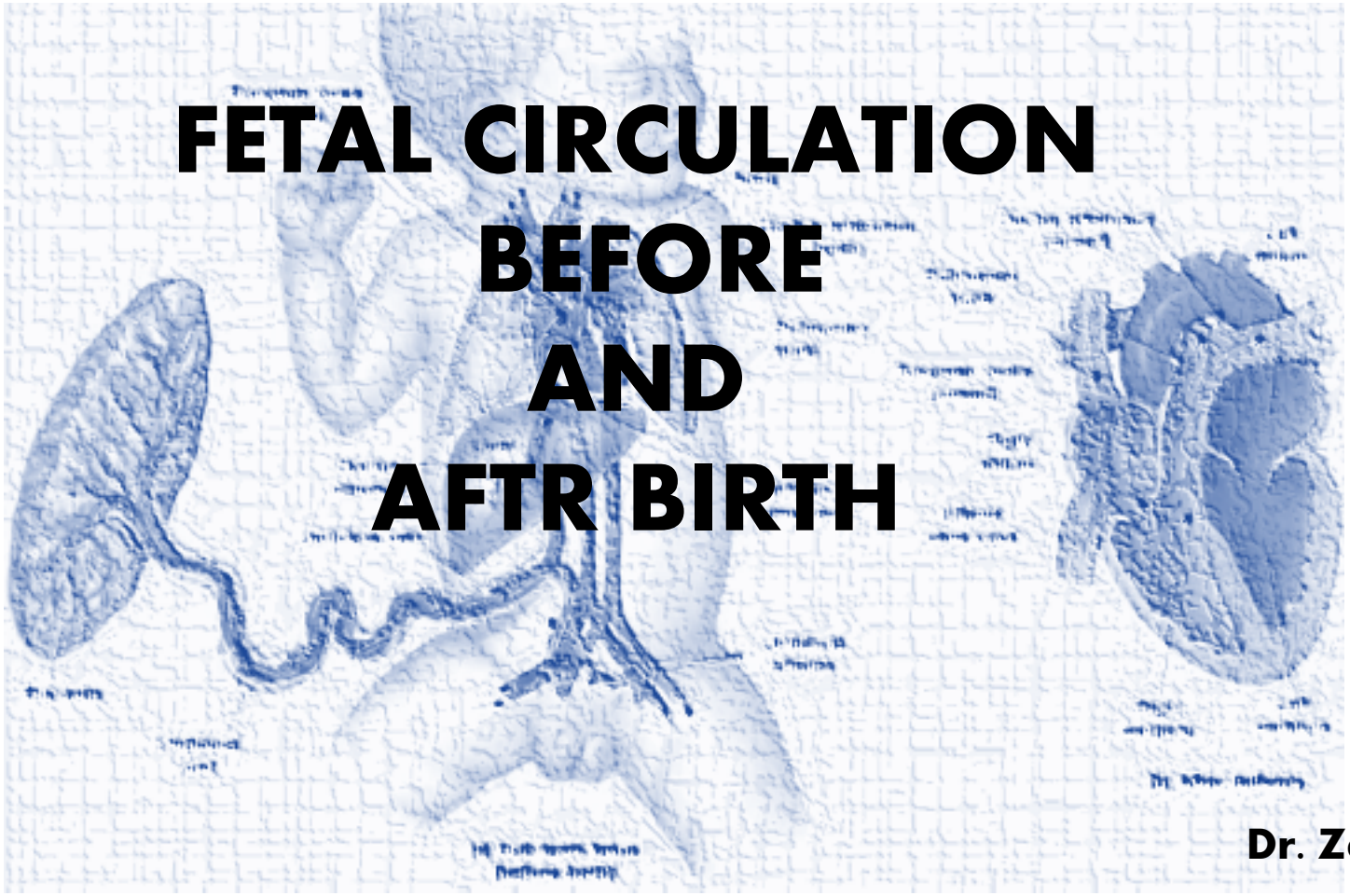
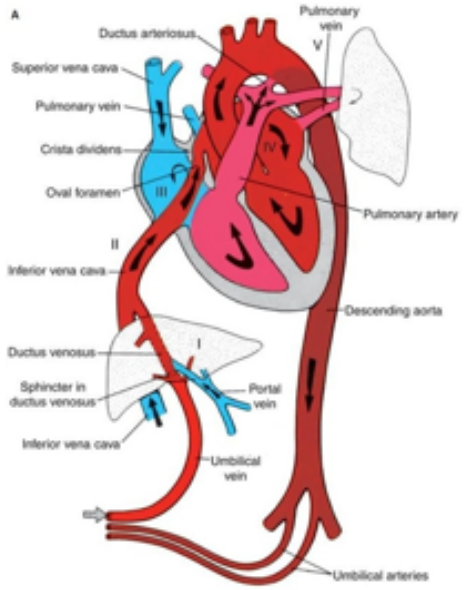
FETAL CIRCULATION BEFORE AND AFTR BIRTH

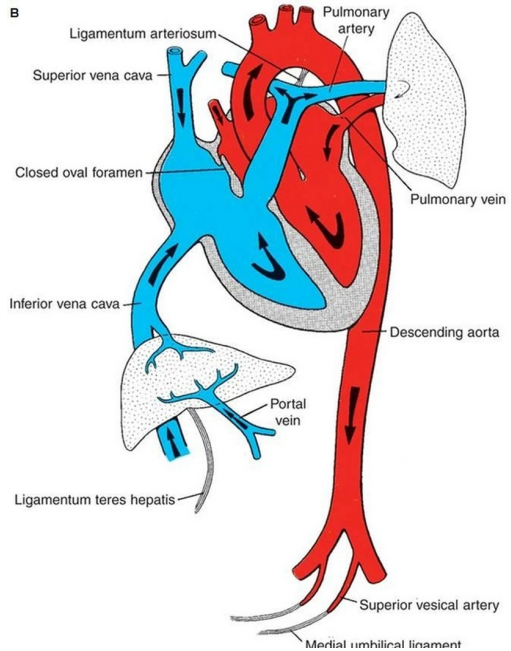


Dr. Zahid Kaimkhani

FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

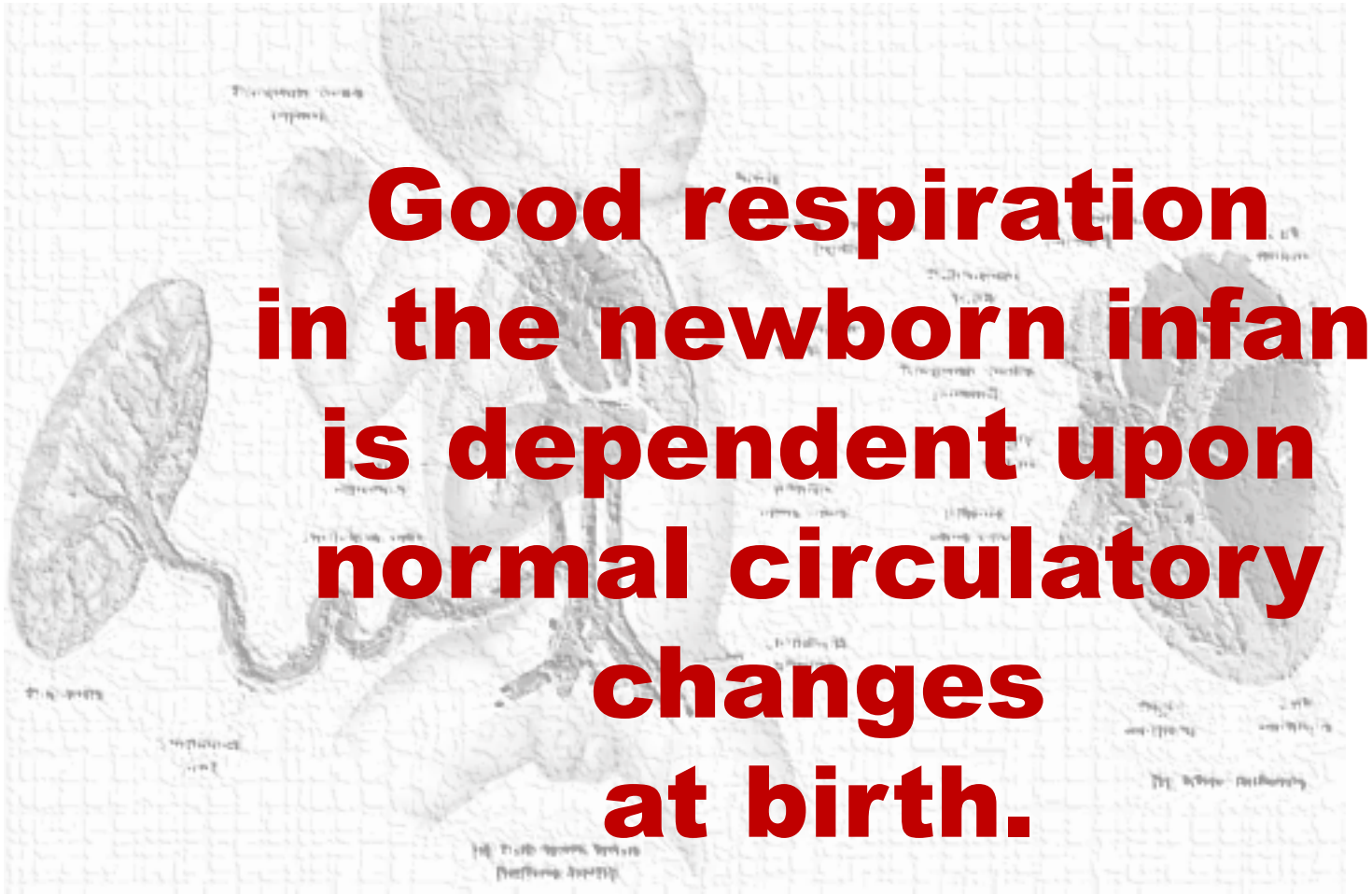


"Nature is neither lazy nor devoid of foresight. Having given the matter thought, she knows in advance that the lung of the fetus does not require the same arrangements of a perfected lung. She has therefore anastomosed the pulmonary artery with the aorta, and the left and right atria. . . ." -Galen, 2nd Century (129-200)



The fetal CVS is designed to:

- **Serve prenatal needs**
- **Permit modification at birth (to establish the neonatal circulatory pattern**

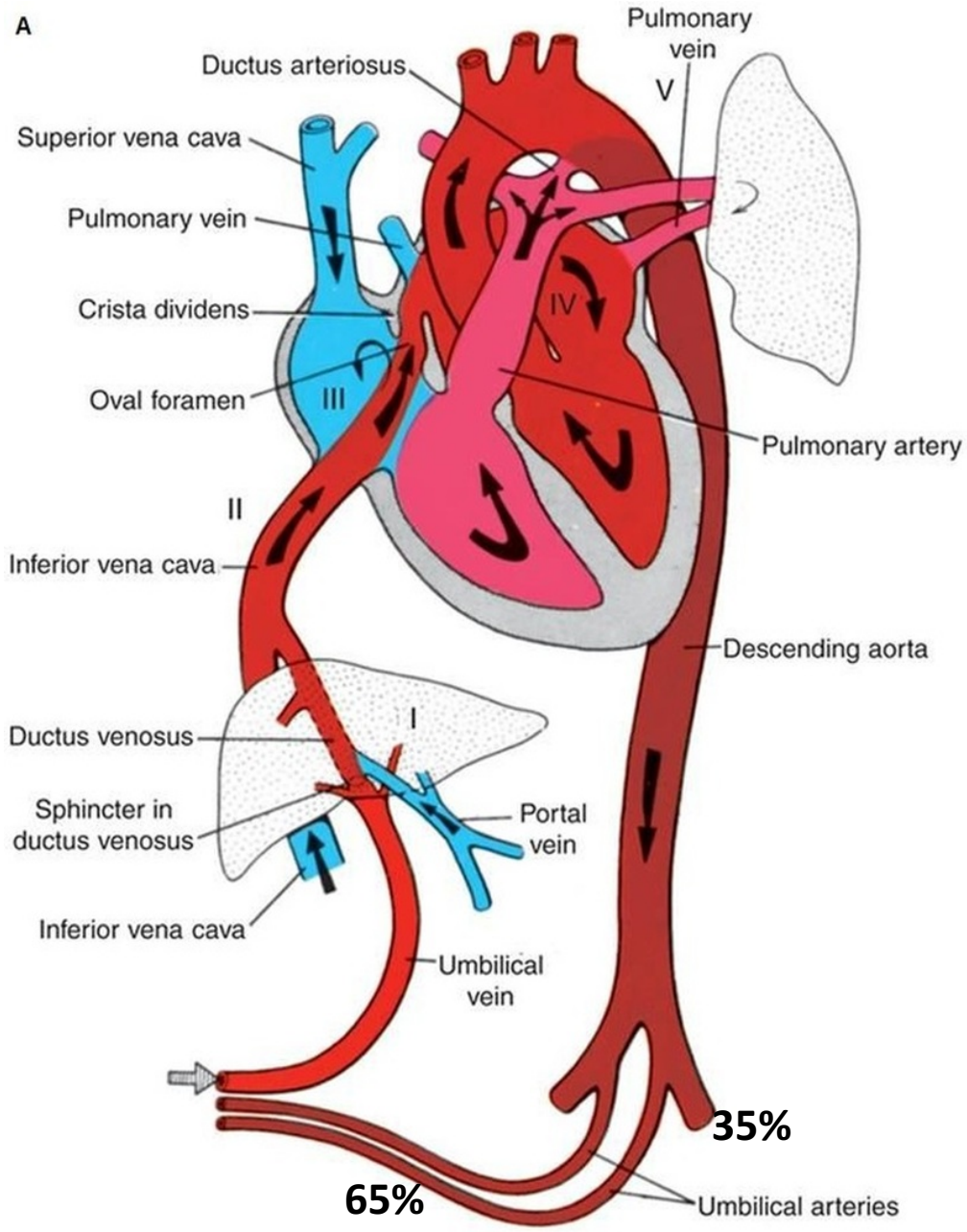


Good respiration in the newborn infant is dependent upon normal circulatory changes at birth.

FETAL CIRCULATION

Most important vascular structures in transitional circulation are:

- **Ductus venosus**
- **Oval foramen**
- **Ductus arteriosus**

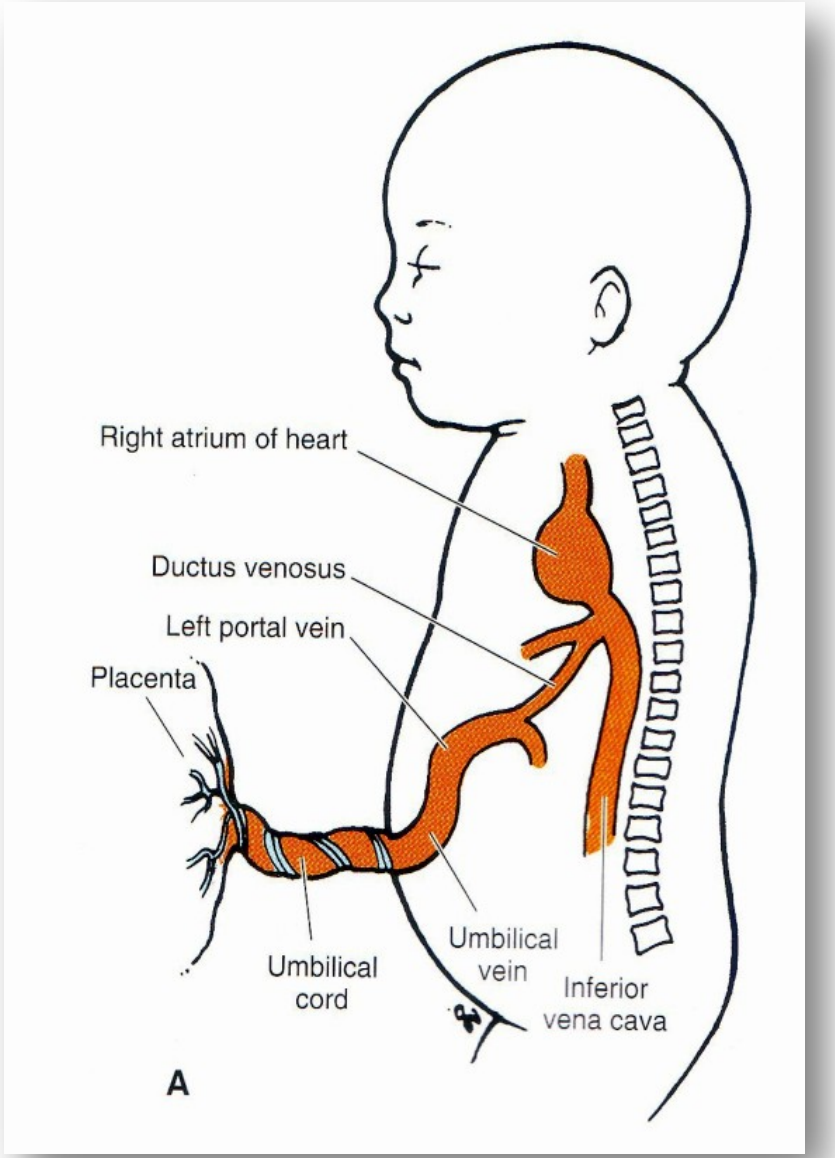


FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

BEFORE BIRTH

- **Blood reaches & leaves the fetus through the umbilical cord.**

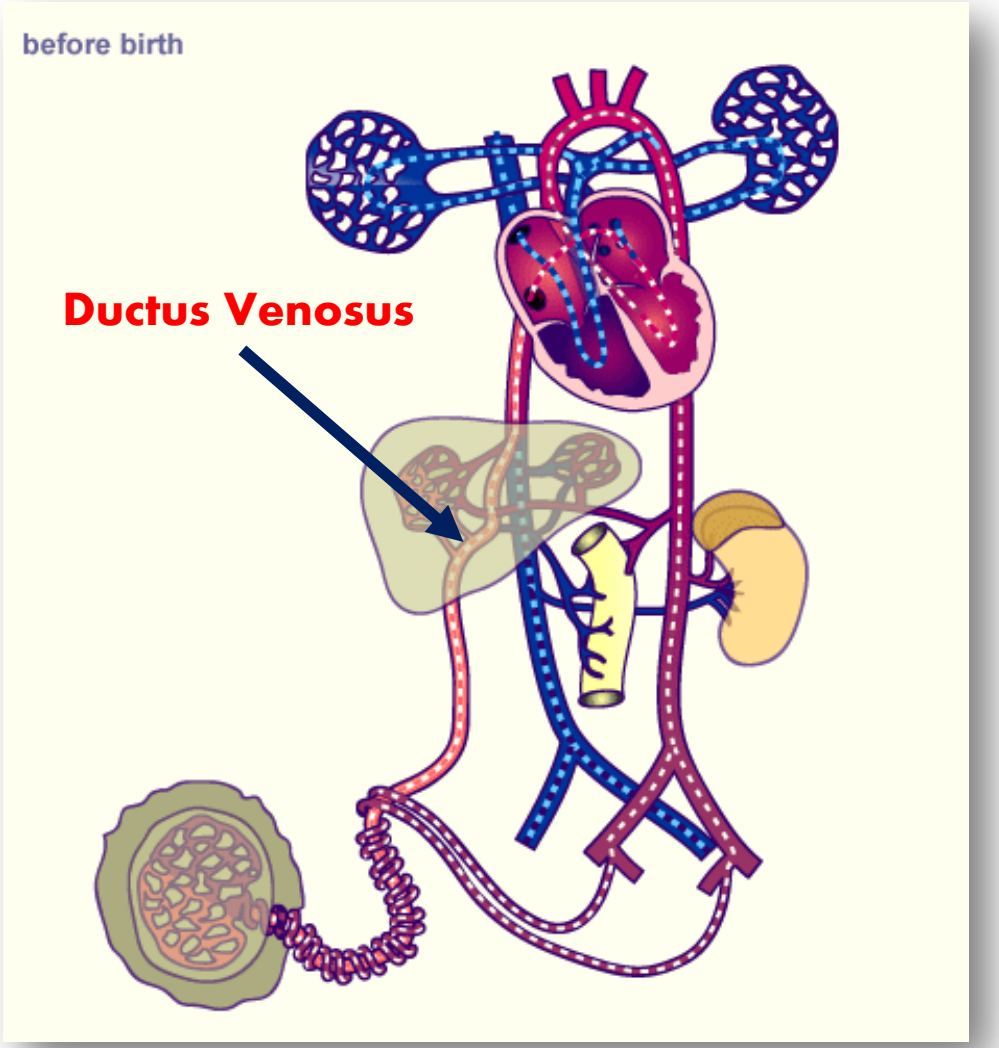
- **The umbilical cord contains**
  - **Two arteries and**
  - **One vein.**



FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

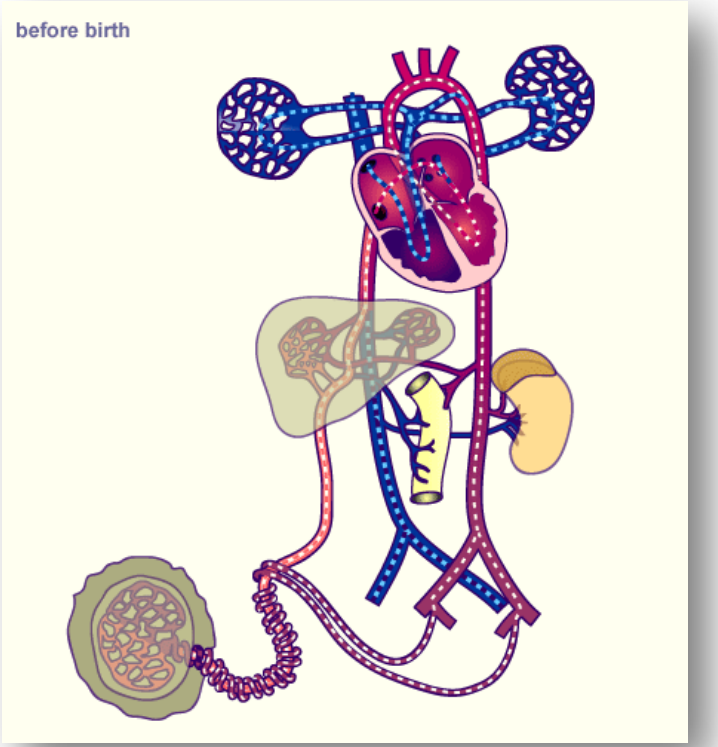
BEFORE BIRTH

- Highly oxygenated blood passes from the placenta through the **umbilical vein**.
- **Half** of this blood reaches the IVC through the **ductus venosus**.
- The other **Half** passes to liver sinusoids then to the IVC.



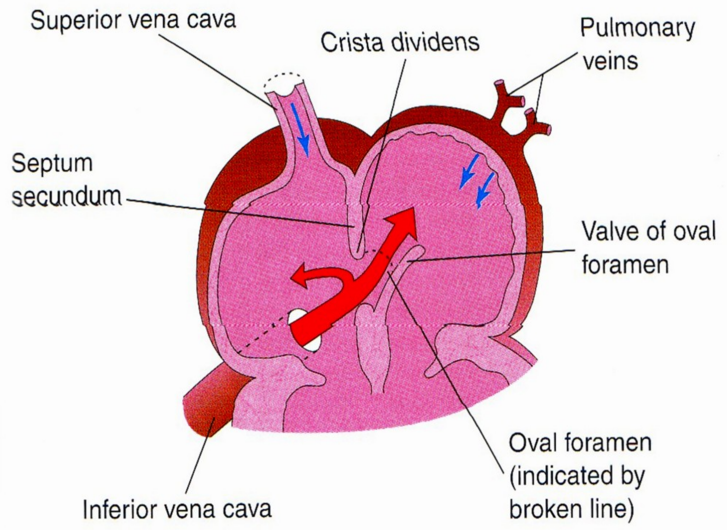
FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

BEFORE BIRTH



- **Blood of the IVC reaches the right atrium, then left atrium through the Foramen Ovale.**

- **Then to the left ventricle to the ascending aorta, and the aortic arch to supply head & neck brain, cardiac muscle and upper limbs.**

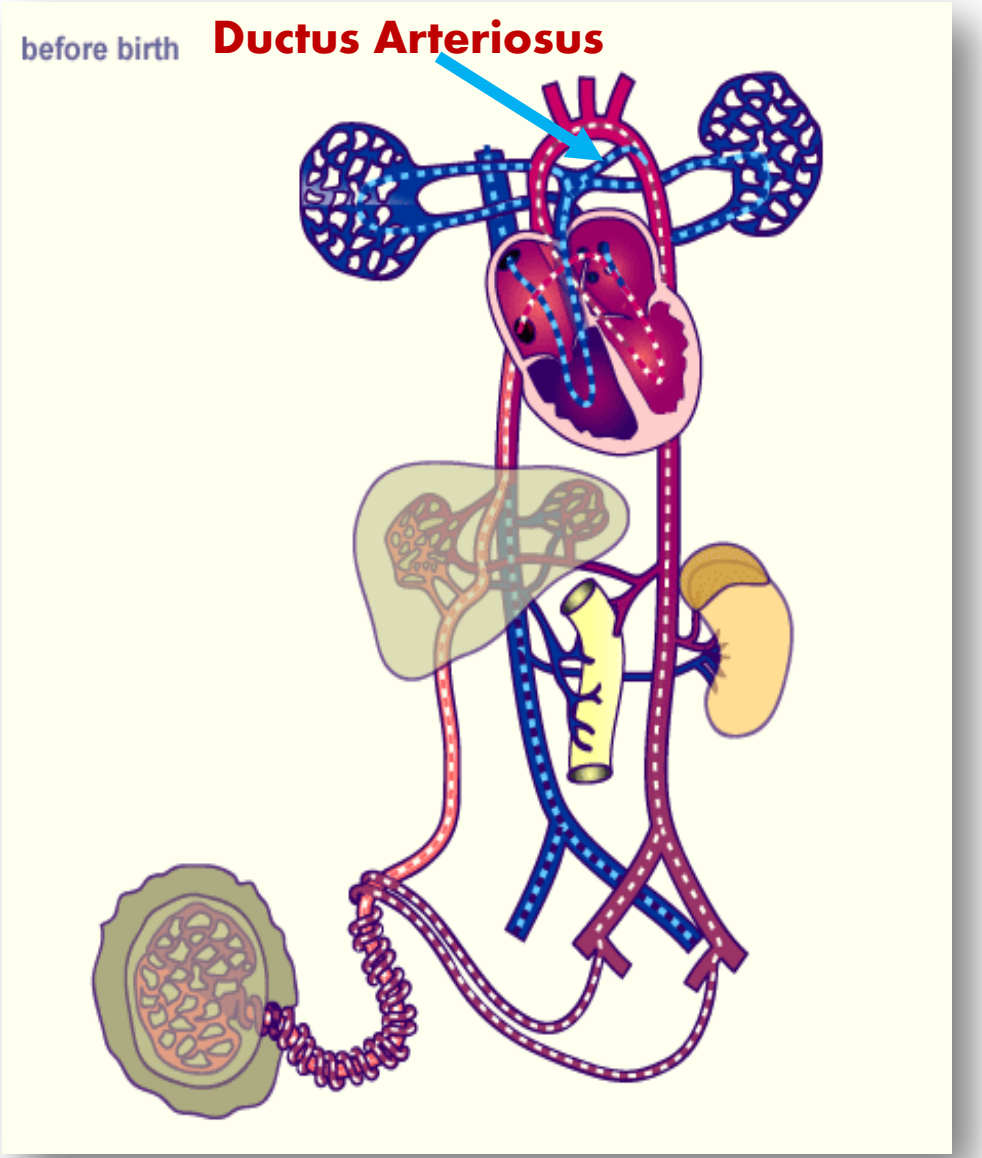


FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

BEFORE BIRTH

Small amount of highly oxygenated blood in right atrium mixes with venous blood of the SVC passes to RIGHT VENTRICLE .

Then to the pulmonary artery
Then thru Ductus Arteriosus (between the Pulmonary trunk & Proximal part of the descending aorta), to the fetal body.
And then back to placenta via the umbilical arteries.

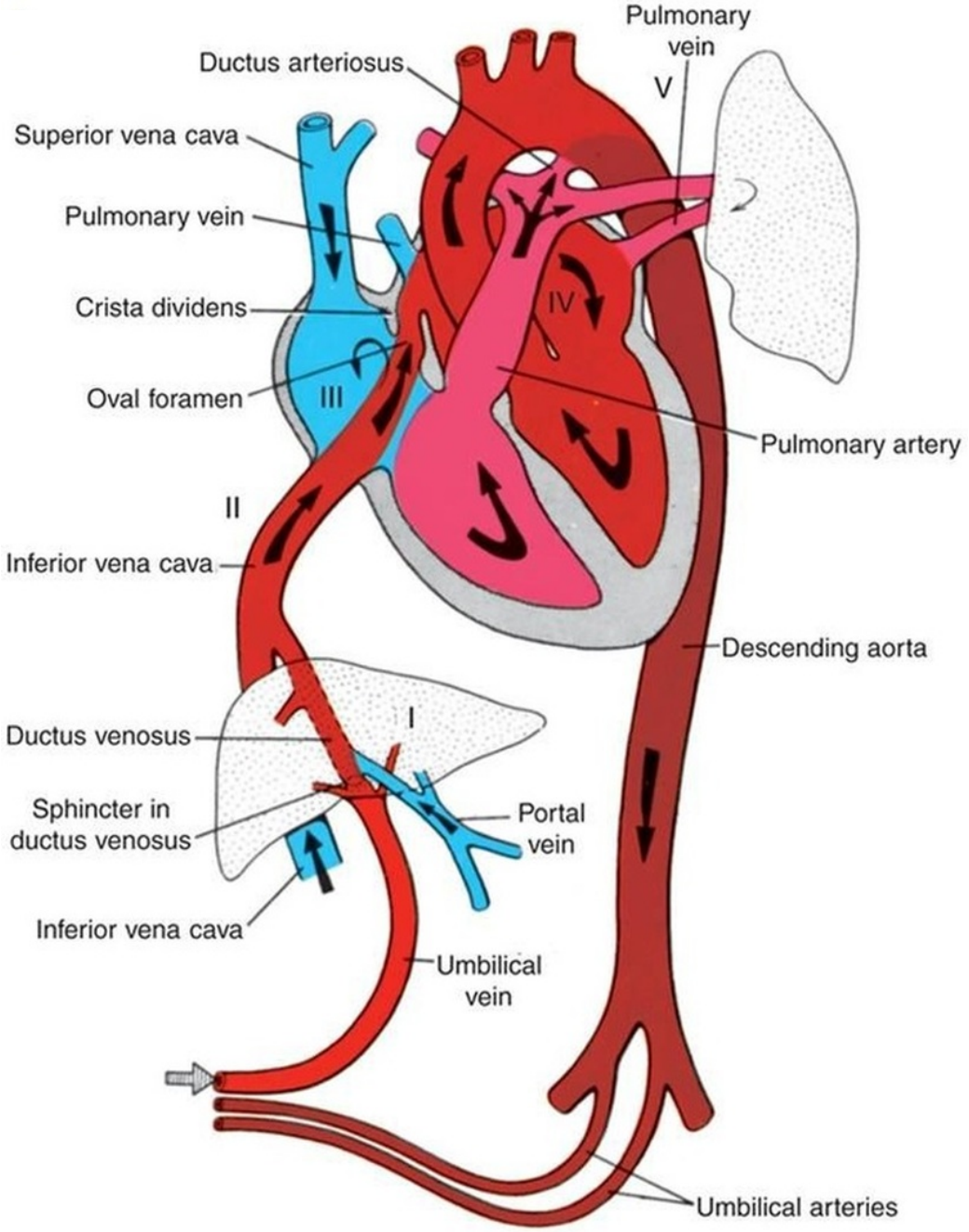


Fetal circulation before birth

Arrows, direction of blood flow.

NOTE: Where oxygenated blood mixes with deoxygenated blood:

I. **In the liver,**
II. **In the inferior vena cava,**
III. **In the right atrium**
IV. **In the left atrium, and**
V. **at the entrance of the ductus arteriosus into the descending aorta.**



BEFORE BIRTH

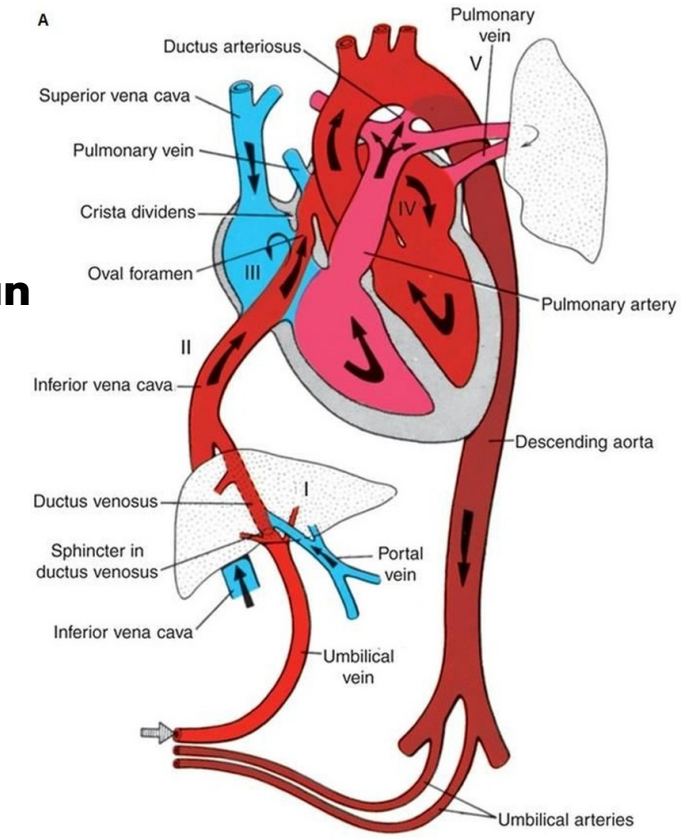
Blood from the placenta (80% saturated with O_2)

⬇

Thru umbilical vein

⬇

return to fetus



At Liver

- Most of the blood enter **THE DUCTUS VENOSUS [DV]** (bypass the liver) an flows directly to IVC (half in KLM)
- A smaller amount enter the liver sinusoids and MIXES with blood from portal circulation (GIT)

Is there a sphincter mechanism in DV?

- YES , MORE physiological then anatomical
- Close to the entrance of the umbilical vein
- Regulates flow of umbilical blood thru the liver sinusoids
- Closes during uterine contraction (venous return too high)
- To prevent the overloading of the heart

At inferior vena cava

- a short course
- Mixing of placental blood with deoxygenated blood from LL, abd & pelvis

FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

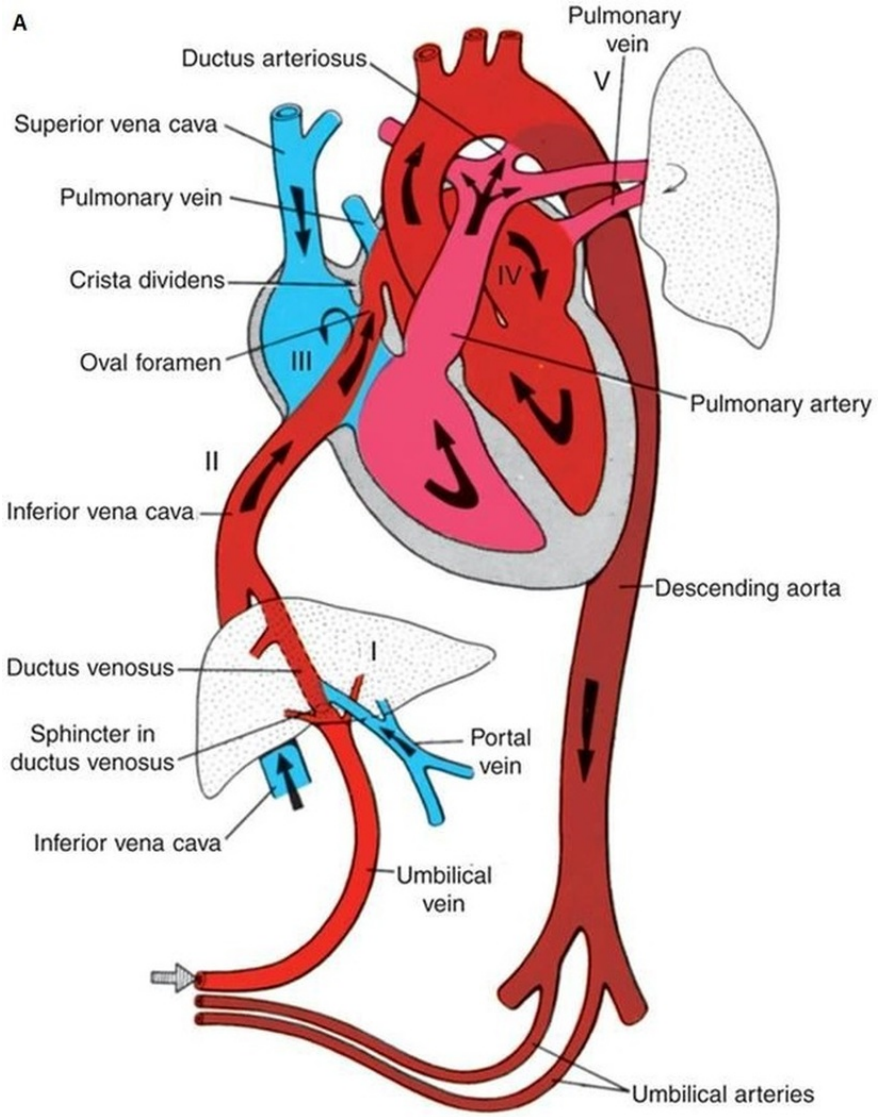
Right Atrium (RA)

- Guided towards the foramen oval (by the valve of IVC)
- Most of the blood passes directly to the left atrium
- Small amount fails and remain in the RA (bcz of the crista dividens --- lower edge of septum secundum)
- Another mixing –with deoxygenated blood thru SVC

Left Atrium (RA)

- Another mixing –with small amount desaturated blood returning from LUNGs

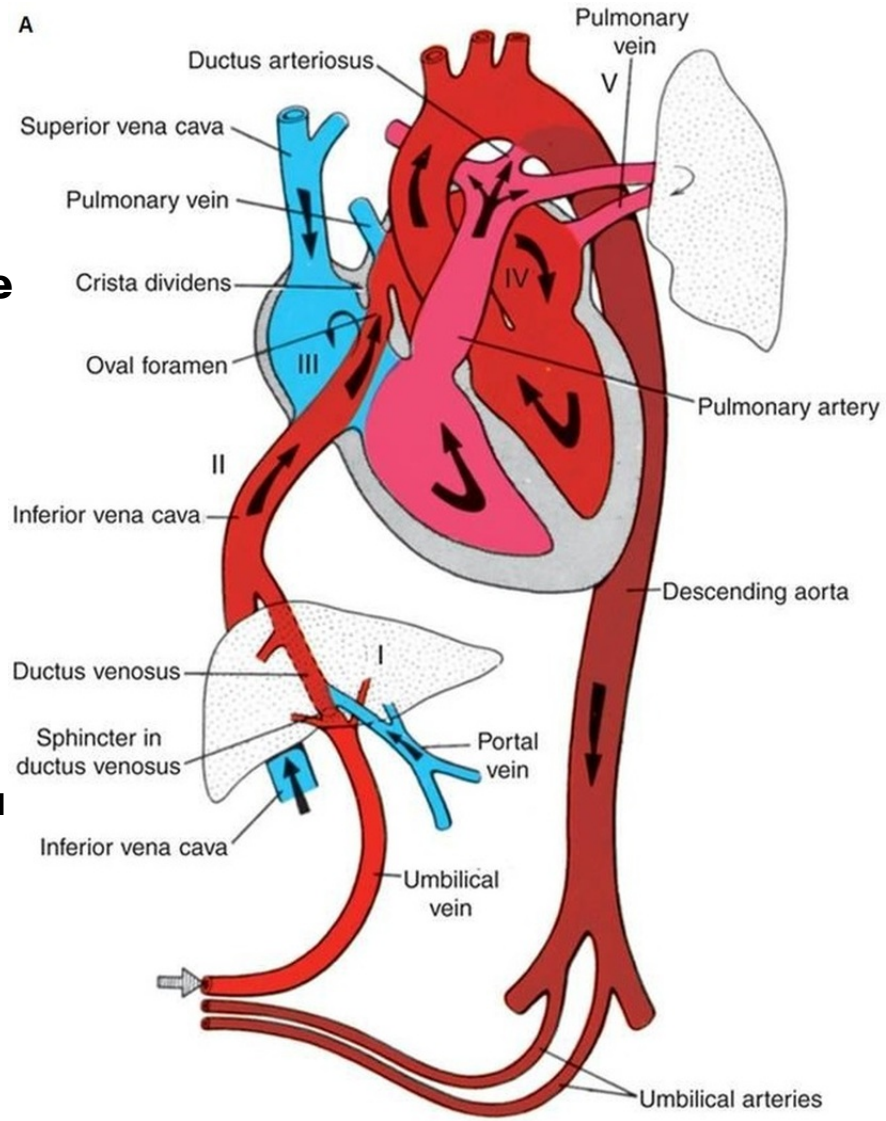
- **Left ventricle**



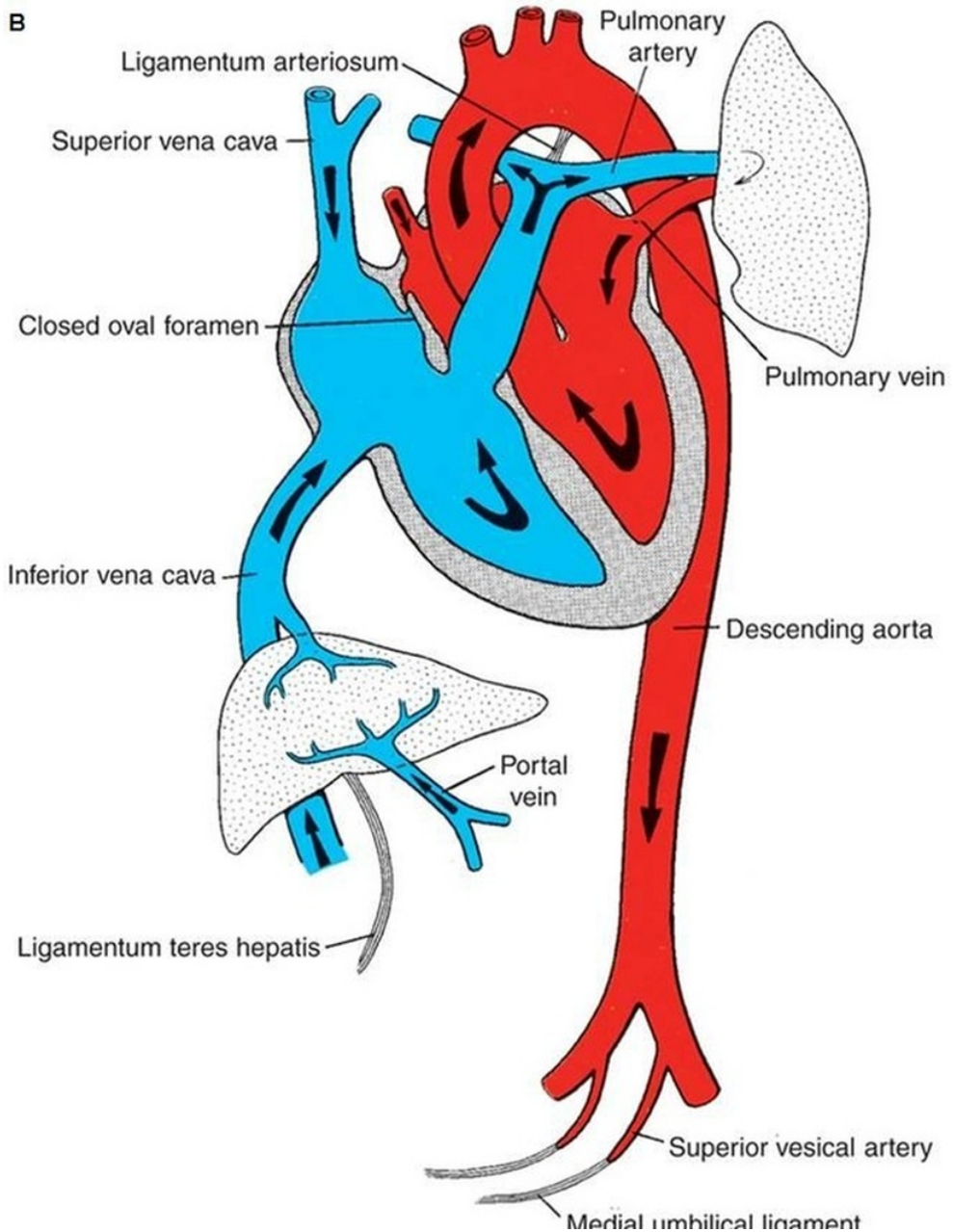
FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

- **Ascending aorta**

- **Organ supplied with Well-Oxygenated blood**
  - **Heart and brain (H&N &UL)–coronary and carotid arteries are the first branches of the AA**
  - **Another shunt and Mixing –Ductus arteriosus**
  - **RA (desaturated blood thru SVC) to RV –to pulmonary trunk thru**
  - **High resistance in pulmonary vessels**
  - **Causes most of the blood passes directly to Descending Aorta via Ductus arteriosus**
  - **Last mixing with blood from proximal aorta**
  - **Finally blood flows toward the fetal body and placenta thru two umbilical arteries (O2 saturation is approx. 58%)**



CIRCULATORY CHANGES AFTR BIRTH



FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

AFTER BIRTH

Ligation of the umbilical cord

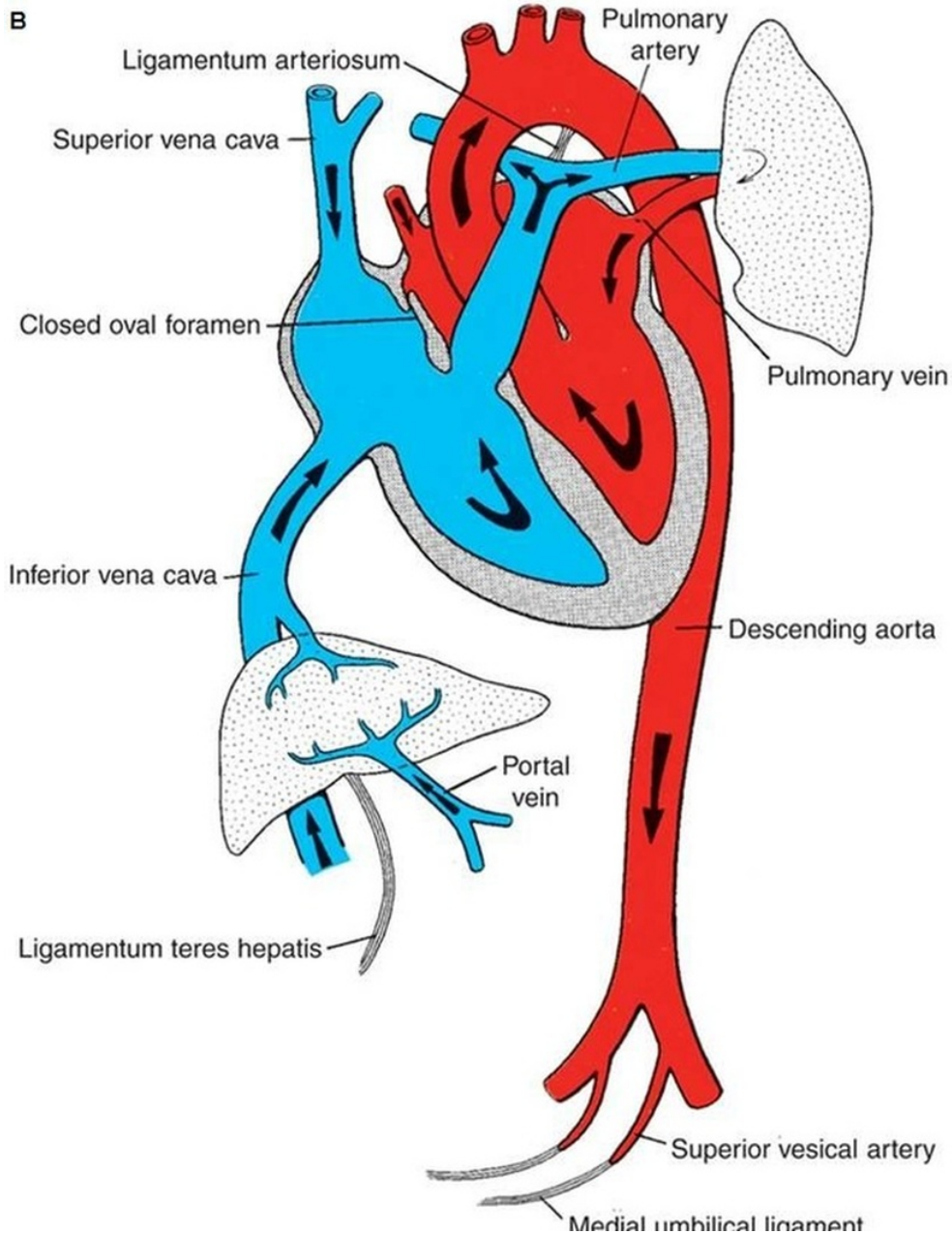
Sudden fall of blood pressure in the IVC and the right Atrium.
The wall of the ductus venosus constricts.

Aeration of the lungs at birth

1- **Marked increase in the pulmonary blood flow.**

2- **Dramatic fall in pulmonary vascular resistance.**

3- **Thinning in the wall of the pulmonary arteries.**



FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

AFTER BIRTH

1. Closure of foramen ovale:

a. Physiological closure

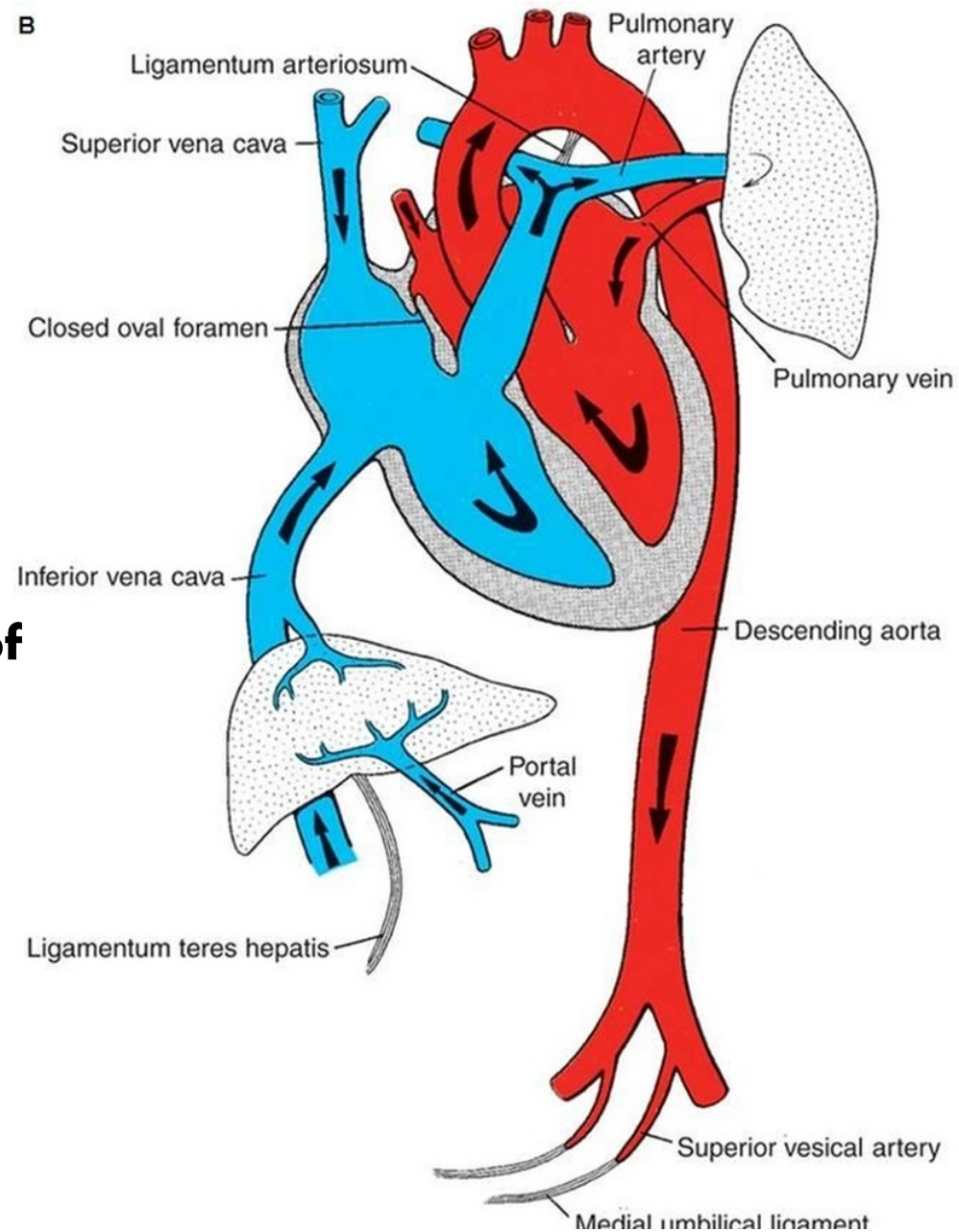
b. Anatomical closure.

2- Constriction of ductus arteriosus:

By the end of the first 24 hours 20% of the lumen of the ductus is closed.

By the end of 48 hours 82% is closed.

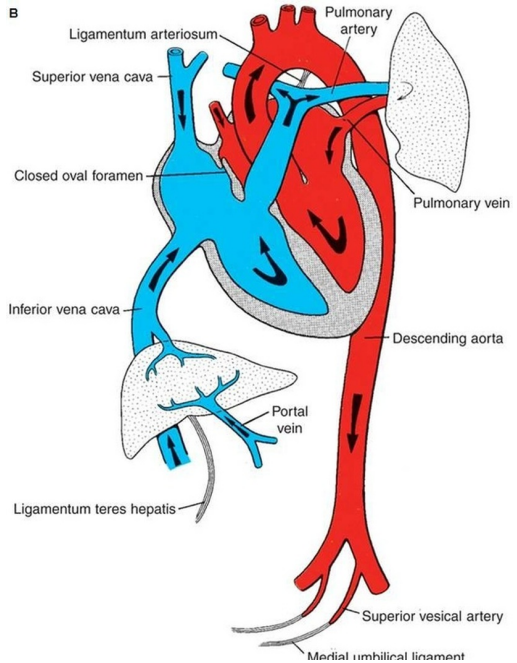
By 96 hours 100% of the duct is closed.



AFTER BIRTH

BRADYKININ:

- released from fetal lungs during their initial inflation.
- has a contractile effect on smooth muscles of the ductus arteriosus.
- action appears to be dependent on the high **Oxygen** saturation of the aortic blood.



When oxygen tension reaches **50** mmHg in the ductus arteriosus it causes constriction of its smooth muscles.

During intrauterine fetal life the patency of ductus arteriosus (before birth) is controlled by the **low** contents of oxygen in the blood passing through it.

So **hypoxia** and other ill-defined factors keep the ductus arteriosus patent.

FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

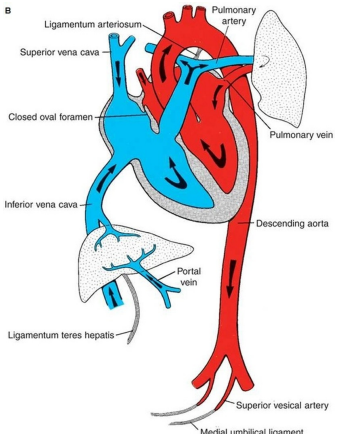
	Functional Closure	Anatomical Closure	Remnant
Umbilical arteries	Few minutes after birth	2-3 month	Medial umbilical ligament(distal part) Superior Vesical arteries (proximal part)
Umbilical veins	Shortly after umbilical arteries		Ligamentum teres hepatis
Ductus Venosus	Shortly after umbilical arteries		Ligamentum venosum
Foramen Ovale	First few breaths / few days	3rd month (KLM) 1 year (langman)	Fossa ovalis In 20% Probe patent foramen ovale
Ductus Arteriosus	Almost immediately after birth	1-3 month	Ligamentum arteriosus
Anomaly			
Patent Ductus Arteriosus [PDA]	Common anomaly 2-3 time more in females		Maternal rubella infection in early pregnancy Premature and born at high altitude

Closure of the umbilical arteries,

- Accomplished by contraction of the smooth musculature in their walls,
- is probably caused by thermal and mechanical stimuli and a change in oxygen tension.

- Functionally, the arteries close a few minutes after birth, although the actual obliteration of the lumen by fibrous proliferation may take 2 to 3 months.

- Distal parts of the umbilical arteries form the medial umbilical ligaments, and
- the proximal portions remain open as the superior vesical arteries.



Closure of the umbilical vein and ductus venosus

- occurs shortly after that of the umbilical arteries. (ALLOWS the blood from the placenta may enter the newborn for some time after birth).

- After obliteration, the umbilical vein forms the ligamentum teres hepatis in the lower margin of the falciform ligament.

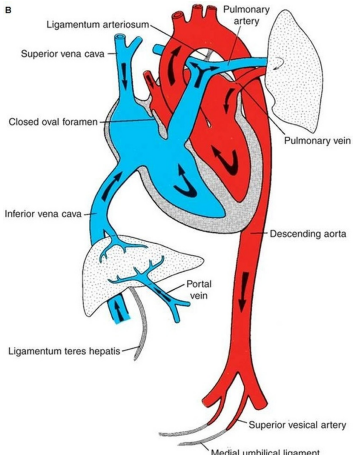
- The ductus venosus, which courses from the ligamentum teres to the inferior vena cava, is also obliterated and forms the ligamentum venosum.

FETAL CIRCULATION AND CIRCULATORY CHANGES AFTR BIRTH

Closure of the ductus arteriosus

- by contraction of its muscular wall occurs almost immediately after birth; it is mediated by bradykinin, a substance released from the lungs during initial inflation.

- Complete anatomical obliteration by proliferation of the intima is thought to take 1 to 3 months. In the adult, the obliterated ductus arteriosus forms the ligamentum arteriosum.



Closure of the oval foramen is caused

- by an increased pressure in the left atrium, combined with
- a decrease in pressure on the right side.

- The first breath presses the septum primum against the septum secundum.

- During the first days of life, however, this closure is reversible. Crying by the baby creates a shunt from right to left, which accounts for cyanotic periods in the newborn.

- Constant apposition gradually leads to fusion of the two septa in about 1 year. In 20% of individuals, however, perfect anatomical closure may never be obtained (probe patent foramen ovale).

Thank You