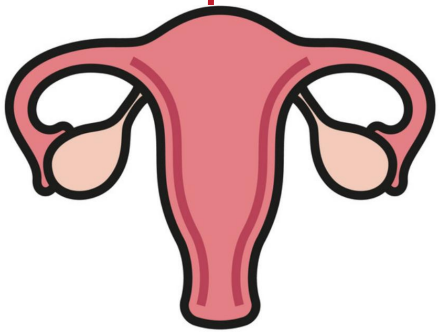

Fetal circulation

Reproductive block-Embryology-Lecture 6

Editing file
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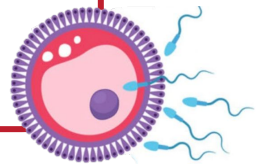

Color index:

Girls' slides	Boys' slides
Main content	Extra
Important	Drs' notes

MED439

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Revised & Approved
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MED438

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Reviewed by Razan AlRabah & Ibrahim Alshaikh

Objectives

At the end of the lecture, students should be able to:

- **Identify the nothing again because there is no objective here**

Part 3
So I decided to turn this into a series “The Diaries of a Dying Man”, pretty dramatic isn’t it? This is the 3rd entry into this series, for those of you who care enough to read the previous two, you’ll have to search for it, but I’ll give you a hint, check pharma and micro teams, which lecs you ask? I won’t say, it’ll ruin the fun.

God who am I even talking to? It’s not like there are any survivors left, and even if there are, I doubt they’ll be this carefree that they’ll read this nonsense. But I need to do this, it’s the only thing keeping me sane.

Today is the 20th of April, 2020. I believe that it’s Monday, but I wouldn’t know for sure. The number of cases is at 2.4 million, Yes, you read that right, million.
I can’t even remember the last time I heard a human voice other than mine, I’ve been hearing voices all day but I’m certain they’re in my head, at least I hope so.
Tbh I’d expect anything these days, my house being possessed wouldn’t be a surprise.
No no that’s not possible, I must be hallucinating. Anyway, thankfully my food supply will last me for a few more months, so that’s not an issue. But I can’t help but worry, who knows how long this will last? I might need to go searching for food in a few months, but for now I can’t be stressed about that or else I’ll really lose my mind.

I hope this end soon, I miss my friends.
-A Terrified Man

Fetal circulation

Fetal Cardiovascular system is designed for two purposes :

1. To serve prenatal needs.
2. To permit modifications at birth, which establish the neonatal circulation.

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

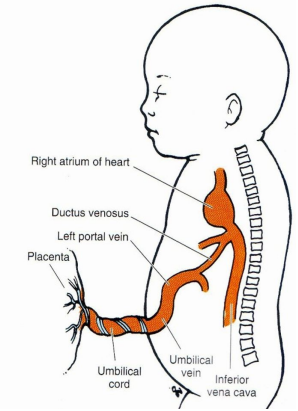
Three structures are very important in the transitional circulation:

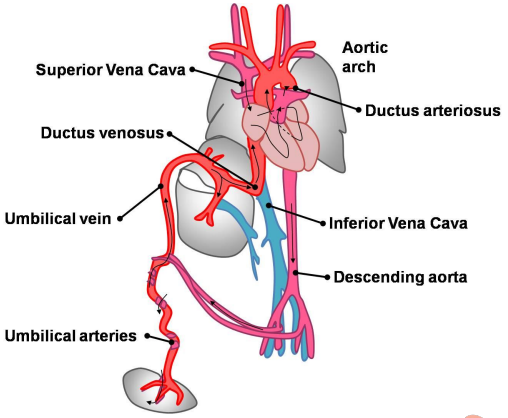
1. Ductus venosus.(duct between 2 veins, umbilical vein and IVC)
2. Ductus arteriosus.(duct between 2 arteries, between pulmonary artery and the aortic artery)
3. Foramen ovale.(opening in the heart between R & L atrium)

(before birth)

Blood reaches & leave the fetus through the umbilical cord which is contains :

1. Two arteries
2. One vein.





Steps Of Fetal Circulation

All of these events happen before birth

1

- 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 first to liver sinusoids then to the IVC.

2

Blood of the IVC which is highly oxygenated reaches the right atrium, then directly to the left atrium through the foramen ovale.

3

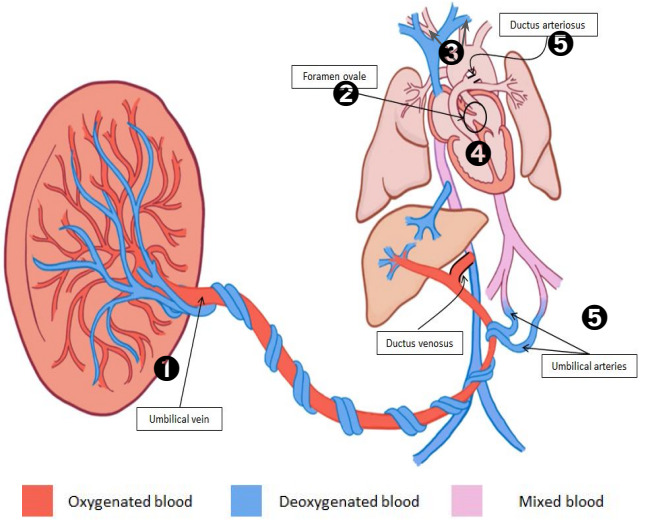
Then to the left ventricle to the ascending aorta , and the aortic arch to supply the head and neck , brain , heart (cardiac muscle) & upper limbs so they receive highly oxygenated blood.

4

Small amount of highly oxygenated blood that remains in right atrium mixes with venous blood of the SVC passes to right ventricle .

5

Then to pulmonary artery then to ductus arteriosus (between the pulmonary trunk, pulmonary & proximal part of descending aorta / between the left Pulmonary artery & arch of the aorta) , to the descending aorta , to the lower half of the fetal body .Then back to placenta via the **umbilical arteries**

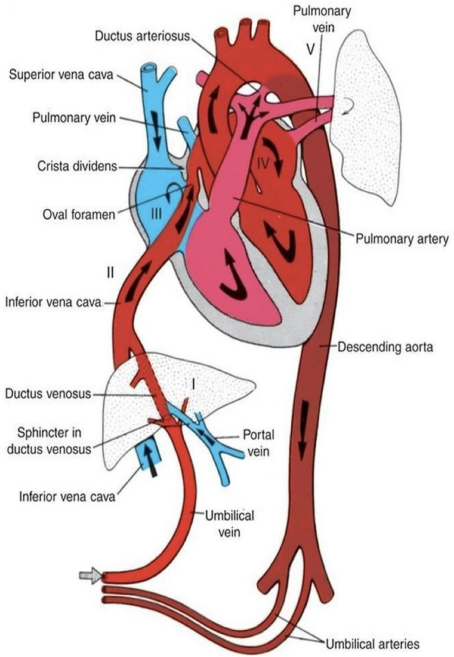


Fetal circulation before birth

Oxygenated blood mixes with deoxygenated blood:

- In the liver
- In the inferior vena cava
- In the right atrium
- In the left atrium
- At the entrance of the ductus arteriosus into the descending aorta.

(In the figure at the right, The arrows point to the direction of blood flow).
Blood from the placenta (80% saturated with O_2) → through umbilical vein → return to fetus



01 At Liver

- Most of the blood enter The Ductus Venosus (DV) (bypass the liver) and 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 than anatomical
- Close to the entrance of the umbilical vein
- Regulates flow of umbilical blood through the liver sinusoids
- Closes during uterine contraction (venous return is too high)
- To prevent the overloading of the heart

Fetal circulation before birth

02 At Inferior Vena Cava

- A short course.
- Mixing of placental blood with deoxygenated blood from LL,abd and pelvis.

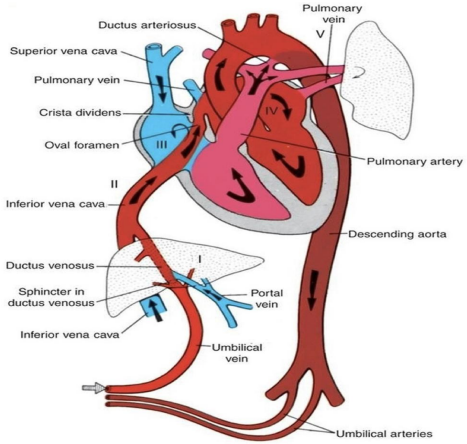
03 Right Atrium (RA)

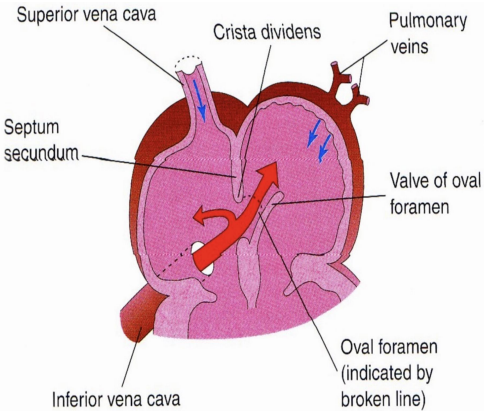
- Guided towards the foramen oval (by the valve of IVC).
- Most of the blood passes directly to the left atrium.
- Small amount fails and remains in the RA (because of the crista dividends - lower edge of septum secundum).
- Another mixing with deoxygenated blood through SVC.

04 Left Atrium (LA)

- Another mixing with small amount of desaturated blood returning from the lungs.

05 Left Ventricle

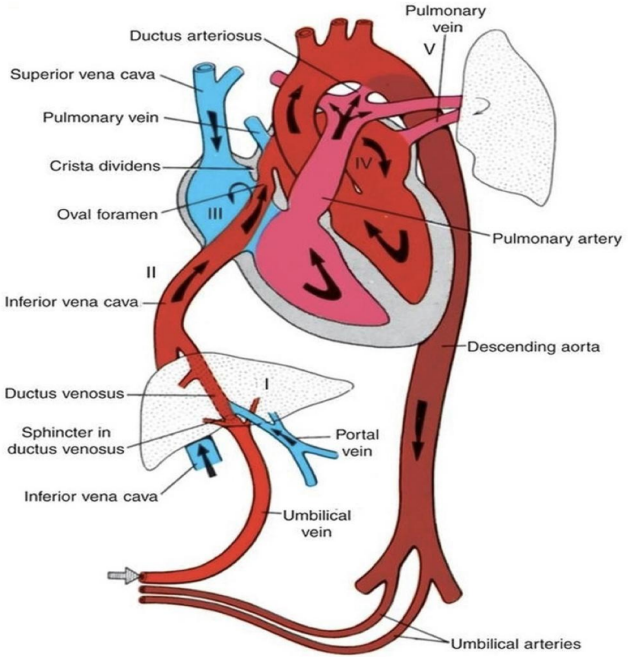




Fetal circulation before birth

06 Ascending Aorta (AA)

- Organ supplied with well-oxygenated blood.
- heart and brain (H&N &UL)- Coronary and carotid arteries are the first branches of AA
- Another shunt and mixing - Ductus Arteriosus
- RA (desaturated blood through SVC) to RV to pulmonary trunk through high resistance in pulmonary vessels, which causes most of the blood to pass directly to descending aorta via ductus arteriosus
- Last mixing with blood from proximal aorta
- Finally blood flows towards the fetal body and placenta through two umbilical arteries (O_2 saturation is approximately 58%)



Circulatory changes after Birth

01 ligation of the umbilical cord

- Sudden fall of blood pressure in the IVC and the right atrium. so, The valve/wall of the ductus venosus constricts.

02 Aeration of the lungs at birth

- Marked increases in the pulmonary blood flow.
- Dramatic fall in pulmonary vascular resistance .
- Thinning in the wall of the pulmonary arteries .

03 Closure of foramen ovale

- physiological closure , (immediately) due to decrease of pressure in the right atrium while increase in left atrium forces the septum primum against the septum secundum
- Anatomical closure ,(12 weeks\3 months) due to proliferation of the epithelium in both septums

04 Constriction of ductus arteriosus

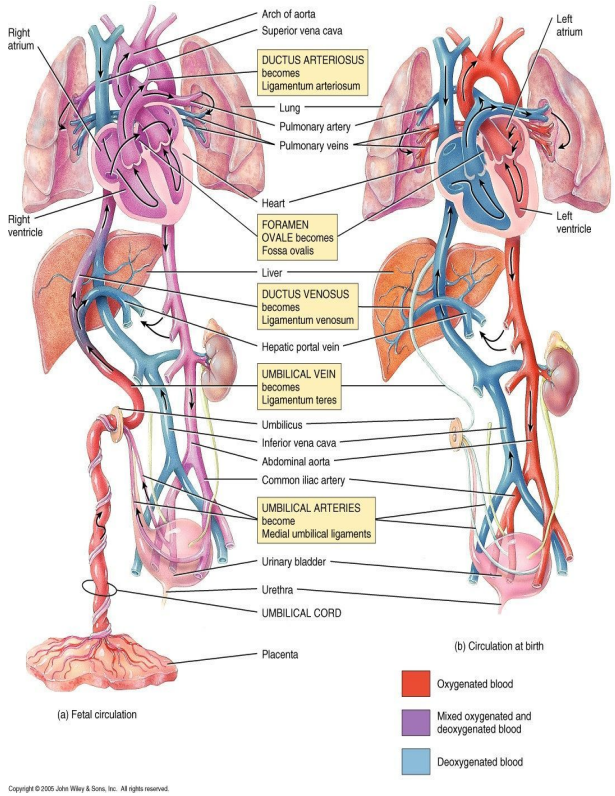
- By the end of the first 24 hours 20% of the lumen of the ductus is closed .
- By the end of 48 hours 82% is closed .
- By 96 hours 100% of the duct is closed .

- there is a substance released from fetal lungs during their initial inflation called **Bradykinin**.
- This substance has a contractile effect on smooth muscles of the ductus arteriosus.
- The action of this substance appears to be dependant 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.

High O2=high bradykinin =high contraction

Adult derivatives of fetal structures

	Functional Closure*	Anatomical Closure*	Remnant / adult derivatives of fetal vascular structures
Umbilical Arteries	Few minutes after birth	2-3 months	- 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 months	Ligamentum Arteriosus
Anomaly*			
Patent Ductus Arteriosus	Common anomaly (2-3 times more in females)		- Maternal rubella infection in early pregnancy. - Premature and born at high altitude.



* : boys slides only

Adult derivatives of fetal structures

1

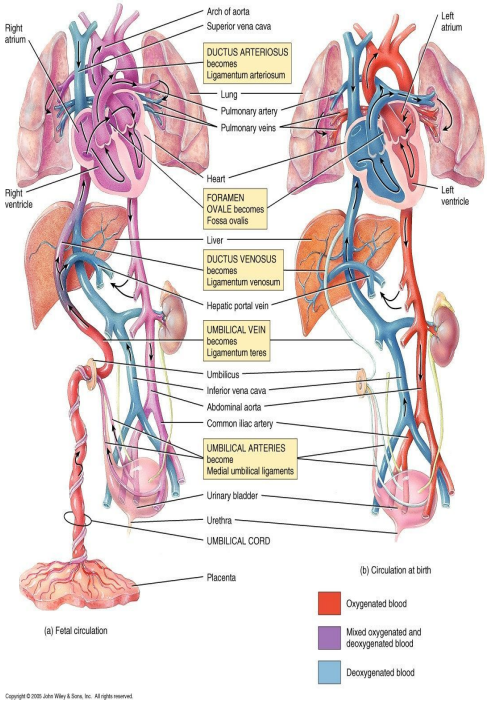
Closure of the Umbilical Arteries:

- 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 **2-3 months**.
- The distal part of the umbilical arteries form the Medial Umbilical Ligament.
- The proximal portion remain open as the Superior Vesical arteries.

2

Closure of the Umbilical Vein and Ductus Venosus:

- Occurs shortly after that of the Umbilical arteries (ALLOWS the blood from the placenta to enter the newborn for some time after birth).
- After obliteration, the Umbilical Vein form 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.

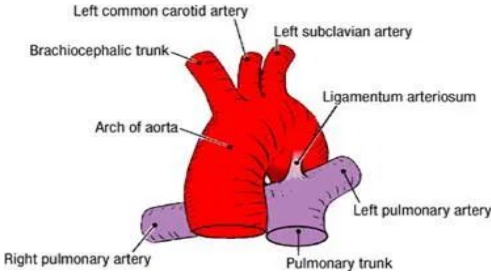


Adult derivatives of fetal structures

3

Closure of the Ductus Arteriosus:

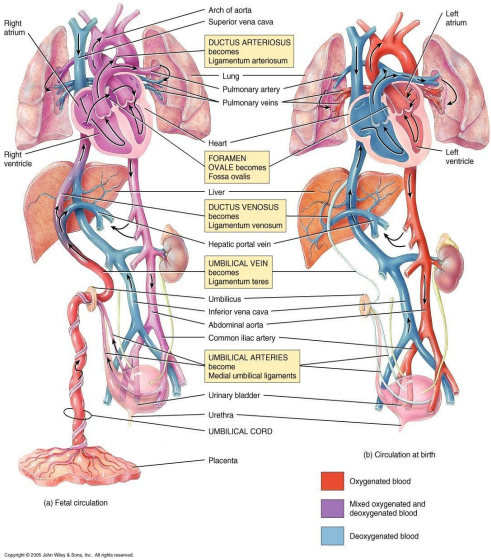
- By contraction of its muscular wall occurs almost immediately after birth: it is mediated by **bradykinin**, a substance released from the lungs during initial inflation.
- Complete anatomical obliteration by proliferation of the intima is thought to take 1-3 months. in the adult, obliterated Ductus Arteriosus forms the **Ligamentum Arteriosum.**



4

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)



QUIZ

Answers: [Q1:B] [Q2:C] [Q3:B] [Q4:B] [Q5:C] [Q6:D] [Q7:A] [Q8:B]

Q1: The umbilical cord contains :

A. Two veins & two arteries.

B. Two arteries & one vein.

C. One vein & one artery.

D. Two veins & one artery.

Q2: The ductus arteriosus will close completely after :

A. 69 hour.

B. 94 hour.

C.96 hour.

D.64 hour.

Q3: Half of blood passes from the placenta reaches the IVC directly through the :

A. Ductus arteriosus.

B. Ductus venosus .

C. Liver sinusoids .

D. Foramen ovale .

Q4: After ligation of the umbilical cord there is sudden fall of blood pressure in :

A. SVC & left atrium .

B. IVC & right atrium.

C. SVC & right atrium .

D. IVC & left atrium .

Q5: In Adult derivatives of fetal Umbilical arteries is:

A. Ligamentum venosum.

B. Ligamentum arteriosum.

C.medial umbilical ligaments.

D. Ligamentum teres .

Q6: In Adult derivatives of fetal Umbilical vein is:

A. Ligamentum venosum.

B. Ligamentum arteriosum.

C.medial umbilical ligaments.

D. Ligamentum teres .

Q7: In Adult derivatives of fetal Ductus venosus is :

A. Ligamentum venosum.

B. Ligamentum arteriosum.

C.medial umbilical ligaments.

D. Ligamentum teres .

Q8: In Adult derivatives of fetal Ductus arteriosus is :

A. Ligamentum venosum.

B. Ligamentum arteriosum.

C.medial umbilical ligaments.

D. Ligamentum teres .

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