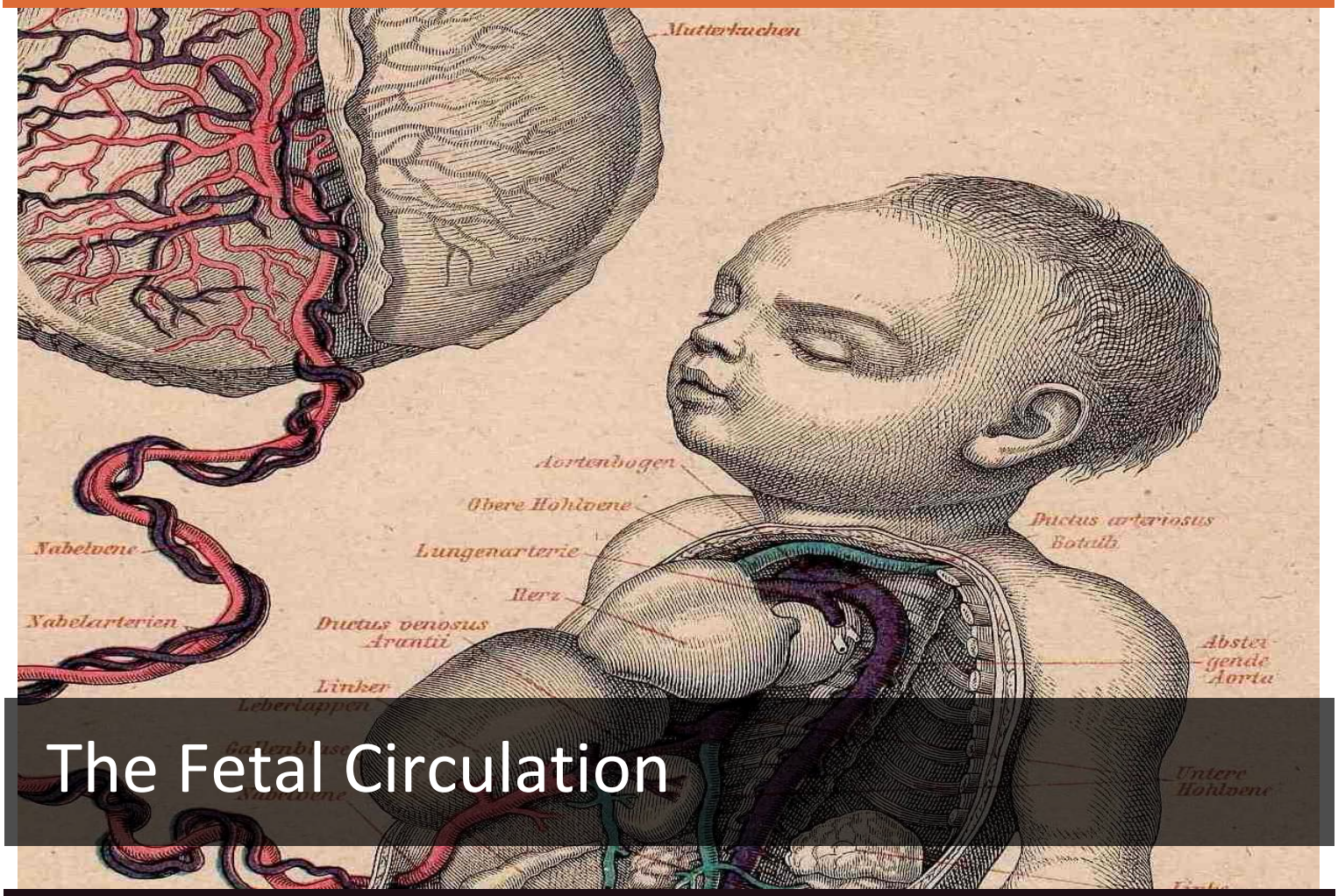

The Fetal Circulation

429 OB/GYN Team

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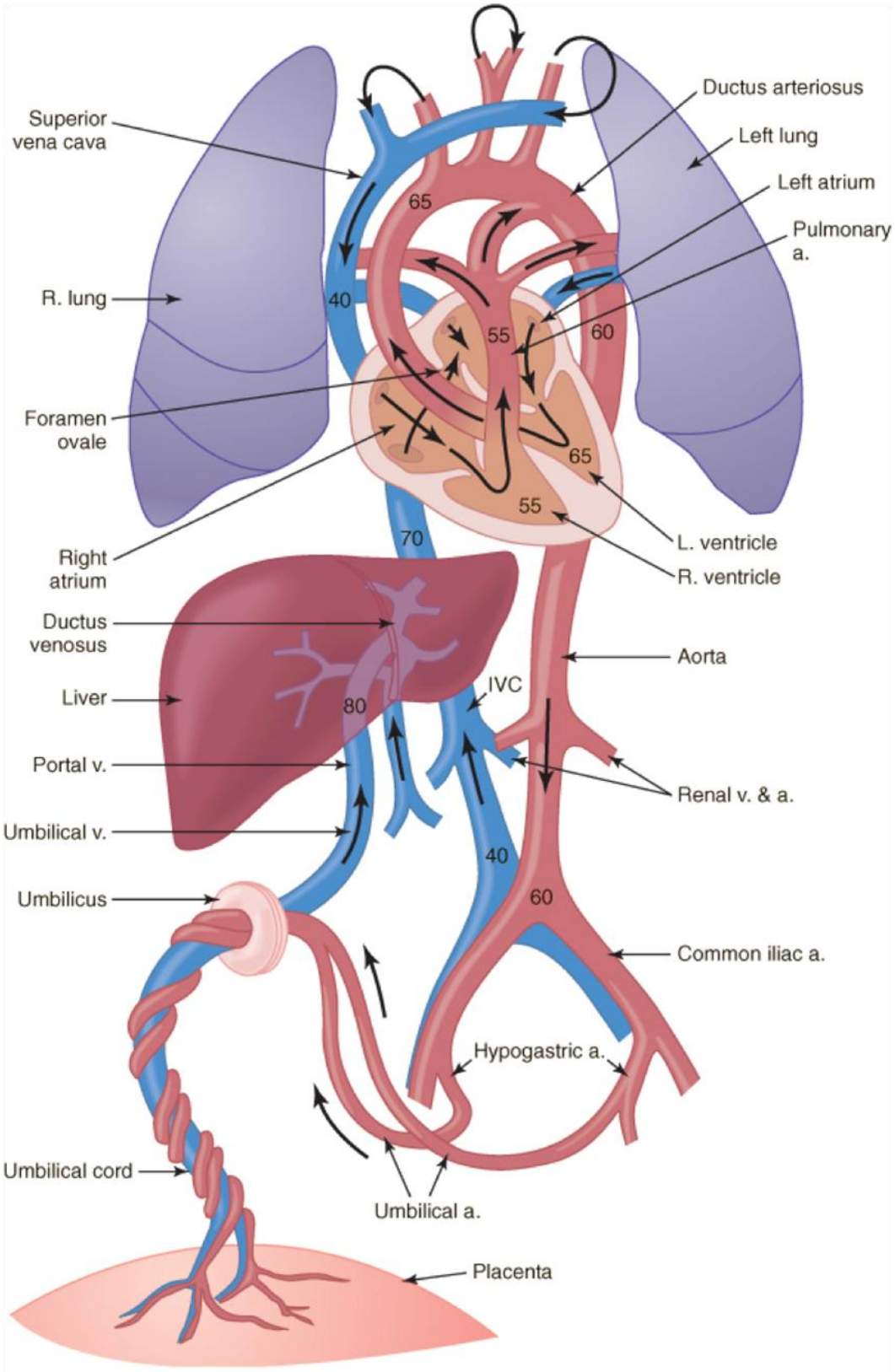
Sources: Lecture, Essentials of Obstetrics & Gynecology 4th Ed by Hacker and Moore, Textbook of Medical Physiology 11th Ed by Guyton & Hall, the Developing Human 8th Ed by Keith L. Moore

Questions: http://ask.fm/TeamNotes429

THE NORMAL FETAL CIRCULATION



ADULT VS FETAL CIRCULATION

- Adult circulation is a series circuit (blood flows through right heart → lungs → left heart → systemic circulation → right heart)
- Fetal circulation is a parallel system. How?
  - Cardiac outputs from right & left ventricles are directed to **different** parts
    - Right heart to: pulmonary artery (small fraction), ductus arteriosus & descending aorta (to lower body)
    - Left heart supply blood to tissues supplied by the aortic arch e.g. the brain and upper body
  - It is characterized by **channels** (ductus venosus, foramen ovale and ductus arteriosus) that function to **maximize** the delivery of **highly oxygenated** blood to the upper body and **BRAIN**, **less highly oxygenated** blood to **LOWER BODY**, and **very low blood flow** to the non-functional **LUNGS**
  - **Components:**

Fetal Structure	From/To	Remnant
Umbilical vein	Umbilicus/ductus venosus	Ligamentum teres
Ductus venosus	Umbilical vein/IVC (bypasses liver)	Ligamentum venosum
Foramen ovale	Right atrium/left atrium	Closed (wall)
Ductus arteriosus	Pulmonary artery/descending aorta	Ligamentum arteriosum
Umbilical artery	Common iliac arteries/umbilicus	Superior vesical arteries; lateral vesicoumbilical ligaments

FETAL CIRCULATION

- Placenta → **Umbilical vein** (**SaO2 = 80%**) → portal system
  - A portion passes through hepatic microcirculation → hepatic veins → Inferior vena cava
  - The majority bypasses the liver through the ductus venosus → directly into inferior vena cava
- In the inferior vena cava (**SaO2 = 70%**)
  - Blood coming through ductus venosus mixes with blood coming from lower body (**SaO2 = 25%**)
- Inferior vena cava → Right atrium
  - 2/3 blood mix with blood coming through superior vena cava (**SaO2= 25%**)
  - 1/3 blood crosses to left atrium through foramen ovale

        - In left atrium: mixes w/poor pulmonary venous return
        - Then passes to left ventricle to **ASCENDING** aorta
- Left ventricle → proximal aorta (**SaO2 = 65%**) → branches to brain & upper body
- Right ventricle (**SaO2 = 55%**) → pulmonary trunk → ductus arteriosus → descending aorta (**SaO2 = 60%**) → lower body
- Descending aorta
    - Major portion of flow goes to → <branches of hypogastric of common iliac> **umbilical arteries** (**deoxygenated blood**) → placenta

ROLE OF FORAMEN OVALE

- Creates a right-to-left shunt → oxygenated blood passes to left atrium & left ventricle → pumped to upper body & brain
- It is a defect in the atrial wall that opens because of the *higher pressure in the right heart*
- Why is the pressure higher in the right heart?
    - The presence of the placenta decreases the **systemic vascular resistance** →↓ the pressure the **left heart** has to pump against
    - The **lungs** are non-functional & collapsed → pulmonary vascular resistance is very high → **Right atrial & right ventricular** pressures are high

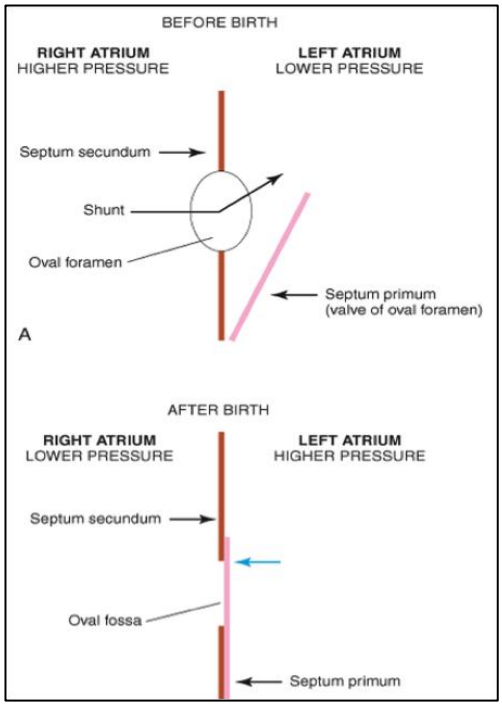
ROLE OF DUCTUS ARTERIOSUS

- It allows right ventricular output to bypass the lungs
- It is important that the ductus arteriosus opens **DISTAL** to aortic arch branches. Why?
    - To prevent the less saturated blood coming from the RV from mixing with blood going to the brain and upper body
    - So, it maintains the high oxygen saturation (65%) present in the proximal aorta

CHANGES AFTER BIRTH (POST-NATAL CIRCULATION)

1. Elimination of the placental circulation
2. Dilatation of the pulmonary vessels and establishment of the pulmonary circulation
3. Closure of the ductus venosus

4. Closure of the **foramen ovale**
    a. Changes in pulmonary pressure → ↓ right atrial press. + ↑ left atrial press. → blood going through foramen ovale now tries to reverse the flow → the valve that lies over the foramen on the left side closes over this opening → no further flow

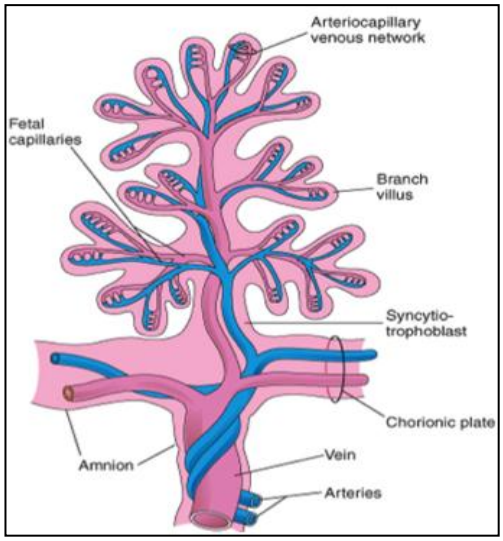


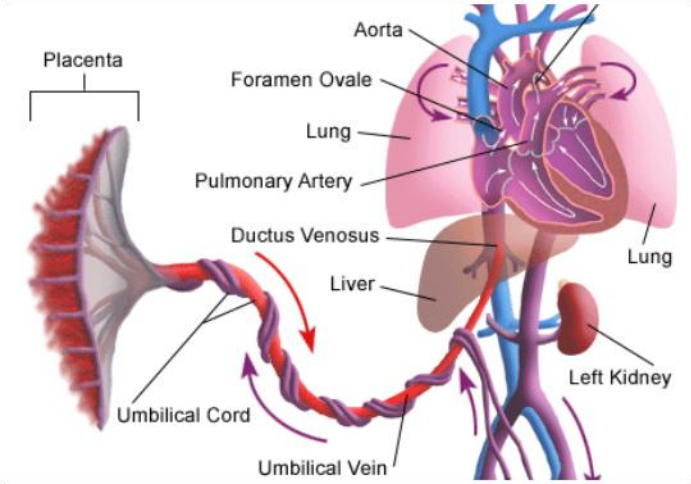
5. Gradual constriction & eventual obliteration of the **ductus arteriosus**
    a. Immediately after birth, hypoxia causes the infant to breathe and expand the lungs → pressure drops and resistance to blood flow decreases
    b. Blood flow from aorta to placenta stops → ↑ systemic resistance → pressure ↑ in aorta
    c. As a result, forward blood flow through ductus arteriosus (from pulm. Trunk to aorta) stops → high oxygen conc. In aortic blood → muscles of ductus constrict until they close completely
    d. Withdrawal of maternal prostaglandins from the infant's circulation also contributes to closure

The closure of vascular shunts will change the circuitry from "in parallel" to "in series".

SUMMARY

- ☑ Fetal circulation is totally different from adult circulation.
- ☑ All materials required for fetal growth and maturation is delivered through the placenta
- ☑ There are two umbilical arteries and one umbilical vain
- ☑ The highly oxygenated blood will come from the chorionic villi
- ☑ It will pass into thin-walled veins that follow the chorionic arteries to the site of attachment of the umbilical cord.
- ☑ They converge here to form the **umbilical vein. This large vessel carries oxygen-rich blood to the fetus.**





Fetal circulation

places where the oxygenated blood will mix with deoxygenated blood

1- in the liver

2- IVC

3-RA (it contain blood coming from SVC)

4- LA (contain blood coming from the pulmonary vein)

5- Aorta

Thank you