

Patent Ductus Arteriosus

Case #13

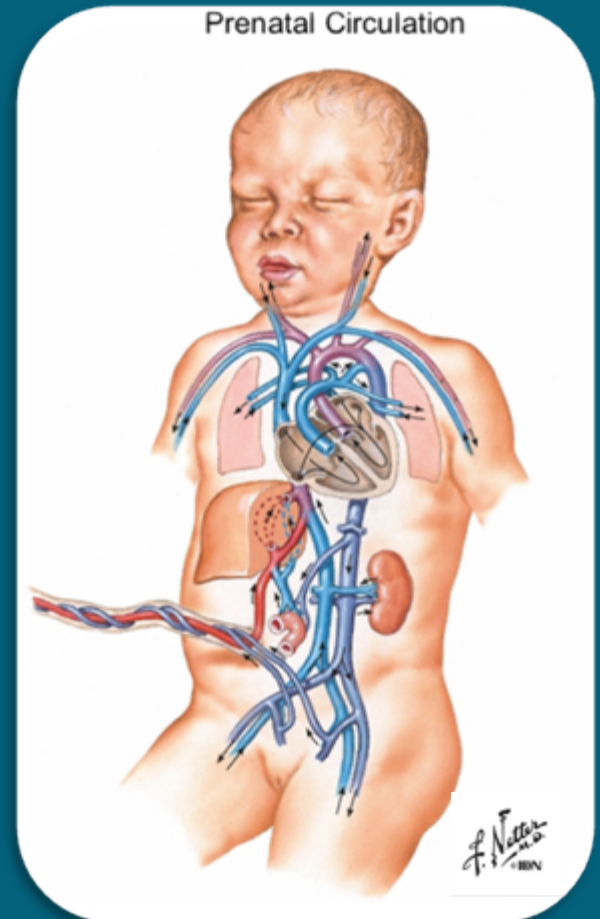
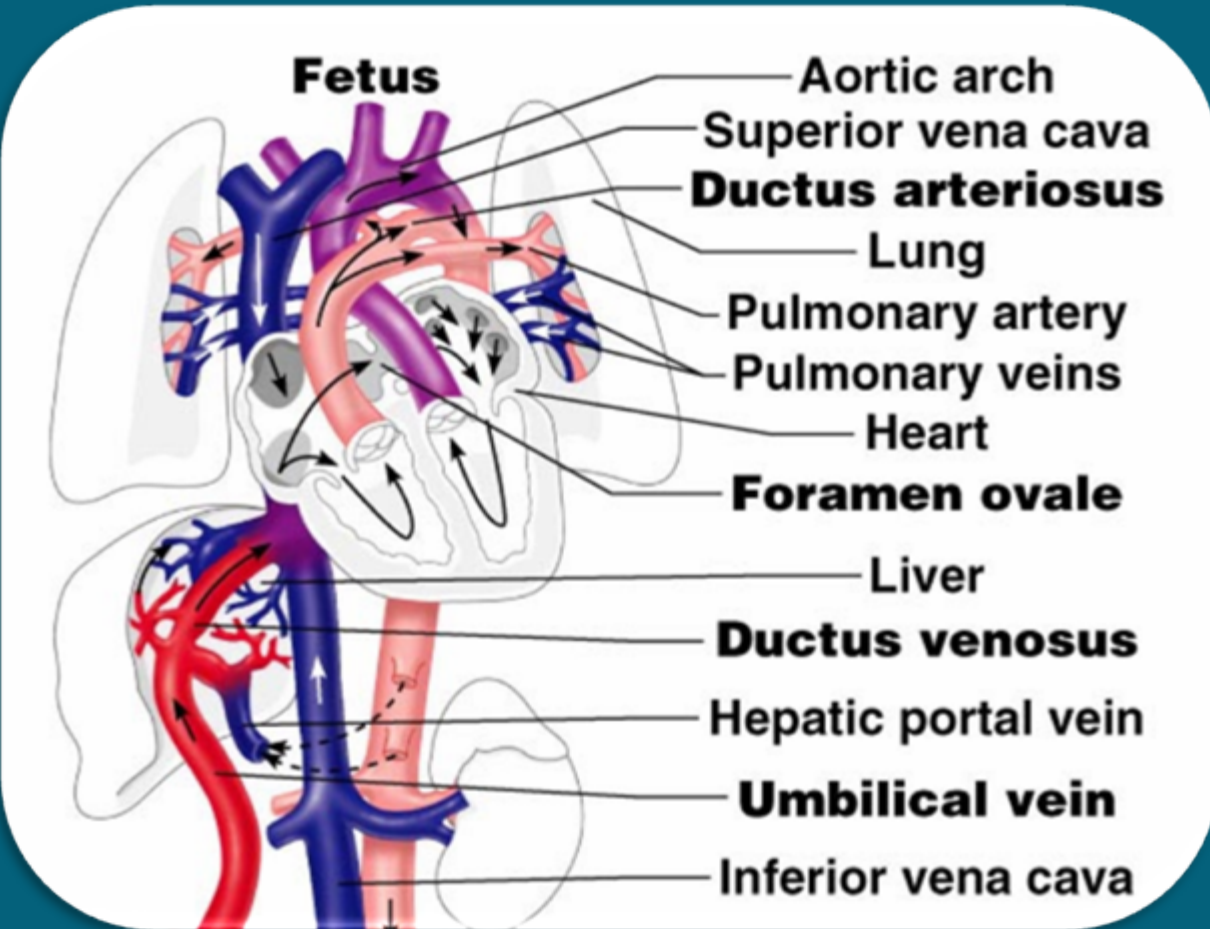
By: Ruth Medcalf

September 25, 2008

Ductus Arteriosus

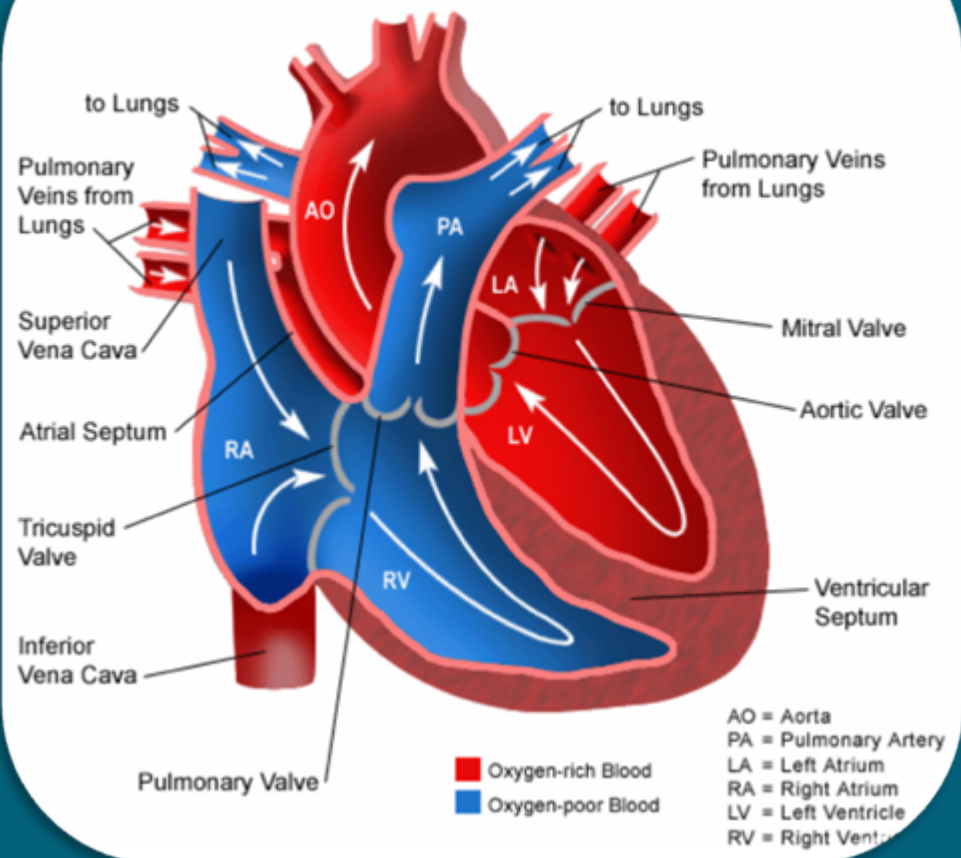
- ✧ During fetal life, the **ductus arteriosus** is a normal vessel connecting the pulmonary artery with the aorta.
 - ✧ Essential because it allows blood to bypass circulation to the lungs
 - ✧ Contributes 60% of total cardiac output throughout fetal life
 - ✧ Maintained by prostaglandins
- ✧ After birth, the ductus arteriosus closes and forms the ligamentum arteriosum
 - ✧ Blood oxygen changes
 - ✧ Drop in prostaglandin (vasodilator) release
 - ✧ Increase in endothelin (vasoconstrictor) release

Prenatal Circulation

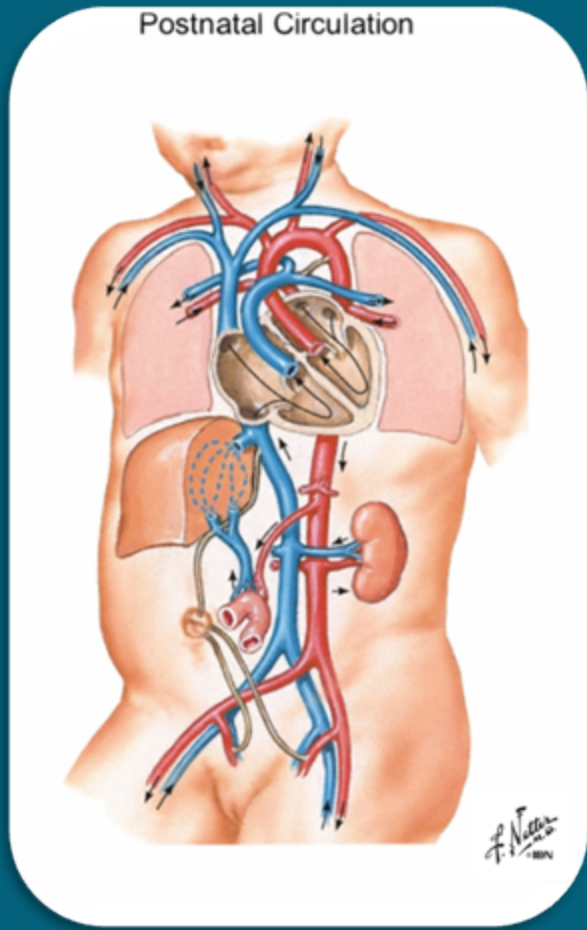


Postnatal Circulation

Normal Heart

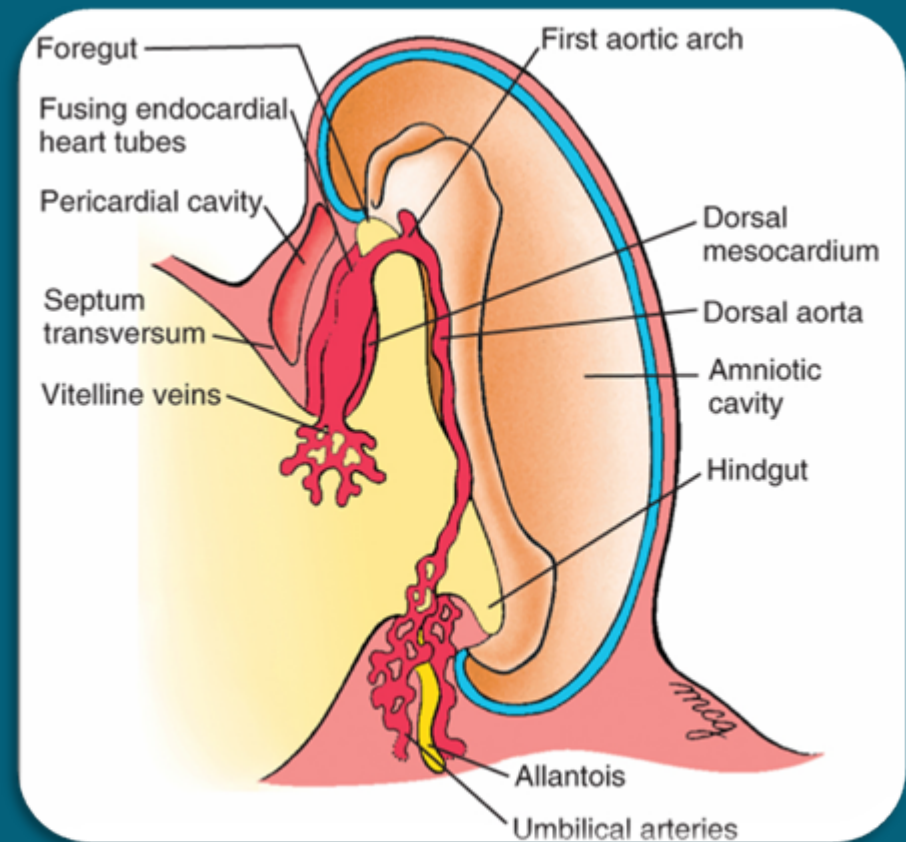


Postnatal Circulation



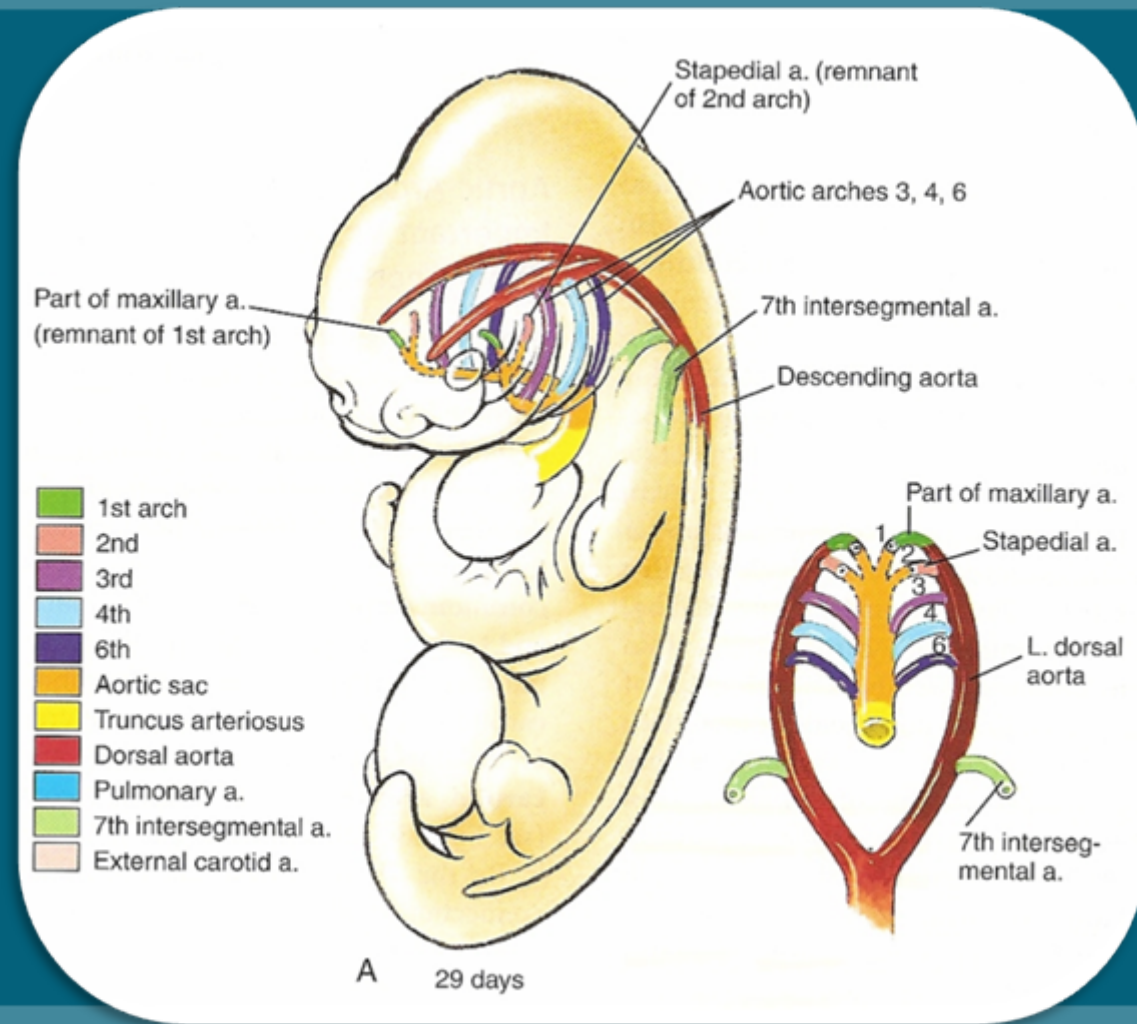
Formation of First Aortic Arch

- ☀ 1st aortic arch and dorsal aorta formed during the 3rd week
- ☀ Paired dorsal aortae develop on either side of notochord and connect to the fusing endocardial heart tubes
- ☀ Head fold pulls cranial ends of dorsal aortae ventrally to form the first aortic arch
- ☀ Four more arches will develop during the 4th and 5th weeks

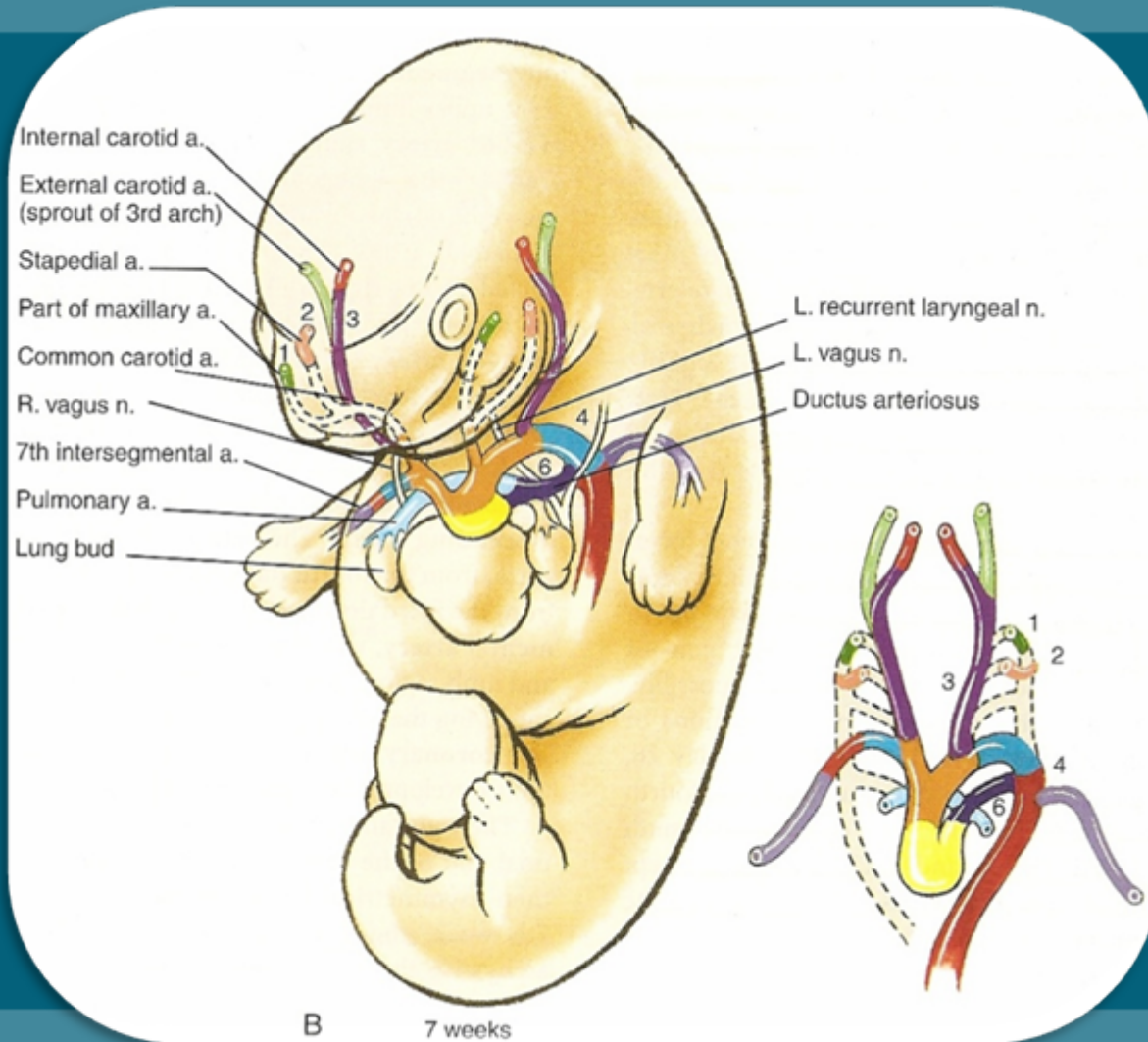


Development of Aortic System

- ☀ Five pairs of aortic arches: 1, 2, 3, 4, 6
- ☀ 1st arch complete by day 24
- ☀ 2nd arch forms on day 26 as 1st arch regresses
- ☀ 3rd and 4th arches form on day 28
- ☀ 6th arch forms on day 29 as 2nd arch degenerates



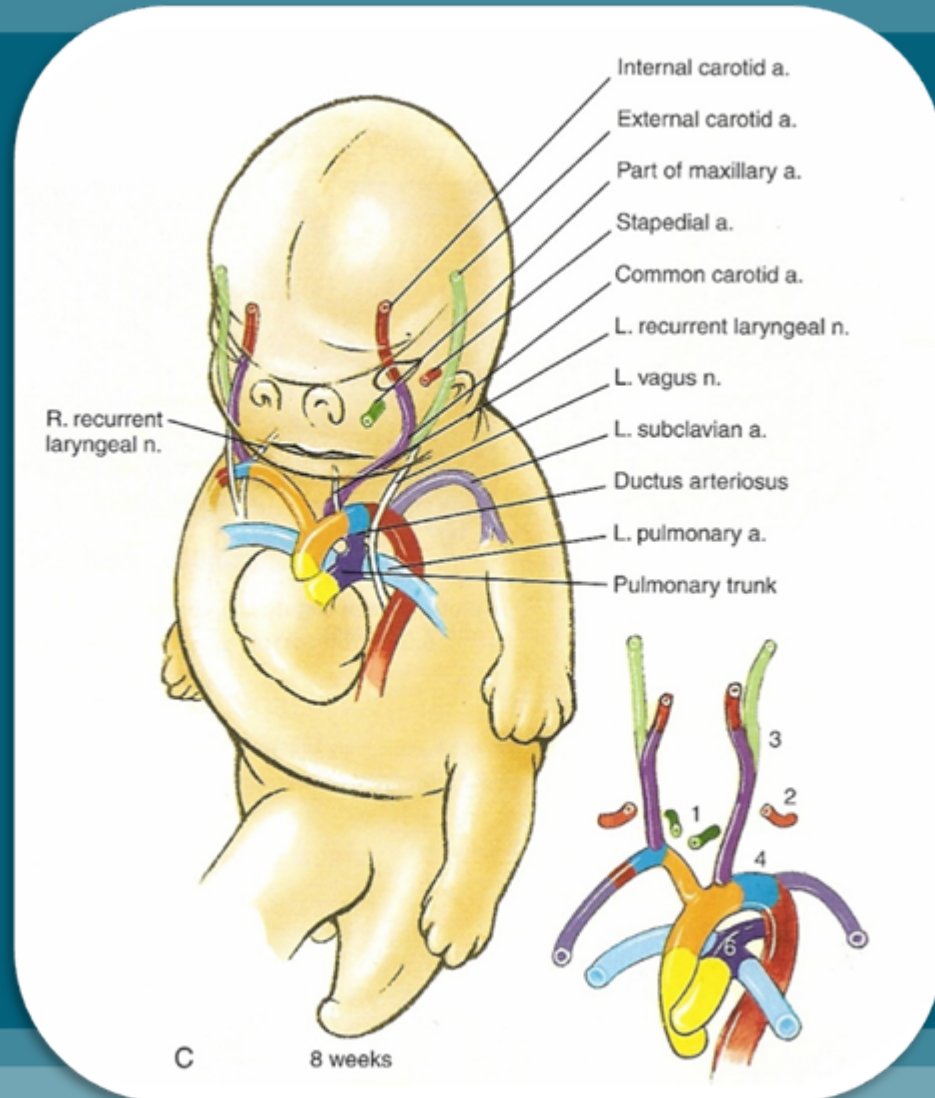
Development of Aortic System



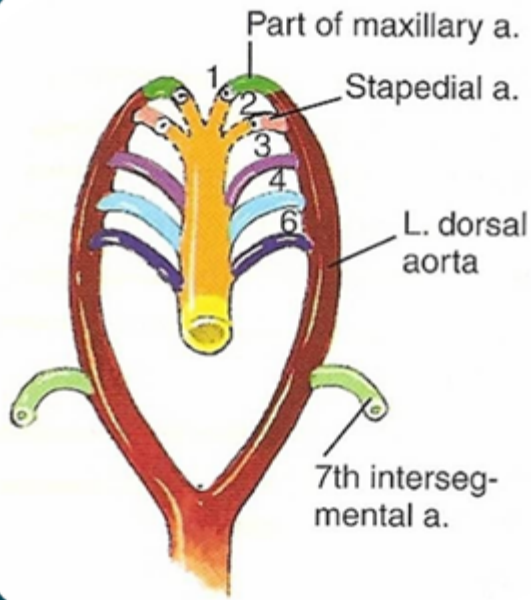
- ☼ Arteries arising from the 1st three pairs of aortic arches are bilateral
- ☼ Vessels derived from arches 4 & 6 develop asymmetrically

Fate of Aortic Arches

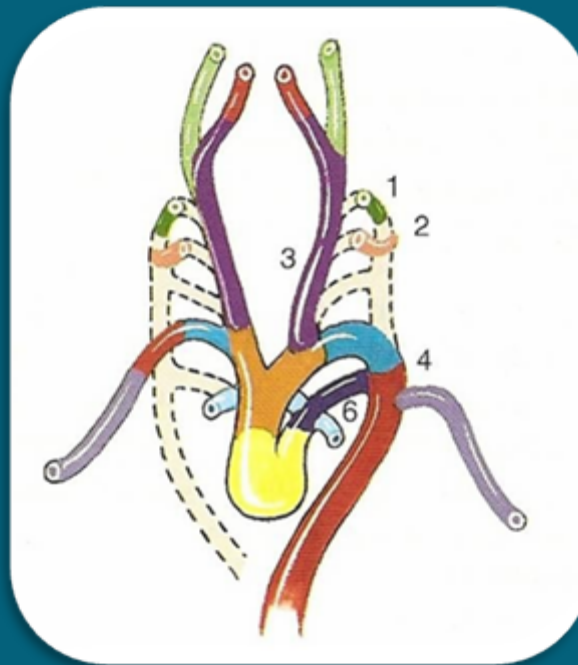
- ☀ Ductus arteriosus derived from the 6th aortic arch
- ☀ Asymmetric development of recurrent laryngeal branches of vagus nerve
- ☀ Left recurrent laryngeal nerve loops under ductus arteriosus
- ☀ Right recurrent laryngeal nerve loops under the right subclavian artery



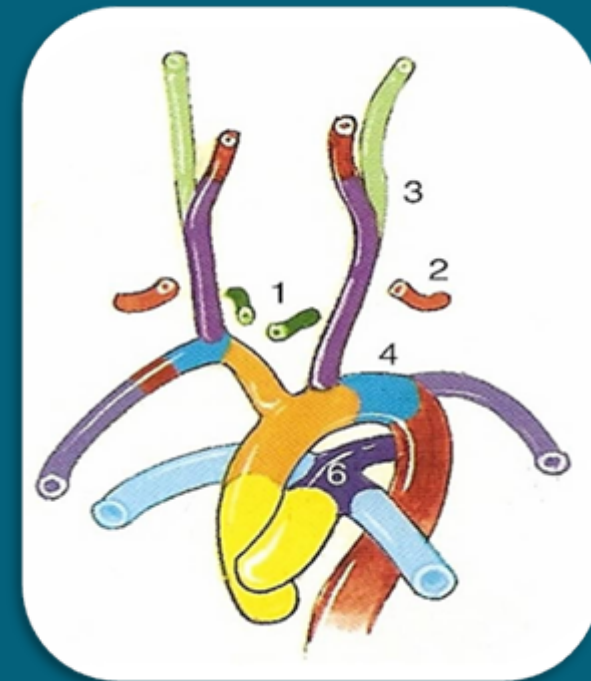
Development of Aortic System



Day 29



7 Weeks



8 Weeks

Case Study—History & Symptoms

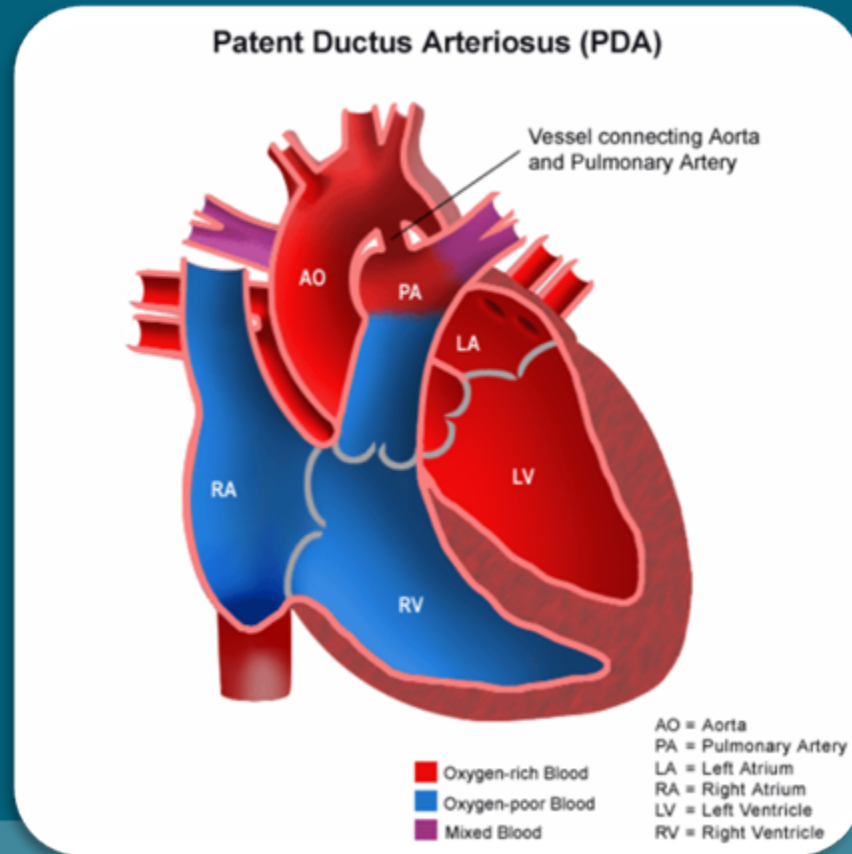
- ☼ 18 month old female
- ☼ Acyanotic (absence of cyanosis)
- ☼ Height and weight are below average
- ☼ Mental development normal
- ☼ Heart murmur detected during recent treatment for pneumonia
- ☼ “machinery” heart murmur
 - ☼ Accentuated during systole
 - ☼ Heard in the second intercostal space, left of the sternum
- ☼ Thrill is present over the precordium
- ☼ The mother had rubella in the first few months of pregnancy

Methods of Diagnosis

- ⚙ **Physical examination**
- ⚙ **electrocardiogram** - a test that records the electrical activity of the heart, shows abnormal rhythms and, detects heart muscle damage.
- ⚙ **x-ray** - a diagnostic test which uses invisible electromagnetic energy beams to produce images of internal tissues, bones, and organs onto film.
- ⚙ **echocardiogram** - a noninvasive test that uses sound waves to produce a study of the motion of the heart's chambers and valves.
- ⚙ **cardiac catheterization (when other heart defects are suspected)** - a test in which a small catheter (hollow tube) is guided through a vein or artery into the heart to help see any defects on x-ray.

Case Study—Diagnosis

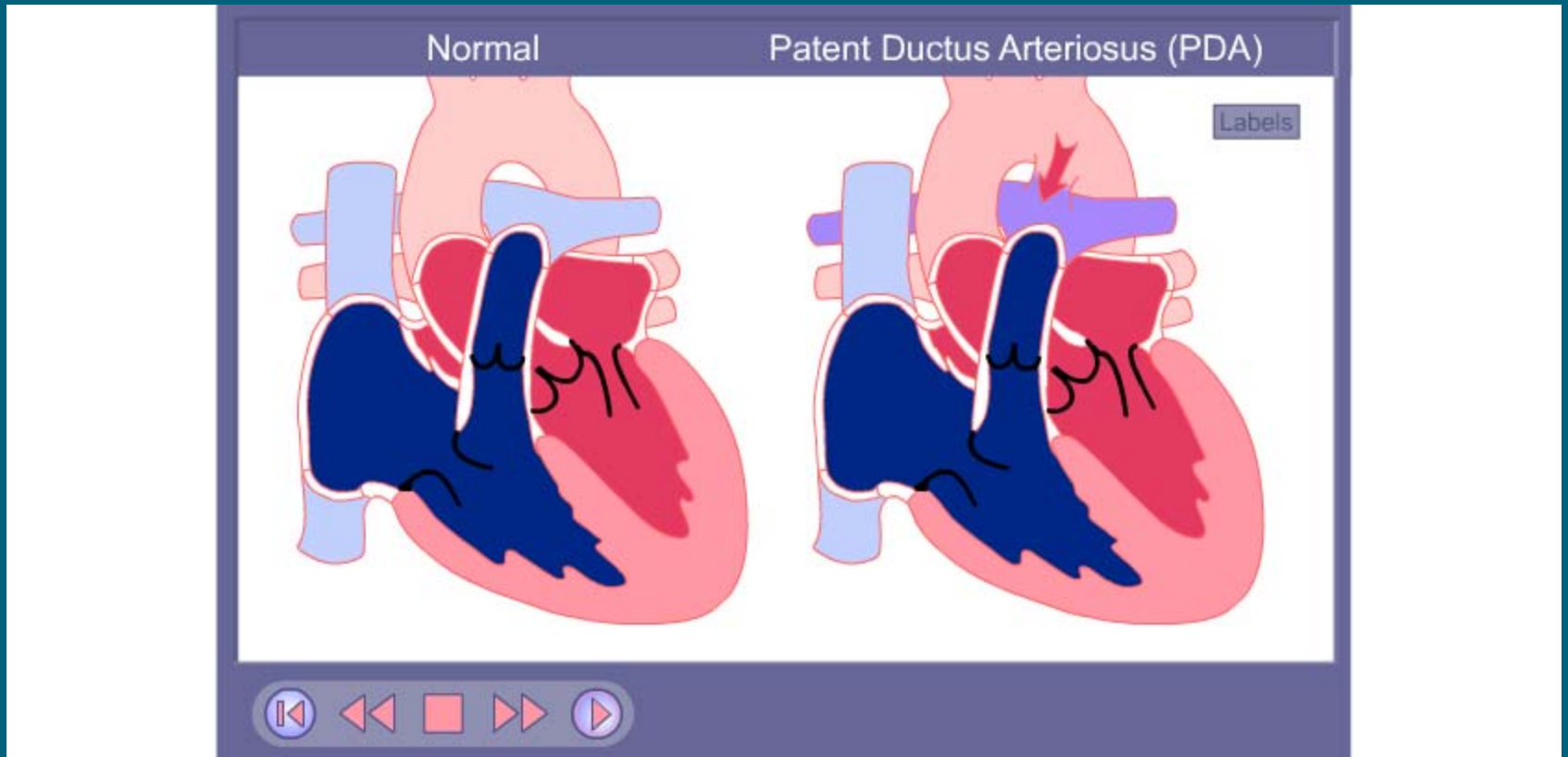
Medium-sized Patent Ductus Arteriosus (PDA)



Patent Ductus Arteriosus

- ☼ Patent ductus arteriosus is a condition in which the connecting blood vessel between the pulmonary artery and the aorta in fetal circulation, called the ductus arteriosus, stays open in a newborn baby.
- ☼ Left to Right shunt from the aorta to the pulmonary artery.
 - ☼ $\frac{1}{2}$ to $\frac{1}{3}$ of blood traveling in the aorta will enter pulmonary artery
 - ☼ Blood is circulated 2-3 times for every one time it enters systemic circulation
- ☼ Left ventricle experiences hypertrophy because of increased workload
- ☼ Increased blood flow to lungs increases pulmonary pressure, which increases pressure in the right ventricle, which can ultimately lead to congestive heart failure.
- ☼ Abnormal blood flow increases risk of bacterial endocarditis

Patent Ductus Arteriosus



Statistics on PDA

- ☀ Incidence of Patent Ductus Arteriosus (PDA): 1 in every 2,000 births
- ☀ PDA accounts for 10% of all congenital heart disease.
- ☀ If isolated PDA is untreated, 30% of the infants will die.
 - ☀ Cause of death will usually be Congestive Heart Failure
- ☀ Various sizes of ducts, ranging from lengths of 2-8 mm and diameters of 4-12 mm.
- ☀ Occurs to females more frequently (2 female:1 male)

Causes/Risk Factors

- ☼ Premature birth: 75% of infants of 28-30 weeks gestation have PDA.
- ☼ Genetics
- ☼ More common in children whose mothers developed rubella during the first trimester of pregnancy.
- ☼ High altitude and low atmospheric oxygen tension (hypoxic conditions) have been associated with persistence of the PDA.
- ☼ Neonatal respiratory distress syndrome
- ☼ Associated with other congenital defects: hypoplastic left heart syndrome, transposition of the great vessels, and pulmonary stenosis
- ☼ Can lead to endocarditis

Treatment Guidelines

- ⊗ Treatment varies on the size of the PDA.
 - ⊗ Some PDA are small and not detected
- ⊗ PDA should be closed immediately in a child if:
 - ⊗ there is congestive heart failure which does not respond to medical treatment
 - ⊗ there is increasing pulmonary vascular resistance
- ⊗ PDA should be closed electively between the ages of 2-4 if the patient is asymptomatic.

Treatment Options

⚙ Medications

- ⚙ Doctors use nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen or indomethacin

⚙ Surgery

- ⚙ Cardiac catheterization: through the catheter a plug or coil may be deployed to close the ductus arteriosus.
- ⚙ Standard surgical approach
 - ⚙ Posterolateral incision was made into the 3rd or 4th fourth interspace, with the mediastinum separated between the phrenic and vagus nerves
 - ⚙ The vagus nerve was retracted to expose the recurrent laryngeal nerve where it passes behind the ductus
 - ⚙ Ductus closed with metal clamp
 - ⚙ The thoracic wall was then resealed

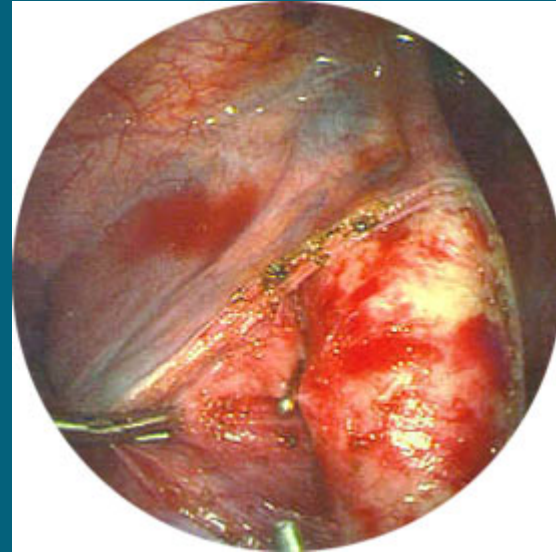
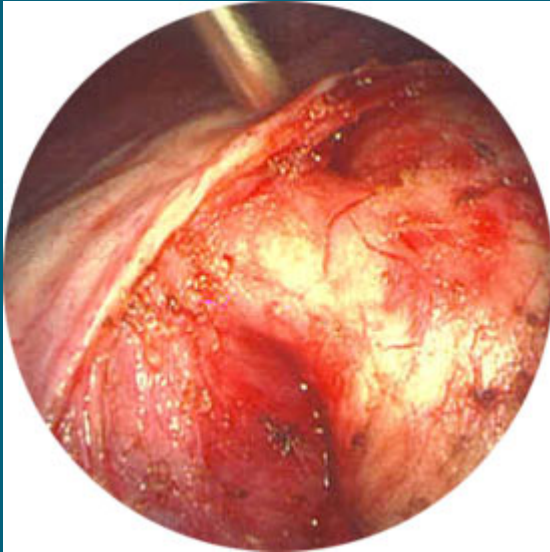
Surgery



Surgery



Surgery



Results

- ☀ The patient's recovery went smoothly.
- ☀ Ten days after the surgery, she was found to have:
 - ☀ No precordial thrill and murmur
 - ☀ Her X-rays showed a decrease in heart volume and lung vascularity
- ☀ This indicates that the patient's duct has been sealed and that she is on her way to recovering.

Benefits?

- ⚙ Some babies have heart defects that require the patent ductus arteriosus to remain open for them to survive.
- ⚙ **Pulmonary atresia** (an underdeveloped or blocked pulmonary valve) PDA is the only way to supply an adequate source of blood flow to the lungs so that oxygen can be delivered to the blood. In these patients, the ductus arteriosus supplies blood to the lungs from the aorta.
- ⚙ **Underdeveloped or severely narrowed aorta** (like that seen in hypoplastic left heart syndrome), the PDA is crucial to allow adequate blood flow to the body. In these patients, the ductus arteriosus supplies blood to the body from the pulmonary artery.
- ⚙ In these cases, the pt can be treated with an infusion of prostaglandins to keep the duct open

The Bottom Line

- ✧ PDA is a condition in which the connecting blood vessel between the pulmonary artery and the aorta in fetal circulation, called the ductus arteriosus, stays open in a newborn baby.
- ✧ Left to Right shunt from the aorta to the pulmonary artery.
 - ✧ $\frac{1}{2}$ to $\frac{1}{3}$ of blood traveling in the aorta will enter pulmonary artery
 - ✧ Blood is circulated 2-3 times for every one time it enters systemic circulation
- ✧ Left ventricle experiences hypertrophy because of increased workload
- ✧ Increased blood flow to lungs increases pulmonary pressure, which increases pressure in the right ventricle, which can ultimately lead to congestive heart failure.
- ✧ Abnormal blood flow increases risk of bacterial endocarditis
- ✧ Treatments include medication (NSAIDs) or surgery

References

- ⚙ <http://www.mayoclinic.com/health/patent-ductus-arteriosus/DS00631>
 - ⚙ <http://www.mayoclinic.com/print/patent-ductus-arteriosus/DS00631/METHOD=print&DSECTION=all>
- ⚙ <http://www.cincinnatichildrens.org/health/heart-encyclopedia/anomalies/pda.htm#beneficial>
- ⚙ <http://pediatricheartsurgery.com/chd4.asp>
- ⚙ <http://www.emedicine.com/emerg/topic358.htm>
- ⚙ <http://www.nlm.nih.gov/medlineplus/ency/article/001560.htm>
- ⚙ <http://www.medindia.com/Patients/patientinfo/Patent-Ductus-Arteriosus.htm>
- ⚙ <http://www.indiana.edu/~anat550/cvanim/fetcirc/fetcirc.html>
- ⚙ [http://www.embryology.ch/anglais/pcardio/patholcardio03.html#HerzfehlermitLinksRechtsShunt\(zyanotisch\)](http://www.embryology.ch/anglais/pcardio/patholcardio03.html#HerzfehlermitLinksRechtsShunt(zyanotisch))
- ⚙ Schoenwolf et al: Larsen's Human Embryology, 4th Edition. Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc.