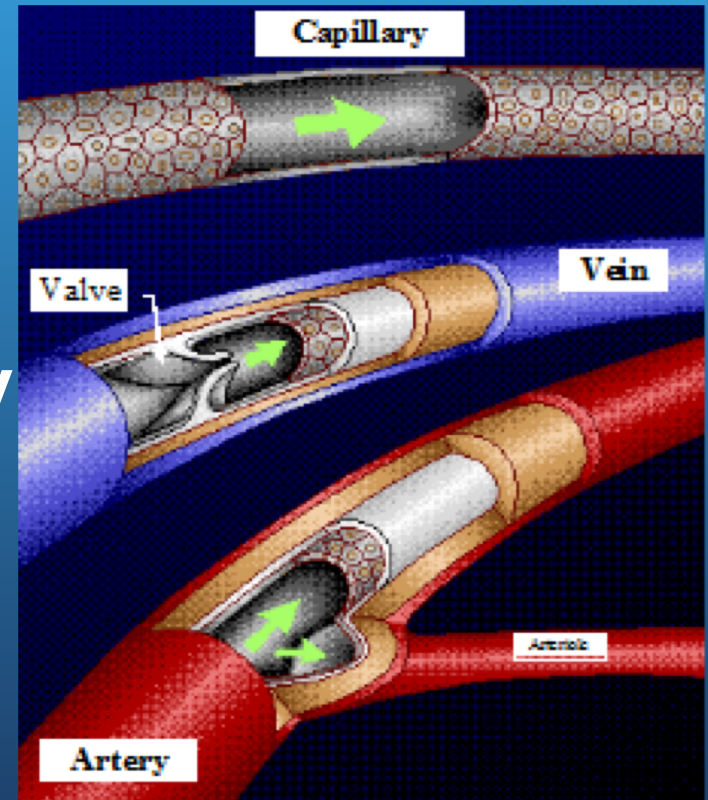


The Circulatory System!

A. Functions of the Circulatory system:

1. Bring **nutrients** to the cells.
2. Take **wastes** away from the cells.

[Ted Ed: Oxygen's Journey](#)



Five Types of Blood Vessels

I. Arteries and arterioles

A. Carry blood **away** from the **heart** to the **tissues**.

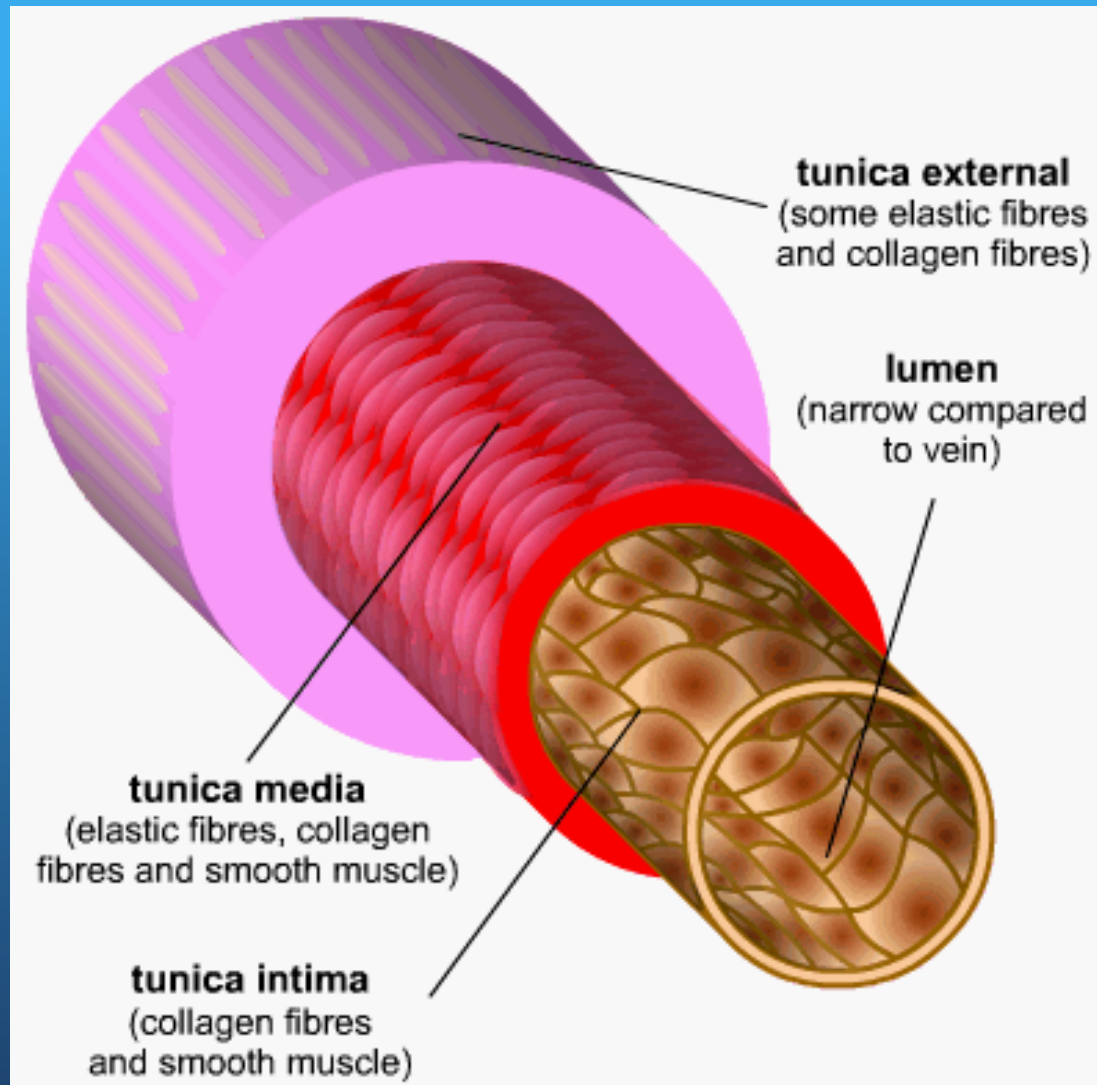
B. **Arteries**

1. **Large**, carry blood **away** from the **heart**.

2. Thick **elastic** walls to allow for it to stretch.

3. Surrounded by **smooth** muscle to control the diameter of the artery.

Artery Structure



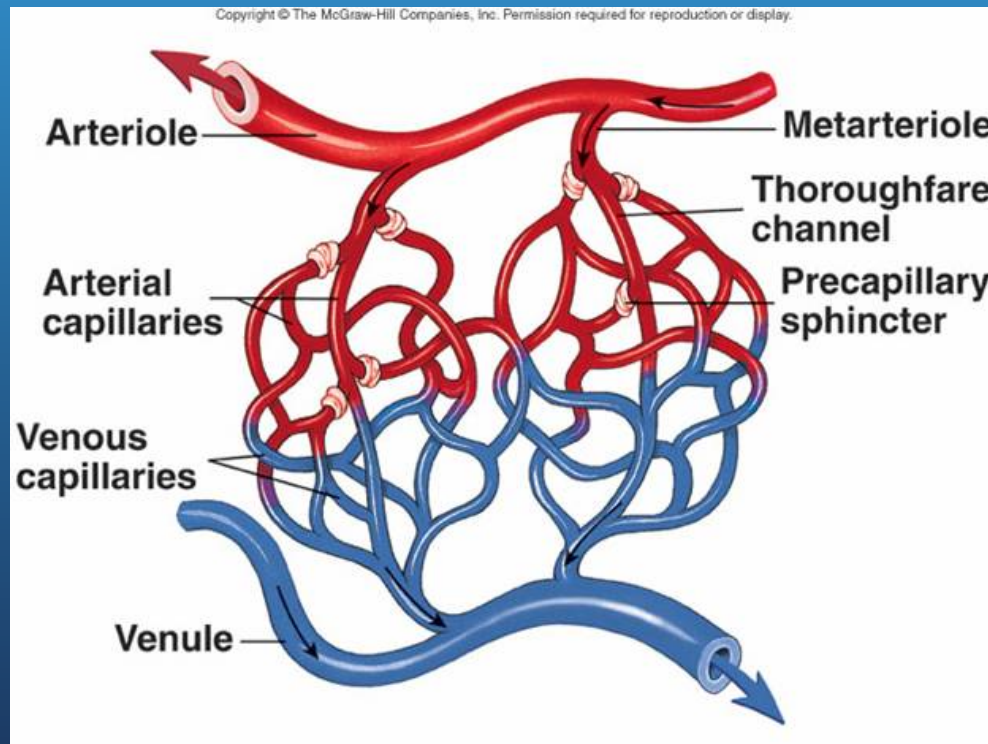
[ANIMATION](#)

C. Arterioles

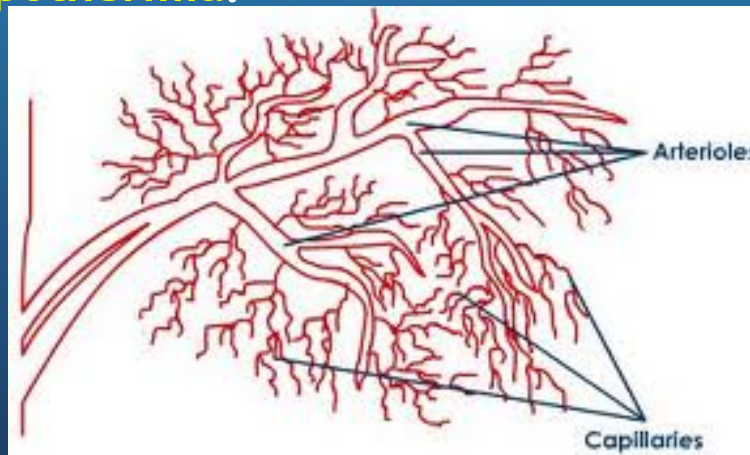
1. Arteries branch into **arterioles**.
2. About **0.2 mm** in diameter or smaller.
3. Mostly **smooth** muscle to allow for more control of the arteriole.

II. Capillaries

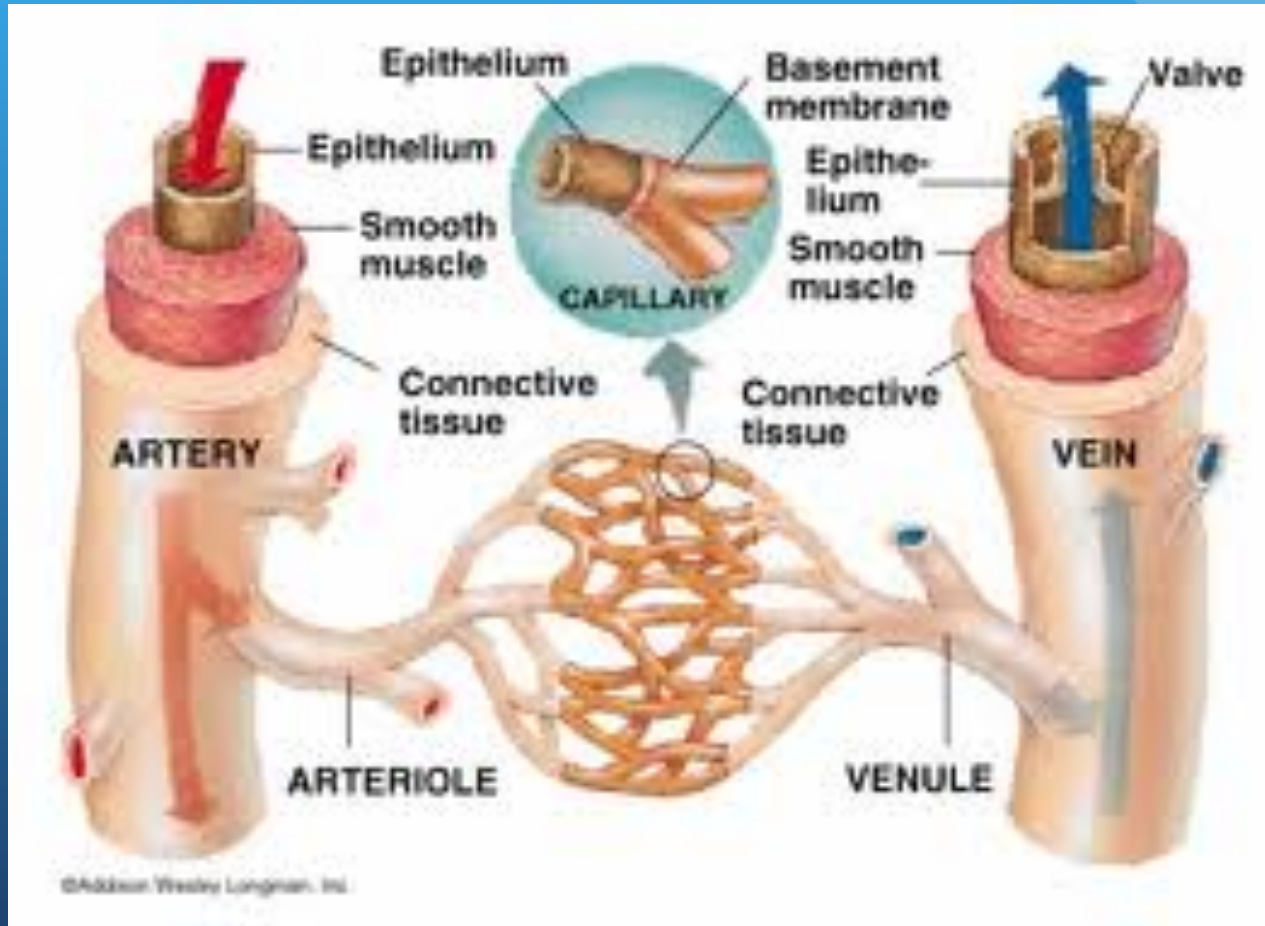
A. Capillaries connect the **arterioles** to **venules**, and exchange material with the **tissues**.



1. **Arterioles** branch into small vessels called **capillaries**.
2. Capillaries are very narrow, **microscopic** tubes.
3. The walls of these tubes are **one** cell layer thick.
4. **Gases** and **small** molecules like **glucose** exchange across the walls of the capillaries.
5. In a capillary bed some, many, or most of these **sphincter** muscles may be closed off so that **less** or **more** blood flows to that area, as needed
 - a. e.g. more blood to **muscles** when they are **working**.
 - b. e.g. less blood flow to the surface of the **skin** during **hypothermia**.



III. Veins and venules



Veins and Venules

A. Carry blood **from** the **tissues** to the **heart**

B. **Veins**

1. Walls are **thinner** than arterial walls.
2. Veins have **valves** which allow blood to flow only toward the **heart** when they are open and prevent the backward flow of blood when they are closed.
3. Act as a **blood reservoir**.

C. **Venules**

1. **Venules** join together to form veins
2. Drain the blood from **capillaries** and then join to form a **vein**.

IV. Location of Blood

- A. **Veins** contain about **75%** of the body's blood.
- B. **Arteries** contain about **20%** of the body's blood.
- C. **Capillaries** contain about **5%** of the body's blood.
- D. There is close to **100,000** km of blood vessels!

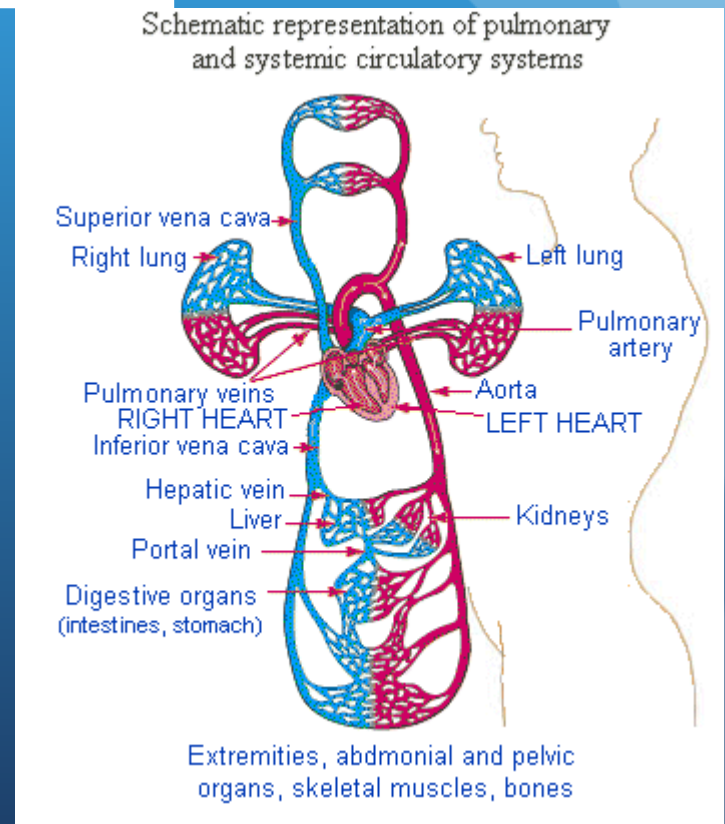
Pulmonary and Systemic Circulation

I. Cardiovascular system

- A. Divided into 2 circuits:
 - 1. **PULMONARY CIRCUIT**
 - 2. **SYSTEMIC CIRCUIT**

Vertebrate Circulatorium

Overview of P+S Systems



II. Pulmonary Circuit

- A. Path of blood from the **heart** to/from the **lungs**.
- B. Powered by the **right ventricle** of the heart.
- C. **Deoxygenated** blood from all tissues collects in the **right atrium**, is pumped to the **right ventricle**, then is sent to the **pulmonary trunk**, which divides into **pulmonary arteries**, which divide up into the **arterioles** of the **lungs**.
- D. These **arterioles** take blood to the **pulmonary capillaries**, where **CO₂** and **O₂** are exchanged.
- E. The **oxygenated** blood then enters **pulmonary venules**, then the **pulmonary veins**, and finally back to the **left atrium**.

III. The Systemic Circuit

- A. Includes all blood vessels **except** those in the **pulmonary** circuit.
- B. Blood is pumped to the tissues and organs by the **left ventricle** of the heart.
- C. From the tissues, blood collects in the **right atrium** via the **superior (anterior) vena cava** which drains the head and upper body and the **inferior (posterior) vena cava** which drains the lower body
- D. Blood is then pumped to the lungs through the **pulmonary** circuit

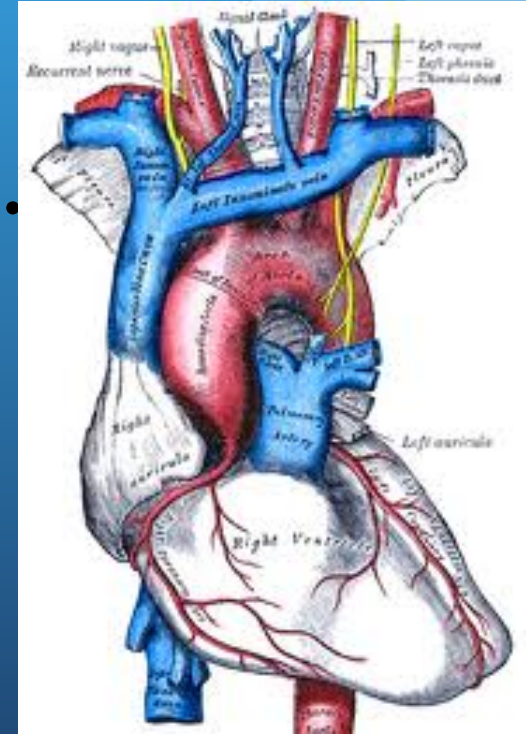
IV. Oxygenated and Deoxygenated blood

A. In the **pulmonary** system

1. **Arteries** carry **deoxygenated** blood.
2. **Veins** carry **oxygenated** blood.

B. In the **systemic** system

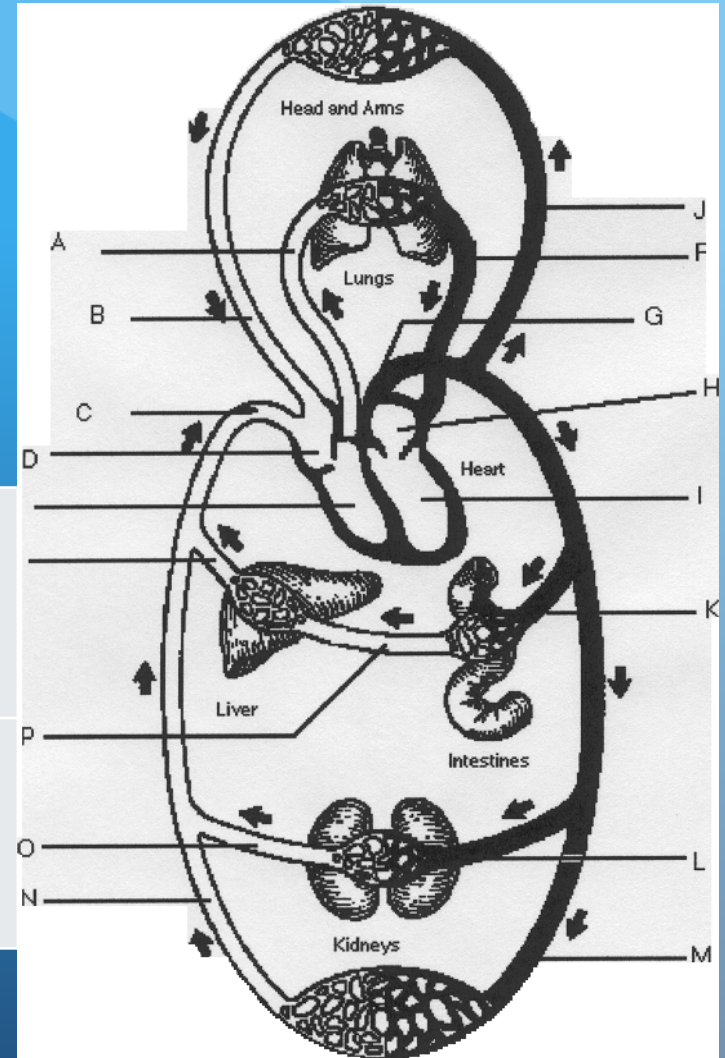
1. **Arteries** carry **oxygenated** blood.
2. **Veins** carry **deoxygenated** blood.



Significant Vessels

I. Pulmonary Circuit

A	Pulmonary Artery	Takes unoxygenated blood from the right ventricle to the lungs
F	Pulmonary Vein	Brings oxygenated blood to the left atrium from the lungs



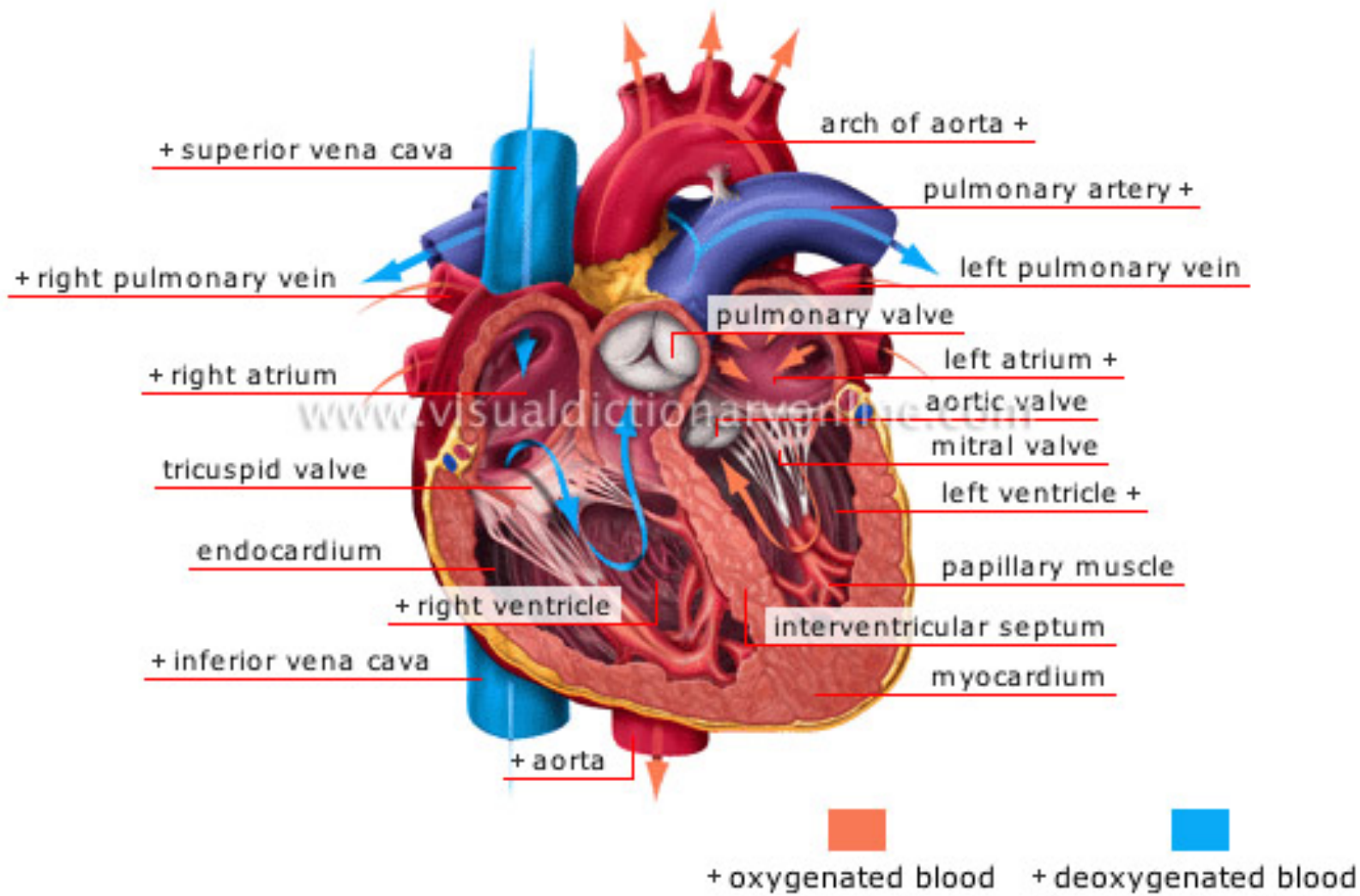
II. Systemic Circuit - Arteries

G	Aorta	Largest artery. Takes blood to major body regions/organs from the left ventricle
J	Carotid Artery	Takes blood to head , subclavian arteries branch off
K	Mesenteric Artery	Takes blood to the intestines
L	Renal Arteries	Takes blood to the kidneys from the aorta
M	Iliac arteries	Takes blood to the legs from the aorta

III. Systemic Circuit - Veins

B	Superior or Anterior Vena Cava	Largest vein Collects blood from jugular (head) and subclavian (arms) veins Blood enters right atrium
C	Posterior or Inferior Vena Cava	Largest vein Collects blood from lower body Blood enters right atrium
O	Renal vein	Returns blood from the kidneys to posterior vena cava
P	Hepatic Portal Vein	Connects the blood vessels of villi to the liver , carries nutrient rich blood to liver for processing *Portal system is a vascular system that begins and ends in capillaries
Q	Hepatic Vein	Returns blood from the liver to posterior vena cava
N	Iliac veins	Returns blood from the legs to posterior vena cava

IV. Chambers of the Heart



D	Right Atrium	Pumps blood into right ventricle
E	Right Ventricle	Pumps deoxygenated blood to lungs
H	Left atrium	Pumps blood into left ventricle
I	Left ventricle	Pumps oxygenated blood into the aorta

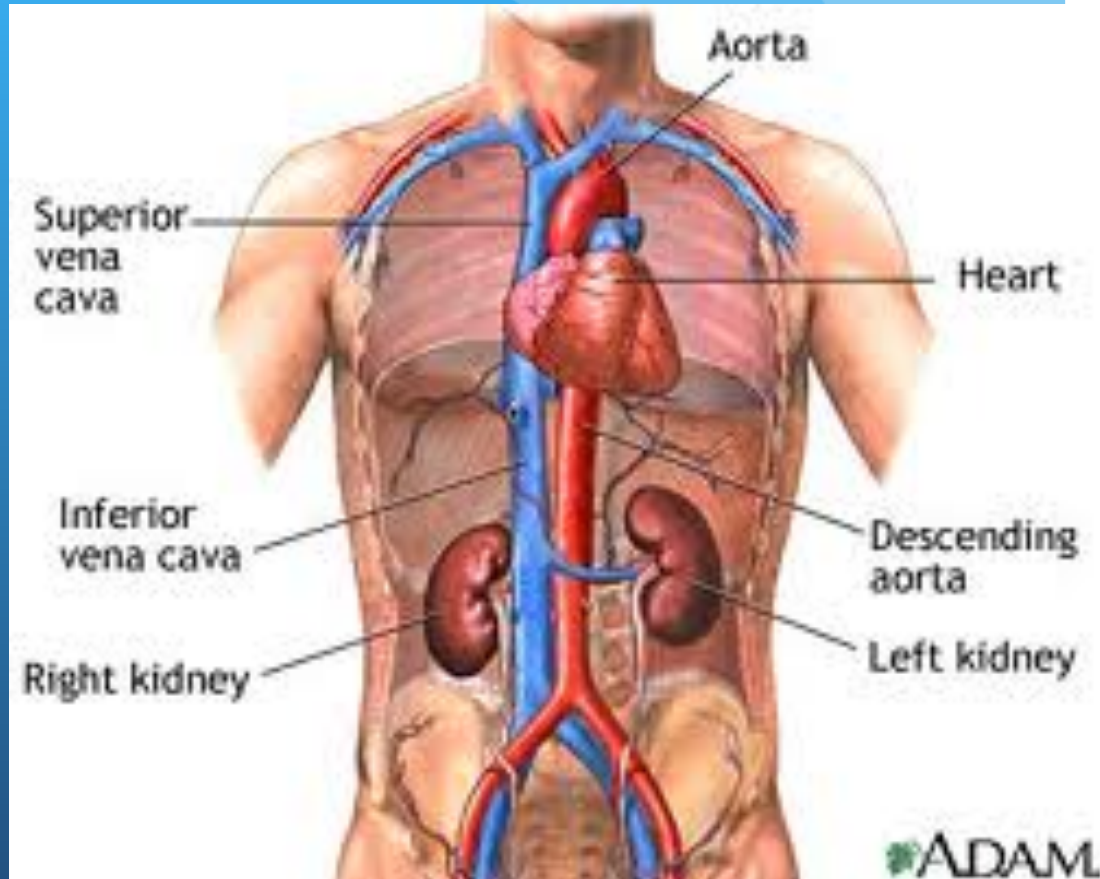
Path of a blood cell

1. You should also be able to describe the flow of blood around the body through any major organ!



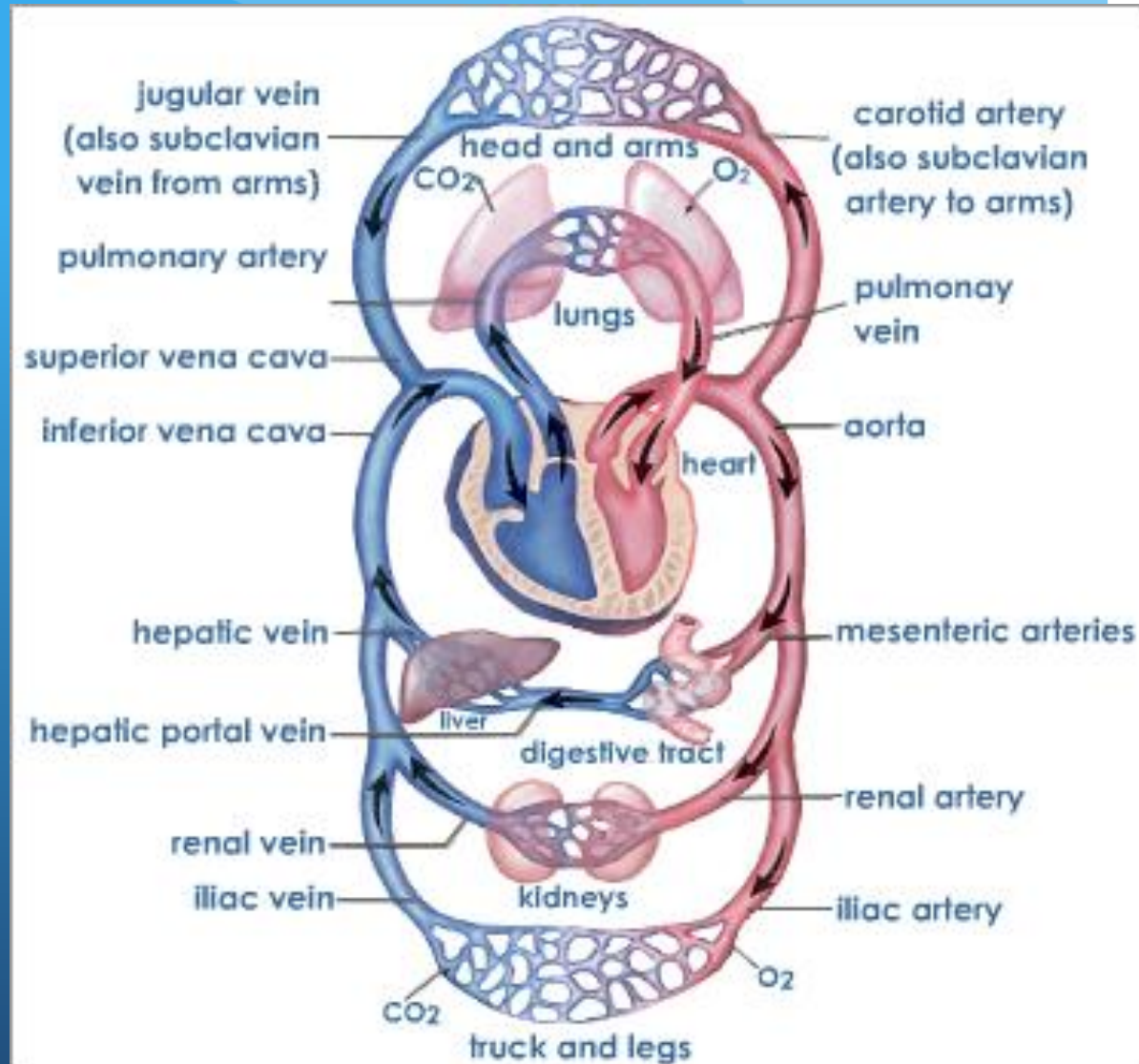
2. Path of blood to kidneys

a. Left ventricle *to* aorta *to* renal artery *to* renal arterioles *to* capillaries *to* venules *to* renal vein *to* inferior vena cava *to* right atrium



3. Path of blood to the intestines

a. **Left ventricle to aorta to mesenteric artery to mesenteric capillaries to hepatic portal vein to hepatic capillaries to hepatic vein to inferior vena cava to right atrium**



Outline the path of blood from the Heart to the Lungs and back:

**RIGHT Ventricle, Pulmonary artery, Lung
Capillaries, Pulmonary Vein, Left Atrium**

Outline the path of blood from the Heart to the big toe and back:

**Left Ventricle, Aorta, Iliac Artery, Capillary beds
of toe, Iliac Vein, Inferior Vena Cava, Right Atrium**

Adult and Fetal Circulation

I. Fetal Heart

- A. Heart develops in **3rd** and **4th** weeks in uterus.
- B. At end of **8** weeks, the embryo's organ systems, including heart, are functioning.
- C. During **fourth** month, fetal heartbeat is loud enough to be heard with stethoscope



Image: Ultrasound showing 4 chamber heart

[Video: 12 week ultrasound - you can see beating heart](#)

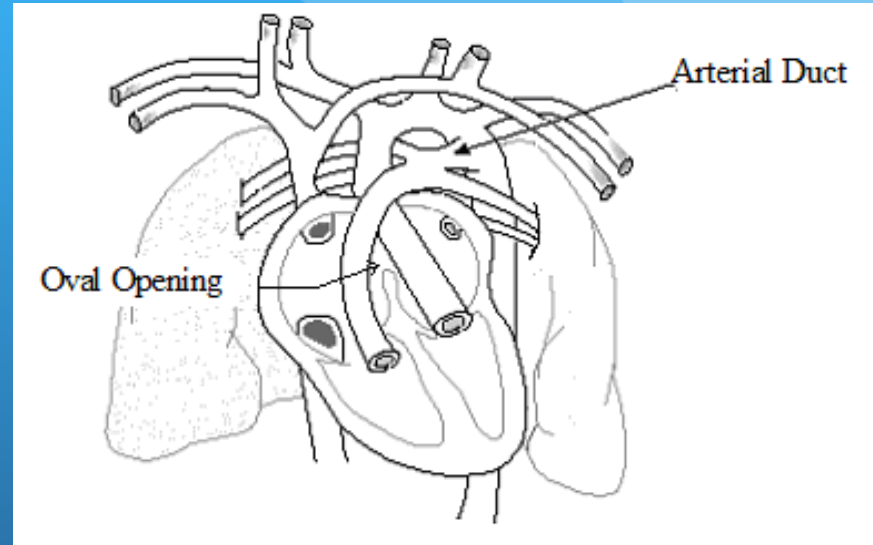
Differences Between Fetal and Adult Circulation

A. Differences

1. Fetal **lungs** are **NOT** used to provide **oxygen** since it cannot breathe **air** inside the womb because is immersed in amniotic fluid
2. Fetus must get all its **nutrients** from **mom**, as well as let her take care of its **wastes**.

Four Features Unique in the Fetus

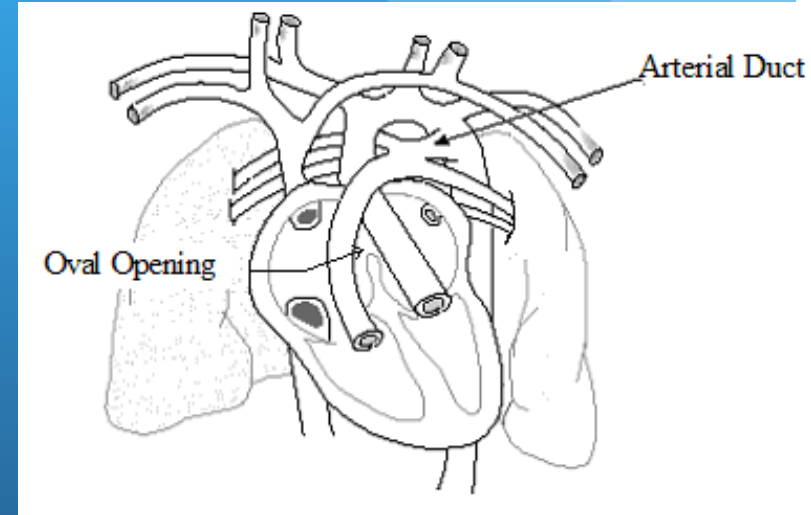
1. **OVAL OPENING (foramen ovale)**
 - a. Opening between the **right** and **left** atria, covered by a flap that acts like a **valve**.
 - b. Some of the blood from the **right** atrium is therefore pumped through this flap and into the **left** atrium, bypassing the **pulmonary** circuit.



- c. If the oval opening doesn't close after birth, it can cause mixing of blood and "**blue babies**". Correct with open heart surgery.

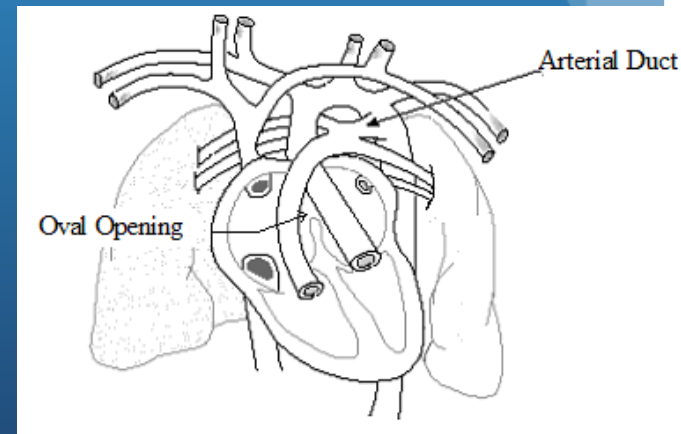
2. ARTERIAL DUCT (ductus arteriosus)

- a. Connects **pulmonary artery** and **aorta**.
- b. Much of the blood being pumped out of the **heart** to the **lungs** will be directed away from the **lungs** and into the **aorta**.
- c. Like the oval opening, the arterial duct's function is to bypass the **pulmonary** circuit.



3. UMBILICAL ARTERIES AND VEINS

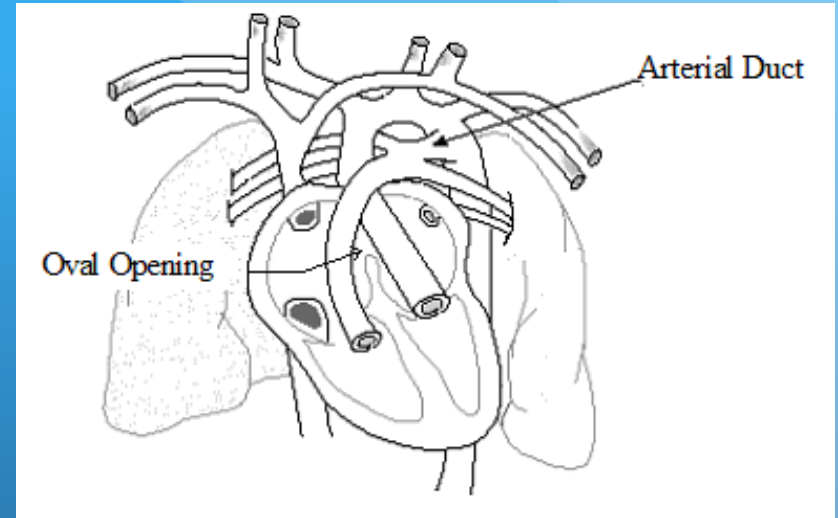
- a. Vessels that travel to and from **PLACENTA**
 - i. Placenta is a membrane shared by the **mother** and **baby** across which **gases**, **nutrients**, and **wastes** are exchanged
- b. **Artery** travels toward **placenta** with **waste**
- c. The **umbilical** arteries are grafted to the **iliac** arteries.
- d. **Vein** travels from placenta to fetus with blood rich in **O₂** and **nutrients**



4. VENOUS DUCT

(ductus venosus)

- a. Connects **umbilical vein** to the **vena cava** to bring the blood back to the baby's heart.
- b. It attaches right at the babies **liver**, but bypasses most of the **liver**.
- c. This is why chemicals ingested by the mother can seriously affect the baby



Fetal Circulation Animation

The path of the blood through the fetus

- A. Begin with blood collecting in **RIGHT ATRIUM**
- B. From there, blood can go into **LEFT ATRIUM** through **OVAL OPENING** plus into **RIGHT VENTRICLE** through **ATRIOVENTRICLE VALVE**.
- C. **RIGHT VENTRICLE** to **PULMONARY ARTERY**. Most of blood will go through **ARTERIAL DUCT** into **AORTA**.
- D. Aorta to tissue.

- E. **UMBILICAL ARTERIES** lead to placenta, where exchange of gases and nutrients take place.
- F. **UMBILICAL VEIN** carries O₂ rich blood.
- G. It enters the **VENOUS DUCT**, passes through liver.
- H. **VENOUS DUCT** joins with **INFERIOR VENA CAVA** (it mixes here with deoxygenated blood) and this mixed blood goes back to the heart.

[Placenta Video](#)