



Biology 12 - Chapter 12

Overview/Objectives:

- **Introduction**

- Overview of the circulatory system

- **12.1 The Blood Vessels**

- Three types of blood vessels; functions & differences

- **12.2 The Heart**

- Path of blood through the heart
- What happens during a heartbeat/how it is controlled

- **12.3 The Vascular Pathways**

- Path of blood to lungs and return
- Path of blood to major parts of the body and return
- Cause of blood to flow in arteries and veins

- **12.4 Blood**

- Components of blood and their functions
- Steps of a blood clot
- Exchange of materials between blood and tissues

- **12.5 Cardiovascular Disorders**

Introduction: What is the circulatory system?

- The circulatory system carries blood and dissolved substances to and from different places in the body.
- The Heart has the job of pumping these things around the body.
- The Heart pumps blood and substances around the body in tubes called blood vessels.
- The Heart and blood vessels together make up the **Circulatory System**.

12.1 The Blood Vessels

blood from the heart gets around
the body through blood vessels

There are 3 types of blood vessels

- a. **ARTERY**
- b. **CAPILLARY**
- c. **VEIN**

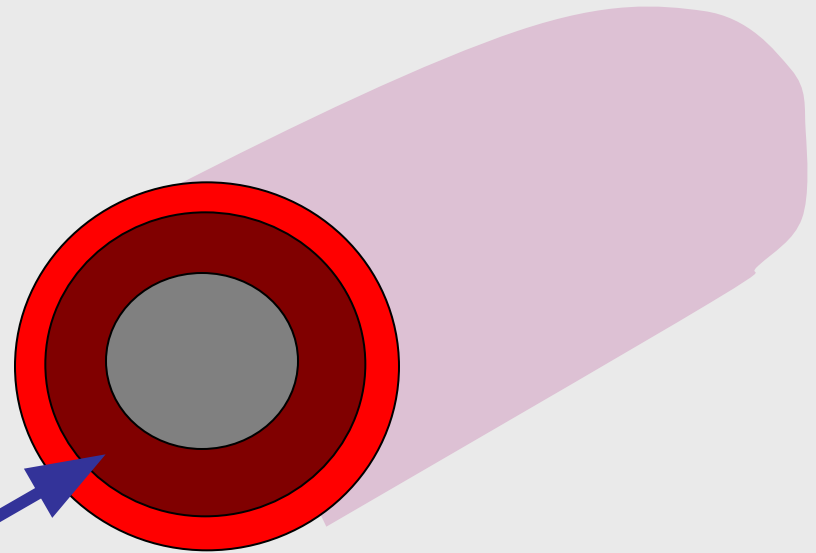
a. The ARTERY

Arteries carry blood away from the heart.

the elastic fibres allow the artery to *stretch* under pressure

thick muscle and elastic fibres

Arterioles- small arteries mostly composed of smooth muscle

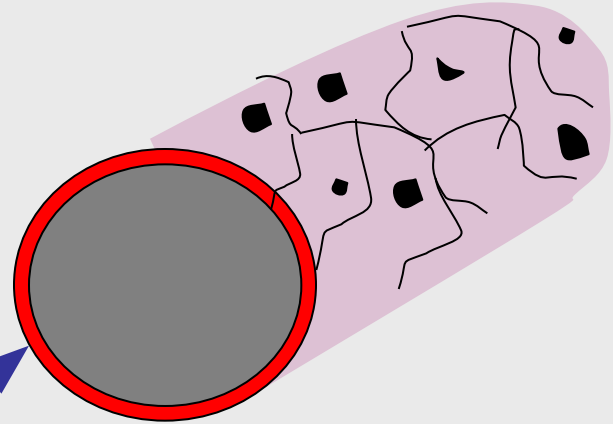


the thick muscle can contract to *push* the blood along.

b. The **CAPILLARY**

Capillaries link Arteries with Veins

they exchange materials between the blood and other body cells.

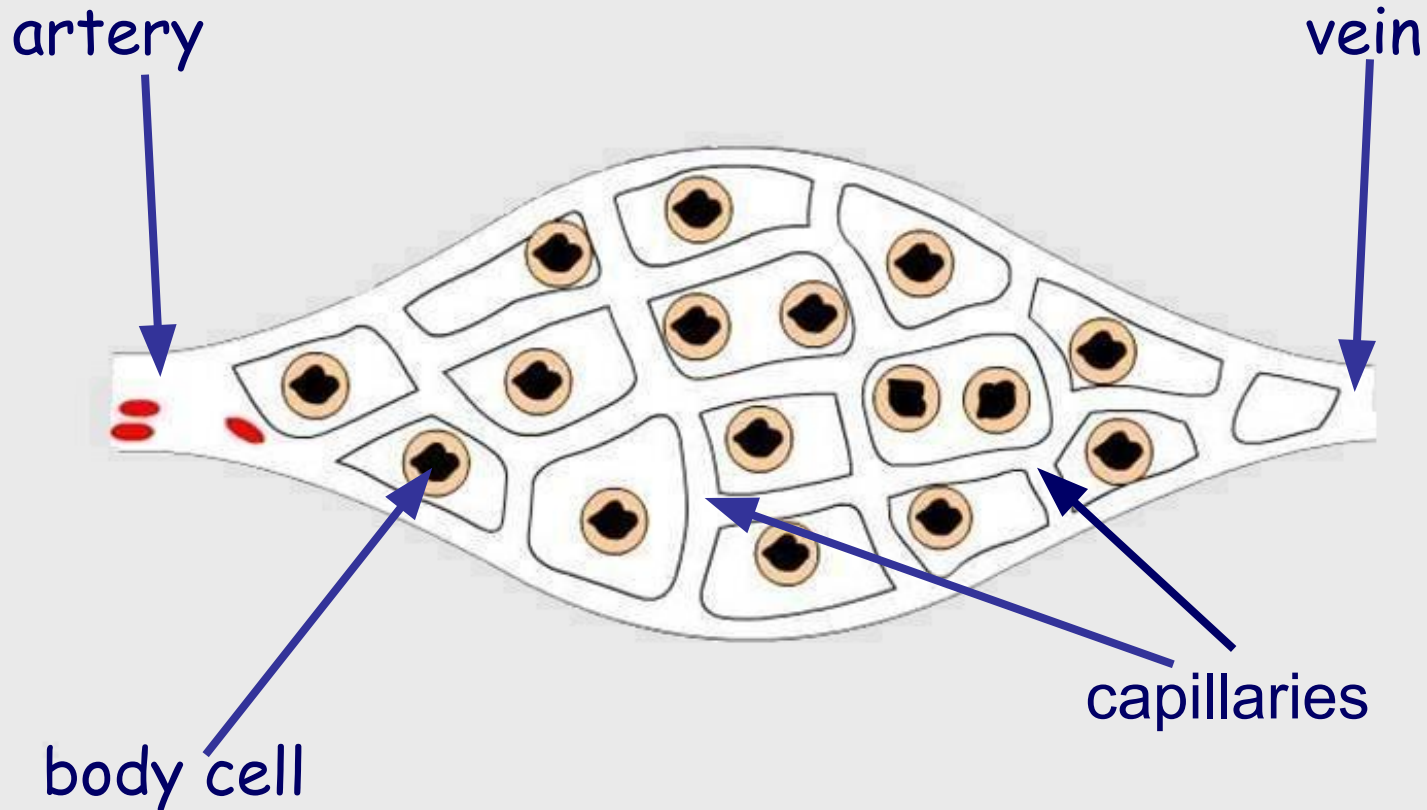


the wall of a capillary is only one cell thick

The exchange of materials between the blood and the body can only occur through capillaries.

The CAPILLARY

A collection of capillaries is known as a **capillary bed**.



c. The VEIN

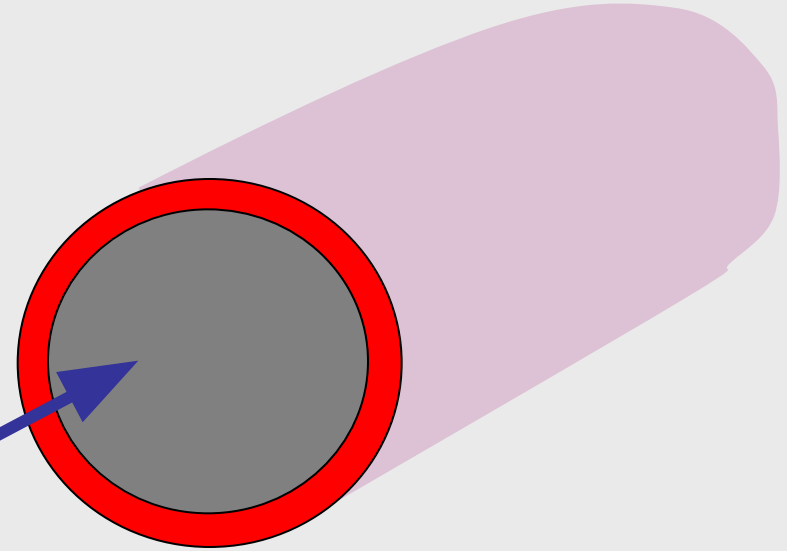
Veins carry blood towards from the heart.

veins have valves which act to stop the blood from going in the wrong direction.

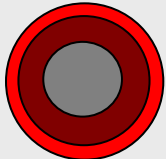
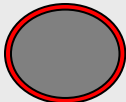
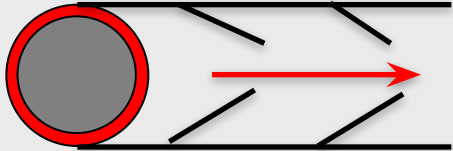
thin muscle and elastic fibres

venules- (small veins) drain blood from capillaries and join to form a vein

body muscles surround the veins so that when they contract to move the body, they also squeeze the veins and push the blood along the vessel.



Summary of Blood Vessels

Basis of Contrast	Artery	Capillary	Vein
Structure	Thick, elastic walls	Very thin walls	Thin walls with valves
Diagram			
Function	Blood away from heart	Connect artery and vein; exchange	Blood to heart; one way flow by valves
Location	Deep along bones	everywhere	Surface surrounded by muscle
Movement	Spurts by heart	Smooth and slow	Smooth by muscle contraction
Type of Blood	oxygenated		deoxygenated

12.2 The Heart

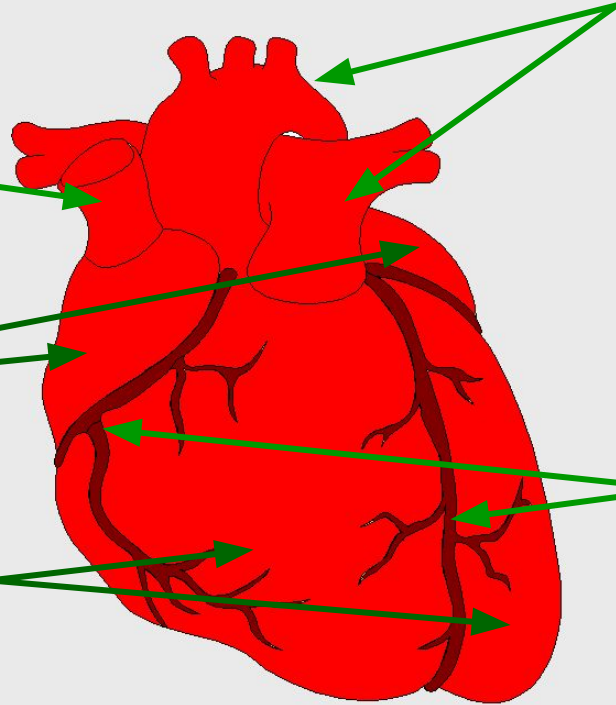
This is a **vein**. It brings **deoxygenated** blood from the body, except the lungs.

These are **arteries**. They carry **oxygenated** blood away from the heart.

2 atria

2 ventricles

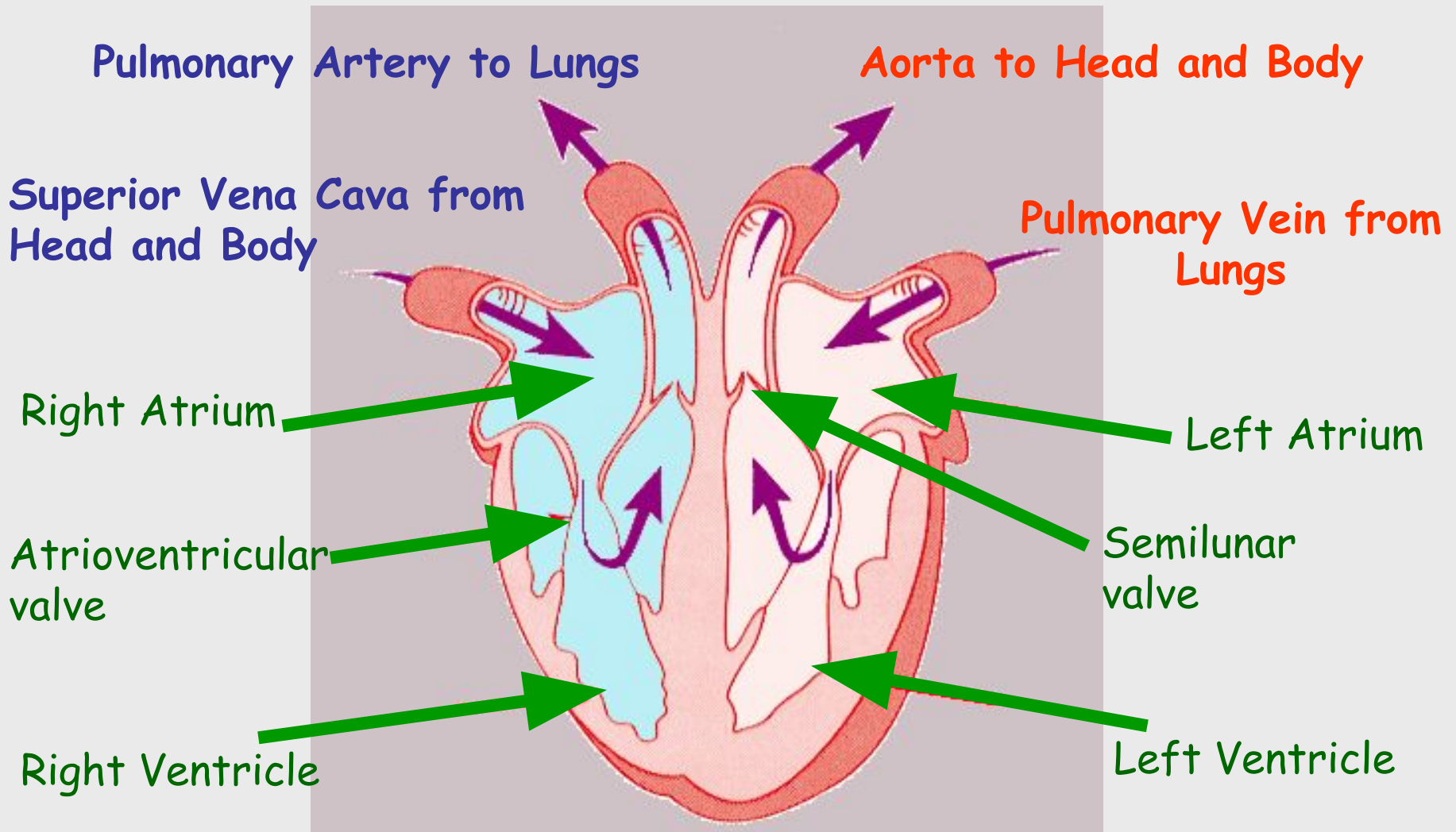
Coronary arteries, the hearts own blood supply



The heart has four chambers

now lets look inside the heart

Inside The Heart

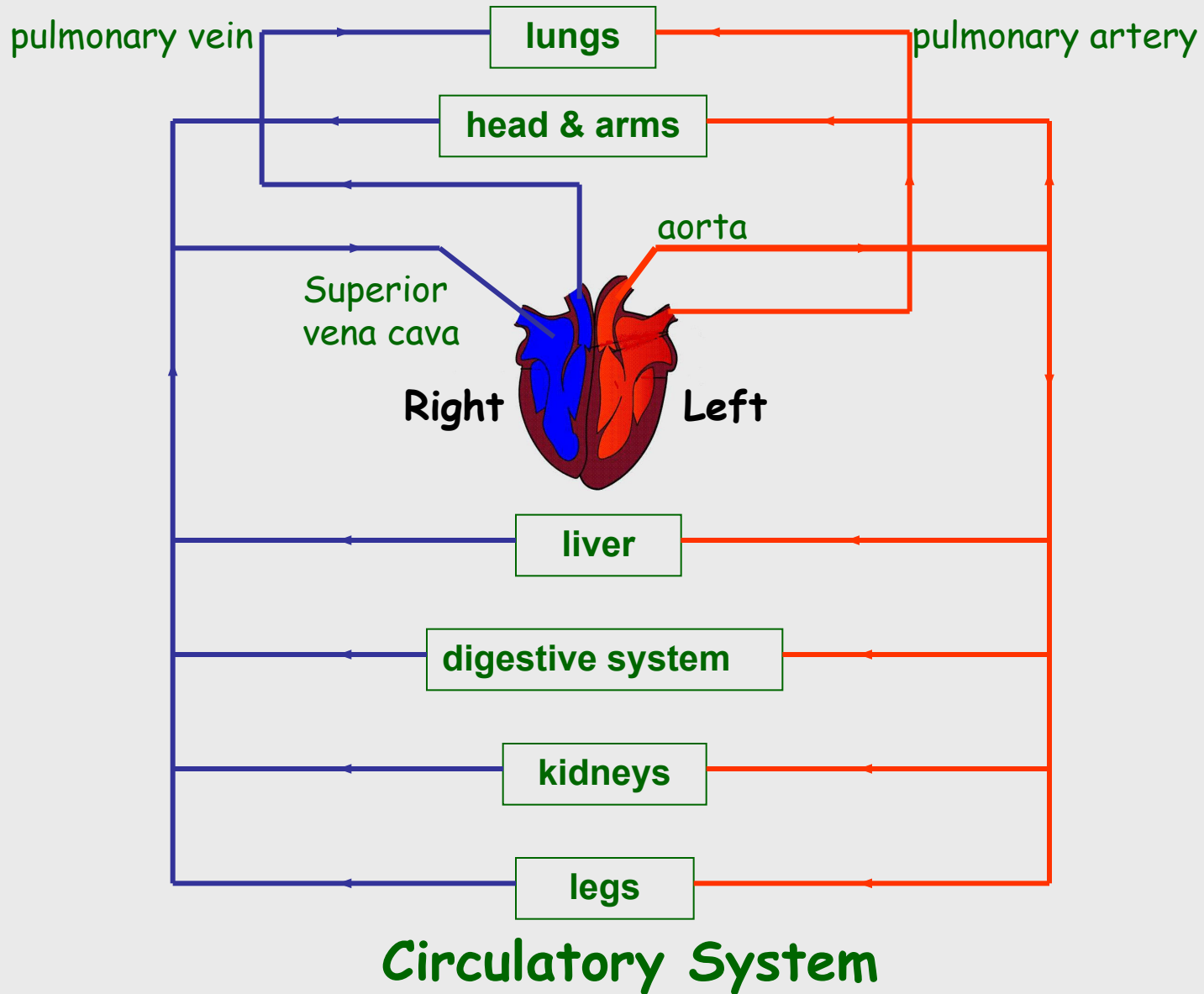


Heart Anatomy

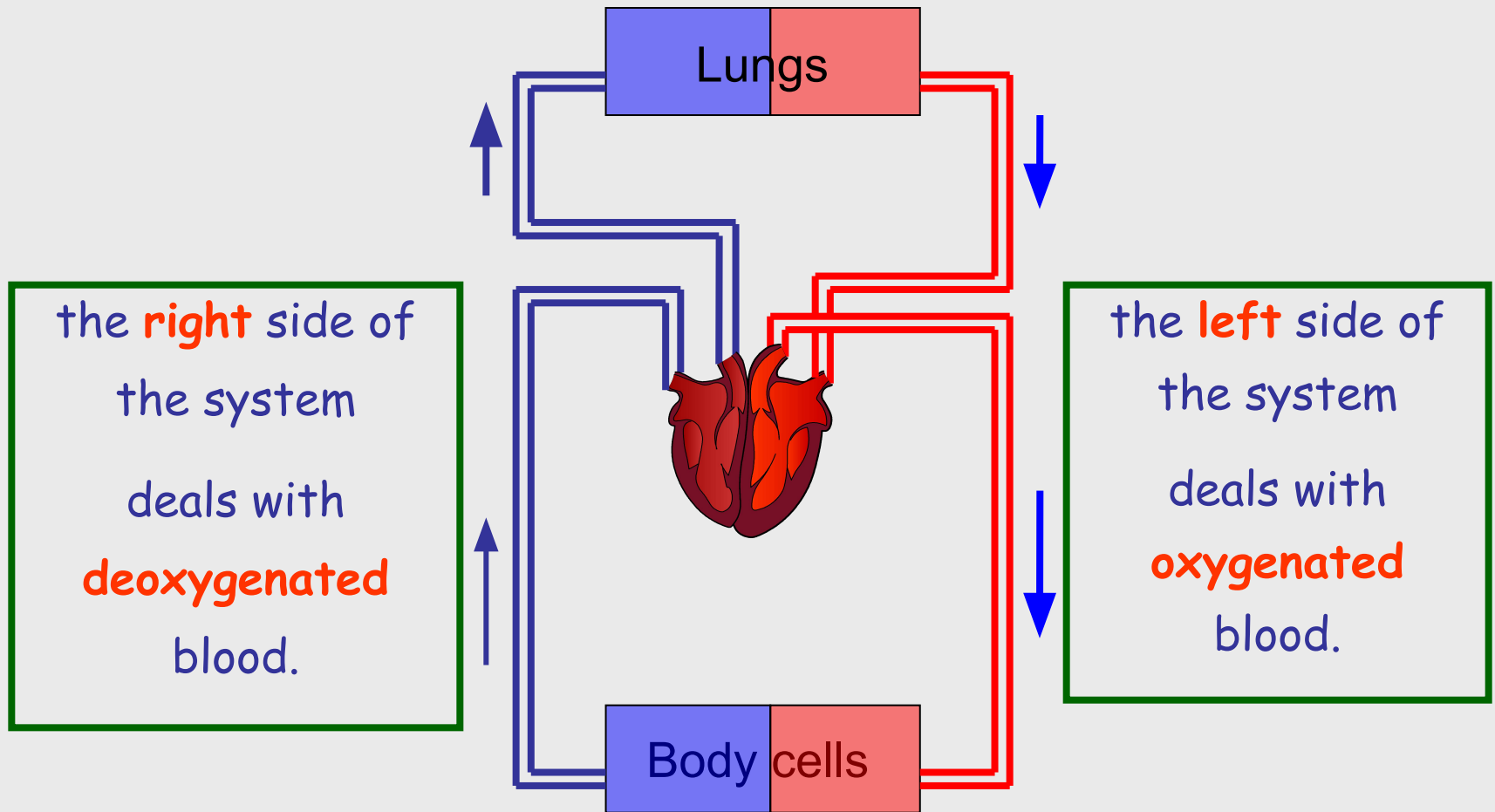
The heart is a cone-shaped, muscular organ about the size of a fist

- **Myocardium**= major portion of the heart consisting of cardiac muscle tissue
- **Pericardium**= thick, membranous sac where the heart lies
- **Septum**= separates the inside of the heart into right side and left side
- **Chordae tendineae** = strong, fibrous strings that support the valves; prevents valves from inverting

How does this system work?

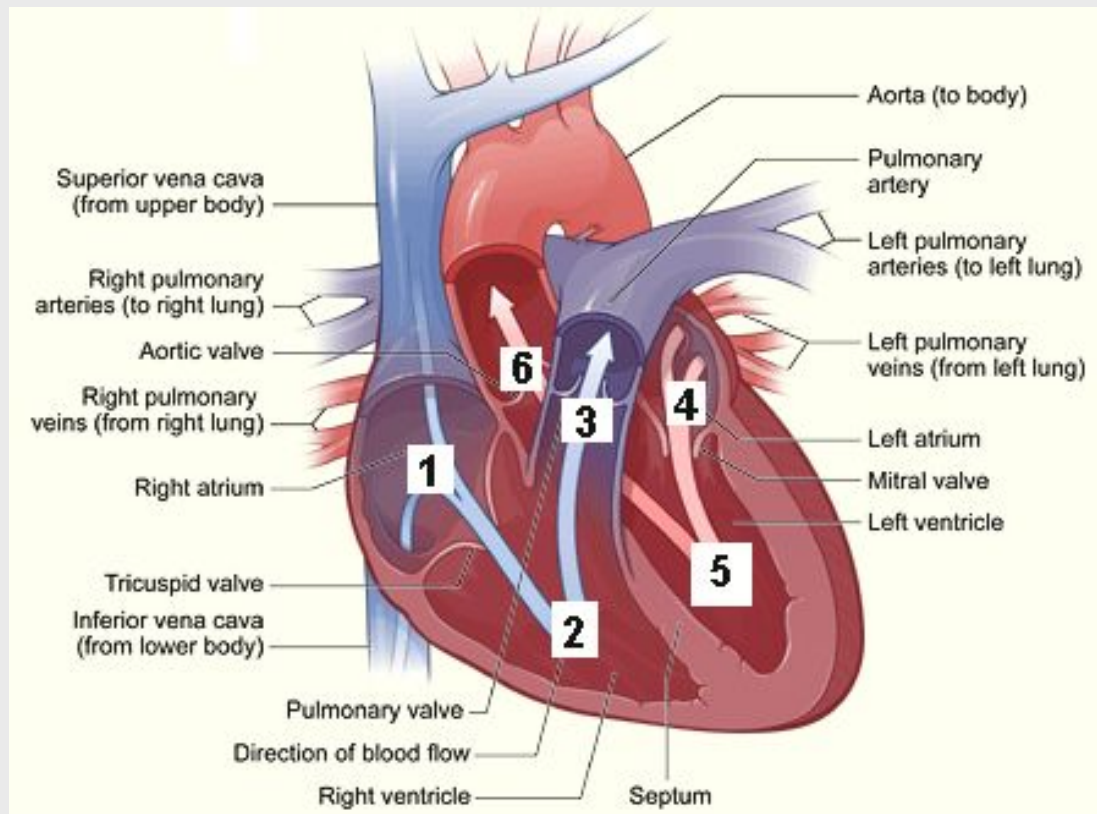


Our circulatory system is a double circulatory system.
This means it has two parts parts.



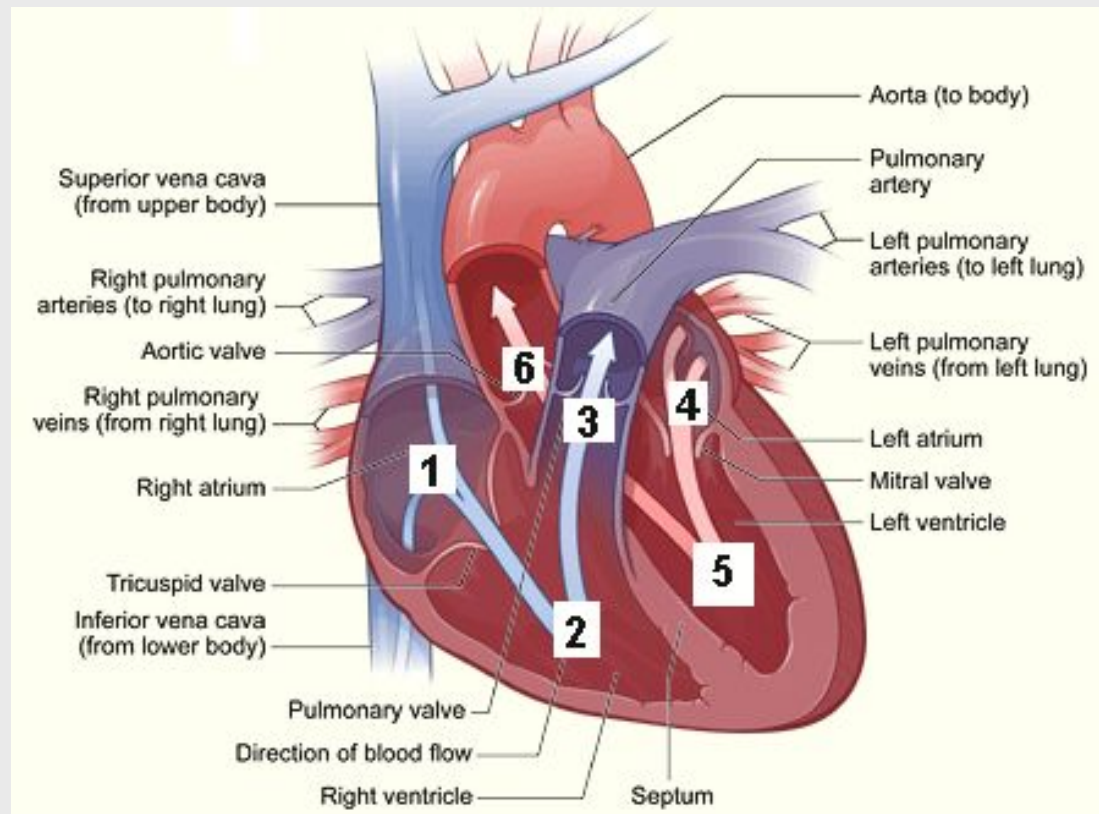
Passage of Blood Through the Heart (1)

1) The **Superior Vena Cava** and the **Inferior vena cava** (which carry deoxygenated blood) enter the right atrium



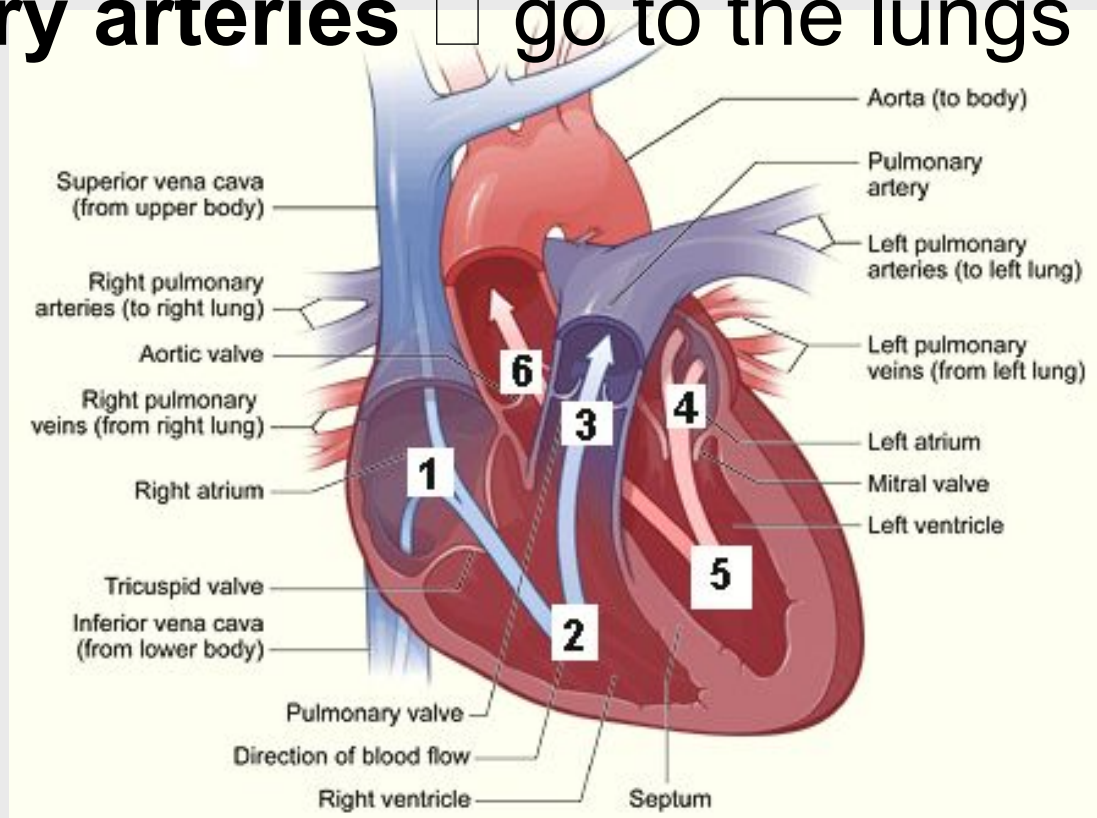
Passage of Blood Through the Heart (2)

2) The **right atrium** sends blood through the **atrioventricular valve** (tricuspid valve) to the **right ventricle**



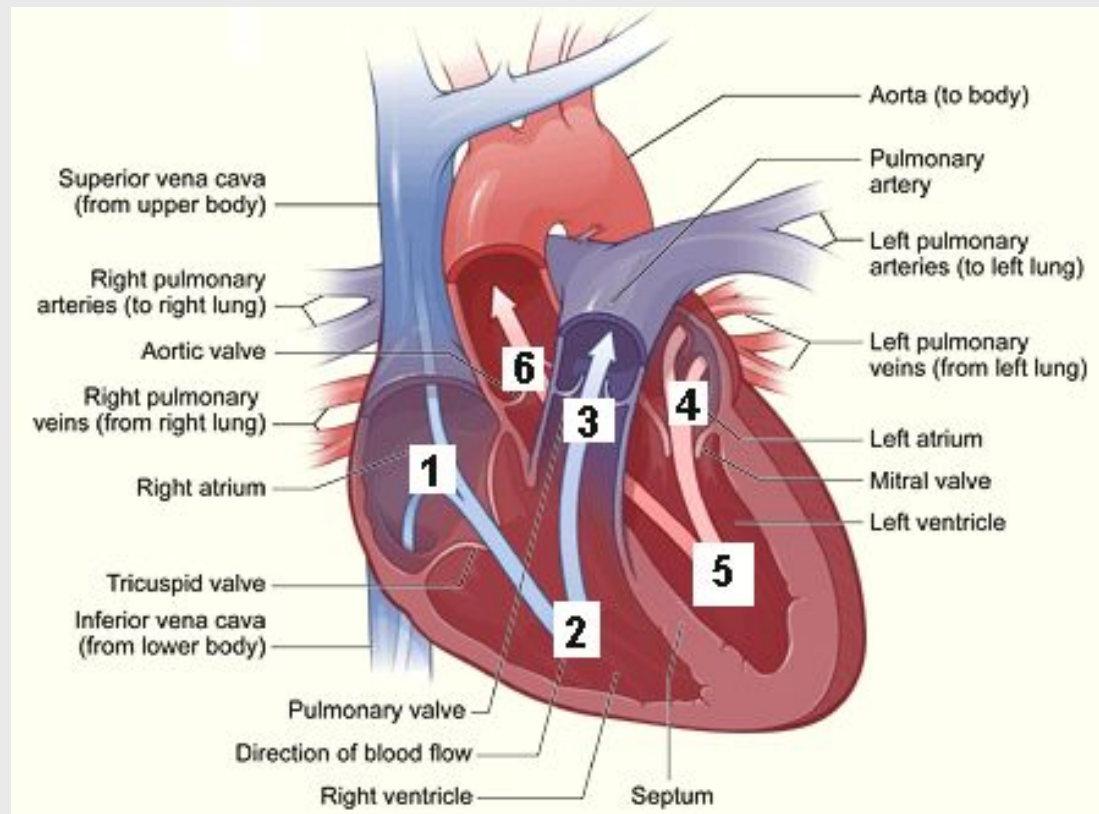
Passage of Blood Through the Heart (3)

3) The **right ventricle** sends blood through the **pulmonary semilunar valve** into the pulmonary trunk □ divides into two **pulmonary arteries** □ go to the lungs



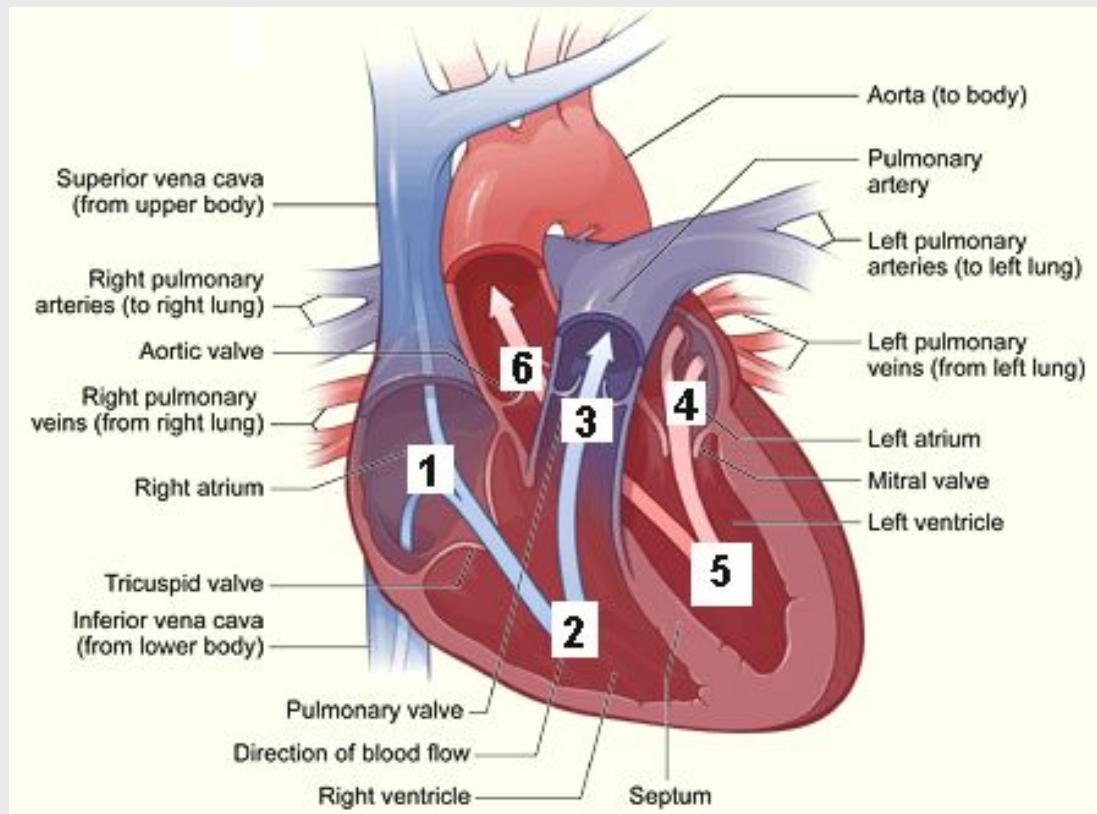
Passage of Blood Through the Heart (4)

4) Four **pulmonary veins** which carry oxygenated blood from the lungs, enter the **left atrium**



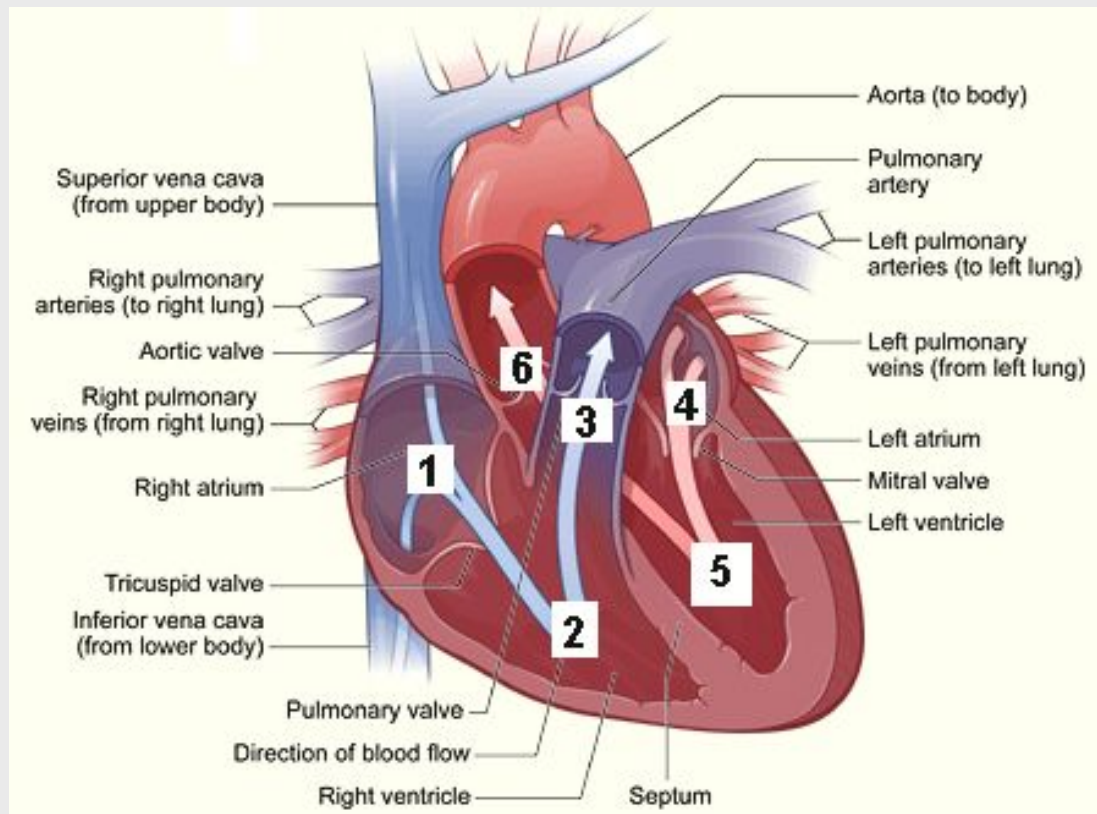
Passage of Blood Through the Heart (5)

5) The **left atrium** sends blood through an **atrioventricular valve** (bicuspid valve) to the **left ventricle**



Passage of Blood Through the Heart (6)

6) The **left ventricle** sends blood through the **aortic semilunar valve** into the **aorta** to go to the body



Regulation of Heartbeat

- **Cardiac Cycle**= each heartbeat
 - **Systole**= contraction of heart muscle
 - **Diastole**= relaxation of heart muscle

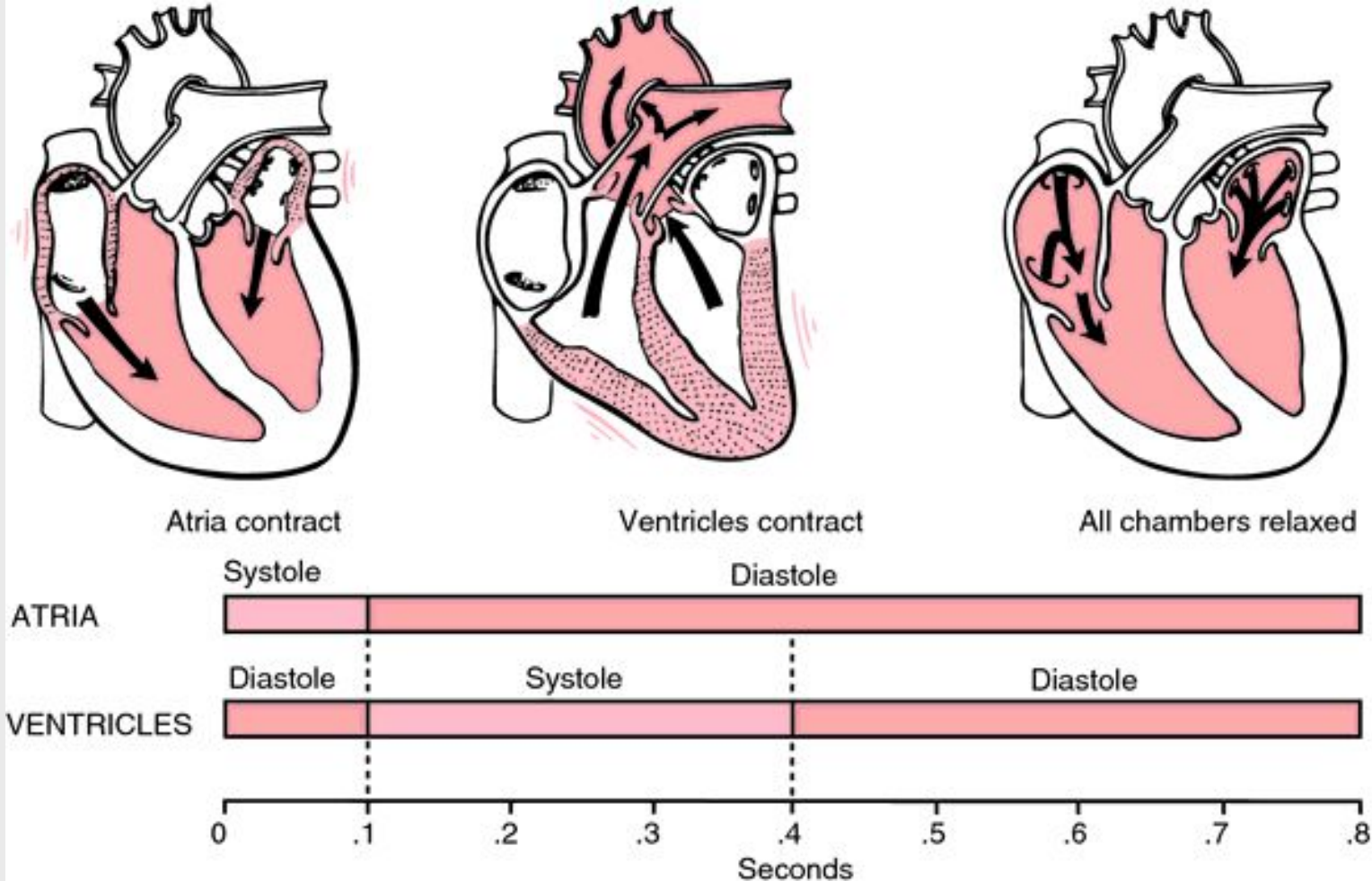
1) Two atria contract (systole) while ventricles relax (diastole) ~ 0.15 sec

2) Two ventricles contract (systole) while atria relax (diastole) ~ 0.30 sec

3) All of the chambers relax (diastole) ~ 0.40 sec

Normal adult heart rate = 60 – 80 bpm

Heartbeat

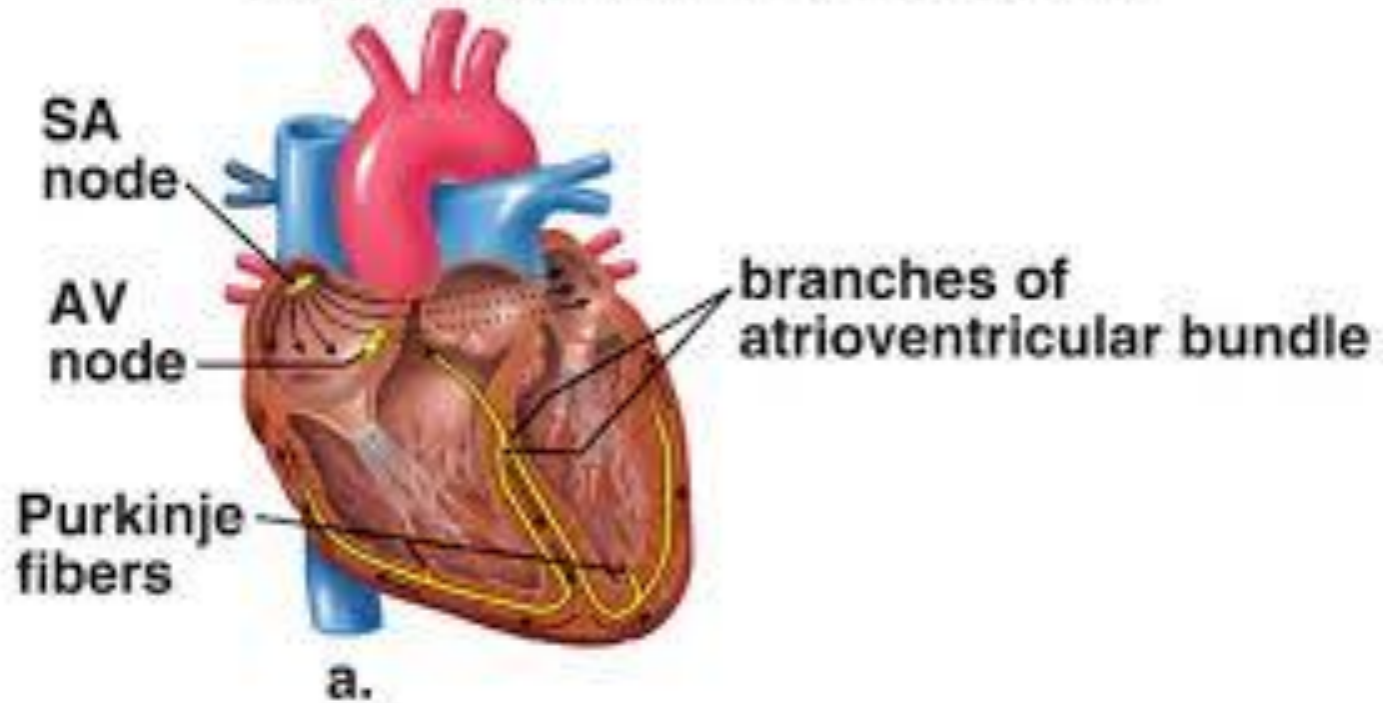


Intrinsic Control of Heartbeat

- **SA (sinoatrial) node**= located in upper dorsal wall of right atrium
 - SA node initiates heartbeat and automatically sends out impulse every 0.85 sec, which causes atria to contract
 - called **pacemaker** because keeps heartbeat regular
- **AV (atrioventricular) node**= located in the base of the right atrium
 - when pulse from SA node arrives at AV node it signals (via **AV bundle**) ventricles to contract by way of **Purkinje fibers**

Intrinsic Control of Heartbeat

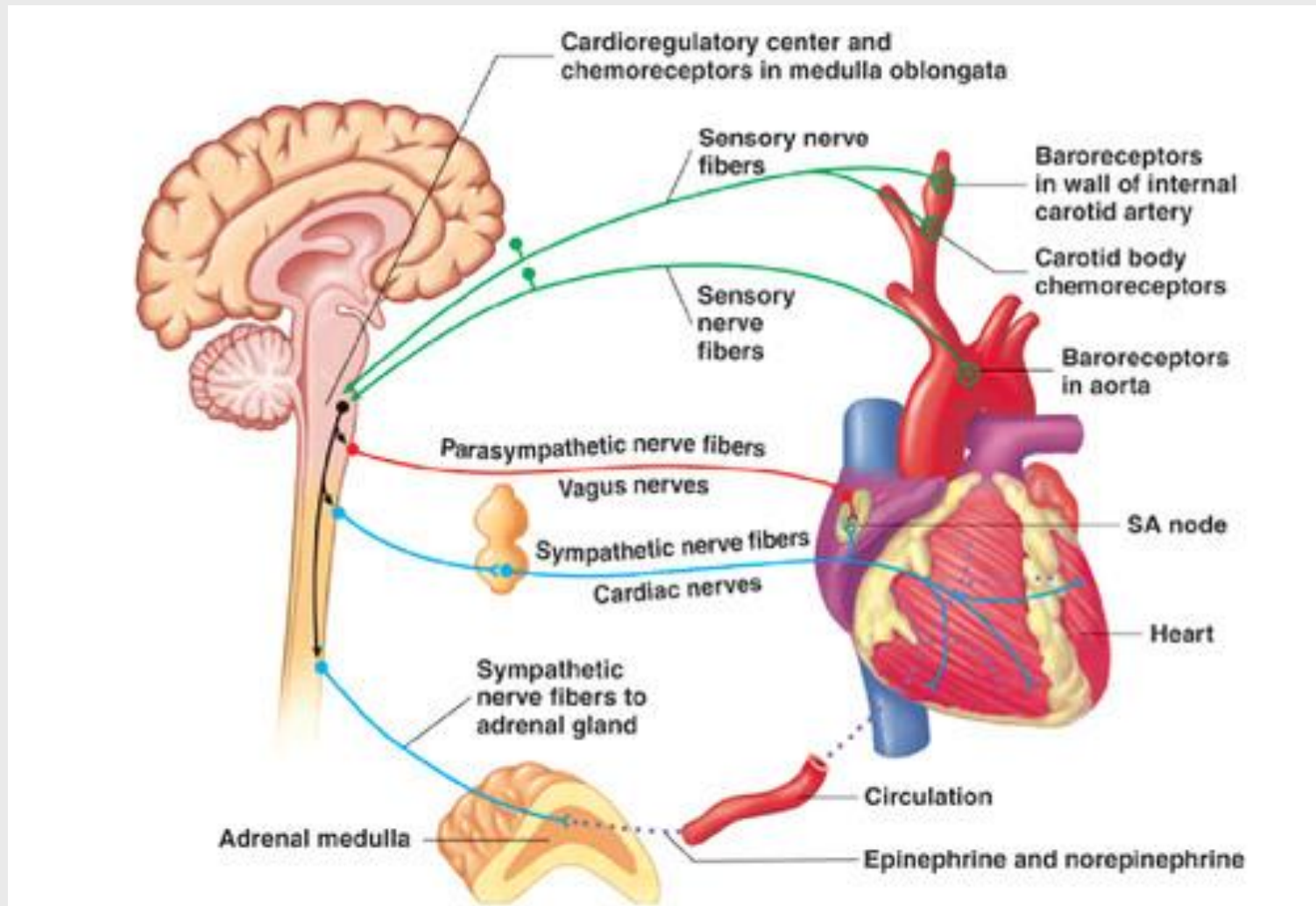
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Extrinsic Control of Heartbeat

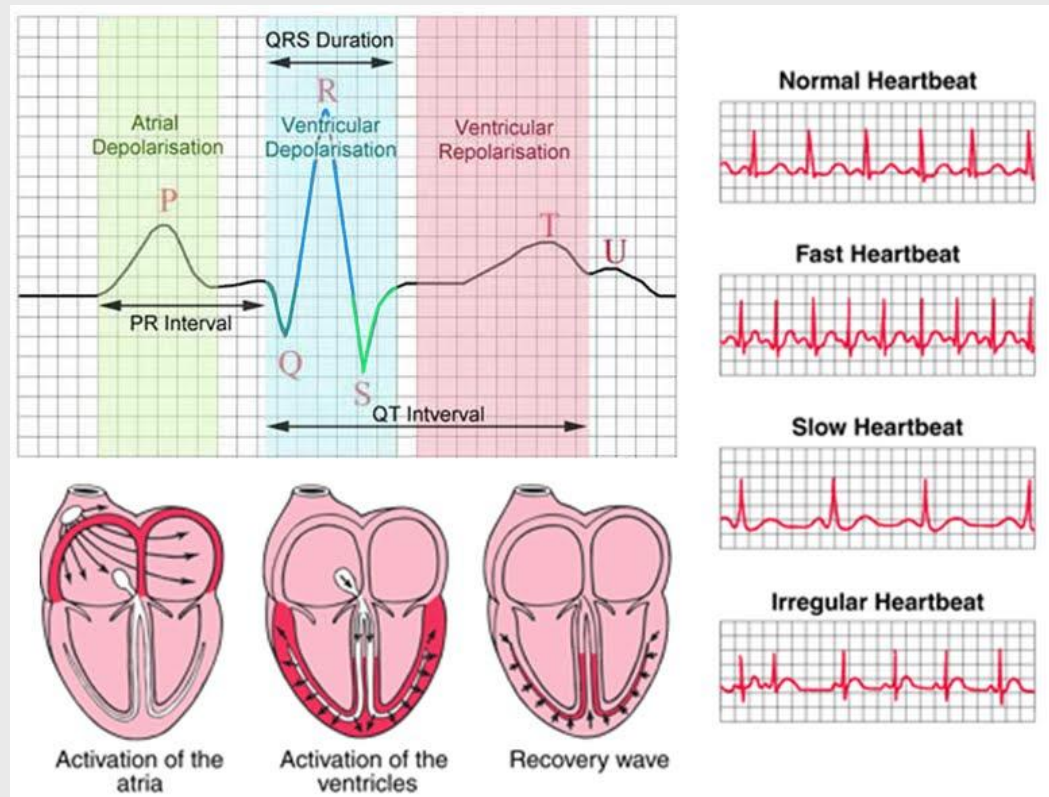
- Cardiac control center in the **medulla oblongata** (heartbeat can be altered by the nervous system)
 - 1) **Parasympathetic**= resting state
decreases SA and AV nodal activity
 - 2) **Sympathetic**= active state
increases SA and AV nodal activity
- Hormones **epinephrine and norepinephrine** (released by adrenal medulla) also stimulate the heart ex. During exercise

Extrinsic Control of Heartbeat



The Electrocardiogram

- **Electrocardiogram (ECG)**= recording of the electrical changes that occur in the myocardium during a cardiac cycle



12.3 The Vascular Pathways

Two Paths of Blood:

Pulmonary Circuit □ heart and lungs

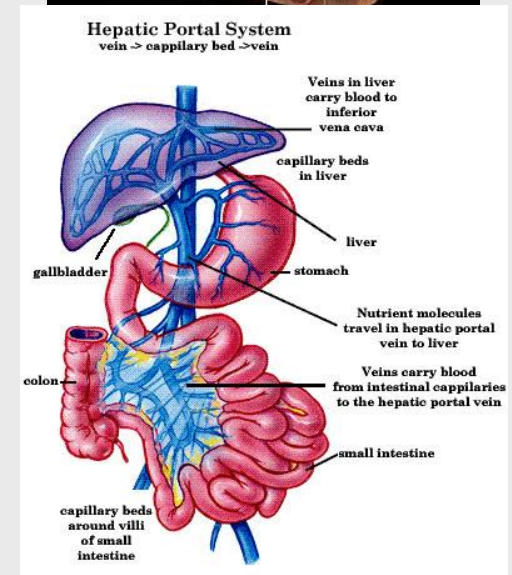
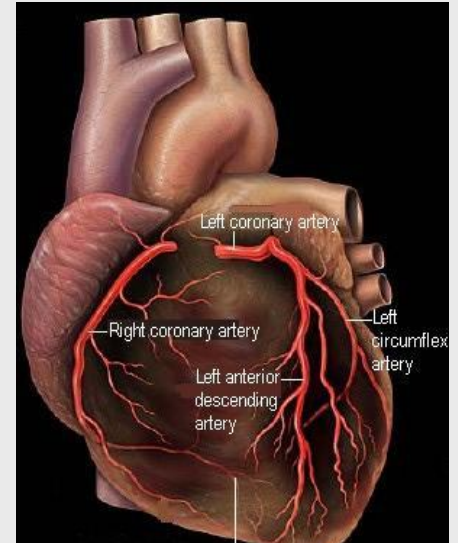
- a) **Pulmonary arteries**- take deoxygenated blood to the lungs
- b) **Pulmonary veins**- return oxygenated blood to the heart

Systemic Circuit □ heart and all other parts of the body

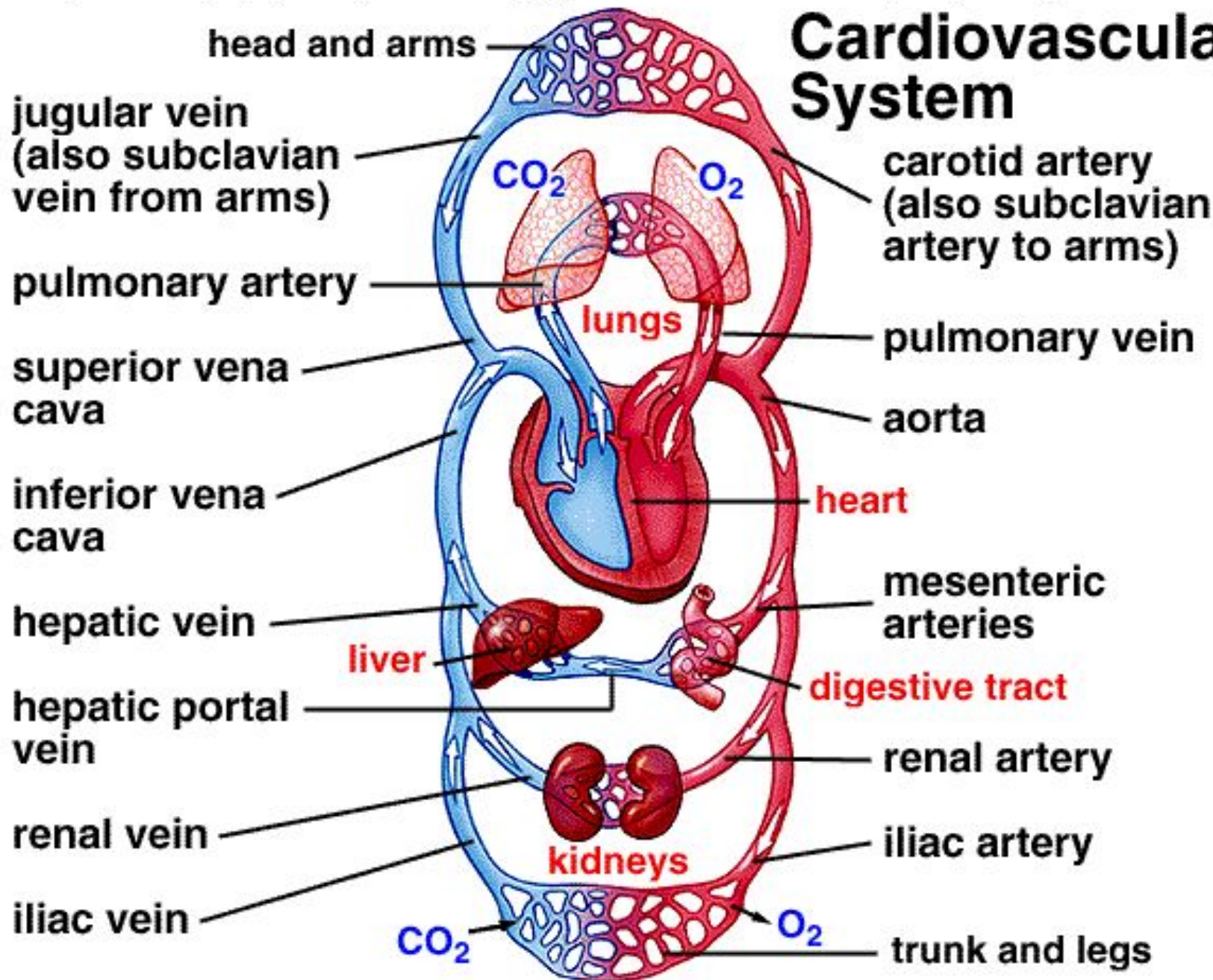
- a) **Superior Vena Cava**- deoxygenated blood from head, chest and arms to heart
- Inferior Vena Cava**- deoxygenated blood from lower body to heart
- b) **Aorta** – oxygenated blood from heart to the body

Vascular Terms to Know

- **Coronary arteries**= serves the heart muscle itself (the heart is not nourished by the blood in its own chambers)
- **Hepatic portal system**= connection between the circulatory system and the liver



Cardiovascular System



Blood Flow

- **Blood pressure**= pressure of blood against the wall of a blood vessel
- **Systolic pressure**= reached during ejection of blood from the heart
- **Diastolic pressure**= occurs while heart ventricles are relaxing

Blood pressure is normally 120/80

systolic

diastolic

- **Hypertension**= high blood pressure (result of diet [fat and salt], stress and lack of exercise etc.)
- **Hypotension**= low blood pressure (result of fitness, drugs etc.)

Comparing Blood Flow

- **Blood Flow in Arteries**

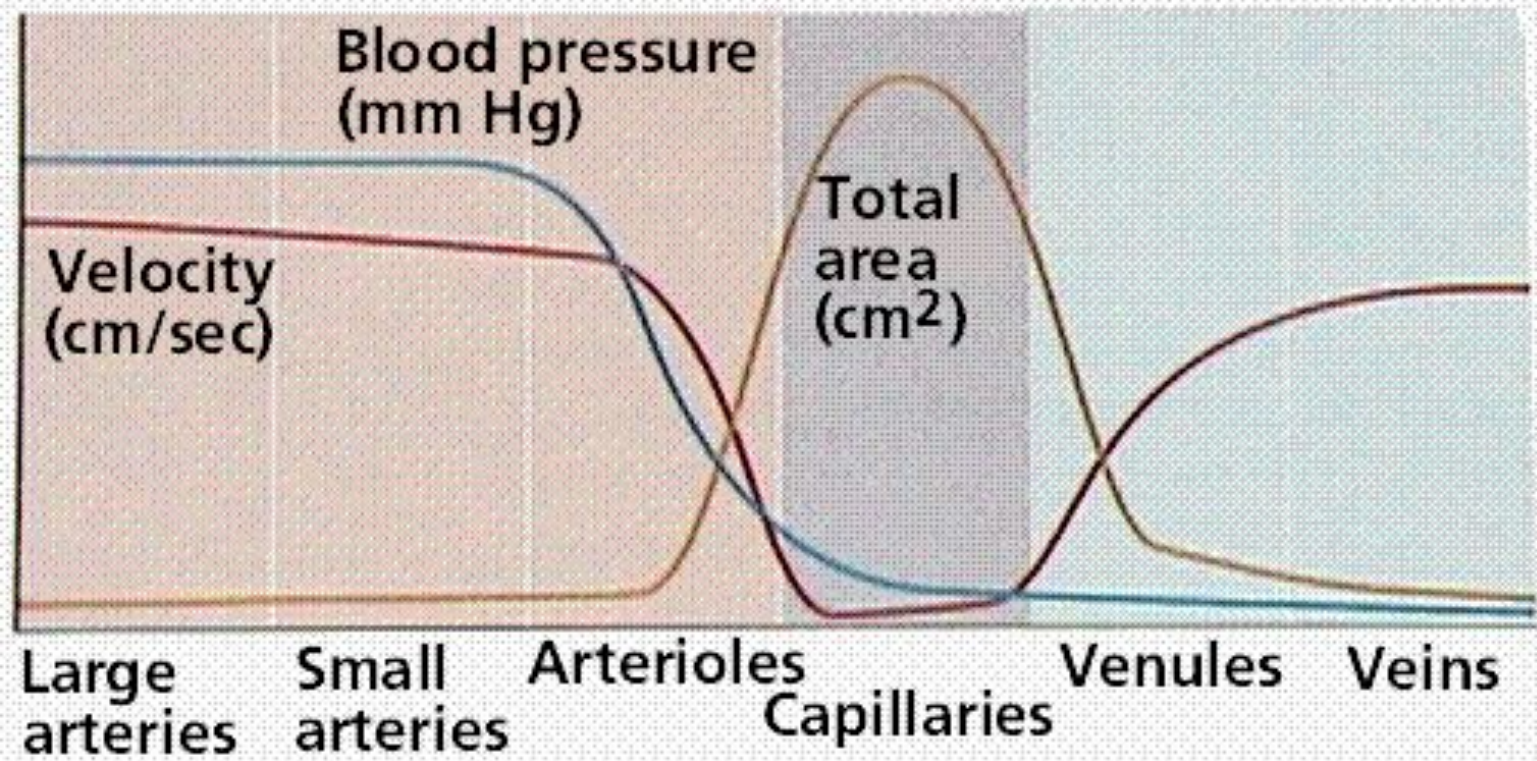
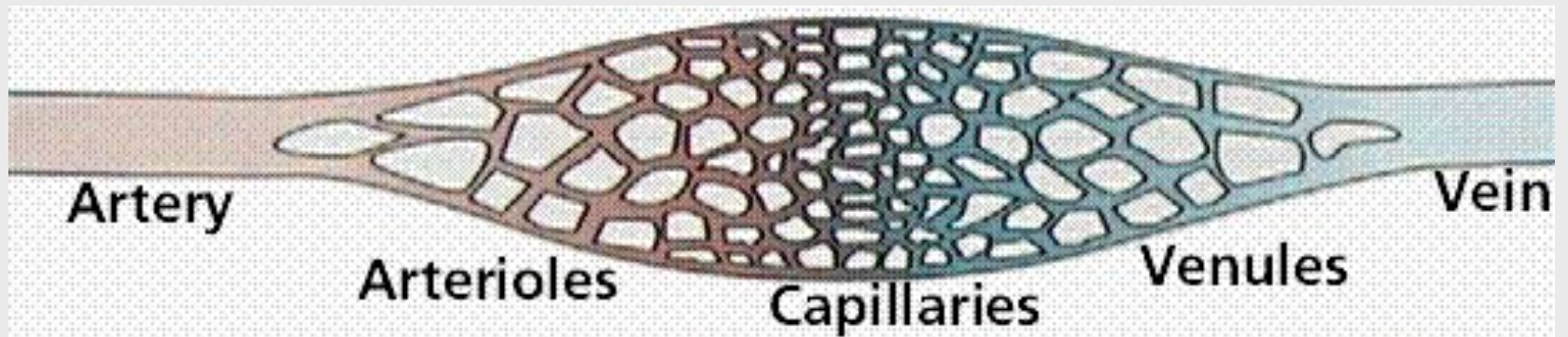
- Blood pressure is highest in the **aorta**
- Blood pressure is lowest in the **venae cavae**
- Varies throughout body; decreases with distance from **left ventricle**

- **Blood Flow in Capillaries**

- Very slow blood flow; allows substances to be **exchanged** to tissues

- **Blood Flow in Veins**

- Minimal blood pressure
- Venous return depends on:
 1. **Skeletal muscle contraction**
 2. Presence of **valves** in veins
 3. **Respiratory** movements



Capillary Exchange

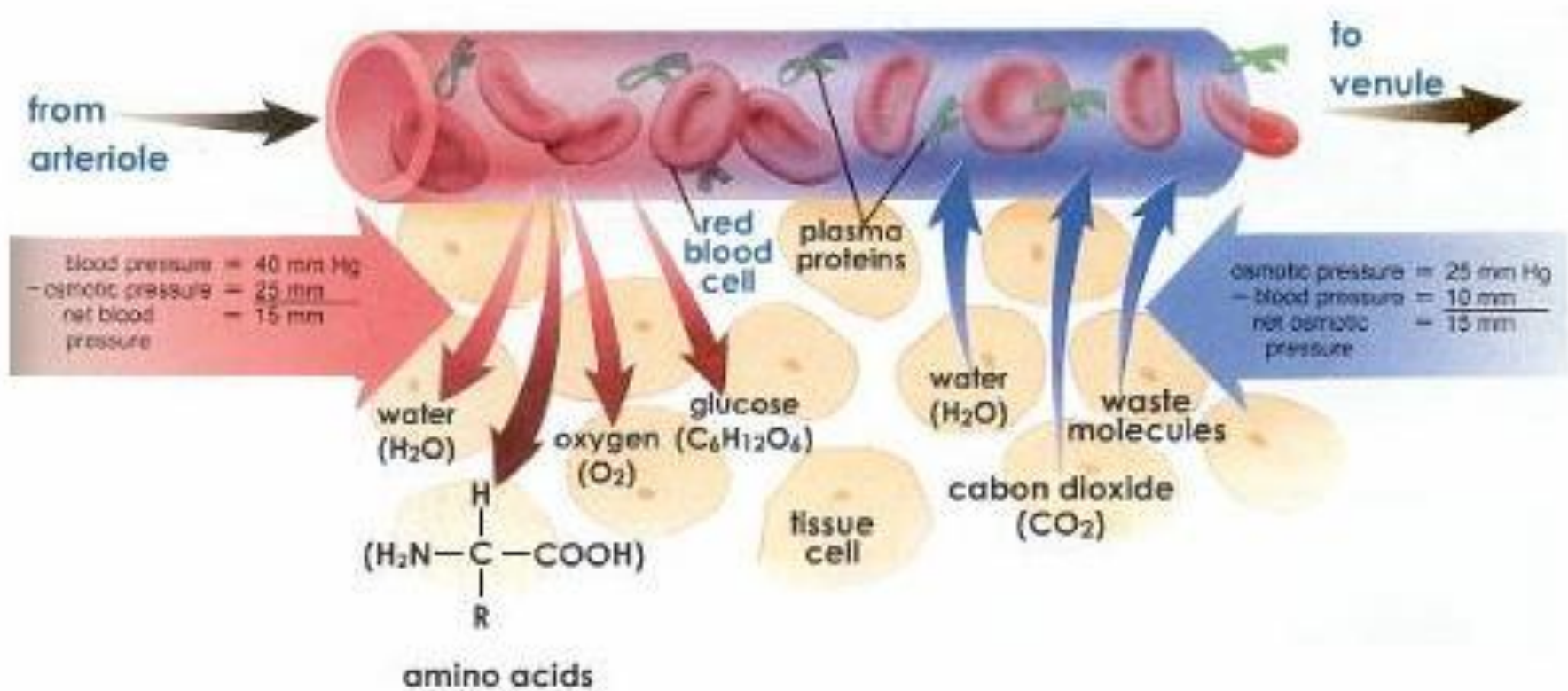
Two forces primarily control exchange of fluid through the capillary wall:

- 1) **Osmotic pressure** □ causes water to move from tissue to blood (venous end of capillary)
 - 2) **Blood pressure** □ causes water to move from blood to tissue (happens at the arterial end of a capillary)
- **Tissue fluid**= substances that leave a capillary/ fluid between the body's cells
 - **Lymph**= tissue fluid within lymphatic vessels

Creating and Maintaining Blood Pressure

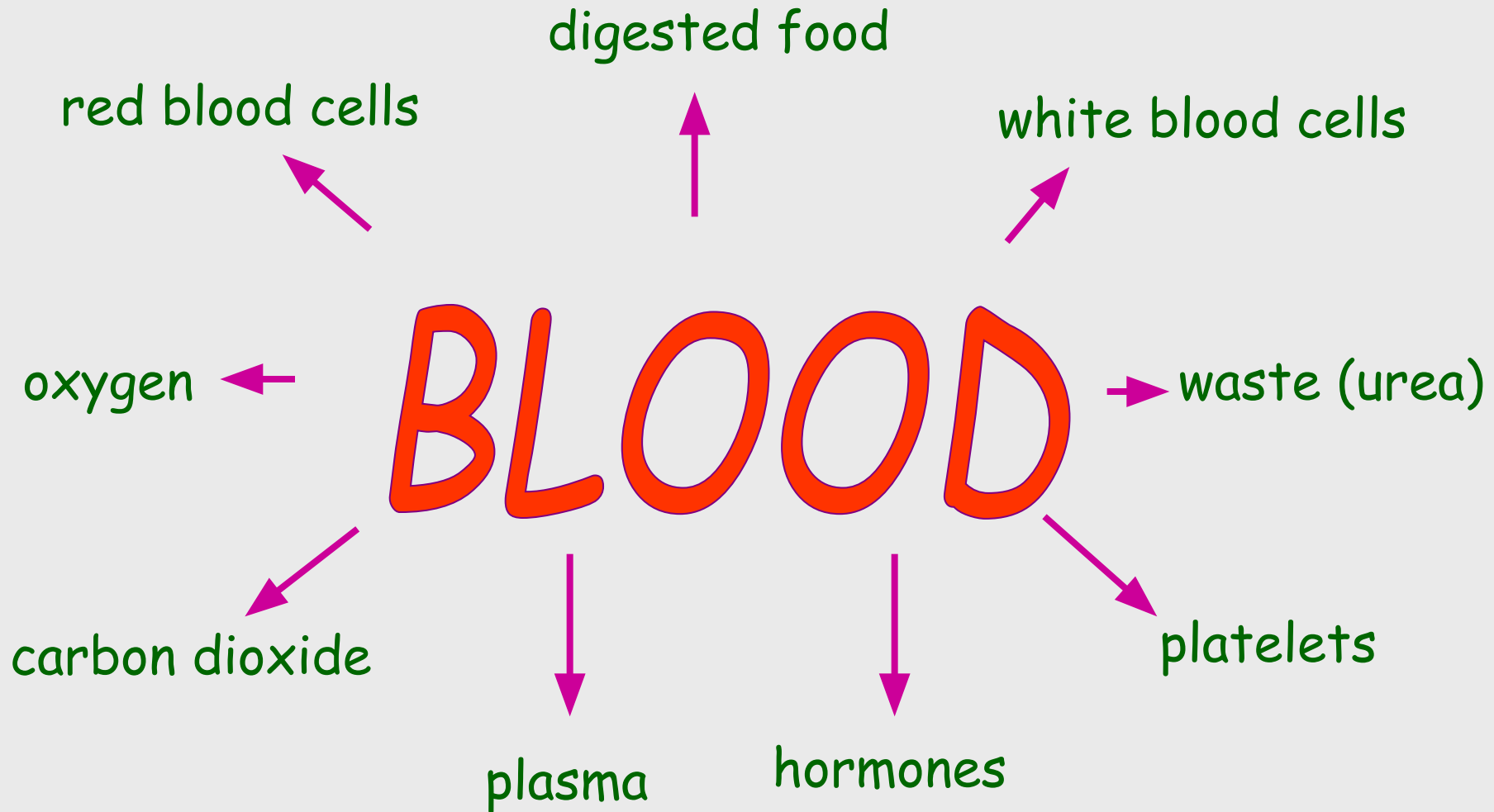
5 factors, listed in descending order of importance:

- 1) Heart contractions-** influenced by bpm and amount of blood per beat
- 2) Peripheral resistance-** influenced by diameter of blood vessel (smaller vessel = greater pressure required to force blood through)
- 3) Elasticity of arteries-** expansion and recoil action helps maintain blood pressure
- 4) Viscosity of the blood-** thicker requires more pressure to circulate it
- 5) Volume of blood in the system-** loss of blood decreases blood pressure



Capillary Exchange

12.4 Blood



Composition of Blood

A) Formed Elements – 45% by volume (solid)

- i. **Erythrocytes** (red blood cells) □ transport O_2 and CO_2
- ii. **Leukocytes** (white blood cells) □ fight infection
□ 5 types (neutrophils, eosinophils, basophils, lymphocytes, monocytes)
- iii. **Thrombocytes** (platelets) □ blood clotting

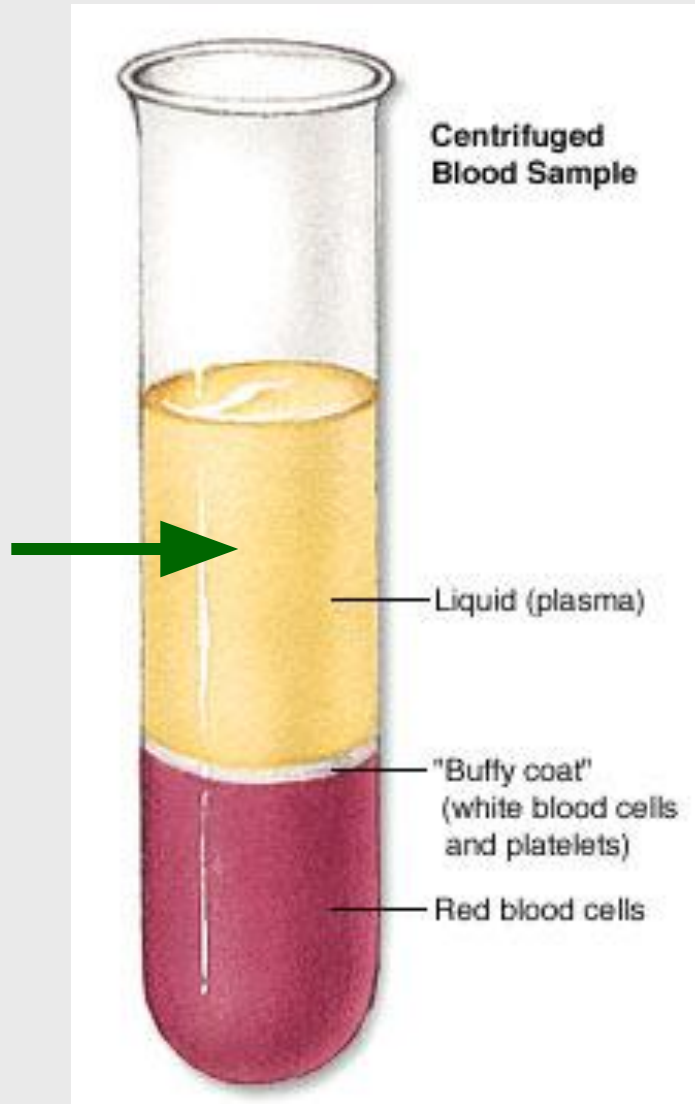
Composition of Blood Cont'

B) Plasma- 55% by volume (liquid)

- i. **Water** □ maintains blood volume (pressure)
□ transports material
- ii. **Plasma protein** (ex. Fibrinogen □ clots, albumin and prothrombin)
- iii. **Gases** □ oxygen, carbon dioxide in the form of bicarbonate ions (HCO_3^-)=base
- iv. **Nutrients** □ glucose, amino acid, fatty acid etc.
- v. **Electrolytes** □ (ions: Na^+ , K^+ , Cl^-)
- vi. **Wastes** □ ex. Urea and creatine

Plasma

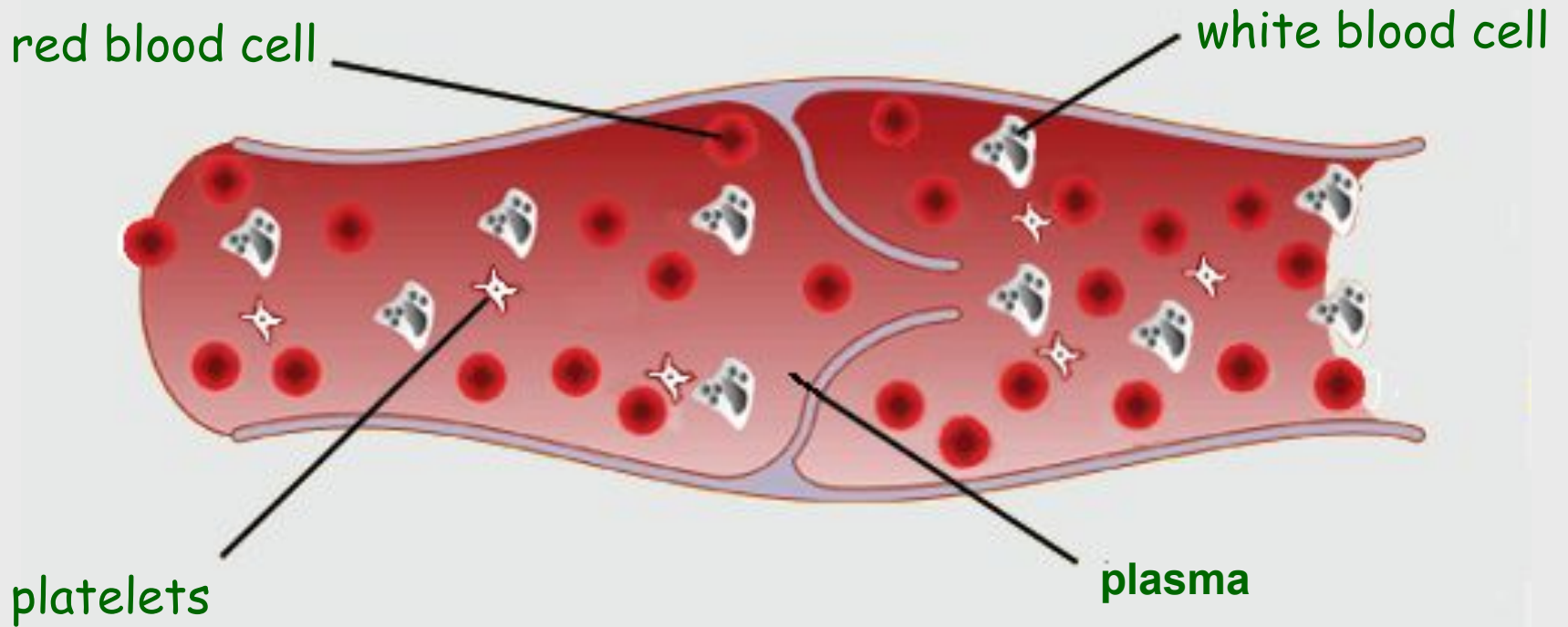
A straw-coloured liquid that carries the cells and the platelets which help blood clot.



It also contains useful things like;

- carbon dioxide
- glucose
- amino acids
- proteins
- minerals
- vitamins
- hormones
- waste materials like **urea**.

The Blood



Red Blood Cells

a biconcave disc that is round and flat **without a nucleus**

contain **haemoglobin**, a molecule specially designed to hold oxygen and carry it to cells that need it.



can **change shape** to an amazing extent, without breaking, as it squeezes single file through the capillaries.

White Blood Cells



there are many different types and all contain a **big nucleus**.

the two main ones are the **lymphocytes** and the **macrophages**.

macrophages 'eat' and **digest** micro-organisms .

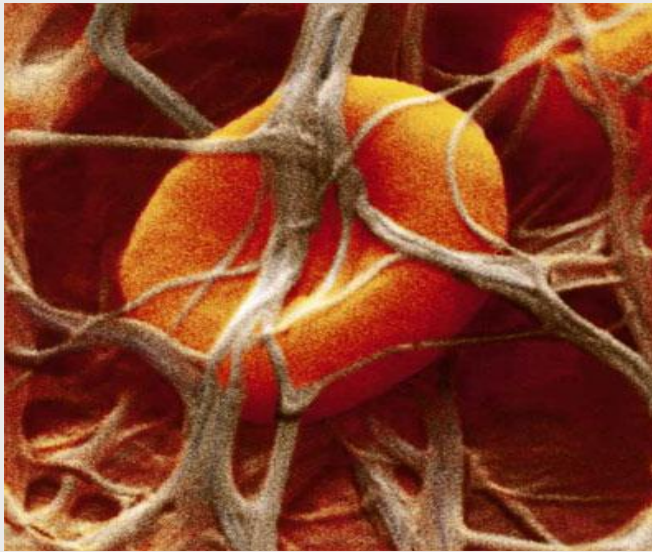
some **lymphocytes** fight disease by making **antibodies** to destroy invaders by dissolving them.

other **lymphocytes** make **antitoxins** to break down poisons.

Platelets



Platelets are bits of cell broken off larger cells.



Platelets produce tiny **fibrinogen fibres** to form a net. This net traps other blood cells to form a **blood clot**.



Summary: Difference Between Blood Cells

Feature	Red Blood Cell	White Blood Cell	Platelet
Shape	Biconcave (no nucleus)	Variable	Tiny cell fragments
Function	Transports O₂ and CO₂	Fight infection	Blood clots
Origin	Bone marrow	Bone marrow and lymph tissue	Bone marrow
Life span	120 days	Variable: days □ years	day
“Name”	erythrocyte	lukocyte	thrombocyte

Blood Clotting

Damaged tissue cells release tissue thromboplastin. Platelets form a platelet plug

Prothrombin activator

Prothrombin
(protein in
blood)

Ca^{2+}

Thrombin
enzyme

Fibrinogen
(protein in
blood)

Ca^{2+}

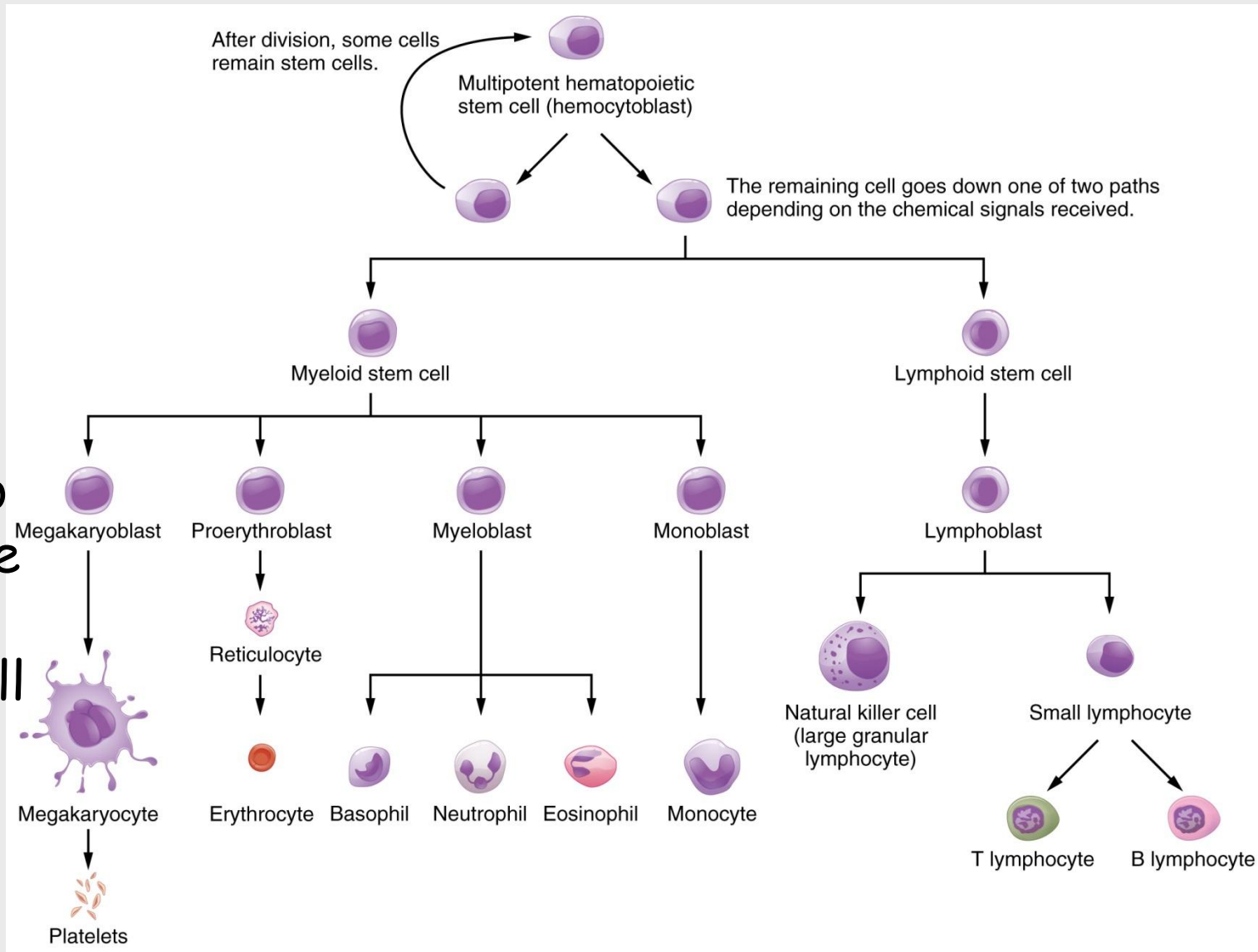
Fibrin
threads (red
blood cells
are trapped
among fibrin
threads)

Blood clot

Hemophilia=
inherited clotting
disorder;
deficiency in
clotting factor

Bone Marrow Stem Cells

Stem cell=
Cell that is
ever capable
of dividing
and
producing
new cells
that go on to
differentiate
into
different cell
types



Fetal Circulation

The fetus has 4 features not present in adults:

1)Oval opening= an opening between the atria.

This allows blood to by-pass the right ventricle □
doesn't go to pulmonary artery and lung

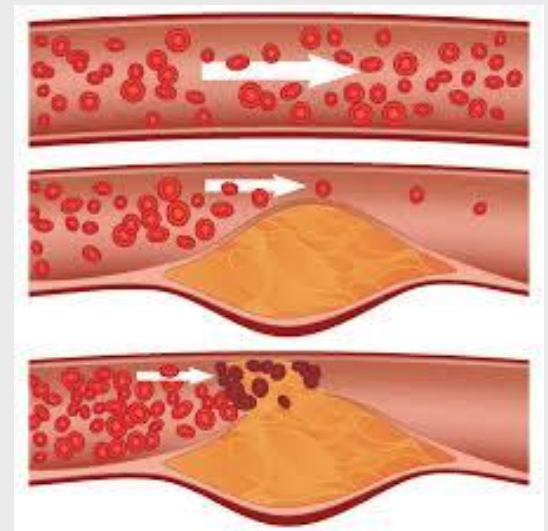
2)Arterial ducts= Duct between pulmonary trunk and aorta which allows blood that has gotten into the pulmonary trunk to by-pass the lung

3)Umbilical Arteries and Vein= travel to and from the placenta

4) Venus Duct= connection between the umbilical vein and inferior vena cava to allow blood high in oxygen and nutrients from the mother to go directly to the heart of the baby

12.5 Cardiovascular Disorders

- **Atherosclerosis**- accumulation of fatty material (usually cholesterol) beneath the inner lining of the arteries = **plaque**
 - **Thrombus**= stationary plaque
 - **Embolus**= plaque that is dislodged and moves along with blood
 - **Thromboembolism**= clot that has been carried in the blood stream but is now stationary (must be treated or serious occur)



Cardiovascular Disorders Cont'

- **Stroke (cerebrovascular accident)=** small cranial arteriole bursts or is blocked by an embolus □ lack of oxygen to brain □ death or paralysis
- **Heart attack (myocardial infarction)=** portion of the heart muscle dies due to lack of oxygen
- **Aneurysm=** ballooning of a blood vessel

Some Solutions to Cardiac Disorders

- Coronary Bypass Operations
- **Angioplasty** (clearing clogged arteries)
- Dissolving Blood Clots
- Heart Transplant
- Artificial Heart

They key is prevention! Stay fit and eat well!

Video Time!

- If you have time (20 min)

The Circulatory System:

<http://www.youtube.com/watch?v=AlcAF34MPpU>

- Short Video

The Circulatory System 3D

<http://www.youtube.com/watch?v=uKdZVt1vBIQ>