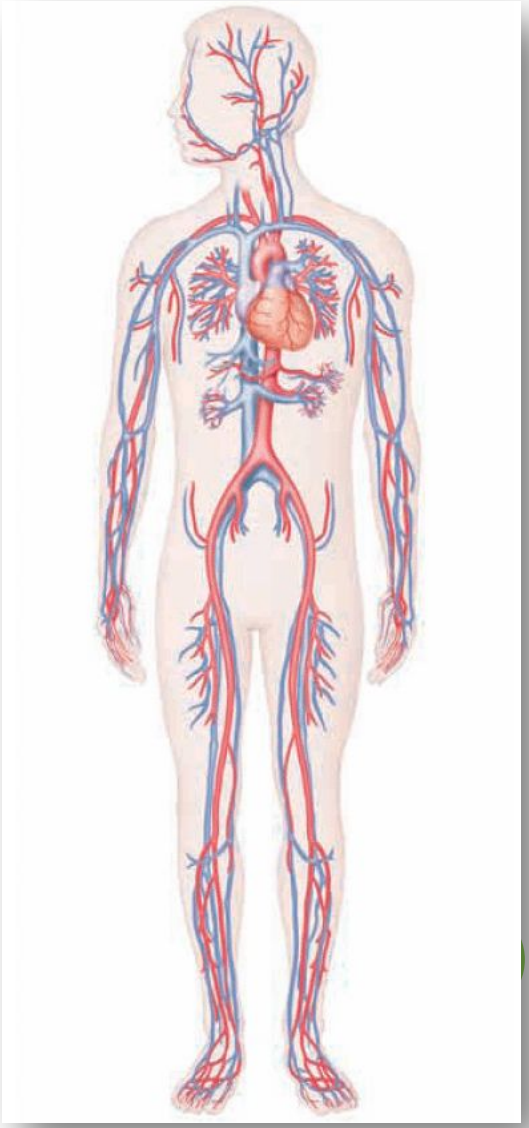
HUMAN CIRCULATORY SYSTEM

Functions of human circulatory system

The human circulatory system functions like a network of highways. It transports materials around the body.



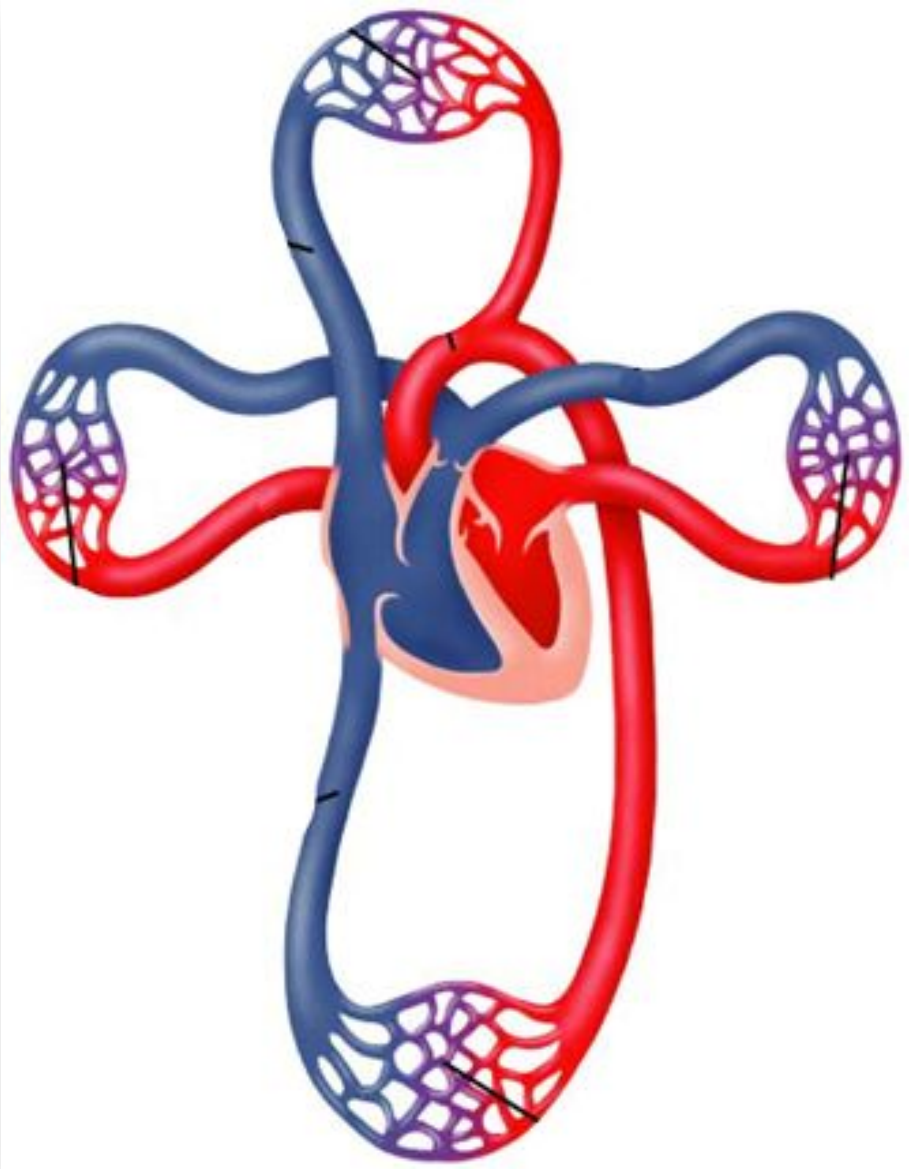
SOME TRANSPORTED MATERIALS

- Oxygen
- Carbon dioxide
- Digested food
- Hormones
- Waste chemicals - urea
- Heat

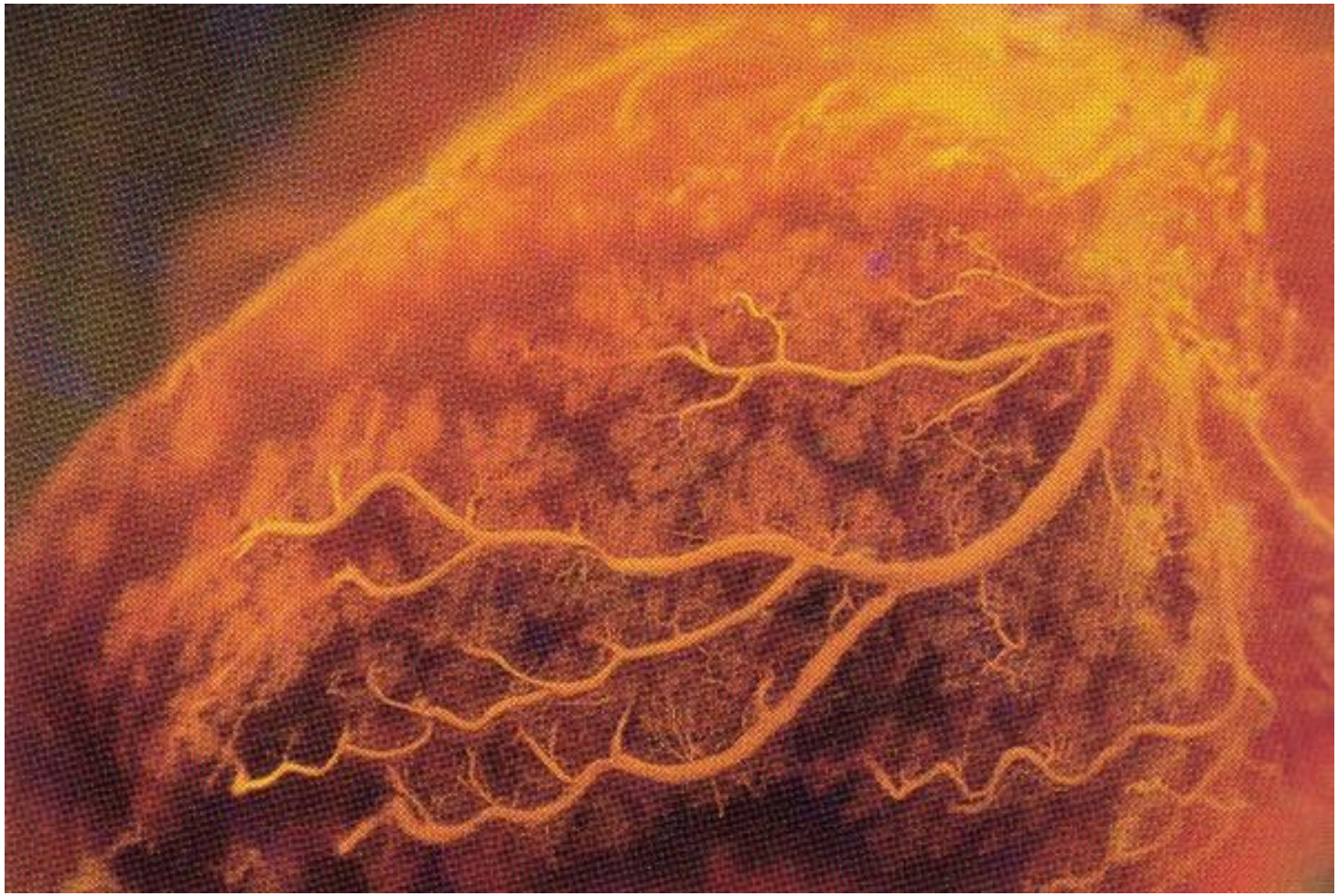
The Human Circulatory System

It consists of:

- **HEART**
- **BLOOD VESSELS**
- **BLOOD**



The Heart



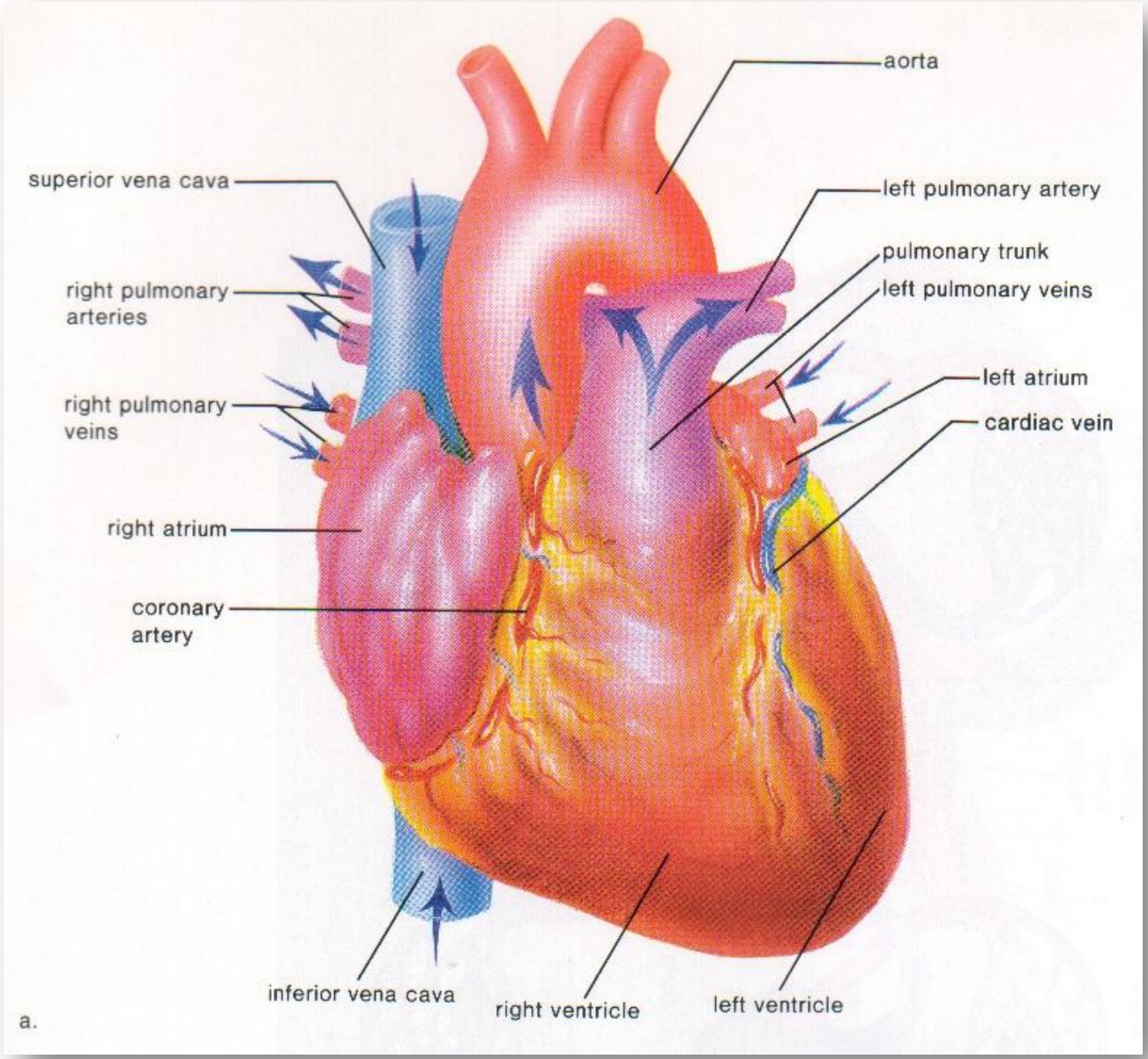
HEART FACTS:

- About 250-340 grams,
- In your life time, pumps about 300 million liter of blood,
- It contracts about 2.5 billion times.

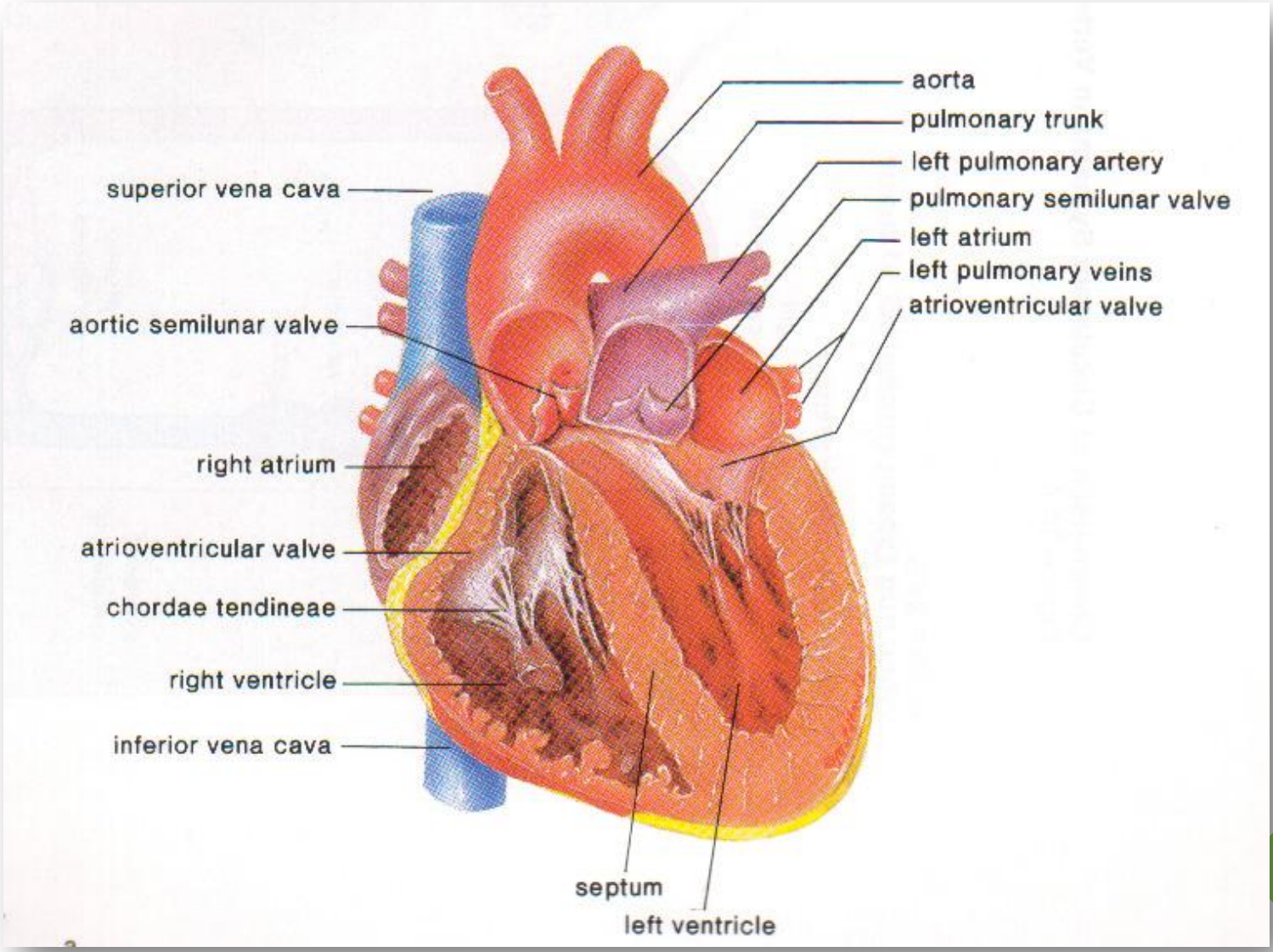
Main structure of the heart

- The heart is made of a special type of muscle called **cardiac muscle** which contracts and relaxes rhythmically for a lifetime.
- The heart is located in the chest cavity and is surrounded by a membrane called the **pericardium**.
- The blood vessels which supply food and oxygen to heart are called as **coronary arteries.**

External Structure



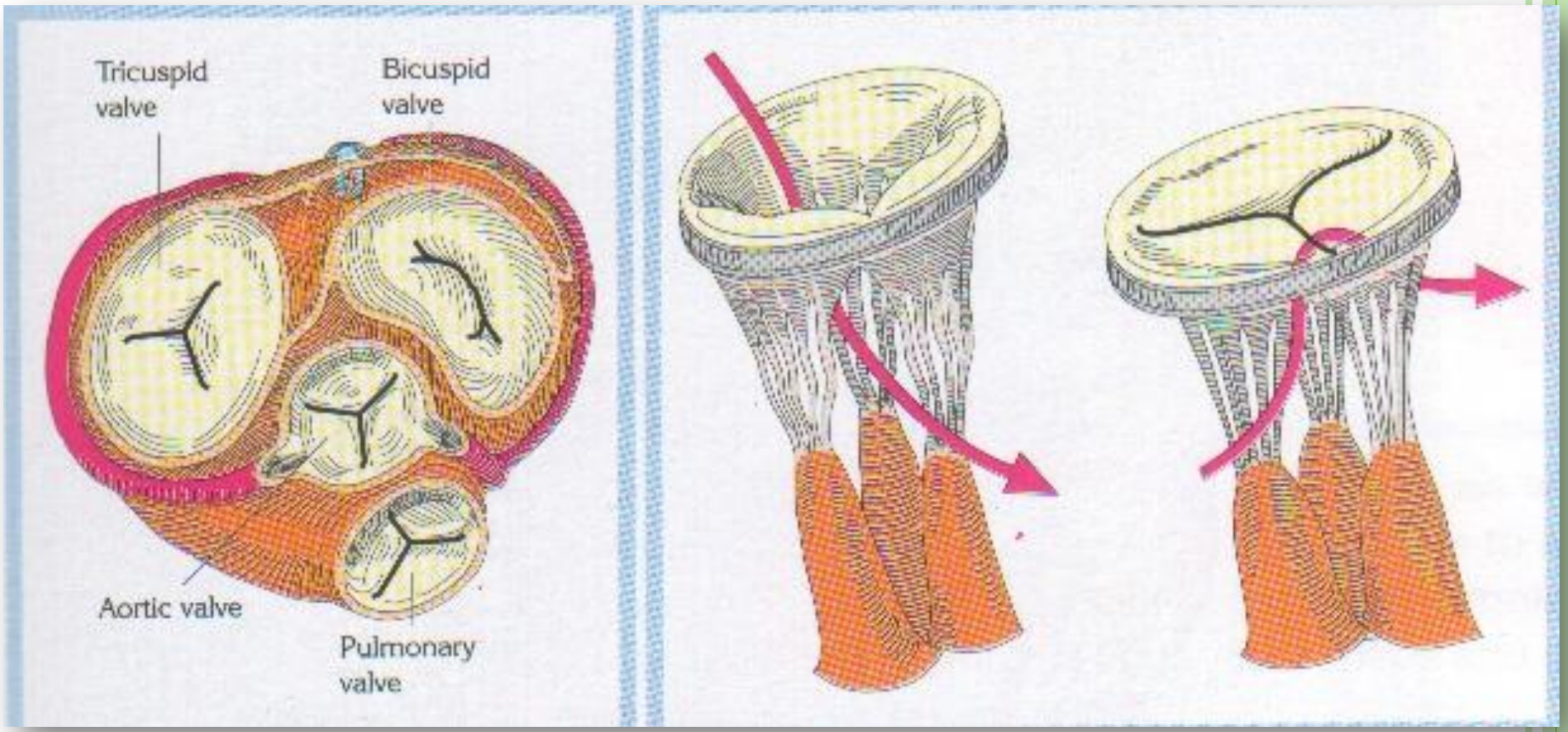
Internal Structure



Internal Structure Of The Heart

- The heart consists of four chambers :
- The two upper chambers = **ATRIA**
- The two lower chambers = **VENTRICLES**
- Between atria and ventricle there are valves, preventing the blood coming back to the atria when the ventricles contract.
- The valve on the left is **BICUSPID VALVE**
- The valve on the right is **TRICUSPID VALVE**
- The **lub-dub** heart sound is generated by valves.

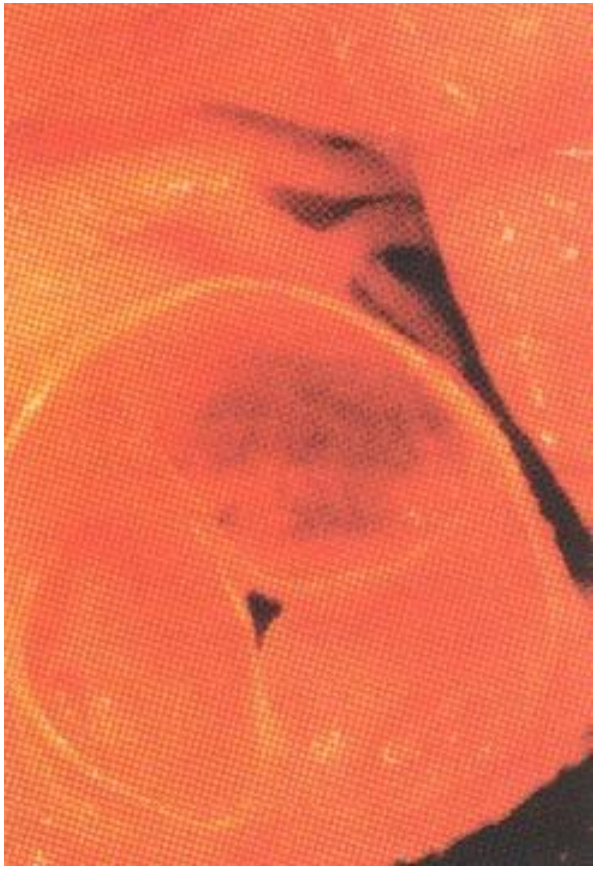
VALVES

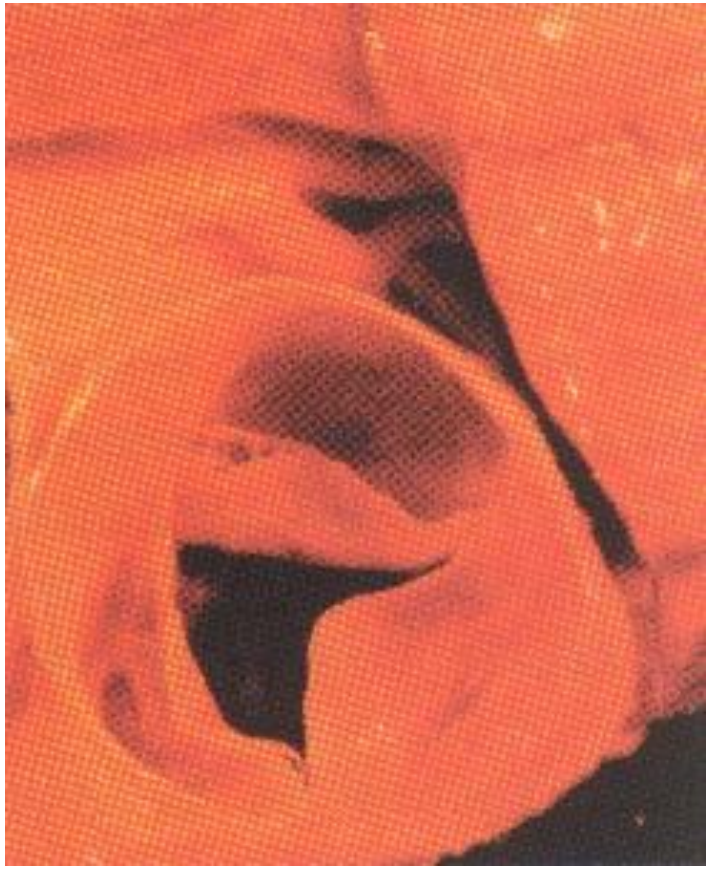

Tricuspid valve
Bicuspid valve
Aortic valve
Pulmonary valve

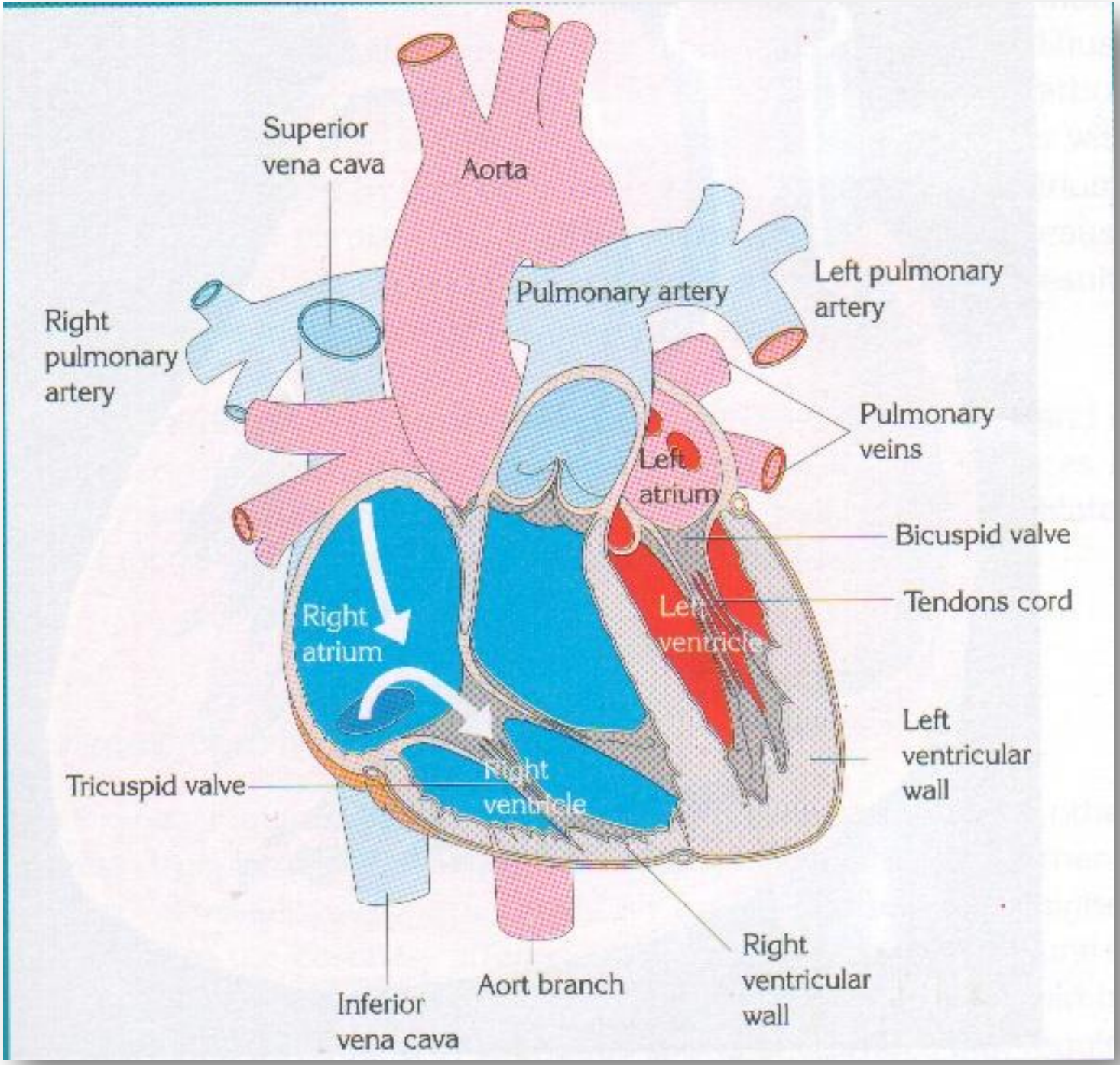
Semilunar Valves

- Semilunar valves are found between the arteries and the ventricles.
- They prevent the blood entering the arteries when the ventricle contract.
- Between left ventricle and aorta there is **aortic valve**
- Between right ventricle and pulmonary artery there is **pulmonary valve**

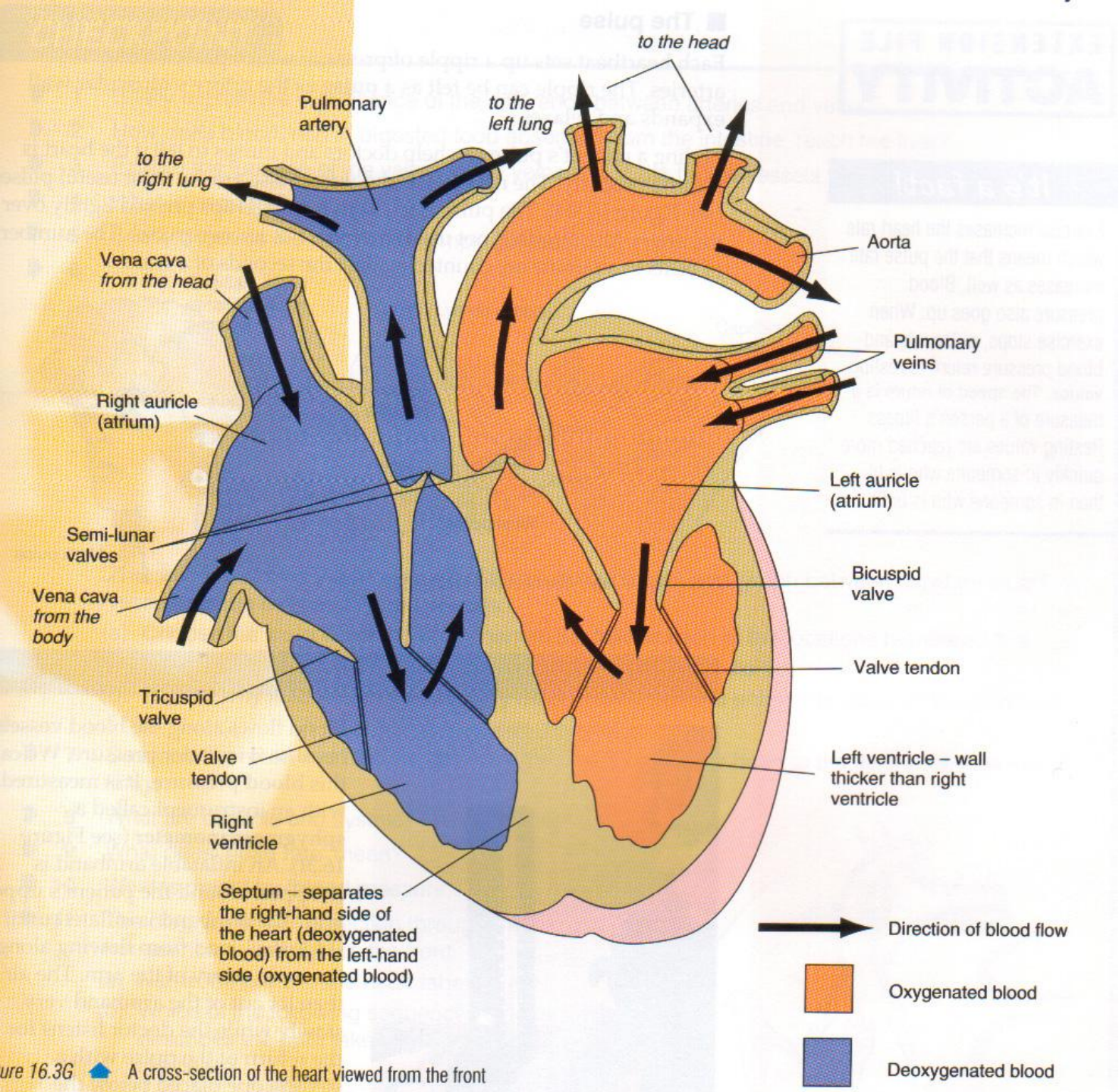
VALVES






Superior vena cava
Aorta
Left pulmonary artery
Pulmonary artery
Right pulmonary artery
Pulmonary veins
Left atrium
Bicuspid valve
Tendons cord
Right atrium
Left ventricle
Left ventricular wall
Tricuspid valve
Right ventricle
Right ventricular wall
Aort branch
Inferior vena cava

CARDIAC CYCLE

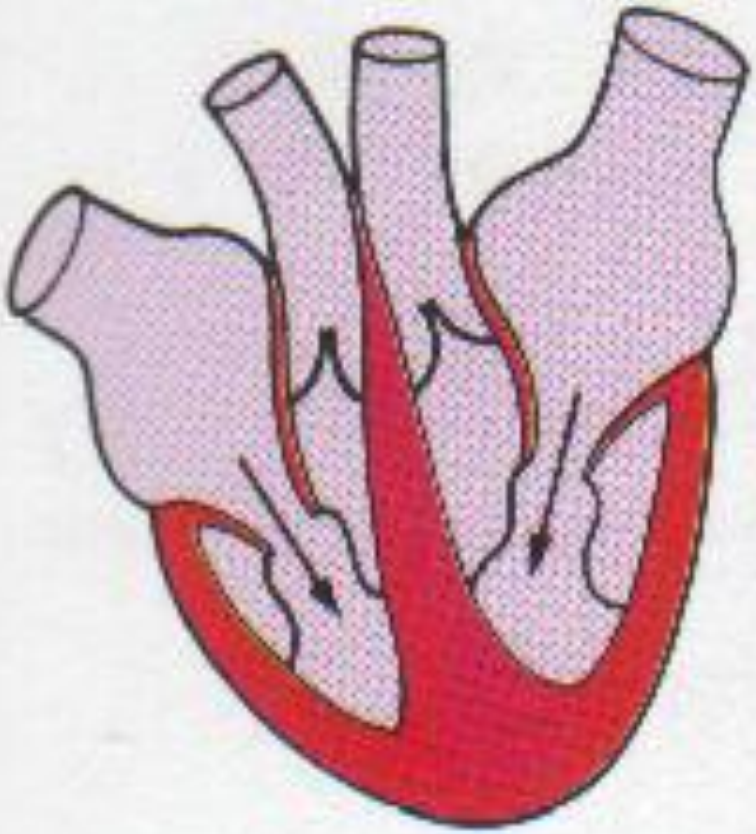


ure 16.3G A cross-section of the heart viewed from the front

Cardiac activity

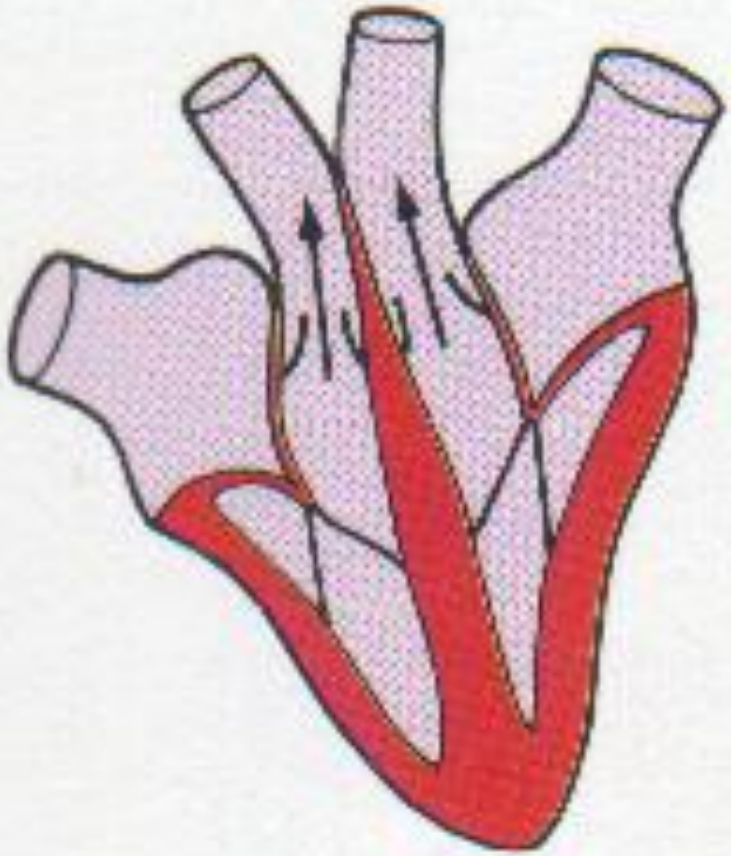
- The heart pumps blood into the body.
- **Relaxation** of heart is known as **diastole**.
- **Contraction** of heart is known as **systole**.
- Blood is pumped into the ventricles by atrial contraction, and blood is pumped into the vessels by ventricular contraction.

HEART RELAXING
(diastole)



Ventricular muscle relaxes
Bicuspid and tricuspid valves open
Pocket valves close
Blood flows from atria into ventricles

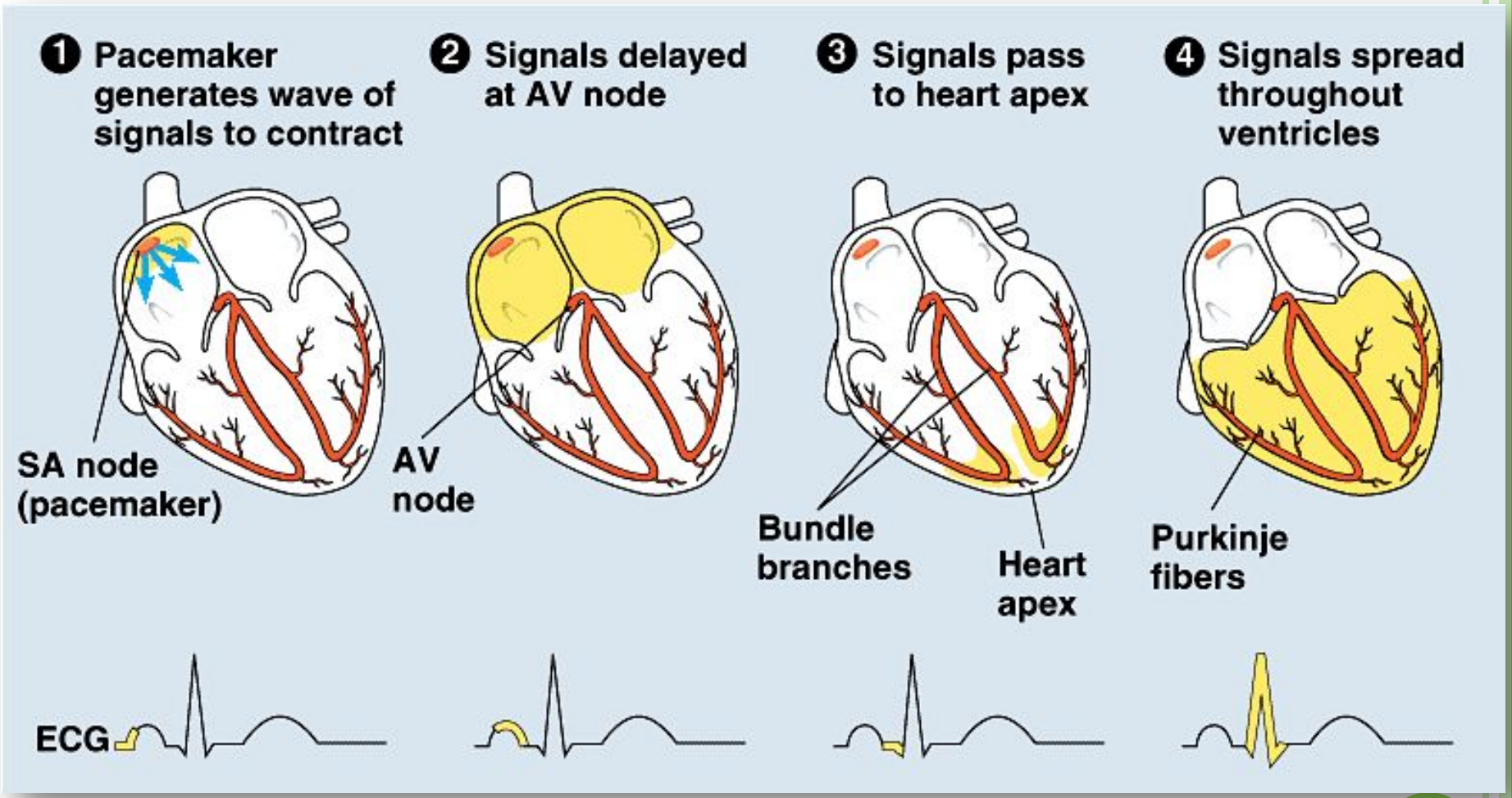
HEART CONTRACTING (systole)



Ventricular muscle contracts
Bicuspid and tricuspid valves close
Pocket valves open
Blood flows from ventricles into arteries
Chords become tight and prevent atrio-ventricular valves turning inside out

Control of HEART

- Heartbeat is controlled by **autonomic nervous system**.
- The autonomic nervous system stimulates the sinoatrial node and atrioventricular node for initiation of a contraction. The atria and ventricles contract as a result.
- SA node sends impulses to heart every **0.85 seconds**


1 Pacemaker generates wave of signals to contract
2 Signals delayed at AV node
3 Signals pass to heart apex
4 Signals spread throughout ventricles
SA node (pacemaker)
AV node
Bundle branches
Heart apex
Purkinje fibers
ECG

Heart Rate

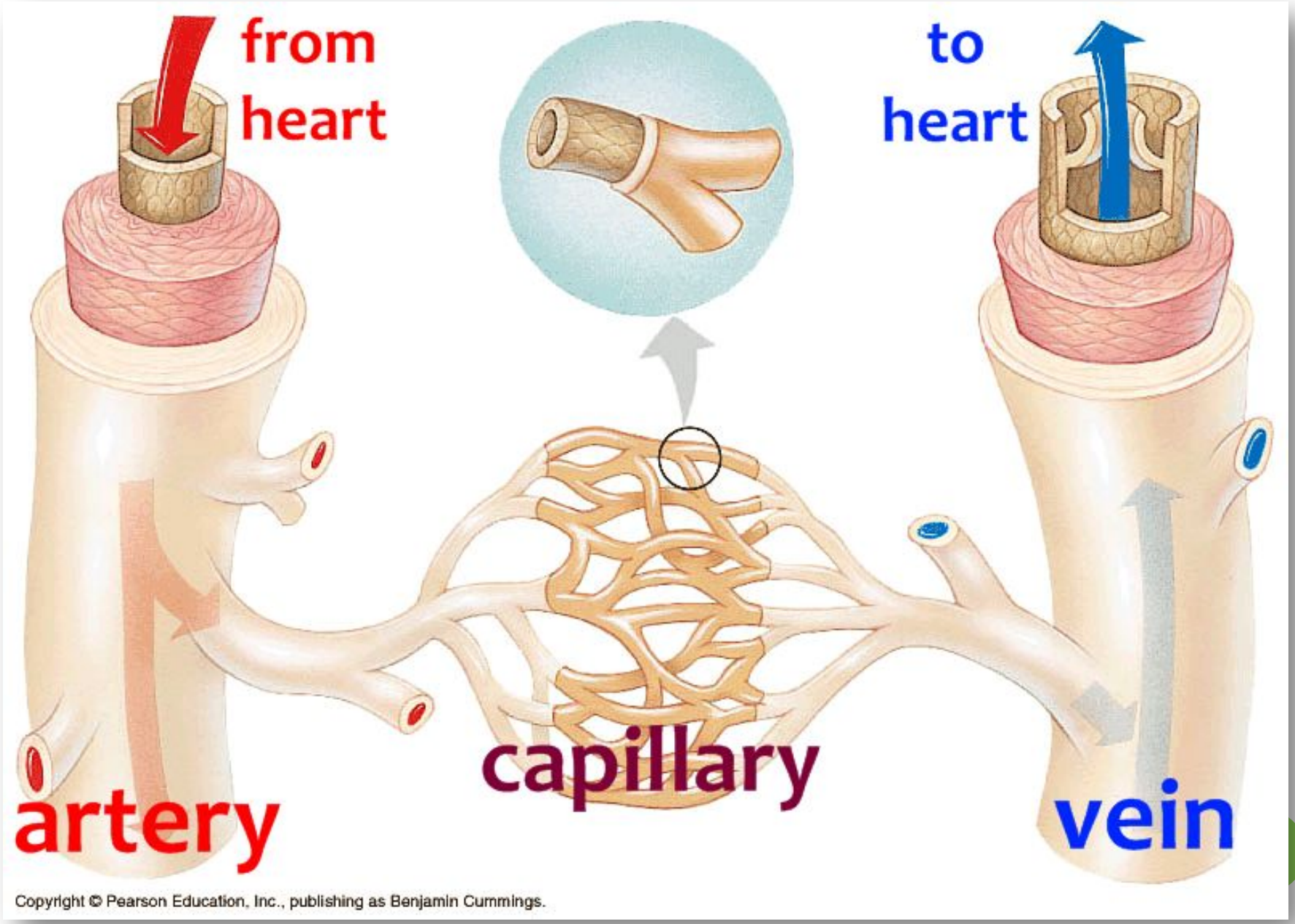
- **Parasympathetic** nerves reduces the heart rate.
- **Sympathetic** nervs speed up the heart rate.
- **Acetylcholine** reduces the heart rate.
- **Adrenaline** speed up the heart rate.
- **CO_2** reduces the heart rate.
- **High temperature** increases the heart rate.

BLOOD VESSELS

There are 3 types of vessels in our body.

These are;

- ARTERIES
- VEINS
- CAPILLARIES

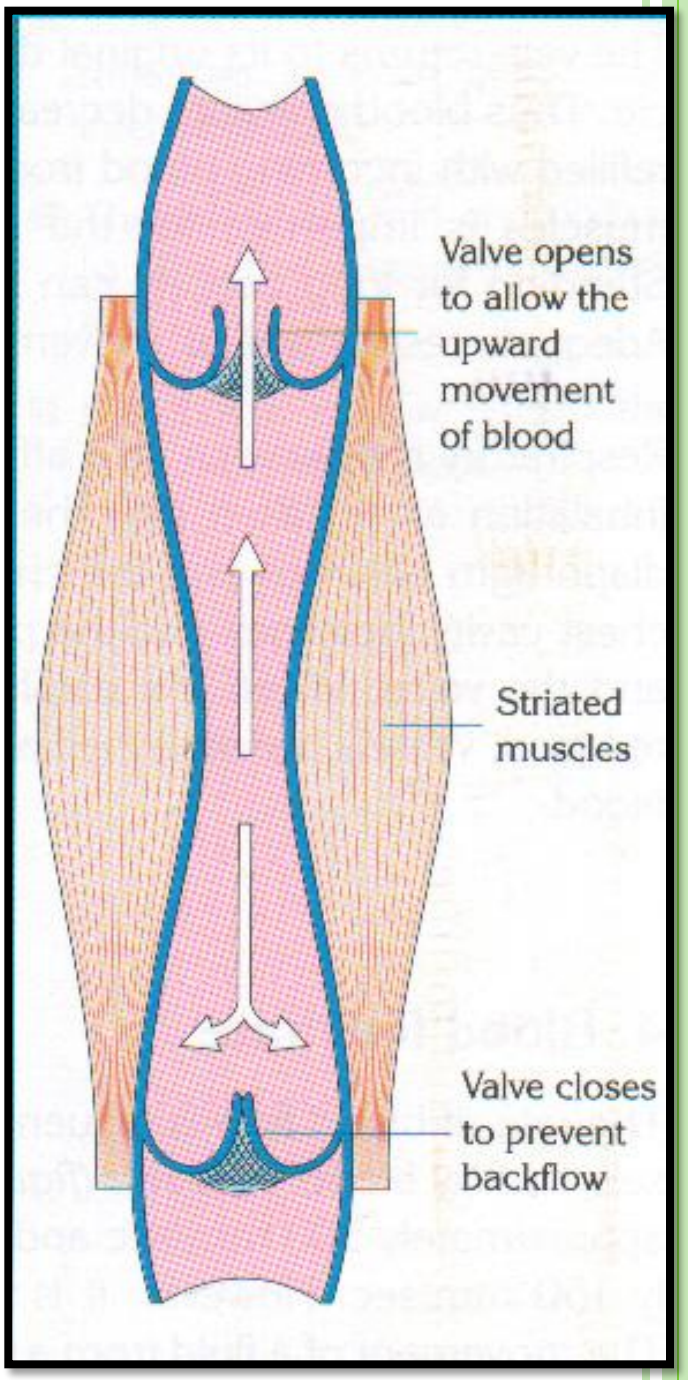


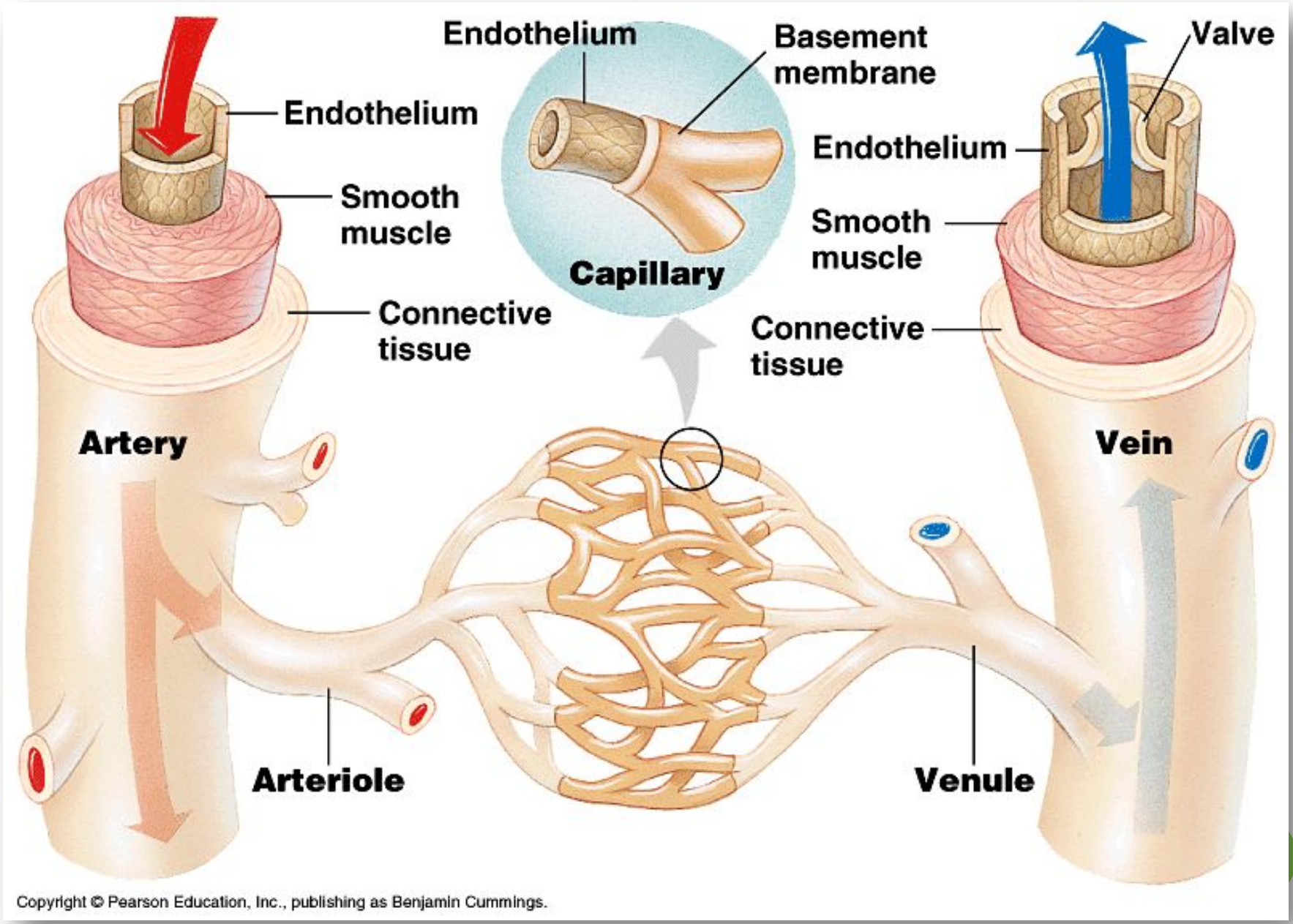
1. Arteries

- Arteries carry blood **away from heart** to the different tissues of the body.
- Artery walls are **stronger** and **thicker** and more **elastic** than the veins.
- The **pulse** is the rhythmic contraction and relaxation of arteries which are parallel to the contraction of the heart.
- Branches of arteries are called as **arteriole**.
- They carry mainly **oxygenated** **blood**

2. Veins

- Veins carry blood to heart
- Their **walls** are much **thinner** than the walls of arteries.
- Veins are farther from the heart and exposed to **lower pressures**.
- Veins are **larger in diameter** than arteries.
- Most veins have one-way **valves**. A **valve** is a flap of tissue that ensures blood passes through but does not flow backwards.
- Branches of veins are called as **venules**
- Veins mainly carry **deoxygenated** blood




Endothelium
Basement membrane
Valve
Endothelium
Endothelium
Smooth muscle
Smooth muscle
Capillary
Connective tissue
Connective tissue
Artery
Vein
Arteriole
Venule
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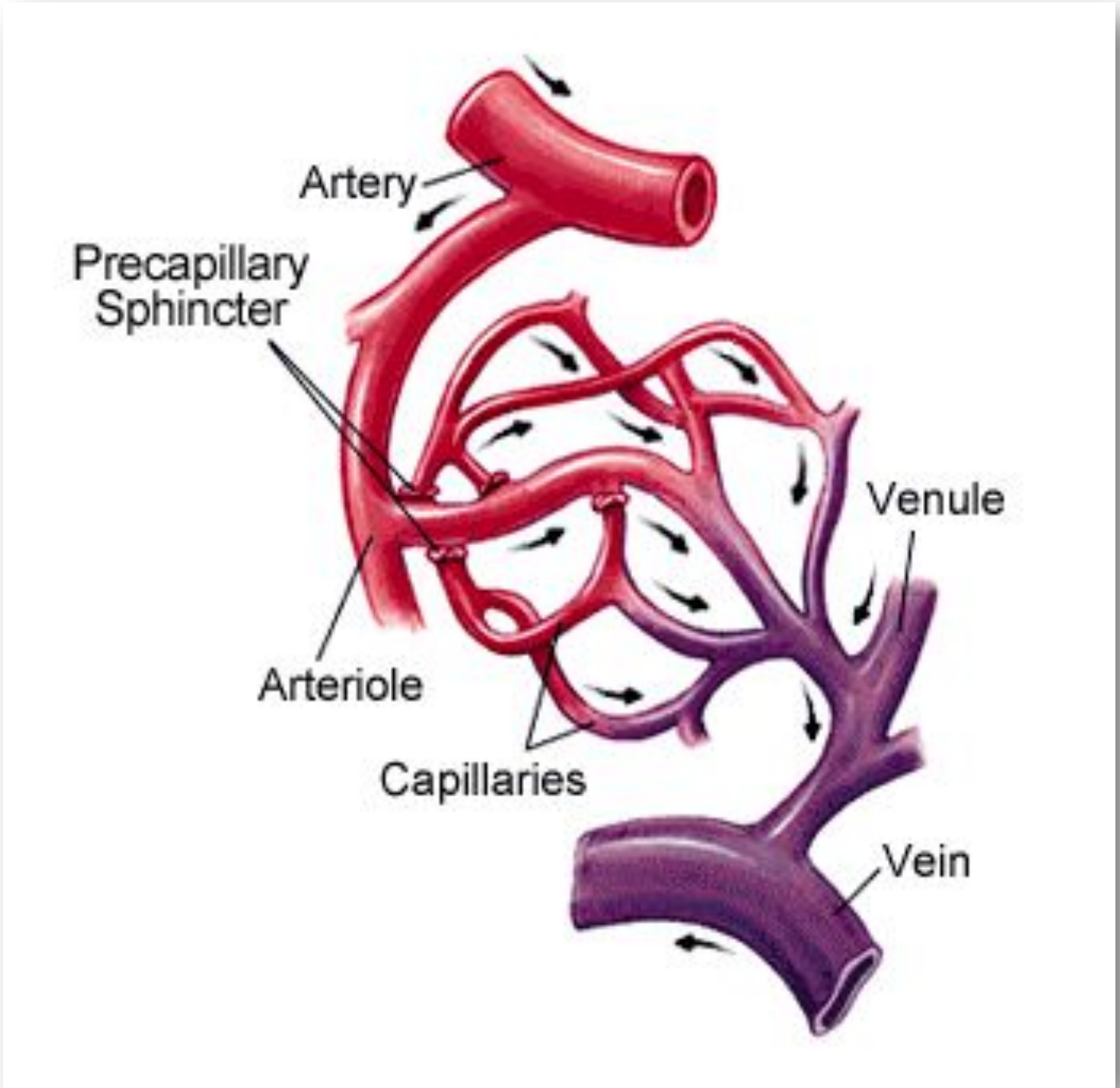
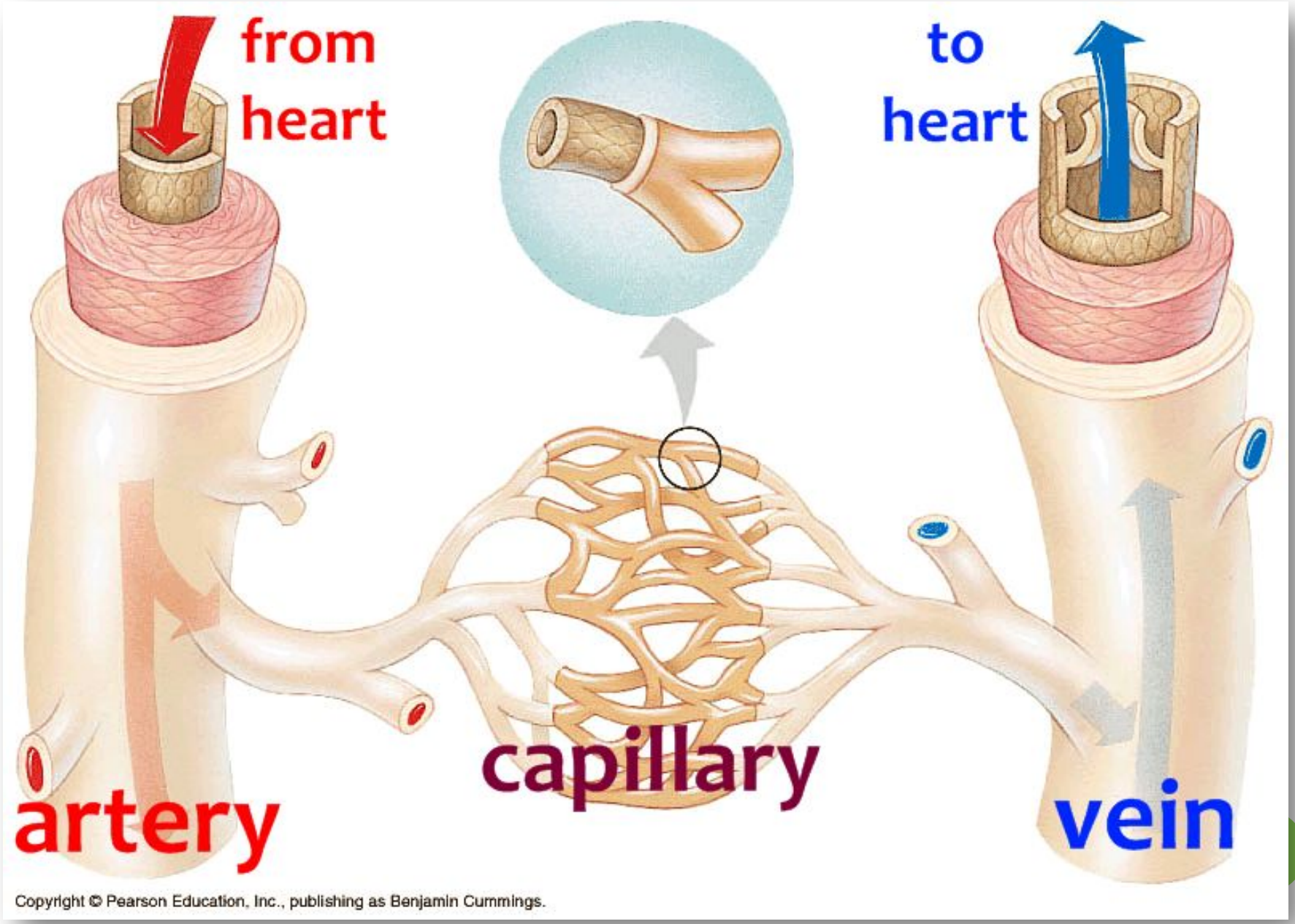
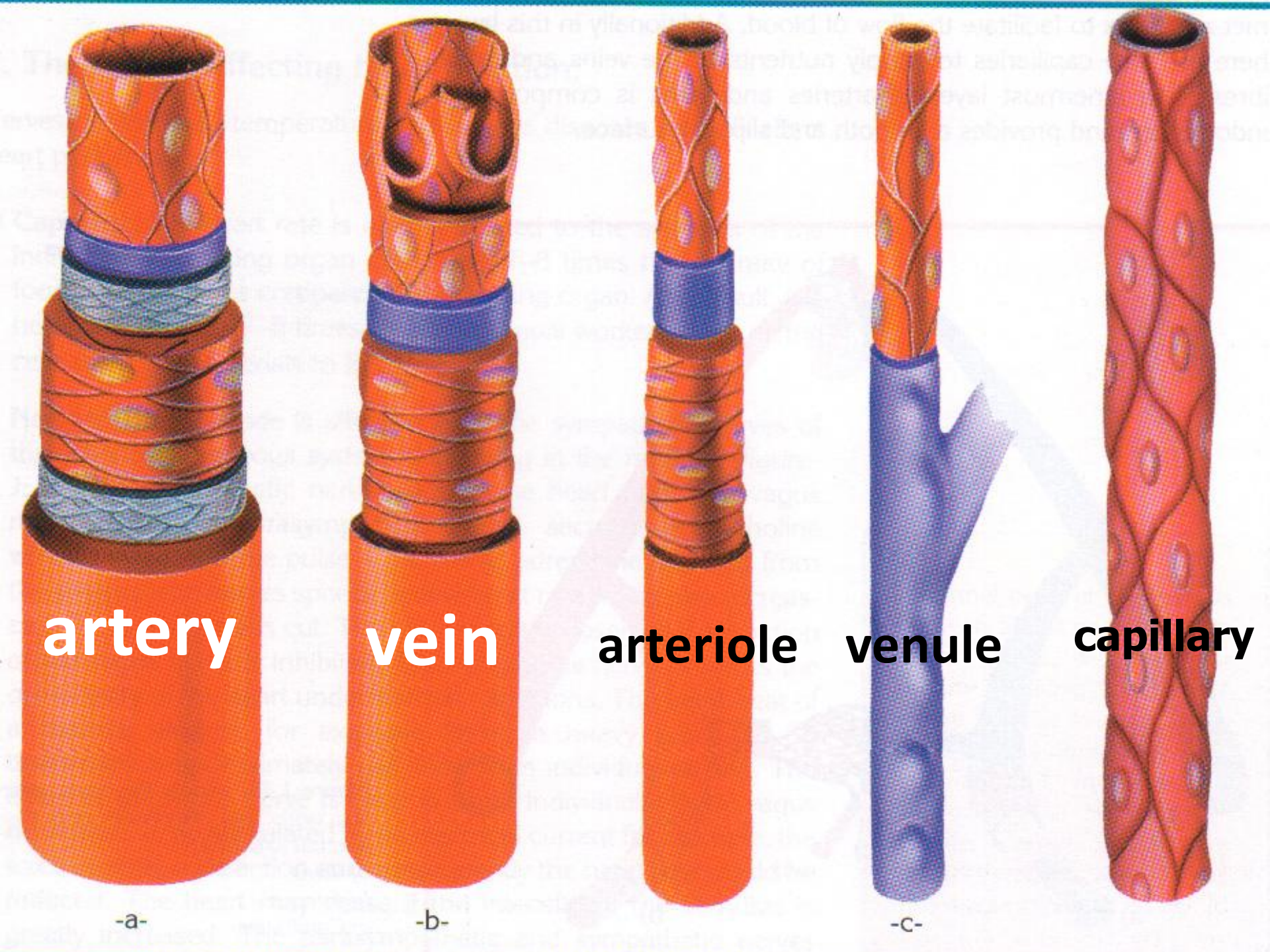
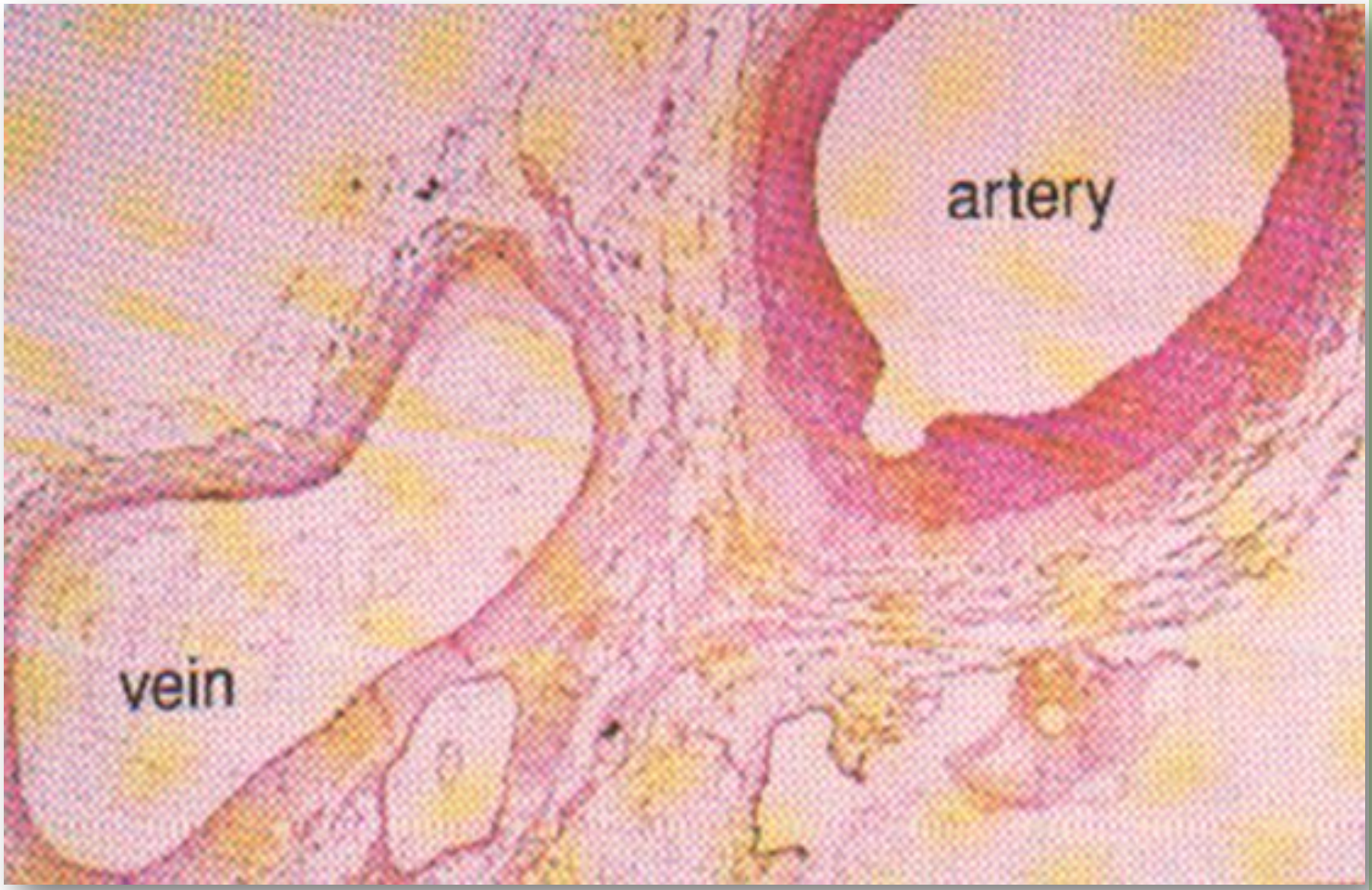
3. Capillaries

- Capillary walls are only **one cell thick**. Gas and nutrient molecules pass easily through their thin walls.
- They are **non-muscular** in structure.
- Capillaries **connect arteries** to the **veins**.


Artery
Precapillary Sphincter
Arteriole
Capillaries
Venule
Vein



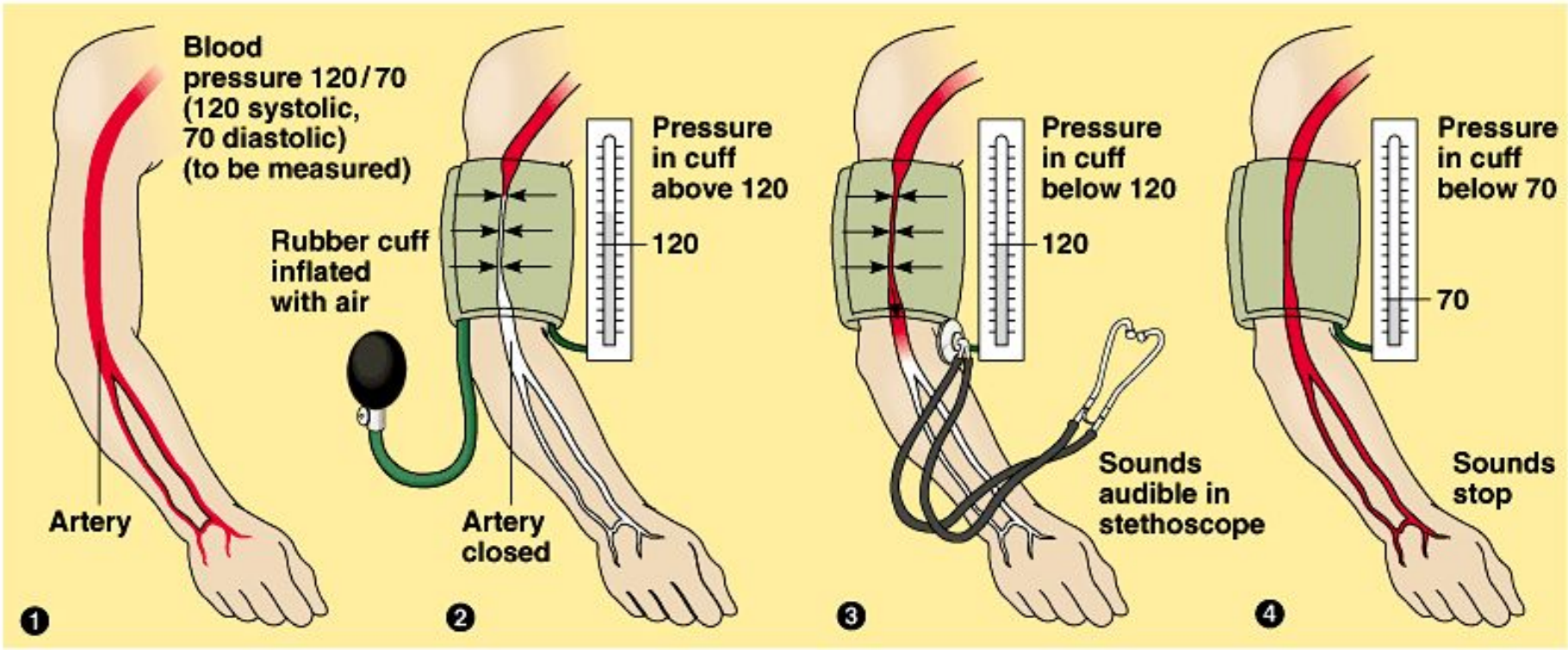

artery
vein
arteriole
venule
capillary
-a-
-b-
-c-

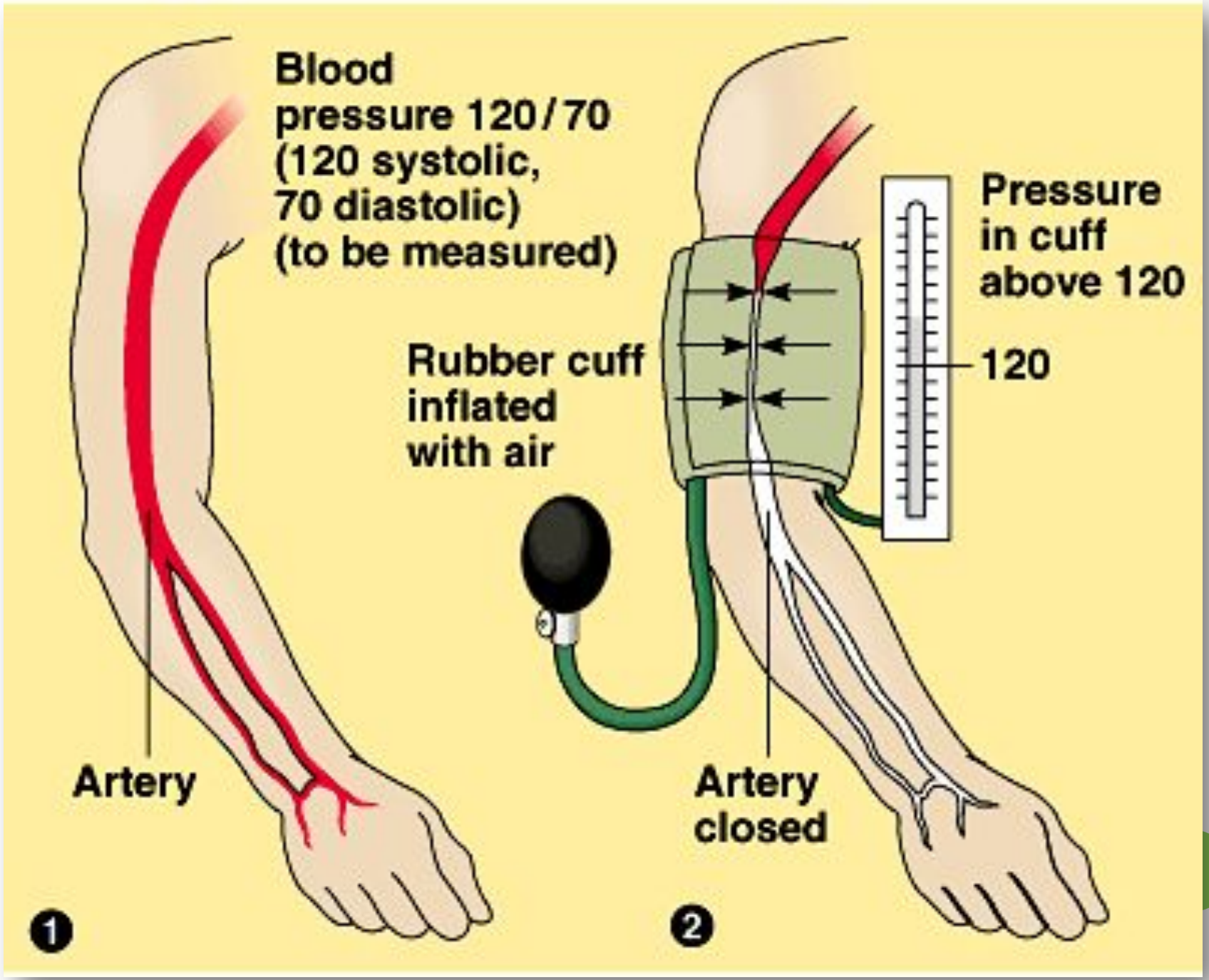

artery
vein

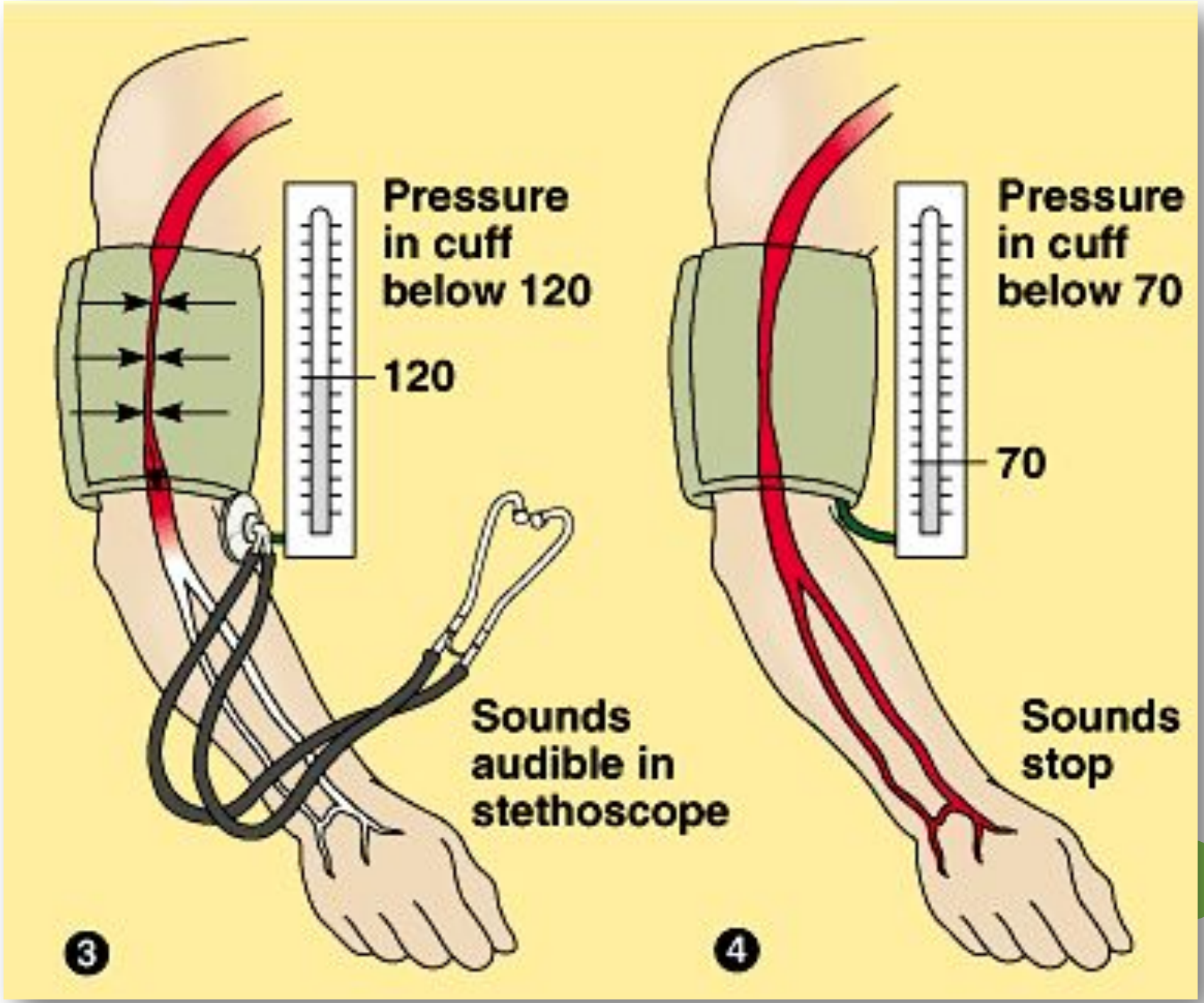
Blood Pressure

- Blood exerts pressure on the walls of vessels during circulation
- Blood pressure **increases** when the ventricles contract (**systole**) and **decreases** when the ventricles relax (**diastole**)
- In normal healthy human **systolic pressure is 120** mm Hg and **diastolic is 70** mm Hg (120/70)
- The blood pressure **increases** during physical work, and **decreases** during rest and sleep
- Abnormal increase of blood pressure is known as **hypertension**
- Abnormal decrease – **hypotension**

Measuring Blood Pressure



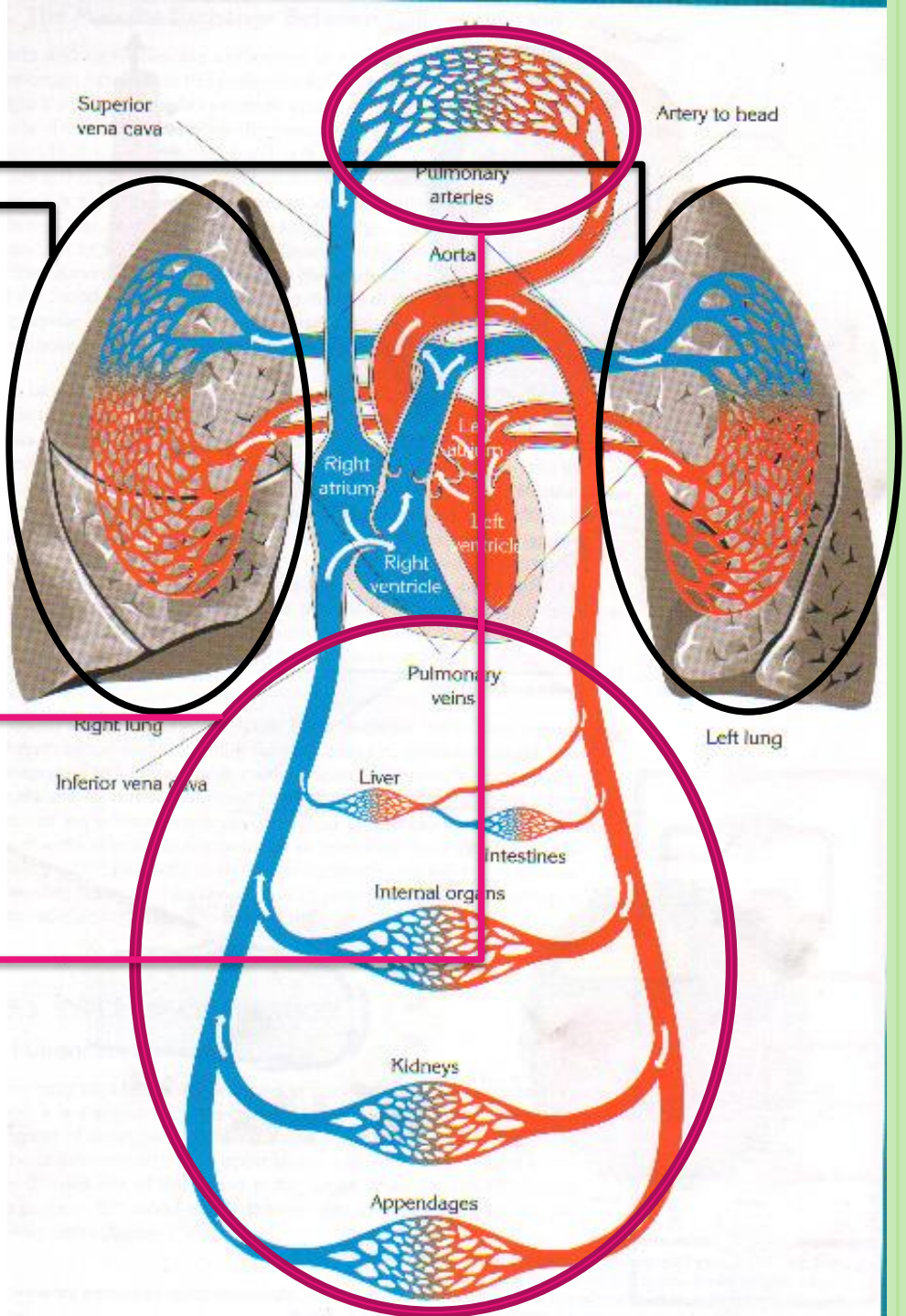

Blood pressure 120/70 (120 systolic, 70 diastolic) (to be measured)
Artery
1
Rubber cuff inflated with air
Pressure in cuff above 120
120
Artery closed
2


Pressure in cuff below 120
120
Sounds audible in stethoscope
3
Pressure in cuff below 70
70
Sounds stop
4

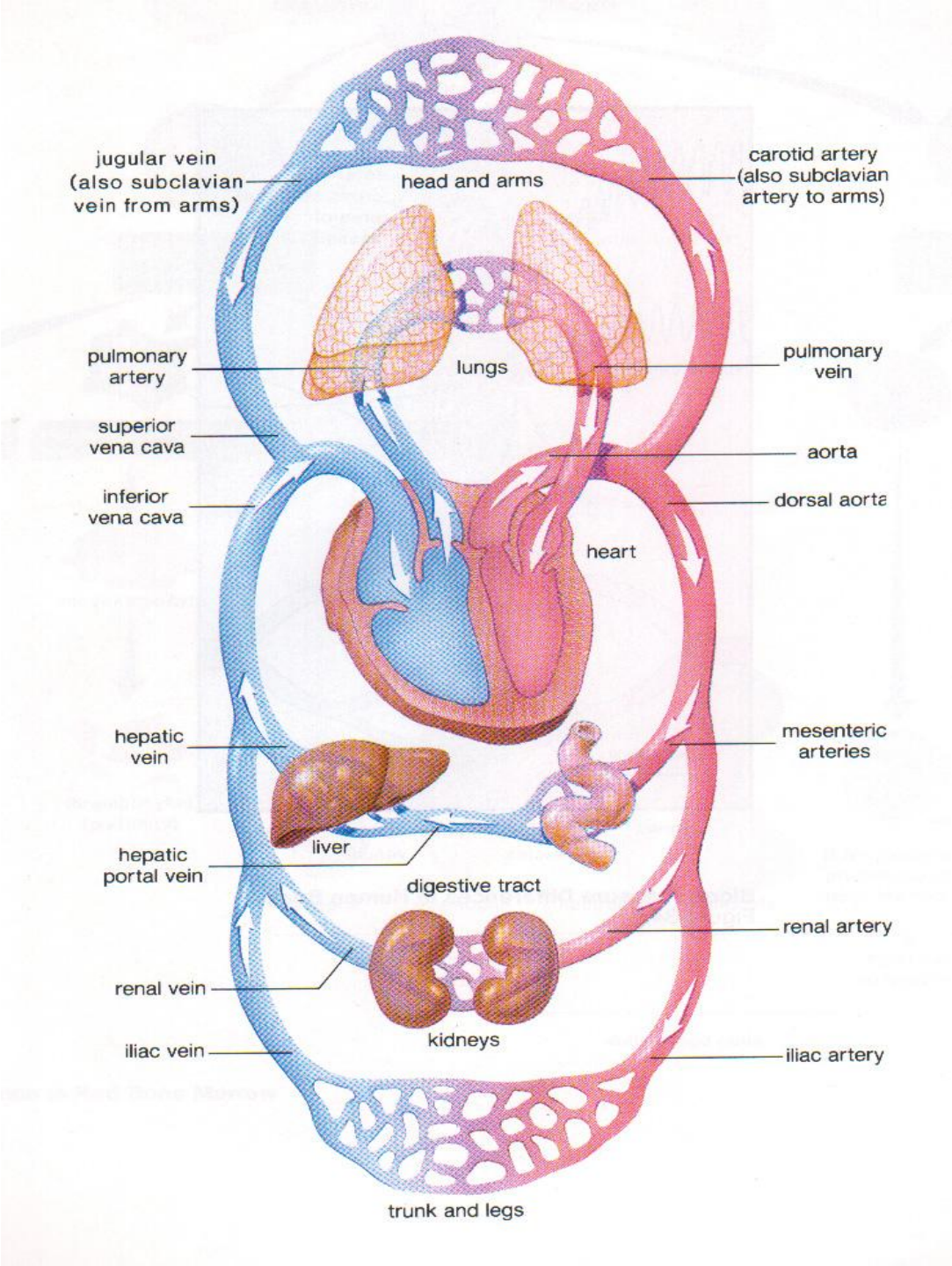
Blood Circulation

- There two types of circulation in human body:
- **1. <u>Pulmonary Circulation</u>:** Oxygen poor blood is pumped into lungs. And oxygen rich one is brought back to the heart.
- **2. <u>Systemic Circulation</u>:** Oxygen rich blood is pumped into body parts. And contaminated blood is brought back to the lungs.

Pulmonary circulation

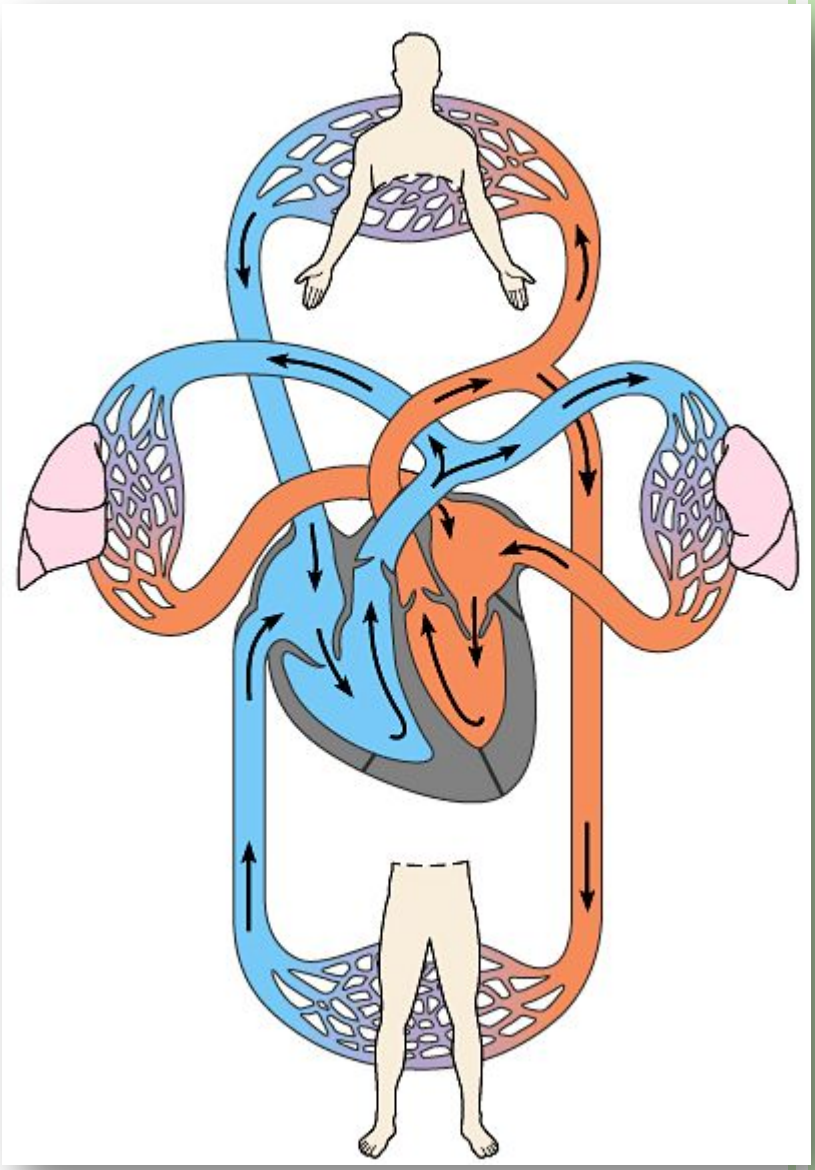


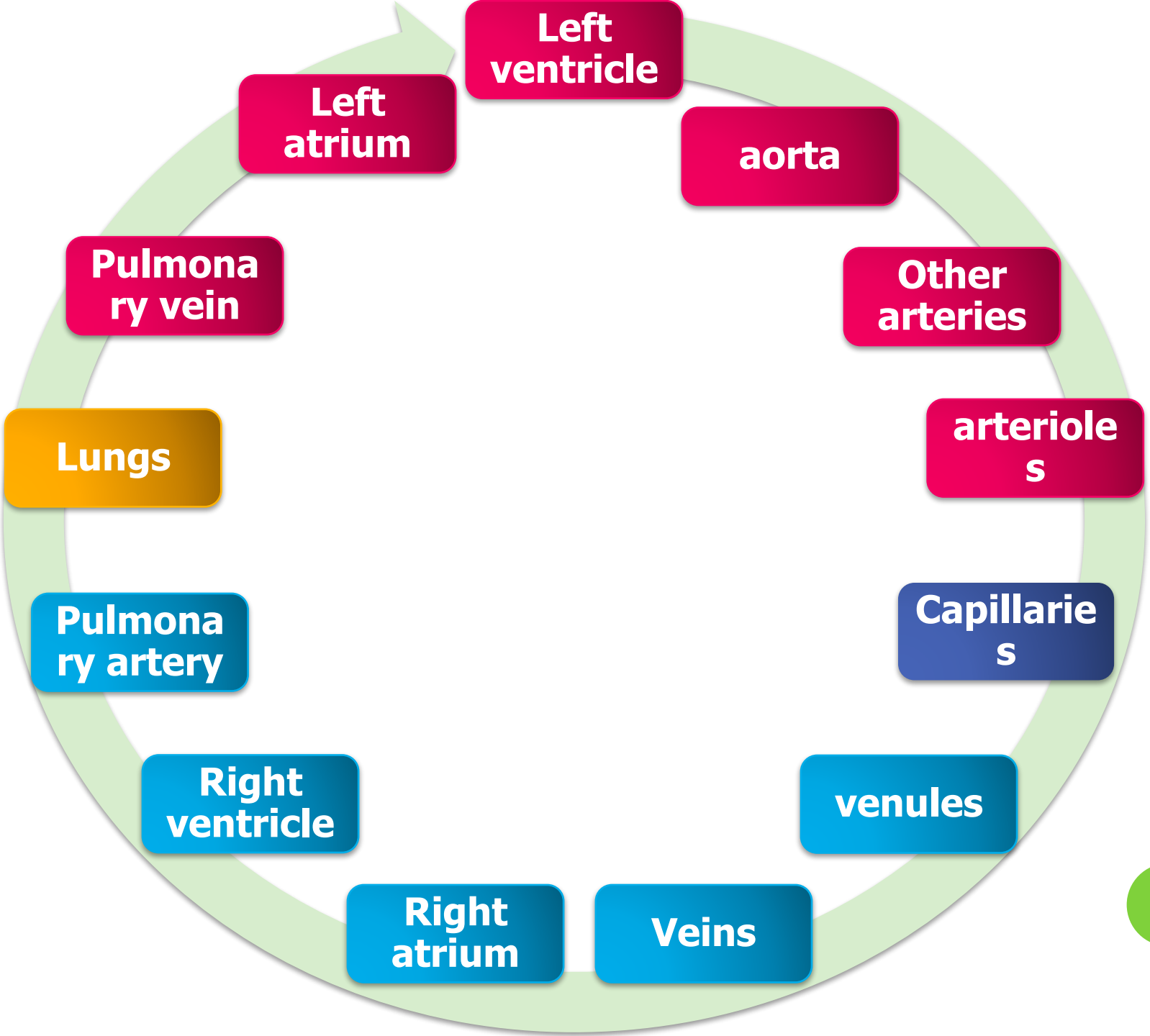
Systemic circulation


jugular vein
(also subclavian
vein from arms)
head and arms
carotid artery
(also subclavian
artery to arms)
pulmonary
artery
lungs
pulmonary
vein
superior
vena cava
aorta
inferior
vena cava
dorsal aorta
heart
hepatic
vein
mesenteric
arteries
liver
hepatic
portal vein
digestive tract
renal artery
renal vein
kidneys
iliac vein
iliac artery
trunk and legs

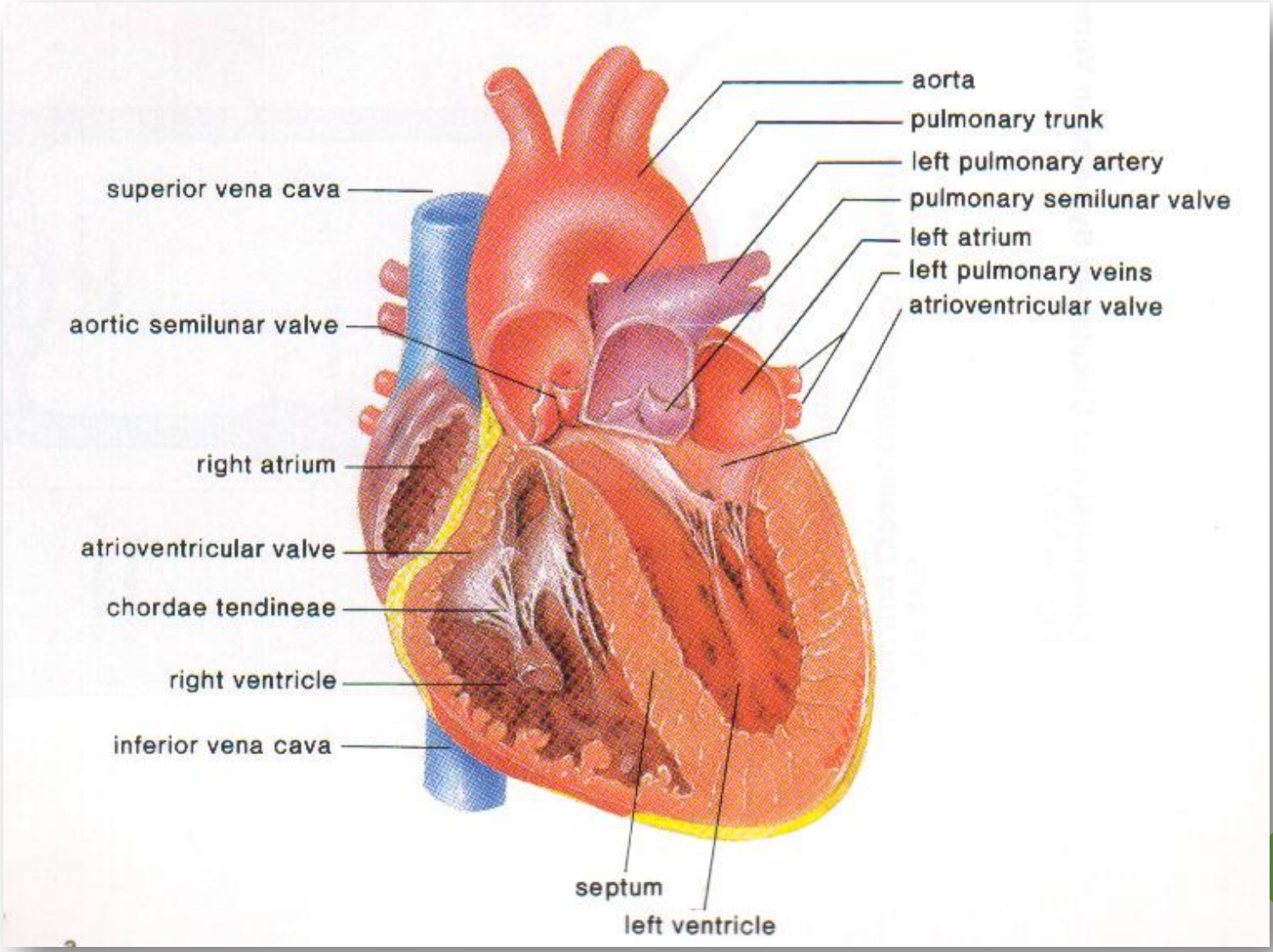
Blood Movement

- Left ventricle pumps **oxygenated** blood to body, that's why it's walls are thicker
- Right ventricle pumps **deoxygenated** blood to lungs
- **All arteries** except **pulmonary artery** carry oxygenated blood
- **All veins** except **pulmonary vein** carry deoxygenated blood




Left ventricle
aorta
Other arteries
arterioles
Capillaries
venules
Veins
Right atrium
Right ventricle
Pulmonary artery
Lungs
Pulmonary vein
Left atrium

Internal Structure



BLOOD

- Blood is a type of tissue that formed by mesoderm layer of embryo.
- An adult Human body has approximately 5,5 liters of blood.

FUNCTIONS OF BLOOD

- Transport of materials
- Hormone transport
- Homeostasis
- Immune response
- Blood Clotting

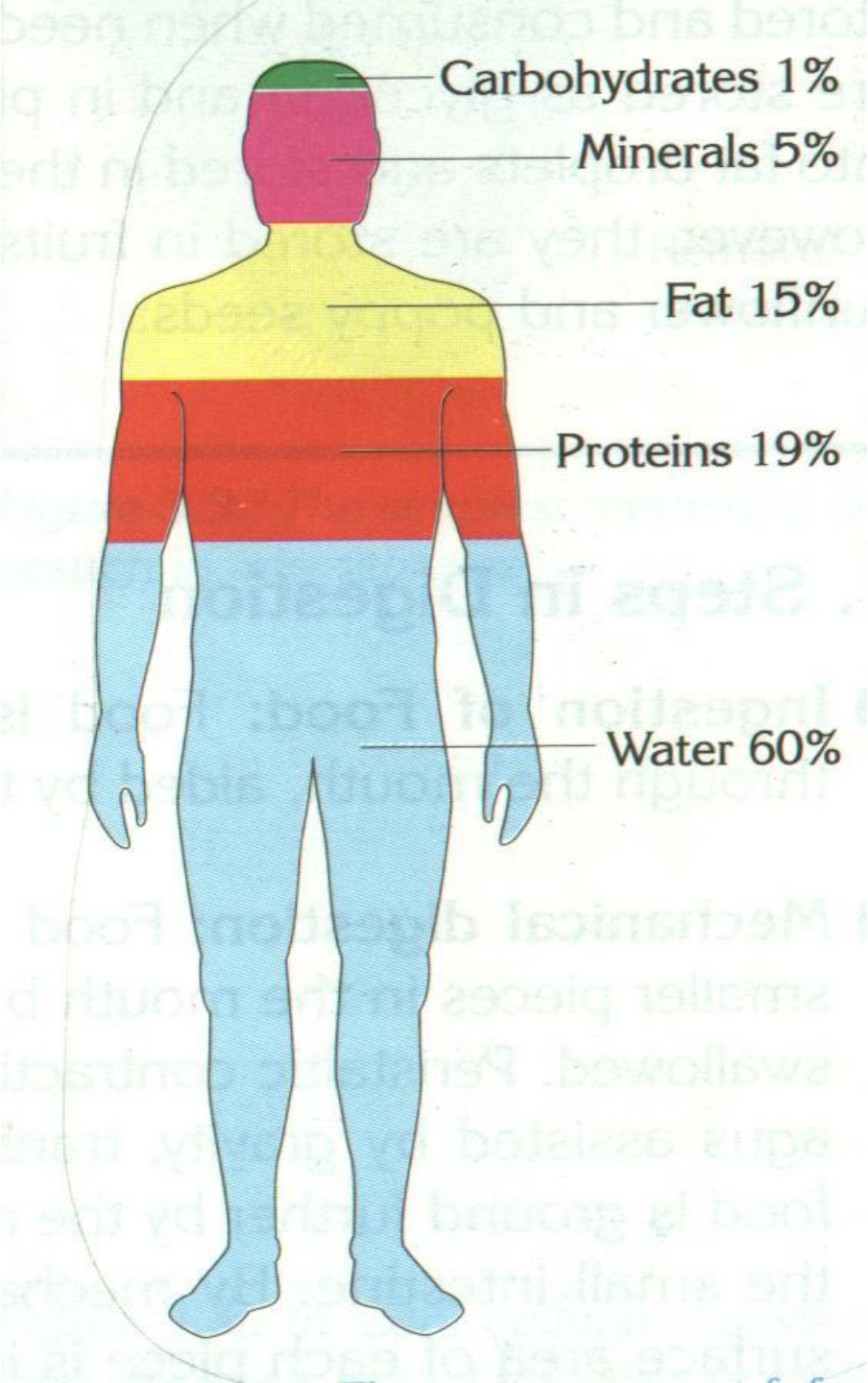
BLOOD COMPONENTS

Blood contain 2 main parts. These are:

- Blood Plasma
- Blood cells

Blood Plasma

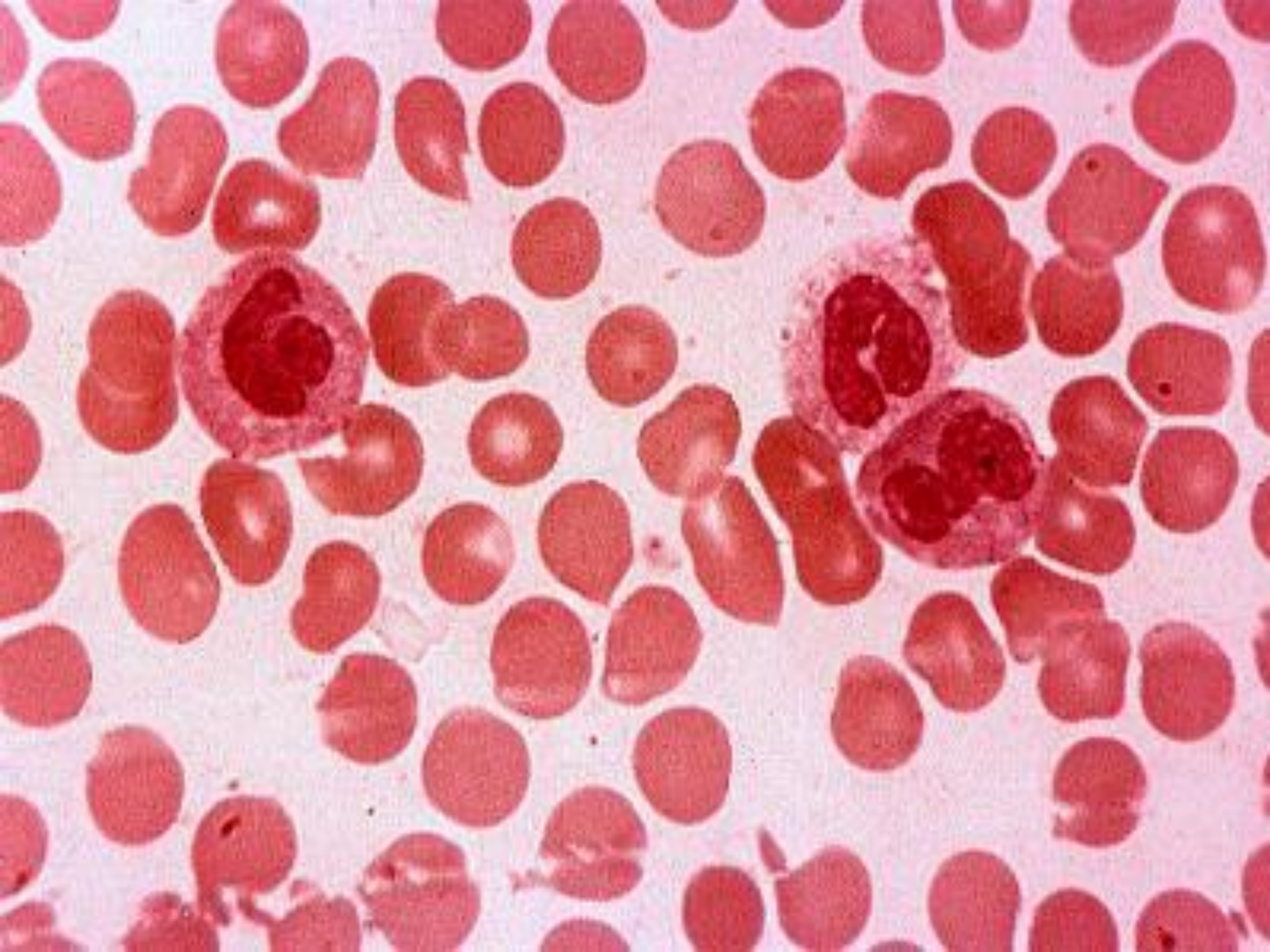
- Plasma is liquid part of blood. It includes **water (90%)** and **dissolved proteins**. It also contains salts, glucose, aminoacids, fatty acids, vitamins, hormones and cellular wastes.


Carbohydrates 1%
Minerals 5%
Fat 15%
Proteins 19%
Water 60%

Blood Cells

There are three types of blood cells:

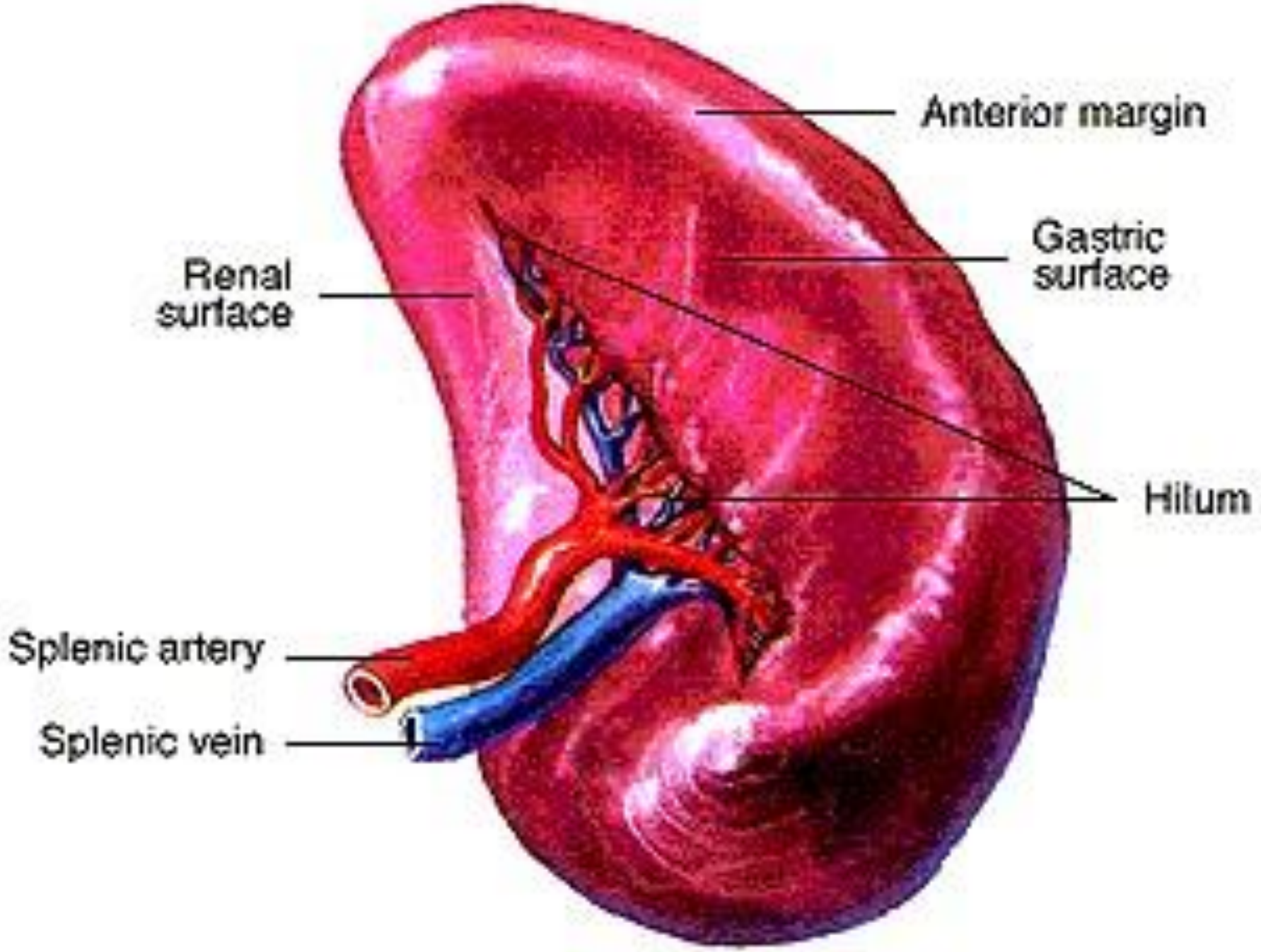
- Erythrocytes (=Red Blood Cells)
- Leucocytes (=White Blood Cells)
- Thrombocytes (=Platelets)

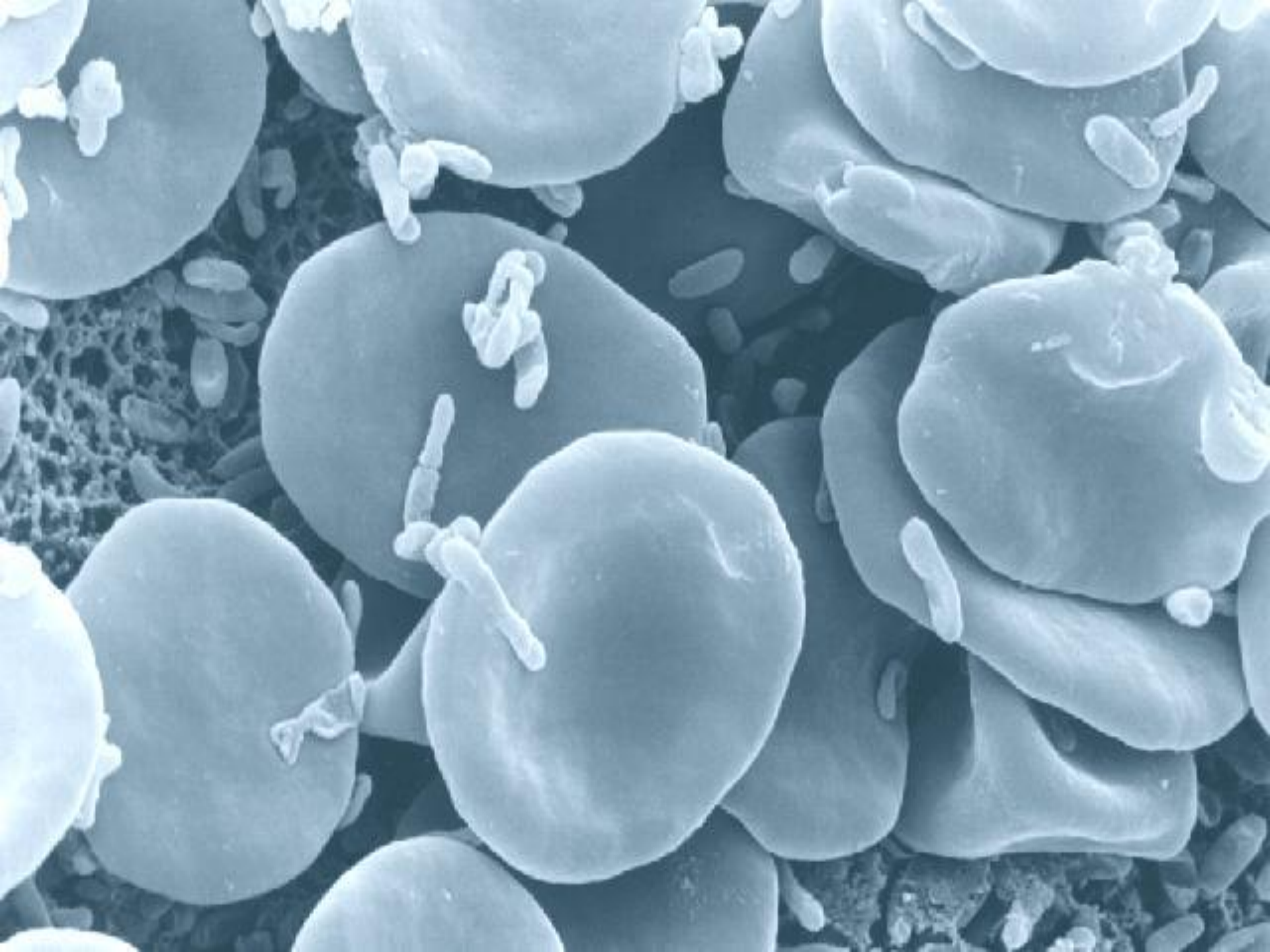


ERYTHROCYTES

- There are approximately 5 to 5,5 million of erythrocytes per cubic millimeter of blood.
- The major function of erythrocytes is to transport oxygen from lungs to tissues and transport CO_2 from body tissues to lungs.

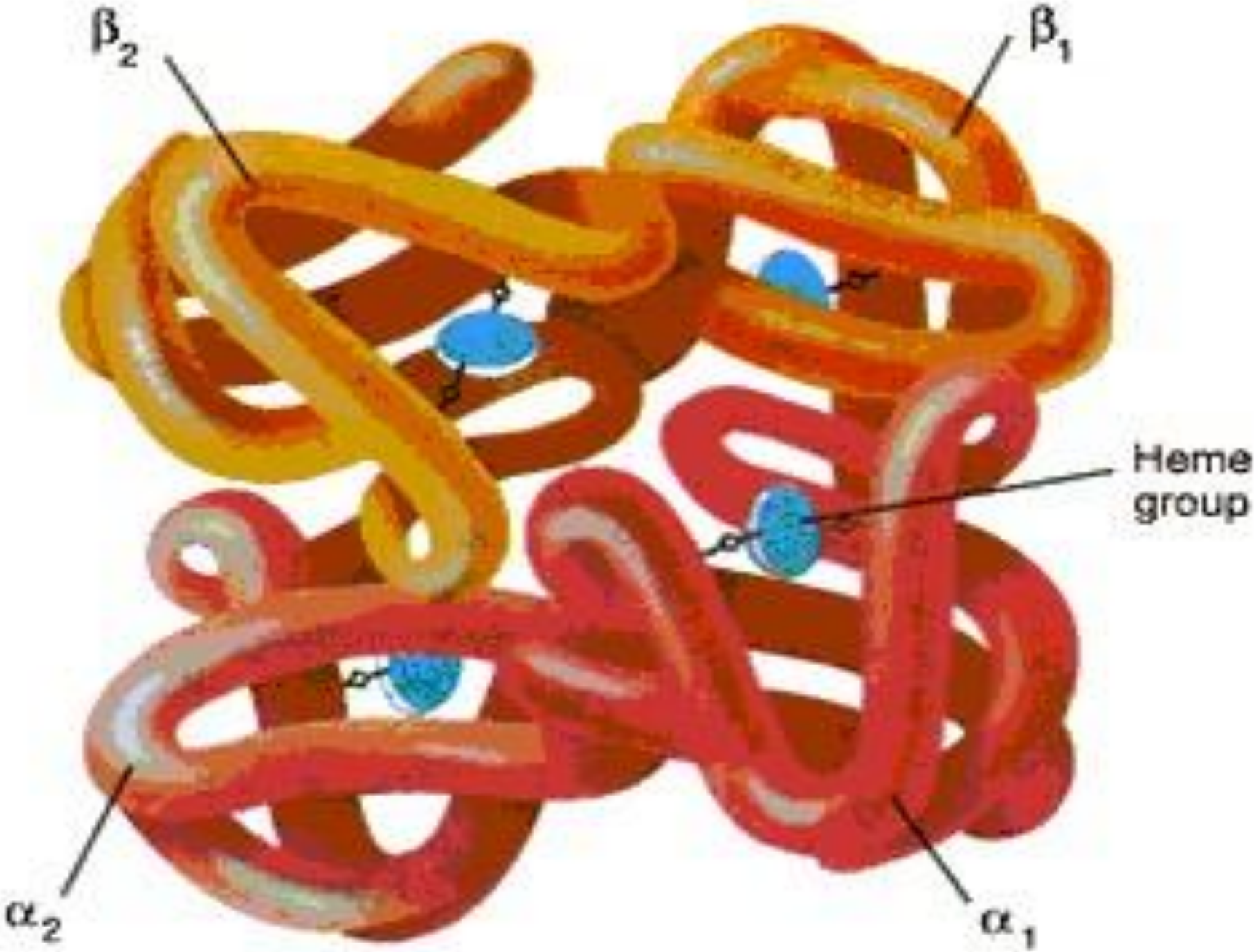
- Mammalian erythrocytes have no nucleus at adult (maturation) stage.
- They are produced by red bone marrow.
- Erythrocytes live(!) for **120 days**
- Erythrocytes are broken down by Reticulo-Endothelial System in spleen, liver and lymph nodes.

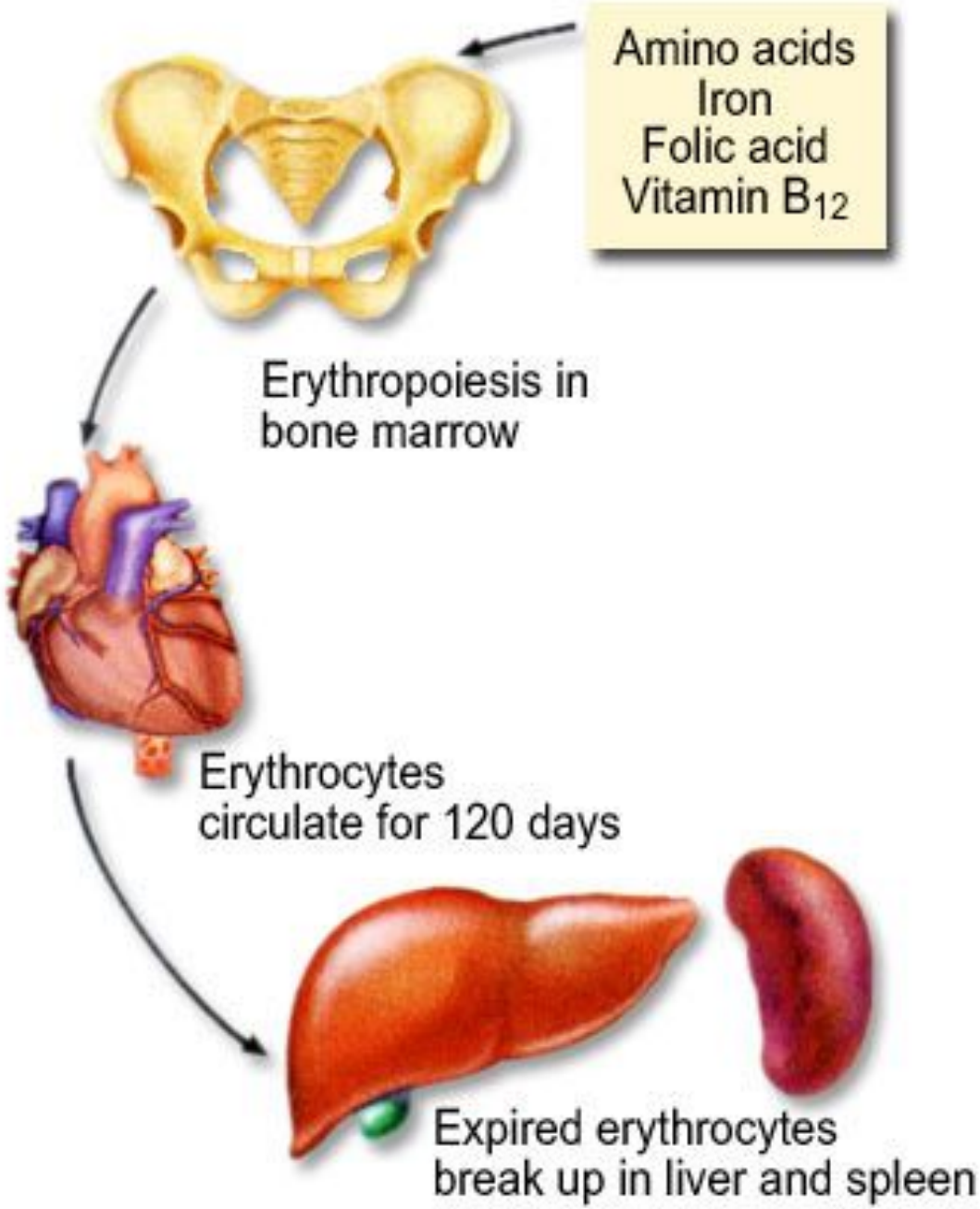

Anterior margin
Gastric surface
Renal surface
Hilum
Splenic artery
Splenic vein



HEMOGLOBIN

- Erythrocytes are filled with hemoglobin.
- Hemoglobin is **iron (Fe)** containing pigment.
- It gives **red color** to blood.
- Hemoglobin carries **oxygen**.
- Erythrocytes live(!) for 120 days

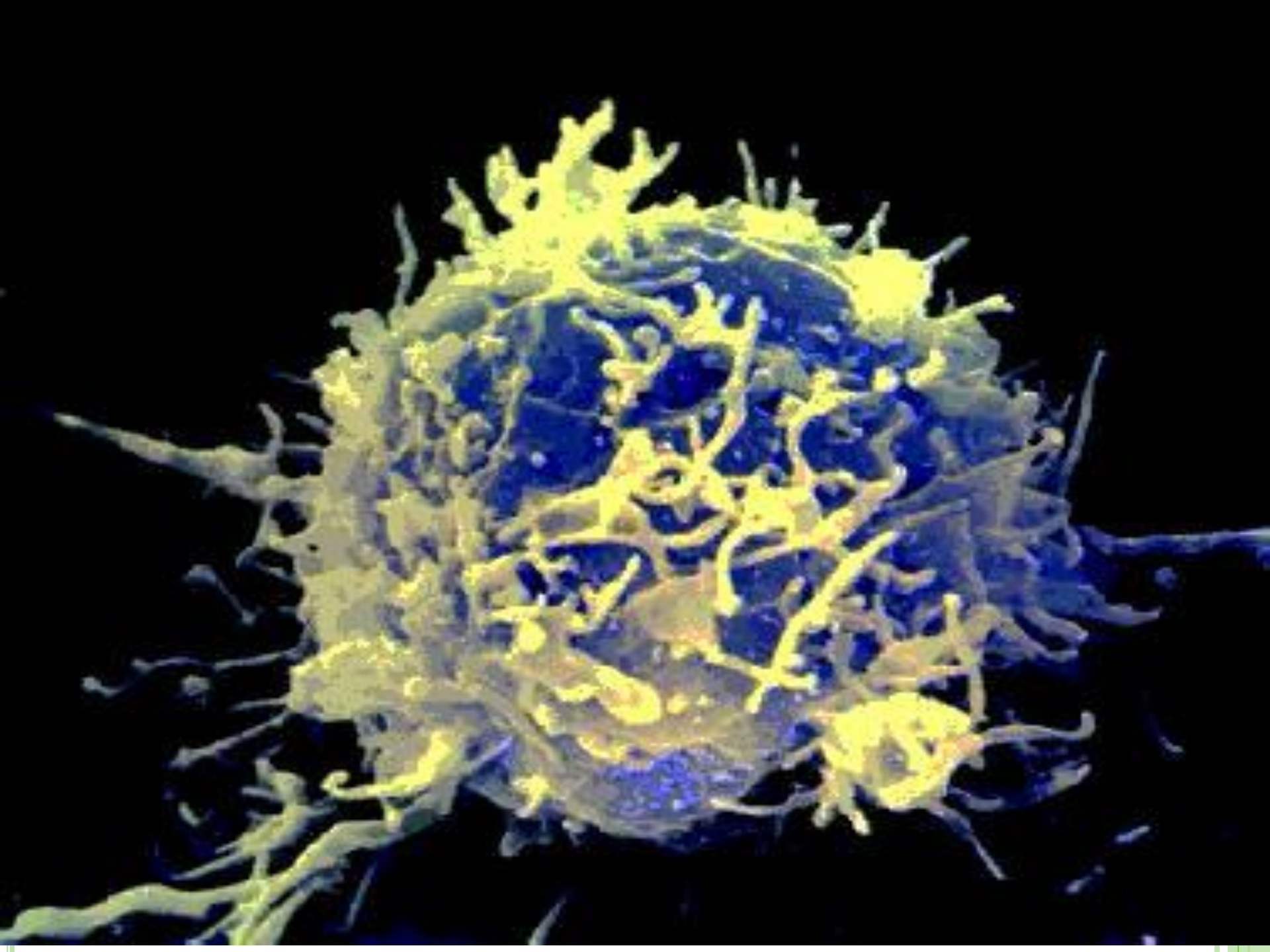

β2
β1
Heme group
α2
α1


Amino acids
Iron
Folic acid
Vitamin B_{12}
Erythropoiesis in bone marrow
Erythrocytes circulate for 120 days
Expired erythrocytes break up in liver and spleen

LEUCOCYTES

- Leucocytes **protect** the body from **infections**.
- They are produced by **red bone marrow** and **lymph nodes**.
- They can move through the tissue.

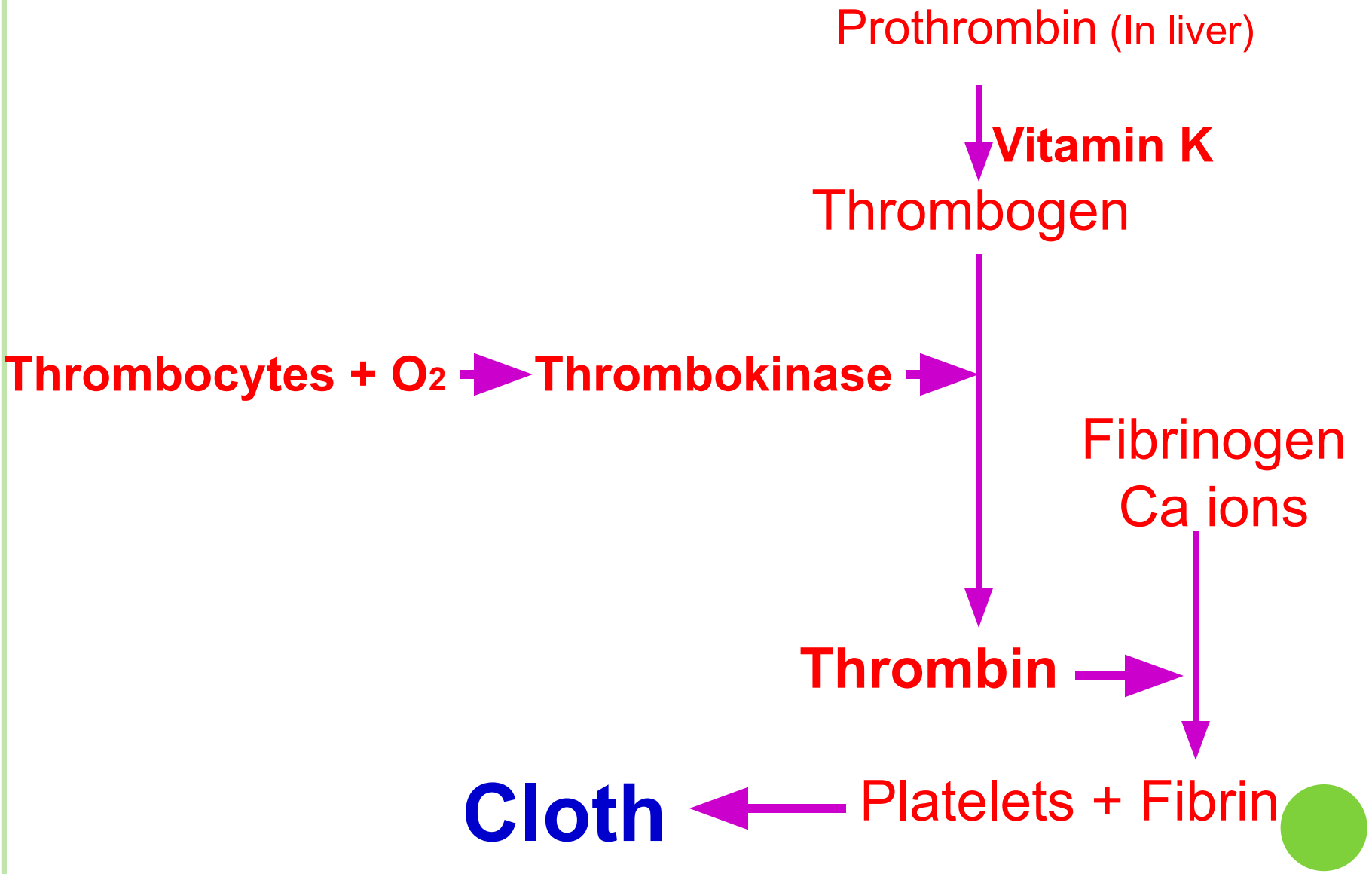
- Normally there are only 6000 to 8000 leucocytes per cubic millimeter of blood. When there is an infection in the body, number of leucocytes may increase to 30000 per cubic millimeter.

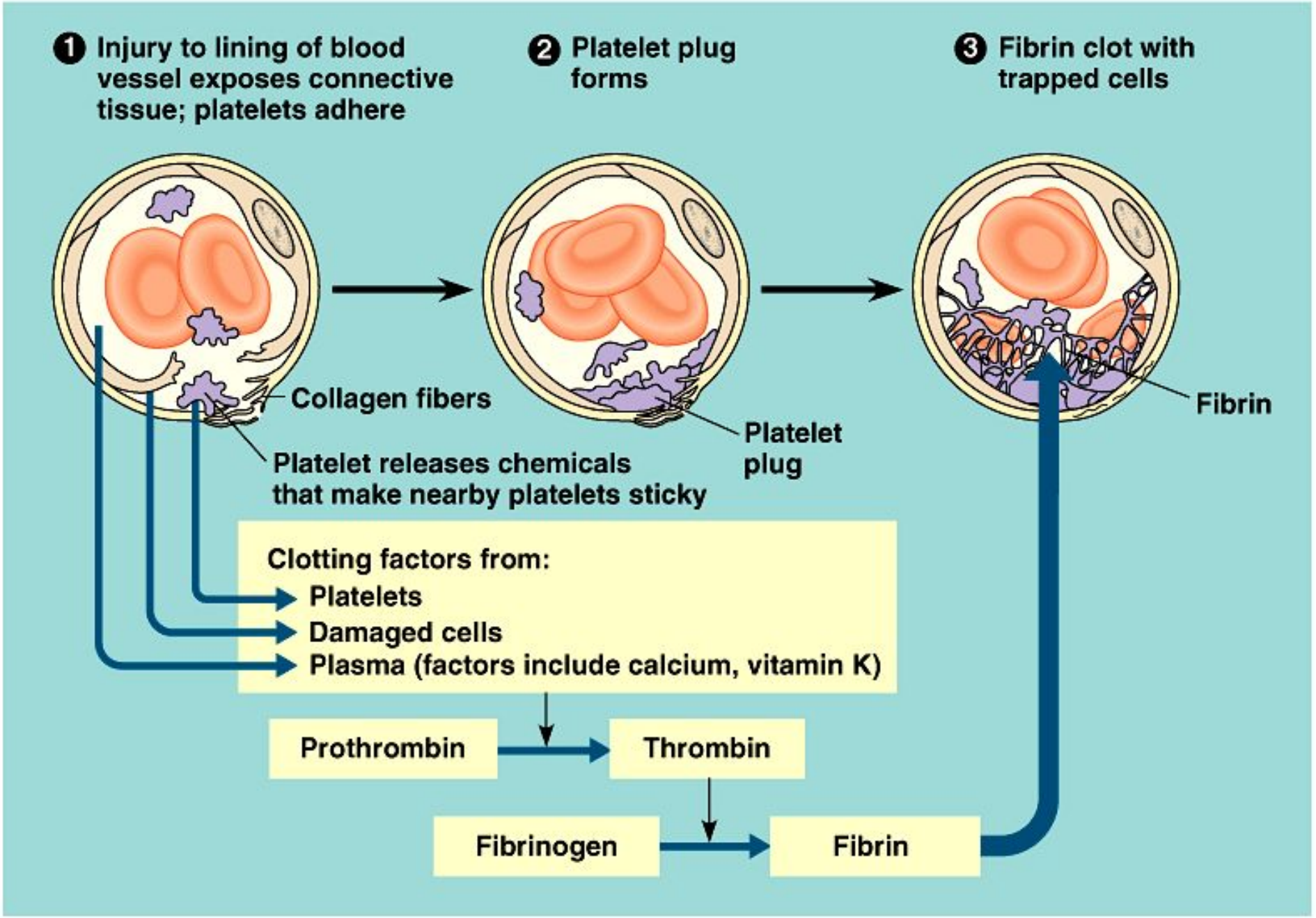


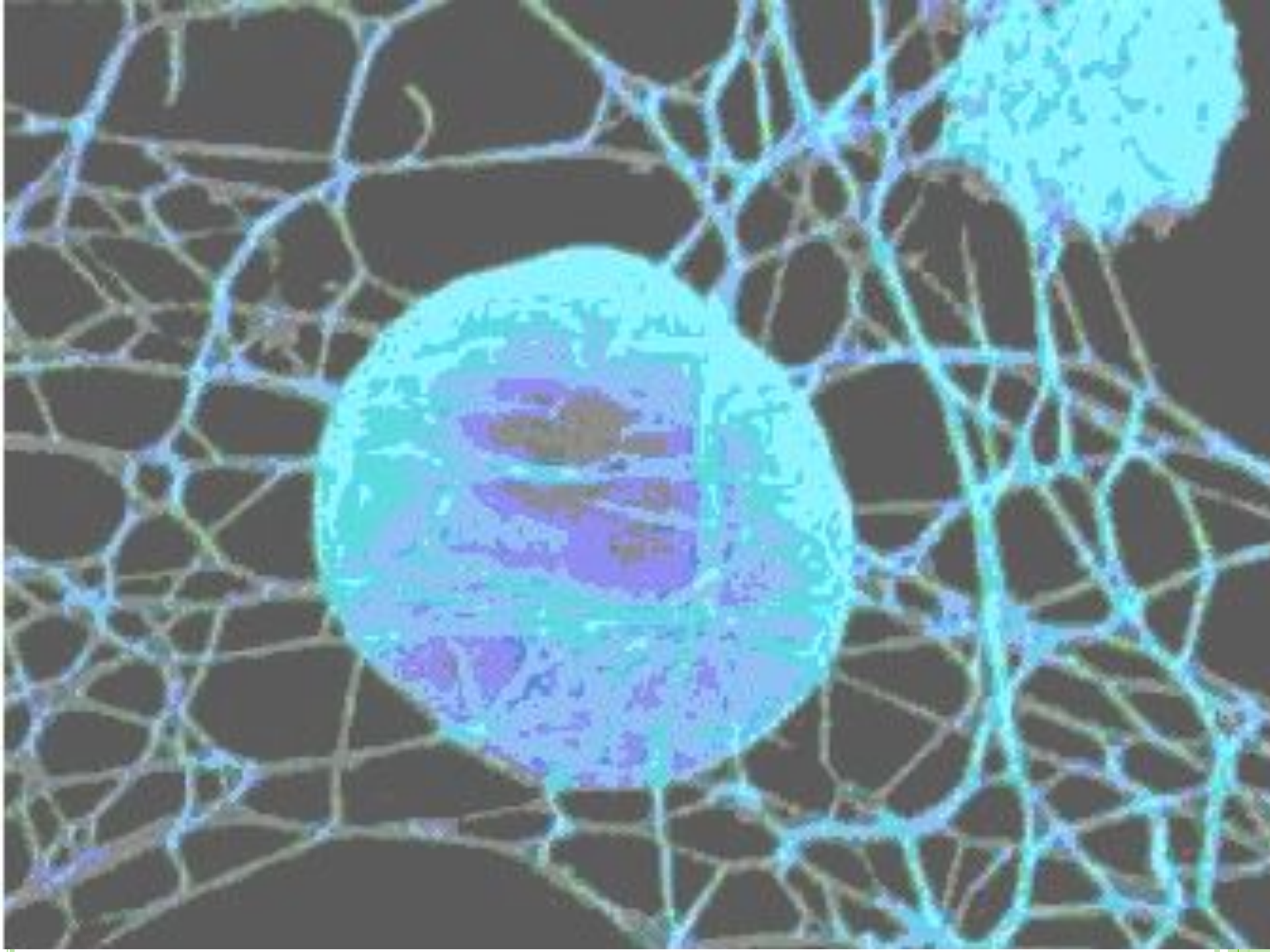
PLATELETS

- Platelets are produced by **bone marrow.**
- They play major role in **blood clotting**.
- Blood clotting is the solidification of blood in order **to stop bleeding**.

THE MECHANISM OF BLOOD CLOTTING





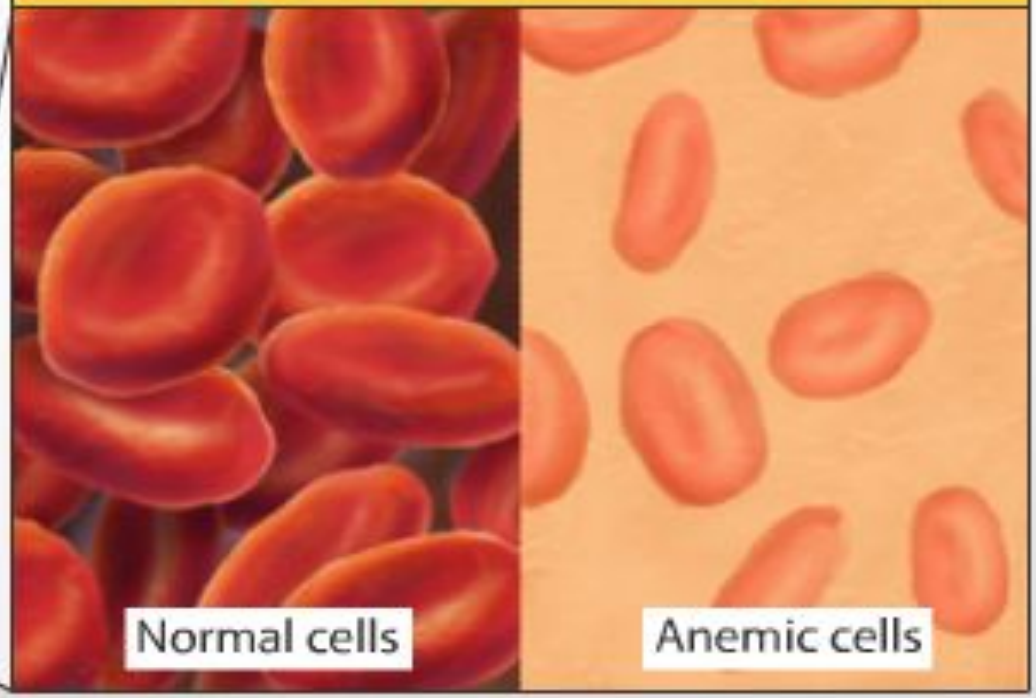


Diseases related to circulatory system

- Anemia
- Leukemia
- Arteriosclerosis

Anemia

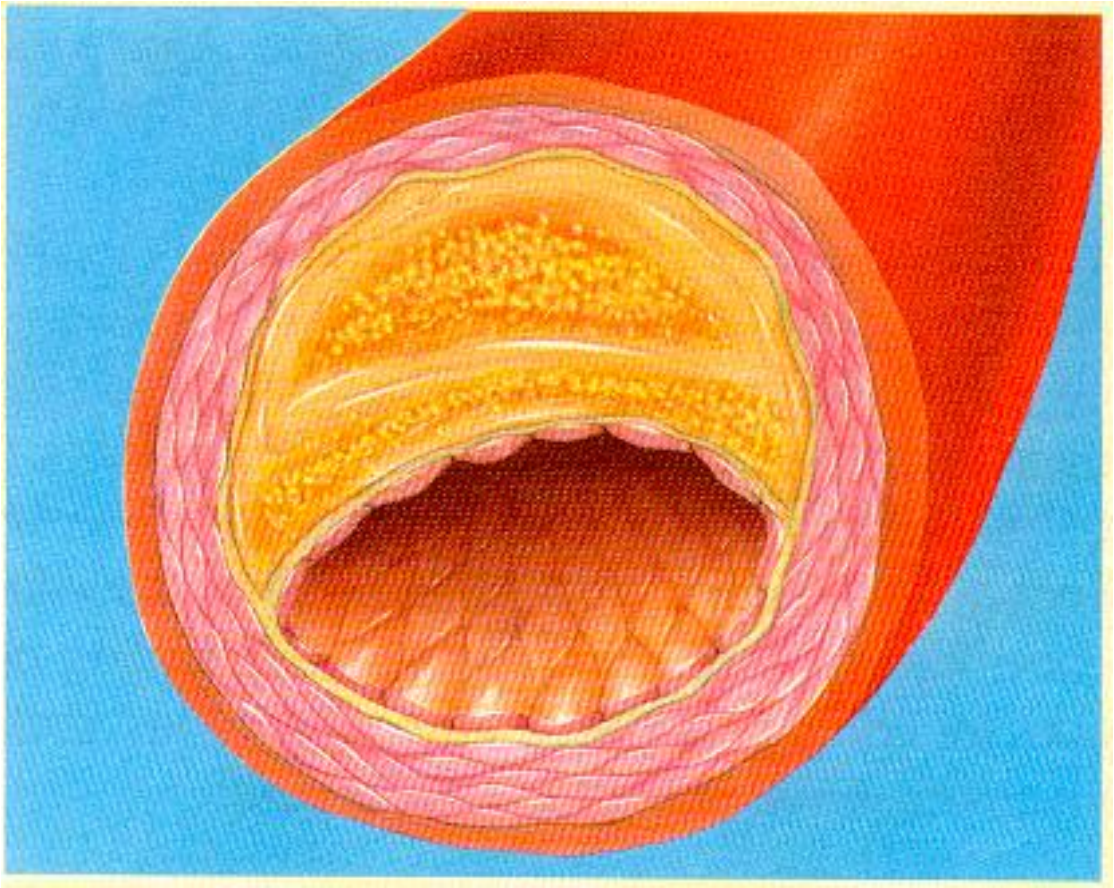
Diagnosis



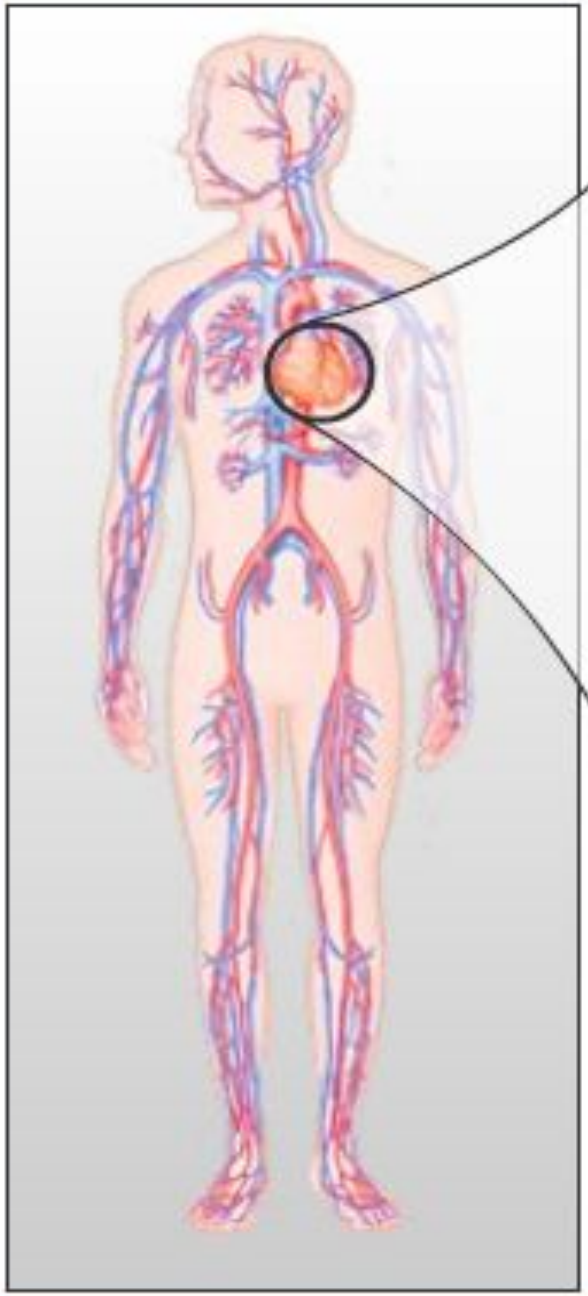
Anemia may result from blood loss or nutritional deficiencies. Foods high in iron such as spinach salad can help prevent anemia.

Arteriosclerosis

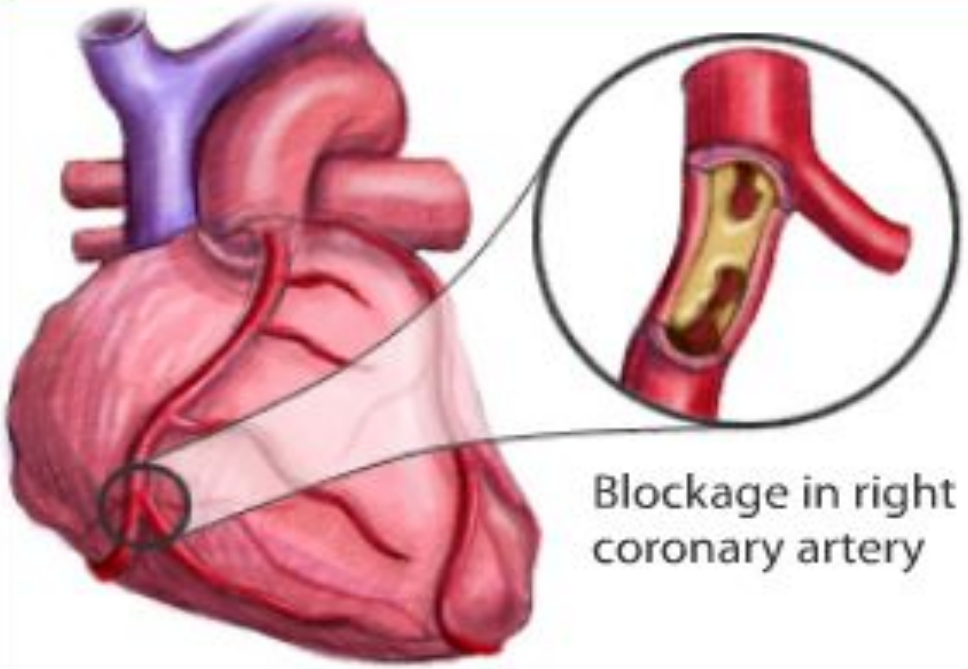
- When blood vessels **become narrow** and **lose their elasticity**
- **Fats** and **Ca^{++}** ions adhere to the walls of blood vessels, and by this stroke and heart attack may occur
  - This disease occurs as a result of eating disorders
  - Is seen mainly in men and women over the age 40



Heart attack, infarcts



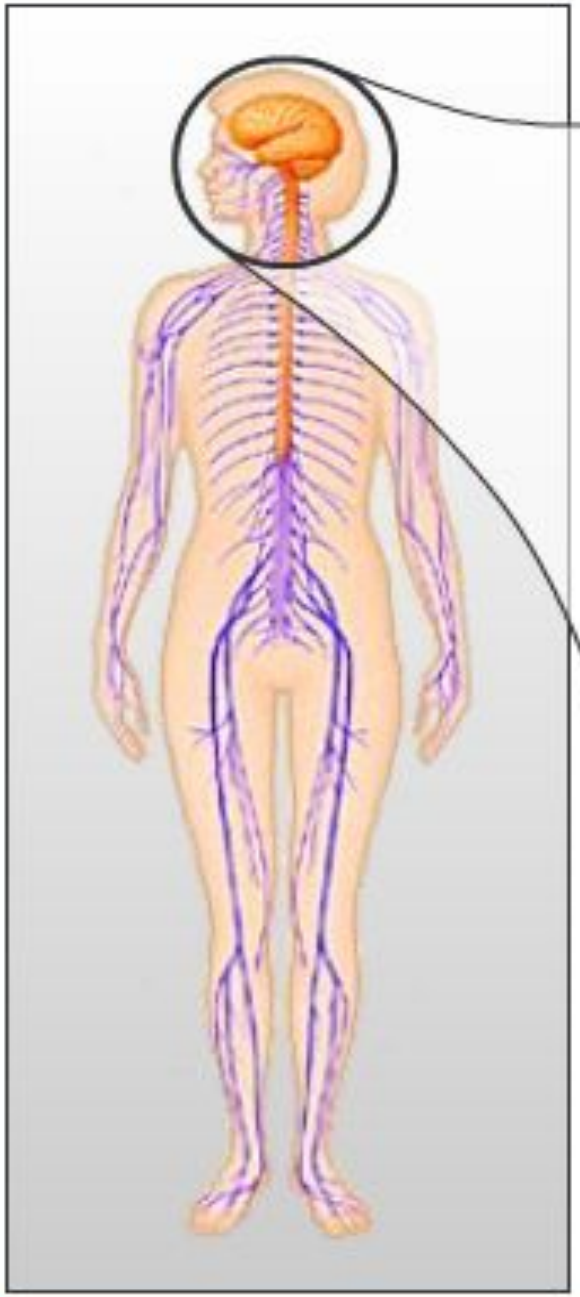
Diagnosis



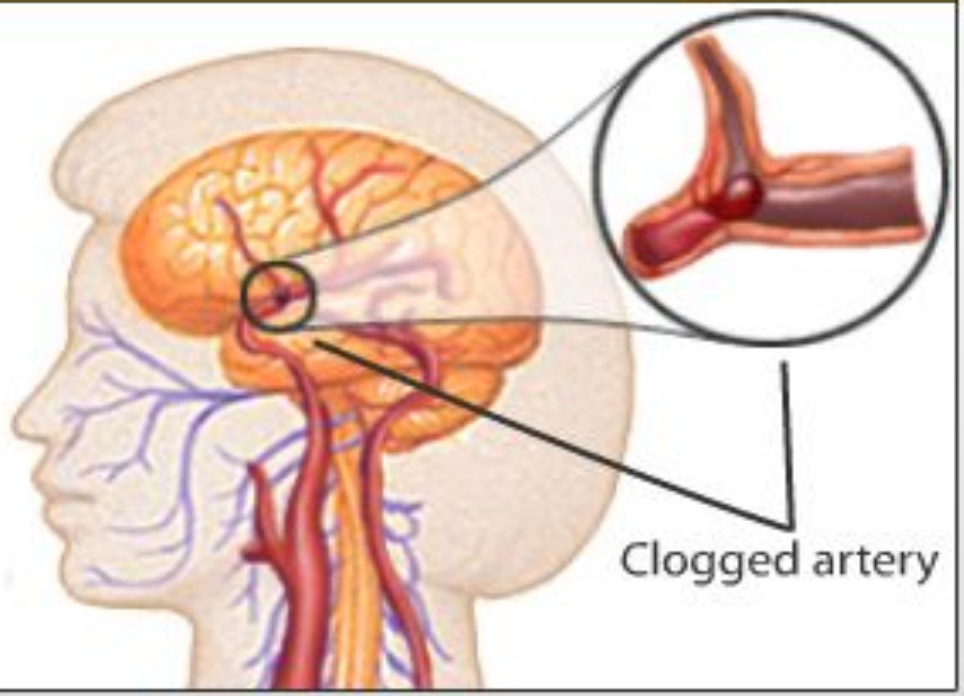
Blockage in right coronary artery

When the coronary arteries become blocked, the cells of the heart do not receive blood and oxygen. Heart cells begin to die after 4 to 6 hours without blood.

STROKE



Diagnosis



When cells in the brain are cut off from their blood supply, and consequently their supply of oxygen, they will die. The effects of a stroke may be so minor as to hardly be noticed, or may result in irreversible changes in a person's mental and physical abilities.