CIRCULATORY SYSTEM

Introduction

FUNCTIONS

HEART FACTS

Main structure of the heart

CARDIAC ACTIVITY

Heart beating video

DISORDERS AND DISEASES

Blood circulation

BLOOD VESSELS

Blood

Doc's

True-False

Completion

Outline

Learning objectives

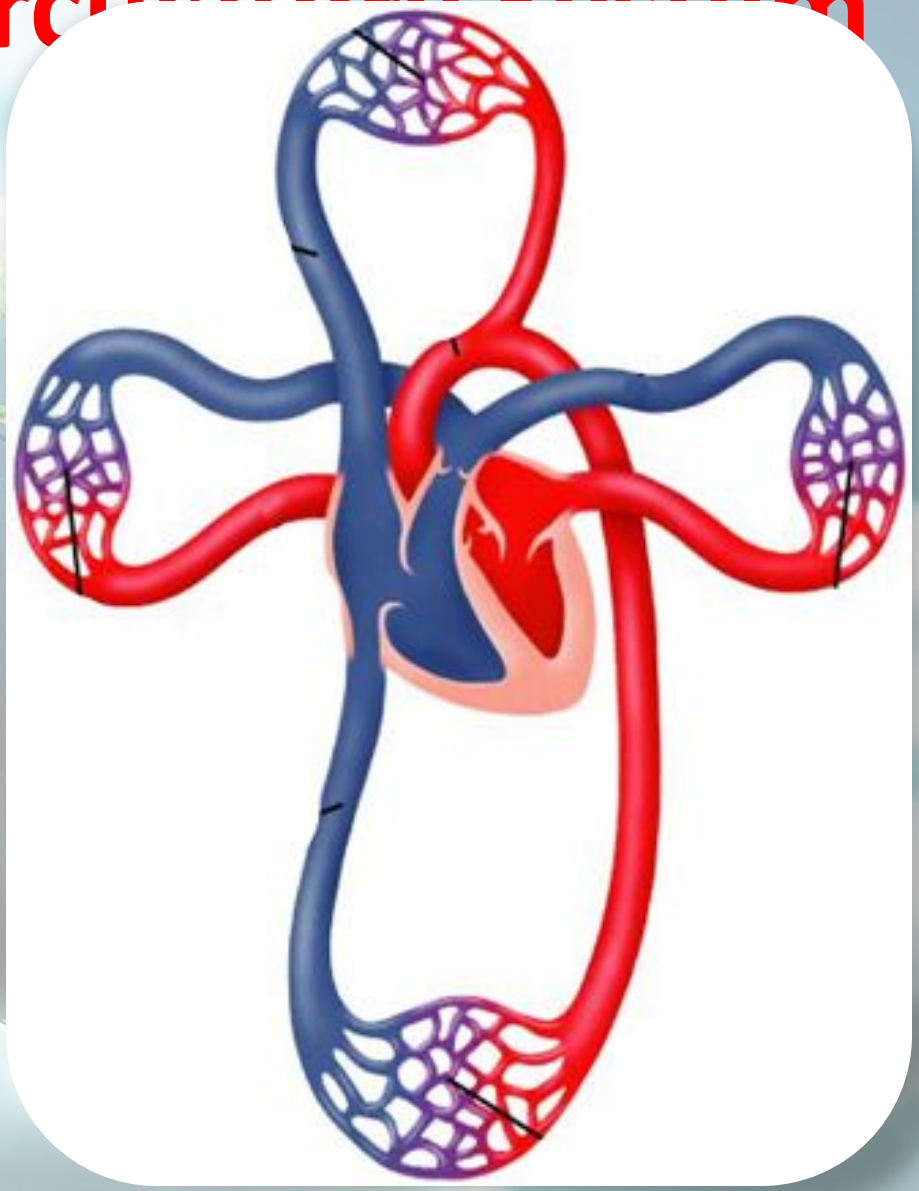
GAME

HUMAN CIRCULATORY SYSTEM

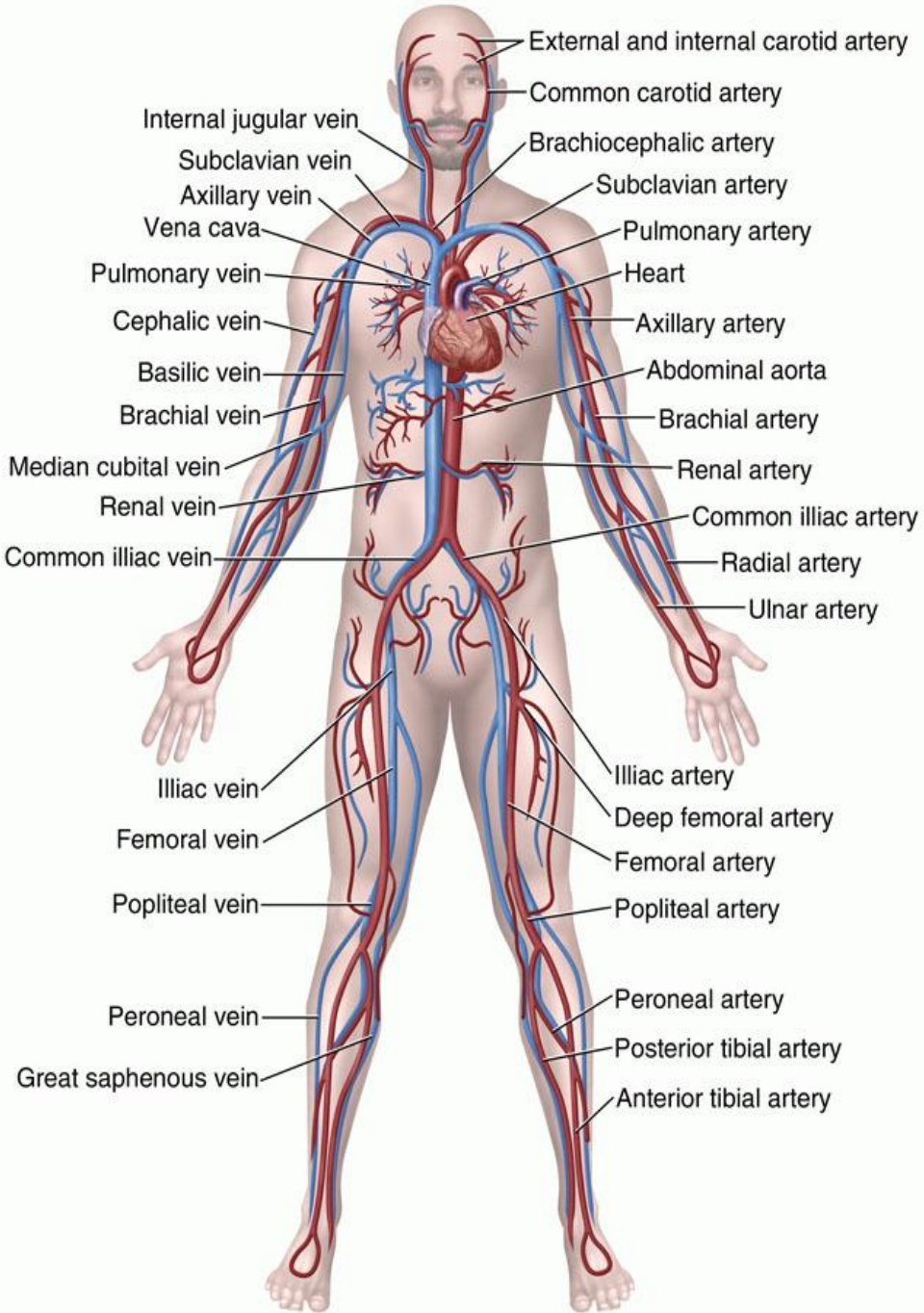
The Human Circulatory System

It consists of:

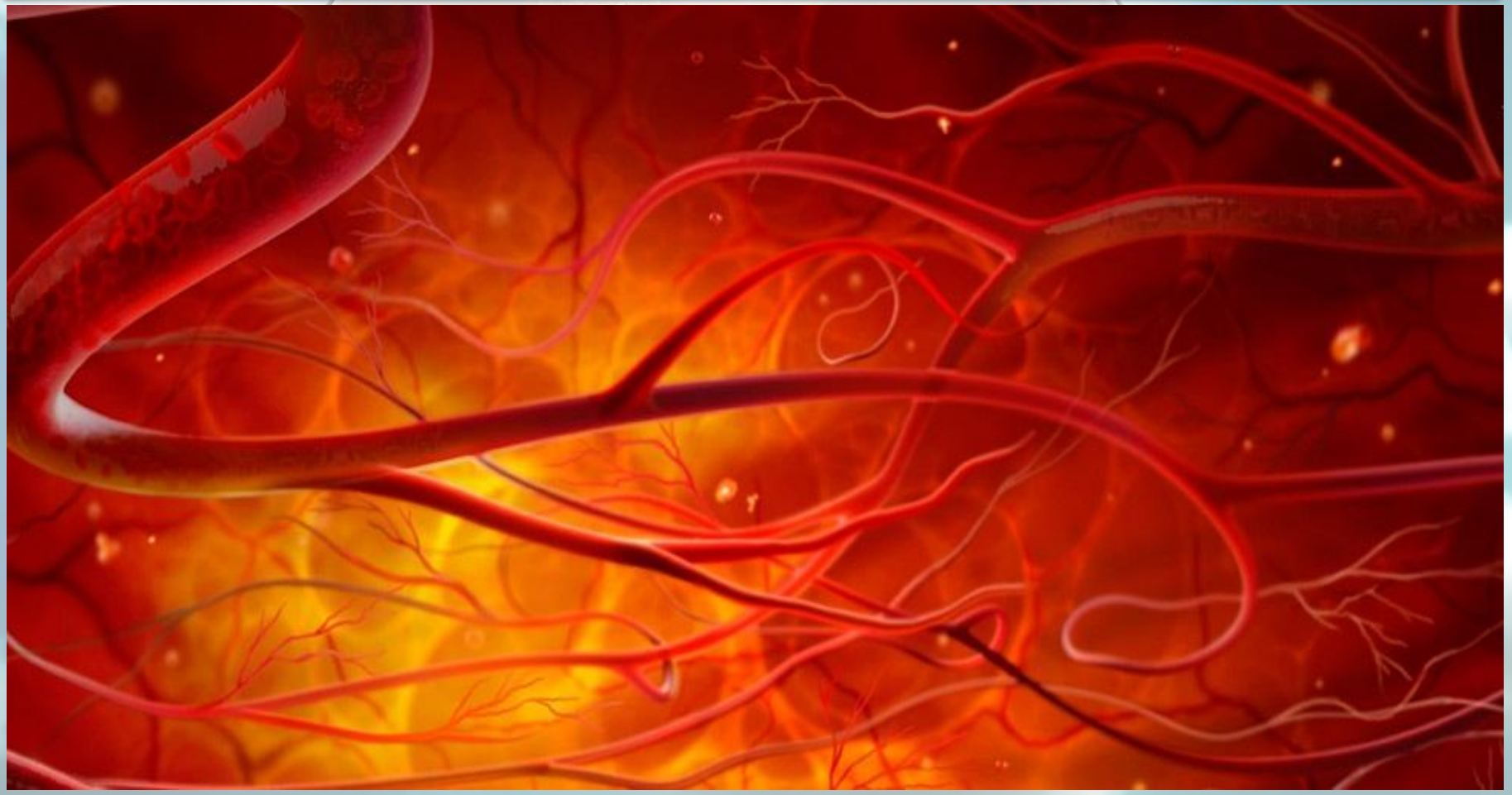
- **HEART**
- **BLOOD VESSELS**
- **BLOOD**



Circulatory System



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



Functions of human circulatory system

IT TRANSPORTS:

- **Oxygen and Carbon dioxide**
- **Digested and absorbed food or nutrients**
- **Hormones, vitamins and minerals**
- **Wastes: urea and other metabolic products**
- **Heat**
- **Immunity agents: immune cells and**

Functions of human circulatory system

It plays an important role in gas exchange

Supply body cells with nutrients, minerals and vitamins

Remove toxic wastes away from the cells

Regulates body's temperature

Fight antigens(Ex: Viruses)

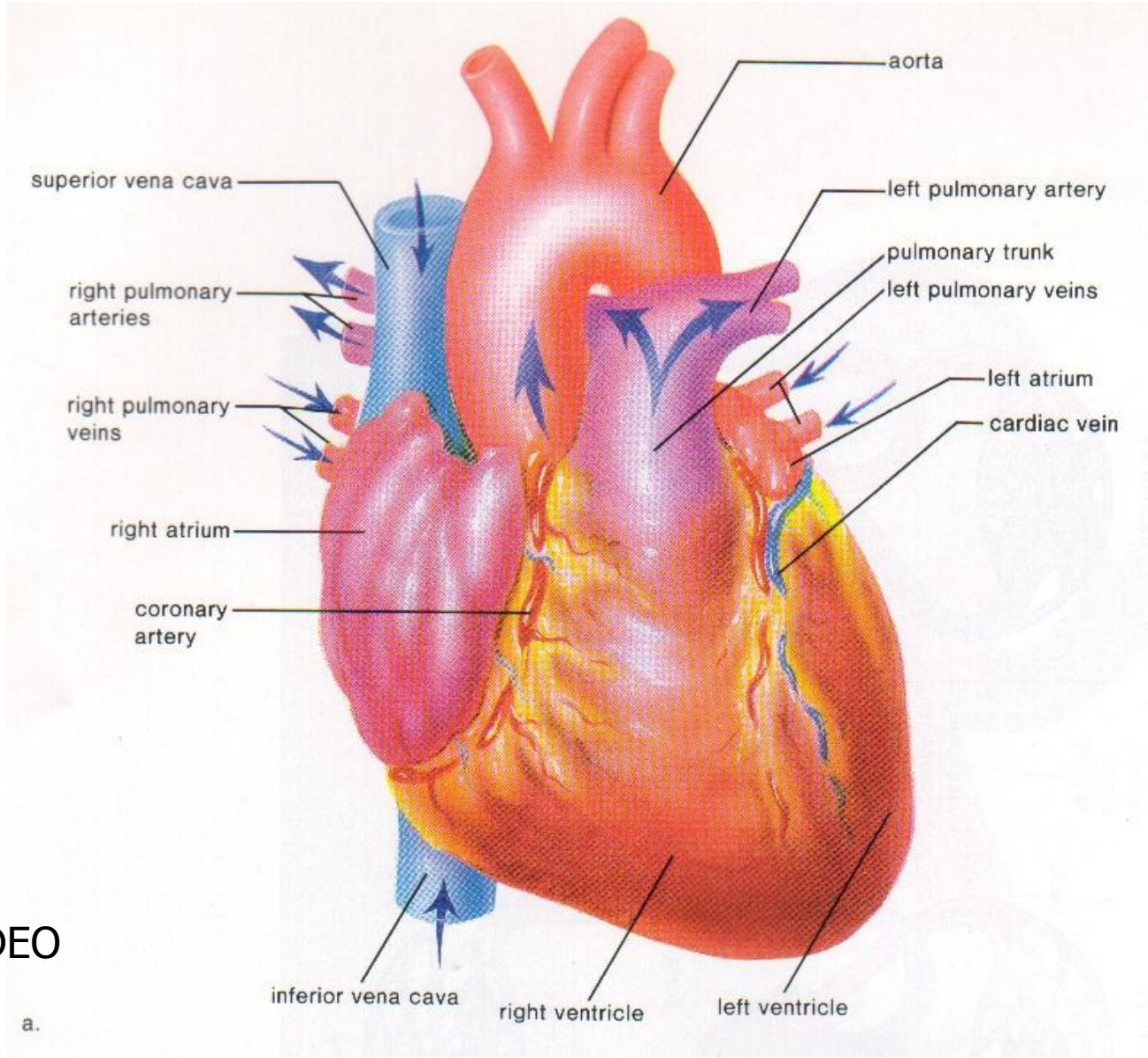
HEART FACTS:

- 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

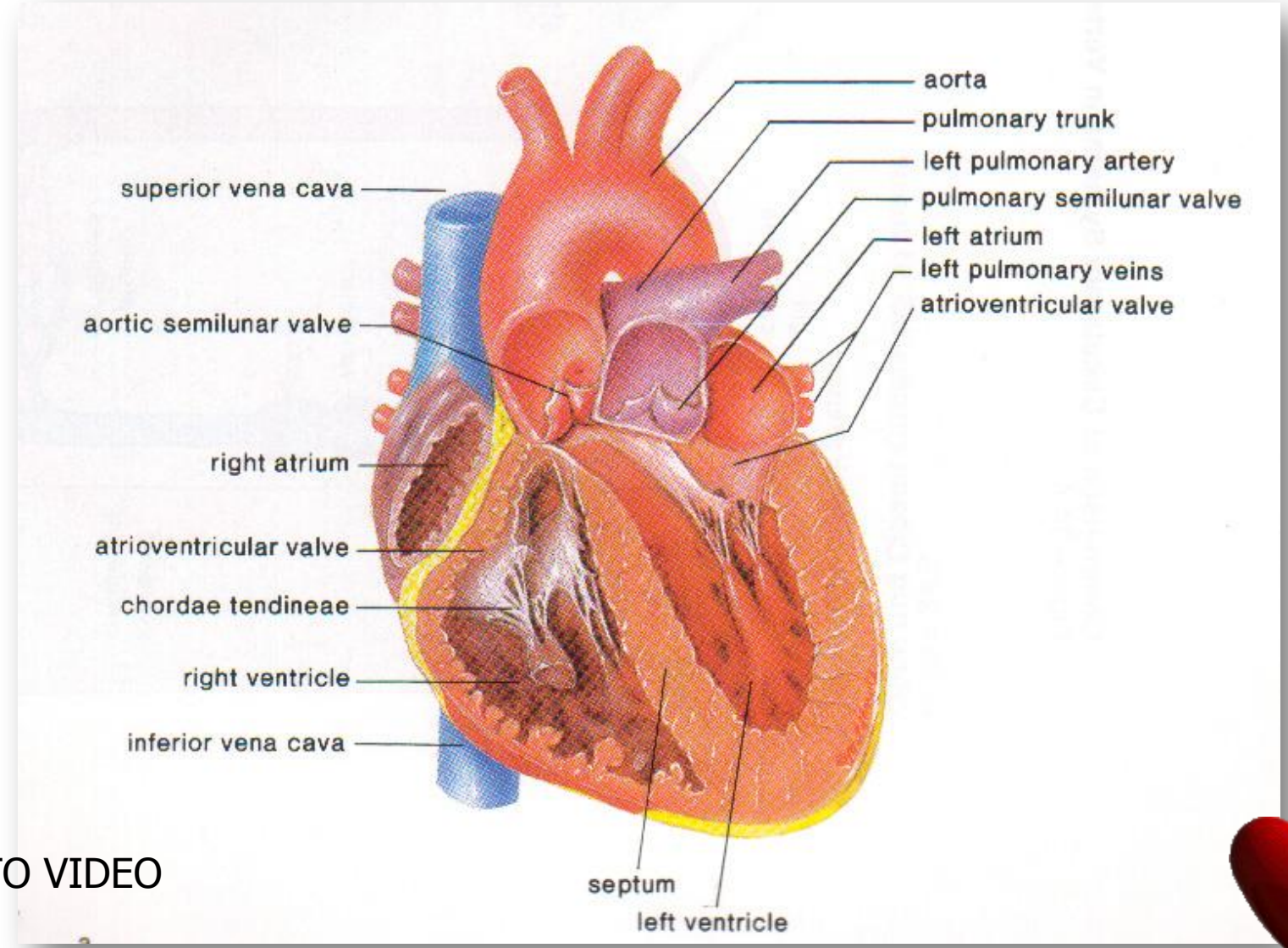
- The heart is made of a special type of muscle called **cardiac muscle** which contracts and relaxes rhythmically for a lifetime.
- The heart is located in the chest cavity and is surrounded by a membrane called the **pericardium**.
- The blood vessels which supply food and oxygen to heart are called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

External Structure



GO TO VIDEO

Internal Structure



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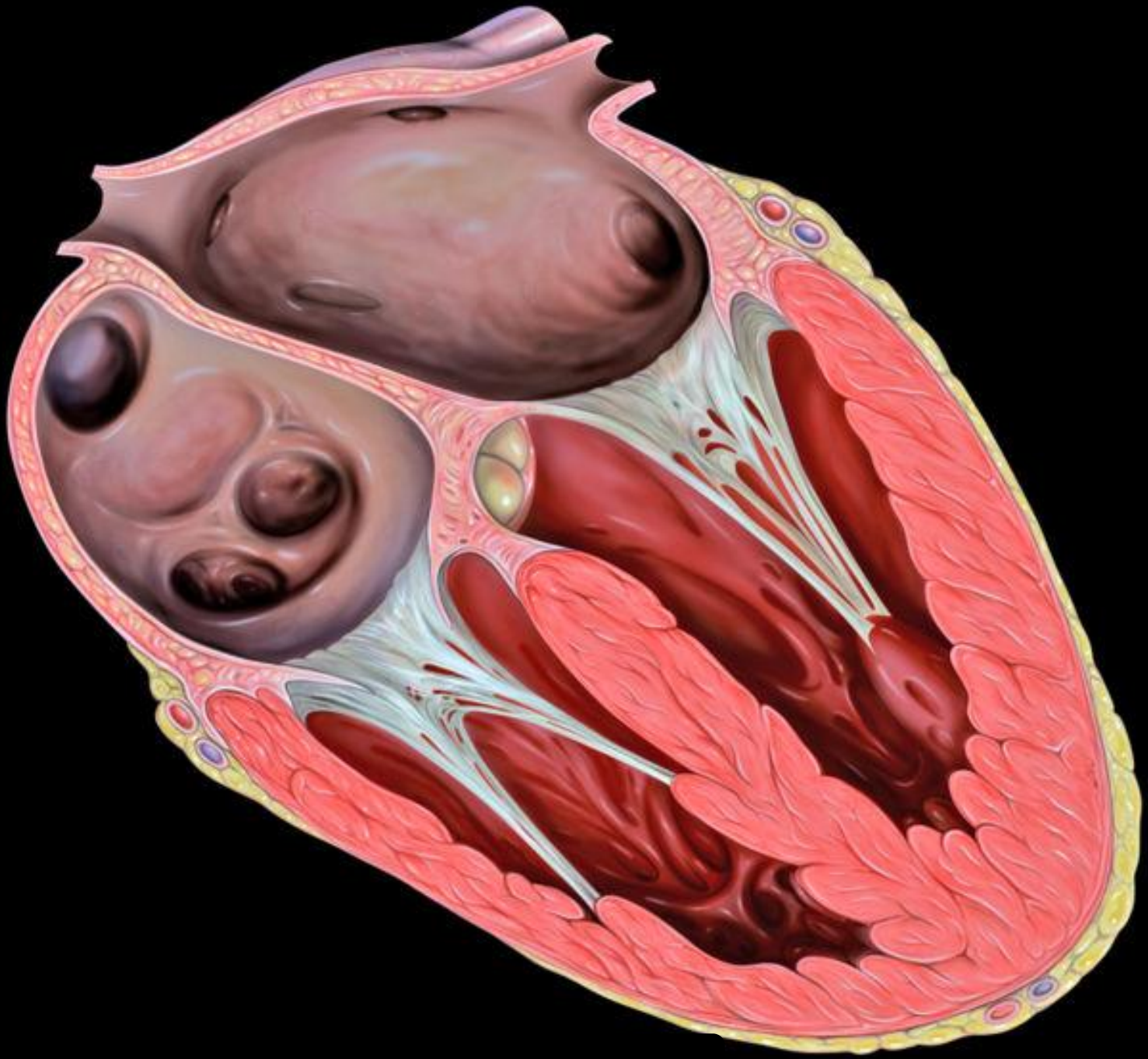
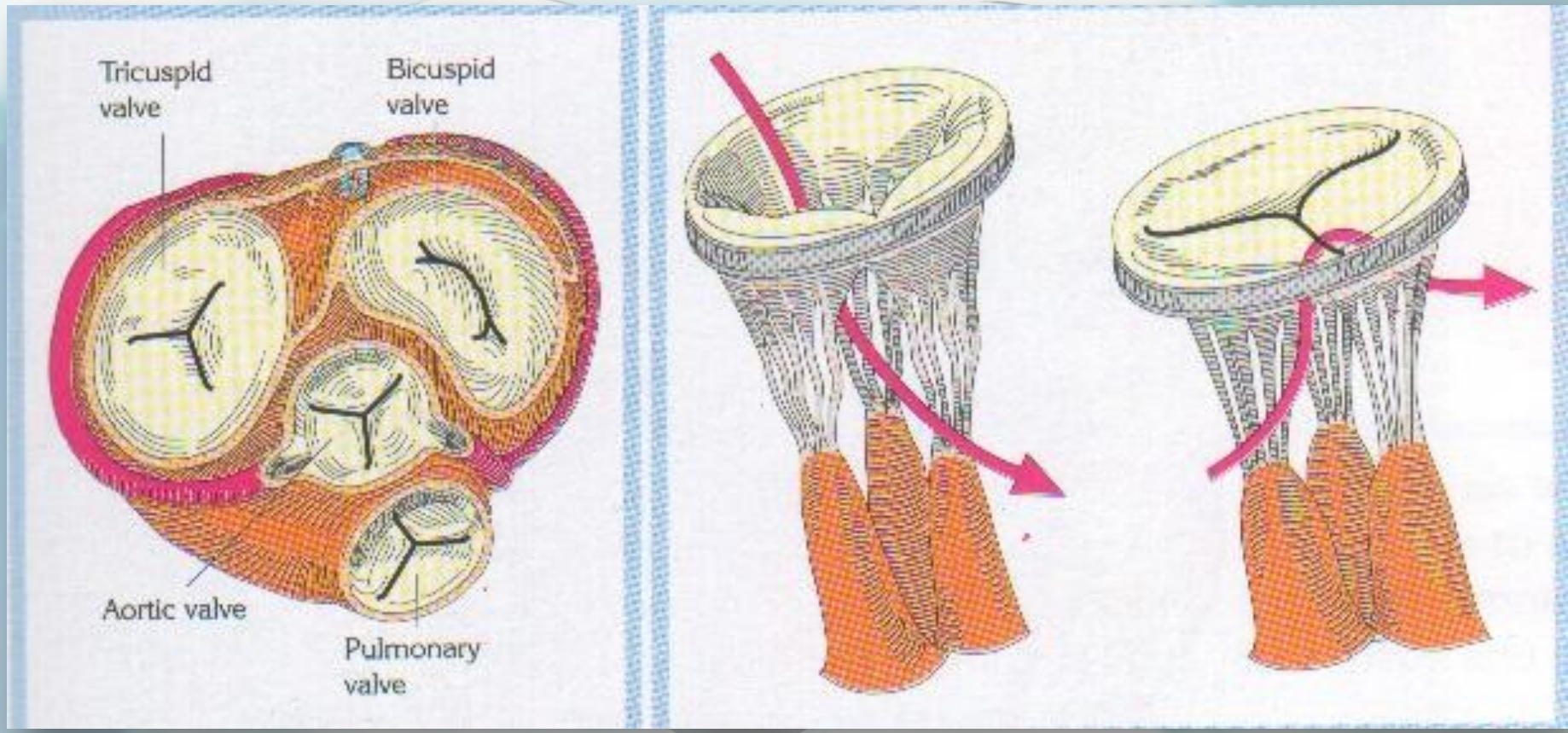


Internal Structure Of The Heart

- 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.

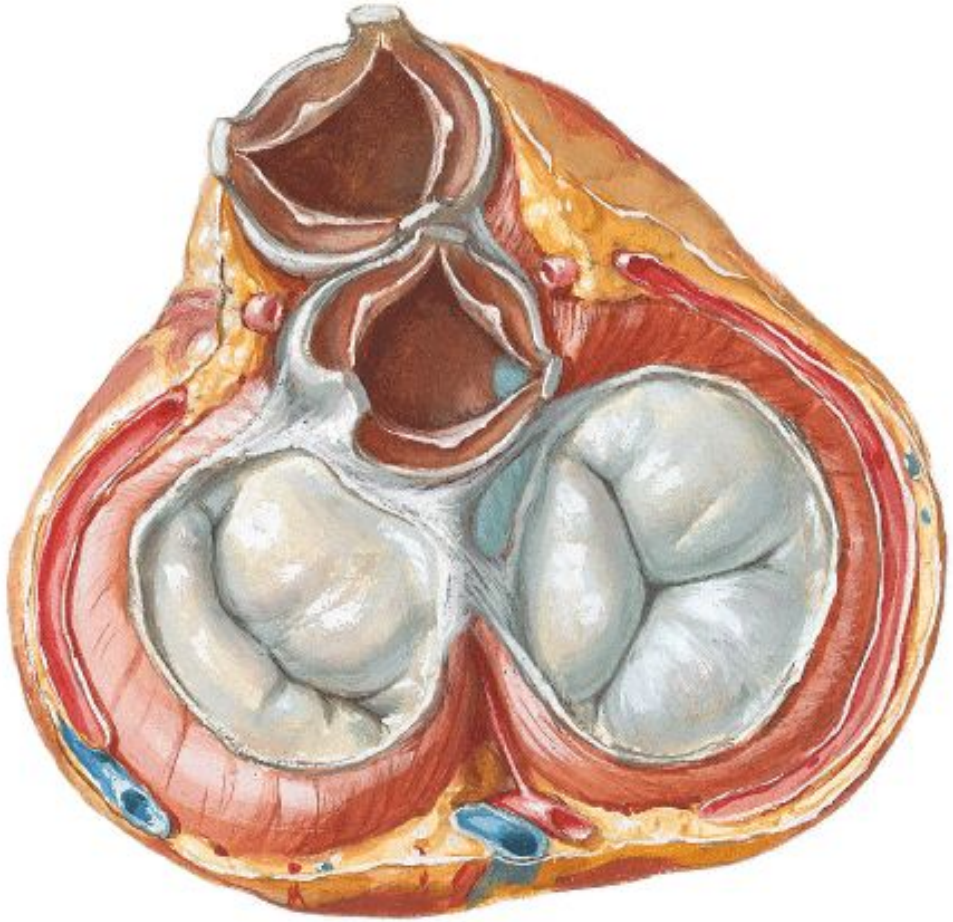
VALVES


Tricuspid valve
Bicuspid valve
Aortic valve
Pulmonary valve

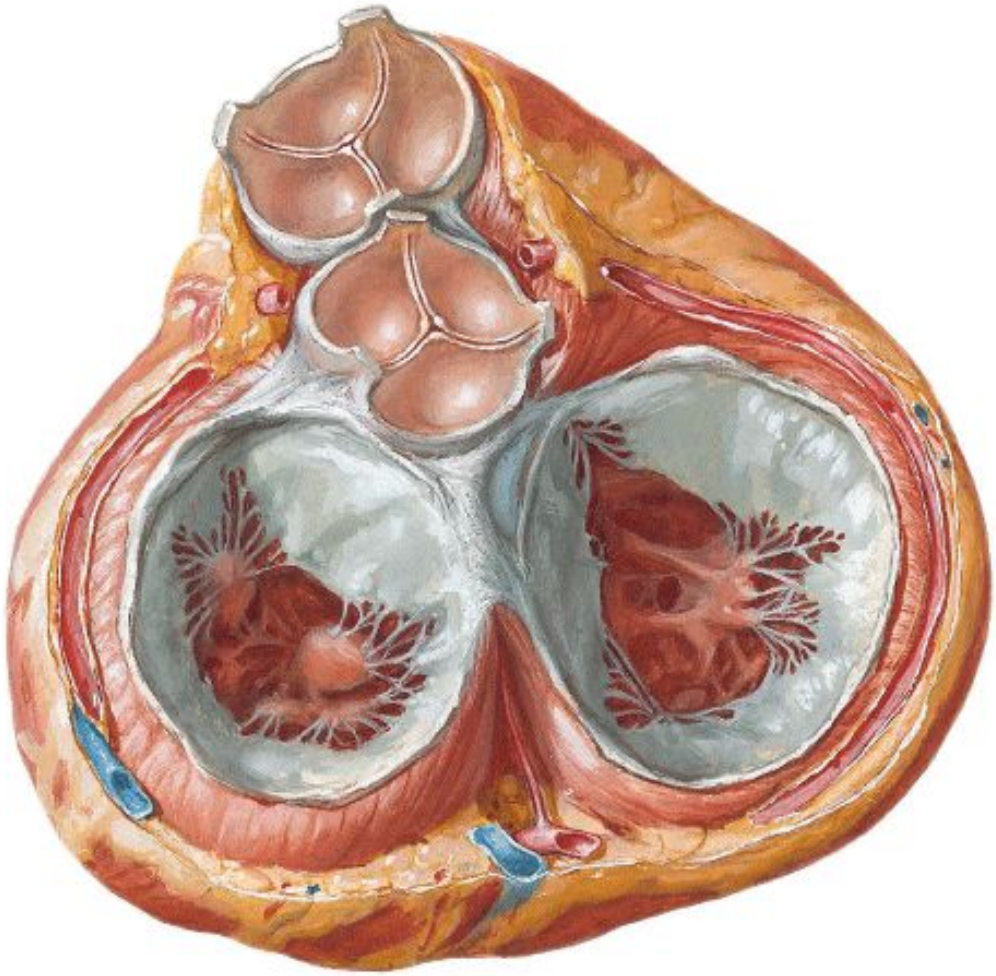
Semilunar Valves

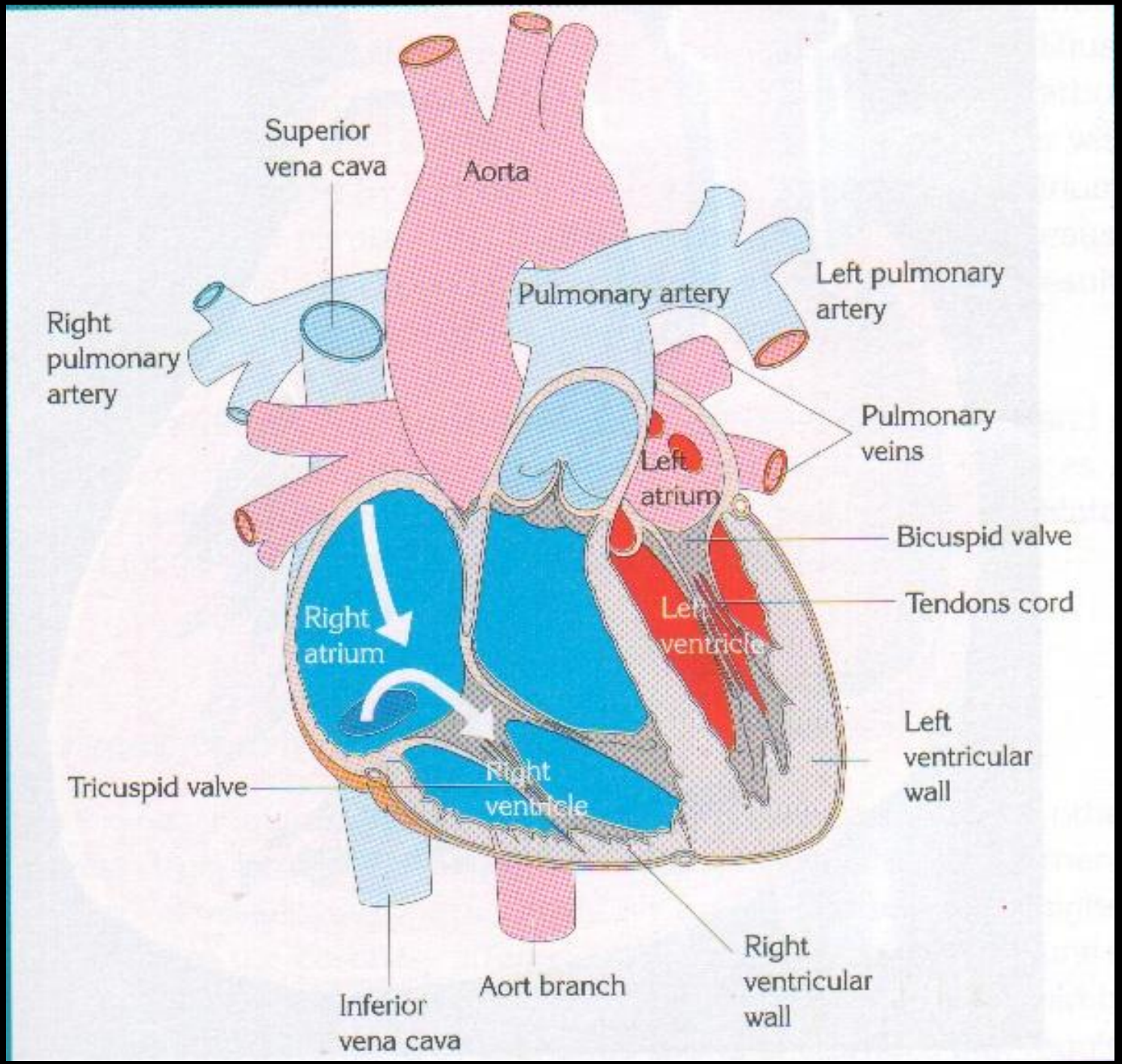
- Semilunar valves are found between the arteries and the ventricles.
- They prevent the blood entering the arteries when the atria contract.

Valves of Heart in Systole



Valves of Heart in Diastole

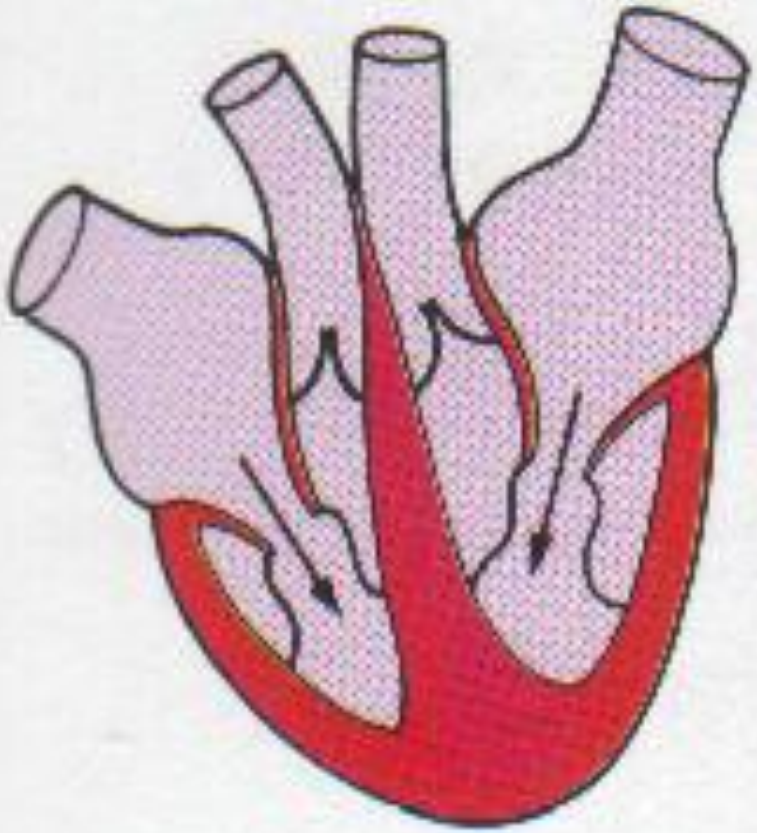



Superior vena cava
Aorta
Left pulmonary artery
Pulmonary artery
Right pulmonary artery
Pulmonary veins
Left atrium
Bicuspid valve
Tendons cord
Right atrium
Left ventricle
Left ventricular wall
Tricuspid valve
Right ventricle
Right ventricular wall
Aort branch
Inferior vena cava

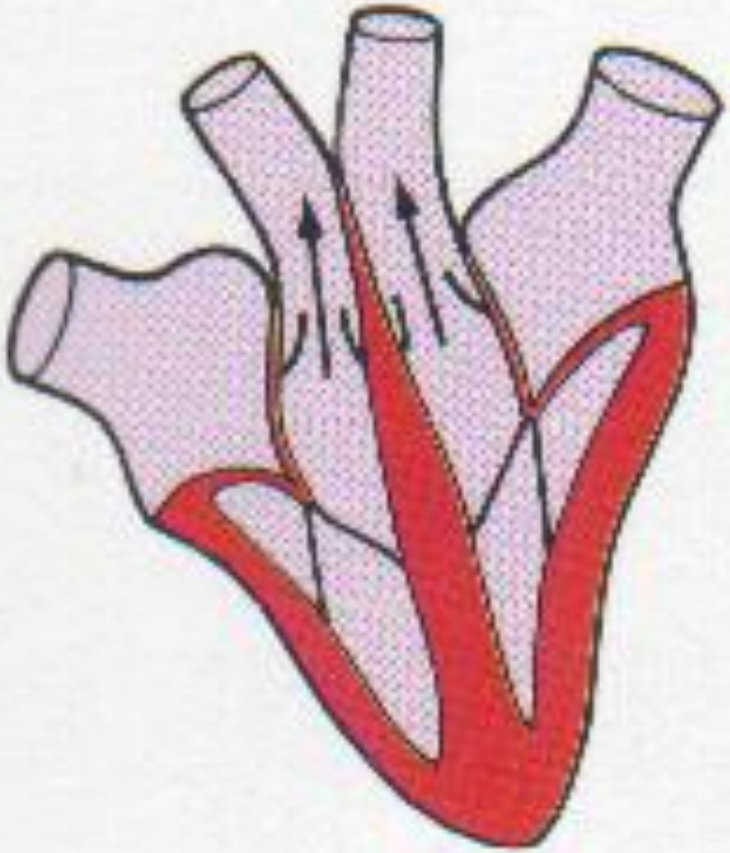
Cardiac activity

- 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



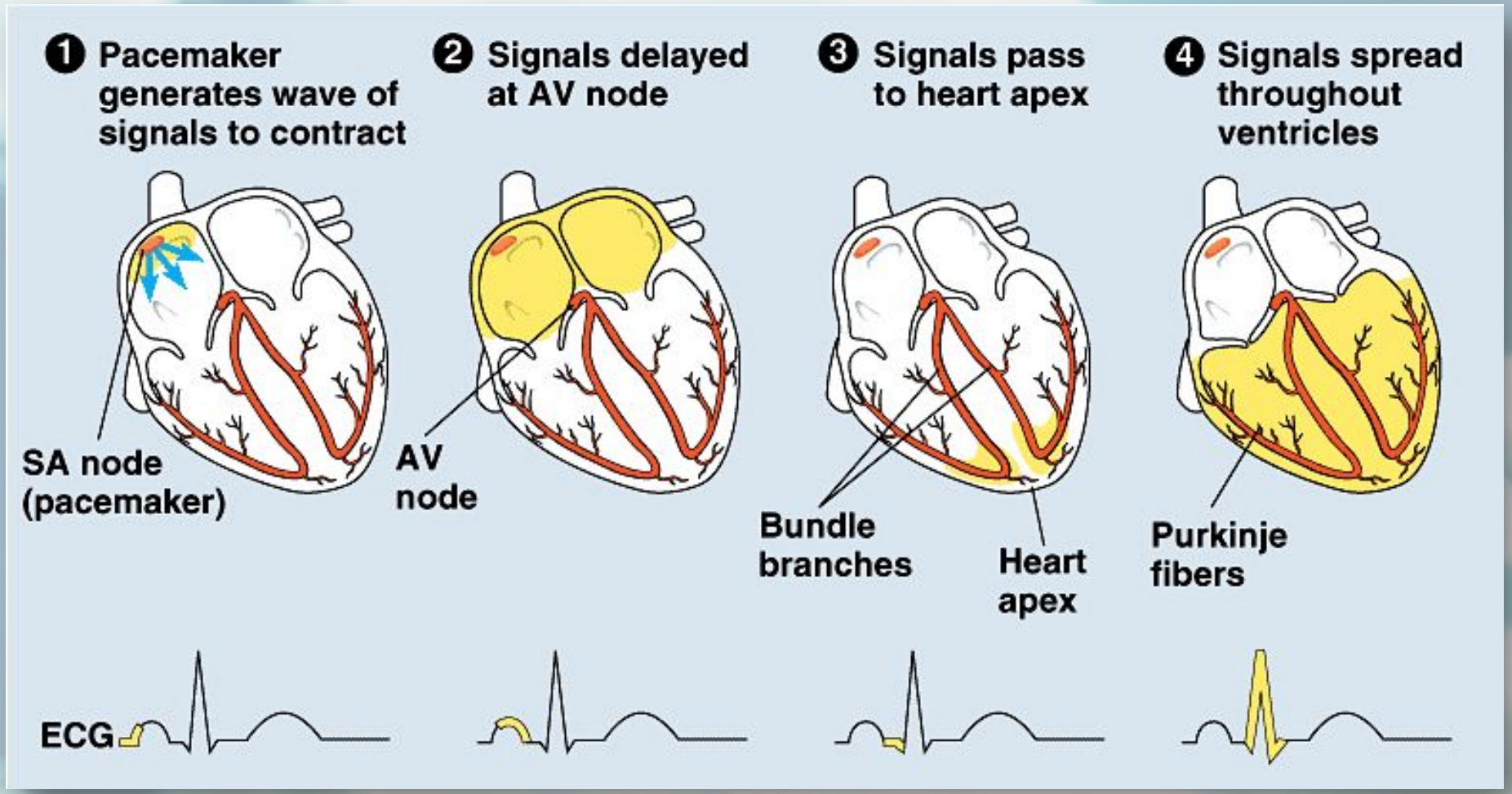
HEART CONTRACTING (systole)

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

Heart beating 3D video

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.

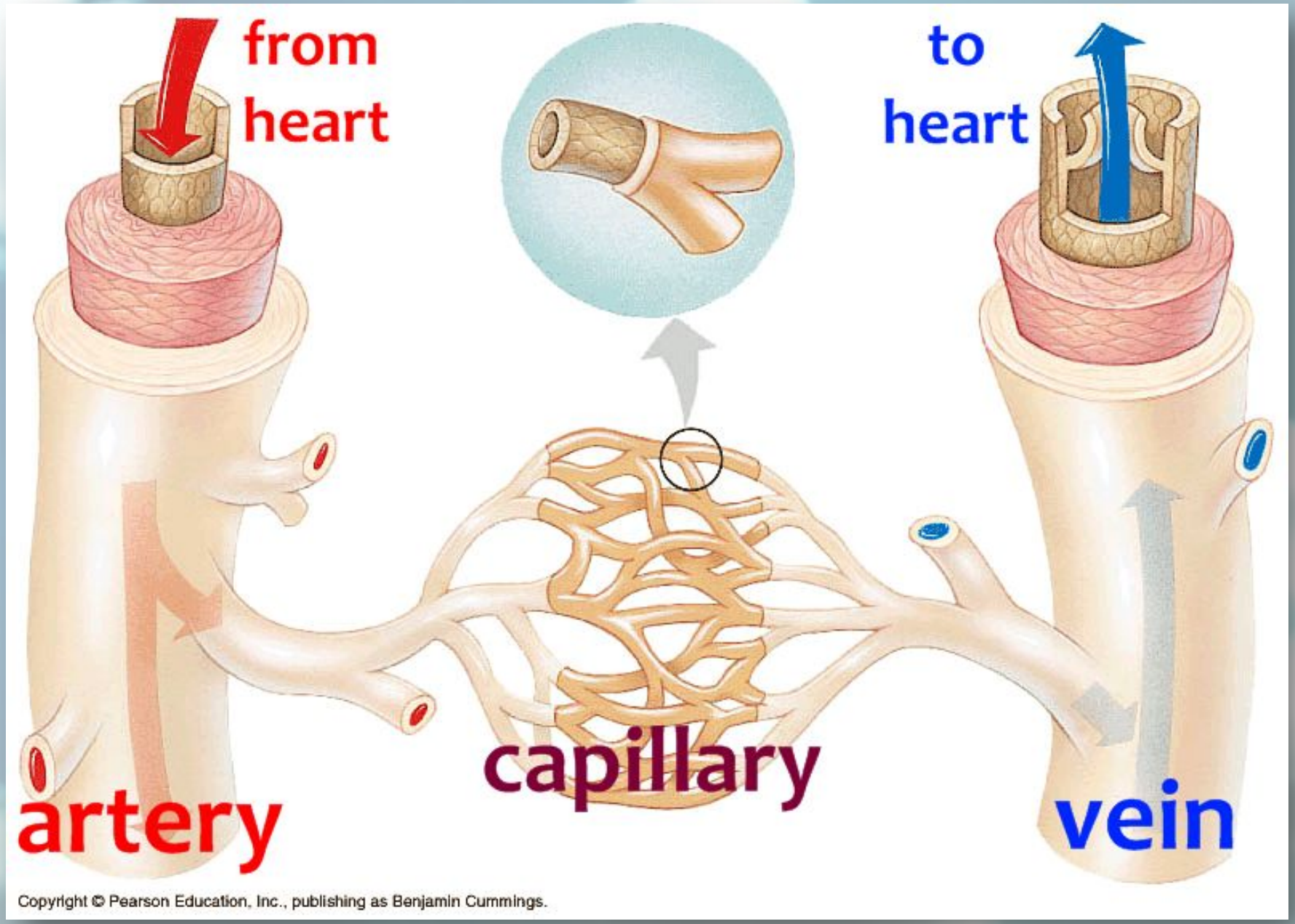
BLOOD VESSELS

There are 3 types of vessels in our body.

These are;

- ARTERIES
- VEINS
- CAPILLARIES`

Blood vessels(photograph)

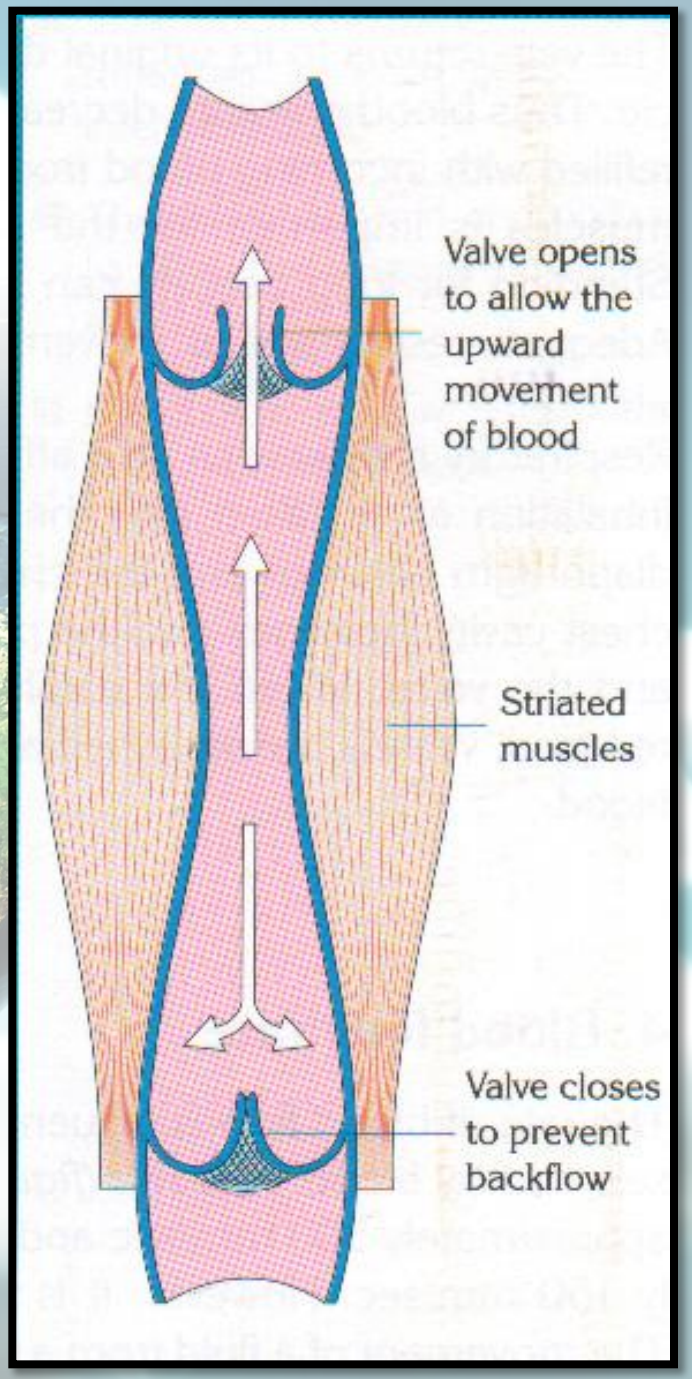


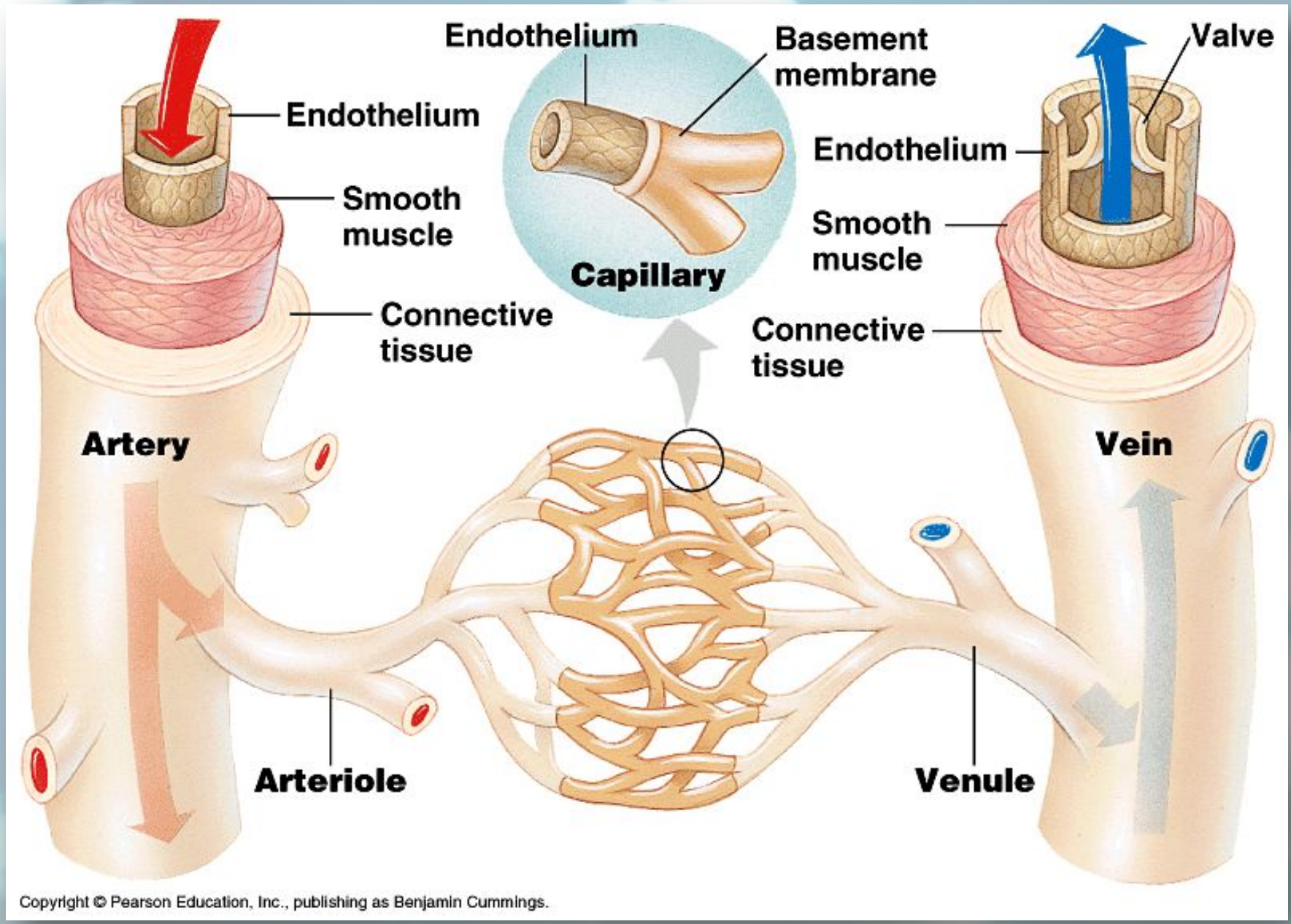
1. Arteries

- 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**

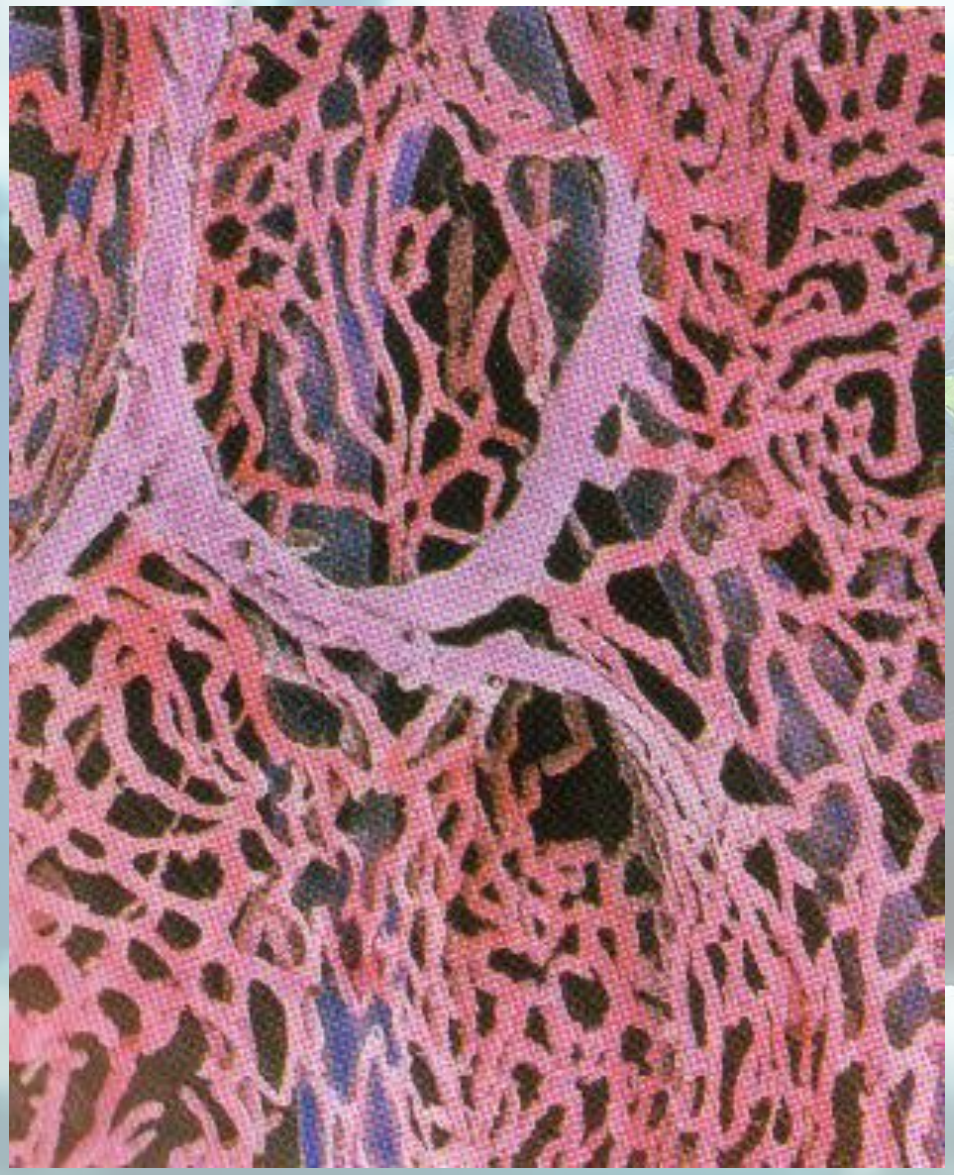
2. Veins

- 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

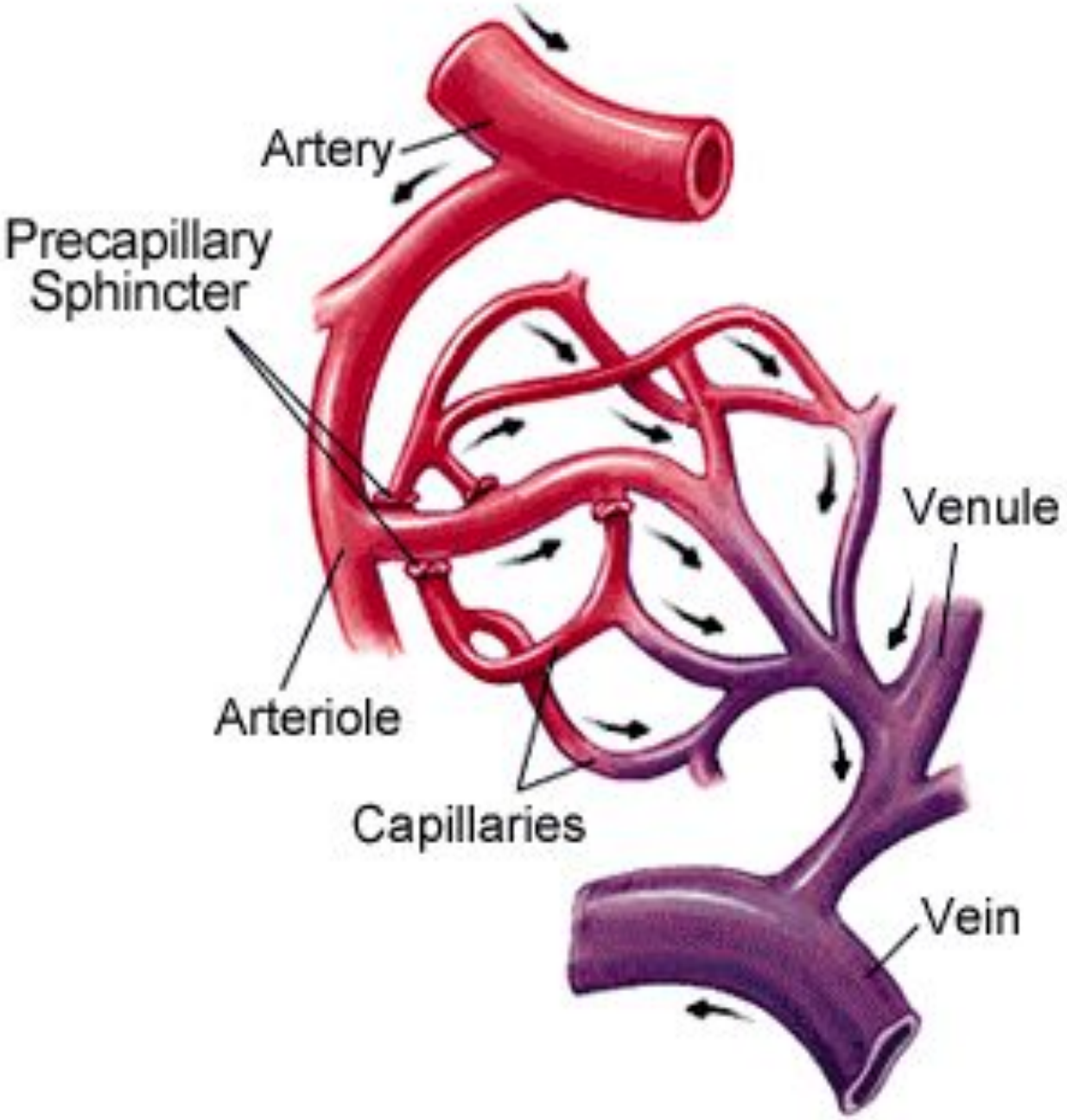


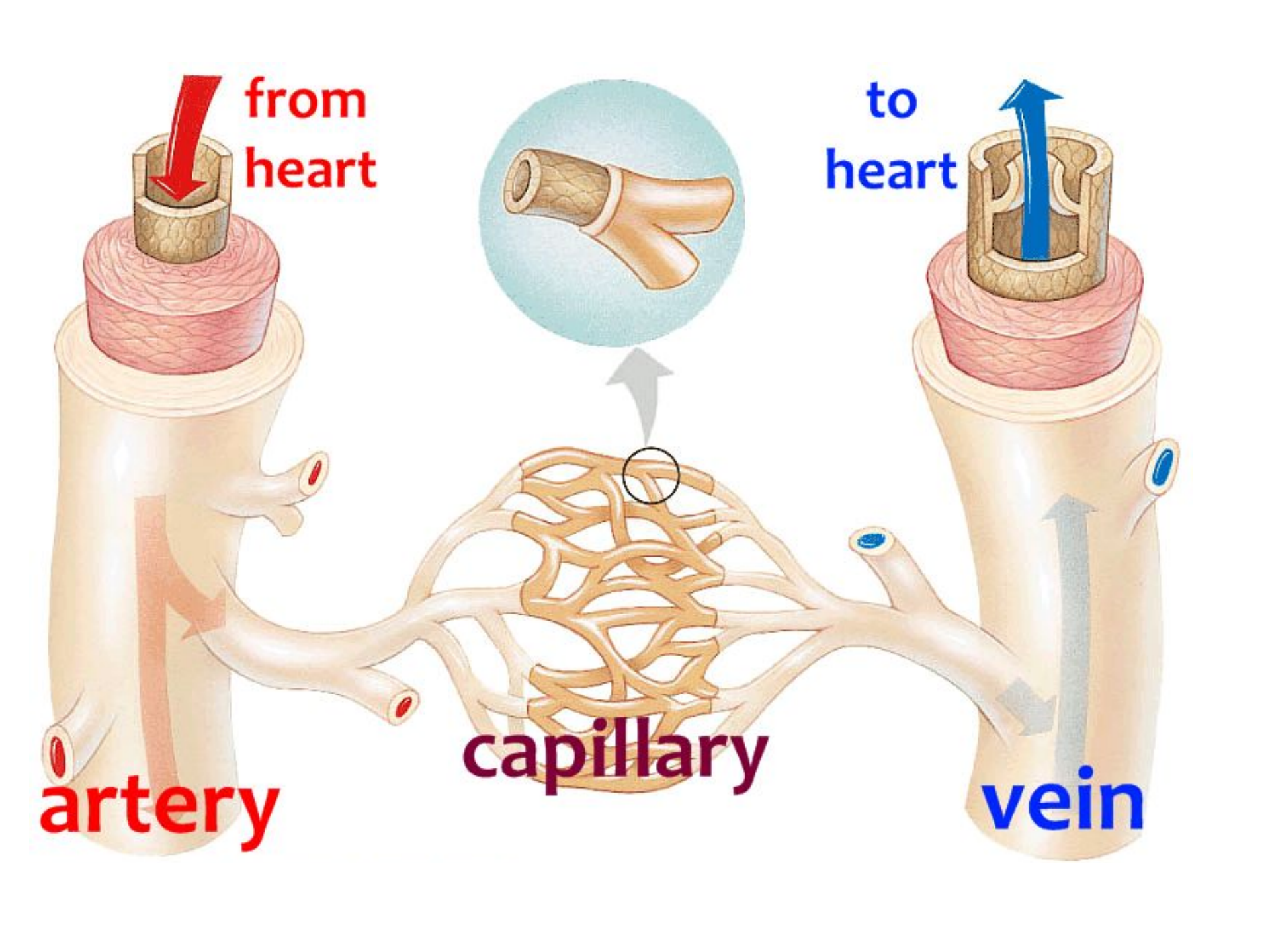


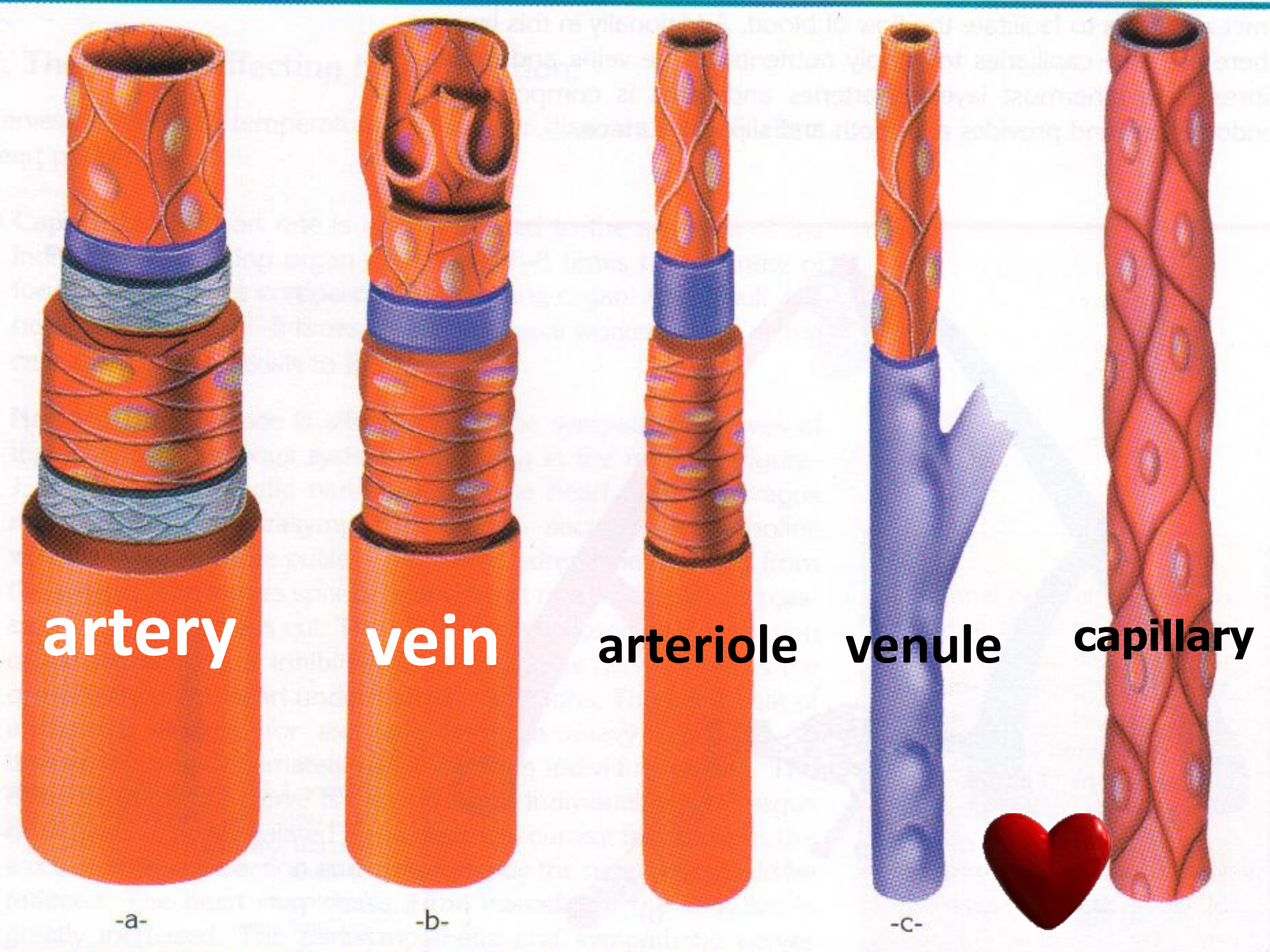
3. Capillaries



- 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

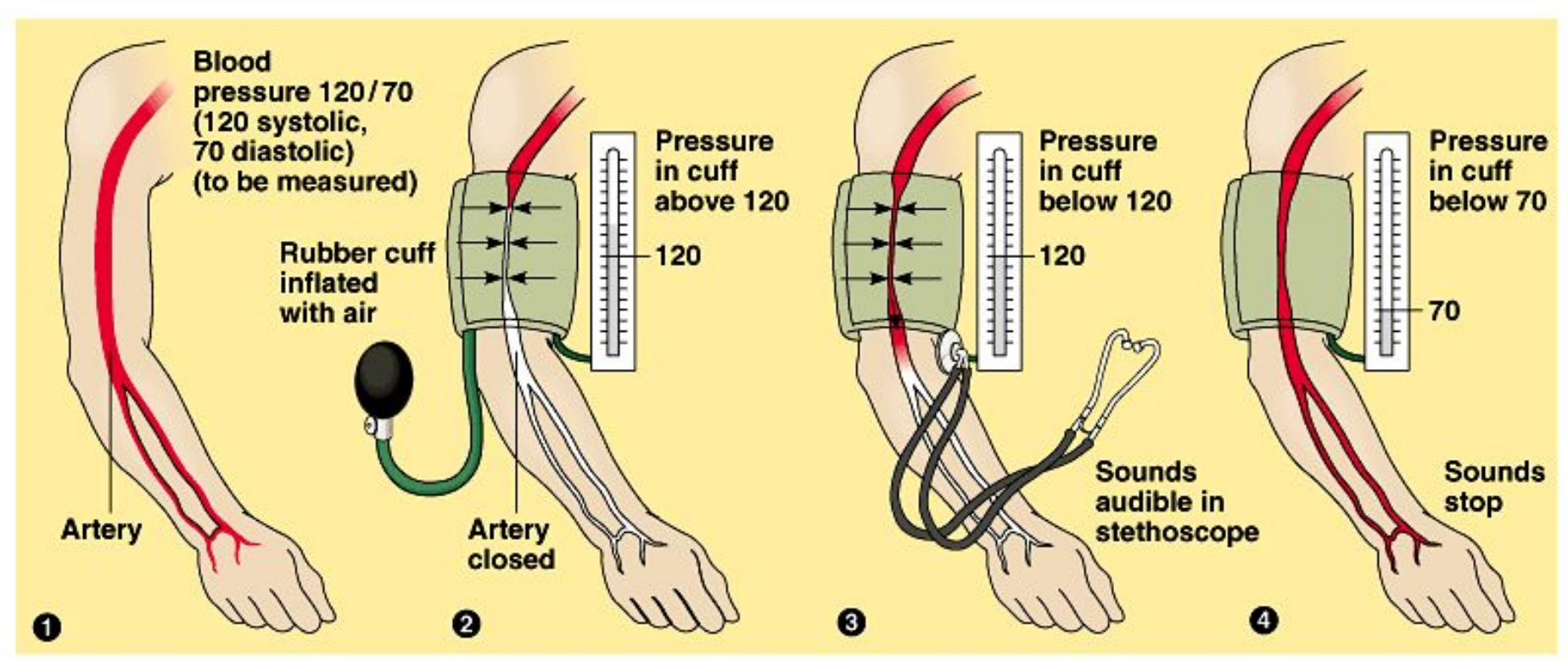

from heart
to heart
capillary
artery
vein

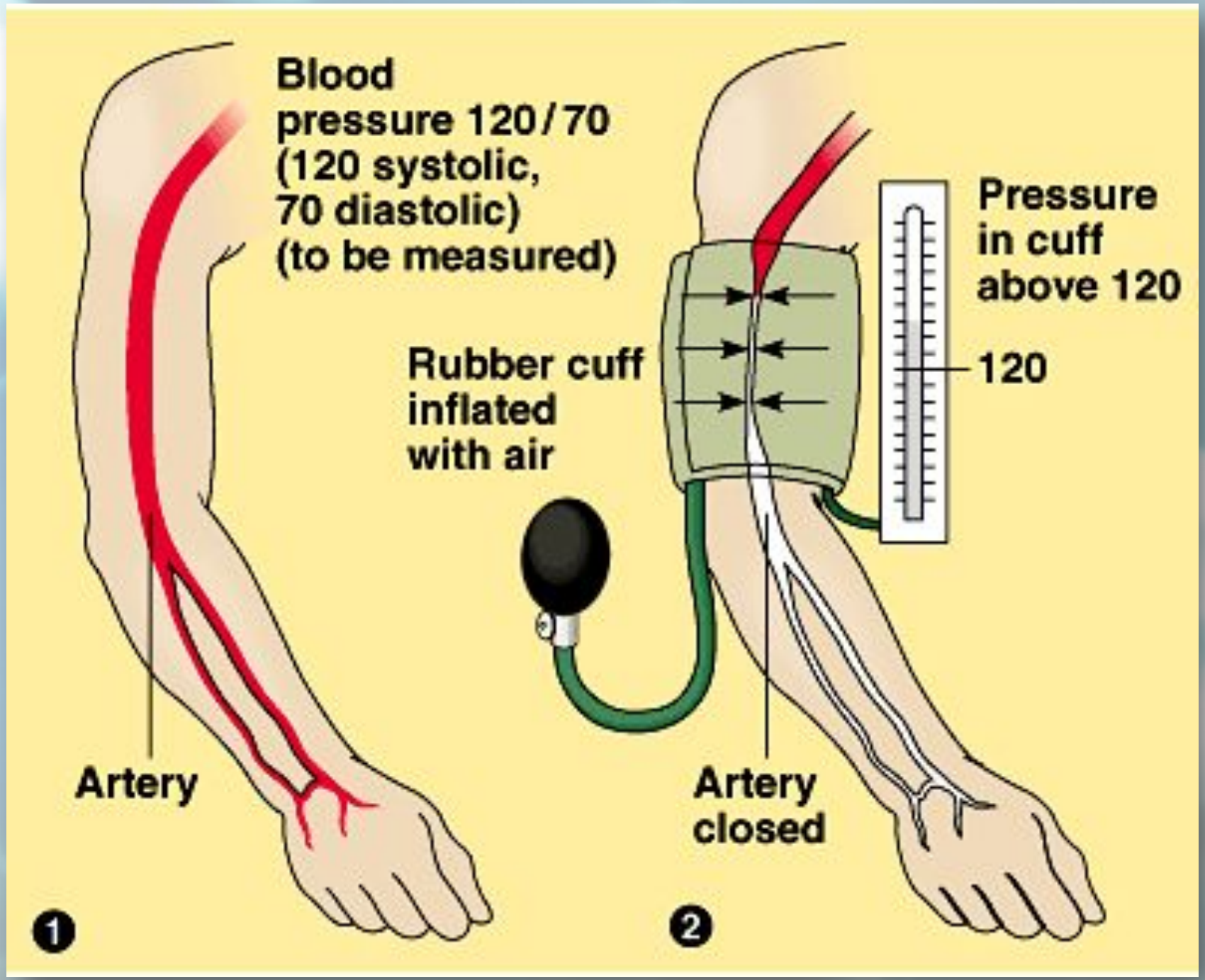

artery
vein
arteriole
venule
capillary
-a-
-b-
-c-

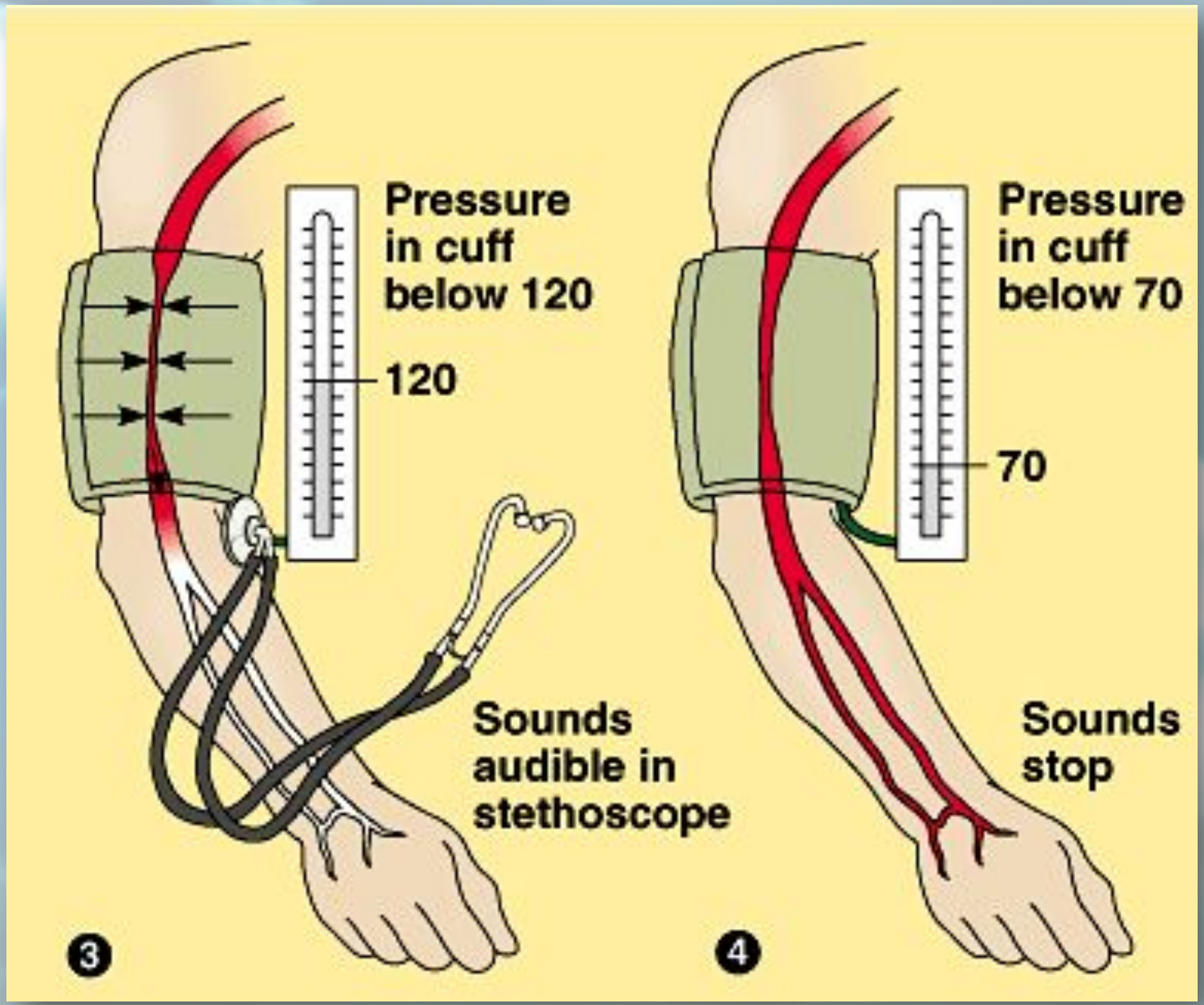
Blood Pressure

- 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

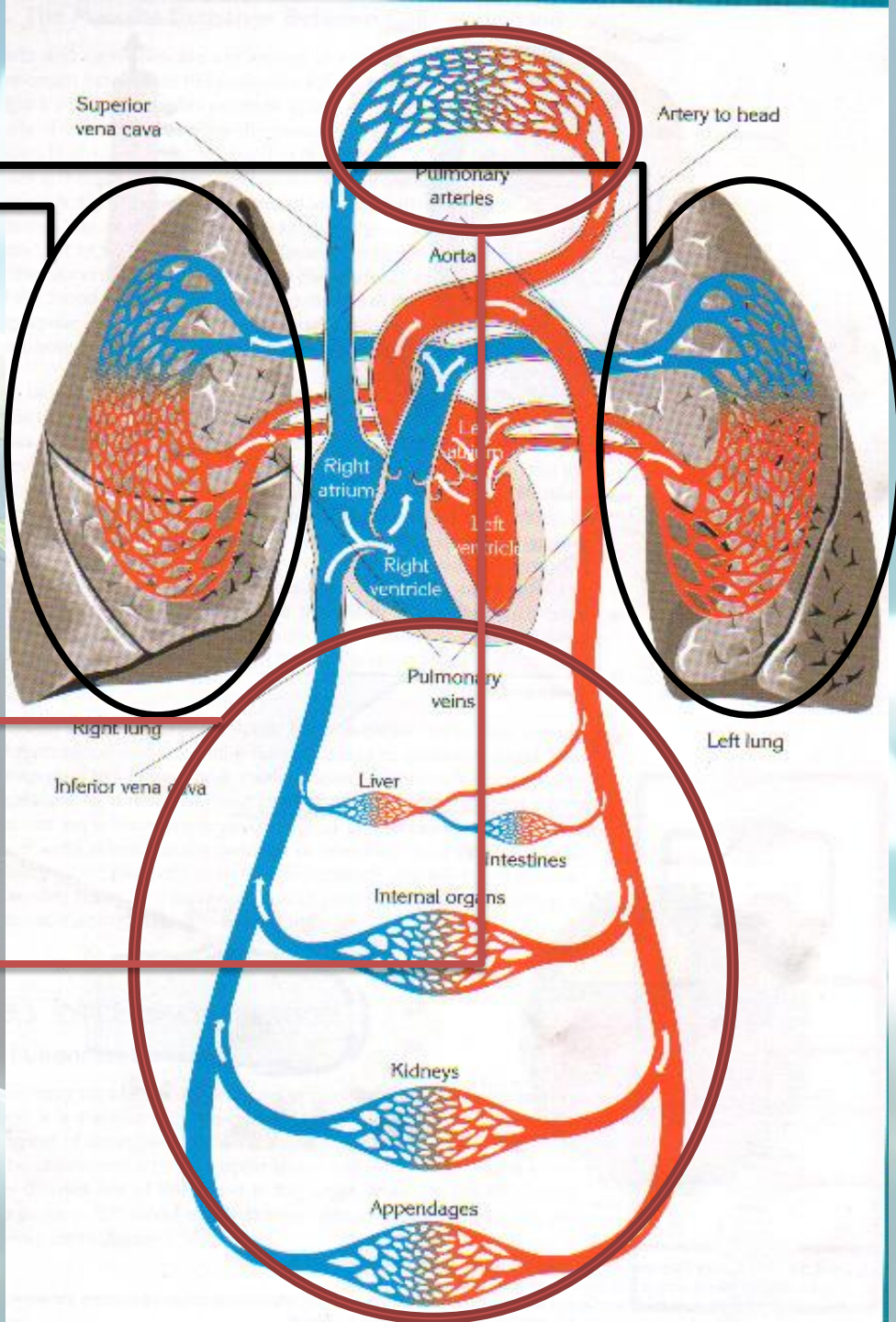

Pressure in cuff below 120
120
Sounds audible in stethoscope
3
Pressure in cuff below 70
70
Sounds stop
4

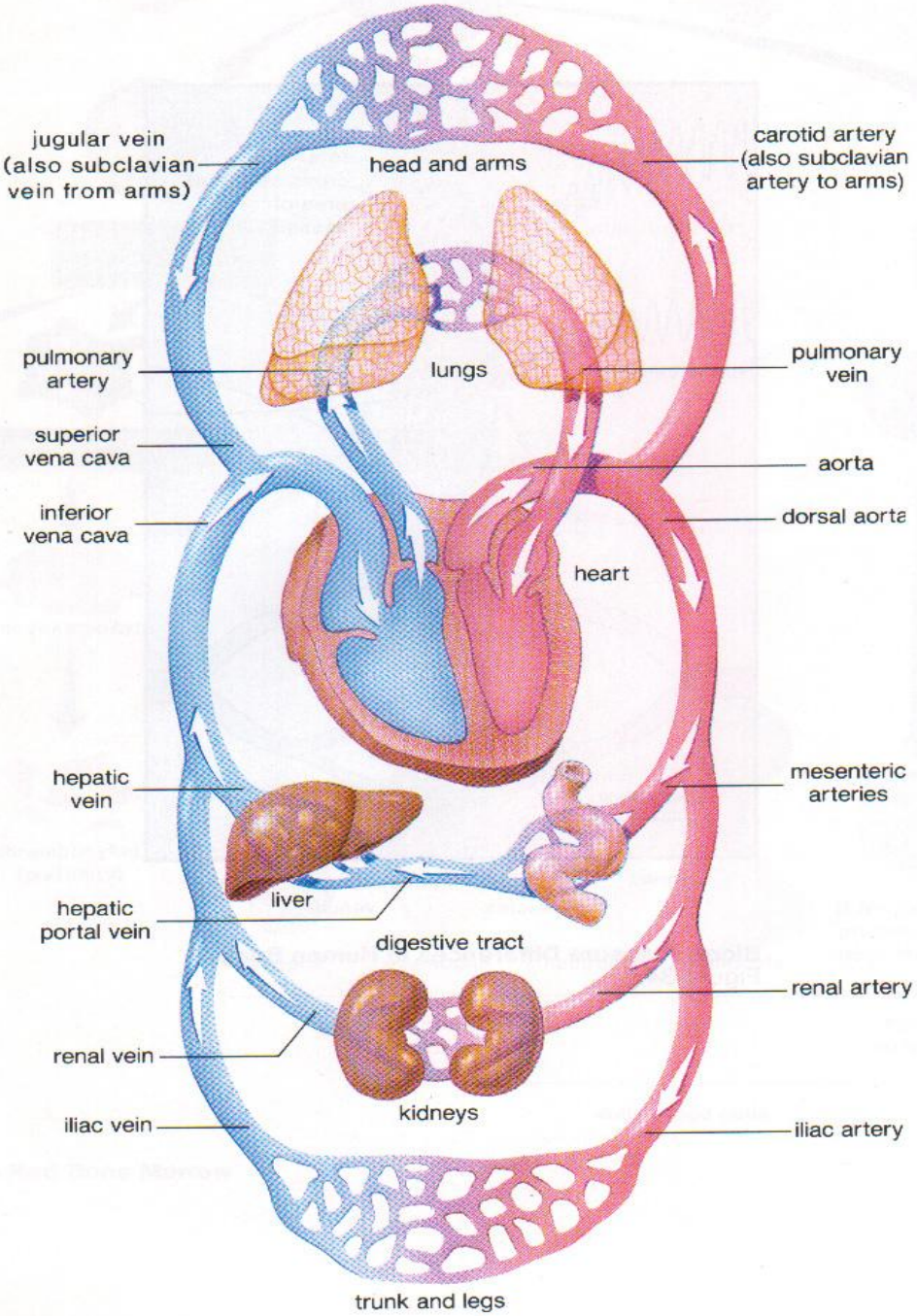
Blood Circulation

- 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

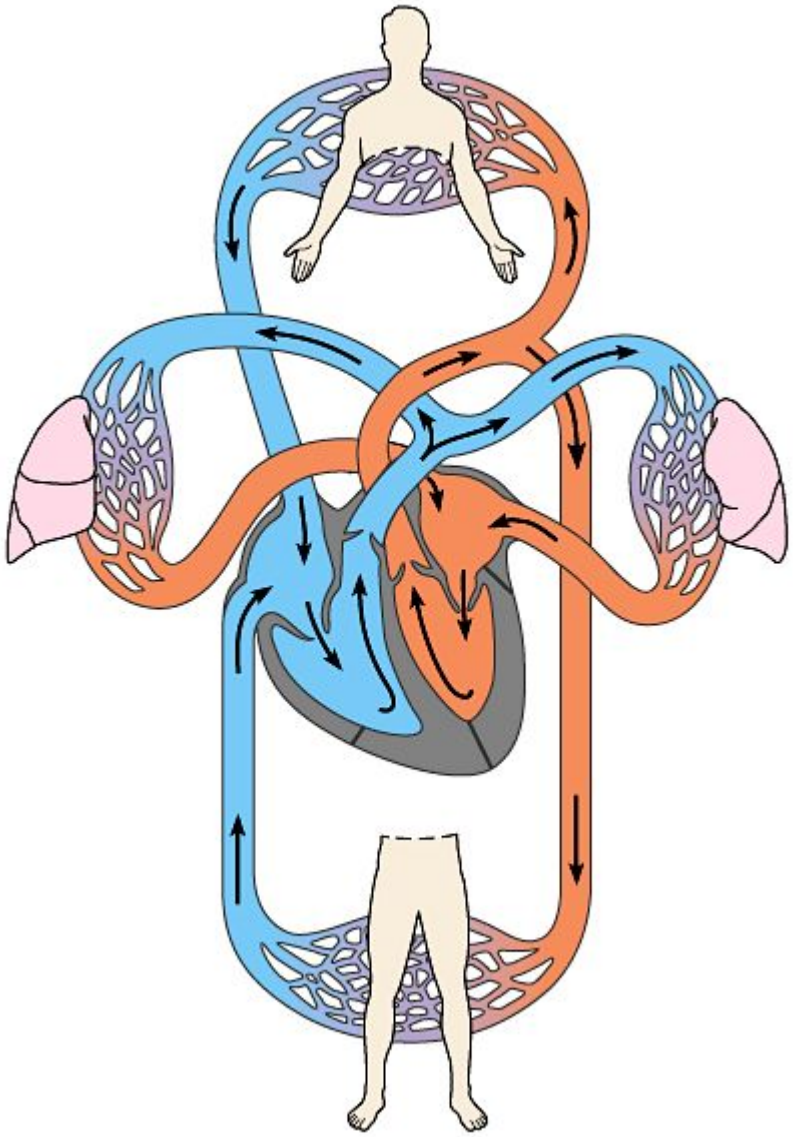
Systemic circulation

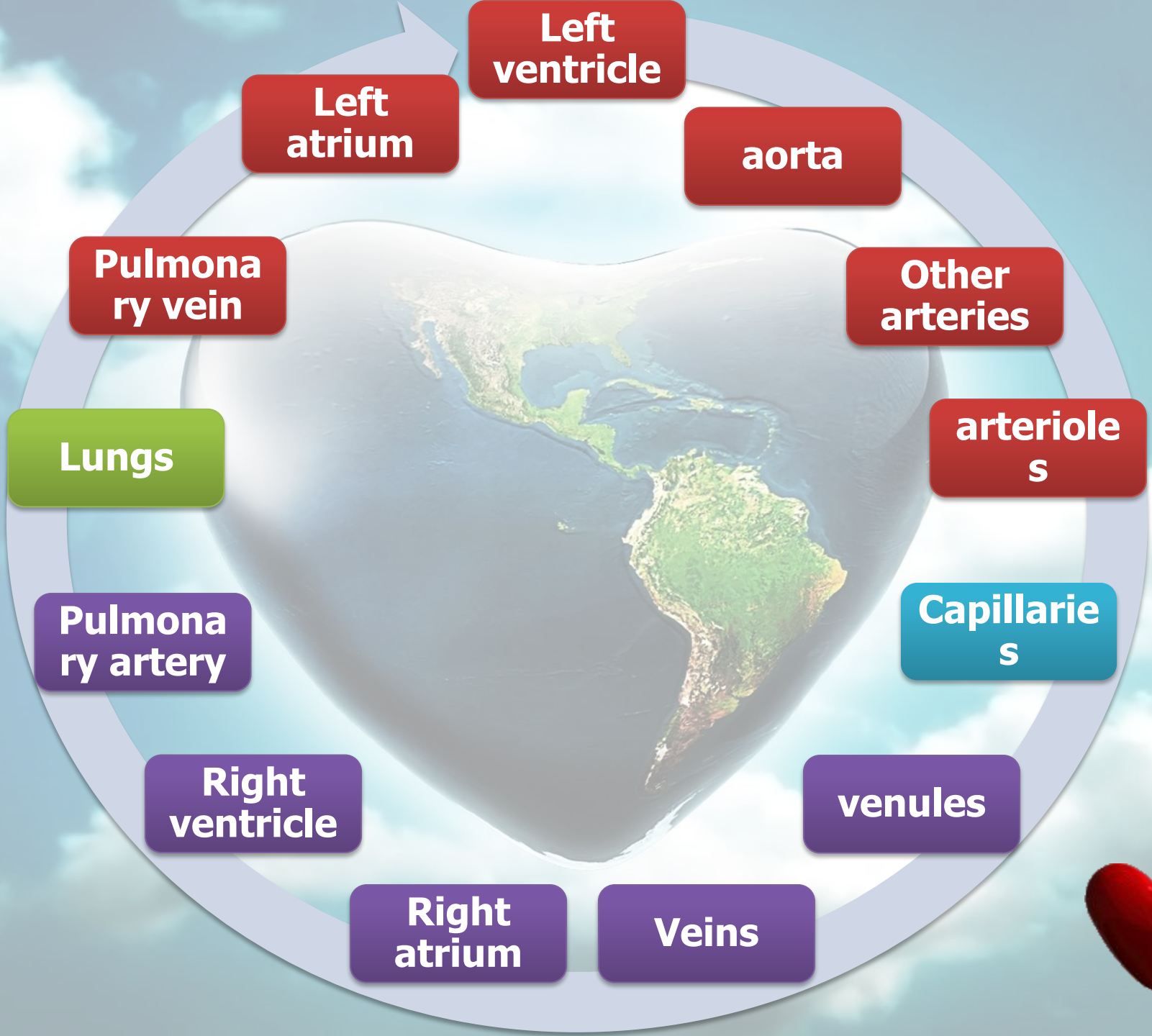



jugular vein
(also subclavian
vein from arms)
head and arms
carotid artery
(also subclavian
artery to arms)
pulmonary
artery
lungs
pulmonary
vein
superior
vena cava
aorta
inferior
vena cava
dorsal aorta
heart
hepatic
vein
mesenteric
arteries
liver
hepatic
portal vein
digestive tract
renal artery
renal 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
Left atrium
aorta
Pulmonary vein
Other arteries
Lungs
arterioles
Pulmonary artery
Capillaries
Right ventricle
venules
Right atrium
Veins

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

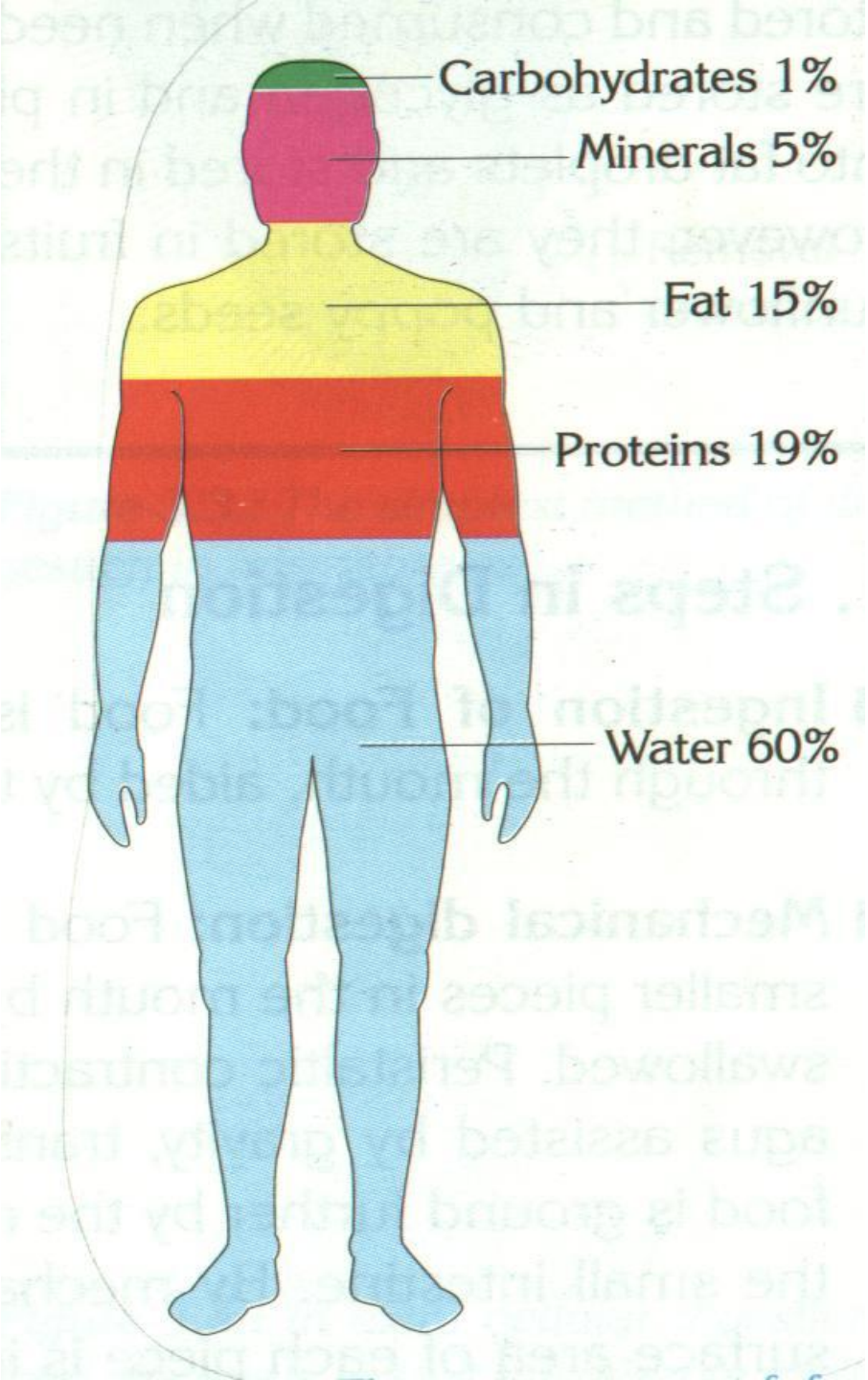
BLOOD COMPONENTS

Blood contain 2 main parts. These are:

- Blood Plasma
- Blood cells

Blood Plasma

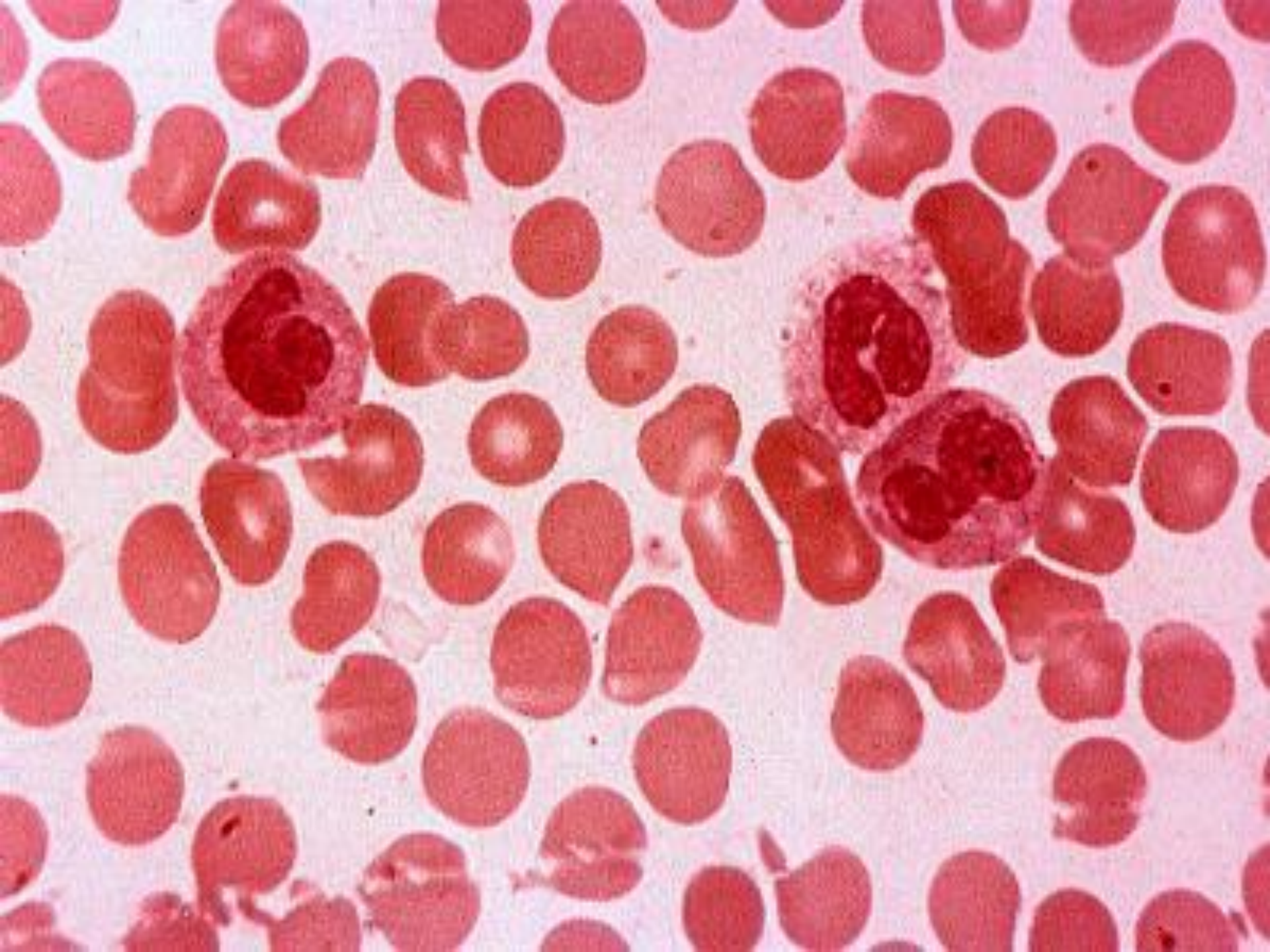
- Plasma is liquid part of blood. It includes **water (90%)** and **dissolved proteins**. It also contains salts, glucose, aminoacids, fatty acids, vitamins, hormones and cellular wastes.


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

Blood Cells

There are three types of blood cells:

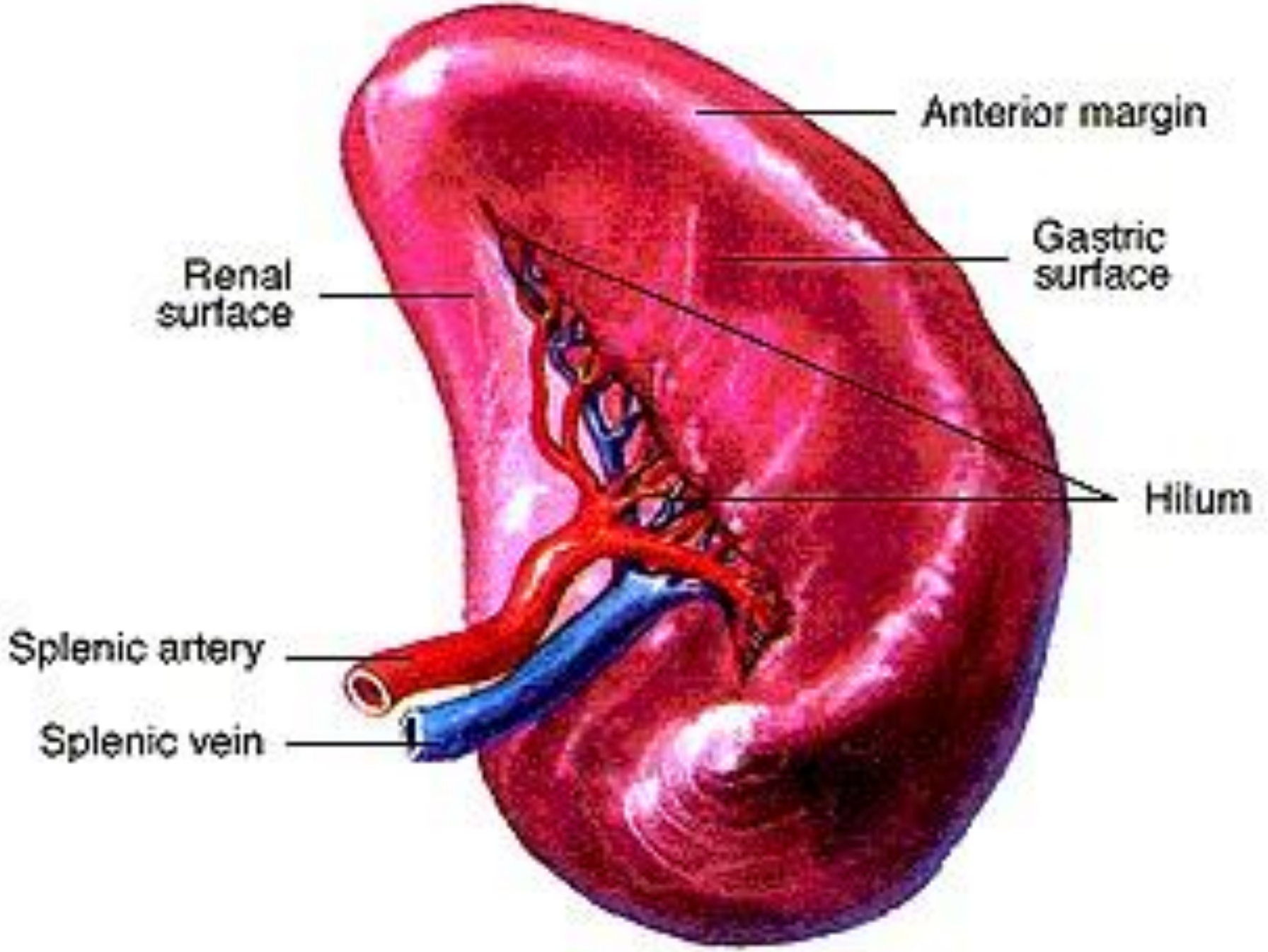
- Erythrocytes (=Red Blood Cells)
- Leucocytes (=White Blood Cells)
- Thrombocytes (=Platelets)

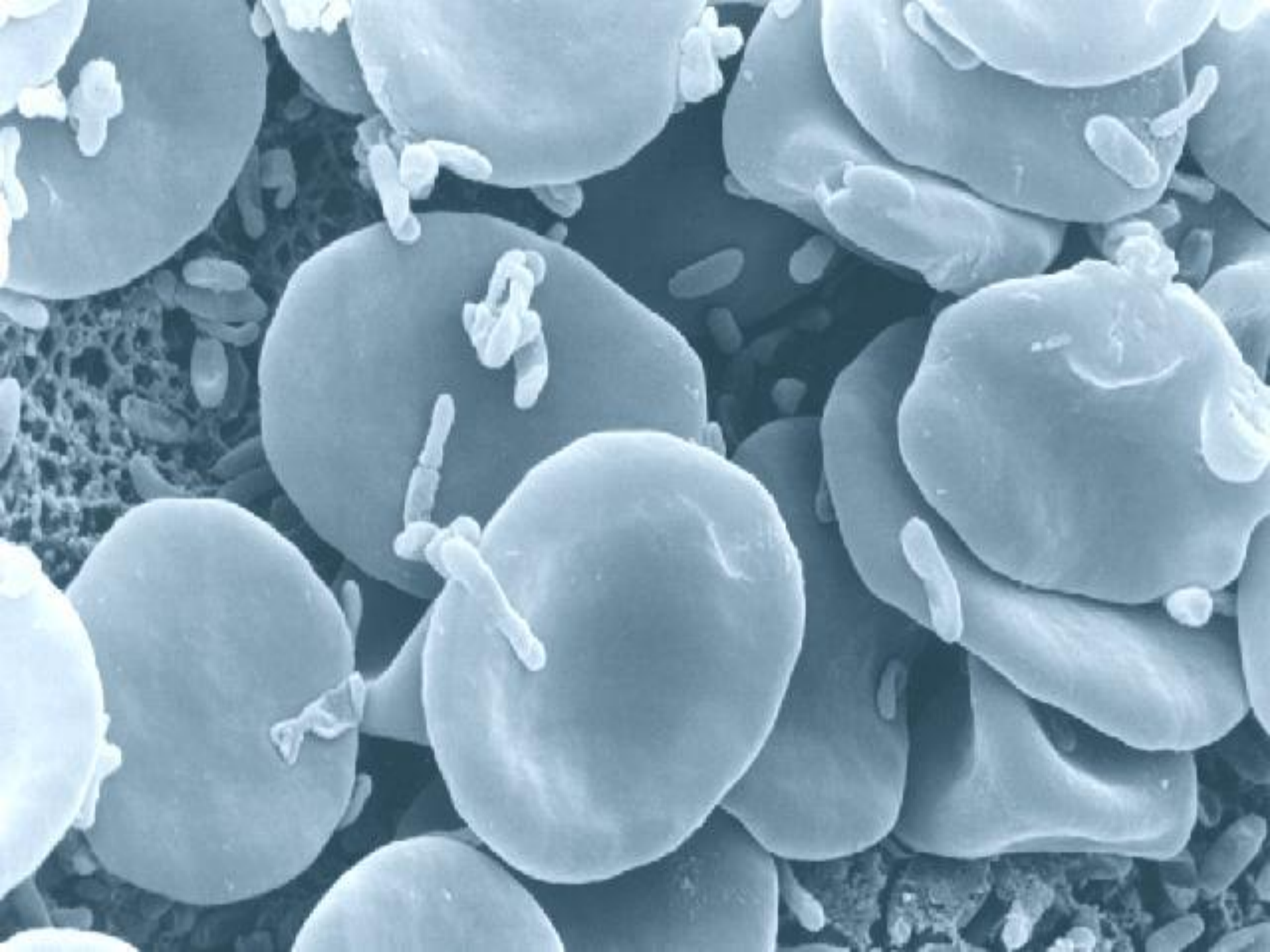


ERYTHROCYTES

- 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.

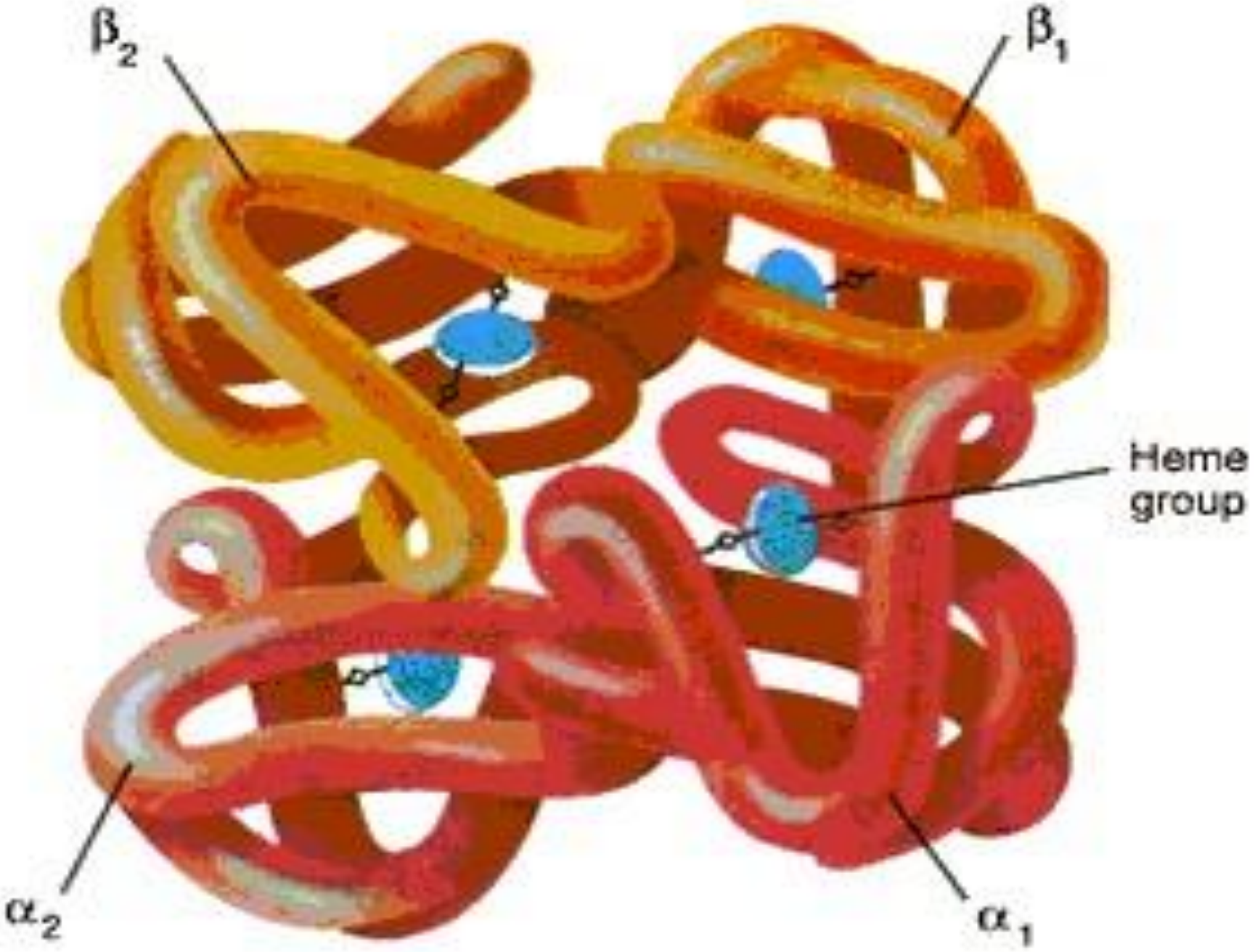
- Mammalian erythrocytes have no nucleus at adult (maturation) stage.
- They are produced by red bone marrow.
- Erythrocytes live(!) for **120 days**
- Erythrocytes are broken down by Reticulo-Endothelial System in spleen, liver and lymph nodes.

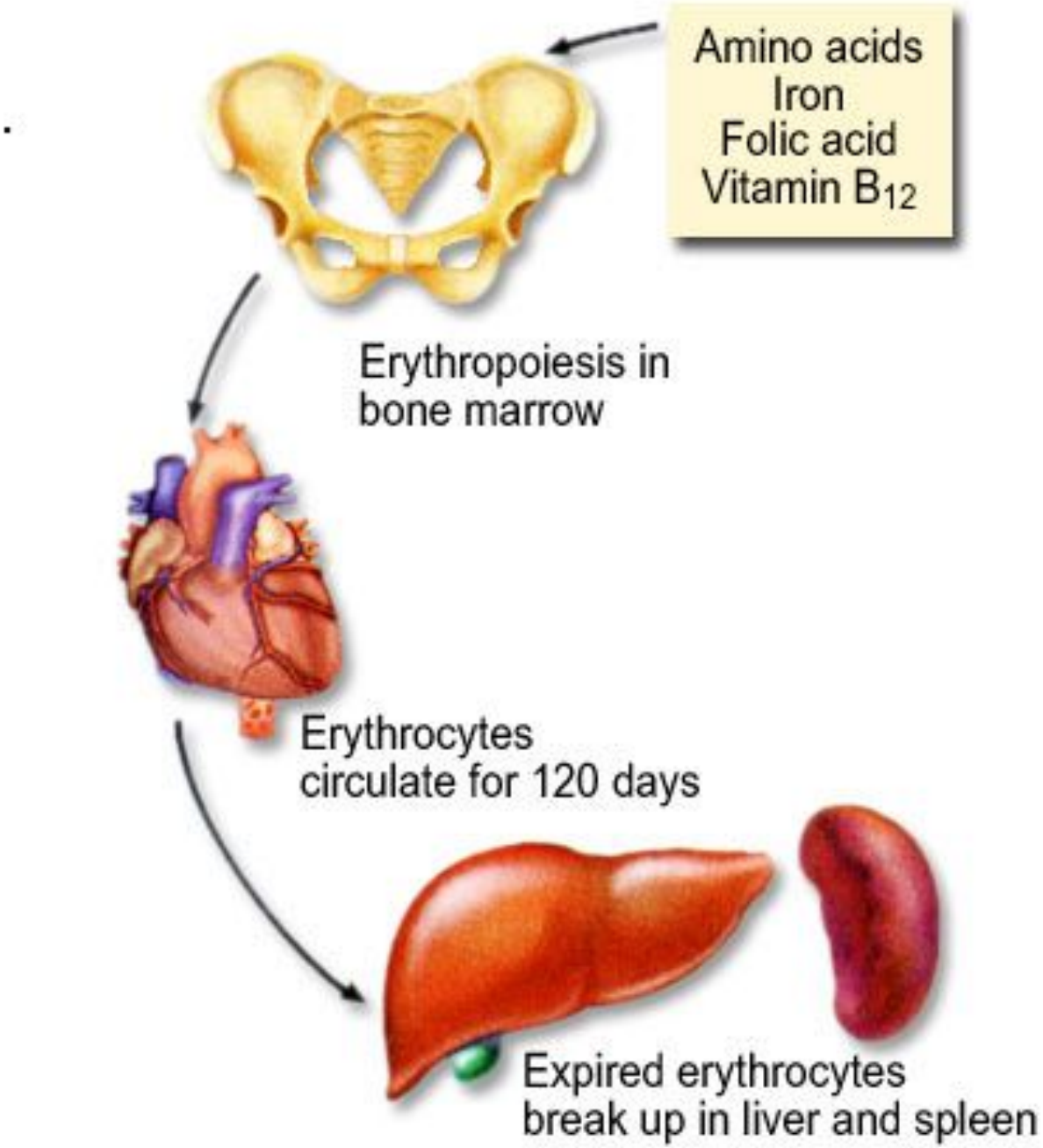

Anterior margin
Gastric surface
Renal surface
Hilum
Splenic artery
Splenic vein



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

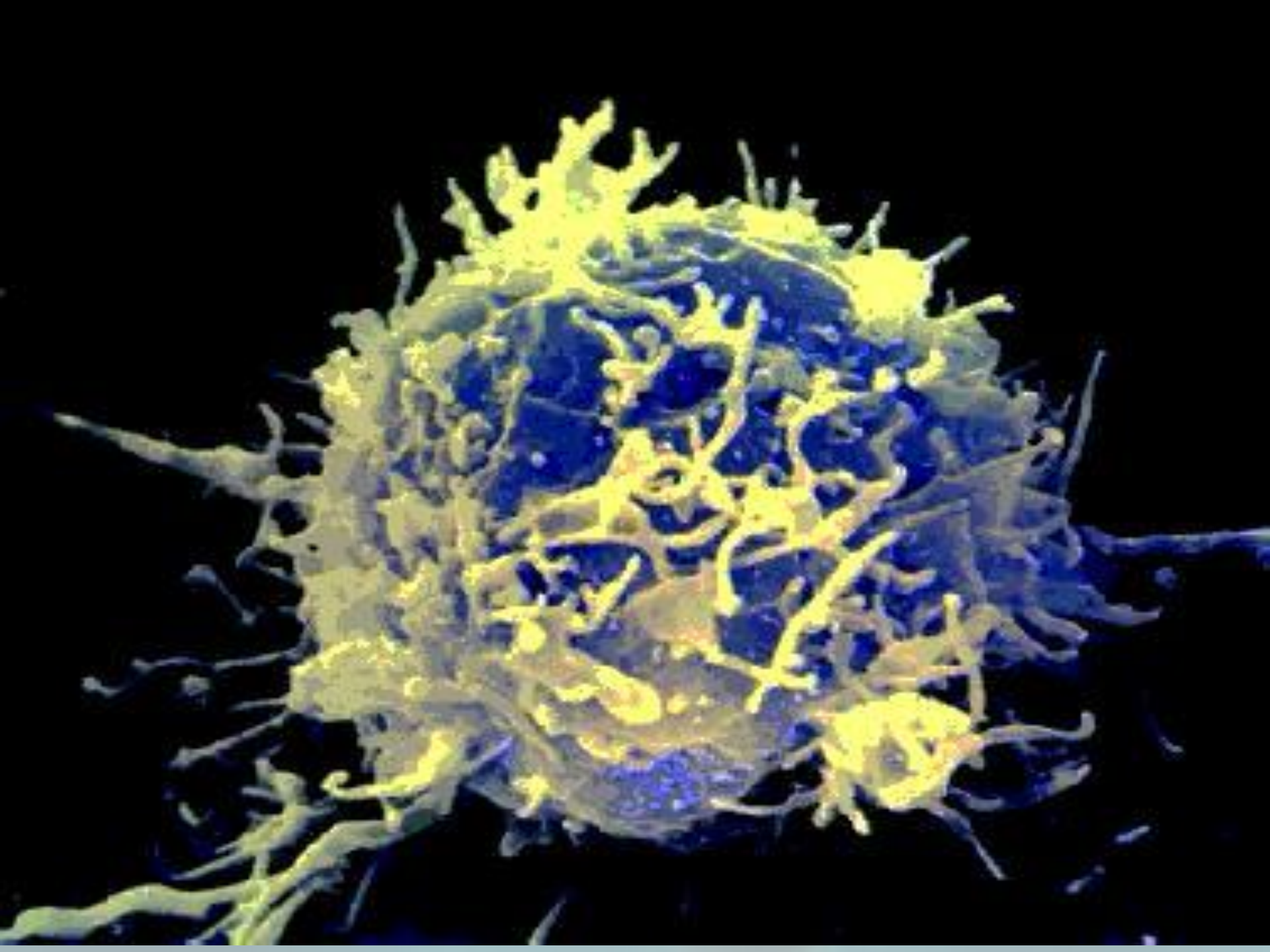

β2
β1
Heme group
α2
α1


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.

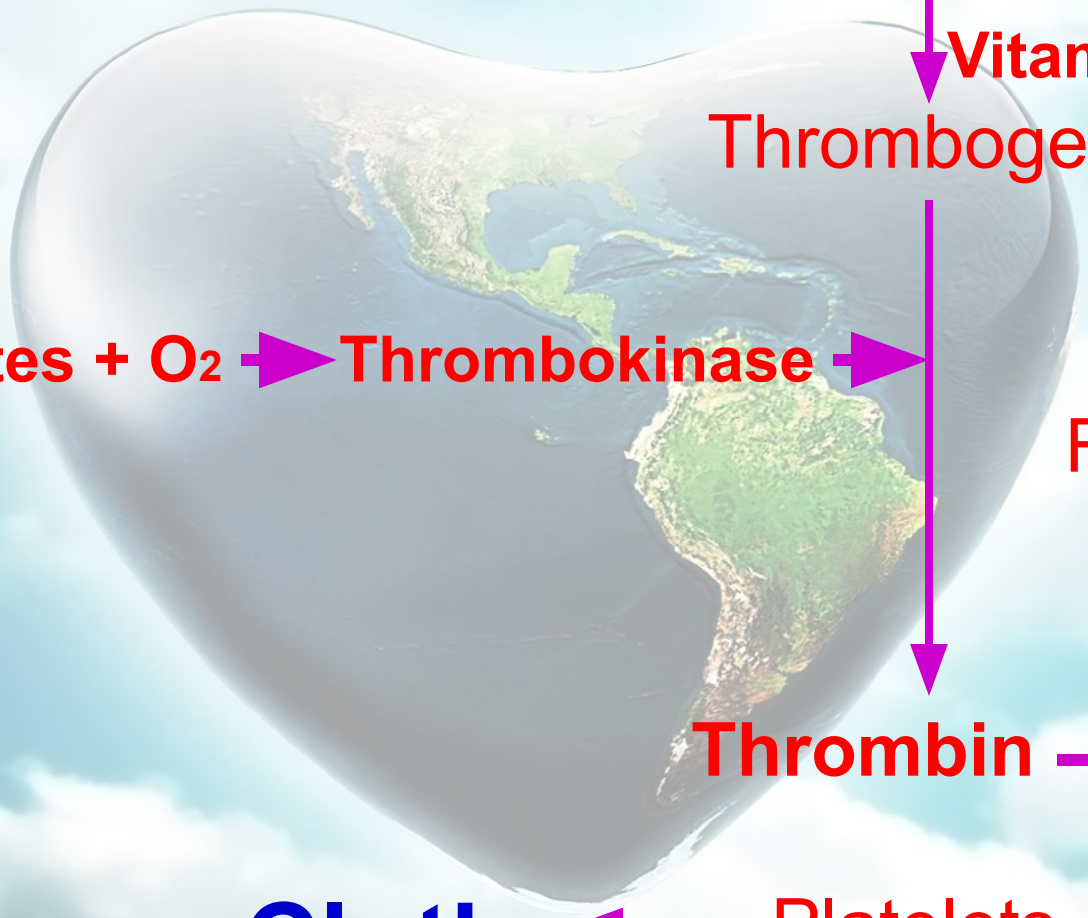
- **Normally there are only 6000 to 8000 leucocytes per cubic millimeter of blood. When there is an infection in the body, number of leucocytes may increase to 30000 per cubic millimeter.**



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



Prothrombin (In liver)

Vitamin K

Thrombogen

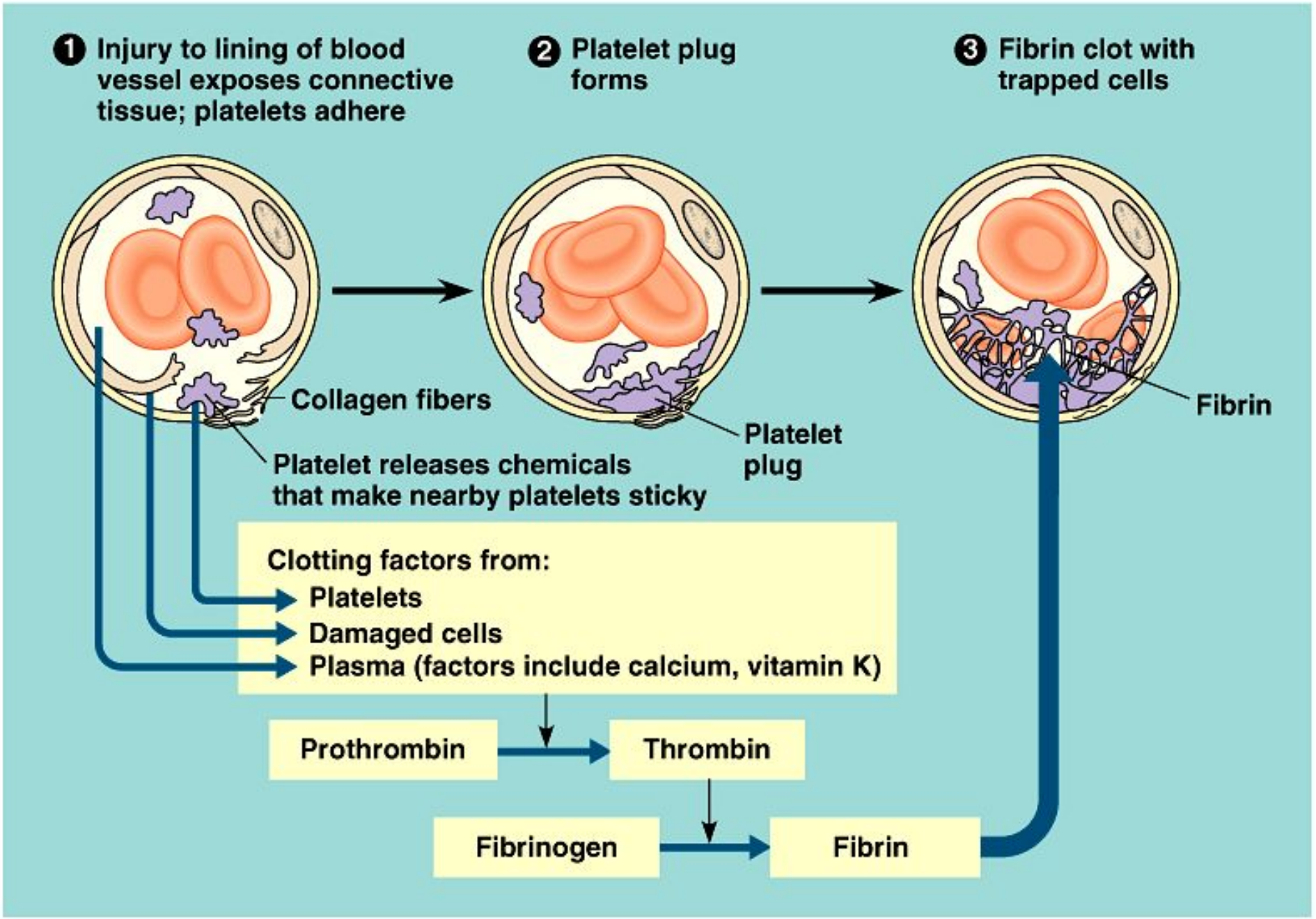
Thrombocytes + O_2 → **Thrombokinase** →

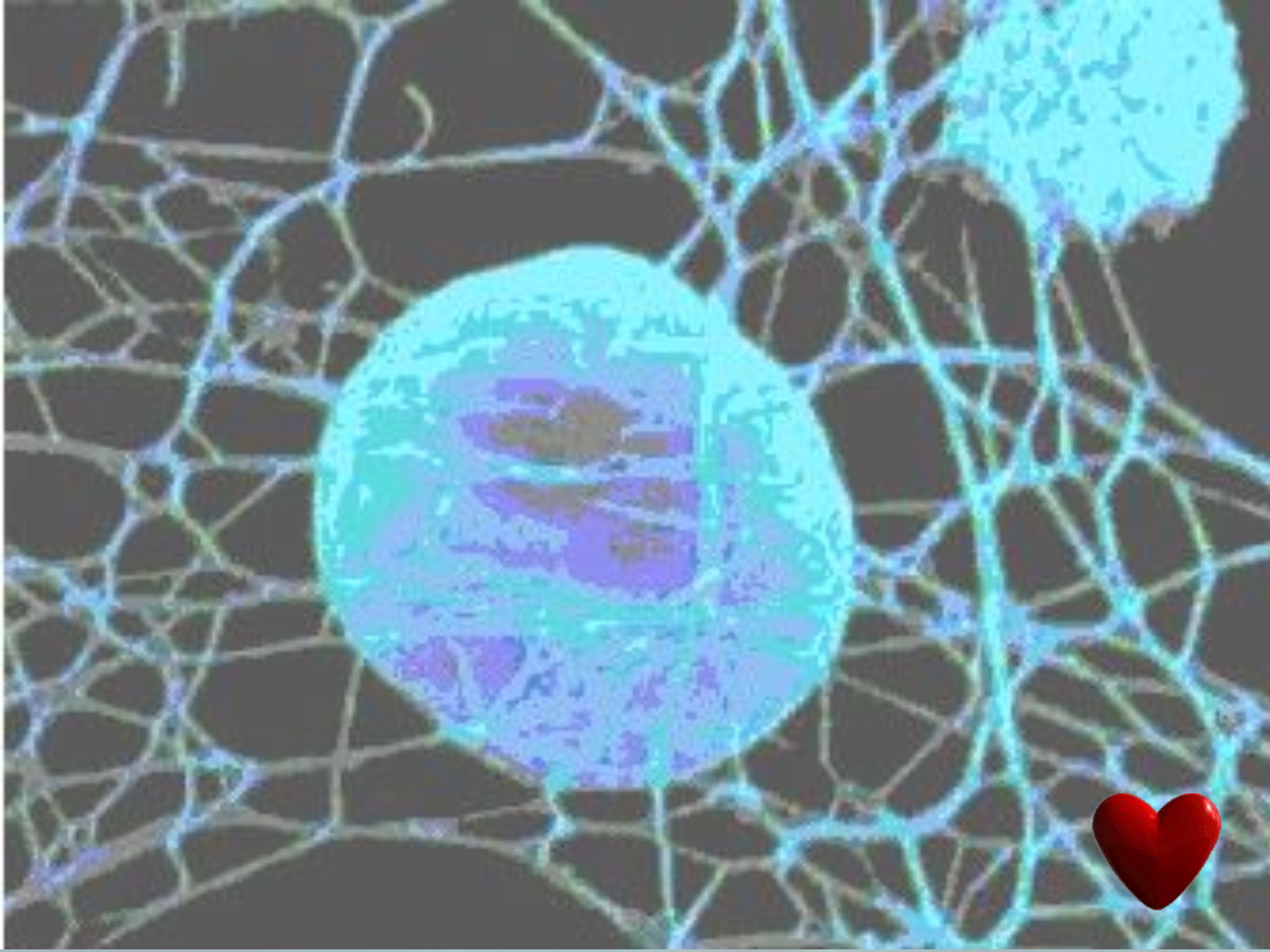
Fibrinogen

Ca ions

Thrombin →

Cloth ← Platelets + Fibrin



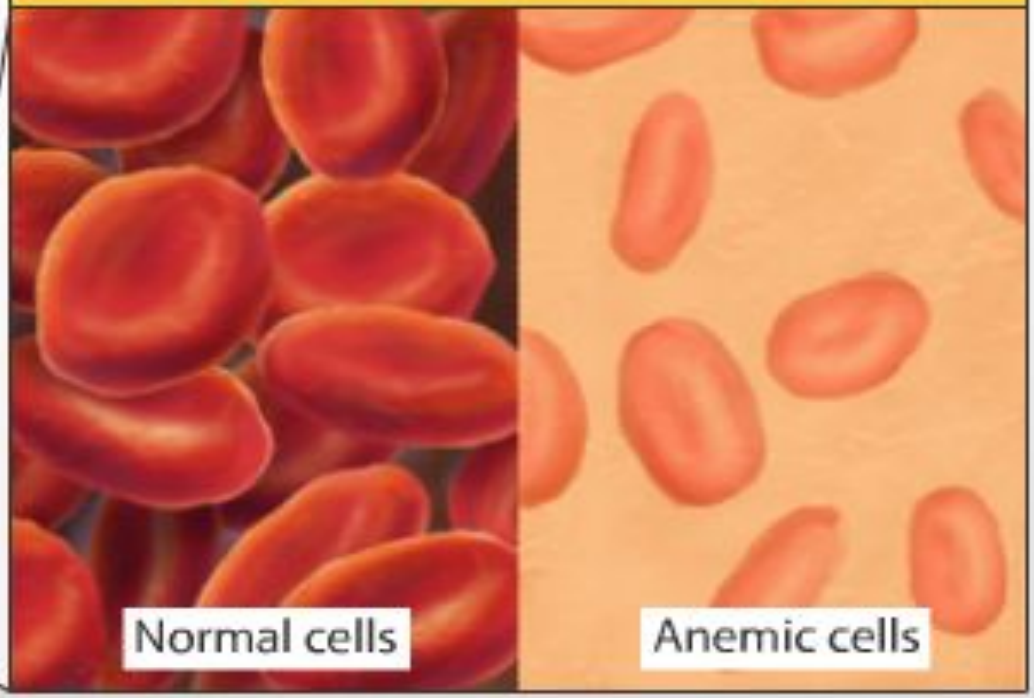


Diseases related to circulatory system

- Anemia
- Leukemia
- Arteriosclerosis

Anemia

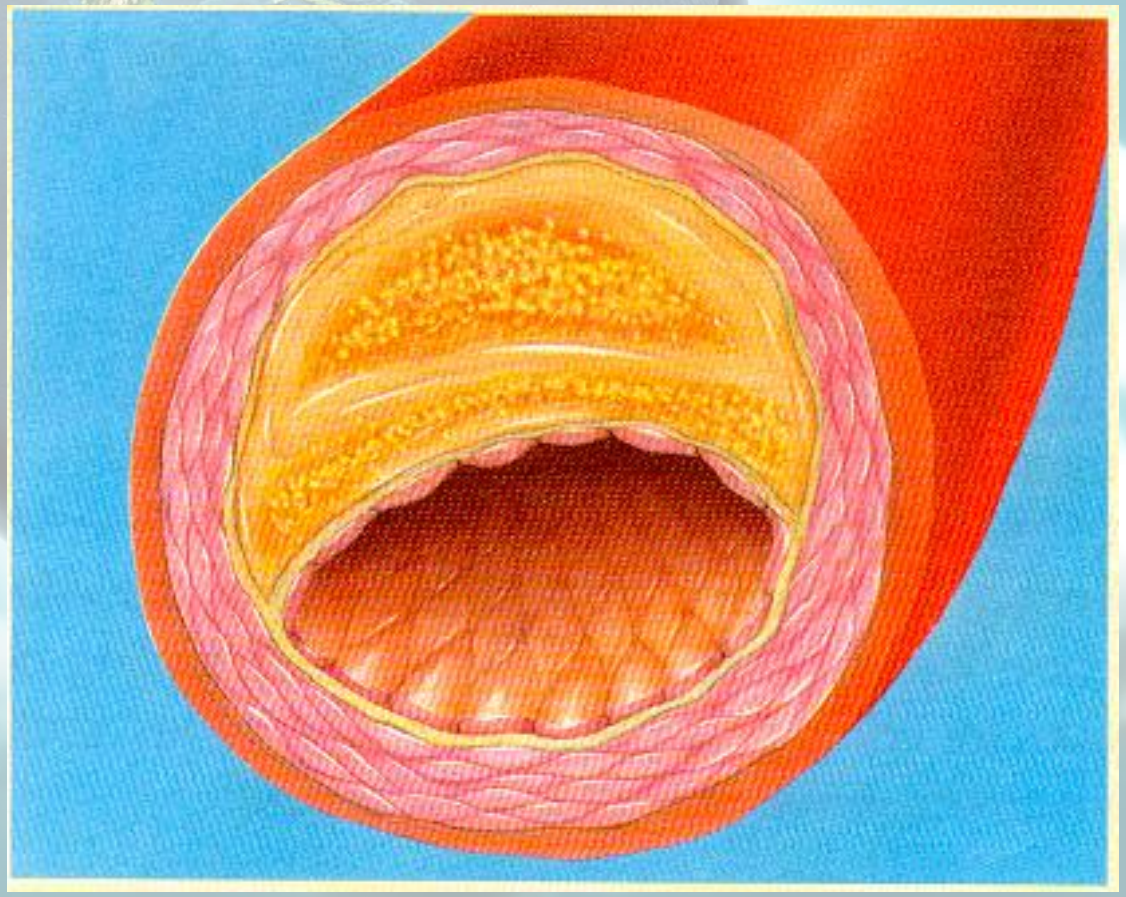
Diagnosis



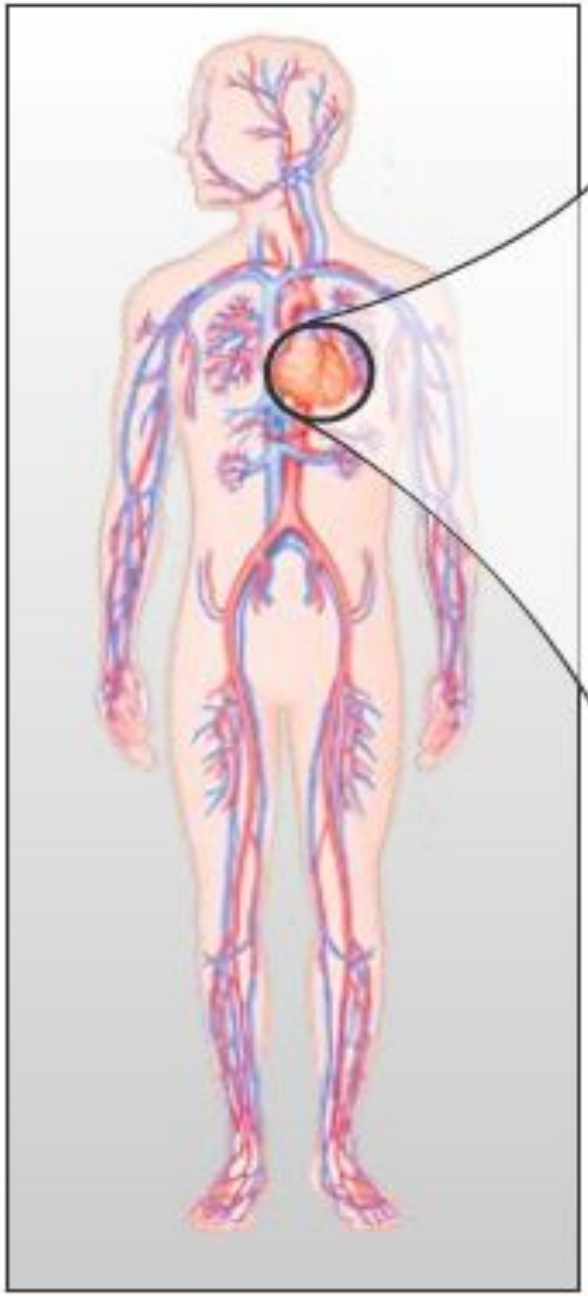
Anemia may result from blood loss or nutritional deficiencies. Foods high in iron such as spinach salad can help prevent anemia.

Arteriosclerosis

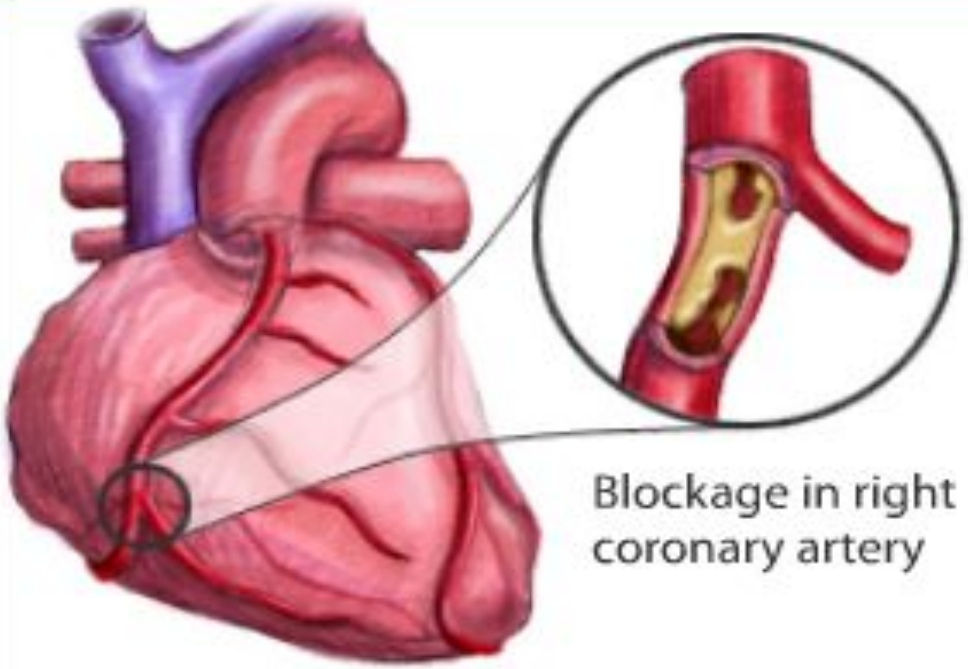
- When blood vessels **become narrow** and **lose their elasticity**
- **Fats** and **Ca^{++}** ions adhere to the walls of blood vessels, and by this stroke and heart attack may occur
  - This disease occurs as a result of eating disorders
  - Is seen mainly in men and women over the age 40



Heart attack



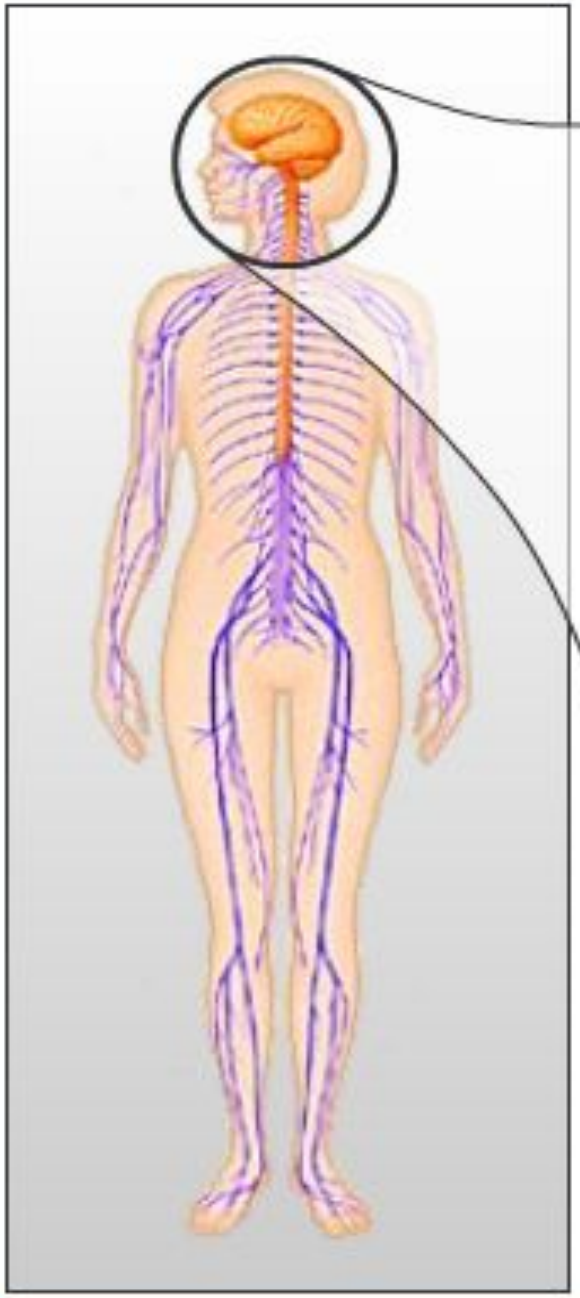
Diagnosis



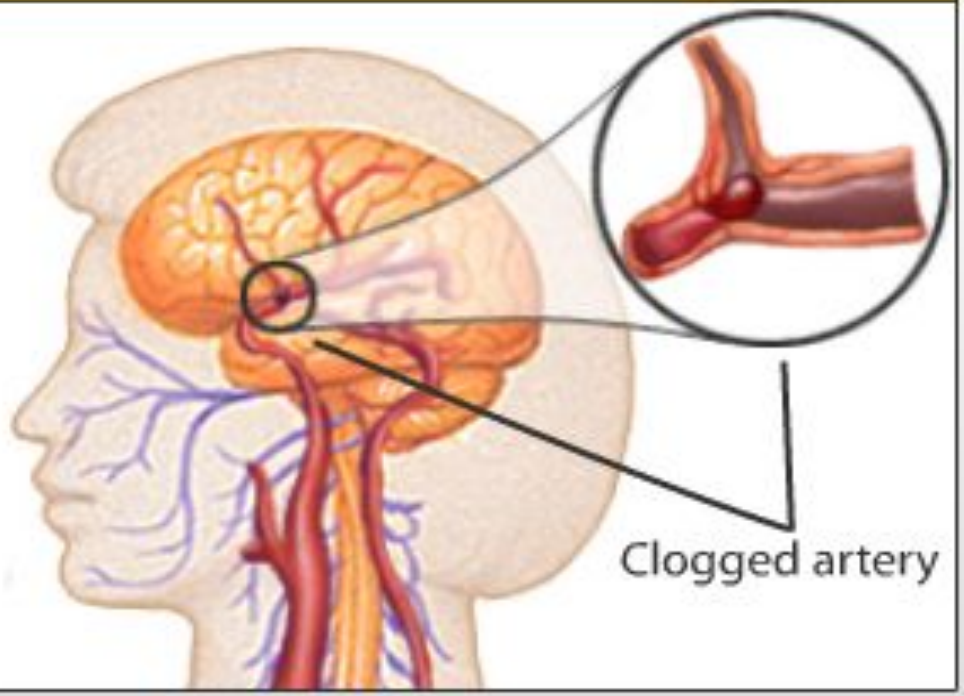
Blockage in right coronary artery

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.

TRUE or FALSE

- Open circulatory system is a characteristic for vertebrates.
  - FALSE
- Red blood cells are also named as leucocytes.
  - FALSE
- There 2 types of circulation in human body
  - TRUE
- There are 3 types of blood cells
  - TRUE
- In pulmonary circulation blood moves from heart to lungs
  - TRUE
- The plasma proteins constitute 7 – 9 % by weight of the plasma.
  - TRUE
- There are 3 chambers in human heart
  - FALSE

- Hemoglobin is carbohydrate
- FALSE
- The right sides of the heart have oxygenated blood and left sides of the heart have deoxygenated blood.
- FALSE
- Capillaries are non-muscular and only one cell thick.
- TRUE
- Materials exchange take place in capillaries between blood and tissues.
- TRUE
- The rate of blood is most rapid(fast) in arteries, slightly slower in veins and slowest in the capillaries.
- TRUE
- Blood pressure is high in veins, lower in capillaries and lowest in the arteries.
- FALSE

Fill in the blanks

- ……. Is placed in the chest cavity between lungs, it has four chambers, two …… and two ……
- The function of the ……. is to prevent the backflow of blood and to keep blood moving in one direction.
- …… veins carry oxygenated blood from lungs to the heart.
- ……..is innermost layer of heart, it is only one cell thick.
- ……has cardiac muscle and coronary vessels.
- ……are located between arteries and veins.

hear t

ventric

atria

valv e

les

pulmon ary

endocar dium

myocard ium

capillari es

Cardiovascular system

Duration 3 week (3x2=6 hours)

- **The function of cardiovascular system**
- **Human cardiovascular system**
- **Heart**
  - Function and structure
  - Cardiac activity
  - Cardiac circulation and heart nutrition
  - **Blood vessels**
  - Arteries
  - Capillaries
  - Veins
  - The blood movement in the vessels
  - Blood pressure in the vessels
  - Material exchanges between vessels and body cells
  - **Blood**
  - Function of blood
  - Plasma and blood cells
  - Blood types and transmition
- **Types of circulation**
  - Pulmonary circulation
  - Systemic circulation
  - Placental circulation

LEARNING OBJECTIVES OF THE CARDIOVASCULAR SYSTEM

AFTER THE STUDENTS HAVE STUDIED THESE SUBJECTS THEY SHOULD BE ABLE TO

- Name the organs of the circulatory system and discuss their function.
- Explain the function of circulatory system
- Name and describe the locations and functions of the major part of the heart
- Trace the pathway of blood through the heart chambers
- Trace the pathway of blood through the vessels of coronary circulation
- Discuss the cardiac cycle and explain how it is controlled
- Identify the parts of normal ECG pattern and discuss the significance of this pattern
- Compare the structure and function of the major types of blood vessels
- Describe how substances exchanged between the blood in capillaries and tissue fluid surrounding body cells
- Describe the mechanisms that return venous blood to the heart
- Compare the pulmonary and systemic circulation
- Identify and locate the major arteries and veins of the pulmonary an systemic circulation
- Explain the arterial pulse and blood pressure
- Explain some cardiovascular disorders and diseases
- Understand how cardiovascular system helps other body systems and the relation between cardiovascular and other body systems

the end