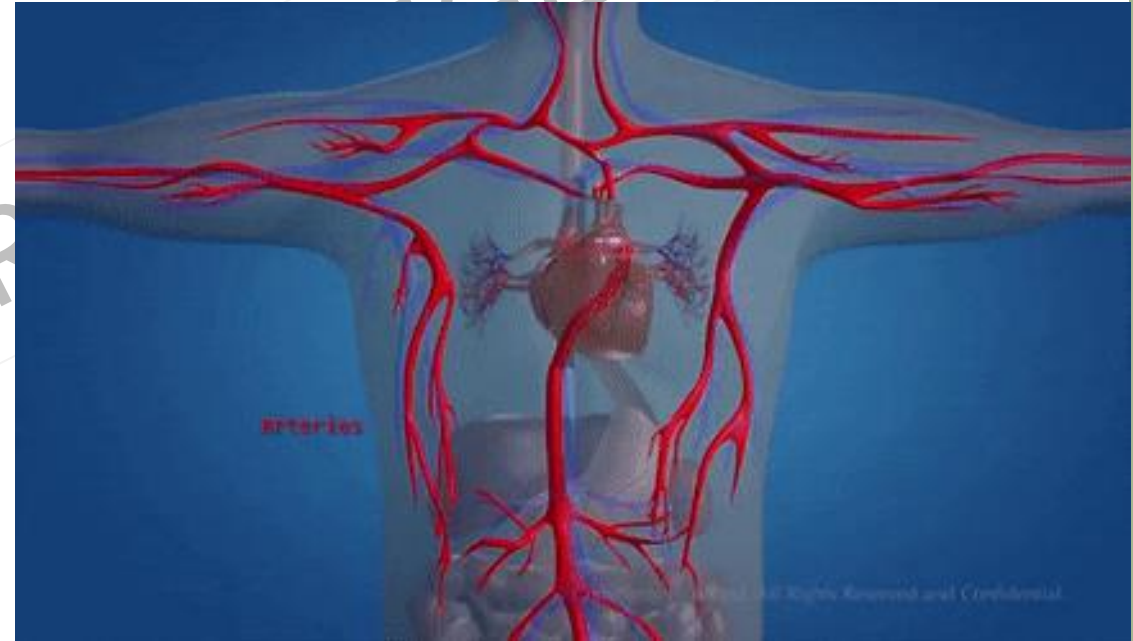


8.8 CIRCULATION IN ANIMALS

Arati G Raut

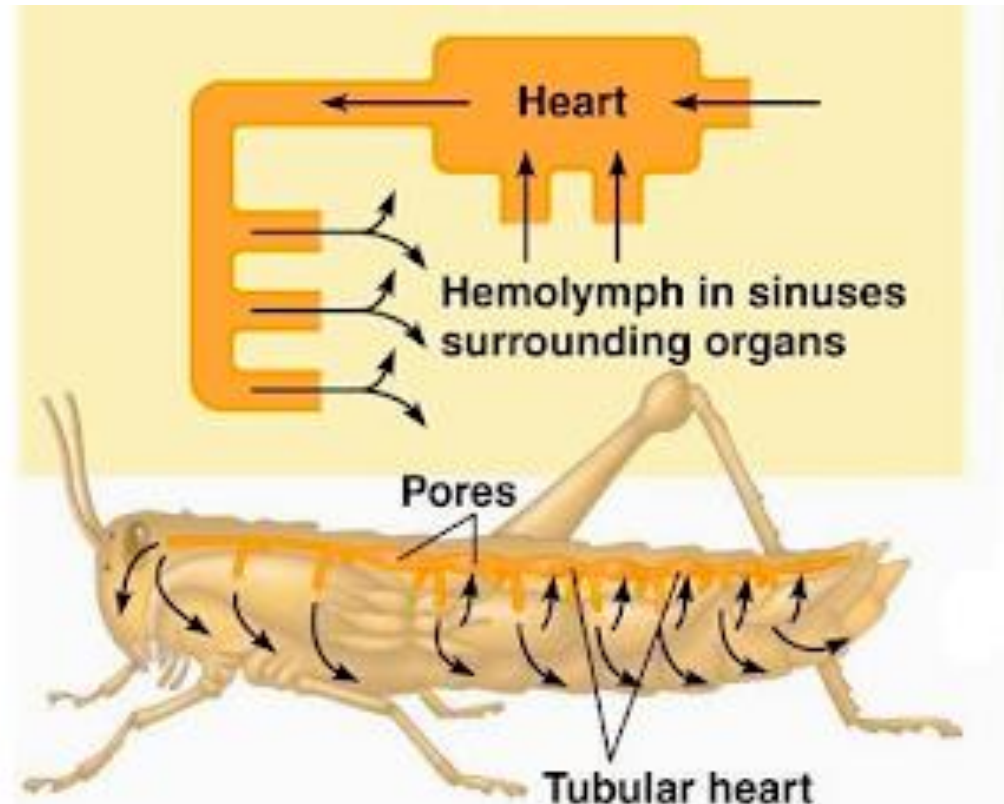
BLOOD VASCULAR SYSTEM:

- HIGHER FORMS SPECIAL CIRCULATING FLUID
- BLOOD
- (Pumped by heart through blood vessels)

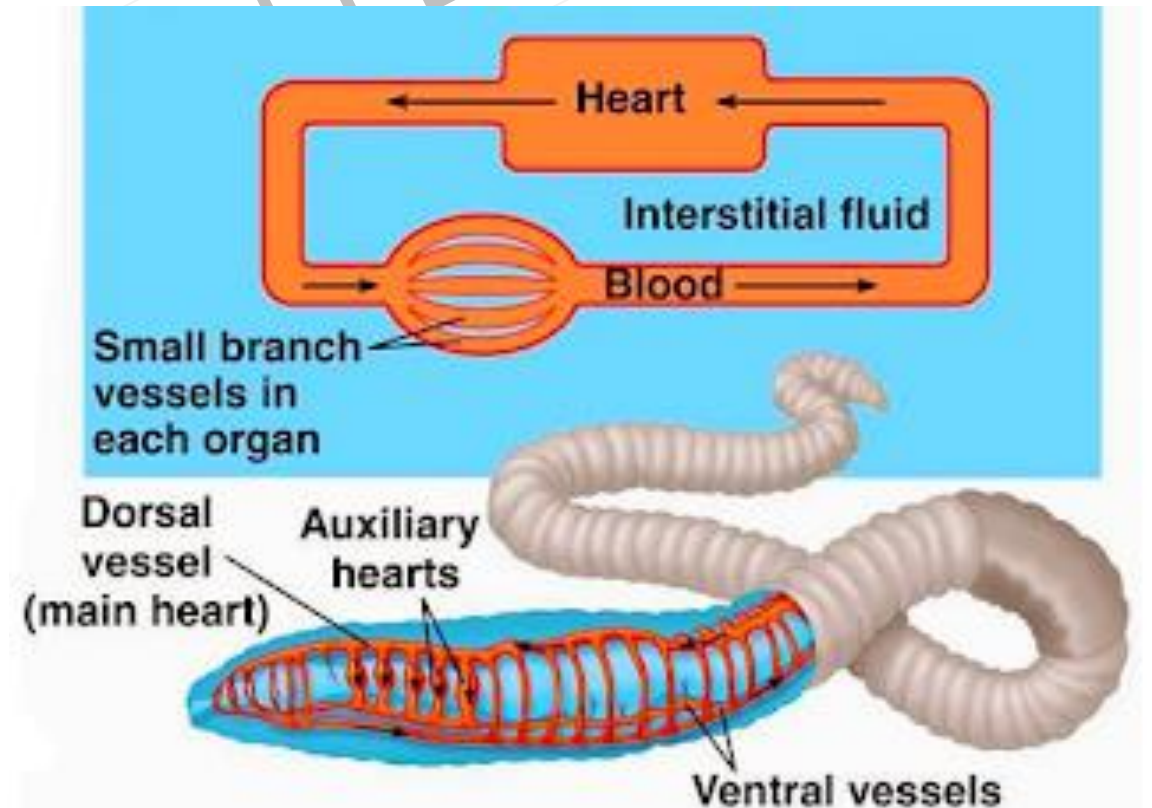


TYPES OF BLOOD VASCULAR SYSTEM:

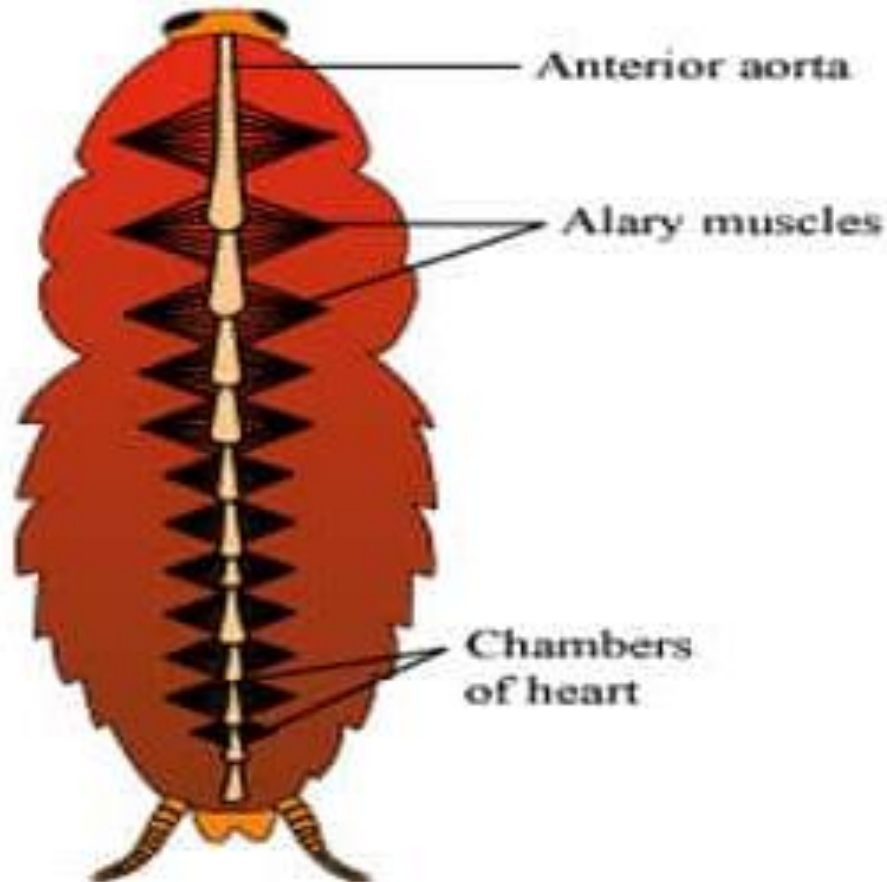
OPEN CIRCULATION



CLOSED CIRCULATION



COCKROACH –Open circulatory system

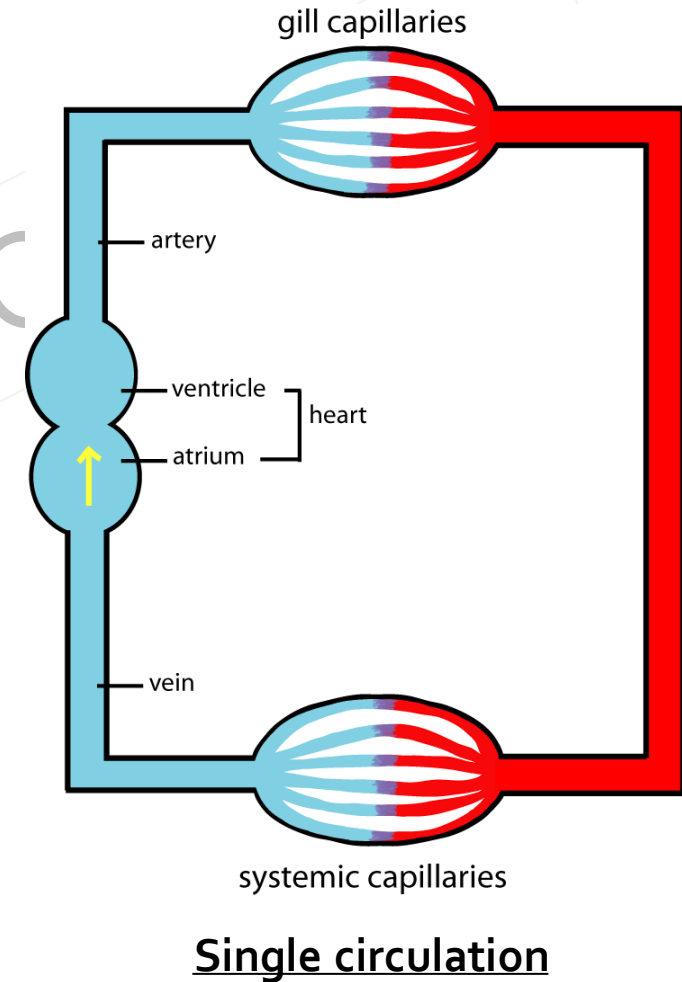
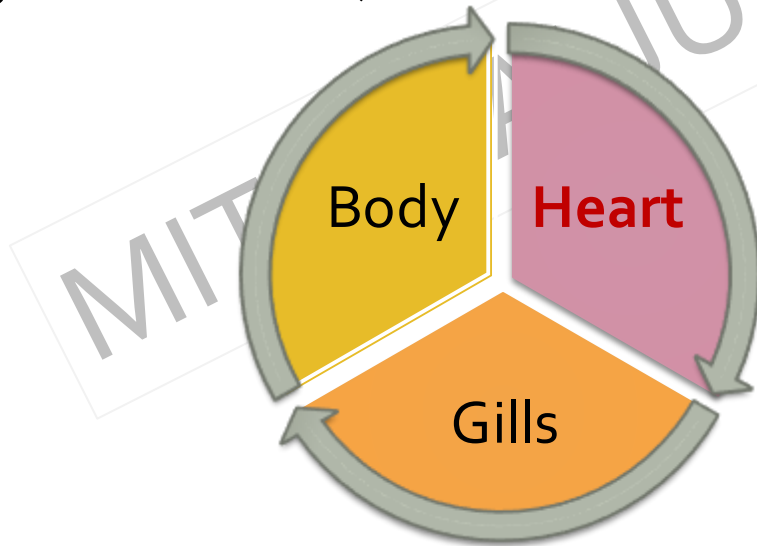


OPEN CIRCULATION	CLOSED CIRCULATION
Visceral organs lie in blood filled <u>Haemocoel</u> .	Blood circulated through a network of <u>blood vessels</u> .
<u>Direct exchange</u> of materials between cells and blood	Cells and blood <u>not in direct contact</u> with one another
<u>Low</u> pressure of blood.	<u>High</u> pressure of blood.
<u>No</u> respiratory pigment	Contains <u>Respiratory pigment</u> .
<u>No transportation</u> of resp. gases	<u>Transportation</u> of Resp. gases.
<u>Eg. Arthropods.</u>	<u>Eg. Annelids, Higher molluscs, Vertebrates.</u>

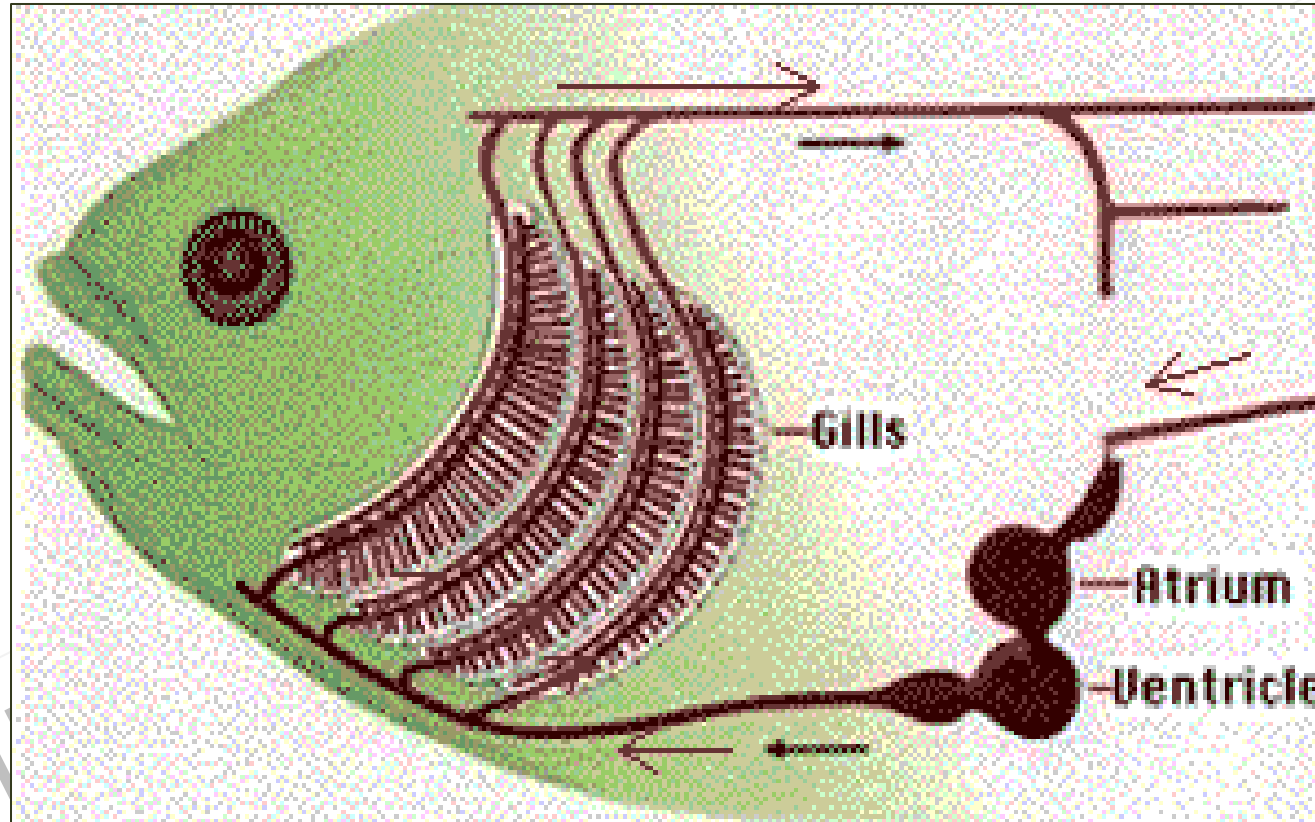
TYPES OF CLOSED CIRCULATION:

1) SINGLE CIRCULATION

- In fishes.
- Blood passes through heart only once in each cycle.
- Venous heart (Heart carries only deoxygenated blood)



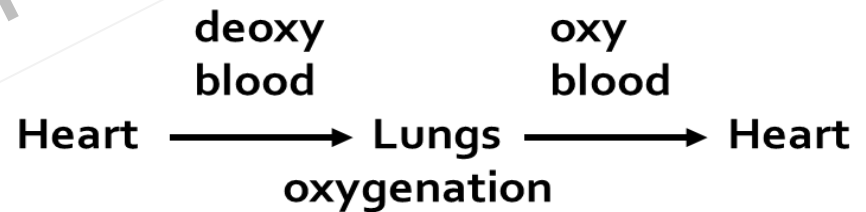
SINGLE CIRCULATION: e.g. fishes



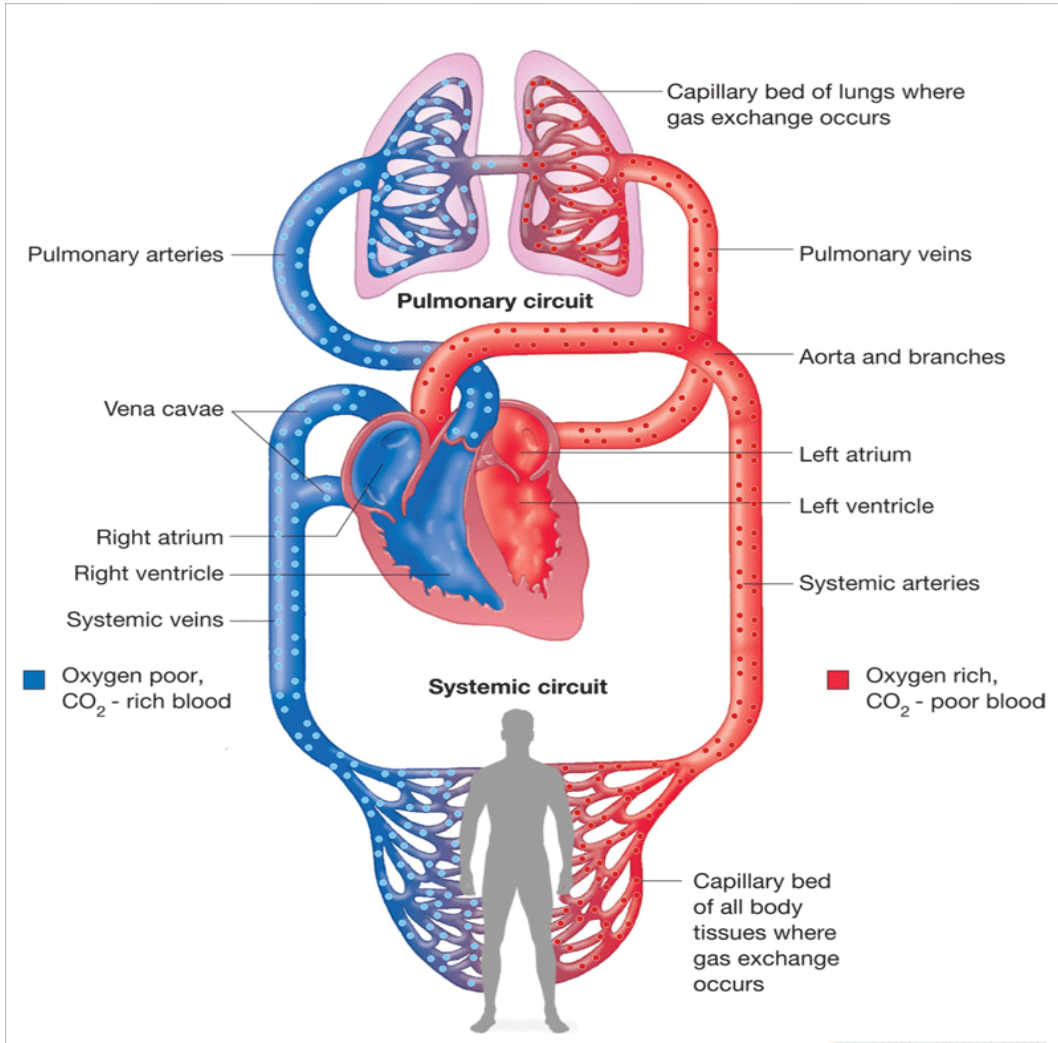
2) DOUBLE CIRCULATION:

- In Birds and mammals
- Blood passes **twice** through heart in each cycle.

Pulmonary Circulation



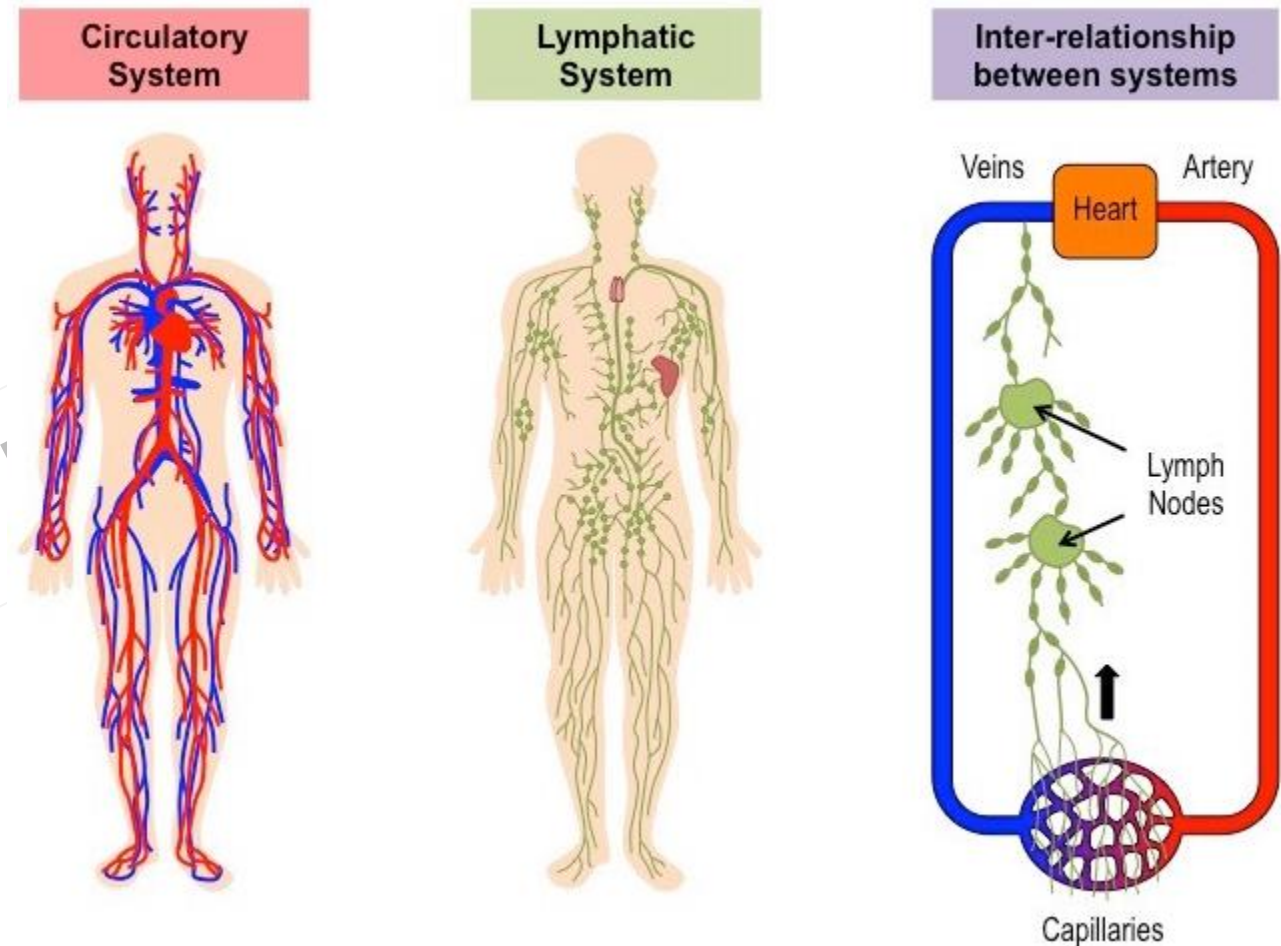
Systemic Circulation



8.9 Circulatory System in Human:

Composed of:

- 1) Blood vascular system
- 2) Lymphatic system



BLOOD VASCULAR SYSTEM:

- 1) Blood
- 2) Heart
- 3) Blood vessels

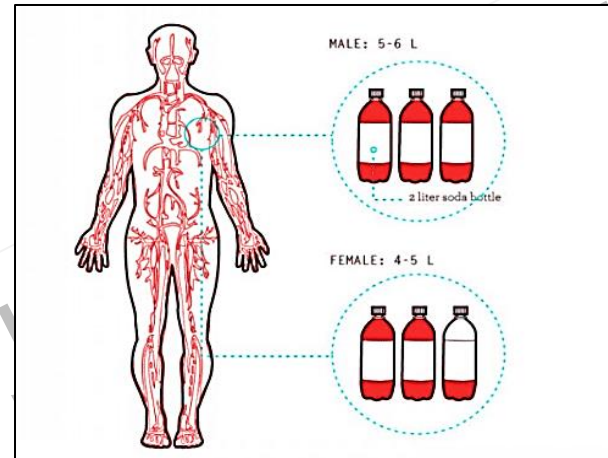
1) BLOOD: (Embryonic mesoderm)



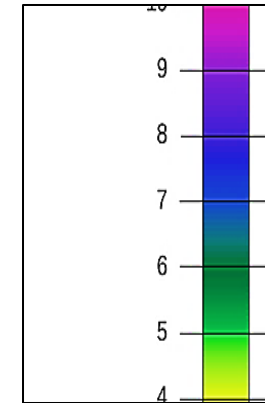
Haematology –
Study of blood



Red in colour



4 to 6 litres



Blood 7.4

pH 7.4
Slightly alkaline



Salty and Viscous

COMPOSITION OF BLOOD:

Main components:

- a) Fluid plasma (55%)
- b) Formed elements (44%)



Whole blood



Centrifuged blood

Plasma

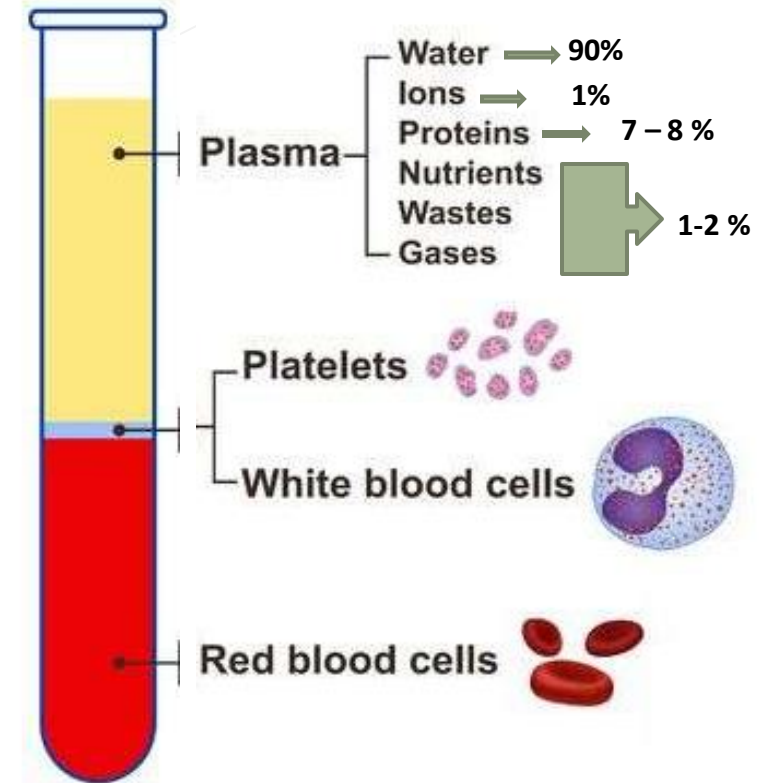
White Blood Cells
and Platelets

Red Blood Cells

PLASMA (55%)

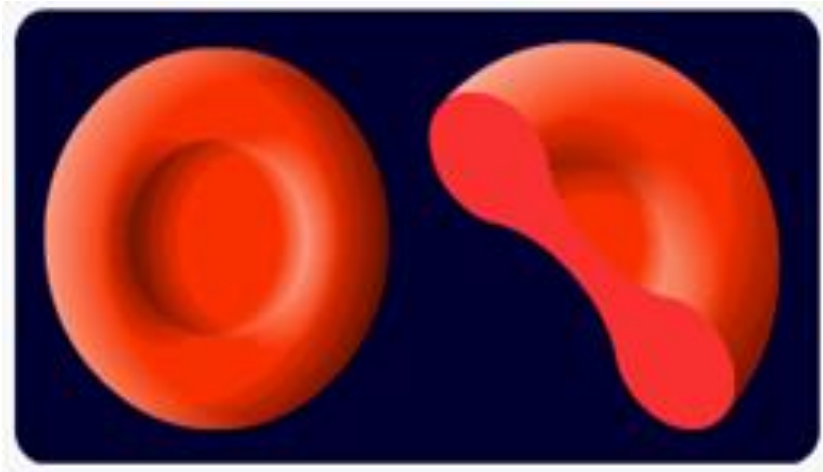


- Straw coloured
- Viscous
- Alkaline fluid



FORMED ELEMENTS(44%)

8.10 Red blood corpuscles / Erythrocytes / RBC's



Shape : Circular, Biconcave

Cell structure : enucleated, membrane bound organelles absent.

Cytoplasm rich in hemoglobin (270 million in 1 RBC)

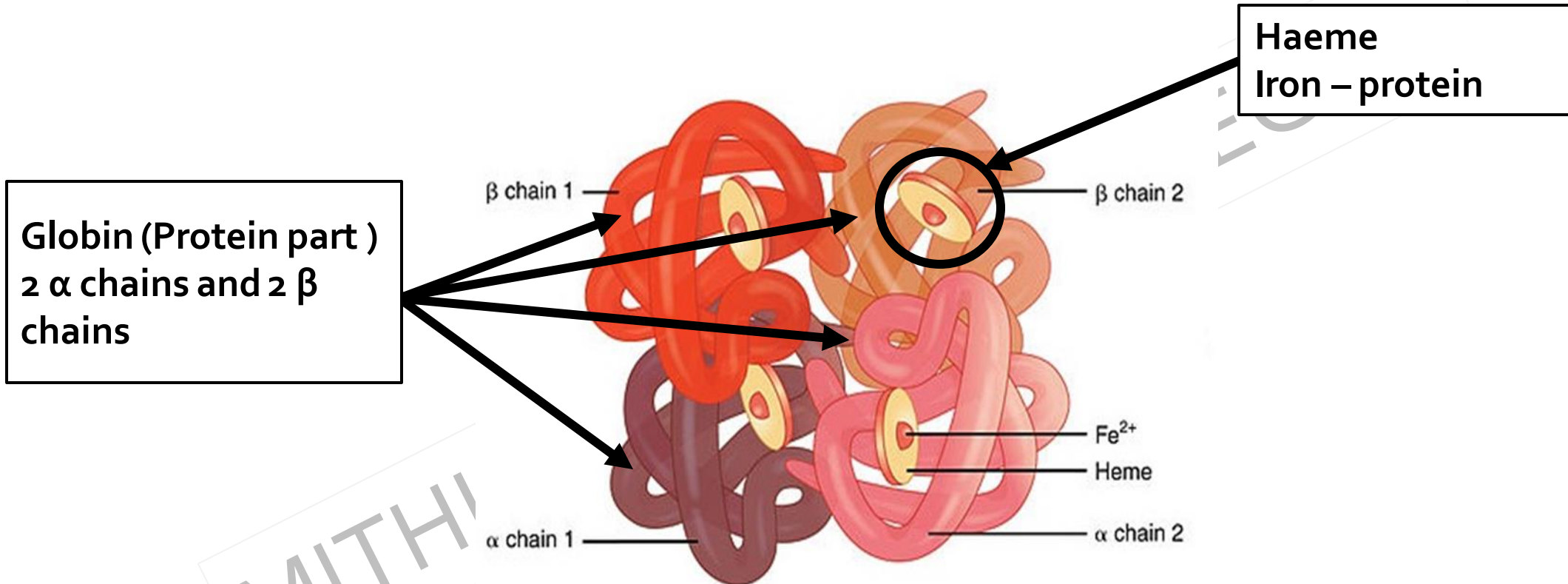
Contains enzyme Carbonic anhydrase

Life span : 120 days

Function

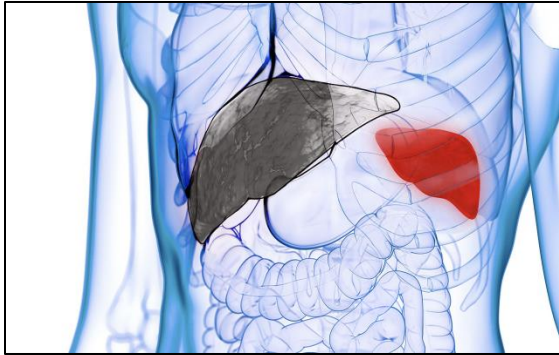
- Transport of respiratory gases
- Maintains pH of blood
- Maintains Viscosity of blood

Haemoglobin: Protein – Iron Complex

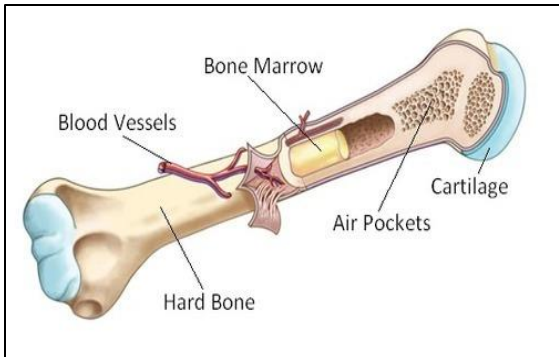


Erythropoiesis (formation of RBC's)

Birth



Foetus – Liver and Spleen



Adult - Red bone marrow

Folic Acid
Vit B12
Haeme protein

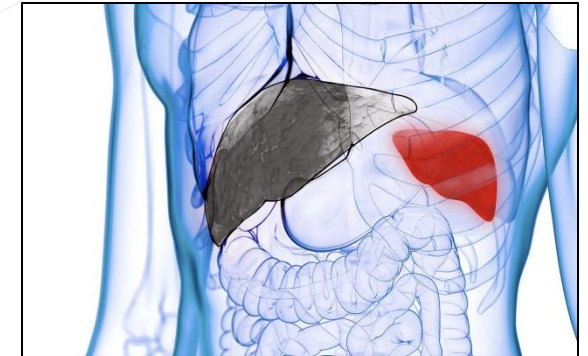


**Haemocyto blasts /
Reticulocytes**

Erythropoietin
from Kidneys

Life span
120 days

Death



**Graveyard of RBCs
Liver and Spleen
Worn out RBCs are
degraded here**

Some important values

RBC Count

Males – 5.1 to 5.8 million/mm³

Females – 4.3 to 5.2 million/mm³

Haemoglobin Content

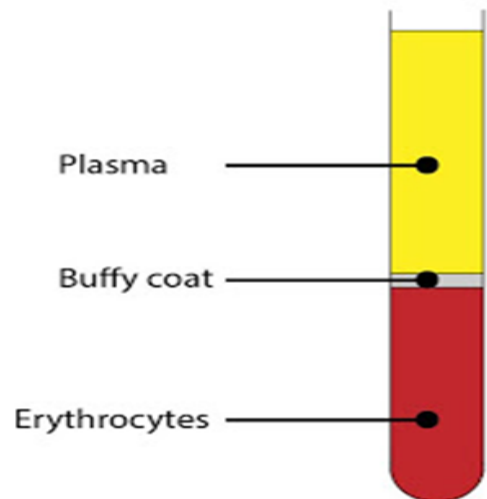
Males – 14 to 17 gm%

Females – 13 to 15 gm %

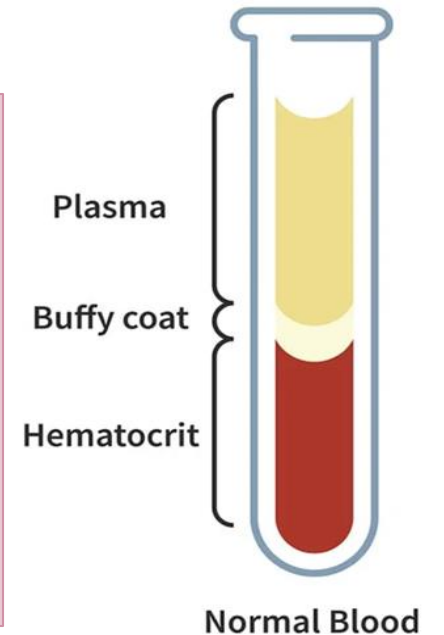
Normal

Erythrocytopenia

Polycythemia



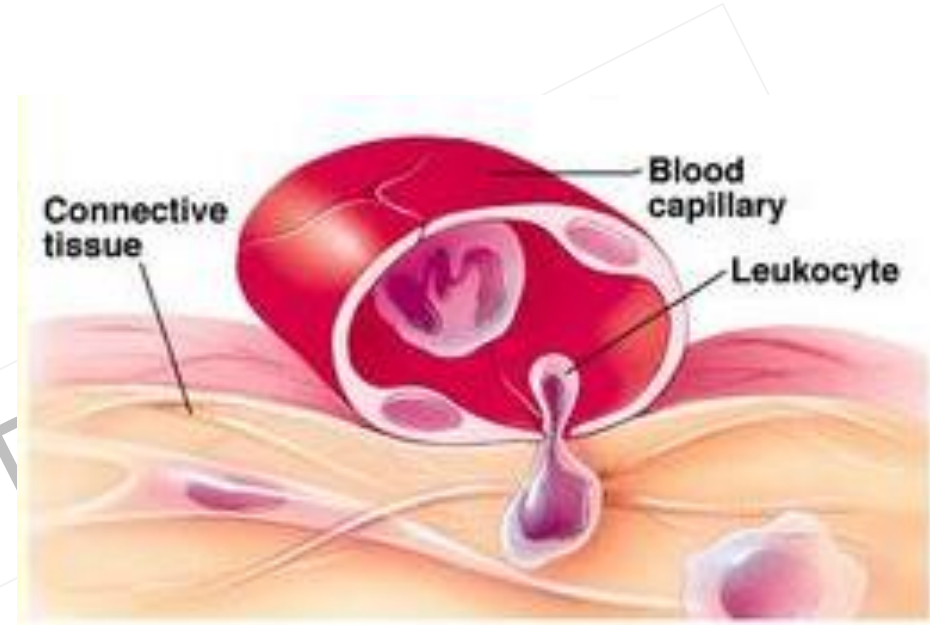
Haematocrit
Ratio of
volume of
RBCs to total
volume of
blood



8.11 White blood corpuscles /Leucocytes/WBC's



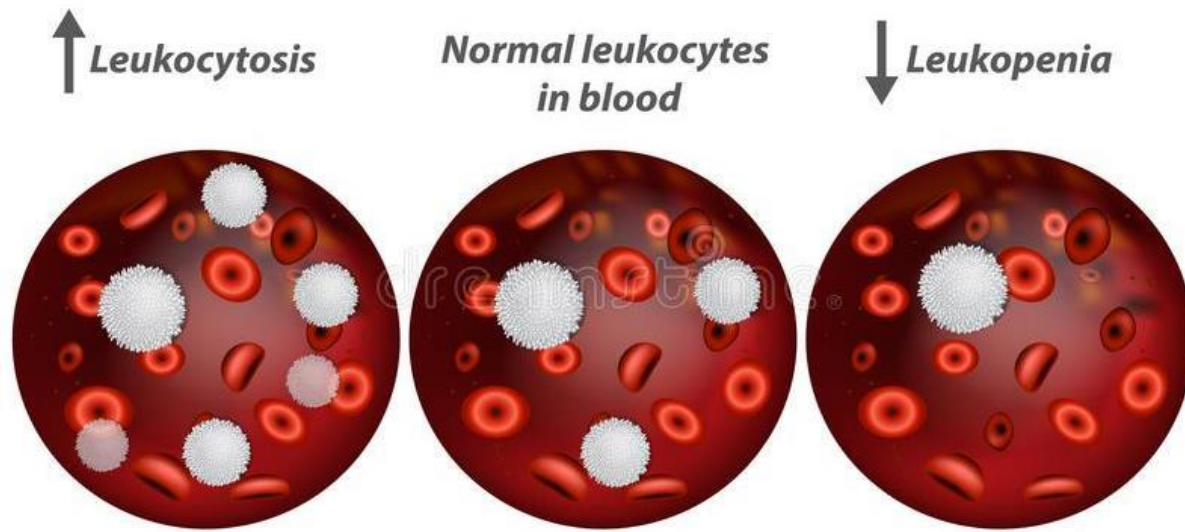
- Colorless
- Nucleated
- Amoeboid
- Defense of body



DIAPYDEDESIS

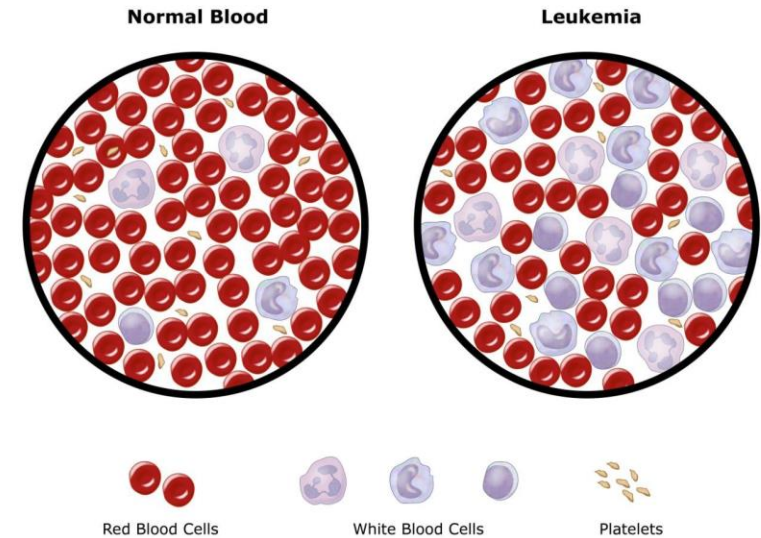
Some important values

WBC Count - 5 to 11 thousand /mm³



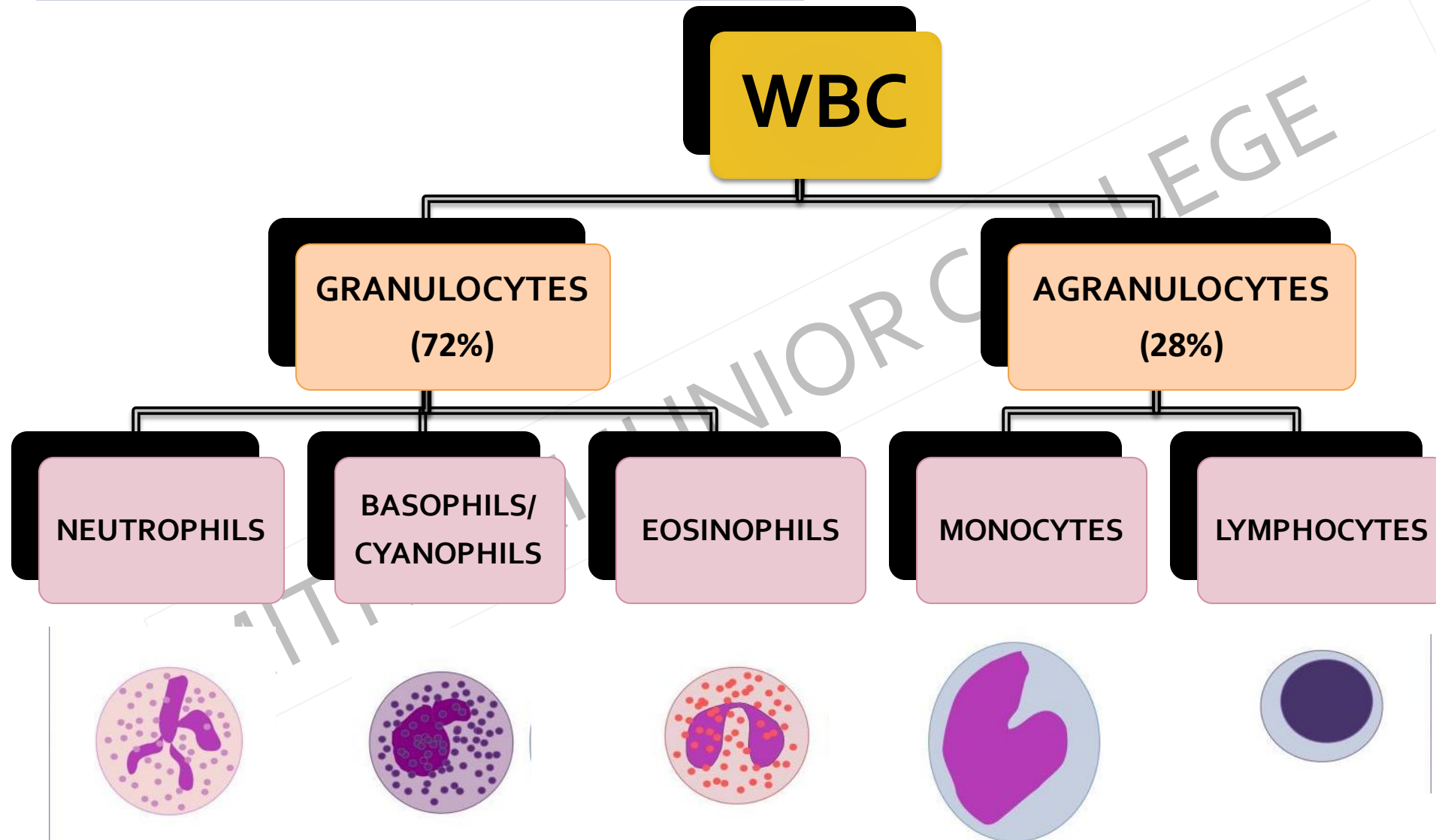
Infection, During pregnancy, Newborn babies

HIV, AIDS, TB patients



Leukemia
Uncontrolled increase in WBC number
Type of cancer

TYPES OF LEUCOCYTES:



Types of WBC's(Polymorphism)

72 %

Granular Cytoplasm
Granules – secretory vesicles

Polymorpho nuclear
Leucocyte cells
(PMNC)

Formed from Myeloid
stem cells, cannot
divide

Granulocytes

Neutrophil (70%)



(phagocytosing a bacteria
and other pathogens)

Nucleus – 2 to 7 lobed

Eosinophil (1-3%)



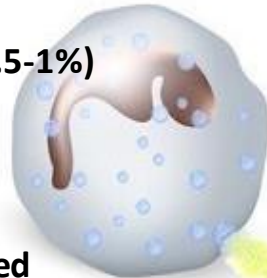
(control mechanisms
associated with allergy)

Nucleus -bilobed

Basophil (0.5-1%)

(contain
histamine
and heparin)

Nucleus- twisted



Histamine release
from the basophils

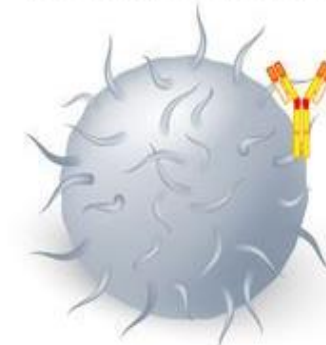
Agranulocytes

Monocyte (3-5%)
(phagocytosis)



Nucleus –kidney shaped

Lymphocyte (25-30%)
(secretion of antibodies)



Nucleus- spherical

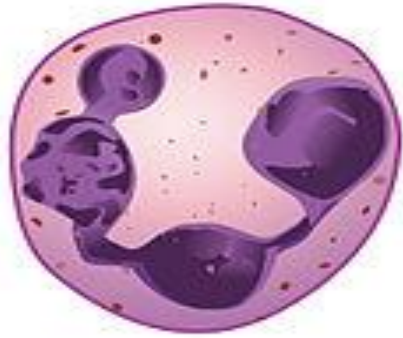
28 %

Agranular cytoplasm

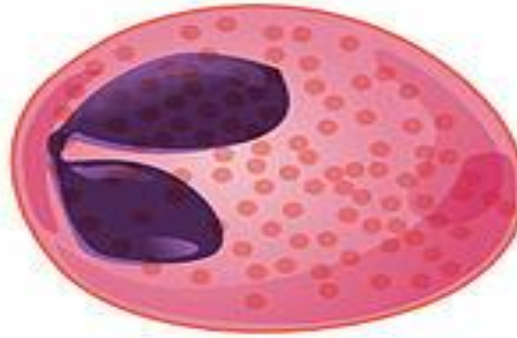
Large non lobulated
nucleus

Lymphoid stem cells,
can divide

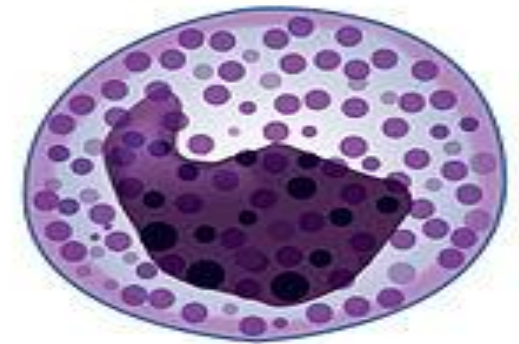
WBCs – Types of Granulocytes:



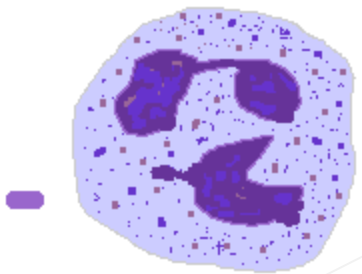
Neutrophil



Eosinophil



Basophil



70%
Neutral stain
Nucleus - Many Lobed
Perform amoeboid
movement and
phagocytosis

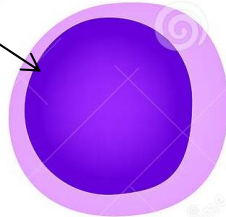
1 – 3 %
Acidic stain (Eosin)
Nucleus - Bilobed
Destroy Ag- Ab complex,
increase in allergic reactions
Antihistamine property,
detoxification .

0.5 - 1 %
Basic stain (methylene blue)
Nucleus - Twisted
Present in Allergic conditions
Secretes- Heparin, Histamine
and serotonin

WBCs – Types of Agranulocytes:

25 to 30 %

Large
Spherical nucleus



Lymphocyte

T lymphocyte B lymphocyte

Helper
T Cells

Killer
T Cells

Memory
T cells

Suppressor
T cells

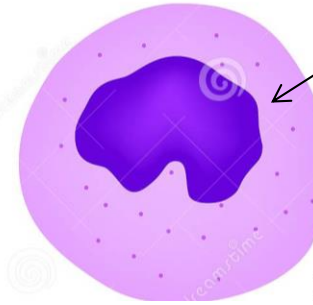
Smallest WBC

B lymphocyte – humoral immunity

T lymphocyte – cell mediated immunity

3 to 5 %

Large
Bean / kidney
shaped nucleus



Monocyte

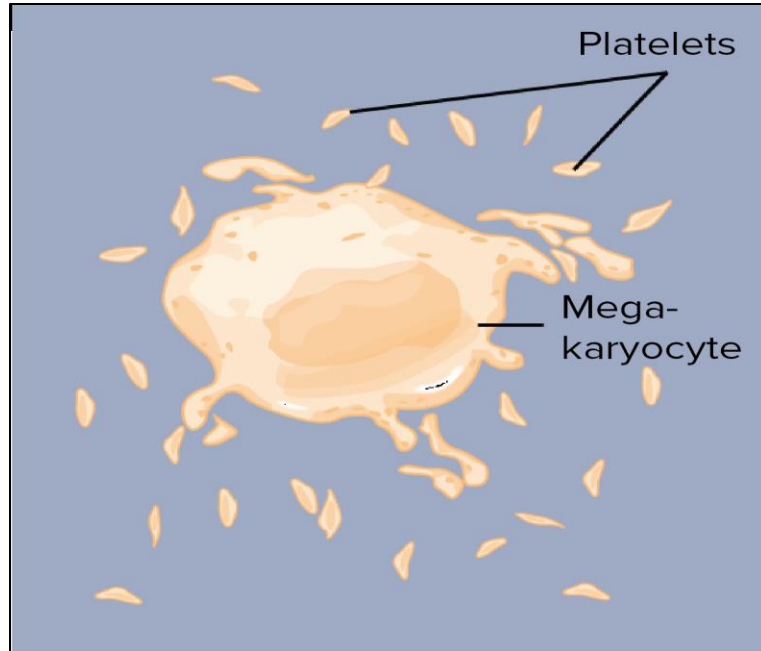
Largest WBC

Actively motile

Gives rise to
Macrophages

Phagocytic

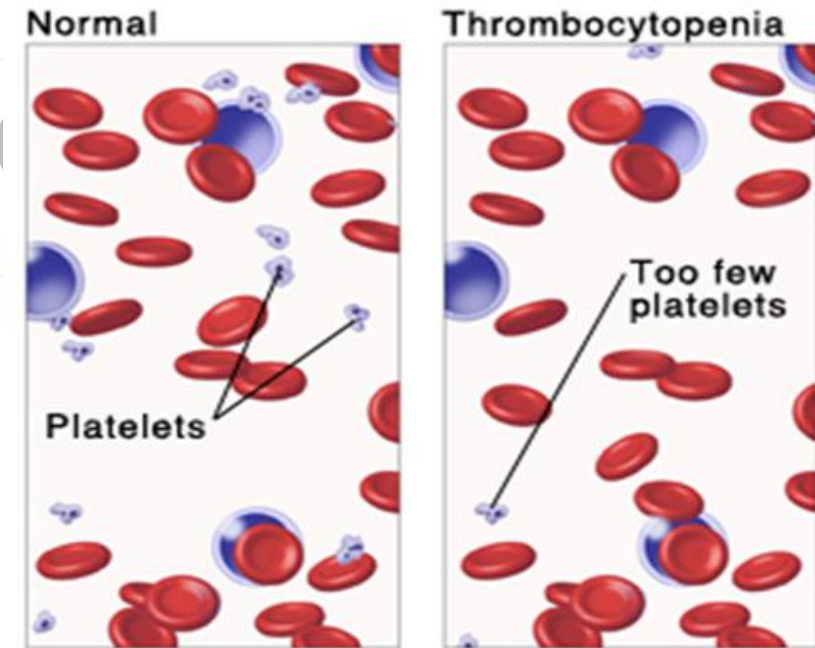
8.12 Thrombocytes / Platelets:



Small, oval, enucleated cell fragments

Function: secrete platelet factors, forms platelet plug (Thrombus), serotonin (vasoconstrictor)

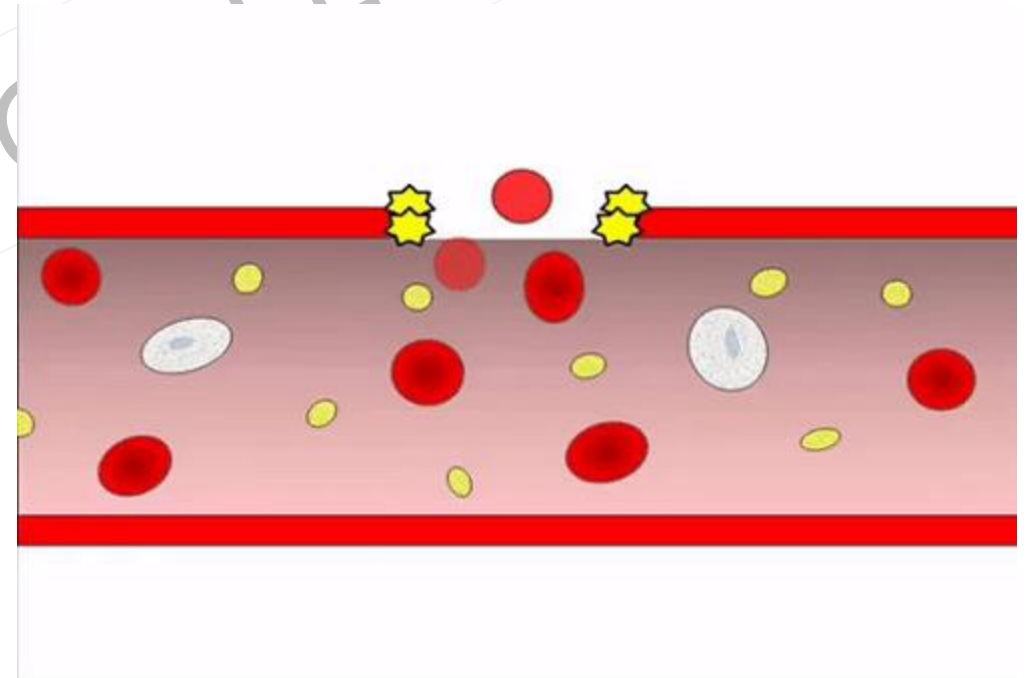
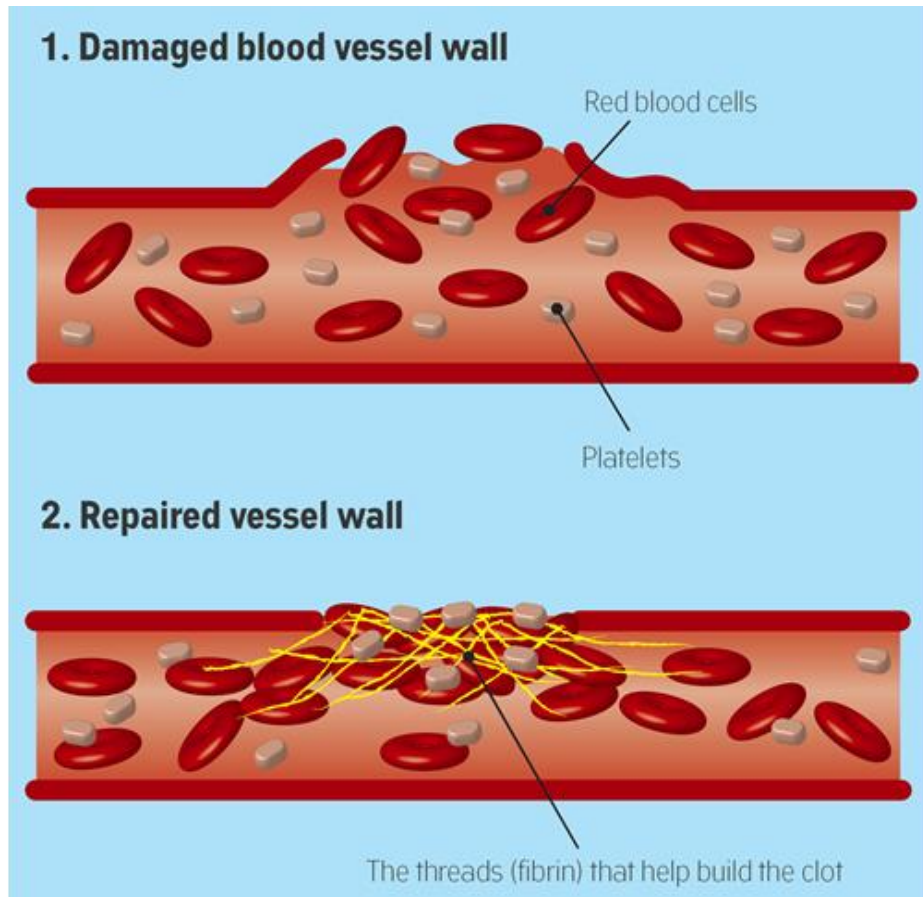
Platelet Count – 2.5 to 4.5 lakh /mm³



Thrombocytopenia (low thrombocytes)
(haemorrhage)

Blood Clotting / Blood Coagulation

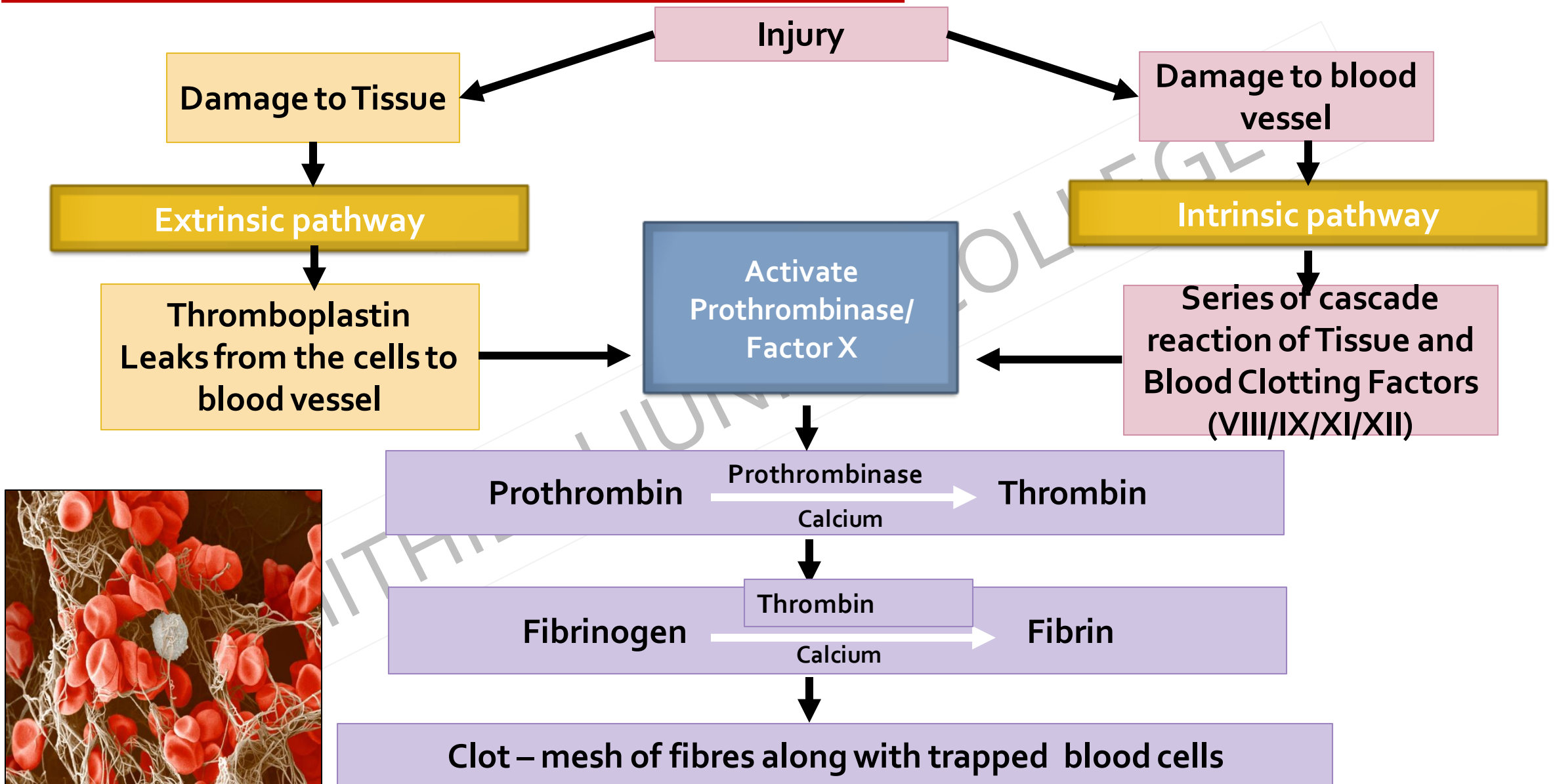
Process of converting the liquid blood into a solid form.



Requires:

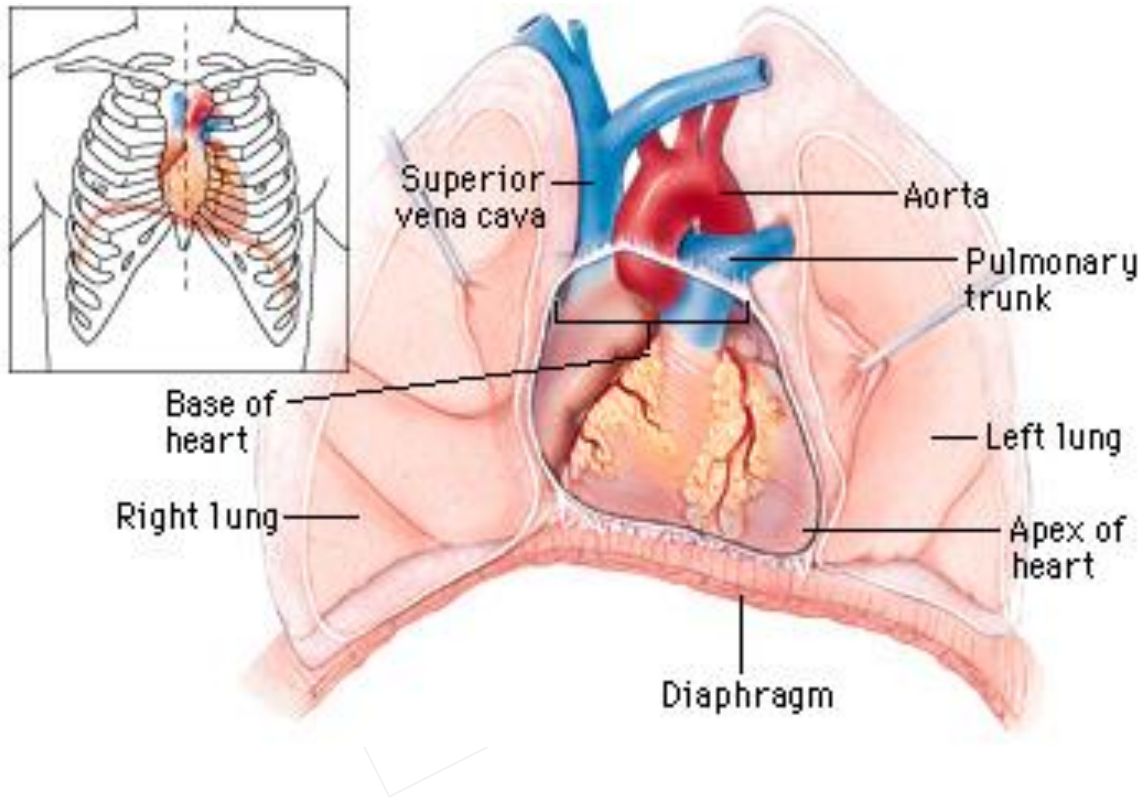
- Blood Clotting Factors – 12 BCF (I to XIII) produced by liver, platelets and damaged tissues.
 - - Fibrinogen
 - - Prothrombin
 - - Thromboplastin (Tissue factor)
 - - Calcium ions
 - - Prothrombinase (Thrombokinase)

Blood Coagulation – Process



8.13 Heart:

- Heart - main pumping organ.



Reddish brown

hollow

muscular

Wt 300gm males , 250gms females

Mediastenum

Above diaphragm

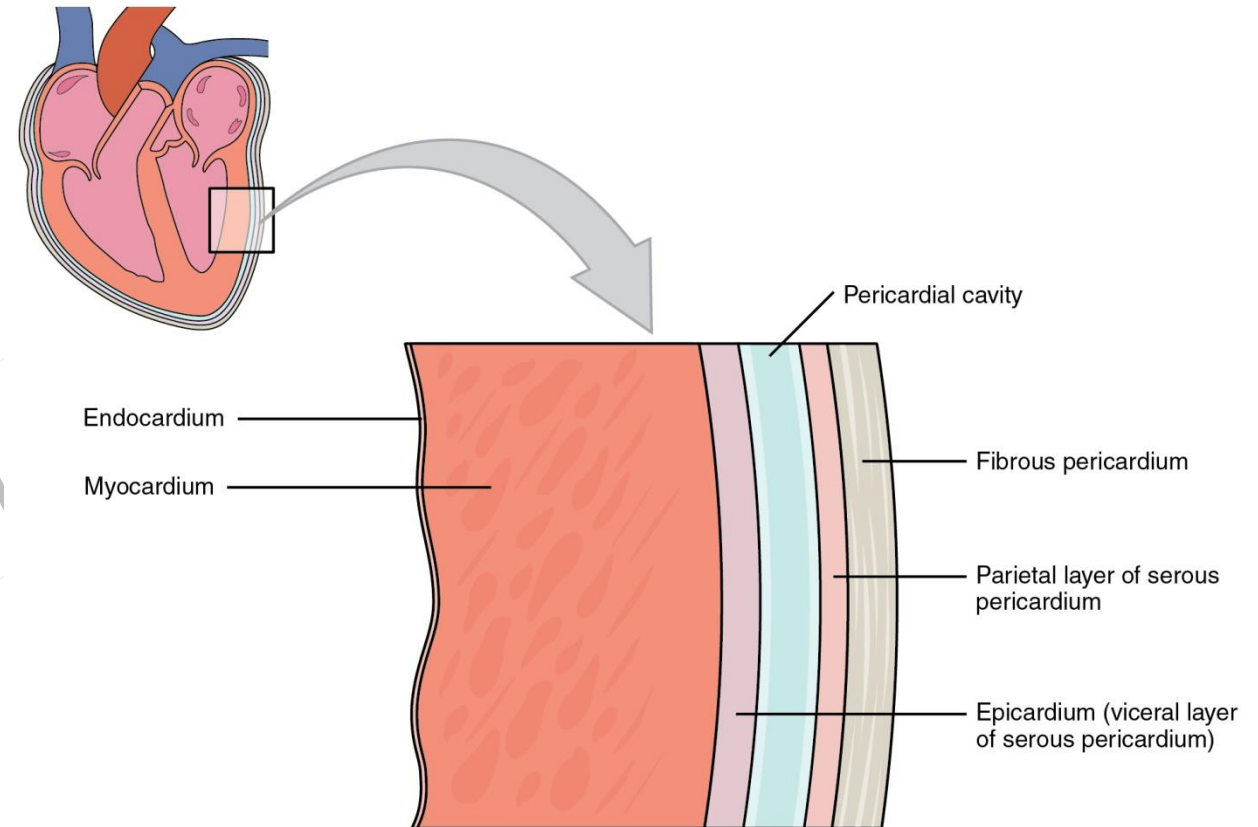
- Heart - enclosed in **pericardium**.
- Pericardium - outer **fibrous** and inner **serous** pericardium.
- Serous pericardium - divisible into two layers (**parietal and visceral layer**)

- In between Parietal and visceral layers is **pericardial space**.
- **Pericardial fluid** (about 50ml))
- a shock absorber
- protects the heart from mechanical injuries.

Heart : mesodermal in origin.

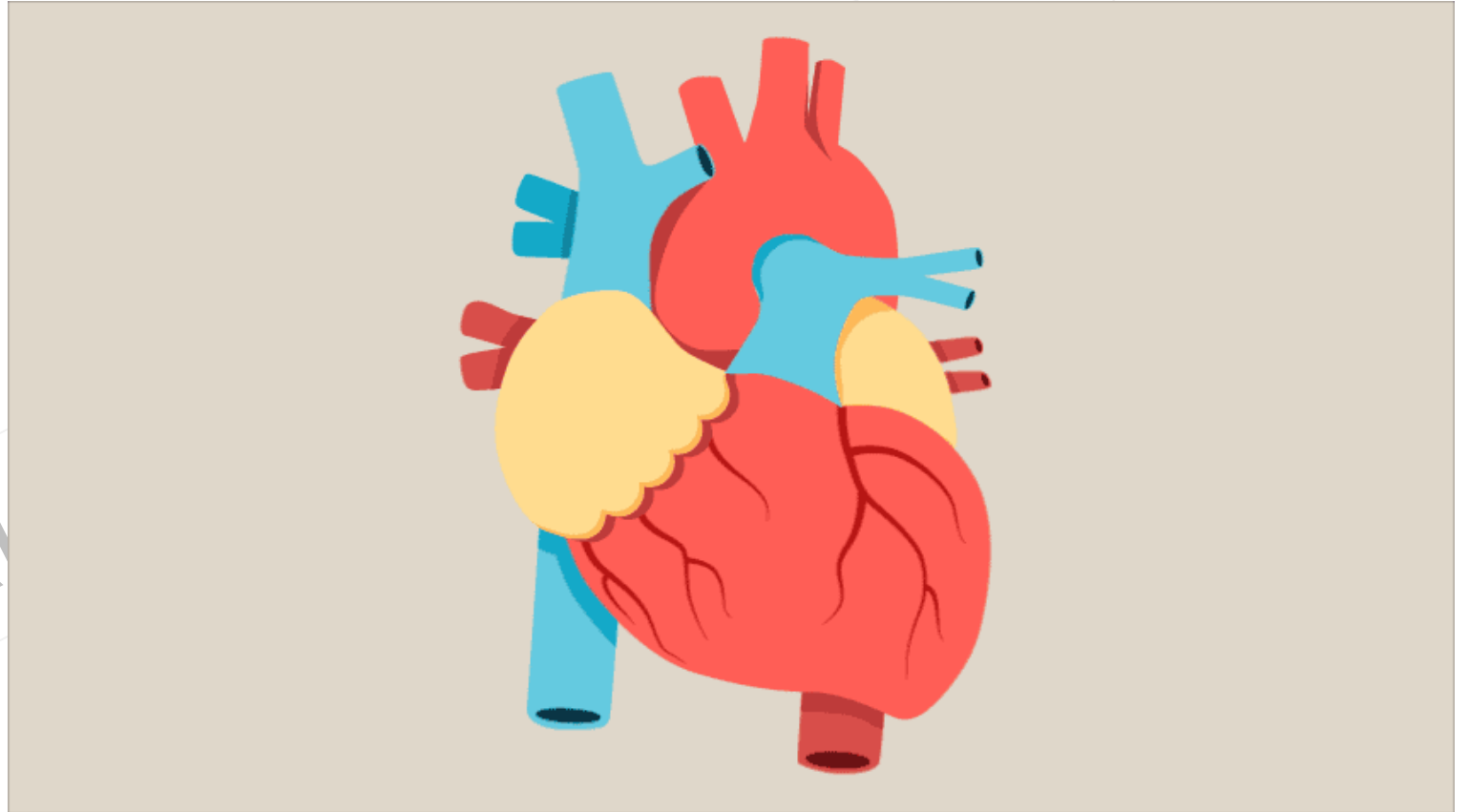
Three layers:

- outer **epicardium**(protective)
- middle **myocardium**(contraction and relaxation)
- inner **endocardium** (protective)



EXTERNAL STRUCTURE OF HEART:

- Four chambered
- Superior- Atria
- Inferior- ventricles
- Transverse groove – Coronary sulcus / Atrioventricular groove (between atria and ventricles)
- interventricular sulci (harbour coronary arteries and veins)
- Pulmonary trunk
- Systemic Aorta (ascending aorta /systemic or aortic arch/descending aorta)
- Aortic arch – 3 branches
 - Brachiocephalic artery
 - Left common carotid
 - Left subclavian
- Ligamentum arteriosum
- Remnant of ductus arteriosus
- Superior and inferior venacava
- Pulmonary veins.



Sternocostal surface

Left Atrium

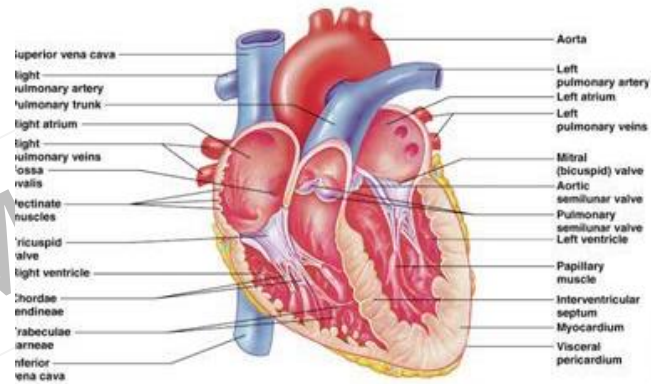
Left Ventricle

Right Atrium

Sinus coronary sulcus

Anterior Inter ventricular sulcus

Right Ventricle



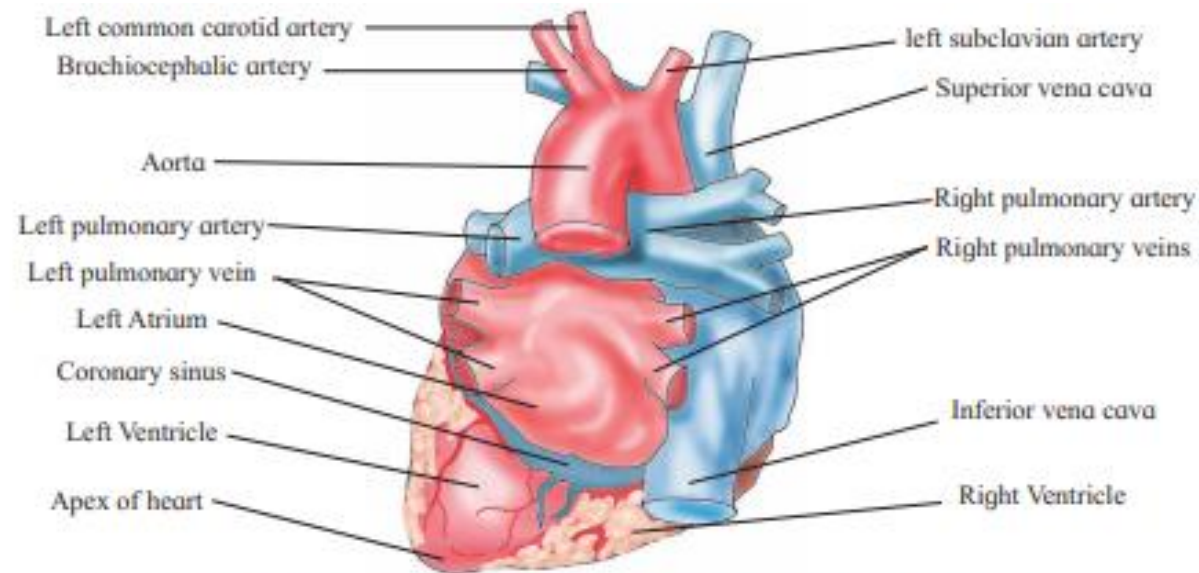


Fig. 8.18 : Posterior (dorsal) view : External structure of human heart

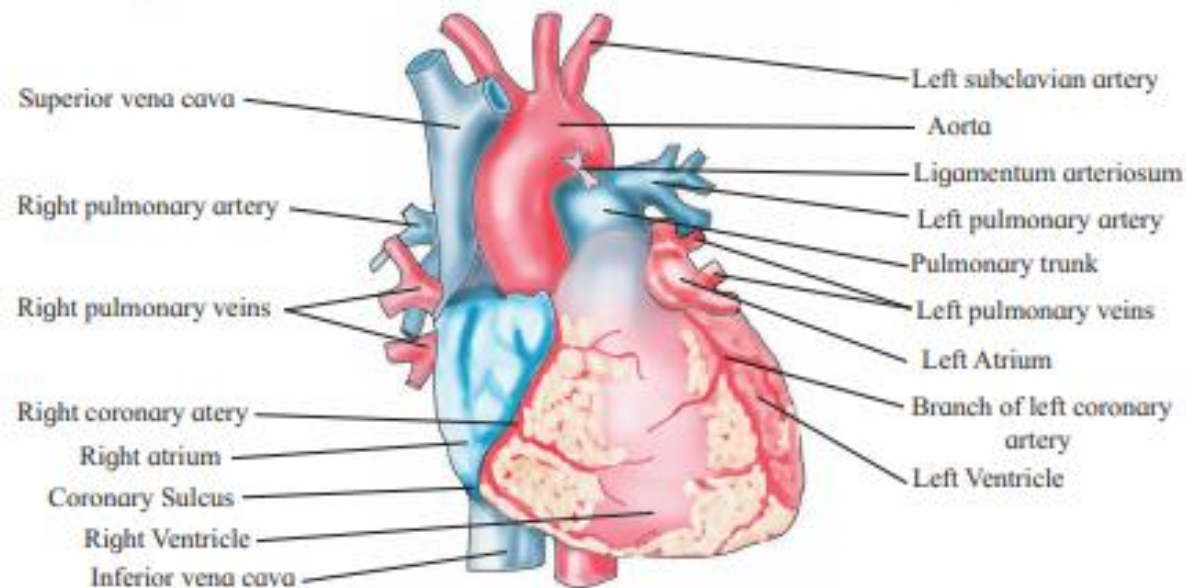


Fig. 8.19 : Anterior (ventral) view : External structure of human heart

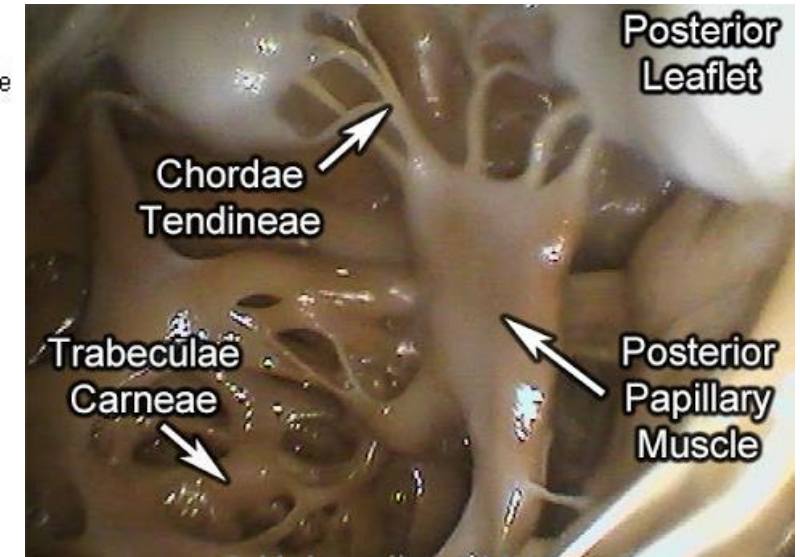
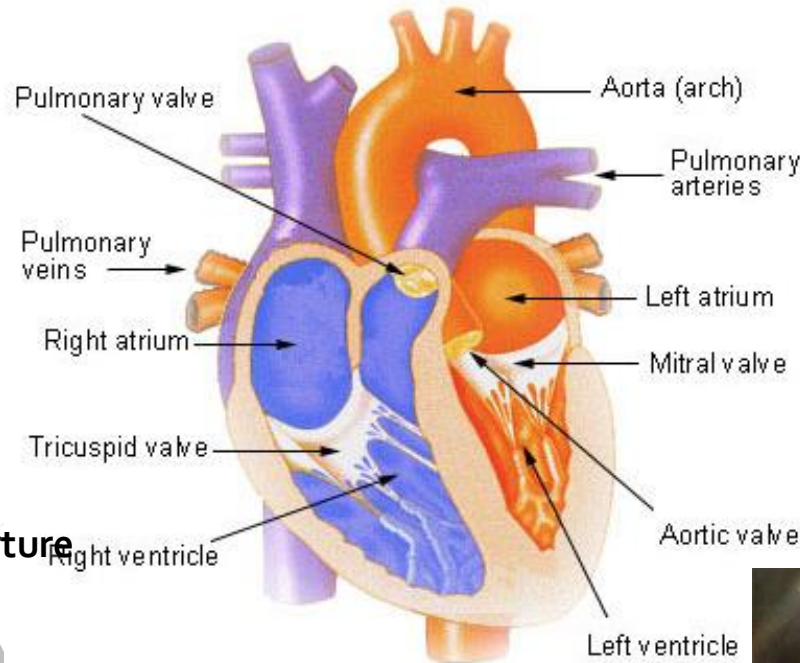
INTERNAL STRUCTURE OF HEART:

ATRIA:

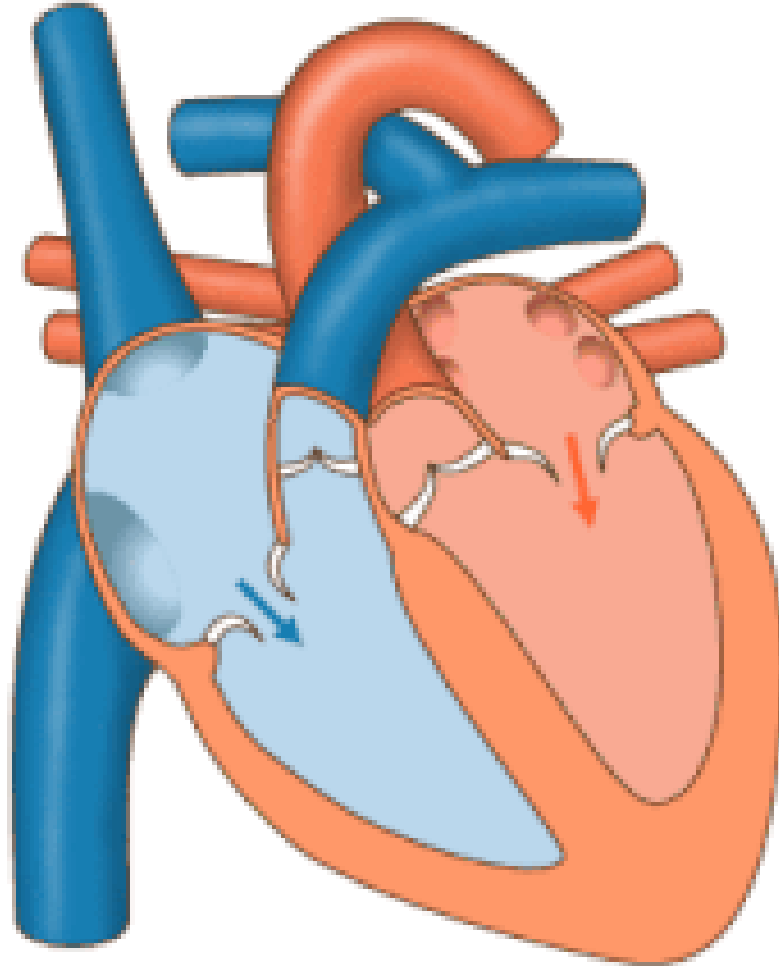
- Thin walled
- Inter-auricular septum (fossa ovalis)
- Remnant of foramen ovalis
- RA- both vena cava and and coronary sinus
- Postcaval – **Eustachian valve**
- Coronary sinus – **Thebasian valve**
- Pulmonary veins open – Left atrium
- Atrioventricular apertures – Cuspid valves
- Tricuspid valve- Right AV Aperture**
- Bicuspid valve (Mitral valve)- Left AV Aperture**

VENTRICLES:

- Thick walled**
- Inter-ventricular septum
- Left ventricle-3times more thick
- Inner surface-ridges - Columnae carnae/ trabeculae carnae
- Inelastic fibres – chordae tendinae
(attach valves to papillary muscles ,regulating their opening and closing)
- Pulmonary aorta and aorta –**three semilunar valves**
- Valves: unidirectional flow and prevents backflow**



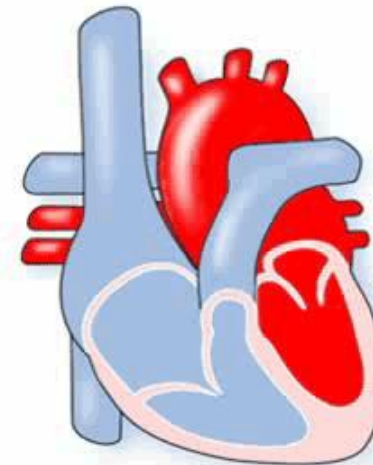
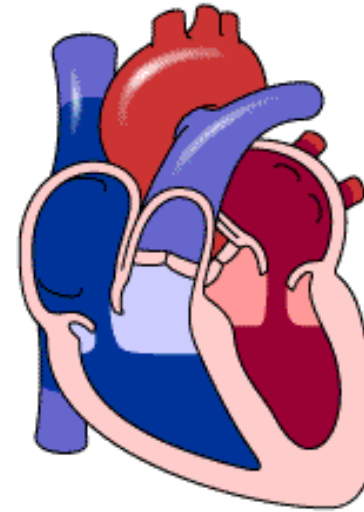
MITHI



GE

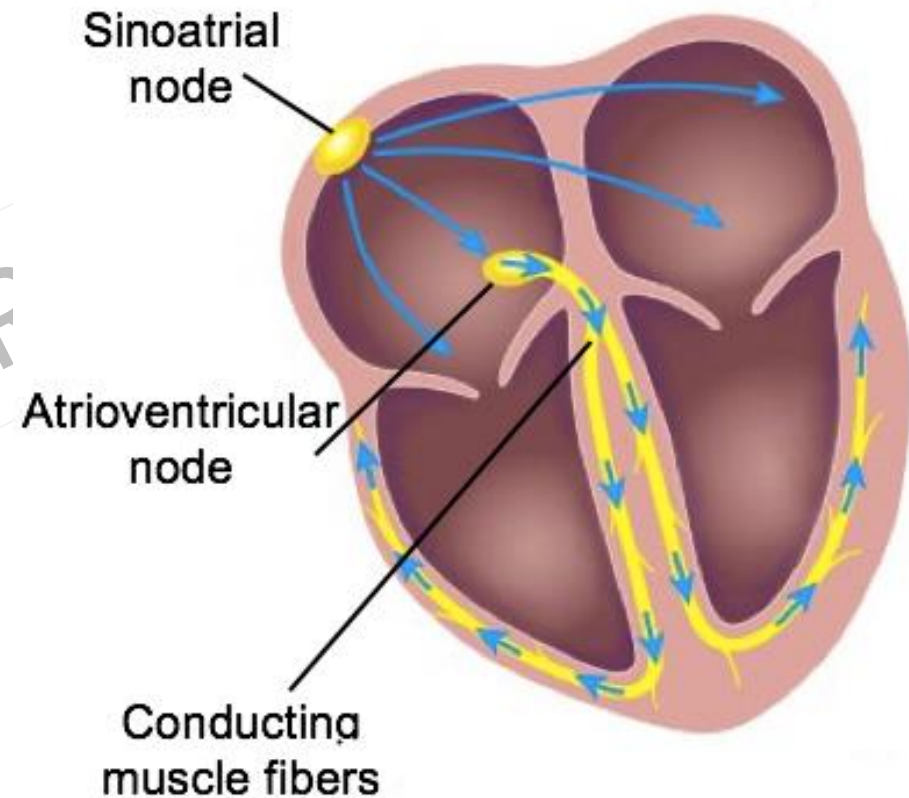
Pumping action of heart:

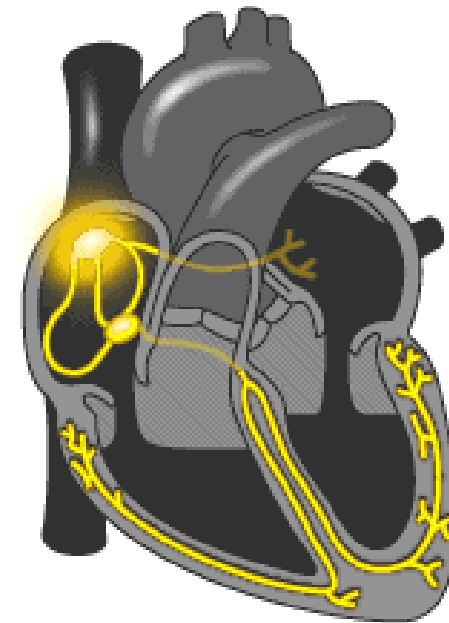
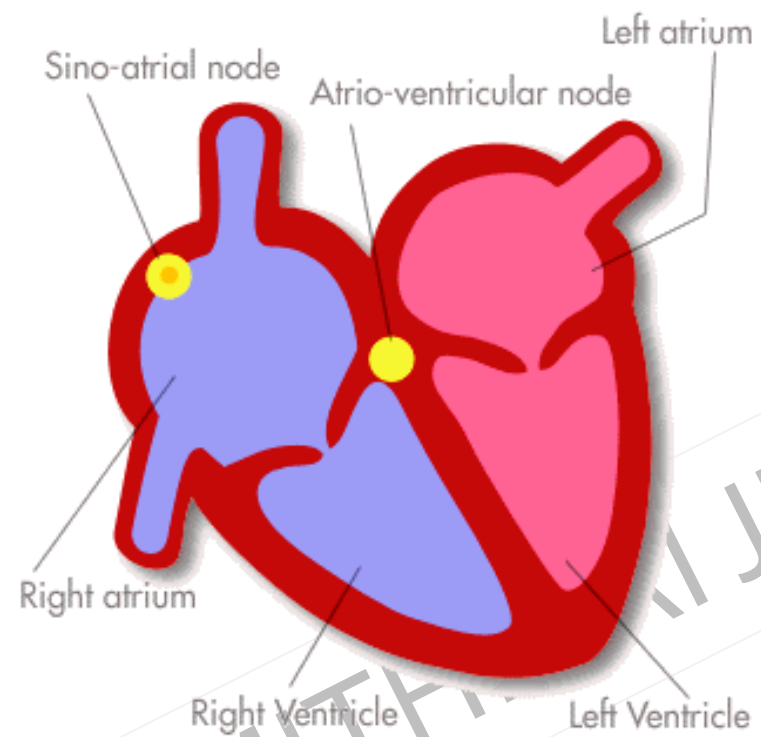
- Heart – Pumping organ
- rhythmic contraction and relaxation
- Contraction- Systole
- Relaxation- Diastole
- **Heart beat** – single systole followed by diastole
- **Heart rate:** 70-72 times /min
- **Stroke volume:** each heart beat ventricles pump 70ml of blood
- **$H.R \times S.V = \text{CARDIAC OUTPUT}$**
(volume of blood pumped out per min)
- $CO = SV \times HR$
 $= 72 \times 70 = 5040\text{ml} = 5 \text{ liters of blood per min}$



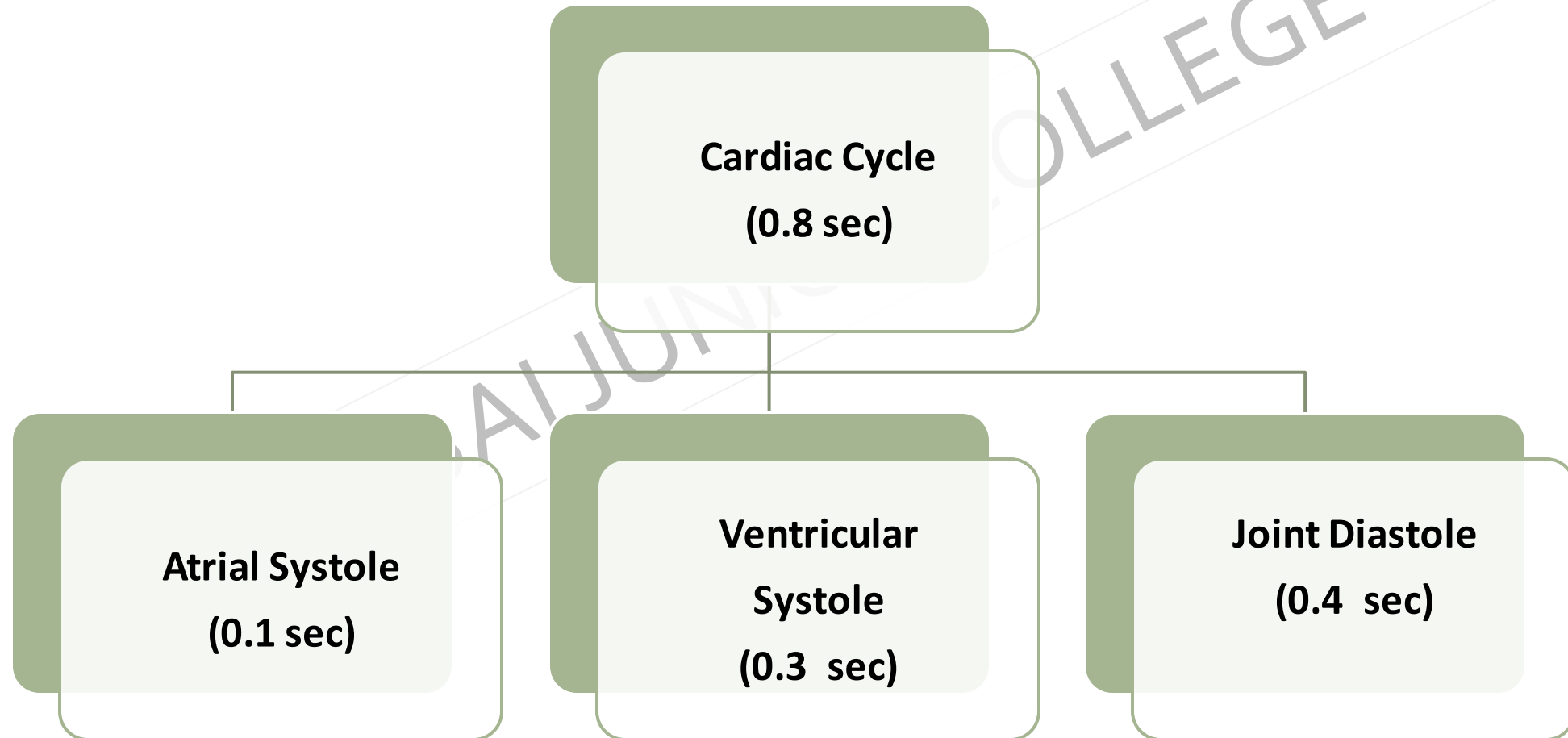
Conducting tissue of heart:

- Human heart- **Myogenic**
- auto rhythmicity
- specialized cardiac muscles – nodal tissue
- Consists of
 - **SA Node /Sino- atrial node (PACE MAKER)**
 - **AV Node/ Atrioventricular node (PACE SETTER)**
 - **Bundle of His/Tawara**
 - **Purkinje fibres**

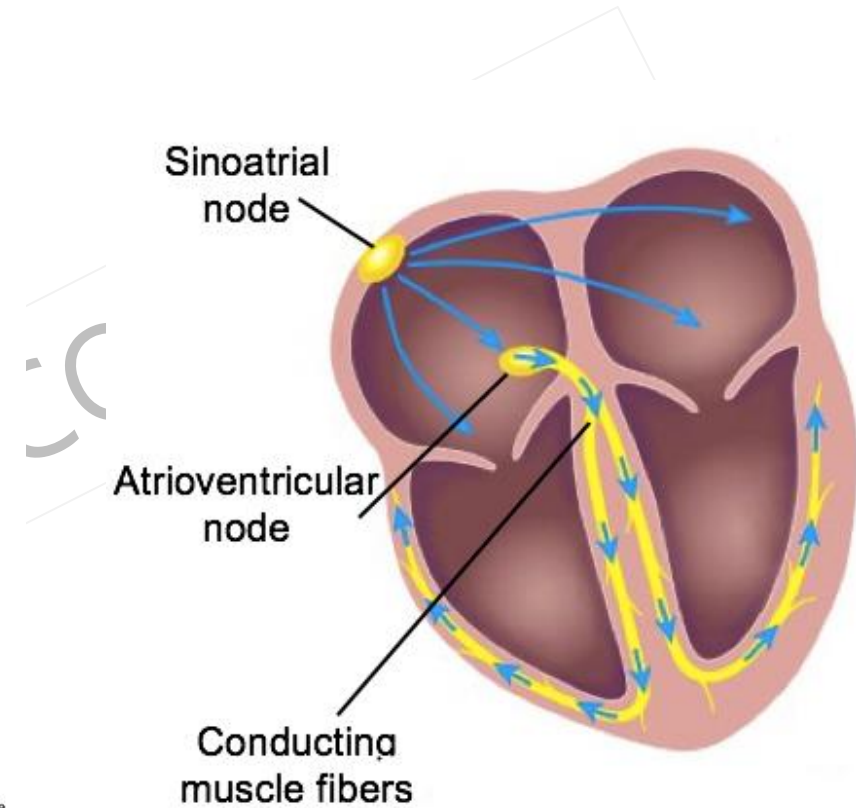
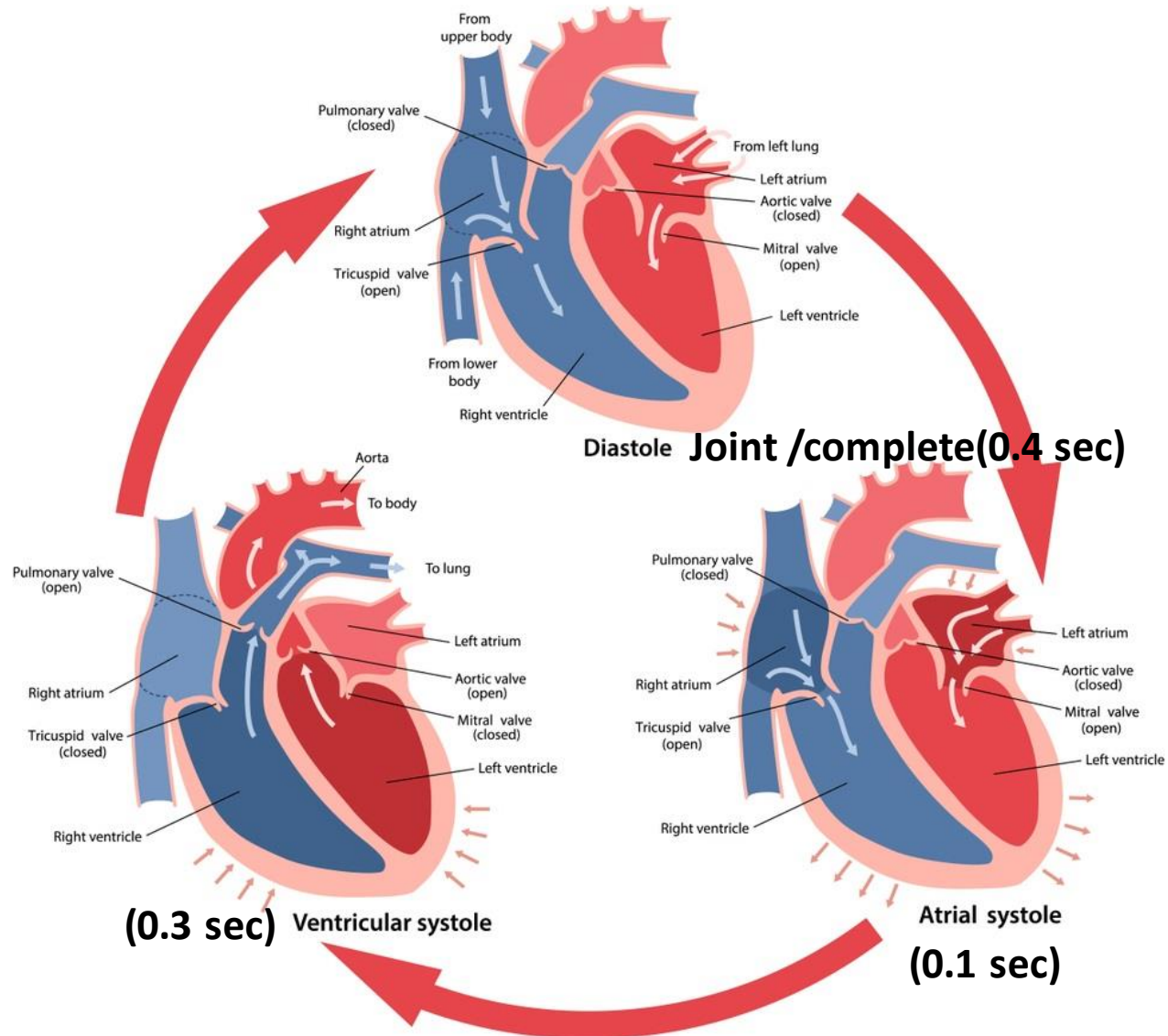




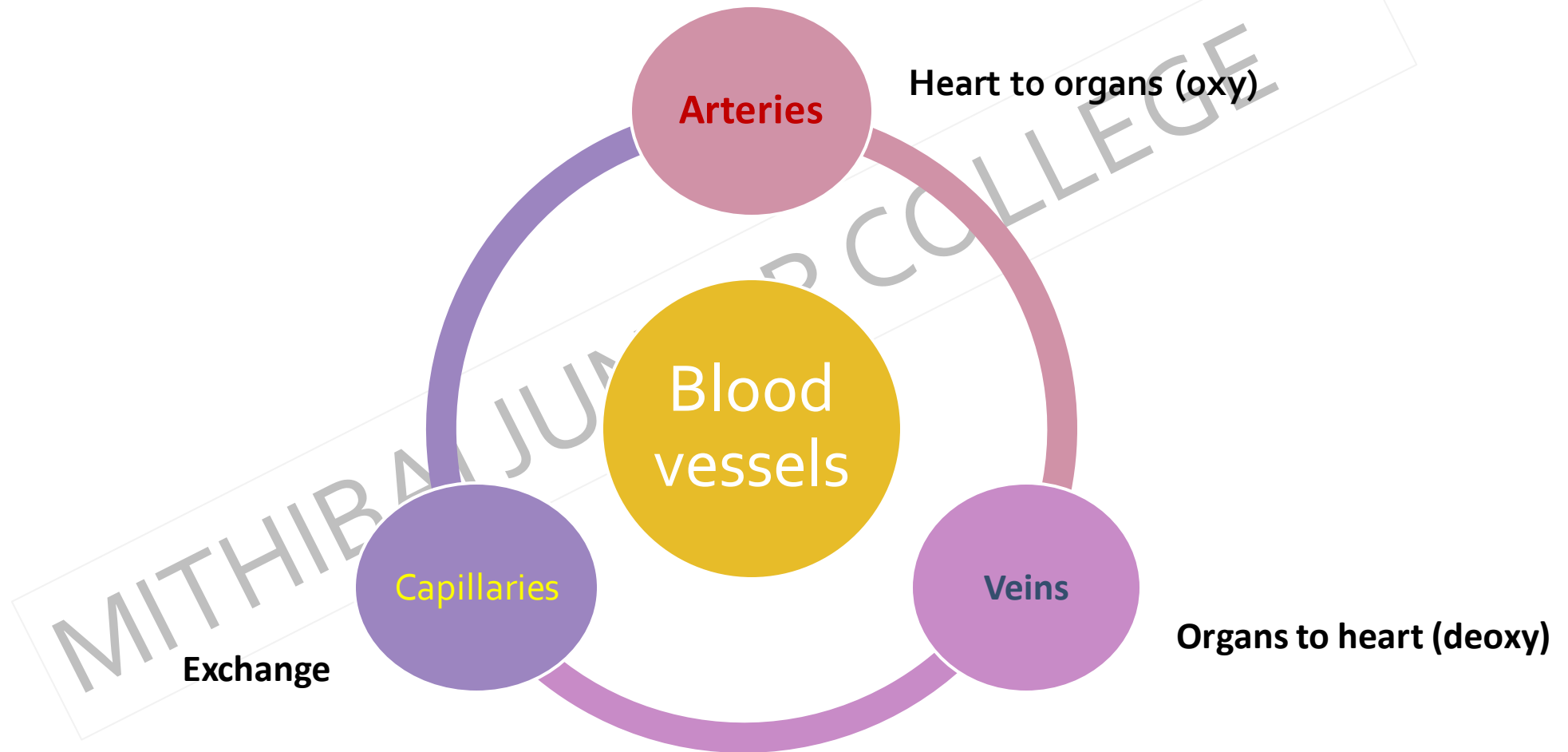
8.14 Working mechanism of human heart

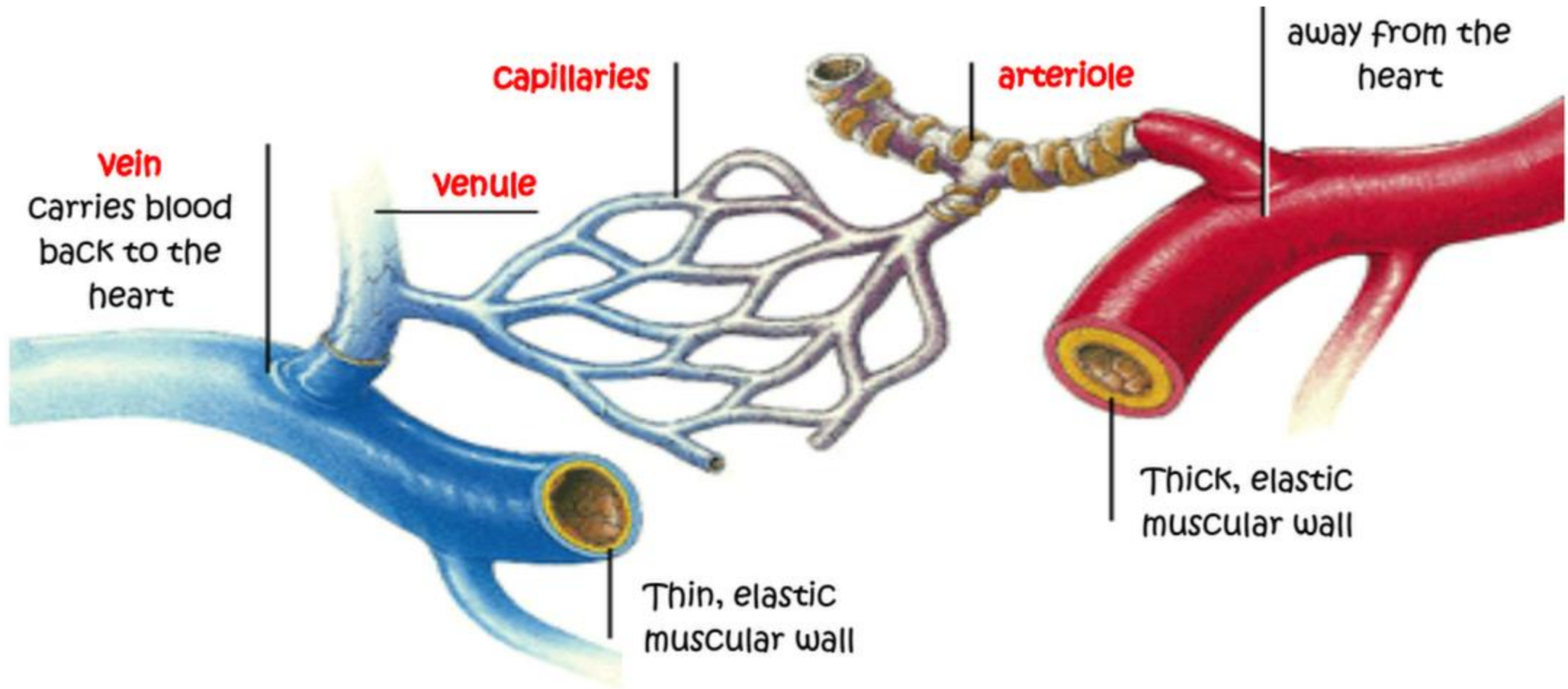


Cardiac cycle (0.8 sec)



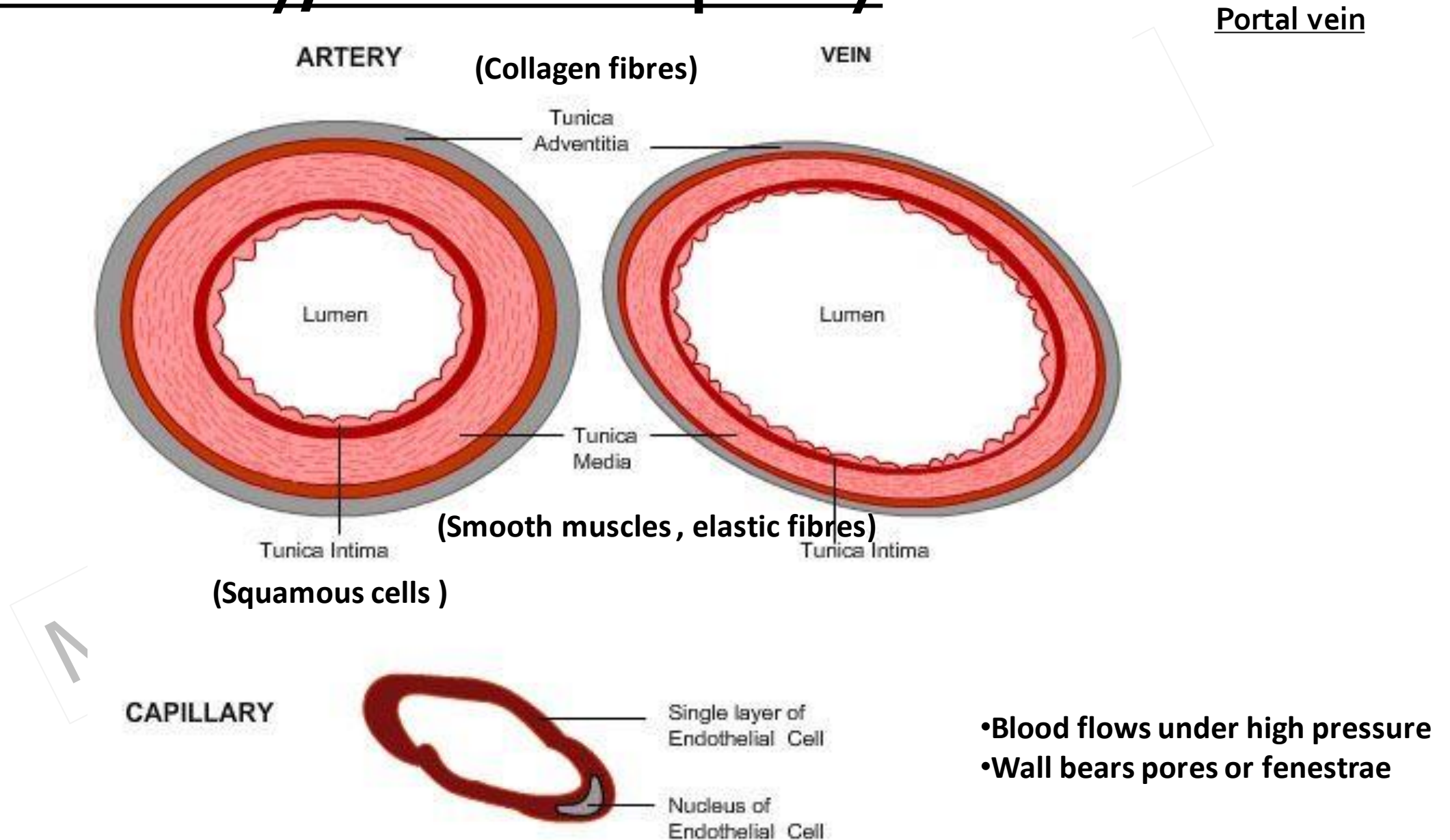
8.15 Blood vessels:





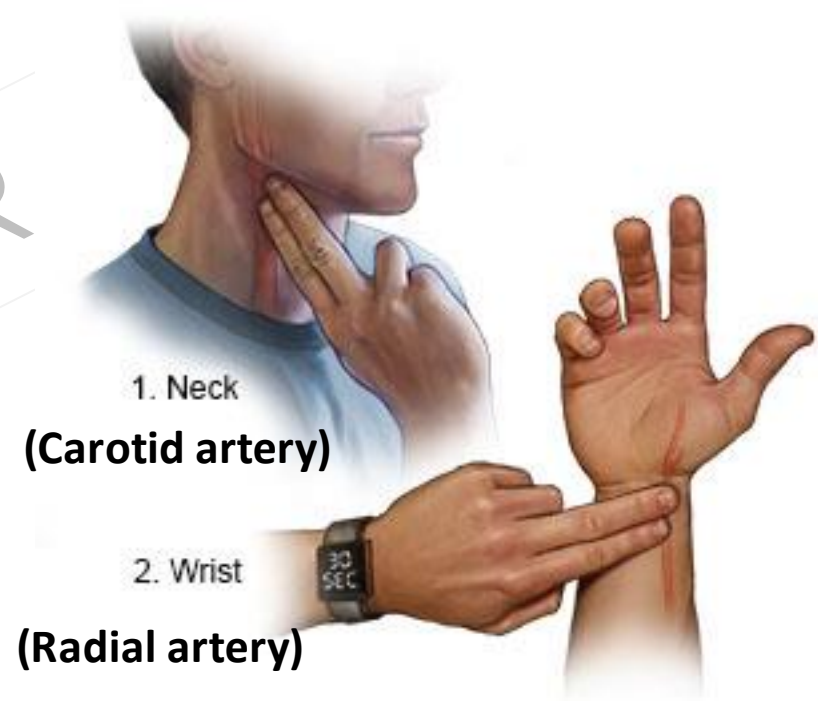
Arteries	Veins
Carry blood from heart to organs	Carry blood from organs towards the heart
Usually situated deep	Usually superficial
Carry oxygenated blood (except pulmonary artery)	Carry deoxygenated blood (except pulmonary veins)
Thick wall (tunica media)	Comapratively thinner (tunica media)
No valves	Valves present
Blood flows under high pressure	Blood flows under low pressure

T.S of Artery, Vein and capillary

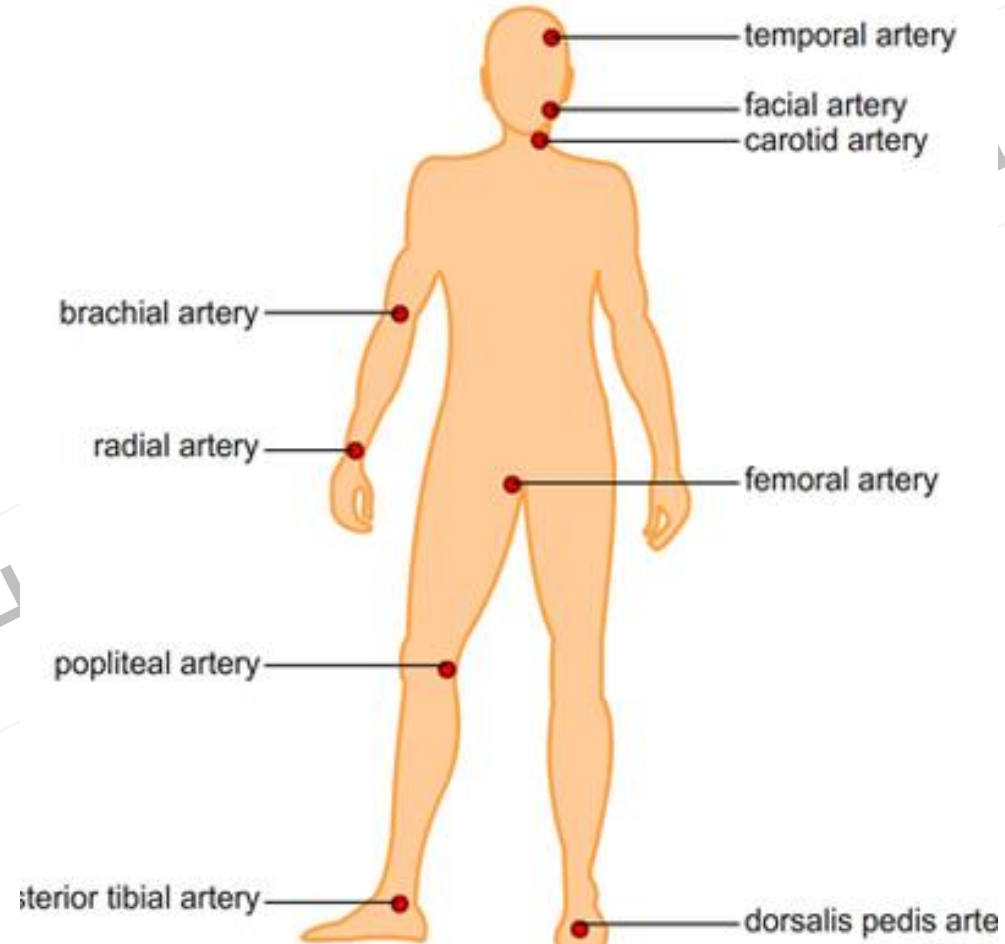


PULSE:

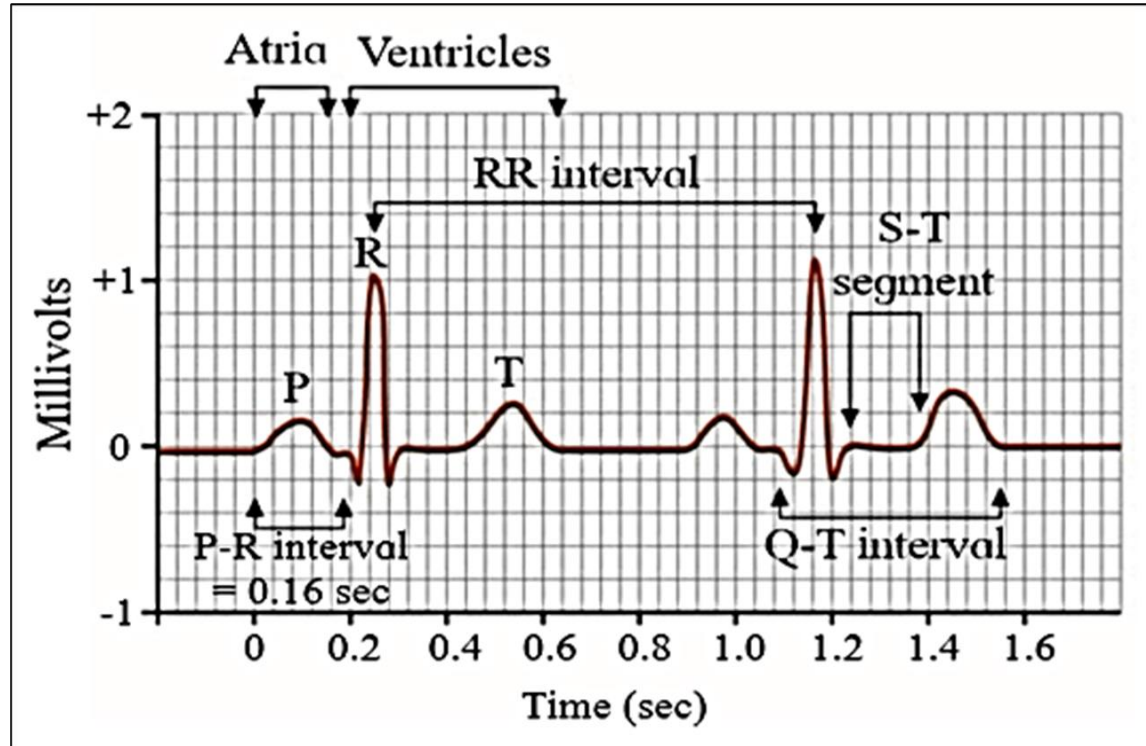
- Series of pressure waves that travel through arteries due to ventricular systole.
- Felt easily in superficial arteries
- Pulse rate is equal to heart rate
- Tachycardia(above 100beats /min)
- Bradycardia (below 60 beats/min)



PULSE POINTS:



8.17 Electrocardiogram



ECG helps to diagnose:

- Abnormality in conducting pathway
- Enlargement of heart chambers
- Damages to cardiac muscles
- Reduced blood supply to cardiac muscles
- Causes of chest pain

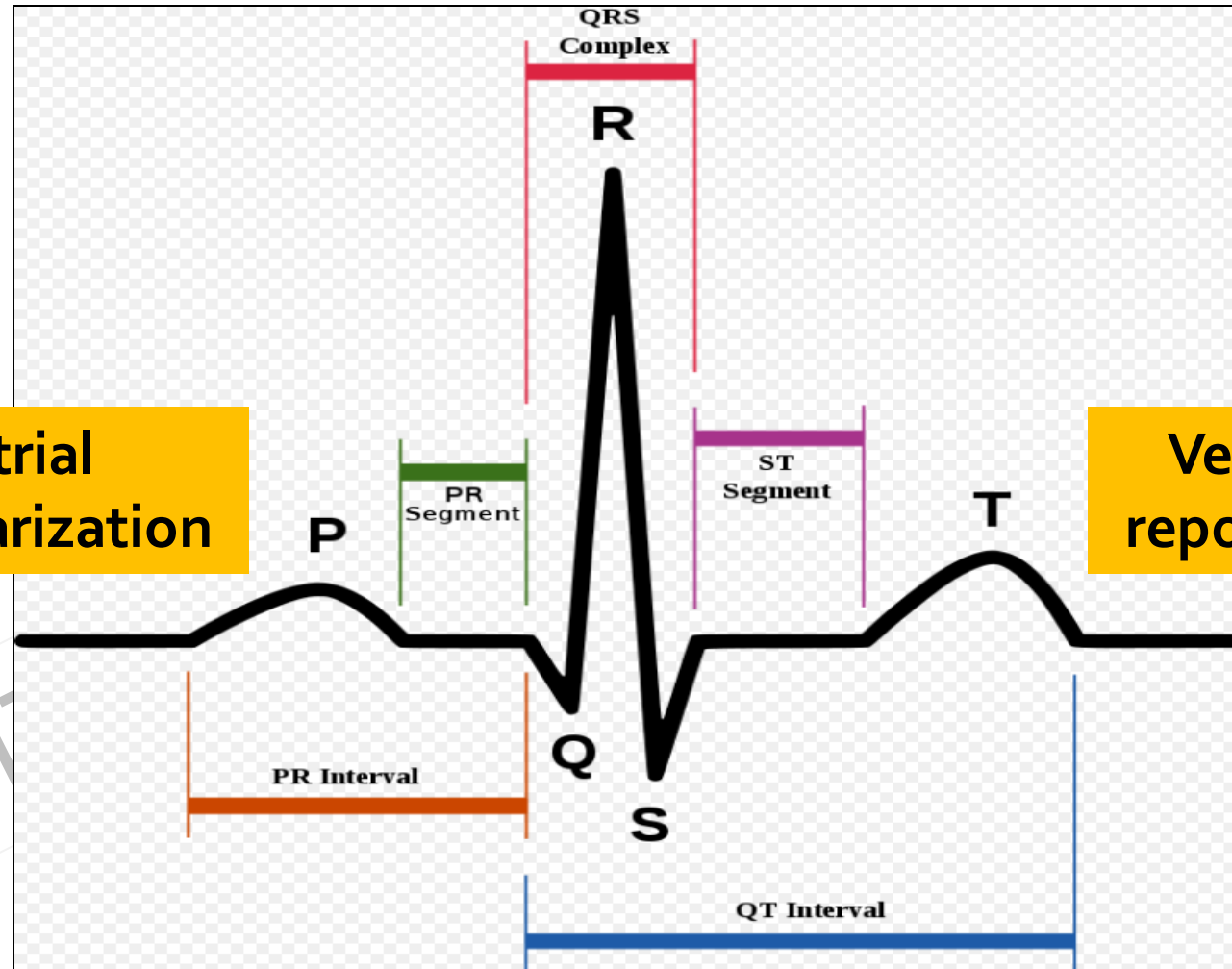
ECG – Graphical recording of electrical variations detected at the surface of the body during their propagation through the wall of the heart.

8.17 Electrocardiogram

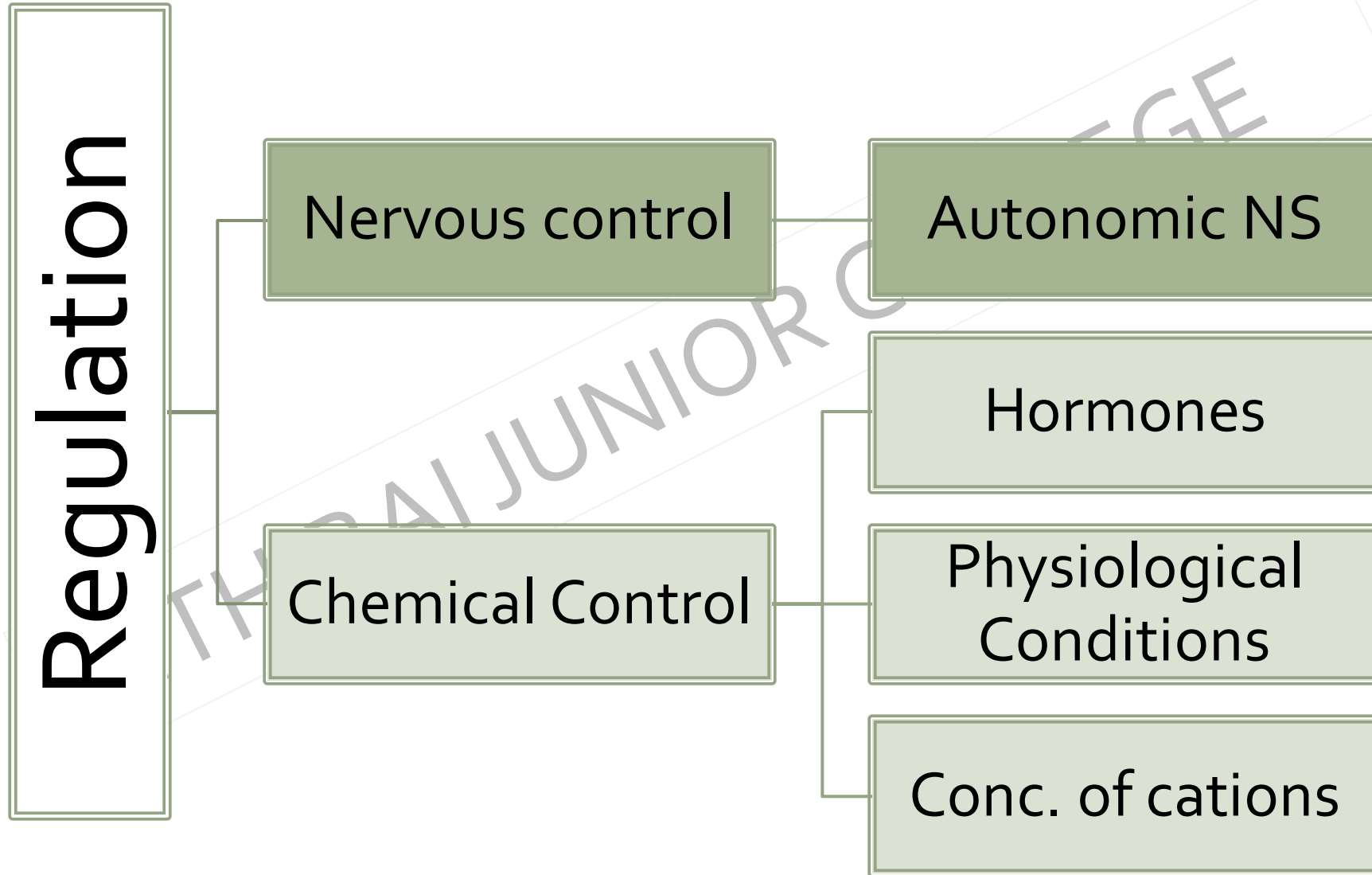
Ventricular
depolarization

Atrial
depolarization

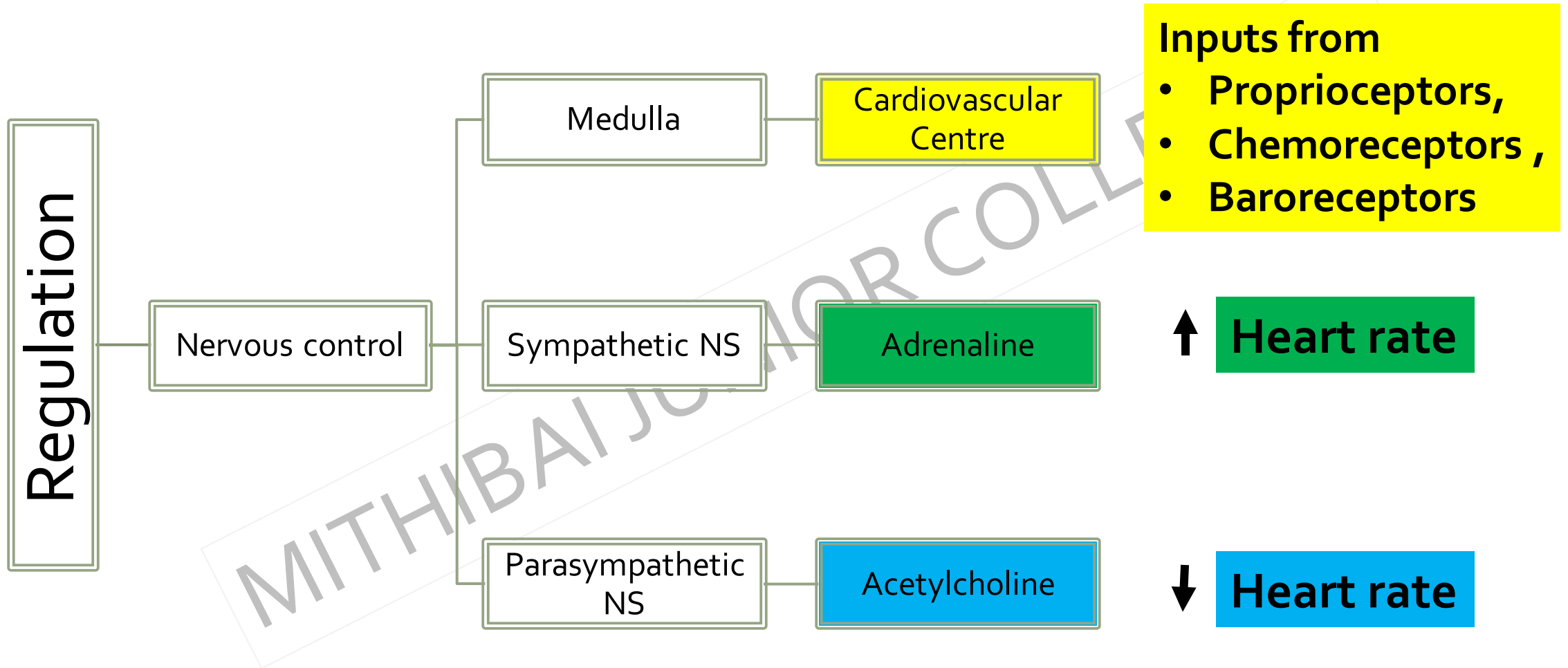
Ventricular
repolarization



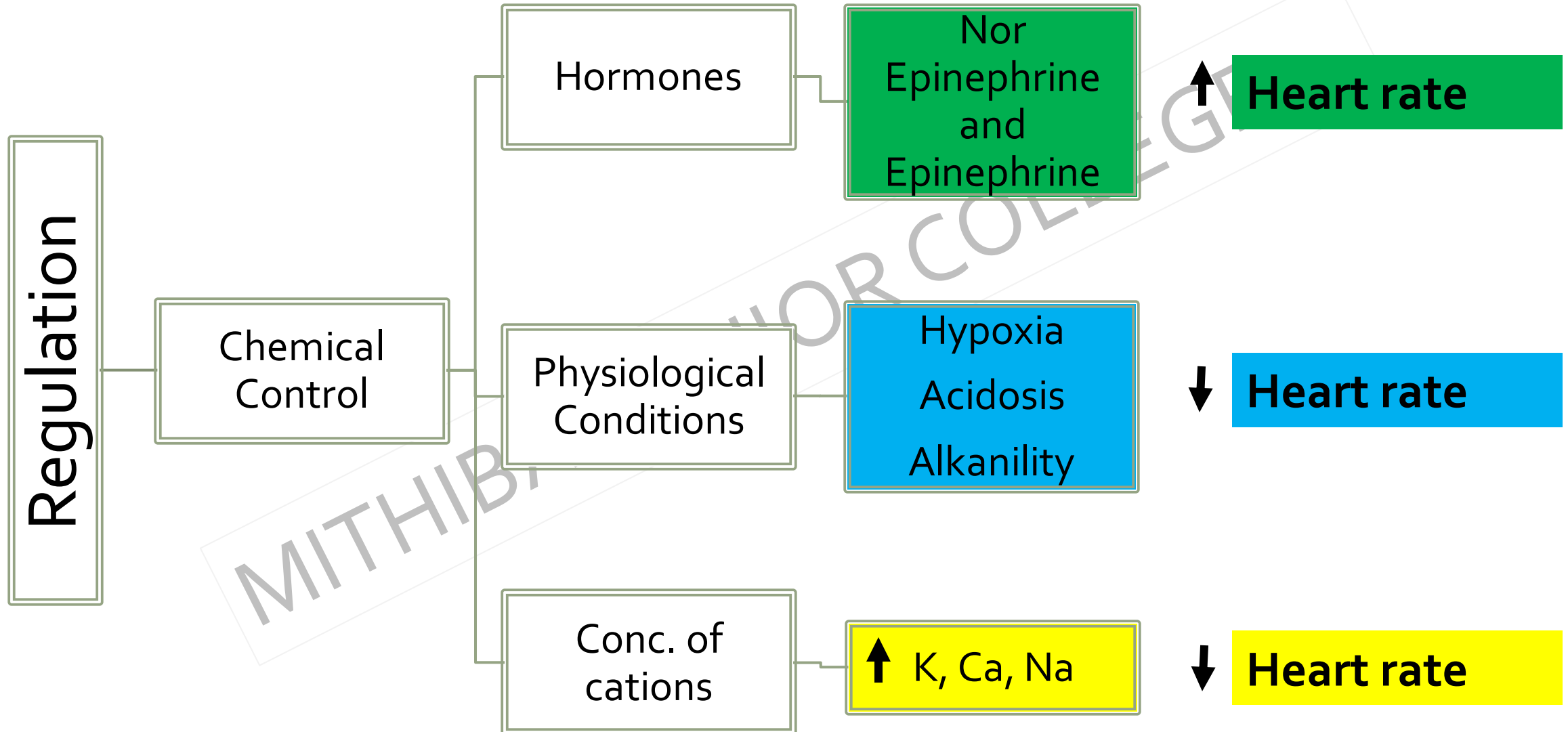
Heart – Regulation of Cardiac Activity



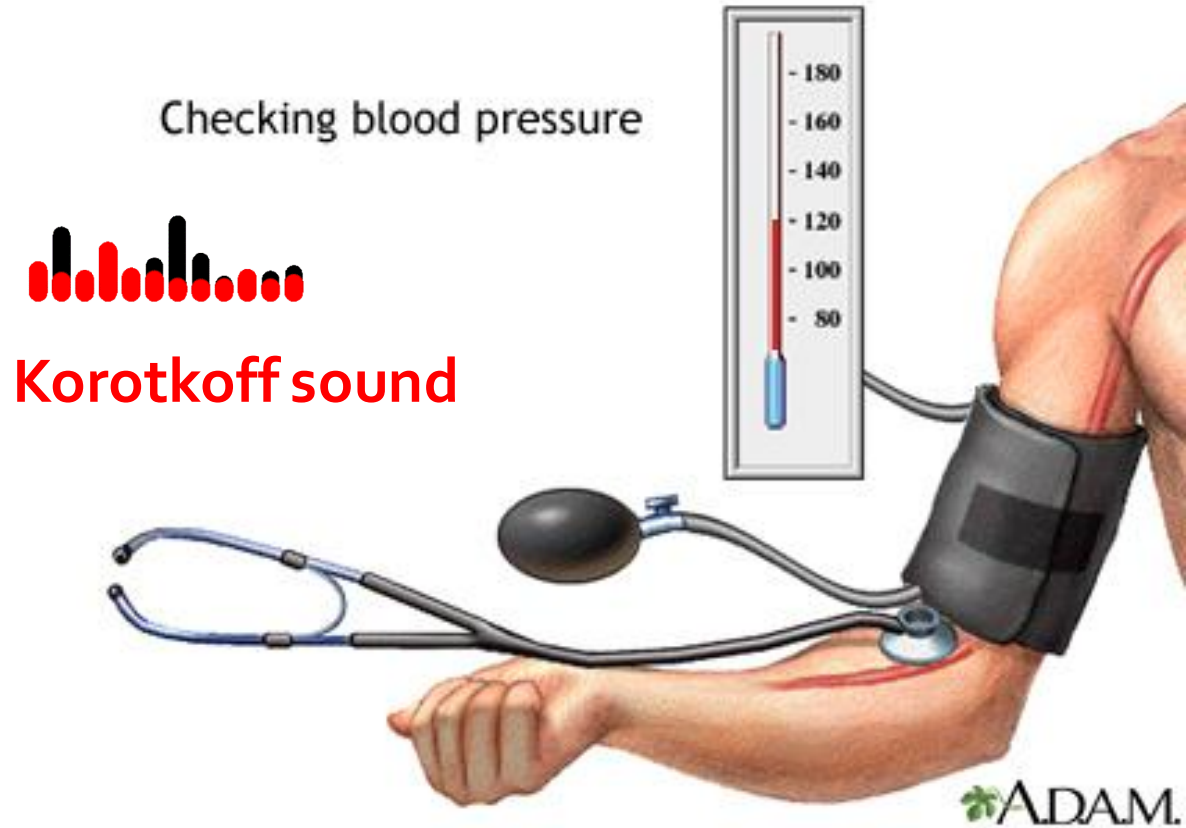
Heart – Regulation of Cardiac Activity



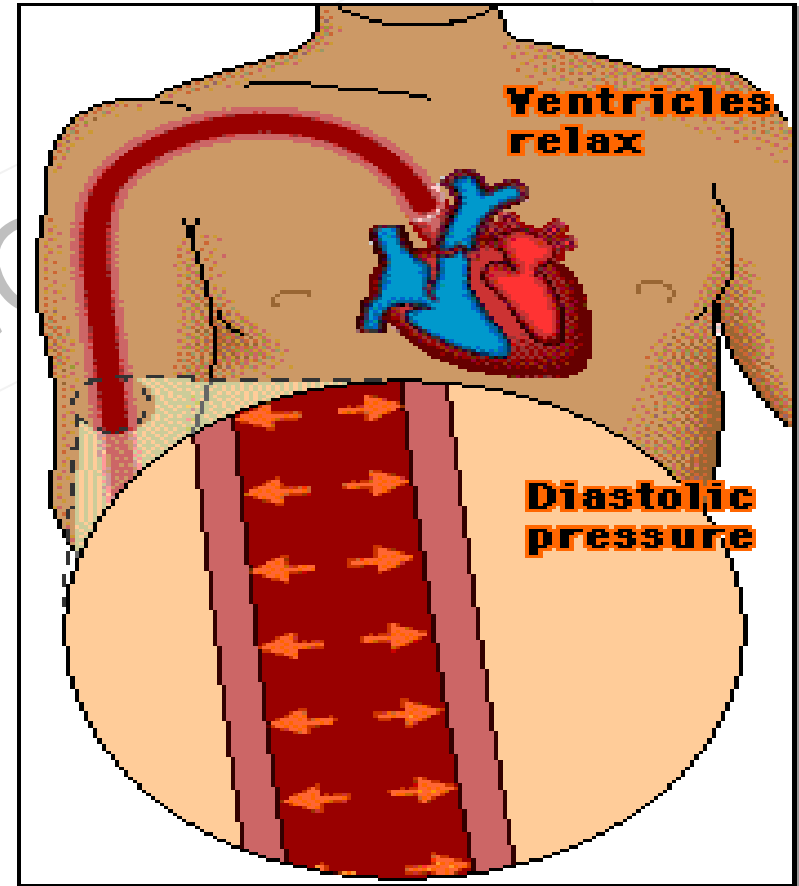
Heart – Regulation of Cardiac Activity



8.16 Blood Pressure



Sphygmomanometer

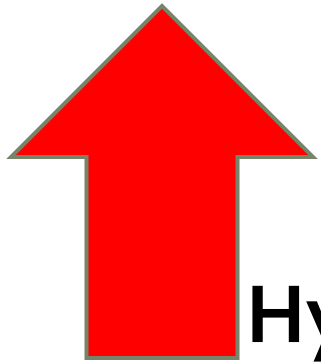


8.16 Blood Pressure

Systolic Pressure

Diastolic pressure

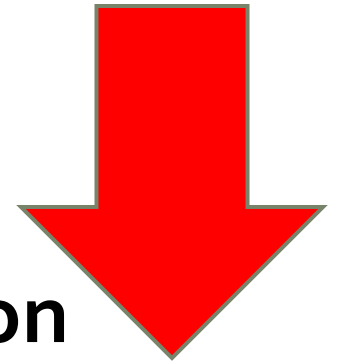
BP of normal healthy adult – 120/ 80 mmHg



Hypertension

Higher than **140/90 mmHg**

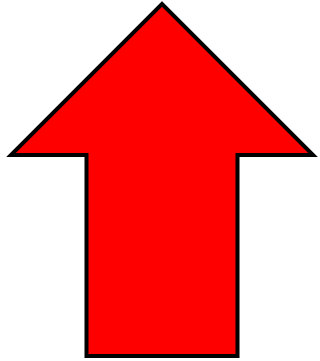
- Volume of Blood
- Arteriosclerosis
- Atherosclerosis
- Renal Diseases
- Hormonal changes
- Obesity
- Cardiac Output
- Venous return
- Length and diameter of vessels
- Peripheral Resistance of blood
- Physical State
- Age and Gender
- Emotional state



Hypotension

Lower than **90/60 mmHg**

Heart Disorders



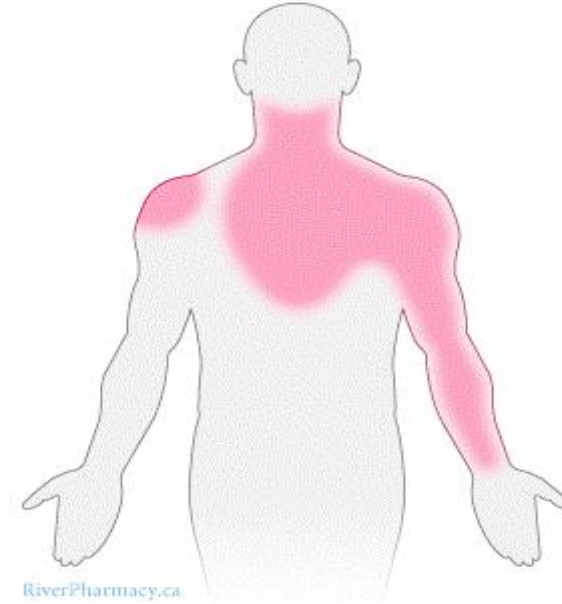
Hypertension

Higher than **140/90 mmHg**

Effects

- Angina pectoris
- Heart – lowered Blood supply, may lead to myocardial infarction
- Brain hemorrhage
- Kidney failure

Angina pectoris



Effects

Pain in chest neck, lower jaw, left arm and left shoulder

Cause

Exertion due to reduction in blood supply to cardiac muscles

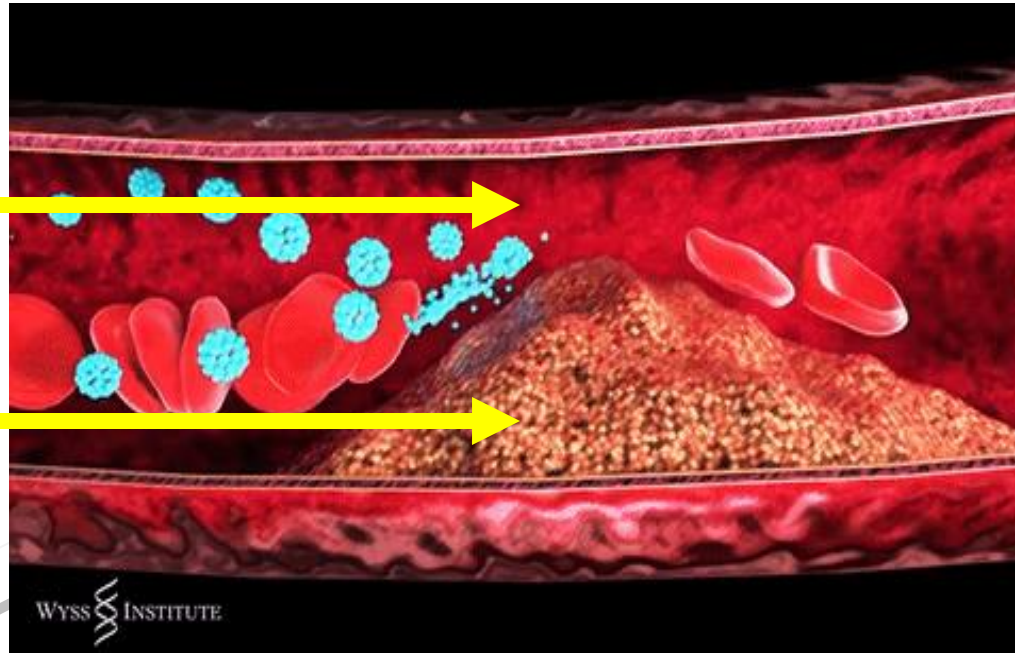
Heart Disorders

Coronary Artery Disease (CAD) –Atherosclerosis

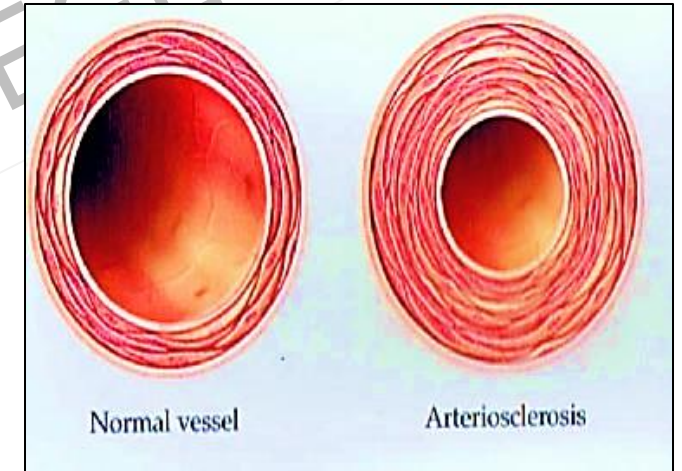
Narrow Lumen

Plaque

Deposition of Ca,
fat, cholesterol or
fibrous tissue



Arteriosclerosis

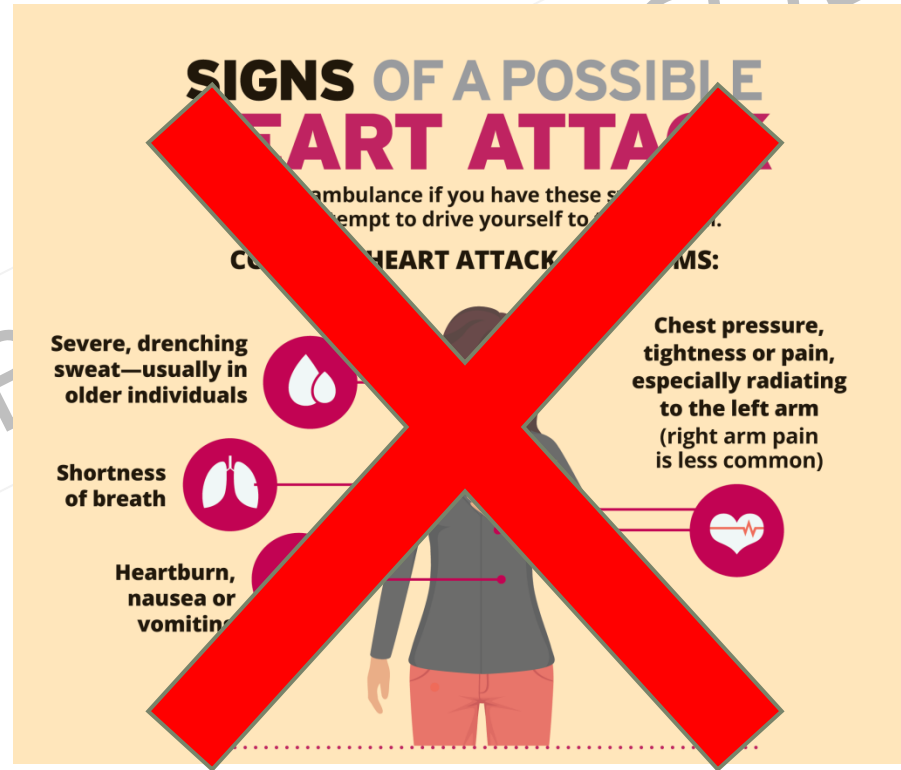


Inelasticity and
hardening of arteries

Heart Disorders

Silent Heart Attack – Silent Myocardial infarction

Mild symptoms confused with normal discomfort



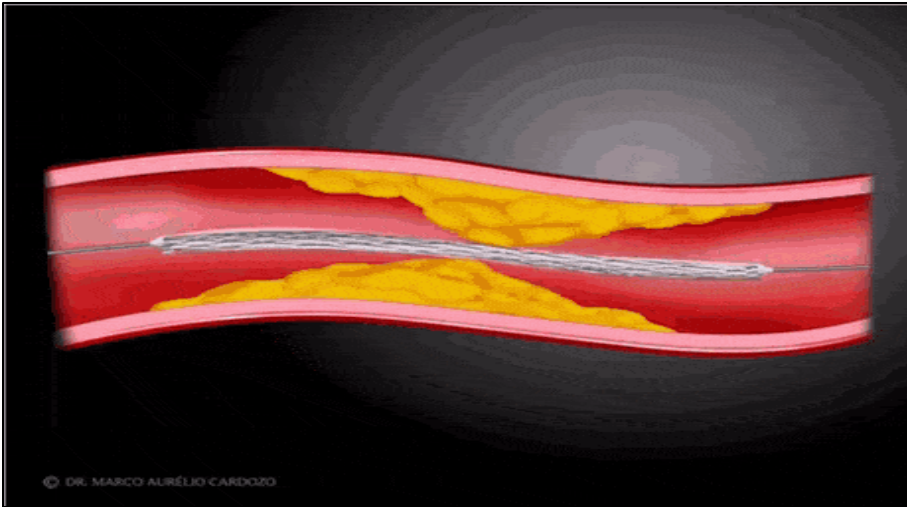
Heart Disorders – Diagnosis

Angiography



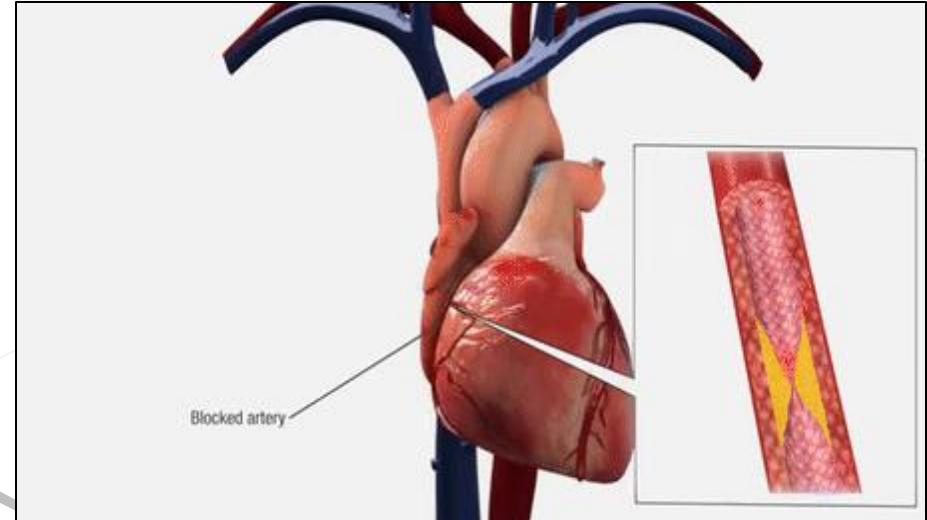
X ray imaging of cardiac vessels to locate the blockage

Heart Disorders – Treatment



Angioplasty

Stent is inserted to at the site of blockage to restore blood supply



Bypass surgery

Atherosclerotic region is bypassed with graft artery or vein



Heart Transplant

Patients must take immunosuppressive drugs for the rest of their lives to keep the immune system from attacking transplanted organs.

8.18 Lymphatic System

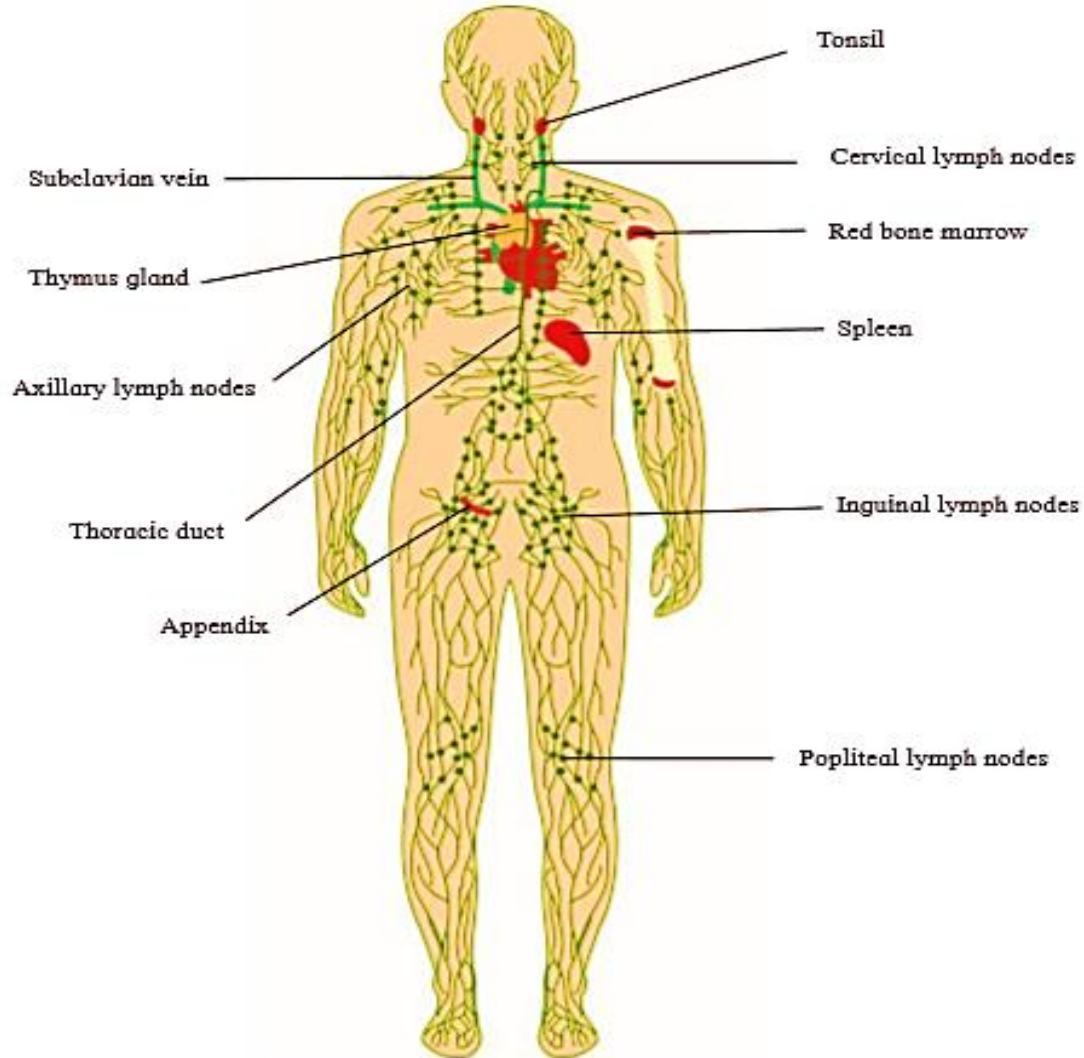


Fig. 8.27 : Lymphatic System

Lymph

=

Blood

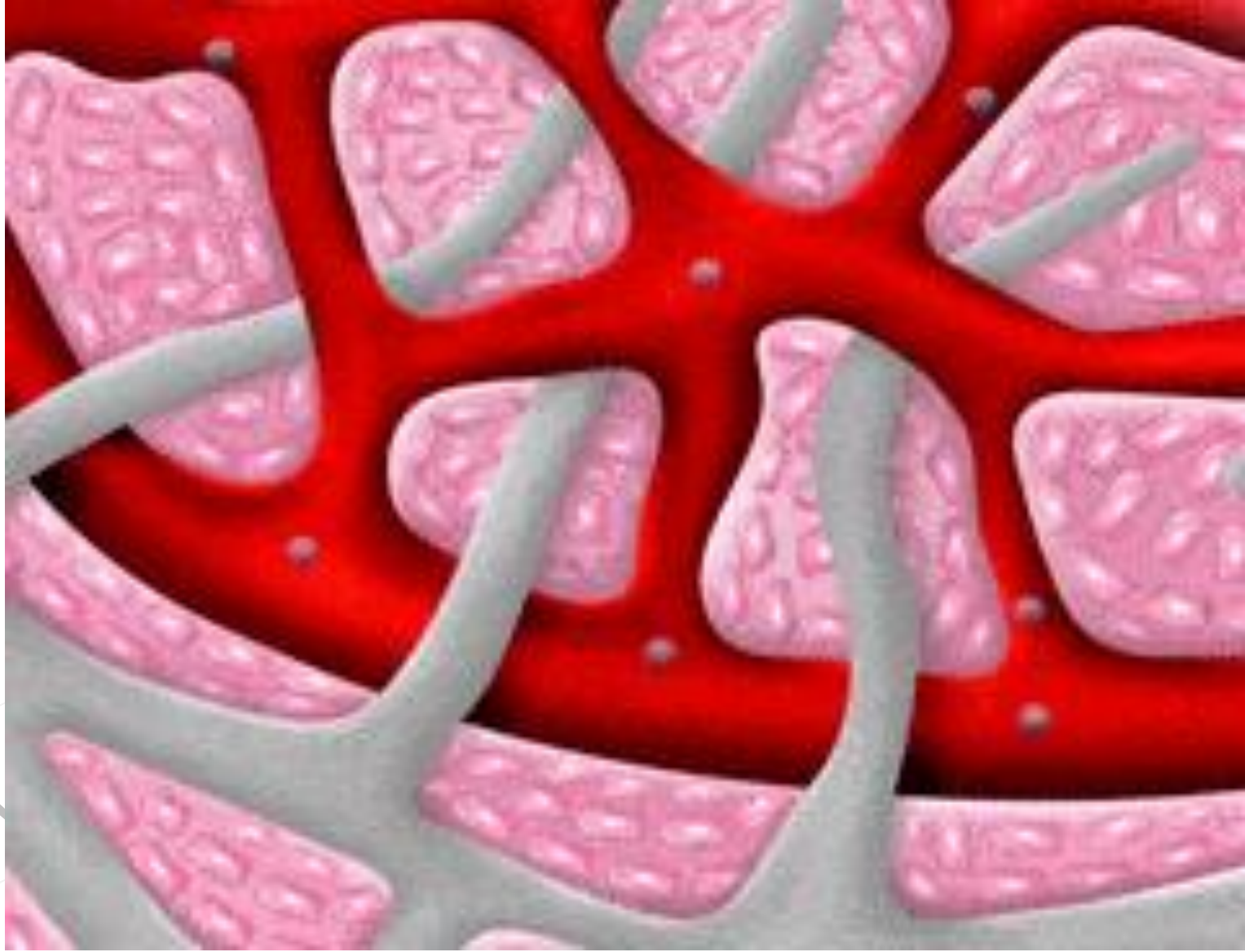
-

RBCs,
Platelets,
proteins

Lymphatic Capillaries and vessels

Thoracic duct and Right lymphatic duct

Lymph nodes and Lymphoid organs



8.18 Lymphatic System

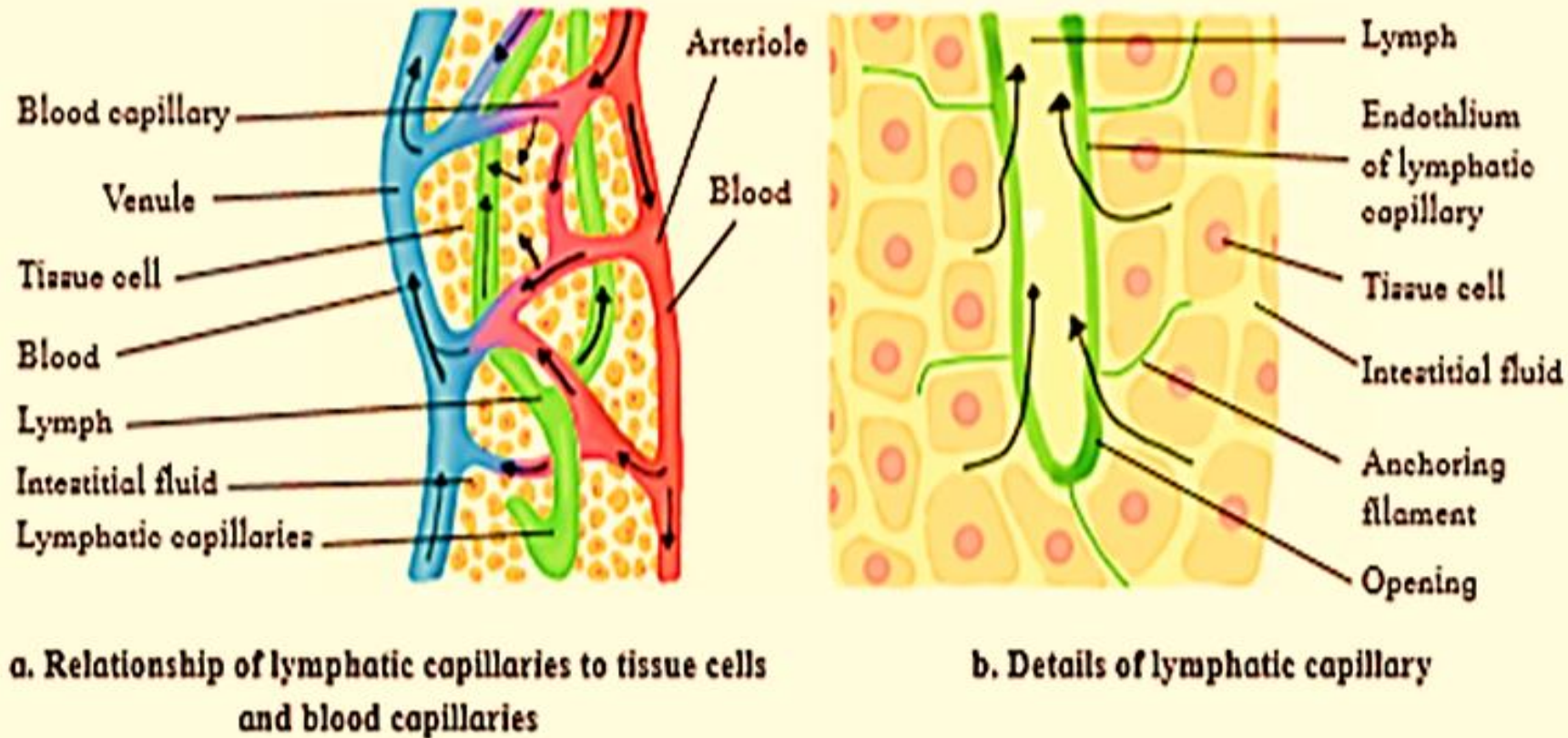


Fig. 8.28 : Circulation and Lymphatic System

Fluid from
Intercellular spaces



Lymphatic capillaries



Lymphatic vessels



Lymphatic Ducts



Discharged into veins

BOOKS
NOURISH
THE BRAIN



COLLEGE

Keep learning

Thank u