10.1 TYPES OF CIRCULATORY SYSTEM

The necessity for transport systems in complex multicellular organisms

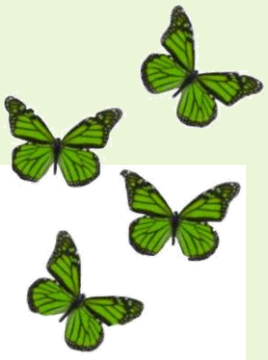
= blood circulatory system

- Requires essential substances (oxygen and nutrients)
- Expels cellular waste products (carbon dioxide and nitrogenous wastes)
- Substance exchange cannot occur by diffusion because the cells are too far away from the environment.

Types of circulatory systems

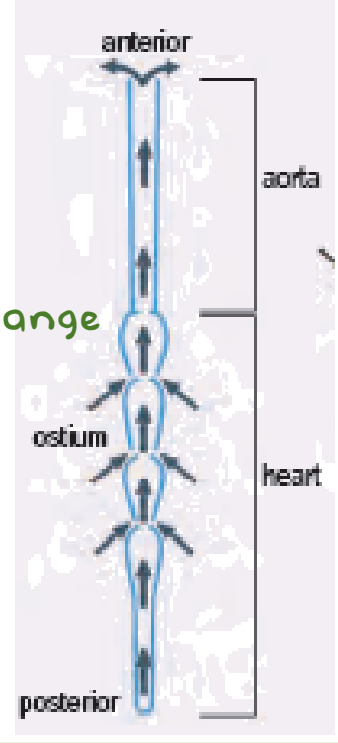
OPEN CIRCULATORY SYSTEM

- haemolymph flows directly into the haemocoel
  haemolymph = blood-like nutritious liquid
  haemocoel = body cavity



C.S INSECTS

- Heart contracts
  | Haemolymph to
  haemocoel substance exchange
- heart relaxes
  | ostium
  heart



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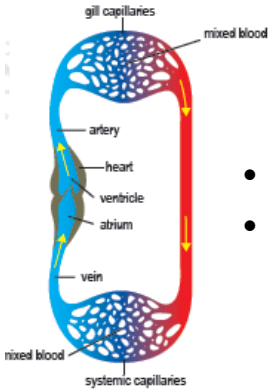
CLOSED CIRCULATORY SYSTEM

- blood is always contained in a continuous closed Blood
- exchange of substances that are essential to cells occurs across the walls of blood capillaries.

C.S FISH



- Single c.s because of 1 – direction blood flow
- has two chambers (1 atrium & 1 ventricle)

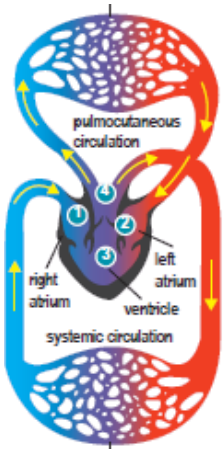
Ventricle → Gill capillaries → Gas exchange → Systematic capillaries

Systematic capillaries → Oxgenated blood → Tissue → Capillaries → [veins] → Atrium

Capillaries → [CO_2]

Tissue → [O_2]

C.S AMPHIBIA



- Double c.s (pulmocutaneous & systematic)
- Incomplete (blood are mixed)
- Has three chambers (2 atria & 1 ventricle)
- pulmocutaneous circulation :

Heart ⇄ Lungs and skin → Exchange of gases

- systemic circulation :

Oxygenated

Heart ⇄ Body tissues

Deoxygenated

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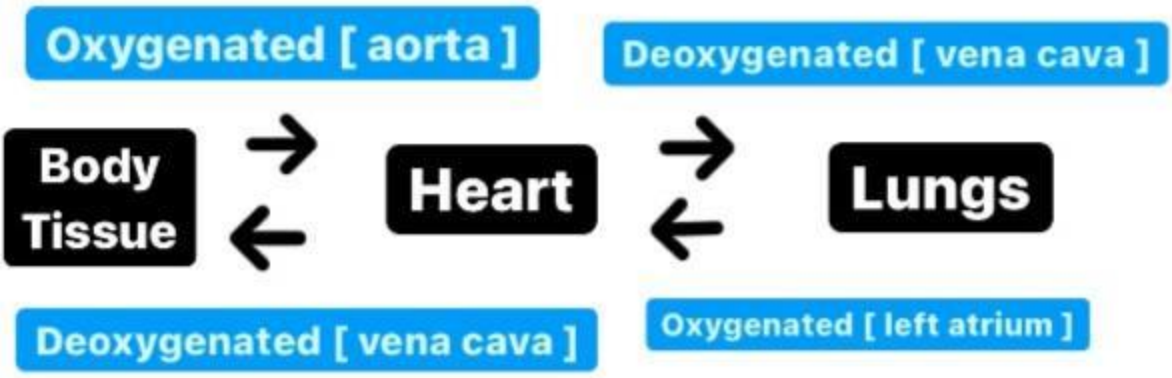
C.S HUMANS

- Double c.s
- complete
- 4 chambers (2 atria & 2 venticles)
- Systemic circulation • Pulmonary circulation



Similarities

The circulatory system is found in all multicellular organisms.
The circulatory system consists of a heart to pump blood or haemolymph (in insects).
The circulatory system functions to transport nutrients and wastes.
The heart has valves that ensure blood flows in one direction.

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10.2 Circulatory System of Humans

BLOOD

CELLS

ERYTHROCYTES

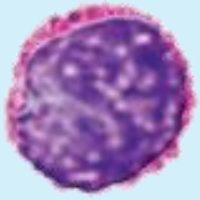
LEUCOCYTES

PLATELETS

GRANULOSIT

AGRANULOSIT

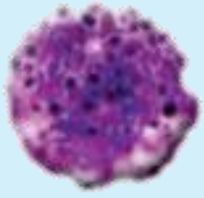
Neutrophils



Lymphocytes

Eosinophils

Monocytes



Basophils

PLASMA

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SOLUBLE SUBSTANCES

- Protein: Albumin, globulin, fibrinogen
- Nutrients: Glucose, amino acids, vitamin
- Respiratory gases : O2 & CO2
- Wastes
- Enzyme

WATER

FUNCTIONS OF BLOOD

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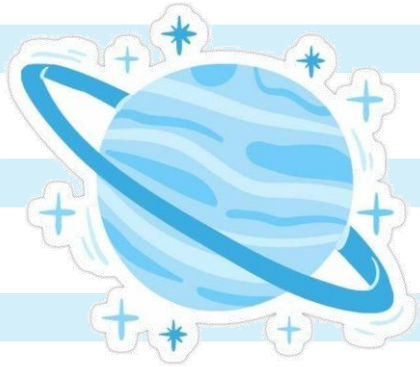
Transport heat

Transport water

Transport nutrient

Transport waste products

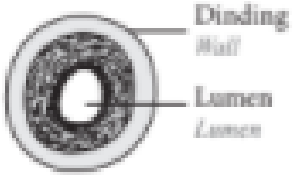
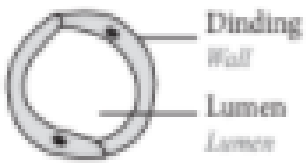
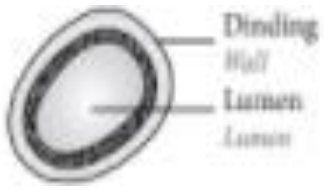


Transport oxygen

Transport hormones

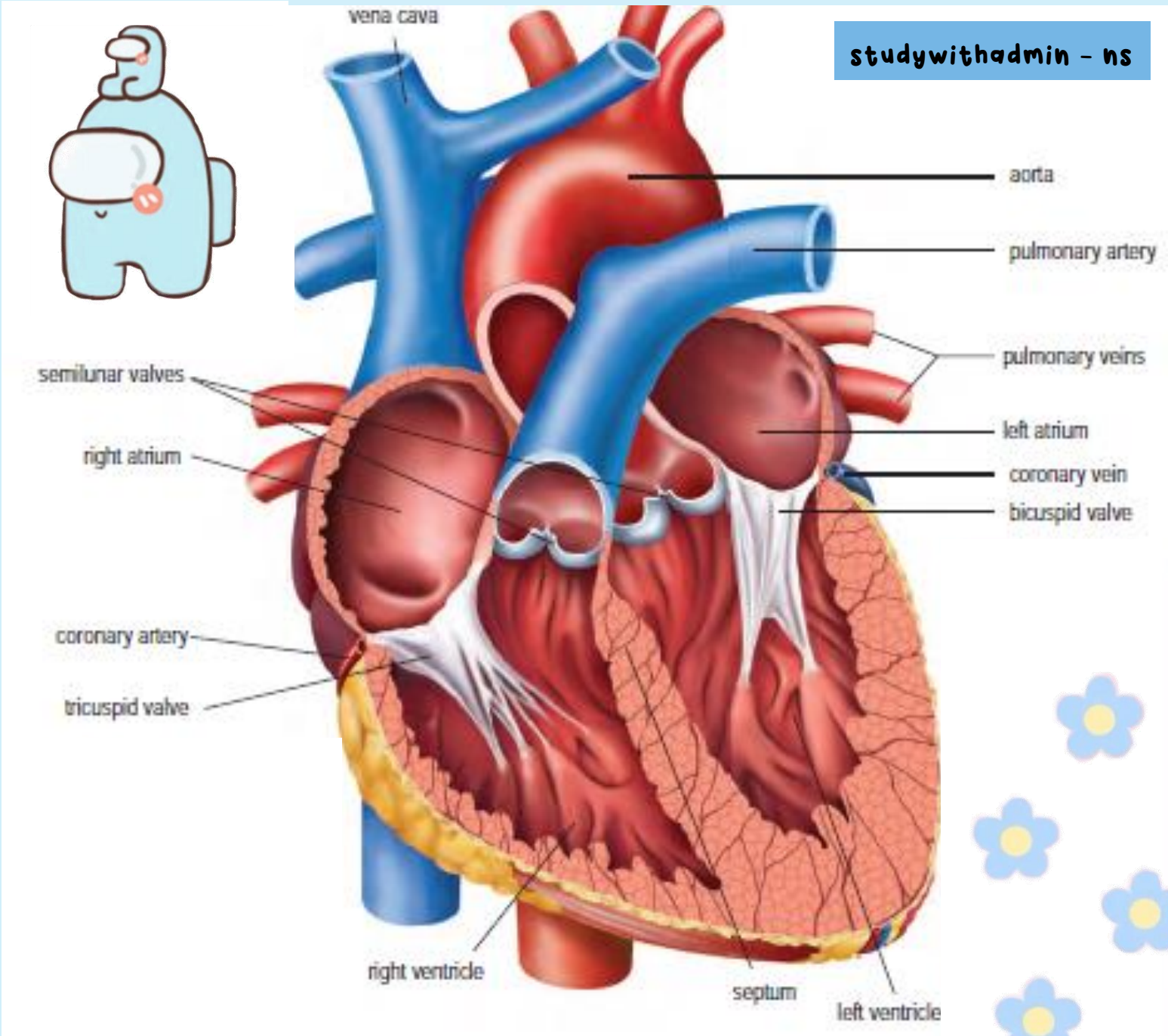
Transport carbon dioxide

COMPARISON OF HUMAN BLOOD VESSELS

CHARACTERISTICS	ARTERY	CAPILLARY	VEIN
STRUCTURE 			
SIZE OF LUMEN	small	none	large
MUSCULAR WALL	thick	tiada	thin
PRESENCE OF VALVES	none	none	peresent Ensures blood flow in one direction without backflow

CHARACTERISTICS	ARTERY	CAPILLARY	VEIN
BLOOD PRESSURE	High	Lower than arteries but higher than veins	Lower than arteries and capillaries
BLOOD FLOW	Transports blood to the entire body from the heart	Transports blood from arteries to veins	Transports blood from the body tissues to the heart

THE STRUCTURES OF THE HUMAN HEART



THE STRUCTURES OF HEART

1. The human heart weighs about 250 g to 350 g and is the size of a fist.
2. It is located in the thoracic cavity above diaphragm and protected by the rib cage
3. The cardiac muscles of the heart is myogenic which means it contracts and relaxes automatically and are not controlled by the nervous system..
4. Enclosed by pericardium to protect heart muscle tissue.
5. The function of a valve is to ensure blood flows in one direction and to prevent backflow
6. It has 4 chambers :
   a) Atrium wall is thinner as it only pumps blood to ventricle
   b) Left ventricular wall is thicker than right ventricular wall.
   c) This is because left ventricle pumps blood to the whole body
   d) Right ventricle only pumps blood to the lungs..

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10.3 Mechanism Of Heartbeat

Heartbeat

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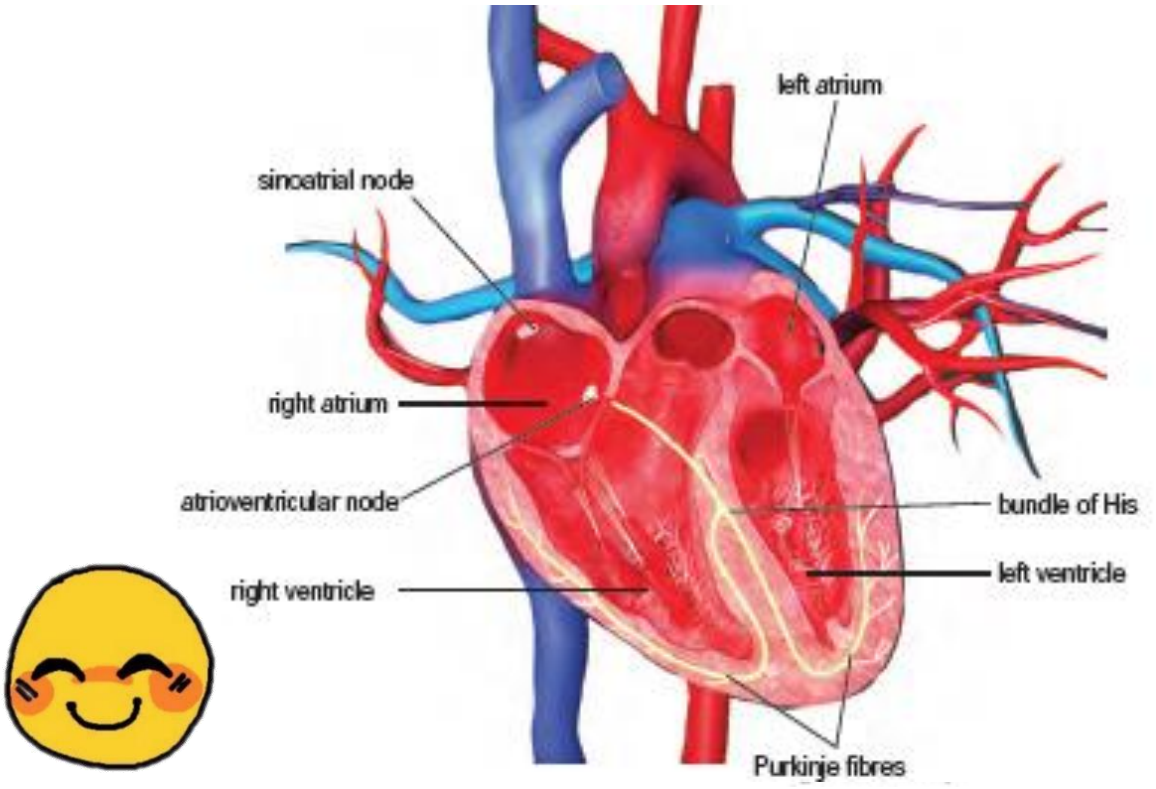
1. **Average heartbeat = 72 times/minute**



2. **Sinoartrial node (SA node) and atrioventricular node (AV node) function to ensure the heart rate is at the correct pace..**
3. **Sinoartrial node (SA node) is also known as a pacemaker**

PACEMAKER SETS AND COORDINATES HEART CONTRACTIONS BUT IT IS ALSO INFLUENCED BY:

- **Nervous system**
- **Endocrine system**
- **Sympathetic and parasympathetic nerves**
- **Adrenaline (hormone)**

4. Sequence of contraction of the heart muscles which results in the pumping of blood by the heart.

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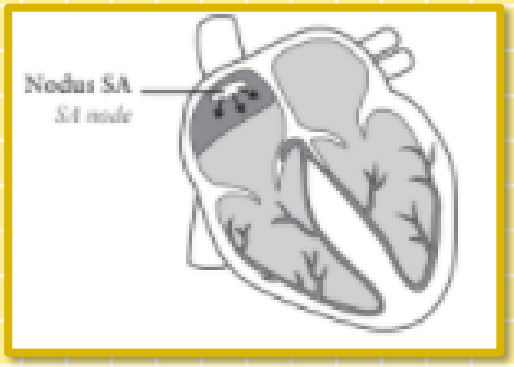
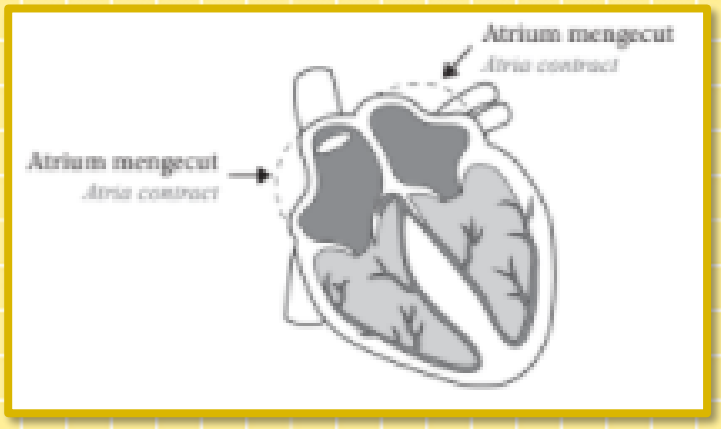
1



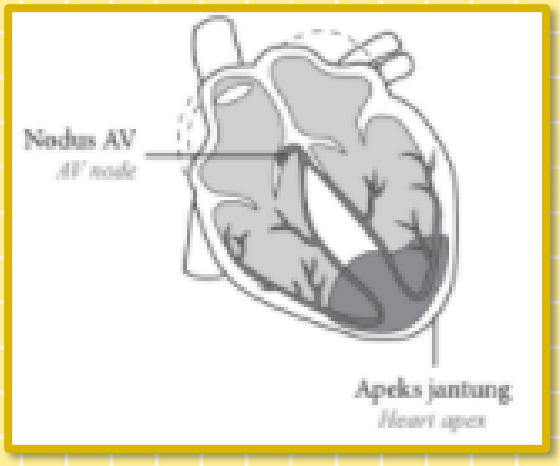
The SA node generates electrical impulses.

2



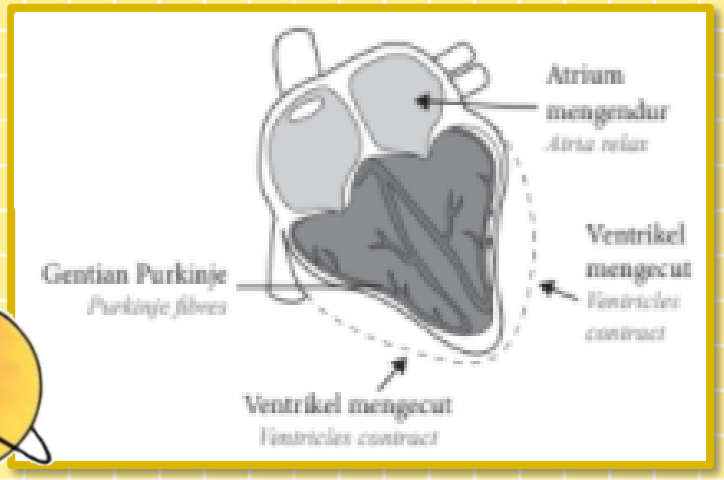
The electrical impulses spread rapidly over the walls of both atria, causing the atria to contract simultaneously. The contractions of the atria cause the blood pressure in the atria to increase and pump the blood into the ventricles.

3



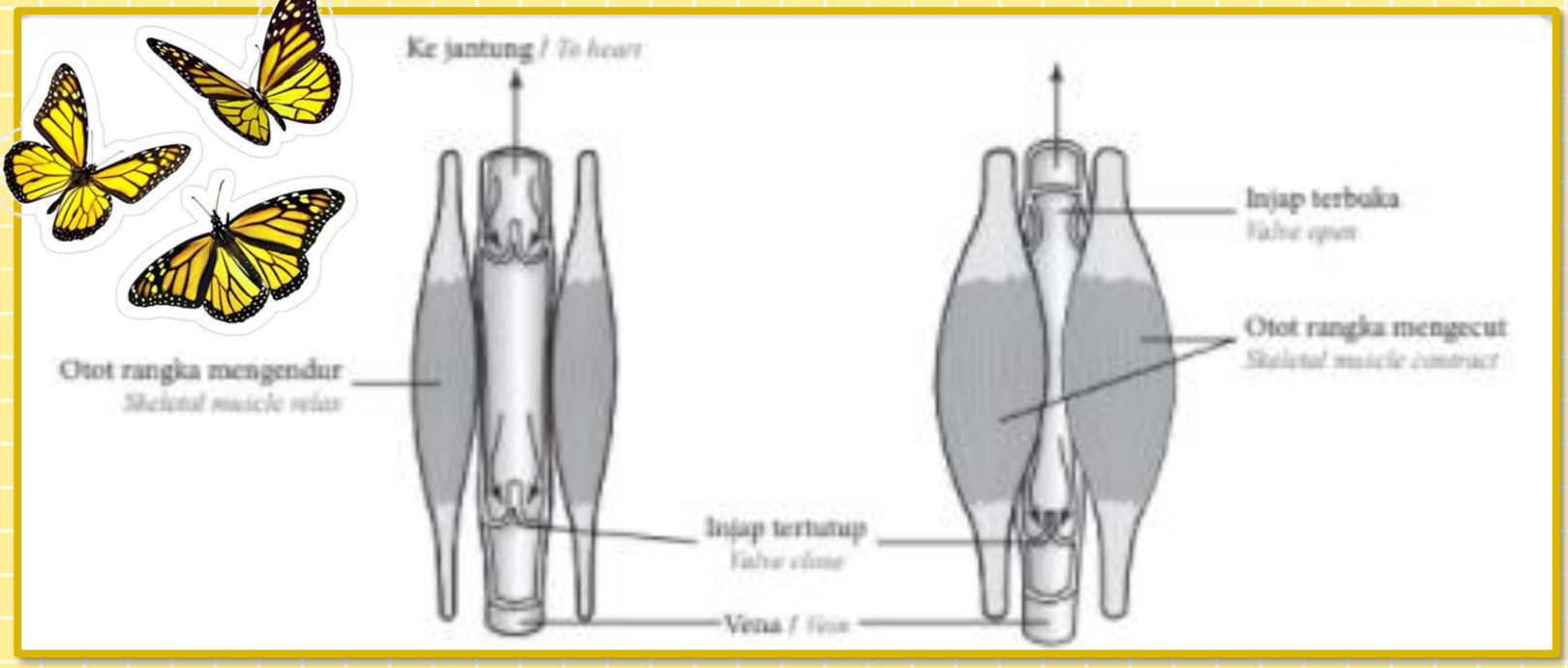
The electrical impulses reach the AV node. The electrical impulses spreads through His fibres and Purkinje fibres to the heart apex.

4



The electrical impulses spread to the ventricles causing them to contract simultaneously. This causes the blood pressure in the ventricles to increase and blood is pumped to lungs and the whole body.

5. When skeletal muscles around the vein contract , the vein constricts and the valve opens . This causes blood to be pushed upwards along the vein.



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10.4 Mechanism of Blood Clotting

IMPORTANCE OF BLOOD CLOTTING MECHANISM

- Prevent entry of pathogen
- Maintain blood pressure
- Maintaining blood flow in a closed circulatory system
- Prevent excessive blood loss

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MECHANISM OF BLOOD CLOTTING

Damaged blood vessel → Blood exposed to collagen fibres → stimulates → Agglutination of platelets

Agglutination of platelets → Form thrombokinase

Calcium ion + Vitamin K + Form thrombokinase

Prothrombin (Inactive protein plasma) → Thrombin (Active plasma protein which acts as an enzyme)

Thrombin (Active plasma protein which acts as an enzyme) → Fibrinogen (Soluble)

Fibrinogen (Soluble) → Fibrin (Insoluble)

Fibrin is insoluble and forms a mesh of sticky network ton :

1. trap red blood cells
2. act as a plug to stop bleeding

Fibrin (Insoluble) → Blood clot

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BLOOD CLOTTING PROBLEMS

HAEMOPHILIA

THROMBOSIS

EMBOLISM

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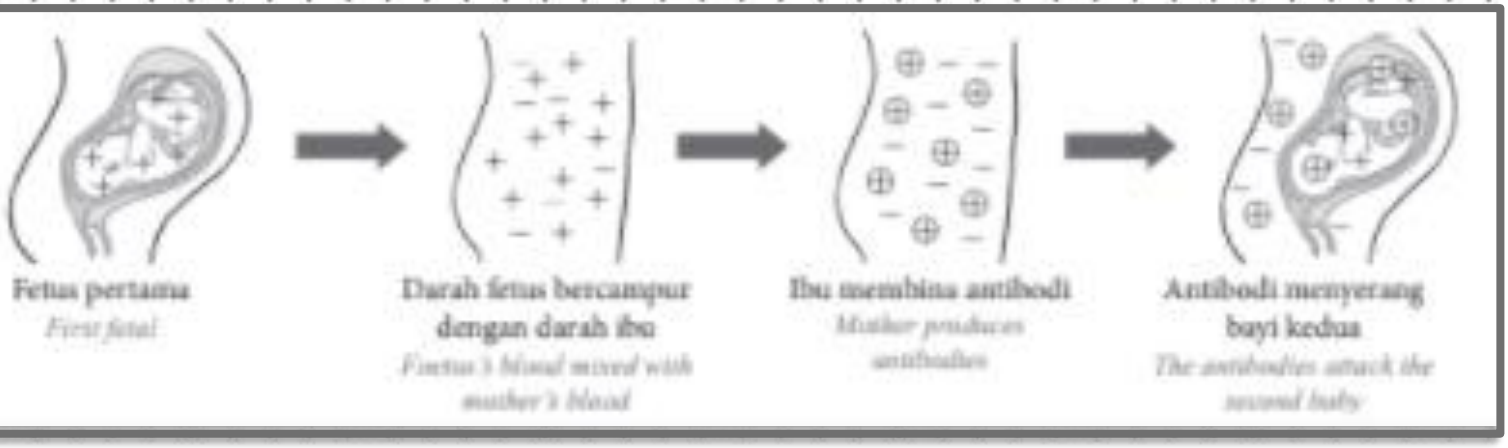
10.5 blood groups of humans

	KUMPULAN DARAH			
	A	B	AN	O
ANTIGEN (ON THE ERYTHROCYTES)	Antigen A	Antigen B	Antigen AB	No antigen
ANTIBODY (IN THE SERUM)	Anti-B	Anti-A	No antigen	Anti-A & Anti-B
CAN DONATE BLOOD TO BLOOD GROUPS	A and AB	B and AB	AB only	A , B , AB and O Universal donor
CAN RECEIVE BLOOD FROM BLOOD GROUPS	A and O	B and O	A , B , AB adn O Universal recipients	O only

Other than the ABO blood group system, there is another blood group system which is Rhesus factor. Rhesus factor is an antigen D found on the surface of erythrocytes. Those with this antigen D is known as Rhesus positive and those without antigen D is known as Rhesus negative.

ISSUE WITH RHESUS FACTOR

- If the Rh-negative mother carries the first Rh-positive baby, no agglutination occurs as the mother's blood is separated from the foetal blood by placenta.
- In the last month of pregnancy, small amount of foetal blood may enter the mother's bloodstream.
- This stimulates the mother's immune system to produce antibodies anti-D..
- If the mother is pregnant with Rh-positive second baby, the existing anti-D antibody in the mother's blood will cross the placenta and destroy the fetal red blood cells.
- This may cause a brain malfunction and death to the second baby..



- Way to avoid agglutination on second pregnancy: Inject anti Rh globulin to the mother just after the first pregnancy to prevent mother's body from producing anti Rhesus antibody.

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10.6 HEALTH ISSUES RELATED TO THE HUMAN CIRCULATORY SYSTEM

1. Importance of having a healthy cardiovascular system

- encourages a healthy growth of cells
- tranports substances required by body cells such as nutrients and oxygen to allow the cells to use the oxygen and glucose for cellular respiration
- transports waste substances such as carbon dioxide to be excreted

2. Cardiovascular diseases

cardiovascular disease (arteroscierosis)

↓ **DUE TO**

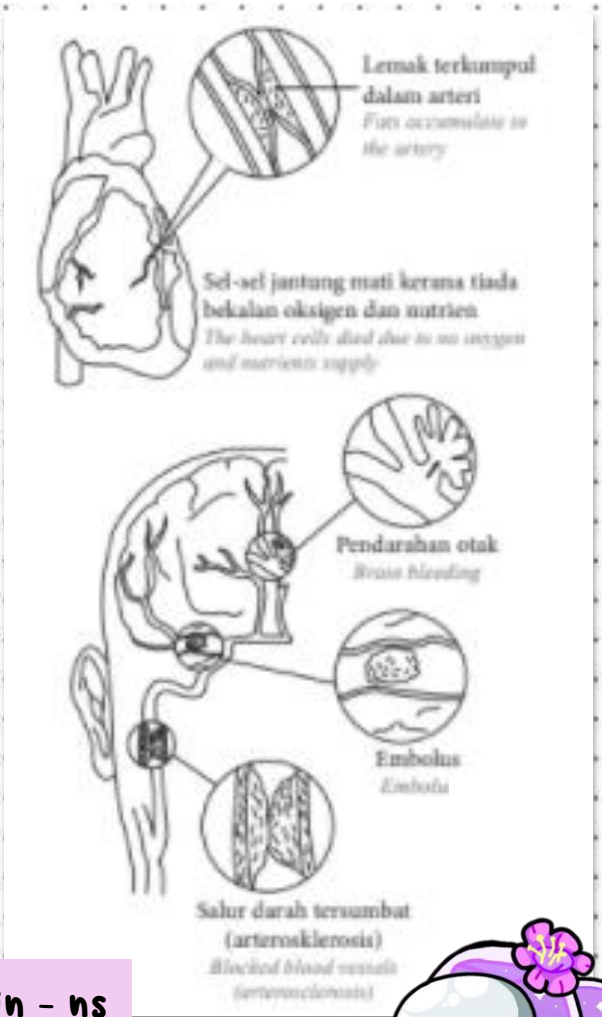
blockage of arterial walls with the accumulation of fatty substances (cholesterol).

↓

clogged blood vessels fail to transport oxygen and nutrients to the brain and heart.

↓ **Diseases**

Paralysis, heart attack, stroke, high blood pressure



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a) Atherosclerosis

the narrowing of the lumen of an artery due to the formation of plaque on the wall of the artery. this blocks the flow of oxygenated blood to the body tissues.

b) Arteriosclerosis

the thickening of the inner wall of the artery that causes it to be hard. a healthy artery is flexible and elastic .

c) Angina

chest pain or discomfort caused when your heart muscles do not get enough oxygenated blood .

d) Myocardial infarction

also known as heart attack. it occurs when blood flow decreases or stops to the heart, causing damage to the heart muscle.

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10.1 Lymphatic System of Humans

FORMATION OF THE TISSUE FLUID AND LYMPH:

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1 Blood that reaches the arterial end of the blood capillary has a high pressure due to the small diameter of capillaries and the pumping force of the heart.

2 This pressure allows the blood plasma to diffuse continuously from the blood capillaries to the intercellular space.

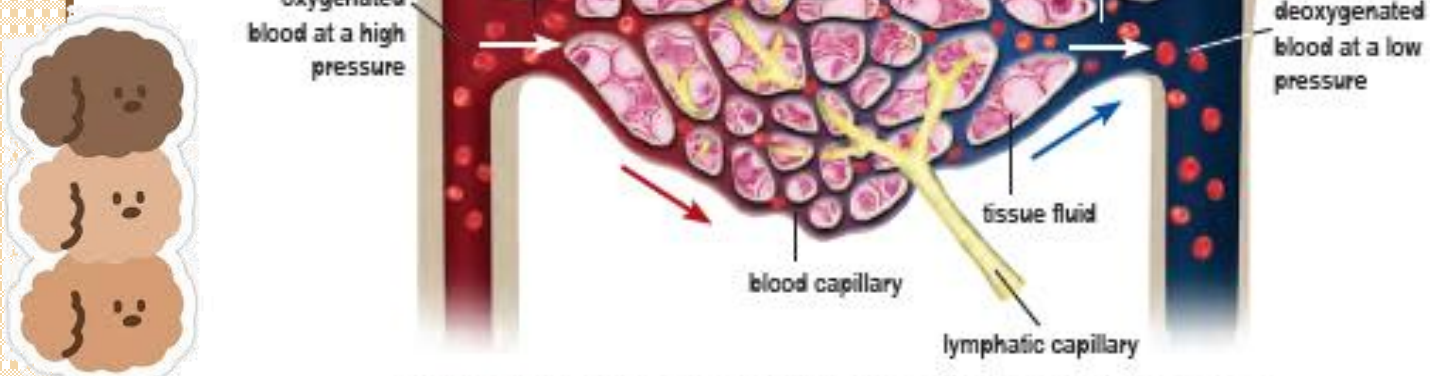

FIGURE 10.20 Exchange of substances between blood capillaries and body cells

3
- Blood plasma that occupies the intercellular space and constantly bathes cells is called **tissue fluid**.
- The tissue fluid does not contain any erythrocyte, platelet and plasma protein because these are too large to diffuse out of the blood capillaries.

4
- Tissue fluid allows the exchange of materials in the blood and cells to occur.
- Nutrients and oxygen diffuse from tissue fluid to body cells.
- Simultaneously, excretory products and carbon dioxide diffuse from body cells to blood capillaries through the tissue fluid.

COMPARISON BETWEEN BLOOD, INTERSTITIAL FLUID AND LYMPH

85% diffuses back to blood capillaries

15% to lymphatic capillaries

BLOOD ⟵ TISSUE FLUID ⟶ LYMPH

PERSAMAAN

Contains nutrients, hormones, enzymes, waste substances, respiratory gases and leucocytes

DIFFERENCES			
CONTENTS	BLOOD	INTERSTITIAL FLUID	LYMPH
CELLS	Erythrocytes, leucocytes and platelets	Some white blood cells	Lymphocytes
FATS	low	low	High
GLUCOSE	80 –120 mg per 100 cm3	Low	low
AMINO ACIDS	High	low	low
OXYGEN	high	low	low
CARBON DIOXIDE	low	High	High

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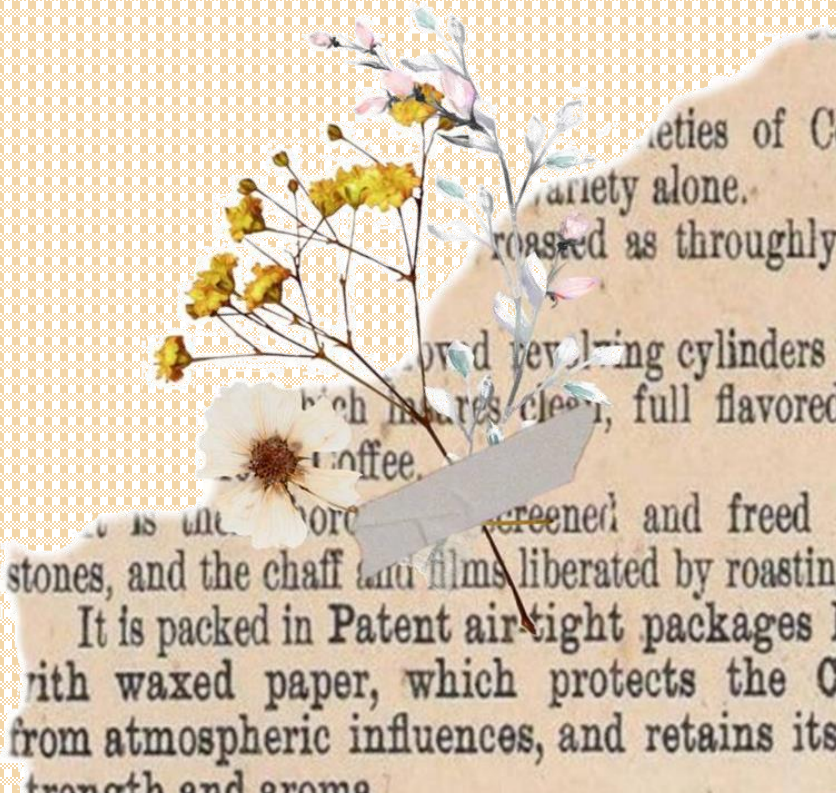
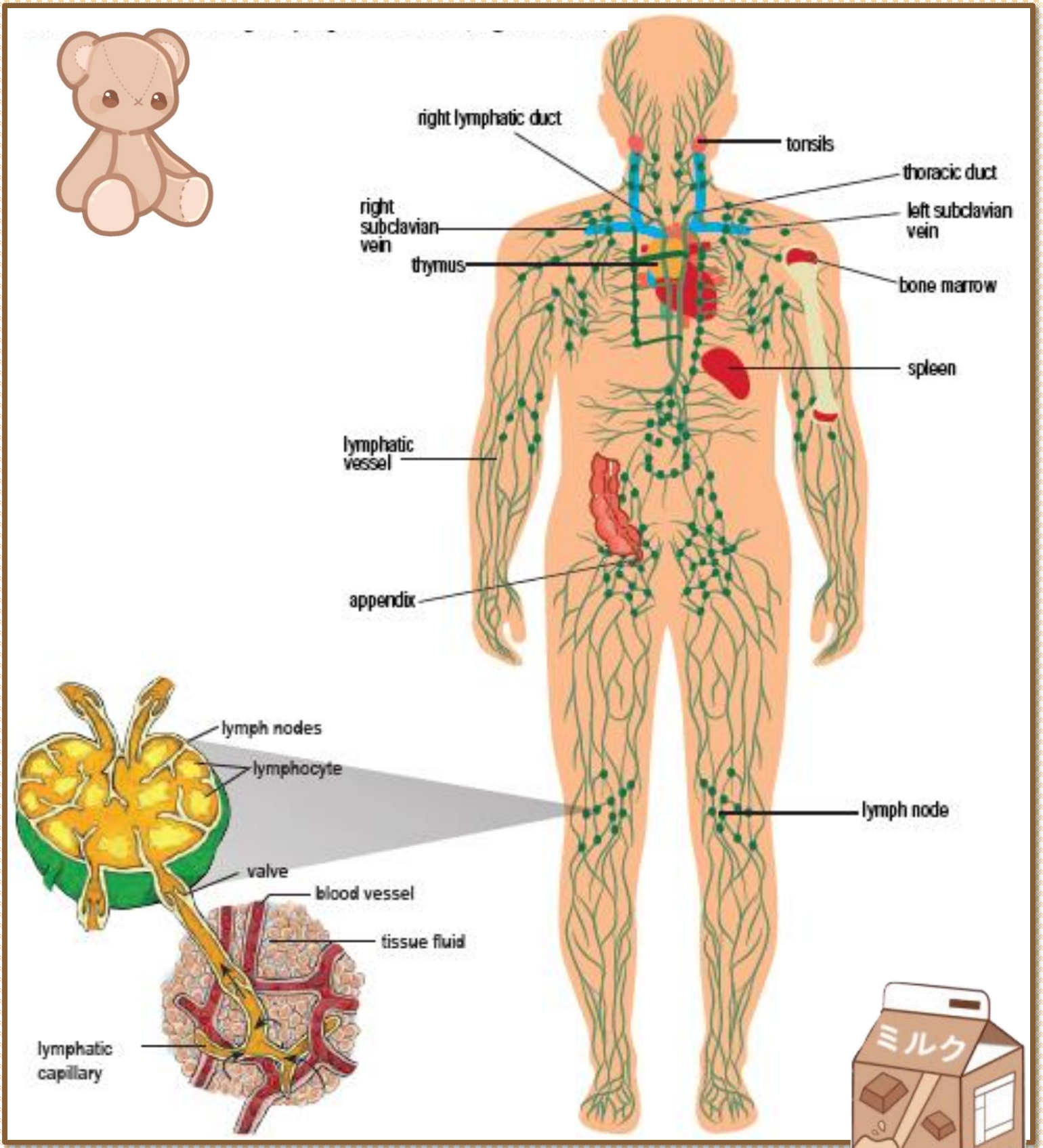


LYMPHATIC SYSTEM

- 8 structures in lymphatic system



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a) Two important lymphatic vessels in lymphatic system are:
   I. Duktus toraks
   II. Right lymphatic duct
b) Thoracic duct connects all the lymph vessels from the abdomen, thorax and left side of the body to the left subclavian vein
c) Right lymphatic duct connects all the lymph vessels from the right hand and right side of head to the right subclavian vein
d) Lymphatic vessels have thin walls, large lumens and more valves compared to blood vessels.
e) The presence of the valve in the lymphatic vessel is to ensure the flow of the lymphatic fluid is in one direction only and inhibits the return flow.
f) Lymphatic capillary receives lymph which is interstitial fluid through diffusion and would next flow to lymphatic ducts
g) Lymphatic nodes act as bacterial / microorganisms filter when the lymph passes through it .
h) Spleen is an organ that produces lymphocytes (body defence mechanism) and destroys red blood cells
i) Thymus and bone marrow work to produce white blood cells particularly lymphocytes

PEMBENTUKAN LIMFA

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- 85% of the interstitial fluid diffuses back into blood capillaries.
- 15% diffuses into lymphatic capillaries, producing lymph

Lymph nodes filter all bacteria // microorganisms when lymph flows through it.

Lymph flows into lymphatic vessels:
a) Thoracic duct
b) Right lymphatic duct

Lymph re-enters blood circulatory system.

RELATIONSHIP BETWEEN THE LYMPHATIC SYSTEM AND THE CIRCULATORY SYSTEM

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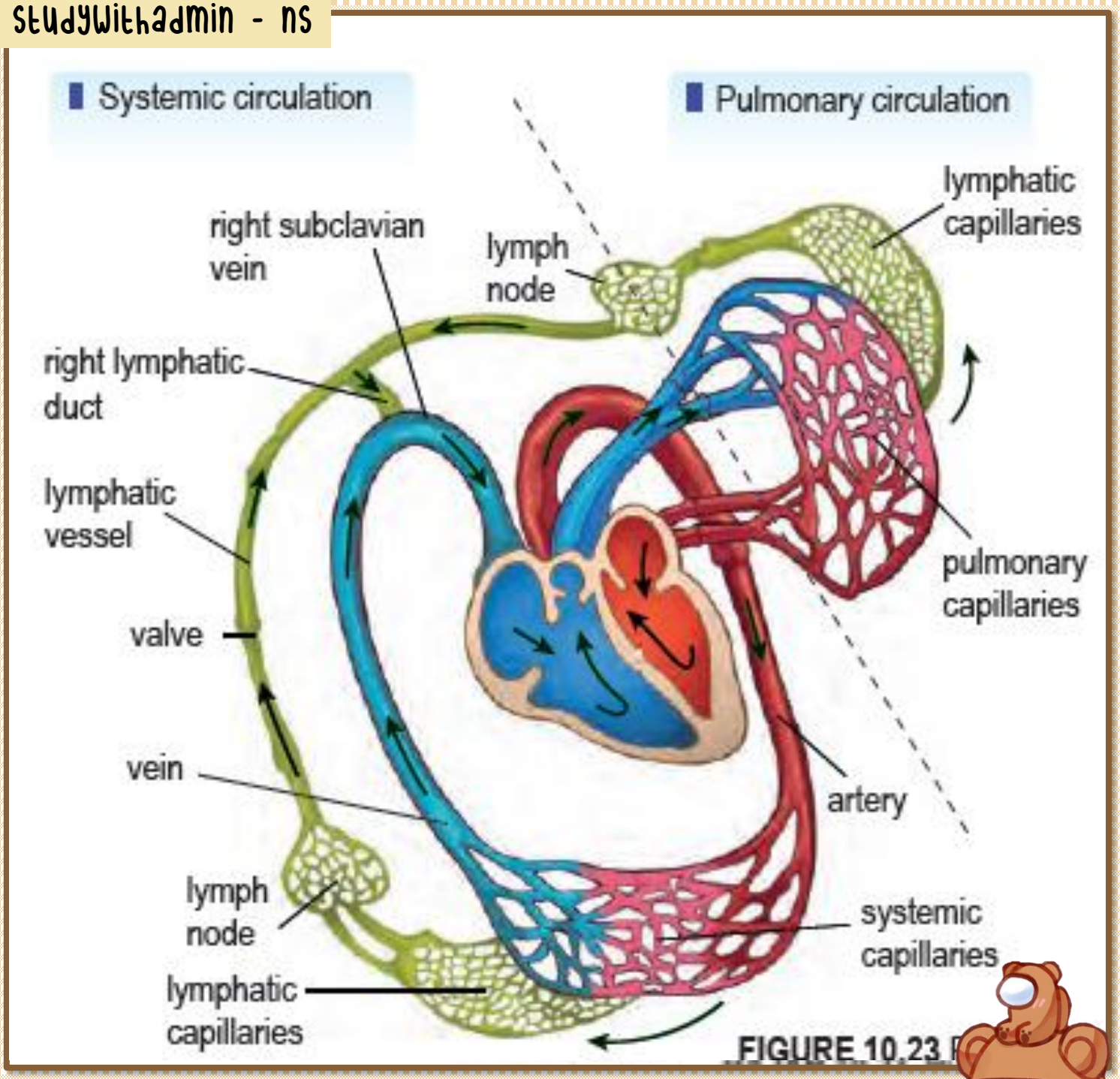

FIGURE 10.23

THE NEED OF THE LYMPHATIC SYSTEM

- Returning excess interstitial fluid into blood stream to maintain blood pressure and blood volume
- Transports lipid droplets and lipid soluble vitamins into bloodstream
- Transports lipid droplets and lipid soluble vitamins into bloodstream

10.8 HEALTH ISSUES RELATED TO THE HUMAN LYMPHATIC SYSTEM

CAUSES OF OEDEMA

PARASITIC INFECTION
DEFICIENCY IN PLASMA PROTEIN
PREGNANCY
PROLONGED BEDRIDDEN PATIENTS

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