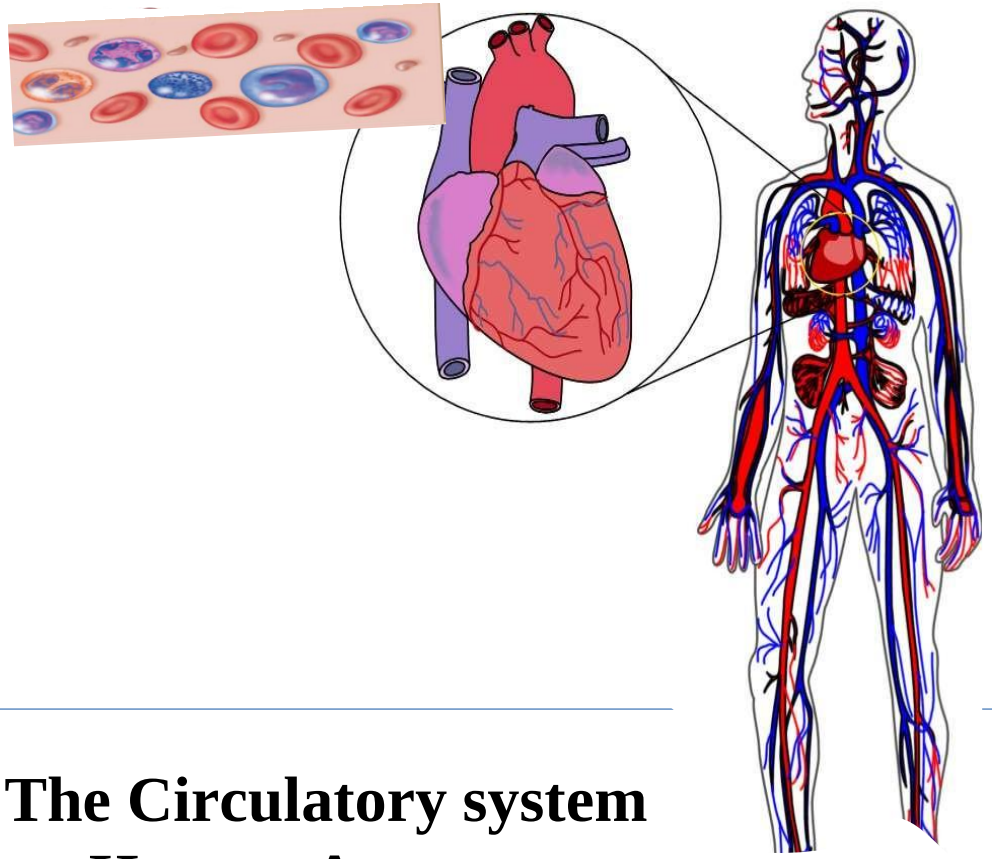


The Circulatory system
Human Anatomy

Assistant lecturer. Sawsan S. Hameed
Biology department

TIU
2021-2022

Objectives of this lecture

You should be able to describe the following;

- Functions of the circulatory system
- Anatomical structure of the circulatory system
- The components of circulatory system
- The three most basic categories of blood vessels
- The anatomical structures of blood vessels
- Blood composition and types of blood cells
- Anatomical structure of the heart

The circulatory system system introduction

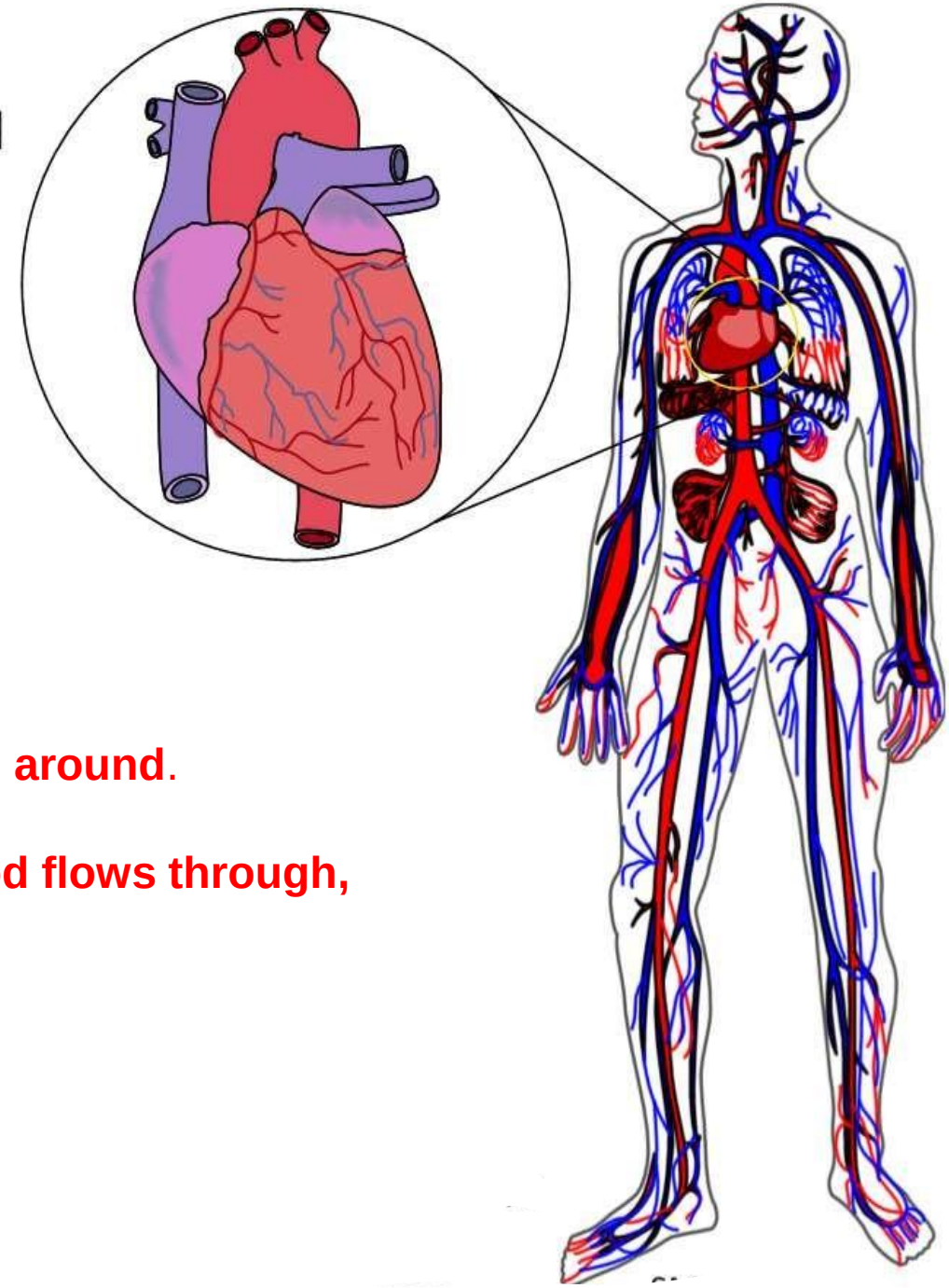
- Blood is denser and more viscous (thicker) than water and feels slightly sticky.
- The temperature of blood is 38°C (100.4°F), about 1°C higher than oral
- A slightly alkalline pH ranging from 7.35 to 7.45 (average = 7.4).
- The blood color varies with its oxygen content, it is bright red when saturated with oxygen, it is dark red when unsaturated.
- Blood constitutes about 20% of extracellular fluid, amounting to 8% of the total body mass.

The Circulatory System Functions

5 Major Functions of the Circulatory (Cardiovascular) System

- Transports oxygen to cells and collects carbon dioxide back.
- Transports nutrient and Transports waste product.
- Protection; white blood cells protect against disease by phagocytosis, antibodies, interferons, and complement.
- Healing; Blood clot (become gel-like), which protects against excessive blood loss after injury
- Transports hormone.
- Body temperature regulation.

The components of the circulatory system



The parts of the circulatory system are;

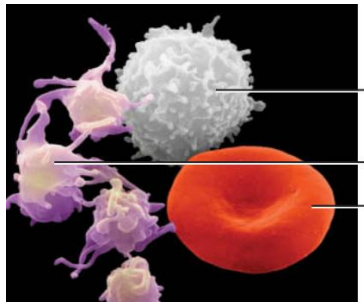
- **1. The blood**
  - **Plasma**
  - **Blood cells;**
    - **White blood cells**
    - **Red blood cells**
    - **Platelets**

- **2. The heart that pumps the blood around.**

- **3. The blood vessels that the blood flows through,**
  - **Arteries**
  - **Veins**
  - **Capillaries**

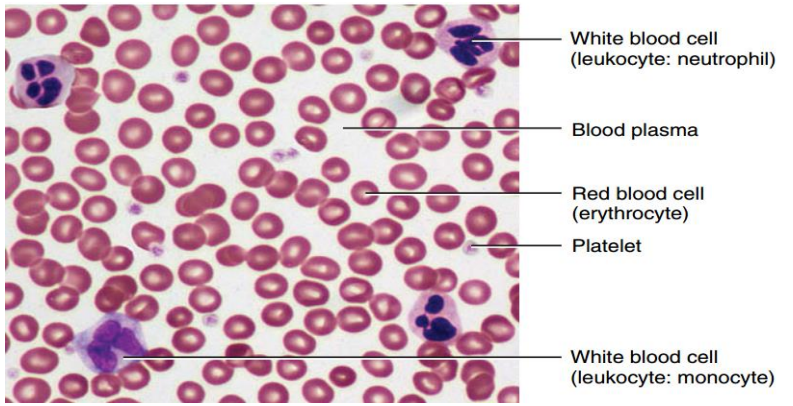
Blood is a connective tissue that consists of blood plasma (liquid) plus (red blood cells, white **blood cells**, and platelets).

Plasma light yellow liquid and the largest component of the blood
Dissolves or carries all other
components of blood, nutrients, wastes and hormones



Erythrocytes (Red blood cells)

Transport oxygen in haemoglobin molecule
It has a small, round, and biconcave shape cell lacks nucleus and give the blood its colour

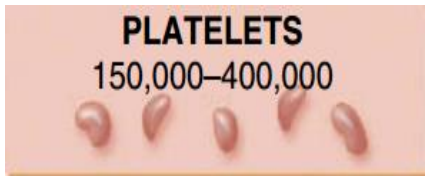


Leucocytes (White blood cells)

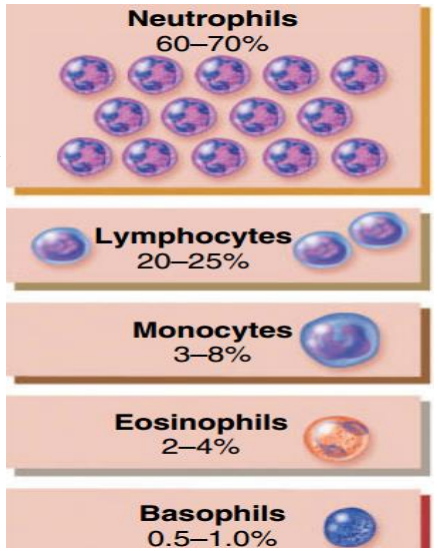
Phagocytes 'eat up' pathogens and dead cells.
Lymphocytes (B-cells, T-cells) for the immune
and it has single nucleus which is multilobed between 2 and 5 lobes.

Platelets

Clotting of blood following damage to cells or erythrocytes.



White blood Cells types



Blood vessel

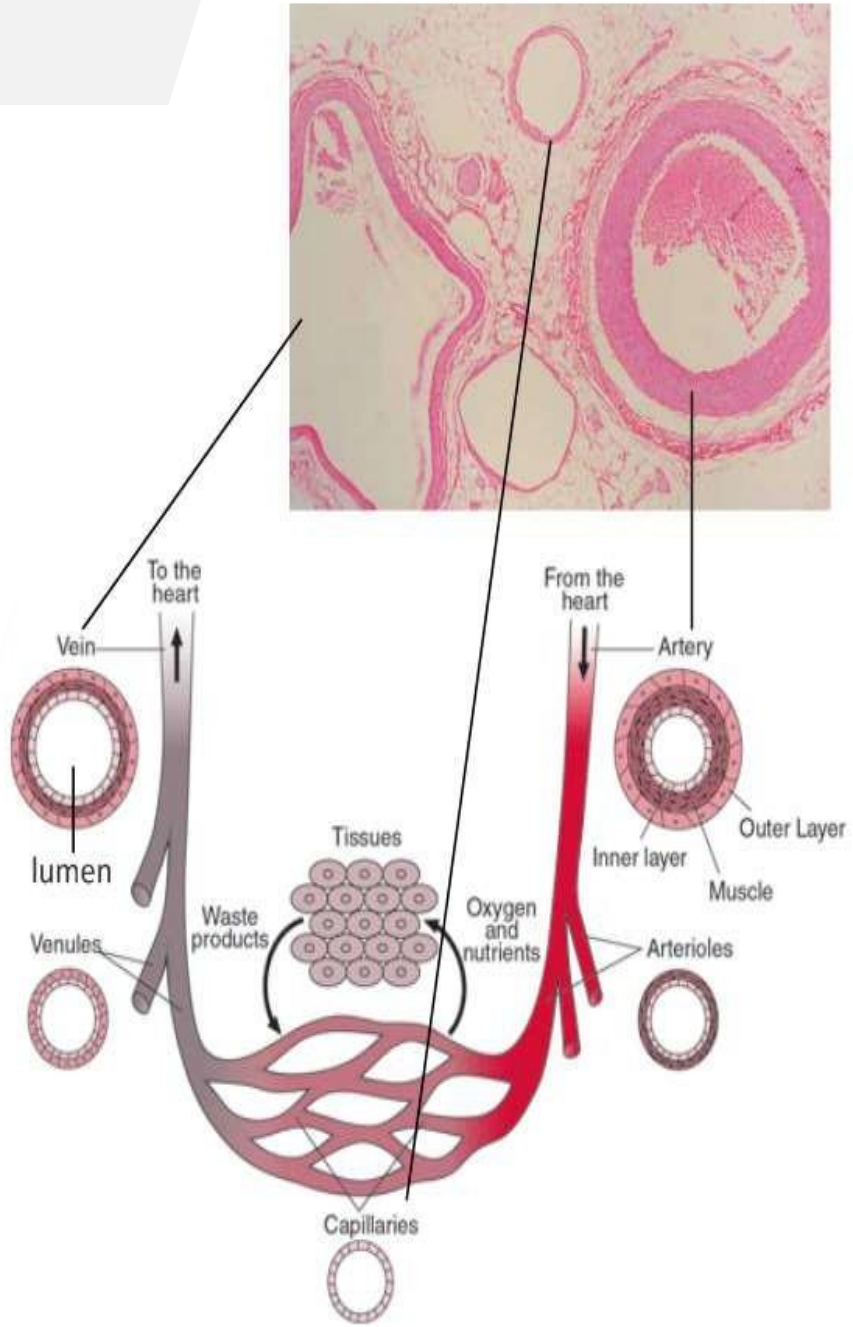
There are three main types of blood vessel:

Arteries; blood vessels that carry high pressure blood away from the heart to tissues that need it

Capillaries are very small blood vessels (< 10 µm diameter) so that it can penetrate every tissue in the body. Blood moves slowly through them under low pressure providing opportunities for the exchange of substances.

Veins blood vessels that carry low pressure blood back to the heart using valves to ensure blood flows in the correct direction.

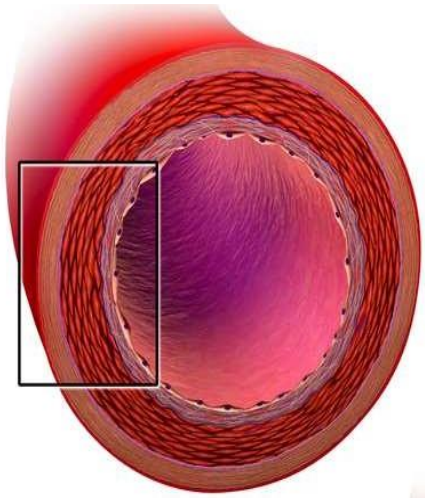
Arteries and veins are the names for large structures, smaller arteries are known as arterioles and correspondingly smaller veins are venules.



The anatomical structure of arteries

- Arteries convey blood at high pressure from the ventricles to the tissues of the body.
- Arteries have **muscle** cells and elastic fibres in their walls.
- The muscle and **elastic fibres** assist in maintaining blood pressure between pump cycles.

Thick muscular wall and fibrous outer layer help the artery to withstand high pressure



Muscle contracts to decrease the size of the lumen. This causes an increase blood pressure and therefore maintains high blood pressure between the pulses of blood travelling from the heart.

Elastic fibres stretch to increase the lumen with each pulse of blood. After the pulse of blood passes the fibres recoil decreasing the lumen size and therefore helping to maintain a high blood pressure.

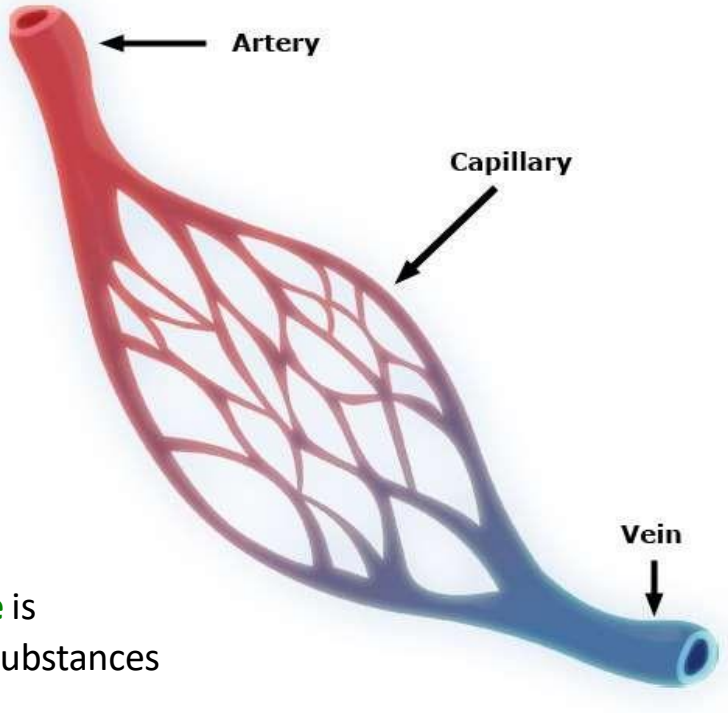
Relatively, **thick walls** and **small lumen, more Elastic fibres to** maintains **high blood pressure**.

The anatomical structure of capillaries

Capillaries are the smallest blood vessels and are adapted for the exchange of substances to and from the blood.

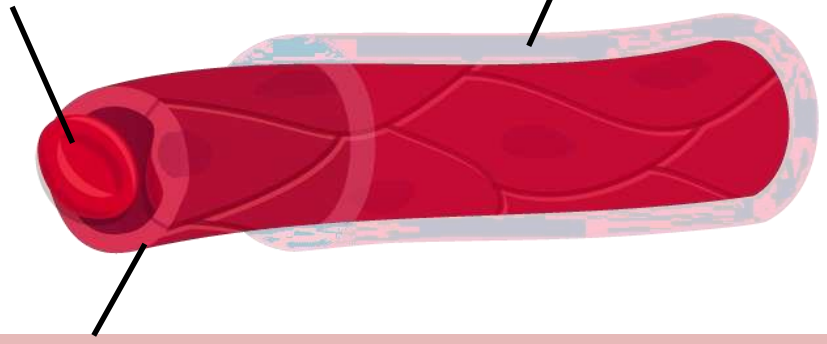
This enables tissues to gain nutrients and molecules such as oxygen and to rid themselves of waste material.

Capillaries also allow substances to enter and leave the organism, e.g. gas exchange of oxygen and carbon dioxide in the lungs.



Blood travels **slowly** under **low pressure** allowing more opportunity for exchange.

Basement membrane is **permeable** to many substances



Wall is one cell thick allows easy diffusion of substances in and out of the capillary due to the short diffusion distance.

The walls and membrane can contain **pores** to further aid the diffusion of substances

The massive number of capillaries networks spresent and the small lumen is to increase the surface area for the exchange of substances

Blood flows through capillaries to reach tissues.
Capillaries have permeable walls that allow exchangeof materials between cells in the tissue and the blood in thecapillary.

The anatomical structure of veins

Veins collect blood at low pressure from the tissues of the body and return it to the atria of the heart. Valves in veins and the heart ensure circulation of blood by preventing backflow.

Veins return blood to the heart for re-circulation.

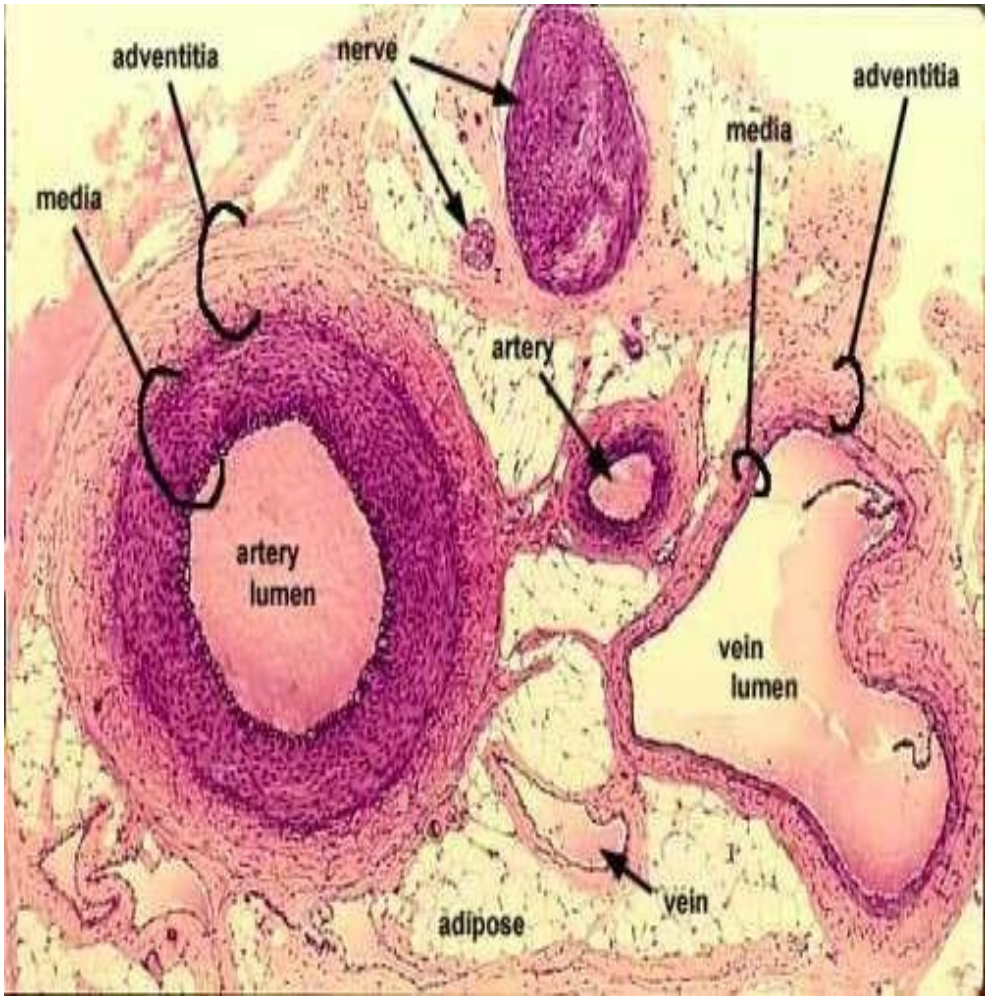
The **large lumen** means that the blood is under **low pressure**.

Because there is less pressure to resist the **walls of the veins are thinner and less elastic** than arteries.

They also contain **less muscle** than the arteries.

Relatively, **thin walls** and **large lumen, less elastic fibres, low blood pressure**.

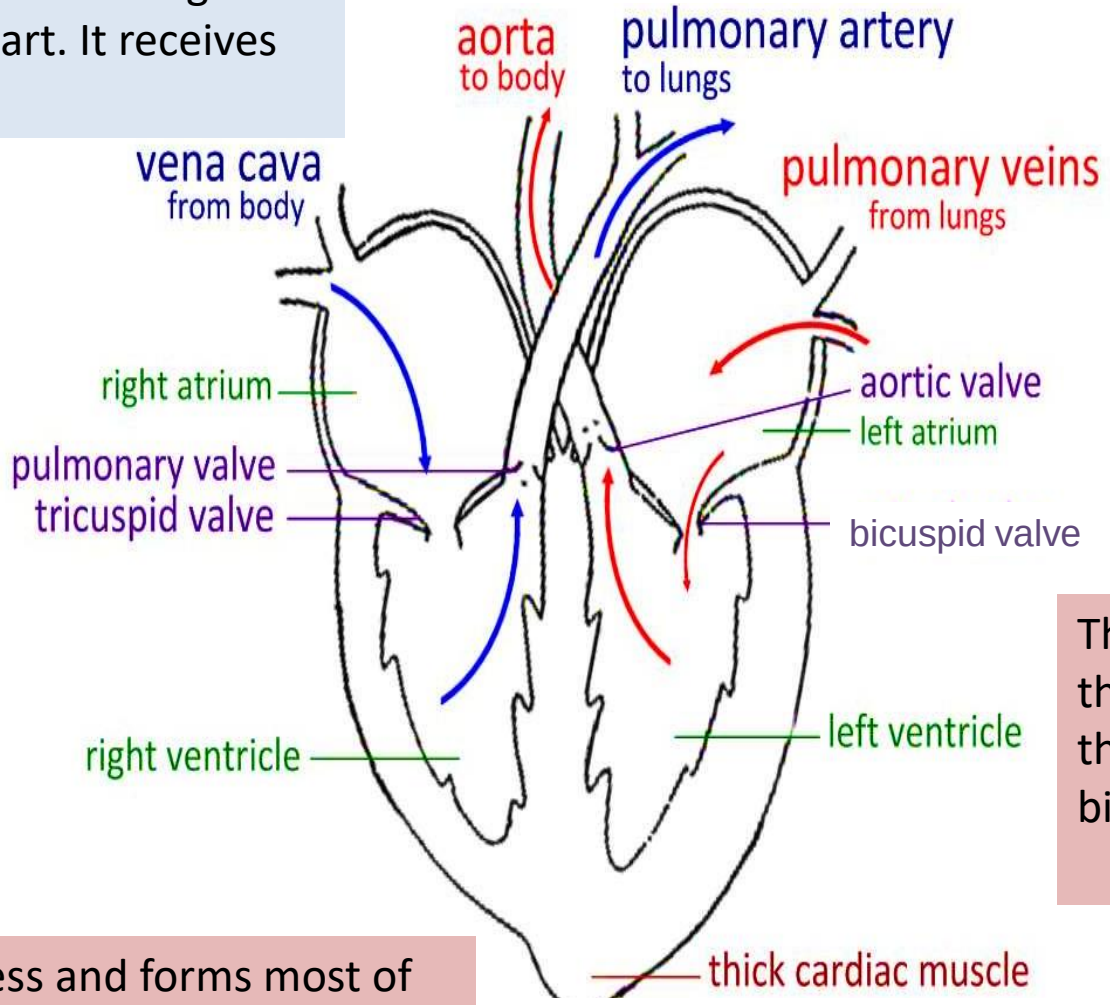
Because of the low pressure **valves are required to prevent back-flow of the blood** and therefore ensure that the blood moves towards to heart.



The Heart

The right atrium average thickness and forms the right surface of the heart. It receives blood from veins

The inside of the **posterior** atrium wall is smooth; the inside of the **anterior** wall is rough due to the presence of muscular ridges



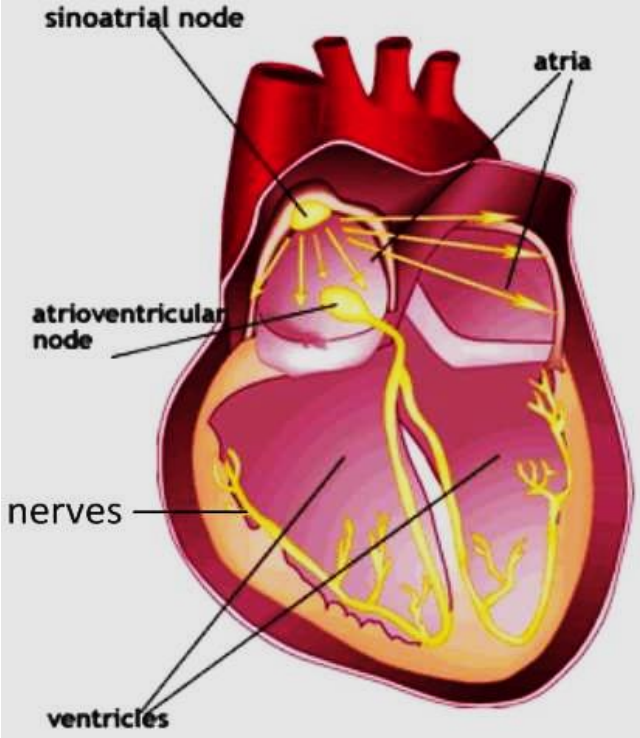
The left atrium is about the same thickness as the right atrium and forms most of the base of the heart

The left ventricle is the thickest chamber of the heart, and has the bicuspid valve

Average thickness and forms most of the anterior surface of the heart. Has the the tricuspid valve

- The heart beat is initiated by a group of specialized muscle cells in the right atrium called the **sinoatrial node (pacemaker)**.
- The sinoatrial node sends out an electrical signal that stimulates contraction of the walls of the atria and then its propagated through the walls of the ventricles.

Beating of the heart is due to myogenic muscle contraction.



http://www.mda.org/publications/Quest/q106resup.html

This means the myocyte (muscle cell) itself is the origin of the contraction and is not controlled externally.

A region of myocytes called the sinoatrial node (pacemaker) controls the rate of the heartbeat.

A wave of excitations is sent from the sinoatrial node, causing the atria to contract. This excitation is conducted to the atrioventricular node, where it is passed through nerves to the muscles of the ventricles, causing them to contract.

Myogenic initiation of the contraction means that the heart does n stop beating - it is not a conscious process.

The thin-walled atria deliver blood under less pressure into the adjacent ventricles. Because the ventricles pump blood under higher pressure over greater distances, their walls are thicker

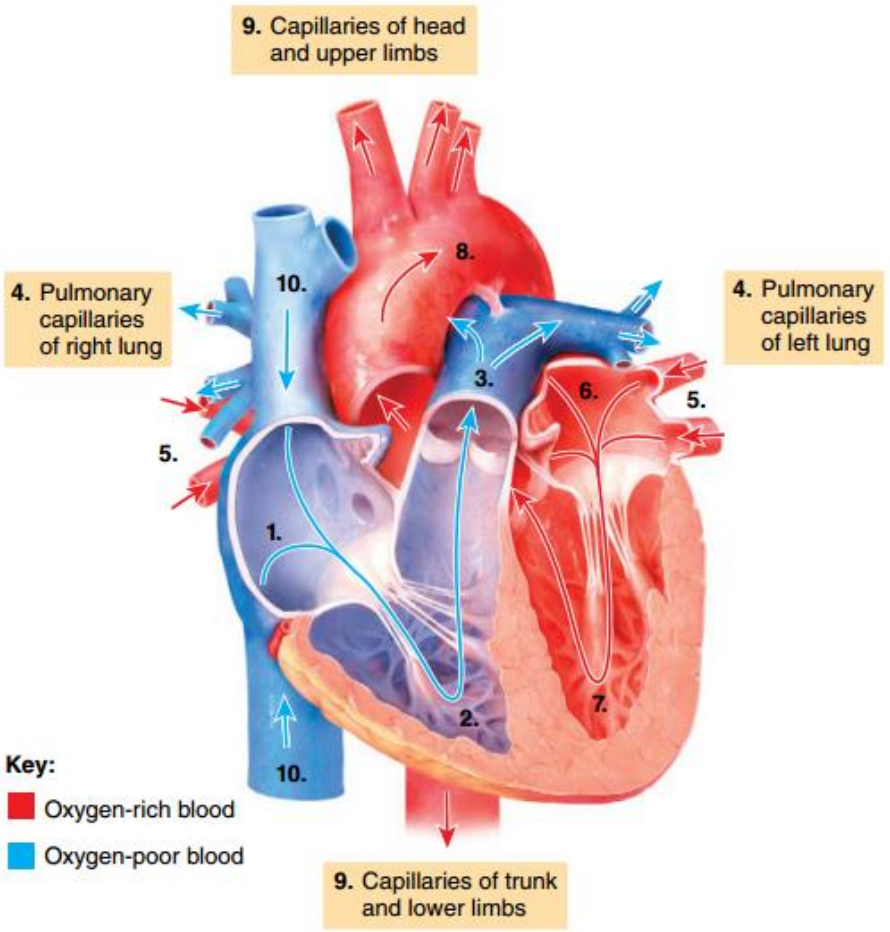
Although the right and left ventricles act as two separate pumps that simultaneously eject equal volumes of blood, the right side has a much smaller workload. It pumps blood a short distance to the lungs at lower pressure, and the resistance to blood flow is small.

The left ventricle pumps blood great distances to all other parts of the body at higher pressure, and the resistance to blood flow is larger. Therefore, the left ventricle works much harder than the right ventricle to maintain the same rate of blood flow.

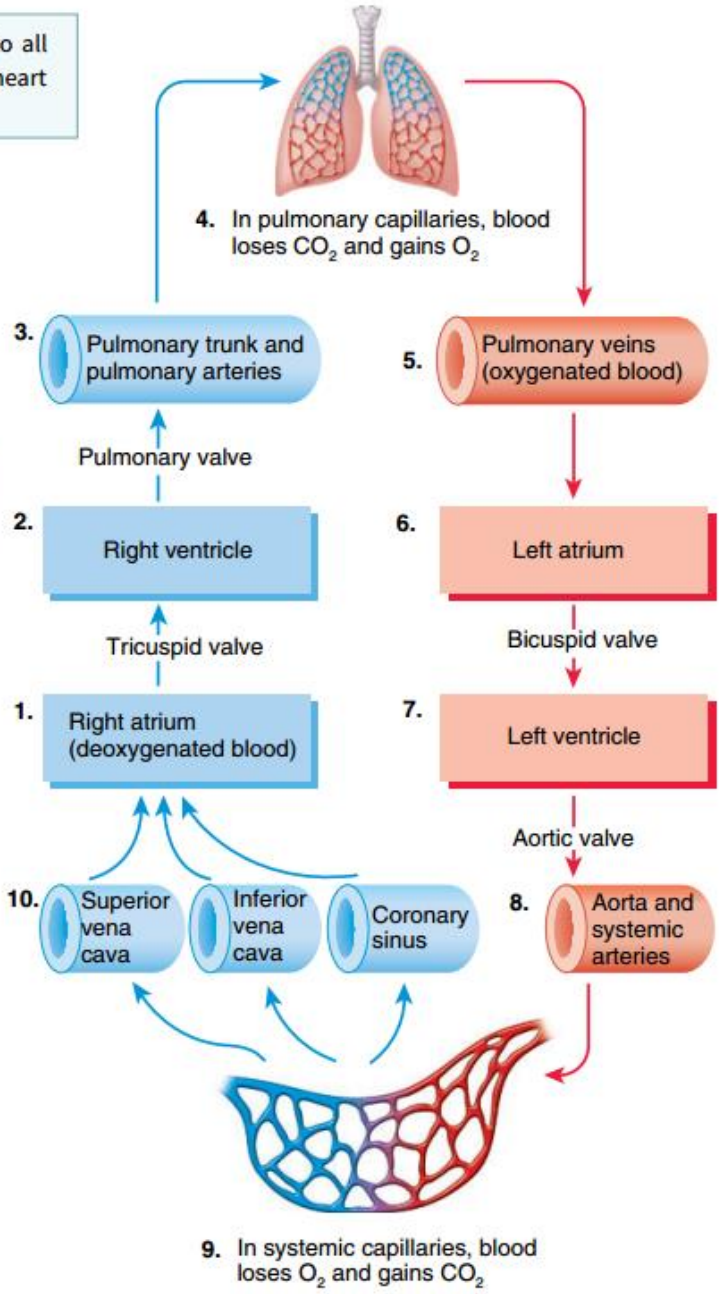
The anatomy of the two ventricles confirms this functional dif erence—the muscular wall of the lef ventricle is considerably thicker than the wall of the right ventricle

FIGURE 20.7 **Systemic and pulmonary circulations.**

The left side of the heart pumps oxygenated blood into the systemic circulation to all tissues of the body except the air sacs (alveoli) of the lungs. The right side of the heart pumps deoxygenated blood into the pulmonary circulation to the air sacs.



(a) Path of blood flow through heart

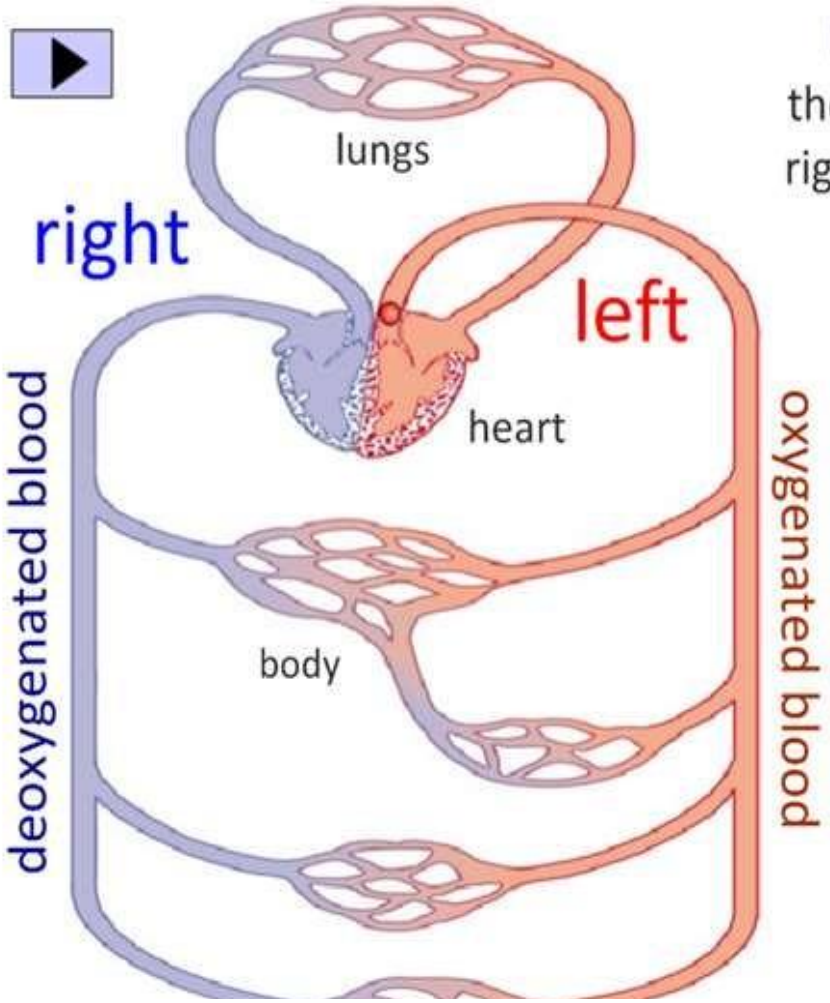


(b) Path of blood flow through systemic and pulmonary circulation

Q Which numbers constitute the pulmonary circulation? Which constitute the systemic circulation?

Double Circulation

Blood passes through the heart twice on one circuit of the body.



Deoxygenated blood (low O_2, high CO_2) returns to the heart via the right atrium. It is pumped from the right ventricle to the lungs, where carbons dioxide is offloaded and oxygen is picked up.

It is now oxygenated blood (high O_2, low CO_2).

Oxygenated blood enters the left atrium and is pumped from the left ventricle to the body, where oxygen is used for respiration and carbon dioxide is collected as a waste product.

And now it's deoxygenated, it makes its way back to the right atrium and the cycle continues.

http://www.kscience.co.uk/animations/blood_system.swf

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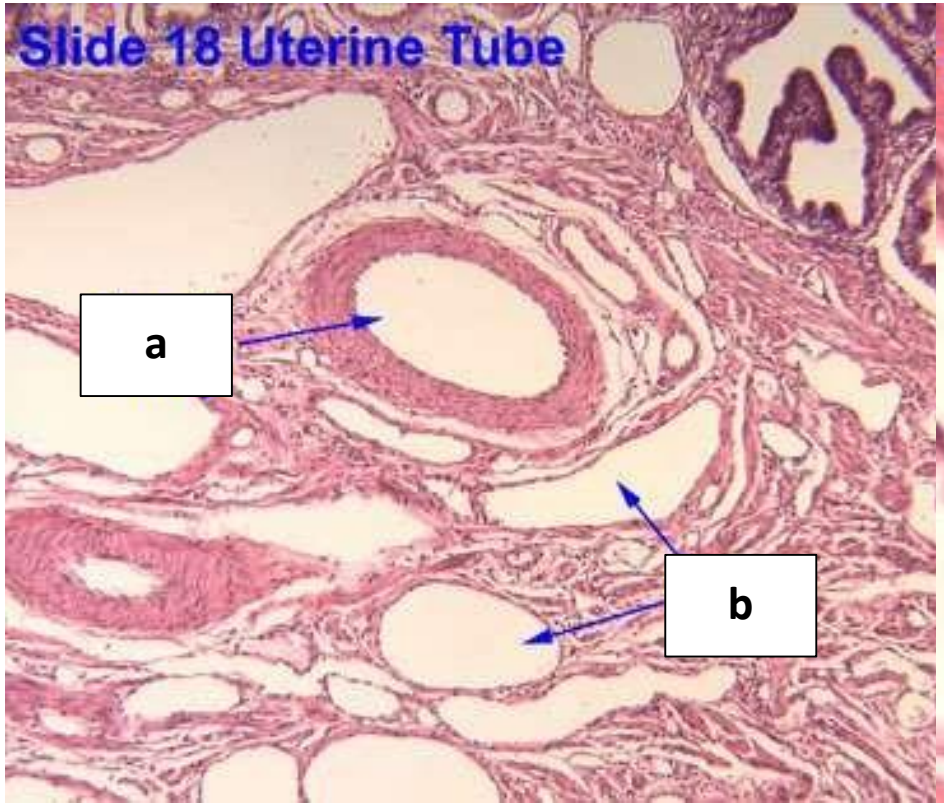
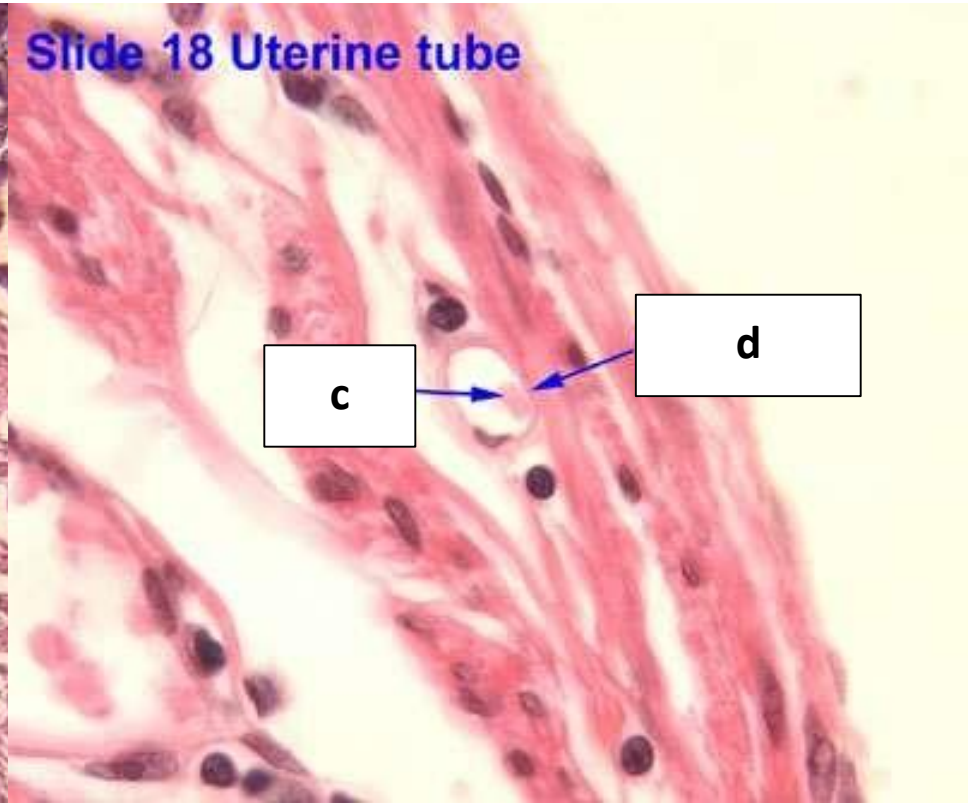
Q&A

- Explain the functions of blood.
- Describe the physical characteristics and principal components of blood.
- What substances does blood transport?
- List the elements in blood plasma and describe their functions

Identify the labelled structures using your understanding of blood vessels.





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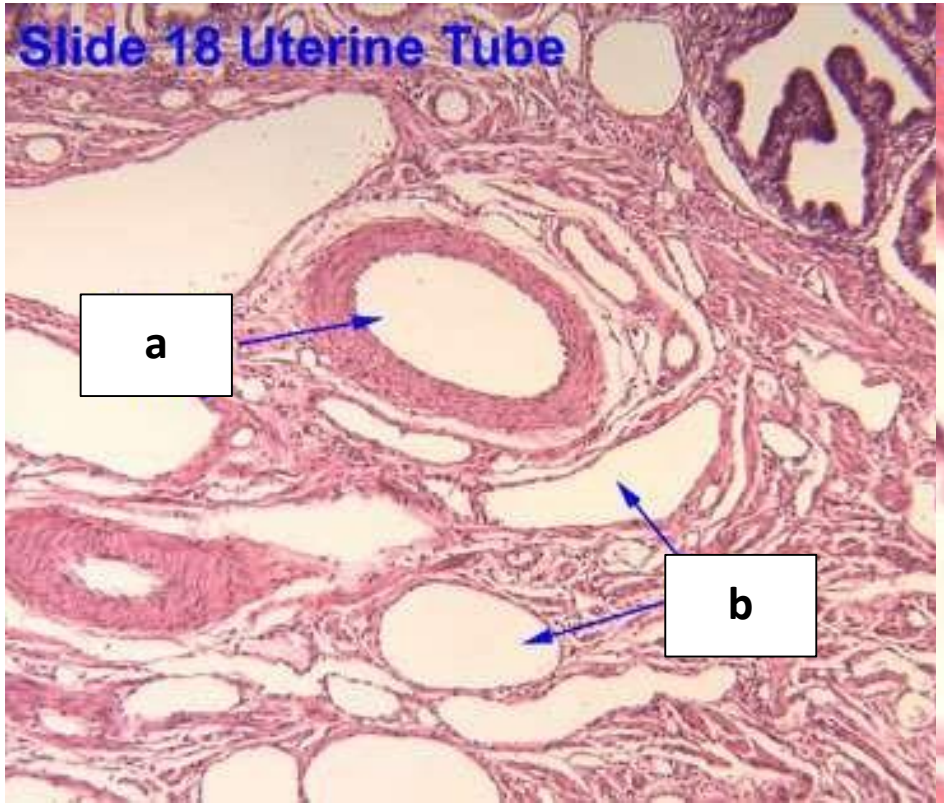

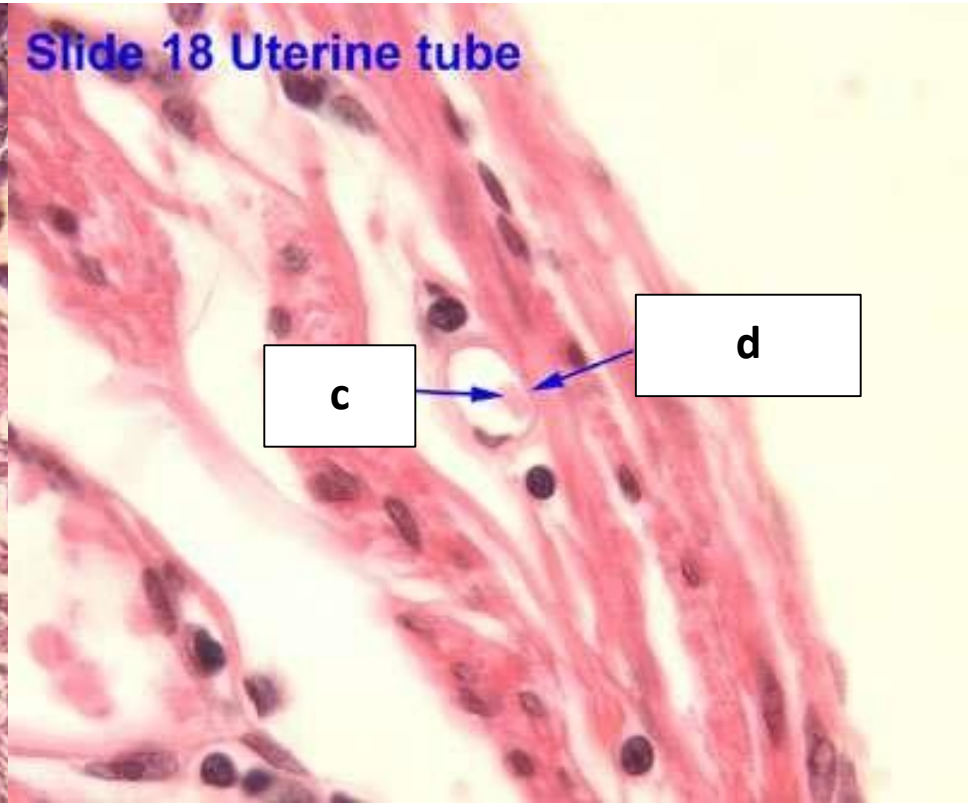

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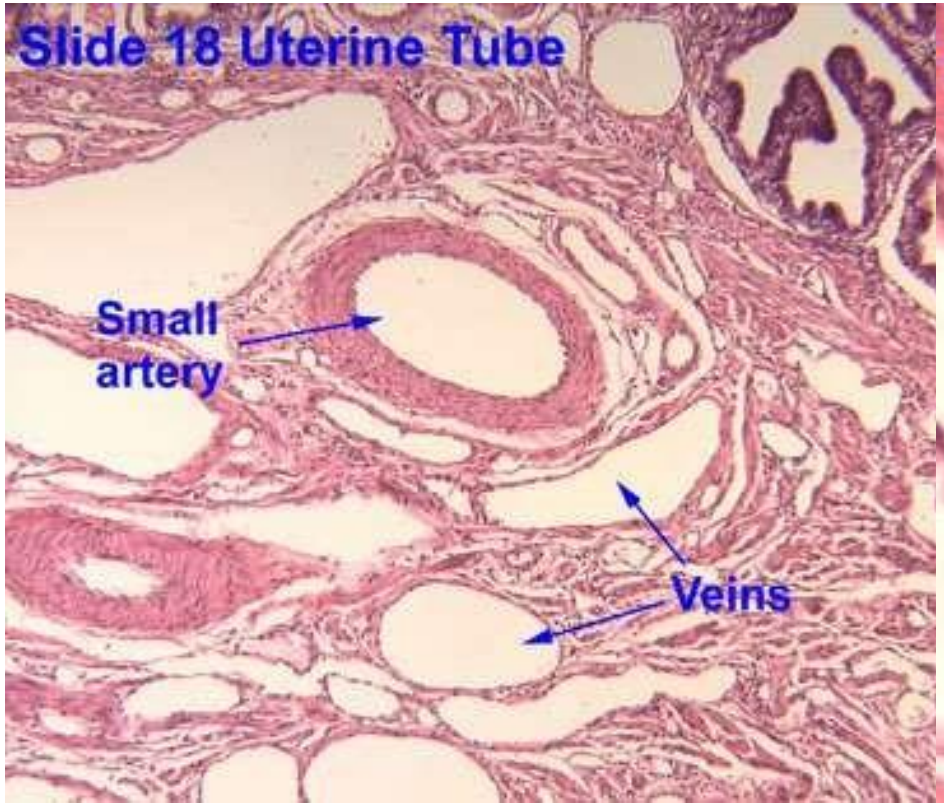

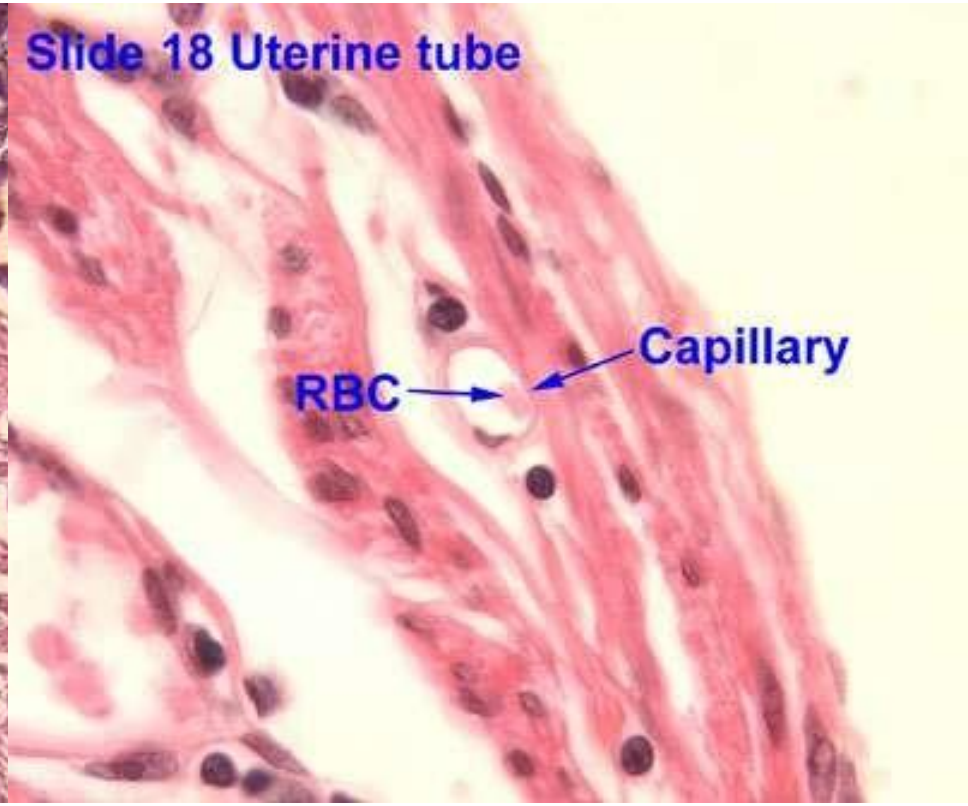

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