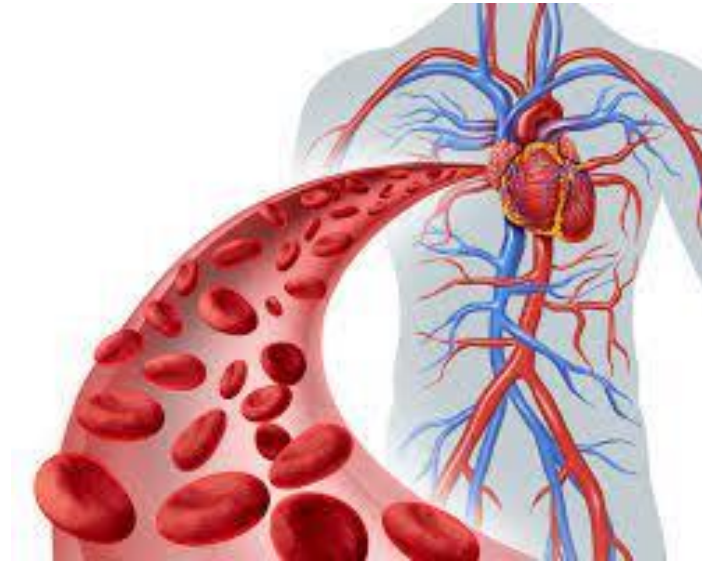




3.2 Blood and Circulation



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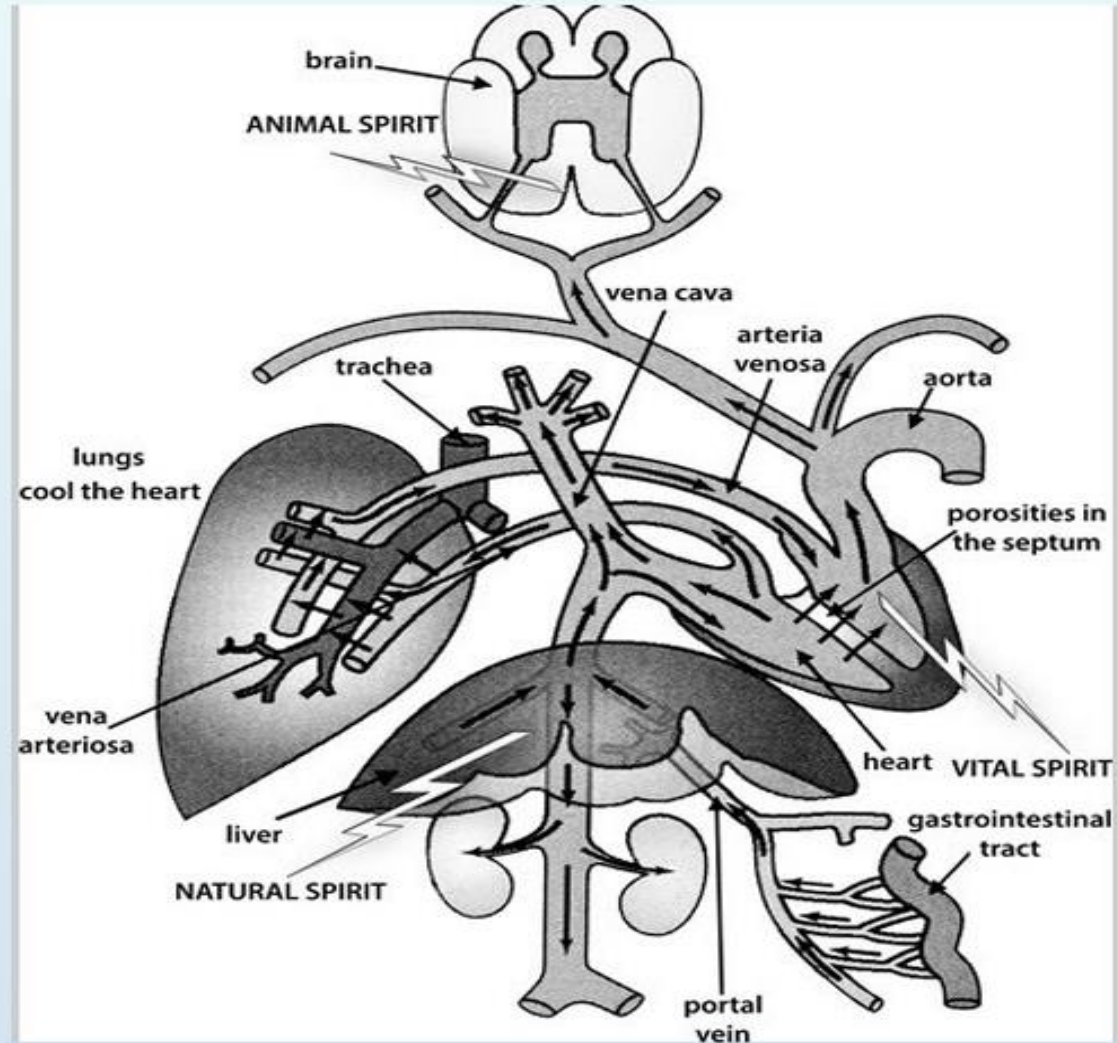
معتمدة من

Blood was thought to flow away from the heart carrying vital spirit to the organs

In 169AD Galen said that blood was made in the liver and the heart.

This diagram shows blood flowing from the heart and liver to the organs of the body as Galen described.

This illustrates 15th century ideas about blood flow.



Blood is circulated around the body in tubes called blood vessels. The heart is the organ that pumps blood throughout the body.

The heart, blood and blood vessels make up the circulatory system. The function of the circulatory system is to transport oxygen and nutrients to all body cells and carry away waste products.

<https://www.youtube.com/watch?v=73ei6YD0VnM> introduction

<https://www.youtube.com/watch?v=cYMEp80rwHE>

Blood <https://www.youtube.com/watch?v=81w0BXg7QJA>

Blood is a transport fluid that delivers necessary substances to cells including oxygen, and nutrients such as amino acids, and carries waste products such as carbon dioxide and urea.

Blood is composed of the following:

- **Plasma**, which is a clear, yellowish liquid made up mainly of water. It also contains substances as proteins, hormones, salts and sugars.

(It transports blood cells, ions, soluble nutrients, hormones and carbon dioxide)

- **Red blood cells** (erythrocytes), which make up around 40% of blood volume. Red blood cells are formed in the bone marrow. Their life span is about 120 days and therefore must be constant formed. Their main function is to transport oxygen to cells and carry away carbon dioxide.

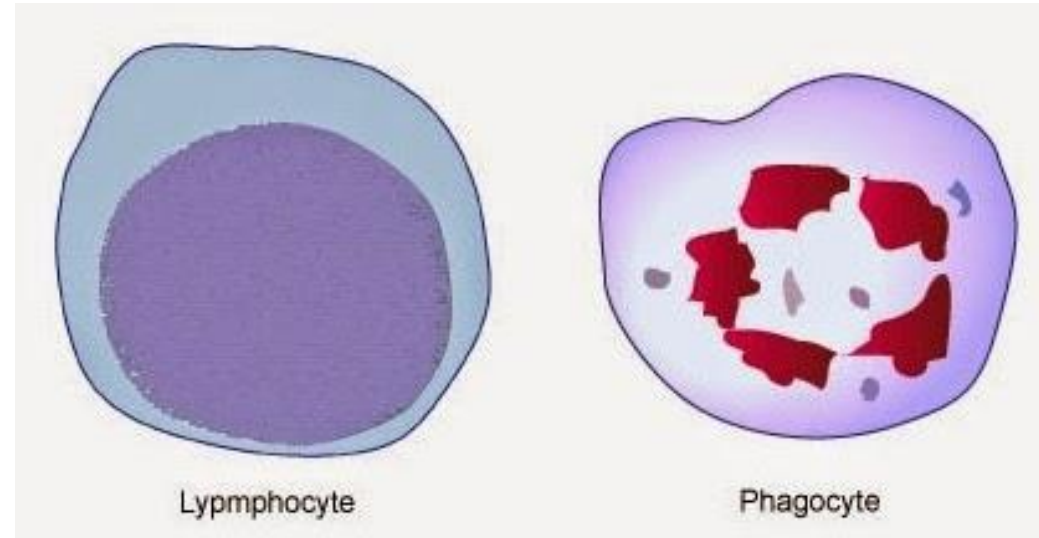
Red blood cells also transport waste such as carbon dioxide back to our lungs to be exhaled. Red blood cells can carry oxygen due to a protein called hemoglobin.

- **White blood cells** (leukocytes), which have major role in the body's immune response. They are essential to protect the body against foreign particles such as bacteria and viruses by producing antibodies.

- **Platelets**, which are the smallest cells in blood. They have a major role in blood clotting and control of bleeding.



Red blood cells & white blood cells



Lymphocyte

Phagocyte

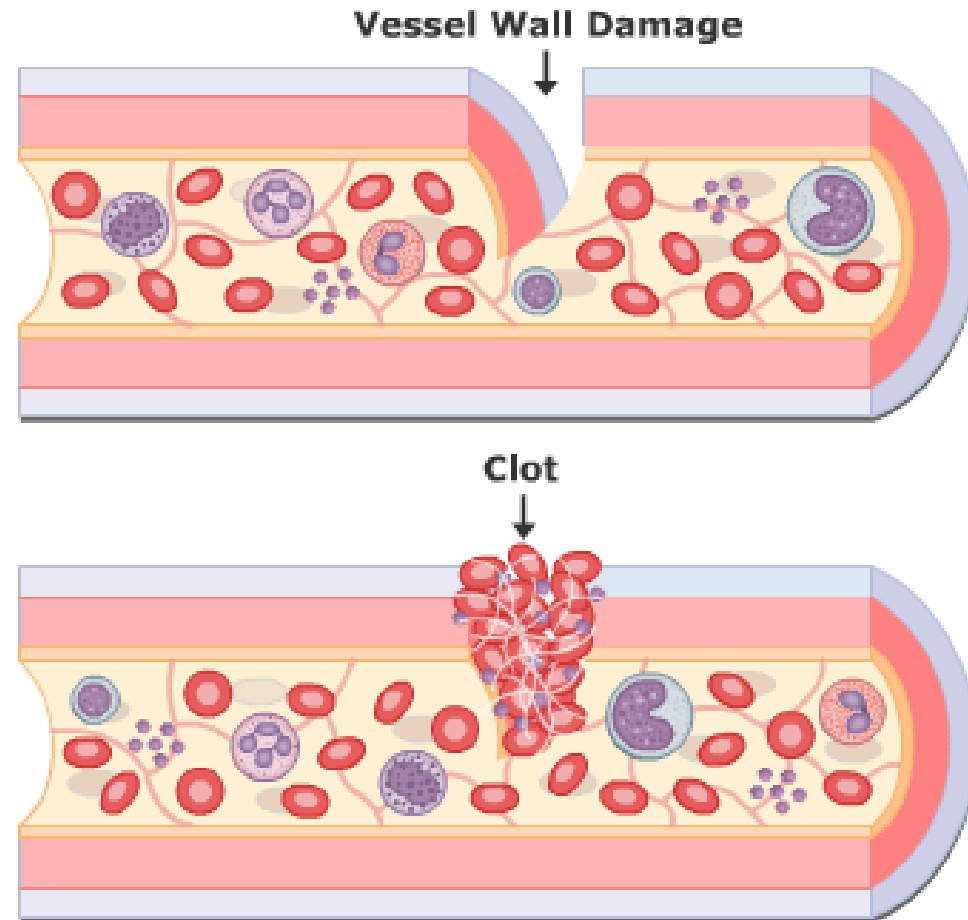


White blood cells



Blood Clotting https://www.youtube.com/watch?v=HFNWGCx_Eu4

- **Blood Clotting** : When there is a cut or damage in the skin or in any capillary under the skin or in the body (or when platelets are exposed to air), platelets are stimulated to produce an enzyme.

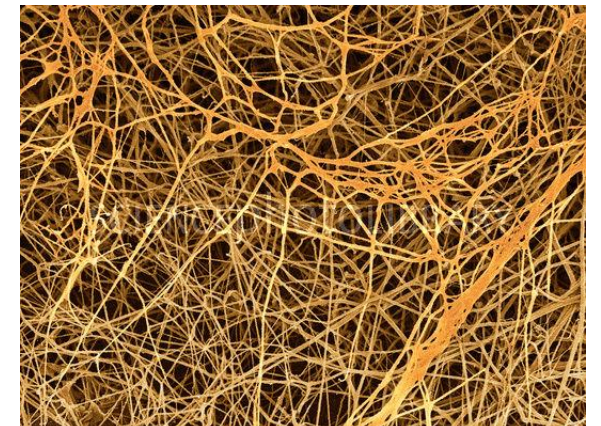
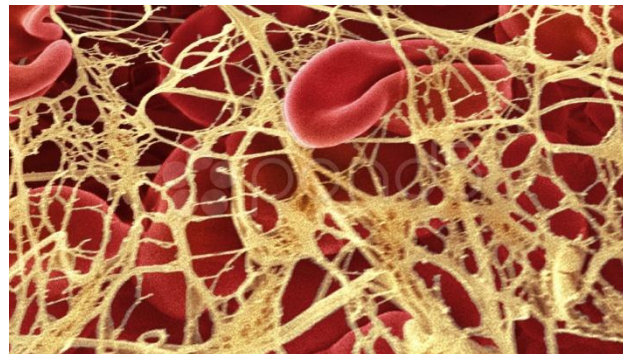
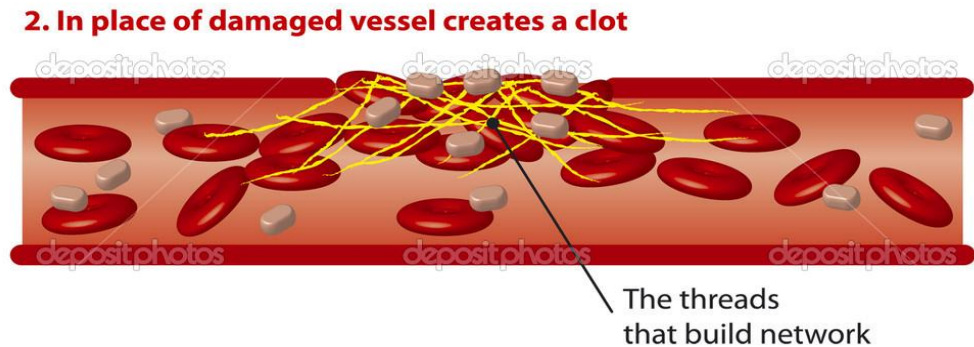
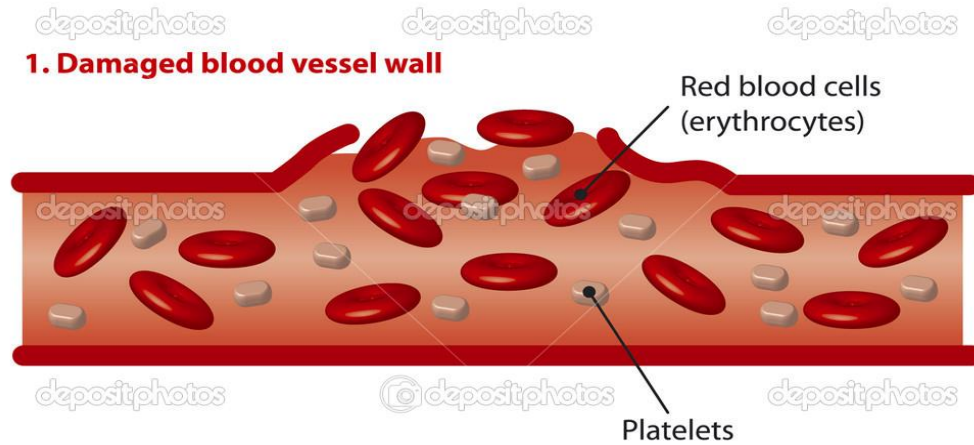


- **Thrombin** (active enzyme) in the presence of **calcium ions**. The active thrombin works on a soluble protein called **fibrinogen** and converts it into fibrin which is **insoluble**. The insoluble fibrin and the trapped cells make a mesh which prevents

- 1) **excess bleeding**
- 2) **prevents the entrance of pathogens** from the cut or injury.

After a time the mesh dries making a scab which protects the damaged tissue while the new skin grows

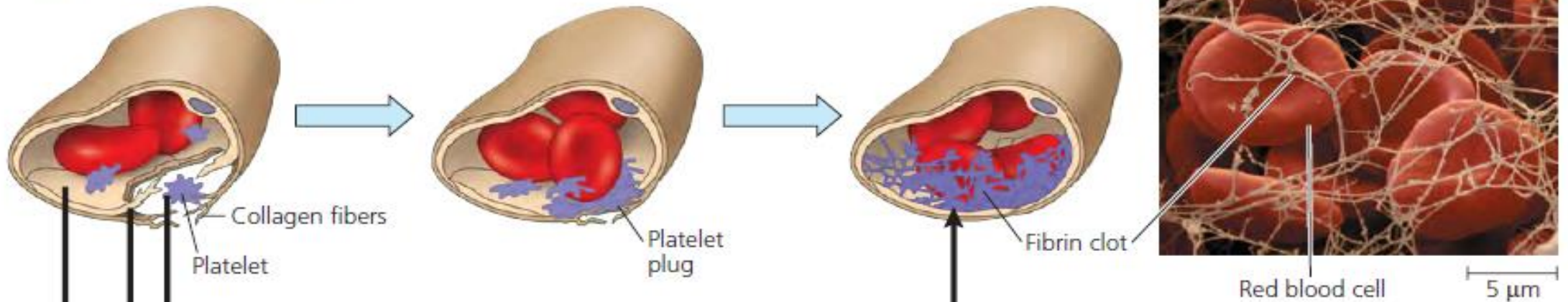
Formation of a blood clot



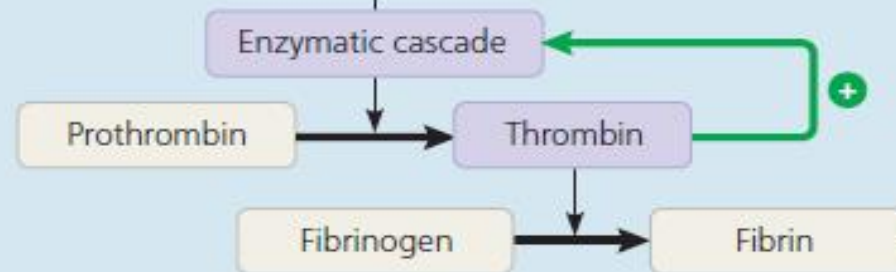
1 The clotting process begins when the endothelium of a vessel is damaged, exposing connective tissue in the vessel wall to blood. Platelets adhere to collagen fibers in the connective tissue and release a substance that makes nearby platelets sticky.

2 The platelets form a plug that provides emergency protection against blood loss.

3 This plug is reinforced by a fibrin clot when vessel damage is severe.



Clotting factors from:
Platelets
Damaged cells
Plasma (factors include calcium, vitamin K)



Fibrin clot formation

Clotting factors released from the clumped platelets or damaged cells mix with clotting factors in the plasma, forming an enzymatic cascade that converts a plasma protein called prothrombin to its active form, thrombin. Thrombin itself is an enzyme that catalyzes the final step of the clotting process, the conversion of fibrinogen to fibrin. The threads of fibrin become interwoven into a clot (see colorized SEM above).



The clot develops into a scab which protects the damaged tissue while new skin grows

- The blood clots dry and form a scab, which protects the tissue underneath from pathogens

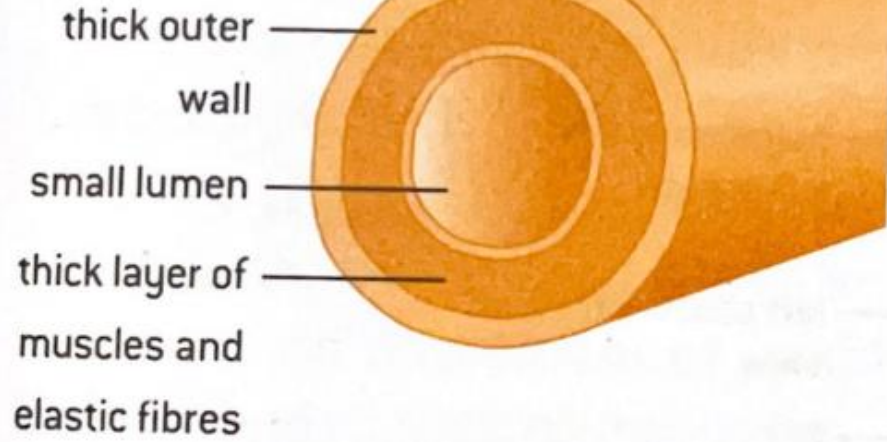
Blood vessels

Blood vessels are tubes in which blood circulates around the body.

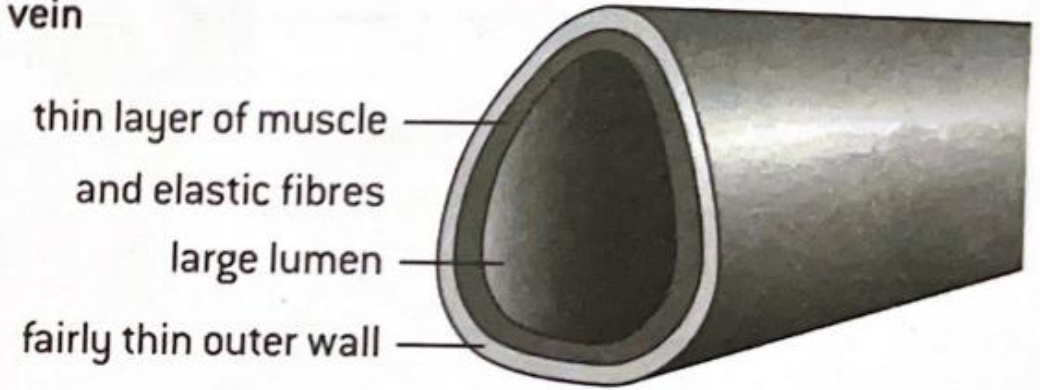
There are three main types of blood vessels (figures 9 and 10):

- **Arteries**, which carry blood away from the heart. Arteries branch into small vessels called arterioles. Arteries have thick muscular walls to withstand the high pressure of blood. They also have a narrow lumen (internal passageway).
- **Veins**, which carry blood to the heart. Veins branch into small vessels called venules. Veins have thinner walls and a larger lumen than arteries. The blood they contain is at low pressure. Veins also have valves to prevent the backflow of blood.
- **Capillaries**, which are the very thin vessels that connect the arterioles and the venules. They are one cell thick to allow for the exchange of materials between cells in the tissue and the blood in the capillary. For example, oxygen diffuses from the capillary into the tissue and carbon dioxide diffuses from the tissue into the capillary.

a) an artery



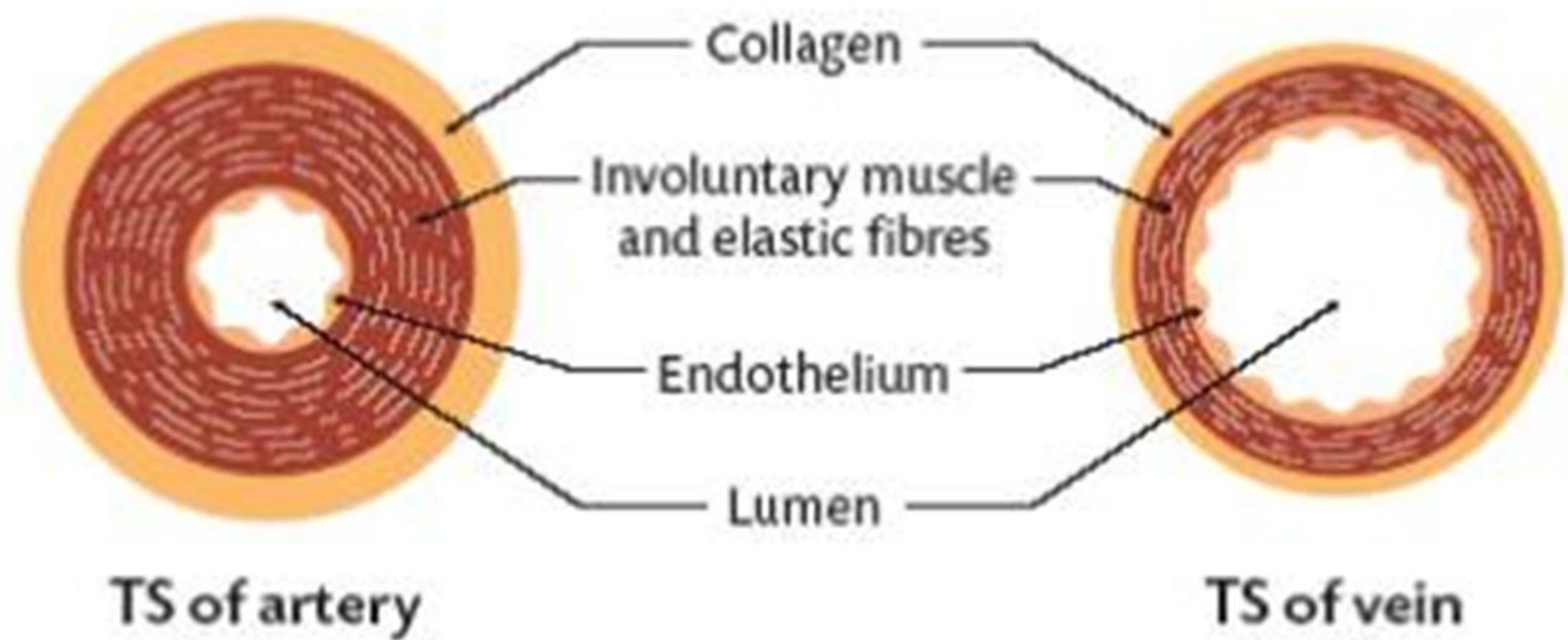
b) a vein



c) a capillary

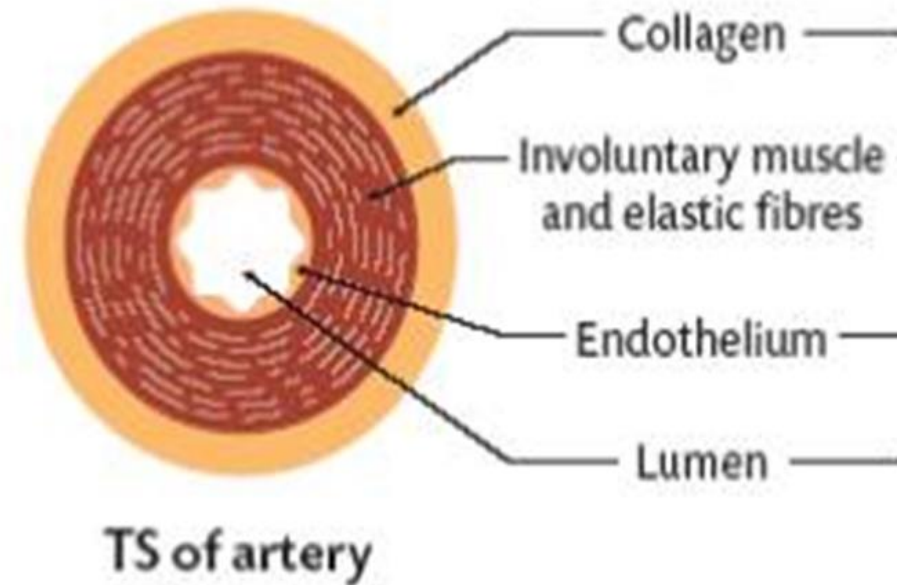


Figure 10. Cross-sectional structure of **(a)** an artery, **(b)** a vein and **(c)** a capillary



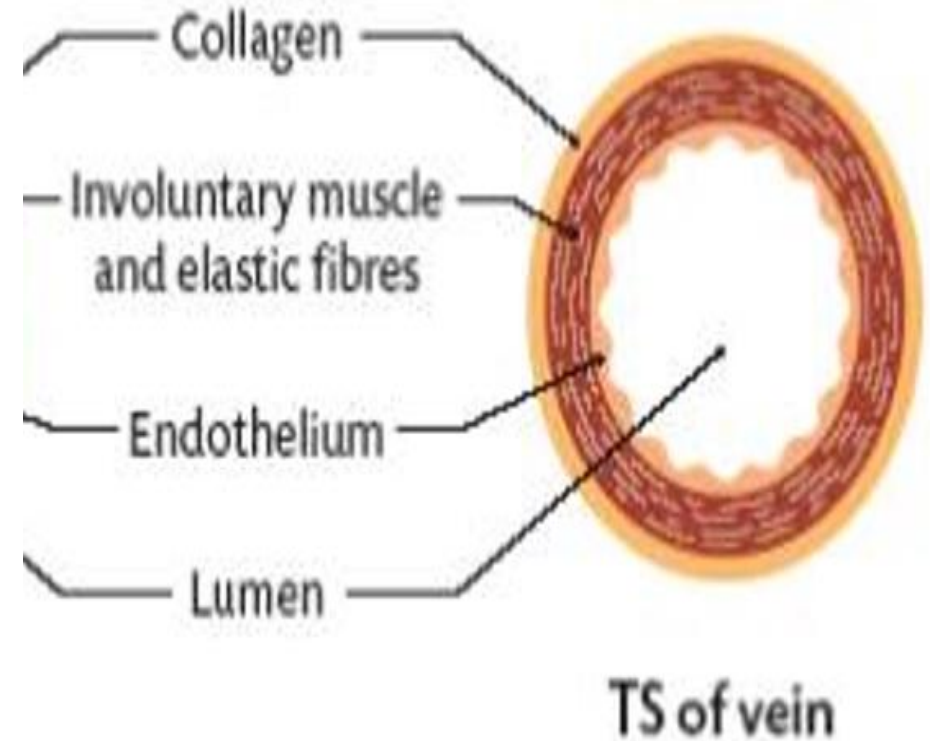
Explain how the structure of the arteries is related to their function?

The artery has a narrow lumen and thick muscular walls to maintain the high pressure so that blood can be pushed far distances around the body. The artery is made up of a thick layer of smooth muscle which allows it to exert a high pressure during contraction.



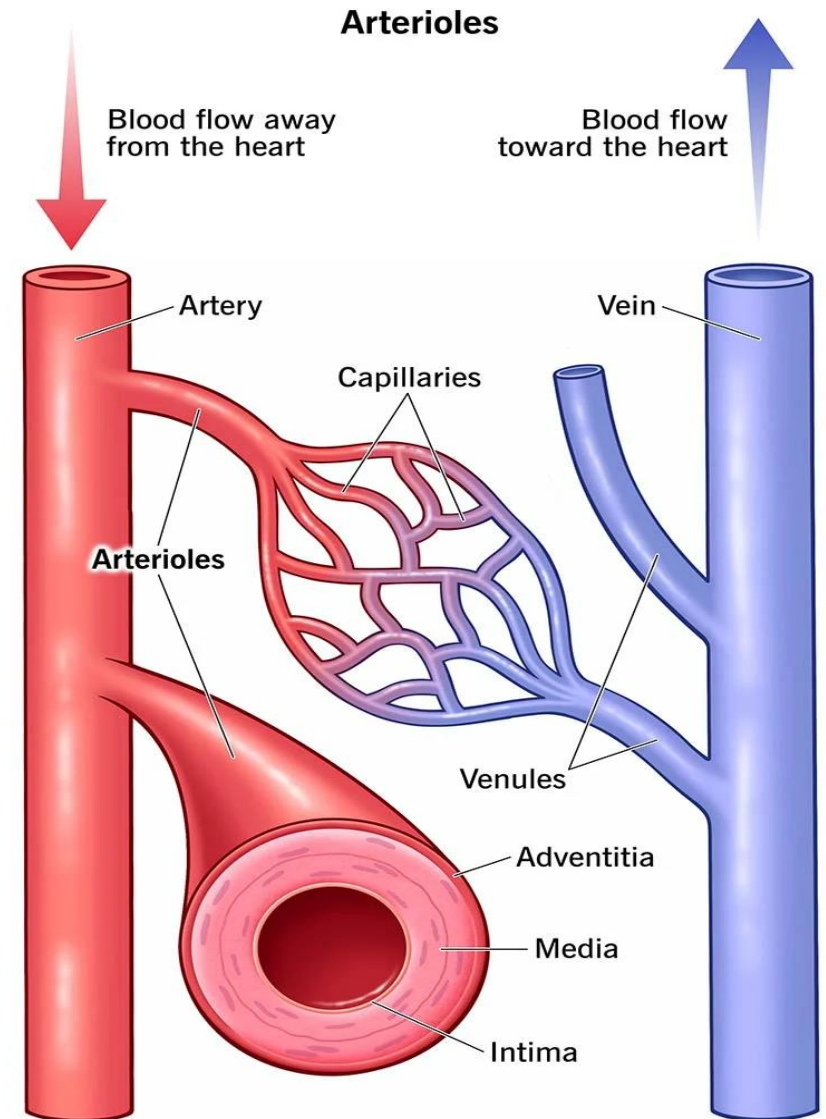
Explain how the structure of the veins is related to their function?

The walls of veins have the same three layers as the arteries. Although all the layers are present, there is less smooth muscle and connective tissue. This makes the walls of veins thinner than those of arteries, which is related to the fact that blood in the veins has less pressure than in the arteries.



Arterioles, small blood vessels that carry blood away from your heart, are connectors between your arteries and capillaries. They control your blood pressure and blood flow throughout your body, using their muscles to change their diameter. They also link to capillaries to exchange oxygen, nutrients and waste.

Venules are very small blood vessels that connect your capillaries with your veins throughout your body. Your venules have the important function of moving blood that contains waste and lacks oxygen from your capillaries to your veins. From there, your blood can make its way back to your heart.



Erythrocytes are red blood cells. The name "red blood cell" derives from the appearance of the red blood cells after centrifuging as a red layer. The term erythrocyte comes from an ancient Greek origin where prefix "erythro" means "red" and "cyte" means "cell".

Leukocytes are white blood cells, The name "white blood cells" derives from the appearance of the white blood cells as a white layer after centrifuging. The term leukocyte comes from an ancient Greek origin where prefix "leuko" means "white" and "cyte" means "cell".

Arteries are the largest blood vessels; they carry blood away from the heart.

Veins are smaller than arteries, they carry blood to the heart.

Capillaries are the smallest blood vessels, they connect the arterioles and venioles.

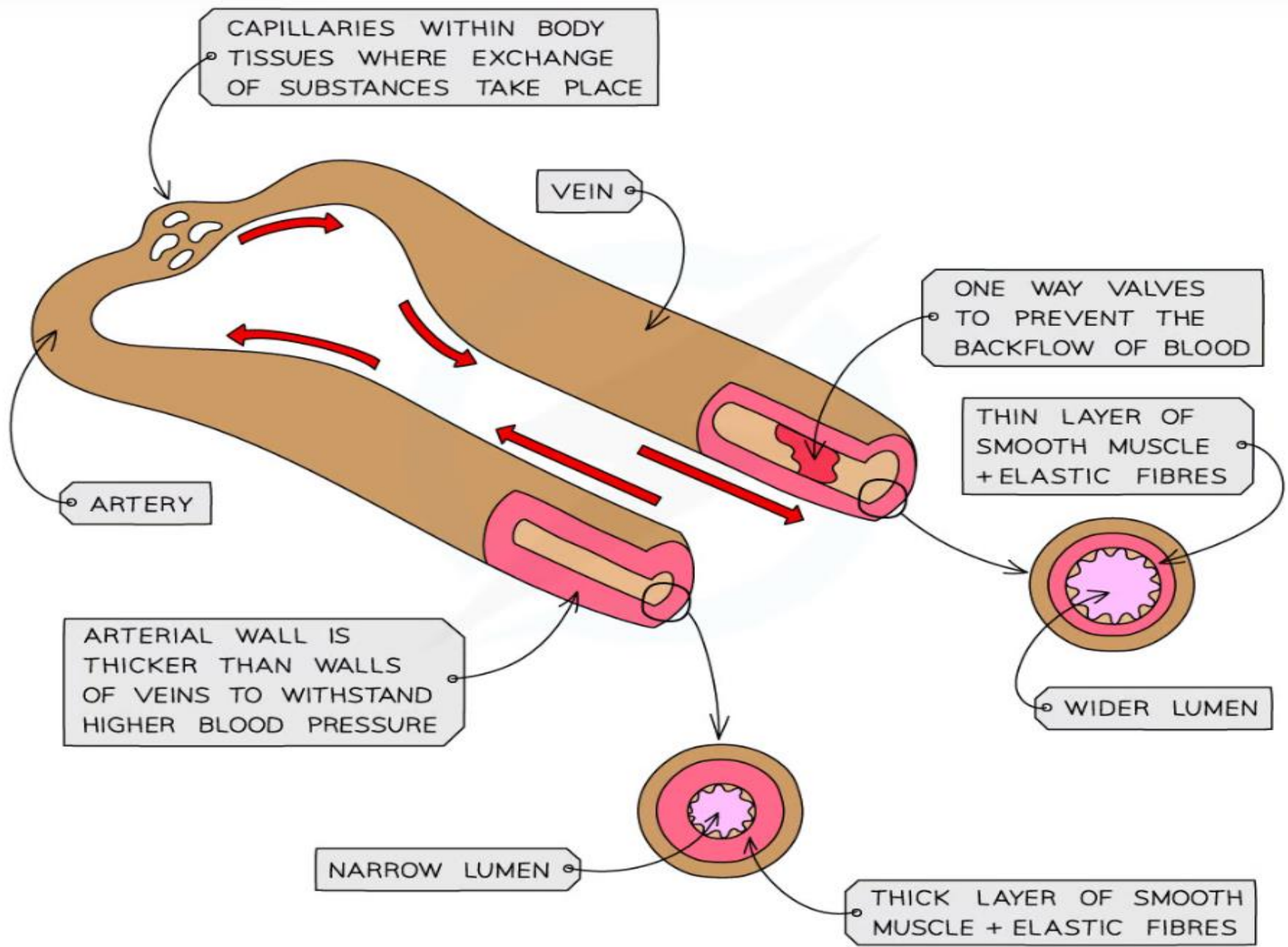
Summary

Arteries

- Carry blood at **high pressure away from the heart**
- Carry **oxygenated** blood (other than the pulmonary artery)
- Have **thick muscular walls** containing elastic fibres
- Have a **narrow lumen**
- Speed of flow is **fast**

Veins

- Carry blood at **low pressure towards the heart**
- Carry **deoxygenated** blood (other than the pulmonary vein)
- Have **thin** walls
- Have a **large lumen**
- Contain **valves**
- Speed of flow is **slow**



- Carry blood at **low pressure** within tissues
- Carry **both oxygenated and deoxygenated blood**
- Have walls that are **one cell thick**
- Have 'leaky' walls
- Speed of flow is **slow**

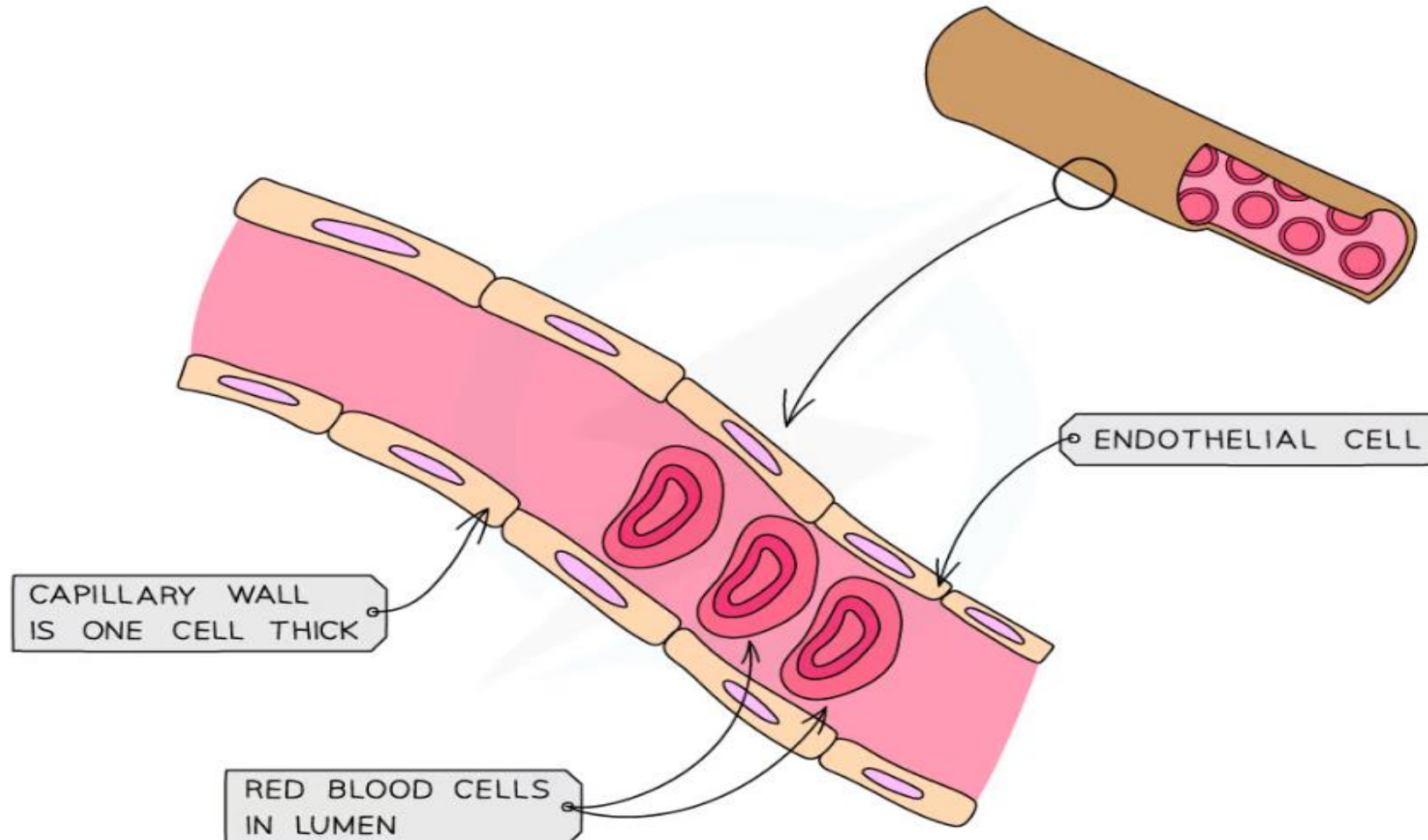


Fig. 1 shows a section through a blood vessel.

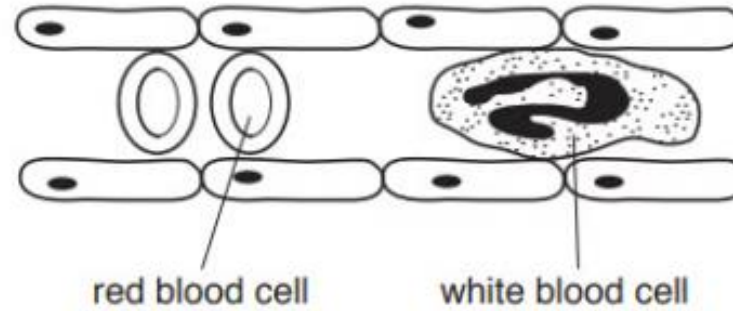


Fig. 1

Identify the type of blood vessel shown in Fig. 1.

Capillary

Blood circulates around the body in arteries, veins and capillaries.

Place ticks (✓) in the correct boxes in Table 1 to show the features of arteries.

Table 1

structure and function	arteries
carries blood at high pressure	✓
carries blood towards the heart	
has a thick wall	✓
has a narrow lumen	✓
has valves present throughout the vessel	

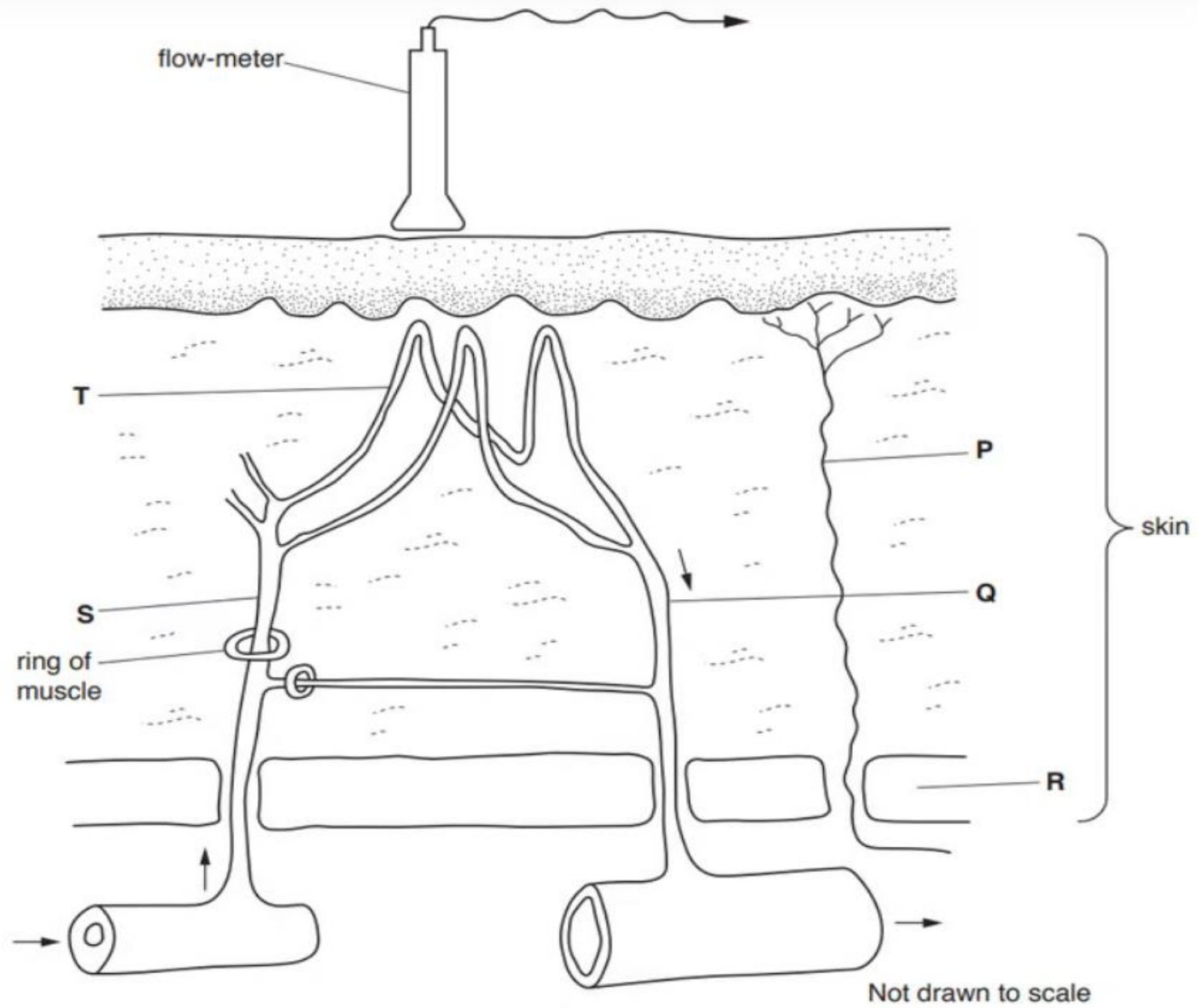


fig. 1

- (i) State the name of cell **P**.

- (ii) State the types of blood vessel labelled **Q**, **S** and **T**.

- (iii) State the name of the tissue at **R** that provides insulation.

Answer 1a

(a) (i) Cell **P** is:

Any **one** of the following:

- Sensory neurone; [1 mark]
- Temperature / thermo- receptor (neurone); [1 mark]

(a) (ii) Blood vessels **Q**, **S** and **T** are:

- **Q** - Venule; [1 mark]
- **S**- Arteriole; [1 mark]
- **T** - Capillary; [1 mark]

Be sure to state 'venule' and 'arteriole' rather than 'vein' and 'artery' here.

(a) (iii) Tissue **R** that provides insulation is:

- Fat / fatty tissue; [1 mark]

[Total: 5 marks]

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Thank you