

**WEEK 1 SUPPLEMENT**

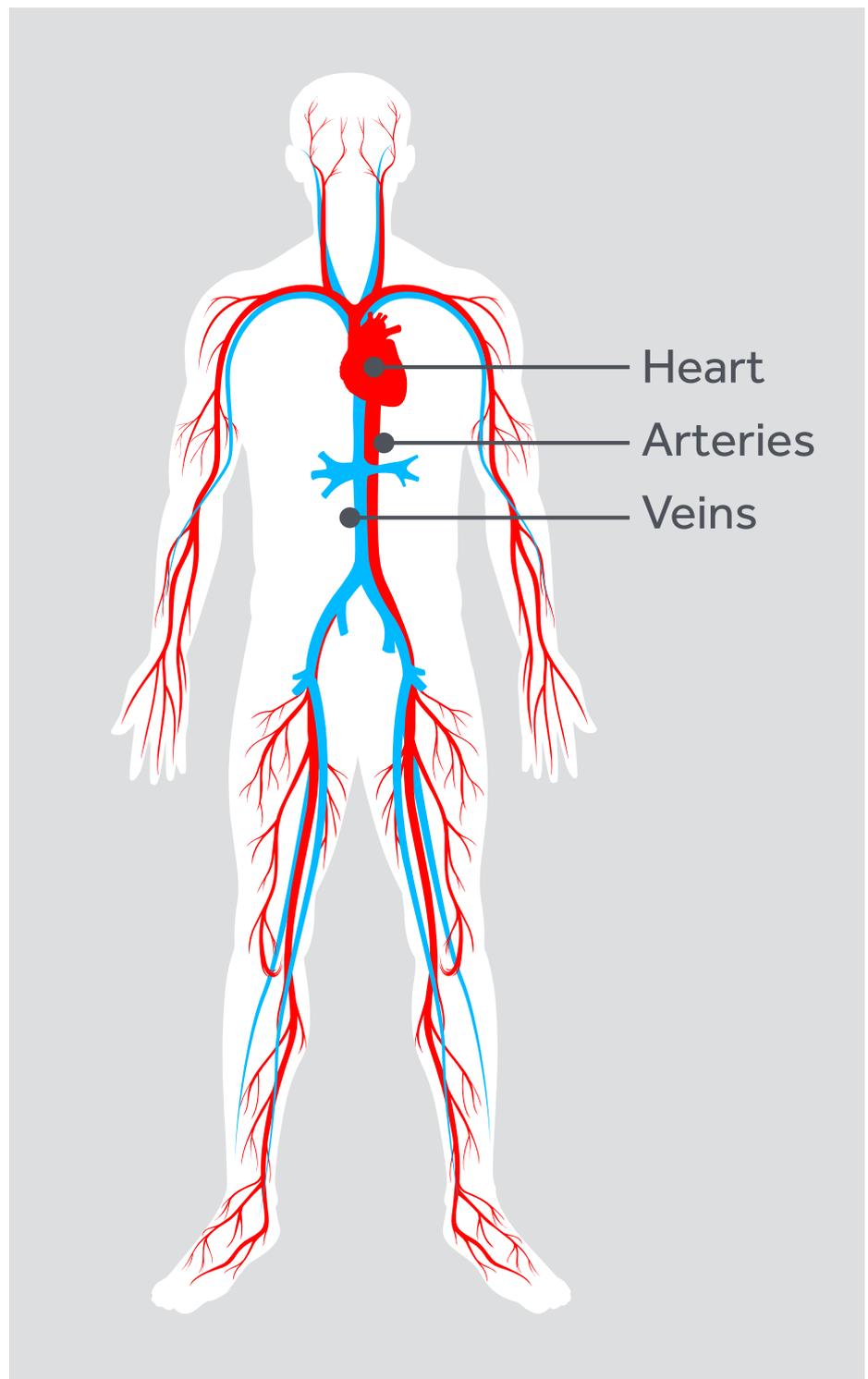
# HEART HEALTH

A Beginner's Guide to Cardiovascular Disease

## THE CARDIOVASCULAR SYSTEM

**FIGURE 1:**

The cardiovascular system consists of the blood vessels (the circulatory system) and the heart (which pumps the blood through the vessels). This system acts as a transport network to deliver oxygen and nutrients to the tissues of the body. Arteries (shown in red) carry blood away from the heart whilst veins (shown in blue) carry blood back to the heart.

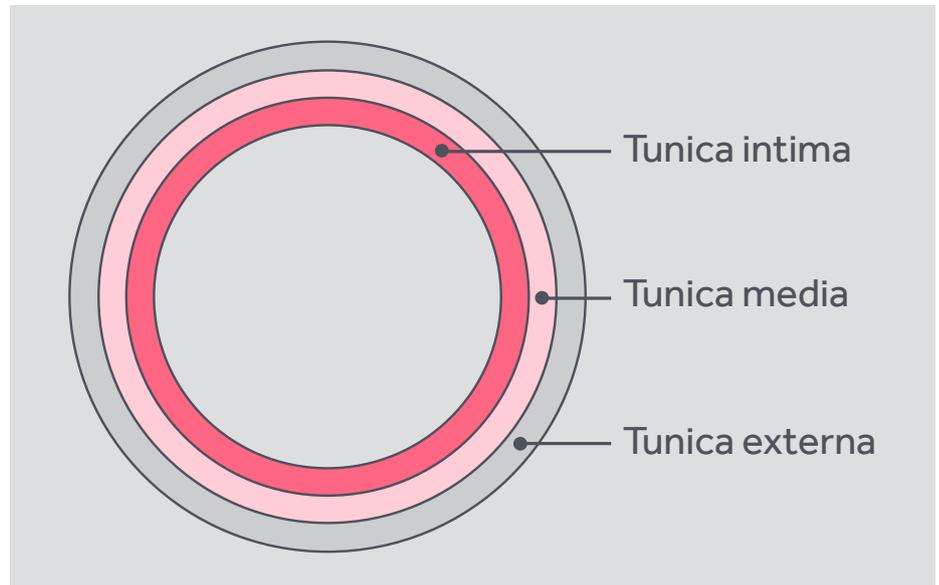


## THE CIRCULATORY SYSTEM

The circulatory system consists of several different types of blood vessels: the arteries, veins, capillaries and lymphatic vessels. The different types of vessel share a similar structure consisting of 3 layers, or tunicae.

### FIGURE 2:

A cross-section of a blood vessel showing the three layers of the blood vessel wall. The tunica intima is the innermost layer and consists of a layer of endothelial cells and the subendothelial matrix. The tunica media is the middle layer and consists of smooth muscle cells. The tunica externa (or adventitia) is the outer layer and consists of connective tissue.

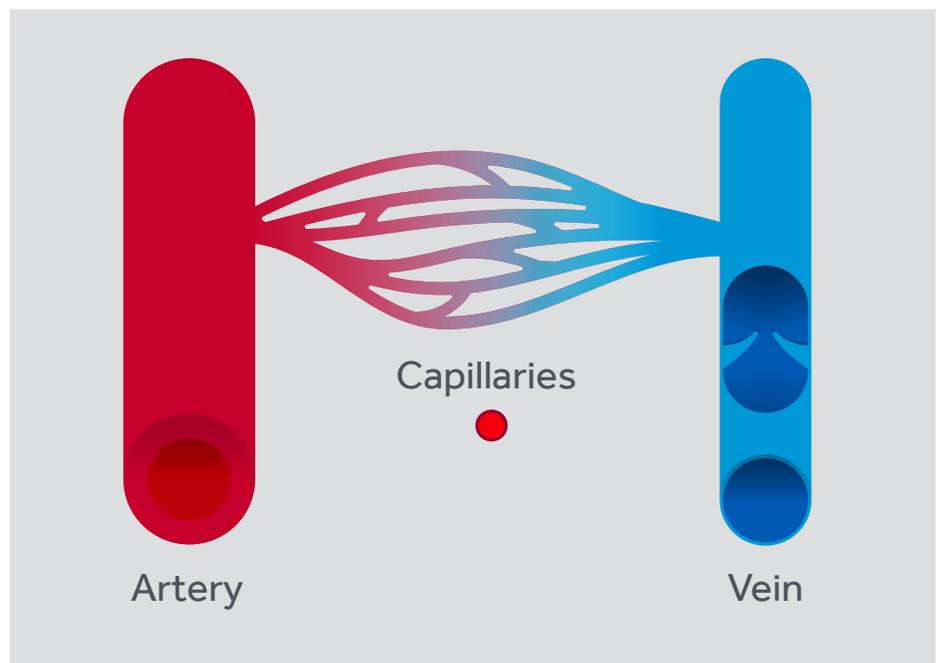


### FIGURE 3:

The largest artery in the body is known as the aorta and receives blood as it is squeezed out of the heart under high pressure. The aorta branches into smaller and smaller blood vessels known as arteries and then arterioles. Arteries and arterioles have a thicker tunica media (smooth muscle layer) that enables them to change their diameter. This helps them cope with the force of blood (as it is squeezed out of the heart at high pressure) and also to direct blood to different parts of the body by narrowing or widening arteries in different areas.

The smallest blood vessels are known as capillaries. These consist of a single layer of endothelium (no tunica media or externa) and are the site of transfer of oxygen from the blood into the tissues and carbon dioxide from the tissues back into the blood.

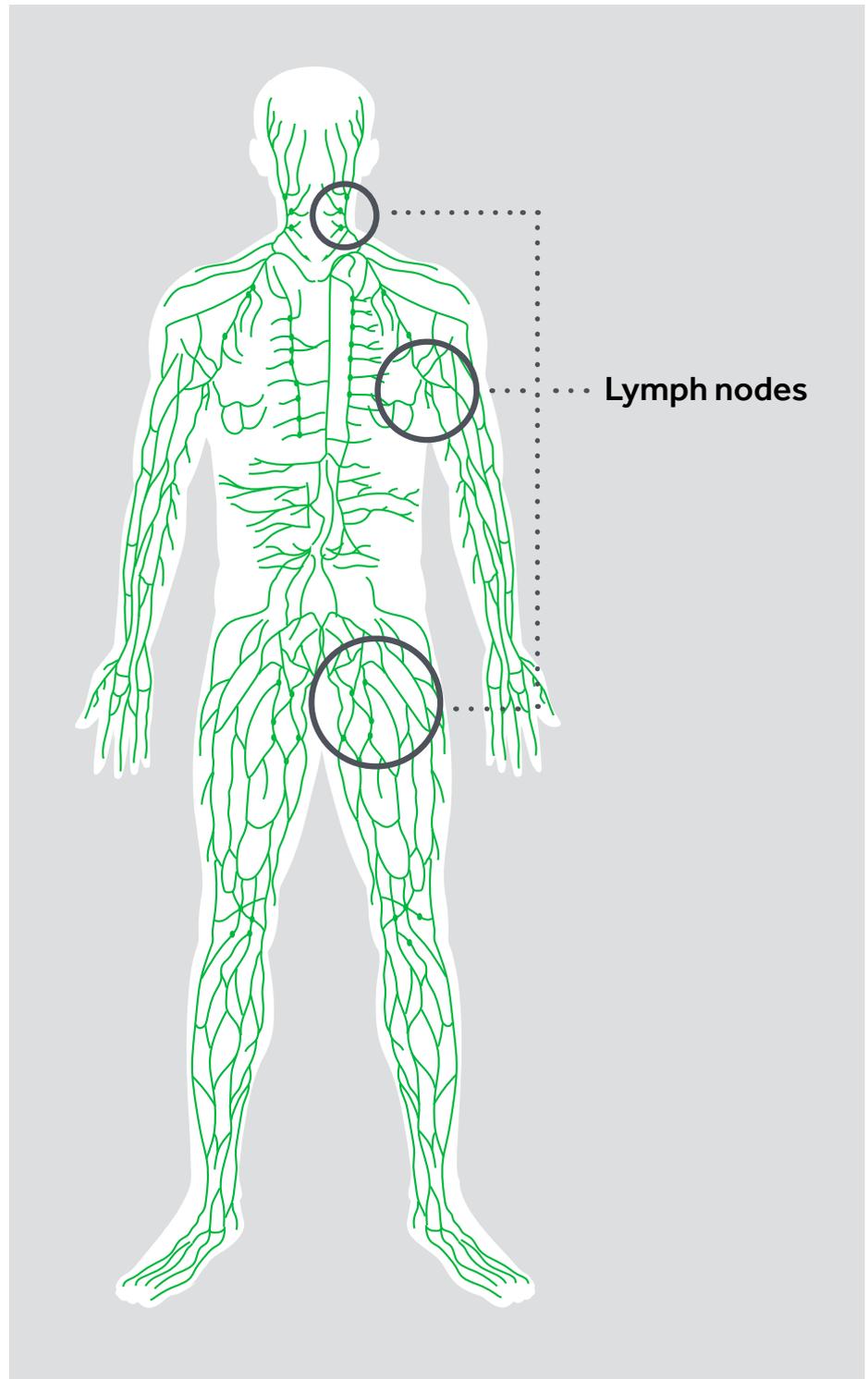
Capillaries enlarge into venules, which become veins and finally the largest of the veins, the vena cava. As venous blood is under a lower pressure veins have a thinner tunica media. They also have a valve system to prevent the backflow of blood.



## LYMPHATIC SYSTEM

**FIGURE 4:**

Lymphatic vessels transport a liquid known as lymph. Lymph is clear as it doesn't contain any red blood cells and so lymphatic vessels weren't discovered until many years after arteries and veins. Along with oxygen some fluid leaves the blood at the capillaries. This clear fluid bathes the cells of the body. Some of this fluid drains back to the heart via the lymphatic system rather than via the venous system. The lymph is filtered at sites known as lymph nodes, which trap and destroy pathogens. Lymph nodes are found in various places around the body including the neck, armpit and groin and can become enlarged when you have an infection. Once filtered by the lymph nodes the lymph travels to the heart where it enters the large subclavian veins to re-join the blood.



## THE RESPIRATORY SYSTEM

Every cell in the body requires oxygen to function and produces waste products such as carbon dioxide. The respiratory system delivers these gases to the cardiovascular system for transport around the body.

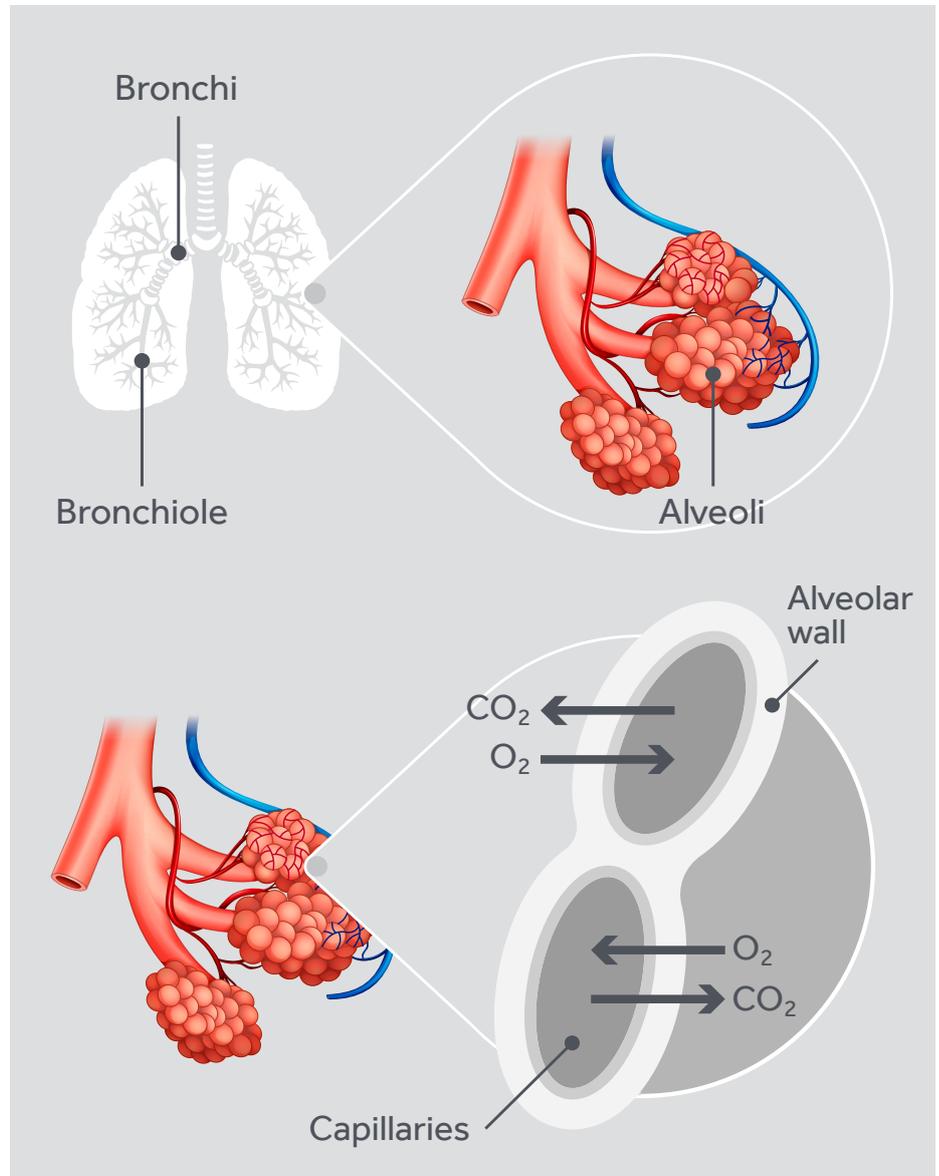
### FIGURE 5:

The function of the cardiovascular system is to transport oxygen from the lungs (the respiratory system) to the tissues and carbon dioxide from the tissues back to the lungs.

A) Air enters through the nose and mouth, travels down the trachea and into one of two bronchi (left and right), to each lung.

B) As the bronchi become smaller they become bronchioles. At the end of the bronchioles are tiny sacs called alveoli.

C) Alveoli are the sites where oxygen and carbon dioxide move between the air and the blood. They are shaped like bunches of grapes to maximise the surface area for transfer. Oxygen moves from the inhaled air in the lungs into the blood and carbon dioxide moves from the blood into the lungs so that it can be exhaled.



## BLOOD

Blood can be defined as a liquid that fills the vascular compartment and serves to transport dissolved materials and blood cells throughout the body<sup>1</sup>.

1. Porth and Matfin (2009). Pathophysiology. 8th Edition. Lippincott, Williams and Wilkins.

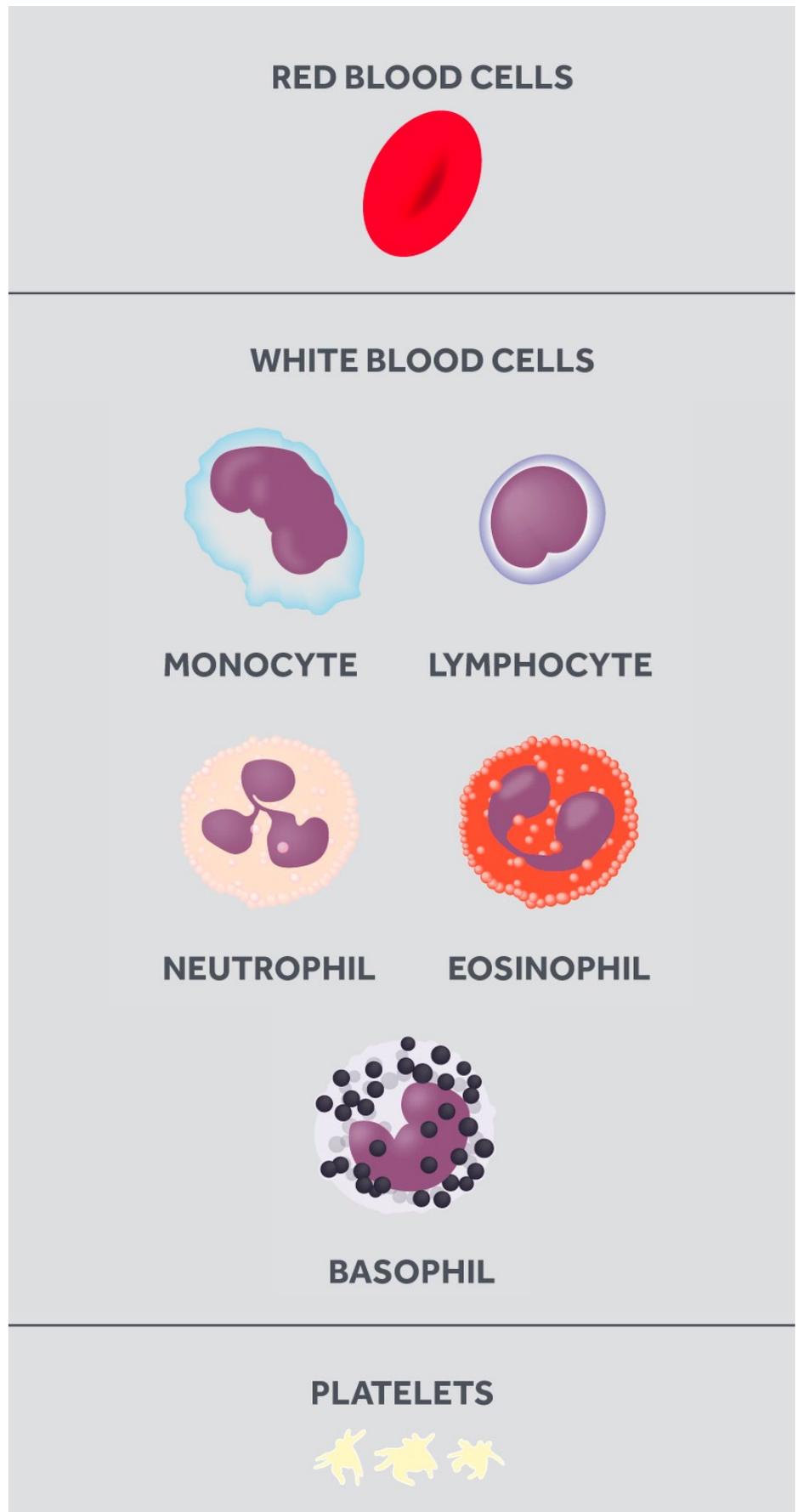
### FIGURE 6:

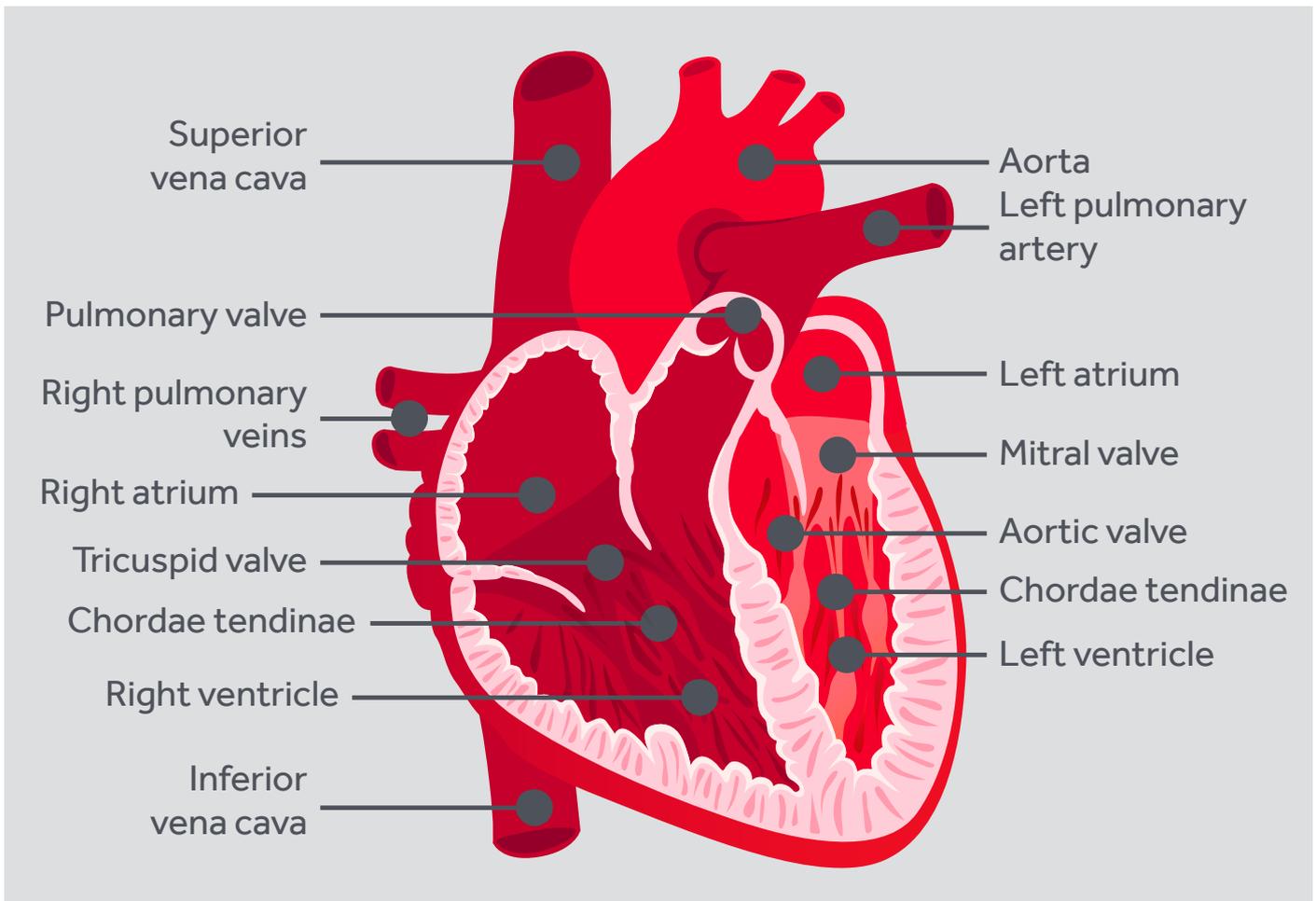
There are 3 main types of blood cells, the red blood cells, white blood cells and platelets.

A) The red blood cells make blood look red and carry oxygen around the body. They are anucleate (they don't have a nucleus) so that they can carry more oxygen and they are a biconcave shape (a bit like a doughnut) so that they can squeeze through tiny blood vessels. Red blood cells are the most common blood cell. In one drop there are about 500 million of them!

B) The white blood cells are involved in the immune system, defending the body from attack. White blood cells are bigger than red blood cells and are round in shape. There are several different types of white blood cell and each is specialised to attack different things. Monocytes help to clear up dead or dying tissue, lymphocytes attack viruses, neutrophils attack bacteria, whilst eosinophils and basophils are involved in allergic reactions.

C) Platelets are the tiniest blood cells and are involved in blood clotting. They don't have a nucleus and are able to change their shape. When you cut yourself the platelets in your blood become activated. They stick together to plug the wound and help to stop bleeding.





## THE HEART

Your heart is about the size of your clenched fist. This muscular organ squeezes around 100,000 times a day to pump blood around your body. The inside of the heart consists of 4 chambers, the 2 atria at the top and the 2 ventricles at the bottom. Deoxygenated blood (lacking oxygen) from the body enters the right atrium and passes into the right ventricle. The right ventricle then contracts (squeezes), pumping the blood to the lungs where it becomes oxygenated. Oxygenated blood returns to the left atrium and passes into the left ventricle. The thick muscular wall of the left ventricle then contracts, pumping the blood around the body to deliver the oxygen.

The heart has 4 major blood vessels that deliver blood to and from the heart. The vena cava is the largest vein in the body and returns deoxygenated blood to the right atrium. The aorta is the largest artery in the body and transports oxygenated blood from the left ventricle to the body. The pulmonary arteries and veins transport the blood between the heart and the two lungs. Arteries carry blood away from the heart, thus the pulmonary arteries leave the right ventricle and go to the lungs, and the pulmonary veins go from the lungs to the

left atrium. Usually arteries carry oxygenated blood and veins carry deoxygenated blood, but the pulmonary vessels are different. Arteries have a thicker tunica media to cope with higher pressure, therefore the pulmonary arteries carry blood away from the heart (under higher pressure) and pulmonary veins towards the heart.

Heart valves ensure the blood travels through the heart in the right direction by preventing backflow. The two semilunar valves sit between the ventricles and the large blood vessels. The aortic valve sits on the left, between the left ventricle and aorta, and the pulmonary valve on the right, between the right ventricle and the pulmonary artery. Two atrioventricular valves sit between the atria and ventricles, the mitral valve on the left and the tricuspid valve on the right. Tiny papillary muscles attach to chordae tendinae (fibrous cords) to anchor the atrioventricular valves to the floor of the heart. These tiny muscles contract to prevent the valves from being turned inside-out (like an umbrella on a windy day).

### FIGURE 7:

The internal structure of the heart showing the 4 chambers (2 atria, 2 ventricles), the 4 heart valves (mitral, tricuspid, aortic and pulmonary valves), the 4 major blood vessels (aorta, vena cava, pulmonary arteries and pulmonary veins) and the chordae tendinae that anchor the valves and prevent them from turning inside out.

**FIGURE 8:**

For each heartbeat an ECG produces a line with a series of peaks and troughs that represent the change in electrical activity of the heart. It starts with a small peak called the P wave which represents the electrical activation of the 2 atria, causing them to contract.

There is then a short gap known as the PR interval where the electrical signal travels from the atria, through the sinoatrial node and down the septum of the heart to the apex. The QRS complex is the trough, largest peak, trough, and represents the electrical activation of the 2 ventricles, causing the ventricles to contract from the apex upwards, pushing blood upwards towards the aorta and pulmonary artery. This is followed by the T wave which is the small peak that represents the recovery of the ventricles.

