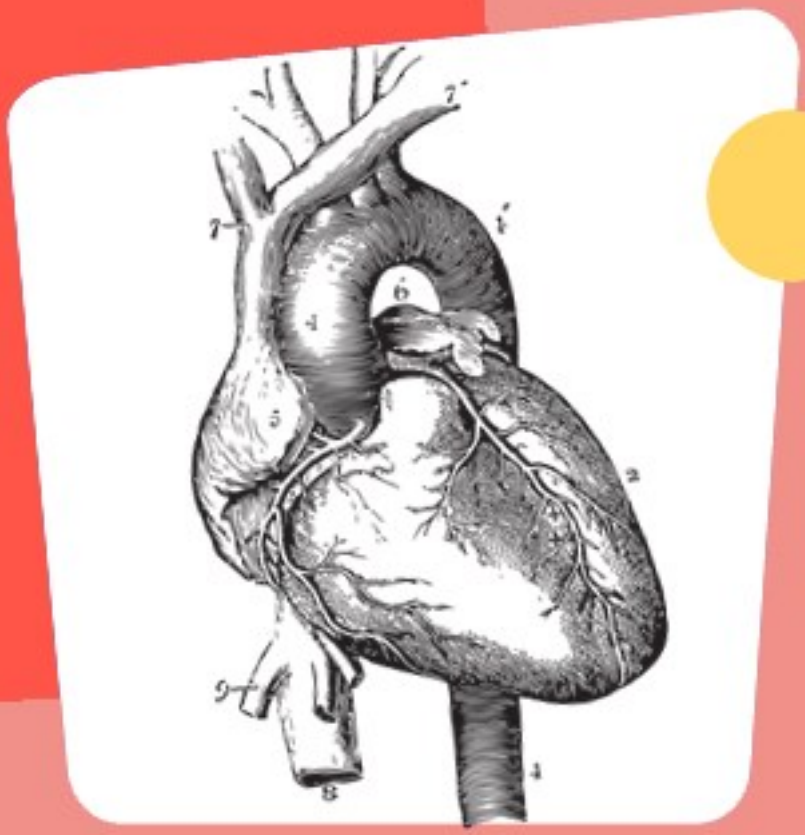


Session 1:

Cardiovascular System

The CVS is made up of the heart and blood vessels, all working together. The heart functions as a pump. The blood vessels act as pipes, carrying blood through the body.

DOCTORS LIVE

What is the cardiovascular system?

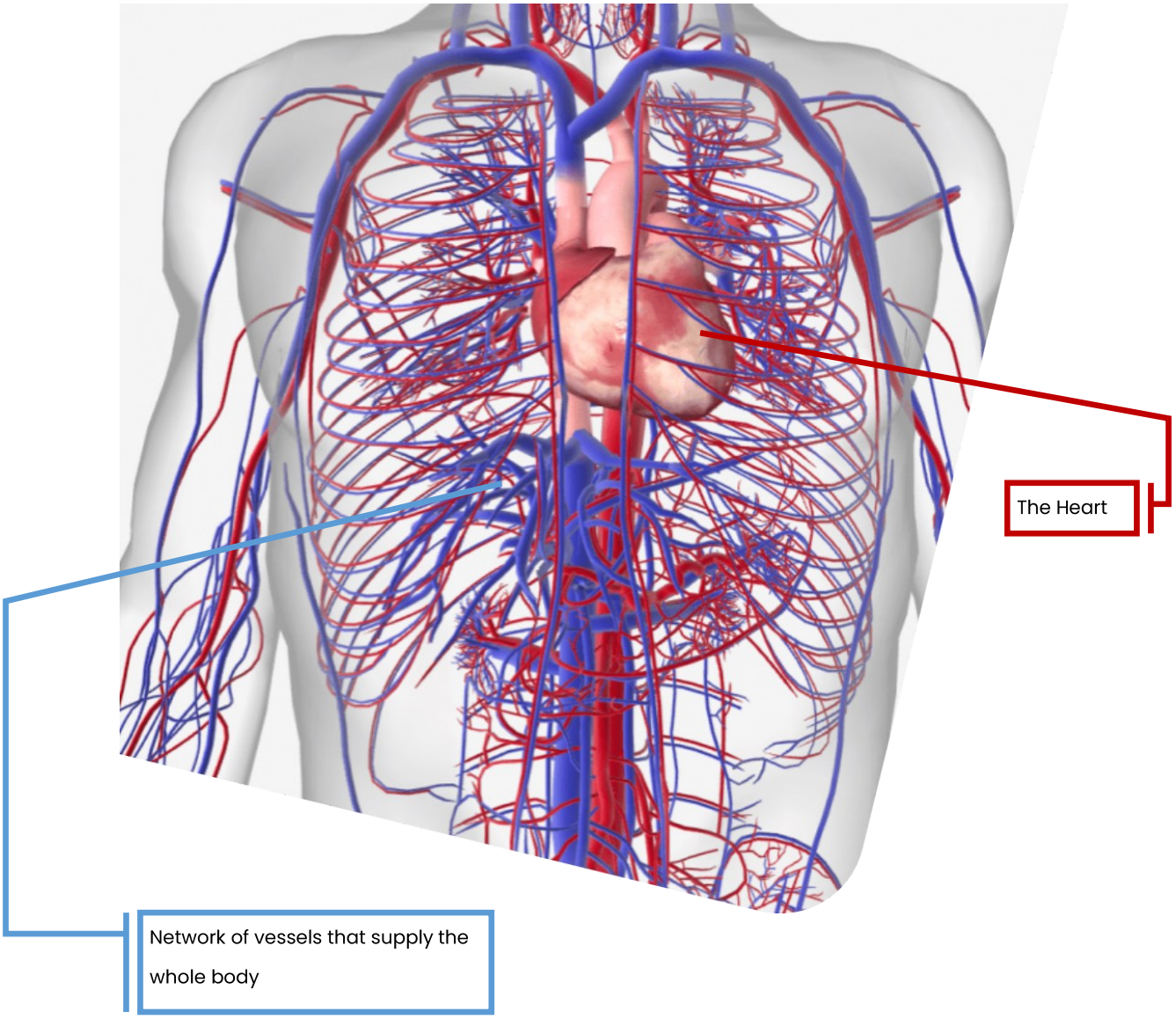
Consists of the **heart**

(a muscular pumping device)

+

A closed network of **vessels**

(arteries, veins and capillaries)



What is the function of the CV system?

- ◊ Circulates OXYGEN and removes CARBON DIOXIDE.
- ◊ Provides cells with NUTRIENTS.
- ◊ Removes the waste products of metabolism to the excretory organs for disposal.
- ◊ Protects the body against disease and infection.
- ◊ Clotting stops bleeding after injury.
- ◊ Transports HORMONES to target cells and organs.
- ◊ Helps regulate body temperature

Blood

45% solids (cells) and 55% fluids (plasma).

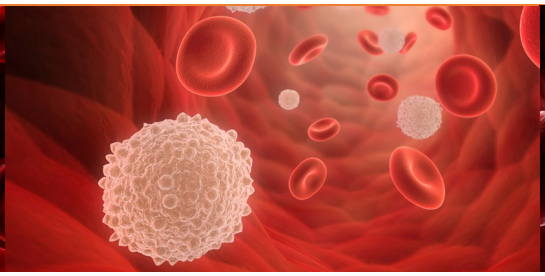
Plasma

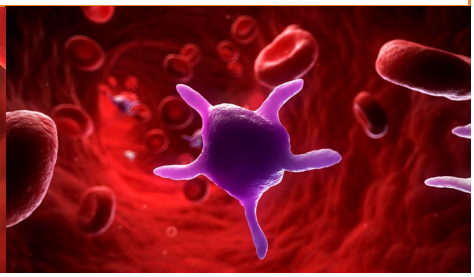
- ◊ This is mostly water—all the other components float in this.
- ◊ Contains proteins, nutrients, hormones, antibodies, and dissolved waste products.

General types of blood cells:

- ⇒ ERYTHROCYTES(red cells)
- ⇒ LEUKOCYTES(white cells)
- ⇒ THROMBOCYTES(platelets)

ERYTHROCYTES(red cells)	LEUKOCYTES(white cells)	THROMBOCYTES(platelets)
• small red disk shaped cells. • Contain HAEMOGLOBIN, which combines with oxygen in the lungs and is then transported to the body's cells. The haemoglobin then returns carbon dioxide waste to the lungs.	• Help the body fight bacteria and infection. When a tissue is damaged or has an infection the number of leukocytes increases. • Leukocytes can be classed as granular or non granular. • There are three types of granular leukocytes (eosinophils, neutrophils, and basophils) • Three types of non-granular (monocytes, T-cell lymphocytes, and B-cell lymphocytes).	• Aid the formation of blood clots by releasing various protein substances. • When the body is injured thrombocytes disintegrate and cause a chemical reaction with the proteins found in plasma, which eventually create a thread like substance called FIBRIN. The fibrin then "catches" other blood cells which form the clot, preventing further loss of blood and forms the basis of healing.



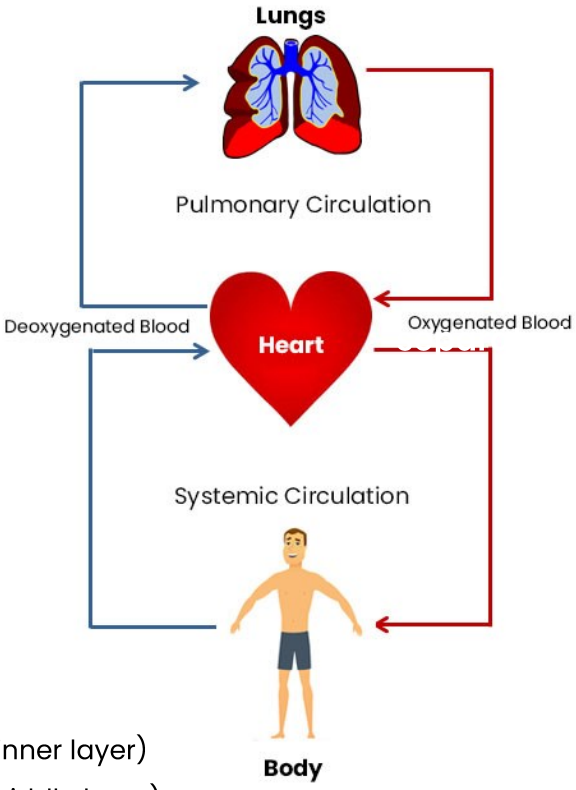


What is the heart ?

Hollow muscular organ - pumps blood around the body.

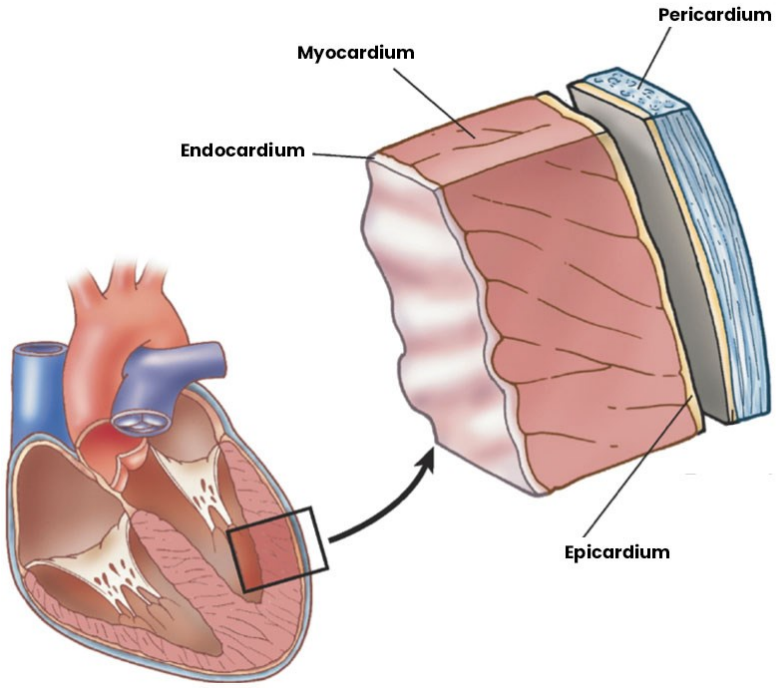
Dual Circulation

- Right side receives **deoxygenated** blood from body and sends it to the lungs to be oxygenated
- Left side receives **oxygenated** blood from the lungs and sends it out to the rest of the body.



The Heart has four layers;

- ENDOCARDIUM (inner layer)
- MYOCARDIUM (middle layer)
- EPICARDIUM (outer layer)
- PERICARDIUM - protective membrane surrounding it



What inside the heart ?

There are four chambers which are separated by valves.

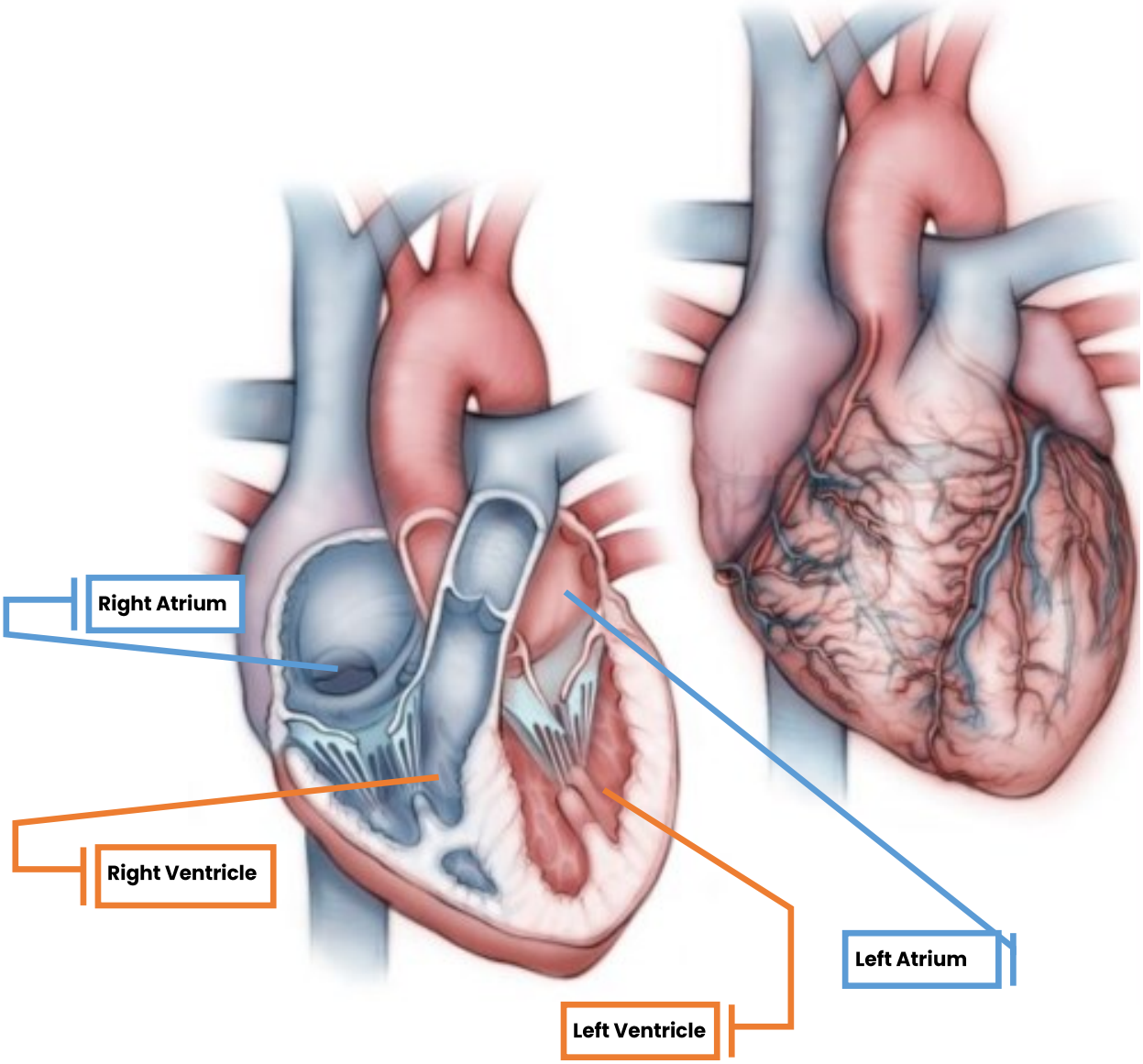
⇒ 2 Atria

⇒ 2 Ventricles

When the heart beats...

Atria contract while the ventricles relax, then the ventricles contract while the atria relax.

The valves are to stop blood flowing in wrong direction

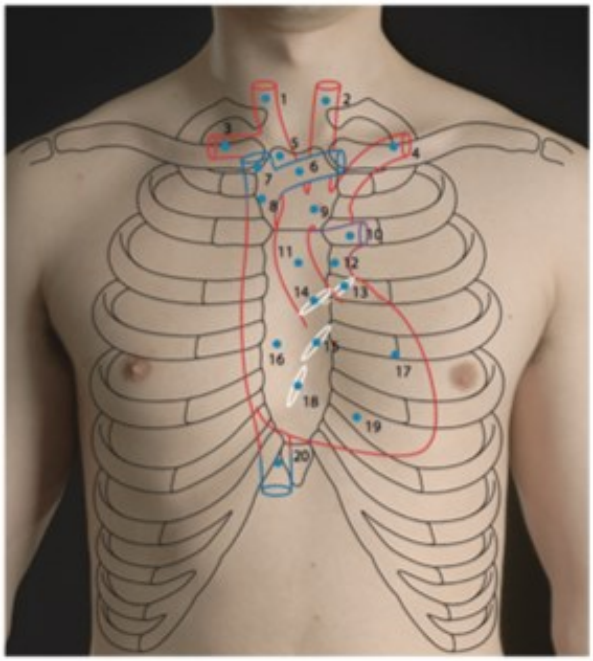


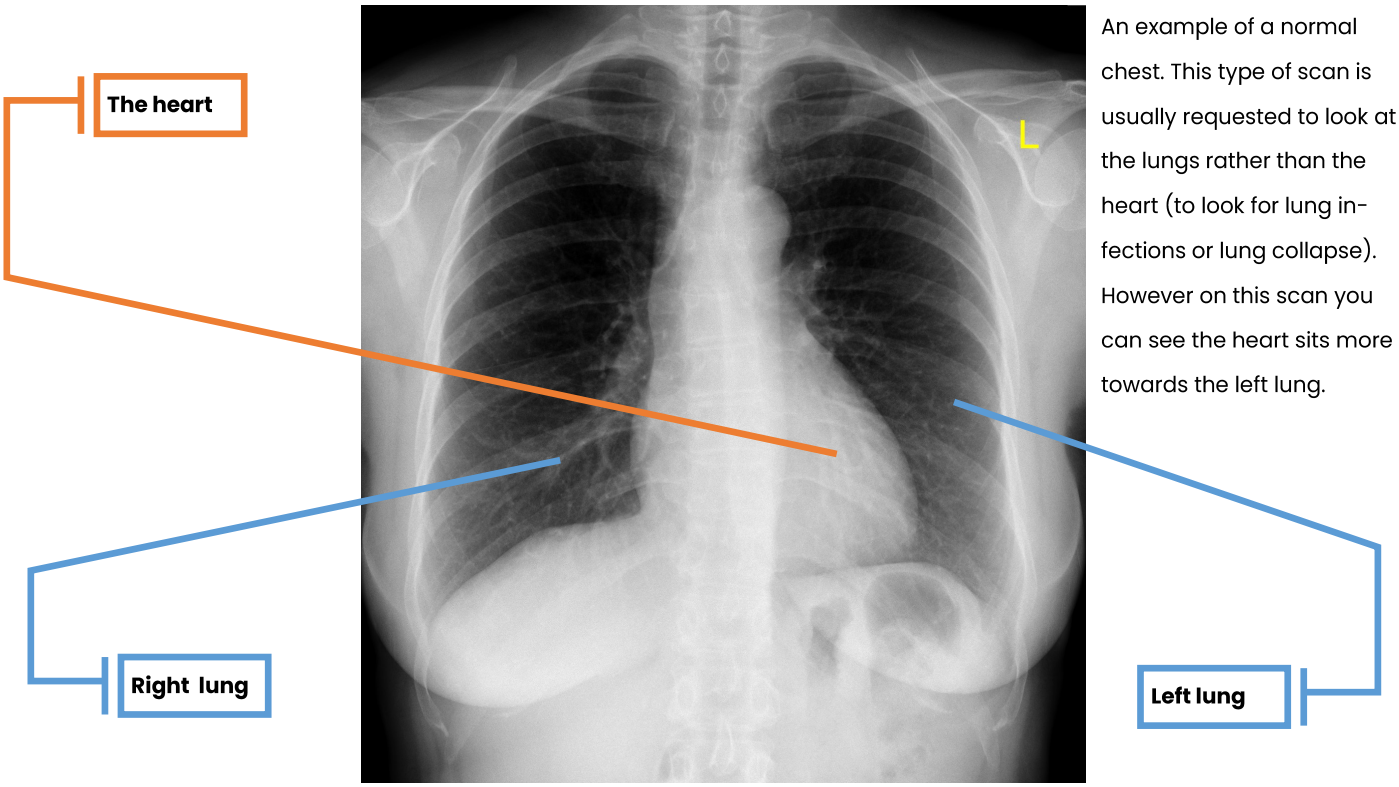
Where is the heart?

⇒ Heart sits within the thorax

⇒ Between the two lungs in an area called the mediastinum

⇒ More towards the left side





An example of a normal chest. This type of scan is usually requested to look at the lungs rather than the heart (to look for lung infections or lung collapse). However on this scan you can see the heart sits more towards the left lung.

Cardiac Cycle

Heart contracts in rhythmic fashion - natural pacemaker

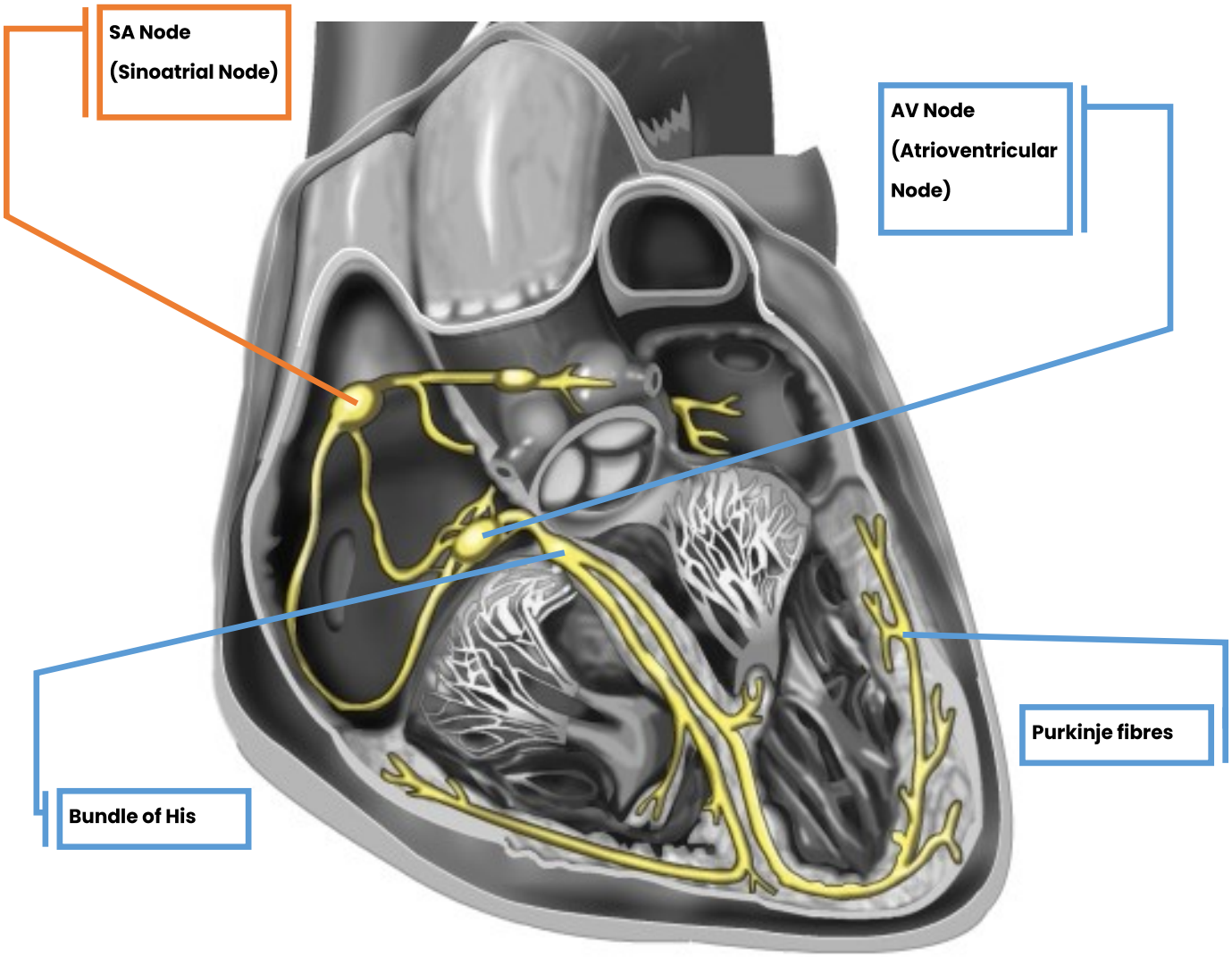
Two phases diastole and systole

Diastole = relaxed

Systole = contracted

Different phases - ie different parts of the heart contract at different times in order to give time for the chambers to fill and to send blood in the right direction.

The heart beat is initiated in a group of cells called the 'Sinoatrial Node' which are situated in the wall of the right atrium.



SA Node → AV Node → Bundle of His → Purkinje Fibres

What are the vessels

Body has 60000 miles of blood vessels

Arteries

⇒ Thick walled

⇒ High pressure

⇒ Carry blood away from the heart

⇒ Carry oxygenated blood to tissues (except for pulmonary artery)

⇒ Do not have valves

Veins

⇒ Thin walled

⇒ Low pressure

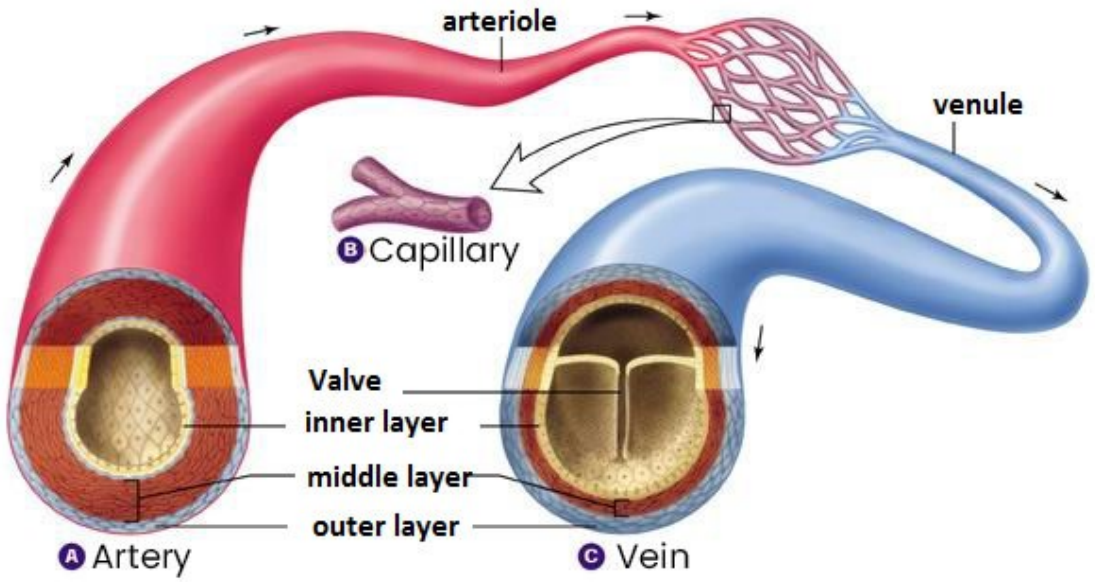
⇒ Carry blood towards the heart

⇒ Carry deoxygenated blood back to the heart (except for pulmonary veins)

⇒ Have valves to stop blood flowing backwards

Capillaries

Capillaries are tiny blood-containing structures that connect arterioles to venules. They are the smallest and most abundant form of a blood vessel in the body. **Capillaries** are small enough to penetrate body tissues, allowing oxygen, nutrients, and waste products to be exchanged between tissues and the blood.



The aorta and its branches

01

The largest artery in the body

02

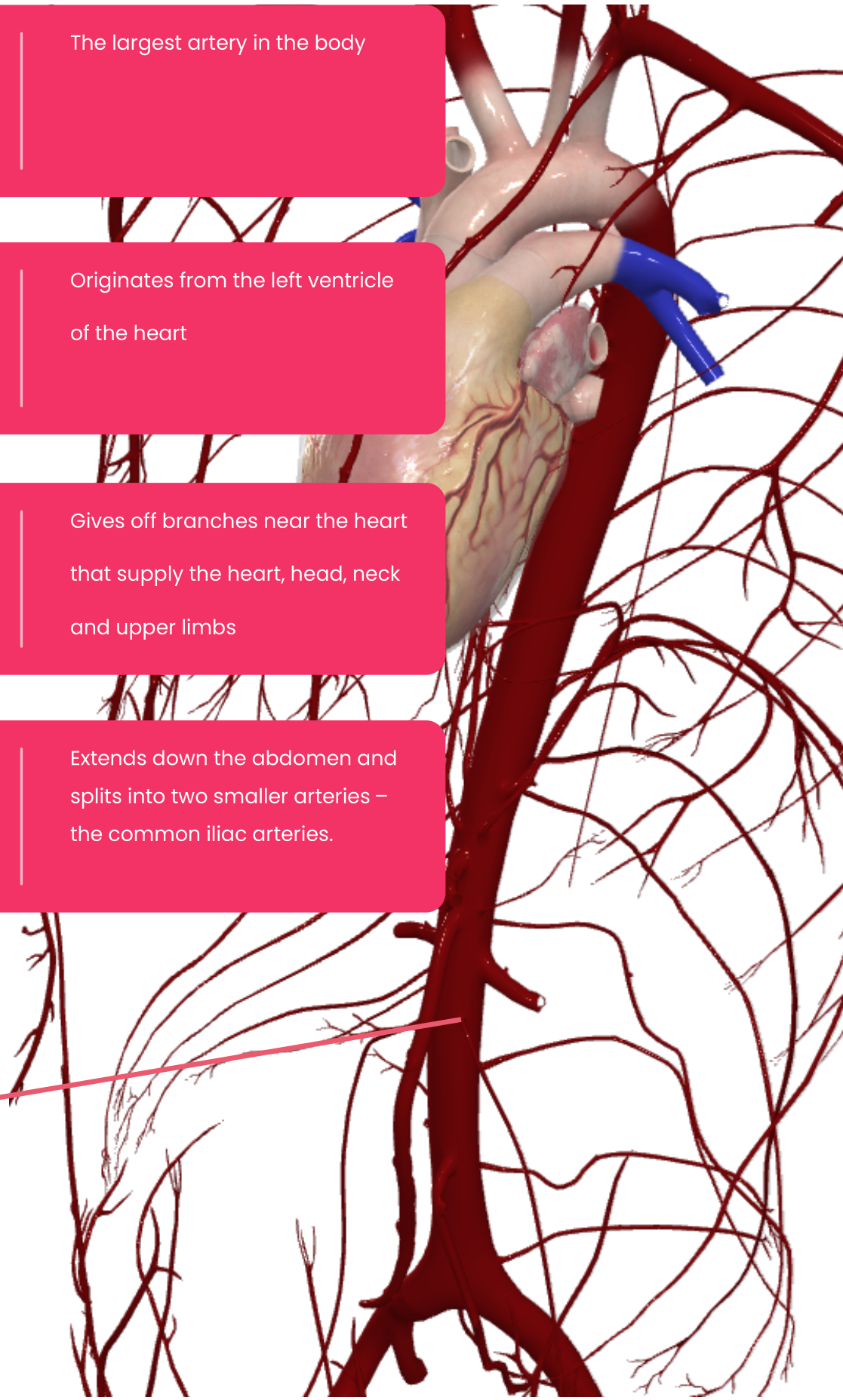
Originates from the left ventricle of the heart

03

Gives off branches near the heart that supply the heart, head, neck and upper limbs

04

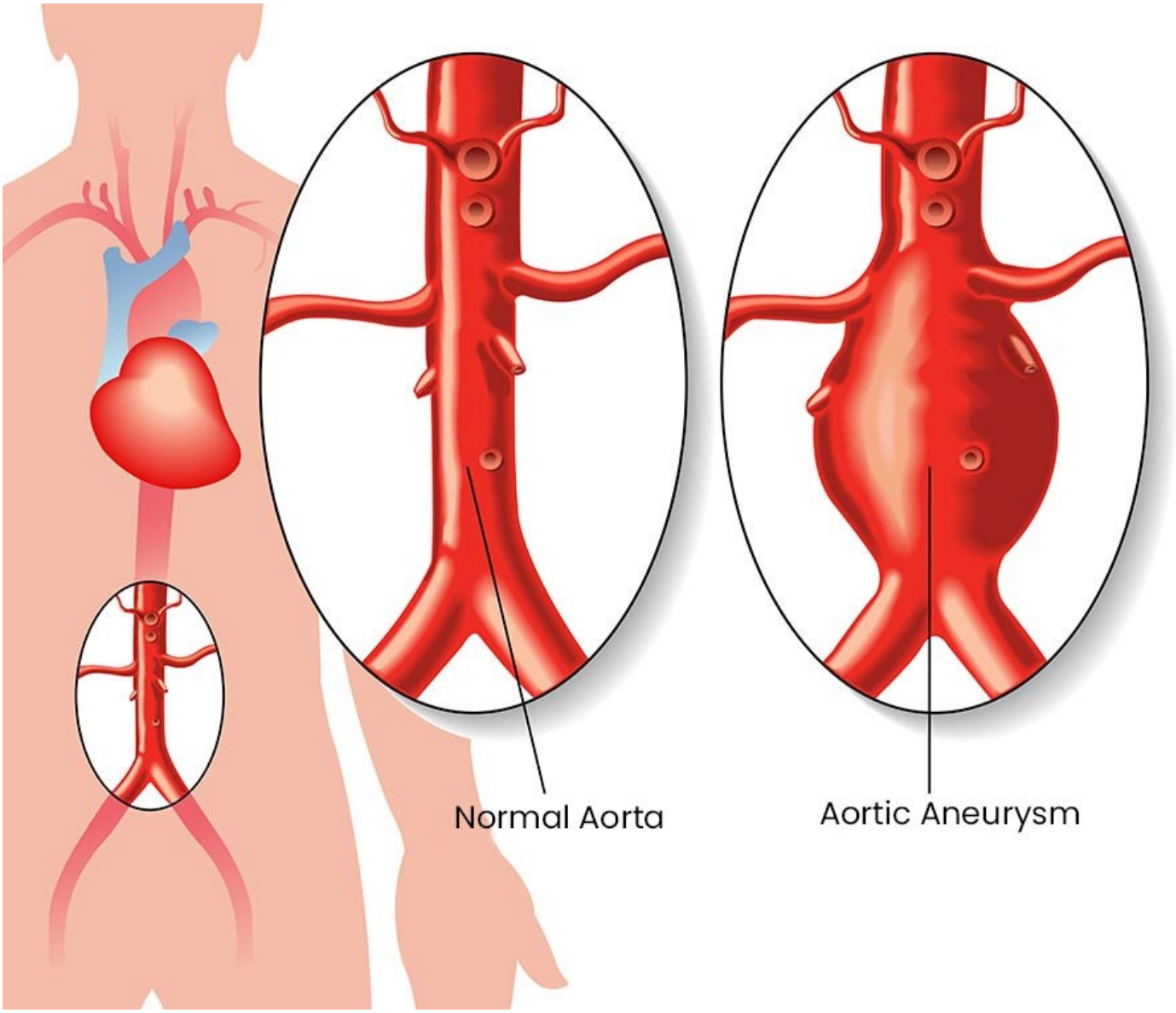
Extends down the abdomen and splits into two smaller arteries – the common iliac arteries.



Abdominal Aorta

What is an Aortic Aneurysm?

- As we get older the aorta wall gets weaker. Sometimes when the aorta wall get weak enough it starts to balloon and become larger. This is called an aneurysm.
- Aneurysm can increase in size over time and if they become large enough and the wall becomes weak enough the aneurysm might rupture (think of a balloon popping). This is a medical emergency, because the patient will be bleeding profusely internally.
- This condition is more common in males (especially above the age of 65) and patient's suffering from hypertension (high blood pressure) because there is increased pressure on the walls of the aorta.
- Men above the age of 65 are called for screening to measure the aorta size when they are 65.
- Aneurysm can also happen in other parts of the body for example in the brain. This is called a berry aneurysm because it resembles a small berry.

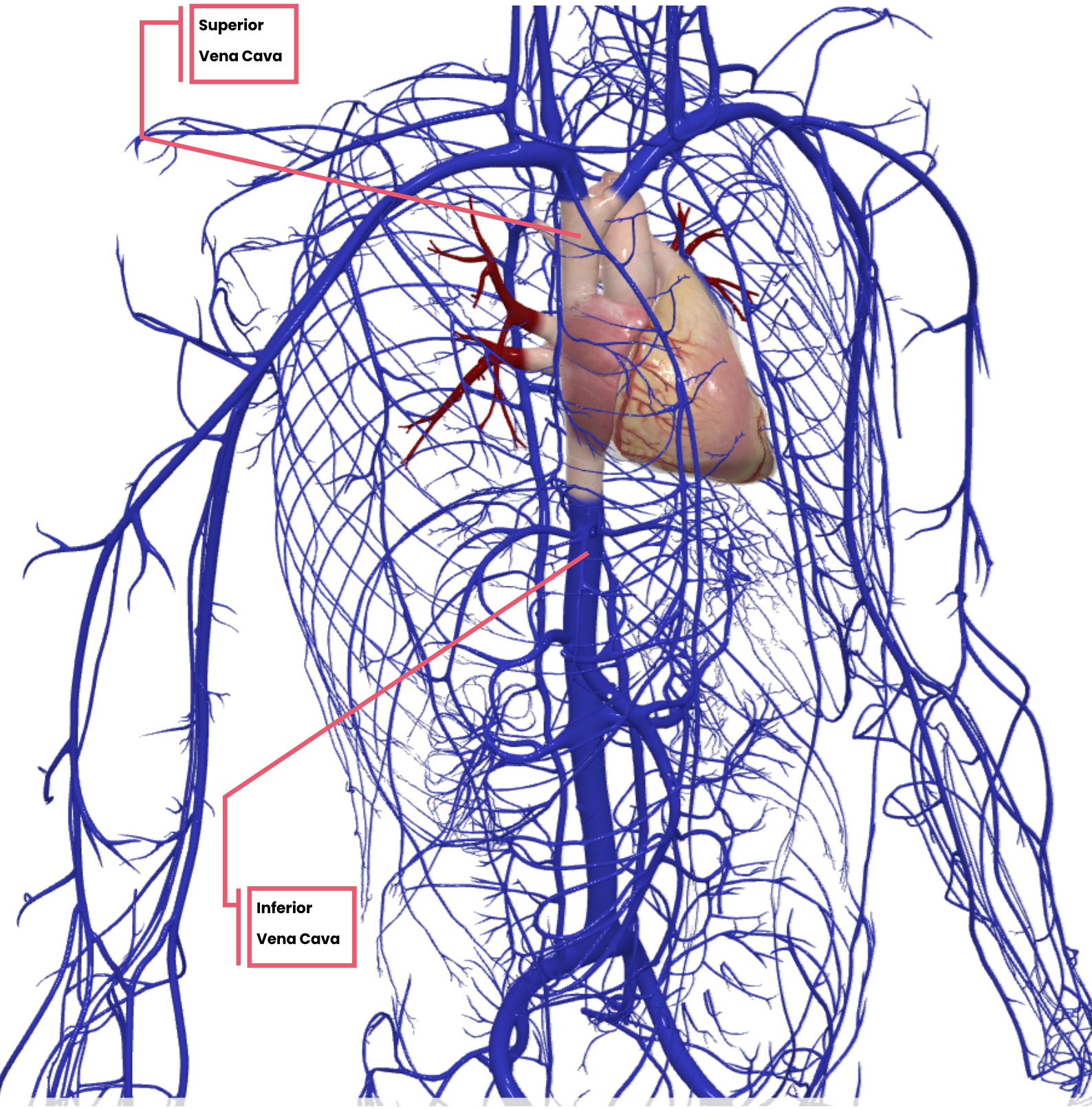


The superior and inferior vena cava

The Superior and Inferior Vena Cava are the largest veins in the body. They drain back blood into the right atrium.

The superior vena cava drains the head, neck and upper limbs (arms).

The inferior vena cava drains all the intrabdominal organs and lower limbs.



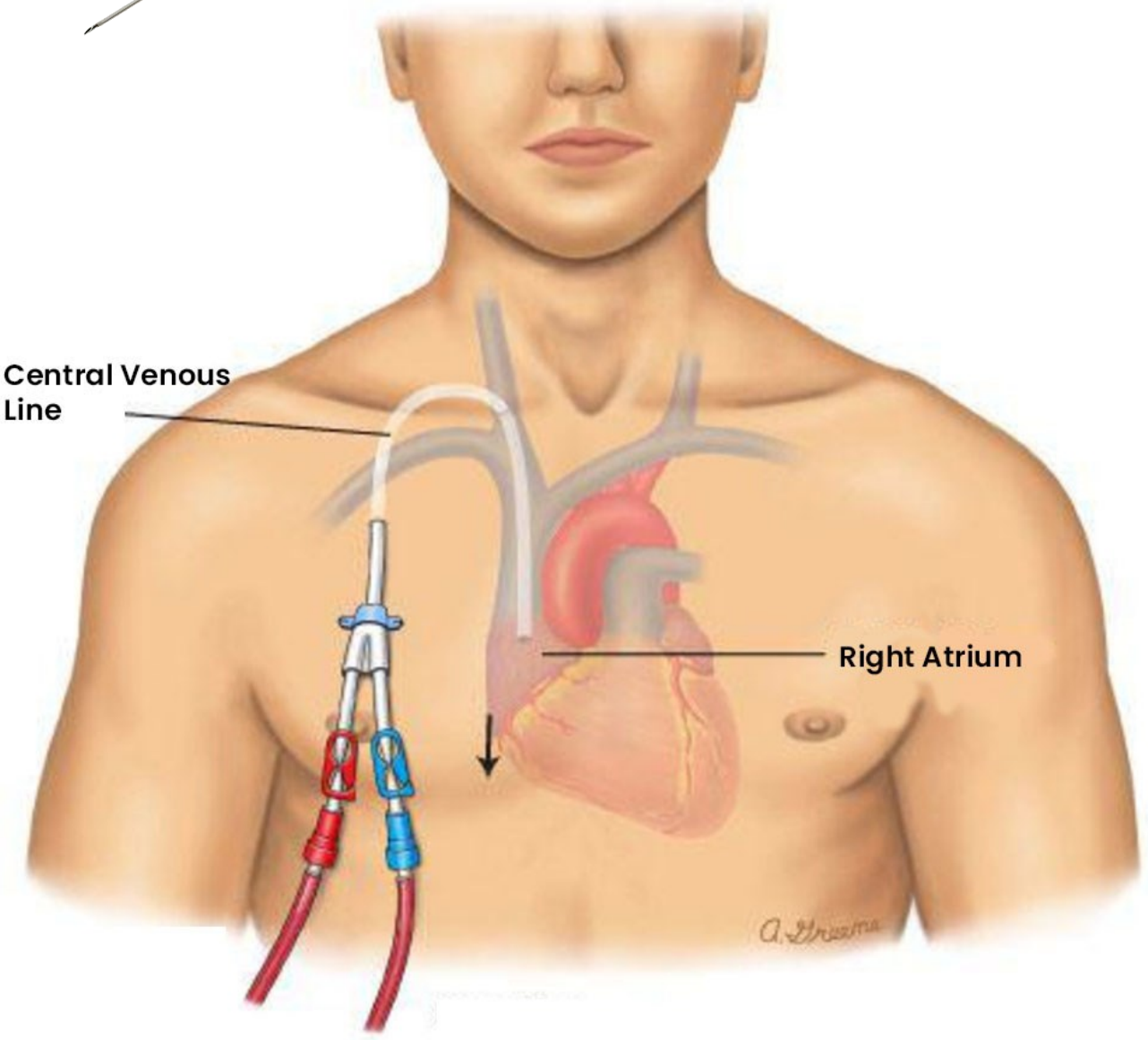
What is a cannula?

When some patients are in hospital they will need to be fitted with a small tube into their veins. This is called a cannula or intravenous access (the general public sometimes refer to it as a 'drip'). This allows the medical team to administer medication as well as take blood.

For example, if the patient has a more severe infection they will need antibiotics to be given directly into the vein. This is called **intravenous antibiotics** and is usually given in a cannula in the hand or arm.

More unwell patients or patients that require special drugs like chemotherapy have a cannula placed directly into the vena cava. This is called a central line. Commonly patients in the intensive care unit have this type of line.

An example of a cannula. They come in different sizes. Usually the colour denotes the size of the canula. Orange Is usually the largest and purple the smallest.



Case Study—Myocardial Infarction

70 year old patient presents with sharp 9/10 pain on the left side of his chest. The pain seems to spread to the left shoulder and neck. He is also feeling breathless.

- The patient above is exhibiting the typical symptoms of a heart attack (myocardial infarction).
- This is when the coronary arteries (which supply the heart) are blocked.
- An atherosclerotic plaque slowly builds up in the inner lining of a coronary artery and then suddenly ruptures, causing a clot (thrombus) to form. When the coronary artery is closed it can't supply the heart muscle with vital oxygen and nutrients.
- Without oxygen supply the heart muscle starts to die.

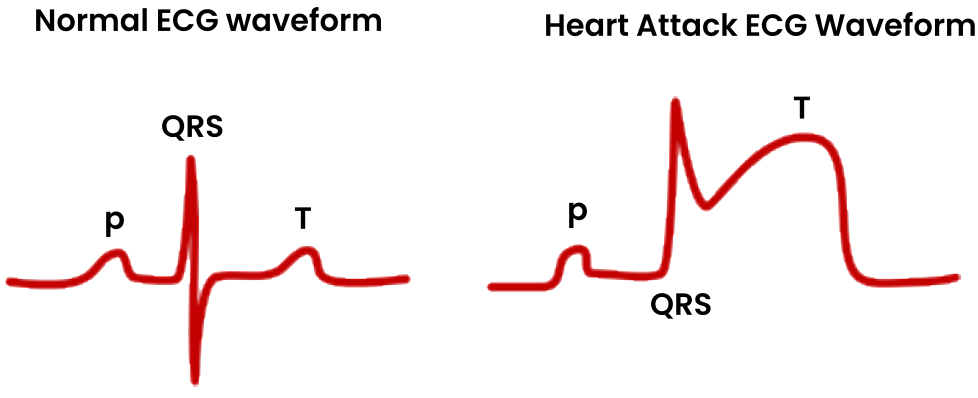
How do we investigate a Myocardial Infarction?

Blood test:

- Damage to your heart from a heart attack causes certain proteins to slowly leak into your blood. Enzymes are special proteins that help regulate chemical reactions
- The most common protein measurement is called cardiac troponin.
- The levels of the enzyme are raised when heart cells are damaged.

Electrocardiogram (ECG):

- An ECG is the tracing of the electrical activity of the heart. If the heart attack is big enough it could cause disruption to the electrical activity in the heart and so the ECG will look abnormal.
- This is a more severe heart attack and it is called a STEMI (ST elevation myocardial infarction).



In a heart attack the line between the QRS and T wave rises – this is called **ST segment elevation**. This is how doctors know a heart attack is occurring.

How do we treat a Myocardial Infarction

We need to restore blood supply to the heart. We can do this in 3 main ways:

- **Coronary angioplasty**

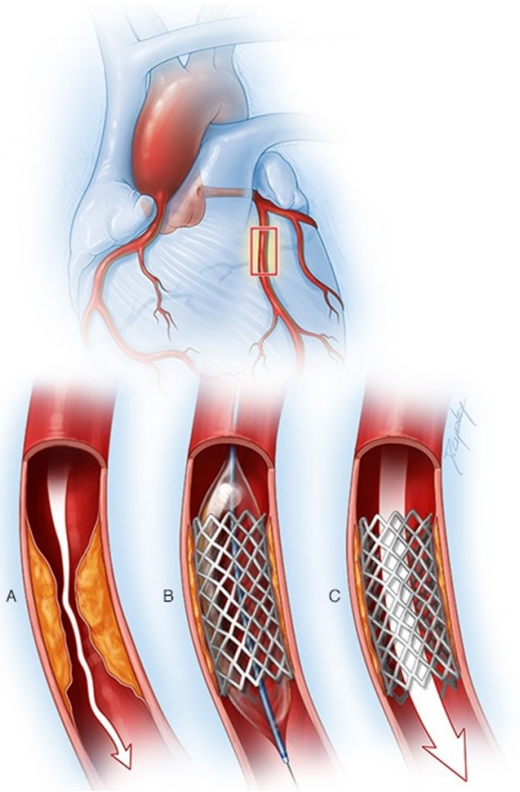
  This is when specialist doctors (interventional cardiologist) use wires to places stents in the coronary arteries and open them up.

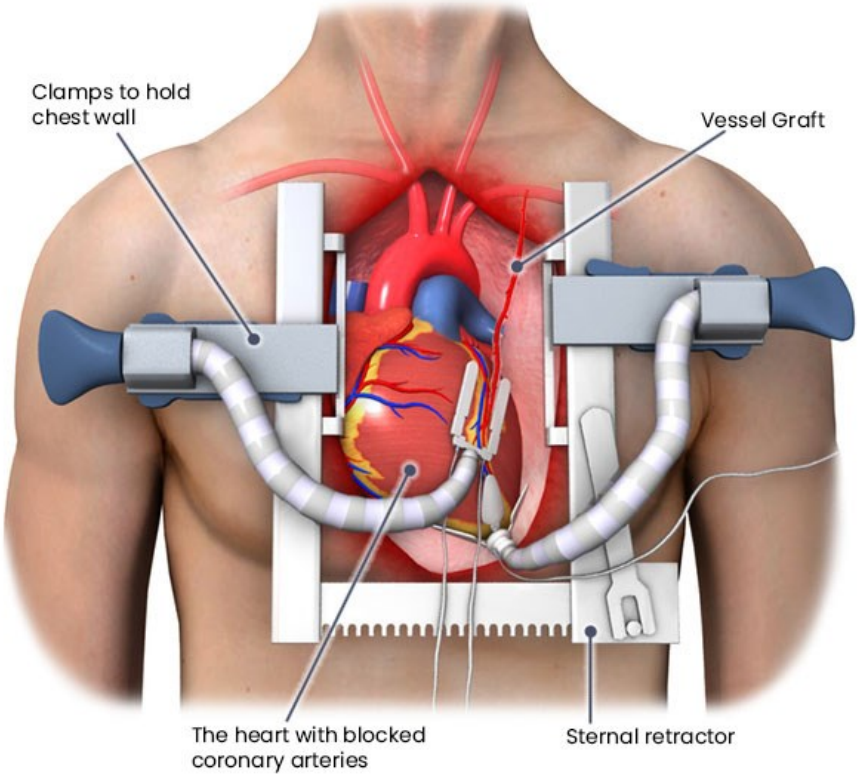
- **Coronary artery bypass graft (CABG)**

  This is when veins or arteries are taken from somewhere else in the body (usually veins are taken from the legs). They are then attached by specialist surgeons (cardiothoracic surgeons) to the blocked coronary arteries to create a diversion of the blood across the blockage (a bypass).

- **Medicine to break down blood clots (thrombolysis)**

  These are strong medication that break down clots. Examples are streptokinase and alteplase.



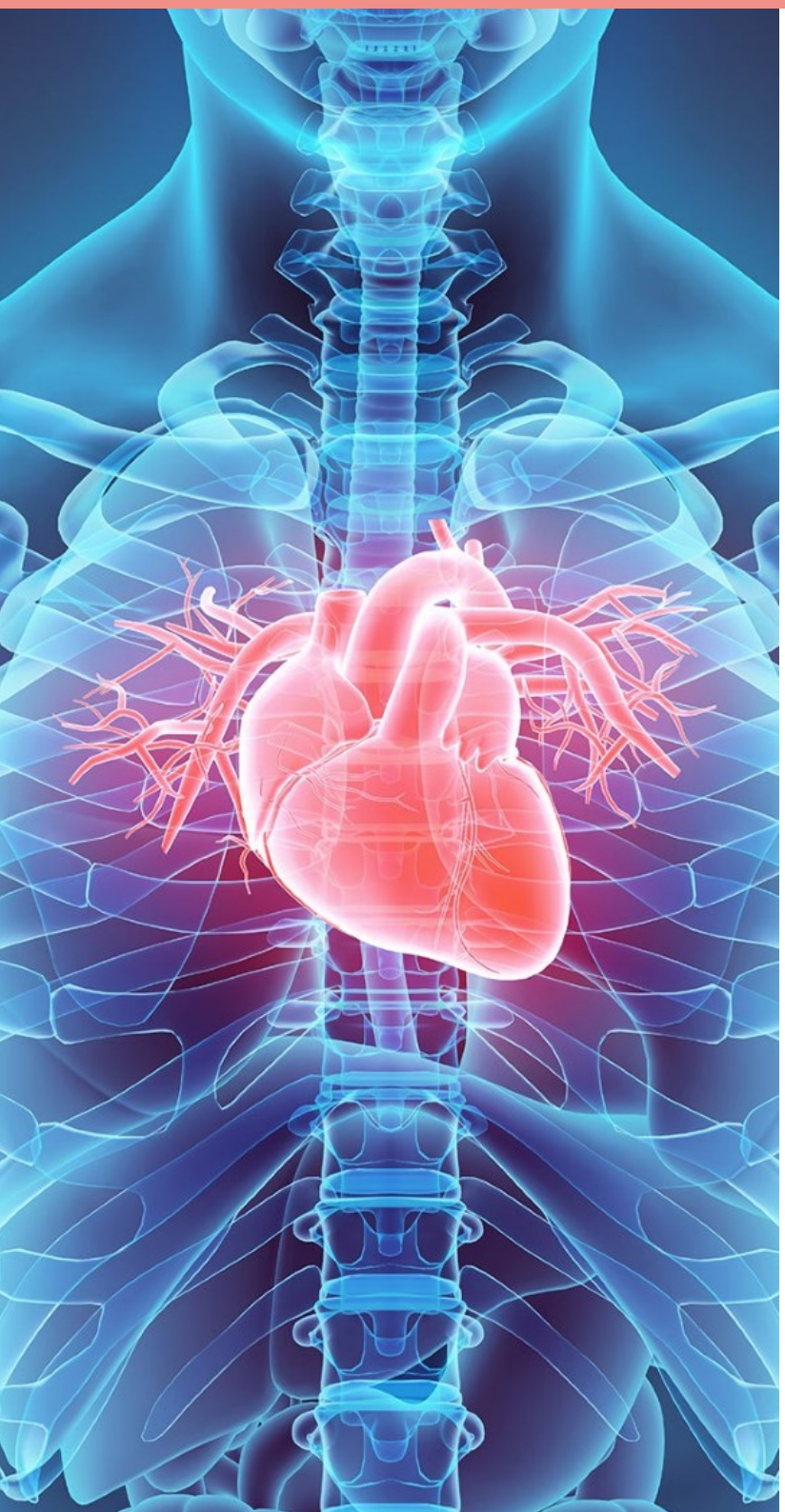


Option 1 - Coronary angioplasty using wires to 'unclog' the coronary vessels that are blocked.

Option 2 - Coronary Artery Bypass Graft which is open heart surgery using vessels from other parts of the body ('grafts') to bypass the blocked coronary arteries

Session 1 – CVS Learning Points

The CVS is made up of the heart and blood vessels, all working together. The heart functions as a pump. The blood vessels act as pipes, carrying blood through the body.



Anatomy

The heart sits in the thoracic cavity. The thoracic cavity has complicated anatomy. The heart is composed of four chambers and four valves.

Physiology

How the heart works. The stages of the cardiac cycle and how its coordinated by a natural inbuilt pacemaker found in the right atrium.

Pathology

Cardiovascular disease is the leading cause of death worldwide. Myocardial infarction is heart damage caused by lack of blood flow to the heart muscle.