CAIE Biology IGCSE

9: Transport in Animals

Notes

(Content in **bold** is for Extended students only)

Circulatory systems

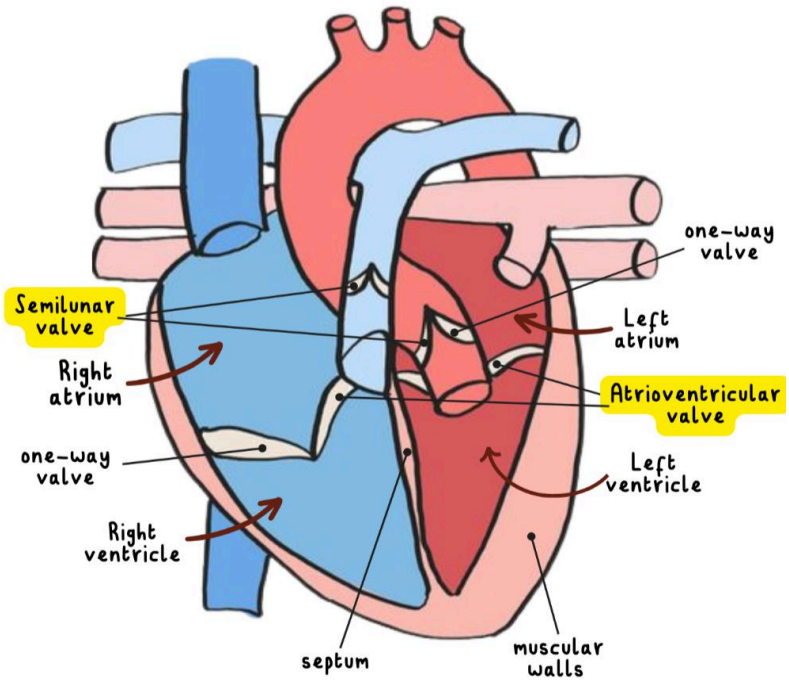
The **circulatory system** acts as the main transport system in animals. It is made up of **blood vessels** such as **arteries, veins and capillaries**, with a **pump** and **valves** to ensure one-way flow of blood.

Fish have a single circulatory system. This means that their heart only has two chambers, and blood passes through it only once on its circuit around the body. Oxygen is absorbed as blood passes the gills, thus fish do not have lungs.

Mammals, in contrast, have a double circulatory system, meaning that blood passes through the heart twice each circuit of the body. This means that the mammalian heart must have four chambers to keep oxygenated and deoxygenated blood separate. Mammals require double circulatory systems as they are larger and have a greater need for oxygen to use in respiration for warmth, as opposed to fish which are cold blooded. Double circulatory systems are also more efficient at supplying oxygen and can maintain a high blood pressure.

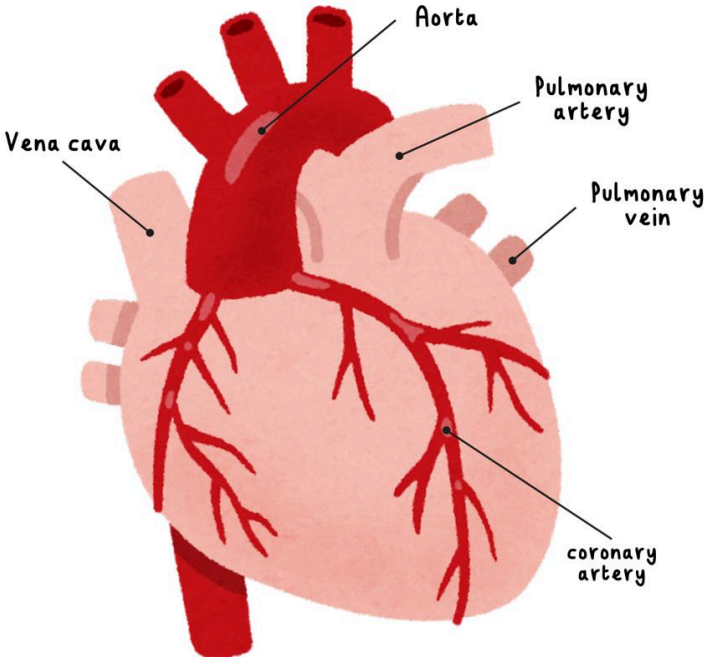
The heart

Structure of the heart:



Highlighted in yellow = supplement only

The image below shows the blood vessels coming into and out of the heart:



Heart function:

1. **Deoxygenated blood enters the heart through the vena cava (vein) into the right atrium.**
2. **The right atrium contracts and blood moves through a one-way valve (tricuspid valve) to the right ventricle.**
3. **The ventricle contracts and blood exits the heart through a one-way valve (semilunar valve) to the lungs via the pulmonary artery.**
4. **Blood becomes oxygenated in the lungs and then returns to the heart via the pulmonary vein, entering the left atrium.**
5. **The left atrium contracts and blood moves through a one-way valve (bicuspid valve) into the left ventricle.**
6. **The left ventricle contracts and oxygenated blood exits the heart past the semilunar valve through the aorta (artery) and travels around the body, becoming deoxygenated. The wall of the left ventricle is much thicker than the right side, as it must be able to pump blood at high pressure around the entire body, rather than just to the lungs. The walls of both ventricles are thicker than the atria walls.**
7. **The left and right sides of the heart are separated by the septum, which makes sure that oxygenated and deoxygenated blood remain separate.**

Valves are present in the heart and veins to prevent backflow of blood. The bicuspid and tricuspid valves are known as the atrioventricular valves as they prevent backflow of blood between the ventricles and atria. They are not present in arteries as the pressure is high enough that backflow does not occur.

Usually, **deoxygenated blood travels in veins to the heart** and **oxygenated blood travels in arteries away from the heart**. The only exception to this is the **pulmonary artery**, which carries **deoxygenated blood** from the heart to the lungs, and the **pulmonary vein** which carries **oxygenated blood** from the lungs to the heart.

Heart monitoring:

The heart can be monitored using an **electrocardiogram (ECG),** which records the electrical signals in the heart that cause contractions of the atria and ventricles. It can also be monitored by listening to the **pulse rate** and listening to sounds of **valves closing.**

Pulse rate is affected by a variety of factors. **Physical activity** is a factor that can influence **short-term** heart rate changes. When physical activity is carried out, the **heart rate increases. During a physical activity, muscles respire to produce energy for movement. Aerobic respiration requires oxygen, thus the heart rate speeds up so that blood is pumped around the body more quickly, allowing more oxygen to be delivered to respiring tissues.**

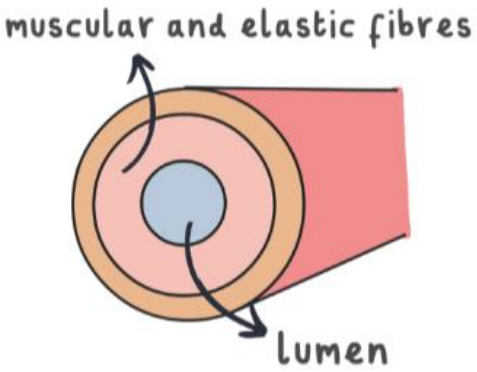
Coronary heart disease:

Coronary heart disease is caused by a **buildup of cholesterol in the coronary artery** which **narrows and eventually blocks the artery**, limiting **blood flow to the heart**. Cholesterol is a result of too much saturated fat in the diet, thus eating a healthy diet can reduce the risk of coronary heart disease. Regular exercise can also decrease the risk of coronary heart disease by **lowering blood pressure**. Other risk factors include stress, smoking, genetic predisposition, age and gender.

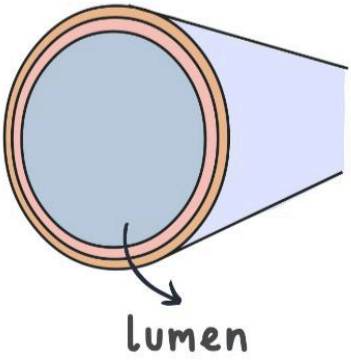
Blood vessels

Adaptations of blood vessels:

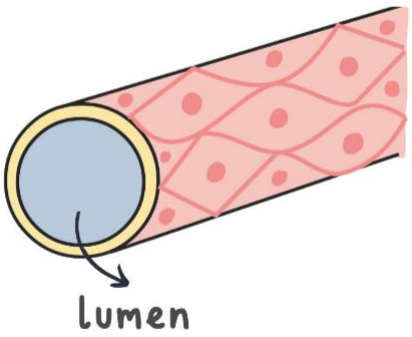
- Arteries carry **oxygenated** blood at high pressure to the tissues. They have a **small lumen, thick elastic layer and wall** **to maintain high pressure without bursting.** They also have a **thick muscle layer** **to control the volume of blood by dilating and constricting the artery. At tissues, arteries branch into arterioles, which enter the tissues and become capillaries.**



- Veins, by comparison, have a **larger lumen**, **thin elastic and muscle layer** as the blood travels at **low pressure** back to the heart **so there is no need to control blood flow.** They are also adapted to **prevent backflow** of blood by containing **valves**. **Venules are small veins which are formed by groups of capillary vessels. Venules eventually become veins.**

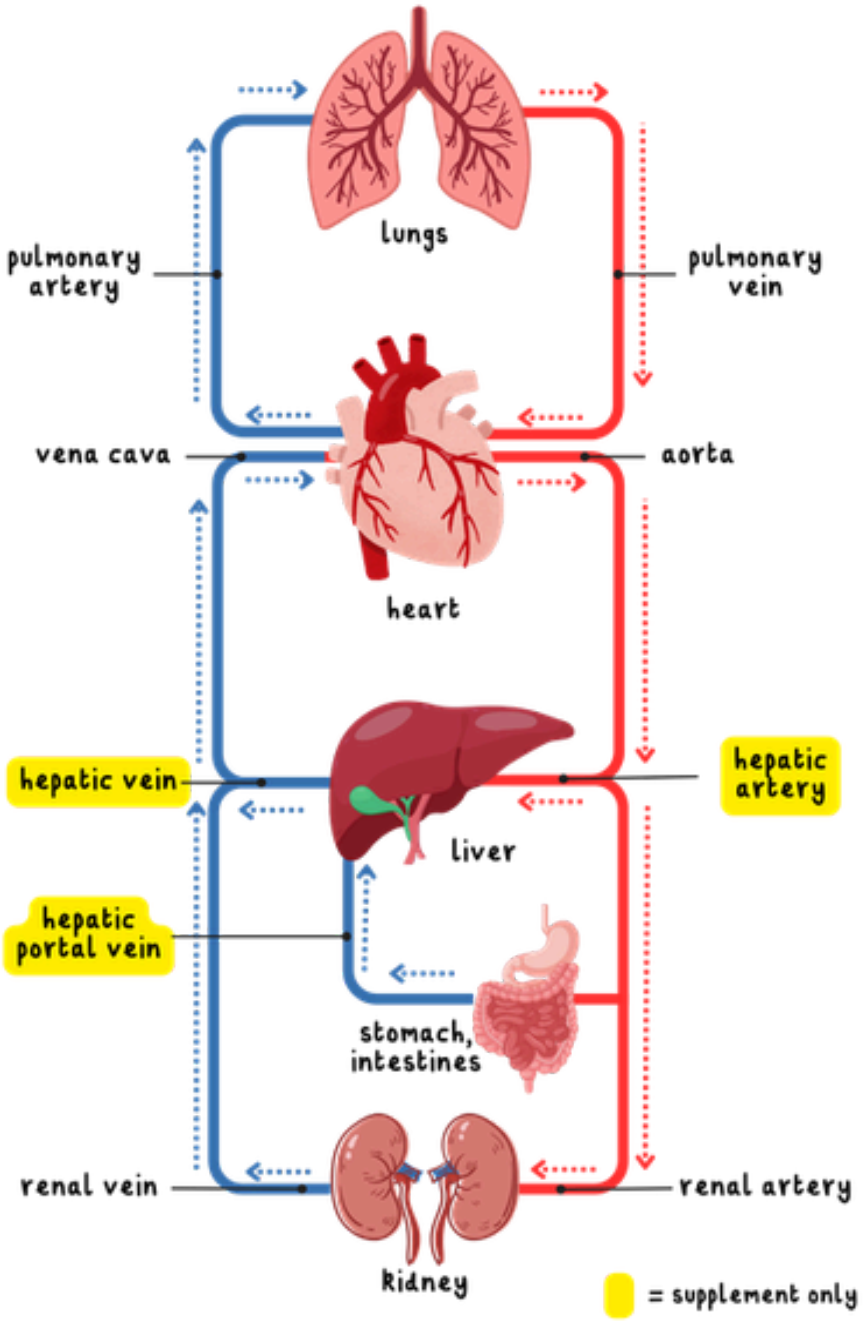


- Capillaries are thin blood vessels which are used to **exchange substances with tissues**, such as oxygen, carbon dioxide and other nutrients. **Therefore, they must be adapted for efficient exchange. They have a large surface area and are branched. They also have a narrow diameter and lumen to decrease diffusion distance, and a slow rate of blood flow to allow time for exchange.**



Major blood vessels in the body surrounding important organs:

The image shows the major arteries and veins branching from the lungs, heart, kidney and **liver.**

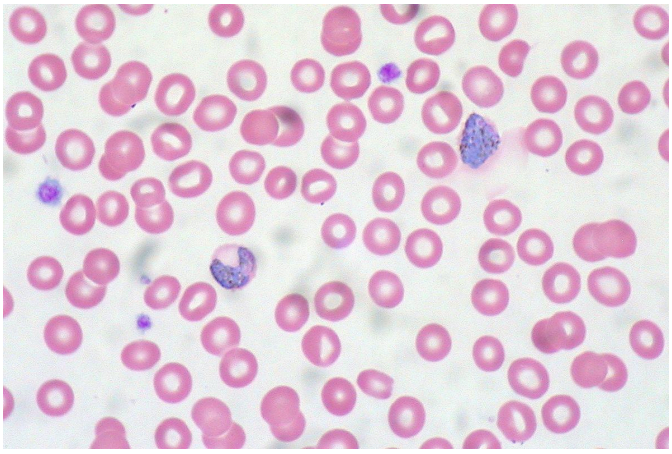


Blood

Our blood is made up of **red blood cells, white blood cells, platelets and plasma.**

- **Red blood cells** - contain **haemoglobin** (protein) which binds to oxygen, allowing it to be transported around the body to cells.

Red blood cells on a photomicrograph:

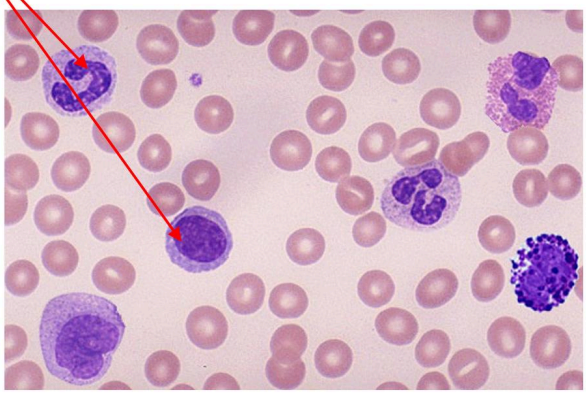


- **White blood cells** - play a major role in **fighting off infection.** **A lymphocyte is a type of white blood cell which produces antibodies.** Antigens are proteins found on the cell membrane of pathogens. Each antibody is **specific** to one type of antigen, and they bind to these antigens, causing the foreign cells to clump together. This makes them harmless as they can no longer enter cells to cause damage. White blood cells, **specifically phagocytes engulf pathogens by phagocytosis** (below).

A white blood cell

White blood cells on a photomicrograph:

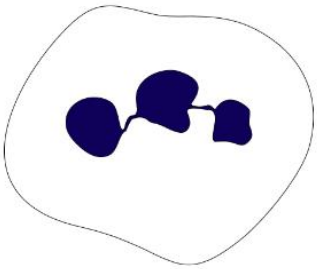
White blood cells



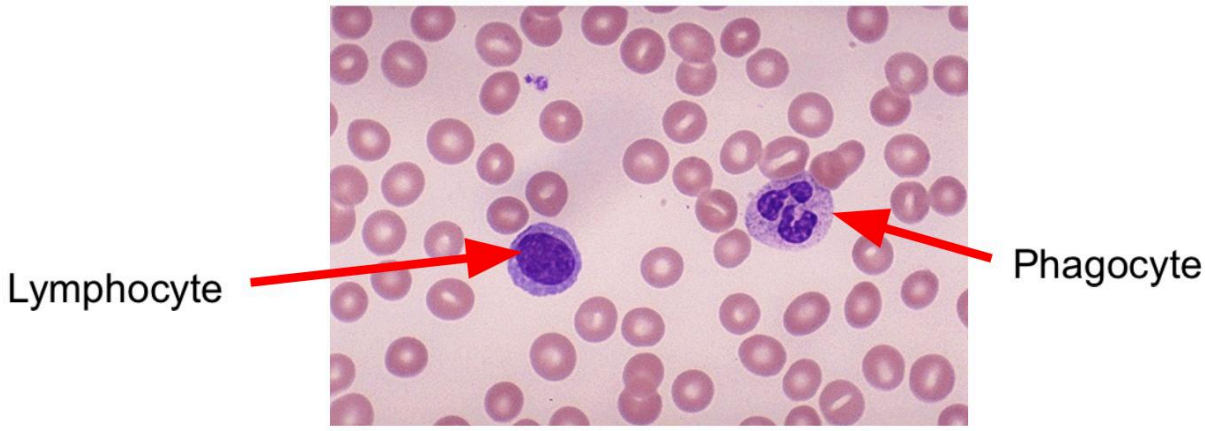
- **Platelets** - involved in blood clotting (below).
- **Plasma** - the liquid in blood vessels in which contains blood cells, ions, soluble nutrients, urea, hormones and carbon dioxide.

Process of phagocytosis:

1. **Phagocyte recognizes and attaches to foreign pathogen**
2. **The membrane of the phagocyte engulfs the pathogen and folds inwards, trapping it inside the phagocyte.**
3. **The phagocyte releases enzymes which break down the pathogen, killing it.**



Identifying lymphocytes and phagocytes on a photomicrograph:



The University of Utah Eccles Health Sciences Library Internet Pathology Laboratory

Blood clotting:

Blood clotting occurs when a blood vessel breaks due to an injury. It is important to prevent blood loss and the entry of pathogens into the body.

Platelets stick to the broken vessel wall and clump together, blocking the cut. Fibrinogen is then converted to a protein called fibrin, which forms a mesh of fibrin fibers across the wound. More platelets stick to this mesh. This forms a scab and prevents bleeding by blocking the cut. This prevents blood loss and allows the vessel to heal, as well as preventing pathogens from entering the blood vessel.