CAIE Biology A-level

Topic 8: Transport in Mammals

Flashcards

Define the term “closed circulatory system”.

Define the term “closed circulatory system”.

A circulatory system in which the blood pumped by the heart is contained within blood vessels. The blood does not come into direct contact with the cells. Closed circulatory systems are found in animals, e.g. vertebrates.

Describe the journey of blood through the human circulatory system with reference to the 4 major blood vessels of the heart.

Describe the journey of blood through the human circulatory system with reference to the 4 major blood vessels of the heart.

heart (r) → pulmonary artery → lungs → pulmonary vein → heart (l) → aorta → body → vena cava → heart (r)

Define the term “double circulatory system”.

Define the term “double circulatory system”.

A circulatory system in which the blood flows through the heart twice in two circuits. Blood is pumped from the heart to the lungs before returning to the heart. It is then pumped around the body, after which it returns to the heart again. Double circulatory systems are found in mammals.

What are the advantages of a closed system?

What are the advantages of a closed system?

- Lower blood volume required to keep system moving
- Blood pressure can be controlled and maintained

What are the advantages of a double circulatory system?

What are the advantages of a double circulatory system?

- Maintains blood pressure around the whole body
- Uptake of oxygen is more efficient
- Delivery of oxygen and nutrients more efficient
- BP can differ in pulmonary and systemic systems

Relate the structure of arteries to their function.

Relate the structure of arteries to their function.

- Thick, muscular walls to withstand high pressure
- Elastic tissue allows them to stretch and recoil to prevent pressure surges
- Narrow lumen to maintain pressure
- Smooth muscle which enables them to vary blood flow
- Lined with smooth endothelium to reduce friction and ease flow of blood

Relate the structure of veins to their function.

Relate the structure of veins to their function.

- Wide lumen eases blood flow
- Thin walls eases compression by skeletal muscles
- Require valves to prevent backflow of blood
- Less muscular and elastic tissue as they don't have to control blood flow

Relate the structure of capillaries to their function.

Relate the structure of capillaries to their function.

- Walls only one cell thick giving a short diffusion pathway
- Narrow lumen, red blood cells squeeze through, decreasing the diffusion distance
- Numerous and highly branched, providing a large surface area

Relate the structure of arterioles and venules to their function.

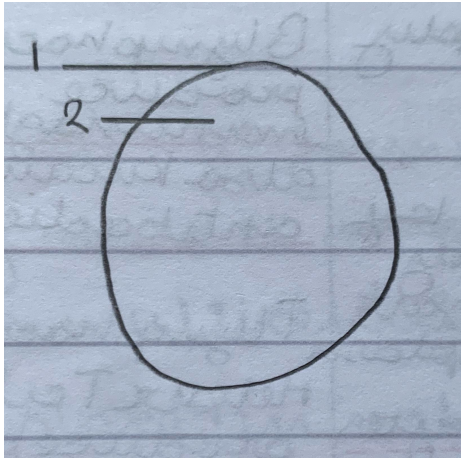
Relate the structure of arterioles and venules to their function.

- Branch off arteries and veins in order to feed blood into and take blood away from the capillaries
- Smaller than arteries and veins so that the change in pressure is more gradual as blood passes through increasingly small vessels

Draw and describe the structure of an erythrocyte.

Draw and describe the structure of an erythrocyte.

- Diameter- 6.2-8.2μm
- Thickness- 2-2.25μm
- Large surface area to volume ratio
- Form biconcave discs
- No nucleus and no large organelles to maximise O_2 carrying ability

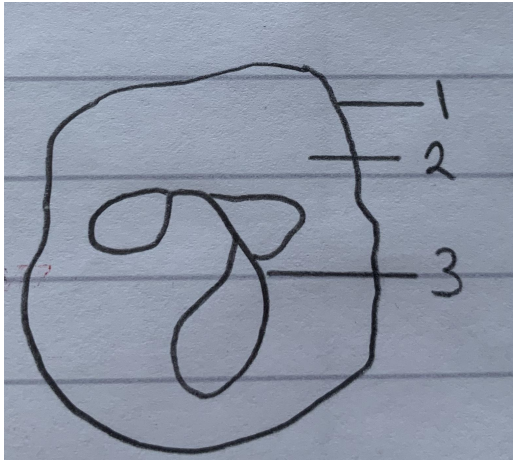


1. Cell surface membrane
2. Cytoplasm - appear dark at edges, becoming lighter in the centre (pink gradient stain under light microscope)

Draw and describe the structure of neutrophils.

Draw and describe the structure of neutrophils.

- Lobed nucleus for flexibility within blood vessels
- Granulocyte

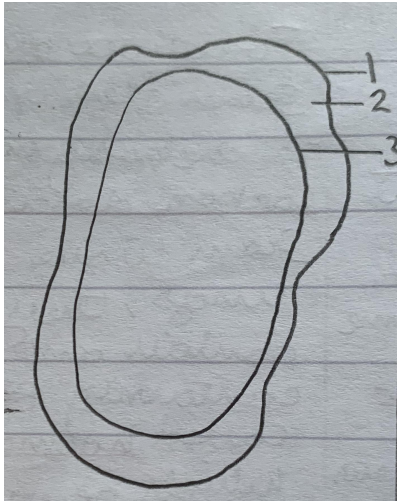


1. Cell surface membrane
2. Cytoplasm (appears granular) stains light blue
3. Lobed nucleus- varies from 3-5 lobes- stains deep blue

Draw & describe the structure of lymphocytes.

Draw & describe the structure of lymphocytes.

- Very large nucleus
- Small amount of cytoplasm
- Agranulocyte



1. Cell surface membrane
2. Cytoplasm- stains pale purple
3. Circular nucleus- stains dark purple

What is tissue fluid?

What is tissue fluid?

A fluid surrounding cells and tissues that contains glucose, amino acids, oxygen and other nutrients. It supplies these to the cells, while also removing any waste materials.

Outline the different pressures involved in the formation of tissue fluid.

Outline the different pressures involved in the formation of tissue fluid.

- **Hydrostatic pressure** - higher at arterial end of capillary than venous end
- **Oncotic pressure** - changing water potential of the capillaries as water moves out, induced by proteins in the plasma

How is tissue fluid formed?

How is tissue fluid formed?

As blood is pumped through increasingly smaller vessels, **hydrostatic pressure** is **greater** than **oncotic pressure**, so fluid moves out of the capillaries. It then exchanges substances with the cells.

Why does blood pressure fall along the capillary?

Why does blood pressure fall along the capillary?

- Friction
- Lower volume of blood

What happens at the venous end of the capillary?

What happens at the venous end of the capillary?

- **Oncotic pressure** is **greater** than **hydrostatic pressure**
- Fluid moves down its water potential gradient back into the capillaries

How is tissue fluid removed?

How is tissue fluid removed?

- Tissue fluid drains into the **lymphatic system** where it is referred to as '**lymph**'
- The lymph returns to the blood via the **subclavian veins**

Give some examples of intracellular and extracellular body fluids in which water is the primary component.

Give some examples of intracellular and extracellular body fluids in which water is the primary component.

Water is a component of:

- Blood plasma (for the transport of substances)
- Cytoplasm
- Tissue fluid (bathes cells)
- Lymph
- Urine for excretion
- Serum

*Why is water important in body fluids?

*2022-2024 specification

*Why is water important in body fluids?

- Water acts as a **solvent** in order to transport material in biofluids
- Water has a **high specific heat capacity** - a large amount of energy is required to change its temperature - facilitating the maintenance of homeostatic conditions

*2022-2024 specification

Describe the role of haemoglobin.

Describe the role of haemoglobin.

Present in red blood cells. Oxygen molecules bind to the haem groups and are transported around the body. They are released where oxygen is needed in respiring tissues.

How does the partial pressure of oxygen affect oxygen-haemoglobin binding?

How does partial pressure of oxygen affect oxygen-haemoglobin binding?

Haemoglobin has variable affinity for oxygen depending on the partial pressure of oxygen, $p(O_2)$:

- At high $p(O_2)$, oxygen **associates** to form oxyhaemoglobin
- At low $p(O_2)$, oxygen **dissociates** to form deoxyhaemoglobin

How is carbon dioxide carried from respiring cells to the lungs?

How is carbon dioxide carried from respiring cells to the lungs?

- Transported in **aqueous solution** in the plasma
- As **hydrogen carbonate ions** in the plasma
- Carried as **carbaminohaemoglobin** in the blood

What is the chloride shift?

*2022-2024 specification

What is the chloride shift?

- Process by which chloride ions move into the erythrocytes in exchange for hydrogen carbonate ions which diffuse out of the erythrocytes
- One-to-one exchange

*2022-2024 specification

Why is the chloride shift important?

*2022-2024 specification

Why is the chloride shift important?

It maintains the electrochemical equilibrium of the cell.

*2022-2024 specification

What is the function of carbonic anhydrase?

What is the function of carbonic anhydrase?

Catalyses the reversible reaction between water and carbon dioxide to produce carbonic acid.

Write equations to show the formation of hydrogen carbonate ions in the plasma.

Write equations to show the formation of hydrogen carbonate ions in the plasma.

Carbonic anhydrase enzyme catalyses:

$CO_2 + H_2O \rightleftharpoons H_2CO_3$ (carbonic acid)

Carbonic acid dissociates:

$H_2CO_3 \rightleftharpoons HCO_3^-$ (hydrogen carbonate ions) + H^+

State the Bohr effect.

State the Bohr effect.

The loss of affinity of haemoglobin for oxygen as the partial pressure of carbon dioxide increases.

Explain the role of carbonic anhydrase in the Bohr effect.

Explain the role of carbonic anhydrase in the Bohr effect.

- Carbonic anhydrase is present in red blood cells
- Catalyses the reaction of carbon dioxide and water to form carbonic acid, which dissociates to produce H^+ ions
- H^+ ions combine with the haemoglobin to form haemoglobinic acid
- Encourages oxygen to dissociate from haemoglobin

Why is a higher concentration of erythrocytes important for human populations living at high altitudes?

Why is a higher concentration of erythrocytes important for human populations living at high altitudes?

- High altitude, low p(O_2), oxygen saturation in erythrocytes will decrease
- To carry an equal volume of O_2 in blood, a higher concentration of erythrocytes is required

What is plasma?

What is plasma?

- Main component of the blood (yellow liquid) that carries red blood cells
- Contains proteins, nutrients, mineral ions, hormones, dissolved gases and waste. Also distributes heat

Describe and explain the shape of a dissociation curve for adult haemoglobin.

Describe and explain the shape of a dissociation curve for adult haemoglobin.

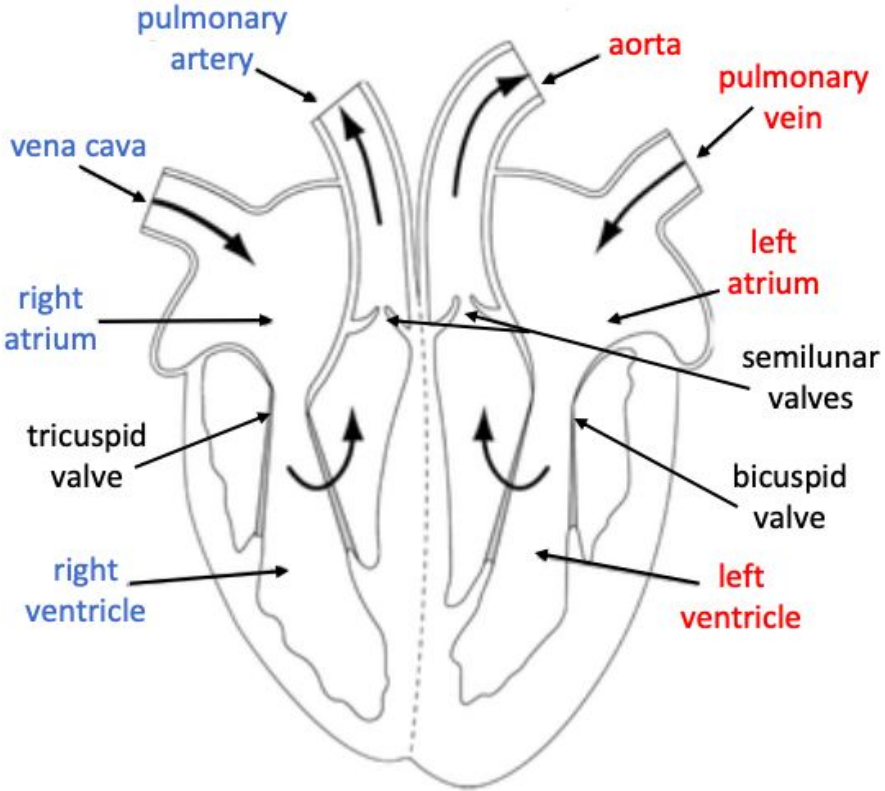
Sigmoidal curve (S-shaped):

- When first O_2 molecule binds, it changes the tertiary structure of haemoglobin so that it is easier for the second and third molecules to bind

- Third molecule changes the tertiary structure of haemoglobin so that it is more difficult for the fourth molecule to bind

Draw a diagram of the human heart, including the names of chambers, vessels, and valves.

Draw a diagram of the human heart, including the names of chambers, vessels, and valves.



Describe what happens during cardiac diastole.

Describe what happens during cardiac diastole.

The heart is relaxed. Blood enters the atria, increasing the pressure and opening the atrioventricular valves. This allows blood to flow into the ventricles. Pressure in the ventricles is lower than in the arteries, so semilunar valves remain closed.

Describe what happens during atrial systole.

Describe what happens during atrial systole.

The atria contract, forcing the atrioventricular valves open. Blood flows into the ventricles.

Describe what happens during ventricular systole.

Describe what happens during ventricular systole.

The ventricles contract. The pressure increases, closing the atrioventricular valves to prevent backflow, and opening the semilunar valves. Blood flows into the arteries.

Explain how the heart contracts.

Explain how the heart contracts.

- SAN initiates and spreads impulse across the atria, so they contract. Thick fibrous walls prevent impulse spreading directly to ventricles
- AVN receives, delays, and then conveys the impulse down the bundle of His
- Impulse travels into the Purkinje fibres which branch across the ventricles, so they **contract from the bottom up**.

Top tip: consider the importance of this ↑

The walls of the chambers of the heart vary in thickness - explain this.

The walls of the chambers of the heart vary in thickness - explain this.

- Walls of both atria relatively thin, only have to cap blood in ventricles as ventricles fill mostly passively
- Left ventricle wall significantly thicker than right, left must provide pressure for systemic flow, right only has to supply pulmonary system. Both are thicker than the atria