Biology – Exchange and Transport in Animals (autumn term)

Key Vocabulary

Diffusion - The random movement and spreading of particles. There is a net (overall) diffusion of particles from a region of higher concentration to a region of lower concentration.

Metabolism - All the chemical reactions that occur in an organism.

Surface area : volume (SA : V) ratio - The total amount of surface area of an object divided by its volume. The bigger the ratio, the more surface area something has per unit volume.

Urea - A waste product made in the liver from excess amino acids.

Erythrocyte - Another term for red blood cell.

Haemoglobin - The red, iron-containing pigment found in red blood cells.

Lymphocyte - A type of white blood cell that produces antibodies.

Phagocyte - A white blood cell that is capable of engulfing microorganisms such as bacteria.

Aorta - The major artery leading away from the heart.

Atrium - An upper chamber in the heart that receives blood from the veins.

Ventricle - A lower chamber in the heart that pumps blood out into the arteries.

Important Information

The **surface area : volume ratio** (**SA : V**) is the surface area divided by the volume, or

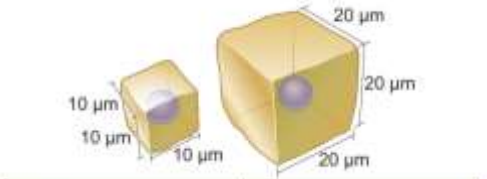
$$\frac{\text{surface area}}{\text{volume}}$$

The bigger this ratio, the more surface area something has per unit volume. Diagram C shows that as cells get bigger, their SA:V ratio gets smaller. If the ratio is too small, a cell cannot get enough raw materials fast enough. So, there is a limit to the size of cells.

The particles in a solution move randomly in all directions. This causes an overall ('net') movement of the solute particles, from higher concentration to lower concentration. No net movement occurs when the concentrations are equal (although the individual particles are still moving).

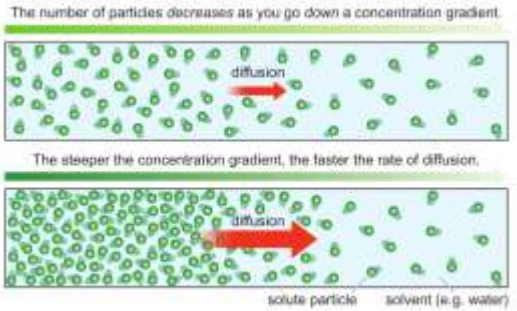
The difference between two concentrations forms a **concentration gradient**. The bigger the difference, the *steeper* the concentration gradient and the faster the rate of diffusion.

Graphs and Diagrams

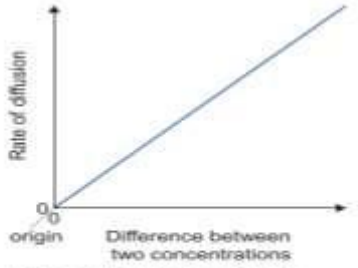


surface area = 6 × (10 × 10) = 600 µm²	surface area = 6 × (20 × 20) = 2400 µm²
volume = 10 × 10 × 10 = 1000 µm³	volume = 20 × 20 × 20 = 8000 µm³
SA : V = 600 / 1000 = 0.6	SA : V = 2400 / 8000 = 0.3

C Cells of different sizes have different SA:V ratios.



A The greater the difference between concentrations, the faster the rate of diffusion.



B The rate of diffusion is directly proportional to the concentration difference.

Pulmonary artery - An artery that carries deoxygenated blood from the right atrium to the lungs.

Pulmonary vein - A vein that carries oxygenated blood from the lungs to the left atrium.

Heart valve - A structure made of flaps of tissue between an atrium and a ventricle of the heart. The heart valve stops blood flowing in the wrong direction when the heart muscle contracts.

Stroke volume - The volume of blood the heart can pump out with each beat.

Aerobic respiration - A type of respiration in which oxygen is used to release energy from substances such as glucose.

Anaerobic respiration - A type of respiration that does not need oxygen.

Lactic acid - The waste product of anaerobic respiration in animal cells.

Heart structure

There are four **chambers** in the heart. Blood from most of the body enters the right **atrium** through the **vena cava** (a large vein). At the same time, blood from the lungs enters the left atrium through the **pulmonary vein**. When these top chambers are full, the muscles around them **contract** to push blood into the **ventricles**. The muscles in the ventricle walls then contract, forcing blood out of the heart. As this is happening, the muscles in the atria walls relax and these chambers refill with blood.

Cardiac output

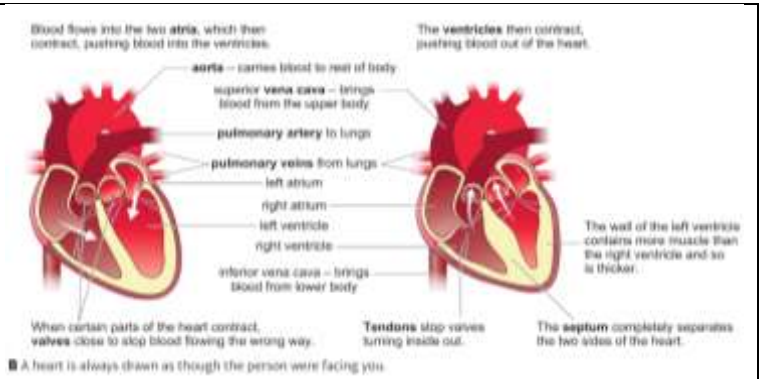
The contraction and relaxation of muscles during each heartbeat is controlled by **impulses** from the nervous system. The **heart rate** is the number of times the heart beats in a minute. The volume of blood pushed into the aorta in each beat is the **stroke volume**. It is measured in litres. The **cardiac output** is the volume of blood pushed into the aorta each minute, and can be calculated using the equation:

cardiac output (litres/min) = stroke volume (litres/beat) × heart rate (beats/min)

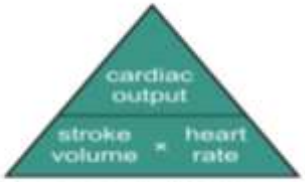
Method

Wear eye protection.

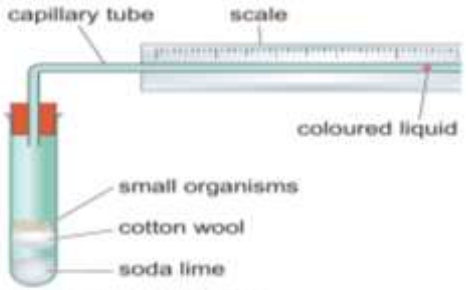
A Collect a tube with some soda lime, held in place with cotton wool. The soda lime absorbs carbon dioxide. Soda lime is corrosive, so do not handle it. The cotton wool is there to protect you and the organisms.
B Carefully collect some of the small organisms in a weighing boat.
C Gently shake the organisms out of the container and into the tube.
D Insert the bung and capillary tube, as shown in diagram B.
E Set up a control tube.
F Place both tubes into a rack in a water bath at a set temperature. It is best to tilt the rack slightly so that the capillary tubes hang over the side of the water bath at an angle.
G Wait for five minutes to let the organisms adjust to the temperature of the water bath.
H Hold a beaker of coloured liquid to the ends of the capillary tubes, so that liquid enters.
I Mark the position of the coloured liquid in the tube and time for five minutes.
J Mark the position of the coloured liquid again, and measure the distance it has travelled.
K Repeat the experiment at different temperatures.



B A heart is always drawn as though the person were facing you.



D This triangle can help you rearrange the equation for cardiac output. Cover up the quantity you want to calculate and write what you see on the right of the = sign.



B a simple respirometer