CHURCH STRETTON SCHOOL

Triple Science - Biology

SB8 Knowledge organiser

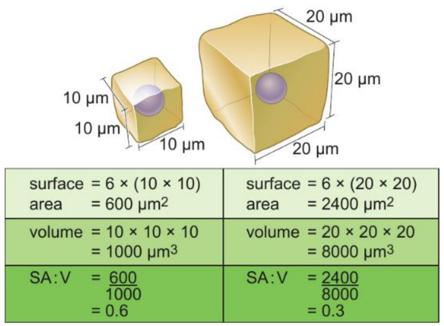
B8: Exchange and Transport in Animals

Lesson sequence

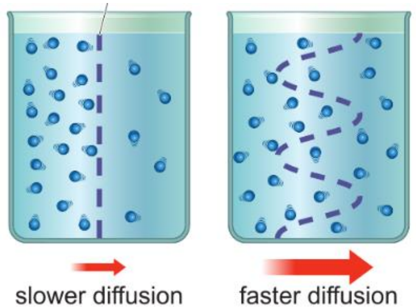
1. Efficient exchange and transport
2. Factors affecting diffusion
3. The circulatory system
4. The heart
5. Cellular respiration
6. Core practical – respiration rates

1. Efficient exchange and transport	
Substances needed by body	Oxygen, glucose, nutrients.
Waste products	Carbon dioxide, urea.
Transport	Moving substances around the body.
Exchange	Moving substances in and out of our cells.
Diffusion	The way substances move in and out of cells – they diffuse from high to low concentration.
Increasing diffusion	High surface area, thin surfaces
Surface area:volume ratio	Surface area / volume.
Importance of SA:volume ratio	A higher ratio means there is more surface area, so substances can diffuse in and out of cells more quickly.
Alveoli	**Role:** Air sacs in lungs where CO_2 and O_2 are exchanged. **Adaptations:** millions of them gives a high surface area, good blood supply maintains a high concentration gradient, thin walls increases diffusion.

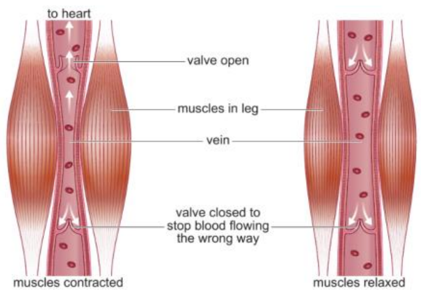
$$\text{rate of diffusion} \propto \frac{\text{surface area} \times \text{concentration difference}}{\text{thickness of membrane}}$$



2. Factors affecting diffusion	
Concentration	The amount of a sub-component in a solution.
Concentration gradient	The difference in concentration between two points.
Surface Area	The amount of exposed area of an object or organism.
Linear relationship	If you double one variable, the other will double as well. The two variables give a straight-line graph.
Directly proportional	The rate of increase in one variable is the same as the rate of increase in the other variable.
Inversely proportional	The rate of increase in one variable is the same as the rate of decrease in the other variable.
Fick's law	Describes the relationship between the rate of diffusion and the three factors that affect diffusion.

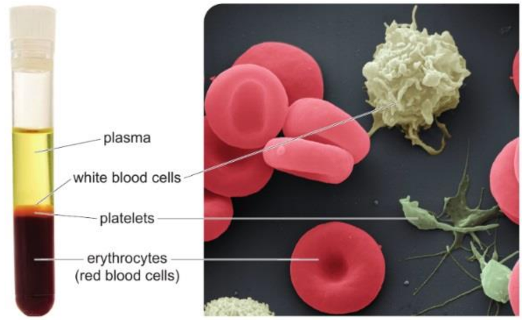


3. The Circulatory system	
Circulatory system	Your heart, arteries, capillaries and veins which work together to pump blood around the body.
The role of blood	To carry oxygen and nutrients to our cells and take waste products away.
Arteries	**Role:** Carry blood away from the heart. **Adaptations:** Thick muscle walls to withstand the high pressure, elastic fibres to stretch as pressure increases during a pulse.
Capillaries	**Role:** To exchange nutrients and waste between the blood and cells. **Adaptations:** Thin walls to increase diffusion, many of them to give a high surface area.
Veins	**Role:** To carry blood towards the heart. **Adaptations:** Thin walls because pressure is low, wide because blood is moving slowly, valves so blood flows right way.



Pulse	A rhythmic beating in the arteries caused by the beating of the heart.
Components of blood	Plasma, red blood cells, white blood cells, platelets.

Plasma	A straw-coloured liquid that carries the blood cells and dissolved substances such as urea, carbon dioxide and glucose.
Red blood cells (erythrocytes)	Contain haemoglobin to carry oxygen around the body.
White blood cells	Fight pathogens (infections). Many types including: **Phagocytes** – engulf ('eat' pathogens. **Lymphocytes** – produce antibodies to attack pathogens.
Platelets	Small fragments of cells that help the blood to clot when you are cut.



4. The heart	
Heart	A double pump that pumps blood: **Right side**: to lungs **Left side**: around the whole body.
Atria (atriums)	The two chambers at the top of the heart. Right: receives blood from body Left: receives blood from lungs.
Ventricles	The two chambers at the bottom of the heart Right: pumps blood to lungs Left: pumps blood to body.

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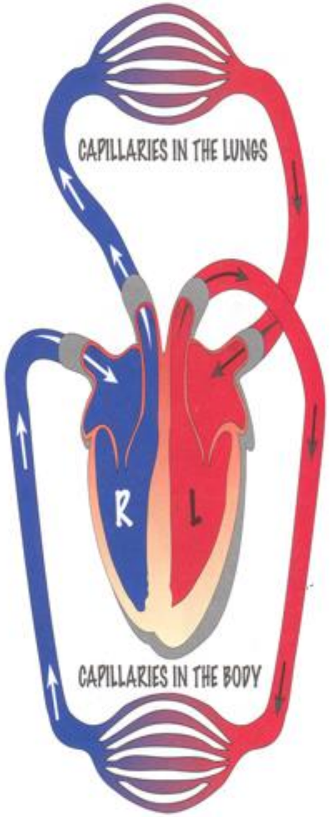
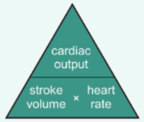
Valves	Prevent blood from flowing from the ventricles back to the atria.
Vena cava	Carries blood from the body into the right atrium.
Pulmonary artery	Carries blood from the right ventricle to the lungs.
Pulmonary vein	Carries blood from the lungs to the left atrium.
Aorta	Carries blood from the left ventricle to the body.
Cardiac output	Cardiac output = stroke volume x heart rate.
Increasing cardiac output	Stronger heart beats (higher stroke volume), higher heat rate.



Worked example

Calculate the cardiac output of a heart that pumps out 0.083 litres of blood 59 times per minute.

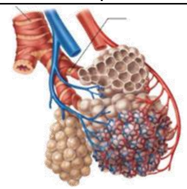
cardiac output = stroke volume × heart rate



cardiac output = 0.083 × 59 = 4.9 litres/min (to 2 significant figures)

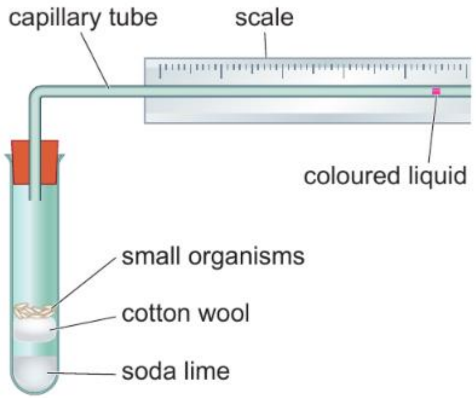
5. Cellular respiration	
Respiration	An exothermic reaction carried out in all living cells to release energy from food molecules such as glucose.
Aerobic respiration	The main type of respiration, which takes place in mitochondria and uses oxygen.
Aerobic equation	glucose + oxygen → carbon dioxide + water
Anaerobic respiration	A form of respiration that releases less energy but extremely quickly. Takes place in the cytoplasm.
Anaerobic equation	Glucose → lactic acid
Role of aerobic respiration	To provide an energy boost during intense exercise when aerobic respiration alone isn't enough.
Lactic acid	A poison that builds up in muscles during anaerobic respiration leading to muscle tiredness and cramp.
Excess post-exercise oxygen consumption	We continue to breath heavily and have a high heart rate after exercise to get lots of oxygen to the muscles to oxidise harmful lactic acid to CO_2 and H_2O.

6. Core practical – rate of respiration (CP7)	
CP7 – Key question	How does temperature affect the rate of respiration in small animals?
CP7 - Set up the respirometer	Place some soda lime (absorbs CO_2) into the test tube put a protective layer of cotton wool over it, add ten maggots, insert in bung with capillary tube and put in water bath to adjust for 5 mins.
CP7 - Run the respiration experiment	Dab the open end of the capillary tube with red food colouring and start the stopwatch.
CP7 - Record results	Every five minutes for fifteen minutes, measure the distance travelled by the food colouring.
CP7 - Vary the temperature	Repeat the experiment in water baths set to different temperatures.
CP7 - Results	The higher the temperature, the faster the animas respire.



Exam-style question

Suggest an explanation for why the heart is sometimes called a 'double pump'. *(2 marks)*



Exam-style questions

1 a State the gas produced by aerobic respiration in the organisms. *(1 mark)*
  b Explain fully why the blob of coloured liquid moves in the capillary tube. *(3 marks)*

2 Describe one way in which the risk of harm is reduced in this experiment. *(1 mark)*

3 A student suggests using a small paintbrush to move the small organisms from a tray into her weighing boat. State why this would be a good idea. *(1 mark)*

4 a Describe how you would set up a control tube. *(1 mark)*
  b Explain why a control tube is necessary. *(2 marks)*

5 The experiment was set up using three large tubes at 25 °C. One tube was a control, one contained 20 g of active mealworms, and the other contained 20 g of slow-moving waxworms.
  a State the two control variables in this experiment. *(2 marks)*
  b State the independent variable. *(2 marks)*
  c In five minutes, the blob of coloured liquid moved 10 mm for the mealworms. Predict what would happen in the other two tubes. *(2 marks)*
  d Explain your predictions. *(2 marks)*
  e The moving of the liquid by 10 mm corresponds to a total change in volume of 5 mm^3. Calculate the rate of respiration in terms of the volume of oxygen used up per gram of organism per minute. Show your working. *(2 marks)*

6 State the lowest and the highest temperature at which you would test the respiration rate in small organisms. Give reasons for your choices. *(2 marks)*

7 Table C shows the results of one experiment to measure the effect of temperature on the respiration rate of waxworms.
  a Explain why the measurements were repeated for each temperature. *(1 mark)*
  b Plot all the results on a scatter graph. *(2 marks)*
  c Identify the anomalous result. *(1 mark)*
  d Suggest an explanation for this anomalous result. *(1 mark)*
  e Draw a line of best fit through the remaining points. *(1 mark)*
  f Describe the correlation shown in your graph. *(1 mark)*
  g Suggest an explanation for this correlation. *(2 marks)*