

CB8a: Efficient transport and exchange

- 4th** 1 two from: lungs, kidney, liver, skin
- 6th** 2 a proteins
- 6th** b urea
- 5th** c by the kidneys (in the urine)
- 5th** 3 lungs – oxygen; small intestine/gut – glucose
- 7th** 4 a Inside: the glucose diffuses down the concentration gradient, from higher concentration to lower concentration. The arrow shows this process and starts inside the capillary, so the inside has a greater glucose concentration than the outside.
- 7th** b There are more oxygen molecules inside the capillary than outside. A better answer would include that oxygen molecules move down the concentration gradient (or contain a description of how oxygen molecules have a net movement from an area in which they are in higher concentration to an area in which they are in lower concentration).
- 6th** 5 its walls are thin, so molecules do not have far to diffuse
- 7th** 6 a $3 \times 3 \times 3 = 27 \mu\text{m}^3$
- 7th** b $3 \times 3 \times 6 \text{ sides} = 54 \mu\text{m}^2$
- 8th** c $54/27 = 2$ (this is presented as a unit-less ratio – the unit if used would be μm^{-1})
- 8th** 7 If cells are too big, diffusion will not be fast enough to be able to supply all parts of the cell with enough of the materials it needs.
- 9th** 8 thin walls and large surface area (for faster diffusion)
- S1**
- oxygen – enters by diffusion – needed for (aerobic) respiration
 - carbon dioxide – leaves by diffusion – is a waste product
- S2**
- SA:V of cube of side $15 \mu\text{m} = 0.4$ (this is presented as a unit-less ratio – the unit would be μm^{-1})
 - SA:V of cube of side $25 \mu\text{m} = 0.24$

- The larger the cube, the lower the SA:V ratio.

- E1**
- (air is breathed into the lungs)
 - oxygen diffuses into the blood
 - into a capillary
 - in alveoli in the lung
 - which has a large SA:V ratio to speed diffusion
 - which has thin walls between air and blood to speed diffusion
 - carried in circulatory system
 - diffuses out of a capillary
 - diffuses into muscle cell
 - carbon dioxide diffuses out of muscle cell
 - diffuses into capillary
 - carried in the circulatory system
 - diffuses from the capillary into the lung alveoli
 - (air is breathed out)

Exam-style question

- All cells need a supply of substances/oxygen/glucose/food to stay alive. (1)
- Diffusion is too slow to get all these materials to all the cells. (1)

CB8b: The circulatory system

- 4th** 1 heart, arteries, capillaries, veins
- 6th** 2 a the capillaries form a fine network
- 7th** b to allow a fast rate of diffusion
- 6th** 3

arteries	thick wall to withstand pressure OR elastic/muscular wall to squeeze back on the blood and even out the flow
veins	valves to stop blood flowing the wrong way OR valves to help move blood against gravity OR thin walls allow (skeletal) muscles to squeeze the veins and push the blood along
capillaries	thin wall to allow fast diffusion

- 7th** 4 The pulse is caused by each beat of the heart.
- 7th** 5
- blood collects in the legs
 - making them swell

- 6th** 6 Urea is carried in the plasma but oxygen is carried in (red blood) cells.
- 5th** 7
- no nucleus – so greater amount of haemoglobin can be packed in to take up oxygen
 - (biconcave) shape – to increase surface area and allow faster diffusion of oxygen in and out
- 7th** 8 A phagocyte surrounding/digesting a foreign cell.
- 8th** 9 Those that are carrying more oxygen have a brighter red colour.

S1

Feature	Arteries	Veins
wall	thick (with elastic and muscle)	thin
valves	no	yes
oxygen in blood (in most)	higher	lower
carbon dioxide in blood (in most)	lower	higher
glucose in blood (in most)	higher	lower
Urea* in blood (in most)	lower	higher

*Most students will not have considered urea (produced from the breakdown of amino acids). And students are not expected to have considered uric acid (produced from the breakdown of DNA) but this may be included by some, particularly if the question is worked on in a group.

- E1** A good answer will contain these points:
- hardness will mean that arteries cannot stretch
 - so blood flow is not smoothed out so much
 - narrower diameter will make it harder for blood to flow
 - slowing down blood flow
 - meaning that some tissues may not get enough oxygen/glucose/food molecules

Some students may include the effects of narrower arteries on blood pressure but this is not expected.

Exam-style question

Three of the following points:

- oxygen is carried by red blood cells
- oxygen diffuses in/out of cells along its concentration gradient
- oxygen binds to/is carried by haemoglobin
- blood is pumped by the heart (3)

CB8c: The heart

- 7th** 1 It does not get the substances it needs (since blood carries those substances) for respiration.
- 5th** 2 a two
- 5th** b The heart is always drawn as though it belongs to someone facing you.
- 6th** 3 (vena cava), right atrium, right ventricle, pulmonary artery, capillaries (in lungs), pulmonary vein, left atrium, left ventricle, (aorta)
- 8th** 4
- haemoglobin is brighter red when carrying more oxygen
 - blood in the aorta has just been oxygenated by the lungs
 - blood in the veins (vena cava) has returned from the capillaries in the tissues, which have removed the oxygen
- 6th** 5 The left ventricle has to pump blood around most of the body but the right ventricle only needs to pump blood to the lungs.
- 6th** 6 They stop blood flowing the wrong way.
- 6th** 7 a $0.07 \times 55 = 3.85$ litres/min
- 7th** b $5/50 = 0.1$ litres
- 8th** 8
- exercise increases the size of the ventricles/strengthens the muscles in the ventricle wall
 - so stroke volume is increased
 - a higher stroke volume means that the heart has to beat fewer times in a minute to achieve the same cardiac output

S1 Two from:

- contains valves – to stop blood flowing the wrong way
- muscular walls – to pump blood around the body
- tendons – to stop valves turning inside out

E1 A good answer will include some or all of these points:

- some blood will flow the wrong way back into his right atrium when the right ventricle contracts
- so less blood will be pumped to the lungs
- breathing faster helps to get as much oxygen as possible into the blood

- by maintaining a higher concentration gradient

Exam-style question

Two of these points:

- the heart has two/left and right sides
- each side pumps to a different part of the body
- each side carries blood with different concentrations/amounts of oxygen (2)

CB8d: Cellular respiration

- 1 The body is constantly moving/keeping warm/producing and breaking down substances.



- 2
- some of the energy released by the reactions
 - is transferred by heating
 - to the surroundings/tissues/body
 - it is an exothermic process



- 3 Hummingbird muscle cells are packed with mitochondria.



- 4 glucose



- 5
- energy is used for movement
 - the more movement, the more energy is required



- 6 a
- breathing is happening faster/deeper
 - so more oxygen is passing into the capillaries in the lungs (and so into the arteries)

(Some students may explain this in terms of maintaining a high concentration gradient or expanding the lungs further to increase surface area, but this is not required.)



- 6 b
- veins carry blood that has been through muscles
 - as the muscles work harder, they remove more and more of the oxygen
 - which they need for respiration



- 7 lactic acid



- 8 a
- extra oxygen is needed to replace the oxygen lost from the blood and muscles
 - for aerobic respiration to release energy to remove the lactic acid



- b
- fitter people have hearts with bigger stroke volumes
 - so they can pump more blood around their bodies in a shorter amount of time
 - meaning a quicker/greater supply of oxygen to those areas that need it
 - thus removing the need for extra oxygen more quickly

S1 A good table will contain points such as these:

	aerobic respiration	anaerobic respiration
reactants	glucose, oxygen	glucose
products	carbon dioxide, water	lactic acid
when used	all the time	at certain times*
where it occurs	mitochondria	cytoplasm**
amount of energy released	more	much less

- *A simplification since there is background anaerobic respiration occurring all the time.
- **A simplification in that the reactions at the start of both types of respiration are the same and occur in the cytoplasm.

- E1
- smaller mammals have a larger surface area:volume ratio
 - so energy has more area through which to be transferred
- E2
- they respire faster
 - so that more energy is released by the reactions and can be transferred to the body

Exam-style question

One of:

- It allows a sudden burst of energy without needing additional oxygen.
- It allows a person to keep running/exercising/fleeing danger even if oxygen is in too short supply for aerobic respiration. (1)

CB8d Core Practical – Respiration rates

- 1 a carbon dioxide (1)
b oxygen is used up; (1) the carbon dioxide

- produced is absorbed by the soda lime;
(1) this reduces the pressure inside the tube and so the blob moves towards the tube. (1)
- 2** cotton wool bung prevents contact with soda lime (1)
- 3** a good idea because it minimises the risk of harming the organisms (1)
- 4** **a** exactly the same as the tube with the organisms but leave the organisms out. (1)
b to ensure that any movement of the coloured liquid is due to the presence of the organisms (1) and not just due to the passage of time and/or the effect of temperature. (1)
- 5** **a** mass of organisms, temperature (2)
b the type of worm (1)
c control tube – the coloured liquid would not move; (1) wax worms – the coloured liquid would move less than 10 mm. (1)
d control tube – because there are no organisms to use up oxygen/a part of the air; (1) wax worms – because they are less active and so will have a lower rate of respiration. (1)
e $5 \text{ mm}^3/20 \text{ g} = 0.25 \text{ mm}^3/\text{g}$
 $0.25/5 \text{ min} = 0.05 \text{ mm}^3/\text{g}/\text{min}$ (1)
- 6** Not below freezing (since this may harm the cells of the maggots) (1 – for both the temperature and the reason). Not above 40 °C (accept a range from 30–45 °C) since maggots are unlikely experience these temperatures in reality/their enzymes may start to denature/ may cause injury to the maggots (1 – for both the temperature and the reason).
- 7** **a** To increase your confidence that the results are correct. (1)
b correctly plotted points (1) scatter graph with suitable axes and labels. (1)
c 30 °C, 10 mm (1)
d a leak in the container allowing air into it, OR starting the stopwatch to time too late/ stopping it too early. (1)
e line of best fit (1)
f the higher the temperature, the greater the rate of respiration/the faster the coloured liquid blob moves (1)
g at higher temperatures organisms/ enzymes are more active, (1) so more respiration is needed to release energy. (1)