

Mark schemes

1

- (a) (i) Changes shape of antitrypsin;

Reference to hydrogen/ionic/disulfide bonds;
No longer attaches to/interacts/ reacts with trypsin;

Accept protease

2

- (ii) Higher the concentration of hydrogen peroxide, more amino acids/
proteins affected;
More antitrypsin molecules change shape;

2

- (b) (Longterm smokers) inhale a lot of hydrogen peroxide;
Smokers have more active enzyme that damages lung tissue;
Reducing gas exchange surface;

2 max

[6] (a) Active transport against / facilitated down with concentration gradient;

2

Accept answers in terms of water potentials

Active transport uses ATP/energy, /facilitated doesn't;

Reject along/across gradient

Active uses carrier (proteins), / facilitated (often) uses channel (proteins);

2 max

- (b) Lipid/fatty acid part of membrane is non-polar/hydrophobic;

Accept lipid/fatty acid bilayer

Oxygen and carbon dioxide small/ non-polar (molecules);

Oxygen/carbon dioxide can diffuse through/dissolve in/
get between molecules in this layer;

Down a concentration gradient;

2 max

- (c) Brings more oxygen/removes carbon dioxide;

Maintains diffusion/concentration gradients;

Between alveoli and blood/capillaries;

Reject references to surface area

2 max

[6]

3

(a) (explanation must be linked to structures to gain second mark for each linked pair)

filaments / lamellae ;	large SA;
gill plates or secondary lamellae;	
large number of capillaries;	to remove oxygen / to maintain a gradient;
thin epithelium;	short diffusion pathway;
pressure changes;	to bring in more water / to maintain gradient;
countercurrent flow (or description);	exchange / diffusion along whole length / concentration gradient maintained / equilibrium not achieved / blood always meets water with higher oxygen concentration;

6

(b) (i) requires 20 cm³ of oxygen / extracts 7.2 cm³ of oxygen /
reject if referring to volume of water

$$\frac{20}{7.2};$$

$$2.7 / 2.8 \text{ (dm}^3\text{h}^{-1}\text{);}$$

(correct answer award 2 marks)

2

(ii) high (relative) density / heavy; requires large input of energy as difficult to push back out;

2

(c) (for each pair second point must be linked to first) to provide same amount of oxygen; need to have more water flowing over gills;

OR

metabolic rate / respiration increases (with increase in temperature);
so more oxygen required;

2 max

[12]

QWC 1

4

(a) 1. mouth opens, operculum / opercular valve shuts;

2. floor of mouth lowered;

3. water enters due to decreased pressure / increased volume;

4. mouth closes, operculum / opercular valve opens;

5. floor raised results in increased pressure / decreased volume;

6. high / increased pressure forces / pushes water over gills;

4 max

- (b) 1. alveoli provide a large surface area;
 2. walls of alveoli thin to provide a short diffusion pathway; 3. walls of capillary thin / close to alveoli provides a short diffusion pathway;
 4. walls (of capillaries / alveoli) have flattened cells;
 5. cell membrane permeable to gases;
 6. many blood capillaries provide a large surface area;
 7. intercostal / chest muscles / diaphragm muscles / to ventilate lungs / maintain a diffusion / concentration gradient;
 8. wide trachea / branching of bronchi / bronchioles for efficient flow of air;
 9. cartilage rings keep airways open;
(reject moist and thin membranes)

6 max

[10] (a) exchange / diffusion across body surface / skin;

5 short diffusion pathway / distance / large SA:V ratio;

2

- (b) large numbers of lamellae so large SA; lamellae thin so short (diffusion) pathway to blood / capillaries; high rate of oxygen uptake for respiration / energy release;

(accept more oxygen)

3

[5] (a) contraction of (diaphragm) muscles flattens diaphragm;

6

contraction of intercostal muscles raises ribcage;
 increase in volume decreases pressure;

3

- (b) (i) tidal volume increases steeply, then increase slows down after 10 to 15 km h⁻¹;

1

- (ii) breathing rate increases slowly then steeply after 10 to 15 km h⁻¹;

(max 1 if no reference to speed where change occurs in either (i) or (ii))

1

- (c) $20 \times 2.75 = 55 \text{ dm}^2$;

(award 1 mark for correct method i.e. tidal volume \times rate);

2

[7]

- (i) (waxy so) impermeable to water / waterproof / stops water

7 passing through;

1

- (ii) reference to hairs / position of stomata (sunken stomata / stomata in pits)

LINKED to reduced air movement / trap layer of air /
trap water vapour (*reject water*) / maintains humidity;

reduces diffusion gradient / concentration gradient of water /
water potential gradient;

OR

stoma can close;
reduces area for evaporation or transpiration;

[3] (a) (i) one feature; 2

8

then linked Explanation;

(many) filaments / lamellae / secondary lamellae;
so large surface area;

large number of capillaries; (NOT "good blood supply")
maintains a diffusion gradient / removes oxygen;

thin epithelium / lamellae wall;
short diffusion pathway;

2

(ii) maintains diffusion / concentration gradient / equilibrium
not reached;
diffusion occurs across whole length (of lamellae / gill);

2

(b) less energy needed / continuous flow of water or O₂;

1

[5]

1 (a) (diffusion) gradient will be maintained all the way along the gill / the amount of oxygen in

9

the water is always higher than in the blood / the numbers in the water are always higher
than in the blood;
more oxygen will diffuse into the blood;

2

(b) 100 cycles per minute;
(*principle of 60 / x or 0.6 seen gains one mark*)

2

[4]

(i) Because there are big differences;

10

any correct named example e.g. lung cancer / bronchitis much lower in women than in men;

2

- (ii) easier to compare if sample size effectively the same; different numbers of people in each group;

2

[4] (a) (gills have) lamellae on filaments;

11

lots of both;

2

- (b) (i) all 3 go up;

Accept converse

1

- (ii) more oxygen can be supplied; for more respiration;

Accept answer relating to CO₂

2

[5] (a) Immediate / rapid increase, steady rise and plateau clearly identified;

12

Ignore references to rest period if clearly identified as such

1

- (b) Find value of pulmonary ventilation from graph / 26-28; Divide by breathing rate / 20;

2

- (c) Air is from nose / trachea / bronchi / not been in alveoli / dead space; Gas exchange / diffusion only in alveoli / not in these structures;

2

[5] (a) Epithelium of alveolus, capillary wall / epithelium / endothelium, plasma;

13

1

- (b) Cell wall;
Capsule;
Flagellum;
Mesosomes;
Plasmid;
Genetic material / DNA / nucleoid;
Ribosomes;

Accept references to size only if some idea of range is given

max 2

- (c) Large (surface) area; For diffusion;

or
Short distance to centre of cell / to all haemoglobin;
For diffusion;

2

- (d) (i) Correct answer of approximately 7800 / 8000 = 2 marks
Incorrect answer but clearly derived by
dividing diameter of cell A by 7 = 1 mark

2

(ii) Idea of cut through maximum diameter / middle;

1

[8]

14

$$\frac{10}{20} \times \text{measurement} / \frac{1}{2} \times \text{measurement} \quad (\text{a}) ;$$

= 1.25 to 1.5;

allow 1 mark if correct working shown

max 2

- (b) Maintains concentration gradient (over
whole length of gill) / diffusion can occur
over whole gill;
More oxygen enters blood (/ more CO₂ leaves);
More (aerobic) respiration / more energy release in muscle / for
swimming; 'more' needed ONCE only

3

[5] (a) Diaphragm (muscle) contracts;

15

Flattens / Increases volume of chest;
Reduced pressure allows air to enter;

3

- (b) Allows comparison;
As organs differ in size / as larger organs will need more blood;

2

- (c) 2 marks for 40.91 / 40.9 / 41
1 mark for 59.09 / 59.1 / 59

2

- (d) (i) Some oxygen still in lungs (which will enter the blood) / removal of carbon dioxide
(from blood);

1

(ii) More blood available for other organs;
Supplying oxygen / glucose / removing carbon dioxide;
OR

Diaphragm muscles not contracting (as not breathing);
Will not require (as much) oxygen / glucose;

2

[10]

(a) Muscles (associated with breathing) relax;

16

1

(b) Produces lower pressure (and air moves in down pressure gradient);

1

[2] (a) (i) less at **A** / more at **B**;

17

(accept inspiration and expiration as equivalent to A and B)

1

(ii) carbon dioxide diffuses / passes / into alveoli / from blood; as
higher concentration in blood / low concentration in alveolus;

(first mark for site and direction, second for cause)

2

(b) curve increases; *(reject if
decreases)* then levels
out;

2

(c) (i) contract; ribs move
upwards / out;
increasing volume / decreasing pressure in chest / thorax / lungs;

3

(ii) intercostal muscles relax;

(if you can ignore ref to internal contracting, do so)

1

[9] (a) increasing carbon dioxide concentration / partial pressure;

18

(decrease in oxygen negates)

1

(b) (oxygen is used in) respiration therefore diffuses (from
tracheae) to tissues; oxygen unable to enter organism;

2

(c) spiracles not open all the time; therefore there is less water
loss
(by diffusion through spiracles);

2

[5] (a) (Small alveoli with) large surface area;

19

For diffusion;

2

(b) (i) Epithelium / epithelial / squamous / pavement cells; *Reject endothelium.*

1

(ii) 0.11 μm ;

1

(c) (i) Less oxygen / more carbon dioxide / more water vapour; *Two differences required, but only one mark for this part of the question.*

1

(ii) Gas exchange takes place in alveoli / does not take place in trachea;

1

(d) (i) Pulmonary artery;

1

(ii) Concentrations reach equilibrium / become equal;
Diffusion occurs when there is a concentration gradient (so some will remain in blood);
OR
Lung cells / vessel cells respire;
Add / produce carbon dioxide;

2

[9] (a) 235–240;;

20

(one mark for an answer between 200-300 based on 2 - 3 stomata in 0.01mm²

Alternatively, one mark for calculating the area of the rectangle correctly as 0.016 – 0.017mm²)

2

(b) grows in arid / dry conditions;
less surface area;
(rate of) transpiration / water loss would be reduced;

3

[5]

21 (a) (i) high / higher CO₂ concentration / lack of oxygen;

1

- (ii) CO₂ asphyxiates / is toxic; lack of oxygen for (aerobic) respiration;
OR
lack of energy / ATP (for pumping movements);
reduced muscle function / muscle fatigue

2 max

- (b) removal of (excess) CO₂ / oxygen to break down lactate / to repay oxygen debt / to enable aerobic respiration;

1

[4] (a) up and out;

22

1

- (b) (i) does not require work / effort / involve muscle contraction / energy expenditure;

1

- (ii) active as it involves contraction of muscles;

1

- (c) liver moves back; increases volume of lungs; pressure lower (in lungs than outside);

3 max

- (d) *maximum of three marks for description, points 1 to 4*

1 inhaled air contains more oxygen than exhaled air;

2 inhaled air contains less carbon dioxide than exhaled air;

3 inhaled air contains less water (vapour);

4 relative amount / percentage of nitrogen also changes;

5 respiration results in lower blood oxygen / higher blood carbon dioxide;

6 oxygen enters blood / carbon dioxide leaves blood in alveoli;

7 by diffusion;

8 water vapour diffuses from moist surface;

6 max

[12]

- (a) 1. Large surface area provided by lamellae / filaments increases diffusion / makes diffusion efficient;

23

Q Candidates are required to refer to lamellae or filaments. Do not penalise for confusion between two

2. Thin epithelium / distance between water and blood;

3. Water and blood flow in opposite directions / countercurrent;
4. (Point 4) maintains concentration gradient (along gill) / equilibrium not reached / as water always next to blood with lower concentration of oxygen;
5. Circulation replaces blood saturated with oxygen;
6. Ventilation replaces water (as oxygen removed);

6

- (b) Mixing of air and water (at surface);

Air has higher concentration of oxygen than water;

Diffusion into water;

Plants / seaweeds near surface / in light;

Produce oxygen by photosynthesis;

2 max

- (c) Not much oxygen near sea bed;

Toadfish haemoglobin (nearly) saturated / loads readily at / has higher affinity for oxygen at low partial pressure (of oxygen);

2

- (d) The chimpanzee and the bonobo are more closely related (than to the gorilla);

They have identical amino acids / one of the amino acids is different in the gorilla;

2

[12] (a) Phagocytes engulf / ingest pathogens / microorganisms / bacteria / viruses;

24

Phagocytes destroy pathogens / microorganisms / bacteria / viruses;

Lung diseases are caused by pathogens / microorganisms / bacteria / viruses;

Q Allow description of process of engulfing

2 max

- (b) (i) Alveoli / lungs will not inflate / deflate fully / reduced lung capacity;

Breathing out particularly affected / no longer passive;

2

- (ii) Alveolar walls thicken;

Longer diffusion pathway;

Scarred / fibrous tissue;

Reduces surface area (for gaseous exchange);

Q Diffusion is essential for 2nd point and surface area for 4th point.

4

(c) (i) Cancer develops 20 – 30 years after exposure (to asbestos);

1

(ii) Smoking / air pollution / specified industrial source;

1

[10] (a) (i) Many people do not go to the doctor;

25

1

(ii) 36000;

No marks awarded for working here as calculation is very straightforward

1

(b) Same sugars / antigens on bacteria / nerve cells;

Do not accept references to same shape as equivalent to complementary.

Bind with antibody / form antigen-antibody complex;

Reject react

Have complementary shape / fit binding site;

Reject active site

3

(c) Diaphragm will not move down / flatten / contract;

Ignore references to breathing out

Thoracic cavity / lung volume not increased so cannot breathe in;

2

[7] (a) (i) Through alveolar epithelium;

26

Through capillary epithelium / endothelium;

Accept: Through lining / wall of alveolus and capillary for 1 mark

Accept: squamous epithelial cells for 'epithelium'

Neutral: alveolar endothelium

Neutral: references to diffusion

Q Correct use of terminology;

2

(ii) (Thicker alveolar wall) – no mark

Neutral: less diffusion

(So) Longer diffusion pathway / slower diffusion;

Neutral: references to surface area

1

(b) (i) (In alveolus)

Need the idea of air moving and oxygen concentration

Brings in air containing a high(er) oxygen concentration;

Neutral: reference to carbon dioxide concentration

Removes air with a low(er) oxygen concentration;

2

(ii) Circulation of blood / moving blood;

Neutral: blood Neutral: short diffusion pathway

1

(c) Long time between decrease in mining and increase in cases;

Graph shows fluctuations;

Correlation does not prove causation / there may be other causes of miner's lung;

Improved diagnosis methods;

Do not know number of cases / baseline before 1990;

Not all cases reported / not all individuals with miner's lung visit a doctor;

Accept: correct use of figures from graph for the first marking point: e.g. cases do not increase until after 2000 / 2001-2004 / 10 years later.

2 max

[8] (a) Filaments / lamellae provide large surface area;

27

Thin / flattened epithelium / one / two cell layers so short diffusion pathway (between water and blood);

Countercurrent / blood flow maintains concentration / diffusion gradient;

Q Do not credit thin cell walls / membranes

2 max

(b) (i) Large / wide range of values (so can fit on graph);

1

(ii) Decrease in uptake with increase in mass / negative correlation;

1

(iii) Enables comparison;

As animals differ in size / mass;

2

[6]