

1. (a) (i) Fish has ventilation system which replaces water;
highly oxygenated water
(circulatory system brings in) blood with low concentration of
oxygen/blood removes oxygen;
counter current system/description; 4
- (ii) One cell thick/single layer of(epithelial) cells lining alveolus;
flattened/pavement/squamous;
capillaries surrounded by single layer of cells;
capillaries and alveoli are close; max. 3
- (b) **Note: Accept converse argument throughout**
Small organisms have large surface/volume ratio;
as, for example, most protoctista/single-celled
organisms/platyhelminths/cnidaria;
diffusion/exchange over body surface/skin;
(the need for) specialised respiratory/gas-exchange surfaces in larger
animals;
diffusion is a slow process;
cells of larger organisms are a long way from gas exchange surface;
must be supplied by transport system/circulatory system/blood; max 6
- [13]**
2. (a) Large animals have small surface area to volume ratio;
Large mammals are homoiothermic;
Lose less heat to environment;
By radiation/convection/conduction;
Fat;
For insulation; max 4
- (b) Very severe environmental conditions in Finland;
Few species able to withstand these;
Producing unstable ecosystem;
Few alternatives/
Change in numbers of one species will affect those that feed on it; max 4
- [8]**
3. (a) countercurrent mechanism;
helps maintain diffusion gradient; 2
- (b) mackerel has shortest total distance;
for diffusion;
(activity requires) oxygen for respiration / ATP production; 3
- [5]**

4. Mackerel has the shortest total distance;
for diffusion;
(activity requires) oxygen for respiration / for ATP production; 3 [3]
5. (a) Molecules will have more (kinetic) energy;
Move faster;
Reject references to vibrating in this context 2
- (b) (i) Oxygen diffuses faster/has a higher rate of diffusion
in air than in water; 1
- (ii) Alveolar epithelium/surface is permeable to small molecules;
Water is a small molecule;
Higher concentration of water in cell/blood than outside;
Water diffuses from blood/cells into alveoli; max 2
- (c) Large number gives large (total) surface area;
For diffusion;
Short distance between tracheoles gives short pathway;
Movement/diffusion through muscle is slow;
*Reject references to muscle simply being close to tracheoles. Must convey
idea of short pathway to gain credit for third point.* 3 [8]
6. (a) Correct answer 200 μ - 2 marks
Incorrect answer clearly resulting from
division of measured length by 300 - 1 mark; 2
- (b) (i) Large surface area to volume ratio; 1
- (ii) Gas exchange surface long distance from (some) respiring tissues;
Blood system allows rapid transport/faster supply;
Diffusion is slow; max 2 [5]
7. (a) Rough endoplasmic reticulum;} *Endoplasmic reticulum*
smooth endoplasmic reticulum;} = 1 mark
mitochondria
ribosomes;
Golgi body;
(accept : lysosomes / centrioles;
reject : chloroplasts / parts of organelles) max 2

- (b) (i) Large numbers of chloroplasts/ grana / 'lots' of chlorophyll;
Different pigments that can absorb different wavelengths;
Tall / thin / long shape (perpendicular to light);
Chloroplasts can migrate within cells.
(reject: cells near surface; large surface area) max 2
- (ii) Thin cell walls;
Large surface area (: volume ratio) (for diffusion);
Gaps/spaces between adjacent cells / walls not touching.
(reject: moist; air spaces in spongy mesophyll) max 2

[6]

8. (a) Large surface area (for diffusion);
thin alveolar wall / one cell thick / only 2 cells (from air to blood);
detail - e.g. flattened cells in alveolar/capillary wall;
ventilation (of alveoli) keeps oxygen-concentration high;
flow/circulation of blood keeps oxygen concentration low;
maintains diffusion gradient / short diffusion pathway (*in context*); max 4
- (b) A - B: volume of lungs/ thorax increases;
due to contraction of diaphragm muscles;
contraction of (external) intercostal muscles raising ribs;
pressure falls / decreases;
B - C: atmospheric pressure / difference in pressure forces air in;
C - D: Pressure increased by elasticity of lungs;
contraction of (internal) intercostal or abdominal muscles;
D - E : air expelled, so pressure falls / due to thorax pressure.
(may refer to letters on graph, or refer clearly to pressure) max 6
- (c) Water too dense to move in and out of lungs;
low oxygen concentration in water;
high metabolic rate in mammals requires high oxygen intake. max 2
- (d) Water flows in opposite direction to blood;
across (gill) lamellae;
so difference in concentration maintained;
diffusion gradient maintained / diffusion over full length. max 3

[15]

QWC Award 1 or 0 according to criteria

9. (a) (i) Arrow from vein towards artery, across lamella. 1
- (ii) Water with high oxygen conc. meets blood with low oxygen conc;
(may be derived from correct diagram)
Difference in concentration maintained (across lamella);
Diffusion gradient maintained. 2

- (b) (i) 79 (Allow 78-80) – gains 2 marks.
 Length of cycle calculated from graph (0.75 - 0.77s) - gains 1 mark
 Correct method (60 divided by cycle time),
 but cycle wrong time - gains 1 mark 2
- (ii) Floor of mouth cavity lowered (increasing volume). 1

[6]

10. (a) 82% 1

(b) Concentration gradient maintained over whole lamella;
 Diffusion gradient maintained / oxygen taken up over whole lamella;
 Equilibrium never reached; 2 max

(c) Decreases surface area;
 (Thick wall) slows down diffusion rate / increases diffusion
 pathway; (NOT less diffusion)
 Mask increases concentration gradient / difference; 3

[6]

11. (a) the larger the organism the smaller the SA:V ratio; 1

(b) has small SA : V ratio:
so low rate of heat loss / less heat loss in relation to volume or mass;
 limbs small:
so reduced area for heat loss;

OR limbs small in relation to body size:
so low rate of heat loss / reduced area for heat loss /
 less heat loss in relation to body size;

OR *accept* large amount of fat / blubber;
So insulation effect / low rate of heat loss:
 (*keeps warm neutral*) 4 max

[5]

12. (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 (dm³h⁻¹); (correct answer award 2 marks)

2

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

2 max

(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

13. (a) exchange/diffusion across body surface/skin;
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]

14. (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]

15. (a) (i) one feature;
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) fish closes mouth and raises the floor of the mouth;
 this decreases the volume / increases the pressure (of mouth);
 Increased volume / decreased pressure of opercular cavity;
 water forced over the gills;
 operculum / opercular valve opens; 3 max

- (c) less energy needed / continuous flow of water or O₂; 1

[8]

16. (a) (diffusion) gradient will be maintained all the way along the gill / the amount of oxygen in 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) (i) 100 cycles per minute; 2
(principle of 60/x or 0.6 seen gains one mark)
- (ii) shuts mouth;
 raises the floor of the mouth cavity;
 decreases volume in the mouth cavity; 2 max
- (iii) the fish has lowered the floor of its mouth cavity;
 (therefore) the pressure in the mouth falls below that of the opercular cavity;
OR
 the fish has closed the flap covering the opercular cavity;
 (therefore) the pressure in the opercular cavity increases above that of the mouth cavity; 2
17. (a) Small surface area to volume ratio;
 Loses less heat (to the water); 2
- (b) (i) Diffusion through cell/body surface; 1
Q The key term here is diffusion
- (ii) Small organisms have large surface area to volume ratio;
 Rate of diffusion depends on surface area;
 All parts of cell only a short distance from exchange surface; 2 max
- (c) Surface area of leaves;
 Different shoots will have leaves with different surface areas; 2
- (d) Draw line/curve of best fit/from line/curve of best fit;
 Find slope/gradient/divide distance moved by time; 2

[8]

- (e) 1 Air enters through (open) spiracles;
2 Through tracheae;
3 Diffusion gradient in trachea
4 Tracheae associated with all cells/closely associated with cells;
5 Oxygen diffuses into cells;
6 Ventilation replacing air in tracheae;
7 Body covered with (waterproof) waxy layer/cuticle;
8 Spiracles are able to close;

6 max

[15]