A-Level Biology

Insect and Fish Gas Exchange

Mark Scheme

Time available: 78 minutes
Marks available: 62 marks

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1.

(a)
1. Tracheoles have thin walls **so** short diffusion distance to cells;
2. Highly branched / large number of tracheoles **so** short diffusion distance to cells;
3. Highly branched / large number of tracheoles **so** large surface area (for gas exchange);
4. Tracheae provide tubes full of air **so** fast diffusion (into insect tissues);
5. Fluid in the end of the tracheoles that moves out (into tissues) during exercise **so** faster diffusion through the air to the gas exchange surface;
   OR
   Fluid in the end of the tracheoles that moves out (into tissues) during exercise **so** larger surface area (for gas exchange);
6. Body can be moved (by muscles) to move air **so** maintains diffusion / concentration gradient for oxygen / carbon dioxide;

1. Do not accept unqualified references to thin membranes.

Max 2 if any reference to blood

Ignore references to spiracles

5. Accept 'water' for fluid.

Accept 'cells' and 'tissues' as interchangeable words.

3 max

(b)
1. Damselfly larvae has high(er) metabolic / respiratory (rate);
2. (So) uses more oxygen (per unit time / per unit mass);

Idea of 'more / high' is needed for both mark points.

2. Accept 'needs' for 'uses'

2. Ignore references to absorbing / obtaining / uptake of more oxygen

2

(c) Mean SA = 9.85 $\underline{mm^2}$ / 9.9 $\underline{mm^2}$;
Percentage uncertainty of SA = 18.5 / 18.7 / 19;

If both answers incorrect 1 mark for

Percentage uncertainty of dimensions 11.8 / 12 and 6.70 / 6.7
Surface area correctly calculated with correct units but not rounded to appropriate sf (9.8532 $\underline{mm^2}$)
Surface area correct (with appropriate sf) but no / incorrect unit given

Both answers correct = 3 marks

1 answer correct only = 2

Both answers incorrect = max 1

3 max

(d) 1. Don't use shading;
2. Only use single lines / don't use sketching (lines) / ensure lines are continuous / connected;
3. Add further labels / annotations;
4. Don't cross label lines;
5. Add magnification / scale (bar);

Reject 'colour in'.

Reject 'use of electron microscopes'

Ignore 'use a sharp pencil'

2 max

[10]

2. (a) (i) Spiracle;

Accept: Spiracles

1

(ii) Tracheole/trachea;

Accept: Tracheoles/tracheae

Ignore: System

1

(b) 1. Oxygen used in (aerobic) respiration;
2. (so) oxygen (concentration) gradient (established);

Accept description of gradient

Ignore: 'along gradient idea' unless direction is made clear

Ignore: movement through gas/water

Reject: gradient in wrong direction

3. (so) oxygen <u>diffuses</u> in; 2 and 3.

Accept: oxygen moves down a <u>diffusion</u> gradient for 2 marks

3

(c) 1. Abdominal pumping/pressure in tubes linked to carbon dioxide release;

MP1 relates to description of link shown in graphs

2. (Abdominal) pumping raises pressure in body;

Needs idea of causation, not just description of correlation

3. Air/carbon dioxide pushed out of body /air/carbon dioxide moves down pressure gradient (to atmosphere);

Reject ref to concentration gradients/diffusion

3

[8]

3. (a) increasing carbon dioxide concentration / partial pressure;
(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]

4.

(a) 1. Spiracles (lead) to tracheae (that lead) to tracheoles;

2. Open spiracles allow diffusion of oxygen from air

OR

Oxygen diffusion through tracheae/tracheoles;

3. Tracheoles are highly branched so large surface area (for exchange);

4. Tracheole (walls) thin so short diffusion distance (to cells)

OR

Highly branched tracheoles so short diffusion distance (to cells)

OR

Tracheoles push into cells so short diffusion distance;

5. Tracheole walls are permeable to oxygen;

6. Cuticle/chitin in tracheae impermeable so reduce water loss;

7. Spiracles close (eg.during inactivity) preventing water loss;

Accept 8. (Tiny) hairs around spiracles reduce evaporation

5 max

(b) Breathing in

1. Diaphragm (muscles) contract **and** diaphragm flattens;

Accept lungs or thorax for 'thoracic cavity'

2. External intercostal muscles contract **and** ribcage pulled up/out;

3. (Causes) volume increase **and** pressure decrease in thoracic cavity (to below atmospheric pressure);

Breathing out

4. Diaphragm (muscles) relaxes **and** internal intercostal muscles contract;

5. (Causes) volume decrease **and** pressure increase in thoracic cavity (to above atmospheric pressure);

Accept labelled structures in correct position on a diagram

[10]

5.

(a) 1. Water and blood flow in opposite directions;

Accept: diagram if clearly annotated

2. Maintains concentration / diffusion gradient / equilibrium not reached / water always next to blood with a lower concentration of oxygen;

Must have the idea of 'maintaining' or 'always' in reference to concentration / diffusion gradient

Accept: constant concentration / diffusion gradient

3. Along whole / length of gill / lamellae;

Accept: gill plate / gill filament

3

(b) 1. (Thicker lamellae so) greater / longer diffusion distance / pathway;

***Q** Neutral: 'thicker' diffusion pathway*

2. (Lamellae fuse so) reduced surface area;

Accept: reduced SA:VOL

2

(c) (i) Correct answer of **5.1** or **5.14(2857)** (dm^3) = 2 marks;;

*Allow 1 mark max for an answer of **5** if the correct answer of **5.1** or **5.14(2857)** is **not** shown*

One mark for incorrect answers that show **36** or **0.4 × 90** or **90 ÷ 7;**

2

(ii) 1. Increased metabolism / respiration / enzyme activity;

Accept: enzymes work more efficiently

2. Less oxygen (dissolved in water);

Neutral: references to increased kinetic energy (of water molecules)

1 max

[8]

6.

(a) 1. Many lamellae / filaments so large surface area;

2. Thin (surface) so short diffusion pathway;

1 & 2 must each have a feature and a consequence

2

(b) 1. Water and blood flow in opposite directions;

Allow diagram showing counter-flow

2. Blood always passing water with a higher oxygen concentration;

3. Diffusion gradient maintained throughout length (of gill)
OR
Diffusion occurs throughout length of gill
OR
If water and blood flowed in same direction equilibrium would be reached;

3

[5]

7.

(a) F = Filament **and**
G = (Secondary) lamella(e) / (gill) plate;

Reject gill arch

Accept primary lamella(e) for F

1

(b) 1. Water **and** blood flow in opposite directions;

2. Maintains diffusion/concentration gradient of oxygen

Accept: converse for carbon dioxide

Accept: equilibrium not reached

OR

Oxygen concentration always higher (in water);

3. (Diffusion) along length of lamellae/filament/gill/capillary;

Accept: all/whole of lamellae/filament//gill/capillary

3

[4]

8.

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

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 <u>partial pressure</u> (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]