AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.3.2 GAS EXCHANGE

SCORE	PERCENTAGE
/443	%

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Q1.

(a) 1. (Across) alveolar epithelium;

2. Endothelium / epithelium of capillary;

Incorrect sequence = maximum of 1 mark

2

(b) 1. (The alveolar epithelium) is one cell thick;

Reject thin membrane

2. Creating a short diffusion pathway / reduces the diffusion distance;

2 max

(c) **For**

1. Significantly higher concentrations of CO (compared with no smoking) with closed window (as no overlap in 2 × SD);

Accept higher concentrations of CO with closed window are not due to chance

Idea of higher is required, not just difference

2. Any increase in CO could be dangerous;
OR
CO causes less oxygen to be carried / provided (which could be deadly in children);

3. (significantly) higher levels after (just) 5 minutes (with closed windows supporting short journey statement);

Idea of higher is required, not just difference

Against

4. No idea if (roughly) 5ppm is 'deadly';

5. No significant difference with open window (as 2 × SD overlaps);

Accept difference with open window could be due to chance

6. No data on child breathing rates;
OR
Idea that children breathe faster but have smaller lung volume, so overall volume of CO inhaled could be similar;

4 max

[8]

Q2.

(a) 1. Named structures – trachea, bronchi, bronchioles, alveoli;

Reject mp1 if structures from other physiological systems are named but award mp2 if the correct structures are in the correct order.

2. Above structures named in correct order

OR

Above structures labelled in correct positions on a diagram;

Reject mp1 if structures from other physiological systems are named but award mp2 if the correct structures are in the correct order.

3. Breathing in – diaphragm contracts **and** external intercostal muscles contract;

4. (Causes) volume increase and pressure decrease in thoracic cavity (to below atmospheric, resulting in air moving in);

For thoracic cavity accept 'lungs' or 'thorax'.

Reference to 'thoracic cavity' only required once.

5. Breathing out - Diaphragm relaxes **and** internal intercostal muscles contract;

*Accept diaphragm relaxes **and** (external) intercostal muscles relax **and** lung tissue elastic (so recoils).*

6. (Causes) volume decrease and pressure increase in thoracic cavity (to above atmospheric, resulting in air moving out);

For thoracic cavity accept 'lungs' or 'thorax'.

Reference to 'thoracic cavity' only required once.

If idea of thoracic cavity is missing or incorrect, allow ECF for mark point 6.

6

(b) 1. Both contain ester bonds (between glycerol and fatty acid);

All statements must be clearly comparative or linked by the candidate, not inferred from separate statements.

Accept mark points shown on adjacent annotated diagrams.

2. Both contain glycerol;

3. Fatty acids on both may be saturated or unsaturated;

4. Both are insoluble in water;

5. Both contain C, H and O but phospholipids also contain P;

Must relate to element.

6. Triglyceride has three fatty acids and phospholipid has two fatty acids plus phosphate group;

7. Triglycerides are hydrophobic/non-polar and phospholipids have hydrophilic and hydrophobic region;

Accept 'non-polar' for hydrophobic and 'polar' for hydrophilic.

8. Phospholipids form monolayer (on surface)/micelle/bilayer (in water) but triglycerides don't;

5 max

(c) 1. Glucose **and** galactose;

Ignore α or β for glucose

2. Joined by condensation (reaction);

3. Joined by glycosidic bond;

4. Added to polypeptide in Golgi (apparatus);;

4

[15]

Q3.

(a) 1. Measure (each stoma) using eyepiece graticule;
2. Calibrate eyepiece graticule against stage micrometer / ruler / graph paper;
3. Take a number of measurements (to calculate a mean);

2. Accept micrometer slide

3. Idea of enough readings for a reliable mean (min. 5)

3

(b) 1.48;

Accept 1.5 and 1.479

1 mark for PS3 = 7.1 (μm) and ABA = 4.8 (μm)

2

(c) 1. (Causes less stomatal opening so) less transpiration;
OR
Less evaporation;
OR
Less water lost by diffusion;

2. (So more) water available for photosynthesis / metabolism / support;
OR
(So) less water needed from the (dry) soil;

2. Water conserved / retained is insufficient

2. Ignore respiration

2

(d) (Closes the stomata so) fewer / no spores enter leaf;

1

[8]

Q4.

(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]

Q5.

(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]

Q6.

(a) 1. Kinesis;

Ignore any prefix

2. Movement is random / non-directional
OR
Insect is not moving towards a particular stimulus;

2

(b) 1. Less respiration so less gas exchange;

2. (So) spiracles open less so less water loss;

2

(c) Taxis;

Ignore any prefix

1

(d) No (no mark), the insect does not move in circles;

Shows kinesis / results similar to **Figure 1**;

2

(e) **For (max 1)**

1. The data show a positive correlation;

Must state this as the description is given in the stem.

2. Large sample / number of insects so valid / reliable / representative;

Against (max 1)

3. (however) there are overlaps in individual experiments at all humidities;

4. 70–90% humidity there is little / no change in movement / movement only increases after 76% humidity;

Accept any value in this range

2 max

[9]

Q7.

(a) 1. Line graph with rate on y axis and temperature on x axis and linear scales;

2. Values calculated to appropriate sf;

3. Rates correctly calculated and plotted, with ruled line connecting points and no extrapolation;

3

(b) 8 or 9;

1

(c) 1. Determine the area under the curve;

1

(d) 1. Enzymes / metabolism faster;

2. Higher rate of respiration and carbon dioxide production / release;

3. Spiracles open more often / remain open to excrete / get rid of carbon dioxide / get more oxygen;

Note – explanation required

3

[8]

Q8.

(a) 1. Contraction of internal intercostal muscles;
2. Relaxation of diaphragm muscles / of external intercostal muscles;
3. Causes decrease in volume of chest / thoracic cavity;
4. Air pushed down pressure gradient.

4

(b) 19(%);

1

(c) 1. Muscle walls of bronchi / bronchioles contract;
2. Walls of bronchi / bronchioles secrete more mucus;
3. Diameter of airways reduced;
4. (Therefore) flow of air reduced.

4

[9]

Q9.

(a) 1. Trachea and bronchi and bronchioles;
2. Down pressure gradient;
3. Down diffusion gradient;
4. Across alveolar epithelium.

Capillary wall neutral

5. Across capillary endothelium / epithelium.

4 max

(b) (About) 80.0%.

1

(c) 1. (Group **B** because) breathe out as quickly as healthy / have similar FEV to group **A**;
2. So bronchioles not affected;
3. FVC reduced / total volume breathed out reduced.

*Allow this marking point for group **C***

3

[8]

Q10.

(a) Stomata per mm^2 or cm^2
OR
Number per mm^2 or cm^2;

Accept: mm^{-2} or cm^{-2}.

Reject: per μm^2 or μm^{-2}.

Reject: the use of a solidus / as being equivalent to per.

Ignore: 'amount'.

1

(b) 1. Single/few layer(s) of cells;

Accept: more/too many/overlapping.

*'Single layer' without reference to cells/tissue should **not** be credited.*

2. So light can pass through;

2

(c) 1. Distribution may not be uniform
OR
So it is a representative sample;

Accept: more/fewer stomata in different areas.

Ignore: anomalies/random/bias.

2. To obtain a (reliable) mean;

Accept: 'average'.

2

(d) 1. Hairs **so** 'trap' water vapour and water potential gradient decreased;
2. Stomata in pits/grooves **so** 'trap' water vapour and water potential gradient decreased;
3. Thick (cuticle/waxy) layer **so** increases diffusion distance;
4. Waxy layer/cuticle **so** reduces evaporation/transpiration.
5. Rolled/folded/curled leaves **so** 'trap' water vapour and water potential gradient decreased;
6. Spines/needles **so** reduces surface area to volume ratio;

*1, 2 and 5. Accept: humid/moist air as 'water vapour' but **not** water/moisture on its own.*

1, 2 and 5. Accept: diffusion gradient as equivalent to water potential gradient.

1, 2 and 5. Accept: less exposed to air as an alternative to water potential gradient.

*6. Accept: spines/needles **so** 'reduce area'.*

2 max

(e) 1. Water used for support/turgidity;
2. Water used in photosynthesis;
3. Water used in hydrolysis;
4. Water produced during respiration;

2 max

[9]

Q11.

(a) (Simple) diffusion;

Reject: facilitated diffusion.

1

(b) 1. Thin/small **so** short diffusion pathway;

Reject: thin membrane/wall/cells.

2. Flat/long/small/thin **so** large surface area to volume ratio/surface area : volume;

Accept: small volume to surface area ratio.

2

(c) 1. High/50% saturation (with oxygen) below (pO_2 of) 0.2 kPa;

*Accept: fully saturated **or** above 50% saturation below 0.2kPa.*

Accept: any number between 0.08 and 0.2 kPa

2. (Oxygen) for respiration;

2

(d) 1. Water potential higher in worm
OR
Lower water potential in seawater;

Accept: correct reference to water potential gradient if direction of water movement is given.

Accept: ψ for water potential.

2. Water leaves by osmosis (and worm dies);

Reject: worm/cells burst.

2

[7]

Q12.

(a) 1. Large sample size;

Accept: 20 + as equal to large sample size.

2. Individuals chosen at random;
3. Are healthy;
4. Equal number of males and females;

Accept: same sex/gender.

5. Repeat readings;

2 max

(b) 1. (For) comparison;

Accept: provides a benchmark/standard.

2. To see effect of age/emphysema/smoking
OR
Takes into account outliers/anomalous results;

2

(c) Internal intercostal muscle(s) less effective
OR
Less elasticity (of lung tissue);

Accept: different descriptions of less effective.

Recoil without reference to elasticity is insufficient.

Accept: 'less elastin'.

1

(d) 1. Less carbon dioxide removed;

Accept: carbon dioxide increases/high (in body/blood).

1 and 2. Accept: 'low amount' as equivalent to 'less'.

2. Less oxygen (uptake/in blood);

Accept: less oxygen inhaled.

2 and 3. Accept: less oxygen for respiration = 2 marks.

3. Less (aerobic) respiration/ATP
OR
(More) anaerobic respiration;

Accept: (more) lactic acid.

3

[8]

Q13.

(a) 1. Diaphragm moves up /becomes dome shaped;
2. Reduces volume of thorax / increase pressure in thorax;

Accept 'space' for volume, chest/lungs for thorax

3. Pressure in thorax **higher** than outside (air);

Accept chest/lungs

3

(b) 1. FEV_1 of those who have stopped smoking increased after 1 year whereas the FEV_1 of smokers decreased;

Comparison required

2. (Between years 1 and 5, FEV_1 of both decreases but) the rate of decrease in FEV_1 of smokers is faster than those who stopped smoking;

Idea of a faster rate of decrease in smokers, not just quoting final FEV values

2

(c) 1. Airways are narrowed/blocked;
2. Excess mucus (in airway);
3. Inflammation (of airways);
4. Elasticity is lost/scar tissue builds up;

Ignore answers in the context of reduced surface area of alveoli or increased diffusion distance

2 max

[7]

Q14.

(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]

Q15.

(a) (Scientists) used fully grown leaves / used five plants of each (species).

Ignore other references to methodology. Reward only information provided in the Resource.

Do not accept reference to number of <u>leaves</u> − different plants were used.

1

(b) Either

1. Draw around leaf on graph paper;

Mark as a trio − MP1, MP2 and MP3 OR MP4, MP5 and MP6. Do not mix and match.

Both aspects needed for mark − drawing <u>and</u> type of paper.

2. Count squares (however described);

There is no reward for additional detail e.g. dealing with part squares.

3. Multiply by 2 (for upper and lower leaf surface);

OR

4. Draw around a leaf on paper of known mass (per unit area);

Both aspects needed for mark − drawing <u>and</u> mass of paper.

5. Cut out *and* weigh;
6. Multiply by 2 (for upper and lower leaf surface).

3

(c) (i) Species **B** (no mark)

1. Smaller surface area

so

less evaporation / less heat absorbed;

Correctly selected feature <u>and</u> the explanation required for 1 mark.

In all marking points − 'less water loss' is insufficient as an explanation but accept transpiration for evaporation or diffusion.

2. Thicker leaves

so
greater diffusion distance (for water);
Accept 'thicker leaves so more water storage'.

3. Fewer stomata / lower stomatal density
so
less diffusion / evaporation (of water);

4. Smaller surface area to volume ratio
so
less evaporation.

1 max

(ii) 1. Thick(er) cuticle
so
increase in diffusion
distance / slower (rate of) diffusion;
Feature and explanation needed for each mark.
Reject other features not related to leaves.
Reject features related to water storage.
'Cuticle' alone is insufficient (all leaves have a cuticle).
Reject suggestion of 'less' diffusion, for idea of 'slower diffusion', an idea of rate is required.

2. Hairs on leaves
so
reduction in air movements / increase in humidity / decrease in water potential gradient;

3. Curled leaves
so
reduction in air movements / increase in humidity / decrease in water potential gradient;

4. Sunken stomata
so
reduction in air movements / increase in humidity / decrease in water potential gradient.

2 max

(d) Small leaves / surface area *so* (total) number of stomata is low.
Both aspects needed for mark.

1

[8]

Q16.

(a) 1. (No grease)
means stomata are open
OR
allows normal CO_2 uptake;
Allow 'gas exchange' for CO_2 uptake.
'As a control' is insufficient on its own.

2. (Grease on lower surface)
seals stomata

OR
stops CO_2 uptake through
stomata
OR
to find CO_2 uptake through
stomata
OR
shows CO_2 uptake through cuticle / upper surface;

3. (Grease on both surfaces) shows sealing is effective
OR
stops all CO_2 uptake.

3

(b) (i) 1. (Mean rate of) carbon dioxide uptake was constant *and* fell after the light turned off;
Ignore absence of arbitrary units in both marking points.
Both ideas needed for mark.
Accept 'stayed at 4.5' as equivalent to 'was constant'.

2. Uptake fell from 4.5 to 0 / uptake started to fall at 60 minutes and reached lowest at 80 minutes / uptake fell over period of 20 minutes;
One correct use of figures required.
Accept fell to nothing / no uptake for 0.

2

(ii) 1. (Because) water is lost through stomata;
2. (Closure) prevents / reduces water loss;
3. Maintain water content of cells.
This marking point rewards an understanding of reducing water loss e.g. reduce wilting, maintain turgor, and is not related to photosynthesis.

2 max

(c) (i) (Carbon dioxide uptake) through the upper surface of the leaf / through cuticle.

1

(ii) 1. No use of carbon dioxide in photosynthesis (in the dark);
2. No diffusion gradient (maintained) for carbon dioxide into leaf / there is now a diffusion gradient for carbon dioxide out of leaf (due to respiration).

2

[10]

Q17.

(a) 1. Other gases / nitrogen / water vapour in atmosphere / **A**;
2. Only oxygen and carbon dioxide in gas mixtures / **C** and **D**;
3. Composition of / gases in **A** not controlled / composition of gas mixtures / **C** and **D** controlled.

2 max

(b) 1. Breathing rate *lowest* when no carbon dioxide / in (pure) oxygen / B;

Idea of 'lowest' must be stated.

2. (Generally) presence of carbon dioxide increases breathing rate / as concentration of carbon dioxide increases breathing rate increases / there is a positive correlation;

A general point incorporating all concentrations.

3. Breathing rate increases when (carbon dioxide) higher than 0.1% / concentration in atmosphere / A;

This MP requires a specific comparison to 0.1% or the atmospheric concentration.

Accept 'gas mixtures 1 and 2 / C and D' for 'higher carbon dioxide'.

4. Breathing rate of **grasshopper 3** falls in D / 16% / gas mixture 2 (whereas others increase).

Restating data alone is insufficient for any mark point.

3 max

(c) (i) 54;

OR

1. Correct data / column **A** chosen;

A correct answer of 54 gets 2 marks.

MP1 and MP2 allow a possible mark for an incorrect calculation or choice of wrong data.

2. Correct calculation of mean from data chosen;

Check − the three values must be from same column.

2 max

(ii) 1. Small sample / only 3 (grasshoppers)
so may not be representative (of all grasshoppers / insects);
2. Grasshoppers are not the only insects / species;
so genetic / behavioural / metabolic differences;
3. (Insects) not all mature / are at different stages of development / different sizes;
so different metabolic rates;
4. Movement not restricted / not at rest in meadow;
so (rate of) respiration higher;
5. (Naturally-occurring) carbon dioxide concentration lower in meadow;
so breathing rate lower;

Explanations required, therefore both parts of answer required for credit in each marking point.

Accept appropriate converse answers.

Accept 'respiration' for 'metabolism' and vice versa.

3 max

[10]

Q18.

(a) Fish keep moving / swimming / movement of gill covers too fast to count (at higher temperatures).

Accept converse.

Reject personal errors e.g. with counting.

Neutral − 'water not clear' or 'difficult to see movement of gill covers'.

1

(b) 1. There is only one dependent variable / there are not two dependent variables / water temperature is the independent variable / breathing rate is dependent on water temperature;

Accept either approach for 1 mark.

For 'independent' accept 'manipulated'.

Reject −'need two continuous variables'.

2. Water temperature *plus* breathing rate are not both properties of fish
or
water temperature *plus* breathing rate are not both properties of water.

Accept reference to the 'two variables' (instead of water temperature plus breathing rate)

1 max

(c) (i) As (water) temperature increases, oxygen (concentration / solubility) falls and ventilation rate increases.

MP requires all 3 aspects before credit is possible. The correct context is required for each aspect so

e.g. do not reward

'as oxygen concentration falls, water temperature increases'

or

'as temperature increases, ventilation rate increases and oxygen concentration falls'.

1

(ii) 1. As concentration / solubility of oxygen falls
less oxygen flows over gills / less oxygen enters gills / less oxygen enters fish;

For MP1 and MP2 accept converse.

Both aspects needed for mark.

2. (As a result) blood oxygen (concentration) falls / is lower;

3. An increase in ventilation rate increases / maintains the flow of oxygen / carbon dioxide across gills / into (or out of) fish;

Accept idea in relation to either gas or 'gas exchange'.

4. Maintains diffusion / concentration gradient(s) (in gills);

Gradient(s) relates to either / both gas(es).

5. To maintain oxygen supply to cells / tissues / organs / to maintain respiration.

Accept a named example of 'tissues' e.g. muscle.

3 max

[6]

Q19.

(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]

Q20.

(a) 1. Protein synthesis **and** cell wall synthesis **and** cell expansion stop at −0.7 / at a *higher* water potential than other two;

If all 3 are correctly identified in marking point 1, accept 'the others / the other two' in marking point 2, and vice versa

2. Photosynthesis **and** stomatal opening stop at -1.5 / at a *lower* water potential than other three;

Correct processes must be named in at least one of marking point 1 or marking point 2

Where reference to water potential differences are made, they must be comparative, eg 'higher'

2

(b) 1. Stomata allow uptake of carbon dioxide;

2. Carbon dioxide used in / required for photosynthesis;

2

(c) 1. Growth involves cell division / cell expansion / increase in mass;

Marking point 1 is for the principle

2. Protein synthesis stops **so** no enzymes / no membrane proteins / no named protein (for growth / division);

Marking points 2, 3 and 4 require appreciation of 'why' before credit can be awarded

'named' protein must relate to proteins involved in growth or cell division

3. Cell wall synthesis stops **so** no new cells can be made;

Full credit is possible without a statement of the principle (marking point 1)

4. No cell expansion / increase in mass **because** (cells) stop taking up water;

3 max

[7]

Q21.

(a) (i) (Simple) diffusion;

Reject facilitated diffusion

Accept lipid diffusion

1

(ii) 1. Thin walls / cells;

1. 'Short diffusion pathway' alone is an explanation not a description

1. Accept squamous epithelia / one cell thick

2. (Total) surface area is large;

2. Ignore references to 'volume ratio'

2

(b) 1. Loss of elasticity / elastic tissue / increase in scar tissue;

1. Accept elastin

2. Less recoil;

2

[5]

Q22.

(a) Correct answer of 342.8 − 343 = 2 marks;;

Credit incorrect answers that show the numerator as 144 (or 186-42) or denominator as 42 for 1 mark;

2

(b) 1. More air / oxygen enters / air / oxygen enters quickly / quicker;

1. Accept: converse for carbon dioxide

1. Can be in any correct context eg insect, tracheoles, muscle

1. Neutral: air / oxygen enters

(So) maintains / greater diffusion or concentration gradient;

2

(c) Large(r) SA:VOL / short(er) diffusion distance (to tissues);

Accept: thin diffusion pathway

1

(d) 6 / 6.6 / 6.7 / 7 / 7.5 / 8 = 2 marks;;

Different answers given for different interpretations of the graph

Award 1 mark for incorrect answers that have divided 60 by any number;

2

(e) Less / no water lost / (more) water retained;

Accept: less dehydration / less evaporation

***Q** Reject: less 'transpiration'*

***Q** Reject: less water lost by osmosis*

1

(f) 1. Greater surface area exposed to air;

Neutral: shorter diffusion distance

2. Gases move / diffuse faster in air than through water;

*2. **Q** Neutral: 'harder to diffuse'*

2. Accept gases diffuse directly, rather than through water

3. Increases volume / amount of air;

1 max

[9]

Q23.

FOR

1. (If the husband smokes) there's a greater risk of dying from lung cancer / emphysema / cervical cancer;

2. The more the husband smokes, the greater the risk of dying from lung cancer / emphysema;

3. Suitable use of figures from the table to illustrate answer;

AGAINST

4. Little difference in risk of dying of stomach / heart disease;

5. Other factor (than husband smoking) / named factor might cause death;

6. Only one sample / further studies needed;

4 max

[4]

Q24.

(a) 1. The more recent the sample the greater the concentration;

Accept converse

This could be expressed by reference to time e.g. 'concentration has increased since 25 000 years ago

2. Increases most in last 5000 years / more or less constant / slight increase between 30 000 and 15 000 years ago;

2

(b) 1. Variation in data / spread of data;

Reject references to range e.g. 'range of data'

2. Around the mean;

Both marks are possible in the context of using the data

2

(c) 1. Yes as pine leaves not in organic matter of the same age;

2. No as organic matter would be the same age as the pine leaves;

Accept either approach

1 max

(d) Can get more CO_2 for photosynthesis;

More CO_2 enters leaf is insufficient.
Accept light-independent (reaction) as equivalent

1

(e) Any **three** from:

1. (Overall data show) negative correlation;

Do not allow description of correlation because in question stem

2. Little change in number of stomata in last 10 000 years;

3. Small sample size;

4. Only one species studied;

5. Other factors / named factor may have affected number of stomata;

6. Evidence does not support the conclusion between 30 000 and 25 000 years ago / between 5000 years ago and present day;

Accept reference to either one of these age ranges

7. Appropriate reference to standard deviations (in comparing means);

E.g. no overlap between 15 000 and 10 000 years ago

3 max

(f) Any **three** from :

1. Thick cuticle;

2. Small leaves / low surface area;

Accept other ways of describing 'small', e.g. 'needle-like'

3. Hairy leaves;

4. Sunken stomata;

5. Rolled leaves;

3 max

[12]

Q25.

(a) (**P**) Trachea / windpipe <u>and</u> (**Q**) bronchus;

*For **P** or **Q**, accept (ring of) cartilage (i.e. not for both)*
Accept bronchi
Reject bronchioles
Ignore reference to left or right lung

1

(b) 1. Increases volume (in lungs / thorax);

Context must be lungs / thorax
Ignore space increases

2. Lowers pressure (in lungs / thorax);

Accept lungs / chest expand
Ignore reference to 'change in pressure'

3. Air (pushed) in by higher outside pressure / down pressure gradient;

Ignore reference to 'sucked in'

2 max

[3]

Q26.

(a) 1. Random;

Random number generator = 2 marks

2. Method e.g. number generator / number out of a hat;

Same age = 2 marks

OR

3. Matched / all the same;

4. For e.g. age / sex;

2 max

(b) 1. (Differences) are real / significant / not due to chance;

It = the difference

2. (As) bars / SDs do not overlap;

2. Accept: 'standard errors do not overlap' as told 'standard deviation' in the question stem

2

(c) 1. No / slight (placebo) effect;

2. Group **2** and **3** results are similar / the same / SDs / bars overlap;

*2. Accept: other descriptions of Groups **2** and **3***

*2. Accept: that Groups **2** and **3** are not significantly different*

2

(d) 1. (Allows) anomalies to be identified / ignored / effect of anomalies to be reduced / effect of variation in data to be minimised / concordant results;

Accept: 'outliers' instead of anomalies

1. Reject: idea of not recording anomalies / preventing anomalies from occurring

1. Accept: 'cancels out anomalies' as bottom line response

2. (Makes) average / mean (more) reliable;

*2. **Q** Neutral: makes the average / mean more accurate*

2. Ignore: 'more reliable' alone

2

(e) (i) 1. Unethical / unfair not to treat patients;

2. Dangerous / could cause an asthma attack;

1 max

(ii) 1. Ensures normal treatment does not affect results / improvements are only due to the spray;

2. (As) normal treatment is short-lived / effective for less than 24 hours / (24h) is long enough for normal treatment to wear off;

2

(f) (i) 1. (Improvement scores) are qualitative / subjective / rely on own judgement / different patients may assess symptoms differently;

Accept: converse arguments for measuring FEV_1 e.g. quantitative / objective patients cannot lie

2. Some patients may lie / exaggerate / want to please doctors;

1. Neutral: empirical evidence

2

(ii) 1. Not blind / patients knew they were not receiving treatment / patients did not receive treatment;

2. (So) more likely to underestimate / give lower scores / did not expect to improve / less improvement;

2

[15]

Q27.

(a) 1. Flatten / moves down;

1. Ignore: additional information about rib movements

2. (Diaphragm muscle) contracts;

2

(b) 1. Diaphragm contracts / moves down / flattens;

Ignore refs to rib movement

2. Increases volume (of thorax) and decrease in pressure;

2. Accept pressure lower than atmospheric pressure

3. Air moves from high to lower pressure / down pressure gradient;
3. Reject: by diffusion

3

(c) 1. Diffusion;
Accept down diffusion gradient

2. Across (alveoli) epithelium / (capillary) endothelium;
2. Accept: capillary epithelium / squamous cell

2 max

[7]

Q28.

(a) (i) Diffusion;
Ignore references to structures, membrane components etc
Allow simple diffusion
Reject facilitated diffusion

1

(ii) 1. (Thin / flat body) so short distance for diffusion / short diffusion pathway;
Ignore references to membrane, wall, body surface

2. (Thin / flat body so) large surface area to volume ratio;
'It' refers to flatworm's body

2

(b) (i) A group of tissues;
Ignore references to function Group = more than one

1

(ii) 1. (Carbon dioxide enters) via stomata;
Reject stroma

2. (Stomata opened by) guard cells;

3. Diffuses through air spaces;
Allow concentration gradient. Reject along gradient unless direction made clear

4. Down diffusion gradient;

3 max

[7]

Q29.

(a) 1. (Diaphragm / diaphragm muscle) relaxes / relaxed;
Ignore references to inhalation, intercostal muscles or ribs if given as additional information.

2. Domed shape / (diaphragm) moves up;

3. Increases pressure and decreases volume;

3

(b) 1. Extend / extrapolate curve / graph;

2. (Read off where) it flattens / reaches maximum / peaks;

2

(c) 1. (Without inhaler) narrower bronchioles / bronchioles not dilated as muscle (surrounding bronchioles) contracted;

*Assume answer relates to Curve **A**, unless otherwise stated.*

2. Less air able to pass through / more difficult for air to pass through;

2

[7]

Q30.

(a) Something that increases chance / increases probability / makes it more likely;

1

(b) (i) 1976 - / to / and 1980;

1

(ii) 1980 - / to / and 1996;

1

(c) 1. Correlation does not mean that there is a causal relationship;

1. Do not accept casual

2. May be some other factor / named factor associated with vehicles and asthma / producing rise in both;

3. (After 1980) asthma continues to rise but exhaust concentration falls / negative correlation (after 1980);

3

[6]

Q31.

(a) 1. Haemoglobin carries oxygen / has a high affinity for oxygen / oxyhaemoglobin;

2. Loading / uptake / association in lungs;

3. at high p.O_2;

4. Unloads / dissociates / releases to respiring cells / tissues;

5. at low p.O_2;

6. Unloading linked to higher carbon dioxide (concentration);

6. Ignore reference to incorrect pH in relation to effect of higher carbon dioxide concentrations for marking point

6

(b) 1. Allows comparison;

Do not credit 'temperature affects results' on its own;

2. (Different temperature) affects enzymes;

2. Allow reference to denaturation of enzymes.

3. (Different temperature) affects respiration / metabolism;

4. (Different temperature) affects amount of dissolved oxygen;

2 max

(c) 1. Increases then levels out / stops increasing / fluctuates slightly;

2. At 5 (cm^3 dm^{-3}) / 320 (cm^3 $g^{-1}h^{-1}$);

Allow description of 'fluctuates slightly' in terms of candidate quoting figures after 320.

2

(d) 1. *Chronimus longistylus* has higher uptake at low (oxygen) concentrations;

Chronimus longistylus has higher uptake to (oxygen concentration of) 2 / lower uptake after 2; (= 2 marks)

2. (Higher uptake) up to 2 cm^3 dm^{-3};

2. Award mark if candidate uses figures from table e.g. higher at concentration 1 (220) or concentration 2 (285).

Higher uptake at concentration 1 or 2 = 2 marks.

2

(e) (i) More (than in African) lost via gills in Australian lungfish / less (than African) lost via lungs in Australian lungfish;

1

(ii) 1. More / most exchange is via lungs (in African lungfish);

1. Allow converse for first point.

2. Gills will not function / function less efficiently (in air);

2. Allow water is required for gills to function.

2

[15]

Q32.

(i) (Lung volume) increases / reaches a maximum (at **B**);

Do not negate mark for 'breathing out' if qualified e.g. when (lung volume) decreases

1

(ii) Flattens / lowers / moves down;

(Diaphragm / muscle) contracts;

Reject: second mark only if intercostal muscles cause the diaphragm to flatten

2

[3]

Q33.

(a) 1. (Simple / facilitated) diffusion from high to low concentration / down concentration gradient;

Q *Do not allow across / along / with concentration gradient*

2. Small / non-polar / lipid-soluble molecules pass via phospholipids / bilayer;

   Reject: named molecule passing through membrane by an incorrect route

   Accept: diagrams if annotated

   OR

   Large / polar / water-soluble molecules go through proteins;

3. Water moves by osmosis / from high water potential to low water potential / from less to more negative water potential;

4. Active transport is movement from low to high concentration / against concentration gradient;

   Only penalise once if active transport is not named
   e.g. 'movement against the concentration gradient involves proteins and requires ATP' = 2 marks

5. Active transport / facilitated diffusion involves proteins / carriers;

   Accept: facilitated diffusion involves channels

   Reject: active transport involves channels

6. Active transport requires energy / ATP;

7. Ref. to Na^+ / glucose co-transport;

   Credit ref. to endo / exocytosis as an alternative

5 max

(b) 1. Many alveoli / alveoli walls folded provide a large surface area;

   Neutral: alveoli provide a large surface area

2. Many capillaries provide a large surface area;

3. (So) fast diffusion;

   Neutral: greater / better diffusion
   Neutral: fast gas exchange
   Allow 'fast diffusion' only once

4. Alveoli or capillary walls / epithelium / lining are thin / short distance between alveoli and blood;

   Reject: thin membranes / cell walls
   Accept: one cell thick for 'thin'

5. Flattened / squamous epithelium;

   Accept: endothelial

6. (So) short diffusion distance / pathway;

7. (So) fast diffusion;

8. Ventilation / circulation;

   Accept: descriptions for ventilation / circulation

9. Maintains a diffusion / concentration gradient;

10. (So) fast diffusion;

Do not double penalise if description lacks detail
e.g. thin membranes so a short diffusion distance = 1 mark

5 max

[10]

Q34.

(a) (i) Through alveolar epithelium;

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]

Q35.

(a) Filaments / lamellae provide large surface area;

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]

Q36.

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

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]

Q37.

(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]

Q38.

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

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]

Q39.

(a) up and out;

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]

Q40.

(a) 235–240;;
(one mark for an answer between 200-300 based on 2 - 3 stomata in 0.01mm^2
Alternatively, one mark for calculating the area of the rectangle correctly as 0.016 – 0.017mm^2)

2

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

3

[5]

Q41.

(a) (i) high / higher CO_2 concentration / lack of oxygen;

1

(ii) CO_2 asphyxiates / is toxic;
lack of oxygen for (aerobic) respiration;
OR
lack of energy / ATP (for pumping movements);
reduced <u>muscle</u> function / muscle fatigue

2 max

(b) removal of (excess) CO_2 / oxygen to break down lactate / to repay oxygen debt / to enable aerobic respiration;

1

[4]

Q42.

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

Q43.

(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]

Q44.

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

Q45.

(a) Muscles (associated with breathing) relax;

1

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

1

[2]

Q46.

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

= 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 CO_2 leaves);
More (aerobic) respiration / more energy release in muscle / for swimming; *'more' needed ONCE only*

3

[5]

Q47.

(a) Diaphragm (muscle) contracts;
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]

Q48.

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

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]

Q49.

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

Q50.

(i) Because there are big differences;
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]

Q51.

(a) (gills have) lamellae on filaments;
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 CO_2

2

[5]

Q52.

(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) 100 cycles per minute;

(principle of 60 / x or 0.6 seen gains one mark)

2

[4]

Q53.

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

2

[3]

Q54.

(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) less energy needed / continuous flow of water or O_2;

1

[5]

Q55.

(a) contraction of (diaphragm) muscles flattens diaphragm;
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) $20 \times 2.75 = 55$ dm^2;

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

2

[7]

Q56.

(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 <u>thin</u> to provide a short diffusion pathway;
3. walls of capillary <u>thin</u> / 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]

Q57.

(a) exchange / diffusion across body surface / skin;
short <u>diffusion</u> 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]

Q58.

(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 cm^3 of oxygen / extracts 7.2 cm^3 of oxygen /
reject if referring to volume of water

$\frac{20}{7.2}$;

2.7 / 2.8 (dm^3h^{-1});
(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 <u>required</u>;

2 max

[12]

QWC 1

Q1.

Part (a) was not well answered (70.3% scored zero); many students seemingly did not understand what is meant by pathway and gave the mechanism instead.

Question (b) asked for an explanation of a feature of an alveolus, not all of the alveoli. Only 23.3% of students scored two marks, the majority giving answers relating to a large surface area. Those who scored well did have an understanding of a reduced diffusion pathway, but a significant number involved a “thin membrane” or “one-cell-thick membrane” or “thin epithelium” in their response.

(c) was the question students struggled with the most; only 1.2% scored all four marks. Students did not use the data provided, and, when they did, appeared not to understand or use the term significance. Those who used the word simply stated that the ‘data’ or ‘results’ were significant or not, rather than that the increase or difference was significant. They applied standard, learned responses without considering the question, such as “no repeats”, even though the figure shows mean values and standard deviations, i.e. it must have been repeated, “sample size too small”, “correlation does not mean causation”, and “there may be other factors involved”. Students can assume that if an experiment or investigation in a question has been completed by scientists, that it has been completed correctly, unless otherwise stated. There was also a common misconception that children (and not even their haemoglobin) have a high affinity for oxygen. This question evoked many lengthy responses that failed to score any marks. Students tended to write a whole page of raw data comparisons with no conclusions or linger on the same idea for the duration of their answer, stating the same thing in several different ways. A significant number suggested that CO from vehicle emissions was also of importance, hence the high levels with an open window and no smoking. Astute students could see that the CO concentration was significantly and consistently higher after five minutes of exposure to tobacco smoke when the windows were closed. Equally, these same students could also analyse the data and notice that the 2 x SD values for the CO concentrations (when the window was open) overlapped. Therefore, there was no ‘statistical’ difference with these values. The link between Hb and CO was established by some, resulting in less oxygen being carried/delivered or provided to tissues. A small minority appreciated that no evidence/data was available for breathing rates in children. Many students made reference to breathing rates and lung volume. However, they did not manage to make the link that smaller lung volume and higher rate could result in similar volumes of CO being inhaled. Very rarely students questioned whether 5ppm was a deadly level, even though they readily accepted that CO was dangerous. Equally they failed to establish that any increase in CO concentration would be dangerous.

Q2.

Question (a) demanded recall from section 3.3.2 of the specification; 25.6% of students gained five or six marks. Many, however, omitted any reference to the structure at all and it was surprising that very few students elected to draw a labelled sketch to show the gross structure. Many lengthy answers were seen detailing exchange of gases and the features of the alveolar epithelium, neither of which was required by the wording in the question. Many answers included tracheoles as a part of the human gas exchange system. Inhalation tended to be described in the best detail. Marking points 3 and 5 were often not awarded because of a lack of precision in describing the role of the pair of antagonistic intercostal muscles. Many students conflated the two, and referred to them generically. The relaxation and contraction of the diaphragm and its corresponding shape were frequently confused. For example, students referred to the 'flattened' or 'domed' shape of the diaphragm without stating how that occurred. This question had the highest

discrimination index of the paper.

In question (b), although many students could demonstrate knowledge of phospholipids and triglycerides individually, they struggled to complete the required 'compare and contrast' command. When this command is used, every marking point requires a comparative statement that must be clearly made by the student: examiners will not infer links between separate statements – in this case, separate descriptions of phospholipids and of triglycerides. Many students did not include glycerol in their structure of the phospholipid. Some students were distracted into discussions of applications for the molecules, and their energetic values.

Question (c) showed that most students had learned the components of lactose and knew that it would be formed in a condensation reaction, although some omitted that this would result in the formation of a glycosidic bond. Fewer students knew that the lactose would be joined to a polypeptide in the Golgi apparatus. Many described that it would be found on the cell-surface membrane, and some tried to describe where on the polypeptide the lactose would be attached, rather than where in the cell as required by the question. Nearly half of the students scored at least two of the four available marks.

Q3.

There were some excellent answers to question (a) from students who had clearly used this method in their practical activities, but there were some answers which suggested other students had no recollection of this apparatus. Many correctly suggested that they would use the eyepiece graticule to measure the diameter of a large number of stomata to calculate a mean: these students gained 2 marks. Less well known, however, was the idea that the eyepiece graticule must be calibrated against a measuring device such as a stage micrometer or a plastic ruler. However, there were also some lengthy answers that described in great detail how the eyepiece graticule would be calibrated but then failed to give any further information.

Students found the calculation in question (b) difficult, with only about a quarter gaining 2 marks. The main problem was misreading the y axis of the graph as if it was the mean diameter of the stomata rather than the reduction in diameter compared with the control. Consequently, few students were able to gain the one mark available for calculating the reduction in mean diameter compared with the control for PS3 and ABA.

In question (c), more than half of the students gained at least 1 mark for stating that ABA would reduce transpiration, but relatively few went on to explain how this would aid survival in dry conditions. Answers that failed to score were sometimes superficial – "less water lost so more retained" – or suggested that ABA would provide water for the plant.

Many students realised, in question (d), that if the stomatal openings were smaller then fewer spores could enter the leaf. However, others failed to use the information given in the question and did not state that it would be the air-borne spores that would pass through the stomatal pore.

Q4.

(a) Even though the majority of students had some knowledge of the structure of the insect tracheal system, it was surprising how few could explain how it is adapted for efficient gas exchange. It should be noted that this is the context of section 3.3.2 of the specification – adaptations of gas exchange surfaces…for efficient gas exchange and the limitation of water loss. In order to **explain** successfully here, students needed to identify the feature of the tracheal system, and go on to explain how this chosen feature allows for efficient gas exchange. Many students stated that a short diffusion pathway is required, but could not give the feature of the tracheal

system that allowed this. Many students referred to “thin tracheoles”, which was insufficient, or referred to “thin membranes of tracheoles” (demonstrating a similar lack of clarity of understanding of the difference between a cell-surface membrane and epithelial cell layer of an exchange surface to that seen in question 2 part (c)). Similarly, many students appreciated that a large surface area is required, but could not sufficiently explain how this is achieved in an insect with highly branched / numerous tracheoles. There were some very good descriptions of lactate formation, causing water to be drawn out of the ends of the tracheoles, but few students could relate this to faster gas exchange as a result of diffusion through air, or a larger surface area. It was common to see those students, who identified ventilation as being important, then being unable to explain how this maintained a diffusion gradient. Explanations such as “moving carbon dioxide out and oxygen in” were not uncommon, and were not creditworthy. References to spiracles were not given credit as these are essential for limiting water loss but are not essential for efficient gas exchange.

(b) This was designed to test understanding of the statement in section 3.3.1: ‘Students should be able to appreciate the relationship between surface area and volume ratio, and metabolic rate’. Most students saw this question as an opportunity to write about their knowledge of gills as a gas exchange system, rather than focusing on the way of life of the damselfly larvae. Although this led some students to describe how more oxygen could be absorbed, the key to the question was about the increased activity of the damselfly and, therefore, its increased use of oxygen.

(c) Only 7% of students gained all three marks here. Dealing with uncertainties is new to this specification, as is using an appropriate number of significant figures (specification section 6.2, MS 1.1 and MS 1.11). There are clear explanations of using uncertainties and choosing an appropriate number of significant figures in the online Practical Handbook, Sections K and L.

(d) This question tests PS 4.1 from section 8.3 of the specification, linked to required practical activity 5 and apparatus and techniques skill AT e. The most common answers that did not gain credit were suggestions that the drawing should contain more detail, or an electron microscope should be used to enable more detail to be drawn. References to adding more labels were given credit even if the extra parts to be labelled were named incorrectly.

Q10.

(a) Most students were unable to provide appropriate units to compare the distribution of stomata on leaves. The units used varied from nanometres to metres and these were often measurements of length or volume rather than area. A significant number of students were under the mistaken impression that ‘per’ can be represented by a solidus.

(b) Most students were able to obtain one mark in this question usually for explaining that light would be able to pass through a thin piece of tissue. Very few students obtained both marks by further explaining that a single/few layer(s) of cells was required for this to occur. Many students did not gain a second mark due to the use of imprecise terminology, others were clearly confused with references being made to ‘diffusion distance’, ‘water loss’ and ‘electrons’.

(c) Almost 80% of students were able to obtain at least one of the two marks available. Both mark points were seen in relatively equal numbers. A common error was to refer to variation in the number of stomata on different leaves rather than in parts of the same leaf. There were also frequent references to anomalies, not always in the correct context.

(d) The quality of the answers for this question was very disappointing. Consequently, 75% of students scored zero. Some students had not carefully read the question and described a range of xerophytic features of plants rather than those specifically related to leaves. Other students simply described two xerophytic features of leaves but did not provide explanations. However, most students did suggest two xerophytic features of leaves and gave explanations but these explanations lacked detail. Students often referred to 'hairs trapping water' rather than 'water vapour' and omitted any reference to water potential gradients. Another common response was 'a waxy cuticle to reduce water loss' which again lacks sufficient detail to gain credit. A common misconception was that small leaves reduce surface area to volume ratios rather than referring to needles or spines.

(e) This question was problematic for many students, with only a third gaining any marks. The most frequently awarded mark point related to the use of water in photosynthesis. However, almost the same number of students suggested that water was produced in photosynthesis. Slightly fewer students mentioned the use of water to provide support/turgidity. There were far fewer references to the production of water during respiration or its use in hydrolysis. Again, weaker answers suggested that water is used in respiration or provided vague references to water being used for growth. A significant number of students referred to leakage of water from a potometer evidently having misinterpreted the context of the question.

Q11.

(a) The vast majority of students correctly identified the process as diffusion. The most common incorrect responses were osmosis and facilitated diffusion.

(b) Almost two thirds of students gained at least one mark for this question. Often this was achieved by explaining that the small/thin body of a tubifex worm would provide a short diffusion distance. A significant number of students named specific features of the body of a tubifex worm but did not explain how they allowed efficient gas exchange. Conversely, some students referred to a large surface area to volume ratio without relating this to a specific body feature.

(c) Less than 5% of students gained both marks for this question. The vast majority of students did not refer to the percentage saturation of haemoglobin in relation to the partial pressure of oxygen. Most students simply stated that the haemoglobin had a high affinity for oxygen at low partial pressures of oxygen. Approximately, a third of students gained one mark, invariably for referring to the use of oxygen for respiration.

(d) Most students gained one mark for correctly stating that seawater would have a lower water potential than the tubifex worm. Almost a third of students then gained the second mark by explaining that the worm would lose water by osmosis. However, many students did not gain this second mark as they either attempted to relate water potential to oxygen uptake or failed to refer to osmosis. A significant number of students suggested that the tubifex worm would 'burst' in seawater despite correctly identifying the water potential gradient.

Q12.

(a) Most students who gained both marks for this question, often referred to a large sample size and to selecting individuals at random. The idea of selecting healthy individuals and the 'same sex/gender' were also often credited. Fewer students mentioned taking repeat readings for each individual. Students failing to gain a mark often stated that smokers, non-smokers and individuals of similar body size should be selected.

(b) This question provided a similar mark distribution to 6.1 with approximately 70% of students gaining at least one mark. This mark was most often awarded for explaining that a mean FEV1 value could be used to provide a 'comparison' or 'benchmark'. Students gaining the second mark usually referred to determining the effect of smoking or ageing on the FEV1 value. Incorrect responses often described the benefits of twenty five year olds being selected in terms of their health or lung function.

(c) One in four students obtained this mark by referring to the reduced elasticity of lung tissue or the weakening of the internal intercostal muscles. Incorrect responses often involved vague descriptions of reduced lung efficiency or reference to incorrect muscles.

(d) Almost 60% of students gained at least two of the three marks available for this question. These marks were usually awarded for explaining that a reduced FEV1 would reduce the uptake of oxygen into the blood and consequently lead to reduced rate of respiration or of ATP production. Some students provided further details on increased anaerobic respiration and lactic acid production. Although many students appreciated that less air would be removed from the lungs, relatively few students linked this to less carbon dioxide being removed. Students scoring zero often provided superficial descriptions of breathing being affected with no references to gas exchange or respiration.

Q13.

(a) The vast majority of students were able to recall the role of the diaphragm in breathing out and more than 80% gained at least 2 marks. However, many wasted time in giving a lot of unnecessary information about the role of intercostal muscles. The most common misconception seen was that the air moved out by diffusion or along a concentration gradient. It was apparent from this question and from question (c) that there are some students who are insecure in their understanding of diffusion and mass flow. Inevitably, there were a few students who did not read the question carefully and wrote about breathing in.

(b) Most students showed that they were able to draw conclusions from the data. Use of figures is a good approach, however, this alone is not enough to make a comparison as the question asked. Students were required to recognise that the rate of decrease of the FEV_1 was greater in those who continued to smoke. Many did state this but there were also many who simply referred to a lower FEV_1 after 5 years in the smokers.

(c) Students had difficulty in applying their knowledge of the effect of smoking on the breathing system to this question. It was common to see answers about the reduced diffusion distance or the reduced surface area of the alveoli. These answers did not score. The majority of students scored at least 1 mark usually for loss of elasticity or scar tissue but relatively few recognised that a reduced FEV_1 is related to a narrowing of the airways. The more able students often wrote about narrowing of the airways due to inflammation or excess mucus production and these students gained both marks.

Q14.

(a) (i) Approximately two thirds of students knew this term and could spell it correctly.

(ii) Many more students were successful in naming 'tracheoles' precisely than in naming 'spiracles' in part (i).

(b) This question discriminated well. Often a lot of unnecessary detail was given about the structure of the tracheal system. Relatively few students mentioned how cellular respiration established the oxygen diffusion gradient and much time was wasted by some in explaining the movement of carbon dioxide. Lungs are thought by more than a minority of students to be insect structures.

(c) Even the ablest of students sometimes gained just a single mark for identifying, and often describing at length, that the chart showed a correlation existed between abdominal pumping and carbon dioxide release. They did not go further to explain what caused the correlation, namely that pressure increased when tubes are squeezed. Having established that a gradient of pressure existed in the tubes, some able students then, incorrectly, referred to diffusion being the mechanism of gas transport. As with BIOL1, examiners suggested there is patchy understanding of differences between the concepts of diffusion and mass flow. Many thought that pumping was a cause of increased carbon dioxide concentration rather than being a response to it and a common misconception was for carbon dioxide production to generate a diffusion gradient which led to its release.

Q15.

(a) It was vital in this question that students used the information provided in Resource A. Other answers relating to general methodology were not creditworthy.

(b) Most students gained mark point 1 and 2 but many did not multiply by two for the upper and lower surface of the leaf in order to achieve mark point 3.

(c) Both parts to this question required a feature and an explanation for each mark point and AS level answers were expected before credit was given; the marking guidelines give the minimum acceptable answer. So, for example, answers relating to water concentration in place of water potential are at a lower level and were, therefore, not creditworthy.

(d) Very few students could combine the two pieces of information from the table to appreciate that the very small leaf surface area meant that the total number of stomata was very low.

Q16.

(a) Most students gave reasonable suggestions for the purpose of treatments 1 and 2 but found the purpose of treatment 3 more difficult to explain. In this question and in question (c)(i), it was important that students had read the information in Resource B stating that these leaves have stomata only on their lower surface.

(b) (i) Students still find it difficult to describe a trend on a graph such as this accurately. Many students failed to state clearly that the rate stayed constant for the first 60 minutes and then fell (as required for mark point 1).

(ii) Some students were not explicit enough in their answer that the water is lost through the stomata in order to achieve mark point 1.

(c) (i) Students who stated that there were stomata on the upper surface of the leaf could not be awarded this mark, as Resource B stated that these leaves have stomata only on their lower surface.

(ii) Most students achieved mark point 1 but only better answers went on to explain why this meant there was no uptake of carbon dioxide.

Q17.

(a) Most were able to suggest two correct reasons for the difference. A minority misunderstood the question and attempted to suggest biological factors which may have brought about a change in the composition of the gas mixtures.

(b) Many students made full use of all the data and were able to clearly describe the key effects shown. Only the best answers made a specific comparison to the breathing rate at the 0.1% carbon dioxide concentration. A number repeated all the data without describing the effect of a change in carbon dioxide concentration. A minority seemed unable to make any valid analysis of the data and made only simplistic statements about the general trend.

(c) The majority of students produced an accurate calculation of breaths per minute. Incorrect answers included working out the mean for all grasshoppers or selecting data from the wrong column.

In part (b) most students were able suggest reasons why the mean may not be reliable but failed to go on and give a suitable biological explanation for the reason given. Many answers included references to possible anomalies and lack of reliability despite this being given in the question. Very few suggested that the carbon dioxide level may be lower in the meadow

Q18.

(a) Only about half of students achieved this mark. Many answers suggested counting errors as the main difficulty or the problem encountered in counting more than one fish at a time. A number of students suggested that different degrees of movement of the gill covers would lead to inaccurate determination of ventilation rates rather than the simple issue that fish are continually on the move.

(b) Only a minority of students knew that data from two dependent variables are needed to draw a scatter diagram. Many suggested the lack of enough data or the continuous nature of the data was the reason.

(c) This question tested the ability to use data from two different graphs. Successful students described the relationship in one clear statement. Unsuccessful students usually gave two conflicting statements or suggested that the increase in ventilation rate was the cause of the reduction in oxygen levels.

Most understood the link between the ventilation rate and oxygen uptake and its subsequent use in respiration or by cells. Only a few appreciated the need to maintain a diffusion gradient and the effect on blood oxygen levels. A surprising number suggested that fish are "warm-blooded" and attempted to link the change in ventilation rate in warmer water to the need for a homeostatic response. Some linked the increased water temperature to increased enzyme activity and thus a demand for more oxygen.

Q19.

Parts (a), (b) and (c)(i) proved to be good discriminators.

(a) 60% of students scored at least two marks. This was usually for appreciating that water and blood flow in opposite directions to maintain a concentration or diffusion gradient. However, relatively few students mentioned that this occurs along the whole length of the gill. Those who scored zero often gave an account of how the gills are adapted for efficient gas exchange, or did not convey the importance of

maintaining a concentration or diffusion gradient. There were also some lengthy descriptions of ventilation in fish. It should be noted that this topic is not included in the specification content for BIOL2.

(b) 70% of students scored full marks for linking thicker lamellae to a greater diffusion distance and the fusion of lamellae to a reduced surface area. However, some failed to pick up a second mark due to a lack of precision; for example, 'less diffusion occurs' and 'the diffusion pathway is thicker'.

(c) (i) A third of students obtained the correct answer of **5.14** and scored both marks outright. However, many students obtained the principle mark for showing 90 × 0.4 or 90 ÷ 7 in their method.

(ii) Very few students obtained the marks by suggesting that an increase in the temperature of the water would increase the fish's metabolism, or rate of respiration, or cause less oxygen to dissolve in the water. The majority of students referred to an increase in kinetic energy, or that water molecules would be moving faster.

Q20.

(a) Some of the lower-scoring students failed to access this question. Credit was available for stating that the relative processes stopped at particular values. Reference to processes happening at those values was insufficient, unless qualified by giving the range of values over which the processes happened. Some assessors incorrectly gave credit where positive, rather than negative, values were shown.

(b) This question proved accessible to most but some explanations were unnecessarily complicated by reference to transpiration.

(c) Many students found this question challenging. They were expected to suggest how growth was prevented when the processes stopped. Merely stating that they stopped was unworthy of a mark. Credit was inappropriately given by some assessors when the potential role of proteins as enzymes or membrane proteins, or the *naming* of a specific protein, had not been given. Some students failed to explain that a lack of cell wall synthesis would affect new cell production and consequently prevent growth. Higher-scoring students frequently achieved full credit.

Q21.

(a) (i) The majority of students knew this term. Some failed to obtain the mark by referring to facilitated diffusion.

(ii) The features of alveoli were well known. When students failed to score, it was often because they failed to answer the question but instead described general properties of all gas exchange surfaces. Common stand-alone answers that did not gain marks were: thin cell walls, one-cell thick membranes, thin membranes, thin lining, and folded lining. No mark was awarded for references to individual alveoli having a large surface area.

(b) This question was usually answered well. Students who did not gain marks often gave a general description of the causes and symptoms of fibrosis, rather than explaining why these prevented air being breathed out of the lungs.

Q22.

(a) This proved to be a good discriminator. One-third of students used the correct

formula and generally had little difficulty in gaining both marks. Of the remaining two-thirds, most obtained one mark for using the correct numerator or denominator.

(b) Most students gained at least one mark. This was usually for the idea of maintaining a concentration or diffusion gradient. Surprisingly, relatively few students appreciated that abdominal pumping would result in more air entering, or that air would enter quicker. Many simply stated that air was 'forced in'.

(c) Most students gained this mark by referring to a large surface area to volume ratio. Relatively few mentioned a short diffusion distance. Unfortunately, a minority of students suggested that a small size provides a *small* surface area to volume ratio.

(d) Different interpretations of the graph resulted in most students obtaining a correct answer. A common incorrect response was '5'. This was due to students incorrectly measuring the time between the spiracles opening as 12 seconds.

(e) Most students appreciated that an insect opens its spiracles at a lower frequency in dry conditions and that this reduces water loss.

(f) It was disappointing that only one-fifth of students obtained this mark. Correct responses usually always mentioned that gases move faster in air than in water. Relatively few mentioned an increase in the volume of air but instead mentioned an increase in the concentration of oxygen. Similarly, references to surface area were often in the wrong context. They suggested that the surface area of the tracheoles increased, rather than the surface area of the tracheoles *exposed to air.*

Q23.

Students did not score highly on this question. They often failed to interpret the question and use the data appropriately. Few students quoted correct figures and many failed to realise that the figures for stomach cancer and heart disease showed little difference. Many wrote in terms of contracting the disease rather than dying from it, as referred to in the resource. Others vaguely referred to ‘certain diseases’ and therefore failed to gain credit. In many cases, students simply repeated answers they had learned from past papers. These answers often gained one mark for referring to the idea that other factors are involved.

Q24.

(a) In general, students made good use of the data, as required, answering this question. Weaker answers only identified the overall trend.

(b) There was some misinterpretation of this question by students. All that was required was a description of what standard deviation shows, namely, the variation in, or spread of data about, the mean value. Some attempted to discuss standard deviation values related to the data obtained but there was no specific direction to do so in this case.

(c) Given that two possible approaches to this question were possible, the majority of students were able to make one acceptable line of reasoning.

(d) The link between carbon dioxide and photosynthesis was not apparent to a large number of students. Thus, they failed to gain the mark for this question.

(e) Although all responses were seen within the work that was moderated, most students could not make three relevant points – the mark allocation was the key for this – to justify whether the results supported the conclusion. It was rare to see

recognition of a negative correlation, although some described such but were only repeating the question stem and, for doing so, there is no credit. This type of question reflects a weakness with the assimilation of resource material. The likelihood of another factor being responsible was the most common point made, but this supports the idea that many students produce rehearsed answers without showing a comprehension of what is in the resources.

(f) Many students finished strongly with a question relying on recall. The Marking Guidelines specifically referred to “thick” cuticle but some assessors credited reference to ‘waxy’ as an alternative.

Q25.

This question was intended to be a highly accessible start to the paper but produced a lot of discrimination.

(a) A third of students could not name both structures.

(b) Answers to this question were better and a majority scored two marks. It was pleasing to see many references to pressure gradients and relatively few references to ‘sucking’ air into the lungs.

Q26.

(a) 60% of students scored full marks and the first route on the mark scheme was the most popular. Students scoring one mark typically mentioned ‘random’. However, some responses conveyed a failure to read the question stem carefully enough. Consequently, they answered a different question from the one asked and produced answers such as ‘reduces bias’, ‘use a double blind trial’, ‘ensure there is the same number of patients in each group’ and ‘do not tell patients which treatment they are receiving’.

(b) It was disappointing that 60% of students were unfamiliar with the use of standard deviation and scored zero. Only a quarter of students stated that the bars did not overlap and related this to the difference in results between Group **1** and the other groups as being significant, or not due to chance. Weaker responses that did make reference to the standard deviation bars usually went no further than to state that the bar for Group **1** was larger than that of the other groups.

(c) Three-quarters of students were aware that there was no evidence of a placebo effect, or that this effect was slight. However, the ability to link this to data shown in the graph proved to be a good discriminator.

(d) Two-thirds of students gained one mark for the idea that anomalies could be identified. However, some thought that repeats prevented anomalies from occurring or being recorded. It was only the best responses that referred to allowing a more reliable mean to be calculated. Taking additional readings does not necessarily allow results to be closer to the true value. Hence, references to ‘a more accurate mean’ were not credited. Weaker responses often referred to ‘the results’ being more reliable or more accurate, without further qualification.

(e) (i) Just over half of students gained this mark. Students who failed to score typically repeated information given in the question stem. The most typical response seen was ‘so that the normal treatment was the same for all patients’.

(ii) Almost all students scored at least one mark. This was usually for appreciating

that the normal treatment would not affect the results. Weaker responses usually relied on vague, stock *How Science Works* phrases, e.g. 'so a comparison can be made', 'it would give less reliable results' and 'to make it a fair test'. There was also evidence that a minority of students failed to read the question carefully enough. Their responses referred to albuterol as, the normal treatment or FEV as the experimental drug.

(f) (i) 80% of students scored at least one mark. This was usually for stating that improvement scores are subjective or qualitative. Only 10% of students went further and suggested that some patients might lie, exaggerate or want to please doctors. Again, weaker responses typically repeated information given in the question stem, e.g. 'the improvement score is how much the patients felt their symptoms had improved so it less reliable'.

(ii) Almost all students scored at least one mark. This was usually for the idea that patients knew they were not receiving any treatment. However, two-thirds of students were able to complete the story by linking this to patients being more likely to give lower improvement scores.

Q27.

(a) Many students complicated what should have been a straightforward question by adding a lot of unnecessary information. Many failed to recognise that the question was asking for what happened between times P and Q and described what was happening at P and at Q. Others did not distinguish between the instructions 'describe' and 'explain' and went on to give an unnecessary explanation. There was also some confusion as to whether the diaphragm moved up or down when the muscle contracted.

(b) Over half the students answered well and gained all three marks. However, as in part (a) there were many who included a lot of unnecessary information, usually about the intercostal muscles. While this did not necessarily result in the student failing to gain credit, it did waste time. Students should be encouraged to use the correct terminology; it was common to see references to space and size rather than volume, and concentration rather than pressure. There was some confusion between cause and effect with students stating that it was the intake of air that caused the movement of the diaphragm and the increase in volume. Students who stated that the air entered by diffusion could not gain the final marking point.

(c) Most students gained one mark for stating that the oxygen moved by diffusion but only the more able students referred to the epithelial or endothelial cells that made up the walls of the alveoli and capillary.

Q28.

(a) (i) The term diffusion was known well, with the majority of students answering correctly.

(ii) This question was successfully answered by the vast majority of students. Where students failed to gain a mark it was because they referred to the flatworm having a large surface area rather than a large surface area to volume ratio.

(b) (i) Many students could recall that an organ is a group of tissues.

(ii) Few students gained all three marks for this question but most achieved one or two marks in clearly appreciating that carbon dioxide enters a leaf through

the stomata. Students clearly understood the process of diffusion but failed to gain credit where they stated that diffusion occurs across or along, rather than down, the gradient.

Q29.

(a) All that was required in answer to this part of the question was a description of the role of the diaphragm in exhalation. Consequently, those who read and understood the question usually gained maximum credit. There were many, however, who failed to notice that the question related to a person breathing out and wrote either about inhalation or about both inhalation and exhalation. Among these students, frequent crossing out and replacement of terms suggested much uncertainty over the detail of the mechanism involved. This was occasionally compounded by a failure to separate the roles of diaphragm and ribs with references to the diaphragm moving up and out. Other students misunderstood the question completely and wrote about the effect of the inhaler.

(b) Many students again ignored the instruction given in the question and made no attempt to use the graph. These students often inappropriately applied the formula linking pulmonary ventilation to tidal volume and breathing rate. Others assumed that the breath had been completed in 6 seconds and simply read off the corresponding value from the y-axis. It was only the very best students who appreciated that the curve required extrapolation to the point where it levelled.

(c) Although this part of the question was frequently well answered, there was a widespread failure to refer specifically either to curve **A** or **B**. Failure to clarify this meant that, on occasion, it was not possible to award credit. Weaker students were clearly uncertain of the roles of bronchioles and wrote of increased surface area and oxygen diffusing through the bronchiole walls. There were also comments that suggested confusion between asthma, emphysema and even tuberculosis.

Q30.

(a) An encouraging number of students correctly suggested that a risk factor would increase the likelihood or chance of an event occurring. Where errors occurred, they usually involved incorrectly referring to risk factors causing, or being a side effect of, specific diseases. Defining a risk factor as a factor which affects risk was considered to be insufficient to gain credit.

(b) Most students correctly distinguished between positive and negative correlation although there were those who explained either in their answers to part (b) (ii) or part (c) that negative correlation meant no correlation.

(c) The better students had clearly examined the data presented in the question and referred to correlation not necessarily meaning causation and to the negative correlation from 1980 onwards. These students sometimes suggested that other factors such as population increase could explain the rise in both the number of cases of asthma and of the concentration of substances from vehicle exhausts. It was clear that many students took refuge in set responses that might have been relevant to previous questions but did not apply to the data here. Such responses included poor diagnosis and factors that might have explained the increase in asthma cases but had little bearing on the increase in the concentration of substances from vehicle exhausts. There were also a number of answers along the "we do not know" theme. Answers to questions of this nature should be based on the material that has been provided. "We do not know" is generally an inappropriate response.

Q31.

(a) This question produced a good spread of marks. Most students referred to haemoglobin combining with oxygen in red blood cells and appreciated that loading took place in the lungs. Some students then described the unloading of oxygen at respiring tissues and these students often linked this to the increase in carbon dioxide. Generally, only better students referred to high and low partial pressures of oxygen and gained maximum marks. A significant minority of responses ignored loading and unloading of oxygen and described the passage of oxygenated blood through the circulatory system.

(b) Almost half the students failed to gain a mark as they often simply referred to it being a 'fair test' without an explanation. Most answers gaining credit mentioned enzymes and better students linked this to respiration to gain two marks. Answers relating to the temperature affecting the amount of dissolved oxygen were fairly infrequent as were references to enabling 'comparisons' between the larvae of both species.

(c) Most students appreciated that the mean rate of oxygen uptake increased and then levelled out with an increase in oxygen concentration in the water. However, only better students specifically referred to where oxygen uptake levelled out. Students gaining zero marks often stated that there was a positive correlation between the variables.

(d) Many students noted, for one mark, that Chironomus longistylus has a higher oxygen uptake at lower concentrations of oxygen. However, less than 25% of students used the data to support their observation and gain a second mark.

(e) (i) Almost 80% of students gained this mark, often by stating that more oxygen is lost via the gills in Australian lungfish than in African lungfish.

(ii) Most students were aware that more exchange is via the lungs in African lungfish. However, far fewer students gained a second mark by mentioning that gills would not function in air.

Q32.

(i) 90% of candidates gained this mark for noting that the volume of air in the lungs increased. Candidates who failed to score usually referred to ‘fluctuations’ in the graph.

(ii) Just over 40% of candidates scored full marks. However, most candidates gained one mark for stating that the diaphragm contracts or flattens. Some answers went into unnecessary detail about the role of the intercostal muscles and ribcage in inhalation. This was not asked for. Additionally, a minority of weaker candidates thought that the intercostal muscles move the diaphragm.

Q33.

This question discriminated well across the ability range and there were many excellent answers to parts (a) and (b). Weaker candidates were often let down by poor expression and this was particularly notable for part (b).

(a) Approximately half of the candidates gained at least three marks. Most correctly described movement down a concentration gradient by diffusion and against a concentration gradient by active transport. The requirement for energy or ATP in active transport was frequently noted. Similarly, many candidates were aware that membrane proteins are involved in active transport or facilitated diffusion. However,

some disqualified this mark for stating that active transport involves channel proteins. Better candidates also referred to the movement of water by osmosis and related the property of a molecule to its route through the plasma membrane. Weaker candidates sometimes confused active transport and facilitated diffusion. Similarly, a minority described the structure of the membrane, without any reference to transport across it.

(b) Just over half of candidates gained at least four marks. It was pleasing to see better candidates often scoring full marks. References to a flattened epithelium or many capillaries providing a large surface area were rare. However, all other marking points were frequently seen. Many candidates appreciated the role of ventilation or circulation in maintaining a concentration gradient. Unfortunately, weaker candidates often gave answers that lacked detail or were out of context e.g. 'thin membranes', 'better diffusion' and 'faster gas exchange'. Similarly, they did not usually relate 'large surface area' to the many alveoli present. A minority of candidates started their answer with Fick's equation but did not relate this to the question in sufficient detail.

Q34.

(a) (i) Very few candidates gained two marks for this question. Only the most able used the correct scientific terminology to name the layers of the alveolus and capillary through which oxygen passes. A mark was often awarded for 'alveolar epithelium' or referring to the wall of both alveolus and capillary. However, a number of candidates who referred to the capillary simply stated that oxygen entered, without any reference to a layer. A number of weaker candidates referred to 'one cell thick membranes' or gave answers that focused solely on diffusion. Similarly, a minority of candidates referred to the passage of air through the 'bronchial tree', from trachea to alveoli.

(ii) This proved to be a good discriminator. Nearly 60% of candidates gained this mark for explaining that a thicker alveolar epithelium would increase the diffusion pathway or reduce the rate of diffusion. Candidates who failed to score usually referred to 'less diffusion', 'less surface area' or 'a longer pathway for gas exchange'.

(b) (i) Approximately one third of candidates gained one mark for the idea that ventilation brings in air with a high concentration of oxygen. However very few then went on to mention the removal of air with a low concentration of oxygen. References to the removal of air almost always referred to carbon dioxide concentration. This was not credited. Similarly, many candidates did not read the stem of the question carefully and described the need for a concentration gradient between the alveolus and blood. This was usually expressed in terms of where the concentration of oxygen would be high and low. A minority of candidates described the roles of the ribcage, intercostals muscles and diaphragm in ventilation.

(ii) Many candidates gained the mark for the idea that the circulation of blood also helps to maintain the concentration gradient between the alveolus and capillary. However, some candidates did not attempt this question or gave answers that related to the properties of a gas exchange surface.

(c) This was well answered and most candidates scored at least one mark. This was usually for the idea that miner's lung may be caused by other factors. Better candidates noticed fluctuations on the graph and made reference to a suitable year when the number of cases had dramatically increased. Weaker candidates often gave vague answers such as 'the number of cases gradually increased' without

qualification or they suggested how coal dust may have affected the lungs over time.

Q35.

(a) Most candidates gained at least one mark often by explaining that filaments and/or lamellae in the gills provide a large surface area allowing efficient gas exchange. The failure of many candidates to gain both marks was often due to poor use of terminology particularly in relation to the short diffusion pathway between the blood and water and the countercurrent flow mechanism.

(b) (i) Approximately half the candidates obtained this mark appreciating that a logarithmic scale enabled the plotting of a large range of values.

(ii) The vast majority of candidates correctly described the relationship between body mass and oxygen uptake.

(iii) It was surprising that only one in every five candidates obtained both marks for this question. Many candidates obtained a mark for indicating that measuring oxygen uptake per gram of body mass would enable a comparison to be made. However, only better candidates linked this to the difference in body mass or size of the animals.

Q36.

(a) Although it was evident that most candidates had a good idea of the role of phagocytes, poor use of terminology often resulted in marks not being awarded. It was common to see responses such as phagocytes 'fighting disease' or destroying 'foreign bodies' or 'infections'. Nevertheless, approximately a third of candidates obtained both marking points.

(b) (i) Most candidates obtained one mark for stating that the lungs would not fully inflate or deflate. However, very few candidates obtained a second mark for suggesting that breathing out would particularly be affected or that the rate of diffusion would be reduced. There was some confusion over the meaning of the term *elasticity* with many references to 'lungs contracting and relaxing'.

(ii) This proved to be an effective discriminator. The vast majority of candidates obtained at least one mark often by referring to the presence of scarred or fibrous tissue in the lungs. Most candidates then gained a second mark by linking this to a reduction in the surface area for effective gaseous exchange. Fewer candidates specifically referred to the thickening of the alveolar walls but instead mentioned thickening of lung tissue. However, a significant number of candidates were able to link this thickening to a longer diffusion pathway.

(c) (i) Most candidates obtained this mark using the information in the passage to explain that lung cancer develops 20 – 30 years after exposure to asbestosis. Candidates failing to gain this mark often provided incomplete responses such ae 'it takes a long time for cancer to develop'.

(ii) The vast majority of candidates obtained this mark by referring to smoking.

Q37.

(a) Candidates showed a good understanding of the adaptations of gills for efficient gas exchange. Although there were some who wrote in very general terms about 'gills', most candidates linked surface area to the possession of gill filaments or lamellae and to diffusion. The principle of counter-current flow was frequently mentioned and

it was clear that most candidates had an excellent understanding of this concept. Some illustrated their answers with diagrams and these were occasionally very helpful.
Candidates should be aware, however, that marks can only be awarded for diagrams that are properly labelled. There were numerous sketches on which were written figures that might have represented anything. Some points were made less frequently or less convincingly. There was relatively little mention of the roles of ventilation and circulation in maintaining the concentration gradient and many struggled to describe the short diffusion path in sufficient detail to gain credit. There were also a number of frequent misconceptions. These included references to air passing over the gills; to diffusion only being able to take place in water, and to the presence of carbon dioxide being essential for the diffusion of oxygen.

(b) Successful responses to this part of the question usually referred to photosynthesis or to the diffusion of oxygen from the higher concentration in the air. There were many answers, however, that involved fanciful ideas about generation of oxygen at depth and this bubbling to the surface, or incorporated the concept of need, such as that there was less oxygen at depth because the toadfish did not need it.

(c) This answer illustrated a common failing among less able candidates in answering questions that involve application of knowledge. They were often inclined to rely on recall and, while most were able to indicate that the toadfish environment was low in oxygen, they not infrequently related this to high altitude. There was also a tendency to give answers that were too brief, omitting reference to the context of low partial pressure when describing the high affinity of toadfish haemoglobin for oxygen.

(d) Answers to this question tended to fall into two categories. Either candidates gave very good answers that made the points in the mark scheme succinctly, or they wrote at length about the three organisms without ever quite answering the question. However, it was encouraging to see many excellent answers to a question set in a context which is new to the specification.

Q38.

(a) Most candidates were able to extract the relevant information from the passage and explain that many of those with the illness failed to see a doctor. The concept of a ratio in part (ii) proved difficult for some to understand. Although there were many correct answers there were many that should have been considered, at best, to have been improbable.

(b) Many candidates were able to comment on the identical nature of the sugars in the bacterial antigens and on the surface of nerve cells. For some, this led to a comprehensive account of antibody binding and the formation of an antibody-antigen complex. Others rather lost their way at this stage and did no more than suggest that this led to antibodies ‘attacking’ the nerve cells.

(c) There were many lengthy accounts presented in answer to this part of the question. Able candidates frequently described the entire process of ventilation and extended their answers onto additional sheets before eventually arriving at a point where they describe the effects of paralysis. It was clear, however, that many candidates had little idea of the precise role of the diaphragm. It was not infrequently described, for example, as ‘pushing the ribs up and out’. Such statements as ‘breathing in causes the diaphragm to flatten’ were common and revealed confusion between cause and effect.

Q39.

(a) Most candidates gained the mark available here although there were some who reversed the direction of movement and occasional inappropriate references to ribs “expanding”.

(b) Those candidates who, in part (i), attempted to define “passive” as being the opposite of “active” and therefore not involving muscle contraction usually gained credit. Others, however, appeared to consider autonomic events as occurring without the use of energy and many referred to “unconscious” or not having to “think about it”. Part (ii), however, was well answered and most candidates were able to extract the relevant information from the passage and explain why breathing out in crocodiles could be considered to be active.

(c) Where the quality of written communication was acceptable and candidates expressed their answers in terms of volume and pressure, responses to this question were generally sound. It was encouraging to see so many candidates displaying a clear understanding of the unfamiliar biology on which this question was based.

(d) Many of the weakest candidates failed to gain any credit for this part of the question. The reasons were varied. They attempted to offer explanations based on inaccurate versions of the carbon cycle; they assumed that inspired air only contained oxygen and expired air contained nothing but carbon dioxide, or they failed to make clear the differences that they were required to describe. Candidates of more modest ability tended to identify the differences in the relative amounts of oxygen and carbon dioxide but failed, despite in some cases writing at great length, to offer cogent explanation. Better again were candidates who described these differences and offered explanations in terms of diffusion across the alveolar epithelium. The very best candidates commented additionally on water vapour and the change in the relative amount of nitrogen.

Q40.

(a) Very few candidates correctly worked out the area as 0.0167mm^2 and many seemed to have a basic problem with calculating areas. It was common to see 0.1 x 0.1 = 0. I mm^2. Many candidates failed to gain credit by carrying out calculations that were not clearly identified. A common approach was to estimate the number of stomata in an area 0. 1mm x 0. 1mm, which gained credit if done correctly. Many gave answers that were clearly incorrect, such as 20-25 or even 0.25!

(b) Most candidates picked up the 2 marking points but some failed to gain the second point by incorrectly stating that ‘fewer stomata prevent water loss’. Few answers referred to the idea of there being a reduced surface area.

Q41.

(a) The question asked candidates to explain what caused the given changes in pumping movements of the locust’s abdomen in the different gases. Many candidates interpreted this as the purpose the locust had in mind and scored no marks. In part (i), since the only parameter changed was to replace normal atmospheric air with pure carbon dioxide, then the increase in carbon dioxide concentration (or possibly the reduction in oxygen concentration) should have been the obvious cause of the changed abdominal pumping frequency. In (ii), some very strange hypotheses were proposed about the locust becoming ‘adapted’ to breathing pure carbon dioxide or that the level of this pure carbon dioxide was somehow declining with time. Some realised there would be a lack of oxygen for respiration and, hence, less energy available to power the muscles involved in driving the pumping movements.

(b) Since a possible advantage to the locust was asked for here then ideas relating to outcome were appropriate in this case. Sensible suggestions included expulsion of the excess carbon dioxide or the provision of more oxygen enabling aerobic respiration or the breakdown of lactate.

Q42.

(a) (i) Although the graph in this question was probably unfamiliar, it was pleasing to note from the answers that many could interpret it and clearly understood what was represented.

(ii) Answers here were seldom so convincing. There was much irrelevant discussion of oxygen uptake and transport. Where carbon dioxide was mentioned, many candidates failed to link diffusion to events in the lungs. Perhaps more disturbing was the widespread misconception that diffusion of carbon dioxide is directly affected by the oxygen concentration gradient. Answers such as “Because oxygen has been taken in, there will be a high concentration so carbon dioxide can no longer diffuse out” were not infrequent.

(b) The answers which gained credit showed the volume of air increasing during inspiration but seldom drew on the information in the graph to indicate that a maximum value would be reached.

The simple strategy of checking on their own inspiration might have helped candidates here.

(c) Produced many excellent answers and it was encouraging to note so many using such terms as contract and relax, volume and pressure to explain the role of the intercostal muscles. It should be noted however that the specification does not require a knowledge of the roles of the internal and external intercostal muscles and, for some, this extra detail proved their downfall.

Q43.

(a) Most candidates correctly spotted the rise in the partial pressure of carbon dioxide.

(b) Most candidates produced a good logical account and achieved both marks.

(c) Again most candidates clearly knew what was expected and produced clear logical answers.

Many candidates who produced answers that did not actually relate water loss to spiracles movements failed to gain the second mark. Some candidates confused spiracles with stomata.

Q44.

(a) It was disappointing to observe that few candidates appeared to take note of the mark allocation for this part of the question. Two marks should have suggested that rather more was required than ‘large surface area’. To gain full credit it was necessary to link this aspect of the exchange surface with diffusion.

(b) AQA apologises for the error in the diagram accompanying this question. Clearly, the diameter of the red blood cell should have been given as 7.5 mm, not 0.75 mm. This information was not required for the calculation so it was felt safer to remove it completely, hence the erratum notice. In part (i), most candidates recognised cell layer **B** as epithelium although there were occasional incorrect references to

endothelium or epidermis. Part (ii), however, created problems for many in that they either chose to calculate the maximum thickness or encountered difficulties with the decimal point.

(c) In part (i), those candidates who understood the meaning of the word 'composition' were generally able to refer correctly to the concentrations of oxygen and carbon dioxide, although occasional poor expression left the examiners uncertain as to whether the concentrations quoted referred to the alveoli or to the trachea. However, there were many who clearly did not understand what was meant by composition and referred to such features as 'the percentage of the air' or pressure differences. There were many comprehensive answers to part (c)(ii) although some candidates again experienced difficulties in expressing their ideas.

(d) Although most answers were correct, there were occasional references to the pulmonary vein and to various chambers of the heart in part (i). In part (ii), the best candidates clearly appreciated that the lung cells would be respiring and would produce carbon dioxide, or that the concentration of carbon dioxide in the blood would reach equilibrium with that in the alveoli. Others produced responses that, even if not gaining credit, were at least biologically sound. What was disturbing, however, were the many answers along such lines as 'the heart needs oxygen to continue beating so it changes some into carbon dioxide' or 'there is not enough oxygen in the lungs to replace all the carbon dioxide'.

Q45.

(a) The quality of the answers to part (a) were very much centre-based and often reflected completion of the relevant subject matter from the specification rather than an inherent lack of understanding. Better candidates had clearly encountered muscles and could give some account of their role in breathing. Even among these candidates, however, errors and lack of precision were apparent. There were still far too many references to 'messages' or to nerves 'telling' various organs what to do.

(b) Most candidates were correctly able to link an increase in lung volume with a reduction in pressure, although there were many who were of the opinion that air is drawn into the lungs against a pressure gradient.

Q46.

(a) Most candidates were unable to choose the minimum distance to measure on the photograph between the water and a red blood cell in the fish gill. Calculations based on an incorrect initial measurement still gained some credit.

(b) While most were able to write at length about how counterflow maintained the oxygen concentration gradient, only some went on to point out that the benefit to the fish was that it would obtain more oxygen from the water and hardly any explained that the extra oxygen would be useful to a fish since it would result in a higher rate of respiration.

Q47.

(a) Answers were either of an excellent standard, describing succinctly how the action of the diaphragm led to an increase in thoracic volume and a decrease in pressure, or they demonstrated a limited and confused understanding of the principles involved. Many less able candidates wrote about both inhalation and exhalation. The examiners ignored irrelevant material where possible but could not do so where information concerning exhalation contradicted that given for inhalation. Considerable uncertainty was demonstrated over the precise change in shape of the

diaphragm during inhalation. It was often described as moving upwards or outwards, answers which suggested confusion with movement of the ribs.

(b) Incorrect responses to this question could be divided into two categories. Many candidates obviously failed to interpret the data correctly, not noticing that they concerned a single animal. Answers referring to allowing a comparison between the organs of different sized animals were thus, clearly, incorrect. Others failed to identify the intended emphasis in the question and explained such points as why grams rather than kilograms were selected; why units were in grams rather than in cubic centimetres, or why they related to tissue. Good candidates went beyond the idea of a"fair test" and referred to differences in size of the organs concerned.

(c) It is of concern that so many A level biologists fail to attempt any question which involves numbers, particularly when it involves the straightforward calculation of a percentage. There were many correct responses but others showed working which revealed a lack of understanding of what was involved, seemingly selecting figures at random and carrying out mathematical manipulations which proved impossible to follow or to comprehend. The large number of candidates who subtracted the data for the seal under water from that for the animal on land made the first step towards an answer and gained some credit.

(d) Candidates who appreciated that an air-breathing seal would be unable to continue breathing while under water were usually able to make some progress with this question. Such candidates generally noted in part (i) that continued blood flow to the lungs would result in removal of residual oxygen. Surprisingly many candidates encountered difficulties here because they based their answers on the transfer of oxygen to the lungs in order to allow breathing to continue. Where common sense prevailed, answers to part (ii) usually involved some reference to the diaphragm not contracting, allowing blood to be diverted elsewhere. It was not uncommon to find answers where cause and effect were confused, and there were a number of accounts in which candidates clearly saw a reduction in blood flow as the key feature in preventing diaphragm contraction under water.

Q48.

(a) Only the best candidates interpreted the diagram correctly and, having done this, were able to describe the pathway in appropriate biological language. There were rather too many references to walls and membranes to be sure of understanding. In addition, there was some interpretation of the question as requiring a reference to the mechanism involved. This resulted in some lengthy explanations of the process of diffusion.

(b) Common correct answers were the possession of a capsule and a cell wall, but there was a disappointing number of incorrect responses. These tended to arise either because the candidate sought to compare a prokaryotic cell with an unspecified eukaryotic cell, or because references were made to features such as nuclei and mitochondria which were absent from prokaryotic cells. Many of the responses made in this question clearly highlighted the perils of failing to read the question carefully.

(c) Candidates who explained the advantage of a disc shape in terms of increased surface area encountered few problems in equating this property to diffusion. Others were less successful, either because they were unable to explain the flattened shape of the cell in terms of a short diffusion pathway, or because they constructed inappropriate arguments based on the amount of haemoglobin present or the flexibility of the cells.

(d) Despite the frequency of such calculations in Unit tests, candidates met with only limited success in part (i). This part of the question gave rise to two problems which created particular difficulties. Candidates had to select the right measurement to represent the diameter and they had to convert this measurement to micrometres. Both tasks presented major hurdles to those of more limited ability. Further difficulties arose from a failure to calculate magnification from the data provided. Part (ii), however, was generally answered well, although there were those who sought to offer explanations based on resolution or the orientation of the specimen, perhaps relying on uncertain memories of previous mark schemes.

Q49.

(a) The pattern of change consisted of three phases, an immediate increase followed by a slower rise to a plateau. The performance descriptors for AS biology recently released by QCA indicate that the ability to describe trends and patterns in data is held to be indicative of a grade E candidate. Despite this, large numbers of candidates show little competence with this skill, either in theory papers or in their coursework. The main problems encountered in this particular question were a failure to distinguish between rest and activity, and the frequency of responses based on such simplistic ideas as that “during exercise the rate of pulmonary ventilation goes up”.

(b) The relationship between pulmonary ventilation, breathing rate and tidal volume created something of a challenge. Although better candidates could generally re-arrange the equation, they still experienced difficulty in explaining how the value for the pulmonary ventilation could be obtained from the graph. Less able candidates frequently incorporated stroke volume or time into the account and multiplied or divided by these quantities.

(c) Many candidates were able to offer lucid explanations of the information provided and showed familiarity with the concept of dead space. Others, not always the weaker candidates, confused this concept with residual volume. Otherwise sound answers were sometimes marred by imprecise expression. The term “throat” was often used, for example, to refer to the airways.

Q50.

In part (i) most candidates were aware that there are differences in the figures for men and women. However, despite being asked to use an example from the tables, many failed to do so. In part (ii) many candidates were aware that percentages lead to ease of comparison, but few referred to differing sample sizes.

Q51.

(a) Despite the straightforward nature of this question very few candidates scored both of the marks available. Clearly candidates had limited knowledge of the basic structure of fish gills. Over 50% of the responses referred to lamellae and gill plates as the two principal structures rather than describing the presence of lamellae on filaments.

(b) This part was well answered and better candidates often implied causation in their responses, with statements such as “as gill surface area increases, so do mass and swimming speed”.

Most of the better candidates scored both marks here. Less able candidates often failed to give an explanation of what the increased oxygen uptake was for.

Q52.

There were mixed responses to this question on ventilation in fish.

(a) Few candidates gained full marks. Many of them simply stated that the diffusion gradient was maintained, or failed to appreciate that the fish obtain more oxygen.

(b) Many candidates gained two marks for the number of ventilation cycles in a minute. The most common mistake was 2 cycles per minute.

Q53.

The role of the cuticle was well known. Some candidates failed to gain marks through incomplete answers such as ‘the cuticle reduces transpiration’ rather than relating water loss to the impermeable nature of the cuticle. In part (ii), most candidates were able to describe a feature that reduces water loss, but only the more able candidates explained how the feature reduces transpiration by affecting the water diffusion gradient.

Q54.

The quality of the answers here were very centre-specific.

(a) Candidates frequently scored high marks in part (i), but some candidates failed to mention a specific feature. The most common answer was that filaments or lamellae increased the surface area. In part (ii), the idea of maintaining the gradient was often recognised, but not over the whole length of the gill.

(b) There was only an occasional reference to energy or that there would be a continuous flow. There were many vague answers to ‘it being less efficient’.

Q55.

(a) This was surprisingly poorly answered with many candidates providing descriptions of a standard lower than that expected for GCSE. There was generally a lack of a clear sequence in the descriptions with links not being made between an action and its effect, such as contraction of intercostal muscles and raising of the ribcage. The link between an increase in volume and a decrease in pressure was often omitted, as was the required reference to diaphragm muscle. Some candidates concentrated on a description of the nervous control of breathing which was not part of this module.

(b) This was considered a more straightforward question and was usually well-answered. Marks were lost by poor terminology, candidates sometimes describing a decrease in tidal volume rather than a slowing down in the rate of increase. A minority attempted to explain the curves without offering a description.

(c) The majority of candidates gained the principle mark but only the better candidates gave the correct answer. A significant number was unable to read the data correctly. The most common mistake was to read off both the tidal volume and breathing rate

from where one of the lines crossed the x axis at 20 km h^{-1}, producing answers of 40 (2 × 20) or 77.5 - 77.6 (2.75 × 27.5). Some candidates having correctly obtained the data then carried out the wrong calculation.

Q56.

(a) There was a large range of answers to this question., including some excellent, detailed descriptions, which achieved full marks. A frequent mistake was to misinterpret the question and give a detailed but irrelevant explanation of the counterflow mechanism. Some candidates were unclear about the structure of the gills and produced confused accounts of the roles and functions of the buccal cavity and operculum. Some clearly did not understand the principle of ventilation at all.

(b) Answers to this question proved disappointing. Many candidates understood the basic structure and function of the lungs but did not produce detailed accounts, using appropriate AS terminology. Answers tended to concentrate on surface area of alveoli and short diffusion pathways, or to give detailed descriptions of lung structure and the mechanism of breathing, without linking this to the uptake of oxygen.

Q57.

(a) Many candidates scored one mark most commonly for recognition of the short diffusion pathway, which was often related to the SA:V ratio. Surprisingly few answers then went on to relate this to exchange occurring across the body surface.

(b) Again, only the very weakest candidates failed to gain the surface area mark, usually omitting to link the increased surface area to number of lamellae present. Only the better candidates explained fully the short diffusion pathway in relation to the blood capillaries. Poor expression with reference to respiration and ‘synthesising energy’ appeared in a number of weaker answers.

Q58.

(a) There were some excellent answers to this question with many candidates gaining full marks. Examiners were looking for each feature being linked to how it fulfils its function. Marks were therefore lost by candidates who failed to specify the functional advantage of a described feature. Imprecise descriptions including ‘thin gills’ and ‘good blood supply’ also failed to gain credit. The countercurrent principle was well understood and most candidates were aware of filaments and lamellae, but very few included details of secondary lamellae or gill filaments.

(b) The calculation was beyond most candidates, with very few even attempting it. Some did calculate 20 cm^3 but then gave it as the actual answer. A majority of candidates realised water is denser than air, but only the better candidates linked this to energy input. Very few referred to difficulty in pushing the water back out. Some candidates associated tidal movement with decreased efficiency of the countercurrent mechanism.

(c) This question was not well answered, most candidates giving vague descriptions of ‘more oxygen being absorbed’. Only the very best candidates appreciated the increased amount of water flowing resulted in the same amount of oxygen being extracted.