AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.3.1 SURFACE AREA TO VOLUME RATIO

SCORE	PERCENTAGE
/314	%

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Q1.

(a) As size increases, ratio (of surface area to volume) decreases;

Accept converse.

Comparison required, e.g., smaller organisms have a larger ratio

1

(b) Two marks for correct answer in range of 1.75 to 1.76032;;

Accept for 1 mark, incorrect answer using radius 0.87 / 0.88 / 0.880 / 0.8802 / 0.88015;

OR

Accept for 1 mark, incorrect answer with correct rearranged equation, e.g.,

Radius = $\sqrt{(\text{surface area} \div 4\pi)}$

OR

= $\sqrt{9.73 \div 12.56}$

OR

= $\sqrt{0.77}$ / $\sqrt{0.774}$ / $\sqrt{0.775}$

OR

r^2 = *surface area ÷ 4 π*

OR

r^2 = *9.73 ÷ 12.56*

OR

r^2 = *0.77 / 0.774 / 0.775*

2

(c) (Measures) small uptake / amount / quantity / volume / concentration / rate (of oxygen uptake);

OR

Avoids use of powers of ten / standard form / many decimal places;

Ignore weight / accuracy

1

(d) More accurate / less error (in measuring mass);

OR

Causes less distress / damage to animal (to measure mass);

OR

Easier / quicker (to find mass) **because** irregular shapes;

OR

Fewer measurements / calculations;

*Ignore references to **human** error*

Accept converse if reference made to volume

Reject if comparison is made with surface area.

1

(e) (Oxygen used in) respiration, **which** provides energy / ATP;

OR

(Oxygen is used in) respiration, **which** is a metabolic process / chemical reaction;

Reject produces energy

Reject references to anaerobic respiration

1

(f) 1. No information about egg;

2. So cannot compare all stages (in Table 2);

Idea of comparing all three stages needed

3. No statistical information / test / t-test / comparison of standard deviations;
OR
No measure of significant differences;

Reject statements that "results" are not significant

Reject references to chi squared or correlation coefficient

3

[9]

Q2.

(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]

Q3.

(a) 1. (Overall) outward pressure of 3.2 kPa;
2. Forces small molecules out of capillary.

2

(b) Loss of water / loss of fluid / friction (against capillary lining).

1

(c) 1. High blood pressure = high hydrostatic pressure;
2. Increases outward pressure from (arterial) end of capillary / reduces inward pressure at (venule) end of capillary;
3. (So) more tissue fluid formed / less tissue fluid is reabsorbed.

Allow lymph system not able to drain tissues fast enough

3

(d) 1. Water has left the capillary;
2. Proteins (in blood) too large to leave capillary;
3. Increasing / giving higher concentration of blood proteins (and thus wp).

3

[9]

Q4.

(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]

Q5.

(a) 1. Water potential becomes lower / becomes more negative (as sugar enters phloem);
2. Water enters phloem by osmosis;
3. Increased volume (of water) causes increased pressure.

3

(b) 1. Rate of photosynthesis related to rate of sucrose production;
2. Rate of translocation higher when sucrose concentration is higher.

2

(c) 1. Rate of translocation does not fall to zero / translocation still occurs after 120 minutes;

2. But sucrose no longer able to enter cytoplasm of phloem cells.

2

[7]

Q6.

(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]

Q7.

(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]

Q8.

(a) 1. Lower affinity for oxygen / releases more oxygen / oxygen is released quicker / oxygen dissociates / unloads more readily;

***Q** Neutral: the organism / body has a lower affinity for oxygen / releases more oxygen*

2. (To) muscles / tissues / cells

3. (For) high / rapid respiration;

***Q** Reject: '**produces** more energy' on its own*

Neutral: reference to partial pressure

Accept: (for) respiration to produce more energy in the form of ATP / release more energy

3

(b) (i) 1. Small SA:VOL;

Neutral: small limbs / small ears / extremities

Neutral: small SA

Accept: large VOL:SA

Neutral: reference to fat / blubber / insulation

2. (So) reduces heat loss / (more) heat retained;

Note: MP2 is independent of MP1

2

(ii) 1. Brain is the same, others fall;

Note: 1. might not be given in the same sentence

Assume that 'other organs fall' = all three organ categories fall

Accept: 'blood flow is reduced to all organs except for the brain'

2. Brain controls other organs / remains active / needs constant supply of oxygen;

Accept: 'seal would die' = brain remains active

3. Lungs not used / are used less / seal is not breathing / heart rate decreases / heart pumps less / blood diverted to muscles;
Reject: seal is not respiring

3

[8]

Q9.

(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]

Q10.

(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]

Q11.

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]

Q12.

(a) (i) (We should maintain biodiversity to)
Prevent extinction / loss of populations / reduction in populations / loss of habitats / save organisms for future generations (idea of);
Neutral: references to 'playing God' / animal rights

1

(ii) A suitable example of how some species may be important financially e.g.

1. medical / pharmaceutical uses;

2. commercial products / example given;

3. tourism;

4. agriculture;

5. saving local forest communities;

1 max

(b) 1. Fewer plant species / decrease in plant diversity;

Accept: converse arguments for islands with a high percentage of forest remaining

1. Neutral: fewer plants

2. Fewer habitats nesting sites / niches / food sources / varieties / less protection from predators / hunters / environment;

2. Neutral: fewer homes

2. Neutral: less food

2

(c) 1. Number of (individuals / birds of) each species;

1. Neutral: number of species

2. Total number of individuals / birds of all species;

2. Accept: 'total number of birds' as given context for 'all species' in the investigation

2

(d) 1. (Larger birds have) a low(er) SA:VOL;

Neutral: reference to fat / feathers

2. (So) less heat loss / more heat retained;

MP2 is independent of MP1

2

[8]

Q13.

(a) Hydrolysis (reaction);

Accept phonetic spelling

1

(b) 1. Too big / wrong shape;

Wrong charge - neutral

Accept insoluble

2. To fit / bind / pass through (membrane / into cell / through carrier / channel protein);

3. Carrier / channel protein;

Accept carrier / channel protein not present

3

(c) Foreign / (act as) antigen / non-self;

Reject foreign cells

1

(d) 1. Dose to be given;

Accept: interaction with other drugs

2. No (serious) side effects;

3. How effective;

4. Cost of drug;

2 max

[7]

Q14.

(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]

Q15.

(a) 1. Phagocyte attracted to bacteria by chemicals / recognise antigens on bacteria as foreign;

2. Engulf / ingest bacteria;

3. Bacteria in vacuole / vesicle;

4. Lysosome fuses with / empties enzymes into vacuole;

5. Bacteria digested / hydrolysed;

1. Accept names chemical e.g. toxin

2. Allow description of engulfing

3. Accept: bacteria in phagosome

5. Neutral: Break down

5. Accept digestive enzymes destroy bacteria

5. Do not accept ''destroy bacteria'' as it is in question stem

4 max

(b) 1. Microvilli provide a large / increased surface area;

2. Many mitochondria produce ATP / release or provide energy (for active transport);

3. Carrier proteins for active transport;

4. Channel / carrier proteins for facilitated diffusion;

5. Co-transport of sodium (ions) and glucose or symport / carrier protein for sodium (ions) and glucose;

6. Membrane-bound enzymes digest disaccharides / produce glucose;

1. Reject villi on epithelial cells
1. Accept brush border
2. Accept large SA:vol ratio
3. Need idea of ''lots"
4. Reject: energy produced
5. Accept Na^+K^+ pump
6. Neutral: Channel proteins
7. Accept named example

6

[10]

Q16.

(a) Cell wall;

Starch (store);

Chloroplast;

Accept: phonetic spelling

2 max

(b) Insoluble;

Reduces / 'stops' water entry / osmosis / does not affect water potential / is osmotically inactive;

Accept: description for first point e.g. 'does not dissolve'.

2

(c) Light sensitive eyespot / eyespot detects light;

Flagellum enables movement towards light;

Chloroplast / chlorophyll absorbs light / for photosynthesis;

Do not penalise references to 'many chloroplasts'.

3

[7]

Q17.

(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 <u>diffusion</u>;

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

5 max

[10]

Q18.

(a) Loading / uptake / association of oxygen at high p.O_2;

In lungs (haemoglobin) is (almost) fully saturated / in lungs haemoglobin has a high affinity for oxygen;

Unloads / releases / dissociates oxygen at low p.O_2;

Unloading linked to higher carbon dioxide concentration;

Allow converse for second marking point in tissues i.e. haemoglobin has low affinity / releases most of its oxygen.

Mark for haemoglobin having high affinity for oxygen must be 'in lungs'.

3 max

(b) (i) Larger the mammal the more to the left / steeper / 'higher' is the curve / the higher the affinity for oxygen;

Allow converse.

Ignore references to Bohr shift

1

(ii) Smaller mammal has greater surface area to volume ratio;

Smaller mammal / larger SA:Vol ratio more heat lost (per unit body mass);

Allow converse explanation for larger mammals or lower surface area to volume ratio.

Smaller mammal / larger SA:Vol ratio has greater rate of respiration / metabolism;

Allow suitable named mammal as alternative to smaller or larger mammal.

Oxygen required for respiration so (haemoglobin) releases more oxygen / oxygen released more readily / haemoglobin has lower affinity;

4

[8]

Q19.

(a) Measure with eyepiece graticule / scale;
Calibrate with stage micrometer / scale on slide / object of known size;
Repeats and calculate the mean;
OR
Use a ruler to estimate the field diameter under microscope;
How many droplets go across the field;
Repeats and calculate mean;

Accept references to radius

3

(b) (i) Two mark for correct answer of 4 : 1;;
One mark for incorrect answer but working shows that candidate has clearly attempted to compare values of r^2 / 6^2 and 3^2 / 36 and 9;

Idea of comparing ratios
A ratio of 1 : 4 should gain 1 mark

2

(ii) Small droplets have a larger surface area to volume ratio;
More surface for lipase (to act), leading to faster digestion of triglycerides;
Fatty acids are produced more quickly so pH will drop more quickly in curve Y / with bile salts / less fatty acids in curve Z / without bile salts so pH drop more slowly;

3

[8]

Q20.

(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]

Q21.

(a) (i) Mitochondrion;

Neutral: cristae

1

(ii) (Site of aerobic) respiration / ATP production / energy release;

***Q** Reject: anaerobic respiration*

***Q** Reject: energy produced*

Active transport / transport against the concentration gradient;

Accept: energy produced in the form of ATP

2

(b) 89 – 91 gains 2 marks;

Correct answer gains 2 marks outright

Principle of:

$$\frac{\text{correct measured length}}{\text{magnification}}$$ gains 1 mark;

89-91 (mm) / 1000 <u>or</u> 8.9-9.1 (cm) / 1000 gains 1 mark

2

(c) Suitable explanation given e.g.

Accept: converse arguments

Reduced <u>surface area</u>; (So) less absorption;

*Neutral: structure **Z** incorrectly named*

(Membrane-bound) enzymes less effective;
(So) proteins / polypeptides not digested;

Reduced surface area for absorption gains 2 marks

Cell membranes damaged;
(So) Fewer / less effective carrier / channel proteins;

Accept: references to diffusion and active transport for 'absorption'

Carrier / channel proteins damaged;
(So) less absorption;

Reject: active transport if linked to channel proteins

2

[7]

Q22.

(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]

Q23.

(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]

Q24.

(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]

Q25.

(a) Lengthways / down the root;

Through one tissue only / through same part / same proportion of tissues;

2

(b) To prevent the water from evaporating / prevent evaporation;

Changing the concentrations / water potential (of solution);

2

(c) (i) Plot data on a graph;

Find (sucrose concentration) from the graph where the ratio is 1;

2

(ii) No, because the results are given as a ratio / as a proportion of initial

length;

1

[7]

Q26.

(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]

Q27.

21 – 25	Extended abstract Generalised beyond specific context	Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question. Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained. No significant errors or irrelevant material. For top marks in the band, the answer shows evidence of reading beyond specification requirements.
16 – 20	Relational Integrated into a whole	Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained. Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with

		appropriate use of terminology. Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.
11 – 15	Multistructural Several aspects covered but they are unrelated	Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.
6 – 10	Unistructural Only one or few aspects covered	Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.
1 – 5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	**Definition**
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process.

	When considering, for example, the importance of a process, the explanation must be at A-level standard. 'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at A-level standard.

Heat and many different substances are transferred within the body and between the body and the environment. Please note that to obtain full credit, students must use information to **explain how surface area is linked to this transfer**.

Topics

3.1.7	Water
3.2.3	Transport across cell membranes

3.3.1	Surface area to volume ratio
3.3.2	Gas exchange
3.3.3	Digestion and absorption
3.3.4	Mass transport
3.5.3	Energy and ecosystems
3.5.4	Nutrient cycles
3.6.4	Homeostasis is the maintenance of a stable internal environment

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q28.

(a) Two marks for correct answer of 64.285 / 64.3 / 64;
(allow 1 mark for (8100 / 100 × 30) / 37.8)

2

(b) dissolve in / add ethanol then mix with water;
emulsion / white colour indicates triglycerides present;

2

(c) (i) increase the surface area for absorption;
(ignore wrong ref. to name)

1

(ii) **R** = tissue fluid / interstitial fluid / extracellular fluid / intercellular space;
S = lymph(atic) vessel / lymph capillary / lacteal;

2

(iii) proteins are synthesised by **U**;
involvement of ribosomes;
protein isolation / transport (inside RER);
vesicle formation;

2 max

(iv) exocytosis / description of;
because of size / too large to leave by other methods;

2

[11]

Q29.

(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]

Q30.

(a) Muscles (associated with breathing) relax;

1

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

1

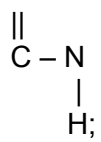
[2]

Q31.

(a) Rate of movement / diffusion proportional to concentration gradient / difference in concentration;
High concentration of potassium ions inside cell compared to outside;
Must mention high concentration. Ignore reference to other factors if reasoning is appropriate.

2

(b) (i)



1

(ii) 10;

1

(c) Action of vanilomycin depends on fluidity of membrane;
Fluidity reduced / not fluid at low temperatures;
Pore formed by gramicidin A remains in place / permanent;

3

(d) Pore between sterol molecules lined with polyene antibiotic;
Hydrophobic region next to sterol;

2

[9]

Q32.

(a) Large surface area to volume ratio;
For diffusion;
OR
Flat / thin;
So oxygen can reach all haemoglobin / centre rapidly / short pathway;

max 2

(b) (i) Partially permeable / allows water through but not sucrose;
Accept semi-permeable / selectively permeable.

1

(ii) Phospholipid (in membrane) / bilayer dissolved / broken down;
Allows haemoglobin / contents to leak out;

2

[5]

Q33.

(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]

Q34.

(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]

Q35.

(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]

Q36.

(a) shallow roots enable rapid uptake of rainfall (in **X** and / or **Z**);
widespread / shallow roots allow collection of larger volume water / over a larger area / rapid uptake of water (in **Z**);
swollen stem for water storage (in **X**);
deep roots for accessing deep groundwater (in **Y**);
small / no leaves so little transpiration;

3

(b) **Z**;
wide spread of roots for rapid water absorption;
(accept **X**; if linked to leaves channelling water to roots)
(ignore references to water storage abilities)
(accept other responses if justified)

2

[5]

Q37.

(a) (i) <u>one</u> feature;
<u>then linked</u> 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]

Q38.

(a) transmission / reflected / misses chlorophyll / chloroplasts / wrong wavelength;

1

(b) (larger area) to absorb light;
(larger surface area) to absorb carbon dioxide;
short diffusion pathway for gases / oxygen / CO_2;
light able to penetrate to all cells;

2 max

(c) effect;
detail;
effect on photosynthesis;
some effects are less light / light absorbed by water
different wavelength of light
temperature
availability of carbon dioxide
availability of water

(more than one effect award 1 mark only)

3

[6]

Q39.

(a) 1. mouth opens, operculum / opercular valve shuts;
2. floor of mouth lowered;
3. water enters due to decreased pressure / increased volume;
4. mouth closes, operculum / opercular valve opens;
5. floor raised results in increased pressure / decreased volume;
6. high / increased pressure forces / pushes water over gills;

4 max

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

6 max

[10]

Q40.

(a) exchange / diffusion across body surface / skin;
short diffusion pathway / distance / large SA:V ratio;

2

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

3

[5]

Q1.

In (a), most students (70.3%) knew the relationship and described it correctly. Some misinterpreted the question and wrote about the advantage of having a large or small surface area to volume ratio; for example by discussing diffusion or gas exchange. Some missed the idea of describing a relationship and gave specific examples, for example “large organisms have small ratios”.

Question (b) discriminated pretty well. Most students successfully changed the subject of the equation to find the radius and converted this figure into a diameter. Some failed to gain a mark because they left the subject of the equation as r^2, or they did not double the radius to give the diameter. Many answers showed that students understood the mathematics skill associated with rounding numbers.

Students found question (c) difficult (60.5% scored zero) because it asked them to apply an understanding of practical procedures to a novel context. Many failed to focus on the idea of small quantities and wrote instead about “the small organism” or “this is a small unit of measurement”. Others gave standard answers such as “easier to compare” or “more accurate/precise”, again insufficient. Those who gained the mark usually did so for writing about the small or low uptake of oxygen. A few students demonstrated good understanding of mathematics principles by realising that using μmol would avoid the use of standard form or the use of many decimal places, and often gave a detailed explanation to reinforce their clear understanding.

Many answers to question (d) did not go further than “it is easier or quicker to measure mass”. However, 38.1% of students gained the mark and all the alternatives on the mark scheme were seen multiple times. Some students gave illogical suggestions, like “masses of a development stage would be different whereas volumes are the same”, and others “that these were too small to measure”.

For (e), there were a lot of seemingly good answers that avoided reference to respiration and so did not gain credit. Others went no further than oxygen is used in respiration, so is a measure of metabolic rate; again, this was insufficient. Some students implied incorrectly that oxygen is a reactant in all metabolic processes; others gave the usual misconception of energy ‘production’, and breathing was confused with respiration in more than a few answers. Those who achieved the mark (25.1%) demonstrated, often in an accurate and concise passage, a good ability to apply their understanding. Both alternatives on the mark scheme were often seen.

In question (f), most students demonstrated their ability to use results to make a conclusion by identifying there was no information about the egg, so one mark was very accessible. Some incorrectly suggested the dash in the table meant eggs did not respire or were dead. Many did not comprehend the reference in the table to ‘mean’, so suggested incorrectly that only a single tadpole or frog was studied. Others gave tadpole as the stage where no information was presented, which is not shown in the table. Few students explained precisely why a relationship is not concluded from only two data points. Very few made reference to there being a lack of statistics. Some students misunderstood this question and gave their own conclusion for these results.

Q2.

(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.

Q7.

(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.

Q8.

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

(a) 70% of students related the shift to the right of the curve for haemoglobin with a lower affinity, enabling oxygen to be released to tissues. However, some thought that this shift gave haemoglobin a higher affinity, so that more oxygen could be carried to muscles. A minority of students 'hedged their bets' and mentioned both. Many students were aware that oxygen is released to respiring tissues. However, the ability to relate vigorous exercise with a high rate of respiration was only seen in the best responses.

(b) (i) 70% of students scored full marks. Those who did not typically referred to surface area only, a *larger* SA:VOL, a *smaller* VOL:SA, fat or small extremities.

(ii) Half of students scored at least two marks. This was usually for describing how the rate of blood flow to the different organs changed during the dive and appreciating that the brain needs to remain active. The weakest responses usually did no more than state the values shown in the graph for each organ. However, better responses did appreciate that these changes in blood flow were to enable oxygen to be conserved. Similarly, they also explained the reduced blood flow to the lungs in terms of the seal not breathing when underwater. Surprisingly, a minority of students thought that seals use gills when diving and therefore less blood needs to flow to the lungs. Many students noted the reduced blood flow to the heart. However, relatively few linked this to a reduced heart rate. The suggestion that blood flow is diverted to muscles was rarely seen.

Q9.

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.

Q10.

(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.

Q11.

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.

Q12.

(a) (i) 40% of students gave one ethical argument for maintaining biodiversity that was of A-level standard. This was the idea of preventing extinction or loss of habitats. References to animal rights, or 'playing God' were classed as neutral.

(ii) Just under half of students gave one economic argument for maintaining biodiversity. The most common responses that gained credit referred to medicine, tourism or agriculture.

(b) This proved to be a good discriminator. Nearly two-thirds of students gained at least one mark usually for the answer 'fewer habitats'. Very few students mentioned that a lower percentage of the original forest meant that fewer plant species would be present. The ability to express the idea of 'fewer food sources' discriminated well. This was often conveyed in weaker responses as 'less food', which was not credited.

(c) 85% of students scored at least one mark. This was usually for 'number of each species'. It should be noted that the specification requires students to be able to calculate one specific index of diversity. The 'number of species' is not required to

calculate this index of diversity. Consequently, this response was classed as neutral

(d) 70% of students scored full marks. Students who did not typically referred to surface area only, a *larger* SA:VOL, a *smaller* VOL:SA, fat or feathers.

Q13.

(a) Many students gave the correct answer, hydrolysis. Those who failed to score usually confused hydrolysis with condensation.

(b) Many students correctly identified that the peptide was too large or insoluble and therefore gained one mark. Only the more able students went on to explain that peptides would therefore not be able to pass through the carrier or channel protein. There was a significant number of students who wrote about active transport despite facilitated diffusion being referred to in the question.

(c) This question was generally answered well with most students recognising that the peptide would be considered “foreign” or “non-self”. Those students who failed to score often referred to the peptides as cells.

(d) Some students failed to use the information in the passage, which stated that the drug had already been tested on patients with coeliac disease, and produced answers referring to trialling on animals or people without the disease. The majority correctly wrote about side effects, though some gave this answer twice with slightly different wording. Large numbers of answers gave generic responses here such as age or gender, without giving any thought to the context of the question.

Q14.

(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.

Q15.

(a) Phagocytosis was well understood by candidates and many gained full marks. Many, however, wasted time by describing antigen presentation which was not required. Almost all candidates knew that the bacteria would be engulfed and many referred to their inclusion in a phagosome or vacuole. Weaker candidates failed to gain marks through imprecision, e.g., not realising that the lysosomes fuse with the phagocytic vesicle and just writing about them releasing enzymes or not specifying what sort of enzymes and then repeating the stem by saying the bacteria were destroyed without any mention of digestion or hydrolysis.

(b) Many candidates failed to realise that this question was about cell adaptation. There

was a lot of confusion between adaptations of the cell and of the intestine wall generally, with many answers focusing on factors such as a good blood supply and maintaining a steep concentration gradient. Such responses were not relevant to this question. Many candidates had a good understanding of glucose co-transport and described this in detail, usually gaining two or three marks, even though their answers were not focused on cell adaptation. Most scored one mark for understanding a large surface area was involved but many attributed this to villi rather than to microvilli. Better candidates gained a further two marks for explaining the cells would have a large number of mitochondria that provide the ATP for active uptake.

Q16.

(a) The vast majority of candidates obtained both marks, usually by naming the cell wall and chloroplast as structures that are present in plant cells but not in animal cells. Very few candidates scored zero.

(b) Most candidates gained one mark for stating that starch is insoluble. However, less than half the candidates were then able to suggest an advantage of this in terms of osmosis or water potential. A common error was to suggest that starch would not move into or out of the cell by osmosis.

(c) Most candidates scored two on this question and over a third of candidates gained all three marks. Generally there was a clear understanding of the roles of the chloroplast and eyespot. A smaller percentage of candidates was able to explain the role of the flagellum. A significant number incorrectly involved the starch store in their answer.

Q17.

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.

Q18.

(a) Almost a third of candidates obtained maximum marks by clearly describing how haemoglobin loads and unloads oxygen in different parts of the body. Other candidates often lost marks by failing to refer to partial pressure of oxygen or to the percentage saturation of haemoglobin in the lungs and tissues. Weaker candidates tended not to use the graph and often demonstrated a lack of understanding of the terms dissociation and affinity.

(b) (i) Most candidates gained this mark for correctly describing the relationship between the size of mammals and the oxygen dissociation curves of their haemoglobins.

(ii) Most candidates correctly related the size of mammal to a large or small surface area to volume ratio and appreciated that oxygen was required for respiration. However, weaker candidates had difficulty explaining the relationship between the surface area to volume ratio of mammals and the position of the oxygen dissociation curves of their haemoglobins. There was also some confusion between the size of a mammal and the amount of heat lost from its surface area.

Q19.

(a) This presented major difficulty to the vast majority of candidates, despite its inclusion as a required procedure in the specification (Section 3.3.2). Nevertheless most candidates made an attempt but this usually involved the incorrect use of magnification and observed size.

A minority of responses included the use of eyepiece graticules and stage micrometers or equivalent pieces of apparatus. Difficulty was experienced when trying to explain calibration.

Many candidates attempted to use a ruler directly for measurement of the drops rather than using it to estimate the field of view.

(b) (i) A large number gained both marks with ease. The calculation of the ratio of surface areas of the droplets proved difficult to others, many not gaining any marks at all. Some candidates gave the ratio in reverse.

(ii) There was a large variation in the responses of candidates in this part. Only a minority of candidates mentioned surface area to volume ratio for the first marking point. Many centres rewarded responses which made no reference to the volume.

Candidates who did not make reference to the surface area to volume ratio, but had realised that the surface area of the droplet was normally larger, were able to suggest that greater contact was possible with the lipase or enzyme. Most centres credited the fourth marking point too generously, awarding the mark when there was no reason for the fall in pH.

Q20.

(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.

Q21.

(a) (i) Over 90% of candidates correctly identified organelle **Y** as a mitochondrion.

(ii) This question proved to be a good discriminator. Most candidates gained at least one mark for the function of mitochondria in terms of respiration, energy release or ATP production. Better candidates usually went on to link this to active transport. Unfortunately, some candidates disqualified the first mark through poor expression e.g. ‘energy produced’ and ‘produces ATP for respiration’. Similarly, some answers referred to facilitated diffusion and linked this to a requirement for ATP. A minority of candidates incorrectly referred to structure **Y** as either ‘microvilli’ or ‘ribosome’. This resulted in incorrect answers relating to surface area and protein synthesis respectively.

(b) Most candidates gained one mark for the principle of dividing the measured length by the magnification. However, only the best candidates were able to convert the measured length to micrometres. Candidates who failed to score often divided the magnification by the measured length.

(c) Most candidates scored one mark for mentioning a reduced surface area. The more able usually went on to link this to reduced absorption for full marks. However, some candidates disqualified this mark by referring to less protein being absorbed. Relatively few candidates referred to the cell membrane or membrane proteins.

Q22.

(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.

Q23.

(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.

Q24.

(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.

Q25.

This unit requires practical work to be undertaken that includes the effect of solute concentration of water uptake by plant tissue. In this question, therefore, candidates were required to demonstrate their understanding of such prescribed practical techniques. It was evident from the responses to this question that although many candidates had some experience of related practical investigations, they had little understanding of the procedures involved. Many otherwise sound candidates gained very little credit on this question.

(a) The diagram clearly showed two different tissues, but only the best candidates based their answers on this information and described cutting the cylinders in such a way as to ensure that they consisted of the same tissue. Many of the answers did little more than reiterate what have become standard responses in past practical assessments without attempting to apply general principles to a novel situation. In this particular case, references to the same cork borer or the same length were irrelevant. There were also a number of vague references to ensuring that this would be a fair test. Candidates would be well advised not to use this term without appropriate amplification.

(b) It was immediately apparent from marking this question that many of the less able candidates had undertaken practical investigations without any understanding of what they were trying to do. Thus there were numerous responses that indicated confusion with investigations of enzyme activity or respiration. Where candidates did appreciate that the essential purpose of the bungs was to minimise evaporation, it was uncommon for them to refer to the evaporation of water evaporating resulting in a change in the concentration of the sucrose solution.

(c) Candidates who read this question with sufficient care should have noted that it referred to the results provided in the table. Accounts, therefore based on repeating the investigation with other sucrose solutions were inappropriate and did not gain credit. The investigations carried out for assessment of practical skills at AS all require candidates to plot their data as appropriate graphs, and it was hoped that candidates would have applied a similar approach here. Relatively few did, and of these, even fewer appreciated that they should identify the concentration of sucrose in which the ratio of final length to initial length was 1. Few candidates displayed an understanding of the concept of a ratio in part (ii).

Q26.

(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.

Q27.

The essays varied greatly in length and biological content, but less so in breadth and relevance. Many essays showed good evidence of planning in a way which would clearly be useful to the author, and which kept their work relevant. Some candidates failed to plan at all.

The competence with which the scientific terminology was used was pleasing, with many technical terms being used in the majority of essays. Weaker candidates tended to relate their work in everyday language, dwelling on the distribution of large surface areas rather than on the link with transfer processes.

This essay was chosen by a large number of candidates, some of whom used it effectively to demonstrate their A-level knowledge. Sadly, a large number submitted essays of a very general nature, with much of the work being at GCSE level. Candidates were very clear on what is meant by a large surface area, and often quoted Fick’s Law to illustrate the point. This lead on to discussions of the lungs, the placenta and the digestive system in most cases. Unfortunately this did not include the expected A-level detail regarding the large numbers of alveoli, the microvilli of the placenta and small intestine, and the presence of increased numbers of transport proteins in folded membranes. There was confusion over villi and microvilli, both being cited as found in the mouth, lungs, stomach and large intestine. In the placenta work, there was confusion over the umbilical cord as a site of transfer. Descriptions of the shape of the alveoli were often of a culinary rather than a biological nature. Weaker candidates tended to stray on to other aspects illustrated by

Fick's Law, and introduced irrelevant material on concentration gradients and the shortness of the diffusion pathway.

The understanding of the difference between surface area, and surface area to volume ratios was apparent on a lot of good quality scripts. Other candidates happily compared the large surface area of a mouse with the small surface area of an elephant with little thought of what they are actually saying! Confusion was rife when the descriptions of surface area to volume ratios were added, with a lot of erroneous links being made to men of different shapes. Some discussions of BMR were competent, but sadly this was rarely the case. Some candidates failed to write about heat transfer despite this being in the title. Those who did were able to describe the vasodilation/vasoconstriction processes quite well but were often unclear as to the exact nature of the blood vessels involved. Little comment was found on the way in which sweating cools the body. Heat transfer was often mentioned in the context of pregnant mothers, but weaker candidates seemed to think this was by radiation, conduction and convection.

When the essay moved onto cells there were some good comments on the significance of the shape of red blood cells, but these were often confused with haemoglobin. The work on the chloroplasts, mitochondria and endoplasmic reticula was welcome but rare.

Candidates who chose this essay found it harder to display their A-level knowledge, and marks were often fairly meagre for scientific content. A disappointingly large number were of GCSE standard. This title needed a more thoughtful approach, with care taken to include sufficient depth to the answer rather than being fairly repetitious around the theme.

Q28.

Unit 6

(a) Although the correct answer was given by many candidates, a significant minority made arithmetical errors or rounded their answers incorrectly.

(b) The emulsion test was most frequently cited but the method was often not described correctly.

Many of these responses used water or ethanol as the sole reagent or cited an incorrect test. A small minority of candidates gave details of incubating with lipase and testing for pH change, these answers received the appropriate credit.

(c) Microvilli were correctly identified and their function described by most candidates in part (i).

Part (ii) caused problems to the weaker candidates and the vast range of alternative answers generated by these candidates indicated that they had not understood the diagram. Part (iii) produced good responses from the candidates who correctly identified the rough endoplasmic reticulum, although a small proportion thought the structure was the Golgi body. Part (iv) was generally poorly answered. The most common incorrect response was facilitated diffusion.

Often these responses were given in answers which clearly indicated the size of the chylomicrons and it was interesting to observe the lack of coherent thinking displayed by many candidates.

Unit 7

(a) Calculations of the recommended daily lipid intake were often incorrect, a common

error being to disregard the given energy content of one gram of lipid. Some spoiled their answers by inappropriate rounding or by compounding rounding approximations in a two-stage calculation.

(b) Many candidates did not know the details of the emulsion test for lipids. Benedict.s, the biuret test and the iodine test were all suggested.

(c) In (i), most knew that the microvilli shown in the diagram would increase the surface area for absorption of the products of digestion. However, in (ii), the identification of **R** and **S** was rarely correct. **R**, the tissue fluid, was sometimes thought to be 'cytoplasm', a 'blood vessel', or merely a 'space'. **S**, the lymph vessel or lacteal, was thought to be a 'blood vessel', a 'lysosome', even the 'small intestine'. In part (iii), many recognised organelle **U** as the rough endoplasmic reticulum and knew that the protein part of the chylomicron would be made here, better candidates emphasising the part played by its ribosomes. Some correctly suggested a role in transport, perhaps mentioning vesicle formation. Others incorrectly thought triglycerides were synthesised here, despite the indication in the diagram that this was fulfilled by the smooth ER. It was evident in (iv) that many candidates had no appreciation of the size of the chylomicrons – despite having been given the information in the stem to section (d) that they were composed of many triglyceride molecules and were surrounded by proteins. Hence, 'diffusion', 'facilitated diffusion' and 'active transport' were not sensible answers. Better candidates knew that such large structures could only leave the cell by exocytosis.

Q29.

(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'.

Q30.

(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.

Q31.

(a) Although most candidates were able to identify active transport as the process by which potassium ions normally enter bacterial cells, they enjoyed less success in using Fick's law to explain the leakage of these ions when the plasma membrane was damaged.

(b) Most candidates, in drawing the peptide bond in part (i), attempted to link the relevant groups, although they were not always certain as to the origin of the constituent atoms of the water molecule. In part (ii), candidates who sketched tyrocidin as a cyclic polypeptide generally, but by no means always, correctly determined the number of peptide bonds. Although nine was perhaps understandable as an incorrect response, it was difficult to identify the logic underlying the choice of two and five, which figured more frequently than might have been expected.

(c) The answers to this part of the question were in the text, the key points being that transport by vanilomycin depended on the fluid nature of the membrane while Gramicidin A formed a permanent pore. Although many candidates offered comprehensive answers based on these ideas, others incorrectly identified one or other of the antibiotics concerned as an enzyme and, as a result, offered inappropriate explanations.

(d) Candidates clearly found part (f) demanding and although there were those who recognised that a pore lined by molecules of the polyene antibiotic would provide the most likely solution, most failed to distinguish between the possible and the extremely unlikely.

Q32.

(a) A number of candidates either failed to read the question with sufficient care, or chose to ignore the instruction about shape, and produced inappropriate answers relating to the absence of a nucleus or the possession of haemoglobin. Those who confined their answers to relevant points usually referred to the surface area of the cell, unfortunately frequently stopping short of a reference to the all-important principle of the surface-area to volume ratio. The role of diffusion in the uptake of oxygen was seldom mentioned.

(b) Although it was clear from the answers to part (i) that most candidates recognised that osmosis accounted for the shrinkage of the cells in the sample, few were able to draw the conclusion that the plasma membrane was partially permeable. Candidates seldom went further than to explain that the observation resulted from

water loss, or reflected a thin membrane. Less able candidates also attempted to explain the role of detergent in terms of osmosis. Of those who recognised that a lipid solvent would dissolve the phospholipids present in the plasma membrane, few provided a satisfactory explanation of the result. There were a number of incorrect references to the leakage of organelles from the cell accounting for the red coloration.

Q33.

(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.

Q34.

(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.

Q35.

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.

Q36.

(a) Most candidates could identify three features which were adaptations to desert conditions. Some candidates were rather vague with responses like ‘lots of roots’, and many failed to identify which plant(s) they were referring to.

(b) Most candidates correctly identified **Z** as the resurrection plant and gained two marks. The most common error was suggesting plant **X** because of its ability to store water. This was not given credit.

Q37.

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’.

Q38.

This question was generally well answered although a significant number of candidates failed to read the question carefully enough and described what might happen to the energy that had **not** fallen on the producers.

Most candidates were able to suggest one appropriate reason for the seaweed having a large surface area. Many failed to give a second reason with some giving vague answers in terms of ‘gaseous exchange’ rather than explaining it in terms of the ease of absorption of carbon dioxide. A number of weaker candidates responded in terms of respiration rather than photosynthesis.

Many candidates included some good detail as to how their chosen environmental factor might affect the rate of photosynthesis. Appropriate references to the light dependent or light independent stages were included.

Q39.

(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.

Q40.

(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.