16		i	large / increase the, surface area / SA:Vol ratio ✓ *idea of*: increase (the rate of) oxygen absorption / described ✓ oxygen levels in the lake are low ✓	2 max	**ALLOW** 'for oxygen absorption' if mp1 given e.g. of description: 'for (more) oxygen to diffuse in (through skin)' **Examiner's Comments** This question relates the properties of a good exchange surface, to the conditions in the lake. The majority of candidates were able to suggest that the skin folds provided a larger surface are or a large surface area to volume ratio. More able candidates added that this enabled the frog to absorb more oxygen from the water. Candidates should be encouraged to make clear that extra surface area helps to absorb more oxygen, ie they should make their explanations comparative. Few candidates suggested that this was because the oxygen levels in the lake were not very high. Despite the clear link to oxygen absorption in the stem of the question there were some unusual suggestions. For example: the extra folds might be used like fins to help the frog swim; the folds are due to loss of elasticity in the skin due to old age. **Key** **AfL** Guidance to offer for future teaching and learning practice
		ii	**D** large surface area ✓ **E** for (maximum) diffusion ✓	2 max	Mark first **D** response or **E** response only For two marks the **E** mark must be linked to the **D** mark **IGNORE** increase surface area, ref to SA:Vol ratio **ALLOW** idea of more or faster diffusion

			D squamous, epithelium / cells OR alveolar wall, only 1 cell thick / thin ✓ **E** (providing) a short diffusion distance ✓ **D** good, blood supply / ventilation ✓ **E** maintaining / creating a (steep) concentration gradient ✓		**Examiner's Comments** This question no longer relates to the Titicaca frog but to a general point about the lungs. A range of correct responses was seen with large surface area and thin alveolar wall being the most common. Less able candidates often gave poor descriptions of a thin alveolar wall – simply stating 'thin surface'. Examiners were hoping to see more detail than this for a mark to be credited. In general candidates had a good understanding of the features of a good exchange surface and could provide valid explanations. When one feature is asked for, the examiner will mark the first feature described. Candidates should be encouraged to read the question carefully and not add additional features as this takes time that they may use better elsewhere in the examination.
			Total	**4**	
17		i	**H** ✓ **D** ✓ **F** ✓ **C** ✓	4	**Mark the first answer in each cell.** If an additional answer is given that is incorrect then = **0 marks** **IGNORE** correct combinations of letters that correspond to D (e.g. A + F + G + H) **IGNORE** correct combinations of letters that correspond to C (e.g. A + F + G or B + G) **Examiner's Comments** It was good to see so many correct responses for this question. It provided a useful scaffold with letter A provided (to emphasise the direction of the trace) but, nonetheless, the candidates did show a good grasp of the features displayed via the spirometer trace. It was interesting to note that a common error was to select E (the expiratory reserve volume) instead of the correct choice H for the residual

					volume. Total lung capacity was most frequently correct. Several candidates confused F and C.
		ii	1 breathe in as deeply as possible / AW ✓ 2 (and) then force as much air out as possible ✓	2	**IGNORE** ref to using nose clip If they have the deepest breath out before the deepest breath in, then **max 1** (for correct mp 2) 1 e.g. 'breathe in as much as possible' 'inhale as much as you can' 'inhale to maximum' 'breathe in all the air that you can' 2. e.g.'breathe out as hard as possible' 'exhale as much as you can' 'exhale to maximum' 'breathe out all the air that you can' **DO NOT CREDIT** *all* of the air pushed out of lungs **Examiner's Comments** This question was generally answered really well. It demonstrates the emphasis on practical work and the fact that its assessment is now embedded in the question papers. Those with experience were better equipped to describe the process. However, a large minority struggled to link the 'as much as possible' idea to both inhalation and exhalation in terms of quality of expression. Unfortunately, some candidates described breathing out before breathing in and this limited their overall score to 1 mark for this question.
			Total	**6**	
18	a	i	fossils in, known-age / Jurassic, strata / rocks	1	
		ii	DNA / cytochrome c	1	
	b	i	carbon dioxide diffuses down concentration gradient out of the respiring cell (1) carried through body from cell (to tracheoles) by blood passing out via tracheoles / trachea / spiracles (1) respiration generates heat (1) hot gases expand and are less dense so rise up by convection through the mound to vents at mound-top (1)	4	

		ii	*shape,* large or increased surface area to volume ratio (1) smallest area exposed to greatest heat (1)	2	Response **must** be linked to context of avoiding overheating / needing to get rid of heat.
			Total	**8**	
19		i	*Insects* many / branched, tracheae / tracheoles / tubes ✓ *Fish* many / AW , filaments / lamellae / plates✓	**2**	**IGNORE** many spiracles **ACCEPT** many / branched,vessels **ACCEPT** feathery filaments **IGNORE** folding with no reference to an increase in number e.g. primary lamellae folded **but ACCEPT** if primary lamellae, folded into / covered with, secondary lamellae / plates **Examiner's Comments** While this was a seemingly straightforward question, very few candidates achieved full marks here. Candidates often overcomplicated their answers which were generally much longer than the spaces provided. The vast majority of candidates knew the structure of both insects and fish exchange systems, but candidates lost marks due to a lack of 'many' or a reference to 'branching' to explain how surface area was increased. The term 'spiracles' was used frequently when writing answers in this part, which gained no credit. Another common error was talking about tracheal fluid for insects, and the counter-current system for fish, rather than the structure of the gas exchange systems to increase surface area.
		ii	oxygen is in short supply (in lugworm habitat) ✓ rate of diffusion is, insufficient / too slow (to meet needs) ✓ lugworms have a smaller surface area to volume ratio (than some worms) ✓ lugworms have a high(er) <u>metabolic</u> rate ✓	**1 max**	**IGNORE** Live in habitat where gas exchange difficult **DO NOT ACCEPT** no oxygen **ACCEPT** harder to get oxygen **Examiner's Comments** Some candidates failed to realise that oxygen would be in short supply and instead wrote in terms of extracting the oxygen from water, which gained no credit. Some candidates used vague terminology

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>such as ‘air’ or ‘gas’ instead of oxygen, and so failed to get the first mp for the oxygen being in short supply. Many candidates simply referred to the lugworm being surrounded by water as a reason for the external gills and some said it was just due to it being an advantageous adaptation. There was very little reference to the rate of diffusion being too slow or the possibility that lugworms may have a higher metabolic rate, which would have also gained credit.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>20</td><td>a</td><td></td><td>
<table>
<tr><th rowspan="2">Structure</th><th colspan="3">Structural feature present</th></tr>
<tr><th>Cartilage</th><th>Elastic fibres</th><th>Goblet cells</th></tr>
<tr><td>Trachea</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Bronchi</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Bronchioles</td><td>x / ✓</td><td>✓</td><td>x</td></tr>
<tr><td>Alveoli</td><td>x</td><td>✓</td><td>x</td></tr>
</table>
</td><td>3
(AO1.1)</td><td>DO NOT ALLOW hybrid crosses

Trachea given in question, do not mark

1 mark for each correct row</td></tr>
<tr><td></td><td>b</td><td>i</td><td>spirometer ✓</td><td>1
(AO1.1)</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>1.1 (dm^3) ✓</td><td>1
(AO2.6)</td><td>ALLOW range 1.0 to 1.2
(estimate 3.5 - 2.4)</td></tr>
<tr><td></td><td></td><td>iii</td><td>4.5 (dm^3) ✓ ✓</td><td>2
(AO2.6)</td><td>FIRST CHECK ON ANSWER LINE if answer 4.5 , award 2 marks.
If answer incorrect:
ALLOW 1 mark for
calculation of maximum expiration - maximum inhalation i.e. 4.7 – 0.2</td></tr>
<tr><td></td><td>c</td><td></td><td>Summary of instructions to markers:
See instruction 10 on page 5 of this mark scheme.

Level 3 (5–6 marks)
A good description of normal expiration as passive process and comparison /contrast with forced expiration as an active process e.g. energy required / contraction of abdominal muscles.

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</td><td>6
(AO1.2)</td><td>Indicative scientific points may include:

Normal expiration (provides some comparative statements for similarities)

• passive
• diaphragm muscles relax
• diaphragm moves up / becomes dome shaped
• external intercostal muscles relax
• ribs move down and in
• elastic fibres recoil
• volume of thorax reduced</td></tr>
</table>

			Level 2 (3–4 marks) A sound description of normal expiration as passive process e.g. changes in volume or pressure due to muscles relaxing / elastic fibres recoiling. Some comparison / contrast with forced expiration. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence* **Level 1 (1–2 marks)** A basic description of normal expiration OR forced expiration. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** *No response or no response worthy of credit.*		• pressure in thorax increased • pressure in thorax greater than atmospheric pressure so air moves out of lungs Forced expiration (provides contrasting statements for differences) • active • requires energy • internal intercostal muscles contract • ribs pulled down hard • abdominal muscles contract forcing diaphragm up
	d		surface area ✓ surface area to volume ratio ✓ circulatory system ✓ concentration gradient ✓ diffusion pathway ✓	5 (AO1.1)	
			Total	**18**	
2 1	a		surface area to volume ratio = 3 : 1 (small) and 1.5 : 1 (large) **or** large, cube / animal, has smaller SA:vol **or** small, cube / animal, has larger SA:vol ✓ diffusion, distance / pathway, long / deep, in large, cube / animal or diffusion time long in large, cube / animal ✓ relatively / proportionally, small(er) surface cannot supply large(r) volume of cells ✓ specialised exchange surfaces needed for, oxygen / carbon dioxide / gases / nutrients / waste products ✓	2 max (AO2.2) (AO3.1)	**ALLOW** SA : volume or SA : V for surface area to volume ratio **ALLOW** 3 : 2 for 1.5 : 1 **DO NOT ALLOW** reverse ratios 1 : 3 and 1 : 1.5 (unless volume : SA stated) **IGNORE** diffusion, easier / harder **ALLOW** ora diffusion, distance / pathway / time, shorter in small, cube / animal **Examiner's Comments** On this question some candidates calculated the volume and surface area of the cubes shown but expressed the ratio back to front, e.g. saying the surface area to volume ratio was 1 to 3 rather than 3 to 1.

	b		For answers marked by levels of response: Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. **The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. **In summary:** • The science content determines the level. • The communication statement determines the mark within a level. **Level 3 (5–6 marks)** Full and detailed description of respiratory system in both fish and insect, showing how both are adapted to maximise ventilation and gaseous exchange. Reference made to structures shown on both Fig. 6.2 and Fig. 6.3 shown in the insert. *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 1 (1–2 marks)** A description of some of the features of the respiratory systems of both fish and insect but not clearly linked to ventilation or gaseous exchange. Very few references to structures shown on Fig. 6.2 and Fig. 6.3 on the insert. *The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.*	6 (AO2.1) (AO2.3)	**Indicative scientific points may include the following:** ***bony fish ventilation*** water enters mouth ref. volume / pressure, change in buccal cavity water, flows / pushed, over gills water leaves via operculum throughflow system / one direction of flow ***bony fish gas exchange*** gill, filaments / lamellae (shown on Fig. 6.2) large surface area thin short diffusion distance good blood supply / blood vessels (shown on Fig. 6.2) steep concentration gradient counter current system (water and blood move in opposite directions) tips of gill filaments overlap to slow down water movement ***insect ventilation*** muscular movement abdominal, dorso-ventral flattening / telescoping / pumping ref. volume / pressure, change in abdomen thorax, movement / shape change, in flight air drawn in or forced out size of spiracle, changes / controlled external gills in aquatic insects small size / large SA:vol of insects, means diffusion may be sufficient ***insect gas exchange*** gas / oxygen / CO_2, diffuses along tracheae (shown on Fig. 6.3) oxygen dissolves in water at tracheoles diffuses into surrounding cells many tracheoles so large surface area spirals of chitin (shown on Fig. 6.3) hold tracheae open **Examiner's Comments** In **Question 6(b)** candidates needed to refer to structures shown on the insert figures for both fish and insect and relate these to both gas exchange and to

			0 marks No response or no response worthy of credit.		ventilation. Again, partial answers achieved a lower level and mark as did those that contained factual errors. The commonest errors were omitting mention of ventilation mechanisms in fish and confusing the roles of tracheae, tracheoles and spiracles in insects. Candidates should be taught that air (not oxygen) enters spiracles and diffuses along tracheae and that in small resting insects, diffusion alone delivers a sufficient supply of oxygen to tissues.  **AfL** Candidates need to spend some time analysing the demands of a level of response question. A level of response question is likely to require them to address multiple aspects and may require a higher order skill such as linking or comparing of ideas. Careful analysis before starting to write an answer can identify how many areas need to be addressed, and how these areas should be linked. For example, **Question 1(c)(iii)** required that eight areas should be addressed, while **Question 6(b)** required six (structures on the insert identified with comment relevant to gas exchange and to ventilation for fish and again for insects). Candidates may benefit from drawing a table to show the number of areas required as empty boxes, which they can tick off when they have addressed each one.  **Misconception** Many candidates misapplied the terms gas exchange and ventilation. Gas exchange covers the diffusion of oxygen and carbon dioxide at an exchange surface. Ventilation refers to muscular movements that result in the delivery of a fresh supply of air or water to an exchange surface. Ventilation may be tidal (as in mammals) or throughflow (as in fish).

			Total	**8**	
22			maggots are smaller so have greater <u>surface area to volume ratio</u> (than adult flies) ✓ shorter diffusion distance ✓ *idea that* maggots less active so lower metabolic demand for O_2 ✓ no (hard) exoskeleton so can absorb oxygen by diffusion through, skin / cuticle ✓	3	**ALLOW** ORA throughout **ALLOW** SA:V ratio
			Total	**3**	
23			radius (of larva) = 0.8 mm **AND** (larvae) could (rely on simple diffusion) ✓✓	2(AO2.2)(AO3.1)	**ALLOW** calculator value (i.e. 0.79788456) or any correctly rounded value. **ALLOW** correct calculation with incorrect or no conclusion for 1 mark **ALLOW** ecf for correct conclusion drawn from incorrect calculation Award 0 marks for conclusion alone **<u>Examiner's Comments</u>** Most candidates scored well on this question. Those who lost a mark for an incorrect calculation often gained the mark for understanding the significance of their answer regarding the ability of larva to rely on simple diffusion.
			Total	**2**	
24		i	20 indicated as the incorrect value ✓ 19 ✓	**2**	e.g. number written alongside the 20 20 circled or indicated by arrow or other indication **Examiner's Comments** The vast majority of candidates correctly identified 20 as the incorrect answer and gave 19 as the correct one. A few candidates did not round the answer correctly and a very small number identified the mean of 43 as the incorrect number, suggesting that beetle C at 38 was anomalous and so re-calculated the mean excluding 38. Some candidates had

					not read the instructions and left their answer in the 'working out' area.
		ii	tracheole(s) ✓	**1**	**Examiner's Comments** The majority of candidates correctly identified the tracheoles. The most common incorrect answers were bronchioles or trachea.
		iii	**1** mammals have just one trachea **and** insects have multiple tracheae ✓ **2** mammals (much) larger diameter / insects (much) smaller diameter ✓ **3** in mammals trachea has, cartilage / no chitin (support) **and** in insects tracheae have, no cartilage / chitin ✓ **4** mammals have, C-shaped 'rings' / incomplete circle, **and** insects have spiral (support) ✓ **5** mammal trachea is longer / (individual) insect tracheae shorter ✓ **6** mammal trachea branch into bronchi **and** insect tracheae branch into tracheoles ✓ **7** mammal trachea has, smooth muscle / goblet cells / ciliated epithelium **and** (individual) insect tracheae do not ✓	**2**	Statements must be comparative Assume 'it' is the mamma **2 ACCEPT** 'wider / narrower' for 'larger / smaller' diameter IGNORE bigger **4 ACCEPT** descriptions e.g. gap v no gap in strengthening **6 ACCEPT** 'leads to' instead of 'branch into' **Examiner's Comments** Many candidates failed to provide differences between the trachea in a mammal and in an insect, largely because their statements were not comparative, or only a detailed description of one was given. Imprecise terms such as 'bigger' failed to gain credit for the difference in diameter. Chitin and cartilage commonly gained a mark but candidates did not show understanding of the spiral nature of chitin in insects so failed to gain credit for their comparison with the C-shaped rings in mammals. Several candidates failed to realise that the mammalian trachea leads to bronchi rather than directly to alveoli and that insect tracheae lead to tracheoles rather than directly into muscle. Some

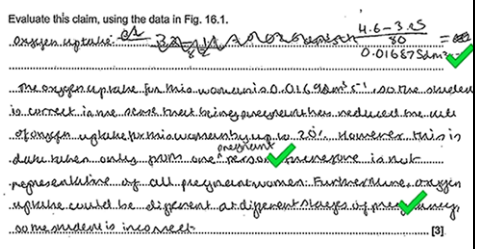
					candidates thought that the mammalian trachea had collagen rings.
			Total	**5**	
25	a	i	**FIRST CHECK ANSWER ON ANSWER LINE** *correct answer = 2 marks* 1,000,000 / 1 x 10^6 ✓ ✓ *1 mark for working if final answer wrong:* 40 x 500 = (20, 000cm3) ✓ or 20 ms is 20/1000 = 0.02 s ✓	2 (AO2.4)	**ALLOW** calculation combined with wrong time figure e.g. 40 x 500 x 3 = 60, 000 **ALLOW** (1s ÷ 0.02 s / 1000 ms ÷ 20 ms) = 50
		ii	(more) infections / irritation / coughing ✓	1 (AO2.1)	**ALLOW** bronchitis / pneumonia / bacterial disease / viral disease
	b	i	to provide, lots of / much, energy / ATP ✓	1 (AO2.1)	**DO NOT ALLOW** make / produce energy. **ALLOW** cell, needs / uses, lots of, energy / ATP
		ii	Golgi apparatus ✓ to, modify / process / package, protein ✓ ref. vesicles / secretion (of mucus) / exocytosis ✓	2 max (AO2.1)	**ALLOW** smooth endoplasmic reticulum / SER **ALLOW** lipid / triglyceride, synthesis (for smooth ER)
			Total	**6**	
26			*cartilage* stops, trachea / bronchus, from collapsing ✓ *elastic fibres* recoil of, alveoli / air sacs ✓	2 (AO1.1)	**ALLOW** for support of trachea / bronchi
			Total	**2**	
27			goblet ✓ noradrenaline ✓ diaphragm ✓ forced / conscious / active / voluntary ✓	**4**	**ACCEPT** phonetic spelling throughout **ACCEPT** norepinephrine **Examiner's Comments** This question proved to be a good differentiator, with only the most capable candidates scoring 4 marks. The most common errors seen by examiners were Acetylcholine or Adrenaline being used instead of Noradrenaline, and the term occurring/finished/happening being used to explain when internal intercostal muscles are used in expiration.
			Total	**4**	
28			***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.***	1	

			Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) *Using a 'best–fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication Statement have been missed.* ***In summary:*** • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.*** **Level 3 (5–6 marks)** Full and detailed description and explanation of the features of the mammalian respiratory system. Candidate demonstrates a detailed understanding of the different features and explains the adaptations of each one to maximise the efficiency of gaseous exchange. *There is a well-developed description and explanation of the majority of relevant features. The information presented is relevant and clearly explained.* **Level 2 (3–4 marks)** Clear description and explanation of the features of the mammalian respiratory system. Candidate demonstrates a reasonable understanding of most of the different features and includes explanations of the adaptations that maximise the efficiency of gaseous exchange. *There is a well-developed description and explanation of some of the relevant features. The information presented is relevant and for the most part clearly explained.*	6	**Indicative scientific points may include:** *Nasal cavity* • large surface area and good blood supply, warms air • mucus secreting cells, trap dust and microbes • moist surfaces, increase humidity and reduce evaporation from surfaces in lung *Trachea* • cartilage rings, stop it from collapsing • ciliated epithelium and goblet cells secrete mucus, trap dust and microbes and move them towards stomach *Bronchi / bronchioles*

			Level 1 (1–2 marks) An attempt at description and explanation of a limited number of the features of the mammalian respiratory system. Candidate demonstrates a limited understanding of the different features with some explanation of the adaptations that maximise the efficiency of gaseous exchange. *There is a logical structure to the answer. The explanations, though basic, are clear.* **0 marks** No response or no response worthy of credit.		• smooth muscle, allows air to move in and out and maintains high concentration gradient of O_2 / CO_2 *Alveoli* • thin (epithelial) wall, reduces diffusion distance • collagen / elastic fibres, elastic recoil to help squeeze air out during exhalation • large number / provide large surface area, to increase rate of diffusion • good blood supply / capillaries, maintains high concentration gradient • surfactant, allows gases to dissolve *Diaphragm / intercostal muscles* • contract to increase volume in lungs, reduce pressure and cause inspiration *NB: Many of the features listed above are common to more than one structure and should be credited where appropriate.*
			Total	**6**	
29		i	*two from* ***(a)** because* 1 lung(s) are, deflated / less inflated / small(er) / volume decreased ✓ 2 diaphragm is, domed / curved up / arched / not flat / relaxed ✓	2	**Only credit answers that refer to (a) as the chosen option** **DO NOT CREDIT** if the 'a' is not clear enough **Indicate that (a) has been chosen by using the green dot** ● 1 **ACCEPT** 'thorax has smaller volume' **IGNORE** ref to chest volume 2 **ACCEPT** higher / moves up **IGNORE** pushed up 3 **ACCEPT** 'rib cage moves down' **IGNORE** ref to intercostal muscles

			3 rib cage is / ribs are, in lowered position / not raised ✓		**Examiner's Comments** Generally this was very well-answered. Most candidates know the position of ribs and diaphragm in expiration but some described inspiration or muddled relaxing and contracting. A small minority of candidates failed to gain marks as they either didn't state the letter of the correct diagram (A) or answered incorrectly with B. A number incorrectly referred to the lungs 'relaxing' and some talked about the lungs being completely empty of air.
		ii	it does not use muscle contraction / muscles (just) relax **or** rib cage, falls / drops (due to gravity) **or** lungs (elastic so) will recoil ✓	1	**IGNORE** ref to energy / ATP **IGNORE** ref to pressure, changes / gradients **IGNORE** ref to intercostal muscles contracting during expiration as Q refers to a passive process **ACCEPT** 'diaphragm relaxes' **IGNORE** 'rib cage moves down' as this could involve muscle contraction **Examiner's Comments** This was moderately well-answered. Most correct answers referred to muscles relaxing. Very few candidates mentioned elastic recoil or the rib cage falling or dropping under the influence of gravity. The most common answers not worthy of credit were a reference to energy / ATP not being needed or pressure differences. Many candidates do not appreciate what passive means in this context, confusing it with subconscious or part of autonomic nervous system. Many of those who correctly recognise passive as not requiring energy then did not connect that to why it doesn't require energy.
		iii	*two from* (*as lumen of airways decrease*) 1 reduction in (lumen) diameter of, bronchi / bronchioles ✓	2	**IGNORE** ref to contraction of muscle (as in Q) 1 **ACCEPT** ref to 'narrowing' for 'reduced diameter' **IGNORE** ref to blocking / size **DO NOT CREDIT** ref to trachea

			2 harder to exhale / more resistance to exhalation / less air can be exhaled ✓ 3 more air remains in the lungs ✓ 4 harder to inhale / more resistance to inhalation / less air can be inhaled ✓ 5 harder to ventilate / more resistance to ventilation / increased breathing rate / gasping ✓		2 **ACCEPT** ref to 'breathing out' for 'exhale' **IGNORE** ref to air leaving / air moving out 4 **ACCEPT** ref to 'breathing in' for 'inhale' **IGNORE** ref to air entering / air moving in 5 **IGNORE** 'hard to breath' 'struggles to get breath' 'short of breath' wheezing ventilation rate **Examiner's Comments** Most answers referred to airways being narrowed and gases (air / oxygen / carbon dioxide) entering, passing, moving in or flowing. Candidates demonstrated lack of scientific language, just referring to air 'moving in / out' rather than inhalation and exhalation. Key terms should be reinforced whilst teaching. The misconception that smooth muscle was present in the trachea was common. Some candidates referred to smooth muscle contraction in artery walls while others thought the muscle contraction would prevent any air from entering or was used to expel air from the lungs. A small number of candidates described the processes of inhalation and exhalation but failed to address the question.
			Total	**5**	
30			C	1	**Examiner's Comments** This question was also quite straightforward and answered correctly by many candidates. For those who could be confused with the intercostal muscles, the movement of the ribcage and contraction of the diaphragm should have been sufficient to choose the correct answer.

			Total	**1**	
3 1			*use of data from Fig.16.1*: calculated rate of oxygen uptake between 0.010 and 0.018 (dm^3 s^{-1}) ✓ calculated reduction in rate of oxygen uptake between 10 and 50% ✓ *supporting statements:* (claim is) correct / incorrect **AND** a comparison of calculated rate with , 20% statement / mean uptake / 0.020 (dm^3 s^{-1}) ✓ *validity statements:* one , woman / reading , is not enough (for a valid conclusion) ✓ (being) 36 weeks pregnant / late pregnancy , is not representative of whole pregnancy / AW ✓	3 max	**ALLOW** MP 1 as a percentage i.e calculated value between 50 and 90% (of mean uptake) **Supporting statements MUST match evidence from calculation** e.g. statement is incorrect because my calculation showed reduction of 40% which is higher than 20% **If calculation in MP1 or MP2 is incorrect MP3 can still be awarded using calculation in response.** **ALLOW** only one woman tested **Examiner's Comments** Good responses to this question assessing AO3, used the information in Fig. 16.1 to calculate oxygen uptake in dm^3 s^{-1} followed by a calculation to work out the percentage reduction compared to 0.02 dm^3 s^{-1} and then compared this by agreeing or disagreeing with the candidate's statement. Relatively few candidates commented on other aspects about the validity of the claim such as the use of only one woman 36 weeks into her pregnancy. **Exemplar 1**  Evaluate this claim, using the data in Fig. 16.1. This response identifies a high attaining response where the candidate has performed a calculation but has also included comments on the validity of the candidate's claim based on the procedure used.
			Total	**3**	

3 2			type / vigour / intensity / AW , of exercise ✓ muscle mass / bone density / fitness / height / build / proportion of body fat / BMI ✓ age ✓ (environmental) temperature ✓ brand / make / type , of smart watch ✓ reference to , exercise / rest , before experiment ✓ named , health / lifestyle , condition ✓	3 max (AO3.4)	***List Rule*** *If all **three** prompt lines used and more than one variable is on prompt line mark the **first** one on each line.* *If only **one** or **two** lines used but there is more than one variable listed mark the first three variables given.* **IGNORE** repeats / replicates / amount of exercise **IGNORE** mass **IGNORE** gender **DO NOT ALLOW** body temperature **ALLOW** same smart watch e.g. asthma e.g. smoking e.g. drugs / anabolic steroids **IGNORE** diet / healthy unqualified / alcohol **Examiner's Comments** Many candidates gained at least two marks here with the most common responses being 'temperature' (of the environment) and 'age' or 'fitness' of the students. There were some responses that were too vague to be credited often referring to the 'health' or 'diet' of the students without being specific.
			Total	**3**	
3 3	a		(A =) spiracle ✓ (B =) trachea ✓	2 (AO2.3)	**ALLOW** spiracles **DO NOT ALLOW** tracheoles **ALLOW** chitin (rings) / taenidia / tracheal tube / tracheae **Examiner's Comments** Many candidates could correctly identify the spiracle from the photomicrograph in (a), with fewer candidates identifying B as trachea. A common error was to identify B as a tracheole. In (b)(ii), few candidates could suggest an improvement to the student's method, possibly indicating little hands-on experience of fish anatomy. Removing gills was often stated as an improvement but this was not linked to either removing the operculum first or observing the removed gills using a hand lens or microscope. Most unsuccessful

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>responses for (c)(i) did not understand the relationship between tidal volume, breathing rate and ventilation rate, and there was also some confusion when converting dm^3 to cm^3. Few candidates scored a mark in (c)(ii), with many candidates writing responses with the correct type of ideas but without sufficient detail. For example, many candidates wrote that artificial selection leads to a smaller gene pool, rather than linking this to more inbreeding leading to the smaller gene pool. The rest of Question 1 was generally well answered with most candidates scoring marks.</td></tr>
<tr><td></td><td>b</td><td>i</td><td>
<table>
<tr><th></th><th>Mouth closes</th><th>Buccal cavity floor lowers</th><th>Operculum opens</th><th>Oxygen diffuses into capillaries</th></tr>
<tr><td>Water moves into the buccal cavity</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>Water moves across the gills and out of the buccal cavity</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
</table>
All 4 columns correct ✓✓
</td><td>2
(AO1.2)</td><td>3 columns correct = ✓</td></tr>
<tr><td></td><td></td><td>ii</td><td>remove operculum / described (rather than cutting up the ventral side) ✓
use pins to hold fish (rather than a hand) ✓
remove gills and observe under a microscope ✓</td><td>1 max
(AO3.3)</td><td>IGNORE ‘remove gills’ unqualified

IGNORE ‘use a microscope’ unqualified</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
</table>

34		i	spiracle (s) ✓	**1**	**ALLOW** stigma(ta) **DO NOT ALLOW** stomata **Examiner's Comments** The majority of candidates correctly named spiracles for **Q16(b)(i)** and whilst **Q16(b)(ii)** was also generally well-answered there were a number of incorrect responses referring to haemolymph or tissue fluid.
		ii	trachea(l) (fluid) ✓	**1**	**IGNORE** haemolymph **IGNORE** tracheole **Examiner's Comments** The majority of candidates correctly named spiracles for **Q16(b)(i)** and whilst **Q16(b)(ii)** was also generally well-answered there were a number of incorrect responses referring to haemolymph or tissue fluid.
			Total	**2**	
35		i	support **or** prevents the trachea(e) from collapsing / keeps the airways open ✓	1	**IGNORE** protection / structure / shape / squashed / strength / stability **Examiner's Comments** Most recognised the role of chitin in support, although some only mentioned properties of chitin such as strength or structure which were not credited.
		ii	*idea that* (their presence) restricts the airflow in the trachea / blocks the airways **or** (leakage of haemolymph) deprives the, tissues / cells, of, oxygen / O_2 / nutrients **or** use of, oxygen / O_2 / nutrients, by mites **or** disease transmission	1	**IGNORE** statements that simply refer to the mites feeding on the haemolymph (as given in Q) **ACCEPT** causes the trachea to collapse **IGNORE** 'affects airflow' unqualified **IGNORE** ref to 'difficult to breathe' **ACCEPT** ref to inflammatory / immune,

			or (mites) release toxins ✓		response **Examiner's Comments** Candidates generally recognised that the mites would obstruct the airways. References to oxygen frequently neglected to mention that the cells or tissues of the honey bee would receive less. Despite the gas exchange system of an insect being on the specification, a significant number of candidates referred to less oxygen reaching the bee's lungs. Other suitable suggestions included disease transmission or toxin production.
			Total	**2**	
36	a		lamella	1	**ALLOW** lamellae.
	b		*three from* many / AW, lamellae / structure A, provide large surface area (1) (presence of) secondary lamellae on main lamellae provide large surface area (1) short distance between blood and, water / outside (1) idea that blood maintains diffusion gradient (1) *any of above linked to* faster diffusion (of oxygen, carbon dioxide) (1)	4	**ALLOW** only if linked to another marking point. **IGNORE** refs to squamous cells as not visible on Fig. 1.1.
	c		*three from* tissue has, one / few, types of cell **and** performs, one / few, functions (1) *idea that* bone has, one / few, types of cell **or** *idea that* bone performs, one / few, functions (1) organs consist of several tissues (1) gills contain two or more **named** tissues (1)	3	**ALLOW** bone, blood, epithelial, connective.
			Total	**8**	
37				**2 max**	***IGNORE** numbered lines and mark as prose* ***IGNORE** references to detail of diagram*

			1 large size / at least 50% of available space ✓ **2** title / heading ✓ **3** labels outside diagram ✓ **4** label lines should not cross over others ✓ **5** continuous lines ✓ **6** no shading ✓ **7** use plain paper ✓ **8** state magnification ✓ **9** correct proportions ✓		**ALLOW once only** no, sketching / feathering for **either** mp5 **or** mp6 **Examiner's Comments** The nine possible mark points for a two mark question meant that the vast majority of candidates were able to achieve at least one mark for **Q16(d)** with over 50% of candidates being credited with both marks. It is pleasing to note that there was a clear indication that practical guidelines had been addressed by centres.
			Total	**2**	
38			removal of <u>operculum</u> (of fish) / move <u>operculum</u> out of the way / cut open <u>exoskeleton</u> (of insect) ✓ method to, observe / display, gills / tracheae / tracheoles ✓	**2**	**ACCEPT** any suitable detail of display method e.g. observe structures under water placing a rod / pencil into buccal cavity to display lamellae staining tracheoles with methylene blue **Examiner's Comments** Candidates' responses indicated that few had observed or carried out this practical. Few could correctly name the structures, such as the bony fish operculum or the

					insect exoskeleton, which needed to be cut through or removed in order to reach the gas exchange systems. Usually only vague descriptions of cutting down the length of the organism were supplied. Very few candidates offered any further detail of how to observe or display the gills or tracheae by flooding with water, lifting relevant parts or the use of appropriate stains.
			Total	**2**	