Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	(inhaled) oxygen is , being used / removed ✓	1	**ALLOW** (exhaled) carbon dioxide , absorbed / removed **ALLOW** less oxygen in exhaled air **Examiner's Comments** Generally well-answered with candidates stating that soda lime absorbs the carbon dioxide produced and/or that oxygen was being used.
		ii	**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 12 / 13 / 14 / 15 (cm^3 kg^{-1}) award 2 marks** ✓✓ oxygen consumption in 120 s = 1.0 dm^3 = 1000 cm^3 so consumption $\frac{1000}{75} = 13$ (cm^3 kg^{-1})	2	**If answer is incorrect** **MAX** 1 mark for answer not to 2 sig. figs. Range of 0.9 to 1.1dm^3 from **Fig.20.1** **ALLOW** 1 mark for failure to convert to cm^3 e.g.1.3 x 10^{-2} / 0.013 / 0.014 (dm^3 kg^{-1}) **OR** volume ÷ 75 (Kg) **Examiner's Comments** This calculation involved three stages. Candidates had to correctly calculate the oxygen consumption from the graph, convert this to cm^3 and then convert this to cm^3/kg by dividing by the mass of the person i.e. 75Kg. Many candidates did not calculate the correct oxygen consumption from the graph. Some graphs showed no annotation suggesting that candidates did a rough estimate without using a ruler to read the volumes accurately. Candidates that realised the requirement of the task could convert dm^3 into cm^3 by multiplying by 1000. An error carried forward mark was available for dividing a stated volume by 75Kg. Most candidates did give their answer to two significant figures as required by the question. Assessment for learning Unit conversion is an invaluable mathematical skill included in this specification. Practice in

					converting units and use of significant figures is a recommended activity. **OCR support** Maths skills handbook can be found to support candidates preparing for assessment. There is also extra support on maths skills in the 'Maths for Biology' resources.
		iii	*At 120-240s* deeper / AW , breaths ✓ amplitude / tidal volume , becomes more variable ✓ same / similar , (calculated) breathing rate ✓	max 2	**ALLOW ora MPs 1 and 2** for 0-120s **ALLOW** greater tidal volume **ALLOW** breaths per minute for breathing rate **Examiner's Comments** It proved challenging for many candidates to read the graph correctly to compare breathing patterns for two different time intervals. Most candidates saw that deeper breaths were visible from 120-240s but did not take the comparison any further. Assessment for learning Analysis is an important skill and can be assessed using e.g. graphs, data tables, ECGs and spirometer traces as in this question. Practice in these areas using secondary data is a recommended activity. **OCR support** Maths skills handbook can be found to support candidates preparing for assessment.
		iv	**1** breathing rate **AND** heart rate both increase ✓ **2** (blood) oxygen , saturation / concentration , decreases / increased concentration of CO_2 (in the blood) ✓	max 4	**MP3 ALLOW** increase in H^+ / H ions for reduction in pH

			3 reduction in pH ✓ **4** (detected by) chemoreceptors in medulla (oblongata) ✓ **5** cardiovascular centre controls heart rate ✓ **6** impulses along , sympathetic / accelerator , nerve (to heart / SAN) ✓ **7** sino-atrial node / SAN , responds by increasing rate at which it generates wave of excitation ✓		**MP4 ALLOW** chemoreceptors , in carotid arteries / aorta for 'in medulla' **MP6 IGNORE** signals / messages **Examiner's Comments** This question required the use of the data from two graphs and the candidate's own knowledge of homeostatic control. Good responses were seen where candidates described the trends shown in both graphs and went on to give a good explanation of homeostatic control to explain the changes seen. Most candidates described the fall in oxygen saturation to gain one mark. Less successful candidates focused on only one figure describing either increased breathing rate **or** heart rate and therefore not achieving marking point 1.
	b		enrich / AW , the air in the spirometer with oxygen ✓ so that high (blood) oxygen saturation is maintained / AW ✓	2	**IGNORE** bigger spirometer **IGNORE** take resting intervals **ALLOW** so oxygen saturation , does not drop too low / is kept above 90% **Examiner's Comments** Good responses recognised that there needed to be a richer oxygen supply and that this is because the oxygen saturation would need to be kept high. Some candidates did not seem familiar with the safe setting up and use of a respirometer of this design, possibly due to lack of practical activity using the spirometer. **Assessment for learning** Centres are encouraged to complete as many practical activities as possible relating to practical themes within the specification. OCR support

					Practical skills handbook can be found to support candidates preparing for assessment. Practical PAG materials can also be used to support candidates with developing their indirect assessment of practical skills.
			Total	**11**	
2			B	1	**Examiner's Comments** Candidates who could use their knowledge of insect ventilation chose option **B** as a correct response. They were able to recall that insects use rhythmic abdominal movements to change the volume of their abdomen to move air in and out of their spiracles.
			Total	**1**	
3			B	1	**Examiner's Comments** This is an example of a multiple choice question that asks candidates to identify the option that is **not** correct. Most candidates recalled that water and blood in gill capillaries flow in opposite directions due to the counter-current flow system for efficient gas exchange across the entire gill surface and chose option **B** as the correct response.
			Total	**1**	
4			A ✓	1	**Examiner's Comments** Some candidates correctly identified A as the correct response. All distractors were seen, indicating that some were unclear of the stages involved with ventilation in bony fish and the correct sequence. Many candidates were able to identify the incorrect references to pressure in the distractors, as C was the most commonly seen wrong response.
			Total	**1**	
5			D ✓	1	**Examiner's Comments** There was a clear split of knowledge in this question with some candidates correctly

					identifying D as the correct response. Many candidates were clear on the mechanisms involved with forced expiration and the role the different muscles play and were able to link their contraction/relaxation to the different stages of breathing.
			Total	**1**	
6			D ✓	1	**Examiner's Comments** Many candidates were given the mark for this question and gave D as the correct response. Candidates often confuse large and small surface area: volume ratios as a concept. This could be further clarified by worked examples with a variety of sized animals as well as comparing the SA:V ration of single celled and multicellular organisms. **Misconception** A common misconception seen was that being multicellular organisms was not a reason for a specialised surface for gas exchange, which could be reinforced through examples.
			Total	**1**	
7			D ✓	1	**Examiner's Comments** Vital capacity is the maximum air that can be expelled after a maximum inhalation. Most candidates correctly identified D as correct, with a number annotating the graph at the highest and lowest peak, ($4.7dm^3$ - $0.2dm^3$ = $4.5\ dm^3$). This highlights the importance of being able to extract data from graphs accurately as well as knowing key definitions of breathing volumes. C was a common incorrect response, indicating that candidates were confusing maximal inhalation with vital capacity.
			Total	**1**	
8	a		thin layer / flattened cells / single layer of (epithelium) cells ✓	1 max	**MARK FIRST ANSWER ONLY** **IGNORE** short diffusion distance (as not a feature but a property) **ALLOW** alveolar wall, one cell thick / thin **ALLOW** alveoli 1 cell thick

			idea of close to many capillaries ✓		**ALLOW** squamous, epithelium / cells **DO NOT ALLOW** 'thin cell wall' or 'thin membrane' **ALLOW** e.g. 'surrounded by capillary network' / good blood supply **Examiner's Comments** Most candidates achieved a mark here for a simple statement such as 'thin wall'. Common errors were for candidates to state 'thin cell wall' which was not accepted as animals do not have cell walls or to state 'short diffusion pathway' which is not a feature of the exchange surface.
	b		bronchiole ✓	1	**ALLOW** broncheole, bronchioles **Examiner's Comments** Many candidates achieved the mark here for 'bronchiole'. However, many candidates were unable to recognise the folded epithelium and ring of smooth muscle that are important features of a bronchiole. 'Bronchus' was the most common error closely followed by 'trachea' and 'capillary'.
	c		smooth muscle ✓ contracts to , constrict / close / AW , bronchiole **OR** relaxes to , dilate / open , bronchiole ✓	2	**ALLOW** involuntary muscle **IGNORE** contraction / relaxation of bronchiole **Examiner's Comments** Relatively few candidates achieved a mark here as they interpreted tissue N as cartilage or elastic tissue. These candidates often knew the correct function of cartilage or elastic tissue. Only the most able or most well-trained candidates recognised tissue N as smooth muscle which can contract to reduce the diameter of the bronchiole. **Assessment for learning** Use of images and interpretation of those images is an important component of GCE Biology. Centres should appreciate that micrographs of tissues and organs must be part of the teaching and learning. Where

					access to laboratory space, microscopes or prepared slides may be an issue, centres can easily use images from the internet. Sites such as https:/www.sciencephoto.com/ have a wide range of good quality images.
			Total	**4**	
9	a	i	(A =) smooth muscle ✓ (B =) cartilage ✓	2 (AO2.3)	**ALLOW** 'involuntary muscle' **IGNORE** elastic fibres / elastin **Examiner's Comments** Only a few candidates were able to identify the tissues labelled A and B. Smooth muscle was often confused with skeletal or striated muscle or just labelled as 'muscle', and cartilage was often labelled as collagen or elastic tissue. **Assessment for learning** Showing students images of photomicrographs from which they need to identify structures and describe what they see may help them to answer similar questions in the future.
		ii	goblet (cells) **and** secrete mucus (to trap microorganisms) ✓ ciliated epithelial (cells) **and** (beat to) move mucus / AW ✓	2 (AO2.3)	**ALLOW** produces, mucus / mucin **DO NOT ALLOW** excrete mucus **ALLOW** ciliated epithelium e.g. 'to, waft mucus / push mucus (upwards / towards throat) / remove mucus' **IGNORE** 'waft / move, dust/ microbes / particles' **Examiner's Comments** This question was generally well answered, with many candidates identifying the cells as 'goblet cells' that secrete mucus and ciliated epithelial cells that beat to move mucus towards the throat. Some candidates lost a mark for naming the cell as a 'ciliated cell' *without* 'epithelium' or just naming it as cilia. Some incorrectly stated that ciliated epithelial cells move mucus to the stomach, or that they move dust or particulates, rather than moving mucus

	b	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 46:1 award three marks** (radius =) 0.065 (mm) ✓ (volume = (4/3) x 3.14 x 0.065^3 =) 0.00115 (mm^3) ✓ 0.053/0.00115 = 46:1 ✓	3 (AO2.2)	**ALLOW 46.1:1 for 3 marks** **If answer given to more than 3 sig figs =2 max** **ALLOW ECF for mp2 and 3 if incorrect radius used** **ALLOW** 0.065 or 0.13/2 seen anywhere in working **ALLOW** $1.15x10^{-3}$ (mm^3) **ALLOW ECF for mp3 if incorrect volume used** (volume =) (4/3) x 3.14 x 0.065^3 = 0.00115 (mm^3) =2 marks (mp1 and 2) **If correct answer not given as ratio e.g. 46 or 46.1 alone = 2 marks** **Examiner's Comments** Some candidates achieved 3 marks easily and most achieved 2 marks, for calculating the radius and the volume correctly. A few candidates didn't score the third mark because they were didn't calculate the correct ratio, e.g. 46:1. Quite a lot of candidates got the ratio the wrong way round or gave an answer to more than 2 significant figures. Some candidates used the diameter rather than the radius, or squared instead of cubing the radius, when working out the volume **OCR support** Help with ratios and other mathematical skills can be found in the OCR Biology Maths Skills Handbook Maths for Biology resources can also be useful to support students with mathematical skills via tutorials and quizzes.
		ii	more, gas exchange / diffusion / AW ✓	1 (AO1.1)	e.g. 'fast(er) / increased , rate of diffusion / gas exchange' e.g. 'greater uptake of oxygen' **IGNORE** 'more efficient gas exchange' / 'maximises area for gas exchange' **IGNORE** 'absorption of oxygen'

					Examiner's Comments Many candidates just mentioned the increase in surface area without relating this to more oxygen uptake, increased gas exchange or a faster rate of diffusion. Other common errors included linking a large SA:V ratio to a shorter diffusion distance, or to more efficient gas exchange or greater absorption of oxygen.
			Total	**8**	
10			***In summary**: 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):* • o *award the higher mark where the Communication Statement has been met.* o *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.*** **Level 3 (5–6 marks)** A full and detailed account of the changes that take place during inspiration and the similarities and differences between the apparatus and the ventilation system in	6 (AO1.1) (AO2.1) (AO2.3)	**Indicative points can include:** **How used:** **Pull down, elastic sheet / button, at base to make balloons expand** + Models diaphragm muscle contracting / diaphragm flattening **Volume in bell jar, gets bigger / increases** + Models thorax volume increase **Pressure in bell jar, gets lower / decreases** + Models thorax pressure decrease **Air pressure outside now higher than in bell jar** + Models higher pressure outside lungs **Air pushed into balloons / balloons fill** + Models air, pushed into / inflating, lungs **Appropriateness**: + Glass tubing represents trachea + Two balloons to model two lungs + Elastic sheet represents diaphragm – Sides of bell jar cannot change shape – Cannot model rib cage, expanding / moving up and out – Cannot model contraction of external intercostal muscles **IGNORE** expiration, elastic sheet stretching **DO NOT CREDIT** steps in **model** or mammal process in reverse sequence (+ = similarity, − = difference) **Examiner's Comments** Few candidates demonstrated confident familiarity with the use of the bell jar apparatus or the sequence of events that occurs during inspiration in a mammal. Level 1 responses drew some structural parallels between the two, such as the balloons

			mammals, including correct reference to volume and pressure changes. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** A detailed account of the changes that take place during inspiration, and some of the similarities and differences given between the apparatus and the ventilation system in mammals. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** An account of some of the changes that take place during inspiration. Must mention at least one correct comparison with the apparatus in and the ventilation system in mammals. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*		representing the lungs and the elastic sheet representing the diaphragm. Descriptions of the inspiration process were often limited , with some candidates suggesting that air must be blown down the glass tubing to inflate the balloons. Many answers strayed from inspiration to expiration, and so responses contained some irrelevant material. Level 1 responses included statements about the elastic sheet being moved up and down without clearly describing the sequence of events that occurred in either scenario (a more accurate response would detail the sheet moving only down in inspiration). The strongest answers at Level 3 commented on differences as well as similarities, and correctly explained how increased volume in the jar or thorax decreases the pressure surrounding the balloons or lungs, causing atmospheric air at a higher pressure to be pushed into the balloons or lungs.
			Total	**6**	
11			**any three from**: *supports conclusion* **1** adding, mycorrhiza / fungus, increased dry mass **AND** phosphate content in (*brb*) mutants / AW ✓ **2** mycorrhiza / fungus, could stimulate growth of, extra roots / root hair cells in mutants ✓ ***max 2 for MPs 3 to 7:*** *does not support conclusion*	3 (AO3.1) (AO3.2)	**ALLOW** ora for **MPs 1** and **3** **MP8** no units required for data quotes

3 (however) dry mass / phosphate content (of mutants), is less than in wild type ✓

4 adding, mycorrhiza / fungus, reduces dry mass / phosphate content, in wild type ✓

5 no information about, (named) control variables / sample size ✓

6 no (named) statistical test carried out / would need to perform a statistical test ✓

7 *idea that* there is no information about other (named) ions required for increasing dry mass ✓

data to support either argument
8 data to compare two sets of data for either dry mass or phosphate content / calculations from data ✓

Plant type	Mycorrhiza fungus added	Dry mass (g pot^{-1})	Phosphate content (mg plant^{-1})
brb mutant	no	0.84 ± 0.10	1.22 ± 0.13
brb mutant	yes	1.23 ± 0.16	2.15 ± 0.25
Wild type	no	3.57 ± 0.16	4.72 ± 0.23
Wild type	yes	2.97 ± 0.36	3.91 ± 0.52

MP8 calculated value e.g. there is a difference in dry mass of 0.39 (gpot^{-1}) between the mutant groups

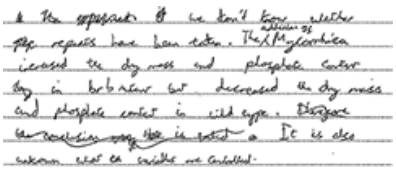
Examiner's Comments

Candidates found the evaluation questions on this exam paper challenging and it was important to give a balance of supporting and non-supporting arguments to gain full marks. Good responses looked at the data for the *brb* mutant with fungus and compared it with the other plants in turn, giving their answer in a logical sequence. A few candidates over-complicated their responses when giving supporting data by trying to convert phosphate content to mg per gram of dry mass and therefore not realising the significance of the increase with the fungus in the *brb* mutant plants. Some candidates lost marks because they only mentioned increase in either dry mass or phosphate for MP1.

Assessment for learning

Evaluation is an important skill in A level Biology and candidates should be taught to take an analytical approach to interpreting experimental data. Candidates should also be encouraged to think about information not provided in the experimental detail, such as control variables or statistical analysis because these almost always offer opportunities to gain marks.

Exemplar 1

					 A good response is shown by this exemplar. The candidate provides a statement in support of the conclusion and two statements that would not support the scientists' conclusion.
			Total	**3**	
12			**A**	1 (AO1.2)	
			Total	**1**	
13			**B** ✓	1	**Examiner's Comments** Relatively few candidates gave the correct response (B). The most common incorrect responses were D and C. **OCR support** There is more support on 'Ratios' on OCR 'Maths for Biology' website, under the 'Ratios, fraction and percentages' tutorial: https:/www.ocr.org.uk/subjects/science/maths-for-biology/arithmetic-and-numerical-computation/
			Total	**1**	
14			**A** ✓	1	**Examiner's Comments** Most candidates gave the correct response (A). The most common incorrect response appeared to be C showing that candidates had thought about the correct proportion (20%) but did not understand the significance of the effect of increasing the thickness. Alternatively, candidates may have misread the question as 'what is the % change in thickness of the alveolus wall'.
			Total	**1**	