Biology A

OCR
Oxford Cambridge and RSA

Respiration
Amy Vickers

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **42**.
- The total number of marks may take into account some 'either/or' question choices.

1. A group of students set up a simple respirometer, as shown in **Fig. 1.1**, and used it to determine the rate of respiration in germinating mung beans.

- They placed a small muslin bag of soda lime into the syringe and then added five germinating mung beans, which were held in place with the syringe plunger.
- The students measured the movement of the red fluid in the capillary tube.
- After each set of readings the plunger was reset to return the fluid to its original position.

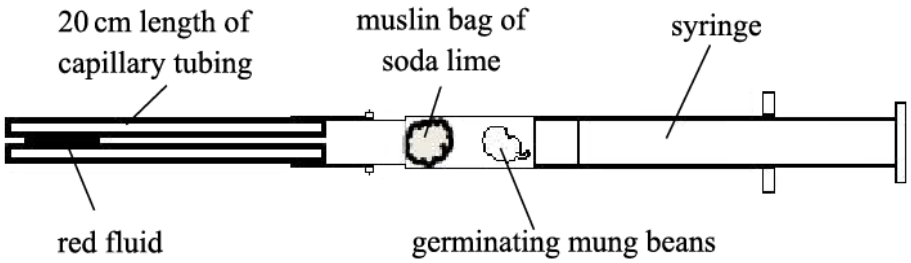

Fig. 1.1

The results are shown in **Table 1.1**.

Time (s)	Distance moved by the red fluid in capillary tube (mm)		
	1	2	3
0	0.0	0.0	0.0
30	11.5	12.0	12.5
60	22.5	21.5	17.5
90	31.0	32.0	32.5
120	41.5	42.0	42.5
150	53.0	54.0	53.5
180	63.0	63.0	64.0
210	72.5	71.0	71.5
240	78.5	79.5	79.0
270	87.5	88.5	87.0

Table 1.1

(a) Give **one** limitation of using this method to investigate respiration rate.

[1]

(b) Read the procedure carefully. Identify **one** variable that had not been controlled in this experiment **and** suggest an improvement to control that variable.

Variable

Improvement

[2]

(c) Describe how you would add the red fluid to the capillary tube at the start of the experiment.

[1]

(d) The data shows an anomalous result at 60 seconds.

Explain why the result is considered to be anomalous **and** describe one correct way of dealing with this type of result.

[2]

(e) Using the data the student obtained, calculate the mean rate of respiration for germinating mung beans between 90 and 150 seconds.

Answer _____ [1]

(f) What additional information would be needed to calculate:

(i) the volume of oxygen taken up by the seeds.

_____ [1]

(ii) the oxygen uptake for this batch of seeds to be comparable with data from another type of bean.

_____ [1]

(g) * The group of students wanted to find out if the rate of respiration of a small invertebrate animal was comparable to that of the mung beans.

Adapt the procedure used to investigate the respiration rate of a small invertebrate, such as a woodlouse or caterpillar, with that of mung beans.

Comment on the results you might expect from this experiment and the conclusions you might draw.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [6]

2. Humans harvest a wide range of fruits and vegetables as food. Cellular respiration supplies energy and forms part of the natural ripening process in fruits and vegetables. This ripening process may continue after the fruits and vegetables are harvested, as the cells continue to respire.

The rate of cellular respiration after harvesting affects the shelf-life of fruits and vegetables as it can lead to changes in food quality. After harvesting, some fruits and vegetables enter a dormant (inactive) state while others remain active during storage.

Table 5.1 contains data that show the respiration rate of a selection of fruits and vegetablesstored at different temperatures after harvesting. The respiration rate is measured by the rate of carbon dioxide produced.

Fruits and vegetables	Respiration rate (mg CO_2 kg^{-1} h^{-1})				
	at 0 °C	at 5 °C	at 10 °C	at 15 °C	at 20 °C
Apple	3	6	9	15	20
Asparagus	60	105	215	235	270
Blackberry	19	36	62	75	115
Cauliflower	17	21	34	44	69
Onion	3	5	7	7	8
Orange	4	6	8	18	28
Parsnip	12	13	22	37	n/a*
Potato	n/a*	12	16	17	22
Turnip	8	10	16	23	25

* no data were collected at these temperatures

Table 5.1

(i) Describe the pattern of respiration shown by cauliflower at increasing storage temperatures of 0 °C to 20 °C.

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[2]

(ii) Discuss what the data in Table 5.1 indicate about the best conditions for storage of fruits and vegetables.

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[2]

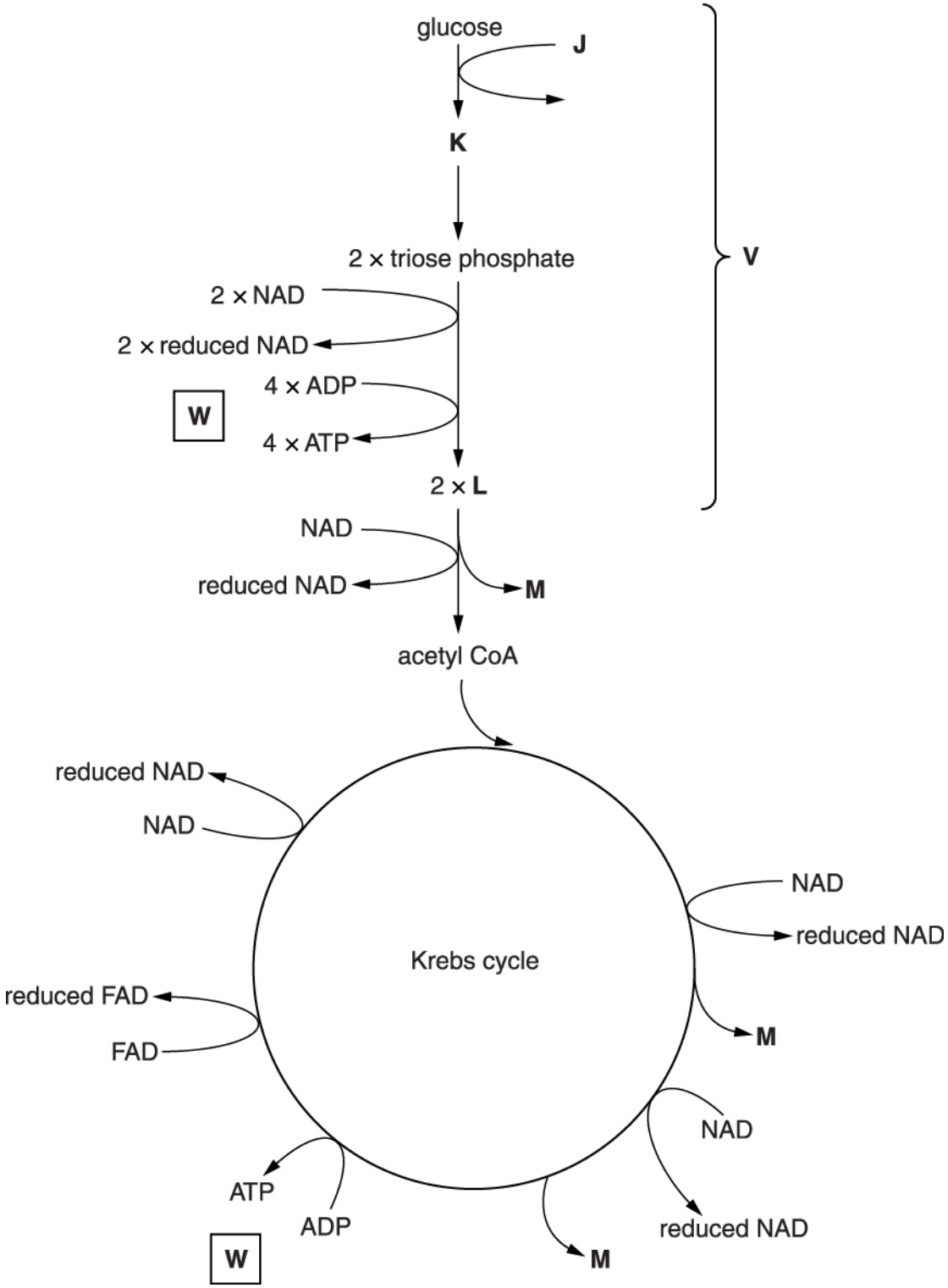
(iii) Identify, with reasons, which fruit or vegetable listed in Table 5.1 is **least** likely to spoil during storage.

[3]

(iv) Which fruit or vegetable listed in Table 5.1 is likely to be the most difficult to keep fresh during storage? Give a reason for your answer.

[1]

3. ATP is produced in cells by the process of respiration. Some of the reactions involved in the process of respiration are outlined in the figure.



(i) Compound **J** is required for the reaction pathway to start.

Identify compound **J**.

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[1]

(ii) Identify compounds **K** to **M**.

K

L

M

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[3]

(iii) Name the pathway labelled **V**.

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[1]

(iv) ATP is produced in two different ways during respiration.

- Some ATP is produced at the points labelled W.
- ATP is also produced using reduced NAD and reduced FAD on the inner mitochondrial membrane.

Outline the differences in the two ways by which ATP is produced in respiration.

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[3]

4. The following passage describes the use of alternative substrates in respiration. Complete the passage by writing in the missing words.

Glucose is not the only substrate that can be used for respiration in cells. Fats are hydrolysed to fatty acids and glycerol during digestion. Glycerol is converted to _____, which can then be decarboxylated to produce an acetyl group which is combined with coenzyme A and can then enter the _____ cycle. Fatty acids are also converted to acetyl coenzyme A. Proteins need to be converted into amino acids which must then be deaminated in the _____ . The resulting molecule can then be converted to pyruvate which enters the _____ reaction. Because energy is required for these processes, the respiration of protein gives a lower yield of _____ than the respiration of carbohydrates.

[5]

5(a). Some companies offer snack foods that contain a higher protein content than usual.
'Protein cookies' are an example of this kind of food. Some protein cookies contain up to 37 g of protein per cookie.

A student examined these foods by measuring the respiratory quotient (RQ) of maggots that were fed different types of cookie.

The student measured the oxygen consumption and carbon dioxide production of maggots when they were fed protein cookies and normal cookies.

The cookies were powdered and treated to remove all fat before being fed to the maggots.

Table 21 is a summary of the results.

Cookie	Carbon dioxide produced ($cm^3\ min^{-1}$)	Oxygen absorbed ($cm^3\ min^{-1}$)
1	13.29	13.56
2	13.04	13.87

Table 21

Use the information in Table 21 to deduce which of the two cookies is the protein cookie. Explain your choice.

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[3]

(b). The student then changed the experiment to investigate whether respiration of the cookies by yeast was different from respiration of the cookies by maggots.

The student planned to allow yeast cells and maggots to respire the cookie powder in anaerobic conditions and measure the RQ over 2 minutes.

State and explain **one** problem with the student's method.

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[3]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a		*idea that* the oxygen will leak from the connectors so reduce the gas movement (1) **or** oxygen uptake may not be a good representation of respiration rate in germinating seedlings (1) **or** a small volume of gas is being measured in the capillary (1) **or** measurements only taken every 30 seconds (1) **or** difficult to read the meniscus (may be subjective) (1)	1	**ALLOW** seal not air tight so will not prevent gas escaping during the experiment **or** *the idea* that gas leakage is a problem and needs to be prevented. **ALLOW** the respiratory substrate stored in the seed will affect the oxygen needed **or** the idea that if photosynthesis has begun oxygen uptake will be disrupted. **ALLOW** need to record the maximum volume of gas taken up during the experiment. **ALLOW** alternative wording e.g. 'more frequent readings are needed'.

Question			Answer/Indicative content	Marks	Guidance
	b		*Variable* the mass of the seeds is not given (1) *Improvement* take the mass of the seedlings at the start (1) *Variable* the volume / mass of soda lime is not specified (1) *Improvement* use a known mass of soda lime each time (1) *Variable* the size of the syringe is not given (1) *Improvement* use a 2 cm^3 syringe (1) *Variable* the capillary tube internal diameter is not given (1) *Improvement* use a capillary tube of length 20 cm and a 1 mm internal diameter (1) *Variable* temperature not controlled (1) *Improvement* allowing apparatus to, stabilise / equilibrate to temperature, before taking readings (1) *AVP* (1)	2	The control method must be suitable, and be directly linked to the variable. ALLOW suggested mass values. ALLOW suggested mass values. ALLOW alternative size if suitable for the activity. ALLOW *idea that* only a linear measurement is obtained not a volume. ALLOW alternative size if suitable for the activity. ALLOW use of a water bath and thermometer to stabilise the temperature. Must be explicit to provide valid data e.g. no scale on the capillary tube, no timing, no details of how to take the readings. Details must be workable and suitable to provide valid results e.g. scale on the capillary tube, use of timing devices, description of how to take readings from the scale etc.
	c		dipped into a small beaker and allowed to run	1	ALLOW suitable details of how the red fluid is added.

Question			Answer/Indicative content	Marks	Guidance
	d		*Explanation* it is more than 10% from the mean **or** it is different from the other data at 60 seconds **or** it does not follow trend for the times for replicate 3 (1) *Action* anomaly should be identified and excluded from processing **or** anomaly must be identified but could be included in calculations **or** repetition to obtain another reading (1)	2	ALLOW 'it is out of line' ALLOW 'it is out of line'
	e		0.36 mm s^{-1} (1)	1	Rate and units required for the mark.
	f	i	the internal diameter of the capillary tube (1)	1	
		ii	the mass of the bean seeds (1)	1	

Question			Answer/Indicative content	Marks	Guidance
	g		* Level 3 (5–6 marks) Describes a clear and detailed experiment that has been effectively adapted for use with chosen invertebrate to allow for the comparison of the rate of respiration with that of mung beans. *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) Describes an experiment to compare the rate of respiration of chosen invertebrate with mung beans but there is insufficient detail of the procedure to allow a valid comparison. *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) An attempt to describe an experiment to investigate the respiratory rate of an invertebrate but little comparison with mung beans. If results or conclusion suggested, likely to be muddled or inaccurate. *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.	6	Relevant points include: experiment • mass of invertebrate and mass of beans the same • safe and ethical use of invertebrates e.g. add screen so that animal(s) cannot touch the muslin bag • bigger syringe needed (5–10 cm^3) • keep temperature constant / same for both assays • keep light constant / same for both assays • use same mass of soda lime in both assays • measuring distance moved by coloured, red liquid at regular time intervals • repeat experiments. results and conclusions • invertebrates rate of respiration is expected to be higher than the rate of respiration of the beans *because* • invertebrates are moving around • metabolic processes require energy / generate heat.
			Total	15	

Question			Answer/Indicative content	Marks	Guidance
2		i		2 max	**Only credit answers that refer to an increase in temperature – no ora**
			1 (as the temperature increases) the respiration <u>rate</u> increases;		**1 Clear statement required – cannot be inferred from figures quoted.** **ACCEPT** positive correlation between temperature and respiration rate **IGNORE** ref to directly proportional
			2 respiration <u>rate</u> doubles with a 10°C temperature increase;		**2 Clear statement required – cannot be inferred from figures quoted**. **CREDIT** $Q_{10} = 2$
			3 **comparative** figures with **correct units** (units once for respiration and once for temperature) in the context of either mp;		3 e.g. • between 0 and 20°C the respiration goes from 17 to 69 mg CO_2 kg^{-1} h^{-1} • between 5 and 10°C the rate changes by 13 mg CO_2 kg^{-1} h^{-1} e.g. • between 0 and 10°C the rate goes from 17 to 34 mg CO_2 kg^{-1} h^{-1} • between 10 and 20°C the respiration goes from 34 to 69 mg CO_2 kg^{-1} h^{-1} **Note**: 'between 0 and 20°C the respiration rate increased from 17 to 69 mg CO_2 kg^{-1} h^{-1}' = **2 marks** (mps 1 & 3) **But** 'at 0°C the respiration is 17 mg CO_2 kg^{-1} h^{-1}' and at 20°C it is 69' = **1 mark** (mp 3) **Examiner's Comments** Most candidates achieved both marks here, demonstrating evidence of sound preparation for this type of question, with good references to data being seen. Most candidates gave a clear general statement

0 °C	5 °C	10 °C	15 °C	20 °C
17	21	34	44	69

Question			Answer/Indicative content	Marks	Guidance
					to gain mark point 1, although a good number only gave lengthy lists of figures. A few failed to refer to 'rate' of respiration. Very few picked up on the idea of Q_{10}. When quoting data, candidates are expected to use units as stated in the source material.

Question			Answer/Indicative content	Marks	Guidance
		ii	1 *best conditions are* low(er) temperatures because respiration rate low; 2 0°C / freezing, could be / is, best; 3 *idea that* 0°C might be too low as (the food cells) might be damaged at 0°C; 4 *idea that* for some (named) food(s) (storage) temperature doesn't seem to matter; 5 *idea that* data is incomplete for, potato / parsnip, so, only limited / no, conclusions can be made; 6 *idea that* if product needs to ripen during storage then a higher temperature (not above 20°C) will be ideal;	2 max	1 5°C or below **IGNORE** statements that simply describe a trend 3 **ACCEPT** ref to freezing instead of 0°C 4 **NOT** asparagus, blackberry or cauliflower 6 **IGNORE** ref to ethene **Note**: '0°C is best as the respiration rate is low' = **2 marks** (mps 1 & 2) **Examiner's Comments** The discursive nature of this question made it a little more challenging. Most candidates, nevertheless, seemed able to access the idea of lower temperatures being better for storage, although, as in part (i), some failed to gain the first mark due to omitting the reference to 'rate'. When using source material such as a table or graph, candidates are expected to quote the precise parameter. Not all made the link to 0°C being best and only a few answers clearly discussed the idea of higher temperatures being desirable if ripening was required. Some candidates did mention that data was incomplete for potato / parsnip but did not describe this as a limitation for drawing conclusions. Others thought these vegetables were not respiring at all. Weak answers described the trend (higher respiration rate at higher temperatures) and just quoted data from the table.

Question			Answer/Indicative content	Marks	Guidance
		iii	1 onion; 2 has low(est) respiration rate; 3 across all temperatures (in the investigation / up to 20°C) **or** temperature has, the least / little, effect on respiration rate; 4 can be, stored / kept, at, higher temperatures / room temperature / at 20°C;	3	1 **DO NOT CREDIT** if an additional suggestion is made 3 **DO NOT CREDIT** 'temperature has **no** effect on respiration rate' 4 **CREDIT** *idea that* no need to store in fridge **Examiner's Comments** This was a relatively straightforward application of data question and one which was attempted successfully by most. Many good answers were awarded the first three mark points in one sentence. A few missed the point completely, selecting asparagus, and some mentioned multiple fruits / vegetables. A significant number of candidates appeared to misread or misunderstand the question and answered in terms of the "highest respiration rate", linking this to having plenty of energy to stay fresh.

Question			Answer/Indicative content	Marks	Guidance
		iv	asparagus and has a high respiration rate across all temperatures / has the highest respiration rate (of the foods);	1	Both parts of the mark point required for the mark to be awarded DO NOT CREDIT 'asparagus' without a supporting reason ACCEPT 'has a high respiration rate even at low temperature(s)' Examiner's Comments Most recognised that asparagus was the correct answer. Those candidates who failed to gain the mark did so either because they named onion (having already mistakenly given asparagus in answer to part (iii)) or because they omitted the reference to 'rate' of respiration. Reasons were expected to refer to the range of possible storage temperatures.
			Total	8	

Question			Answer/Indicative content	Marks	Guidance
3		i	(2 molecules of) ATP / adenosine triphosphate;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
		ii		3	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			K hexose (1,6) (bis)phosphate;		K **CREDIT** glucose (6) phosphate / fructose (1) phosphate / fructose (1,6) diphosphate / hexose diphosphate **DO NOT CREDIT** glucose (1,6) bisphosphate
			L pyruvate;		L **ACCEPT** pyruvic acid
			M carbon dioxide / CO_2;		M if used, formula must be correct
		iii	glycolysis / glycolytic;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** Parts (i), (ii) and (iii) were well answered, indicating the candidates' good knowledge of respiration.

Question			Answer/Indicative content	Marks	Guidance
		iv	by substrate level phosphorylation; detail; by, chemiosmosis/ oxidative phosphorylation; detail;	3 max	e.g. • by removing phosphate from a compound (in the reaction pathway) e.g. • hydrogen lost from, redNAD / redFAD • electrons pass down, ETC / electron transport chain • ref to proton gradient / electrochemical gradient • ref to ATP synth(et)ase **Examiner's Comments** Detail of oxidative phosphorylation was good, although there was some confusion as to where the protons were pumped and whether they moved down or up a gradient. The detail on substrate level phosphorylation was lacking. Candidates were expected to indicate that the phosphate to phosphorylate ADP came directly from a compound in glycolysis or Krebs cycle. The only information offered by most candidates was that ADP added a phosphate to become ATP.
			Total	**8**	
4			pyruvate ✓ Krebs ✓ liver ✓ link ✓ ATP ✓	5	**ALLOW** citric acid / tricarboxylic acid / TCA
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
5	a		cookie 2 is protein cookie ✓ RQ of cookie 2 is 0.94 **AND** RQ of cookie 1 is 0.98 ✓ lower RQ means (cookie 2) must have more protein ✓ RQ closer to 1.0 means more carbohydrate ✓	3 max	**ALLOW** ORA
	b		maggots will not produce CO_2, during lactate fermentation ✓ yeast will produce CO_2, during alcoholic fermentation ✓ measuring RQ requires CO_2 production / RQ value (for maggots) will be lower than normal ✓ **OR** 2 minutes not long enough for, yeast / maggots, to, break down / respire, cookie ✓ CO_2 produced (by yeast) is not from respiration of cookie ✓ RQ (comparison) will be invalid ✓	3	**IGNORE** "maggots will die" because experiment is only for 2 minutes
			Total	**6**	