

Surname	Centre Number	Candidate Number
Other Names		2



GCE A level

1074/01



S16-1074-01

BIOLOGY – BY4

P.M. THURSDAY, 16 June 2016

1 hour 45 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	7	
2.	9	
3.	5	
4.	8	
5.	6	
6.	12	
7.	12	
8.	11	
9.	10	
Total	80	

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ADDITIONAL MATERIALS

In addition to this examination paper you will need a ruler and a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

The quality of written communication will affect the awarding of marks.

Answer all questions.

1. (a) Gram-positive and Gram-negative bacterial cell walls have different structures. Explain how the structure of Gram-negative bacteria allows them to be resistant to certain antibiotics. [2]

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- (b) Microorganisms require certain factors to be supplied in the culture medium to allow them to grow. These are molecules such as amino acids, purines and pyrimidines. State the functions of the following growth factors in microorganisms. [2]

Amino acids

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Purines and pyrimidines

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- (c) It is not possible to culture viruses on sterile agar plates. Explain why. [1]

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- (d) Describe how bacterial culture plates are safely disposed of. [2]

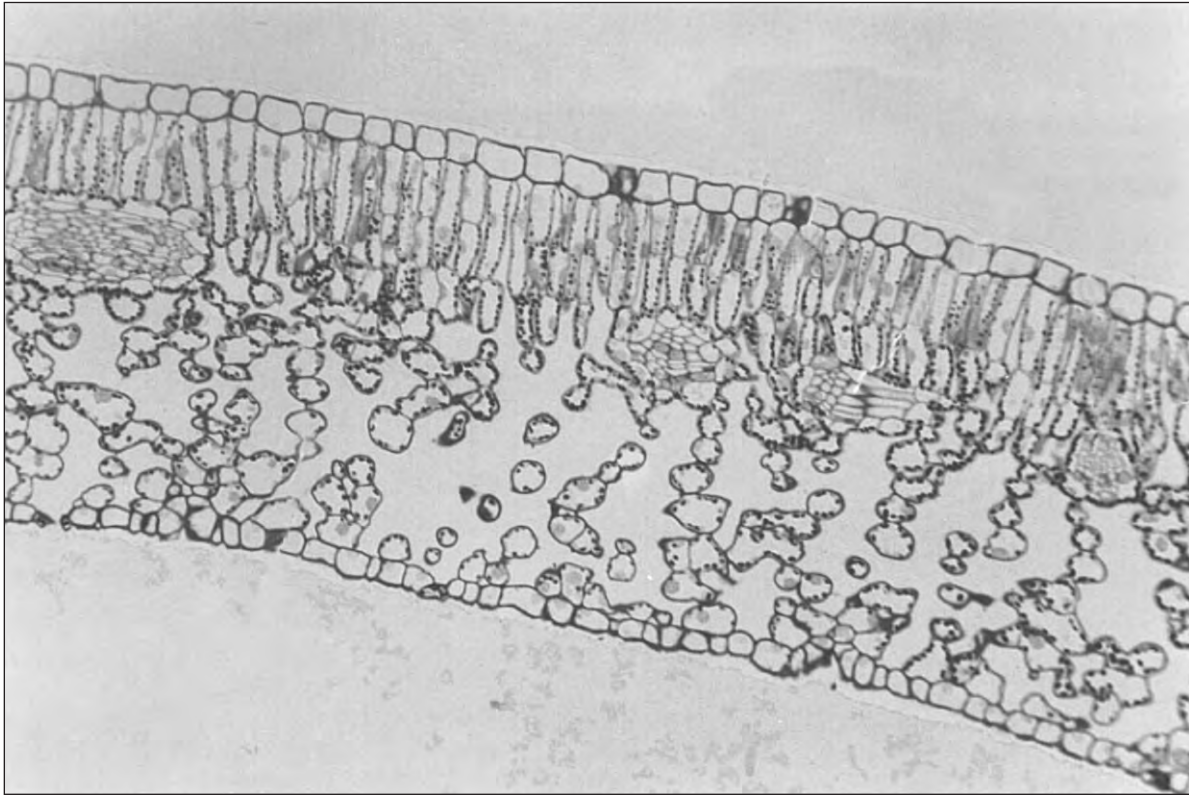
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2. Below is a leaf section as seen with a light microscope.



- (a) **Indicate clearly with an arrow** on the photomicrograph above, the main site of photosynthesis. [1]
- (b) Distinguish between an absorption spectrum and an action spectrum. [2]

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(c) In part of the Calvin cycle, the carbon in carbon dioxide is incorporated into triose phosphate. Briefly describe **this** sequence of reactions. [4]

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(d) How would you expect the pH of the thylakoid space of the chloroplast to differ from the stroma? Explain your answer. [2]

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3. The following table compares the abilities of kidneys of various mammals to concentrate urine.

Species	Max Urine Concentration / a.u.
beaver	520
pig	1100
kangaroo rat	5500

- (a) (i) Describe how the structure of the kidneys in these species would differ, which would explain the trend of data shown. [1]

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- (ii) What does this data suggest about the environments in which each of these mammals live? [3]

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The maximum urine concentration for sheep is shown below.

Species	Max Urine Concentration / a.u.
sheep	3500

- (b) What does this suggest about the environment in which sheep have evolved? Explain your answer. [1]

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4. *Mycobacterium leprae* is a gram positive, intracellular, aerobic bacillus that causes leprosy (Hansen's disease) and has never been successfully cultured on an artificial cell culture medium. The main reason for this appears to be that it is an obligate parasite that lacks many of the genes necessary for independent survival.

One form of *M. leprae* invades and multiplies in Schwann cells. Loss of sensation develops as a result of invasion of the peripheral sensory nerves.

Use the text above to answer the following questions.

- (a) How would these bacteria appear under the light microscope following Grams staining? [2]

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- (b) Explain what is meant by the description '*intracellular aerobic*'. [2]

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- (c) Explain why *M. leprae* is an '*obligate parasite*'. [1]

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- (d) Suggest why there is a loss of sensation in the extremities in cases of leprosy. [3]

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5. Leaf feeding caterpillars may be controlled by *Bacillus thuringiensis* (Bt), a naturally occurring pathogen of insects.

- Bt acts by producing toxic proteins that react with the cells of the gut lining of susceptible insects. These toxic proteins paralyse the digestive system and the infected insect stops feeding within hours.
- Bt must be eaten to be effective and application coverage of the leaves must be thorough.
- If Bt is ingested by other species it is digested without producing toxic proteins.
- Bt persists on foliage for less than a week following application.

Use the text above to answer the following questions.

(a) (i) What type of insect control is described? [1]

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(ii) Explain the advantage of using Bt as described above. [2]

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(iii) Explain **two** disadvantages of using Bt as described above. [2]

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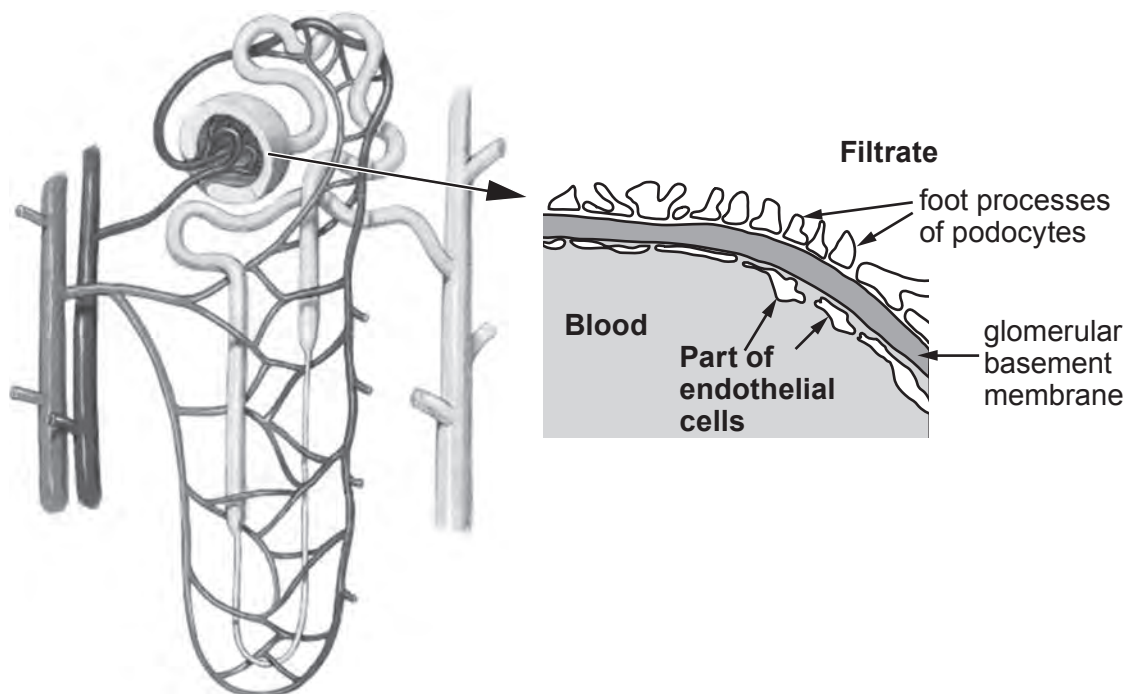
(b) The plum sawfly lays its egg in the embryonic plum fruit at flowering time and its larvae burrow through the young fruit as it develops. Suggest why Bt would be ineffective in this case. [1]

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6. (a) Glucose is not present in normal urine. A person with untreated diabetes produces large volumes of urine containing glucose. The diagram below shows a nephron with a section enlarged to show the site of ultrafiltration of the blood.



- (i) Explain why large proteins are not usually found in the glomerular filtrate. [2]

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- (ii) Glucose is filtered out of the blood, but is not found in urine. Explain why glucose is not present in urine. [2]

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- (iii) If the blood glucose level is high, as may occur in a person with diabetes prior to diagnosis and treatment, glucose is present in the urine. Normally, water is reabsorbed from the collecting duct. Explain why a person with diabetes produces a larger volume of urine than a person that does not have diabetes. [3]

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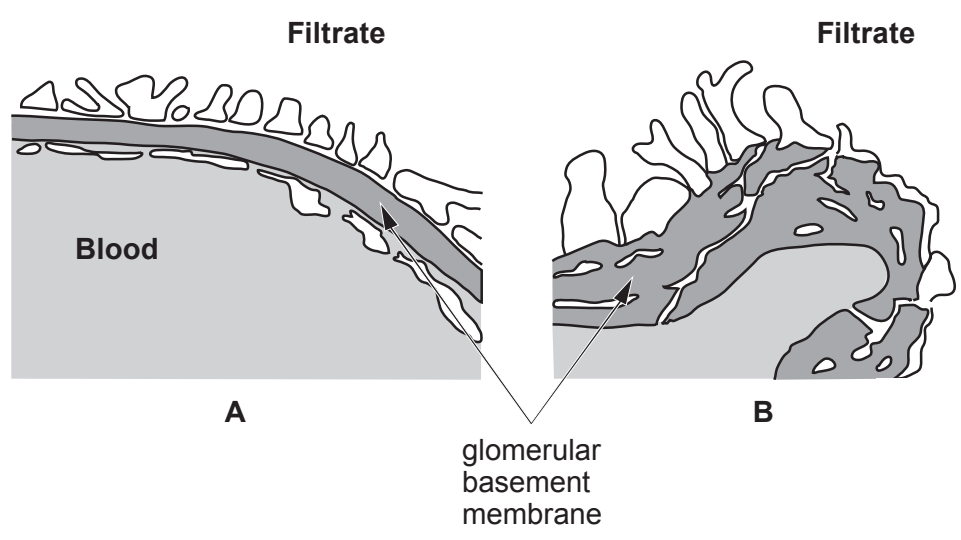
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(b) In Alport syndrome, the glomerular basement membrane is abnormal because it lacks a particular type of collagen. Picture **B** below shows a diagrammatic representation of the condition. Picture **A** shows a normal glomerular basement membrane. Most people with Alport syndrome develop kidney failure in early adult life. In the early stages of the syndrome, symptoms may include blood and protein in the urine.



(i) Briefly describe the biochemical structure of collagen. [2]

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(ii) Using your knowledge of ultrafiltration and the diagrams above, suggest how the symptoms of Alport syndrome are caused. [3]

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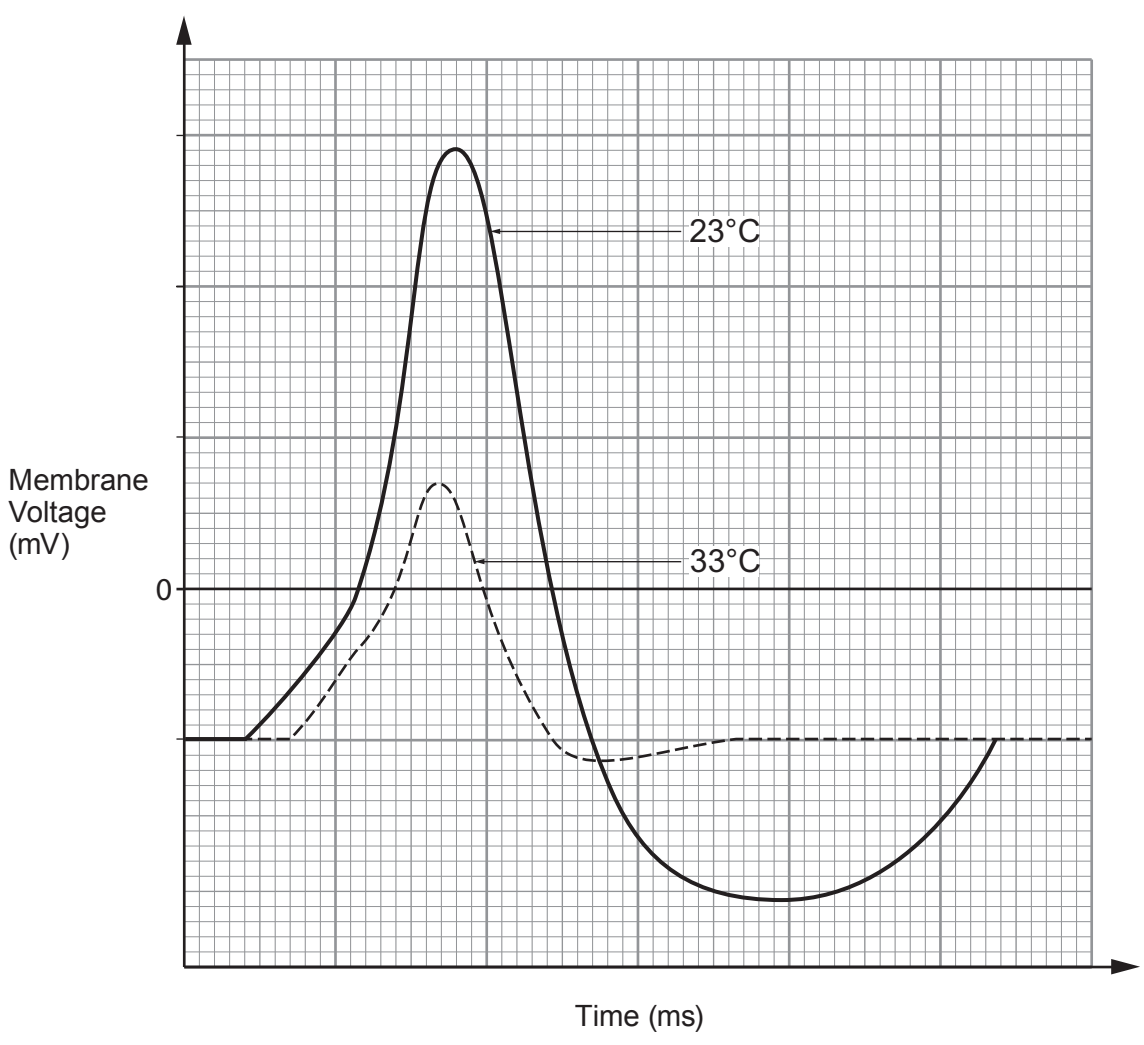
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7. Experiments were carried out to determine the effect of temperature on action potentials in mammalian ear cells. Results are shown below.



(a) Use the graph to describe **three** effects of an increase in temperature on the action potential. [3]

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- (b) The scientists concluded that the opening and closing of potassium gated channels was temperature dependent. Suggest an explanation for the differences shown in the traces. [2]

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- (c) Research has shown that the brains of people with Alzheimer's disease show a loss of function of nerve cells that use the neurotransmitter acetylcholine. The loss of function of these nerve cells is related to the severity of symptoms that people experience. There are no drug treatments available that can provide a cure for Alzheimer's disease. However, medicines have been developed that can reduce symptoms, or temporarily slow down their progression, in some people.

- (i) Briefly describe how the normal functioning of the synapse causes depolarisation of the post synaptic membrane. [2]

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- (ii) It has been noted that patients who are given acetylcholinesterase inhibitors have improved synapse function. Describe the action of acetylcholinesterase inhibitors and why they would result in improved synapse function. [2]

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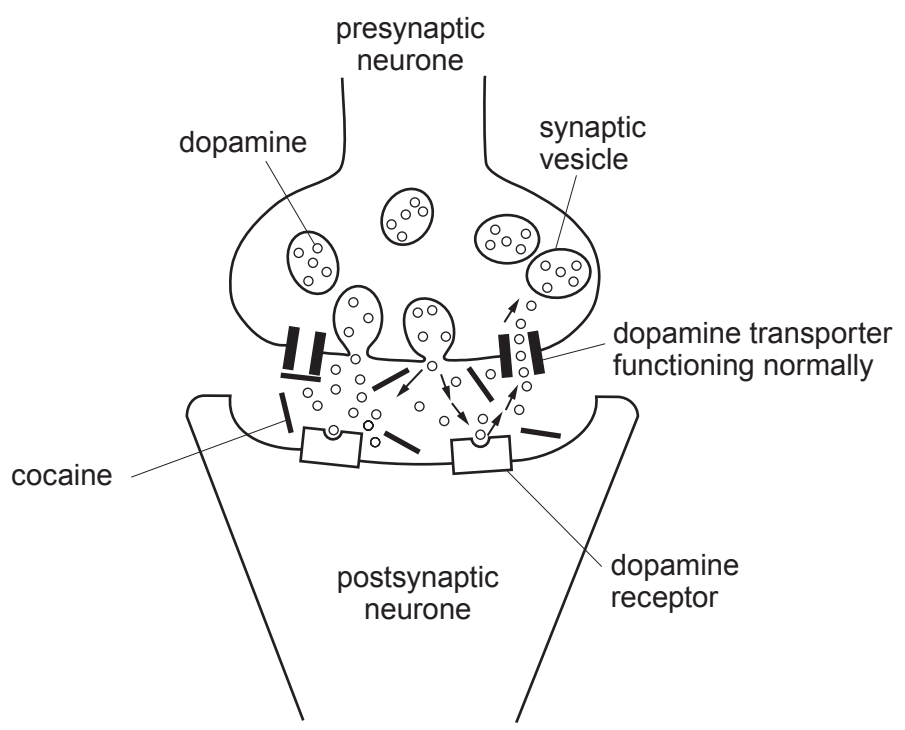
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(d) The diagram below shows the effect of cocaine on synapses where the neurotransmitter is dopamine.



Describe and explain the effect that cocaine has on the synapse.

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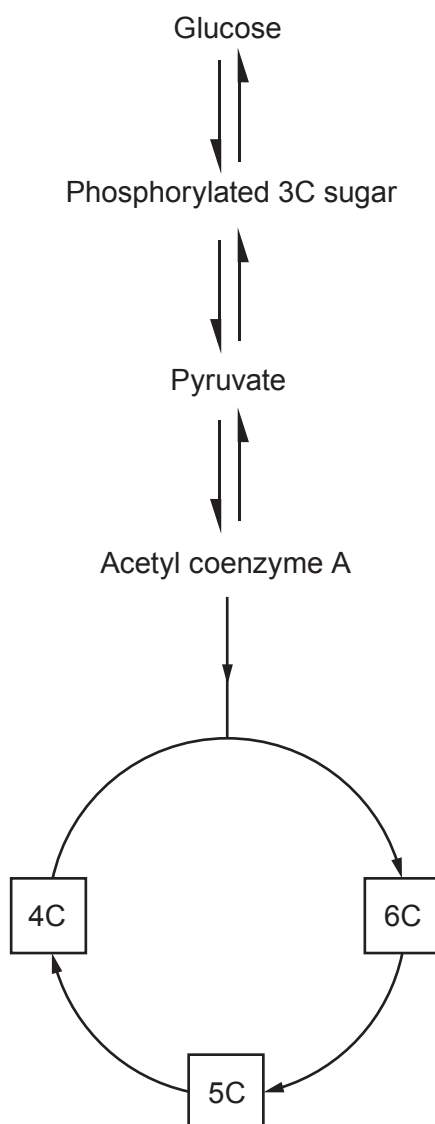
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8. The diagram below shows the stages of glycolysis and the Krebs cycle in respiration.



- (a) Using **labelled** arrows indicate clearly where **amino acids** and the **products of the hydrolysis of triglycerides** (lipids) enter the respiratory pathway. [3]
- (b) Describe the role of oxygen in aerobic respiration. [2]

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- (c) A piece of apparatus called a respirometer can be used to measure the rates of oxygen uptake and carbon dioxide production. Using these results, a respiratory quotient (RQ) can be calculated.
The RQ is defined as the ratio of carbon dioxide produced to oxygen consumed per unit time by an organism.

$$\text{RQ} = \frac{\text{volume of CO}_2 \text{ produced}}{\text{volume of O}_2 \text{ consumed}} \text{ per unit time}$$

Table 1

Rate of oxygen consumption (cm ³ O ₂ min ⁻¹)	Rate of carbon dioxide production (cm ³ CO ₂ min ⁻¹)	RQ (Respiratory quotient)	Substrate being respired
2.55	2.21	0.87	
2.63	2.65	1.01	
2.23	1.55		

- (i) **Calculate the missing value** in the RQ column **in the table above**. [1]

Different respiratory substrates give different RQ values as can be seen in the table below.

Table 2

Substrate	RQ
Glucose	1.0
Amino acid	0.9
Triglycerides	0.7

- (ii) **Complete the substrate column** in **Table 1** using the above information. [1]

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(d) During a sprint an athlete's muscle cells may respire anaerobically to produce ATP.

(i) Name one other metabolic product of anaerobic respiration in muscle cells. [1]

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(ii) Where in a cell does anaerobic respiration occur? [1]

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(iii) Describe the importance of ATP to muscle cells. [1]

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(e) Suggest what would happen to the RQ value if you were investigating anaerobic respiration in yeast and explain your answer. [1]

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9. Answer **one** of the following questions.

Any diagrams included in your answer must be fully annotated.

Either, (a) Describe cyclic and non-cyclic photophosphorylation in photosynthesis. [10]

Or, (b) Describe the biological processes which occur in the nitrogen cycle and briefly explain how agricultural practices lead to increased soil fertility. [10]

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