



Biology

A Level | OCR A | H420



2023 specification
first exams in 2025

Practice Exams for A Level OCR Biology A

Paper 3: Unified Biology

Update v1.2, June 2024

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Teacher's Introduction

This pack contains four Practice Paper 3s for the OCR A Level Biology (A) specification (H420, first teaching September 2015). The papers and corresponding mark schemes in this pack are modelled on the sample assessment material provided by the board.

Paper 1 is entitled 'Breadth in Biology' and covers:

- Module 2: Foundations in Biology
- Module 3: Exchange and Transport
- Module 5: Communication, Homeostasis and Energy

Paper 2 is entitled 'Depth in Biology' and covers:

- Module 2: Foundations in Biology
- Module 4: Biodiversity, Evolution and Disease
- Module 6: Genetics, Evolution and Ecosystems

Paper 3 is entitled 'Unified Biology' and covers all modules, with an emphasis on practical skills and 'How Science Works'.

This paper is designed so it can be used as either a mock examination or a revision activity. The mark scheme is designed with both students and teachers in mind, allowing students to mark their own work and assess their progress. Otherwise, the mark scheme resembles those produced by OCR in their sample assessment material.

Each practice paper contains both short and longer questions in proportion to the sample assessment material. This includes factual recall, explanation and discussion questions, with two 6-mark 'Level of Response' questions per paper. Papers have been designed to ensure that the 'Mathematical Skills' and 'Practical Activity Groups' (PAGs) specified in the new syllabus are assessed.

Across the three Practice Paper packs (Papers 1, 2 and 3), coverage of the specification is complete. A specification analysis grid is also included, enabling teachers to identify questions relevant in tests and exam-technique activities, or as homework assignments.

The authors have aimed to include a spread of material from the relevant topics in each paper, allowing teachers to obtain an overview of their students' knowledge and understanding for each unit.

We hope you and your students find this pack useful.

C Johnson and L Mills, April 2017

Update v1.1, 19 September 2018

Paper 3A, question 2 b) i), pages 8 and 59 – the symbol for standard deviation has been corrected to s

Paper 3B, question 4, pages 26, 27, 69 and 70 – the species has been changed to *O. viridulus*, for accuracy

Paper 3C, question 3 b), pages 76 and 37 – the question has been corrected to state that 'blue light' is passed through the sample

The following questions have been reworded for clarity:

- Paper 3A: 1 a) (pages 5, 58), 1 b) ii) (pages 6, 58)
- Paper 3B: 4 f) (pages 28, 70)
- Paper 3C: 1 b) iii) (pages 32, 73), 2 c) (pages 35, 75), 5 c) iii) (pages 42, 79)
- Paper 3D: 3 c) ii) (pages 52, 86), 4 a) (pages 53, 86)

Update v1.2, 5 June 2024

- Paper 3C: 5 c) (pages 42, 79) – NADH has been corrected to reduced NAD to reflect the 2023 accessibility and clarity amendments to the specification

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* resulting from minor specification changes, suggestions from teachers and peer reviews, or occasional errors reported by customers

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Specification Cross-reference

	A Level Paper 1 (A) Biological Processes	A Level Paper 1 (B) Biological Processes	A Level Paper 1 (C) Biological Processes	A Level Paper 1 (D) Biological Processes	A Level Paper 2 (A) Biological Diversity	A Level Paper 2 (B) Biological Diversity	A Level Paper 2 (C) Biological Diversity	A Level Paper 2 (D) Biological Diversity	A Level Paper 3 (A) Unified Biology	A Level Paper 3 (B) Unified Biology	A Level Paper 3 (C) Unified Biology	A Level Paper 3 (D) Unified Biology
Module 1												
1.1 – Practical skills												
1.1.1 Planning	17	16	16		20		17, 18		1, 2	2, 4	1, 3	4
1.1.2 Implementing			16	17		19			1, 5		2, 3	4
1.1.3 Analysis	17	16		16, 17	21	17, 19		19, 21	3, 5	3, 4	2	2, 5
1.1.4 Evaluation					17	16, 21	17	17, 19, 22	2, 3, 5	4	1, 3, 4	2, 3, 5
Module 2: Foundations in Biology												
2.1 – Foundations in biology												
2.1.1 Cell structure	1, 16	1, 15, 19	1,2, 18	1, 2, 16, 17	1, 14	20				1	1	1
2.1.2 Biological molecules	17	2, 17, 20	3, 16	3, 9	2, 17	1, 12	1, 9, 15, 22	1, 16, 20	1	2, 4	2, 5	3
2.1.3 Nucleotides and nucleic acids		3, 7	4, 19	4	3, 15	2, 13	2	2			3	
2.1.4 Enzymes	17, 20	4, 17, 19	14, 18	5, 6, 17, 20				20		3		1, 2
2.1.5 Biological membranes	6	5, 6, 17	5	19, 20	4	3, 14		1				1
2.1.6 Cell division, cell diversity and cellular organisation	7		6	16	5	4		21	1	1		
Module 3: Exchange and Transport												
3.1 – Exchange and transport												
3.1.1 Exchange surfaces		20	7, 8, 13, 16						3	4		
3.1.2 Transport in animals	2, 4, 9, 19	17, 20	16, 17	18						5	5	
3.1.3 Transport in plants	10, 11, 16, 20	9, 16, 18, 19	9, 20						4	3		4
Module 4: Biodiversity, Evolution and Disease												
4.1 – Communicable diseases, disease prevention and the immune system												
4.1.1 Communicable diseases, disease prevention and the immune system					6, 16	5, 15, 17, 20	3, 7, 10, 19	4, 16, 20		1, 2	4	1, 5

	A Level Paper 1 (A) Biological Processes	A Level Paper 1 (B) Biological Processes	A Level Paper 1 (C) Biological Processes	A Level Paper 1 (D) Biological Processes	A Level Paper 2 (A) Biological Diversity	A Level Paper 2 (B) Biological Diversity	A Level Paper 2 (C) Biological Diversity	A Level Paper 2 (D) Biological Diversity	A Level Paper 3 (A) Unified Biology	A Level Paper 3 (B) Unified Biology	A Level Paper 3 (C) Unified Biology	A Level Paper 3 (D) Unified Biology
4.2 – Biodiversity												
4.2.1 Biodiversity					7, 20	6, 16, 20, 21	4, 11, 17, 21	6	2	3	4	2
4.2.2 Classification and evolution					8, 17, 18	7	5, 16	5			1, 3	
Module 5: Communication, Homeostasis and Energy												
5.1 – Communication and homeostasis												
5.1.1 Communication and homeostasis	3, 12	10, 12, 14, 20	10	8, 16, 19								
5.1.2 Excretion as an example of homeostatic control	13, 17	11, 17	11, 17	20							5	
5.1.3 Neuronal communication	14		16, 17	10, 19						5		3
5.1.4 Hormonal communication	17, 19	13	12	11, 16								3
5.1.5 Plant and animal responses	8, 15, 18, 20	8, 19	20	7, 12						5	2	3, 4
5.2 – Energy for biological processes												
5.2.1 Photosynthesis	5, 20	18	18	13, 15, 17						3	2	1, 4
5.2.2 Respiration	18, 20	19	15, 19	14, 18					5	4	5	
Module 6: Genetics, Evolution and Ecosystems												
6.1 – Genetics and evolution												
6.1.1 Cellular control					9, 19	8, 19	6, 12, 16	15, 21	1, 4			
6.1.2 Patterns of Inheritance					17, 18	16, 18	16, 20	7, 14, 17, 18		3		
6.1.3 Manipulating genomes					10, 17, 19	9, 16, 17	13, 17, 19	12, 13, 18			1, 3	
6.2 – Cloning and biotechnology												
6.2.1 Cloning and biotechnology					11, 21, 22	10, 19	17, 18	9, 10, 11, 16	4, 5			
6.3 – Ecosystems												
6.3.1 Ecosystems					12, 20, 22	21	22	19	2			
6.3.2 Populations and sustainability					13	11	8, 14, 21	8, 22	2	3		2

ZigZag Practice Exam

Supporting A Level OCR

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A Level Biology

Unified Biology

Practice Paper 3A



Name	
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Time allowed

1 hour 30 minutes

Instructions

Answer **all** of the questions and use the space provided.
Use black ink. You may use an HB pencil for graphs and diagrams.

Information

The total number of marks available for this paper is **70**.
Quality of extended response questions are marked with a star (*).
Use of an electronic calculator is permitted.



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1. Osteoarthritis is a condition that affects the bones, typically of elderly people, caused by the breakdown of cartilage, a cushion-like lining at the end of bones which contains the structural protein collagen, which stops the bone from rubbing against other bones.

a) Cartilage contains a single cell type, the chondrocyte. Cartilage does not contain any blood vessels, restricting the ability for healing on the bone.

i) To which biological level of organisation does cartilage belong?

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ii) In the developing foetus, chondrocytes undergo multiple cell divisions in order to form cartilage. At skeletal maturity however, mitosis stops and cell division is halted.

ii) Why is it important that the cell cycle is halted in cartilage?

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iii) Using the information above as well as your own knowledge, suggest two characteristics of collagen provide to cartilage.

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b) Researchers in New York have proposed the use of stem cells to treat the early stages of osteoarthritis. Stem cells can be programmed to express the proteins required to repair the cartilage and prevent the disease.

i) Outline the benefits of using stem cells for this type of treatment.

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A researcher investigating the usefulness of stem cells for this treatment mice. The mice naturally develop osteoarthritis, and upon doing so, the cells into the joints of the mice.

After four weeks, the mice are euthanised (killed) and the researcher dis to observe the cells. The knee joint of a mouse is approximately 2 mm in

- ii) Suggest a safety precaution the investigator should take in order to pathogens.



Using microscopic techniques, the stem cells could be visualised to track

- iii) Explain how the scientist likely prepared the sample to visualise the

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In a separate experiment, the DNA from cartilage is isolated. A DNA sam cells. The researcher uses a technique in which the DNA from the cartil cell DNA. Using this technique, the pattern of DNA fragments could be vis

- iv) What is the name given to this technique?



The DNA sample from the joint is at a concentration of $25 \text{ ng } \mu\text{L}^{-1}$. The DN concentration of $125 \text{ ng } \mu\text{L}^{-1}$. For the technique identified in iv), an equiv used.

- v) Show how a $25 \text{ ng } \mu\text{L}^{-1}$ solution of stem cell DNA can produced from

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2. Agricultural systems tend to have a negative impact on biodiversity, but as the more land is being converted to agricultural uses in order to feed more people, increase biodiversity by increasing the number of habitats in agricultural land.

a) Other than habitat destruction, identify **two** ways in which agriculture re

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A government initiative pays 10 large arable farms (A1–J1) in Illinois, USA, to increase biodiversity by introducing new hedgerows, planting thickets of trees and creating a group of 10 farms (A2–J2), each adjacent to one of the initiative farms, does not.

After 10 years, the government wants to assess whether the measures they have taken increase biodiversity. Each farm collects plant species counts from several randomly chosen areas on the farm, and uses an index of diversity called the Reciprocal Index (RI) to produce a score for the farm.

Farm (Initiative)	Reciprocal Index	Farm (Control)
A1	1.92	A2
B1	1.61	B2
C1	2.43	C2
D1	1.95	D2
E1	2.17	E2
F1	0.92	F2
G1	1.38	G2
H1	2.11	H2
I1	1.73	I2
J1	2.25	J2
Mean	1.847	Mean
Standard Deviation	0.45	Standard Deviation



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- b) A t-test can be used to determine whether mean biodiversity is significant between two groups. The null hypothesis suggests that there is no difference between the two groups.
- i) Using the formula given below, carry out a t-test to compare the two groups of farms.

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\left(\frac{s_1^2}{n_1}\right) + \left(\frac{s_2^2}{n_2}\right)}}$$



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Degree of freedom	p-value		
	0.10	0.05	0.01
8	1.86	2.31	3.36
9	1.83	2.26	3.25
10	1.81	2.23	3.17
16	1.75	2.12	2.92
18	1.73	2.10	2.88
20	1.72	2.09	2.85

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- ii) Using the table of critical values, explain whether the government should be concerned that there is a difference between the two groups.



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- iii) The government initiative aimed to increase biodiversity by paying farmers to create habitats in unfarmed land. Using both the information you have read and your own knowledge, suggest why this experimental method may not have been an appropriate one. Discuss the effectiveness of the government initiative.

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The government initiative is scrapped due to budgetary cuts. A new government has been elected, aware of the benefits of increased biodiversity. However, many farmers have small margins and feel that they cannot afford to make the required changes to their farms.

- c) Propose an argument in favour of biodiversity which the government might use to encourage farmers to increase biodiversity on their farms.

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Farmers can increase crop yields without increasing the size of their farms by using legumes to fix nitrogen. Certain plants, including beans and clover, live in a symbiotic relationship with nitrogen-fixing bacteria, which live in root extensions of the roots called root nodules. The bacteria convert atmospheric nitrogen from the atmosphere into a form the plant can use.

- d) i) Describe the environmental conditions in which this relationship evolved.



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Figure 1 – Root nodules

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- ii)* You are given the following: soybean plants, plant pots, antibiotic s
different nitrate concentrations. Outline an experiment to confirm
nodules are responsible for nitrogen fixation.



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3. An athlete has been training in the Alps mountain range in order to increase his



A doctor has been asked to study how altitude training has affected the athlete's lung capacity. The athlete is asked to breathe into an electronic spirometer, which is connected to a computer.

Traditional float spirometers consist of a floating chamber which moves up and down as the subject breathes. This is attached to a kymograph, which draws a trace onto a revolving drum to record the volume of air in the chamber. Electronic spirometers are used in modern physiology in place of traditional spirometers.

a) Suggest one advantage of using an electronic spirometer and a data logger instead of a traditional spirometer attached to a kymograph.

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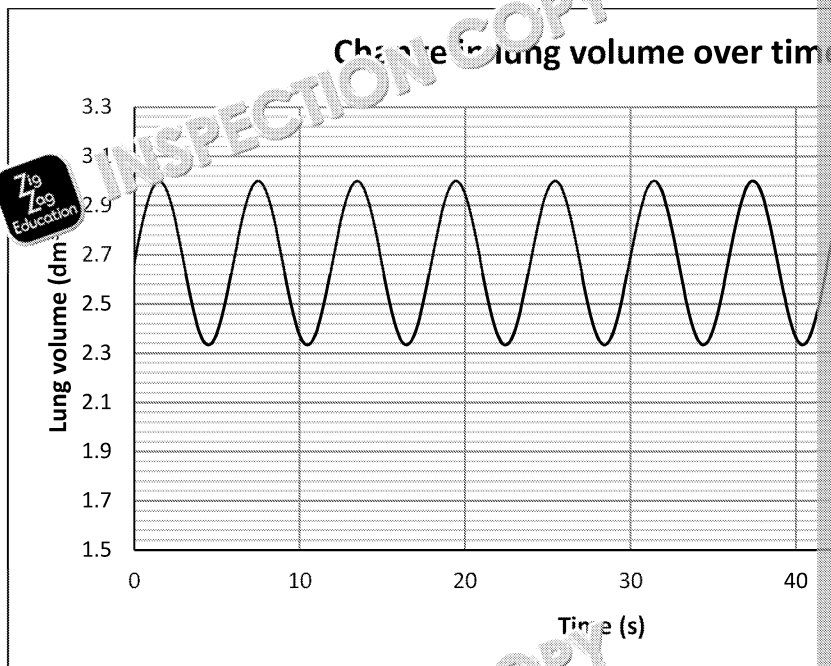


Figure 2 - Lung volume data, athlete at rest

Figure 2 shows the trace from the spirometer. The athlete's total lung volume is known to be 3.0 dm³. Six months previously, before training, the athlete went through a similar test using a spirometer and recording the results. Before training, the athlete was breathing at a rate of 11 min⁻¹ and a tidal volume of 0.55 dm³.

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- b) i) Calculate the percentage change in the athlete's ventilation rate over the 10 minutes and show your working.



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- ii) Suggest why the athlete has experienced a change in ventilation rate.

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- c) Describe the process of breathing in, in terms of the changes in the muscles of the rib cage and the diaphragm.



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- d) The doctor believes that altitude training may lead to an increase in ventilation rate. Suggest three changes which would be required to adapt the doctor's tests into a test of altitude training on ventilation rate.



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4. Agronomists carrying out agricultural research on plants have several advantages over animal subjects. It is quite easy to control environmental conditions and nutrients when doing so does not raise any ethical issues. Plants also have totipotent meristem cells that can become any other type of cell – this makes plants easy to clone, and easy to



Figure 3.1 – Cell undergoing mitosis

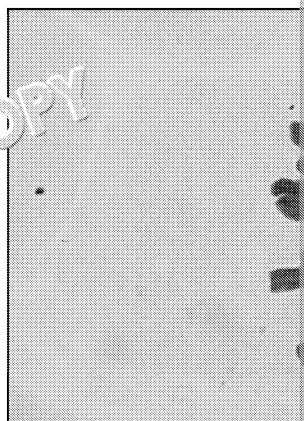


Figure 3.2 – Cell

- a) Figure 3.1 and Figure 3.2 show meristem cells in different stages of mitosis.
- i) Identify the stage of mitosis observed in each figure, by writing 'Figure 3.1' and 'Figure 3.2' in each in the table below.

Mitotic stage	Figure
Prophase	
Metaphase	
Anaphase	
Telophase	

Homeobox genes are highly active in meristem tissue, particularly at the tips of growing shoots.

- ii) Briefly describe the role of homeobox genes in complex organisms.

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- iii) How have homeobox genes been used to study relationships between different species?

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A non-governmental organisation (NGO) focusing on agricultural and economic development is interested in the growth of a variety of crop plants.

The organisation plans to create several genetically identical daughter plants to study how they can study rates of photosynthesis and growth under different conditions. The plants are cut into small pieces called explants, and any bacteria present are killed using antibiotics.

b) Describe how the explants are developed into multiple adult plants.

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The rate of photosynthesis affects the rate at which a plant produces and transports sugar. The rate at which sugar is transported can be an indicator of the rate of photosynthesis.

c)* Discuss how sugars are transported in higher plants, with reference to cell membranes and through vascular tissue.

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5. An investigation is taking place in a school classroom. The students are measuring the rate of respiration of a sample of bacteria.
- a) They grew bacteria from beneath the fingernails of one of the students in a culture of bacteria. The broth contained nutrients and respiratory substrate.

After one day of growing the bacteria in the broth, the broth was transferred to a respirometer as shown in **Figure 4**.

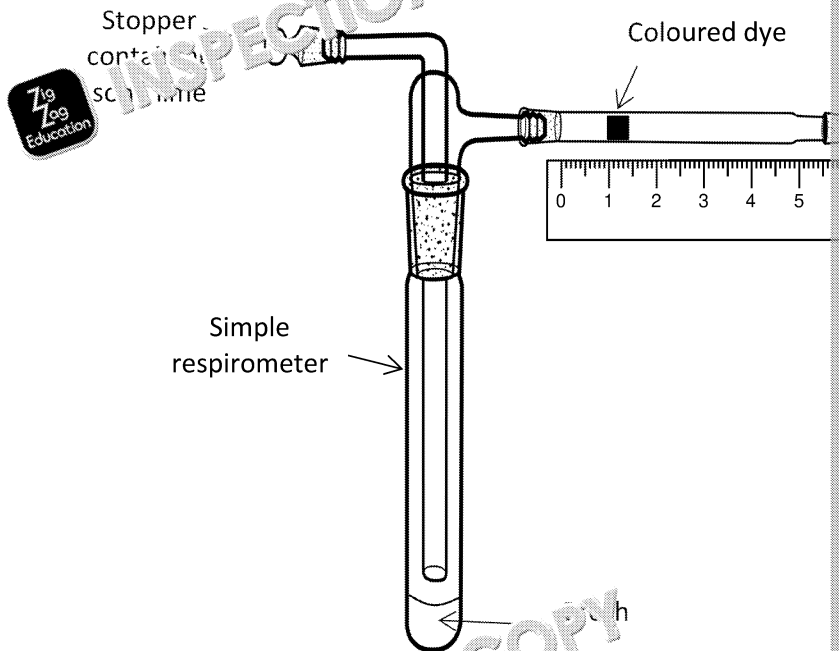


Figure 4

- i) Explain the function of the dye and of the soda lime in this respirometer.
- Dye:

Soda lime:

The students ensured that temperature was maintained throughout this experiment so that temperature could not affect the respiratory rate of the bacteria being investigated. They also controlled the pH of the broth. Specific broths are used for particular cultures of bacteria.

- ii) Suggest how the pH could be controlled during the experiment.
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iii) Lipids may be used as a respiratory substrate in place of glucose. The proportion of lipids in the broth might change the results of the experiment.

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A new experiment is performed, based on the experiment above, with the following conditions:

- A fresh culture of the fingernail bacteria and the broth is produced.
- The fresh culture is covered with a layer of sunflower oil to limit aerobic respiration.
- An identical experiment is performed alongside without sunflower oil.
- The stopper is replaced with a gas analyser that can quantify carbon dioxide production.
- Carbon dioxide release over the first four hours of the experiment is analysed.
- At the end of the experiment, the students autoclave all of the equipment.

b) The results of the data are shown in the graph, in **Figure 5** below.

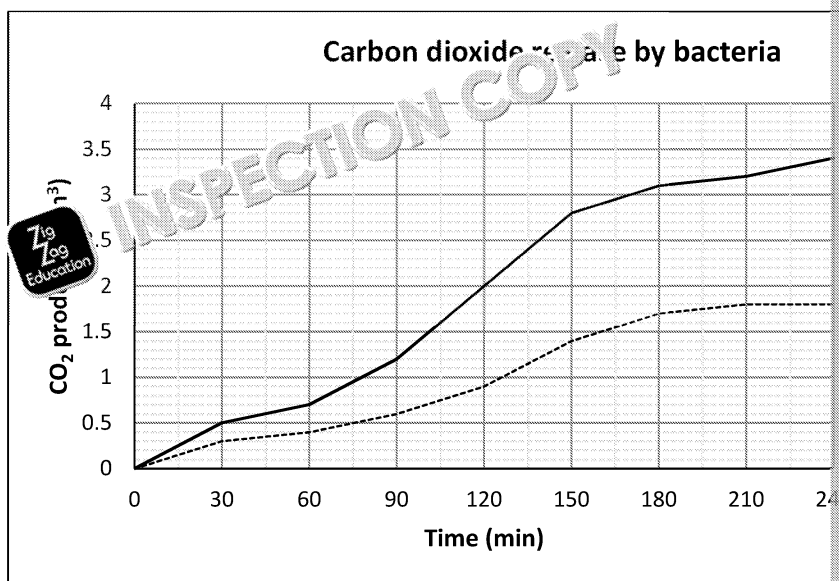


Figure 5

i) Calculate the average rate of respiration of the aerobic experiment.

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- ii) Give an example of a microorganism that is used in biotechnology both in the presence and absence of oxygen.

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- iii) Suggest a reason for the differences between the data produced by experiments.

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The student suggests that the amount of heat produced by the anaerobic tube is less than the amount of heat produced by the aerobic tube. The heat is a consequence of ATP production.

- iv) State why the student's assumption is not correct.

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- v) Explain why the equipment is autoclaved, despite the bacteria being on the hand.

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Practice Paper 3B

Question			Answer
1	a)	i)	(Influenza) virus ✓
		ii)	<p>Any THREE from:</p> <p>ADVANTAGES</p> <p>Can provide herd immunity ✓ with the vaccinating all people ✓</p> <p>Can target specific groups such as infants / older people / those with weak immune ✓</p> <p>DISADVANTAGES</p> <p>Virus mutates quickly, therefore, vaccine will become ineffective ✓</p> <p>Cannot design vaccine until virus has already spread to population ✓</p> <p>Expensive to develop/distribute ✓</p> <p>Time-consuming; allows virus to spread in the time ✓</p>
	b)	i)	<p>$2.5^n = x$, where $n =$ number of cycles and x is total number infected.</p> <p>$n = 12$</p> <p>$2.5^{12} = 3125 = 16$ birds</p>
		ii)	Actual number would be lower – as more birds are infected, chance of coming into contact with uninfected bird is lower
	c)	i)	<p>Scanning Electron Microscope / SEM ✓</p> <p>Magnification is at least 5,000x ✓ from light microscope / Light microscope resolution not high enough to produce clear image at this magnification ✓</p> <p>Three dimensional image is produced – characteristic of SEM but not TEM ✓</p>
		ii)	<p>Binary fission ✓</p> <p>Daughter bacteria are able to spread to both host daughter cells ✓</p>
2	a)	i)	<p>Any TWO from:</p> <p>Development of medicines/drugs ✓</p> <p>Understanding of disease processes ✓</p> <p>Understanding of complex biological processes ✓</p> <p><i>Any other suitable answer</i></p>

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Question		Answer
	ii)	<p>Any TWO from:</p> <p>Large amount of data is required to make predictions about epidemiology ✓</p> <p>Unethical to infect people in order to model disease ✓</p> <p>Model complex interactions under specific conditions, without influence from other systems ✓</p> <p>Allows long-term predictions to be made about disease patterns ✓</p>
	iii)	<p>✓</p>
	b) i)	<p>✓</p> <p>By vaccinating (a large number of the) population, transmission is reduced, protecting those not vaccinated ✓</p>
	ii)	<p>Any TWO from:</p> <p>Lack of trust in science ✓</p> <p>Concern over side effect ✓</p> <p>Concern over non-specificity ✓</p> <p>Vaccination programme is expensive ✓</p> <p>(Belief that) Money better spent elsewhere ✓</p> <p>(Belief that) vaccination causes disease ✓</p>
3	a)	<p>Transpiration is passive; does not use energy from ATP ✓</p> <p>As evaporation occurs from stomata, water is pulled up stem due to capillarity/cohesion ✓</p> <p>Water uptake in roots is active transport; ATP is used to transport ions into the xylem ✓</p> <p>Water follows by <u>osmosis</u> ✓</p>

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Question		Answer																								
b)	i)	<p>Must first calculate capillary tube cross-sectional area (csa) $csa = \pi r^2$ $d = 0.6 \text{ cm}$, so $r = 0.3 \text{ cm}$ $csa = \pi (0.3)^2 = 0.28 \text{ cm}^2 \checkmark$ $V = \pi r^2 \times \text{bubble movement}$</p> <table border="1"> <thead> <tr> <th>Time (s)</th> <th>Bubble movement (cm)</th> <th>Volume of water transpired (cm³)</th> </tr> </thead> <tbody> <tr><td></td><td>0</td><td>0</td></tr> <tr><td></td><td>2.0</td><td>0.56</td></tr> <tr><td>60</td><td>4.2</td><td>1.18</td></tr> <tr><td>90</td><td>6.3</td><td>1.76</td></tr> <tr><td>120</td><td>8.5</td><td>2.38</td></tr> <tr><td>150</td><td>10.5</td><td>2.94</td></tr> <tr><td>180</td><td>12.6</td><td>3.56</td></tr> </tbody> </table>	Time (s)	Bubble movement (cm)	Volume of water transpired (cm ³)		0	0		2.0	0.56	60	4.2	1.18	90	6.3	1.76	120	8.5	2.38	150	10.5	2.94	180	12.6	3.56
Time (s)	Bubble movement (cm)	Volume of water transpired (cm ³)																								
	0	0																								
	2.0	0.56																								
60	4.2	1.18																								
90	6.3	1.76																								
120	8.5	2.38																								
150	10.5	2.94																								
180	12.6	3.56																								
	ii)	<p>Transpiration in a plant cutting</p>																								
	iii)	<p>Rate of transpiration = $\frac{\Delta \text{ volume}}{\Delta \text{ time}}$ Rate = $\frac{3.56 \text{ cm}^3}{3 \text{ min}} = 1.19 \text{ cm}^3 \text{ min}^{-1} \checkmark$</p>																								

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Question		Answer	Ma										
	c) i)	<p>Reduced leaf size: Reduce <u>surface area</u> for water loss ✓ Thick waxy cuticle: Reduces water loss from the <u>upper</u> surface of the leaf, trapping it inside ✓</p>											
	ii)	<p><u>Continuous</u> variation – leaf size can take on any value within a range ✓</p>											
	d) i)	<p>Globular proteins (enzymes are globular proteins, with a 3D-shape active site (this is not the case for fibrous proteins) ✓</p>											
	ii)	<p>Fixes carbon by combining CO₂ with ribulose biphosphate ✓ Produces (unstable 6C compound which breaks down to form) two glycerate-3-phosphate molecules ✓</p>											
	iii)	<p>Expose plants to bright light for sufficient time (so that excess reduced NADP and ATP are produced) ✓ Move plants to dark chamber at specific temperatures, e.g. 15, 20, 25 °C; (this stops light-dependent reactions) ✓ Re-measure after fixed amount of time AND measure triose phosphate / glucose concentration (using a quantitative reagent) ✓ Plants at higher temperatures should produce more sugars, AND, therefore, have faster rate of light-independent reaction ✓</p>											
e)	i)	<table border="1"> <thead> <tr> <th>Project</th> <th>Type of conservation</th> </tr> </thead> <tbody> <tr> <td>Jaú National Park</td> <td><i>in situ</i></td> </tr> <tr> <td>Eden Project</td> <td><i>ex situ</i></td> </tr> <tr> <td>Millonario Seed Bank</td> <td><i>ex situ</i></td> </tr> <tr> <td>Kuru Natural Reserve</td> <td><i>in situ</i></td> </tr> </tbody> </table>	Project	Type of conservation	Jaú National Park	<i>in situ</i>	Eden Project	<i>ex situ</i>	Millonario Seed Bank	<i>ex situ</i>	Kuru Natural Reserve	<i>in situ</i>	
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	ii)	<p>Conservation is protection of an ecosystem by working with people who live or work on the land to manage/limit land use ✓ Preservation is protection of a fragile ecosystem by severely restricting/banning human land use / allowing land use for research purposes only ✓ Example of conservation (e.g. named national park / nature reserve / marine conservation zone.) AND Example of preservation (e.g. protected cave systems, Antarctica) ✓</p>											

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Question		Answer	M
4	a)	No markings on U-tube to measure the movement of the fluid ✓	
	b)	Use a flexible rule / string to measure distance of movement ✓ OR Measure volume of red fluid in U-tube after experiment ✓	
	c)	Mitochondria for ATP production for muscle contraction ✓ Tracheoles provide oxygen for respiration ✓	
	d)	β 1-4 linkage between monomers / units / glucose	
	e)	<p>Level 3 (5–6 marks) A clear, thorough explanation of carbon movement in digestion and respiration, showing attention to detail. Well-constructed explanation with relevant and correct information. Terminology is consistent and correct.</p> <p>Level 2 (3–4 marks) A partial explanation of carbon movement in digestion and respiration, including the breakdown of cellulose and respiration of glucose. Information given is mostly relevant and correct. The answer is in a logical order, but points may not be linked and sometimes lack detail. Terminology is mostly consistent and correct.</p> <p>Level 1 (1–2 marks) An attempt at explaining carbon movement in respiration, with general information provided but answer lacking detail. The explanation is limited and incomplete, and may include confusion or errors. Some relevant information is presented, but some is lacking. Terminology is inconsistent or incorrect.</p> <p>0 marks No response or no correct points in response.</p>	
	f)	$3.00 \text{ g} = 0.003 \text{ kg}$ $92.00 \times 0.003 = 0.276 \checkmark$ $0.276 \times 3.00 = 0.828 \checkmark$ $0.828 \times 1000 = 828 \text{ mg} \checkmark$	

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Question		Answer
	g)	<p>Any THREE of:</p> <p>Ethically questionable to starve locust AND use strict ethical control of animal ✓</p> <p>Still not quantitative / only semi-quantitative AND make measurements with ruler / measuring tube ✓</p> <p>Only a single locust so cannot be statistically analysed AND use more locusts ✓</p> <p>Only a single replicate measurement increase uncertainty / risk of error AND perform more repeats of experiment ✓</p> <p>Locust may move around rapidly for short bursts, using variable amounts of energy, which would skew results AND use slow-moving animal ✓</p> <p>Leaves on tubes may cause air to escape, introducing error AND seal all tubes to stop air escaping ✓</p> <p>Temperature not controlled, and temperature can affect respiration rate AND allow temperature to stabilise / use waterbath ✓</p>
5	a)	<p>i) Heartbeat = 1.45 s</p> <p>Beats per minute = $\frac{60}{1.45} = 41.3$ ✓</p> <p>Pressure = 1.2 kPa</p>
		<p>ii) Cardiac output = stroke volume × heart rate</p> <p>Stroke volume = $\frac{\text{cardiac output}}{\text{heart rate}}$</p> <p>Stroke volume = $\frac{3.3 \text{ dm}^3 \text{ min}^{-1}}{41.3 \text{ min}^{-1}} = 0.08 \text{ dm}^3$ ✓</p>
		<p>iii) Scatter graph ✓</p>



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Question		Answer	M
	b)	<p>Level 3 (5–6 marks) A detailed, well-constructed description of how adrenaline interacts with the nervous system and how heart action is coordinated. Topics are clearly linked together to provide a holistic explanation. Terminology is consistent and correct.</p> <p>Level 2 (3–4 marks) A substantial description of how adrenaline interacts with the nervous system and how heart action is coordinated. Several concepts or stages are explained but are not fully linked together. Terminology is mostly consistent and correct.</p> <p>Level 1 (1–2 marks) A limited and incomplete effort which partly explains why adrenaline affects the heart or how heart action is coordinated. Terminology is inconsistent or incorrect.</p> <p>Level 0 (0 marks) None of the above is more worthy of a mark.</p>	

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