Zig Zag Education

Biology

A Level | OCR A | H420

Practice Exams for A Level OCR Biology A

Paper 2: Biological Diversity

Update v1.3, June 2024

zigzageducation.co.uk

POD 7602

Contents

Teacher's Introduction

This pack contains four Practice Paper 2s 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, 25 September 2017
Paper 2A, Question 1 on pages 5, 81 and 130 – option B in the question and answer has been changed to '4.9 μm'.
Paper 2B, Question 21 b) ii) on page 145 – correction has been made to the marking guidance and the answer.

Update v1.2, 20 September 2018
Paper 2A, Question 17 c) ii) on page 132 – correction has been made to the working and final answer of the chi-squared value.

Update v1.3, 5 June 2024
Changes have been made to reflect the 2023 accessibility and clarity amendments to the specification (and the specification cross-reference table on pages 2-3 has been updated where appropriate):
Paper 2A, Question 17 c) ii) on pages 14, 87 and 132 and Paper 2D, Question 17 c) ii) on pages 68, 123 and 157 – the chi-squared formula has been updated
Paper 2B, Question 5 on pages 26 and 95 – statement 2 amended to focus on T killer cells
Paper 2C, Question 7 on pages 45, 108 and 146 – question on synthetic biology replaced with one on enzymes
Paper 2D, Question 8 on pages 63, 120 and 155 – question on Galapagos Islands replaced with one on competition
Paper 2D, Question 9 on pages 63, 120 and 155 – question on immobilised enzymes replaced with one on co-factors

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			**7**	**9, 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, 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**	**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

A Level Biology

Biological Div[illegible]

Pra[illegible] Paper 2A

Name	

Time allowed
2 hours 15 minutes

Instructions
Answer **all** of the questions and use the space provided.
Use black ink.
You may use an HB pencil for graphs and diagr[illegible]
You will need a ruler.

Information
The total mar[illegible] for this paper is **100**.
The [illegible] for each question are shown in square brackets [ ].
Use o[illegible] electronic calculator is permitted.

Section A

1. An eyepiece graticule and a stage micrometer are used to calibrate a mic

   On the eyepiece graticule, 35 divisions align with 17 divisions of the stage micrometer is 10 micrometres in width.

   Calculate the value of one eyepiece divisio

   A 0.02 µm
   B 4.9 µm
   C m
   D m

   Your answer ☐

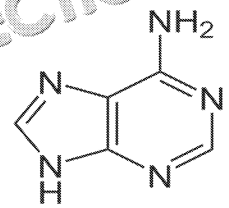
2. The process of creating and splitting organic polymers involves hydrolysi
   Which statement correctly describes this process?

   A Adding a monomer to a polymer chain usually involves hydrolysis, u
   B Adding a monomer to a polymer chain usually involves condensatio
   C Adding a monomer to a polymer chain usually involves hydrolysis, re
   D Adding a monomer to a polymer chain usually involves condensatio

   Your answer ☐

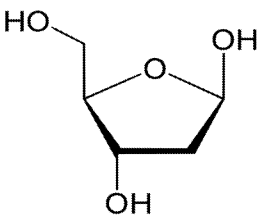
3. Which image below shows the st of a purine?.

   A



   B

   C



   D

   Your answer ☐

4. The cell surface membrane has many roles.

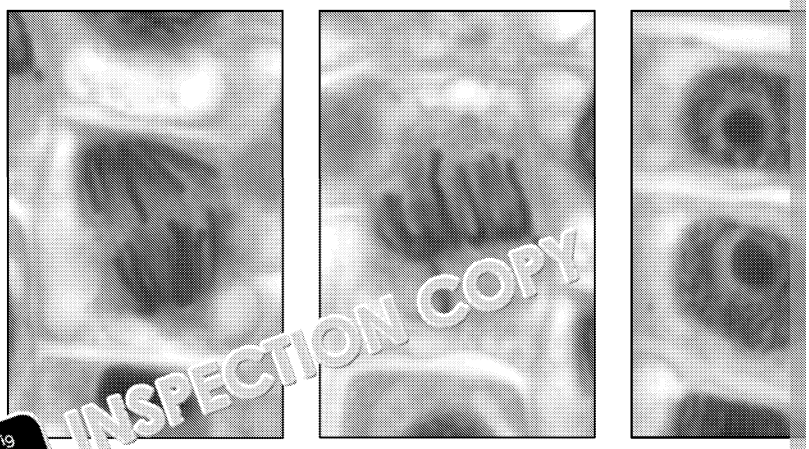
Which of the following statements about the role of the cell surface mem

Statement 1: Site of hormone binding
Statement 2: Site of drug binding
Statement 3: Site of protein synthesis
Statement 4: Site of antigen presentation

A Statements 1, 2 + 3
B Statemen[illegible]
C [illegible]ts 1, 2 + 4
D [illegible]ement 3 only

Your answer ☐

5. Which of the following best describes the stages shown in the images be



A	Prophase	Cytokinesis	Metaph
B	Anaphase	Metaphase	Propha
C	Anaphase	Cytokinesis	Anapha
D	Metaphase	Prophase	Anapha

Your answer ☐

6. Which method is **not** a primary plant defence against infection?

A Producing chitinase to break down the cell walls of fungi growing o
B Producing callose and depositing it in phl[illegible]d plates to prevent
C Producing chemicals which break dow[illegible]orm cyanide.
D Producing T-cytotoxi[illegible]dentify and destroy invading pathoge

Your answer ☐

7. Which of the following statements about levels of biodiversity are true?

Statement 1 – Biodiversity can be measured at a habitat, species or gene
Statement 2 – Biodiversity only occurs where animals are present in a re
Statement 3 – Greater biodiversity means that population sizes of specie

A Statement 1 only
B Statements 1 and 2 only
C Statements 2 and 3 onl
D All statement

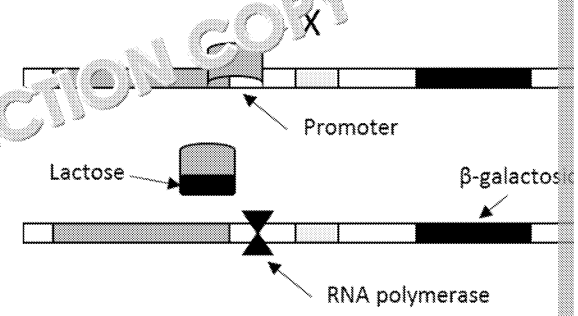
Yo ver

8. Which of the following does not provide support for the theory of evolut

A Evidence that many diverse species use similar enzymes for similar f
B Evidence that the skull of vertebrates shows similarity across the cla
C Evidence of fossils with similar body shape across millions of years.
D Evidence that bacteria existed 3.5 billion years ago.

Your answer

9. The lac operon is shown in the figure below.



Identify the component labelled X.

A Regulator
B Repressor
C Operon
D Cyclic AMP

Your answer

10. Which statement correctly d ib **terminator bases** that are used in D

A A radioac ly la elled nucleotide which is attached to the last ami
B el nucleotide which causes a polymerase enzyme to bind to
C belled nucleotide which causes DNA polymerase to detach from
D A series of nucleotides which causes the fragmentation of a DNA mo

Your answer

11. Many plants can reproduce by vegetative propagation (natural cloning).

Why might a plant benefit from cloning rather than performing sexual r

A Cloning produces viable individuals from only one parent plant.

B Cloning produces populations with a high degree of variation.

C Cloning produces plants that are able to adapt quickly to environm

D Cloning allows selection of useful traits and selection against less u

Your answer ☐

12. Se ry productivity is essential in agriculture, where primary consu ef as possible.

Which of the following statements describe actions taken by farmers to

Statement 1 – Treat all animals with antibiotics to reduce loss of energy

Statement 2 – Select for animals with fastest possible growth rate.

Statement 3 – Slaughter older cows, as these animals are inefficient.

A Statement 1 only

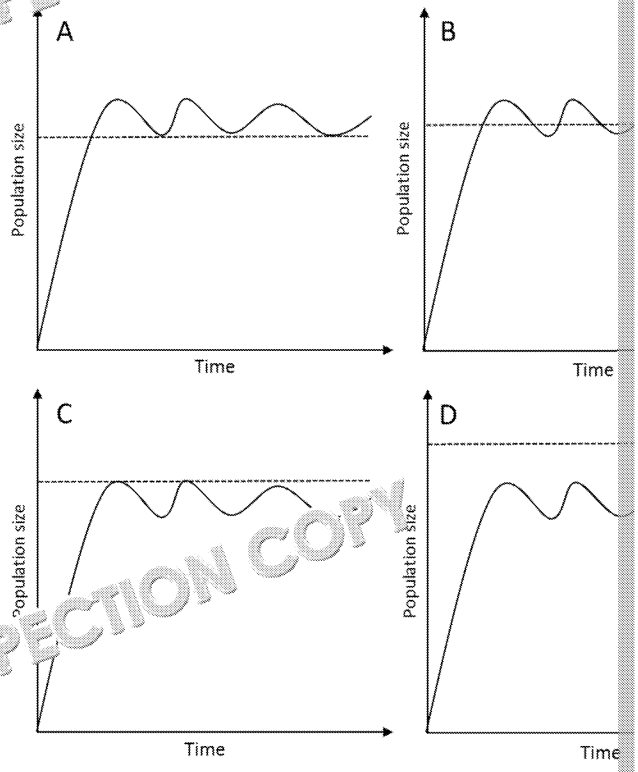
B Statements 1 and 2 only

C Statements 2 and 3 only

D All statements are true

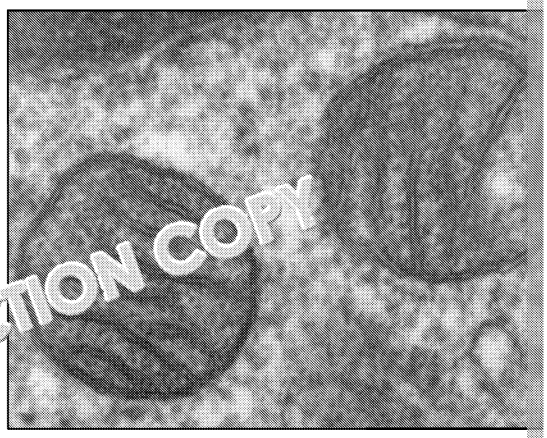
Your answer ☐

13. Which graph best repre nt arrying capacity of an ecosystem?



Your answer ☐

14. Identify the cell organelles shown in the electron micrograph below.



A Chloroplasts

B Rough endoplasmic reticulum

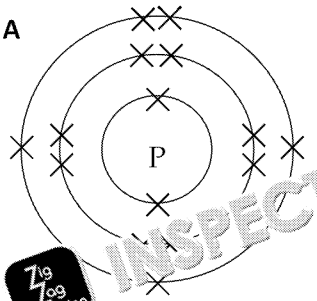
C Mitochondria

D Nuclei

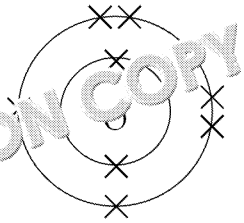
Your answer ☐

15. Which atom is not found in the double helix structure of DNA?

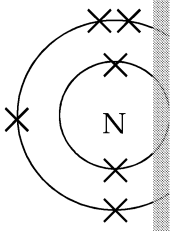
A



B



C



Your answer ☐

Section B

16. An evolutionary arms race exists between disease-causing organisms a

The Ebola virus caused widespread death during an outbreak in 2014. T
Prior to this, it was hypothesised to affect wildlife populations only, wit
defend against the virus. Mutations in the gen e of the virus caused t

a) Ebola is one of many emer s eases caused by pathogens arou

i) Defin pathogen'.

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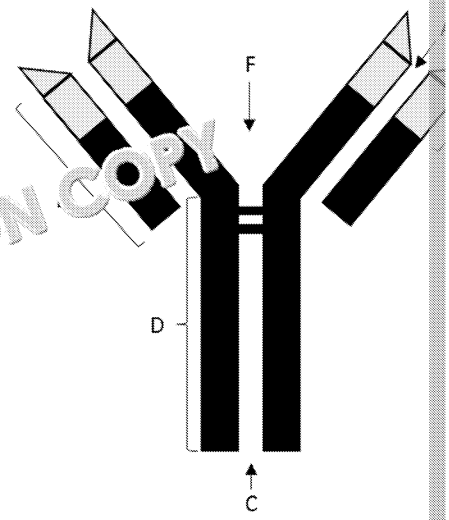
Antibodies to the Ebola virus were identified in a small population
the virus. The figure below shows the structure of an antibody.



ii) Using the labels above, complete the table:

Description	
Region that is the same in every antibody	
Region that binds to a recepto	
Region th an antigen	
gion that is different in every antibody	
Region that is referred to as a 'light chain'	

Upon binding to an antigen, antibodies protect the body in various

iii) Suggest **three** ways in which antibodies work to protect the bo

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Antibodies can be described as a tertiary response to an infection.

iv) Give an example of a primary non-specific and a secondary no example protects against infection.

Primary: .....

Method: .....

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Secondary: .....

Method: .....

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b) The image in Figure 1 shows a blood sample, with red blood cells a Lymphocytes are essential in the immune response to Ebola.

The image represents a volume of 0.003 µL.

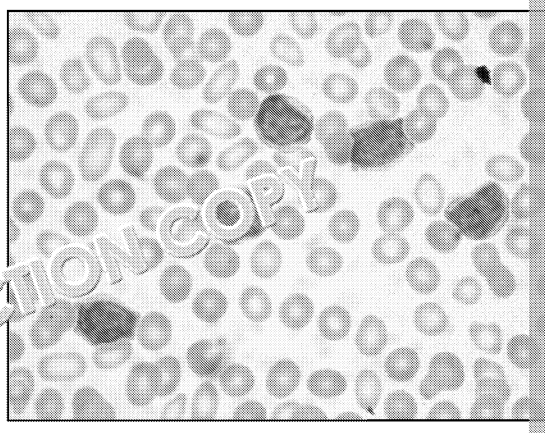

Figure 1

Calculate the number of lymphocytes present in 1 µL of blood. Giv
figures.

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17. Pigmentation is a term used to describe the coloration of the body, incl
skin. In some organisms, such as the fruit fly (*Drosophila melanogaster*)
pigmentation of the eye. The gene is X-linked. As a result, fruit fly eye c
inheritance across a small population or to test the effects of mutations
observed.

a) The gene which controls eye pigmentation in *D. melanogaster* has t

- X_R (dominant, red eyes)
- X_r (recessive, white eyes)

i) What term describes the system for naming a species, such as

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The gene is sequenced [illegible] researchers. Part of this sequence reads
be used to det[illegible]e the expected amino acid sequence using am
one sh[illegible]igure 2. To use this wheel, read outwards from the c

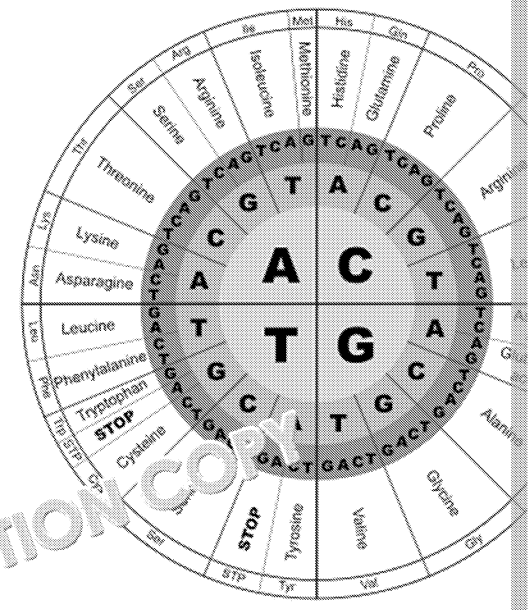

Figure 2

ii) Using the information in Figure 2, state the amino acid sequen

.....

One method of gene sequencing involves breaking DNA molecules
electrophoresis to move the DNA fragments through an agarose ge
Sanger in the approach to gene sequencing that came to bear his n

iii) What factor determines how far each DNA fragment moves th

.....

b) With reference to the stem of this question, state whether these st
flies are correct, and explain your answers.

'A male fly cannot pass on an allele for white eyes to its son.'

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ii) *'A female fly with red eyes will always produce daughters with*

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c) Researchers studying fruit flies know that the gene **al** is located on
A and *a*. This gene controls whether or not fruit flies develop ante

- Individuals with genotype *AA* or *Aa* develop antennae.
- Individuals with genotype *aa* do not develop antennae.

i) Suggest how a mutation can give rise to an allele, such as *a*.

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The researchers think they have discovered a new trait controlled b

- Individuals with genotype JJ or Jj have five-jointed legs.
- Individuals with genotype jj have seven-jointed legs.

They want to find out if the new gene is also found on chromosome
two doubly heterozygous (*AaJj*) flies, producing the offspring shown

Phenotype	N mber of individuals (actual)
Antennae, five-join ed l s	89
No anten w jointed legs	17
nn e, seven-jointed legs	9
antennae, seven-jointed legs	13

Table 1

ii) Carry out a chi-squared test on the results.

Use the formula: $\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$

χ^2 = ...

	Chi-squared Distribution				
Degrees of Freedom	**Critical Value**				
	0.99	**0.975**	**0.95**	**0.9**	**0.1**
1	0.000	0.001	0.004	0.016	2.706
2	0.020	0.051	1	0.211	4.605
3	0.115	0 5	0.352	0.584	6.251
4	( )	0.484	0.711	1.064	7.779
5	0.554	0.831	1.145	1.610	9.236

Table 2

iii) Using information from **Table 2**, explain whether the gene is o

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18. W... p and domesticated sheep belong to the same species, *Ovis a*... free, controlled movements during their lives, they belong to the taxono...

a) All biological organisms can be classified according to this system, f... the 1740s.

i) What taxonomic level does the group Animalia belong to?

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ii) Organisms may also be classified using the domain system. W... belong to?

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iii) Give one exam... molecular biology has led to change... Explai... er.

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b) Wild sheep range in body weight, with some sheep being heavier t... environmental factors affect body weight. Within the range, a she...

i) What name is given to this type of variation?

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ii) Give an e... e ... biotic environmental factor which might ...

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The data below shows body weight for a sample of 12 wild sheep.

Sheep weight (kg)
62.1
51.8
46.2
[illegible]7
52.2
63.7
59.4
48.3
61.9
67.9
50.0
55.2
Mean = 56.2

iii) Calculate the standard deviation of this sample.

The equation is given below:

$$s = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n - 1}}$$

Standard deviation: .....

iv) With reference to selection pressures, explain why most sheep [illegible] most of the time.

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c) Humans have bred many varieties of domesticated sheep through a
be considerably heavier than wild sheep, with more muscle mass an

i) Explain how this process may have occurred.

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ii) Some people argue that artificial selection is unethical because
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Evaluate the arguments against artificial selection, suggesting p
arguments.

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19. A population of bacteria is being grown in a laboratory. The species bein
colonies with a yellow-cream appearance. Upon close inspection, one co
with fuzzy borders and a light red colour.

A bacteriologist isolated DNA from the normal (Pt.C1) and the new (Pt.C2
sequencing.

A part of the sequence generated by his result[illegible]h colony is shown

Colony	Sequence
Pt.C1	CTGATCGGC
Pt.C2	ACATGCTGATCGGC

Table 3

a) Identify the type of mutation identified in the Pt.C2 colony.

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Gel electrophoresis was performed, and the trace is shown in Figure
DNA weights (measured in base pairs, bp).

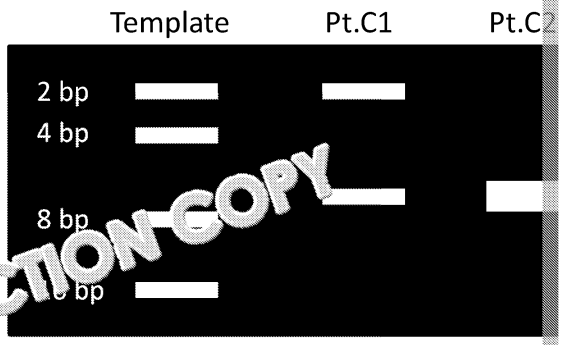

Figure 3

b) Explain the function of a restriction endonuclease and how it likely c

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20. Surtsey is an island formed by volcanic activity off the coast of Iceland. T
1963 and 1967. During its early existence, the island was bare of life, bu
of colonisation. The island is currently being surveyed by ecologists in o
the island.

In a region of the island, the plant life was measured, and the populatio

Species	Number
Sali[illegible]folia	3
[illegible]nkenya peploides	144
Leymus arenarius	120
Mertensia maritima	21

Table 4

a) Calculate Simpson's index of diversity for the region examined.

The formula is given below:

$$D = 1 - \Sigma\left(\frac{n}{N}\right)^2$$

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b) [illegible]e biotic and abiotic factors, and for each type of factor, give an
[illegible]odiversity of the island.

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The establishment of biological organisms on th[illegible]nd is an indicator o
pioneer species was *Leymus arenarius*.

c) Explain why *Leymu[illegible]* is not more widely represented on t

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The island being studied has a lava stream which flows from the volcano

The ecologists aimed to determine the effect the lava stream had on the

d) Outline an experimental protocol the ecologists could use.

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21. Bacterial infections are commonplace in hospitals across the world. In o bacterial infection, a medic must ensure the correct bacterial strain has b medication that will be best placed to treat this strain.

a) A particular strain of a bacterium is isolated fr. a patient. The bac Paper discs of antibiotic are applied o t e h, according to standa from the test are shown in Fe 1.

Bacterial

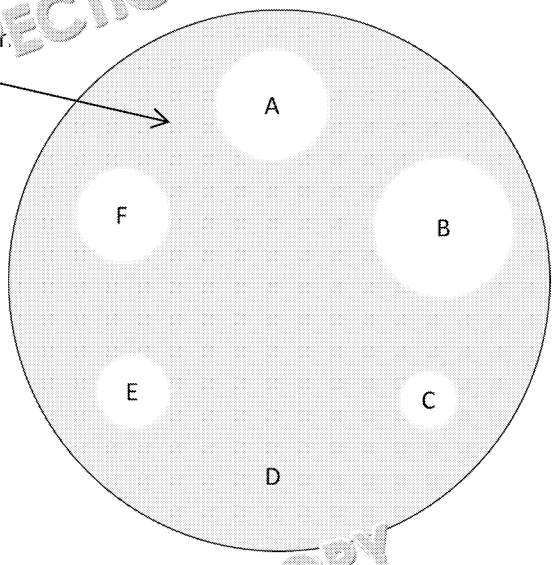

Figure 4

The technician l et up the agar plate applied each antibiotic disc and di e he forceps after applying a single antibiotic.

Explain why the forceps were only used once.

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The results determined that the bacterium belonged to a harmless s
life. In spite of this, the plate was still autoclaved and disposed of s

ii) Suggest the reason for the careful disposal of the bacterial col

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The tec[illegible] reported that $\log_{10}$ of the reduction was 6.8.

Calculate the true reduction in the number of bacteria.

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iv) Calculate the original number of bacteria present in the cultur
your answer as $\log_{10}$ of the number of bacteria.

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b) An incubat[illegible] that used in the laboratory is used to grow b
in producing bacteria are grown in batch fermenters such as th

i) Evaluate the use of this technique, explaining why a batch ferm
this case.

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A technician wants to systematically reduce the number of bacteri

ii) Name the process used to create several mixtures, each conta
and suggest the steps needed to produce a broth containing 1
1×10^7 bacteria.

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22. a) Figure 5, below, shows the decomposition of a tomato. Tomatoes a
water and high sugar content. The second tomato in the image ha
its being refrigerated.

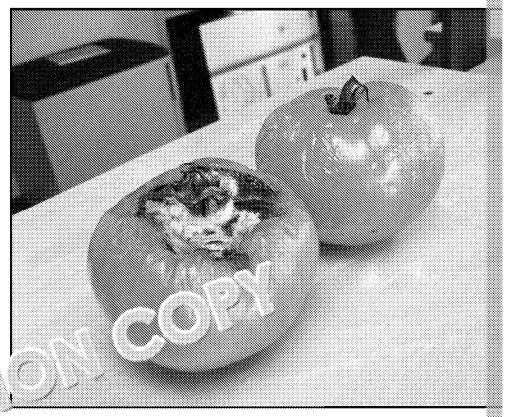

Figure 5

i) State the location of enzyme activity responsible for saprobiot

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Decomposition is an essential process in order to recycle nutrients

ii) Outline how fungi lead to the availability of nitrogen compoun

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As well as fungi, multiple bacteria are involved in the decompositio
the release of nitrogen compounds to the environment.

iii) Give an example of a bacterial species that contributes to nitro

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b) Despite their roles in decomp[illegible]io[illegible]many microorganisms play a v

State one use [illegible]rganisms in the food industry, naming a mic

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.....

Microorganism: .....

.....

[TOTAL 100 MARKS]

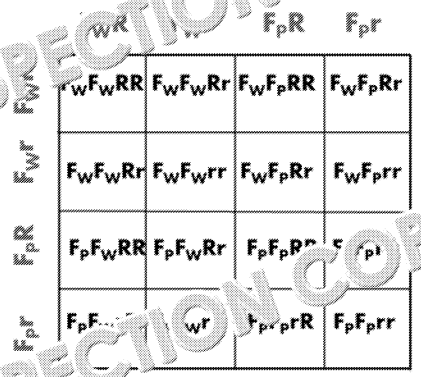
Preview of Questions Ends Here

Practice Paper 2B

Section A

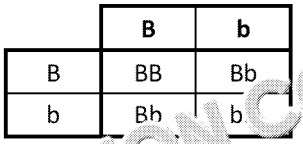
Question	Answer	Marks
1	C	
2	B	
3	D	1
4	B	1
5		1
6		1
7	A	1
8	C	1
9	B	
10	B	1
11	D	1
12	A	1
13		1
14	B	1
15	B	1

Section B

Question			Answer
16	a)	i)	Opportunistic sampling ✓
		ii)	Scientists want a range of plants, but do not need representative sample. ✓
		iii)	All white flowers with round petals. ✓
		iv)	Allele for round petals is dominant over heart-shaped petals. **OR** Allele for heart-shaped petals is recessive to round petals. ✓ Alleles for purple and white flowers are codominant. **OR** Both purple and white flower alleles expressed in heterozygote. ✓
		v)	 Three: white; one heart-shaped, white; six round, patched; two heart-shaped, patched; round, purple; one heart-shaped, purple ✓
	b)	i)	1: c) – Add an excess of nucleotide bases (A, G, C and T). 2: b) – Increase the temperature to between 90–95 °C to break hydrogen bonds. 3: d) – Set the PCR machine temperature to between 55–60 °C to allow primers to bind to DNA. 4: a) – Set the temperature to 72–75 °C – the optimum temperature for DNA polymerase to function.

Question			Answer
		ii)	Plant 1 and Plant 4. ✓ Bands of DNA fragments produced by offspring plant all match bands produced by either Plant 1 or Plant 4. ✓ Suggests that these two plants have each passed on half of their genetic material (to the offspring plant). ✓
	c)	i)	This process is known as artificial selection. ✓ Plants with large and elaborate flowers were selected and cross-pollinated to create many offspring. ✓ (Offspring plants with large flowers crossed to produce more offspring.) Over time selected for alleles which cause large flower size increasing in frequency in the (wild) population. ✓
		ii)	Location where seeds of rare/valuable plants are stored ✓ to preserve genetic diversity **OR** as a genetic resource to protect genetic information about plants **OR** to preserve rare alleles. ✓
17	a)	i)	Indirect transmission ✓ Droplet transmission ✓
		ii)	Bacteria (to treatment with antibiotic) ✓
		iii)	Weaker attenuated strain of bacterium, with small amount of safe antigen. ✓ Primary immune response triggered; body produces memory cells and antibodies. ✓ Secondary immune response is triggered following reinfection.
	b)	i)	General decrease in flu deaths over time / rose to show much greater survival from flu ✓ Many peaks and troughs, likely indicating seasonal variation / new strains developing ✓
		ii)	Receptors on the for antigens. ✓ Has an complementary sites / unique sites that recognise possible antigens. ✓
		iii)	Viruses have genetic material, which can be sequenced. New drugs created which target the viral genome / damage viral RNA / stop replication of the virus / stop the virus producing essential proteins. **OR** Viral strains can be quickly identified. Allows rapid, appropriate treatment / production of vaccines; may prevent pandemics.

Question			Answer
	c)		**Level 3 (5–6 marks)** A detailed, well-constructed answer which includes clear, relevant and correct information about the difficulties encountered in vaccine development and vaccination. *Several different issues with developing and implementing a vaccination programme are considered and linked together. One or more specific examples used. Both pathogenic and human factors are discussed.* **Level 2 (3–4 marks)** A considerable effort to explain the difficulties encountered in vaccine development and vaccination. *Different issues with developing and implementing a vaccination programme are considered but not fully linked. Both pathogenic and human factors are discussed. Information is mostly clear and correct.* **Level 1 (1–2 marks)** Some effort to explain failures in vaccination programmes. *Issues are briefly described but are not explained in detail, and some incorrect information is given. The answer includes either pathogenic or human factors, but not both.* **0 marks** No response or no relevant points in response.
18	a)	i)	<table><tr><th>Rank</th><th>Classification group</th></tr><tr><td>Kingdom</td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td>Heliconius</td></tr><tr><td></td><td>erato</td></tr></table>

Question			Answer
		ii)	Two heterozygous parent butterflies may each carry one copy of the recessive allele. ✓ May each pass that copy on to their offspring due to random fertilisation (creating an offspring with two recessive alleles). ✓ 
		iii)	Populations become reproductively isolated by their choice of mates. ✓ Over time, mutations / genetic drift cause populations to become more genetically different. ✓ Eventually populations so different they undergo sympatric speciation / can no longer produce fertile offspring (and are considered separate species). ✓
	b)	i)	A large number of genes act on fur length / fur length is a polygenic trait. ✓
		ii)	Minimum/average temperature in winter; seasonal variation in temperature; any other sensible answer. ✓
		iii)	Rising Arctic temperatures could cause animal with very long fur to overheat / these animals are wasting energy on reproduction. ✓ These animals are at a selective disadvantage / will have lower reproductive success. ✓ Over time mean fur length is likely to decrease. ✓
	c)		Strong positive relationship between Arctic fox activity and lemming population. ✓ When lemming population is high, Arctic fox activity increases (i.e. 1996, 1999). ✓ Arctic fox productivity reaches maximum every 3–4 years suggesting cyclical pattern. ✓ However: Sometimes Arctic fox productivity increases when lemming population remains very low or falls, i.e. 2001, 2006. ✓ Activity doesn't necessarily improve population size. ✓ Some other factors such as climate, could cause both populations to rise and fall in size. ✓

Question			Answer
19	a)		**Award 2 from techniques and 2 from reasons** **Techniques** • wash hands and clean work area ✓ • use disinfectant ✓ • sterilise the agar gel by heating in autoclave to 121 °C ✓ • use Bunsen burner to make air around Petri dish rise ✓ • if possible, keep lid partially on Petri dish when seeding/streaking/spreading specimen ✓ • replace lid as soon as specimen has been placed on the agar gel ✓ **Reasons** • reduces environmental microorganism count ✓ • stops airborne microorganisms/spores landing ✓ • kills bacteria and fungal spores ✓ • reduces risk of microorganisms on hands/gloves colonising ✓ • reduces risk of microorganisms from environment entering dish ✓
	b)		Fourth dilution = 450 Dilution factor = 15^x Dilution factor of fourth dilution = 15^4 ✓ Cell count = 0 × 15 ✓ O.C.C = 2250 ✓ In standard form = 2.3×10^6 ✓
	c)		The data could be presented in the form of a log graph Would make lower values identifiable / provide view towards larger values / allows individual values to be readable for earlier first 14 hours.
	d)		Apoptosis is the programmed death of cells when they are damaged / compromised by pathogens / not required Allows tissue used as a framework during development to be destroyed, i.e. connective tissue between fingers. **OR** Cells infected by viruses may die to reduce replication and transmission. **OR** Cancerous cells may die within a tumour.

Question			Answer
20	a)		<table><tr><th>S. aureus</th><th>Human skin cell</th></tr><tr><td>Murein/Peptidoglycan ✓</td><td></td></tr><tr><td>Circular molecule, free in cytoplasm ✓</td><td></td></tr></table>
	b)		Genetic diversity = $\frac{\text{Polymorphic loci}}{\text{Total loci}}$ GD = 94,600 / 28,000,000 GD = 0.0337 = 3.4
	c)		**Level 3 (5–6 marks)** A clear, thorough explanation of the evolution and spread of antibiotic resistance, and two or more approaches to reduce the risk of epidemics. *A well-constructed and detailed step-by-step explanation with relevant and correct information. Approaches to reducing risk are both outlined and correctly explained.* **Level 2 (3–4 marks)** A considerable effort to explain the evolution and spread of antibiotic resistance and at least one approach to reduce the risk of epidemics. *A good explanation, with relevant and correct information, but lacking one or two important details. Approaches to reducing risk are outlined, but may not be sufficiently explained.* **Level 1 (1–2 marks)** Some effort to explain the evolution and spread of antibiotic resistance. *The explanation is incomplete and includes some incorrect information. Approaches to reducing risk are vague (e.g. 'keep hospitals clean') or absent.* **0 marks** No response or no correct points in response.
21	a)	i)	Pioneer species ✓

Question			Answer
		ii)	Further from the coast, dead plant matter has decomposed to create more nutrient-rich soil. In these conditions, marram grass is less well-adapted / other plants are better adapted / marram grass is outcompeted by plants which are better adapted.
	b)	i)	Use a belt transect instead of a line transect; this method works better for investi… how … ecosystem changes over distance.
		ii)	0.64 **(** **OR** … 5415 ✓✓✓
		iii)	Cannot be confident of biodiv… y in … at 5 without performing experiment ✓ Biodiversity may be hi… e. … at 3 due to environment being in flux – many niches allow hi… nge … s ✓**OR** Climax community sometimes has lower biodiversity due t… ec… being dominant. ✓