

Biology A (Salters Nuffield)
Advanced
PAPER 1: The Natural Environment and
Species Survival

Total Marks

Wednesday 5 June 2024 – Afternoon

Time: 2 hours

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

**Calculator, ruler,
writing and drawing equipment**

YOU WILL BE GIVEN

Diagram Booklet

INSTRUCTIONS

Answer ALL questions.

**Show all your working out in
calculations and include units
where appropriate.**

**Answer the questions in the spaces provided
in this Question Paper or in the separate
Diagram Booklet – there may be more space
than you need.**

INFORMATION

The total mark for this paper is 100.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

You may use a scientific calculator.

In questions marked with an **ASTERISK (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.**

There may be spare copies of some diagrams.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

- 1 Silver Springs is an ecosystem in Florida.

Energy flow through this ecosystem has been studied.

The value for the light energy entering this ecosystem is $7\,112\,800 \text{ kJ m}^{-2} \text{ yr}^{-1}$

The gross primary productivity (GPP) for this ecosystem is $87\,069 \text{ kJ m}^{-2} \text{ yr}^{-1}$

The value for respiration (R) in this ecosystem is $55\,195 \text{ kJ m}^{-2} \text{ yr}^{-1}$

(continued on the next page)

1 continued.

**(a) (i) Which of the following is the correct value for the net primary productivity (NPP) in this ecosystem?
(1 mark)**

☐ **A 7 025 731 kJ m⁻² yr⁻¹**

☐ **B 697 036 kJ m⁻² yr⁻¹**

☐ **C 142 264 kJ m⁻² yr⁻¹**

☐ **D 31 874 kJ m⁻² yr⁻¹**

(continued on the next page)

Turn over

1(a) continued.

- (ii) Look at the table for Question 1(a)(ii) in the Diagram Booklet. It shows some information on trophic levels in this ecosystem.**

Calculate the percentage of the total light energy entering this ecosystem that is fixed as biomass in the primary consumers.

**Give your answer to two significant figures.
(2 marks)**

_____ %

1 continued.

**(b) Describe the role of mineral ions in the production of plant biomass.
(3 marks)**

Answer space continues on the next page.

Turn over

1(b) continued.

(Total for Question 1 = 6 marks)

Turn over

- 2 Anthropogenic activities are increasing levels of carbon dioxide in the atmosphere.**

An increased level of carbon dioxide in the atmosphere leads to an increased rate of photosynthesis in some plants.

- (a) Describe how carbon dioxide is used in photosynthesis.
(4 marks)**

Answer space continues on the next page.

2(a) continued.

(continued on the next page)

Turn over

2 continued.

(b) The effect of increasing carbon dioxide concentration on photosynthesis in soya bean plants was investigated.

- **Young soya bean plants were placed in six containers**
- **The air in each container had a different concentration of carbon dioxide**
- **After 34 days, samples of the leaves were weighed**
- **The mean dry mass per unit area of leaf was recorded**

Look at the table for Question 2(b) in the Diagram Booklet. It shows the result of this investigation.

(continued on the next page)

2(b) continued.

- (i) Which of the following describes the relationship between the increase in carbon dioxide concentration and the change in dry mass?
(1 mark)**

- ☐ **A exponential**
- ☐ **B negative correlation**
- ☐ **C positive correlation**
- ☐ **D no correlation**

(continued on the next page)

2(b) continued.

- (ii) The measurements were repeated at each concentration to calculate the mean and standard deviation.**

**Which of the following statements explains why this is carried out?
(1 mark)**

- ☐ **A to carry out chi-squared analysis**
- ☐ **B to determine the repeatability of the measurements**
- ☐ **C to improve the accuracy of the measurements**
- ☐ **D to increase the validity of the measurements**

(continued on the next page)

Turn over

2 continued.

(c) Enzymes catalyse some of the reactions involved in photosynthesis.

**Explain why an increase in carbon dioxide concentration above 1000 ppm may not increase the rate of photosynthesis.
(3 marks)**

Answer space continues on the next page.

Turn over

2(c) continued.

[illegible]

(Total for Question 2 = 9 marks)

Turn over

- 3 New drugs are tested in clinical trials before they can be used in treatments on patients.**

One of the first people to isolate and test a drug was William Withering.

- (a) Give the name of the drug he tested.
(1 mark)**
-
-

- (b) Look at the table for Question 3(b) in the Diagram Booklet. Complete the table with a (✓) or a (×) to show which of the stages that take place in contemporary drug trials were carried out by William Withering.
(2 marks)**

(continued on the next page)

3 continued.

(c) Paclitaxel is a drug used in the treatment of cancer.

Cancer involves cells dividing repeatedly in an uncontrolled manner.

Paclitaxel prevents spindle fibres from changing in length.

**Deduce why Paclitaxel prevents cell division in cancer cells.
(3 marks)**

Answer space continues on the next 2 pages.

Turn over

3(c) continued.

Turn over

3(c) continued.

(Total for Question 3 = 6 marks)

4 Cystic fibrosis is an inherited condition.

It is caused by mutations in the gene coding for the cystic fibrosis transmembrane conductance regulator (CFTR) protein.

Some of the mutations cause a change in the primary structure of the CFTR protein.

**(a) Describe how a mutation can change the primary structure of a protein.
(3 marks)**

Answer space continues on the next page.

4(a) continued.

(continued on the next page)

4 continued.

- (b) (i) The CFTR protein is produced in cells of the lung and is involved in the transport of chloride ions.**

**Describe the location of the CFTR protein in the cell membrane of one of these cells.
(2 marks)**

Answer space continues on the next page.

Turn over

4(b)(i) continued.

(continued on the next page)

4(b) continued.

- (ii) Describe how the CFTR protein is transported from the ribosome to the cell membrane.
(3 marks)**

Answer space continues on the next page.

Turn over

4(b)(ii) continued.

(continued on the next page)

4 continued.

- (c) The most common mutation in the CFTR gene produces a protein that has the incorrect shape.**

**Explain why a change in the primary structure of a protein changes the three-dimensional (3D) structure of this protein.
(3 marks)**

Answer space continues on the next page.

Turn over

4(c) continued.

(Total for Question 4 = 11 marks)

5 Photosynthesis takes place in the chloroplast.

(a) Look at the diagram for Question 5(a) in the Diagram Booklet. It shows the structure of a chloroplast with some parts labelled.

**(i) Which part of the chloroplast is labelled L?
(1 mark)**

- ☐ **A a plasmid containing chloroplast DNA**
- ☐ **B the matrix where the Krebs cycle takes place**
- ☐ **C the stroma where the Calvin cycle takes place**
- ☐ **D the thylakoid where the light-dependent reactions take place**

(continued on the next page)

Turn over

5(a) continued.

**(ii) The part labelled J is
(1 mark)**

- ☐ **A the matrix where the
light-dependent reactions
take place**
- ☐ **B the matrix where the
light-independent reactions
take place**
- ☐ **C the stroma where the
light-dependent reactions
take place**
- ☐ **D the stroma where the
light-independent reactions
take place**

(continued on the next page)

Turn over

5(a) continued.

**(iii) Which of the following is stored
in the structure labelled N?
(1 mark)**

☐ **A chlorophyll**

☐ **B glucose**

☐ **C lipid**

☐ **D starch**

(continued on the next page)

5 continued.

**(b) (i) Give the names of TWO products of the light-dependent reactions of photosynthesis.
(1 mark)**

(continued on the next page)

5(b) continued.

- (ii) The rate of light-dependent reactions can be measured in isolated chloroplasts.**

Environmental temperature may affect the rate of these reactions.

**Describe how DCPIP can be used to measure the effect of temperature on the rate of the light-dependent reactions in isolated chloroplasts.
(4 marks)**

Answer space continues on the next 2 pages.

Turn over

5(b)(ii) continued.

5(b)(ii) continued.

(Total for Question 5 = 8 marks)

- 6 Anthropogenic climate change could have caused the warmest years on record in the United Kingdom from 2015 to 2021.**

This is leading to changes in the germination of plant seeds.

Some seeds store starch.

- (a) Describe the structure of starch.
(3 marks)**

Answer space continues on the next page.

Turn over

6(a) continued.

(continued on the next page)

6 continued.

(b) The starch in seeds is broken down by enzymes during germination.

An investigation into the effect of temperature on germination was carried out using seeds from three species of North American woodland plants.

Look at the diagram for Question 6(b) in the Diagram Booklet. The percentage germination of these seeds at the mean spring temperature for these woodlands was compared with an increase of 5 °C.

**(i) Explain the effect of an increase in temperature on germination of these seeds.
(3 marks)**

Answer space continues on the next 2 pages.

Turn over

6(b)(i) continued.

Turn over

6(b)(i) continued.

(continued on the next page)

6(b) continued.

(ii) Global warming can result in climate change.

**Describe how climate change could affect the distribution of plants in woodlands in North America.
(2 marks)**

Answer space continues on the next page.

Turn over

6(b)(ii) continued.

(continued on the next page)

6 continued.

(c) To conserve plant species, seeds may be stored in seed banks.

**Explain why cold and dry conditions are required for the storage of these seeds.
(3 marks)**

Answer space continues on the next page.

Turn over

6(c) continued.

(Total for Question 6 = 11 marks)

- 7 Deer are herbivores living wild and in reserves. Several species of deer can be found in the UK.**

Adult deer have no natural predators in the UK, where deer populations are increasing.

- (a) (i) A population is a group of individuals
(1 mark)**

- ☐ **A of different species living in the same habitat**
- ☐ **B of one species living in different communities**
- ☐ **C of one species living in different ecosystems**
- ☐ **D of one species living in the same habitat**

(continued on the next page)

Turn over

7(a) continued.

(ii) In the wild, several species of deer can live in the same area.

Explain why these deer can live in the same area.

(2 marks)

7 continued.

(b) In one species of deer, a mutation has led to the occurrence of white deer. In some reserves, these white deer have increased in number.

Look at the table for Question 7(b) in the Diagram Booklet. The results of a study of one of these reserves are shown.

(continued on the next page)

7(b) continued.

- (i) The colour of the coats of deer is controlled by a single gene.**

The allele for brown coats is dominant and the allele for white coats is recessive.

**Calculate the number of heterozygotes in this population using the Hardy–Weinberg equation.
(3 marks)**

$$p^2 + 2pq + q^2 = 1.0$$

Answer space continues on the next page.

7(b)(i) continued.

Answer _____

(continued on the next page)

Turn over

7(b) continued.

- (ii) It may be beneficial for a population to contain a higher percentage of heterozygote individuals.**

Which of the following statements correctly explain why this is the case?

- 1. Heterozygotes may have an allele which allows for adaptation if conditions change.**
 - 2. Heterozygotes reduce genetic diversity.**
 - 3. A beneficial allele could be recessive and heterozygotes breeding together may produce a homozygous recessive offspring.**
- (1 mark)**

☐ **A 1 only**

☐ **B 1 and 2**

☐ **C 1 and 3**

☐ **D 2 and 3**

(continued on the next page)

Turn over

7 continued.

(c) A study has shown that grazing by deer reduces plant biodiversity in an area.

An area with a large population of deer was compared with an area from which deer were excluded.

Devise a procedure that could be used to measure plant biodiversity in these two areas.

(4 marks)

Answer space continues on the next 2 pages.

Turn over

7(c) continued.

[illegible]

Turn over

7(c) continued.

(Total for Question 7 = 11 marks)

- 8 The DNA from skeletons of people living in the UK over the last 4000 years has been studied.**

One of the genes studied was the gene for the enzyme lactase.

Lactase is an enzyme that breaks down lactose.

- (a) (i) Which of the following statements about the action of lactase is correct?
(1 mark)**

- ☐ **A lactase changes the products of the reaction**
- ☐ **B lactase increases the activation energy of the reaction**
- ☐ **C lactase is used up in the reaction**
- ☐ **D lactase reduces the activation energy of the reaction**

8(a) continued.

- (ii) Describe the role of ribosomes in the synthesis of lactase.
(3 marks)**

Answer space continues on the next page.

Turn over

8(a)(ii) continued.

(continued on the next page)

8 continued.

- (b) In most mammals, the production of lactase enzyme decreases when the offspring stop feeding on milk.**

In Europe, a single mutation resulted in the continued production of lactase enzyme by children and adults.

Look at the table for Question 8(b) in the Diagram Booklet. The study recorded changes in the frequency of this mutation over the past 4000 years.

- (i) The frequency of this mutation in Central Europe has increased by 457% in the last 4000 years.**

**Calculate the percentage increase in the frequency of this mutation in the UK in the last 4000 years.
(2 marks)**

Answer space continues on the next page.

Turn over

8(b)(i) continued.

_____ %

(continued on the next page)

Turn over

8(b) continued.

- (ii) During the last 4000 years, changes in farming led to a greater increase in the consumption of milk and dairy products in the UK compared with Central Europe.**

Many children and adults in Europe have a mutation that allows continued production of lactase enzyme.

**Comment on the effect of consuming milk and dairy products on the change in the frequency of this mutation.
(4 marks)**

Answer space continues on the next page.

Turn over

8(b)(ii) continued.

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(Total for Question 8 = 10 marks)

Turn over

9 Hepatitis C is a virus that can infect the liver.

In some children, hepatitis C can cause serious liver damage.

(a) After infection with hepatitis C, many people experience a fever.

**(i) Explain the role of a fever in the immune response.
(2 marks)**

Answer space continues on the next page.

Turn over

9(a)(i) continued.

(continued on the next page)

9(a) continued.

(ii) Individuals infected with hepatitis C produce antibodies.

**Describe how the activation of T helper cells leads to the production of antibodies.
(4 marks)**

Answer space continues on the next page.

9(a)(ii) continued.

(continued on the next page)

9 continued.

(b) Hepatitis C enters liver cells and destroys them.

The virus causing hepatitis C has a similar structure to HIV. It is an RNA virus with a lipid envelope and glycoproteins.

**Deduce how the hepatitis C virus is able to enter liver cells.
(3 marks)**

Answer space continues on the next page.

Turn over

9(b) continued.

(continued on the next page)

9 continued.

***(c) Another type of virus that causes liver disease is hepatitis B.**

Look at the table for Question 9(c) in the Diagram Booklet. Infection with hepatitis B can be treated with drugs and a vaccine is available.

**Discuss the use of these different hepatitis B treatments.
(6 marks)**

Answer space continues on the next 3 pages.

Turn over

9(c) continued.

Turn over

9(c) continued.

Turn over

9(c) continued.

(Total for Question 9 = 15 marks)

10 Resistance of bacteria to antibiotics is an increasing problem.

This has required the development of new antibiotics.

Researchers have developed new antibiotics that are effective against a number of strains of bacteria. They are all bactericidal.

**(a) Which of the following statements describes a bactericidal antibiotic?
(1 mark)**

- ☐ **A a substance that can only be used on the skin**
- ☐ **B a substance that kills bacteria**
- ☐ **C a substance that prevents reproduction of bacteria**
- ☐ **D a substance that prevents reproduction of viruses**

10 continued.

(b) Two new antibiotics have been developed: antibiotic A and antibiotic B. These were tested against two species of bacteria resistant to the antibiotic ciprofloxacin.

Each species of bacteria (P and Q) was grown in cultures containing:

- antibiotic A**
- antibiotic B**
- ciprofloxacin**
- no antibiotic**

Each culture was sampled at 0, 1, 2, 4, 6 and 24 hours and the number of viable cells was recorded.

Look at the graphs for Question 10(b) in the Diagram Booklet. The results of this investigation are shown.

10(b) continued.

- (i) Calculate the mean rate of decrease in the number of cells in the first four hours for species P for antibiotic B.
(2 marks)**

Answer _____

(continued on the next page)

Turn over

10(b) continued.

- (ii) Comment on the effectiveness of antibiotics **A** and **B** against both species of bacteria.
(4 marks)**

Answer space continues on the next page.

Turn over

10(b)(ii) continued.

(continued on the next page)

10(b) continued.

***(iii) A further investigation found the optimum concentration needed to kill bacteria for each of the new antibiotics using cultures on agar plates.**

**Devise a procedure that could be used to find the optimum concentration for each antibiotic.
(6 marks)**

Answer space continues on the next 3 pages.

Turn over

10(b)(iii) continued.

Turn over

10(b)(iii) continued.

Turn over

10(b)(iii) continued.

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(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER