

Biology A (Salters Nuffield)

Advanced

PAPER 3: General and Practical Applications in Biology

Wednesday 18 June 2025 – Morning

Time: 2 hours

Question Paper

THIS DOCUMENT MUST BE RETURNED TO
PEARSON AT THE END OF THE EXAMINATION

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

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

**Writing and drawing equipment, scientific calculator
and a copy of the scientific article adapted from
New Scientist (enclosed)**

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.

1 In 1980, a volcano erupted in Washington State, USA.

Ash from the volcano covered surrounding vegetation, killing all the plants.

Succession has been investigated on one of the sides of the volcano.

(a) In one study, species richness on the side of the volcano was measured.

Look at the graph for Question 1(a) in the Diagram Booklet. It shows the change in mean species richness from 1983 to 2005.

(continued on the next page)

1(a) continued.

- (i) State what is meant by the term SUCCESSION.
(2 marks)**

(continued on the next page)

1(a) continued.

- (ii) Calculate the rate of increase in the mean number of species from 1986 to 1995.**

Give your answer to two significant figures and include units.

(2 marks)

Answer _____

(continued on the next page)

1(a) continued.

(iii) Following the eruption, one of the first plant species to be observed was *Lupinus lepidus*.

Give the term used to describe the first species to appear at a location.

(1 mark)

(continued on the next page)

1 continued.

- (b) Species of *Lupinus* have organs called root nodules that contain bacteria.**

Sugars and nutrients are exchanged between the plant and the bacteria in the root nodules.

- (i) State what is meant by the term ORGAN.
(1 mark)**

(continued on the next page)

1(b) continued.

- (ii) Bacteria in root nodules are able to fix nitrogen gas (N_2) into ammonium compounds that the plant can use.**

**Name two organic molecules, containing nitrogen, needed to synthesise proteins.
(2 marks)**

Answer space continues on the next page.

1(b)(ii) continued.

(Total for Question 1 = 8 marks)

2 Stentor coeruleus is a unicellular organism.

Look at the drawing for Question 2 in the Diagram Booklet. It shows the structure of a Stentor coeruleus.

- (a) This Stentor has a height of 1 mm and a diameter of 0·4 mm at the top.**

(continued on the next page)

2(a) continued.

- (i) Calculate the volume of this cone-shaped Stentor.**

Use the equation for the volume of a cone:

$$V = \pi r^2 \frac{h}{3}$$

**Give your answer to three decimal places.
(2 marks)**

_____ mm³

(continued on the next page)

2(a) continued.

- (ii) Give the domain to which
Stentor coeruleus belongs.
(1 mark)

(continued on the next page)

2 continued.

- (b) **Stentors** are found in fresh water attached to pebbles.

The response of **Stentors** to a stimulus was investigated.

A sample of **150 Stentors** was allowed to attach to the bottom of a Petri dish filled with stream water. The **Stentors** were then given two hours to acclimatise.

The Petri dish was then tapped with a ruler once every minute.

After each tap, the percentage of **Stentors** that contracted was recorded.

Look at the graph for Question 2(b) in the Diagram Booklet. The results are shown in the graph.

(continued on the next page)

2(b) continued.

- (i) The frequency of tapping the Petri dish was controlled.**

Give ONE OTHER variable of the tapping stimulus that should be controlled.

(1 mark)

(continued on the next page)

2(b) continued.

- (ii) Show that the mean number of Stentors contracting between 50 and 60 taps is approximately 45 (2 marks)**

(continued on the next page)

Turn over

2(b) continued.

**(iii) Give TWO conclusions that can be drawn
from the results of this investigation.
(2 marks)**

1 _____

2 _____

2(b) continued.

(iv) Explain the results of this investigation.

(2 marks)

(Total for Question 2 = 10 marks)

Turn over

3 Fibrinogen is involved in blood clotting.

A variety of conditions affect the blood clotting process. These include atherosclerosis and dysfibrinogenemia.

- (a) Describe the role of fibrinogen in blood clotting.
(3 marks)**

Answer space continues on the next page.

3(a) continued.

(continued on the next page)

3 continued.

- (b) Some individuals have a clotting disorder caused by abnormal forms of fibrinogen.**

This condition is called dysfibrinogenemia.

Look at the family tree for Question 3(b) in the Diagram Booklet. It shows the inheritance of dysfibrinogenemia in one family.

In this family, the mutation responsible for dysfibrinogenemia is in the fibrinogen gene located on chromosome 4

- (i) Individual T was heterozygous for this mutation.**

State whether this mutation is dominant or recessive.

(1 mark)

(continued on the next page)

Turn over

3(b) continued.

- (ii) Scientists suggested this was a new mutation in this family originating in the genome of individual T.**

**Explain why the scientists suggested this.
(2 marks)**

Answer space continues on the next page.

3(b)(ii) continued.

(continued on the next page)

3(b) continued.

(iii) Blood samples were taken from individuals T and U.

The ability of these blood samples to clot was investigated.

Look at the graph for Question 3(b)(iii) in the Diagram Booklet. The results are shown in the graph.

Give TWO conclusions that can be drawn from these results.

(2 marks)

Answer space continues on the next page.

1 _____

Turn over

3(b)(iii) continued.

2 _____

(continued on the next page)

3 continued.

- (c) Atherosclerosis can increase the risk of blood clots forming.**

Explain how blood clotting in atherosclerosis can result in the death of heart muscle.

(3 marks)

Answer space continues on the next page.

3(c) continued.

(Total for Question 3 = 11 marks)

4 The primary structure of a polypeptide, synthesised on a ribosome, is determined by the genetic code.

(a) Look at the diagrams for Question 4(a) in the Diagram Booklet. They show an RNA dinucleotide formed from two RNA nucleotides and an RNA trinucleotide formed from three RNA nucleotides.

(i) In the Diagram Booklet, draw a circle around ONE base in the dinucleotide.

(1 mark)

(ii) State ONE difference between a nucleotide used to form RNA and a nucleotide used to form DNA.

(1 mark)

(continued on the next page)

4 continued.

- (b) An experiment to determine the genetic code used amino acids labelled with a radioisotope, **RNA** dinucleotides and trinucleotides, ribosomes and a mixture of **tRNA** molecules.

The small **mRNA** molecules used were dinucleotides and trinucleotides with a known base sequence.

Look at the diagram for Question 4(b) in the Diagram Booklet. It shows the method used to determine the genetic code of the amino acid lysine.

- (i) Describe the roles of the ribosomes, **RNA** dinucleotides and trinucleotides and the **tRNA** used in this experiment.
(3 marks)

Answer space continues on the next page.

4(b)(i) continued.

(continued on the next page)

Turn over

4(b) continued.

- (ii) Look at the table for Question 4(b)(ii) in the Diagram Booklet. Some of the results for the amino acid lysine are shown in the table.**

Explain TWO conclusions about the genetic code that can be drawn from the results of this experiment.

(4 marks)

Answer space continues on the next page.

1 _____

4(b)(ii) continued.

2

(Total for Question 4 = 9 marks)

Turn over

5 Doxycycline (**DOX**) is a bacteriostatic antibiotic.

- (a) State what is meant by the term
BACTERIOSTATIC ANTIBIOTIC.
(1 mark)

(continued on the next page)

5 continued.

(b) Antibiotic resistance to DOX was investigated.

A culture of E. coli was treated with DOX and a resistant strain of E. coli called DOX-T0- E. coli was produced.

The DOX-T0- E. coli were then placed in antibiotic free conditions.

After 60 cycles of cell division, they became a different strain called DOX-T60- E. coli.

Look at the graph for Question 5(b) in the Diagram Booklet. It shows the minimum concentration of DOX required to have a bacteriostatic effect on the bacteria.

(continued on the next page)

5(b) continued.

- (i) Explain the effect of 60 cycles of cell division on DOX resistant E. coli (DOX-T0- E. coli).
(2 marks)**

(continued on the next page)

Turn over

5(b) continued.

- (ii) Devise a procedure to determine the minimum concentration of **DOX** required to have a bacteriostatic effect on the bacteria.
(4 marks)

Answer space continues on the next page.

5(b)(ii) continued.

(continued on the next page)

5 continued.

- (c) In a different investigation the effects of two antibiotics, tetracycline and streptomycin, were compared on cultures of *E. coli*.**

Each antibiotic was added to a culture containing 10 000 000 living *E. coli* bacteria at time 0

Samples were removed from the cultures every hour and the number of living bacteria was determined.

Look at the graph for Question 5(c) in the Diagram Booklet. The results are shown in the graph.

(continued on the next page)

5(c) continued.

- (i) Calculate the ratio of living bacteria in the tetracycline culture compared with the streptomycin culture at five hours.
(2 marks)**

Answer _____ :1

(continued on the next page)

5(c) continued.

**(ii) Deduce the effects of these two antibiotics
on *E. coli*.**

(2 marks)

(Total for Question 5 = 11 marks)

Turn over

6 Look at the image for Question 6 in the Diagram Booklet. It shows a coastal tailed frog that is endemic to Western North America.

(a) Coastal tailed frogs live in streams. Coastal tailed frogs feed at night along the edges of streams. They eat invertebrates such as insects, spiders and snails.

**(i) State what is meant by the term ENDEMIC.
(1 mark)**

(continued on the next page)

6(a) continued.

(ii) Describe what is meant by the NICHE of the coastal tailed frog.

(2 marks)

(continued on the next page)

Turn over

6 continued.

- (b) The presence of coastal tailed frogs in streams is used as an indicator of the health of an ecosystem.**

In the past, scientists observed frogs and recorded their locations.

Scientists can now use eDNA to study the locations of these frogs. This method detects frog DNA collected from the water and amplified by PCR.

In one investigation, the two methods were compared.

Observational studies and eDNA methods were used to determine if coastal tailed frogs were present or absent in 45 streams.

The results were:

- Observational studies found these frogs in 9 of the 45 streams.**
- Frog eDNA was also detected in those 9 streams.**
- Frog DNA was also found in 21 streams in which these frogs were not observed.**

6(b) continued.

- (i) Calculate the percentage probability of coastal tailed frog eDNA being detected in a stream in which the frogs were not observed.**

**Give your answer as a whole number.
(2 marks)**

_____ %

(continued on the next page)

6(b) continued.

- (ii) Comment on the advantages and disadvantages of using eDNA methods to identify streams with frogs that are active at night.**
(3 marks)

Answer space continues on the next page.

6(b)(ii) continued.

(continued on the next page)

6 continued.

- (c) The Rocky Mountain tailed frog is closely related to the coastal tailed frog.**

Devise an eDNA method that could be used to identify which of these species of frog is present in streams.

(4 marks)

Answer space continues on the next 2 pages.

6(c) continued.

[illegible]

Turn over

6(c) continued.

(Total for Question 6 = 12 marks)

- *7 The word ‘complementary’ is often used when describing the shapes of biological molecules that interact with each other.**

Discuss the importance of complementary shapes in THREE types of biological molecule found in living organisms.

(9 marks)

Answer space continues on the next 5 pages.

7 continued.

[illegible]

Turn over

7 continued.

[illegible]

Turn over

7 continued.

[illegible]

Turn over

7 continued.

[illegible]

Turn over

7 continued.

(Total for Question 7 = 9 marks)

- 8 The scientific article you have studied is adapted from New Scientist.**

Use the information from the scientific article and your own knowledge to answer the following questions.

- (a) Explain why ‘the distribution of hibernating species on the tree of mammals’ suggests that the common ancestor of all mammals was a hibernator (paragraph 3).
(2 marks)**

Answer space continues on the next page.

8(a) continued.

(continued on the next page)

8 continued.

- (b) Explain how a reduction in physiological activity can result in a reduction in body temperature (paragraph 6).
(3 marks)**

Answer space continues on the next page.

8(b) continued.

(continued on the next page)

8 continued.

- (c) Hibernating mammals, such as the black bear, can maintain a lower core temperature. ‘The black bear (*Ursus americanus*), for example, lowers its core temperature by about 6 °C’ (paragraph 8).**

Describe the processes that would maintain the core body temperature of the black bear at a temperature 6 °C lower than normal.

(5 marks)

Answer space continues on the next 2 pages.

8(c) continued.

[illegible]

Turn over

8(c) continued.

(continued on the next page)

8 continued.

- (d) Tissue samples were collected from different mammals during hibernation. These were analysed to identify which genes were controlling hibernation (paragraphs 10 and 11).**

Explain how scientists could use tissue samples to find out which genes were activated.

(3 marks)

Answer space continues on the next page.

Turn over

8(d) continued.

(continued on the next page)

8 continued.

- (e) Explain why there will be changes in blood pressure when a mammal comes out of hibernation (paragraph 13). (2 marks)**

(continued on the next page)

Turn over

8 continued.

- (f) Urea is a waste product that is usually excreted in the urine of mammals.**

Look at the diagram for Question 8(f) in the Diagram Booklet. It shows a molecule of urea.

During hibernation ‘the thirteen-lined ground squirrel recycles its urea’ (paragraph 13).

Deduce why it is important for a hibernating mammal to recycle urea.

(2 marks)

Answer space continues on the next page.

8(f) continued.

(continued on the next page)

8 continued.

- (g) Explain why the bones and muscles of astronauts on long missions will waste away (“To blearily go” paragraph **B**, pages 10–11).
(2 marks)**

(continued on the next page)

Turn over

8 continued.

- (h) Explain why reducing body temperature from 37.5°C to 32°C would reduce metabolic activity (“To blearily go”, paragraph C, page 11).
(3 marks)**

Answer space continues on the next page.

8(h) continued.

(continued on the next page)

8 continued.

- (i) Describe the role of a neurotransmitter
(paragraph 15).
(2 marks)**

(continued on the next page)

Turn over

8 continued.

- (j) Explain how adenosine affects neural activity in the hippocampus (paragraph 15).
(3 marks)**

Answer space continues on the next page.

8(j) continued.

(continued on the next page)

8 continued.

- (k) Explain how boosting the uptake of adenosine in the brains of the rats could lower the core body temperature of rats without triggering shivering (paragraph 16).**

(3 marks)

Answer space continues on the next page.

Turn over

8(k) continued.

(Total for Question 8 = 30 marks)

TOTAL FOR PAPER = 100 MARKS

END OF PAPER