Cambridge Assessment International Education

Cambridge Pre-U

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

T2679966698

BIOLOGY **9790/02**

Paper 2 Data Analysis and Planning **October/November 2020**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

For Examiner's Use	
Section A	
Section B	
Total	

This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

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Answer **all** questions.

Section A – Data Analysis

1 Respiration in mitochondria requires events that occur at the inner mitochondrial membrane.

Fig. 1.1 shows the five complexes of the inner mitochondrial membrane, and the areas to either side of it.

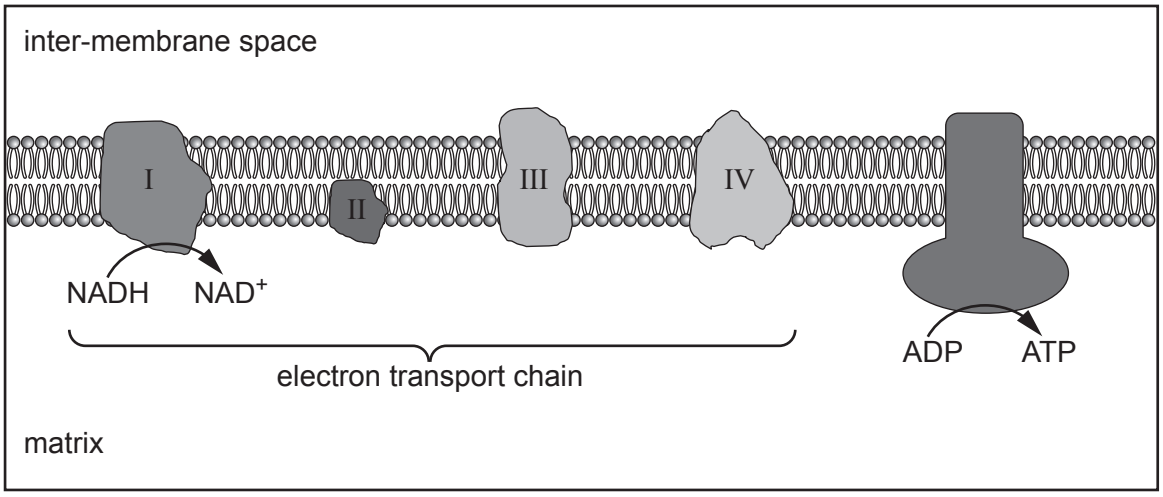

Fig. 1.1

(a) Protons (hydrogen ions) move through the complexes of the inner mitochondrial membrane.

Complete Fig. 1.1 to show the movements of protons across the membrane in a mitochondrion that is functioning normally. [2]

(b) A number of chemicals can disrupt mitochondrial respiration. Some of these are listed in Table 1.1.

Table 1.1

chemical	effect on mitochondrion
oligomycin	inhibits ATP synthase
FCCP	causes protons to leak out of the inter-membrane space back into the matrix without going through ATP synthase
antimycin-A + rotenone	stops electrons passing down the electron transport chain (rotenone affects complex I and antimycin-A affects complex III)

Scientists measured the oxygen consumption rate (OCR) of some cells. They then investigated how the OCR changed when oligomycin was added at 23 minutes, followed by FCCP at 56 minutes, followed by antimycin-A + rotenone at 93 minutes.

Fig. 1.2 shows the results obtained.

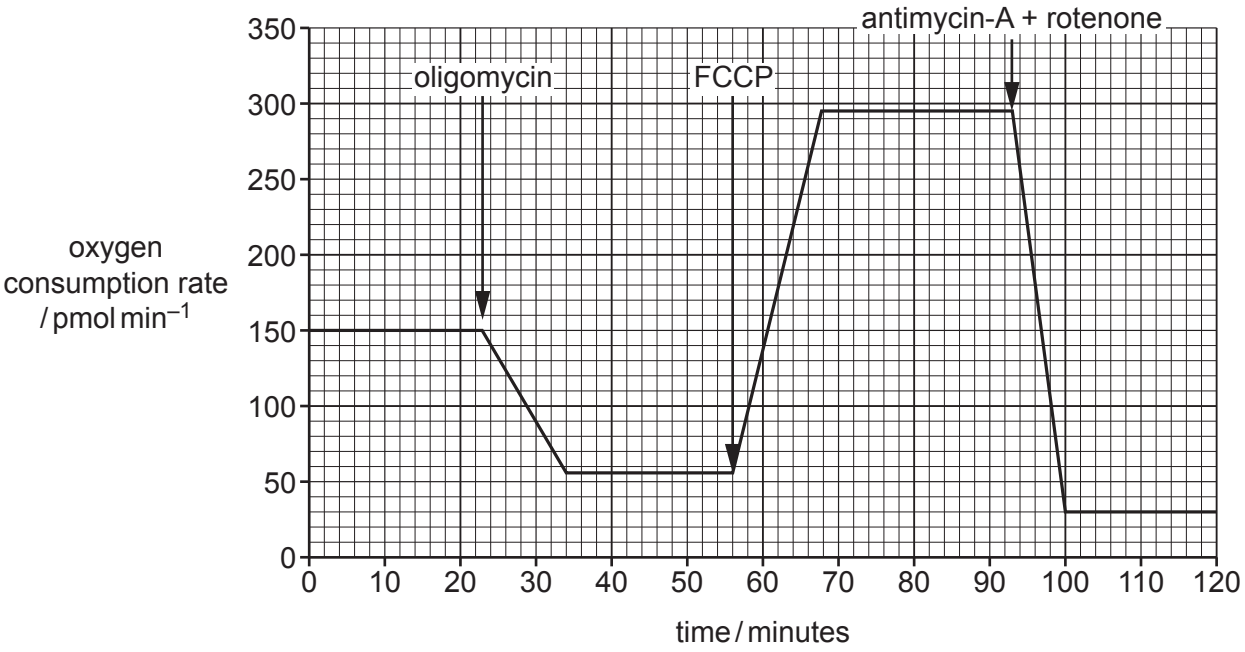

Fig. 1.2

(i) Explain each of the **three** statements with reference to events at the inner mitochondrial membrane.

oligomycin causes a drop in OCR

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FCCP causes a rise in OCR

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antimycin-A + rotenone causes a drop in OCR

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[6]

(ii) Suggest why the oxygen consumption rate of the cell never falls to zero.

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..... [1]

(iii) During respiration, protons 'leak' through the inner mitochondrial membrane into the matrix. The OCR as a result of this leakage can be calculated by determining the difference between the OCR 20 minutes after the addition of oligomycin and the OCR 20 minutes after the addition of antimycin-A + rotenone.

Use Fig. 1.2 to calculate the OCR caused by proton leakage.

..... pmol min^{-1}

[1]

(c) Rotenone has been proposed as a possible treatment for cancer.

Explain why cancer cells are more likely to be affected by rotenone than non-cancer cells.

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..... [2]

(d) Although rotenone has been proposed as a possible treatment for cancer, laboratory experiments have shown that exposure to rotenone may cause death of neurones in the mammalian brain.

Hydrogen sulphide (H_2S) is thought to reduce these effects of rotenone.

Fig. 1.3 shows the results of a study in which cells were incubated with one of the following:

- **A** water
- **B** 100 nmol dm^{-3} rotenone
- **C**, **D**, **E**, **F** 100 nmol dm^{-3} rotenone with a range of concentrations of H_2S.

The number of cells that died as a percentage of the total number of cells was calculated.

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Fig. 1.3

(i) Calculate the percentage increase in the percentage of cells that died after the addition of 100 nmol dm^{-3} rotenone alone (treatment **B**), when compared with treatment **A**.

..... %
[2]

(ii) Comment on the data shown in Fig. 1.3.

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..... [3]

(iii) Suggest why treatment **A** was included.

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..... [1]

[Total: 18]

2 The black-lipped pika, *Ochotona curzoniae*, is a small mammal that lives on the high grassland plateaus of Tibet and China. The pika has a high rate of reproduction. The pika feeds on grasses and sedges and it burrows into the ground, aerating the soil. Farm animals feed on the same grassland plateaus as the pika.

Fig. 2.1 shows a black-lipped pika.

Fig. 2.1

The pika is a food source for carnivores such as foxes, owls and brown bears. The pika is considered to be a keystone species. It is also regarded locally as a significant pest.

(a) Fig. 2.2 shows a food web that includes the pika. The arrows represent energy flow.

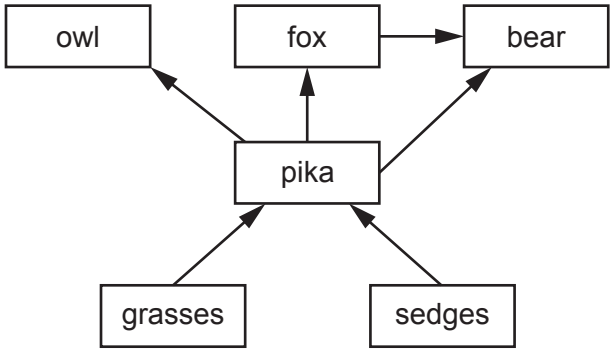

Fig. 2.2

(i) Suggest and explain the effect of the removal of foxes on the owl population.

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(ii) Suggest why the food web shown in Fig. 2.2 is of limited use in studying the ecosystem.

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(iii) Explain what is meant by the term *keystone species*.

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(iv) Suggest why the pika is regarded as a pest.

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..... [2]

(b) A study in 2017 investigated the effect of pika population size on the biomass and biodiversity of the plateau grassland.

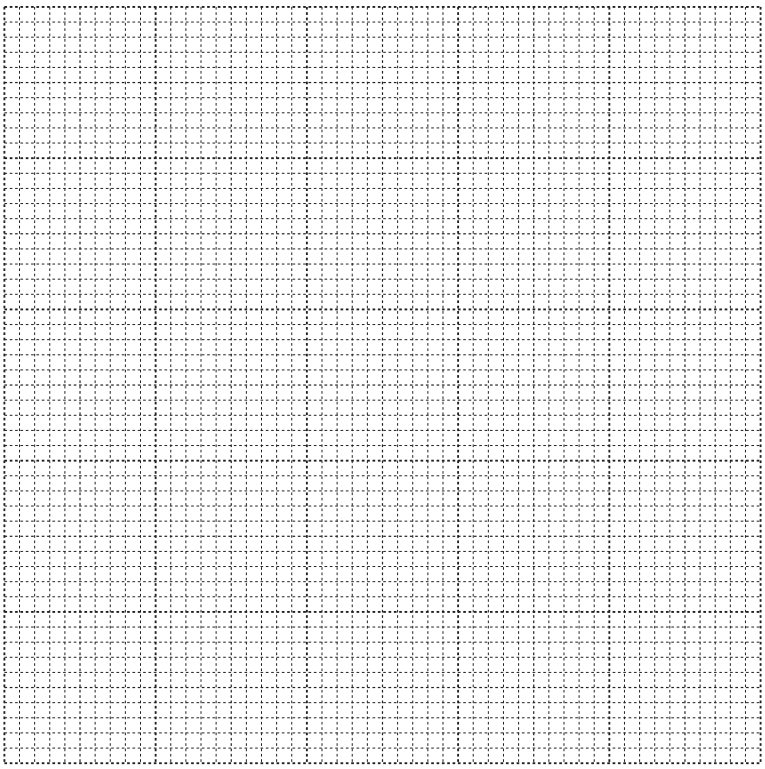
The total plant biomass was measured at different pika densities. The results are shown in Table 2.1.

Table 2.1

pika density / number per 100 m^2	total plant biomass / kg m^{-2}
0	7.2
4	5.0
12	4.1
36	1.6
52	1.4
76	3.2

(i) Plot a graph of the data in Table 2.1.

Draw a curve of best fit.



[4]

(ii) State the name of a suitable statistical test that could be used to determine if there is a significant correlation between pika density and total plant biomass.

..... [1]

(iii) Researchers observed a rise in total plant biomass at high pika density.

Suggest an explanation for this observation.

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(iv) The population density of pika can be estimated using the mark-release-recapture method.

Describe how this method can be used to estimate the population density of pika.

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..... [4]

[Total: 17]

Section B – Planning

3 In the bacterium, *Escherichia coli*, the gene for β-galactosidase is switched on in the presence of lactose. ONPG is a substrate for β-galactosidase and is broken down to produce galactose and a yellow compound, as shown in Fig. 3.1.

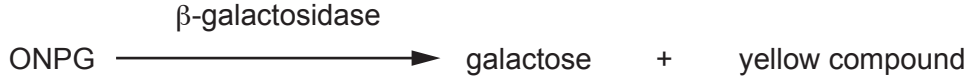

Fig. 3.1

Plan an investigation to find out if the concentration of lactose affects the expression of the gene for β-galactosidase.

You are provided with the following materials. Choose your materials from this list. You may **not** use any additional materials.

- ONPG solution
- 1 mol dm^{-3} lactose solution
- β-galactosidase solution
- phosphate buffer (Z buffer)
- methylbenzene (toluene)
- *E. coli* in nutrient broth
- nutrient broth
- 70% alcohol
- distilled water
- antibacterial cleaner
- culture bottles with lids
- paper towels
- Bunsen burner and gas supply
- heat-proof mat
- matches
- water-resistant marker
- beakers and flasks of different sizes
- clock or electronic timer
- thermometer
- pipettes and pipette fillers
- teat pipettes
- syringes of different sizes
- glass rods for stirring
- test-tubes with bungs
- test-tube racks
- aluminium foil
- autoclave
- large beaker containing disinfectant solution
- colorimeter (to measure light absorbance)
- glass cuvettes (to hold solution for colorimeter)
- thermostatically controlled water-bath
- access to a fume cupboard

Your plan should:

- include a clear statement of the hypothesis or prediction
- identify the key variables
- give full details and explanations of the procedures that you would adopt to ensure that the results are as precise and repeatable as possible
- show how you would present and analyse your results
- include a brief risk assessment
- be written in clear, scientific language.

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