Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

9146912991

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **May/June 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **one** question.
- 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 100.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **24** pages.

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Section A

Answer **all** questions.

1 **(a)** Fig. 1.1 is a diagram of part of a neurone membrane at resting potential.

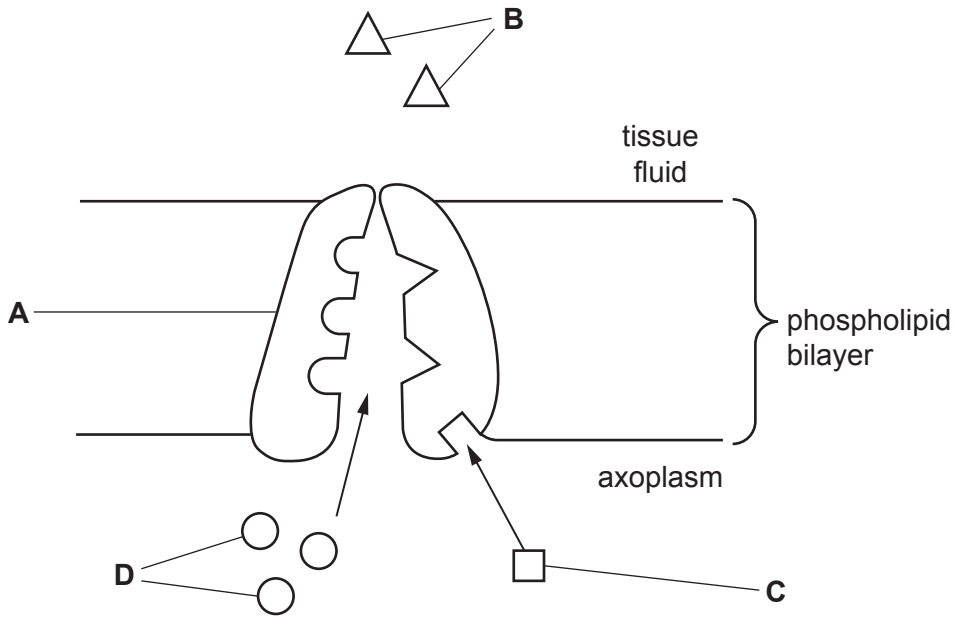


Fig. 1.1

(i) With reference to Fig. 1.1, name **A**, **B**, and **D**.

A .....

B .....

D ..... [3]

(ii) Substance **C** is required to make structure **A** function.

Name substance **C**.

..... [1]

(b) Some drugs can affect the functioning of neuromuscular junctions or cholinergic synapses.

Table 1.1 lists three drugs and describes their action on neuromuscular junctions or cholinergic synapses.

Table 1.1

drug	action of drug
curare	blocks muscle cell membrane receptors at neuromuscular junctions
nerve gas	inhibits acetylcholinesterase function in synapses
alcohol	inhibits exocytosis of neurotransmitters in synapses

Suggest **and** describe the immediate consequence of the action of each drug on a neuromuscular junction or cholinergic synapse.

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..... [5]

[Total: 9]

2 **(a)** All organisms respire. The ATP produced as a result of respiration is used as the energy currency of the cell.

(i) Outline **two** examples of movement in cells that use ATP.

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..... [2]

(ii) ATP cannot be stored in cells so it has to be continually re-synthesised to meet the demands of an organism.

A person with a total quantity of 0.2 moles of ATP needs to hydrolyse 150 moles of ATP per day.

Calculate how many times the total quantity of 0.2 moles of ATP has to be re-synthesised per hour to meet the demand of 150 moles per day.

Show your working and give your answer to the nearest whole number.

answer = ... [2]

(iii) Name the stages in which chemiosmosis occurs in respiration and in photosynthesis.

respiration .....

photosynthesis .....
[2]

(b) Fur seals are mammals that are adapted to live in cold temperatures. Fur seals have large quantities of a type of fat tissue known as brown adipose tissue. Brown adipose cells contain many mitochondria. These mitochondria contain a transport protein called thermogenin.

Fig. 2.1 shows the role of thermogenin in a mitochondrion of a brown adipose cell when external temperatures are cold.

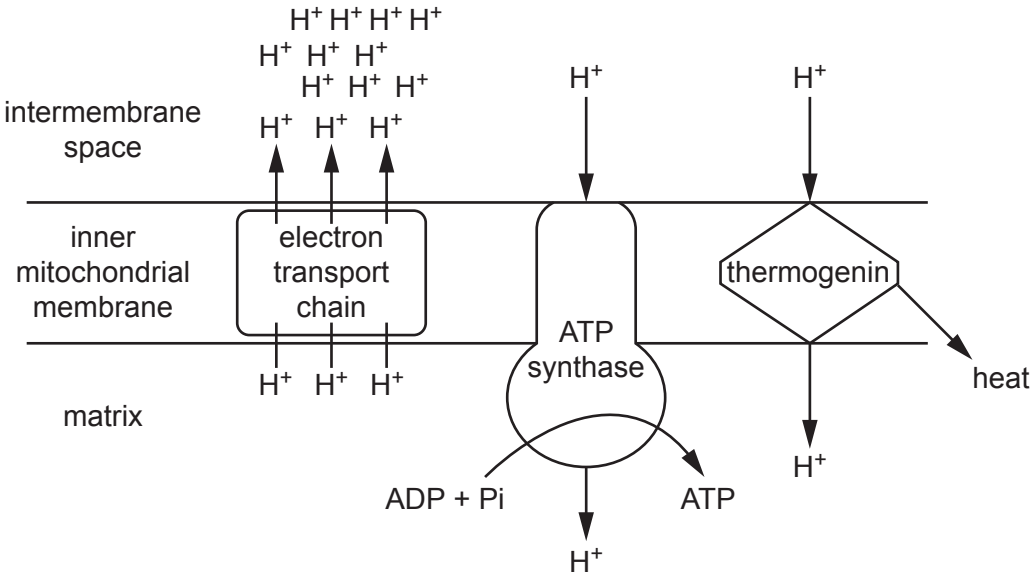


Fig. 2.1

(i) With reference to Fig. 2.1, describe **and** explain the effect of thermogenin on ATP synthesis.

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..... [3]

(ii) When the external temperature is warm, thermogenin cannot function.

When the external temperature becomes cold, thermogenin is able to function as a result of cell signalling:

- adrenaline is released
- adrenaline acts on brown adipose cells
- a sequence of events is triggered that results in the activation of the enzyme lipase
- lipase hydrolyses triglycerides in the cells into fatty acids
- fatty acids enter the mitochondrion
- thermogenin starts to function.

Outline the stages of cell signalling that trigger the functioning of thermogenin.

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..... [3]

[Total: 12]

Question 3 starts on page 8.

3 **(a)** One way to measure global biodiversity is to count the number of species of organisms.

Table 3.1 shows estimates for 2009 of the number of species in some taxa of animals.

The numbers in brackets are the numbers that were updated in 2019 from the International Union for Conservation of Nature and Natural Resources (IUCN) for three intensively studied taxa.

Table 3.1

number of species in each taxon		
kingdom	**phylum**	**class**
animals 1 438 805	arthropods 1 191 770	arachnids 102 248
		crustaceans 47 000
		myriapods 16 072
		insects 1 024 945
		other arthropod classes 1505
	chordates 63 543	fish 31 269
		amphibians 6515 (6722)
		birds 9990 (11 126)
		reptiles 8734
		mammals 5487 (5692)
	molluscs 85 000	
	other animal phyla 98 492	

(i) List **three** features shared by **animal** species.

1 .....

2 .....

3 .....

[3]

(ii) Explain how the classification of species into a taxonomic hierarchy assists the work of conservation bodies such as the IUCN.

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..... [3]

(iii) Table 3.1 shows that the number of species of amphibians, birds and mammals has increased between 2009 and 2019.

Discuss whether the increase in numbers means that these classes of chordate are being successfully conserved.

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..... [2]

(iv) With reference to Table 3.1, identify the class of animals that is most diverse then calculate the percentage of animal species that belongs to this class.

Show your working and give your answer to two significant figures.

answer = ... % [2]

(b) An analysis in 2019 concluded that twice as many insect species have populations that are decreasing in size compared with chordate species. This analysis focused on developed countries that have large human populations.

(i) Outline **two** factors that may cause populations of insects to decrease in size in developed countries that have large human populations.

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..... [2]

(ii) Explain how the introduction of crops that are genetically modified to express the Bt toxin can benefit biodiversity.

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..... [2]

[Total: 14]

4 **(a)** Genetic technology involving the creation of recombinant DNA can be used to treat different human diseases. These include diseases such as diabetes that may have multiple causes and inherited disorders that are caused by a single gene.

Outline **two different** ways of using recombinant DNA technology to treat these diseases.

diabetes .....

.....

.....

single gene disorder .....

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[2]

(b) A new application of recombinant DNA technology uses the genetic modification of a plant to prevent disease. It aims to prevent the most common source of food-borne disease, which is caused by eating food contaminated with pathogenic *Escherichia coli* bacteria.

Scientists genetically modified edible spinach plants to produce colicins. Colicins are antimicrobial proteins that can kill pathogenic *E.coli*. Colicins are normally made by other bacteria.

An experiment was carried out to test this application by spraying an extract of genetically modified (GM) spinach in buffer solution onto raw meat contaminated with pathogenic *E.coli*. The meat was stored at 10 °C for varying lengths of time before the numbers of viable (living) pathogenic *E.coli* bacteria were counted. Fig. 4.1 shows the results.

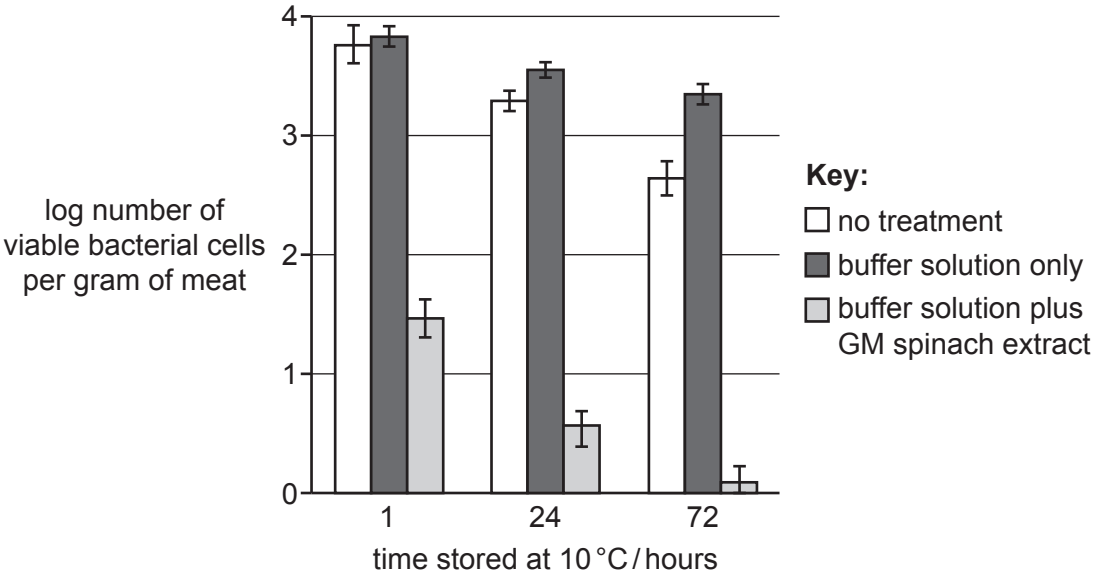


Fig. 4.1

(i) With reference to Fig. 4.1, evaluate the effectiveness of using GM spinach spray on raw meat to prevent food-borne disease.

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..... [4]

(ii) Regulatory authorities may not approve the use of GM spinach spray on raw meat to protect consumers.

Discuss the concerns that may stop regulatory authorities approving this application of recombinant DNA technology.

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..... [3]

[Total: 9]

5 **(a)** Photosynthesis is a complex process involving a light dependent stage and a light independent stage.

(i) Name the products of the light dependent stage that are needed in the light independent stage.

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..... [2]

(ii) Describe the role of chlorophyll b in photosynthesis.

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..... [2]

A student carried out an experiment to investigate the effect of light intensity and light wavelength on the rate of photosynthesis.

- An aquatic plant, *Elodea canadensis,* was put into a beaker containing sodium hydrogencarbonate solution as a source of carbon dioxide.
- To minimise changes in temperature, an LED lamp was used as a source of light.
- The lamp was switched on and the number of bubbles released by the aquatic plant in 1 minute was counted.
- The lamp was placed at seven different distances from the beaker to change light intensity.
- Five replicates were carried out at each lamp distance.
- All other variables were controlled.

(b) The student calculated the light intensity for each distance (d) using $\frac{1}{d^2}$.

Table 5.1 shows the calculated light intensities for each distance.

Table 5.1

distance between plant and lamp / m	light intensity / $\frac{1}{d^2}$
0.025	1600
0.050	400
0.100	
0.150	44
0.200	25
0.250	16
0.300	11

Complete Table 5.1 by calculating the light intensity for distance 0.100 m. [1]

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(c) At each distance from the lamp, the experiment was repeated using a red filter in front of the lamp to give a different wavelength of light. The experiment was repeated using a blue filter and then using a green filter. Each filter transmitted the same light intensity.

The student calculated the mean rate of bubble production as a measure of the rate of photosynthesis.

Fig. 5.1 shows a graph of the results.

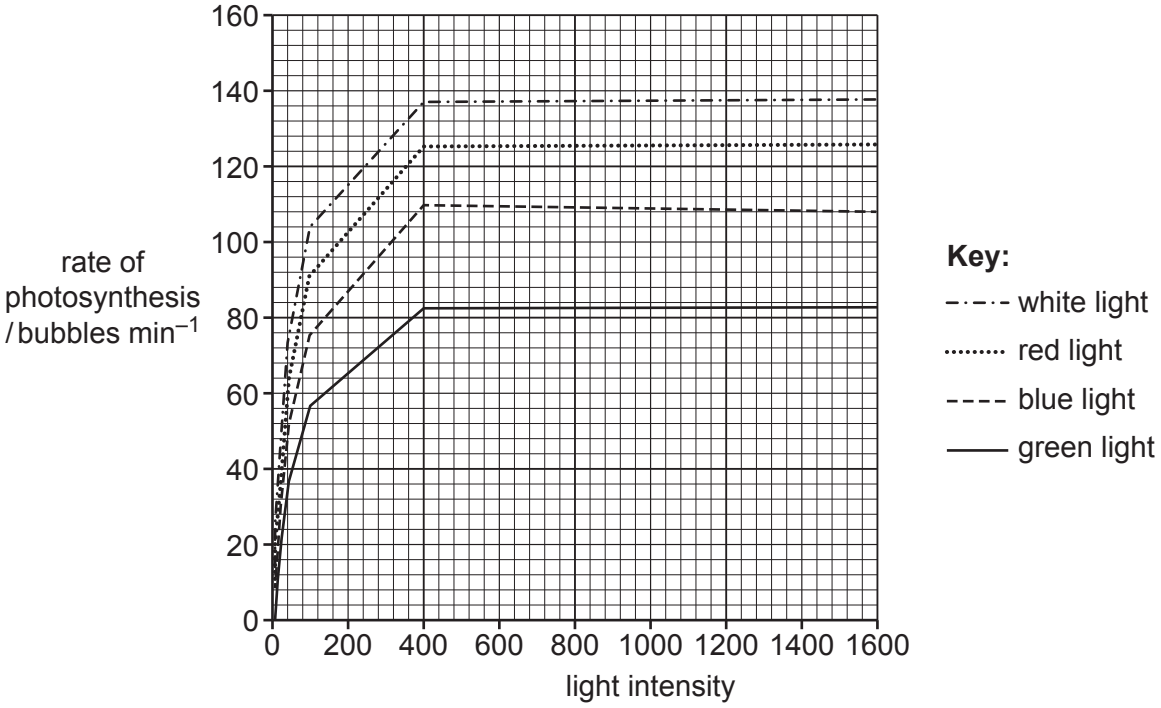


Fig. 5.1

(i) With reference to Fig. 5.1:

- state the range over which light intensity is the limiting factor
- explain why light intensity above this range is not limiting the rate of photosynthesis.

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..... [3]

(ii) At a light intensity of 1600, explain why different colour filters result in different rates of photosynthesis.

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..... [3]

[Total: 11]

6 Glucagon-like peptide-1 (GLP-1) is a hormone consisting of 31 amino acids. It is secreted by specialised intestinal epithelial cells known as L cells.

Fig. 6.1 outlines the secretion of GLP-1 and its effects on the pancreas, brain and stomach.

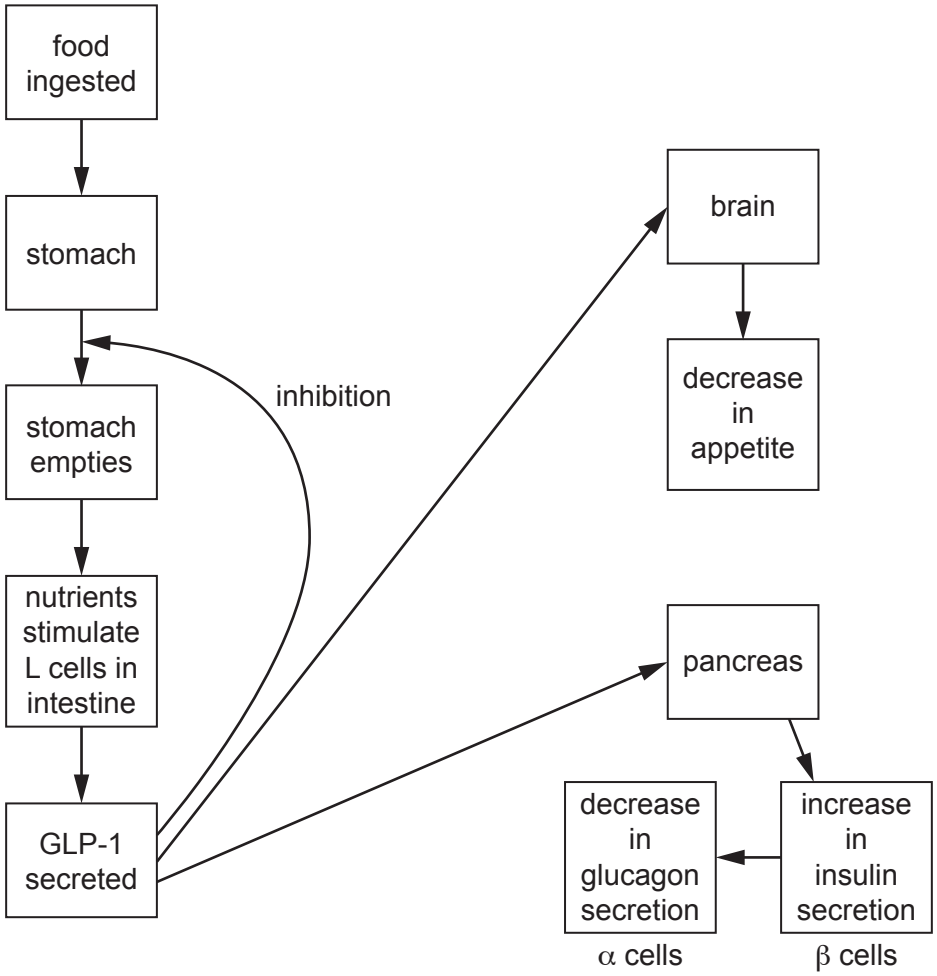


Fig. 6.1

(a) GLP-1 binds to receptors on cell surface membranes of β cells in the pancreas. These cells secrete insulin.

(i) Name the type of membrane component that forms a receptor in the cell surface membrane.

..... [1]

(ii) State how GLP-1 is transported to the pancreas.

..... [1]

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(b) GLP-1 inhibits the secretion of glucagon by α cells in the pancreas.

Describe **two** processes in the liver that are stimulated by glucagon.

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..... [2]

(c) Suggest **one** reason why GLP-1 causes a decrease in appetite.

..... [1]

(d) GLP-1 inhibits the emptying of the stomach. This is an example of negative feedback.

Explain what is meant by negative feedback.

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..... [3]

(e) A transcription factor is involved in the production of GLP-1. An insertion mutation in the gene that codes for the transcription factor can affect the production of GLP-1.

Outline the effect of an insertion mutation on the production of GLP-1.

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..... [3]

[Total: 11]

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7 (a) The fruit fly, *Drosophila melanogaster*, feeds on sugars found in damaged fruits.

A fruit fly with normal features is described as wild type. It has red eyes and its wings are longer than its abdomen. There are mutant variations such as purple eyes or short (vestigial) wings.

Fig. 7.1 shows a wild type fruit fly and a mutant fruit fly with purple eyes and vestigial wings.

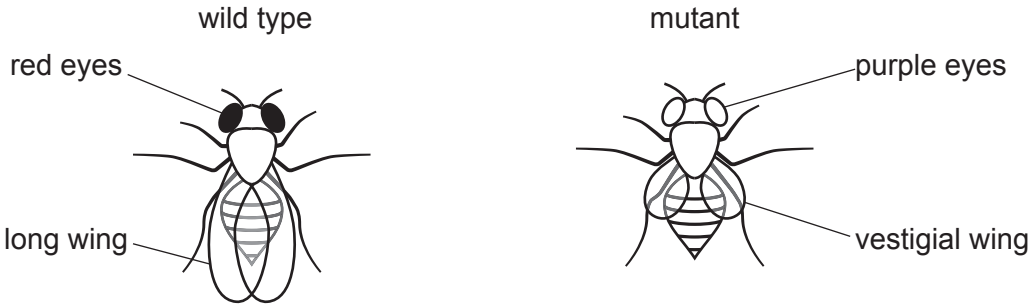


Fig. 7.1

- The genes coding for eye colour and wing length are located on the same chromosome.
- Allele **R** for red eyes is dominant to allele **r** for purple eyes.
- Allele **N** for long wings is dominant to allele **n** for vestigial wings.

Explain what is meant by the terms allele and dominant.

allele .....

dominant .....

.....

[2]

(b) A wild type fruit fly, heterozygous for both genes, was crossed with a fruit fly that was homozygous recessive for both genes.

(i) Table 7.1 is a summary of the cross.

Complete Table 7.1.

Table 7.1

	wild type parent		**double homozygous recessive parent**	
parental phenotype	.....		..... **x**	
parental genotype	.....		**x**	
offspring				
offspring phenotype	....	....	....	....
offspring genotype	.....	.....	.....	.....
number of offspring	1339	1195	151	154

[5]

(ii) Explain why the four offspring phenotypes are not present in a 1:1:1:1 ratio.

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..... [3]

[Total: 10]

8 **(a)** In continuous variation, a population shows a range of phenotypes between two extremes with no distinct groups. Height and mass are examples of phenotypic traits that show continuous variation.

Describe the genetic basis for continuous variation.

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..... [3]

(b) Environmental factors can contribute to continuous variation.

Suggest **two** environmental factors that may affect the body mass of an animal.

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..... [2]

(c) Humans have used selective breeding (artificial selection) for thousands of years to improve the quality of livestock.

Outline the principles of selective breeding in livestock.

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..... [4]

[Total: 9]

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Section B

Answer **one** question.

9 **(a)** Describe how the structure of a mitochondrion is related to its function. [9]

(b) Explain how rice is adapted to grow with its roots submerged in water. [6]

[Total: 15]

10 **(a)** Explain how different types of gene mutation can affect the phenotype **and** outline the effects of the mutant alleles that cause Huntington's disease on the phenotype of a person. [9]

(b) Explain how gibberellin acts on DELLA proteins to stimulate the production of amylase in a germinating seed. [6]

[Total: 15]

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