

CANDIDATE
NAME

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BIOLOGY

9700/42

Paper 4 A Level Structured Questions

May/June 2018

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Section A

Answer **all** questions.

Section B

Answer **one** question.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **21** printed pages, **1** blank page and **2** lined pages.

- 2 (a) In the sweet pea plant, *Lathyrus odoratus*, one gene codes for flower colour and one gene codes for pollen grain shape.

Flower colour is either purple or red. Pollen grain shape is either long or round. The inheritance of these genes is an example of **autosomal linkage**.

- The allele **F** for purple flowers is dominant over the allele **f** for red flowers.
- The allele **G** for long pollen grains is dominant over allele **g** for round pollen grains.

Explain the meaning of the term *autosomal linkage*.

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.....[2]

- (b) A dihybrid cross was carried out between homozygous dominant and homozygous recessive sweet pea plant parents to produce the F1 generation.

The offspring from the F1 generation were crossed to produce the F2 generation.

- (i) Draw a genetic diagram to show a dihybrid cross between two offspring from the F1 generation.

Assume that these genes are closely linked and that there are **no** crossing over events.

- (ii) The actual results of the dihybrid cross are shown in Table 2.1.

Table 2.1

phenotypes of F2 offspring	number of individuals
purple flowers, long pollen grains	284
purple flowers, round pollen grains	21
red flowers, long pollen grains	21
red flowers, round pollen grains	55

State how the results support the fact that this is an example of autosomal linkage.

.....

[1]

- (c) (i) In a test cross, an individual of **known** genotype is crossed with an individual that has a dominant phenotype but unknown genotype.

State the genotype of the **known** individual in a test cross.

.....[1]

- (ii) A test cross was carried out with sweet pea plants known to be heterozygous for both flower colour and pollen grain shape.

The results of the test cross are shown in Table 2.2.

Table 2.2

phenotypes of offspring of test cross	number of individuals
purple flowers, long pollen grains	215
purple flowers, round pollen grains	30
red flowers, long pollen grains	32
red flowers, round pollen grains	210

The result of a test cross can be used to determine a crossover value (COV). A crossover value is the percentage of the total number of offspring showing recombination.

The crossover value (COV) can be calculated using the formula shown in Fig. 2.1.

$$\text{COV} = \frac{\text{number of recombinants}}{\text{total number of individuals}} \times 100$$

Fig. 2.1

Calculate the COV from the results shown in Table 2.2.

COV =% [1]

- (iii) Suggest what information about the relative distance between the linked genes can be gained from crossover values.

.....
 [1]

[Total: 10]

(ii) Suggest **one** environmental factor that affects the growth and reproduction of *Eimeria*.

.....
[1]

(c) A study was carried out to investigate the effect of treating infected chickens with extracts from a plant, *Bidens pilosa*.

B. pilosa is used in traditional medicine for the treatment of some infectious diseases.

- Three populations, each containing 25 chickens infected with *Eimeria* were observed.
- The body mass of each chicken was measured at the start of the study.
- Each population was given a different treatment for 56 days:
 - standard diet with no *B. pilosa* extract
 - standard diet with low dose of *B. pilosa* extract
 - standard diet with high dose of *B. pilosa* extract.
- The body mass of each chicken was measured at the end of the study and the gain in body mass over the 56 days was calculated.
- The mean gain in body mass was calculated for each population.

The results are shown in Table 3.1.

Table 3.1

treatment	mean gain in body mass / g
no <i>B. pilosa</i>	1773.0 ±23.9
low dose of <i>B. pilosa</i>	2093.1 ±34.2
high dose of <i>B. pilosa</i>	2033.3 ±29.9

A statistical analysis of the results of the study of these three populations confirmed that there was a significant difference in mean gain in body mass between low dose *B. pilosa* and high dose *B. Pilosa* extract treatments.

(i) Name a statistical test that could be used to analyse the results of this study.

.....[1]

- (ii) Sketch on Fig. 3.1 curves to show the pattern of variation for gain in body mass in chickens treated with low dose *B. pilosa* extract and in chickens treated with high dose *B. pilosa* extract.

Label one curve '**low dose**' and the other curve '**high dose**'.

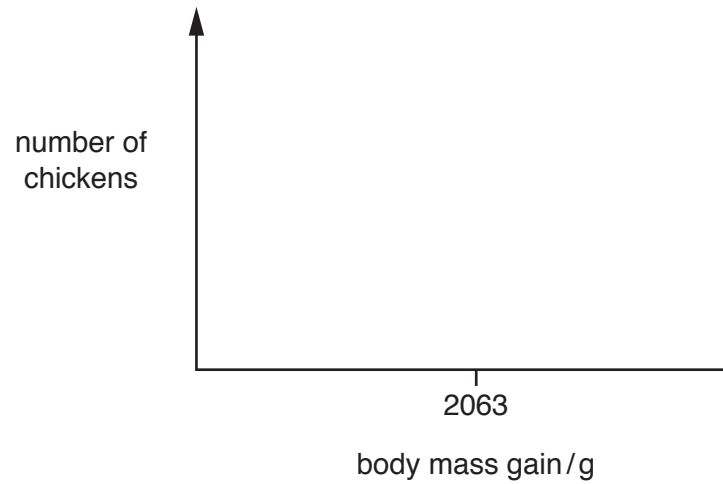


Fig. 3.1

[3]

[Total: 13]

- 5 (a) A severe reduction of blood flow to the brain causes cells to die. This is called a stroke. The after-effects of a stroke can range from recovery to permanent brain damage and death.

A new emergency gene therapy treatment for people who are at risk of brain damage from a stroke was tested in mice.

- The human granulocyte colony-stimulating factor, hG-CSF, is a protein that stimulates the production of stem cells in bone marrow.
- mRNA coding for hG-CSF was obtained and used to make cDNA.
- This cDNA was inserted into an adeno-associated virus (AAV) vector and given in eye drops to mice just after they experienced a stroke.

(i) Explain what is meant by *gene therapy*.

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..... [2]

(ii) Describe the roles of reverse transcriptase and DNA polymerase in making cDNA for hG-CSF.

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..... [2]

(iii) The AAV vector used was unable to replicate itself within the target cells.

Suggest why the researchers chose a vector that could not replicate.

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..... [2]

(b) A study was carried out to investigate the effect of the gene therapy described in (a). Four groups of mice were used.

- Group **A** mice had a stroke. They received eye drops containing AAV vector carrying cDNA for hG-CSF **once** only.
- Group **B** mice had a stroke. They received eye drops containing AAV vector carrying cDNA for hG-CSF **four** times.
- Group **C** mice had a stroke. They received eye drops containing AAV vector carrying the *GFP* gene coding for green fluorescent protein, instead of the cDNA for hG-CSF, **once** only.
- Group **D** mice did not have a stroke. They were not given any eye drops.

(i) Explain why the mice in group **C** were used in the study.

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.....[3]

(ii) Explain why the mice in group **D** were used in the study.

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.....[1]

6 Fig. 6.1 is an outline diagram showing two stages of aerobic respiration.

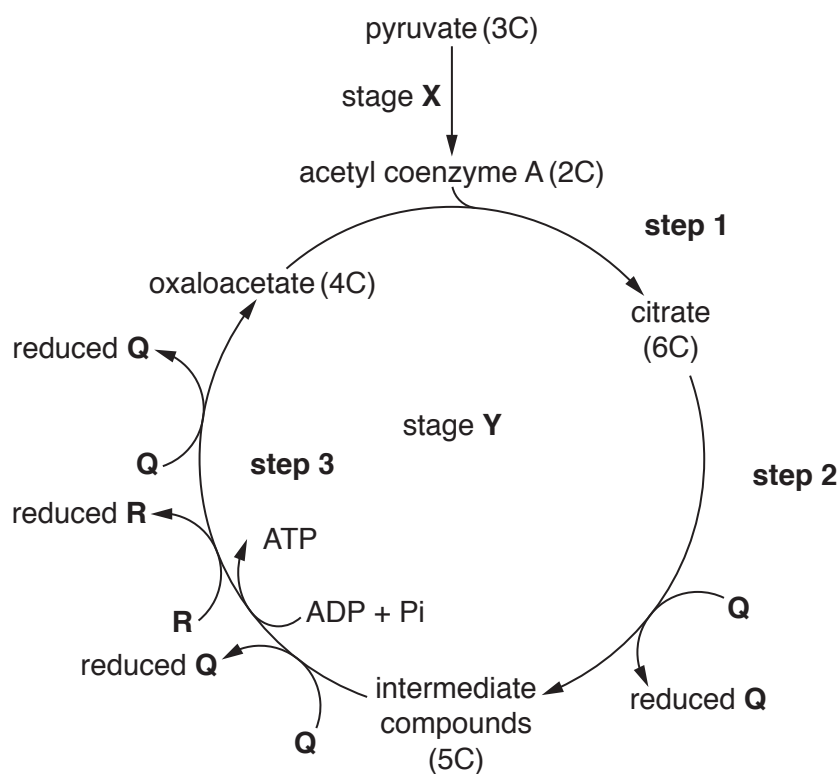


Fig. 6.1

(a) With reference to Fig. 6.1:

name stage **X**

.....

state the precise location of stage **Y**

.....

state the numbered steps in stage **Y** in which decarboxylation occurs

.....

name the type of reaction by which ATP is made during **step 3**

.....

name substances **Q** and **R**.

.....[5]

(b) Uncontrolled cell division can lead to a cancerous tumour. Many cancer cells break down the amino acid glutamine and convert it to a 5-carbon intermediate compound, which is shown in Fig. 6.1.

Suggest how the breakdown of glutamine can lead to the production of ATP in a cancer cell, other than that directly produced during **step 3**.

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..... [2]

[Total: 7]

(c) Fig. 8.1 is a diagram of a neuromuscular junction.

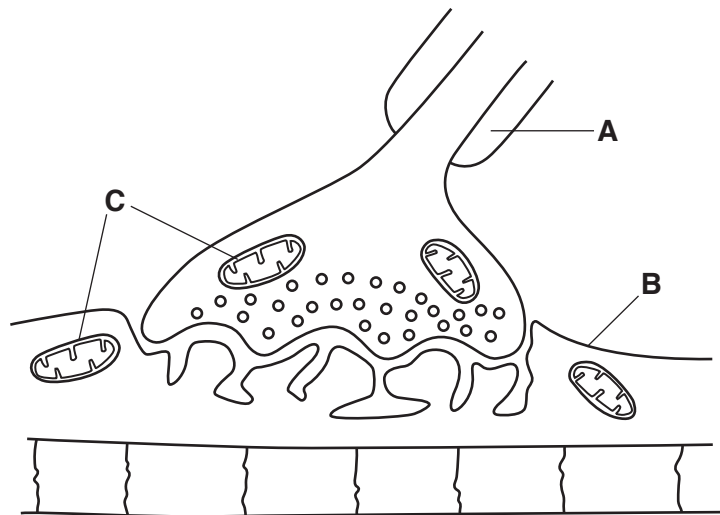


Fig. 8.1

(i) With reference to Fig. 8.1, name structures **A**, **B** and **C**.

A

B

C

[3]

(ii) Outline the importance of structure **A** in the transmission of nerve impulses.

.....

 [2]

(iii) Explain why the structures labelled **C** are needed in a neuromuscular junction.

.....

 [4]

[Total: 15]

[Turn over

