Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1461642828

BIOLOGY **9700/44**

Paper 4 A Level Structured Questions **May/June 2025**

2 hours

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 100.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **24** pages. Any blank pages are indicated.

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[Turn over

1 **(a)** Describe how a decrease in the water potential of the blood leads to an increase in the concentration of antidiuretic hormone (ADH) in the blood.

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(b) ADH is transported in the blood to the cells of the collecting duct of the kidney.

Fig. 1.1 is a diagram outlining the action of ADH on the cells of the collecting duct.

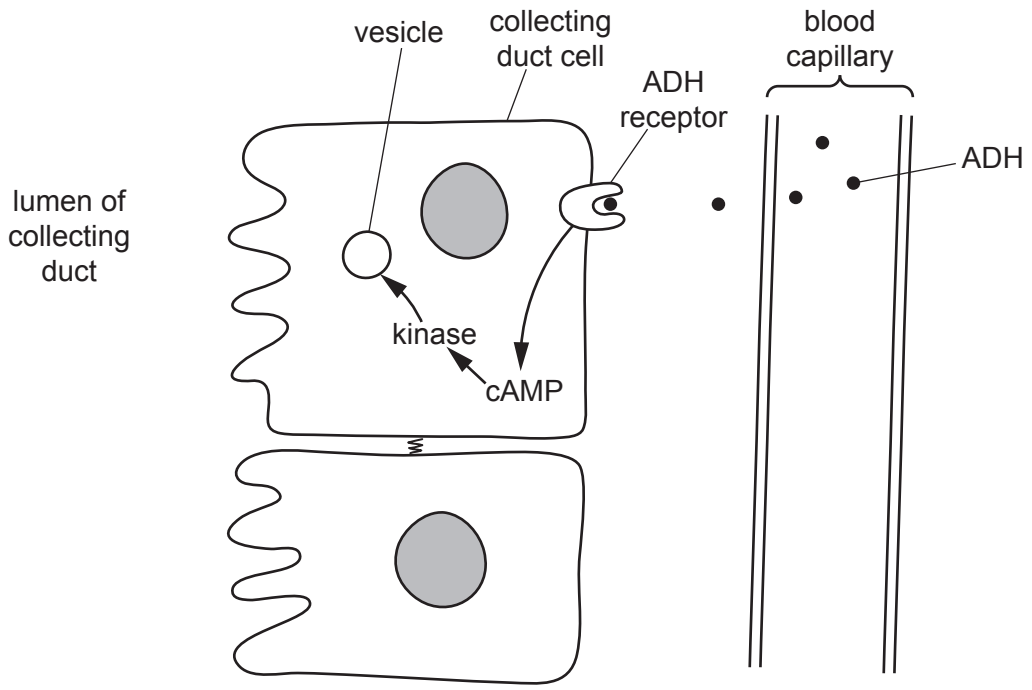


Fig. 1.1

(i) Binding of ADH to the ADH receptor triggers reactions within the cell. One of the first reactions is the production of cyclic AMP (cAMP).

State the term used to describe molecules such as cAMP in cell signalling.

..... [1]

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(ii) Describe the role of the vesicle when stimulated by kinase enzyme.

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..... [2]

(iii) On Fig. 1.1, draw arrows to show the direction of movement of water molecules after the cells of the collecting duct have responded to ADH. [1]

(c) Some people have a rare kidney disorder in which ADH is not able to bind to ADH receptors.

Suggest the effects of this disorder on osmoregulation.

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[Total: 9]

2 Inherited diseases are caused by genetic mutations.

(a) Huntington's disease is an inherited genetic disease.

Using Huntington's disease as an example, outline the relationship between genes, proteins and phenotype.

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(b) Retinitis pigmentosa is an inherited genetic disease that causes loss of vision.

The inheritance of a rare form of retinitis pigmentosa in a family is shown in Fig. 2.1.

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Fig. 2.1

Scientists concluded that the inheritance of this rare form of retinitis pigmentosa is linked to the Y chromosome.

Using evidence shown in Fig. 2.1, explain why the scientists reached this conclusion.

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(c) Incontinentia pigmenti is a disease that affects the skin, hair and central nervous system.

The disease is caused by a dominant allele on the X chromosome.

Construct a genetic diagram to determine the expected offspring for a healthy father and a heterozygous mother with incontinentia pigmenti.

State the expected phenotypic ratio of the offspring.

Use the symbols:
$\mathbf{X^A}$ = allele for incontinentia pigmenti
$\mathbf{X^a}$ = normal allele

offspring genotypes

offspring phenotypes

expected ratio .....
[4]

(d) Some diseases are caused by mutations in regulatory genes.

Suggest how a mutation in a regulatory gene that codes for a repressor protein could cause a disease.

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..... [3]

[Total: 14]

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3 The genetics and evolution of the cat family, Felidae, have been studied by scientists.

(a) The domestic cat, *Felis catus*, is a popular pet.

Fur length in *F. catus* is coded for by two alleles, **H** and **h**:

- the allele for short hair, **H**, is dominant
- the allele for long hair, **h**, is recessive.

(i) The population of domestic cats in a city was studied:

- the population consisted of 15 000 cats
- 6.8% of these cats were long-haired.

Calculate the percentage of cats in the city that were heterozygous for hair length.

You should use the Hardy–Weinberg equations in your calculation.

$p + q = 1$ $\qquad\qquad$ $p^2 + 2pq + q^2 = 1$

Show your working.

answer = ... [3]

(ii) Give **two** reasons why the domestic cat population does **not** meet the conditions needed to apply the Hardy–Weinberg principle.

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..... [2]

(b) Some domestic cats have no tails (tailless). The tailless phenotype in cats is genetically controlled.

Fig. 3.1 shows a tailless cat.

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Fig. 3.1

A small population of domestic cats, including some tailless cats, was introduced to an island called the Isle of Man in the 1700s.

After several generations, without artificial selection from humans, a high proportion of the cat population was tailless.

Suggest why the tailless phenotype became common in the small cat population on the Isle of Man.

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(c) Cheetahs, *Acinonyx jubatus*, are predatory mammals. They have evolved black spots on their fur, which provide camouflage in their habitats.

Describe how the spotted fur phenotype of *A. jubatas* may have evolved through natural selection from a non-spotted ancestor.

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..... [3]

[Total: 11]

4 Organisms are classified in three domains. The domain Eukarya is divided into four kingdoms.

(a) The four eukaryotic kingdoms are listed in Table 4.1.

Complete Table 4.1 by writing '**yes**' or '**no**' to produce a summary of some of the main features of each kingdom.

Table 4.1

kingdom	species may be unicellular	species may have cell walls	species may show autotrophic nutrition
Animalia	no		
Fungi			no
Plantae		yes	
Protoctista			

[4]

(b) Meiosis occurs in the kingdom Plantae.

Fig. 4.1 shows drawings of photomicrographs of three stages of meiosis in the lily plant, *Lilium grandiflorum*. Individual chromosomes and their structure **cannot** be seen clearly.

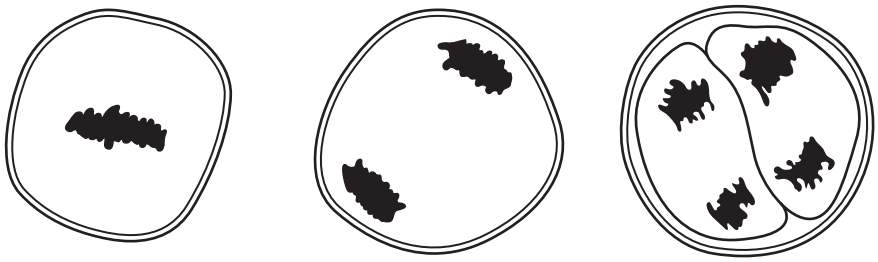


Fig. 4.1

Identify the three stages of meiosis shown in Fig. 4.1.

A .....

B .....

C .....

[3]

(c) The organisms in the other domains are prokaryotes.

Name the **two** domains containing prokaryotic organisms **and** describe differences between these two domains.

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(d) Viruses are not cellular organisms, but they are classified based on their characteristics.

Outline how viruses are classified.

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[Total: 12]

5 Genetic engineering may often involve the transfer of a gene into an organism.

(a) The polymerase chain reaction (PCR) can be used to produce many copies of a gene for transfer.

Describe **and** explain the steps involved in PCR.

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(b) Some species of *Anopheles* mosquitoes, such as *Anopheles stephensi*, transmit malaria. Scientists have created genetically engineered *A. stephensi* mosquitoes in an attempt to reduce the spread of malaria.

A gene called *tTav* was constructed by scientists and transferred into the eggs of *A. stephensi*.

- *tTav* consists of DNA sequences from a bacterium, *Escherichia coli*, and herpes simplex virus, which is a DNA virus.
- The gene codes for tTav protein, which stops the expression of genes that are essential to mosquito development.
- Genetically engineered *A. stephensi* do not survive beyond the larval stage and therefore do not develop into adults.
- A chemical called tetracycline can stop the action of the tTav protein.

Male genetically engineered *A. stephensi* were released into the wild to breed with females. Their offspring had the *tTav* gene.

(i) Describe how the *tTav* gene could have been synthesised and transferred into the eggs of *A. stephensi*.

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(ii) Suggest how the tTav protein prevents the expression of other genes in *A. stephensi*.

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(iii) Genetically engineered *A. stephensi* larvae were exposed to tetracycline in the laboratory.

Suggest why *A. stephensi* larvae were exposed to tetracycline in the laboratory.

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[Total: 11]

6 *Ensatina eschscholtzii* is a species of salamander that lives in woodland ecosystems in California, USA.

Fig. 6.1 shows an ensatina salamander.

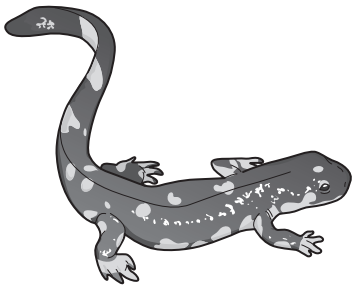


Fig. 6.1

(a) Define the term ecosystem.

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(b) The term species can be defined using different concepts, including the biological species concept and the morphological species concept.

The morphological species concept is based on appearance or observable characteristics.

Describe what is meant by the biological species concept.

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..... [1]

(c) Populations of *E. eschscholtzii* are separated by the Central Valley, shown in Fig. 6.2, which contains conditions unsuitable for salamanders.

Some scientists think that the separated populations of *E. eschscholtzii* have evolved to form different species of salamander.

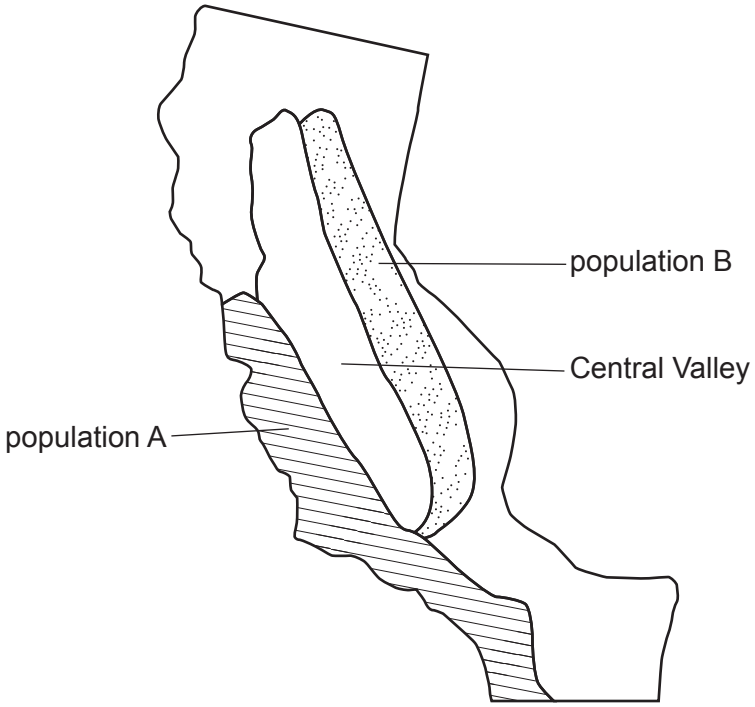


Fig. 6.2

Individuals from different salamander populations may not be able to reproduce with each other, even if they are able to interact.

Explain how salamanders from different populations have evolved to be unable to reproduce with each other.

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[Total: 7]

7 The grass *Oryza sativa* is grown as a food crop to produce rice. Rice plants are adapted to grow with their roots submerged in water.

(a) An experiment was carried out to investigate the development of aerenchyma tissue in the roots of rice plants.

- 10-day old seedlings were grown with their roots submerged in water.
- Some were grown in water that was kept oxygenated and others were grown in water that did not contain oxygen (deoxygenated).
- At 12 hour intervals, some seedlings from each group were removed and transverse sections of their roots were prepared and examined.
- The sections were cut at the same distances from the root tip to check for development.
- The percentage of root tissue that had developed into aerenchyma tissue was calculated.

The results are shown in Fig. 7.1.

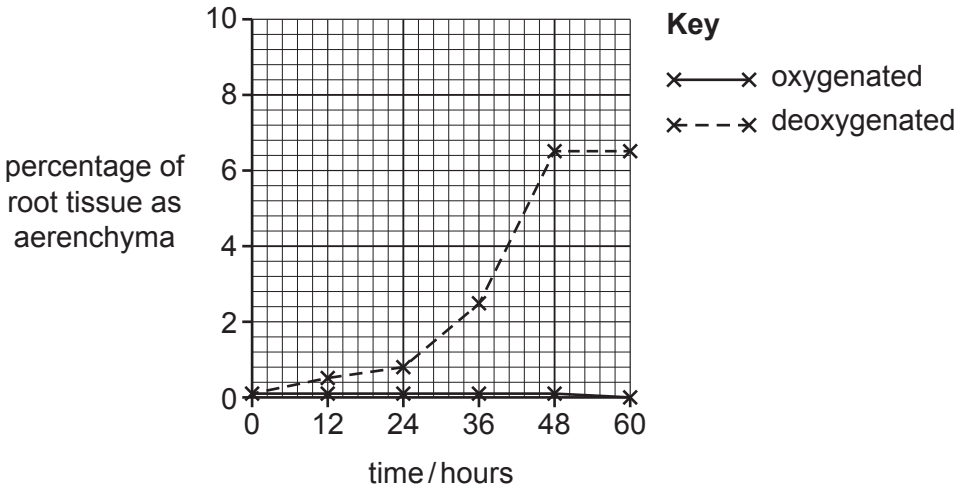


Fig. 7.1

(i) Describe the results shown in Fig. 7.1.

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(ii) Describe the structure of aerenchyma **and** explain how this is an adaptation that allows roots of rice plants to be submerged in water.

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(b) Describe **and** explain **two** other adaptations of rice plants to growing in flooded fields.

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[Total: 10]

8 **(a)** Fig. 8.1 is a transmission electron micrograph of striated muscle.

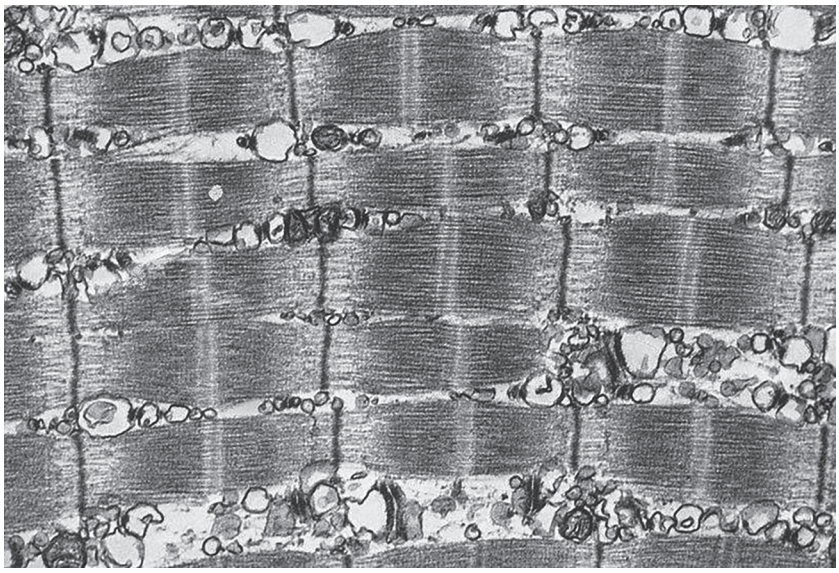


Fig. 8.1

On Fig. 8.1:

- use the letter **P** with a label line to show a region containing only actin
- use the letter **Q** with a label line to show a region containing only myosin
- use the letter **R** with a label line to show a region containing both actin and myosin.

[3]

(b) Striated muscle contraction is explained by the sliding filament model.

Outline the role of the proteins troponin and tropomyosin in the sliding filament model.

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(c) Striated muscles can sometimes become less efficient at contracting if they have been active for a long time. This is called muscle fatigue.

Suggest why muscles may become fatigued.

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[Total: 9]

9 **(a)** Fig. 9.1 is a diagram outlining non-cyclic photophosphorylation.

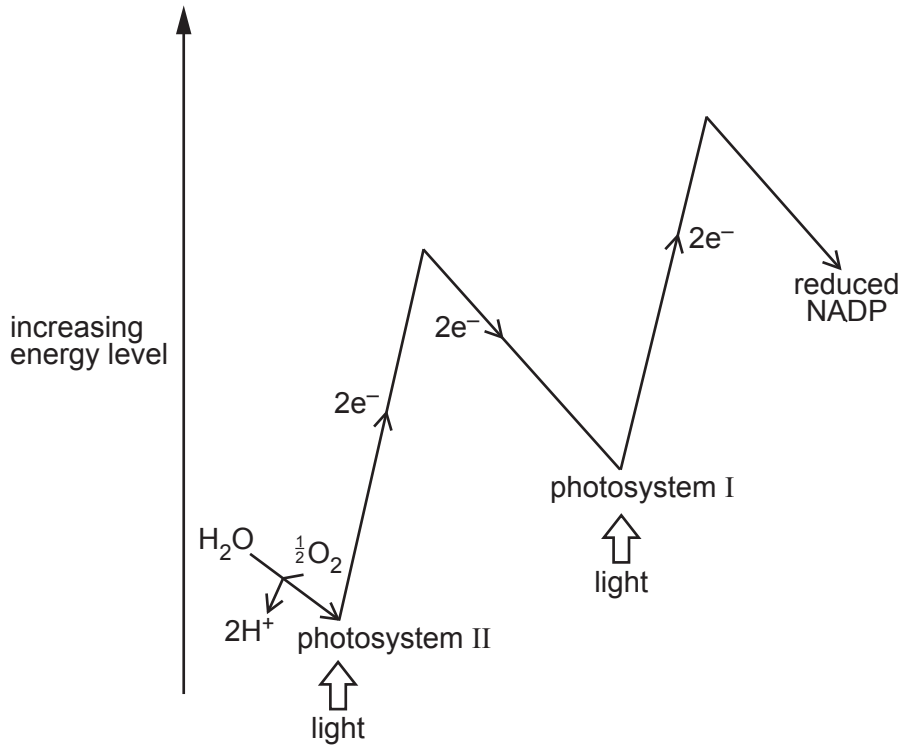


Fig. 9.1

With reference to Fig. 9.1, describe the process of non-cyclic photophosphorylation.

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(b) Fig. 9.2 shows the relationship between the rate of photosynthesis and light intensity.

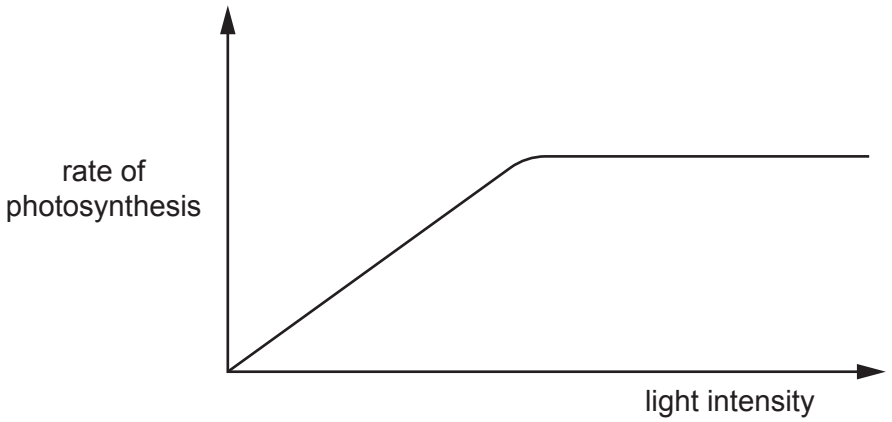


Fig. 9.2

Describe **and** explain the relationship shown in Fig. 9.2.

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[Total: 10]

10 **(a)** The respiratory quotient (RQ) is used to indicate what type of substrate is being metabolised in respiration.

(i) Define the term respiratory quotient.

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(ii) When the unsaturated fatty acid linoleic acid is respired aerobically the equation is:

$C_{18}H_{32}O_2$ + ... O_2 → $18CO_2$ + $16H_2O$ + energy

Calculate how many molecules of oxygen are used when one molecule of linoleic acid is respired aerobically.

answer ..... [1]

(iii) Calculate the RQ for linoleic acid.

answer ..... [1]

(b) Hummingbirds feed on nectar from flowers. Nectar is rich in sugars.

Fig. 10.1 shows a hummingbird.



Fig. 10.1

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A study of aerobic respiration in captive hummingbirds was carried out. The hummingbirds were allowed to feed freely and then made to fast for 4 hours. During the fasting period their RQ values were calculated every 40 minutes.

Fig. 10.2 shows the results from this study.

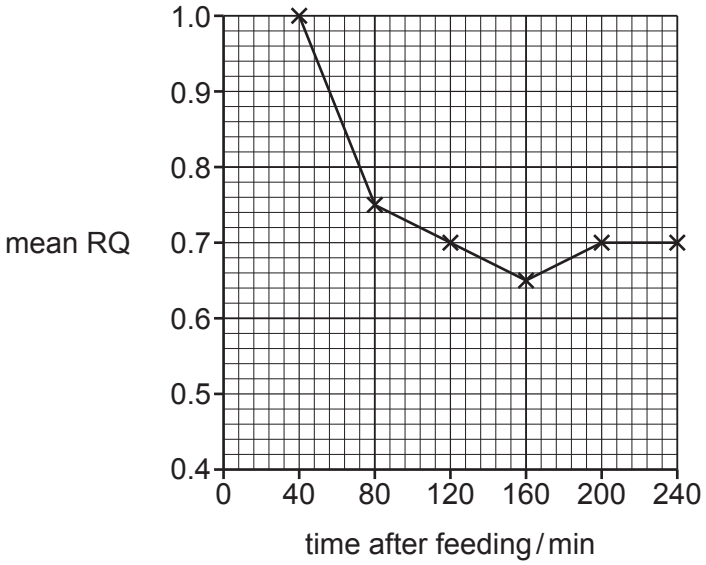


Fig. 10.2

Describe **and** suggest explanations for the results shown in Fig. 10.2.

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[Total: 7]

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