Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

2768820389

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **February/March 2016**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Answer Paper available on request.

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 **24** printed pages, **1** blank page and **3** lined pages.

DC (CW/SW) 122804/2

CAMBRIDGE
International Examinations

Section A

Answer **all** the questions.

1 **(a)** The rate of photosynthesis is affected by a number of environmental factors.

Fig. 1.1 shows the effect of light intensity on the rate of photosynthesis.

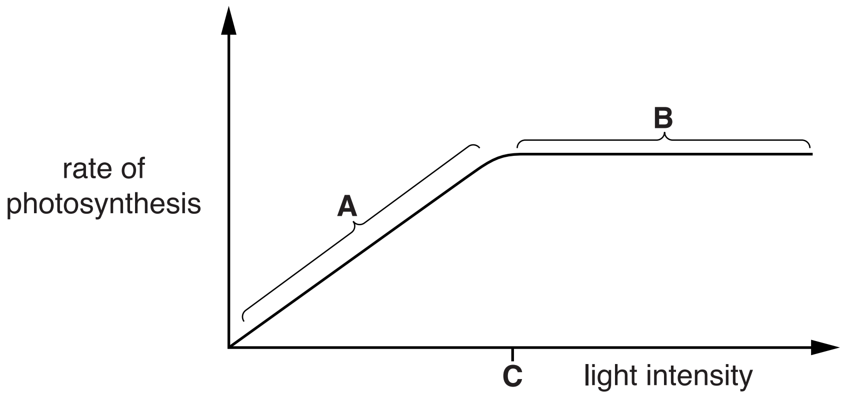

Fig. 1.1

(i) State the limiting factor in region **A** of the graph.

.... [1]

(ii) Explain what is meant by the term *limiting factor*.

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.... [2]

(iii) Explain why there is no further increase in the rate of photosynthesis beyond point **C**.

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.... [2]

(b) For many plants living in temperate regions, the optimum temperature for photosynthesis is approximately 25 °C.

Suggest reasons why the rate of photosynthesis decreases at temperatures above 25 °C.

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.... [4]

[Total: 9]

2 The IUCN Red List provides information about the conservation status of species throughout the world, including the American badger, *Taxidea taxus*, and the black-footed ferret, *Mustela nigripes*.

Fig. 2.1 shows an American badger and Fig. 2.2 shows a black-footed ferret.

Fig. 2.1

Fig. 2.2

Fig. 2.3 shows the IUCN conservation status of the American badger and the black-footed ferret in 1987 and in 2013.

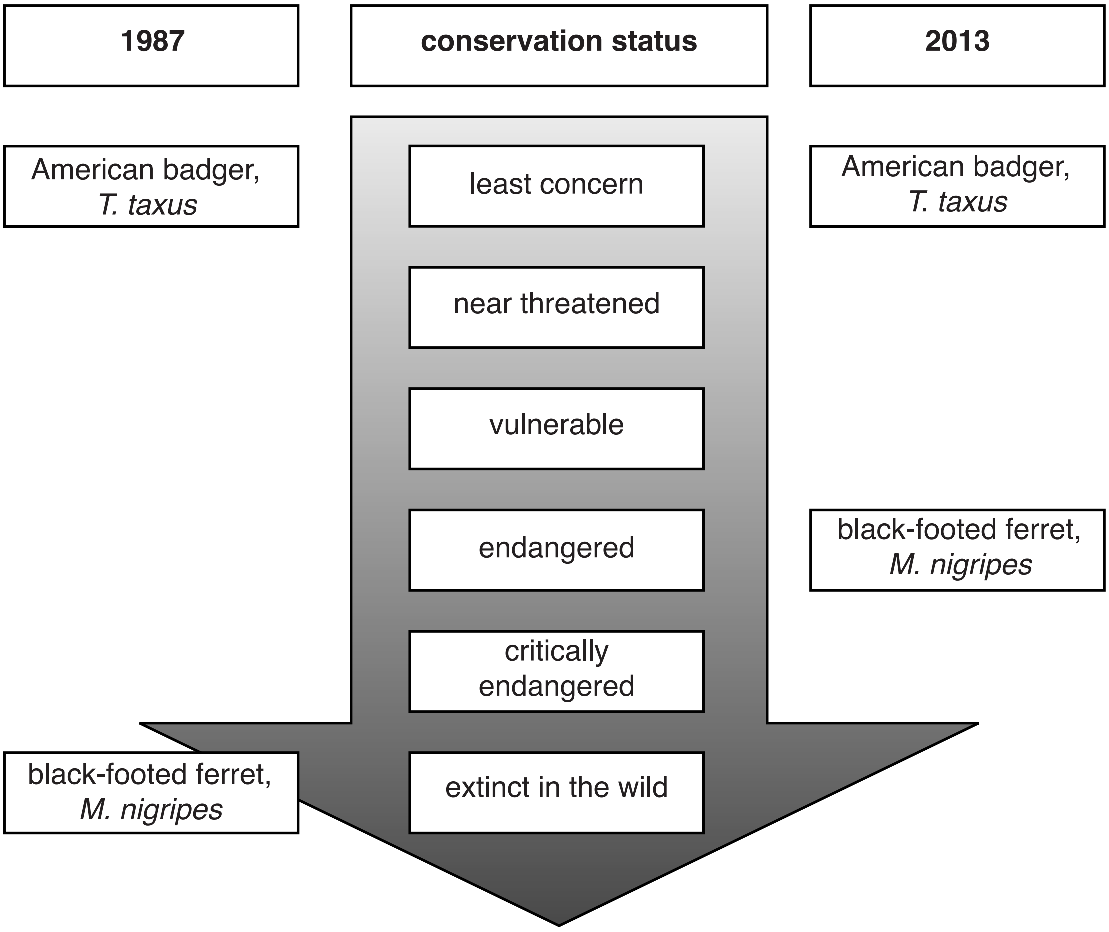

Fig. 2.3

(a) American badgers and black-footed ferrets are both predators.

- American badgers feed on prairie dogs and a range of other animals.
- Black-footed ferrets feed almost entirely on prairie dogs.
- American badgers do not have any animal predators.
- Black-footed ferrets are preyed upon by American badgers and several other predators.

Suggest reasons why black-footed ferrets are an endangered species but American badgers are not.

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.... [2]

(b) In 1987, the world population of black-footed ferrets consisted of only 18 animals living in captivity. A number of different agencies worked together to prevent the extinction of this species. Their goal was to produce young black-footed ferrets to be released into the wild. The survival and breeding of the animals in the wild would then be monitored and supported.

The collaborating agencies included:

- local government
- universities
- zoos
- native tribes that owned undeveloped reservation land.

Outline how these different agencies could contribute to successful conservation of the black-footed ferret.

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.... [3]

(c) Black-footed ferrets were released at three different locations in the wild at different times. Each population was established from captive-bred animals.

Fig. 2.4 shows the population sizes of black-footed ferrets at the three release locations.

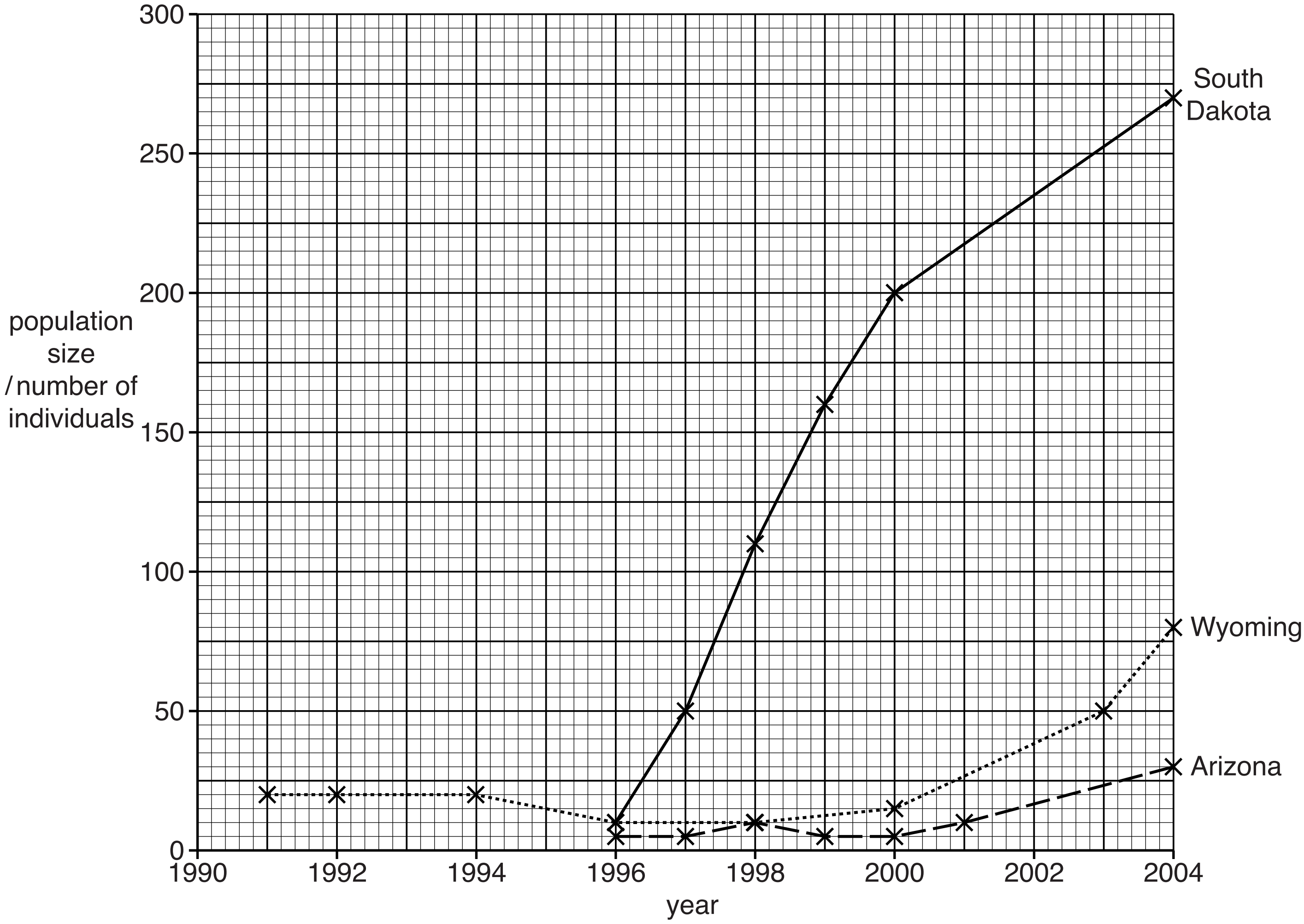

Fig. 2.4

(i) Describe the patterns of population growth at the three locations where black-footed ferrets were released.

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.... [3]

Table 2.1 shows information about the gene pool of the populations of black-footed ferrets and the leg sizes of the black-footed ferrets at each release location in 2004.

All three populations were started by animals from the same captive population. In this original captive population, 100% of the genes surveyed showed polymorphism, that is, they had more than one allele. The mean number of alleles per gene locus was two.

The population at the South Dakota location in 2004 maintained the same level of genetic variation and leg size data as the original captive population, but the populations in Wyoming and Arizona showed changes.

Table 2.1

population location	gene pool data		leg size data	
	percentage of genes that are polymorphic	mean number of alleles per gene locus	mean length of lower back leg bone / mm	mean length of lower front leg bone / mm
South Dakota	100	2.00	69.4	59.0
Wyoming	43	1.43	68.0	56.7
Arizona	100	2.14	69.4	59.0

(ii) Use Table 2.1 to describe how the gene pools and leg sizes of the Wyoming and Arizona black-footed ferret populations have changed, compared to the original captive population.

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.... [2]

(iii) With reference to Fig. 2.4, suggest reasons for the changes you have described in **(ii)**.

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.... [3]

(d) In 2008 some black-footed ferrets were born in captivity as a result of IVF using frozen sperm that had been stored for several years.

Explain the benefits of using frozen sperm in captive breeding programmes.

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.... [3]

[Total: 16]

Question 3 starts on page 10

3 **(a)** Myofibrils in striated muscle consist of contractile units called sarcomeres.

When an impulse stimulates striated muscles to contract, calcium ions are released from the sarcoplasmic reticulum.

Describe how the release of calcium ions leads to the contraction of a sarcomere.

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.... [4]

(b) The many-banded krait, *Bungarus multicinctus*, is a venomous snake.

Fig. 3.1 shows a many-banded krait.

Fig. 3.1

The venom from the many-banded krait contains bungarotoxin. In mammals that are bitten by this snake, the venom acts at the neuromuscular junction, causing muscle paralysis (loss of muscle function).

Suggest how bungarotoxin may cause muscle paralysis.

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.... [4]

[Total: 8]

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4 The process of gametogenesis in male and female vertebrates, including humans, involves meiosis.

(a) Describe how gametogenesis differs between human males and females.

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.... [3]

(b) Fig. 4.1 shows a Komodo dragon, *Varanus komodoensis*. This species of lizard is only found on five Indonesian islands.

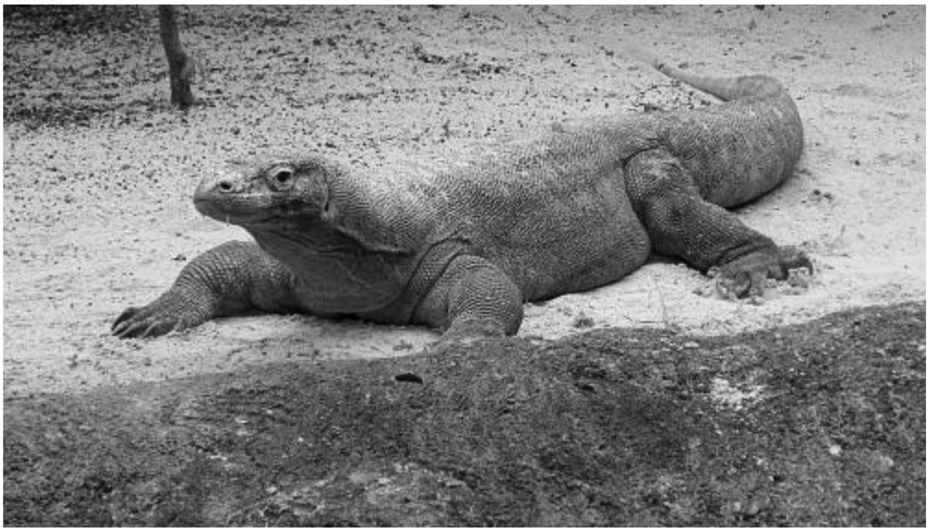

Fig. 4.1

In 2006, two captive female Komodo dragons (**A** and **B**) in British zoos each produced healthy offspring (**1**–**4**) despite never having mated with a male. Female **B** was later mated with a male Komodo dragon (**C**) and produced another offspring (**5**).

Genetic analysis was performed on:

- the two females, **A** and **B**
- their offspring (**1–4**) that had no father
- the male, **C**
- the offspring (**5**) produced by the mating between **B** and **C**.

The results of the genetic analysis are shown in Table 4.1. Different alleles at four gene loci (**P**, **Q**, **R** and **S**) could be distinguished by their different lengths. The alleles for each gene are shaded differently in Table 4.1. The sex chromosomes in this species are called W and Z.

Table 4.1

individual	sex chromosomes	allele length / base pairs (bp)							
		gene locus **P**		gene locus **Q**		gene locus **R**		gene locus **S**	
female **A**	WZ	211	216	151	154	188	200	133	133
offspring **1** from female **A**	ZZ	216	216	151	151	200	200	133	133
offspring **2** from female **A**	ZZ	211	211	154	154	188	188	133	133
female **B**	WZ	211	213	154	154	190	190	137	141
offspring **3** from female **B**	ZZ	211	211	154	154	190	190	141	141
offspring **4** from female **B**	ZZ	213	213	154	154	190	190	137	137
male **C**	ZZ	211	216	151	154	188	206	141	141
offspring **5** from **B** and **C**	WZ	211	216	154	154	190	206	141	141

(i) Using Table 4.1, identify the gene locus that shows the most genetic variability **and** name the process that gives rise to the different lengths of the alleles.

locus ....

process ....
[2]

(ii) Using Table 4.1, state and explain which animals are heterozygous at one or more of the gene loci.

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.... [3]

(iii) Clones are organisms or cells that are genetically identical.

Students made suggestions about the Komodo dragon offspring (**1**–**4**) produced by a female that had never mated with a male.

- Offspring **1** and **2** are clones of each other, and offspring **3** and **4** are clones of each other.
- Offspring **1**–**4** were produced by asexual reproduction using mitosis only.

Explain, with reference to specific loci, whether the data in Table 4.1 support or do not support these suggestions.

*Offspring **1** and **2** are clones of each other, and offspring **3** and **4** are clones of each other.*

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*Offspring **1**–**4** were produced by asexual reproduction using mitosis only.*

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[2]

(c) Reproduction without a male has evolved in a number of species that live on islands.

Suggest advantages and disadvantages of this type of reproduction in an island habitat.

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.... [4]

[Total: 14]

Question 5 starts on page 18

5 **(a)** Fig. 5.1 outlines how two hormones, **A** and **B**, are involved in the regulation of blood glucose concentration.

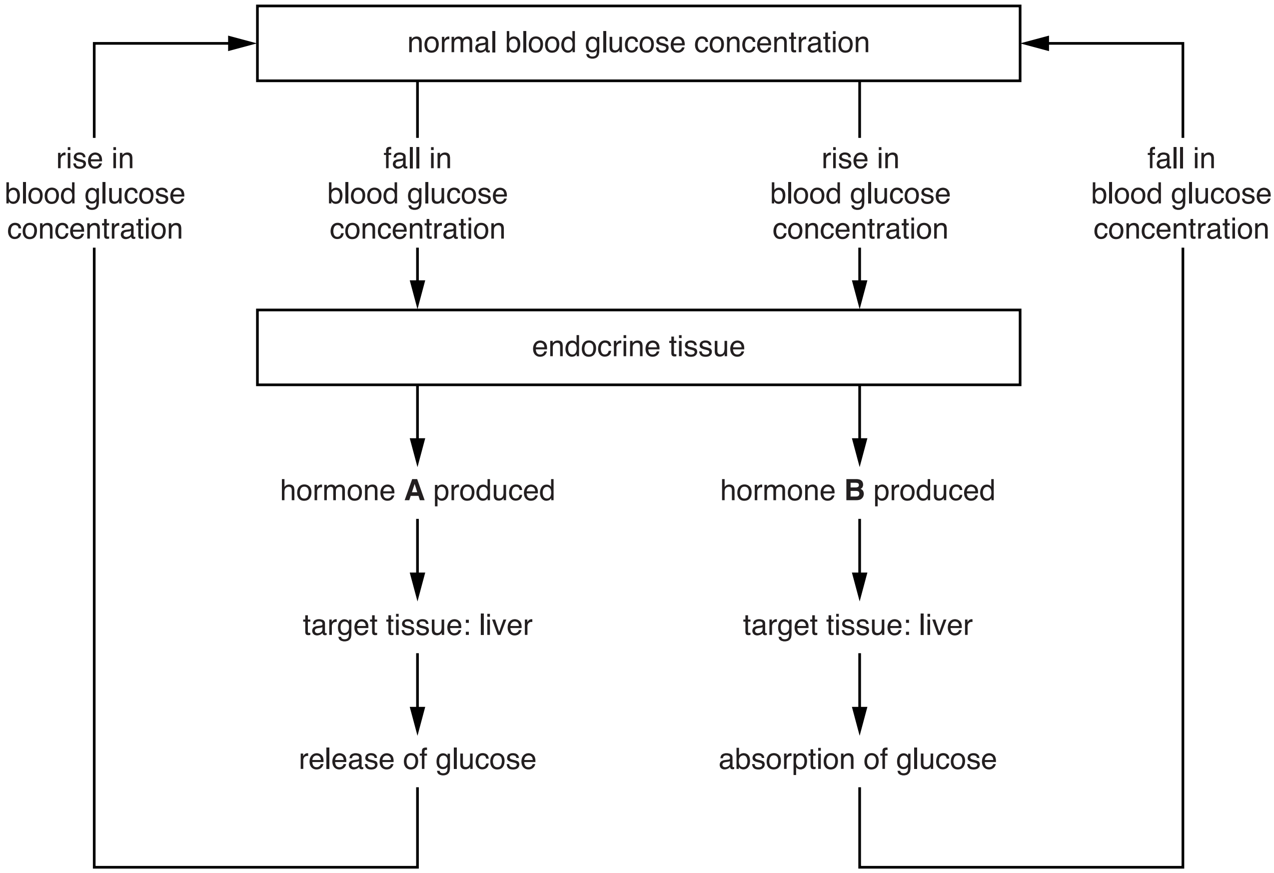

Fig. 5.1

With reference to Fig. 5.1, name:

(i) the control mechanism that regulates blood glucose concentration

....[1]

(ii) hormone **A**.

....[1]

(b) The enzymes glycogen synthetase and glycogen phosphorylase are both involved in the formation and breakdown of glycogen in the liver.

Fig. 5.2 shows the activity of the two enzymes in the liver after consumption of a glucose meal.

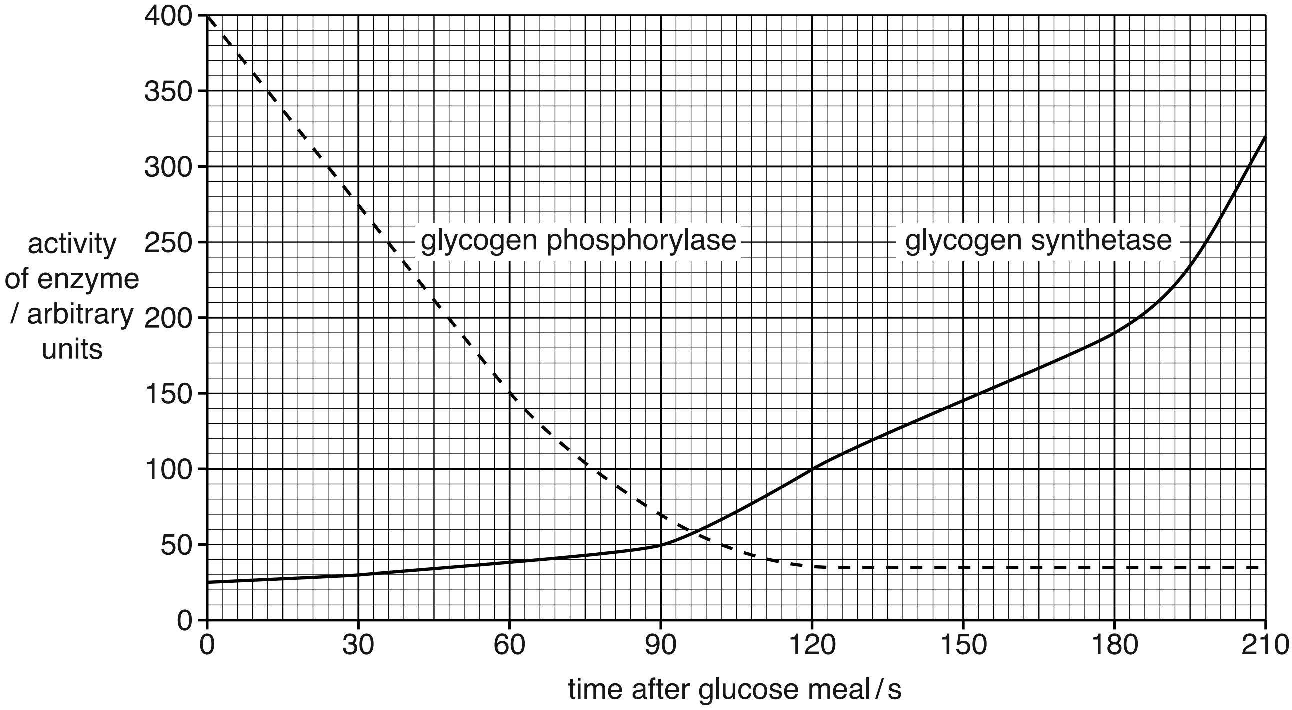

Fig. 5.2

Describe and suggest an explanation for the changes in the activity of the enzymes glycogen synthetase and glycogen phosphorylase.

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....[5]

[Total: 7]

6 *Paramecium* is a ciliated, unicellular protoctist. The cilia are similar in structure to those found in the trachea of a human. The cilia beat to move *Paramecium* through the water in which it lives.

Fig. 6.1 shows *Paramecium*.

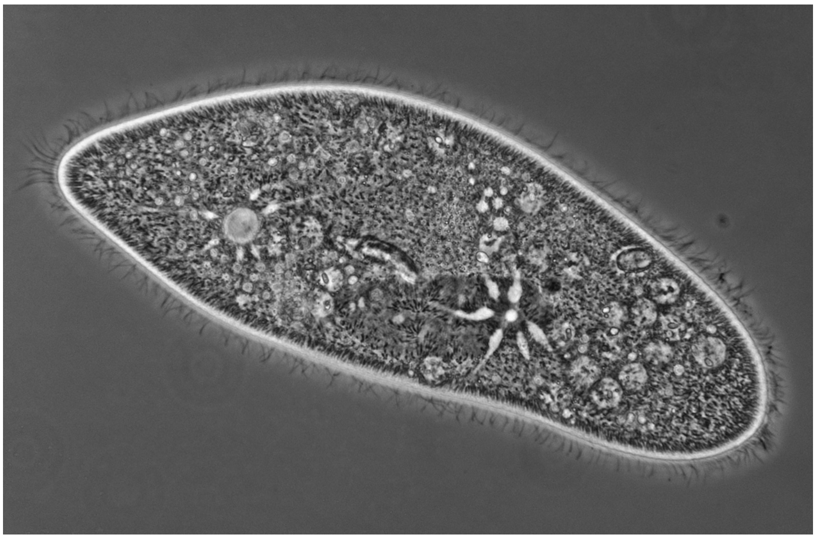

Fig. 6.1

(a) *Paramecium* has anterior and posterior ends. Generally the cilia beat so that the organism is moved forwards. Sometimes reverse movement is needed, for example when the *Paramecium* meets an obstacle.

- The direction of beating of the cilia is linked to the difference in concentration of calcium ions inside and outside the cell.
- There is usually a higher concentration of calcium ions outside than inside the cell.
- When *Paramecium* touches an object, its cell surface membrane becomes deformed.
- The membrane potential becomes more positive inside the cell.
- The organism moves backwards for a short time.

(i) Suggest the sequence of events that occurs to cause the *Paramecium* to move backwards when it touches an object.

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.... [2]

(ii) Suggest how *Paramecium* ensures that there is usually a higher concentration of calcium ions in the surrounding water than inside the cell.

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.... [2]

(b) *Paramecium* has a contractile vacuole that fills up with water. When it is full, the contractile vacuole contracts to expel the water. The rate of contraction of the vacuole depends on the water potential of the surrounding water.

(i) Name the process by which water enters *Paramecium*.

.... [1]

(ii) Suggest the relationship between the rate of contraction of the contractile vacuole and the water potential of the surrounding water.

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.... [1]

(c) Describe how the DNA of *Paramecium* differs from that of a prokaryotic cell.

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.... [2]

[Total: 8]

7 **(a)** Fig. 7.1 is a diagram of a section through a mitochondrion.

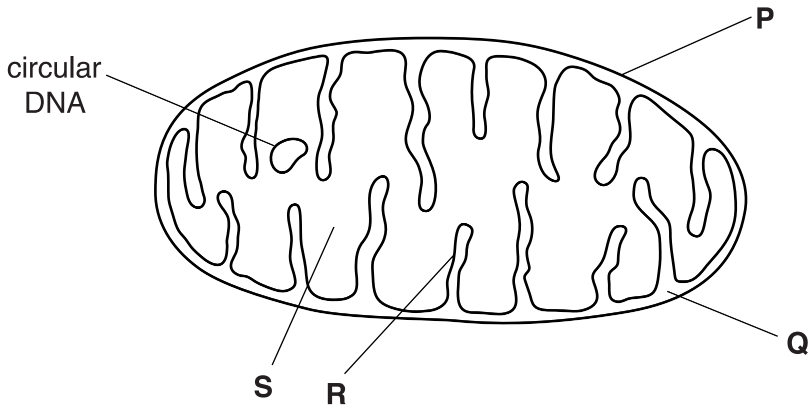

Fig. 7.1

(i) Using Fig. 7.1, state the letter which indicates the site of:

- the Krebs cycle ....
- oxidative phosphorylation ....
- decarboxylation. ....

[3]

(ii) Suggest **one** function for the circular DNA in Fig. 7.1.

....

....

.... [1]

(b) During respiration, exchange of substances takes place between the cytoplasm and the mitochondria.

Complete the table below to list three substances that enter the mitochondria and three substances that leave the mitochondria.

	substance that **enters** the mitochondria	substance that **leaves** the mitochondria
1		
2		
3		

[3]

(c) The poison cyanide binds with cytochrome oxidase, one of the carriers in the electron transport system.

Suggest how ingestion of cyanide by humans leads to death by muscle failure.

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.... [4]

(d) Tripalmitin is a triglyceride. The chemical equation for the aerobic respiration of tripalmitin is:

$$2C_{51}H_{98}O_6 + 145O_2 \longrightarrow 102CO_2 + 98H_2O$$

(i) Calculate the RQ value for tripalmitin.
Give your answer to **2 decimal places**.

Show your working.

answer ....
[2]

(ii) Explain why the usual RQ value for respiration in humans is between 0.7 and 1.0.

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.... [2]

[Total: 15]

8 In a species of snail, shell colour is controlled by a gene with three alleles:

- allele $\mathbf{C^B}$ codes for a brown shell
- allele $\mathbf{C^P}$ codes for a pink shell
- allele $\mathbf{C^Y}$ codes for a yellow shell.

Allele $\mathbf{C^B}$ is dominant to both $\mathbf{C^P}$ and $\mathbf{C^Y}$.
Allele $\mathbf{C^P}$ is dominant to $\mathbf{C^Y}$.

The shells of this snail may be banded (have dark stripes) or non-banded.
The allele for non-banded, **N**, is dominant to the allele for banded, **n**.

(a) State what is meant by the terms *dominant* and *allele*.

dominant ....

....

....

allele ....

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.... [2]

(b) A cross between a brown, non-banded snail and a pink, non-banded snail produces some offspring that are both yellow **and** banded.

(i) State the genotypes of both parents.

brown, non-banded ....

pink, non-banded ....

[2]

(ii) List the parental gametes.

brown, non-banded ....

....

pink, non-banded ....

.... [2]

(iii) State the genotype of the offspring that are both yellow **and** banded.

.... [1]

(iv) Suggest the proportion of offspring expected to be both yellow **and** banded.

.... [1]

[Total: 8]

Section B

Answer **one** question.

9 **(a)** Explain the use of genes for fluorescent or easily stained substances as markers in gene technology. [6]

(b) Discuss the potential advantages of growing genetically modified crops, using examples to help your answer. [9]

[Total: 15]

10 **(a)** Explain how genetic diseases may be treated using gene therapy. [7]

(b) Discuss the advantages of screening for genetic conditions. [8]

[Total: 15]

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