UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6633518797

BIOLOGY **9700/41**

Paper 4 A2 Structured Questions **May/June 2010**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Answer Paper available on request.

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Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
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Answer **all** questions in Section A and **one** question from Section B.
Circle the number of the Section B question you have answered in the grid below.

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.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
9 or 10	
Total	

This document consists of **19** printed pages, **3** lined pages and **2** blank pages.

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Section A

For Examiner's Use

Answer **all** the questions.

1 The flatback turtle, *Natator depressus*, is an endangered species that nests on northern Australian beaches.

Fig. 1.1 shows a flatback turtle.

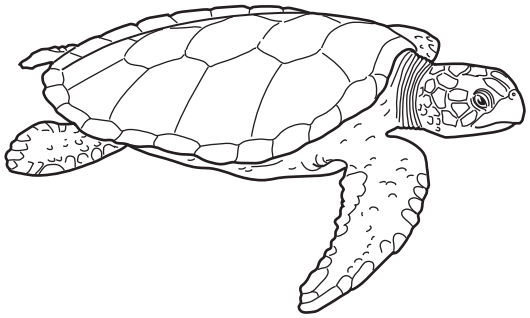


Fig. 1.1

Each female lays approximately 50 eggs per nest, which is a smaller number than all other species of marine turtle. The eggs are buried in the sand and when the hatchlings emerge each has a mass of approximately 43 g. Unlike most marine turtles, flatback turtles spend most of their time in coastal waters. This is where they feed and mate.

Fig. 1.2 shows the numbers of female flatback turtles nesting on a beach in northern Australia between 1993 and 2002.

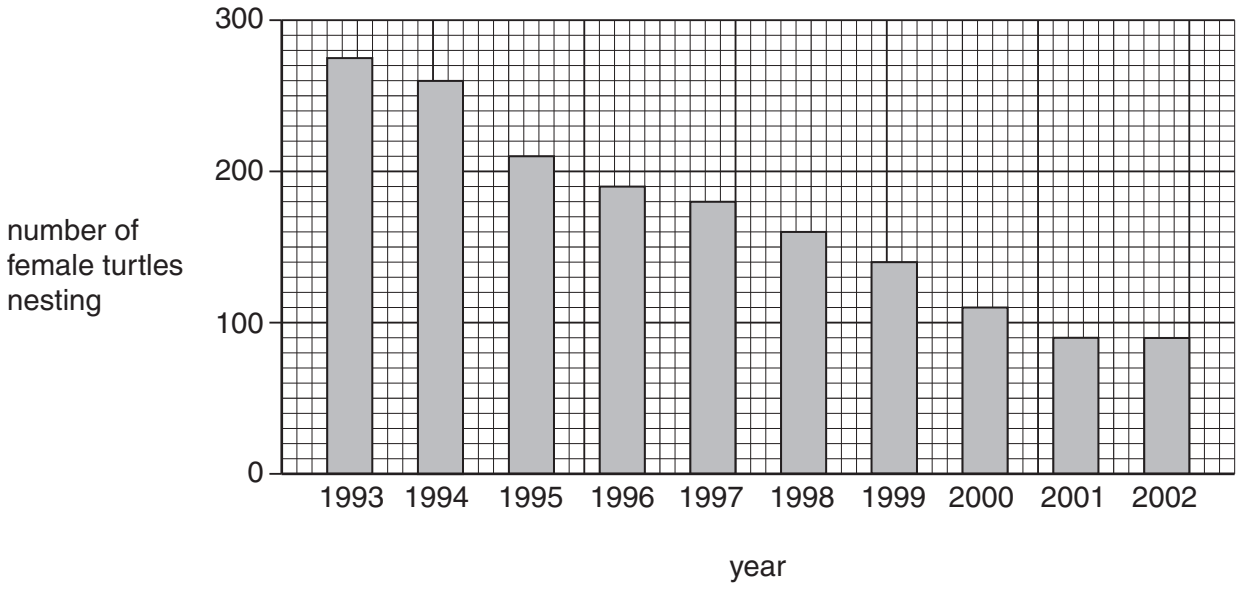


Fig. 1.2

(a) Calculate the mean **rate** of decrease in the numbers of females nesting between 1993 and 2002.

For Examiner's Use

Show all the steps in your calculation.

Answer..... [2]

(b) Suggest ways in which the flatback turtle could be protected.

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..... [5]

[Total: 7]

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[Turn over

2 **(a)** The glycoproteins CD28 and CD40 are found on the surface of T-lymphocytes (T-cells). They are binding sites for cell-signalling molecules and are essential for triggering the cloning of T-cells in an immune response.

For Examiner's Use

A monoclonal antibody (mAb), which could block the CD40 signalling pathway, was produced from hamsters using the hybridoma method.

Outline the procedure, starting with a hamster, for producing mAbs suitable for use in another mammal, such as a mouse.

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..... [4]

For Examiner's Use

(b) The ability of the mAb produced in **(a)** to prevent rejection of transplanted hearts in mice was compared with that of a protein, **P**, which blocks the CD28 signalling pathway.

Four groups of mice were treated as follows:

- group **A** – no treatment
- group **B** – treated with protein **P** only
- group **C** – treated with mAb only
- group **D** – treated with both mAb and protein **P**.

Fig. 2.1 shows the percentage survival of the transplanted hearts in the four groups of mice over a period of 80 days.

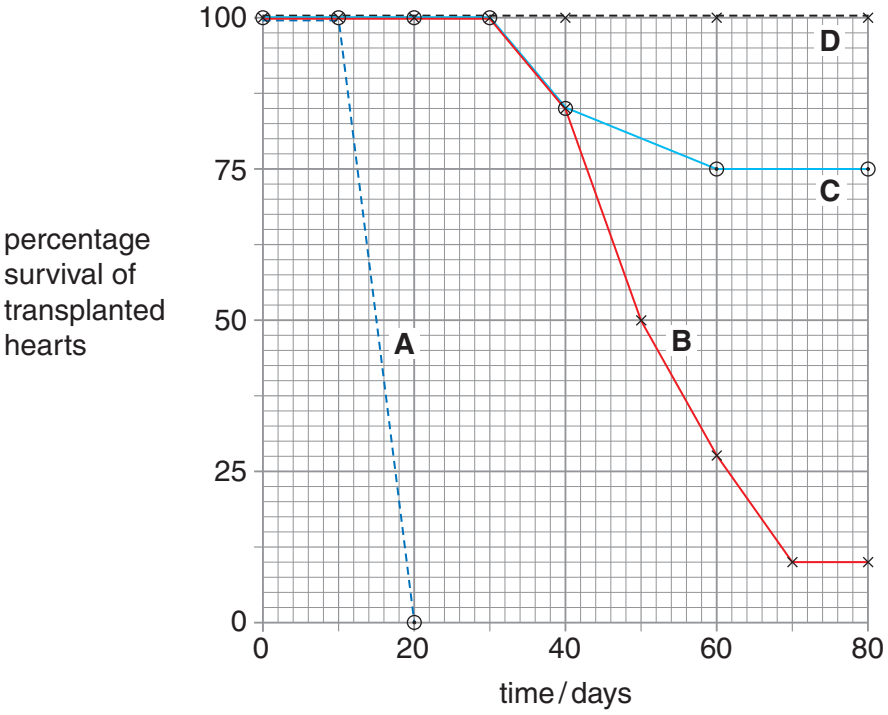


Fig. 2.1

With reference to Fig. 2.1

(i) describe the effectiveness of the four different treatments

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..... [4]

For Examiner's Use

(ii) suggest an explanation for the differences in survival of the transplanted hearts in groups **B** and **D**.

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(c) Examination of the transplanted hearts showed that the hearts in group **A** had significant damage to their coronary arteries, whereas in group **D** these blood vessels appeared normal.

Explain the importance of the coronary arteries of the heart.

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(d) State two uses of mAbs in humans, other than preventing rejection of transplanted tissue.

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2. .....

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[Total: 15]

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3 Fig. 3.1 shows the structure of part of a seminiferous tubule of a human testis.

For Examiner's Use

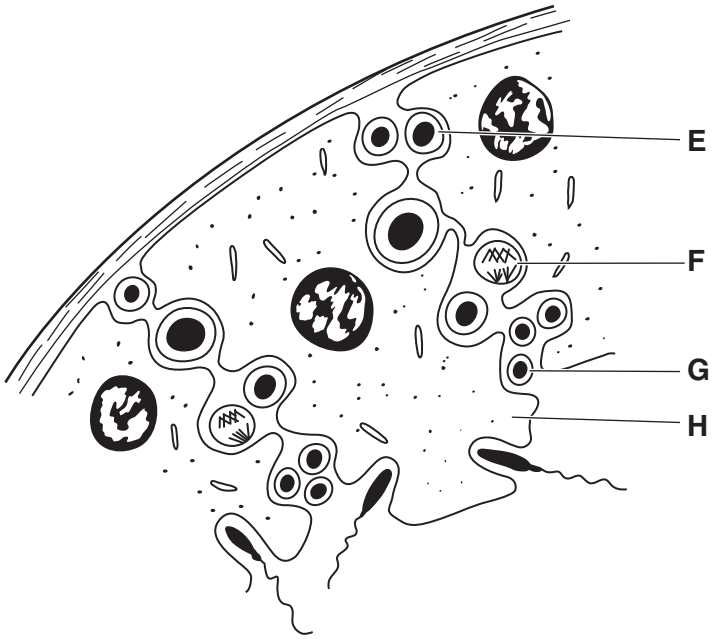


Fig. 3.1

(a) Name cells **E** to **H**.

E .....

F .....

G .....

H ..... [4]

(b) Describe how cell **F** is produced from cell **E** in the process of spermatogenesis.

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[Total: 8]

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4 Fig. 4.1 is a photomicrograph of a transverse section through the leaf of a C4 plant.

For Examiner's Use

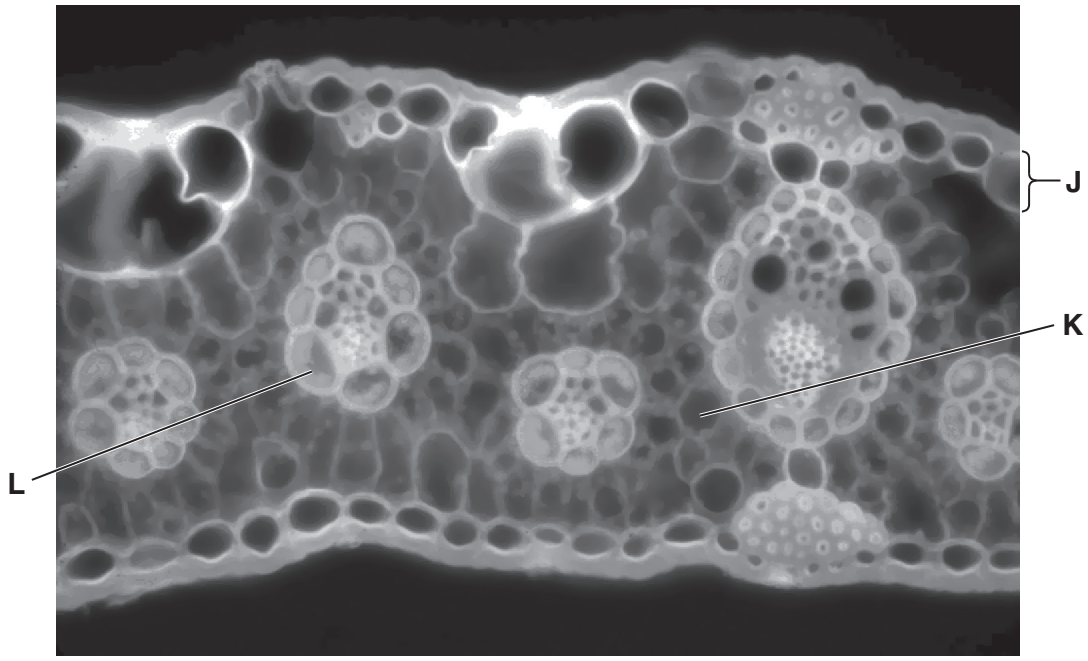


Fig. 4.1

(a) (i) Identify structures **J** to **L**.

J .....

K .....

L ..... [3]

(ii) Outline how this leaf anatomy adapts the plant for high rates of carbon fixation at high temperatures.

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For Examiner's Use

(b) Sorghum is a C4 plant and *Sorghum bicolor* is a major food crop in dry tropical regions. The leaves of *S. bicolor* are covered with a layer of wax made up of a mixture of esters and free fatty acids, with a melting point of 77–85 °C. Waxes from the leaves of non-tropical plants tend to have melting points lower than this. For example, wax from the bayberry, *Myrica* sp., has a melting point of 45 °C.

Suggest how the wax on sorghum leaves helps the plant to survive in dry, tropical regions.

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..... [2]

(c) An investigation was carried out into the response of sorghum to being kept at a low temperature for a short period of time. Soybean plants, which are better adapted than sorghum for growth in subtropical and temperate climates, were used for comparison.

Plants of sorghum and soybean were kept at 25 °C for several weeks and then at 10 °C for three days. The temperature was then increased to 25 °C again for seven days. Day length, light intensity and carbon dioxide concentration were kept constant throughout.

The uptake of carbon dioxide, as mg CO_2 absorbed per gram of leaf dry mass, was measured

- at 25 °C before cooling
- on each of the three days at 10 °C
- for seven days at 25 °C.

The results are shown in Table 4.1.

Table 4.1

plant	carbon dioxide uptake / mg CO_2 g^{-1}				
	at 25 °C, before cooling	at 10 °C			at 25 °C (mean over days 4 to 10)
		day 1	day 2	day 3	
sorghum	48.2	5.5	2.9	1.2	1.5
soybean	23.2	5.2	3.1	1.6	6.4

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For Examiner's Use

(i) Compare the **changes** in carbon dioxide uptake in sorghum and soybean during the three days at 10 °C.

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..... [2]

(ii) During the cooling period, the ultrastructure of the sorghum chloroplasts changed. The membranes of the thylakoids moved closer together, eliminating the spaces between them. The size and number of grana became reduced.

Explain how these changes could be responsible for the low rate of carbon dioxide uptake by sorghum even when returned to a temperature of 25 °C.

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[Total: 15]

5 Anole lizards are found throughout the Caribbean and the surrounding mainland. There are many species. Each species is found only on one island or a small group of islands, apart from *Anolis carolinensis* which is found in mainland Florida.

For Examiner's Use

Fig. 5.1 shows the distribution of four species of anole lizards.



Fig. 5.1

An investigation was carried out into the relationships between these four lizard species, using DNA analysis. The base sequences of a region of mitochondrial DNA from the four species were compared. The results are shown in Table 5.1.

The smaller the number, the smaller the differences between the base sequences of the two species.

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Table 5.1

For Examiner's Use

	A. brunneus			
A. brunneus		***A. smaragdinus***		
A. smaragdinus	12.1		***A. carolinensis***	
A. carolinensis	16.7	15.0		***A. porcatus***
A. porcatus	11.3	8.9	13.2	

(a) With reference to Table 5.1, state the species to which *A. brunneus* appears to be most closely related.

..... [1]

(b) The researchers put forward the hypothesis that the three species, *A. brunneus*, *A. smaragdinus* and *A. carolinensis*, have originated from three **separate** events in which a few individuals of *A. porcatus* spread directly from Cuba to three different places.

Explain how the results in Table 5.1 support the researchers' hypothesis.

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(c) Explain how a population of *A. porcatus* that became isolated on an island could evolve into a new species.

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[Total: 8]

For Examiner's Use

6 **(a)** Explain what is meant by the term *gene mutation.*

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(b) Rickets is a childhood disorder involving the softening and weakening of bones. It is usually caused by a lack of vitamin D, calcium ions or phosphate ions. A rare form of rickets that cannot be successfully treated with vitamin D therapy is caused by a mutant allele on the X chromosome.

Fig. 6.1 shows a pedigree chart for a family that has a history of this condition.

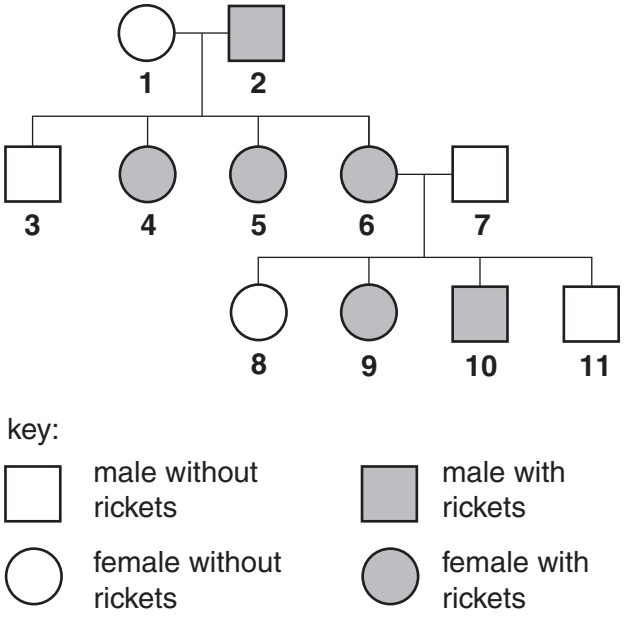


Fig. 6.1

Using the symbols

$\mathbf{X^R}$ for the mutant allele on the X chromosome
$\mathbf{X^r}$ for the non-mutant allele on the X chromosome

state the genotypes of the following individuals.

1 .....

3 .....

9 .....

10 ..... [4]

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(c) The gene in which this mutation occurs codes for a protein found in the cells of the proximal convoluted tubule of the kidney. This protein is involved in phosphate ion transport across membranes.

For Examiner's Use

Suggest why individuals with this mutant allele show symptoms of rickets.

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..... [2]

[Total: 8]

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For Examiner's Use

7 **(a)** The initial stages of respiration convert one molecule of glucose into two molecules of a 3C compound.

State

(i) the name given to these initial stages

..... [1]

(ii) where these stages occur in cells

..... [1]

(iii) the **total** number of ATP molecules formed during these stages.

..... [1]

(b) Most of the ATP formed in respiration is produced within the mitochondria by oxidative phosphorylation.

(i) State the location, in the mitochondrion, of oxidative phosphorylation.

..... [1]

(ii) Outline the process of oxidative phosphorylation.

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(c) In an investigation, mammalian liver cells were homogenised (broken up) and the resulting homogenate centrifuged. Samples of the complete homogenate and samples containing only nuclei, only ribosomes, only mitochondria or only the remaining cytosol were incubated with:

1 glucose

2 pyruvate

3 glucose and cyanide

4 pyruvate and cyanide

Cyanide inhibits oxidative phosphorylation.

After incubation the presence or absence of carbon dioxide and lactate in each sample was determined.

The results are summarised in Table 7.1.

Table 7.1

	samples of homogenate									
	complete		only nuclei		only ribosomes		only mitochondria		only cytosol	
	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate
1 glucose	✓	✓	✘	✘	✘	✘	✘	✘	✘	✓
2 pyruvate	✓	✓	✘	✘	✘	✘	✓	✘	✘	✓
3 glucose and cyanide	✘	✓	✘	✘	✘	✘	✘	✘	✘	✓
4 pyruvate and cyanide	✘	✓	✘	✘	✘	✘	✘	✘	✘	✓

✘ = absent ✓ = present

(i) With reference to Table 7.1, name the two organelles not involved in respiration.

1. .....

2. ..... [1]

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(ii) Explain why carbon dioxide is produced when mitochondria are incubated with pyruvate but **not** when they are incubated with glucose.

For Examiner's Use

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(iii) Explain why, in the presence of cyanide, lactate is produced but carbon dioxide is not.

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..... [3]

[Total: 16]

For Examiner's Use

8 **(a)** Cystic fibrosis (CF) is an inherited disease.

(i) Explain briefly how two parents who do not have CF may have a child with CF.

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..... [2]

(ii) Describe **two** ways in which CF affects the lungs.

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..... [2]

(b) One potential way of treating CF is by using gene therapy.

(i) Outline, with reference to CF, what is meant by *gene therapy.*

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..... [2]

(ii) Describe one possible advantage and one possible disadvantage of using gene therapy to treat CF.

advantage .....

.....

disadvantage .....

..... [2]

[Total: 8]

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Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Explain how the palisade mesophyll cells of a leaf are adapted for photosynthesis. [8]

(b) Outline the light-independent stage of photosynthesis. [7]

[Total: 15]

10 **(a)** Describe the structure of a kidney nephron and its associated blood vessels. [7]

(b) Explain how glomerular filtrate is formed. [8]

[Total: 15]

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Question 4 © http://delta-intkey.com/grass/images/pennis80.gif.

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General Certificate of Education Advanced Level

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BIOLOGY **9700/42**

Paper 4 A2 Structured Questions **May/June 2010**

2 hours

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Additional Materials: Answer Paper available on request.

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For Examiner's Use	
Section A	
1	
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Section A

Answer **all** the questions.

For Examiner's Use

1 The American crocodile, *Crocodylus acutus*, was classified as an endangered species by the USA in 1975. It is found in estuarine regions of southern Florida.

Fig. 1.1 shows an American crocodile.



Fig. 1.1

The salinity of the water was thought to play a part in the distribution of the American crocodile.

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Fig. 1.2 shows the number of American crocodile nest sites in areas with water of varying salinity in southern Florida.

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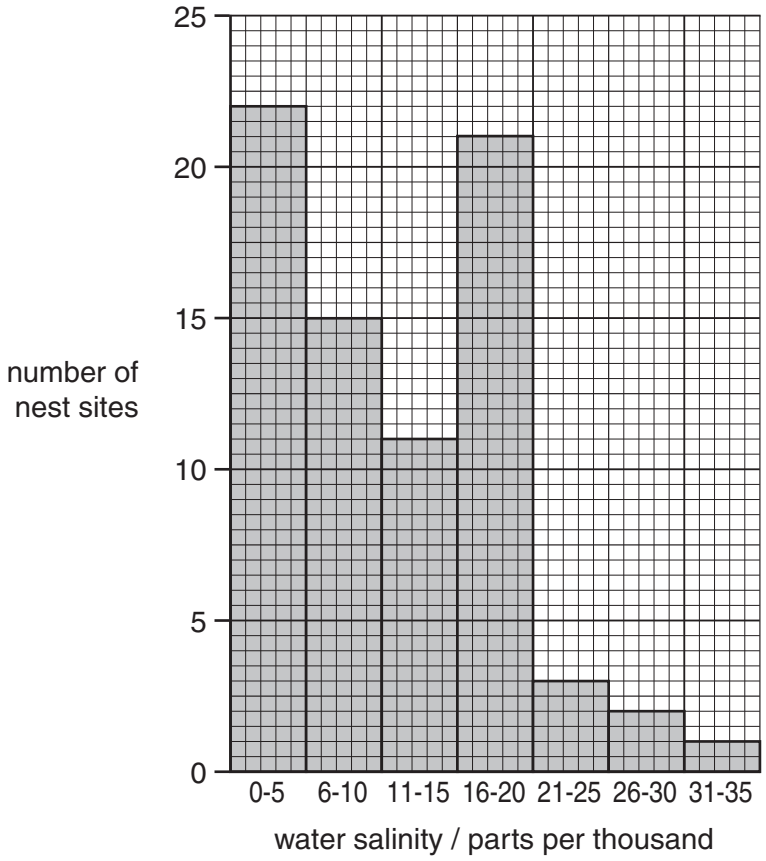


Fig. 1.2

(a) Describe the results shown in Fig. 1.2.

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..... [3]

(b) Much conservation work has been done in the Everglades National Park in Florida, which is a large wetland area. As a result the number of nest sites has increased from 8 in 1975 to 31 in 2000. This has led to a rise in the number of crocodiles.

For Examiner's Use

(i) Calculate the percentage increase in nest sites between 1975 and 2000.

Show your working.

answer .....% [2]

(ii) Suggest two reasons why the population of crocodiles in the Everglades National Park has increased.

1. .....

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2. .....

..... [2]

[Total: 7]

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2 Follicle stimulating hormone (FSH) and luteinising hormone (LH) both consist of two polypeptide chains, the α and β chains.

For Examiner's Use

- The α chains of FSH and LH are identical.
- The β chain of FSH has 111 amino acids and that of LH 121 amino acids.
- FSH and LH bind to different receptors in the cell surface membranes of their target cells.
- This binding leads to steroid synthesis by the target cells.

(a) Explain why FSH does not bind to a LH receptor.

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..... [3]

(b) Name the cells of a human female that carry

(i) FSH receptors .....

..... [1]

(ii) LH receptors. .....

..... [1]

(c) Describe what happens when FSH binds to its receptors on its target cells.

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[Total: 8]

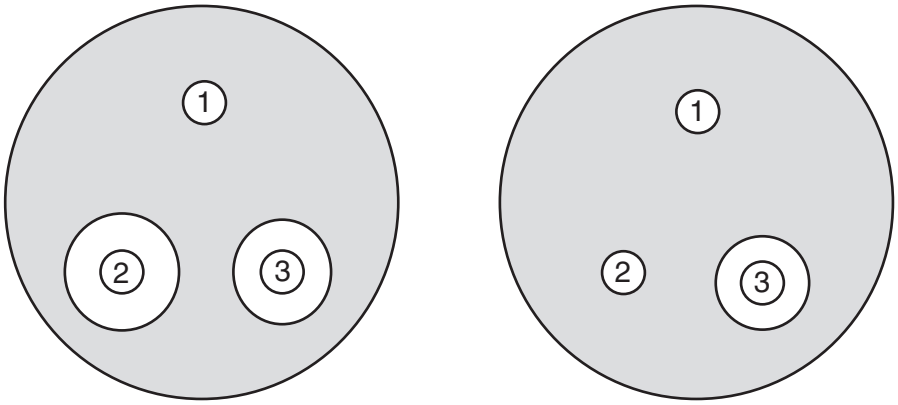
For Examiner's Use

3 The sensitivity of bacteria to antibiotics can be tested using the disc diffusion method. An inoculum of the bacteria is spread onto agar culture plates and then filter paper discs impregnated with antibiotic are pressed onto the surface of the agar. The plates are incubated. Bacteria grow as a 'lawn' across the agar, but a circular zone (the zone of inhibition) appears around any disc where bacterial growth is inhibited.

Two species of bacteria, **A** and **B**, were grown on separate culture plates in the presence of three types of filter paper disc:

1 – no antibiotic (control)
2 – penicillin V, a natural penicillin
3 – carboxypenicillin, a synthetic penicillin.

The appearance of the incubated plates is shown in Fig. 3.1.



bacterium **A** bacterium **B**

Fig. 3.1

(a) With reference to Fig. 3.1, explain the effect of penicillin V on bacterium **A**.

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..... [3]

Bacteria **A** and **B** have different outer layers, as shown in Fig. 3.2.

For Examiner's Use

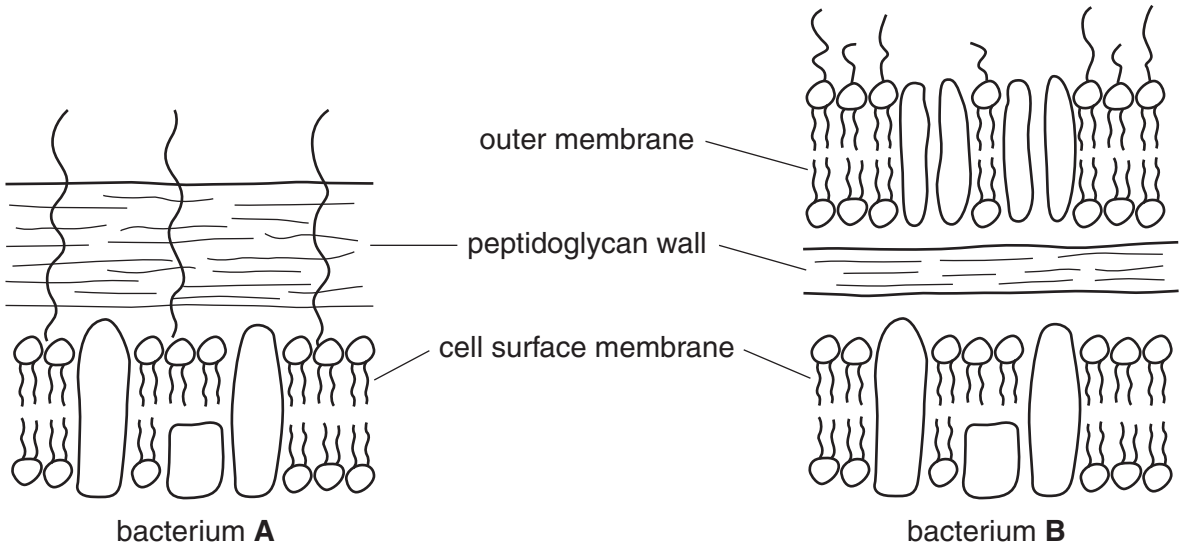


Fig. 3.2

(b) With reference to Fig. 3.1 and Fig. 3.2

(i) describe how the outer layers of bacterium **B** differ from those of bacterium **A**

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..... [2]

(ii) explain the different effects of penicillin V on bacteria **A** and **B**

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..... [2]

(iii) suggest how the synthetic penicillin, carboxypenicillin, is able to affect the growth of bacterium **B**.

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..... [2]

(c) Distinguish between batch culture and continuous culture of microorganisms.

For Examiner's Use

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(d) Explain why batch culture rather than continuous culture is used in the production of penicillin.

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..... [3]

[Total: 15]

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Question 4 starts on page 10

For Examiner's Use

4 Cereal crops, such as sorghum and rice, are a major source of nutrients all over the world.

(a) Explain why cereal crops are important components of many people's diets.

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(b) Alpha amylase is an enzyme produced in germinating seeds, where it hydrolyses starch. Fig. 4.1 shows the effect of temperature on alpha amylase in germinating seeds of sorghum and rice.

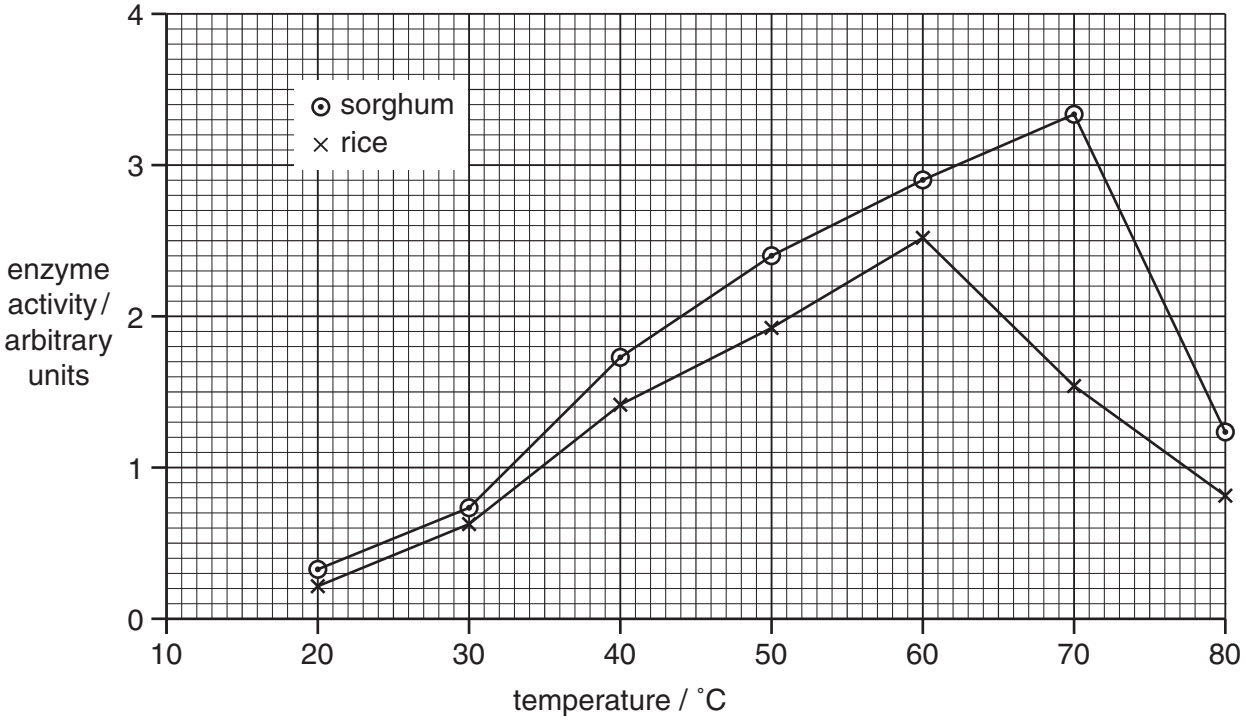


Fig. 4.1

(i) Name the part of the seed that contains starch.

..... [1]

(ii) With reference to Fig. 4.1, compare the effects of temperature on alpha amylase in sorghum and rice.

For Examiner's Use

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(iii) With reference to the types of bonding in proteins, suggest how differences in the tertiary structure of alpha amylase in rice and sorghum could explain the differences in their activities shown in Fig. 4.1.

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..... [3]

For Examiner's Use

(c) Sorghum does not grow well at low temperatures. An investigation was carried out into the response of sorghum to low temperatures at different light intensities.

- Sorghum plants were kept at 25 °C in a light intensity of 215 W m^{-2} for several weeks, and then at 10 °C for three days.
- The temperature was then increased to 25 °C again for seven days.
- The investigation was repeated at light intensities of 170 W m^{-2} and 50 W m^{-2}.
- Day length and carbon dioxide concentration were kept constant throughout.

The uptake of carbon dioxide, as mg CO_2 absorbed per gram of leaf dry mass, was measured

- at 25 °C before cooling
- at on each of the three days at 10 °C
- for seven days at 25 °C.

The results are shown in Table 4.1.

Table 4.1

light intensity / W m^{-2}	carbon dioxide uptake / mg CO_2 g^{-1}				
	at 25 °C, before cooling	during cooling at 10 °C			at 25 °C (mean over days 4 to 10)
		day 1	day 2	day 3	
215	50.1	3.0	0.4	0.2	0.2
170	48.2	5.5	2.9	1.2	1.5
50	22.4	3.0	1.2	0.7	9.2

With reference to Table 4.1

(i) describe **and** explain the effect of light intensity on the rate of carbon dioxide uptake **before cooling**

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..... [3]

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(ii) describe the effect of light intensity on the ability of sorghum plants to survive cooling.

For Examiner's Use

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[Total: 15]

5 The fruitfly, *Drosophila*, has many different species. Three of these species, *Drosophila pseudoobscura*, *D. persimilis* and *D. miranda*, are thought to be closely related.

For Examiner's Use

Samples of these three species were collected from the western United States of America. Fig. 5.1 shows where these species naturally occur.

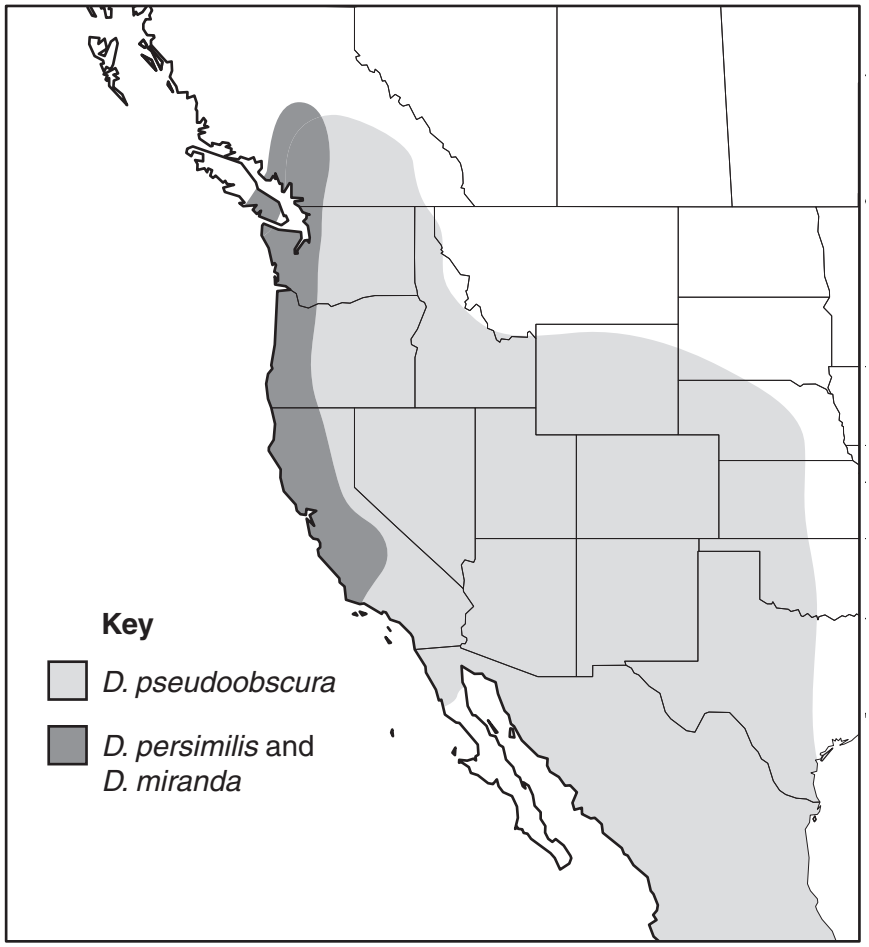


Fig. 5.1

The base sequences of four regions of DNA of each species were sequenced. The divergence of these base sequences in *D. pseudoobscura* and *D. persimilis* from the sequences in *D. miranda* was calculated. The results are shown in Table 5.1.

For Examiner's Use

Table 5.1

DNA region	*Drosophila* species	percentage divergence of base sequence from that of *D. miranda*
1	*pseudoobscura*	2.5
	persimilis	2.4
2	*pseudoobscura*	8.1
	persimilis	7.3
3	*pseudoobscura*	2.1
	persimilis	1.7
4	*pseudoobscura*	1.9
	persimilis	1.7

(a) With reference to Table 5.1, describe the evidence that *D. miranda* may be more closely related to *D. persimilis* than to *D. pseudoobscura*.

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..... [2]

(b) Suggest why there is more divergence in some regions of DNA than in others.

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..... [2]

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[Turn over

(c) The area where *D. pseudoobscura* is found is separated from the areas where the other two species are found by a high range of mountains.

For Examiner's Use

Explain how the species *D. pseudoobscura* could have evolved from a population of *D. miranda.*

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..... [4]

[Total: 8]

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For Examiner's Use

6 In humans a rare, sex-linked, recessive allele results in a change in the shape of the iris in the eye. This condition is know as cleft iris (CI).

(a) Explain what is meant by the term *sex linkage*.

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..... [2]

(b) Using suitable symbols complete the genetic diagram below.

Key to symbols

recessive allele .....

dominant allele .....

parental phenotypes	male with CI	X	normal female
parental phenotypes	.....		.....
gametes	.....		.....

offspring genotypes .....

offspring phenotypes ..... [5]

(c) A woman who is heterozygous for CI becomes pregnant by a man with a normal iris.

State the probability that their child will have CI.

..... [1]

[Total: 8]

7 Fig. 7.1 is an outline diagram of the Krebs cycle. A two carbon acetyl group enters the cycle by combining with a molecule of oxaloacetate. A molecule of citrate is formed which is decarboxylated and dehydrogenated to regenerate the oxaloacetate.
The letters **P** to **V** are steps in the cycle.

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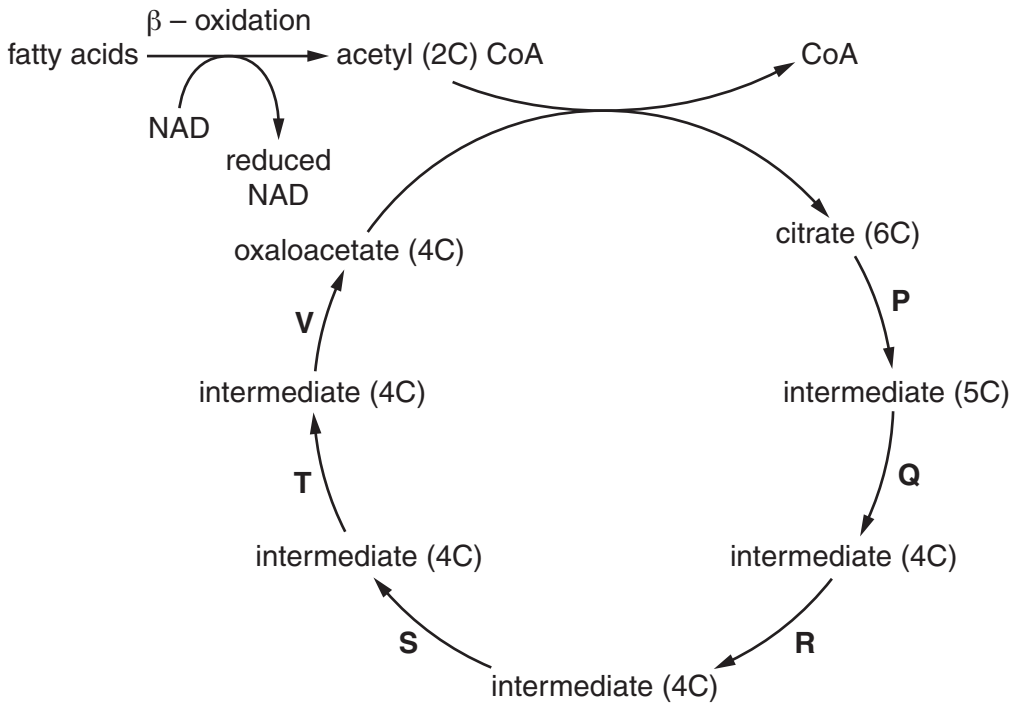


Fig. 7.1

(a) (i) Explain what is meant by the following terms:

decarboxylation .....

dehydrogenation ..... [2]

(ii) Using the letters in the cycle, state where decarboxylation is taking place.

..... [1]

(b) Fig. 7.1 shows that fatty acids can be converted into acetyl coenzyme A (acetyl CoA) by a process known as oxidation. Both this process and the Krebs cycle require NAD. The hydrogen atoms released reduce the NAD molecules.

(i) State the number of reduced NAD molecules that are formed in the Krebs cycle from one acetyl group that enters the cycle from acetyl CoA.

..... [1]

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For Examiner's Use

(ii) State where the reduced NAD molecules are re-oxidised **and** describe what happens to the hydrogen atoms.

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(c) Describe the role of reduced NAD in respiring yeast cells in the absence of oxygen.

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..... [4]

(d) Describe how the production of lactate in muscle tissue **differs** from anaerobic respiration in yeast.

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[Total: 16]

8 Gene technology has many uses including the production of substances such as insulin.

For Examiner's Use

(a) (i) Outline what is meant by *gene technology*.

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..... [2]

(ii) Explain why genes for enzymes that produce fluorescent substances are used as makers in gene technology.

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.....

.....

..... [2]

(b) There is much controversy throughout the world regarding the use of genetically modified (GM) crops.

(i) Suggest **two** advantages of growing GM rice with an enhanced vitamin A content.

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..... [2]

(ii) Suggest **two** disadvantages of growing GM crops.

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..... [2]

[Total: 8]

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Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Describe the structure of photosystems and explain how a photosystem functions in cyclic photophosphorylation. [8]

(b) Explain briefly how reduced NADP is formed in the light-dependent stage and how it is used in the light-independent stage. [7]

[Total: 15]

10 **(a)** Describe the structure of a myelinated sensory neurone. [7]

(b) Explain how an action potential is transmitted along a sensory neurone. [8]

[Total: 15]

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1266983794

BIOLOGY **9700/43**

Paper 4 A2 Structured Questions **May/June 2010**

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 a pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions in Section A and **one** question from Section B.
Circle the number of the Section B question you have answered in the grid below.

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.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
9 or 10	
Total	

This document consists of **20** printed pages, **3** lined pages and **1** blank page.

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Section A

Answer **all** the questions.

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1 The American crocodile, *Crocodylus acutus*, was classified as an endangered species by the USA in 1975. It is found in estuarine regions of southern Florida.

Fig. 1.1 shows an American crocodile.



Fig. 1.1

The salinity of the water was thought to play a part in the distribution of the American crocodile.

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Fig. 1.2 shows the number of American crocodile nest sites in areas with water of varying salinity in southern Florida.

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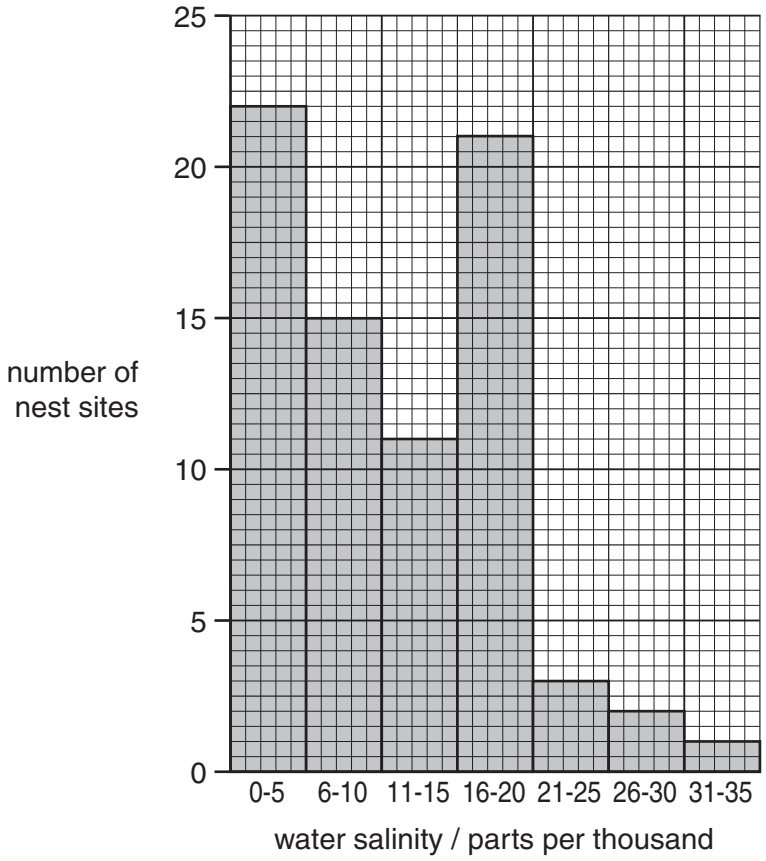


Fig. 1.2

(a) Describe the results shown in Fig. 1.2.

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..... [3]

(b) Much conservation work has been done in the Everglades National Park in Florida, which is a large wetland area. As a result the number of nest sites has increased from 8 in 1975 to 31 in 2000. This has led to a rise in the number of crocodiles.

For Examiner's Use

(i) Calculate the percentage increase in nest sites between 1975 and 2000.

Show your working.

answer .....% [2]

(ii) Suggest two reasons why the population of crocodiles in the Everglades National Park has increased.

1. .....

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2. .....

..... [2]

[Total: 7]

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2 Follicle stimulating hormone (FSH) and luteinising hormone (LH) both consist of two polypeptide chains, the α and β chains.

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- The α chains of FSH and LH are identical.
- The β chain of FSH has 111 amino acids and that of LH 121 amino acids.
- FSH and LH bind to different receptors in the cell surface membranes of their target cells.
- This binding leads to steroid synthesis by the target cells.

(a) Explain why FSH does not bind to a LH receptor.

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..... [3]

(b) Name the cells of a human female that carry

(i) FSH receptors .....

..... [1]

(ii) LH receptors. .....

..... [1]

(c) Describe what happens when FSH binds to its receptors on its target cells.

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[Total: 8]

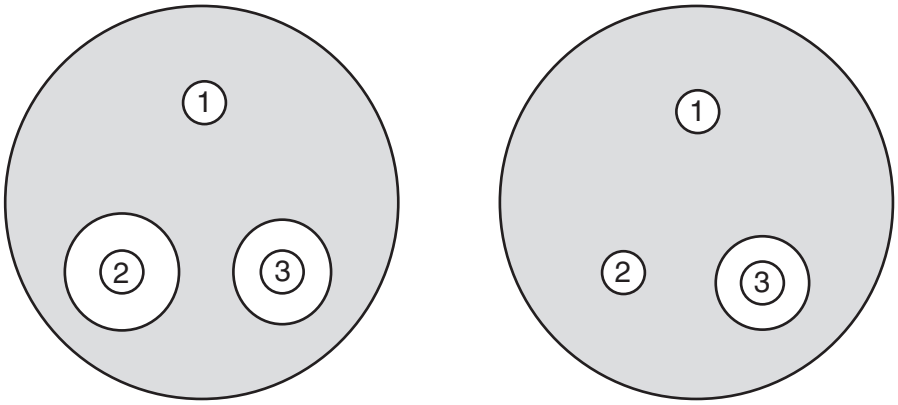
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3 The sensitivity of bacteria to antibiotics can be tested using the disc diffusion method. An inoculum of the bacteria is spread onto agar culture plates and then filter paper discs impregnated with antibiotic are pressed onto the surface of the agar. The plates are incubated. Bacteria grow as a 'lawn' across the agar, but a circular zone (the zone of inhibition) appears around any disc where bacterial growth is inhibited.

Two species of bacteria, **A** and **B**, were grown on separate culture plates in the presence of three types of filter paper disc:

1 – no antibiotic (control)
2 – penicillin V, a natural penicillin
3 – carboxypenicillin, a synthetic penicillin.

The appearance of the incubated plates is shown in Fig. 3.1.



bacterium **A** bacterium **B**

Fig. 3.1

(a) With reference to Fig. 3.1, explain the effect of penicillin V on bacterium **A**.

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Bacteria **A** and **B** have different outer layers, as shown in Fig. 3.2.

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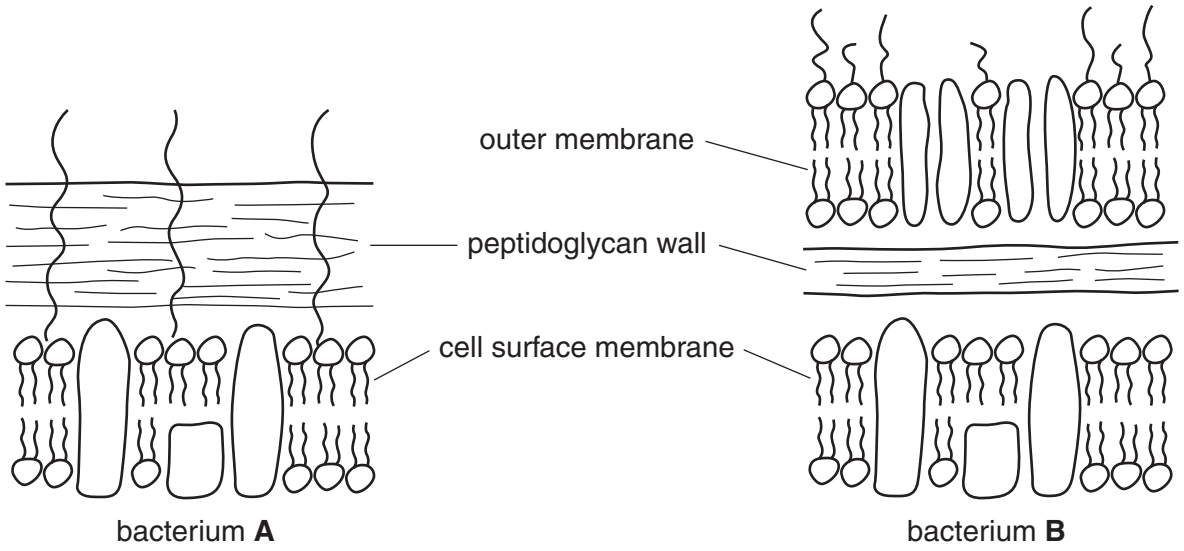


Fig. 3.2

(b) With reference to Fig. 3.1 and Fig. 3.2

(i) describe how the outer layers of bacterium **B** differ from those of bacterium **A**

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(ii) explain the different effects of penicillin V on bacteria **A** and **B**

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(iii) suggest how the synthetic penicillin, carboxypenicillin, is able to affect the growth of bacterium **B**.

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(c) Distinguish between batch culture and continuous culture of microorganisms.

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(d) Explain why batch culture rather than continuous culture is used in the production of penicillin.

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[Total: 15]

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Question 4 starts on page 10

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4 Cereal crops, such as sorghum and rice, are a major source of nutrients all over the world.

(a) Explain why cereal crops are important components of many people's diets.

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(b) Alpha amylase is an enzyme produced in germinating seeds, where it hydrolyses starch. Fig. 4.1 shows the effect of temperature on alpha amylase in germinating seeds of sorghum and rice.

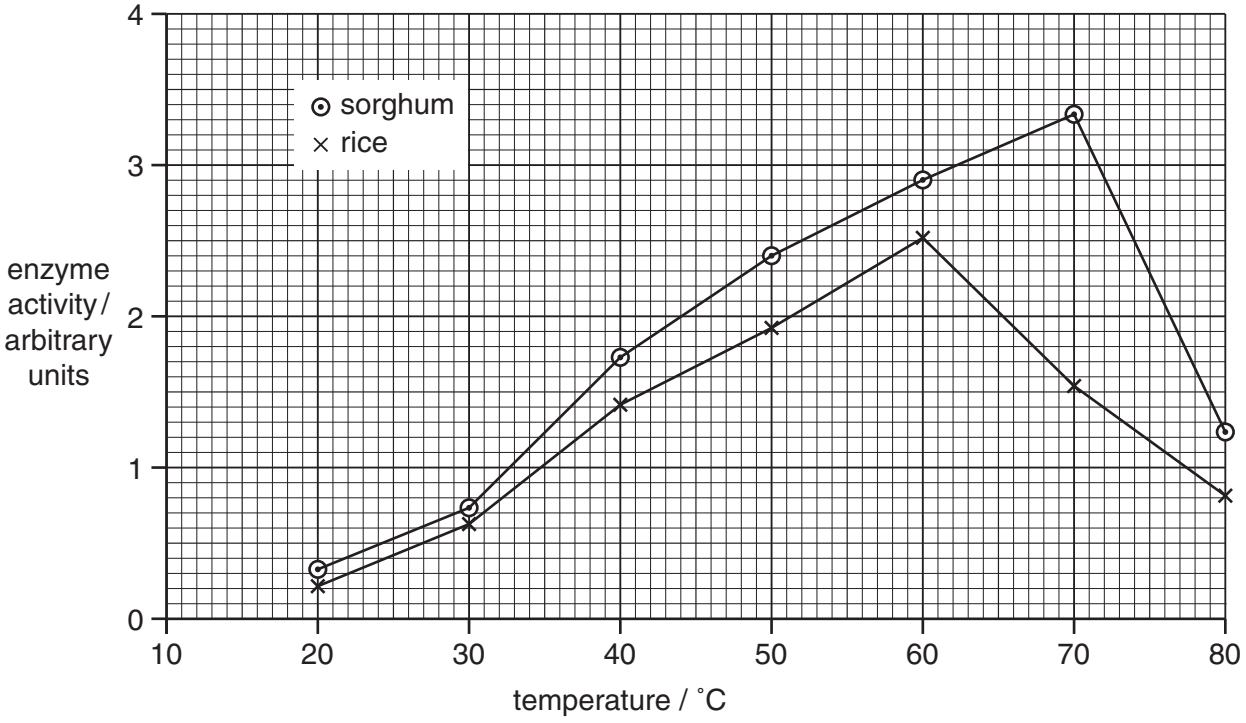


Fig. 4.1

(i) Name the part of the seed that contains starch.

..... [1]

(ii) With reference to Fig. 4.1, compare the effects of temperature on alpha amylase in sorghum and rice.

For Examiner's Use

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(iii) With reference to the types of bonding in proteins, suggest how differences in the tertiary structure of alpha amylase in rice and sorghum could explain the differences in their activities shown in Fig. 4.1.

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(c) Sorghum does not grow well at low temperatures. An investigation was carried out into the response of sorghum to low temperatures at different light intensities.

- Sorghum plants were kept at 25 °C in a light intensity of 215 W m^{-2} for several weeks, and then at 10 °C for three days.
- The temperature was then increased to 25 °C again for seven days.
- The investigation was repeated at light intensities of 170 W m^{-2} and 50 W m^{-2}.
- Day length and carbon dioxide concentration were kept constant throughout.

The uptake of carbon dioxide, as mg CO_2 absorbed per gram of leaf dry mass, was measured

- at 25 °C before cooling
- at on each of the three days at 10 °C
- for seven days at 25 °C.

The results are shown in Table 4.1.

Table 4.1

light intensity / W m^{-2}	carbon dioxide uptake / mg CO_2 g^{-1}				
	at 25 °C, before cooling	during cooling at 10 °C			at 25 °C (mean over days 4 to 10)
		day 1	day 2	day 3	
215	50.1	3.0	0.4	0.2	0.2
170	48.2	5.5	2.9	1.2	1.5
50	22.4	3.0	1.2	0.7	9.2

With reference to Table 4.1

(i) describe **and** explain the effect of light intensity on the rate of carbon dioxide uptake **before cooling**

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(ii) describe the effect of light intensity on the ability of sorghum plants to survive cooling.

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[Total: 15]

5 The fruitfly, *Drosophila*, has many different species. Three of these species, *Drosophila pseudoobscura*, *D. persimilis* and *D. miranda*, are thought to be closely related.

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Samples of these three species were collected from the western United States of America. Fig. 5.1 shows where these species naturally occur.

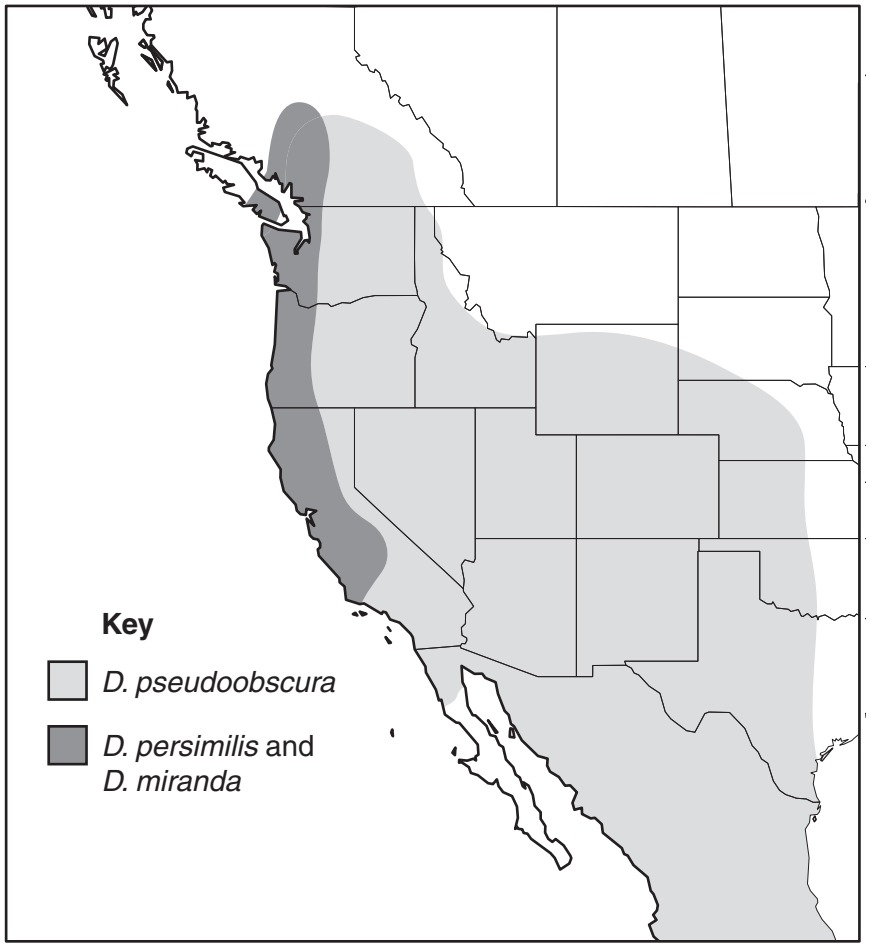


Fig. 5.1

The base sequences of four regions of DNA of each species were sequenced. The divergence of these base sequences in *D. pseudoobscura* and *D. persimilis* from the sequences in *D. miranda* was calculated. The results are shown in Table 5.1.

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Table 5.1

DNA region	*Drosophila* species	percentage divergence of base sequence from that of *D. miranda*
1	*pseudoobscura*	2.5
	persimilis	2.4
2	*pseudoobscura*	8.1
	persimilis	7.3
3	*pseudoobscura*	2.1
	persimilis	1.7
4	*pseudoobscura*	1.9
	persimilis	1.7

(a) With reference to Table 5.1, describe the evidence that *D. miranda* may be more closely related to *D. persimilis* than to *D. pseudoobscura*.

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(b) Suggest why there is more divergence in some regions of DNA than in others.

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[Turn over

(c) The area where *D. pseudoobscura* is found is separated from the areas where the other two species are found by a high range of mountains.

For Examiner's Use

Explain how the species *D. pseudoobscura* could have evolved from a population of *D. miranda.*

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[Total: 8]

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6 In humans a rare, sex-linked, recessive allele results in a change in the shape of the iris in the eye. This condition is know as cleft iris (CI).

(a) Explain what is meant by the term *sex linkage*.

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..... [2]

(b) Using suitable symbols complete the genetic diagram below.

Key to symbols

recessive allele .....

dominant allele .....

parental phenotypes	male with CI	X	normal female
parental phenotypes	.....		.....
gametes	.....		.....

offspring genotypes .....

offspring phenotypes ..... [5]

(c) A woman who is heterozygous for CI becomes pregnant by a man with a normal iris.

State the probability that their child will have CI.

..... [1]

[Total: 8]

7 Fig. 7.1 is an outline diagram of the Krebs cycle. A two carbon acetyl group enters the cycle by combining with a molecule of oxaloacetate. A molecule of citrate is formed which is decarboxylated and dehydrogenated to regenerate the oxaloacetate.
The letters **P** to **V** are steps in the cycle.

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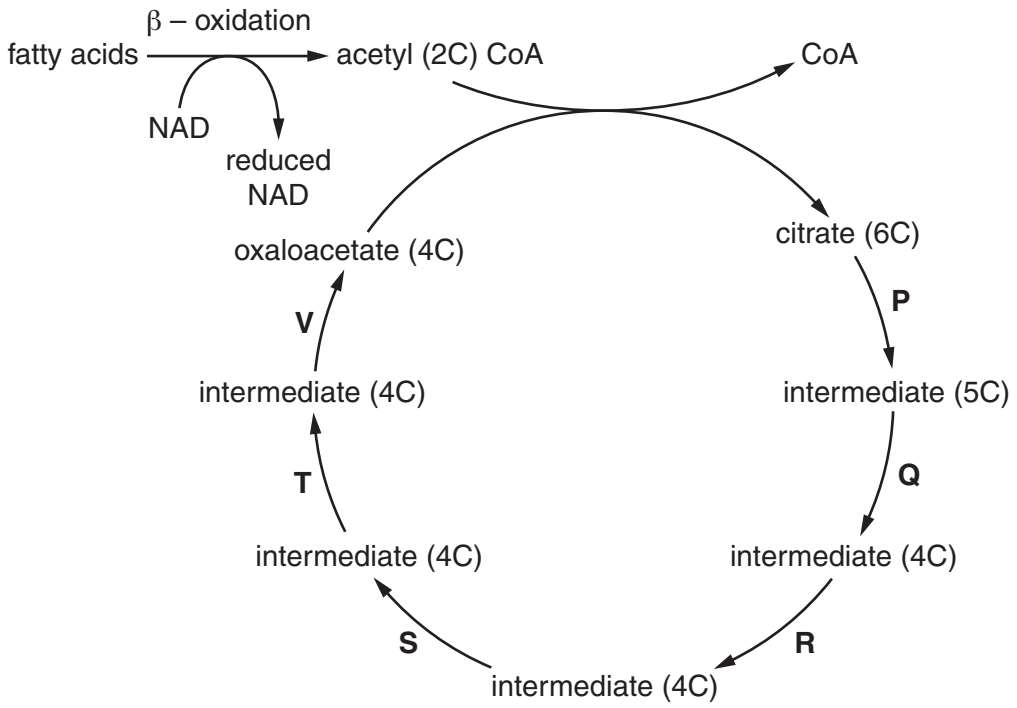


Fig. 7.1

(a) (i) Explain what is meant by the following terms:

decarboxylation .....

dehydrogenation ..... [2]

(ii) Using the letters in the cycle, state where decarboxylation is taking place.

..... [1]

(b) Fig. 7.1 shows that fatty acids can be converted into acetyl coenzyme A (acetyl CoA) by a process known as oxidation. Both this process and the Krebs cycle require NAD. The hydrogen atoms released reduce the NAD molecules.

(i) State the number of reduced NAD molecules that are formed in the Krebs cycle from one acetyl group that enters the cycle from acetyl CoA.

..... [1]

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(ii) State where the reduced NAD molecules are re-oxidised **and** describe what happens to the hydrogen atoms.

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(c) Describe the role of reduced NAD in respiring yeast cells in the absence of oxygen.

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(d) Describe how the production of lactate in muscle tissue **differs** from anaerobic respiration in yeast.

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[Total: 16]

8 Gene technology has many uses including the production of substances such as insulin.

For Examiner's Use

(a) (i) Outline what is meant by *gene technology*.

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..... [2]

(ii) Explain why genes for enzymes that produce fluorescent substances are used as makers in gene technology.

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..... [2]

(b) There is much controversy throughout the world regarding the use of genetically modified (GM) crops.

(i) Suggest **two** advantages of growing GM rice with an enhanced vitamin A content.

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..... [2]

(ii) Suggest **two** disadvantages of growing GM crops.

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..... [2]

[Total: 8]

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Section B

Answer **one** question.

For Examiner's Use

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[Total: 15]

10 **(a)** Describe the structure of a myelinated sensory neurone. [7]

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