UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6965272036

BIOLOGY **9700/41**

Paper 4 A2 Structured Questions **May/June 2011**

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 ink.
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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	
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4	
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8	
Section B	
9 or 10	
Total	

This document consists of **23** 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 polar bear, *Ursus maritimus*, lives in the Arctic regions of the USA, Canada, Norway and Russia. Polar bears move across the Arctic ice sheet to hunt prey such as seals.

Fig. 1.1 shows a polar bear.



Fig. 1.1

The area over which the Arctic ice sheet extends varies throughout the year.

Fig. 1.2 shows the variation in the extent of the Arctic ice sheet for the months of July to November for the years 1979 and 2009.

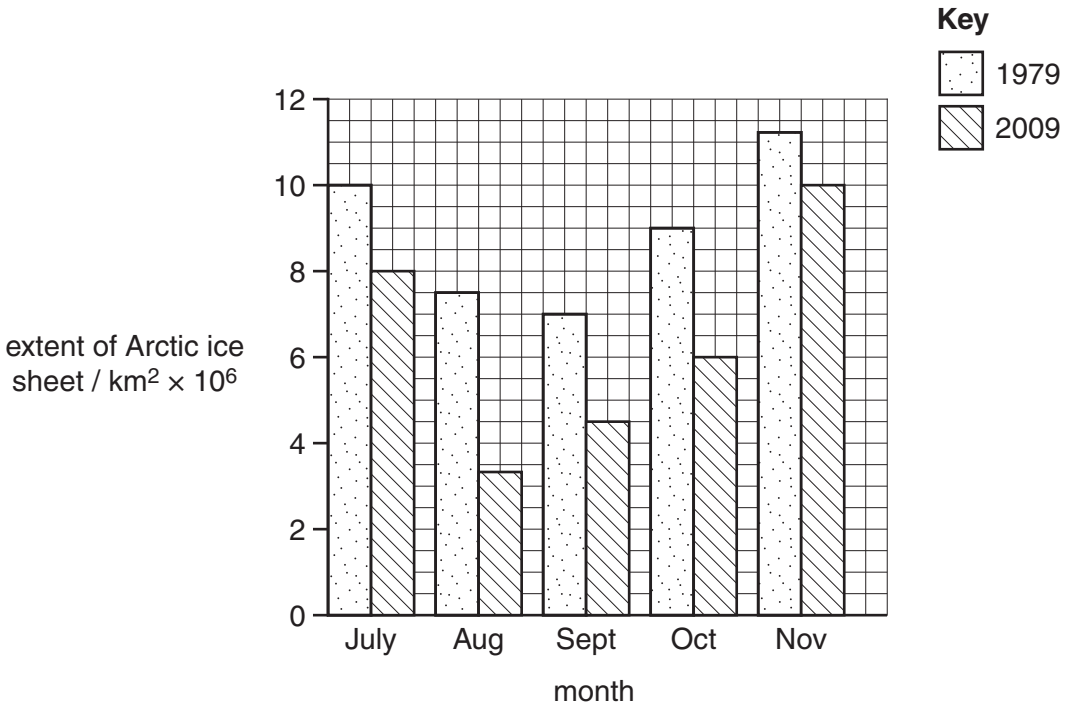


Fig. 1.2

For Examiner's Use

(a) Calculate the percentage reduction in the area over which the ice sheet extends between 1979 and 2009 **for the month of September**.

Give your answer to the **nearest whole number**.

Show your working.

answer ..... % [2]

(b) In 2008 the government of the USA classified *U. maritimus* as an endangered species because it is under threat of extinction.

Suggest what has caused *U. maritimus* to have become endangered.

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(c) *U. maritimus* is a eukaryote. Beneficial bacteria, which are prokaryotic cells, live in the gut of *U. maritimus*.

State three differences between the cells of *U. maritimus* and its gut bacteria.

1. .....

2. .....

3. ..... [3]

[Total: 8]

For Examiner's Use

2 When gold is associated with mineral ores such as iron sulfide, the sulfides must be oxidised to release the gold particles. Since the mid 1990s, gold has been extracted from such ores by bioleaching.

Suitable bacteria oxidise iron sulfide to soluble iron sulfate, releasing Fe^{3+} and SO_4^{2-} ions. The reaction releases heat energy and temperatures within a heap of ore that is being bioleached (a bioheap) can reach 70 °C or higher.

Examples of bacteria used in this bioleaching are shown in Table 2.1.

Table 2.1

example of bacterium	temperature range for growth / °C	activity	natural habitat
Acidithiobacillus ferrooxidans	35 – 45	oxidise iron and sulfur compounds	acid springs
Sulfobacillus thermosulfidooxidans	45 – 65		
Sulfolobus metallicus	65 – 95		

(a) With reference to Table 2.1, suggest

(i) a natural habitat for organisms such as *S. thermosulfidooxidans* and *S. metallicus*

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..... [1]

(ii) why all three species of bacteria, rather than just one species, are mixed with ore in a bioheap.

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(b) The rate of oxidation of the iron in iron sulfide ore was compared in the presence and absence of *A. ferrooxidans* at pH 2.0.

For Examiner's Use

The results are shown in Fig. 2.1.

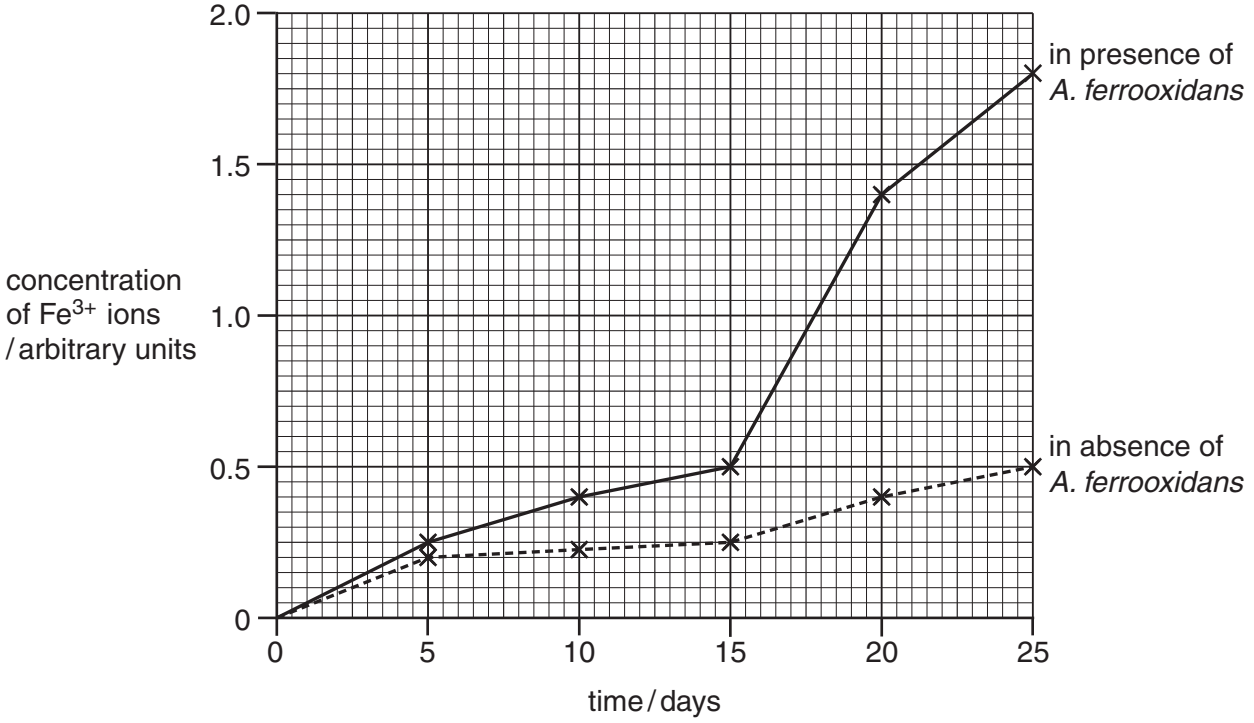


Fig. 2.1

(i) With reference to Fig. 2.1, describe the effect of *A. ferrooxidans* on the oxidation of the ore.

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For Examiner's Use

(ii) Explain why bioleaching is now used on a large scale throughout the world.

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(c) Gold-bearing sulfide ores often contain arsenic, which is potentially toxic to the bacteria used in bioleaching. However, arsenic-resistant strains of *A. ferrooxidans* have been found in some mines.

The activity of two strains of the bacterium, in the presence and absence of arsenic ions, is shown in Table 2.2.

Table 2.2

	oxidation rate of iron in the ore / mg dm^{-3} h^{-1}	
strain of *A. ferrooxidans*	arsenic ions absent	arsenic ions present
1	16	15
2	48	47

Describe the results shown in Table 2.2 **and** explain the role of natural selection in the evolution of arsenic-resistant bacteria.

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[Total: 14]

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3 **(a)** Outline the technique of in-vitro fertilisation (IVF).

For Examiner's Use

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(b) For IVF to be successful, a sperm must have an undamaged plasma (cell surface) membrane, an intact acrosome (a sperm's large lysosome) and be capable of producing ATP for movement.

One method of assessing the quality of a sample of sperm is to mix it with three chemical probes that bind to specific components of the sperm. The probes fluoresce when the sperm are examined with a microscope using ultra-violet (UV) light, allowing their uptake to be determined.

The three probes fluoresce with different colours.

- Probe 1 combines with DNA and fluoresces red, but can enter a sperm only when its plasma membrane is damaged.
- Probe 2 combines with sugars in the acrosome and fluoresces yellow, but can enter the acrosome only when the acrosome membrane is damaged.
- Probe 3 combines with mitochondria and fluoresces bright green in sperm with active mitochondria and less brightly when the mitochondria are less active.

A sample of sperm was mixed with all three probes and examined using UV light.

Complete Table 3.1 by placing ticks (✓) in the appropriate boxes to describe the appearance of sperm that would be suitable for use in IVF.

Table 3.1

	appearance of sperm suitable for use in IVF			
target of probe	red	yellow	green	colourless
DNA				
acrosome				
mitochondria				

[3]

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(c) The technique of intracytoplasmic sperm injection (ICSI) involves injecting a single, chosen sperm into an oocyte. This technique is often used when standard IVF has failed.

For Examiner's Use

Researchers in Hawaii think that the acrosome of the sperm should be removed before the sperm is injected into the oocyte.

Suggest **one** reason why it might improve the success rate of ICSI to remove the acrosome before injecting a sperm into an oocyte.

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[Total: 8]

For Examiner's Use

4 Almost 40% of adults with cystic fibrosis (CF) develop a form of diabetes known as cystic fibrosis-related diabetes (CFRD). This is thought to happen because the build-up of thick secretions in the pancreas destroys β cells.

(a) Explain how the destruction of β cells causes diabetes.

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(b) The bacterium *Pseudomonas aeruginosa* can cause chronic (long-lasting) lung infections. A person with CFRD is likely to have poorer lung function and a greater likelihood of having a chronic lung infection than a person who has CF but does **not** have CFRD.

An investigation was carried out to find out if the severity of damage to lung function in a person with CFRD is affected by

- their gender
- whether or not they have a chronic *P. aeruginosa* infection.

The investigators measured lung function by recording the maximum volume of air that can be expelled from the lungs in the first one second of a forced expiration. This is known as FEV_1. The lower the median FEV_1, the poorer the lung function.

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[Turn over

Table 4.1 summarises the results of this investigation. All the 812 people in the study had cystic fibrosis.

For Examiner's Use

Table 4.1

	without chronic *P. aeruginosa* infection				with chronic *P. aeruginosa* infection			
	male		female		male		female	
	with CFRD	without CFRD	with CFRD	without CFRD	with CFRD	without CFRD	with CRFD	without CFRD
number of people	44	110	52	93	106	166	121	120
FEV_1	71.1	71.4	53.6	73.6	49.0	59.0	42.0	61.0

With reference to Table 4.1

(i) discuss whether or not there appears to be a positive correlation between having a chronic *P. aeruginosa* infection and having CFRD

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..... [2]

(ii) calculate the percentage difference between the FEV_1 of males and females without CFRD and without *P. aeruginosa* infection.

Show your working

answer ..... % [2]

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(iii) outline the conclusions that can be drawn concerning the relationship between gender and the severity of lung damage in a person with CFRD and with *P. aeruginosa* infection.

For Examiner's Use

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(c) In a person with CF, damage to lung function and the increased likelihood of chronic infections are the result of the secretion of thick mucus.

Explain why thick mucus is secreted in the lungs of a person with CF.

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..... [4]

[Total: 15]

For Examiner's Use

5 Both sorghum and maize are important food crops in dry regions of the world, but sorghum is able to produce higher yields than maize in very dry conditions.

This is partly because sorghum plants have a smaller leaf area than maize, and also because sorghum leaves have rows of motor cells along the midrib of the upper surface of the leaf, allowing the leaves to roll up.

(a) Explain how **these two** features adapt sorghum plants for growth in very dry conditions.

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..... [3]

(b) Sorghum is a staple food in Africa, but the major storage protein that it contains, kaffirin, is not easily digested by protease enzymes. The main cause of this is cross-linking between kaffirin molecules.

The digestibility of the protein in five varieties of sorghum was measured when raw, and after cooking. Digestibility was measured as the percentage of the protein that would be broken down to amino acids during digestion.

The results are shown in Fig. 5.1.

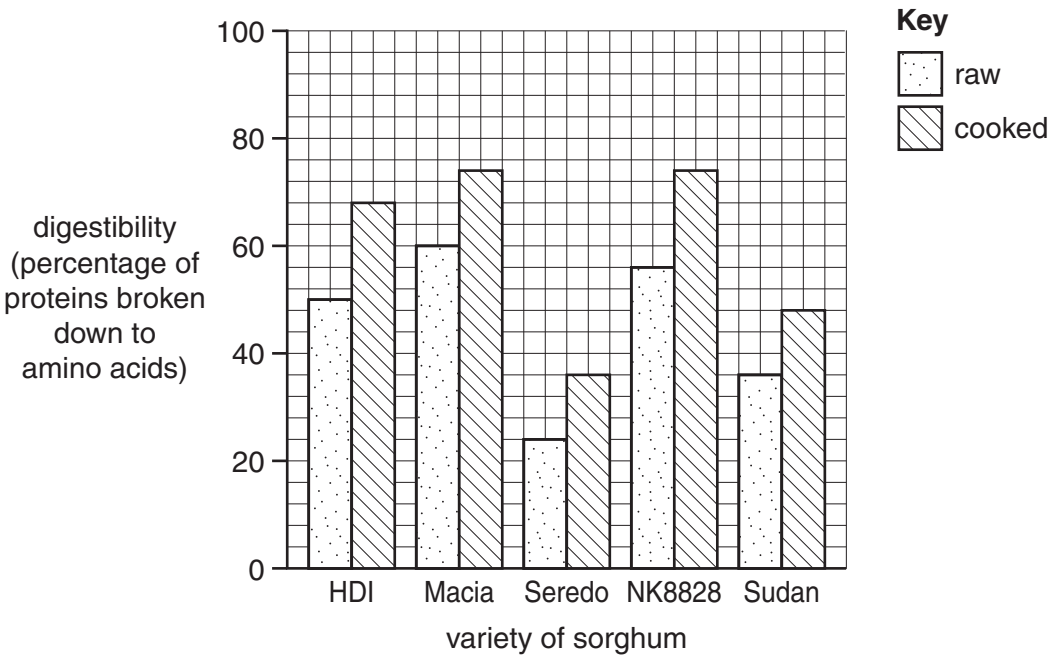


Fig. 5.1

With reference to Fig. 5.1

For Examiner's Use

(i) compare the digestibility of raw and cooked sorghum protein

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..... [2]

(ii) using your knowledge of protein structure and enzyme activity, suggest reasons for the differences you have described in **(i)**.

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..... [3]

[Total: 8]

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For Examiner's Use

6 Canavan disease is a non sex-linked inherited condition that causes progressive damage to neurones of the brain. Symptoms of the condition include a loss of motor skills and mental retardation. The symptoms appear in early infancy and many children with this condition die by the age of four years.

People with Canavan disease lack an enzyme called aspartoacylase which breaks down N-acetyl aspartate. The build up of N-acetyl aspartate can interfere with the formation of the myelin sheath, particularly in neurones of the brain.

(a) Enzymes such as aspartoacylase display specificity.

Outline what is meant by *specificity* of an enzyme.

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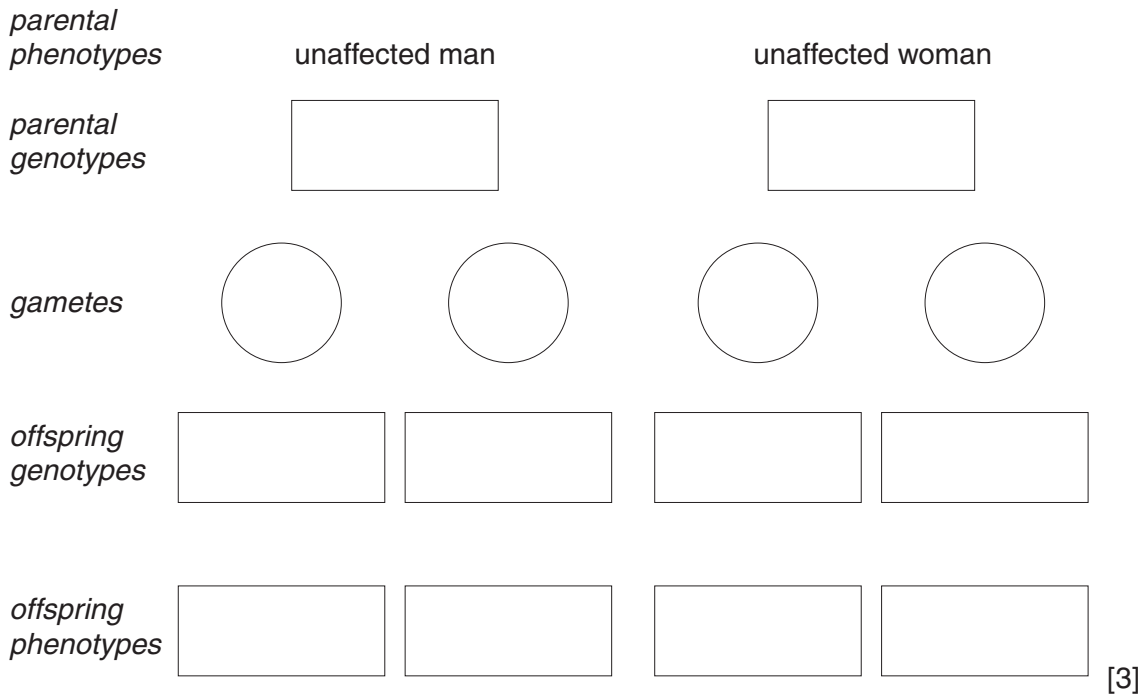
..... [2]

(b) Complete the genetic diagram below to show how an unaffected man and an unaffected woman could produce a child with Canavan disease.

key to symbols

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[3]

(c) Explain the importance of the myelin sheath in the functioning of a neurone.

For Examiner's Use

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[Total: 8]

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Question 7 starts on page 17

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7 **(a)** Complete the following passage about ATP by writing in the missing words.

For Examiner's Use

All living organisms use energy. The most common immediate source of energy is adenosine triphosphate (ATP) which is used in every cell for the movement of ions against a concentration gradient, known as ..... .

ATP is known as the universal currency of energy.

ATP is a phosphorylated nucleotide which is known as a 'high energy' molecule. It is made of an organic base, adenine, a 5 carbon sugar named ..... and three phosphate groups. ATP is very soluble in ..... and easily transported within the cell. The removal of the outer phosphate group by the process of ..... releases energy. The energy released as a result of this reaction can be channelled directly into other reactions in the cell.

A certain proportion of this energy is lost as ..... .

ATP is continually broken down and is reformed at a fast rate by the process of respiration. [5]

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[Turn over

(b) During a sporting event an athlete may have to carry out anaerobic respiration in addition to aerobic respiration to produce sufficient ATP.

For Examiner's Use

Fig. 7.1 outlines both processes in a muscle cell and shows how a liver cell is linked to these processes.

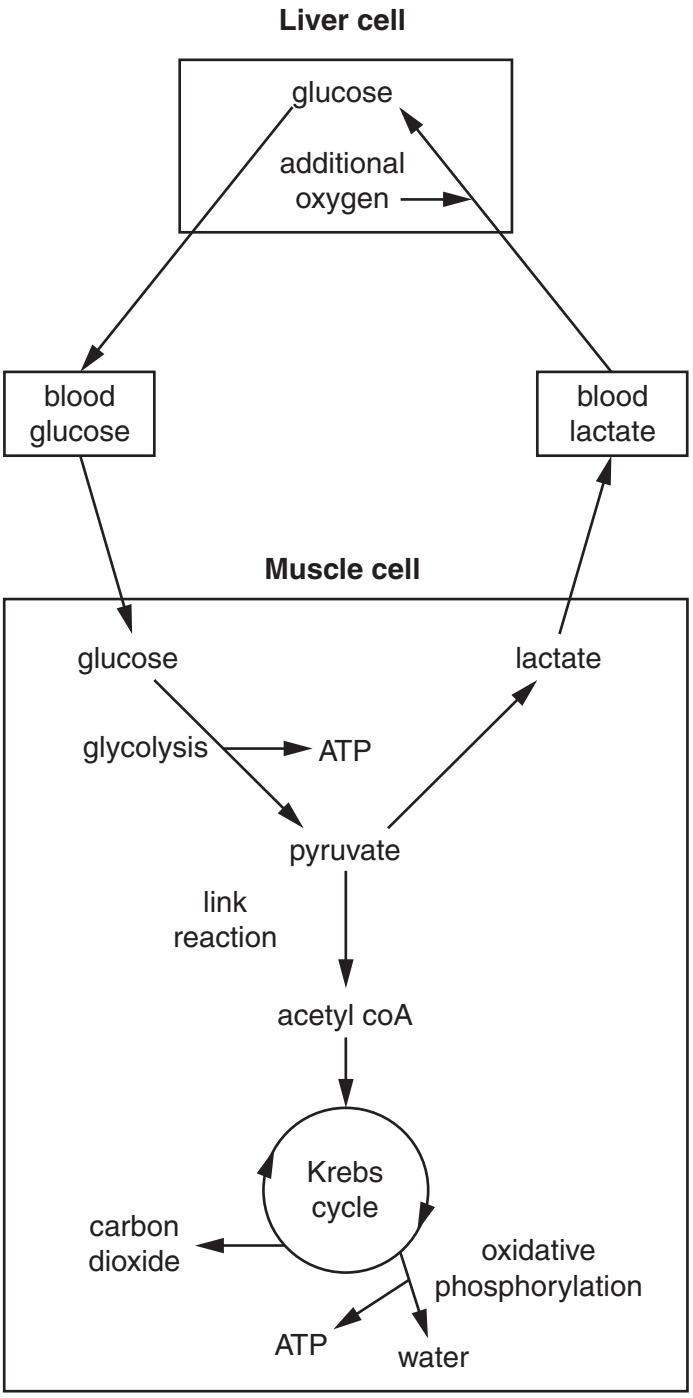


Fig. 7.1

You may refer to Fig. 7.1 in answering questions **(i)** to **(v)** below.

(i) Glucose produced in the liver cell can be released into the blood to maintain blood glucose concentration.

State one use of glucose **within** the liver cell.

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..... [1]

(ii) Suggest why anaerobic respiration is said to be less efficient than aerobic respiration.

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..... [2]

(iii) Complete the table to indicate, within the muscle cell, the precise locations of glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation.

process	precise location
glycolysis	
link reaction	
Krebs cycle	
oxidative phosphorylation	

[4]

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(iv) Glucose is phosphorylated at the start of glycolysis in the muscle cell.

Suggest why this phosphorylated glucose does **not** diffuse out of the cell into the surrounding tissue fluid.

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..... [2]

(v) Additional oxygen is required in the metabolic pathways involved in the conversion of lactate to glucose.

State the term given to this additional oxygen.

..... [1]

[Total: 15]

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Question 8 starts on page 22

For Examiner's Use

8 The hedgehog, *Erinaceus europaeus*, is a small carnivorous mammal native to Northern Europe.

Fig. 8.1 shows a hedgehog.



Fig. 8.1

Hedgehogs were introduced onto a small group of islands off the west coast of Scotland in 1974. The hedgehog population has increased so that there are now over 5000 breeding pairs. These hedgehogs have no natural predators on these islands and their diet consists mainly of bird's eggs.

Fig. 8.2 shows the hedgehog population density in the year 2000**.**

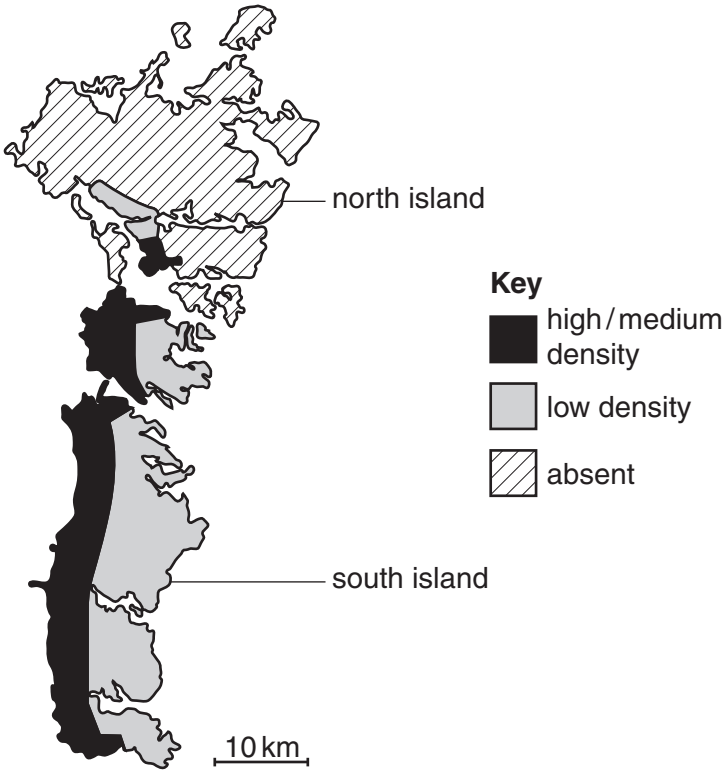


Fig. 8.2

Table 8.1 shows the changes in the populations of the species of birds from 1983 to 2000.

For Examiner's Use

Table 8.1

	breeding pairs in 1983	**breeding pairs in 2000**	**% change in population**
north island			
oystercatcher	928	1122	+21
lapwing	1104	1364	+24
redshank	486	733	+51
south island			
oystercatcher	907	1403	+55
lapwing	1869	1287	–31
redshank	1288	760	–41

(a) Using Fig. 8.2 and Table 8.1, describe the relationship between the hedgehog population density and the changes in the populations of **lapwings** and **redshanks**.

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..... [3]

(b) Suggest an explanation for the increase in the oystercatcher population on the south island, despite the increase in the hedgehog population.

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..... [2]

(c) Explain why the population of hedgehogs on one of these islands may eventually become a different species from that on mainland Scotland.

For Examiner's Use

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..... [4]

[Total: 9]

Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Outline the ways in which the endocrine **and** nervous systems carry out their roles in control and coordination in animals. [8]

(b) Describe the part played by auxins in apical dominance in a plant shoot. [7]

[Total: 15]

10 **(a)** Describe how non-cyclic photophosphorylation produces ATP and reduced NADP. [9]

(b) Outline the steps of the Calvin cycle. [6]

[Total: 15]

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BIOLOGY **9700/42**

Paper 4 A2 Structured Questions **May/June 2011**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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Section A
Answer **all** questions.

Section B
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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.
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For Examiner's Use	
Section A	
1	
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Section B	
10 or 11	
Total	

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Section A

Answer **all** the questions.

For Examiner's Use

1 The natterjack toad, *Bufo calamita*, is an endangered amphibian species in the UK. It comes out of hibernation in April and breeds in pools by sand dunes along parts of the UK coast. A young natterjack toad will take about 10 weeks to develop from a fertilised egg. A natterjack toad feeds at night, by running at its prey, mainly insects and worms, on the sand dunes.

Fig. 1.1 shows a natterjack toad.



Fig. 1.1

(a) Suggest what may have caused the natterjack toad to become an endangered species in the UK.

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(b) Fig. 1.2 shows the number of adult natterjack toads counted from 1989 to 1997 in one area of the UK.

For Examiner's Use

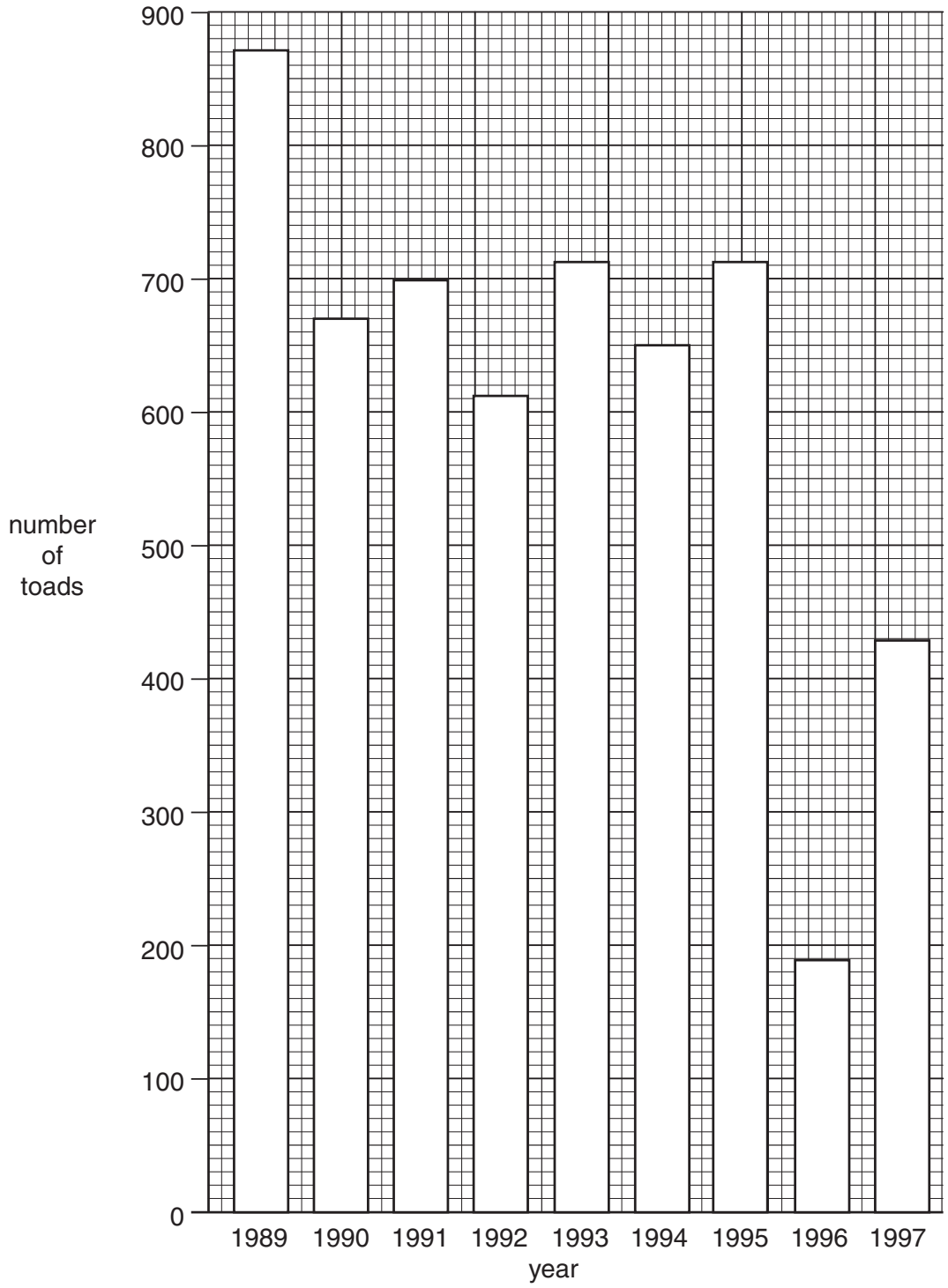


Fig. 1.2

Calculate the mean annual number of adult natterjack toads counted from 1989 to 1997.

Give your answer to the **nearest whole number**.

Show your working.

answer ..... [2]

(c) The natterjack toad is heterotrophic.

For Examiner's Use

(i) Explain what is meant by heterotrophic.

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.....[2]

(ii) Name two kingdoms that are exclusively heterotrophic.

1. .....

2. .....[1]

(d) Each year the International Union for the Conservation of Nature and Natural Resources (IUCN) publishes a list of endangered species called the Red List. The Red List has a very high proportion of vertebrates compared to invertebrates.

Suggest **one** reason **why** the Red List has many more vertebrates than invertebrates.

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.....[1]

[Total: 9]

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Question 2 starts on page 6

2 **(a)** Outline how an enzyme can be immobilised in alginate.

For Examiner's Use

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.....[2]

(b) State two advantages, other than stability, of using an immobilised enzyme in an industrial process compared with the same enzyme that has not been immobilised.

1. .....

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2. .....

.....[2]

(c) Papain is a protease enzyme. Its activity at different temperatures, when immobilised onto an inert support, was compared with its activity in solution.

The results are shown in Fig. 2.1.

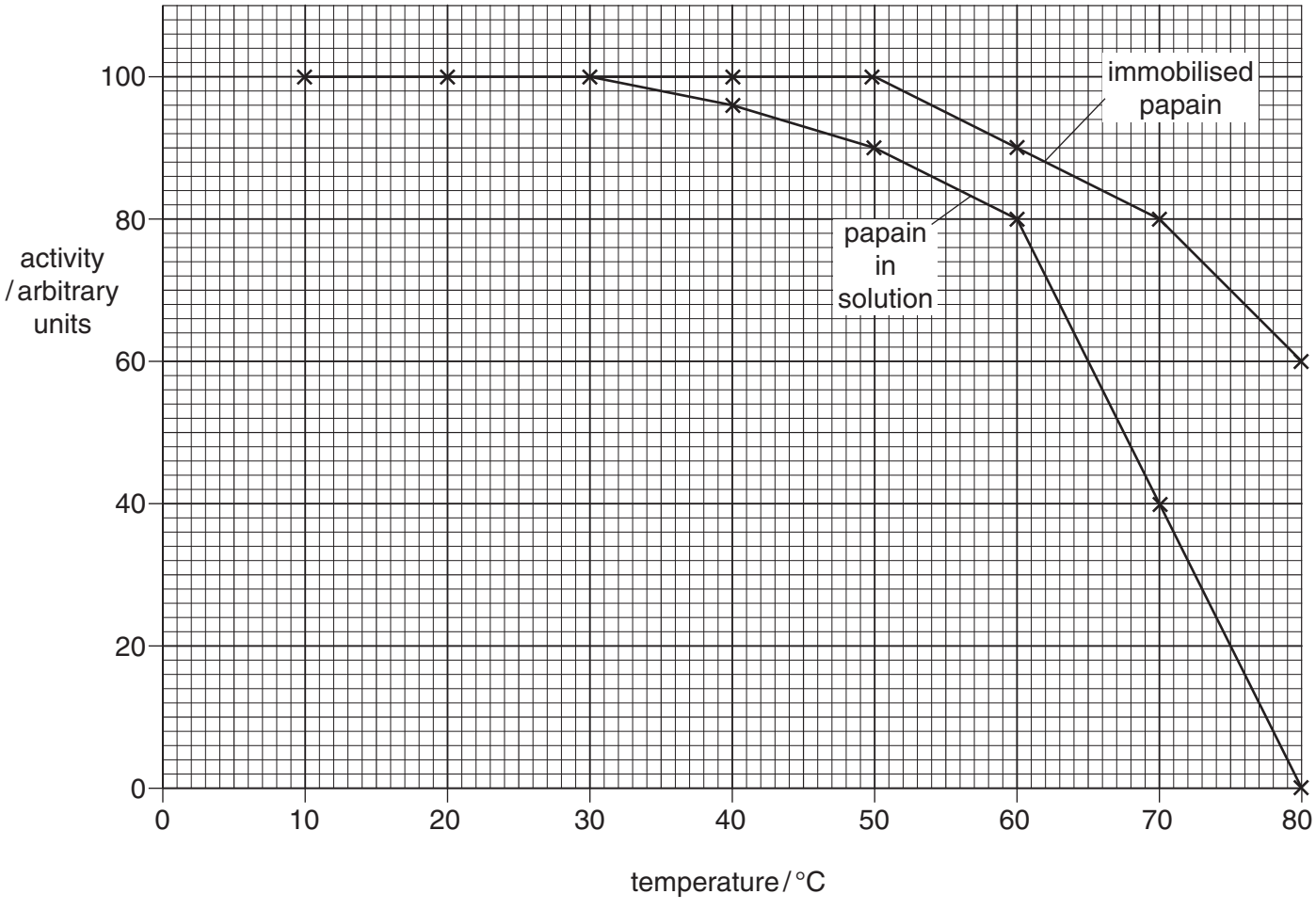


Fig. 2.1

With reference to Fig. 2.1, describe **and** explain the differences in activity of immobilised papain and papain in solution.

For Examiner's Use

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[Total: 8]

For Examiner's Use

3 **(a)** Fig. 3.1 shows a drawing of a section through an ovarian follicle.

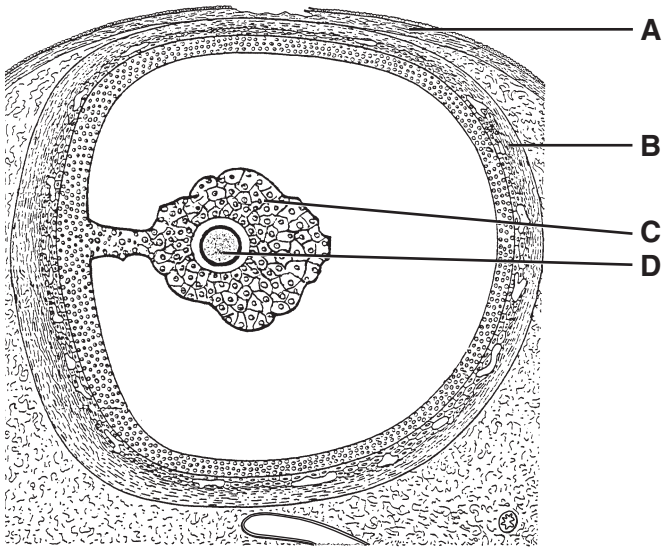


Fig. 3.1

State the names of the parts labelled **A**-**D** in Fig. 3.1.

A .....

B .....

C .....

D ..... [4]

(b) Outline the biological basis of the effect of the oestrogen/progesterone contraceptive pill.

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(c) The zona pellucida of an oocyte is made up of ZP proteins. ZP3, which does not occur anywhere else in the body, has a complex tertiary structure and acts as a receptor for sperm during fertilisation.

For Examiner's Use

A new method of contraception, which does not involve the use of hormones, is in the early stages of development. It involves blocking the expression of the gene coding for ZP3.

(i) Explain how blocking the expression of the gene coding for ZP3 acts as a contraceptive.

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.....[3]

(ii) Explain why it is desirable to devise a method of contraception that does not involve oestrogen and progesterone.

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.....[2]

(iii) Explain why it is important, when blocking the expression of the gene coding for ZP3, that ZP3 is only found in the zona pellucida.

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[Total: 15]

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For Examiner's Use

4 Maize, *Zea mays*, is a major cereal food crop. Unlike most crop plants, maize seed is produced by hybridisation between two different inbred parental strains.

(a) (i) Explain why this is done.

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.....[3]

(ii) Suggest **one** disadvantage of producing seed in this way.

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.....[1]

(b) In the light-independent stage of photosynthesis, the enzyme rubisco catalyses the combination of carbon dioxide with ribulose bisphosphate, RuBP. When the carbon dioxide concentration within the leaf is very low, rubisco tends to combine oxygen, rather than carbon dioxide, with RuBP. This process is called photorespiration. It reduces carbon dioxide assimilation and therefore reduces crop yields.

Photorespiration is most likely to happen in hot, dry conditions.

(i) Suggest **why** photorespiration is most likely to take place in hot, dry conditions.

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.....[3]

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[Turn over

For Examiner's Use

(ii) Explain how the leaf anatomy of a maize plant reduces photorespiration, even in hot, dry conditions.

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(c) It is expected that the carbon dioxide concentration in the atmosphere will increase in the future, which would be expected to increase rates of photosynthesis in many crop plants.

Investigations were carried out into the effect of increased carbon dioxide concentration on the rate of photosynthesis in maize.

- Maize plants were grown in open-air trials, in the same field and were exposed to the same changes in the weather.
- 50% of the plants were exposed to a normal carbon dioxide concentration.
- 50% of the plants were exposed to an increased carbon dioxide concentration.
- The rate of photosynthesis was measured as the net assimilation rate of carbon dioxide.
- Measurements were made at three-hourly intervals between 0700 hours and 1900 hours on three different days.

The results are shown in Fig. 4.1.

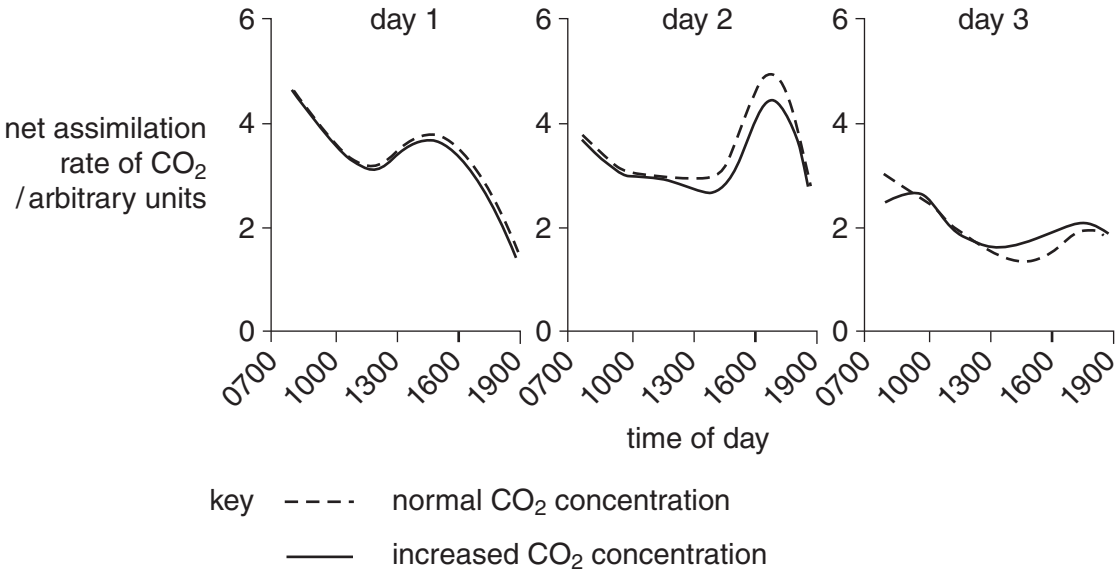


Fig. 4.1

For Examiner's Use

(i) Suggest an explanation for the lack of effect of carbon dioxide concentration on the rate of photosynthesis in maize plants, shown by these results.

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.....[2]

(ii) Suggest **one** explanation for the changes in the rate of photosynthesis between 0700 hours and 1900 hours on day 1.

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.....[2]

[Total: 15]

For Examiner's Use

5 In the USA, about 35% of all maize that is grown has been genetically modified to produce a toxin, called Bt toxin, derived from the bacterium *Bacillus thuringiensis.* The genetically modified plants are known as Bt maize.

(a) Explain the advantages of growing Bt maize.

.....

.....

.....

.....[2]

(b) An investigation was carried out into the potential effects of dead leaves from Bt maize on organisms living in streams that flow through areas where the maize is grown.

The researchers conducted a laboratory-based experiment in which larvae of one species of aquatic caddis fly, *Lepidostoma liba*, were fed on non-Bt maize leaves, or on leaves from Bt maize. The growth rates of the larvae were measured.

The results are summarised in Fig. 5.1.

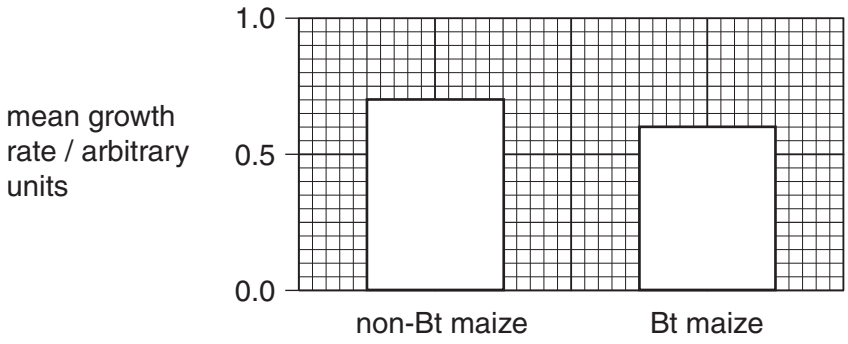


Fig. 5.1

Describe the effect of eating leaves from Bt maize on the growth rate of *L. liba* larvae.

.....

.....

.....

.....[2]

(c) In a second laboratory-based experiment, three groups of larvae of a different species of caddis fly, *Helicopsyche borealis*, were fed on pollen containing:

A no Bt toxin

B Bt toxin at concentrations found in streams in maize-growing areas

C Bt toxin at concentrations twice as high as found in those streams.

The researchers measured the mortality rates of the caddis fly larvae.

Their results are summarised in Table 5.1.

Table 5.1

groups compared	**difference in mortality rate**
groups **A** and **B**	no significant difference
groups **A** and **C**	significantly greater mortality in **C** than in **A**

The researchers were careful to state that their results showed the '**potential** ecological effects' on the caddis fly larvae of growing Bt maize.

Suggest **two** reasons why 'potential ecological effects' is a suitable description of any conclusions that could be drawn from the results of this experiment.

.....

.....

.....

.....[2]

(d) When the results of the experiments described in **(b)** and **(c)** were published, many other scientists criticised the research very strongly.

Suggest why some scientists might wish to suppress results such as these, even if there is no fault with the investigation itself.

.....

.....[1]

[Total: 7]

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6 The Krebs cycle occurs in the matrix of the mitochondrion.

For Examiner's Use

Fig. 6.1 outlines the steps of the Krebs cycle.

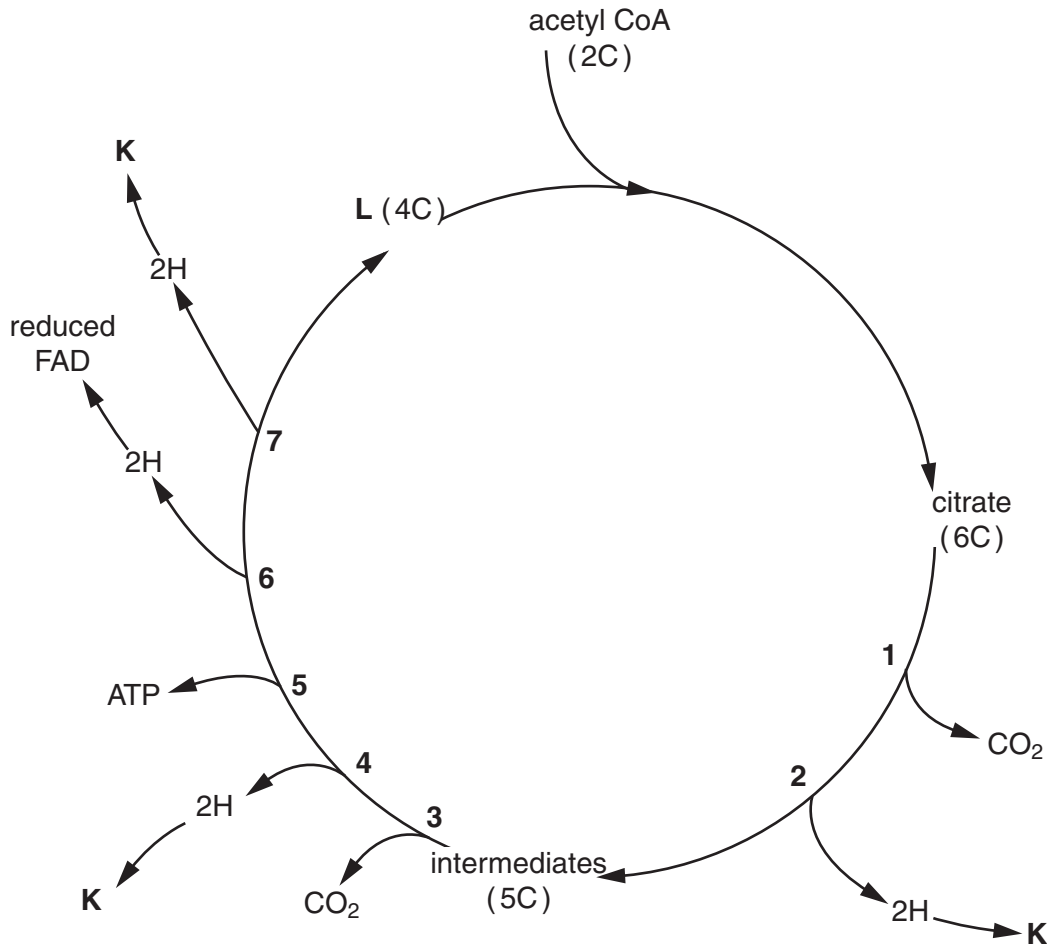


Fig. 6.1

(a) With reference to Fig. 6.1 name the process occurring at:

(i) **1** and **3** ..... [1]

(ii) **2**, **4**, **6** and **7** ..... [1]

(iii) **5** ..... [1]

(b) Name the compounds **K** and **L**.

K .....

L ..... [2]

(c) Most of the hydrogen atoms that are released by the Krebs cycle will take part in oxidative phosphorylation on the cristae of the mitochondria.

For Examiner's Use

Outline the process of oxidative phosphorylation.

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.....[5]

[Total: 10]

7 Meiosis is a type of nuclear division, which produces gametes for sexual reproduction.

For Examiner's Use

(a) Fig. 7.1 shows diagrams of the stages of meiosis, **A** to **J**, but they are not in the correct order.

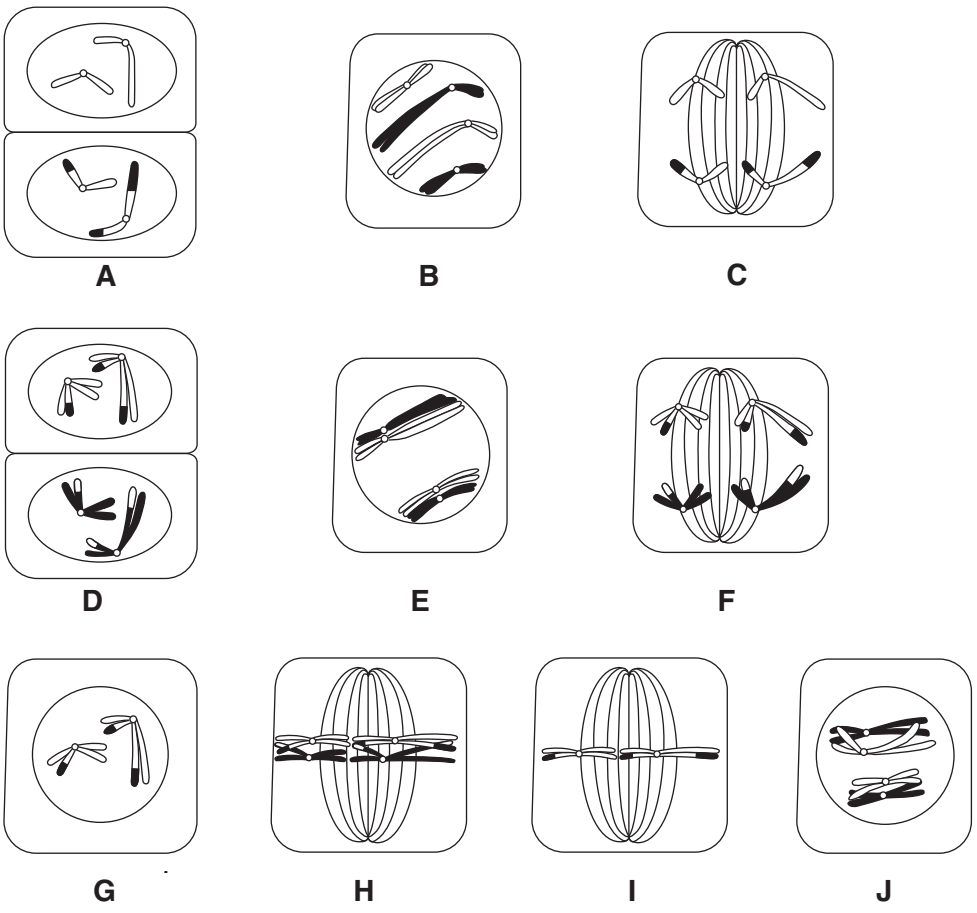


Fig. 7.1

Complete the table below by writing the stages of meiosis in the correct order.

Some of the stages have already been written in the table.

For Examiner's Use

nuclear division	letter of stage
meiosis I	**B**
	D
meiosis II	

[4]

(b) Explain how meiosis can result in genetic variation amongst offspring.

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.....[5]

[Total: 9]

8 The following passage is a summary of the main principles of natural selection.

For Examiner's Use

Some of the words have been omitted.

Write the most appropriate term in each space.

Individuals in a population have great ..... potential and yet the numbers in a population remain roughly ..... . This is because many die due to environmental factors and therefore do not reproduce. There is ..... amongst members of a population and those with the features best adapted to the environment survive. They reproduce and pass on their ..... to their offspring. This may lead to a change in the ..... pool of the population and over time may lead to evolutionary change.

[5]

[Total: 5]

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9 Huntington's Disease (HD) is a severe neurological disorder in which symptoms usually appear after the person has reached sexual maturity. Symptoms include memory loss and changes in personality and mood.

HD is caused by a gene mutation on chromosome 4 in which the triplet code CAG is repeated many times. The resulting allele is dominant.

(a) Explain what is meant by the terms gene mutation and triplet code.

gene mutation .....

.....

.....

.....

triplet code .....

.....

.....

.....[4]

(b) A couple wish to start a family. The man does not have HD but the woman does have the disease. The woman's father does not have the disease.

Complete the genetic diagram below to show the probability of the couple's first child having HD.

key
Huntington allele = T
normal allele = t

parental phenotypes	man without HD	woman with HD
parental genotypes	.....	.....
gametes	.....	.....
offspring genotypes	.....	
offspring phenotypes	.....	

probability of first child having HD ..... [3]

[Total: 7]

Section B

Answer **one** question.

For Examiner's Use

10 **(a)** Describe the photoactivation of chlorophyll **and** its role 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]

11 **(a)** Describe the role of abscisic acid (ABA) in the closure of a stoma. [8]

(b) Describe the role of gibberellins in the germination of barley seeds. [7]

[Total: 15]

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8742173785

BIOLOGY **9700/43**

Paper 4 A2 Structured Questions **May/June 2011**

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 in the spaces provided at the top of this page.
Write in dark blue or black ink.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question
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	
9	
Section B	
10 or 11	
Total	

This document consists of **20** printed pages, **2** lined pages and **2** blank pages.

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Section A

Answer **all** the questions.

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1 The natterjack toad, *Bufo calamita*, is an endangered amphibian species in the UK. It comes out of hibernation in April and breeds in pools by sand dunes along parts of the UK coast. A young natterjack toad will take about 10 weeks to develop from a fertilised egg. A natterjack toad feeds at night, by running at its prey, mainly insects and worms, on the sand dunes.

Fig. 1.1 shows a natterjack toad.



Fig. 1.1

(a) Suggest what may have caused the natterjack toad to become an endangered species in the UK.

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.....[3]

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(b) Fig. 1.2 shows the number of adult natterjack toads counted from 1989 to 1997 in one area of the UK.

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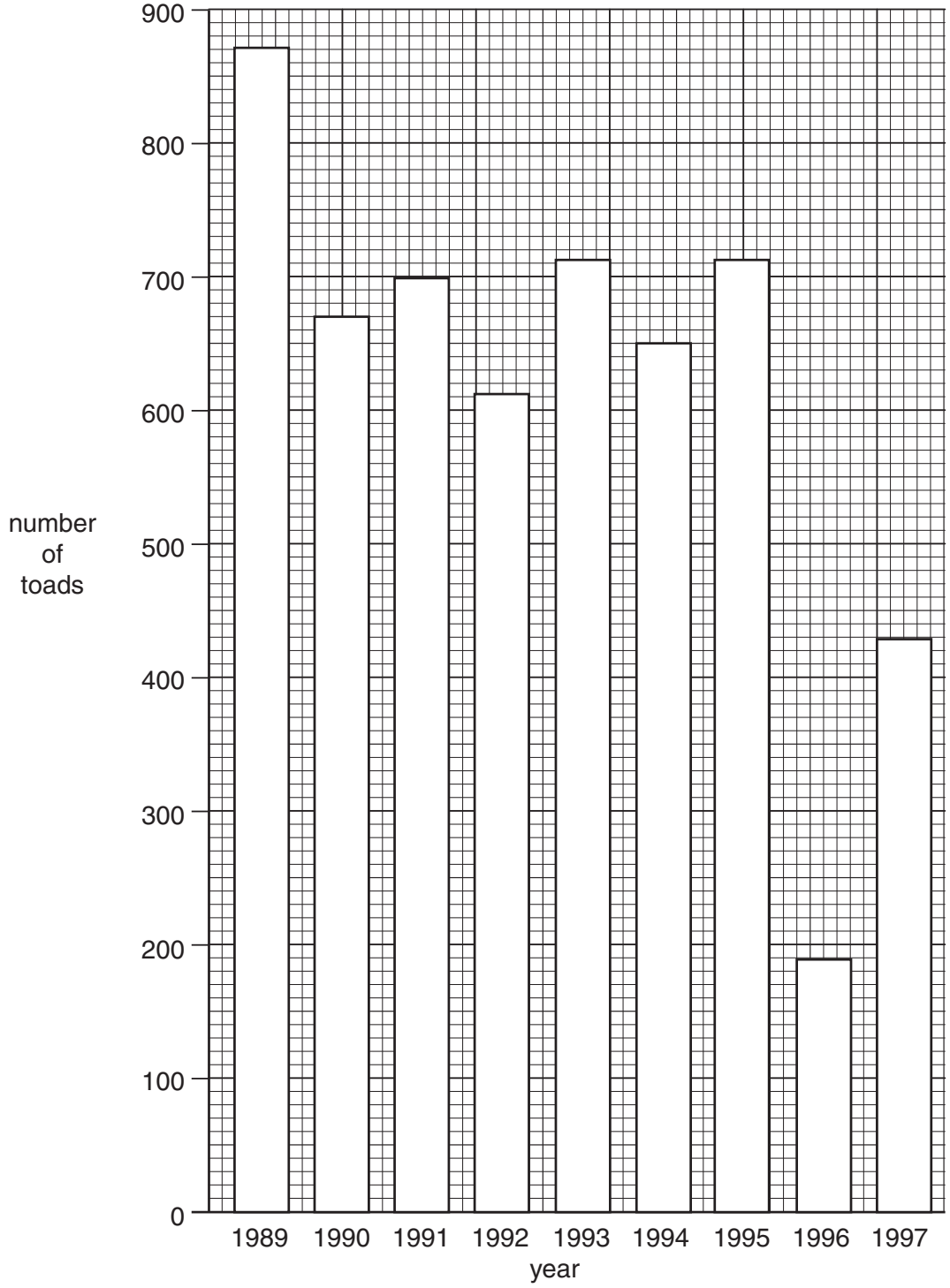


Fig. 1.2

Calculate the mean annual number of adult natterjack toads counted from 1989 to 1997.

Give your answer to the **nearest whole number**.

Show your working.

answer ..... [2]

(c) The natterjack toad is heterotrophic.

For Examiner's Use

(i) Explain what is meant by heterotrophic.

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.....[2]

(ii) Name two kingdoms that are exclusively heterotrophic.

1. .....

2. .....[1]

(d) Each year the International Union for the Conservation of Nature and Natural Resources (IUCN) publishes a list of endangered species called the Red List. The Red List has a very high proportion of vertebrates compared to invertebrates.

Suggest **one** reason **why** the Red List has many more vertebrates than invertebrates.

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.....[1]

[Total: 9]

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Question 2 starts on page 6

2 **(a)** Outline how an enzyme can be immobilised in alginate.

For Examiner's Use

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.....[2]

(b) State two advantages, other than stability, of using an immobilised enzyme in an industrial process compared with the same enzyme that has not been immobilised.

1. .....

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2. .....

.....[2]

(c) Papain is a protease enzyme. Its activity at different temperatures, when immobilised onto an inert support, was compared with its activity in solution.

The results are shown in Fig. 2.1.

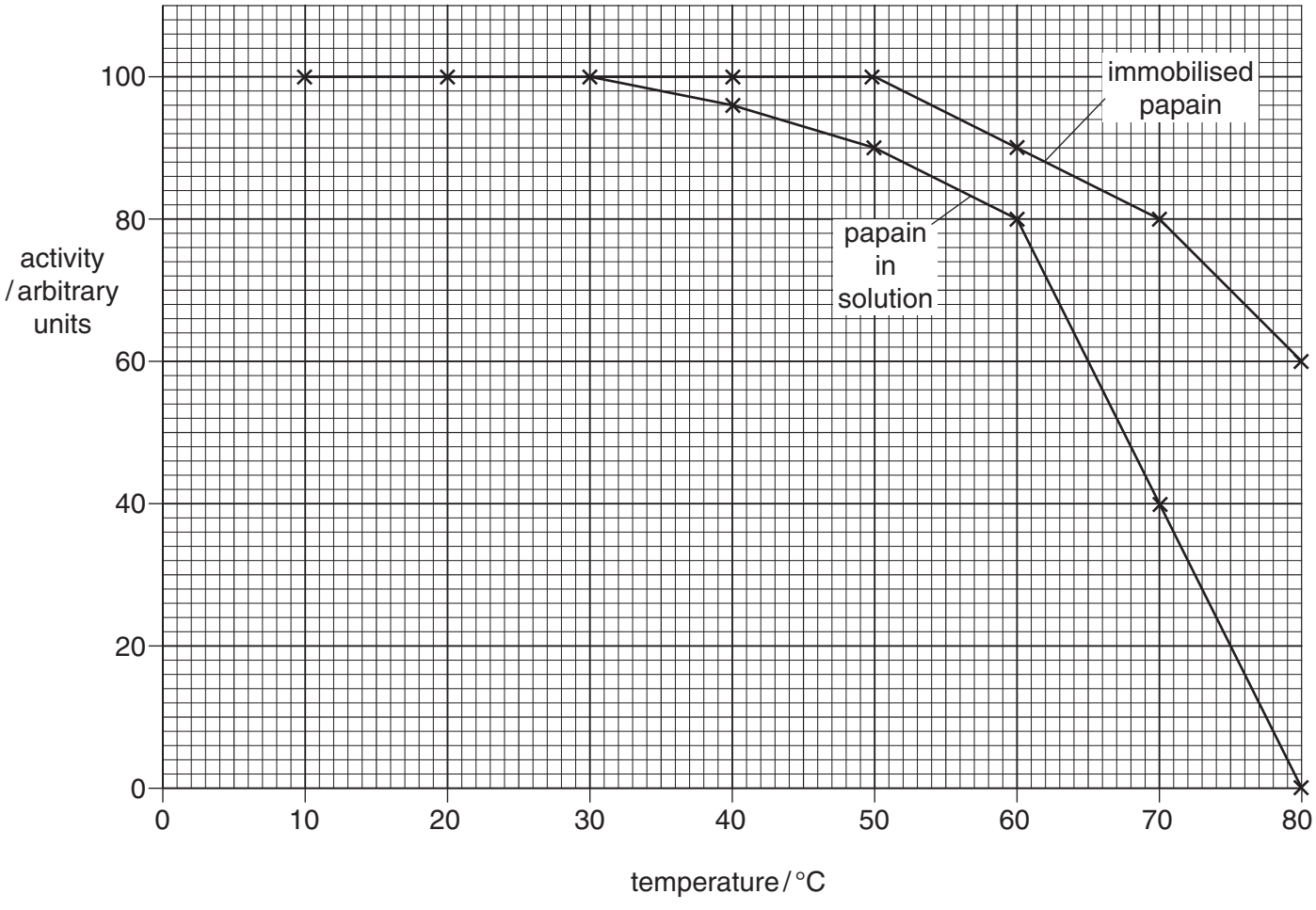


Fig. 2.1

With reference to Fig. 2.1, describe **and** explain the differences in activity of immobilised papain and papain in solution.

For Examiner's Use

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.....[4]

[Total: 8]

For Examiner's Use

3 **(a)** Fig. 3.1 shows a drawing of a section through an ovarian follicle.

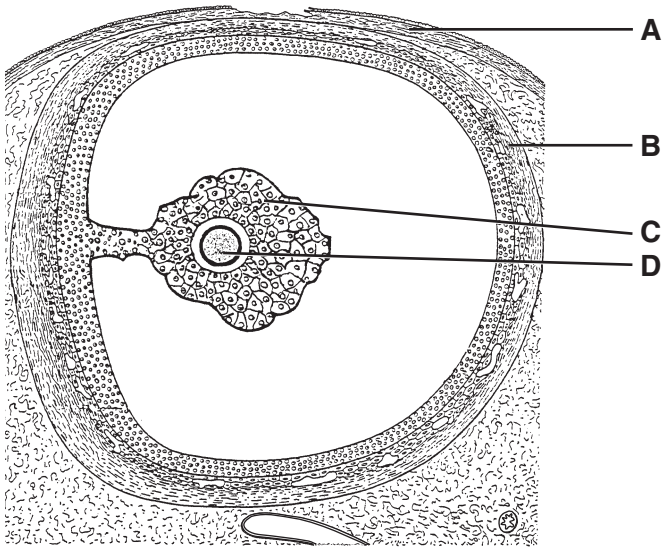


Fig. 3.1

State the names of the parts labelled **A**-**D** in Fig. 3.1.

A .....

B .....

C .....

D ..... [4]

(b) Outline the biological basis of the effect of the oestrogen/progesterone contraceptive pill.

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.....[4]

(c) The zona pellucida of an oocyte is made up of ZP proteins. ZP3, which does not occur anywhere else in the body, has a complex tertiary structure and acts as a receptor for sperm during fertilisation.

For Examiner's Use

A new method of contraception, which does not involve the use of hormones, is in the early stages of development. It involves blocking the expression of the gene coding for ZP3.

(i) Explain how blocking the expression of the gene coding for ZP3 acts as a contraceptive.

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.....[3]

(ii) Explain why it is desirable to devise a method of contraception that does not involve oestrogen and progesterone.

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.....[2]

(iii) Explain why it is important, when blocking the expression of the gene coding for ZP3, that ZP3 is only found in the zona pellucida.

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[Total: 15]

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For Examiner's Use

4 Maize, *Zea mays*, is a major cereal food crop. Unlike most crop plants, maize seed is produced by hybridisation between two different inbred parental strains.

(a) (i) Explain why this is done.

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.....[3]

(ii) Suggest **one** disadvantage of producing seed in this way.

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.....[1]

(b) In the light-independent stage of photosynthesis, the enzyme rubisco catalyses the combination of carbon dioxide with ribulose bisphosphate, RuBP. When the carbon dioxide concentration within the leaf is very low, rubisco tends to combine oxygen, rather than carbon dioxide, with RuBP. This process is called photorespiration. It reduces carbon dioxide assimilation and therefore reduces crop yields.

Photorespiration is most likely to happen in hot, dry conditions.

(i) Suggest **why** photorespiration is most likely to take place in hot, dry conditions.

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.....[3]

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[Turn over

(ii) Explain how the leaf anatomy of a maize plant reduces photorespiration, even in hot, dry conditions.

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.....[4]

(c) It is expected that the carbon dioxide concentration in the atmosphere will increase in the future, which would be expected to increase rates of photosynthesis in many crop plants.

Investigations were carried out into the effect of increased carbon dioxide concentration on the rate of photosynthesis in maize.

- Maize plants were grown in open-air trials, in the same field and were exposed to the same changes in the weather.
- 50% of the plants were exposed to a normal carbon dioxide concentration.
- 50% of the plants were exposed to an increased carbon dioxide concentration.
- The rate of photosynthesis was measured as the net assimilation rate of carbon dioxide.
- Measurements were made at three-hourly intervals between 0700 hours and 1900 hours on three different days.

The results are shown in Fig. 4.1.

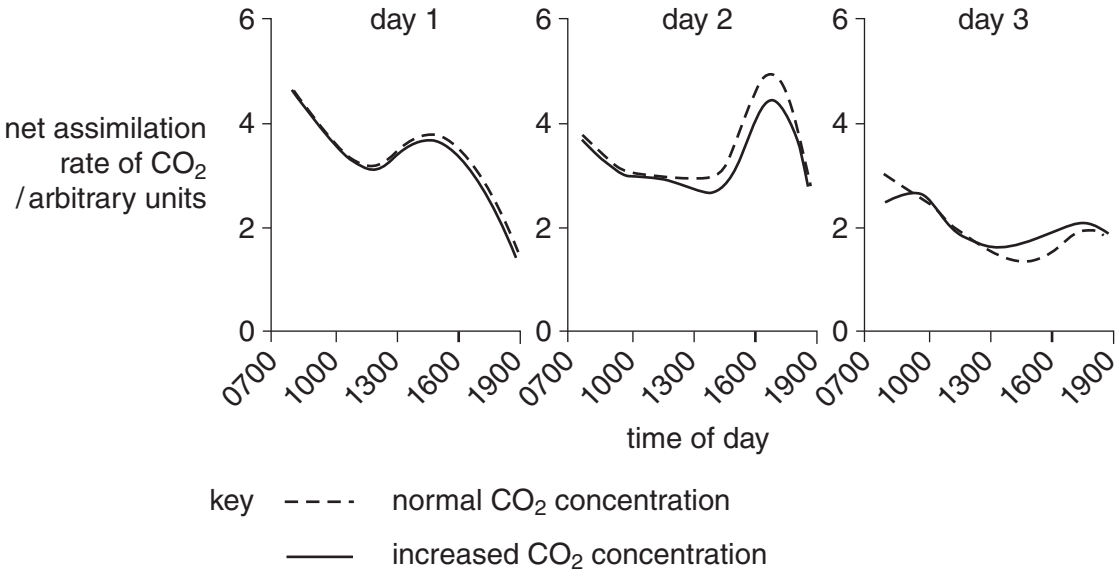


Fig. 4.1

For Examiner's Use

(i) Suggest an explanation for the lack of effect of carbon dioxide concentration on the rate of photosynthesis in maize plants, shown by these results.

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.....[2]

(ii) Suggest **one** explanation for the changes in the rate of photosynthesis between 0700 hours and 1900 hours on day 1.

.....

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.....

.....[2]

[Total: 15]

For Examiner's Use

5 In the USA, about 35% of all maize that is grown has been genetically modified to produce a toxin, called Bt toxin, derived from the bacterium *Bacillus thuringiensis.* The genetically modified plants are known as Bt maize.

(a) Explain the advantages of growing Bt maize.

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(b) An investigation was carried out into the potential effects of dead leaves from Bt maize on organisms living in streams that flow through areas where the maize is grown.

The researchers conducted a laboratory-based experiment in which larvae of one species of aquatic caddis fly, *Lepidostoma liba*, were fed on non-Bt maize leaves, or on leaves from Bt maize. The growth rates of the larvae were measured.

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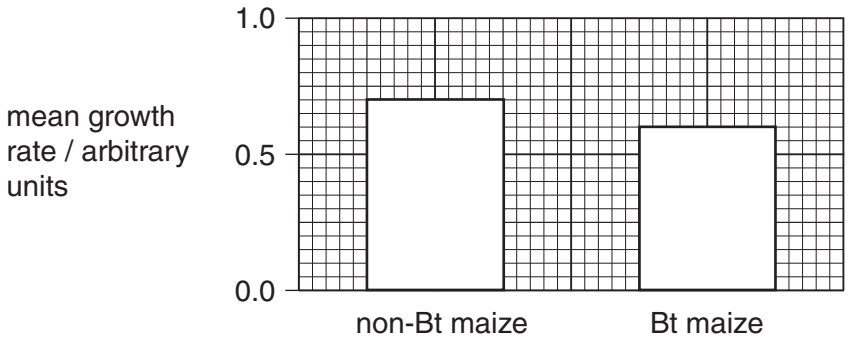


Fig. 5.1

Describe the effect of eating leaves from Bt maize on the growth rate of *L. liba* larvae.

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.....[2]

(c) In a second laboratory-based experiment, three groups of larvae of a different species of caddis fly, *Helicopsyche borealis*, were fed on pollen containing:

A no Bt toxin

B Bt toxin at concentrations found in streams in maize-growing areas

C Bt toxin at concentrations twice as high as found in those streams.

The researchers measured the mortality rates of the caddis fly larvae.

Their results are summarised in Table 5.1.

Table 5.1

groups compared	**difference in mortality rate**
groups **A** and **B**	no significant difference
groups **A** and **C**	significantly greater mortality in **C** than in **A**

The researchers were careful to state that their results showed the '**potential** ecological effects' on the caddis fly larvae of growing Bt maize.

Suggest **two** reasons why 'potential ecological effects' is a suitable description of any conclusions that could be drawn from the results of this experiment.

.....

.....

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.....[2]

(d) When the results of the experiments described in **(b)** and **(c)** were published, many other scientists criticised the research very strongly.

Suggest why some scientists might wish to suppress results such as these, even if there is no fault with the investigation itself.

.....

.....[1]

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For Examiner's Use

Fig. 6.1 outlines the steps of the Krebs cycle.

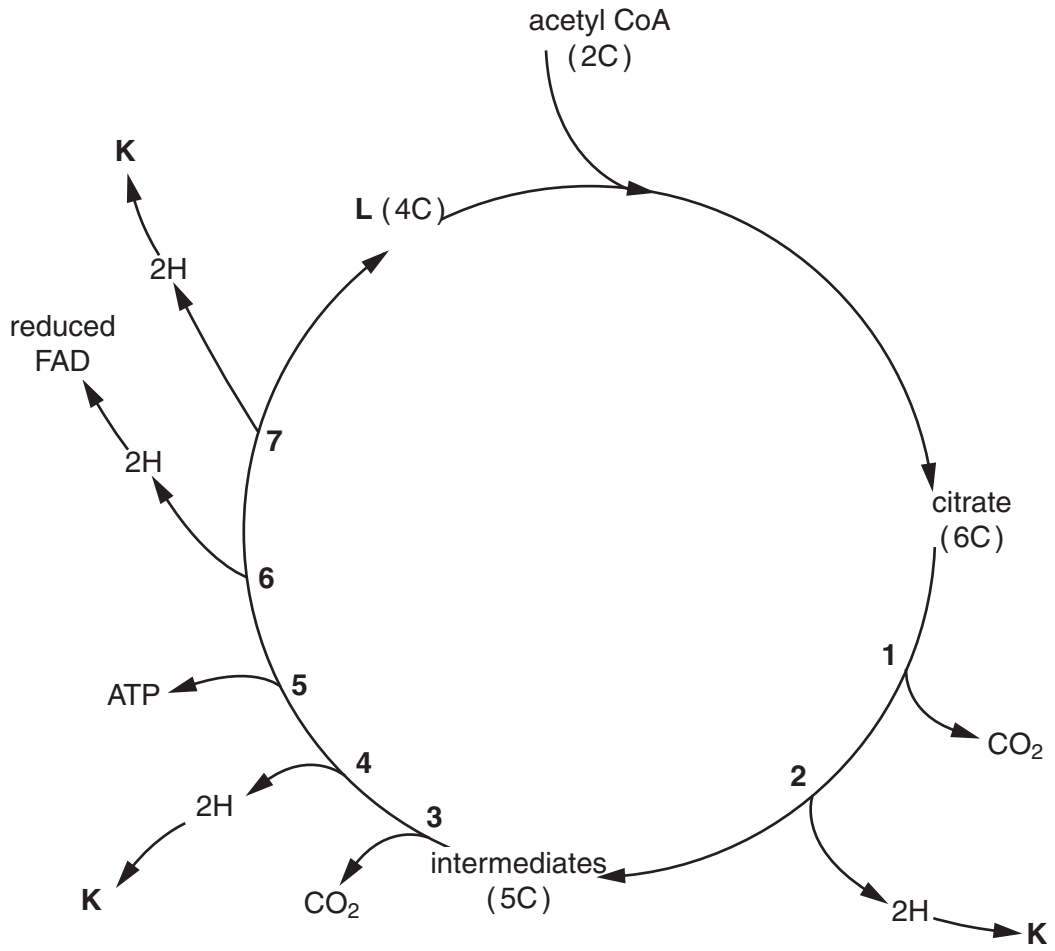


Fig. 6.1

(a) With reference to Fig. 6.1 name the process occurring at:

(i) **1** and **3** ..... [1]

(ii) **2**, **4**, **6** and **7** ..... [1]

(iii) **5** ..... [1]

(b) Name the compounds **K** and **L**.

K .....

L ..... [2]

(c) Most of the hydrogen atoms that are released by the Krebs cycle will take part in oxidative phosphorylation on the cristae of the mitochondria.

For Examiner's Use

Outline the process of oxidative phosphorylation.

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.....[5]

[Total: 10]

For Examiner's Use

7 Meiosis is a type of nuclear division, which produces gametes for sexual reproduction.

(a) Fig. 7.1 shows diagrams of the stages of meiosis, **A** to **J**, but they are not in the correct order.

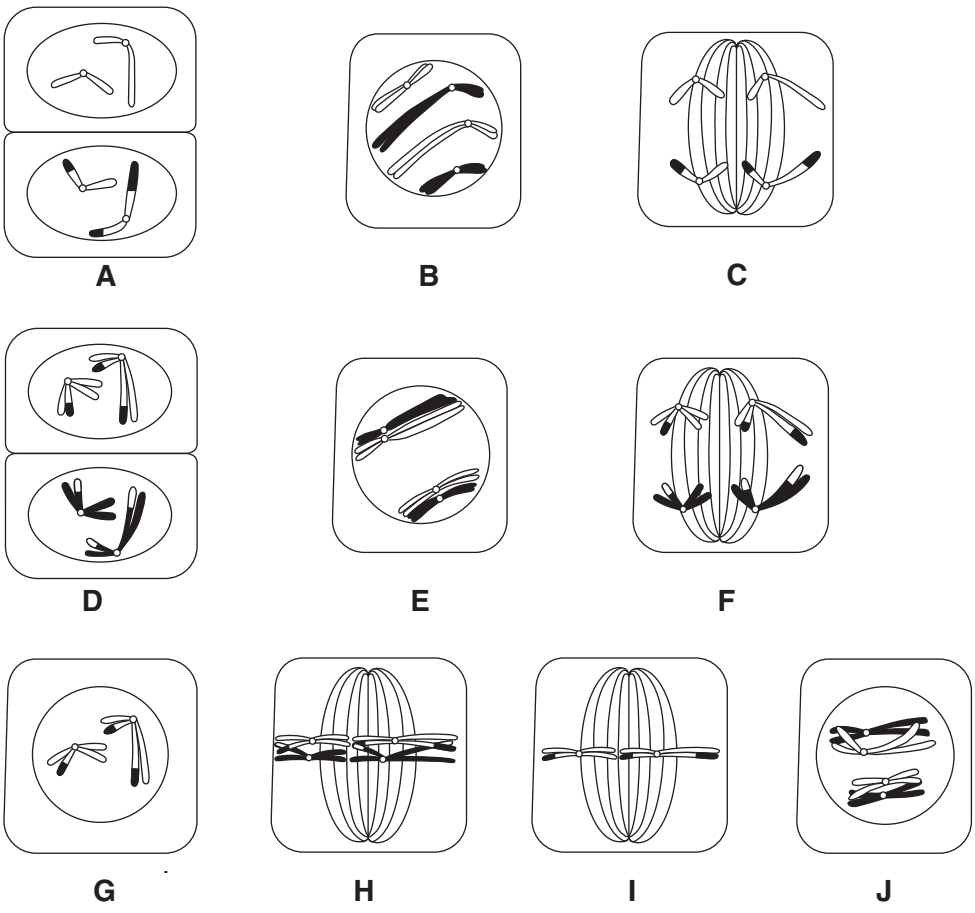


Fig. 7.1

Complete the table below by writing the stages of meiosis in the correct order.

Some of the stages have already been written in the table.

For Examiner's Use

nuclear division	letter of stage
meiosis I	**B**
	D
meiosis II	

[4]

(b) Explain how meiosis can result in genetic variation amongst offspring.

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[Total: 9]

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Individuals in a population have great ..... potential and yet the numbers in a population remain roughly ..... . This is because many die due to environmental factors and therefore do not reproduce. There is ..... amongst members of a population and those with the features best adapted to the environment survive. They reproduce and pass on their ..... to their offspring. This may lead to a change in the ..... pool of the population and over time may lead to evolutionary change.

[5]

[Total: 5]

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9 Huntington's Disease (HD) is a severe neurological disorder in which symptoms usually appear after the person has reached sexual maturity. Symptoms include memory loss and changes in personality and mood.

HD is caused by a gene mutation on chromosome 4 in which the triplet code CAG is repeated many times. The resulting allele is dominant.

(a) Explain what is meant by the terms gene mutation and triplet code.

gene mutation .....

.....

.....

.....

triplet code .....

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.....

.....[4]

(b) A couple wish to start a family. The man does not have HD but the woman does have the disease. The woman's father does not have the disease.

Complete the genetic diagram below to show the probability of the couple's first child having HD.

key
Huntington allele = T
normal allele = t

parental phenotypes	man without HD	woman with HD
parental genotypes	.....	.....
gametes	.....	.....
offspring genotypes	.....	
offspring phenotypes	.....	

probability of first child having HD ..... [3]

[Total: 7]

Section B

Answer **one** question.

For Examiner's Use

10 (a) Describe the photoactivation of chlorophyll **and** its role 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]

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(b) Describe the role of gibberellins in the germination of barley seeds. [7]

[Total: 15]

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