



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE
NAME

CENTRE
NUMBER

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BIOLOGY

9700/41

Paper 4 A2 Structured Questions

October/November 2013

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.

Electronic calculators may be used.

| 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 **22** printed pages, **1** blank page and **1** lined page.



Section A

Answer **all** questions.

For
Examiner's
Use

- 1 (a) Huntington's disease (HD) is an inherited disease of the central nervous system. The symptoms of HD usually develop in adulthood and include uncontrollable muscular movements, short-term memory loss and changes in mood.

HD is caused by a dominant allele of the *huntingtin* gene on chromosome 4.

Explain what is meant by the terms *allele* and *dominant*.

allele

.....

dominant

..... [2]

- (b) The dominant allele of the *huntingtin* gene contains many repeats of a triplet sequence of nucleotides, CAG. The age at which symptoms of HD first appear is linked with the number of CAG repeats.

This is shown in Fig. 1.1.

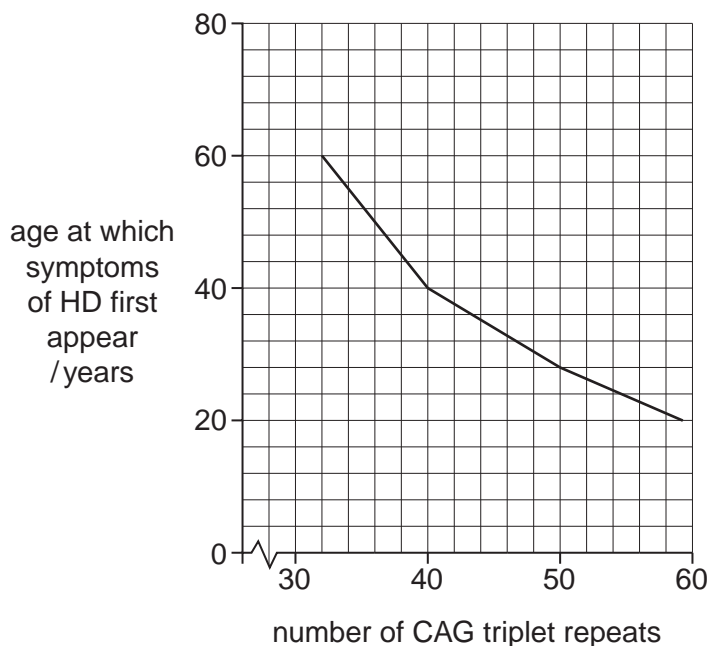


Fig. 1.1

3

Describe the pattern shown in Fig. 1.1.

For
Examiner's
Use

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..... [2]

(c) A blood test to detect the dominant allele is available for people at risk of HD.

Suggest why some people at risk of HD may decide **not** to take the blood test.

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..... [3]

[Total: 7]

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- (c) Scientists synthesised woolly mammoth haemoglobin in order to investigate whether or not the different haemoglobin was part of the mammoth's adaptation to a cold climate.

For
Examiner's
Use

The affinity of haemoglobin for oxygen is affected by the changes in temperature that can occur in mammals, for example in active muscle tissue or close to the skin surface.

It is advantageous for Arctic mammals to have haemoglobin whose affinity for oxygen is only slightly affected by changes in temperature. This is often achieved by using substances called 'red cell effectors', which bind to haemoglobin.

Fig. 2.1 compares the effect of temperature on the affinity for oxygen of woolly mammoth and Asian elephant haemoglobin, with and without red cell effectors.

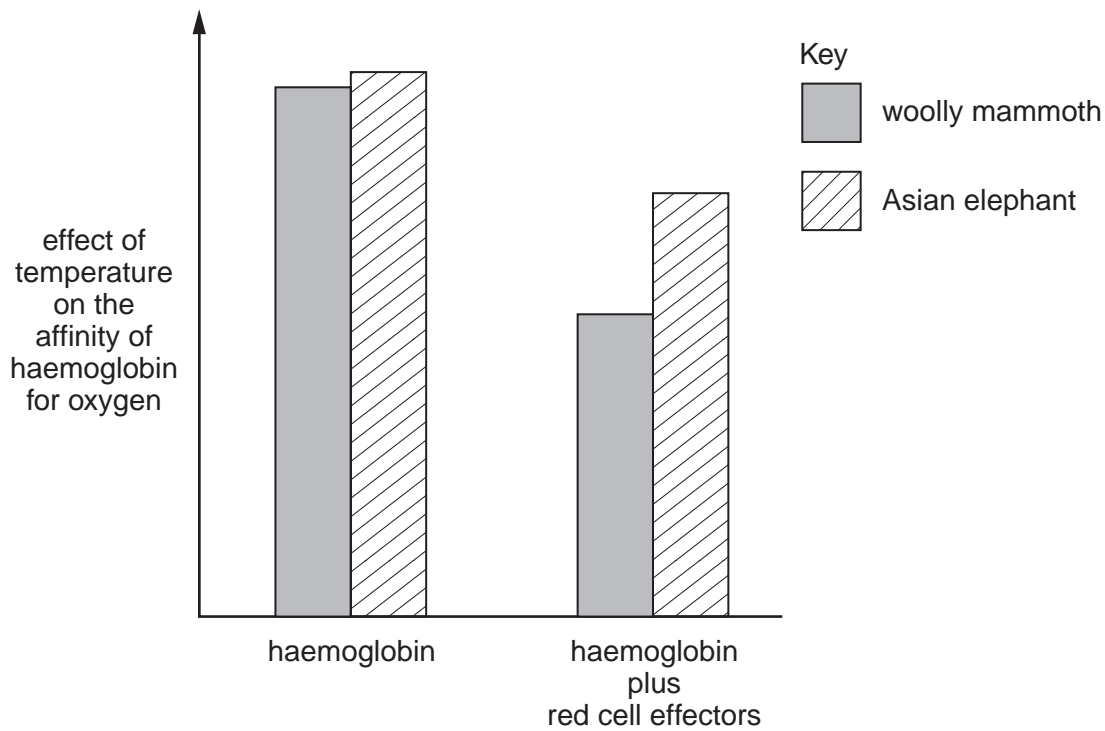


Fig. 2.1

- (i) Suggest why it is advantageous for Arctic mammals to have haemoglobin whose affinity for oxygen is only slightly affected by changes in temperature.

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..... [2]

(ii) Explain whether or not Fig. 2.1 provides evidence that woolly mammoth haemoglobin is better adapted for a cold climate than Asian elephant haemoglobin.

For
Examiner's
Use

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.....[4]

[Total: 14]

3 (a) The components of a molecule of ATP (adenosine triphosphate) are shown in Fig. 3.1.

For
Examiner's
Use

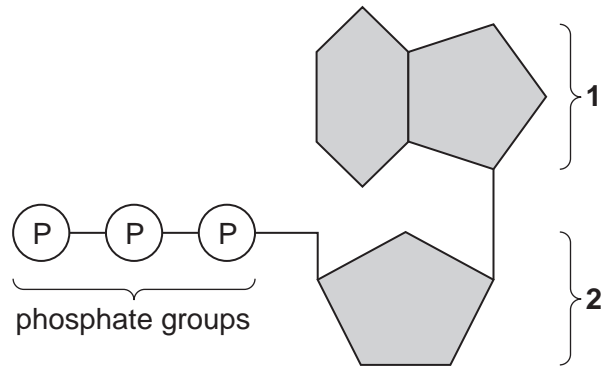


Fig. 3.1

With reference to Fig. 3.1, name components 1 and 2.

1

2 [2]

(b) Describe the consequences for the cell of the following statements.

- Each cell has only a very small quantity of ATP in it at any one time.
- The molecules, ATP, ADP (adenosine diphosphate) or AMP (adenosine monophosphate) **rarely** pass through the cell surface membrane.

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..... [2]

- (c) Glucose is a respiratory substrate. Table 3.1 shows the yield of ATP from some other substrates.

For
Examiner's
Use

Table 3.1

| respiratory substrate | number of ATP molecules produced per mole of substrate |
|------------------------------|--|
| alanine (an amino acid) | 15 |
| glycogen | 39 |
| lactate | 18 |
| palmitic acid (a fatty acid) | 129 |

- (i) Explain the different yields of ATP from glycogen and palmitic acid.

.....

 [2]

- (ii) Describe the circumstances in which alanine and lactate are used as respiratory substrates.

alanine

lactate
 [2]

[Total: 8]

- 4 (a) Blood samples were taken from a 29 year old woman each day for a period of 43 days. The concentrations of oestrogen, progesterone and luteinising hormone (LH) in each sample were measured. The results are shown in Fig. 4.1.

For
Examiner's
Use

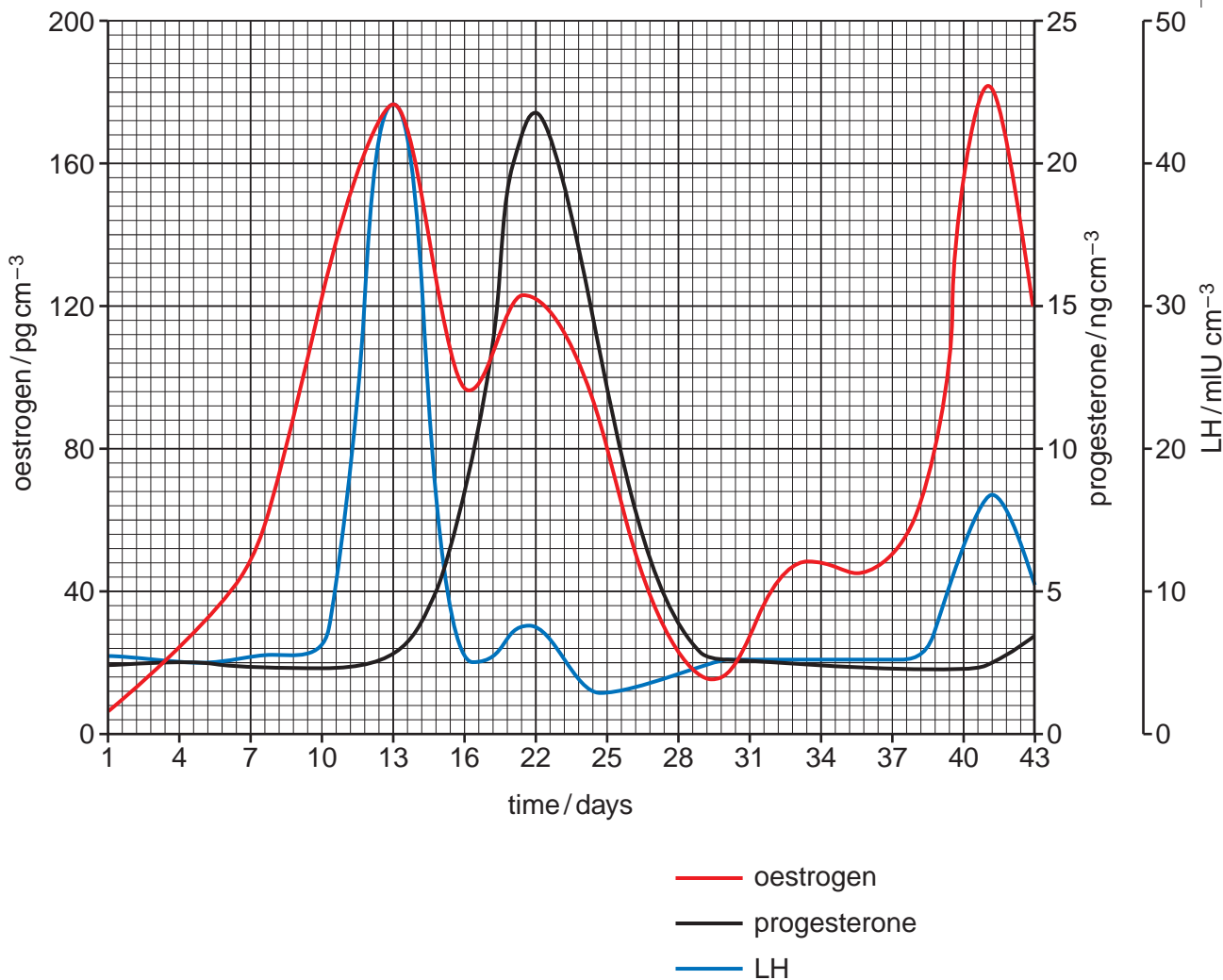


Fig. 4.1

- (i) Estimate the length of the woman's menstrual cycle. Show how you worked out your answer.

answer (days) [2]

- (ii) The luteal phase is the part of the cycle when a corpus luteum is present in the ovaries. It begins immediately after ovulation, and ends when menstruation starts.

Use Fig. 4.1 to suggest when the luteal phase began and ended.

began ended [2]

(iii) Name the organ that secretes LH.

..... [1]

(iv) Describe the roles of LH in the menstrual cycle.

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(b) An investigation was carried out to determine whether the ability of a woman to perform a task involving spatial ability varied at different times of her menstrual cycle.

The investigation involved 12 women. They each performed 24 similar spatial tasks on day 2 and day 22 of their menstrual cycle, for six successive cycles. The tasks involved mentally rotating 3-D shapes.

The researchers used two methods to determine the phase of the menstrual cycle.

- Each woman was asked when her previous menstrual period had begun.
- After each test, a blood sample was taken and the concentrations of oestrogen, progesterone and LH were measured.

(i) Suggest why the researchers used two methods to determine the phase of the menstrual cycle.

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..... [2]

- 5 (a) Maize originated in the Americas, and 55% of the world's maize production is from this part of the world.

For
Examiner's
Use

Fig. 5.1 shows the mean yields of maize in the USA between 1860 and 2010.

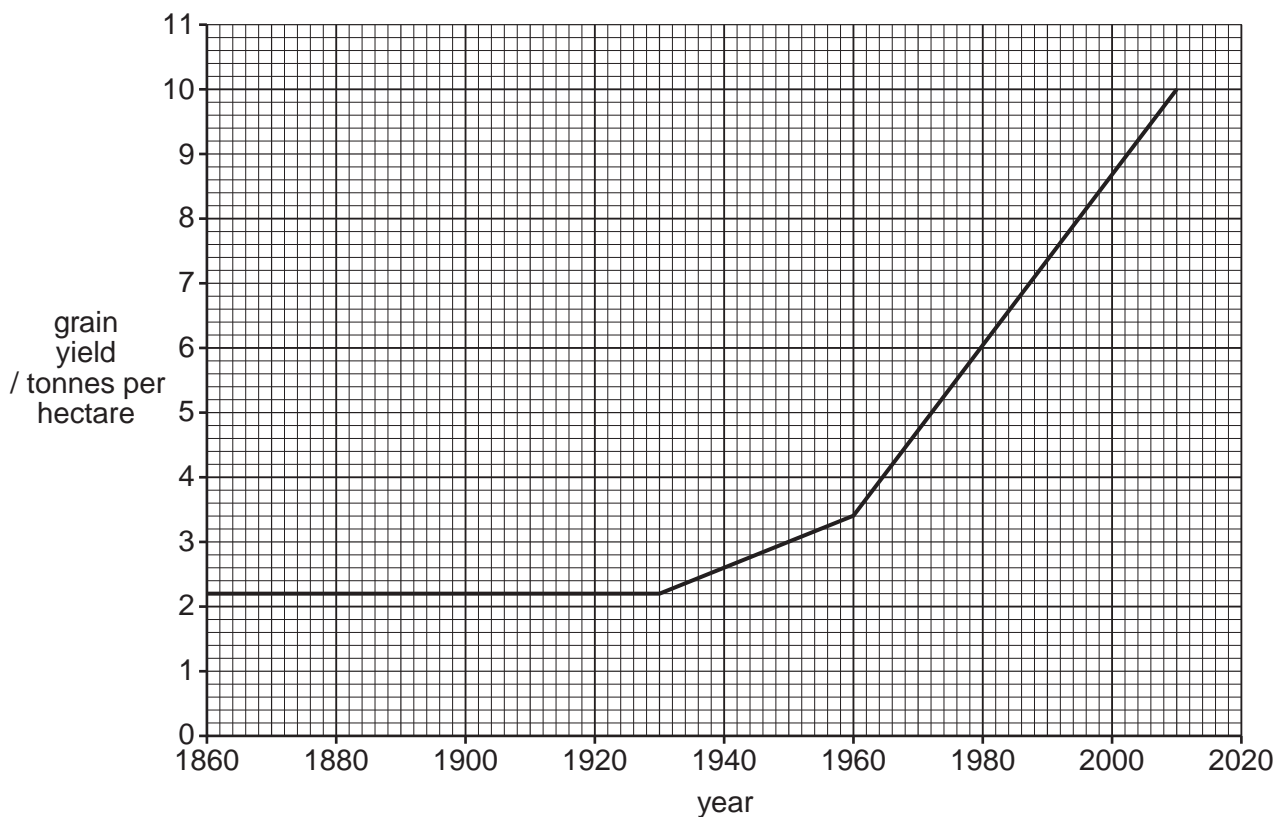


Fig. 5.1

Describe the changes in grain yield between 1860 and 2010.

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..... [3]

- (b) The greatest improvement in maize yields came after growers realised that maize hybrids have a much greater yield than inbred lines.

For
Examiner's
Use

Between 1860 and the 1930s, maize was allowed to pollinate naturally in the field. From the 1930s onward, maize seed was produced using 'double-cross' hybrids.

To produce a double-cross hybrid:

- two different maize plants, **A** and **B**, are crossed to produce a hybrid, **C**
- two other maize plants, **X** and **Y**, are crossed to produce a hybrid, **Z**
- the hybrid **C** is then crossed with the hybrid **Z**, to produce the double-cross hybrid.

From 1960 onwards, maize seed was produced using 'single-cross' hybrids. This involves crossing one inbred (entirely homozygous) plant with a different inbred plant.

Explain why single-cross hybrids are genetically uniform, but double-cross hybrids are not.

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.....[3]

- (c) An experiment was carried out in 1996–1997 to investigate the relative effects of genotype and environment on the yield of maize.

For
Examiner's
Use

Maize seeds with different 'inbreeding coefficients' were used. The greater the inbreeding coefficient, the greater the degree of homozygosity in the maize plants.

Maize seeds with different inbreeding coefficients were planted in two different areas in 1996, and in the same two areas in 1997.

Fig. 5.2 shows the results.

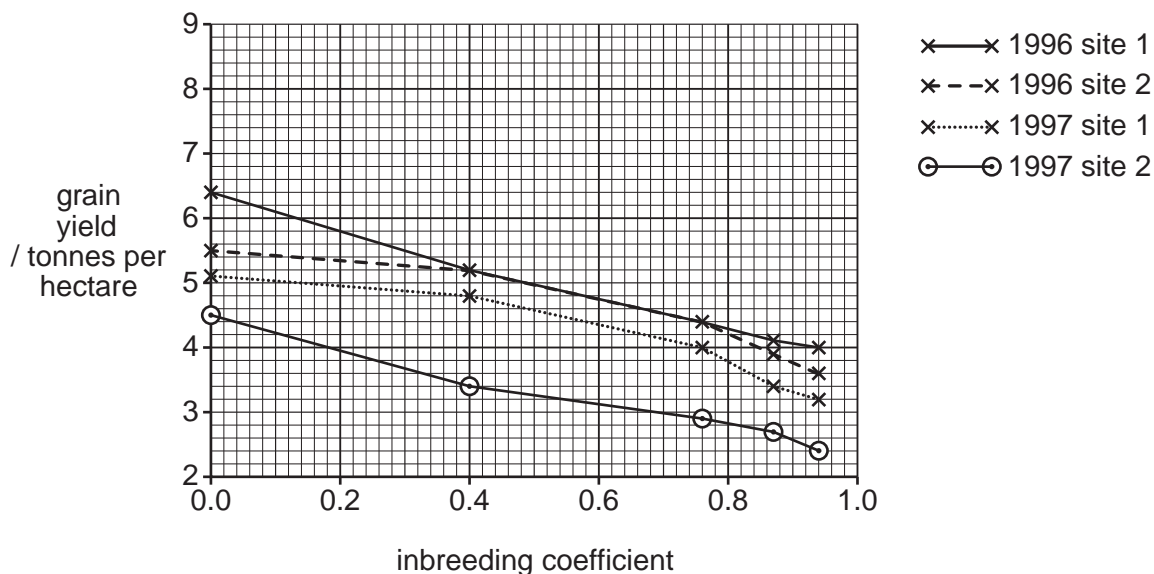


Fig. 5.2

- (i) Inbreeding depression is a reduction in vigour that results from inbreeding.

Explain how the results in Fig. 5.2 demonstrate inbreeding depression in maize.

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..... [2]

- (ii) Explain how the results in Fig. 5.2 show that the environment affects maize yields.

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..... [2]

[Total: 10]

- 6 (a) Table 6.1 shows the mean axon diameter and mean speed of conduction of nerve impulses for four different animals.

For
Examiner's
Use

Table 6.1

| animal | type of neurone | axon diameter / μm | mean speed of conduction / ms^{-1} |
|---------------|-----------------|-------------------------------|---|
| A – mammal | myelinated | 4 | 25 |
| B – mammal | unmyelinated | 5 | 3 |
| C – amphibian | myelinated | 14 | 35 |
| D – amphibian | myelinated | 10 | 30 |

With reference to Table 6.1, describe:

- (i) the effect of myelination on the speed of conduction of impulses in mammals

.....

 [2]

- (ii) the effect of axon diameter on the speed of conduction of impulses in amphibians.

.....

 [2]

- (b) Explain how myelination affects the speed of conduction of impulses.

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 [3]

(c) Multiple sclerosis (MS) is an auto-immune condition of humans in which the body's immune system attacks the myelin sheaths which are then damaged. This leads to a decrease in information reaching the brain from sensory receptors.

For
Examiner's
Use

(i) Suggest how the myelin sheaths may be attacked.

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..... [2]

(ii) Explain why this damage leads to a decrease in information reaching the brain from sensory receptors.

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..... [2]

[Total: 11]

7 (a) An experiment was carried out into the effect of light of different colours on photosynthesis.

For
Examiner's
Use

- 15 leaf discs from the same plant were obtained.
- Five sealed test-tubes were set up, each containing three leaf discs in hydrogencarbonate indicator solution.
- Hydrogencarbonate indicator solution changes colour at different pH values.
- At the start of the experiment the indicator solution in all five test-tubes was orange-red.
- Four of the test-tubes were illuminated by light of a specific colour.
- The test-tubes were illuminated for the same length of time.
- The fifth test-tube was covered in black paper and was a control.

The results are recorded in Table 7.1.

Table 7.1

| colour of light | final colour of hydrogencarbonate solution |
|------------------------|---|
| white | purple |
| blue | purple |
| green | orange-yellow |
| red | purple |
| control – no light | yellow |

When the pH increases, the indicator becomes purple and when the pH decreases, the indicator turns yellow.

(i) Explain the results for the leaf discs illuminated by blue light.

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..... [2]

(ii) Explain why the indicator in the control went yellow.

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..... [2]

(b) Cyclic and non-cyclic photophosphorylation take place in the light-dependent stage of photosynthesis.

For
Examiner's
Use

(i) Describe the role of accessory pigments in photophosphorylation.

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..... [2]

(ii) Write a balanced equation that summarises photolysis.

..... [1]

(iii) State **precisely** the location of photosynthetic pigments within a chloroplast.

..... [1]

[Total: 8]

- 8 (a) The tiger, *Panthera tigris*, is classified as an endangered species by the International Union for the Conservation of Nature and Natural Resources (IUCN). The IUCN publishes an annual list of endangered species called the Red List.

For
Examiner's
Use

Fig. 8.1 shows the number of tigers in the wild between 1900 and 2010.

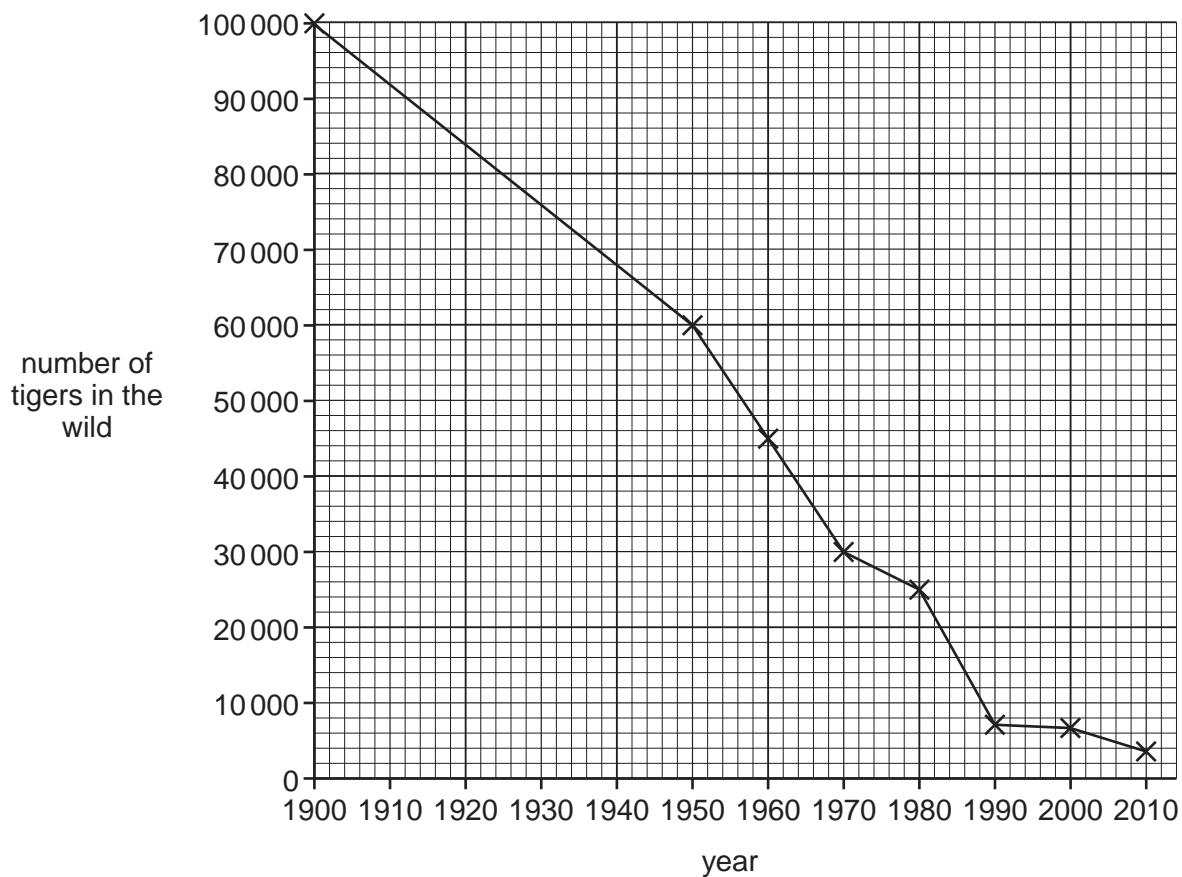


Fig. 8.1

Calculate the overall rate of decrease in number of tigers between 1900 and 2010.

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

answer tigers per year [2]

(b) Describe the reasons why a **named** species has become endangered.

For
Examiner's
Use

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[Total: 6]

- 9 The passage below summarises the effects of gibberellins on seed germination.

Complete the passage by using the most appropriate scientific term(s).

For
Examiner's
Use

When a seed is shed from the parent plant, it is in a state of ,
which means it is metabolically inactive.

When water is absorbed by a seed, it stimulates the production of gibberellin by the
..... within the seed. The gibberellin stimulates the synthesis of
amylase by cells in the layer.

Amylase hydrolyses starch molecules in the converting them
to soluble molecules. These molecules are converted to
glucose which is transported to the embryo, providing a source of carbohydrate that can be
respired to provide as the embryo begins to grow.

Gibberellin causes these effects by regulating genes that are involved in the synthesis of
amylase. It has been shown that application of gibberellin to seeds can cause an increase in
the of the DNA coding for amylase.

[Total: 7]

Section B

Answer **one** question.

*For
Examiner's
Use*

- 10 (a) Explain what is meant by a **gene** mutation and outline the possible consequences of a gene mutation for an organism. [9]
- (b) Explain how faulty CFTR proteins in cell surface membranes can lead to the symptoms of cystic fibrosis. [6]

[Total: 15]

- 11 (a) Describe the main features of an organism belonging to the plant kingdom. [7]
- (b) Describe the structure of a mitochondrion and outline its function in a plant cell. [8]

[Total: 15]

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