Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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3500131762

BIOLOGY **9700/42**

Paper 4 A2 Structured Questions **May/June 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Answer Paper available on request.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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

This document consists of **21** printed pages and **3** lined pages.

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CAMBRIDGE International Examinations

Section A

Answer **all** the questions.

1 **(a)** Fig. 1.1 shows an electronmicrograph of a chloroplast.

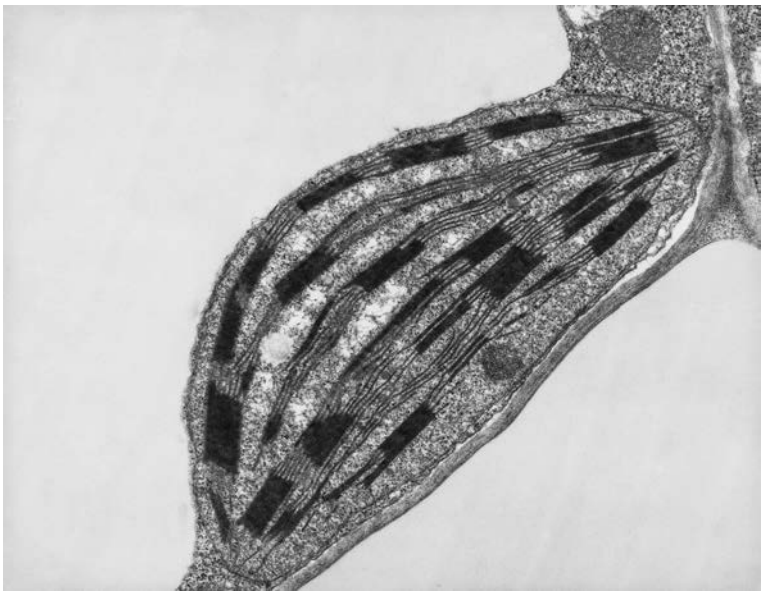


Fig. 1.1

On Fig. 1.1, use label lines and letters to label **one** place where:

L – the light-dependent stage takes place
R – the enzyme rubisco is found.

[2]

(b) Chloroplasts can move within palisade cells.

Suggest **two** advantages of chloroplast movement within palisade cells.

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..... [2]

(c) Complete the following paragraph by naming the most suitable compounds to fill in the gaps.

Rubisco is involved in the fixation of ..... by RuBP (ribulose bisphosphate) in the Calvin cycle. The resulting six carbon compound immediately splits to give two molecules of glycerate-3-phosphate (GP). GP is converted to triose phosphate (TP) using ..... and ..... produced in the light-dependent stage. Some of the TP produced is used to regenerate ribulose bisphosphate so that the Calvin cycle can continue. The remaining TP may be used to synthesise other compounds including ..... which can directly enter the Krebs cycle.

[4]

[Total: 8]

2 Intracytoplasmic sperm injection (ICSI) is a modification of the procedure for in-vitro fertilisation (IVF). A single sperm is injected into an oocyte rather than allowing one of many sperm to fertilise the oocyte.

(a) Suggest **one** problem that may arise from the use of ICSI.

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..... [1]

(b) In preparation for ICSI, infertile women are injected at daily intervals with human follicle stimulating hormone (hFSH) to stimulate the growth and maturation of a number of ovarian follicles. Women may be treated with hFSH extracted from urine (u-hFSH) or with recombinant hFSH (r-hFSH) produced by genetically modified mammalian cells.

Each molecule of hFSH consists of two different polypeptide chains, α and β.
The genes for the α and β chains of hFSH, together with their promoters, have been inserted into mammalian ovary cells.

Explain why promoters need to be transferred with desired genes when producing a genetically modified cell.

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..... [2]

(c) After treatment with hFSH, oocytes are collected from mature ovarian follicles and examined to check that they have reached metaphase II of meiosis.

Describe how an oocyte in metaphase I of meiosis can be distinguished from one in metaphase II of meiosis. You may use labelled diagrams to illustrate your answer.

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[3]

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(d) Two groups of women who were being prepared for ICSI were injected at daily intervals with either r-hFSH or with u-hFSH. The results of their treatment are shown in Table 2.1.

Table 2.1

	group of women receiving r-hFSH	group of women receiving u-hFSH
number of women	63	63
total number of oocytes collected	763	407
number of oocytes in metaphase II of meiosis	634	323

With reference to Table 2.1, compare the effects of treatment with r-hFSH and u-hFSH and suggest an explanation for any differences.

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(e) Whilst the two groups of women described in **(d)** were being injected at daily intervals with FSH, the concentrations of oestrogen in their blood were measured.

The results are shown in Fig. 2.1.

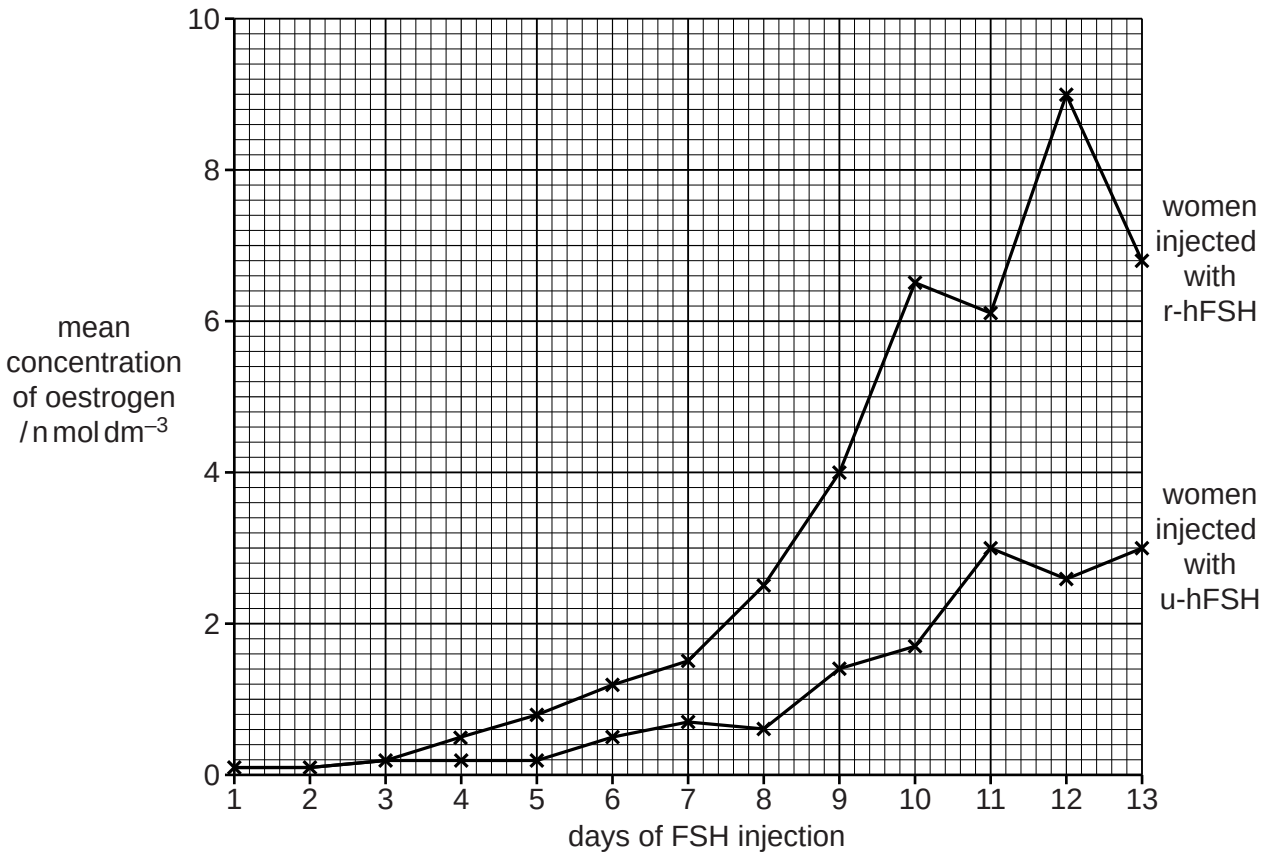


Fig. 2.1

(i) With reference to Fig. 2.1, compare the results for the two groups of women.

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..... [3]

(ii) Describe the role of oestrogen in the preparation of these women to receive an embryo.

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..... [2]

[Total: 14]

3 *Spartina alterniflora* is a grass that grows in salt marshes. It spreads by means of seeds and by underground stems. On its native east coast of North America it prevents salt marshes from being eroded by the sea and provides a food source for a large number of different species of animals.

Some time after its introduction to the west coast of North America in 1973, *S. alterniflora* hybridised with Californian cord grass, *S. foliosa*. The hybrid now outcompetes the native species.

The hybrid differs from its parent species in a number of ways:
- it is taller
- it produces very large numbers of pollen grains which are dispersed by wind to the other species, producing yet more hybrid plants
- it produces larger numbers of seeds capable of germination
- it can self-pollinate.

(a) State the structural features that are characteristic of a wind-pollinated flower **and** explain how each feature contributes to successful pollination.

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..... [5]

(b) Suggest how self-pollination could help the population of hybrid plants to increase.

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(c) Suggest why the hybrid plant is **not** considered to be a new species of *Spartina*.

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..... [1]

[Total: 9]

4 The Italian agile frog, *Rana latastei*, lives in woodlands in northern Italy. The adults breed by laying eggs in water in spring. The eggs hatch into tadpoles, which grow and develop for several weeks, before metamorphosing (changing) into adults and leaving the water. This must take place before cool weather arrives in autumn.

Fig. 4.1 shows an adult agile frog.



Fig. 4.1

This frog is now an endangered species. Many woodlands have been destroyed, leaving only isolated patches in which small populations of the frogs live. In order to try to prevent some of these small populations dying out completely, it has been suggested that tadpoles from larger populations could be introduced into the small populations, in order to increase genetic diversity.

(a) Suggest why increasing genetic diversity could help to conserve populations of Italian agile frogs.

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..... [3]

(b) An argument against introducing individuals from one population into another is that there may be genetic differences between them that have evolved in response to exposure to different selection pressures. These genetic differences could be lost.

An investigation was carried out into the time it takes for tadpoles to develop into frogs in two groups of populations:

- populations living in the cool foothills of mountains
- populations living in the warmer lowlands.

(i) Frogs, like all amphibians, are not able to control their body temperatures. In the wild, tadpoles in the foothills take about one month longer to develop into adult frogs than tadpoles in the lowlands.

Suggest why tadpoles in the foothills take longer to develop into adults than tadpoles in the lowlands.

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..... [2]

(ii) The researchers collected eggs from foothill populations and from lowland populations, and kept them in identical conditions in the laboratory. They measured the masses of samples of the tadpoles until they metamorphosed into adult frogs.

The results are shown in Fig. 4.2. The drop in mass towards the end of development shows when the tadpole changes into a frog.

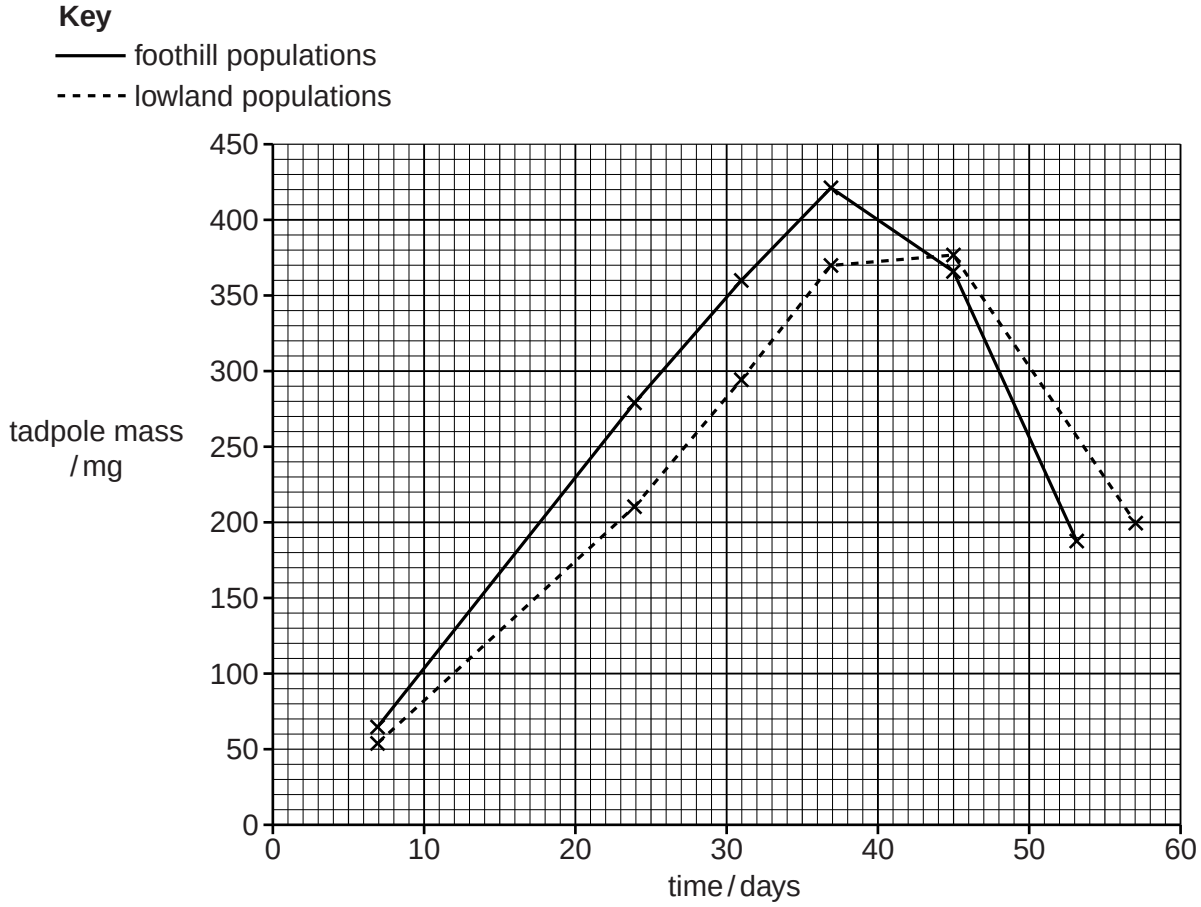


Fig. 4.2

With reference to Fig. 4.2, describe the differences in the growth of tadpoles from foothill and lowland populations.

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(iii) Explain how the results shown in Fig. 4.2 suggest that there are **genetic** differences between the foothill populations and the lowland populations of agile frogs.

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..... [2]

(iv) Suggest how these genetic differences may be important in increasing the chances of survival of the foothill populations in their natural habitat.

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(c) With reference to the evidence from this investigation, explain why it may **not** be good conservation policy to introduce tadpoles of agile frogs from lowland populations to foothill populations.

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[Total: 14]

5 **(a)** Fig. 5.1 shows a type of neurone found in the brain, called a pyramidal cell.

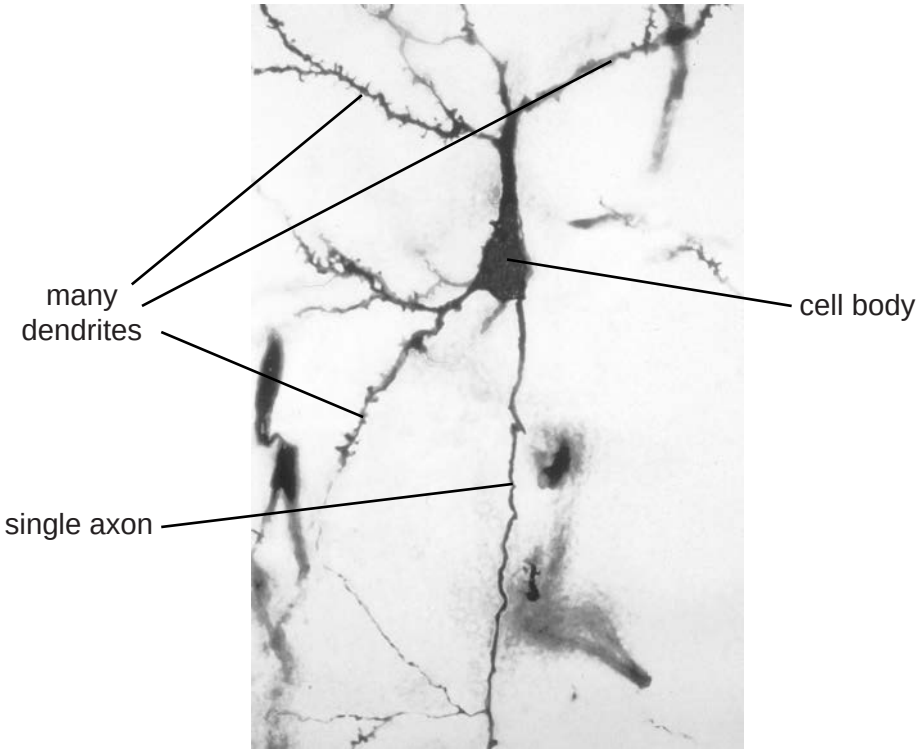


Fig. 5.1

On Fig. 5.1, draw **one** arrow to indicate the direction in which a nerve impulse will travel, as it leaves the cell body of the pyramidal cell. [1]

(b) Fig. 5.2 shows the percentage of energy used for various processes involved in the maintenance of resting potentials and in the reception and transmission of action potentials by a pyramidal cell.

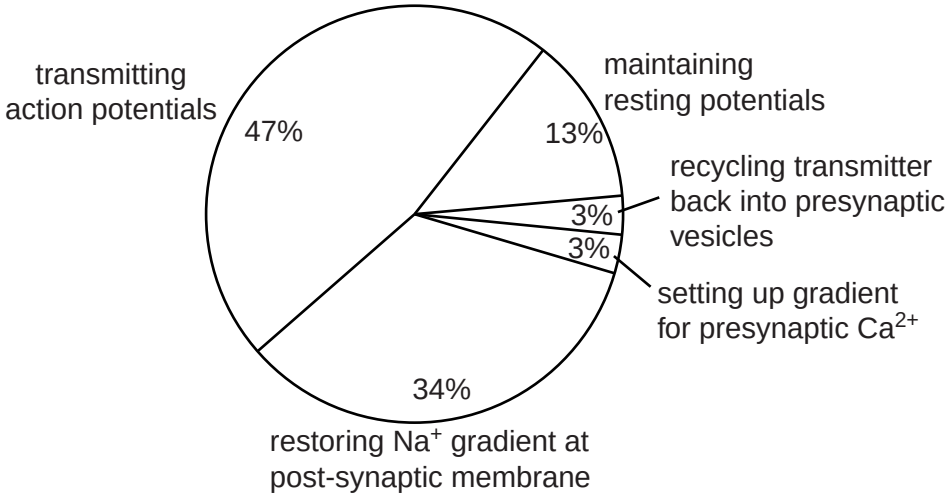


Fig. 5.2

(i) Explain why maintaining a resting potential requires energy.

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(ii) Outline the role of calcium ions in passing on an impulse from the pyramidal cell to another neurone.

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(iii) Pyramidal cells contain large numbers of mitochondria. There are more mitochondria in each dendrite than in the axon.

With reference to Fig. 5.2, suggest reasons for this distribution of mitochondria.

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..... [2]

[Total: 9]

6 Artificial selection has been carried out for thousands of years. An example of this is the Santa Gertrudis breed of cattle, which grow fast and tolerate high temperatures and high humidity. This breed was developed from the following two breeds:

- English shorthorn cattle, which grow fast but do not tolerate high temperatures and high humidity.
- Brahman cattle from India, which tolerate high temperatures and high humidity.

(a) Explain how artificial selection has taken place to produce Santa Gertrudis cattle.

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(b) Suggest **two other** characteristics that may be selected for when carrying out artificial selection in cattle.

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(c) Artificial selection can result in inbreeding.

Suggest problems that may result from inbreeding.

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..... [3]

[Total: 8]

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7 **(a)** All cells need ATP for energy-requiring processes in the body.

Fig. 7.1 shows the molecular structure of ATP.

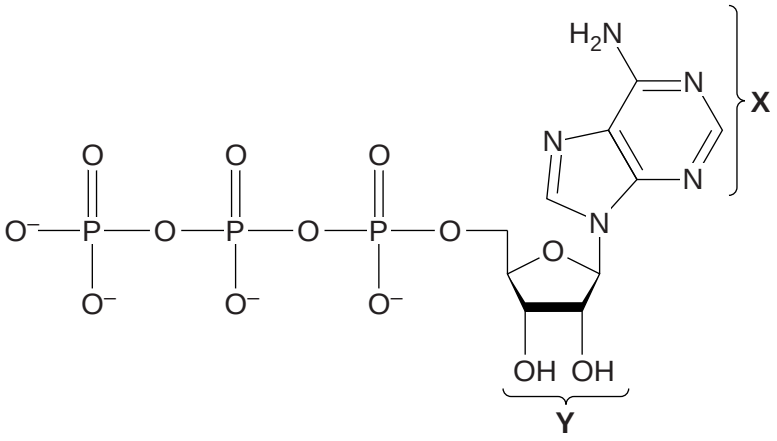


Fig. 7.1

(i) Name the base labelled **X**.

..... [1]

(ii) Name the sugar labelled **Y**.

..... [1]

(b) State **three** reasons why ATP is ideal as an energy currency in all living organisms.

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..... [3]

(c) ATP is produced in three stages of aerobic respiration.

Complete the table below to show two products of each stage, **other than ATP**.

stage	products
glycolysis	1. ..... 2. .....
Krebs cycle	1. ..... 2. .....
oxidative phosphorylation	1. ..... 2. .....

[3]

(d) Carbohydrates and lipids are both used as respiratory substrates.

Table 7.1 shows the energy values of carbohydrates and lipids.

Table 7.1

respiratory substrate	energy value / kJ g^{-1}
carbohydrate	15.8
lipid	39.4

Explain why lipids have a higher energy value than carbohydrates.

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..... [2]

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(e) Respiration can be investigated by calculating the respiratory quotient (RQ).

(i) State how the RQ is calculated.

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..... [2]

(ii) Give the typical RQ values obtained from the respiration of carbohydrates and lipids.

carbohydrate .....

lipid ..... [2]

(iii) Suggest what happens to the RQ value when respiration in yeast becomes anaerobic.

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..... [1]

[Total: 15]

8 An autosomal gene controlling fur colour in cats has three alleles:

- allele $\mathbf{C^B}$ codes for black fur
- allele $\mathbf{C^{CH}}$ codes for chocolate fur
- allele $\mathbf{C^{CM}}$ codes for cinnamon (orange-brown) fur.

Allele $\mathbf{C^B}$ is dominant to both $\mathbf{C^{CH}}$ and $\mathbf{C^{CM}}$.
Allele $\mathbf{C^{CH}}$ is dominant to $\mathbf{C^{CM}}$.

(a) (i) State the name given to the position of a gene on a chromosome.

..... [1]

(ii) A cinnamon-coloured cat must be homozygous.

Explain what is meant by the term *homozygous*.

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..... [1]

(b) Two black cats were crossed. Most of their offspring had black fur and a few had chocolate fur. When they were mature, one of the black offspring was crossed with one of the chocolate offspring. Some of the cats in the second generation had cinnamon fur.

Draw a genetic diagram to show how cats with cinnamon-coloured fur were produced in the second generation.

[6]

[Total: 8]

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Section B

Answer **one** question.

9 **(a)** Describe how electrophoresis is used in genetic fingerprinting. [9]

(b) Explain the advantages of treating diabetic people with human insulin produced by gene technology. [6]

[Total: 15]

10 **(a)** Describe how an enzyme can be immobilised in alginate **and** discuss the advantages of using an immobilised enzyme. [9]

(b) Explain how a dip stick can be used to measure glucose concentration. [6]

[Total: 15]

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