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CAMBRIDGE
International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4801206730

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **May/June 2026**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 100.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **24** pages. Any blank pages are indicated.

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1 Aerobic respiration in cells proceeds in four stages.

(a) Table 1.1 shows the first three stages of aerobic respiration and the location in the cell where glycolysis occurs.

Complete Table 1.1 to show the locations in the cell and the products of the first three stages of aerobic respiration.

Table 1.1

stage	location in the cell	products of this stage
glycolysis	cytoplasm	
link reaction		
Krebs cycle		

[5]

(b) The fourth stage of aerobic respiration, oxidative phosphorylation, involves the process of chemiosmosis. Chemiosmosis also occurs in photosynthesis.

During chemiosmosis, ions move across a membrane down their electrochemical gradient.

Identify:

the ions that move in chemiosmosis in aerobic respiration and in photosynthesis

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the membrane across which these ions move in photosynthesis

.....

the process by which these ions move in chemiosmosis.

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[3]

[Total: 8]

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2 **(a)** Homeostasis allows mammals to maintain relatively constant internal conditions despite changes in the external environment. One condition that is controlled is the water potential of the blood.

(i) Complete the list to show the receptors, coordination systems, effectors and response that achieve the homeostatic control of the water potential of the blood. Two of the answers have been started for you.

stimulus: decrease in blood water potential

initial receptors: .....

coordination systems: nervous system and .....

final effectors: distal convoluted tubule and .....

response: .....

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(ii) Explain why homeostasis of the water potential of the blood is necessary.

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(b) The glomerular filtration rate of the kidneys is 200 dm^3 day^{-1}.

The mean concentration of glucose in the blood is 5 mmol dm^{-3}.

1 mmol of glucose weighs 0.18 g.

(i) Calculate the mass of glucose that is filtered from the blood by the kidneys in one day.

..... g [1]

(ii) A healthy person does **not** lose the mass of glucose calculated in **2(b)(i)** in urine each day due to the processes occurring in the kidneys.

Describe the processes that occur in the kidneys to prevent the loss of this glucose in urine.

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3 Stomata have daily rhythms of opening and closing. Stomatal aperture width and the concentration of potassium ions in guard cells were measured in the leaves of basil plants, *Ocimum basilicum*. The basil plants were grown in conditions of natural light, with optimum temperature and soil moisture.

Figure 3.1 shows the results obtained between the times of 06:00 and 17:00. Error bars have been included.

key

—●— mean stomatal aperture width

--■-- concentration of potassium ions in guard cells

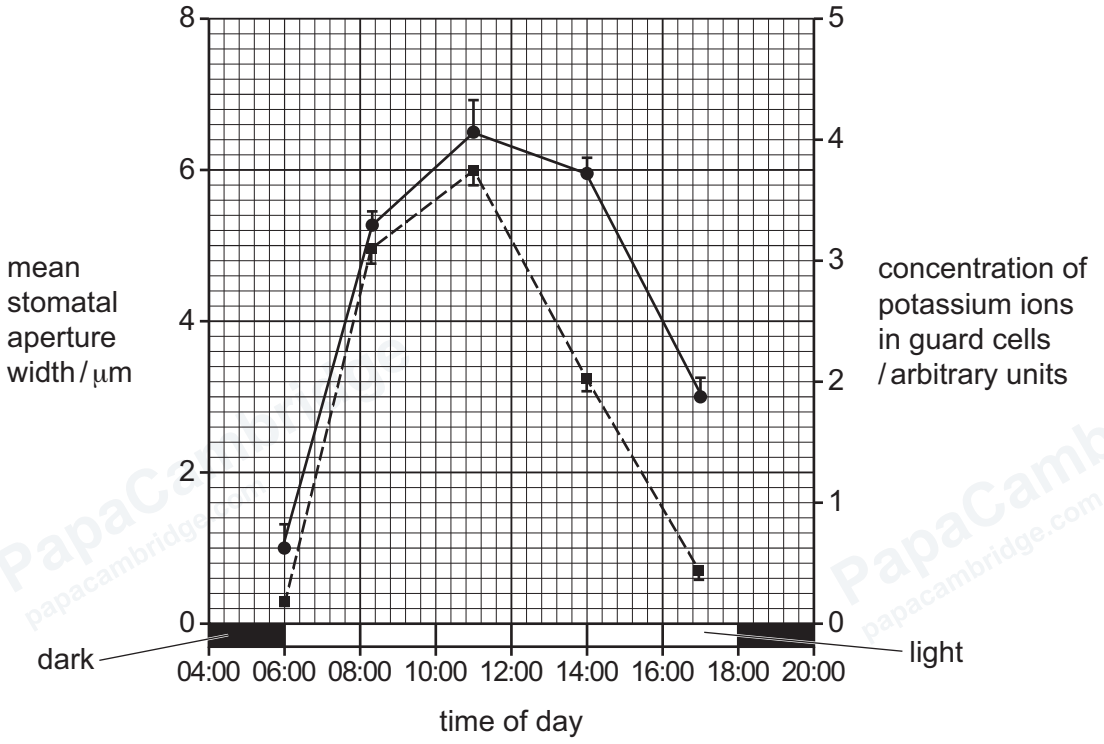


Figure 3.1

(a) (i) With reference to Figure 3.1, describe the changes that occur in mean stomatal aperture width **and** suggest reasons why these changes benefit basil plants.

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(ii) Figure 3.1 shows there is a correlation between mean stomatal aperture width and the concentration of potassium ions in guard cells.

Explain how a change in one of these factors may cause a change in the other factor.

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(b) Researchers observed a daily rhythm in the synthesis of abscisic acid (ABA) in plants.

Suggest whether ABA concentration is more likely to increase when light intensity is increasing **or** is more likely to increase when light intensity is decreasing.

Give reasons for your answer.

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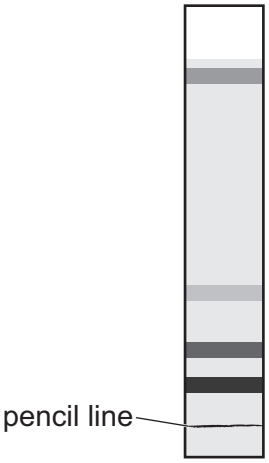
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4 A student separated the pigments in a plant leaf using paper chromatography. The student analysed the positions of the separated pigments to identify the pigments.

Figure 4.1 shows the chromatogram results and analysis.



R_f value	pigment
0.95	carotene
0.71	xanthophyll
0.65	chlorophyll a
0.45	chlorophyll b

Figure 4.1

(a) The student was provided with a prepared extract containing the leaf pigments.

Outline how the student obtained the results shown in Figure 4.1 and analysed them to deduce the names of the pigments present.

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(b) Describe the role of these pigments in a leaf.

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5 Shell colour in the brown-lipped snail, *Cepaea nemoralis*, involves more than one gene.

Gene 1 has three alleles: C^B, C^P and C^Y. These alleles form a dominance hierarchy.

- The dominant allele, C^B, results in a brown shell.
- The allele C^P results in a pink shell.
- The recessive allele, C^Y, results in a yellow shell.
- The allele C^B is dominant to C^P and the allele C^P is dominant to C^Y.

Gene 2 has two alleles, **N** and **n**.

- The dominant allele, **N**, results in a shell without stripes.
- The recessive allele, **n**, results in a shell with stripes.

Figure 5.1 shows a snail with a pink shell without stripes.



Figure 5.1

(a) List **all** the possible genotypes of the snail shown in Figure 5.1.

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..... [2]

(b) A student predicted the shell colour of the F1 offspring that are produced when a cross was carried out between a snail with a brown shell with stripes and a snail with a yellow shell without stripes. Each parent snail was known to be homozygous for gene 1 and homozygous for gene 2.

The student wrote down the cross between the two parent snails:

parental phenotypes	brown with stripes	×	yellow without stripes
parental genotypes	C^BC^B nn	×	C^YC^Y NN

(i) State the genotype and phenotype of the F1 offspring of the cross between these two parent snails.

genotype .....

phenotype .....

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(ii) In a second breeding experiment, snails with the genotype $\mathbf{C^YC^Y}$ **nn** were used in a test cross carried out on the F1 offspring.

The student assumed that each F1 snail would produce four different gametes in equal numbers. The student predicted the results of the test cross between $\mathbf{C^YC^Y}$ **nn** and the F1 offspring. They predicted that the offspring would show a 1 : 1 : 1 : 1 ratio of phenotypes.

Explain how an understanding of meiosis caused the student to assume that there would be four different gametes in equal numbers.

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(iii) The experimental results of this cross did **not** match the prediction of a 1 : 1 : 1 : 1 ratio of phenotypes. Instead, half of the test cross offspring snails were brown with stripes and half were yellow without stripes.

Suggest why the experimental results differed from the predicted 1 : 1 : 1 : 1 ratio.

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(c) Snails of different colours and stripe patterns do not occur in the same numerical proportions in different habitats such as woodland and rough grass.

Scientists compared snail populations in woodland habitats with snail populations in rough grass habitats.

- The scientists counted the number of snails, noting the number of yellow snails and the number of snails without stripes in each population.
- The results were converted to the percentage of yellow snails and the percentage of snails without stripes in each population.
- The scientists sampled populations in many areas of woodland and many areas of rough grass.

Figure 5.2 shows these results plotted on a graph.

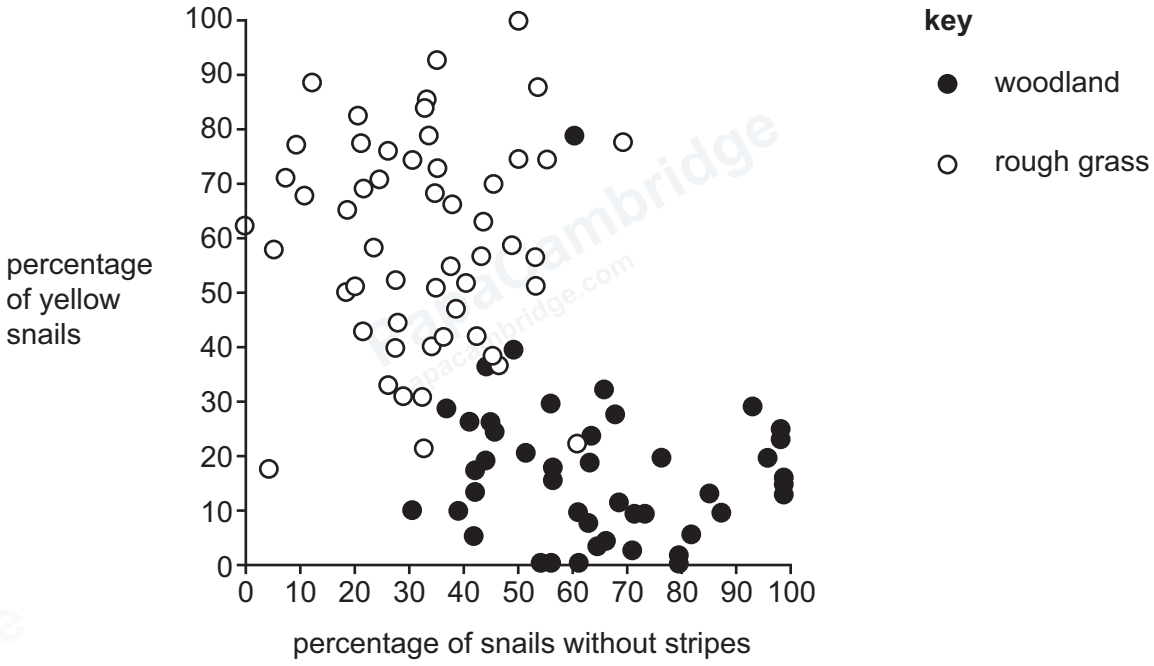


Figure 5.2

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The scientists hypothesised that the selection pressure of birds eating snails was important in determining the proportions of snails with different colours and stripe patterns in woodlands and rough grass.

Explain how the selection pressure of birds eating snails might lead to the results shown in Figure 5.2.

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6 **(a)** The red panda, *Ailurus fulgens*, is an endangered animal found in parts of Asia.

Figure 6.1 shows a red panda.



Figure 6.1

(i) Table 6.1 shows part of the classification of the red panda.

Table 6.1

domain	.....
kingdom	Animalia
phylum	Chordata
class	Mammalia
order	Carnivora
family	Ailuridae
genus	.....
species	.....

Complete Table 6.1 to show the red panda's domain, genus and species. [2]

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(ii) Most animals in the order Carnivora eat other animals. Red pandas have adapted to feed on a specialised diet of the leaves and shoots of bamboo plants.

Suggest why red pandas are classified in the order Carnivora.

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(b) Many zoos around the world have been breeding red pandas for over 80 years. The total number of red pandas in these zoos is currently estimated as 1000 individuals.

In the last 80 years the total number of red pandas living in the wild has halved to approximately 10 000 individuals. This is mostly due to loss of suitable habitat.

In 2011, for the first time, red pandas that had been born in a zoo were released into the wild.

Evaluate the success of efforts to conserve the red panda.

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(c) Only 30% of red pandas in zoos mate and produce offspring naturally. Many red pandas that are born in zoos die before they are 30 days old. For these reasons, zoos may use assisted reproduction.

Outline how assisted reproduction methods help conserve red pandas.

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7 Algae are aquatic photosynthetic protoctists. The alga *Alexandrium* is red in colour. *Alexandrium* causes harmful algal blooms (HABs) that turn seawater red when *Alexandrium* numbers rise to high levels. The abundance of *Alexandrium* depends mainly on abiotic factors.

Alexandrium releases a toxin that accumulates in shellfish such as oysters and mussels. Humans who eat shellfish contaminated with *Alexandrium* toxin show signs of poisoning, which in some cases may cause death.

Figure 7.1 shows the global number of cases of poisoning linked to *Alexandrium* HABs between 1986 and 2018. The line shows the long-term trend in cases of poisoning due to *Alexandrium* HABs.

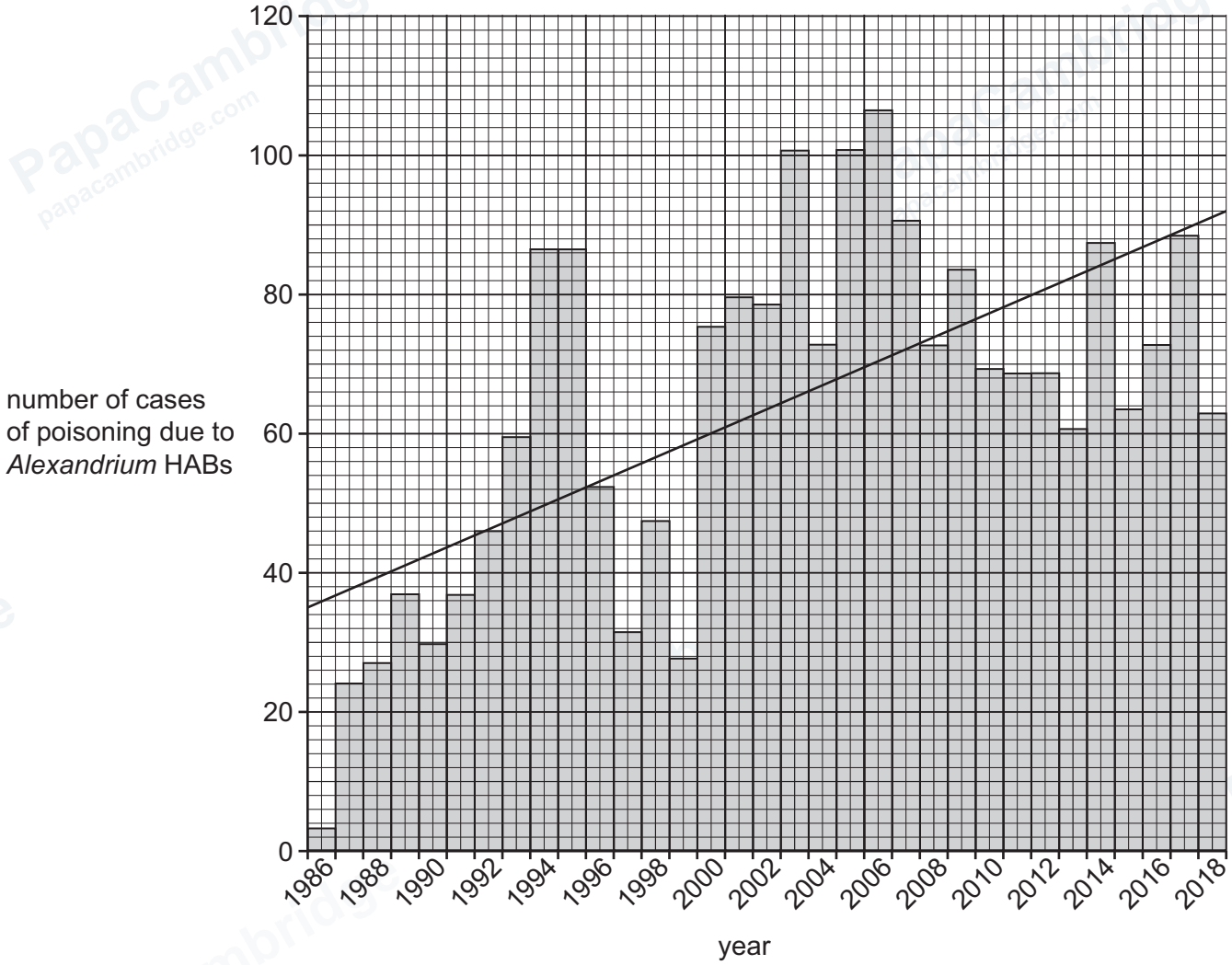


Figure 7.1

(a) (i) Use the long-term trend line shown in Figure 7.1 to calculate the percentage change in cases of poisoning due to *Alexandrium* HABs between the start of 1986 and the end of 2018.

Show your working **and** give your answer to **three** significant figures.

change .....% [2]

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(ii) The number of cases of poisoning due to *Alexandrium* HABs in Figure 7.1 is an indirect measure of the abundance of *Alexandrium*. Changes in the abundance of *Alexandrium* can be related to changes in abiotic factors that affect the metabolism, growth and reproduction of the alga.

Identify, with reasons, **two abiotic** factors that will affect the metabolism of the photosynthetic alga *Alexandrium*.

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(b) The toxin released by *Alexandrium* is described as a neurotoxin. It binds to, and blocks, voltage-gated sodium ion channels in cell surface membranes of neurones, preventing them from functioning. This results in muscle paralysis because calcium ions are not released from the sarcoplasmic reticulum of muscle cells.

Explain how the action of *Alexandrium* toxin on a neurone prevents the release of calcium ions from the sarcoplasmic reticulum of muscle cells of a person who has consumed the toxin.

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8 **(a)** *Petunia axillaris* is a plant with flowers that are pollinated by night-flying moths. To attract moths, *P. axillaris* synthesises compounds at night that are released as scents (attractive smells).

Figure 8.1 shows a flower of *P. axillaris*.

Figure 8.2 shows a moth with large sensory structures known as antennae.



Figure 8.1



Figure 8.2

(i) Moths detect scent chemicals using sensory receptor cells on their antennae.

Outline the role of sensory receptor cells.

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(ii) The compounds that are released as scents by *P. axillaris* are lipids.

Outline how *P. axillaris* could control the production of scent chemicals by regulating gene expression, so that scent chemicals are synthesised **only** at night.

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(b) Microarrays could be used to investigate whether gene expression in *P. axillaris* is different during the day compared to the night.

Figure 8.3 shows some steps that would be performed in this microarray analysis.

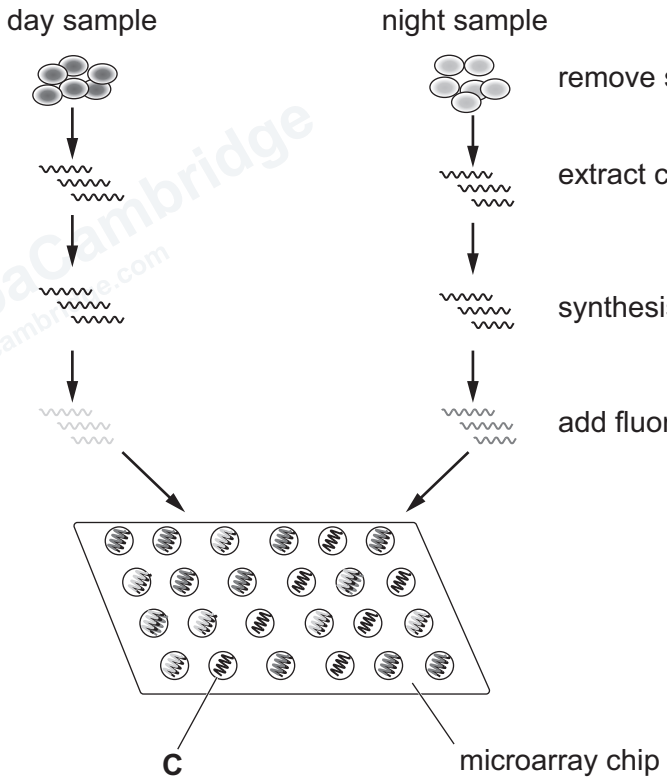


Figure 8.3

Identify **A**, **B** and **C** on Figure 8.3.

A .....

B .....

C .....

[3]

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9 Adenosine triphosphate (ATP) is used by organisms as an immediate source of energy.

(a) List **two** anabolic reactions in cells that need ATP.

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(b) Figure 9.1 shows three stages in the life cycle of a marine invertebrate, the jellyfish *Aurelia aurita*.

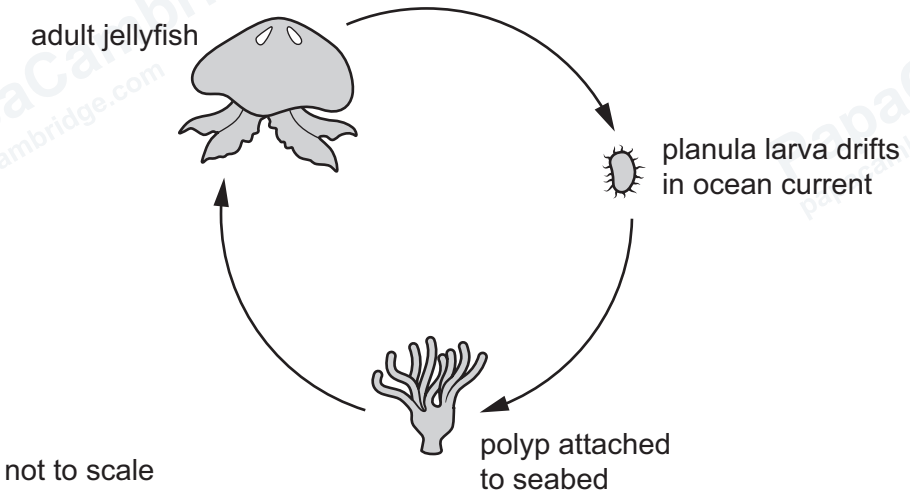


Figure 9.1

(i) Suggest why the adult jellyfish needs more ATP than the other life cycle stages.

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(ii) State **two** ways in which ATP can be synthesised in cells, such as those in *Aurelia aurita*.

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(c) The respiratory quotient (RQ) can identify the respiratory substrate that is being used to synthesise ATP in an organism. A respirometer can be used to calculate the RQ.

Table 9.1 shows the volumes of oxygen used and carbon dioxide produced when three different types of substrate are respired.

Table 9.1

respiratory substrate	volume of oxygen used / cm^3	volume of carbon dioxide produced / cm^3
A	830	830
B	2020	1430
C	970	780

(i) Use Table 9.1 to calculate the RQ for respiratory substrate **B**.

Show your working and give your answer to **two** significant figures.

RQ = ... [2]

(ii) With reference to Table 9.1, state the letter of the respiratory substrate that is a carbohydrate such as glucose.

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10 Genetic engineering is a technology that can be applied to medicine.

(a) Explain what is meant by genetic engineering.

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(b) Outline how severe combined immunodeficiency (SCID) can be treated by gene therapy.

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