



# Cambridge International AS & A Level

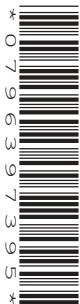
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**BIOLOGY**

**9700/43**

Paper 4 A Level Structured Questions

**May/June 2023**

**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 or correction fluid.
- 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 **28** pages. Any blank pages are indicated.

- 1 (a) The Krebs cycle was named after the biochemist Sir Hans Krebs, who worked out the sequence in 1937.

Fig. 1.1 is an outline of the Krebs cycle.

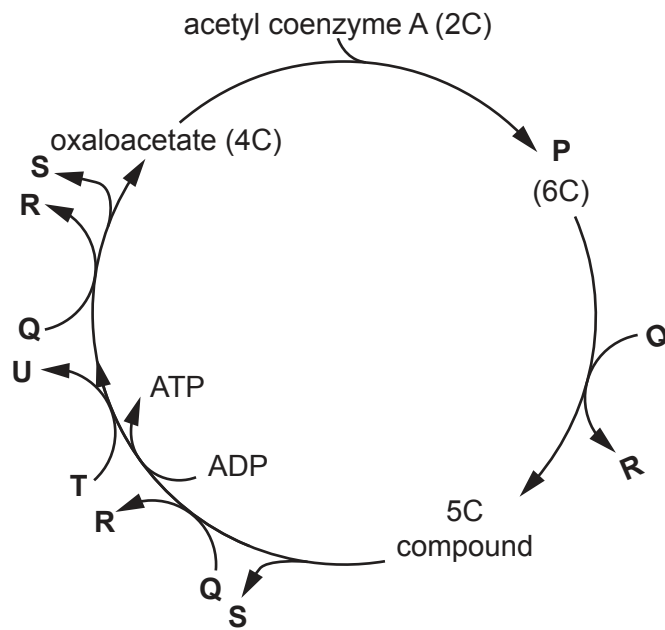


Fig. 1.1

Identify substances P–U.

- P .....
- Q .....
- R .....
- S .....
- T .....
- U .....

[3]

- (b) Describe how ATP is produced from ADP in the Krebs cycle.

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[2]



- 2 Humans use antibiotics to treat bacterial infections. The increased use of antibiotics has led to an increase in the number of strains of bacteria that are resistant to antibiotics.

The evolution of antibiotic resistance in bacteria has resulted from natural selection.

Outline how bacteria become resistant to antibiotics.

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[Total: 7]



- 3 Gene expression in a cell is controlled. When a gene is expressed (switched on), the gene is transcribed. When a gene is **not** expressed (switched off), the gene is **not** transcribed.

Environmental changes can cause some genes to be switched on or switched off.

- (a) An example of control of gene expression in prokaryotes is regulation in the *lac* operon.

The *lac* operon is a length of DNA that is made up of different parts.

Fig. 3.1 shows a simple diagram representing the *lacI* (regulatory) gene and the *lac* operon.



Fig. 3.1

- (i) Outline the main features of the *lac* operon.

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- (ii) Explain the role of the *lacI* gene in the regulation of the *lac* operon.

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(b) The *lac* operon codes for inducible enzymes. Repressible operons code for repressible enzymes.

Suggest **and** explain why it is an advantage to a prokaryote to have a repressible operon.

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[Total: 10]





(c) Suggest the social and ethical implications of gene therapy for SCID that need to be considered before treatment is carried out.

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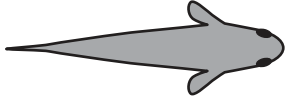
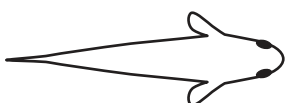


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[Total: 10]

- 5 A freshwater fish species, *Oryzias latipes*, has individuals with four body colour patterns, as shown in Table 5.1.

Table 5.1

phenotype	body colour pattern
red	
white	
red with black spots	
white with black spots	

Two unlinked genes determine the body colour patterns shown in Table 5.1.

One gene controls whether the body colour is red or white:

- dominant allele **R** = red
- recessive allele **r** = white.

The other gene controls whether black spots are present or **not** present:

- dominant allele **B** = with black spots
- recessive allele **b** = without black spots.

A fish that is homozygous recessive at both loci is white.

Genetic crosses were carried out to investigate the inheritance of the four different body colour patterns.

Males that were red with black spots, and homozygous at both loci, were crossed with females that were white. The F<sub>1</sub> offspring were all red with black spots.

These F<sub>1</sub> offspring were then crossed to produce the F<sub>2</sub> generation.

- (a) Table 5.2 shows the observed numbers obtained of each of the four different phenotypes for the F2 generation.

Table 5.2

phenotype	observed	expected	O–E	(O–E) <sup>2</sup>	$\frac{(O-E)^2}{E}$
red with black spots	279	281.25			
white with black spots	95	93.75	1.25	1.5625	0.017
red	96	93.75	2.25	5.0625	0.054
white	30	31.25			
$\chi^2 = \dots\dots\dots$					

Table 5.2 compares the observed numbers with the numbers that would be expected in the F2 generation for a normal dihybrid ratio.

Calculate  $\chi^2$  for the F2 generation by completing Table 5.2.

The formula for  $\chi^2$  is:

$$\chi^2 = \sum \frac{(O-E)^2}{E} \quad [3]$$

- (b) The critical value at  $p = 0.05$  and 3 degrees of freedom is 7.815.

Comment on whether the null hypothesis should be accepted or rejected.

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Further analysis of the results from the F2 generation in Table 5.2 showed that there were no white males or white males with black spots.

In *O. latipes*, females have two **X** chromosomes and males have an **X** and a **Y** chromosome.

It was deduced that, in *O. latipes*:

- the gene that controls body colour is located on the **X** chromosome **and** the **Y** chromosome
- the gene that controls whether black spots are present or **not** is located on an autosome.

- (c) To produce the F<sub>2</sub> generation, red males with black spots,  $X^R Y^R Bb$ , were crossed with red females with black spots,  $X^R X^r Bb$ .

Complete the Punnett square in Fig. 5.1 to show the genotypes and phenotypes of the F<sub>2</sub> generation.

- Use the symbols  $X^R$ ,  $X^r$  and  $Y^R$  for the alleles of the gene that controls body colour.
- Use the symbols  $B$  and  $b$  for the alleles of the gene that controls whether black spots are present or **not**.

Some of Fig. 5.1 has been completed for you.

		female gametes			
		$X^R B$	$X^r B$	$X^R b$	$X^r b$
male gametes	$X^R B$	$X^R X^r BB$		$X^R X^r Bb$	$X^r X^r Bb$
	female			female	female
	red + black spots			red + black spots	white + black spots
$Y^R B$	$X^R Y^R BB$	$X^r Y^R BB$	$X^R Y^R Bb$	$X^r Y^R Bb$	
	male	male	male	male	
	red + black spots	red + black spots	red + black spots	red + black spots	
$X^r b$	$X^R X^r Bb$	$X^r X^r Bb$	$X^R X^r bb$		
	female	female	female		
	red + black spots	white + black spots	red + no spots		
$Y^R b$		$X^r Y^R Bb$		$X^r Y^R bb$	
		male		male	
		red + black spots		red + no spots	

Fig. 5.1

[4]

- (d) Explain why there are no white males or males that are white with black spots in the F<sub>2</sub> generation.

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- (e) In another cross, red males with the genotype  $X^R Y^R bb$  were mated with white females with the genotype  $X^r X^r bb$ . All the male offspring were expected to be red and all the female offspring were expected to be white.

The observed results showed that the offspring included two red females out of 253 and one white male out of 198.

Suggest an explanation for this unexpected result.

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[Total: 13]

6 (a) Fig. 6.1 shows part of the Bowman's capsule of a kidney nephron.

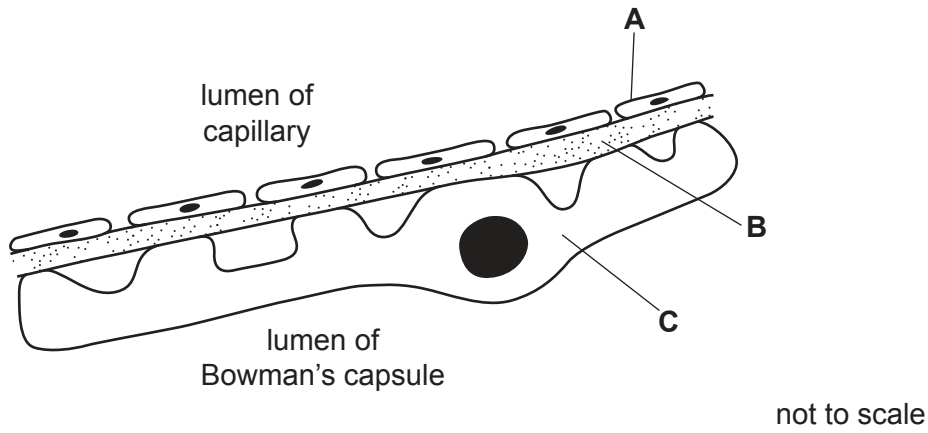


Fig. 6.1

Name structures **A**, **B** and **C**.

- A .....
  - B .....
  - C .....
- [3]

(b) Fluid is forced into the Bowman's capsule by ultrafiltration to form the glomerular filtrate.

Describe the role of structure **B** in ultrafiltration.

- .....
  - .....
  - .....
  - .....
  - .....
- [2]

(c) The main component of the glomerular filtrate formed in the Bowman's capsule is water. Most of this water is reabsorbed as the filtrate passes along the nephron.

- 180 dm<sup>3</sup> of water forms part of the glomerular filtrate each day.
- 1.4 dm<sup>3</sup> of water leaves the body in urine each day.

Calculate the percentage of water in the glomerular filtrate that is reabsorbed as the glomerular filtrate passes along the nephron.

Show your working and give your answer to **one** decimal place.

answer ..... % [2]







With reference to Fig. 7.1:

- describe **two** differences between the muscle fibres of young mice and adult mice
- suggest how these differences may affect the sliding filament model.

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[Total: 8]







- (b) In some brain synapses, the neurotransmitter gamma-aminobutyric acid (GABA) is released. This results in an influx of chloride ions into the postsynaptic neurone.

Suggest **and** explain whether an action potential would be generated in the postsynaptic neurone if GABA is released into a brain synapse.

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[Total: 8]





- (b) Measurements of the surface temperature of land and oceans can be taken from locations around the world. The mean global surface temperature for land and ocean combined can be calculated for a fixed time period.

Scientists calculated:

- the mean global temperature for the twentieth century
- the mean global temperature for each decade (ten years) from 1880 to 2020.

The mean temperature for each decade was compared to the mean for the twentieth century. For each decade, the difference in temperature was calculated.

The calculated differences are shown in Fig. 10.2.

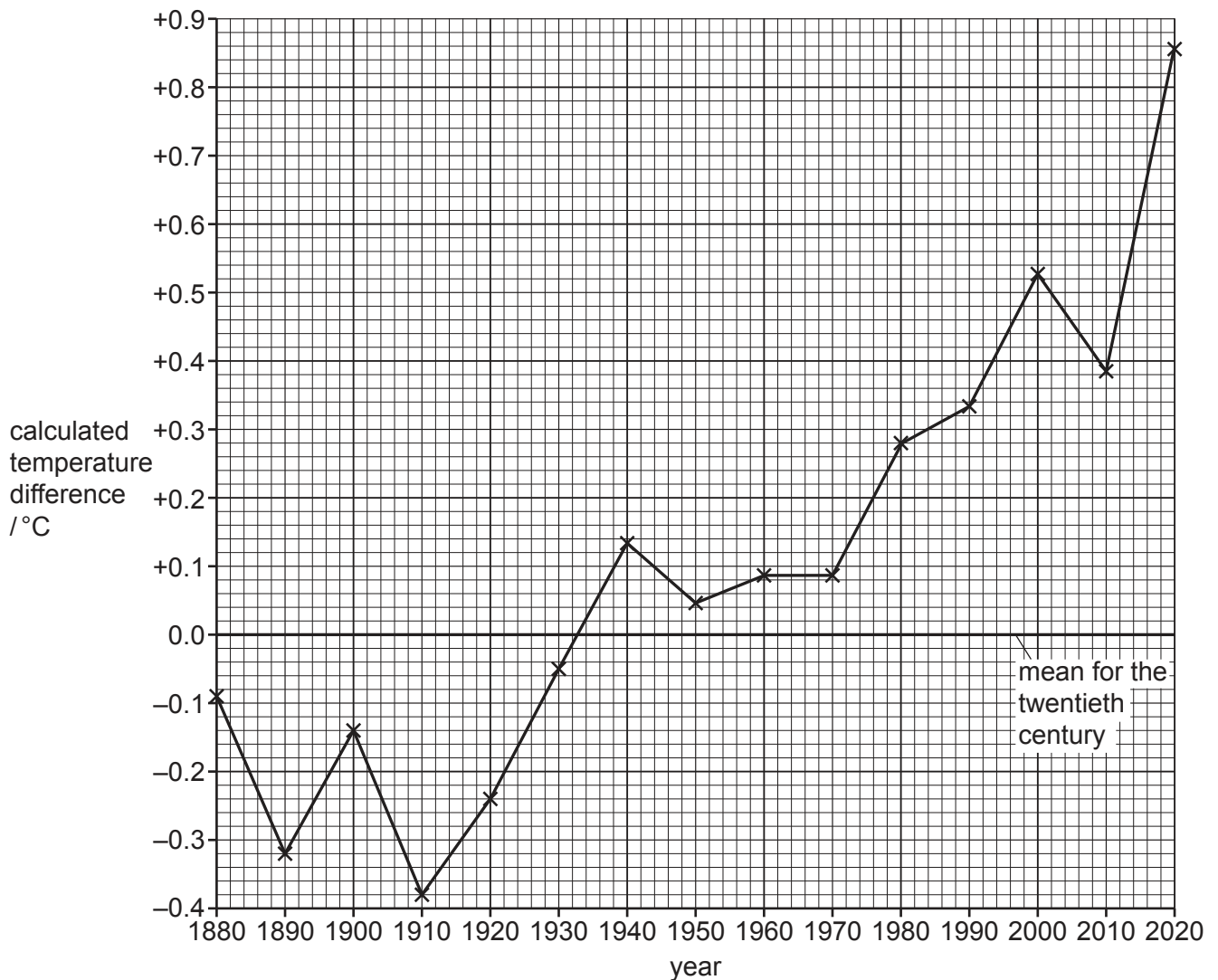


Fig. 10.2



- (i) Calculate the rate of increase in temperature per **decade** between 1980 and 2020.

Show your working.

Write your answer to **two** decimal places.

answer ..... °C per decade [2]

- (ii) Moose populations have decreased in North America since 1980.

Suggest **and** explain reasons for the decrease in moose populations.

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[Total: 9]





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