OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL A-LEVEL

BIOLOGY (9610)

Unit 4 Control

Monday 2 June 2025 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

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Answer **all** questions in the spaces provided.

0 1 Insulin is important in the control of blood glucose concentration.

0 1 . 1 Insulin binds to receptors on target cells.

Describe how this causes the concentration of blood glucose to decrease.

[3 marks]

0 1 . 2 The insulin gene is 1.425 kilobases in length. The DNA helix makes one complete turn every 10 base pairs. Each complete turn is 3.4 nm in length.

Calculate the length of the insulin gene.

Give your answer in micrometres (μm) and to 3 significant figures.

[3 marks]

Length of insulin gene = _____ μm

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0 1 . 3 Mutations in the insulin gene can change the amino acid sequence of insulin. This change can prevent insulin from binding to receptors.

Explain why.

[3 marks]

9

Turn over for the next question

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0 2 The movement of ions is important in the functioning of neurones.

0 2 . 1 Sodium ions and potassium ions can only cross the membrane of a neurone through proteins.

Explain why.

[2 marks]

0 2 . 2 Explain the role of sodium-potassium pumps and ATP in a neurone.

[3 marks]

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Scientists investigate the effects of a drug called lidocaine on neurones.

The scientists:

- use different concentrations of lidocaine
- measure the neurone membrane permeability to sodium ions when stimulated.

Table 1 shows the scientists' results.

Table 1

Concentration of lidocaine / μmol dm^{-3}	Membrane permeability to sodium ions / % of control
0.2	86
0.4	72
0.6	56
0.8	45
1.0	34

0 2 . 3 Suggest why lidocaine can be used during surgery to prevent pain.

[3 marks]

8

Turn over for the next question

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0 3 Scientists investigate the effect of training on the muscle fibres in a large muscle in the leg.

The scientists:

- select 15 healthy male ice hockey players
- take a sample of muscle tissue from each player before and after a training programme.

0 3 . 1 Suggest **two** factors the scientists consider when they select players for the investigation.

[2 marks]

1 _____

2 _____

0 3 . 2 The scientists use muscle tissue samples to record the proportion of fast and slow fibres.

Give **two** features of slow muscle fibres that would allow the scientists to identify them in a muscle tissue sample.

[2 marks]

1 _____

_____

2 _____

_____

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Question 3 continues on the next page

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ANSWER IN THE SPACES PROVIDED

Succinate dehydrogenase (SDH) is an enzyme that catalyses one of the reactions in aerobic respiration.

The scientists use the samples of muscle tissue to find the:

- mean percentage of fast and slow fibres
- mean SDH activity
- mean number of capillaries in contact with muscle fibre per cross-sectional area of muscle fibre (CSA).

Table 2 shows the scientists' results for before and after the training programme.

SE represents standard error.

Table 2

Type of muscle fibre	Mean percentage of fast and slow fibres ± SE	
	Before	**After**
Slow	55.90 ± 4.40	61.24 ± 4.90
Fast	43.20 ± 4.65	38.76 ± 4.50

Type of muscle fibre	Mean SDH activity / arbitrary units ± SE	
	Before	**After**
Slow	0.12 ± 0.02	0.17 ± 0.01
Fast	0.08 ± 0.01	0.08 ± 0.01

Type of muscle fibre	Mean CSA / arbitrary units ± SE	
	Before	**After**
Slow	1.05 ± 0.20	1.40 ± 0.10
Fast	0.85 ± 0.15	1.00 ± 0.15

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0 3 . 3 Describe what the results in **Table 2** show about the effect of training.

[4 marks]

0 3 . 4 After the training programme, the players can exercise for a longer amount of time.

Explain why.

Use information from **Table 2**.

[3 marks]

11

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0 4 A student investigates the effects of indoleacetic acid (IAA) on the growth of seedlings.

The student:

- cuts 20 mm lengths of shoot tips from 50 seedlings of the same age
- puts 10 shoot tips into each of 5 Petri dishes
- adds a different concentration of IAA solution to each Petri dish
- measures the length of each shoot tip after 48 hours
- calculates the mean increase in shoot tip length at each of the IAA concentrations.

Table 3 shows the student's results.

Table 3

IAA concentration / mg dm^{-3}	Mean increase in shoot tip length / mm
0.00	1.4
0.01	1.6
0.10	2.3
1.00	5.4
10.00	6.9

0 4 . 1 Give the reason why the student uses an IAA concentration of 0.00 mg dm^{-3}

[1 mark]

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0 4 . 2 Describe how the student would present the data shown in **Table 3** as a graph.

[3 marks]

0 4 . 3 Describe the results shown in **Table 3**.

[2 marks]

0 4 . 4 Explain how the pattern in the results would be different if the student uses root tips instead of shoot tips.

[2 marks]

Turn over ►

Another student investigates the effect of red light and of blue light on the growth of seedlings.

This is the method the student uses.

1. Cover 10 seedlings with a cardboard box with a hole cut into one side.
2. Shine red light through the hole in the cardboard box.
3. Measure the angle of curvature of the seedlings each day for 7 days (as shown in **Figure 1**).
4. Repeat steps 1–3 for seedlings exposed to blue light.

Figure 1

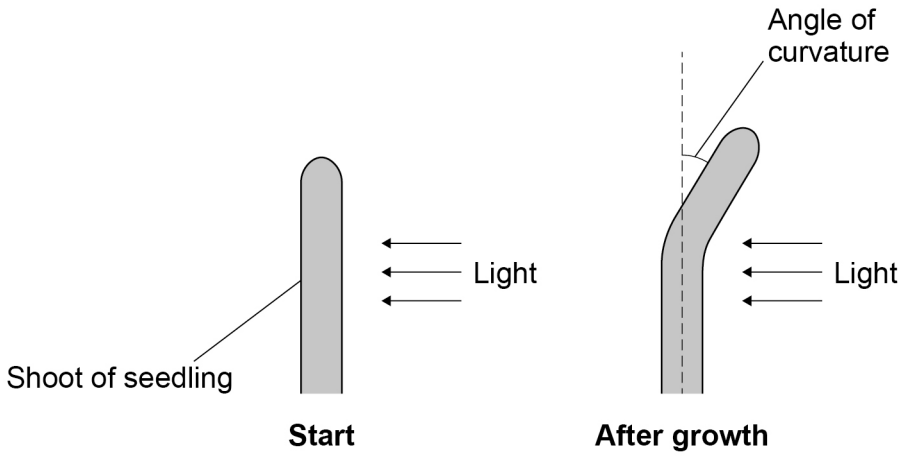
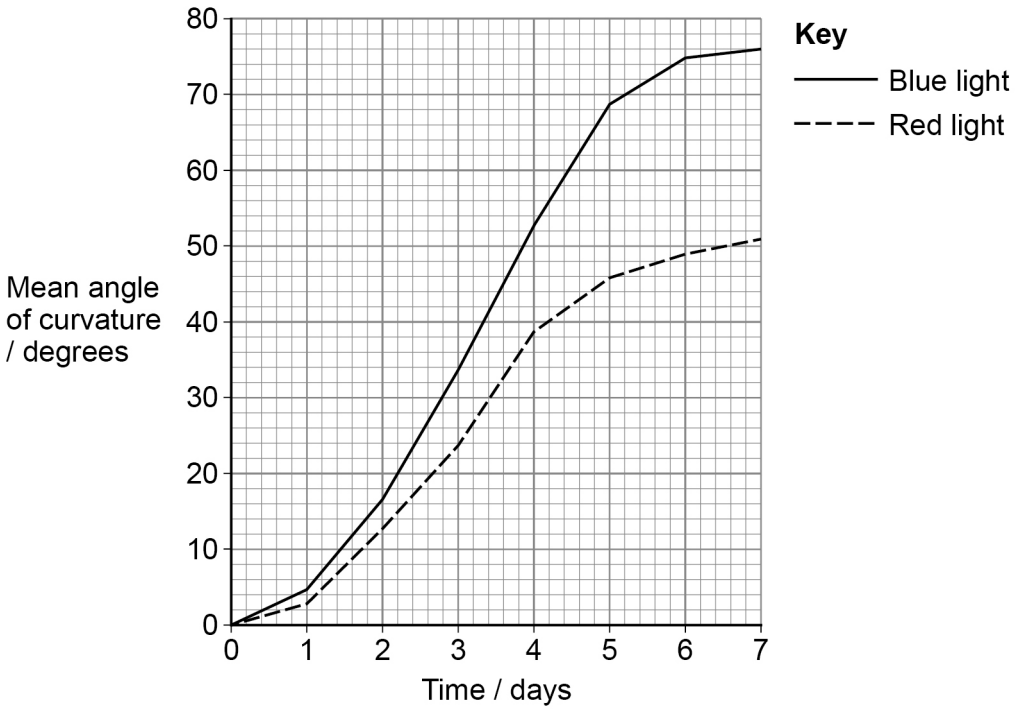


Figure 2

Figure 2 shows the student's results.



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0 4 . 5 Describe the results shown in **Figure 2**.

[2 marks]

0 4 . 6 Explain what causes the response of the seedlings to light.

[2 marks]

12

Turn over for the next question

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0 5 The retina of the eye contains two types of light-detecting cells, rods and cones.

Rods provide **high** sensitivity, but **low** visual acuity.

Cones provide **low** sensitivity, but **high** visual acuity and colour vision.

0 5 . 1 Define **sensitivity** and **acuity** in terms of vision.

[2 marks]

Sensitivity _____

_____

_____

Acuity _____

_____

_____

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The proportion and distribution of rods and cones in the retina is different in different species, leading to differences in vision.

Compared to humans, cats have:

- better night vision
- better peripheral vision (ability to detect movement at the edges of their vision)
- more limited colour vision.

0 5 . 2 Suggest reasons for the differences in vision between humans and cats.

Use your knowledge of the structure of the human retina.

[4 marks]

Better night vision _____

_____

_____

_____

_____

_____

Better peripheral vision _____

_____

_____

More limited colour vision _____

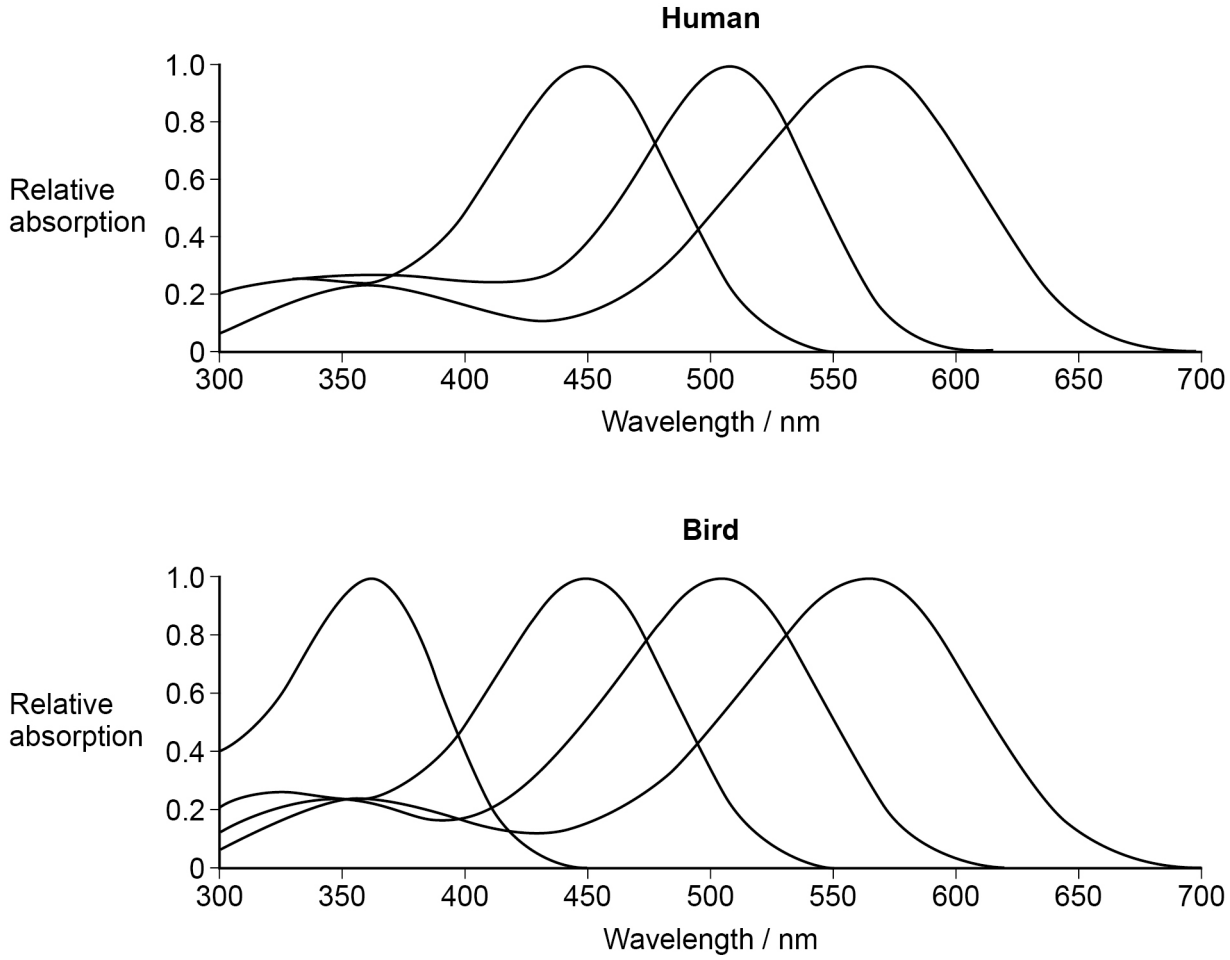
_____

_____

Question 5 continues on the next page

Figure 3 shows the light absorption of cone cells in the retina of a human and of a bird.

Figure 3



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0 5 . 3 Compare light absorption in the cones of birds and of humans.

Use information from **Figure 3**.

[3 marks]

0 5 . 4 Suggest why it is useful for a bird to be able to detect a wide range of wavelengths of light.

[1 mark]

10

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0 6 Recombinant DNA technology involves the transfer of fragments of DNA from one organism to another organism.

0 6 . 1 State why DNA from one species can be successfully expressed in a different species.

[1 mark]

Question 6 continues on the next page

Golden rice is a genetically-modified variety of rice.

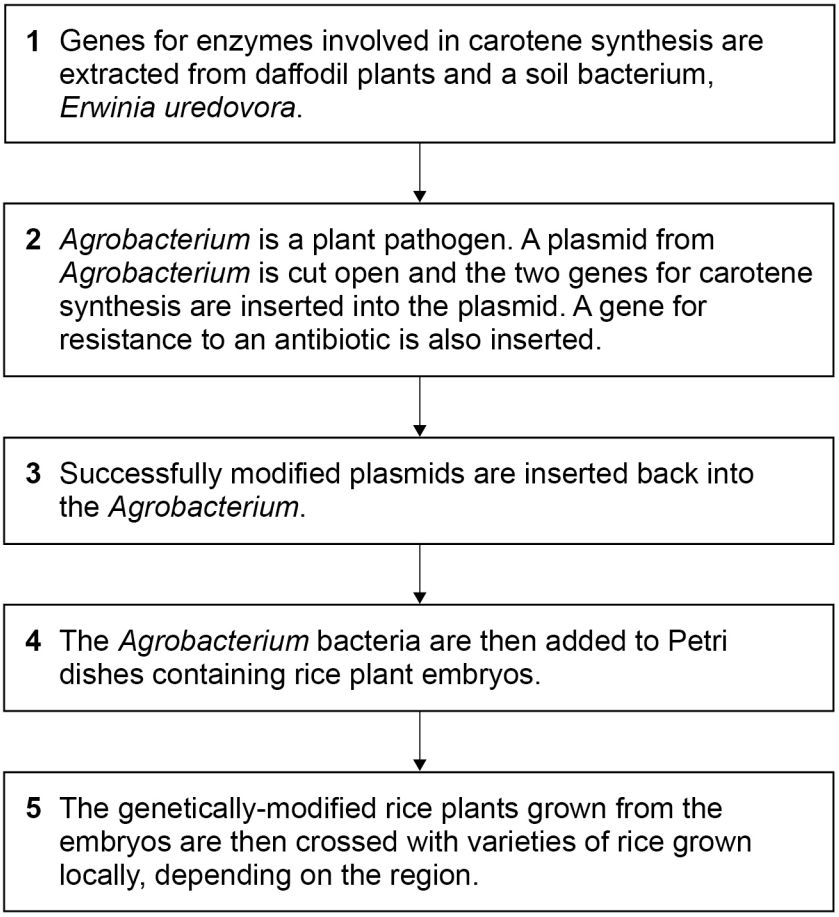
It produces carotene, a chemical required by the body to produce vitamin A.

Vitamin A is involved in many functions in the body.

Vitamin A deficiency is common in some countries, with up to 500 000 children affected annually.

Figure 4 shows the steps involved in creating golden rice.

Figure 4



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0 6 . 2 Explain how the genes for carotene synthesis are inserted into the plasmid in step **2**.

[3 marks]

0 6 . 3 Give the reason why a gene for resistance to an antibiotic is inserted in step **2**.

[1 mark]

0 6 . 4 Suggest why it is necessary to cross the genetically-modified rice plants with varieties of rice that are grown locally (step **5**).

[1 mark]

Question 6 continues on the next page

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Producing genetically-modified crops like golden rice is expensive.

The costs and benefits of golden rice must be calculated to decide how effective the product is compared to alternative treatments for vitamin A deficiency.

Scientists estimated the costs and benefits of growing golden rice in Bangladesh for 15 years.

Table 4 shows the scientists' estimates (all figures are in millions of US dollars).

Table 4

Cost or benefit	**US Dollars (millions)**
Total Research & Development costs	11.6
Health benefits	5767.4
Productivity benefits	2927.4
Total benefits	8694.8
Net benefit	8683.2
Benefit : cost ratio	748.6

0 6 . 5 Describe how each of the following figures have been calculated.

[2 marks]

Net benefits _____

_____

Benefit : cost ratio _____

_____

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The scientists' estimates are based on the predicted length of time the golden rice can be grown and harvested in the farmers' fields.

0 6 . 6 Suggest a reason why the golden rice can only be grown for a limited length of time in the farmers' fields.

[1 mark]

0 6 . 7 Suggest a **different** approach to vitamin A deficiency that countries could use.

[1 mark]

10

Turn over for the next question

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0 7 Most cells in the body contain copies of every gene, but **not** every gene is expressed in every cell.

Gene expression is controlled by many factors, including epigenetics.

During methylation of DNA, methyl groups attach to cytosine bases and prevent gene expression.

0 7 . 1 Describe how methylation of DNA prevents gene expression.

[2 marks]

The cell cycle is regulated by specific genes. Epigenetic changes to DNA are associated with many types of cancer.

0 7 . 2 Explain how too much methylation could lead to cancer.

[2 marks]

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An understanding of the epigenetic control of genes has allowed scientists to develop epigenetic therapies for the treatment of cancers.

The enzymes responsible for DNA methylation are called DNA methyltransferases (DNMT).

A DNMTi is a chemical which inhibits DNMT enzymes by binding to the enzyme permanently.

0 7 . 3 Suggest how a DNMTi works to treat certain types of cancer.

[3 marks]

Question 7 continues on the next page

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DAC and Aza-TdC are two chemicals which act as a DNMTi.

The scientists investigated the anti-cancer activity of the two DNMTi chemicals.

The scientists:

- inject a cell suspension of human cancer cells into mice
- put the mice into one of three treatment groups when tumours reach 150 mg
- inject the mice in each group as follows:
  - group 1 (16 mice) with saline
  - group 2 (18 mice) with DAC
  - group 3 (18 mice) with Aza-TdC
- inject the mice daily for 60 days
- measure the tumours every day (length × width × depth) and calculate the tumour mass from these measurements
- calculate tumour growth delay to decide how effective the treatments were.

0 7 . 4 Why do the scientists wait until the tumours in each of the mice reach 150 mg before starting treatment?

[1 mark]

0 7 . 5 Why is it necessary to calculate the mass of the tumours from measurements of length, width and depth?

[1 mark]

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Tumour growth delay is calculated using the formula:

$$\frac{(T-C) \times 100}{C}$$

where T and C are the median times for the tumour to reach a certain mass in mg for the treatment group (T) and the control group (C).

0 7 . 6 Calculate the tumour growth delay for the two treatments using the following data.

C = 28 days

Treatment 1 (DAC): T = 39 days

Treatment 2 (Aza–TdC): T = 52 days

[1 mark]

Treatment 1 (DAC):

Tumour growth delay = _____ %

Treatment 2 (Aza–TdC):

Tumour growth delay = _____ %

Question 7 continues on the next page

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0 7 . 7 Evaluate the use of these two chemicals for treating cancer in humans.

[5 marks]

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END OF QUESTIONS

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