Oxford Cambridge and RSA

Wednesday 21 June 2023 – Morning

A Level Biology B (Advancing Biology)

H422/03 Practical skills in biology

Time allowed: 1 hour 30 minutes

You must have:
- the Insert (inside this document)
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

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

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*****).
- This document has **20** pages.

ADVICE
- Read each question carefully before you start your answer.

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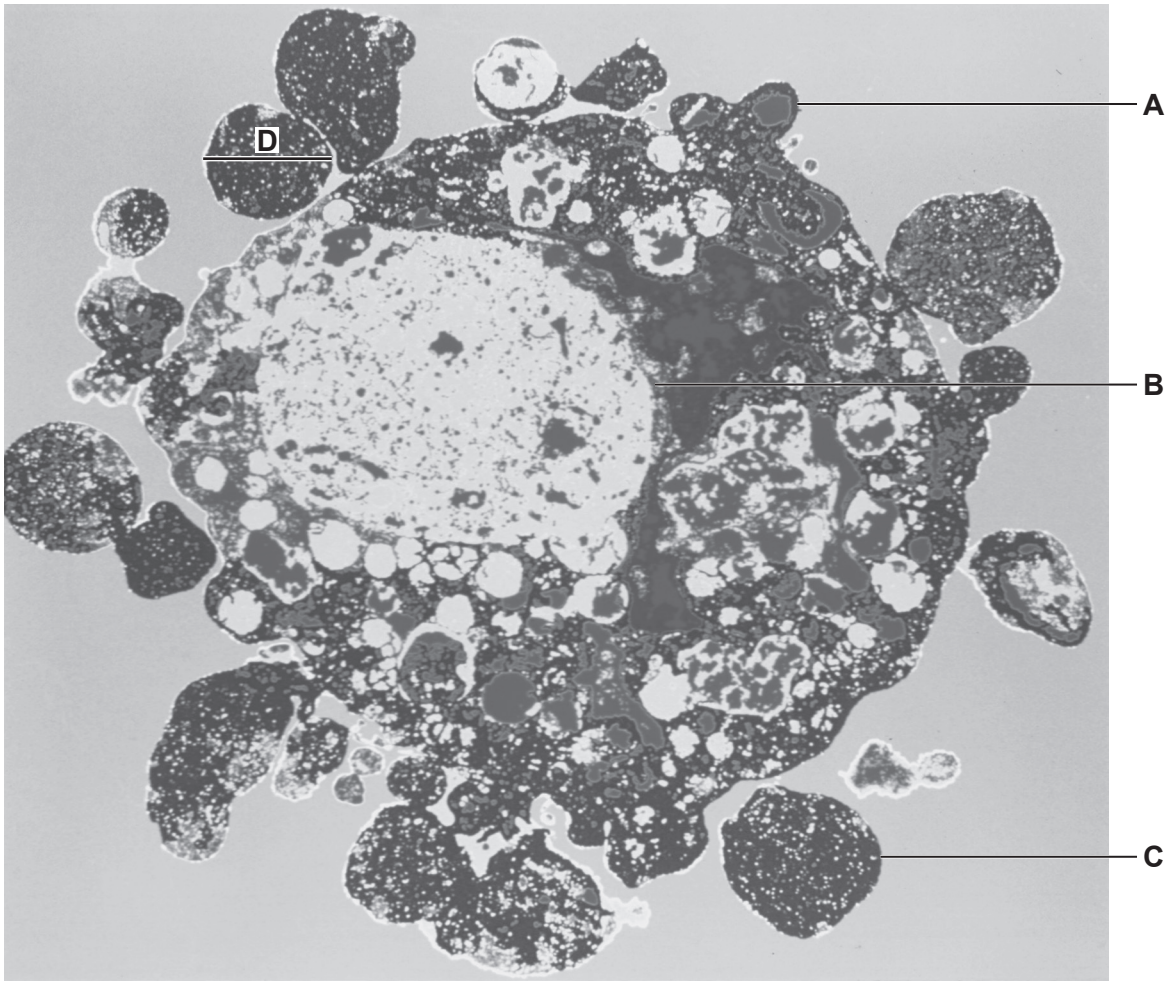
1 Apoptosis is the programmed cell death of damaged or unwanted cells.

(a) **Fig. 1.1** shows a transmission electron micrograph (TEM) of apoptosis of a leucocyte.

Fig. 1.1



(i) Name the following structures and processes shown in **Fig. 1.1**:
- the structure labelled **A** forming in the cell surface membrane
- the process occurring to the organelle labelled **B**
- the structure labelled **C**.

Structure **A** .....

Process **B** .....

Structure **C** .....

[3]

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(ii) The magnification used to produce the TEM in **Fig. 1.1** was × 20 000.

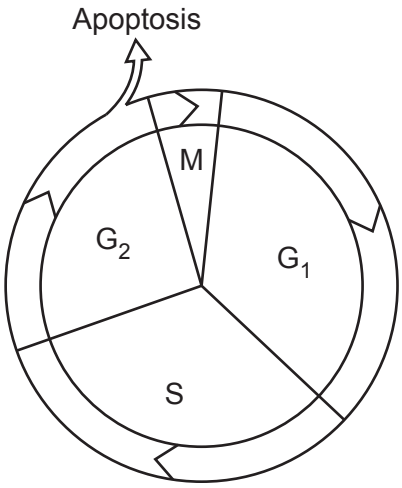
Calculate the actual diameter of the structure labelled **D** in **Fig. 1.1**.

Give your answer in standard form.

Diameter of structure **D** = ... m **[2]**

(b) A diagram of the cell cycle is shown in **Fig. 1.2**. The diagram shows a cell entering apoptosis from the G_2 phase.

Fig. 1.2



(i) Suggest and explain why the cell in **Fig. 1.2** entered apoptosis from G_2.

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..... **[1]**

(ii) Outline a molecular mechanism that caused the cell to start apoptosis.

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..... **[1]**

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(c) Stem cells go through many cycles of cell division but remain undifferentiated.

The table shows some of the features of stem cells.

Complete the table. Use ticks (✓) to indicate the features that are observed in different types of stem cell.

Feature	Totipotent	Pluripotent	Multipotent
Can differentiate into any type of cell			
Present in an embryo			
Present in an adult human			

[2]

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2 The conditions in a plant's habitat affect its rate of photosynthesis.

(a) Explain why plants are dependent on photosynthesis for their survival.

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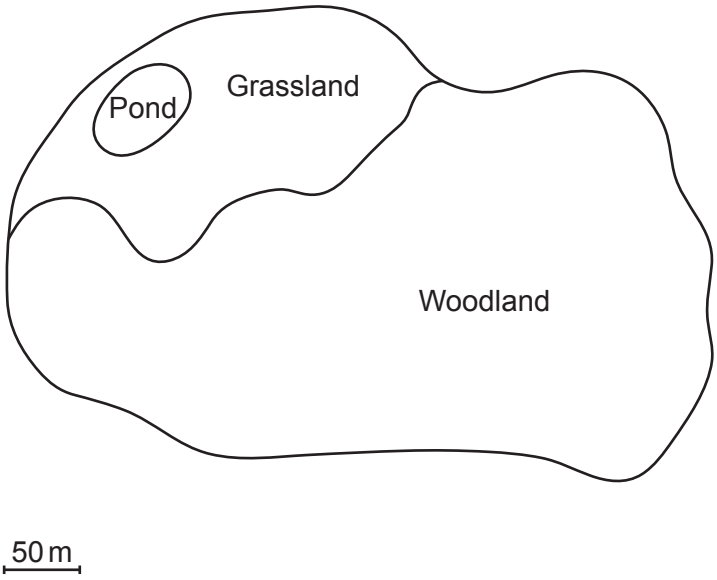
..... **[2]**

(b) Black medic, *Medicago lupulina*, is a species of plant that tends to grow best in open areas, where it is exposed to high light intensities.

Lady fern, *Athyrium filix-femina*, is a species of plant that tends to grow best in damp, shaded woodland.

(i) A student observed both species of plant growing in their local area, which is shown in the diagram.



The student outlined a plan for sampling the abundance and distribution of the two species:

- Pick 10 locations on the map, 5 in the woodland and 5 in the grassland.
- Record whether the species (black medic and lady fern) are visible at each location.

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Describe how the student can improve their plan for sampling the abundance and distribution of the two species.

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..... **[4]**

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(ii)* The student read that woodland plants, such as lady fern, might not receive all wavelengths of visible light equally.

The student planned to investigate the effect of light wavelength on the rate of photosynthesis in black medic and lady fern.

The student planned to measure rates of photosynthesis by placing each plant in a sealed, transparent container. Each container had a sensor connected to computer software to monitor carbon dioxide concentration.

Outline an experimental plan that could be used to compare the effect of light wavelength on the rate of photosynthesis in black medic and lady fern.

Your plan should include a suggestion of an appropriate statistical test, but you do **not** need to include any details of how to measure the rate of photosynthesis.

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(iii) The student performed the Benedict's test on solutions from the leaves of both species.

- For each of the species, the same method was used to prepare the solution.
- The Benedict's test was performed on samples of each solution using a measuring cylinder to measure the volume of each solution.
- After performing each Benedict's test, the student compared the final colour of the solution to a colour chart.
- The student repeated the Benedict's test five times.

Describe and explain **one** way to improve the precision of the student's results.

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..... **[2]**

(iv) The student also tested for the presence of starch in various tissues of the plants.

State how to test for starch.

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(c) When a plant is exposed to high light intensities, excess light energy is absorbed by photosystem II in chloroplasts. This can potentially damage the photosystems.

A process called nonphotochemical quenching (NPQ) protects plants by converting the excess light energy absorbed by photosystem II to heat energy.

NPQ can continue even when light intensity has decreased and NPQ is no longer needed. This makes photosynthesis inefficient and reduces the rate of CO_2 fixation.

(i) Explain why the continuation of NPQ in low light intensities reduces the rate of CO_2 fixation.

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..... **[2]**

(ii) Genes responsible for NPQ and other aspects of photosynthesis in plants can be identified by sequencing and analysing DNA.

DNA needs to be extracted and purified before it is analysed.

Name the substances that should be added to remove histone proteins from DNA and to precipitate the DNA.

Remove histone proteins .....

Precipitate DNA .....
[2]

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3 The kidney is an organ of filtration and osmoregulation, but its functions can be hindered by several different diseases.

(a) A student dissected a kidney. One half of the dissected kidney is shown in **Fig. 3.1** on the **Insert**.

Draw a simple diagram of the dissected kidney, shown in **Fig. 3.1**, in the space below.

On your diagram, label the cortex, renal pyramids and ureter.

[3]

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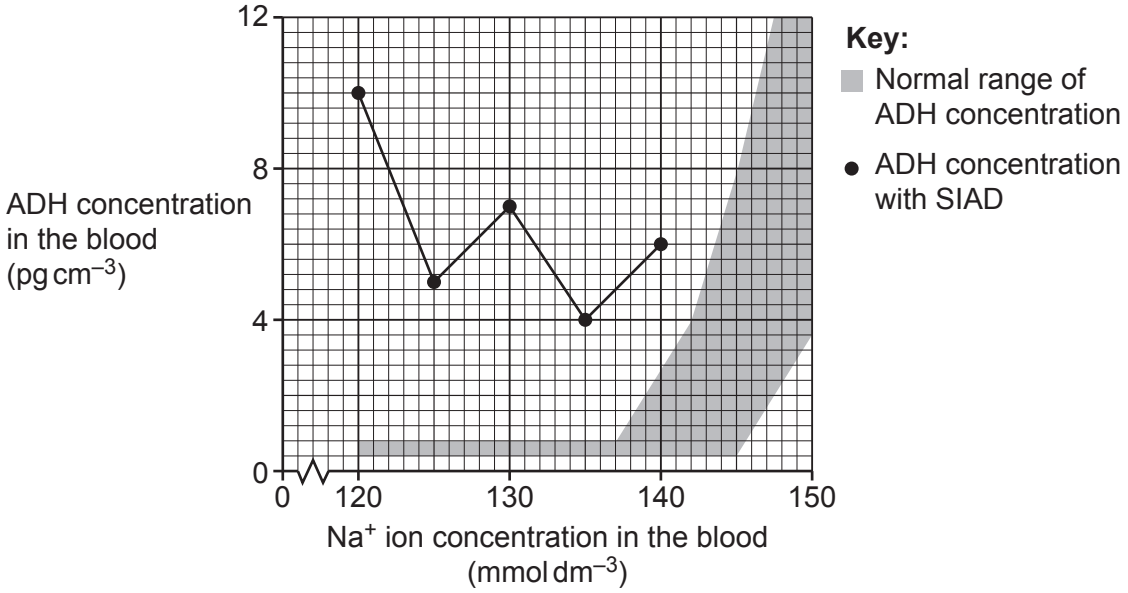
(b) Osmoregulation in the kidney can be affected by a condition called syndrome of inappropriate antidiuresis (SIAD).

Fig. 3.2 shows how ADH concentration in the blood changes with blood sodium ion (Na^+) concentration in:

- normal homeostasis
- people with one type of SIAD.

Fig. 3.2



Explain the conclusions you can make from **Fig. 3.2** about the effect of SIAD on osmoregulation.

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(c) Glucose is normally reabsorbed from the proximal convoluted tubule of the kidney.

In some conditions, such as diabetes mellitus, glucose remains in the filtrate and can be detected in urine.

Biosensors are used to detect glucose in urine.

The sentences describe how biosensors can detect glucose in urine.

Complete the sentences using the most appropriate words or phrases.

Glucose test strips contain an enzyme called ..... ,

which converts glucose to gluconic acid and hydrogen peroxide. Another enzyme,

..... , converts hydrogen peroxide to oxygen and water. Oxygen

reacts with a chemical on the test strip to produce a colour change. In recent years, a

polarimeter device has been developed. The polarimeter gives a digital readout of the

glucose concentration in urine, in units such as ..... .

[3]

(d) Kidney failure has a variety of possible causes.

This is a description of kidney failure:

The person noticed their symptoms developing over a long period of time. Unusual tissue, not normally found on a healthy kidney, could be seen on the outside of the kidney.

Suggest and give a reason for a possible cause of kidney failure in this person.

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(e) Outline the possible future use of stem cells in kidney transplant surgery.

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..... **[2]**

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4 The domestic rabbit, *Oryctolagus cuniculus domesticus*, is a subspecies of European rabbit. It is a popular pet and has been selectively bred for fur colour and other features.

(a) Complete the taxonomic ranks to show the classification of *Oryctolagus cuniculus domesticus*.

Domain: .....

Kingdom: .....

Phylum: Chordata

Class: Mammalia

Order: Lagomorpha

Family: Leporidae

Genus: .....

Species: .....

[2]

(b) A student bred two pet rabbits several times to produce a total of 48 offspring.

One of the parental rabbits had upright ears and black fur. The other parental rabbit had floppy ears and brown fur.

The student researched the genetics of the two traits (ear position and fur colour) and the family tree of the two rabbits. The student predicted the offspring phenotypes would be:

- 25% black fur, upright ears
- 25% black fur, floppy ears
- 25% brown fur, upright ears
- 25% brown fur, floppy ears

The student used the chi squared (χ^2) test to determine whether the phenotypic ratio of the offspring was significantly different from their expectations.

Their null hypothesis was:
'There is no difference between the expected phenotypic ratio of the offspring and the observed phenotypic ratio of the offspring.'

The student's expected and observed results are shown in **Table 4.1**.

Table 4.1

Phenotype	Expected number	Observed number
Black fur, upright ears	12	10
Black fur, floppy ears	12	17
Brown fur, upright ears	12	8
Brown fur, floppy ears	12	13

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(i) Calculate χ^2 for the results shown in **Table 4.1**. Use the formula:

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

Give your answer to **3** significant figures.

χ^2 = ... **[3]**

(ii) A χ^2 probability table is shown in **Table 4.2**.

Table 4.2

Degrees of freedom	**Probability (*p*)**		
	0.10	**0.05**	**0.01**
1	2.71	3.84	6.64
2	4.60	5.99	9.21
3	6.25	7.82	11.34
4	7.78	9.49	13.28
5	9.24	11.07	15.09

Using your answer to **(i)** and the data in **Table 4.2**, state and explain what you can conclude about the student's results.

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(c) Another aspect of rabbit fur colour is colour density.

One gene controls colour density. This gene has several alleles, including:

- C^F, which results in full colour. This allele is dominant to the other two alleles.
- C^S, which results in shaded colour. This allele is dominant to C^A.
- C^A, which results in albino fur (no colour).

A pair of rabbits were bred. 50% of their offspring had full colour, 25% were shaded, and 25% were albino.

State the genotypes of the two parental rabbits that produced these offspring.

Parent 1 .....

Parent 2 .....
[2]

(d) **(i)** Rabbits can inherit genetic diseases.

The probability of a rabbit inheriting a genetic disease can be assessed.

Name the method used for assessing the risk of an animal inheriting a genetic disease.

..... **[1]**

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(ii)* Rabbits can also develop diseases such as anaemia and lymphosarcoma that affect the number of erythrocytes and leucocytes in their circulatory system.

If such a disease is suspected, the rabbit's blood can be sampled and the blood cells can be analysed.

Describe a method that could be used to observe blood cells **and** a method used to identify blood cells from the blood of a rabbit.

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Additional answer space if required.

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(e) Rabbits, like all mammals, have a double circulatory system.

Explain the importance to mammals, such as rabbits, of having a double circulatory system.

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..... **[2]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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