Oxford Cambridge and RSA

Tuesday 20 October 2020 – Afternoon

A Level Biology B (Advancing Biology)

H422/03 Practical skills in biology

Time allowed: 1 hour 30 minutes

You must have:
- the Insert
- 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.
- 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.
- 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.

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 **24** pages.

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

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Answer **all** the questions.

1 A student used the following method to investigate the effect of increasing duration of exercise on pulse rate.

1. Two sample groups of ten people were selected.
2. The resting pulse rate was recorded for each person, using the radial artery on the wrist.
3. Each person ran on a treadmill for 1 min.
4. The pulse rate was taken immediately after exercise.
5. The measurements were repeated for exercise durations of 2–10 min.
6. All measurements were repeated.

(a) **(i)** State **two** variables that the student would need to control when planning this investigation. For each variable give one reason why that variable must be controlled.

Variable .....

Reason .....

.....

Variable .....

Reason .....

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[4]

(ii) The student also used secondary data in this investigation.

Explain **two** advantages of using secondary data in investigations.

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

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(b) Fig. 1.1 shows the heart rate of an athlete before and during a race.

- Stage 1 is at rest.
- Stage 2 is immediately before the starting pistol is fired.
- Stage 3 is immediately after the race has finished.

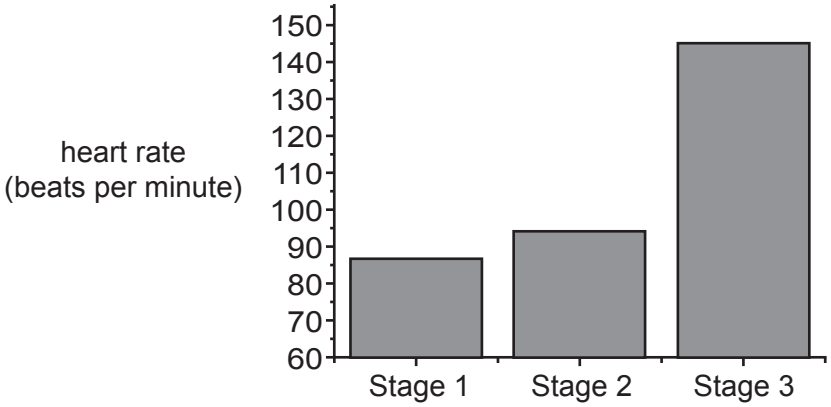

Fig. 1.1

(i) Describe and explain the effect of Stage 2 on heart rate.

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

(ii) The following measurements were made of the athlete during the race:

Stroke volume = 165 cm^3

Heart rate = 145 bpm

Calculate the cardiac output for this athlete.

cardiac output = ... units ..... **[1]**

(iii) Explain why cardiac output decreases at very high heart rates.

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

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(c) Fig. 1.2 shows an electrocardiogram (ECG) trace for a normal heartbeat. Fig. 1.3 shows an ECG trace of a patient suffering a heart attack.

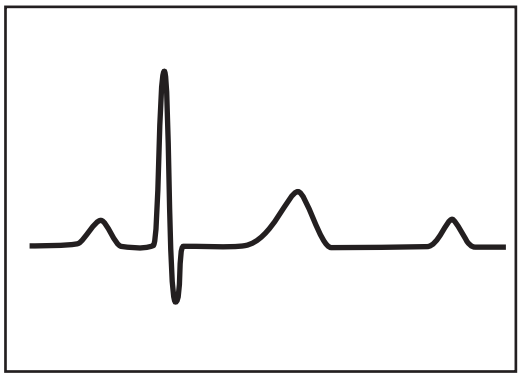

Fig. 1.2

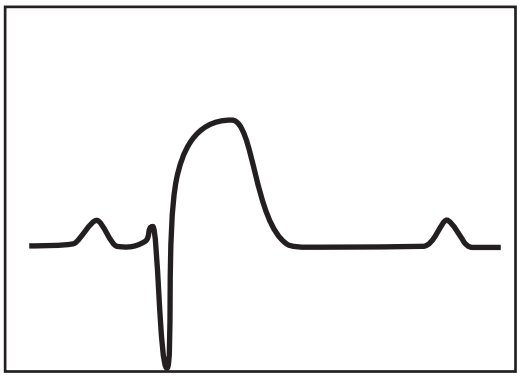

Fig. 1.3

(i) Which **one** of the following patterns, visible in Fig. 1.3, would indicate that the patient may be having a heart attack.

Place a tick (✓) in the appropriate box.

Elevation of the ST section	
Abnormally shaped P-wave	
Deep S wave	

[1]

(ii) The ECG trace in Fig. 1.4 was recorded using a smartphone app.

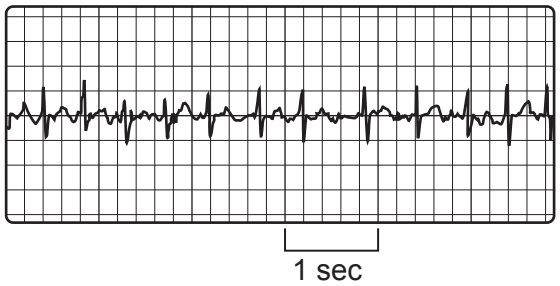

Fig. 1.4

Using Fig. 1.4 and your knowledge suggest why atrial fibrillation could lead to a cardiac arrest.

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

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(d)* An investigation was carried out into the effectiveness of smartphone apps for early diagnosis of heart conditions.

Two statements that were provided in this investigation.

Statement 1:

- Patients with compatible smartphones were issued with a smartphone app.
- The sample was composed of 148 patients 53 male, 95 female; average age 41 years, range 7 to 78, with two patients over 75.
- Patients were asked to record an ECG when they experienced symptoms of palpitations.
- Patients were linked to doctors via a secure website and could upload ECGs.
- Median time from symptoms to diagnosis was 9 days.
- In most cases no significant cardiac rhythm disturbance was found.

Statement 2:

- My patient was a 68 year old man with atrial fibrillation. He had previously been using cardiac event monitors to check his heart rhythm and started to use a smartphone app instead.
- Cardiac event monitors require the patient to wear electrodes attached to the chest, continuously for 30 days and to avoid the use of anything that may disrupt the signal, such as electric toothbrushes, metal detectors or mobile phones.
- With the smartphone app, I provide feedback so that the patient knows what his cardiac rhythm is doing and whether he is having symptoms.

Statement 1 was made by the scientists who carried out the investigation.
Statement 2 was made by a GP who was interviewed during the investigation.

Using the information given in Statements 1 and 2, evaluate the use of the smartphone app in the monitoring of heart conditions. **[6]**

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Additional answer space if required.

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2 Plants are usually adapted to living in conditions of different light intensities.

The leaf of a plant that is adapted to living in shade will differ from the leaf of a plant that is adapted to living in sunlight.

A student investigated the correlation between leaf and petiole sizes of two species of ivy plants. The following procedure was carried out:

- a random sampling technique was used to collect 10 samples of species A and 10 samples of species B
- the variables of leaf width and petiole length, shown in Fig. 2.1, were measured.

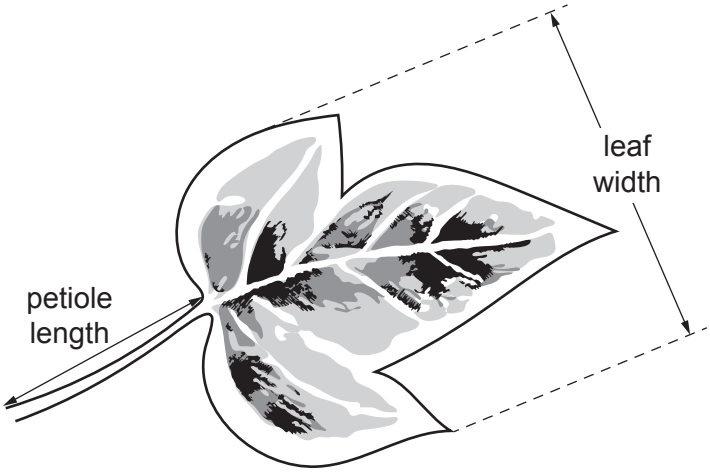

Fig. 2.1

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Some of the student's results are shown in Table 2.1.

Sample	Species A					
	Petiole length (mm)	Rank	Leaf width (mm)	Rank	d	d^2
1	28		52			
2	30		55			
3	17		31			
4	31		52			
5	35		56			
6	45		61			
7	46		62			
8	77		98			
9	33		40			
10	57		69			
					Total	

Table 2.1

(a) **(i)** Complete the missing values **in Table 2.1** for species A. **[2]**

(ii) Calculate Spearman's rank correlation coefficient (r_s).

Use the formula: $r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$

r_s = ... **[2]**

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(iii) The null hypothesis for this investigation was:

'There is no significant correlation between leaf width and petiole length.'

Write a conclusion for the results.

Your conclusion should explain whether the null hypothesis should be rejected or accepted at the 5% level of probability.

	10%	5%	2%	1%
n				
1	–	–	–	–
2	–	–	–	–
3	–	–	–	–
4	1.0000	–	–	–
5	0.9000	1.0000	1.0000	–
6	0.8286	0.8857	0.9429	1.0000
7	0.7143	0.7857	0.8929	0.9286
8	0.6429	0.7381	0.8333	0.8810
9	0.6000	0.7000	0.7833	0.8333
10	0.5636	0.6485	0.7455	0.7939

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

(b) Xerophytic plants are plants that are adapted to living in very dry conditions.

The table below gives a description of some adaptations of xerophytic plants.

Complete the table by indicating with a tick (✓) whether the adaptation is **behavioural**, **physiological** or **anatomical**.

Adaptation	Behavioural	Physiological	Anatomical
Stomata open only at night			
Stem becomes more rounded with fewer folds when water is available			
Stomata are located in sunken pits			

[3]

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(c) *Metasequoia occidentalis* is an extinct species of redwood tree that grew in forests approximately 39 million years ago.

A group of students wanted to find out if the leaves of *M. occidentalis* were adapted to sun or shade conditions.

They obtained three electron micrographs showing the ultrastructure of chloroplasts that had been extracted from:

- fossilised leaf samples of *M. occidentalis*
- leaf samples of *M. glyptostroboides*, a living *Metasequoia* species that had been growing in sun conditions
- leaf samples of *M. glyptostroboides* that had been growing in shade conditions.

(i) Suggest **one** reason for using a living species of *Metasequoia* in this investigation.

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

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(ii)* One of the students made drawings of a chloroplast from each of the three electron micrographs. These are shown in Fig. 2.2a, Fig. 2.2b and Fig. 2.2c.

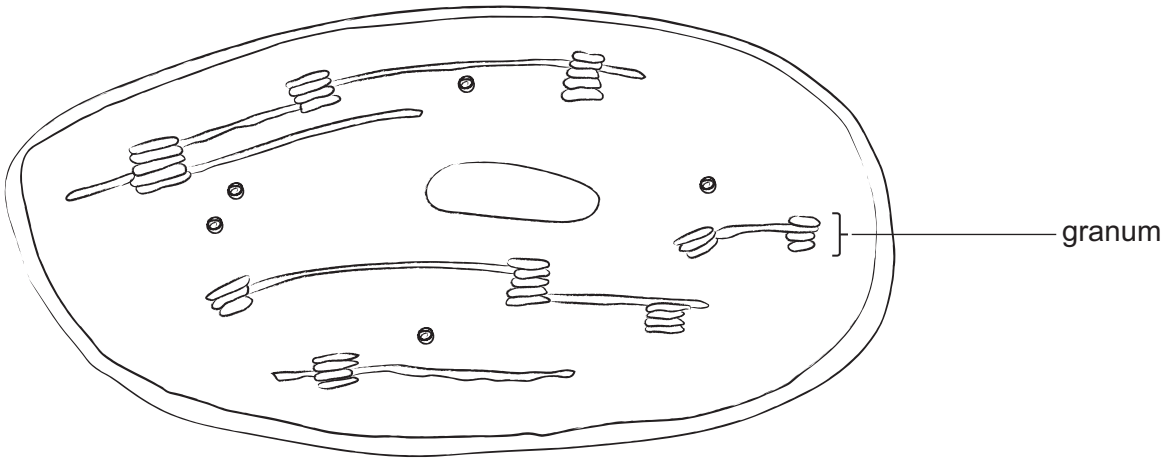

Fig. 2.2a chloroplast from *M. occidentalis*

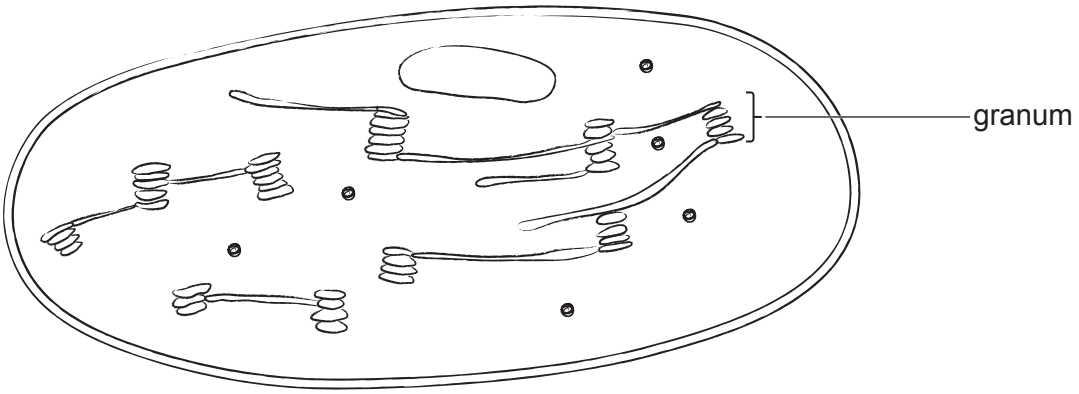

Fig. 2.2b chloroplast from *M. glyptostroboides* in sun conditions

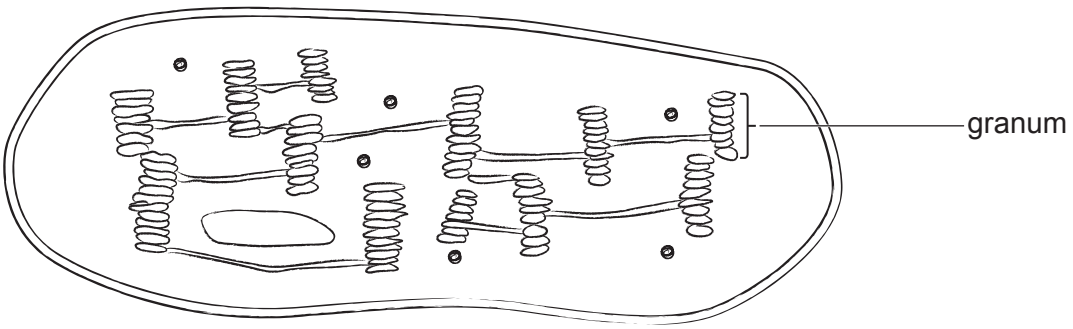

Fig. 2.2c chloroplast from *M. glyptostroboides* in shade conditions

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The student concluded that:

M. occidentalis is likely to have grown in sun conditions with high light intensity.

Evaluate this conclusion. **[6]**

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Additional answer space if required.

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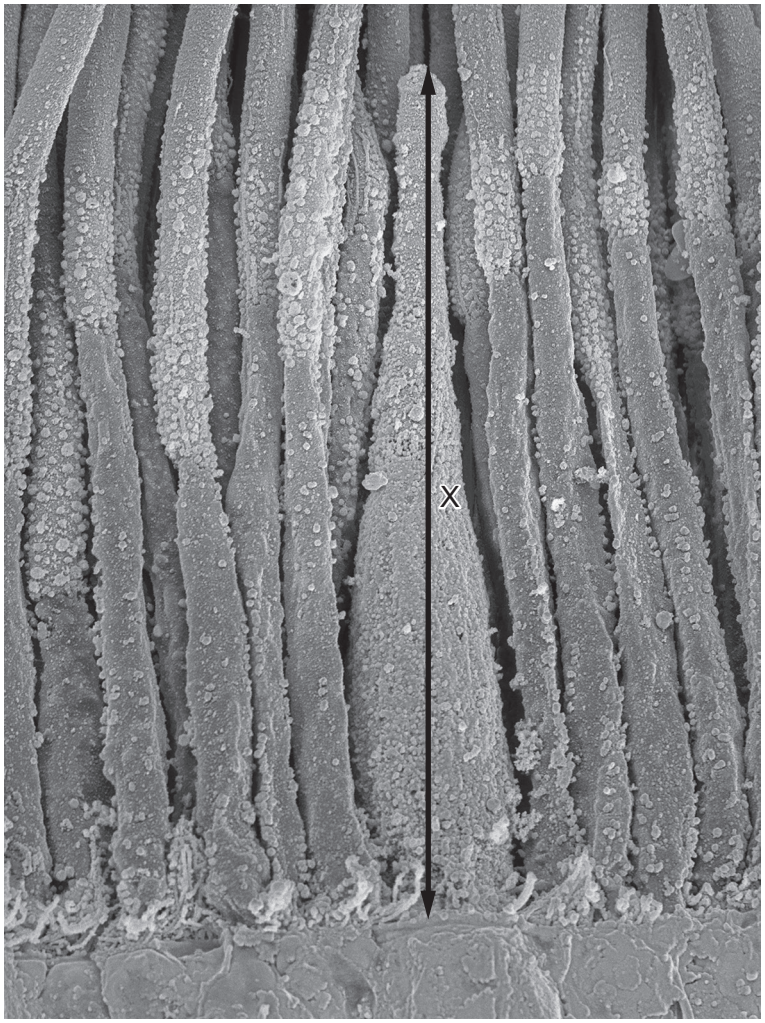
3 Fig. 3.1 is a scanning electron micrograph of receptor cells in the retina of the human eye.



×4000 magnification

Fig. 3.1

(a) **(i)** Calculate the actual height of the cone cell using line **X**.

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

height of cone cell = ... μm **[2]**

(ii) Name the photosensitive pigment found in cone cells.

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

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(iii) Give **two disadvantages** of the technique used to prepare the image in Fig. 3.1.

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

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(b) Fig. 3.2 is a light micrograph of a section through a mammalian eye.

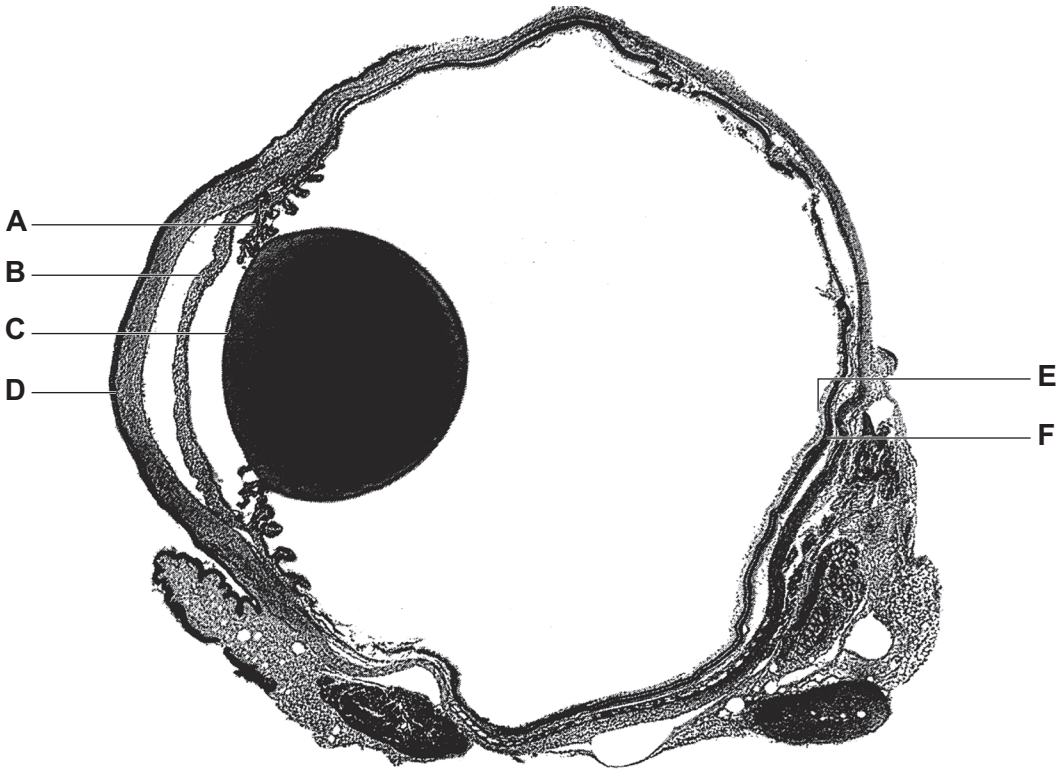

Fig. 3.2

Complete the table below about the structures labelled **A** to **F** in Fig. 3.2.

Label	Name	Function
A	ciliary muscle	....
B	.....	Controls amount of light entering the eye
C	.....	Focuses light rays
D	cornea	....
E	retina	....
F	.....	Pigmented layer to prevent internal reflection

[3]

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(c) A student is performing a dissection of a sheep's eye and wishes to extract the lens. The eye is covered in fatty tissue.

Describe how the items of equipment are to be used in the dissection and the actions that should be taken to ensure safe working in a dissection procedure.

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..... **[3]**

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(d) Retinopathy is an eye condition which can be caused by diabetes.

An investigation into the incidence of diabetic retinopathy in the UK was carried out.

Some of the data from the study are shown in the table below.

Age (years)	Frequency density
$35 \leqslant X < 46$	28
$46 \leqslant X < 63$	26
$63 \leqslant X < 69$	33
$69 \leqslant X < 81$	45
$81 \leqslant X < 95$	31

(i) Using the data in the table, plot a histogram on the grid provided.

[3]

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(ii) Calculate how many cases of diabetic retinopathy were found between the ages of 63 and 81.

number of cases = ... **[2]**

(iii) Explain why it is an advantage to use large sample sizes.

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

(iv) A key finding of the study was large regional variation in the incidence of retinopathy, after accounting for age, gender, deprivation and ethnicity.

Suggest a reason for the large regional variation.

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

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4 Fig. 4.1, **on the insert**, is a light micrograph of a transverse section through a mammalian spinal cord.

(a) In the space below, draw an annotated tissue plan of Fig. 4.1. Include labels for the following structures: central canal, grey matter, white matter, and meninges.

[4]

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(b) Fig. 4.2 shows a light micrograph and Fig. 4.3 shows a scanning electron micrograph of nerve cells in the human brain.

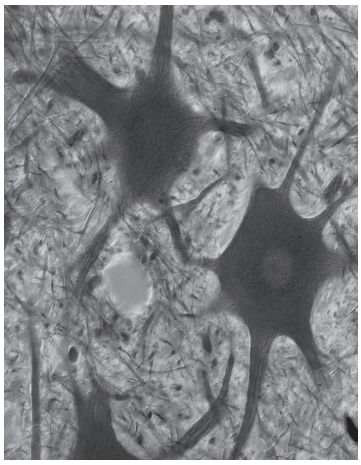

Fig. 4.2

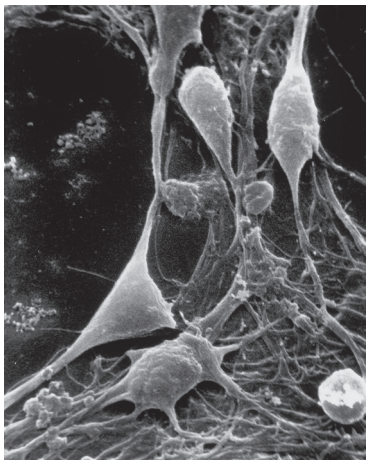

Fig. 4.3

The images in Fig. 4.2 and Fig. 4.3 were taken from the same tissue and were produced at the same magnification.

Explain why the image in Fig. 4.3 shows greater detail compared with the image in Fig. 4.2.

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

(c) The autonomic nervous system is divided into two branches, the sympathetic and parasympathetic nervous systems.

Complete the table to compare the sympathetic and parasympathetic nervous systems.

Feature	Parasympathetic nervous system	Sympathetic nervous system
Neurotransmitter		noradrenaline
Position of ganglion	ganglion is close to the effector	

[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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