

FOR OFFICIAL USE



National  
Qualifications  
2016

Mark

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**X707/77/01**

**Biology**  
**Section 1 — Answer Grid**  
**and Section 2**

MONDAY, 9 MAY  
9:00 AM – 11:30 AM



\* X 7 0 7 7 7 0 1 \*

Fill in these boxes and read what is printed below.

Full name of centre

Town

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Forename(s)

Surname

Number of seat

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Date of birth

Day

Month

Year

Scottish candidate number

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**Total marks — 90**

**SECTION 1 — 25 marks**

Attempt ALL questions.

Instructions for completion of Section 1 are given on *Page 02*.

**SECTION 2 — 65 marks**

Attempt ALL questions.

**A Supplementary Sheet for Question 1 is enclosed inside the front cover of this question paper.** Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not you may lose all the marks for this paper.



\* X 7 0 7 7 7 0 1 0 1 \*

The questions for Section 1 are contained in the question paper X707/77/02.

Read these and record your answers on the answer grid on *Page 03* opposite.

Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).
2. There is **only one correct** answer to each question.
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

### Sample Question

The thigh bone is called the

- A humerus
- B femur
- C tibia
- D fibula.

The correct answer is **B** — femur. The answer **B** bubble has been clearly filled in (see below).

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

### Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:

A	B	C	D		A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	✓	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

or



\* X 7 0 7 7 7 0 1 0 2 \*

# SECTION 1 — Answer Grid



	A	B	C	D
1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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[Turn over for next question

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\* X 7 0 7 7 7 0 1 0 5 \*

SECTION 2 — 65 marks

Attempt ALL questions

It should be noted that question 11 contains a choice.

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1. Read through the Supplementary Sheet for Question 1 before attempting this question.

(a) Refer to Figure 2 in the Supplementary Sheet for Question 1.

- (i) Use the data to describe the egg-laying of uninfected mosquitoes. 2

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- (ii) If the box plots were perfectly symmetrical, mean values for egg-laying would be very close to median values.

State what can be deduced about the **mean** number of eggs laid by infected mosquitoes in relation to the median value. 1

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- (iii) Describe the effect that *Plasmodium* infection has on the fecundity of mosquitoes used in the study. 1

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(b) Refer to Figure 3 in the Supplementary Sheet for Question 1.

- (i) The data shows that infection by *Plasmodium* appears to increase the longevity of female mosquitoes.

Explain why the difference between the two groups can be regarded as significant. 1

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- (ii) Suggest a benefit to the parasite of its vector living longer. 1

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1. (continued)

(c) Refer to Figure 4 in the Supplementary Sheet for Question 1.

- (i) Explain what the lines of best fit indicate about the relationship between longevity and fecundity in both infected and uninfected mosquitoes.

2

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- (ii) State, with justification, whether or not this data is reliable.

1

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[Turn over



2. Scientists have reported that neurons produced in cell culture from human stem cells have the potential to function when grafted into the site of a spinal injury in rats.

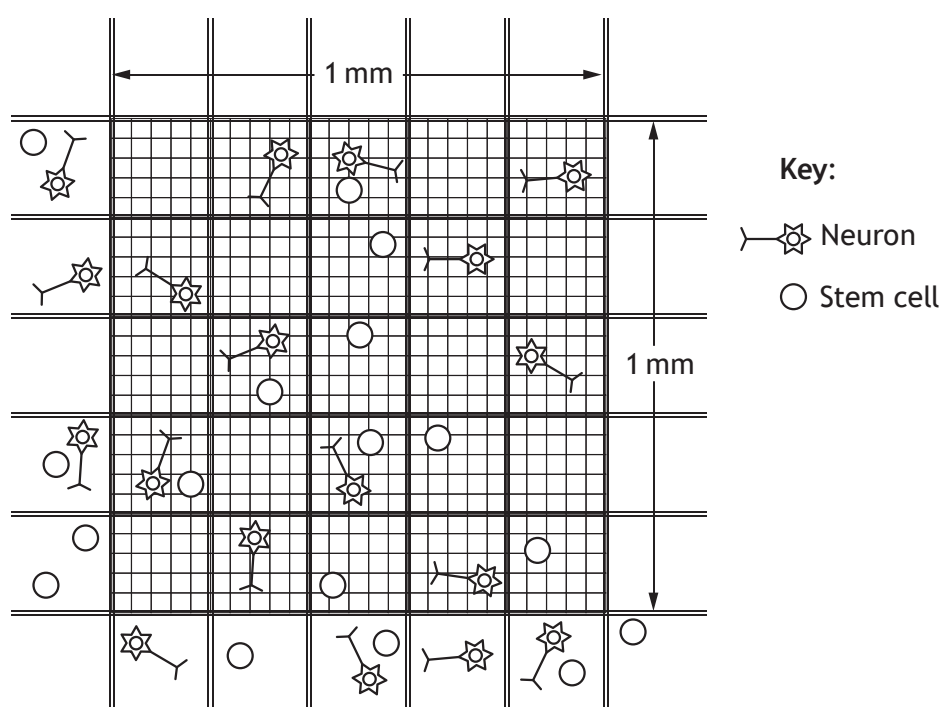
- (a) State why the cell culture medium in which the neurons were cultured should contain serum.

1

- (b) Scientists used a haemocytometer to perform a cell count to calculate the number of stem cells that developed into neurons.

The diagram below represents a sample from a culture placed in a haemocytometer and viewed under a microscope.

The grid is 0.1 mm in depth.



- (i) Calculate the number of **neurons** in 1 cm<sup>3</sup> of the culture.

1

*Space for calculation*

\_\_\_\_\_ neurons

- (ii) Suggest **one** disadvantage of cell counts performed using the haemocytometer.

1





2. (continued)

- (c) Bright field microscopy was used to view the cells grafted into the site of spinal injury.

State another type of biological material that can be viewed using bright field microscopy.

1

- (d) In studies involving animals, state **one** way in which harm to the animals can be minimised.

1

[Turn over



\* X 7 0 7 7 7 0 1 0 9 \*

3. Multiple sclerosis (MS) is a neurological condition in which the body's immune system destroys the myelin sheath that surrounds and insulates nerve axons.

A clinical study was carried out into the effects of a new drug *interferon beta-1b* for this condition. A randomised trial, with a negative control group (placebo), was carried out across four different health centres. During the study patients were given one of three treatments: 0.00 mg (placebo), 0.05 mg or 0.25 mg interferon. The patients administered the drug themselves at home.

The study measured how effective the drug was by asking patients to record any worsening of symptoms after 2 years of treatment. The study involved 372 patients aged 18-50 years. Fourteen patients dropped out before completing the trial.

Patients' results are shown in Table 1.

Table 1

Level of interferon beta-1b in treatment (mg)	Proportion of patients reporting no worsening of symptoms after 2 years of treatment (%)
0.00	16
0.05	18
0.25	25

At one health centre 52 patients were MRI scanned every 6 weeks to monitor any new damage to nerve tissue. The results are shown in Table 2.

Table 2

Level of interferon beta-1b in treatment (mg)	Proportion of patients showing new nerve damage (%)
0.00	29
0.05	no data recorded
0.25	6

- (a) Identify the independent variable in this trial.

1

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- (b) This trial was carried out *in vivo*.

State **one** advantage of this type of trial.

1

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3. (continued)

(c) Explain why a placebo group was included in this trial.

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(d) Suggest **one** way in which the results of the trial may not be reliable.

1

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(e) Describe an ethical issue that the researchers would need to consider before this trial.

1

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(f) Suggest **two** conclusions that can be drawn from the results of this trial.

2

Conclusion 1 \_\_\_\_\_

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Conclusion 2 \_\_\_\_\_

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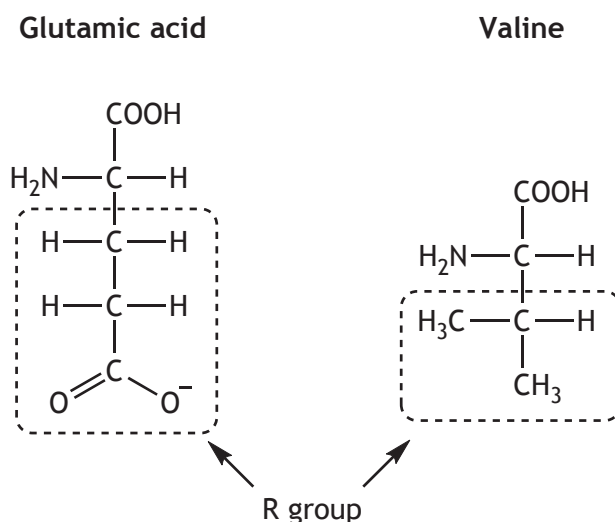
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4. Sickle cell anaemia is an inherited blood disorder that reduces the ability of red blood cells to transport oxygen round the body by changing the structure of haemoglobin.

In sickle cell anaemia, the primary structure of a haemoglobin subunit is altered; the amino acid glutamic acid is substituted by the amino acid valine.

The structures of glutamic acid and valine are shown below.

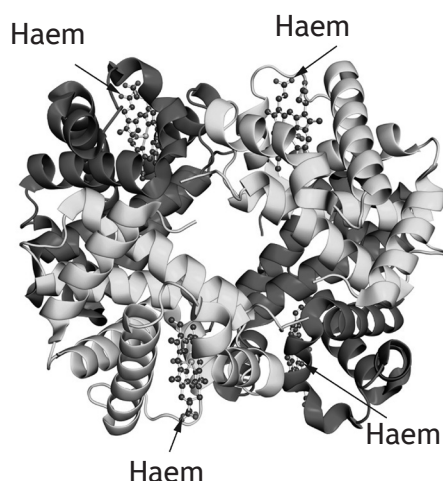


- (a) State the class of amino acids to which valine belongs.

1

- (b) Identify **one** type of secondary structure shown in the haemoglobin molecule in the figure below.

1



4. (continued)

- (c) Explain the term cooperativity in relation to oxygen binding to haemoglobin.

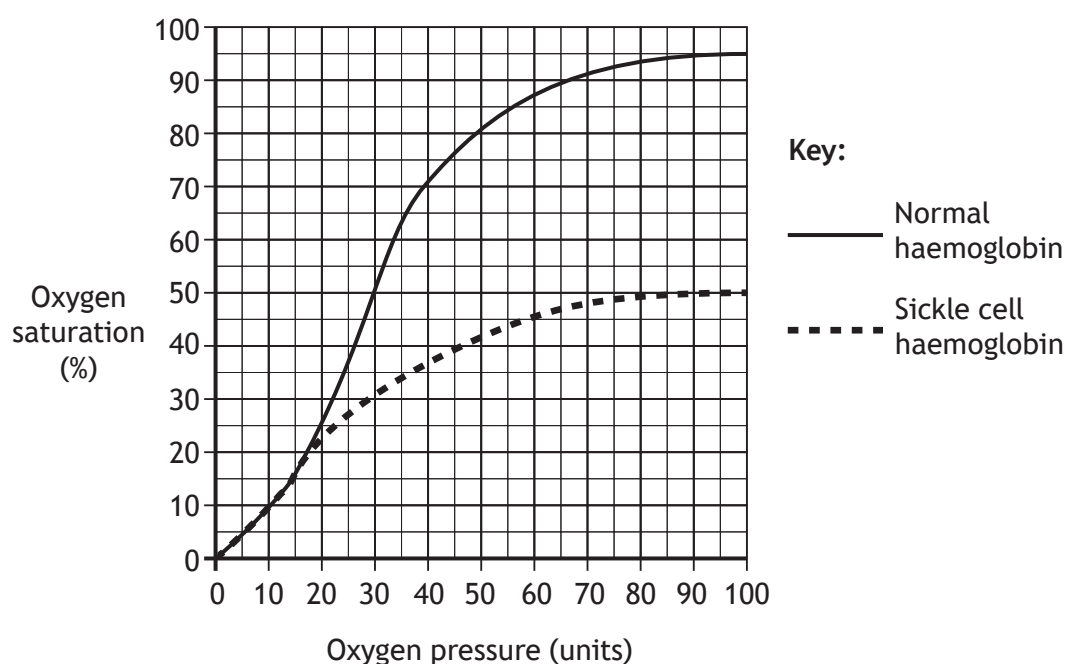
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- (d) The graph below shows the oxygen saturation of haemoglobin at different oxygen pressures for an individual with normal haemoglobin and for another individual with sickle cell haemoglobin.



Use the graph to compare the oxygen saturation of normal and sickle cell haemoglobin as oxygen pressure increases.

2

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- (e) Molecules of sickle cell haemoglobin clump together preventing access to oxygen binding sites.

Suggest why this is a result of the substitution of glutamic acid by valine.

1

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5. Describe the structure of spindle fibres and explain their role in the movement of chromosomes during cell division.

4

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6. The sodium potassium pump (Na/KATPase) is a membrane protein found in animal cells.

(a) Give **one** function of sodium potassium pumps.

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(b) Describe the role of ATP in altering the affinity of the pump for sodium ions ( $\text{Na}^+$ ).

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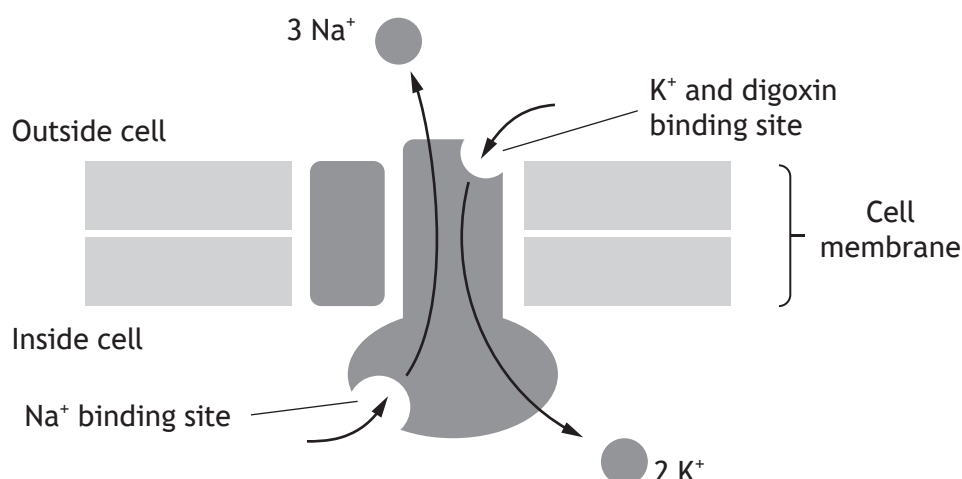


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(c) Digoxin is a chemical that inhibits the sodium potassium pump by binding to the potassium ion ( $\text{K}^+$ ) binding site as shown in the diagram below.



Explain why binding by digoxin prevents further binding of sodium ( $\text{Na}^+$ ) ions by the pump.

2

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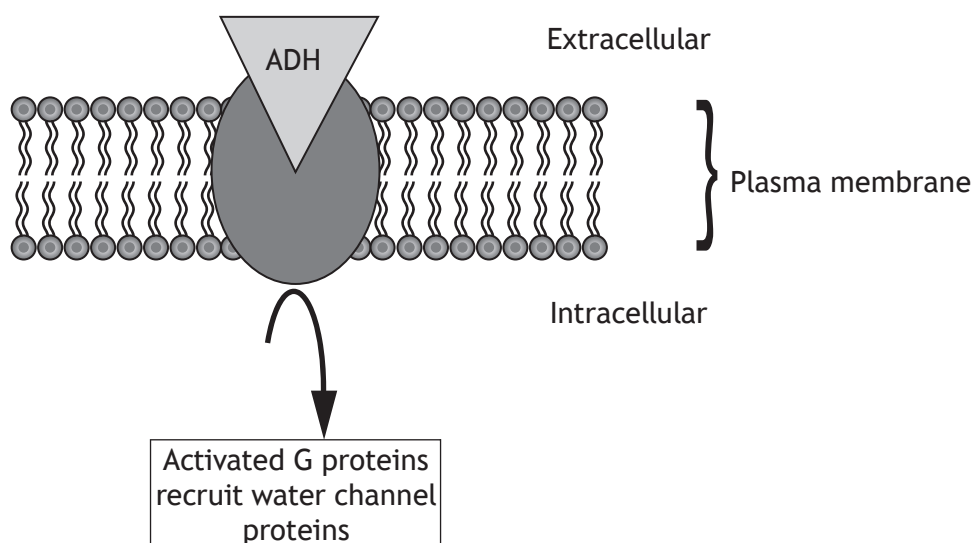
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7. Binding of antidiuretic hormone (ADH) to its receptor on the plasma membrane of kidney collecting duct cells triggers the recruitment of water channel proteins as shown below.



- (a) (i) Name the water channel protein involved in this process.

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- (ii) Name the process by which a response within the cell is triggered by the binding of ADH to its cell surface receptor.

1

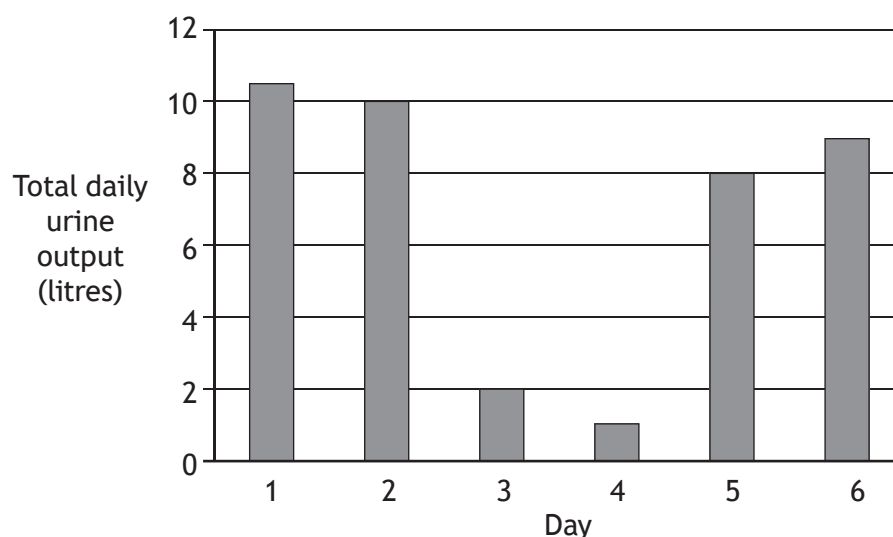
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7. (continued)

- (b) A urine output of greater than 0.05 litres per kg body mass per day is considered diagnostic of diabetes insipidus. The bar chart below shows the urine output over 6 days of a 70 kg individual being investigated for diabetes insipidus. During days 3 and 4 the individual was treated with the drug *desmopressin*, a synthetic form of ADH.



- (i) Use the data to confirm that a diagnosis of diabetes insipidus is correct for this individual. 1

*Space for calculation*

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- (ii) Give evidence from the graph that supports the conclusion that *desmopressin* is an effective treatment. 1

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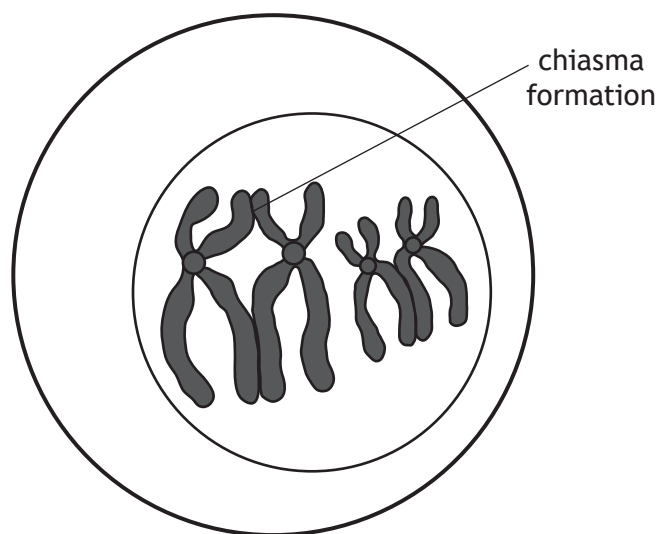
- (iii) Diabetes insipidus results from failure to recruit water channel proteins to the cell membrane.

Identify the cause of recruitment failure in this individual. 1

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8. The diagram below shows the pairing of homologous chromosomes in a cell undergoing meiosis.



- (a) Name the type of cell that undergoes meiosis. 1

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- (b) (i) Explain how the chiasma formation between the paired homologous chromosomes shown in the diagram leads to variation. 2

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- (ii) Name the process that ensures haploid gametes produced by meiosis contain a mixture of chromosomes of maternal and paternal origin. 1

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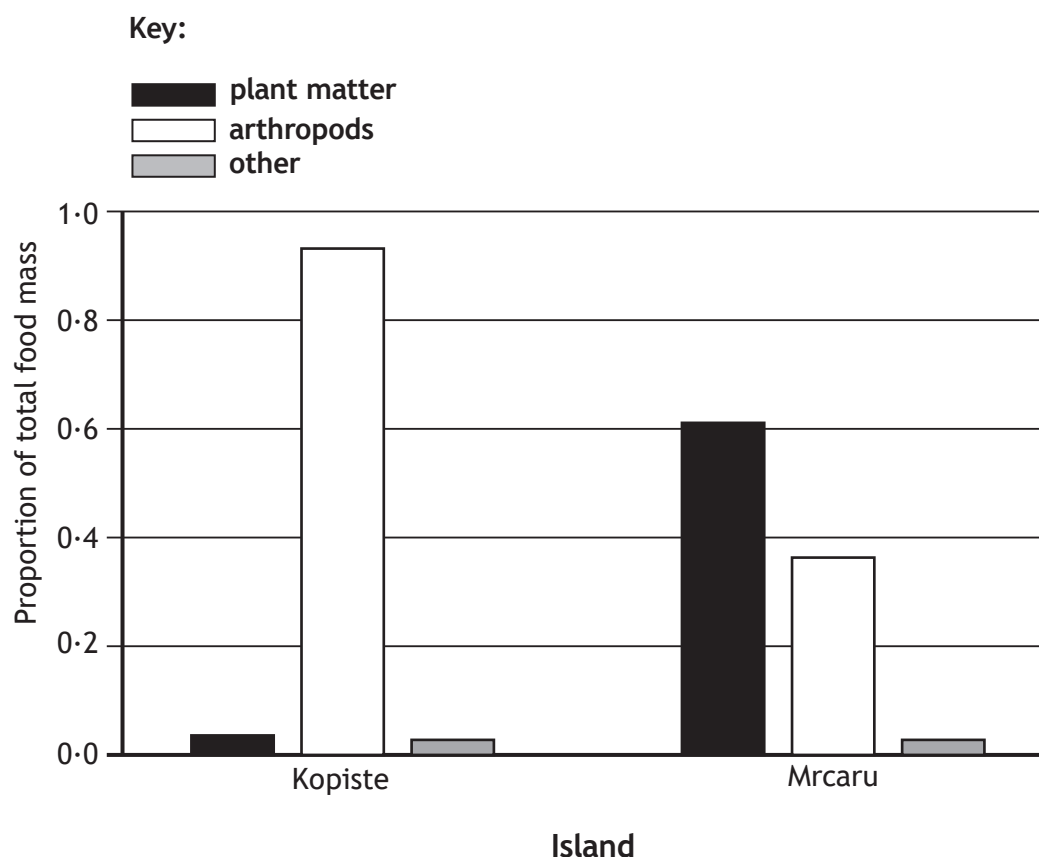
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9. In 1971, biologists moved five adult pairs of Italian wall lizards (*Podarcis sicula*) from their small home island of Kopiste to the neighbouring small island of Mrcaru, which did not have a lizard population. On their return in 2005 Mrcaru was found to have a large population of *P. sicula* (confirmed by genetic analysis) with significantly larger heads and a greater bite force than the lizards from Kopiste. Their digestive systems were also found to contain microorganisms that assist in the breakdown of plant cell walls.

The summer diets of the two lizard populations are shown below.



- (a) Describe the most significant change in the summer diet of the lizards on Mrcaru.

1

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9. (continued)

- (b) (i) Explain how the information supports the conclusion that the changes to the lizard population on Mrcaru were the result of natural selection.

2

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- (ii) Evolution of the lizards on Mrcaru occurred very rapidly.  
State **one** factor that can increase the rate of evolution.

1

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- (c) This study involved taking representative samples of the lizard populations on the two islands.

State **one** feature of a representative sample.

1

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[Turn over



10. The Figures below show male and female capercaillies (*Tetrao urogallus*) which are found in some Scottish pine forests. Males are much larger and darker than females and the breast feathers of the male have a metallic green sheen.



male capercaillie



female capercaillie

- (a) State the term used to indicate the different body forms of males and females belonging to this species. 1

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- (b) Capercaillies are a lekking species. Males perform displays during which they fan their tails, hold their wings down and make a variety of sounds. These features, which are attractive to females, are thought to serve as honest signals.

- (i) Explain what is meant by a lekking species. 1

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- (ii) Explain why this display is often given as an example of sexual selection. 1

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- (iii) If the display provides honest signals, state the benefit that may be obtained by females receiving these signals. 1

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10. (continued)

(c) Peacocks are the males of another lekking bird species, *Pavo cristatus*, whose natural habitat is the dense forests of South-East Asia. As well as the visual stimulus of a tail-feather display, peacocks, during mating, can emit a distinctive “hoot”. These hoots are loud enough to be heard by other females, out of sight of the lek, who may be attracted by the calls and provide the dominant males at the lek with additional mating partners.

- (i) Suggest why auditory stimuli are advantageous to species inhabiting forest ecosystems.

1

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- (ii) Recent research has found that some peacocks emit hoots in the complete absence of females at the lek. Females are still attracted to the lek by these sounds. Such “solo” hoots have been described as “dishonest signals”.

Explain what is meant by a “dishonest signal” in this behaviour.

1

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[Turn over for next question



11. Answer **either A or B** in the space below and on *Page 25*.

**A** Discuss reproduction under the following headings:

- |  |   |
|--|---|
| (i) costs and benefits of sexual reproduction;                   | 4 |
| (ii) asexual reproduction as a successful reproductive strategy. | 5 |

**OR**

**B** Discuss endoparasitic infections under the following headings:

- |  |   |
|--|---|
| (i) difficulties involved in their treatment and control;        | 7 |
| (ii) benefits of improved parasite control to human populations. | 2 |

Labelled diagrams may be used where appropriate.





MARKS

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SPACE FOR ANSWER FOR QUESTION 11

[END OF QUESTION PAPER]



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MARKS

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



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## ACKNOWLEDGEMENT

Question 4(b) - petarg/shutterstock.com

Question 10 – Bildagentur Zoonar GmbH/shutterstock.com

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