

FOR OFFICIAL USE



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National  
Qualifications  
2018

Mark

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**X707/76/01**

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

TUESDAY, 15 MAY  
9:00 AM – 11:30 AM



Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Number of seat

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Date of birth

Day

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Month

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Year

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Scottish candidate number

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**Total marks — 100**

**SECTION 1 — 20 marks**

Attempt ALL questions.

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

**SECTION 2 — 80 marks**

Attempt ALL questions.

Questions 11 and 14 contain a choice.

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. 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.



The questions for Section 1 are contained in the question paper X707/76/02.

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).

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<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**.

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<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:

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	or	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<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"/>



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"/>



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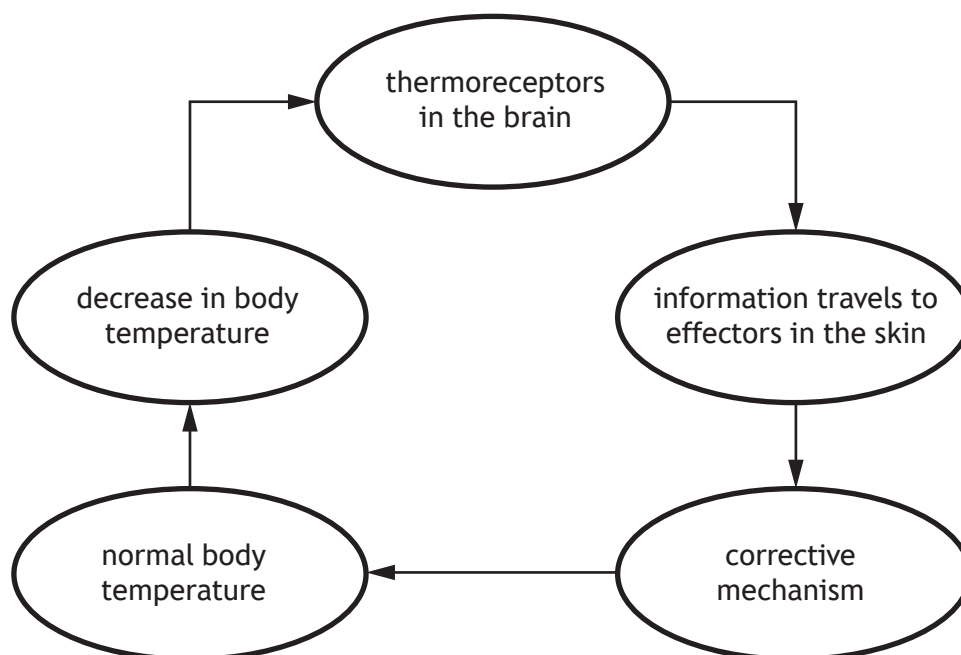
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SECTION 2 — 80 marks  
 Attempt ALL questions  
 Questions 11 and 14 contain a choice

1. The diagram illustrates thermoregulation in mammals following a decrease in body temperature.



- (a) (i) Name the type of control used in thermoregulation as shown in the diagram. 1
- \_\_\_\_\_
- (ii) Name the part of the brain in which thermoreceptors are found. 1
- \_\_\_\_\_
- (iii) State how information travels to the effectors in the skin. 1
- \_\_\_\_\_



## 1. (continued)

(b) Effectors in the skin include muscles in the walls of blood vessels.

- (i) Describe the response of these effectors to a decrease in body temperature.

1

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- (ii) Explain how this response would help return body temperature to normal.

1

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(c) Explain why it is important for a mammal to regulate its body temperature.

1

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\* X 7 0 7 7 6 0 1 0 7 \*

2. *Daphnia* (*Daphnia pulex*) is a species of water flea that lives in fresh water. An investigation was carried out into the effect of water temperature on the heart rate of one *Daphnia*. The results are shown in the table.

Water temperature (°C)	Heart rate (beats per minute)
2	175
7	184
12	194
17	207
22	219

- (a) Calculate the average increase in heart rate per °C between 2 °C and 22 °C.

1

Space for calculation

\_\_\_\_\_ beats per minute per °C

- (b) *Daphnia* is a conformer. Use evidence from the table to confirm this statement.

1

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- (c) Explain how an increased water temperature would result in a higher metabolic rate in *Daphnia*.

2

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- (d) State the type of response shown by conformers to maintain an optimum metabolic rate.

1

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\* X 7 0 7 7 6 0 1 0 9 \*

3. The bacteria *Streptomyces* is a microorganism found in soil. It produces a secondary metabolite, the antibiotic streptomycin, which kills other microorganisms. *Streptomyces* live in close association with plant roots. These plants produce soluble carbohydrates which are released into the soil through their roots.

(a) (i) Name the growth phase during which streptomycin is produced. 1

\_\_\_\_\_

(ii) Explain the advantage to *Streptomyces* of producing an antibiotic such as streptomycin. 1

\_\_\_\_\_  
\_\_\_\_\_

(b) The relationship between *Streptomyces* and the plant roots is described as mutualistic.

(i) Suggest the benefit to *Streptomyces*. 1

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(ii) Suggest the benefit to the plant. 1

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



3. (continued)

- (c) An investigation was set up to compare the effectiveness of streptomycin with other antibiotics by measuring the survival of bacteria. A species of bacteria was grown in the presence of different concentrations of antibiotics and the percentage which survived was calculated. The results are shown in the table.

<i>Antibiotic</i>	<i>Concentration of antibiotic (<math>\mu\text{g}/\text{cm}^3</math>)</i>	<i>Survival of bacteria (%)</i>
Fusidic acid	10	6
Chloramphenicol	25	42
Erythromycin	5	49
Gentamycin	10	5
Tetracycline	25	35
Streptomycin	10	35

- (i) Name one antibiotic with which streptomycin could be validly compared. 1

\_\_\_\_\_

- (ii) Give a conclusion which can be drawn from the results. 1

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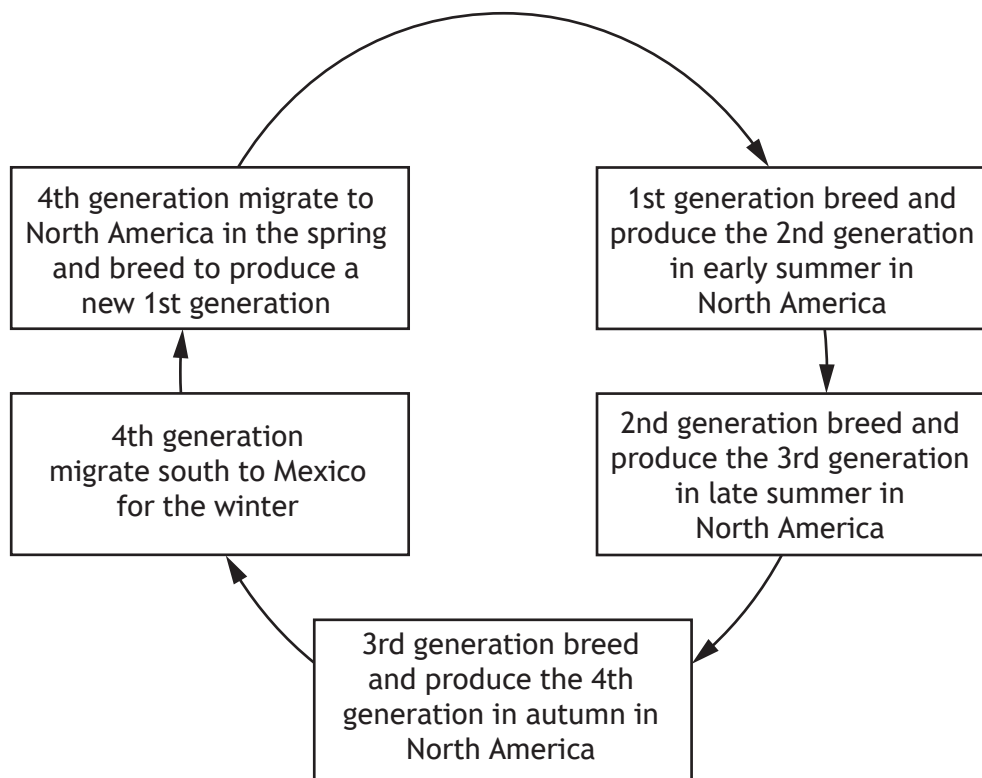
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4. The diagram shows information on the breeding and migration of Monarch butterflies (*Danaus plexippus*). Each generation dies after laying eggs.



- (a) State one advantage and one disadvantage to the Monarch butterfly of migration to Mexico.

2

Advantage \_\_\_\_\_

\_\_\_\_\_

Disadvantage \_\_\_\_\_

\_\_\_\_\_



\* X 7 0 7 7 6 0 1 1 2 \*

## 4. (continued)

- (b) The migratory behaviour of the Monarch butterfly from North America to Mexico is innate.

Use the information given to justify this statement.

1

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- (c) Some species of hummingbird also migrate between North America and Mexico. They have high metabolic rates which they reduce while resting each night during the migration period.

Name this reduction in metabolic rate.

1

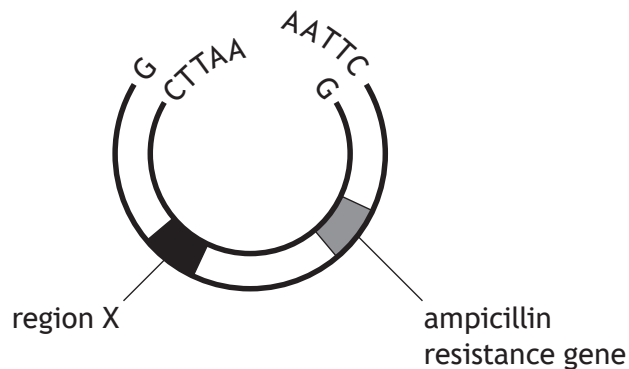
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5. The diagram shows some features of a plasmid which has been cut open by a restriction endonuclease to allow a gene from a donor chromosome to be inserted.



The DNA recognition sites for three restriction endonucleases, *E coR1*, *BamH1*, and *HindIII*, are shown in the table. The arrows indicate where each restriction endonuclease cuts the DNA sequence.

Restriction endonuclease	DNA sequence recognised
<i>E coR1</i>	↓ G A A T T C C T T A A G ↑
<i>BamH1</i>	↓ G G A T C C C C T A G G ↑
<i>HindIII</i>	↓ A A G C T T T T C G A A ↑



\* X 7 0 7 7 6 0 1 1 4 \*

5. (continued)

- (a) (i) A restriction endonuclease was used to remove a gene from a donor chromosome.

Use information from the diagram and the table to identify the restriction endonuclease which would be used to allow the gene to be inserted into the plasmid.

Give a reason for your answer.

2

Restriction endonuclease \_\_\_\_\_

Reason \_\_\_\_\_

- (ii) Name the enzyme which would be used to seal the gene into the plasmid.

1

\_\_\_\_\_

- (iii) A culture of bacterial cells, 20% of which had taken up this modified plasmid, were grown on a nutrient agar plate. The plate was incubated and 250 colonies of this bacteria grew.

Predict the number of colonies which would have been expected to grow if the nutrient agar plate had contained the antibiotic ampicillin.

1

*Space for calculation*

\_\_\_\_\_

- (b) Name region X, shown in the diagram, which ensured that the modified plasmid would be passed on to daughter cells.

1

\_\_\_\_\_

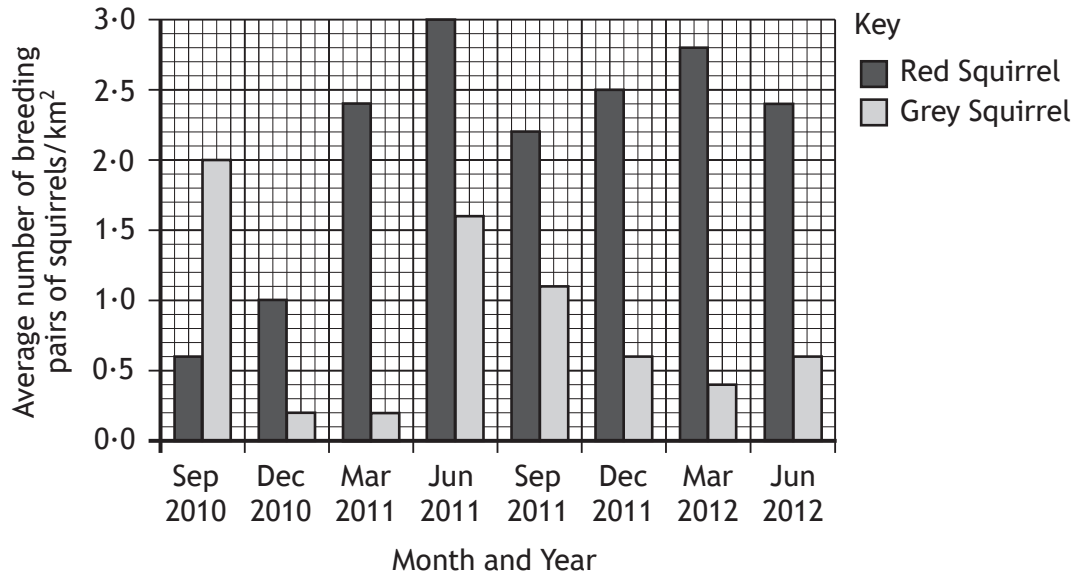
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6. An investigation was carried out to monitor the populations of red squirrels (*Sciurus vulgaris*) and grey squirrels (*Sciurus carolinensis*) in a 15 km<sup>2</sup> wooded area.

The average number of breeding pairs of each species was recorded between September 2010 and June 2012.

The results are shown in the graph.



- (a) (i) Use values from the graph to describe the changes in the average number of breeding pairs of grey squirrels from March 2011 to March 2012.

2

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- (ii) Calculate the total number of breeding pairs of red squirrels in the wooded area in September 2011.

1

Space for calculation

\_\_\_\_\_ breeding pairs

- (iii) Express, as the simplest whole number ratio, the number of grey squirrels to red squirrels in June 2012.

1

Space for calculation

\_\_\_\_\_ : \_\_\_\_\_  
grey : red



\* X 7 0 7 7 6 0 1 1 6 \*

6. (continued)

- (b) Pine martens (*Martes martes*) live in wooded areas and prey on squirrels. Populations of pine martens, red squirrels and grey squirrels were estimated in two other wooded areas using automatic cameras. These cameras are triggered by the movement of passing animals.

The results are shown in the table.

Wooded area	Estimated number of grey squirrels	Estimated number of red squirrels	Estimated number of pine martens
1	88	645	45
2	465	112	12

- (i) Suggest why the method used to estimate the numbers of pine martens and squirrels may lead to inaccurate results. 1

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- (ii) Use evidence from the table which could be used to support the following statements.

- 1 Pine martens are more successful predators of grey squirrels than of red squirrels. 1

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- 2 Grey squirrels compete more successfully for food than red squirrels. 1

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- (c) Grey squirrels have spread rapidly and eliminated native red squirrels from much of the UK.

State the term used to describe grey squirrels in the UK as a result of this. 1

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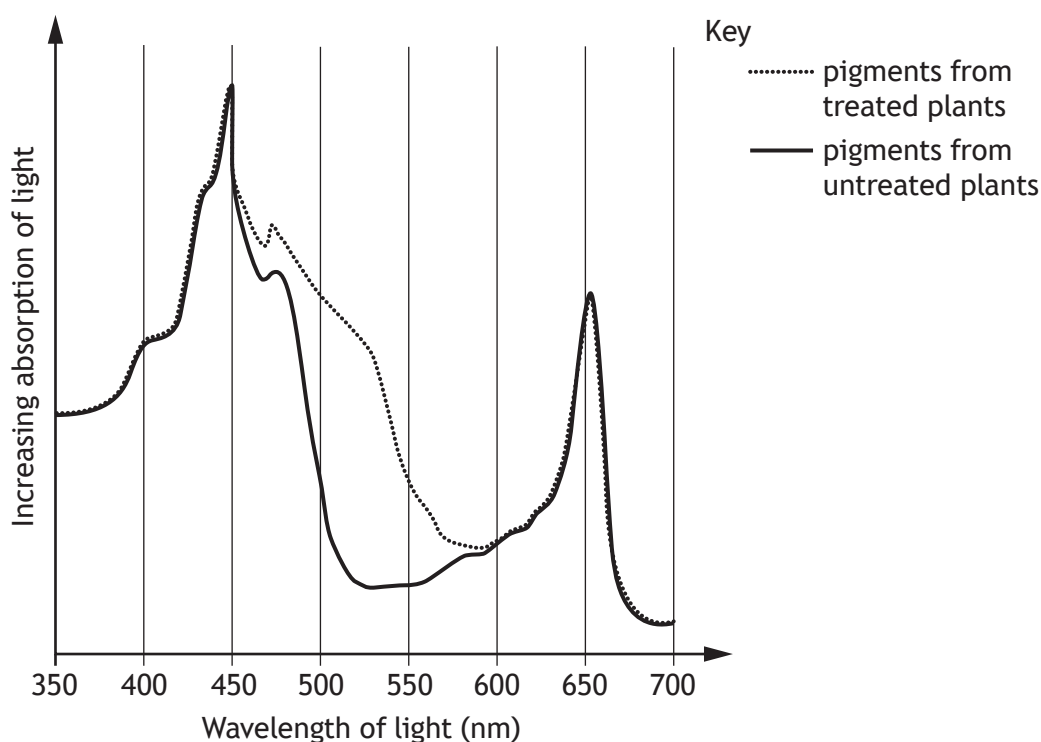
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7. Oil extracted from the seeds of the crop false flax (*Camelina sativa*) can be used as fuel. An investigation was carried out into the effect of a plant growth regulator paclobutrazol (PBZ) on the photosynthetic pigment content of the leaves and the oil yield from the seeds of false flax. The results are shown in the table.

Treatment	Average photosynthetic pigment content (mg/g of leaf)		Average oil yield (g/plant)
	Chlorophyll a and b	Carotenoids	
Untreated	3.28	3.02	1.7
Treated with PBZ	3.27	3.98	2.4

Absorption spectra for pigments from the treated and untreated plants were produced and are shown in the graph.



- (a) (i) Use values from the graph to describe the difference in absorption spectra of the pigments from treated and untreated plants. 1

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7. (a) (continued)

(ii) Use evidence from the table to explain the difference in the absorption spectra.

1

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(iii) State one use that plants make of the light energy absorbed by pigments during photosynthesis.

1

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(b) Suggest why seeds from the plants treated with PBZ yield more oil.

2

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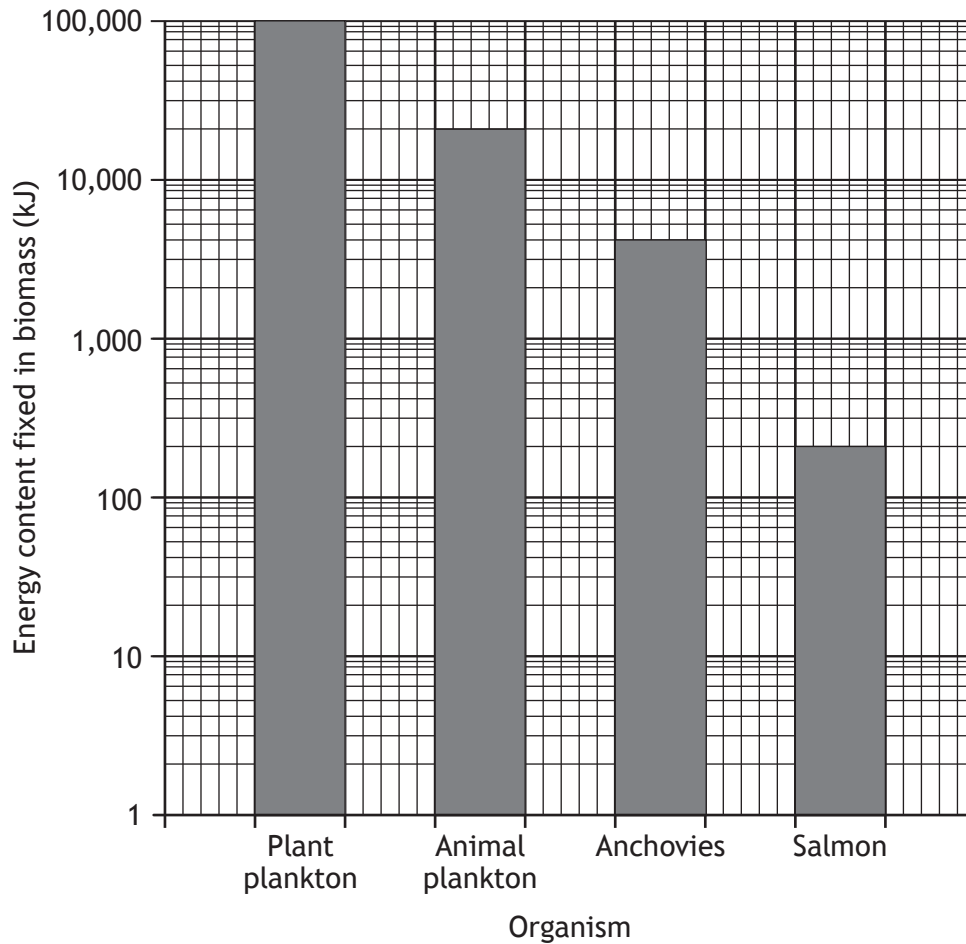
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\* X 7 0 7 7 6 0 1 1 9 \*

8. Salmon can be reared in fish farms where they are sometimes fed small fish such as anchovies. Anchovies feed on animal plankton which feed on plant plankton.

The energy contents at each trophic level in this food chain are shown on a log scale in the bar graph.



- (a) (i) State the energy content fixed in the biomass of salmon. 1

\_\_\_\_\_ kJ

- (ii) Plant plankton fix 2% of the solar energy they receive in their biomass.

Calculate the **total** solar energy to which the plant plankton were exposed. 1

*Space for calculation*

\_\_\_\_\_ kJ



\* X 7 0 7 7 6 0 1 2 0 \*

## 8. (continued)

(b) The human population is increasing.

- (i) State the term used to define the ability of the human population to access food of sufficient quantity.

1

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- (ii) In terms of energy explain the advantage to the human population of consuming anchovies rather than salmon.

1

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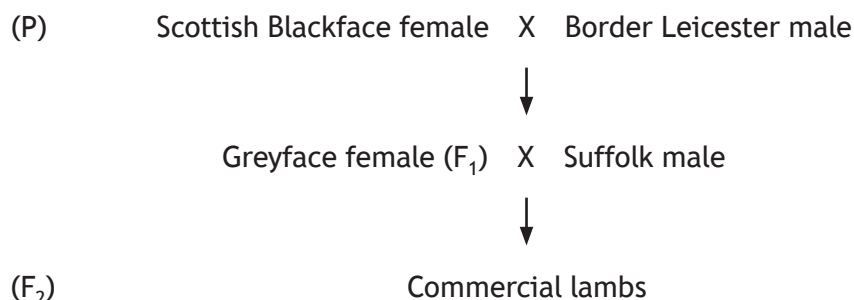
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\* X 7 0 7 7 6 0 1 2 1 \*

9. The diagram shows crosses in a breeding programme involving different breeds of sheep.



(a) Suggest a reason why breeding programmes such as this include crossbreeding. 1

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(b) Explain why Greyface sheep are produced by crossbreeding Scottish Blackfaces with Border Leicesters instead of breeding F<sub>1</sub> Greyface sheep together. 1

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(c) To produce commercial lambs which show a desired dominant characteristic, Suffolk males homozygous for that characteristic are used.

(i) Name the type of cross used to identify if the genotype of the desired characteristic in Suffolk males is homozygous. 1

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(ii) Explain the importance of selecting a Suffolk male homozygous for the desired dominant characteristic. 1

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## 9. (continued)

- (d) Spider lamb syndrome is a hereditary condition in sheep caused by a recessive deleterious allele which results in limb deformities.

State why inbreeding could cause an increase in the number of lambs born with this condition.

1

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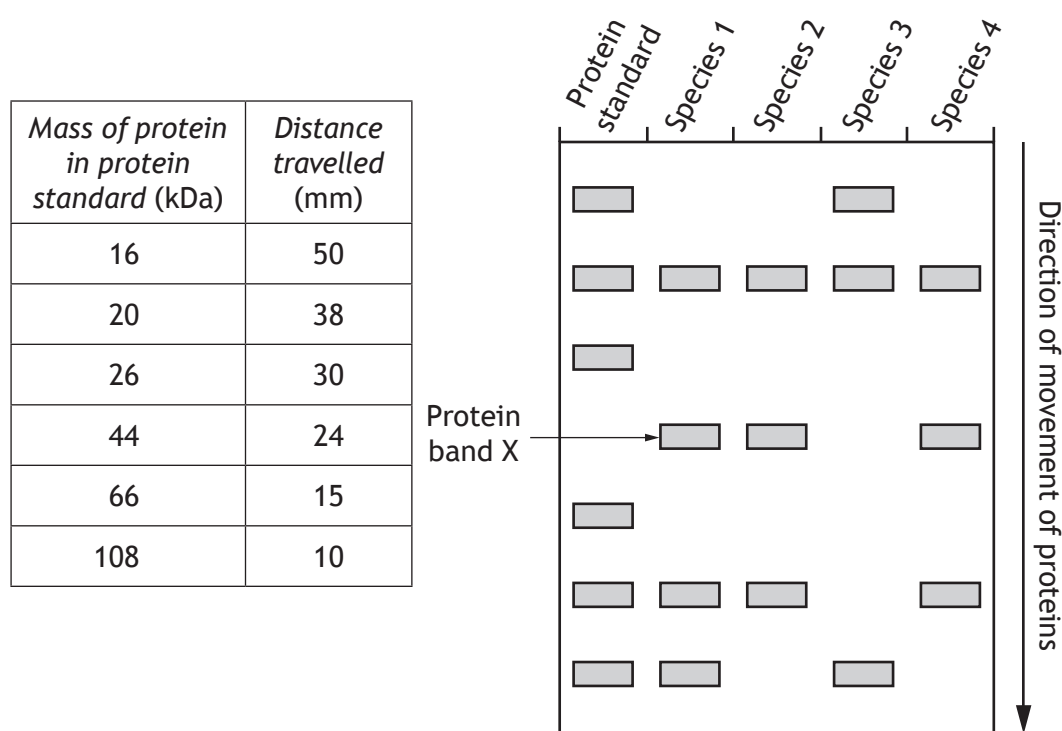
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10. An experiment was carried out to investigate the evolutionary relatedness of four species of fish by comparing proteins extracted from the fish. The more closely related species are, the more proteins they have in common.

A sample of muscle tissue from each species of fish was heated in a solution to extract proteins.

The protein extracts were analysed by gel electrophoresis which separates proteins according to their mass. A protein standard containing proteins of known masses was also analysed.

The results of the gel electrophoresis are shown in the diagram. Each band represents a protein.



- (a) (i) Identify **two** variables related to the protein extraction, not already mentioned, which should be kept constant so that a valid conclusion can be drawn. 2

1 \_\_\_\_\_  
 2 \_\_\_\_\_

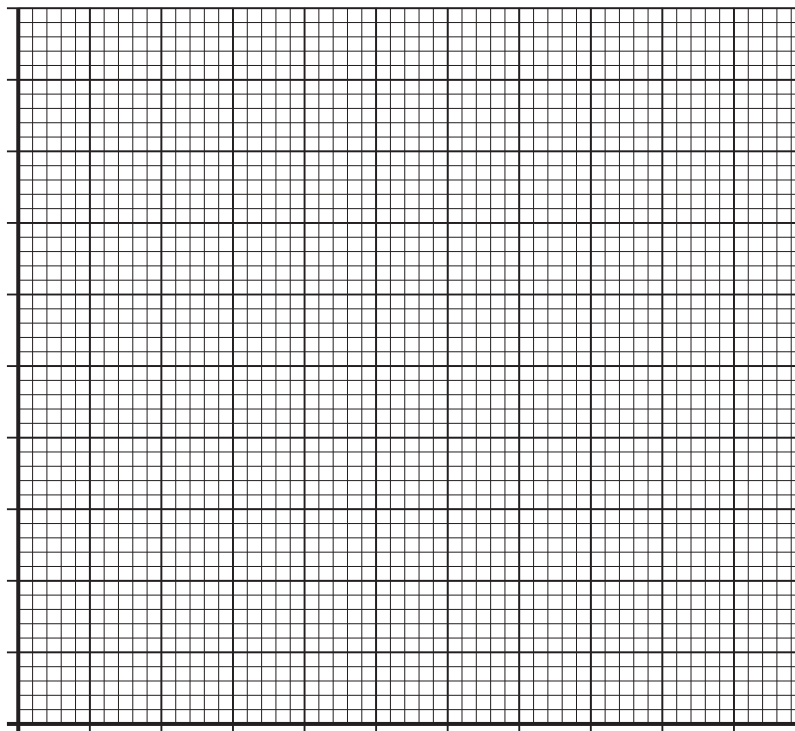
- (ii) During the preparation the samples were heated. This unfolds the proteins changing their three-dimensional shape.  
 Name one type of bond that could have been broken to cause this change. 1

\_\_\_\_\_



10. (continued)

- (b) (i) Draw a line graph to show the distance travelled by the protein bands in the gel against the mass of protein in the protein standard. 2  
 (Additional graph paper, if required, can be found on *page 33*)



Mass of protein in protein standard (kDa)

- (ii) Band X travelled 28 mm. Use the graph to identify the mass of the protein in band X. 1

\_\_\_\_\_ kDa

- (iii) Each species of fish contains a protein with a mass of 66 kDa. One amino acid has an average mass of 0.12 kDa. Calculate how many amino acids that would be expected in this protein. 1

*Space for calculation*

\_\_\_\_\_

- (iv) Explain why it was concluded that species 1, 2 and 4 are more closely related to each other than they are to species 3. 1

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 \_\_\_\_\_



MARKS

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11. Answer **either A or B**.

A Write notes on components of biodiversity and how these are measured.

4

OR

B Write notes on parasitic relationships and transmission of parasites.

4



\* X 7 0 7 7 6 0 1 2 6 \*

12. Congenital lactase deficiency in humans is caused by very low activity of the enzyme lactase, resulting in individuals being unable to digest lactose in milk. This is caused by a number of different mutations in the lactase gene.

(a) One of the mutations involved causes a frame-shift mutation in the lactase gene.

(i) Name a gene mutation which causes a frame-shift.

1

\_\_\_\_\_

(ii) Describe the effect of this frame-shift mutation on the lactase gene and on the structure of lactase.

2

Effect on lactase gene \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Effect on structure of lactase \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(b) (i) Some mutations occur in the sequences which regulate the transcription of the lactase gene.

Suggest why this may lead to more lactase enzyme being produced.

1

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(ii) Mutations in this gene are more common in Finland than in other parts of Europe. This is thought to be due to a small number of individuals who settled in Finland many generations ago.

State the term which describes this change in gene frequency when a small population of individuals breaks away from a larger population.

1

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\* X 7 0 7 7 6 0 1 2 7 \*

13. Scientists have used chemicals to produce polyploids to try to improve the characteristics of kiwi fruit plants.

The table shows some characteristics of fruit from the original diploid plant (2n) and two polyploids produced from it (4n and 6n).

Ploidy	Characteristics of fruit			
	Average fruit mass (g)	Average fruit length (mm)	Average fruit diameter (mm)	Vitamin C content (units)
2n	96.5	74.4	51.7	123.0
4n	115.8	76.1	60.0	119.0
6n	145.0	86.8	60.0	124.0

- (a) (i) State which characteristic is least affected by polyploidy. 1

\_\_\_\_\_

- (ii) Describe the relationship between ploidy and average fruit diameter. 2

\_\_\_\_\_  
 \_\_\_\_\_  
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- (b) Calculate the percentage increase in average fruit mass when the chromosome number is doubled. 1

*Space for calculation*

\_\_\_\_\_ %



MARKS

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13. (continued)

- (c) Describe the event that has occurred in the cells of the kiwi fruit plant that resulted in polyploidy.

1

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- (d) Polyploids have whole genome duplications.  
Explain the importance of this in evolution.

1

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\* X 7 0 7 7 6 0 1 2 9 \*

14. Answer **either A or B** in the space below and on *pages 31* and *32*.

**A** Write notes on DNA under the following headings.

- (i) Organisation of DNA in prokaryotic and eukaryotic cells; 4
- (ii) The polymerase chain reaction (PCR). 5

**OR**

**B** Write notes on RNA under the following headings.

- (i) Structure and functions of different types of RNA; 6
- (ii) RNA splicing. 3



\* X 7 0 7 7 6 0 1 3 0 \*



MARKS

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SPACE FOR ANSWERS

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MARKS

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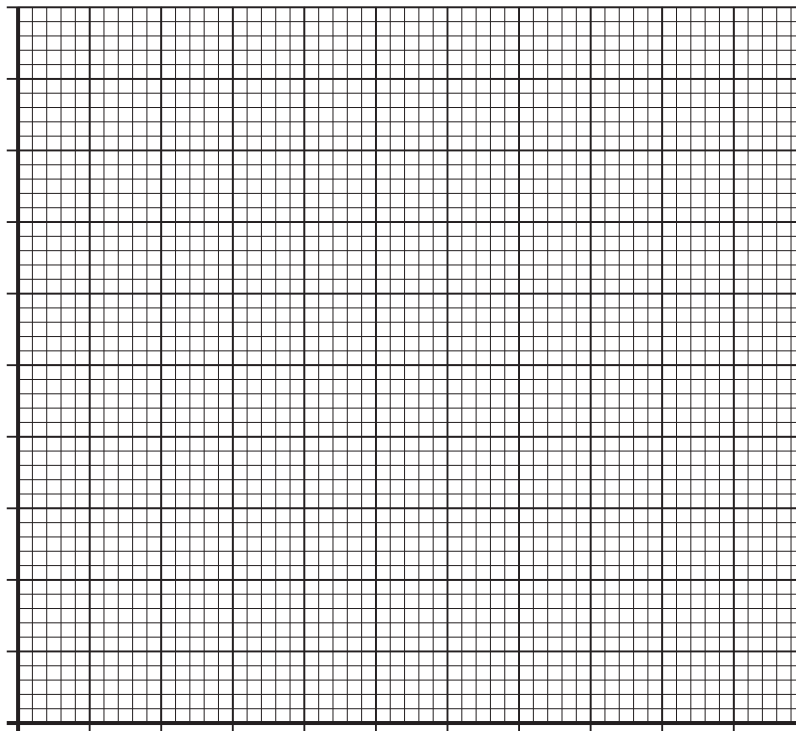
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MARKS

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 10 (b) (i)



Mass of protein in protein standard (kDa)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



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