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**EP04/H/02**

**Biology**  
**Section 1—Questions**

Date — Not applicable

Duration — 2 hours 30 minutes

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Instructions for the completion of Section 1 are given on *Page two* of your question and answer booklet EP04/H/01.

Record your answers on the answer grid on *Page three* of your question and answer booklet.

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



\* EP04H02 \*



**SECTION 1 — 20 marks**

**Attempt ALL questions**

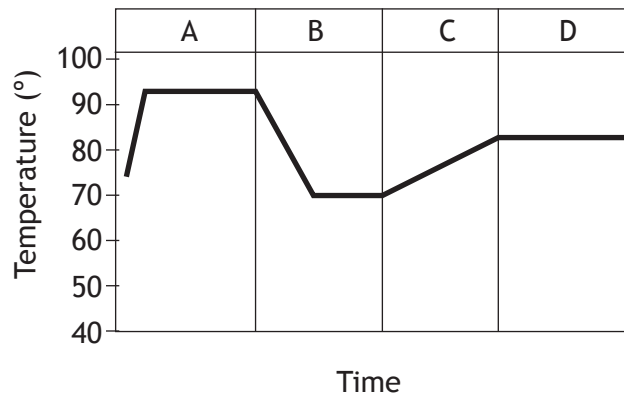
1. The statements below refer to DNA sequences in the chromosomes of eukaryotic species.

- 1 code for protein
- 2 regulate transcription
- 3 are transcribed but not translated

Which statements describe the DNA sequences which make up the genome?

- A 1 only
- B 1 and 2 only
- C 1 and 3 only
- D 1, 2 and 3

2. The graph below shows the temperature changes involved in one cycle of the polymerase chain reaction (PCR).



Which letter indicates when primers would bind to target sequences of DNA?

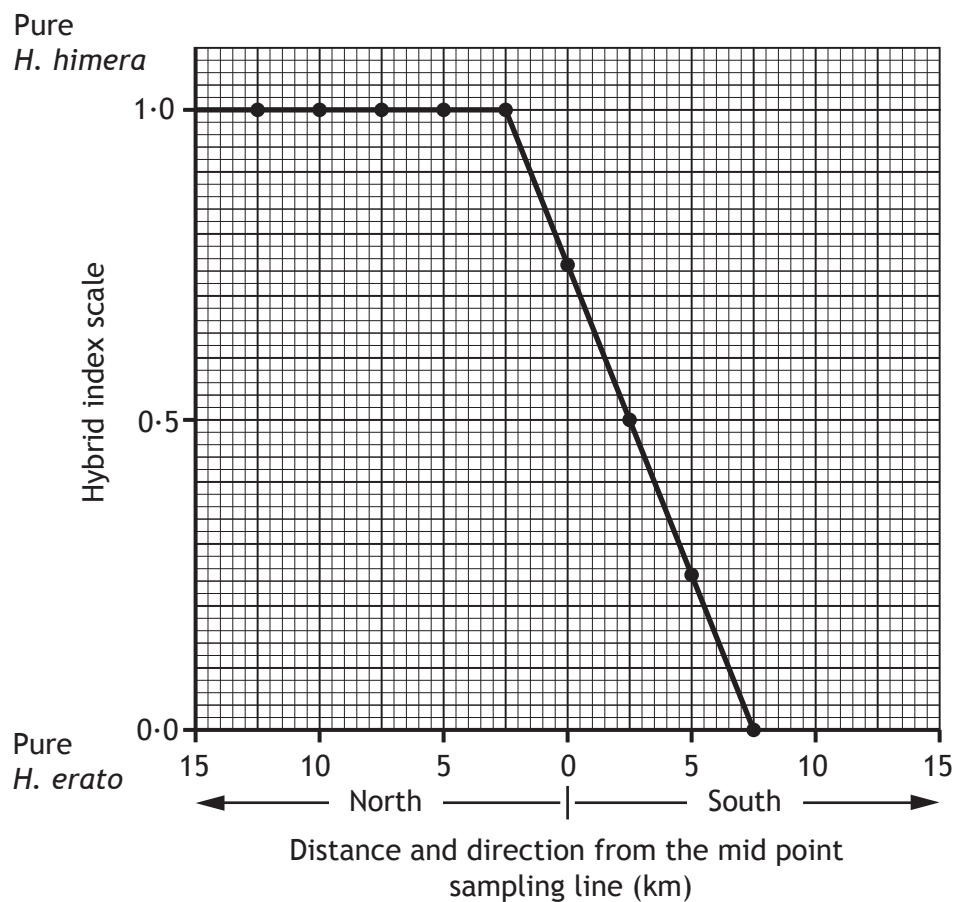
Questions 3 and 4 refer to the information and the graph below.

In Ecuador, populations of two species of butterfly, *Heliconius erato* and *Heliconius himera*, overlap and form a zone in which hybrid individuals are found.

Butterflies were collected from sites along a line extending north and south from a central point close to the middle of the hybrid zone. Each butterfly was scored on a scale from 0.0 to 1.0.

A score of 0.0 is pure *H. erato* and a score of 1.0 is pure *H. himera*. Values in between are hybrids.

The results are shown in the graph below.



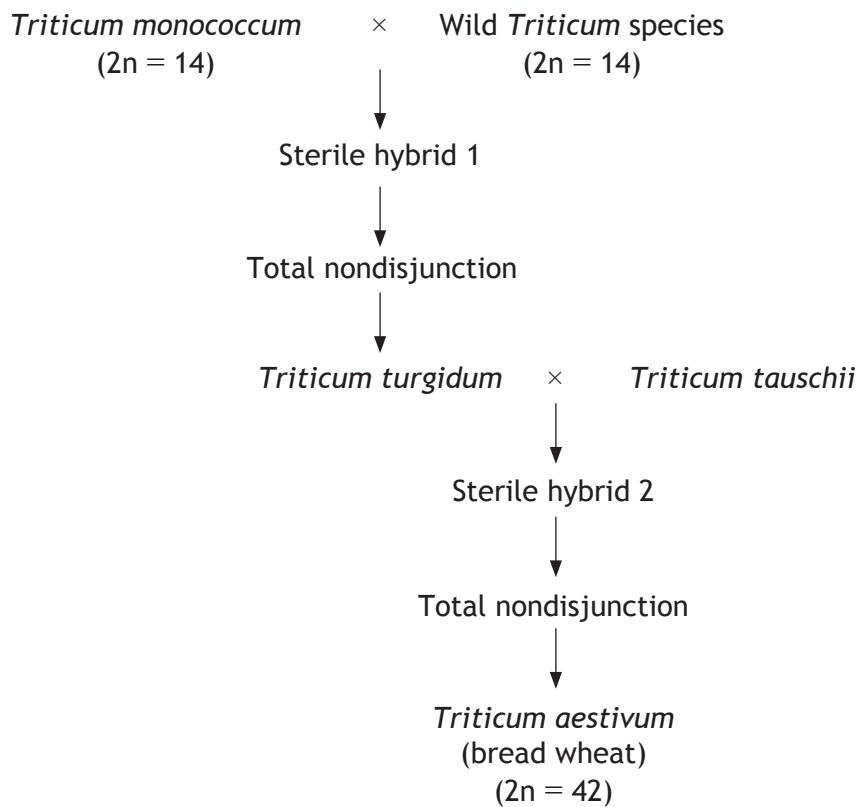
3. How wide is the zone in which hybrids were found?

- A 5.0 km
- B 7.5 km
- C 10.0 km
- D 12.5 km

4. Which line in the table below shows the distance and direction of a site at which hybrids with a score of 0.25 would be expected?

	<i>Distance (km)</i>	<i>Direction</i>
A	2.5	south
B	5.0	south
C	1.0	north
D	7.5	north

5. The diagram below represents stages in the evolution of *Triticum aestivum* (bread wheat). The diploid chromosome numbers of some species involved are given.



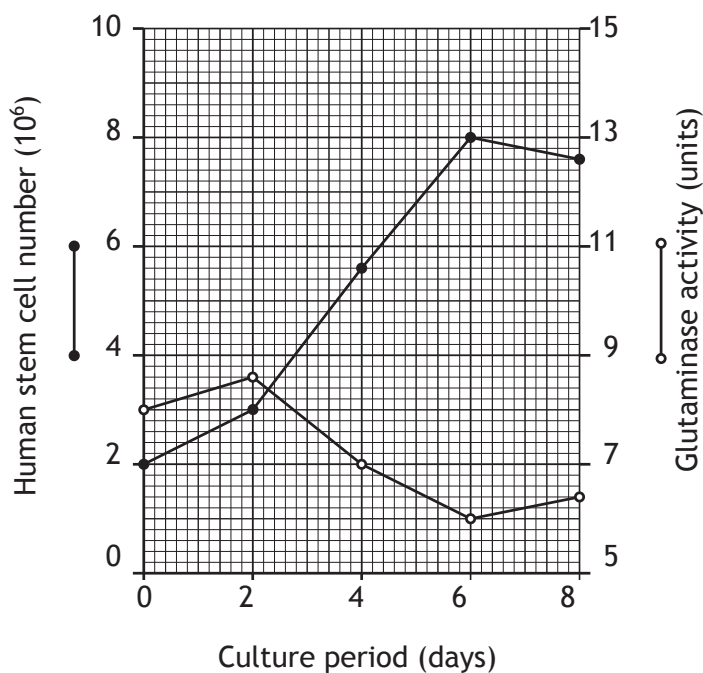
Which line in the table below indicates the diploid chromosome numbers of *Triticum turgidum* and *Triticum tauschii*?

	<i>Triticum turgidum</i>	<i>Triticum tauschii</i>
A	14	14
B	28	28
C	14	28
D	28	14

6. Genetic drift is a change in gene frequency, particularly in small populations. Which of the following is true of genetic drift?

- A It is random and influenced by the founder effect.
- B It is non-random and influenced by the founder effect.
- C It is random and influenced by natural selection.
- D It is non-random and influenced by natural selection.

7. The graph below shows the changes in the number of human stem cells in a culture. The activity of the enzyme glutaminase present in the cells over an eight-day period is also shown.



How many units of glutaminase activity were recorded when the cell number was 50% of its maximum over the eight-day period?

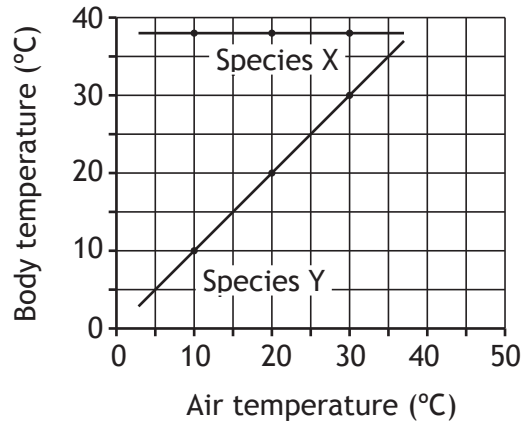
- A 3
- B 4
- C 8
- D 9

8. Which line in the table below shows the roles of proteins embedded in phospholipid membranes?

	<i>Roles of protein</i>		
	<i>enzymes</i>	<i>pores</i>	<i>pumps</i>
A	✓	✗	✗
B	✗	✓	✓
C	✗	✗	✓
D	✓	✓	✓

9. An inhibitor of an enzyme-catalysed reaction can be described as competitive if
- A its effect is decreased by raising substrate concentrations
  - B it is the final product in a metabolic pathway
  - C it switches off the gene encoding the enzyme
  - D it permanently changes the shape of the active site.

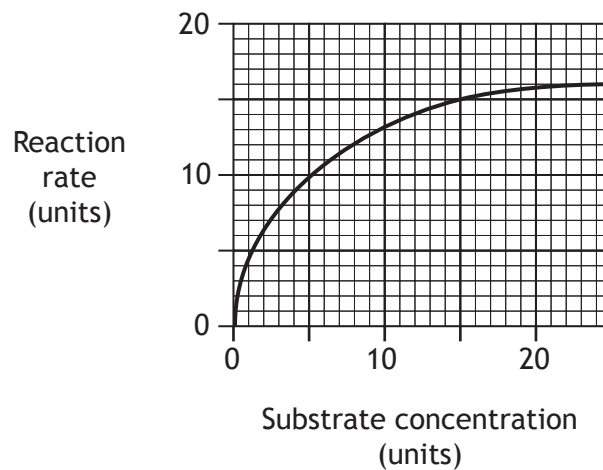
10. The graph below shows the relationship between air temperature and the body temperature of two animal species, X and Y.



Which line in the table below describes species X and Y?

	<i>Species X</i>	<i>Species Y</i>
A	regulator	regulator
B	regulator	conformer
C	conformer	regulator
D	conformer	conformer

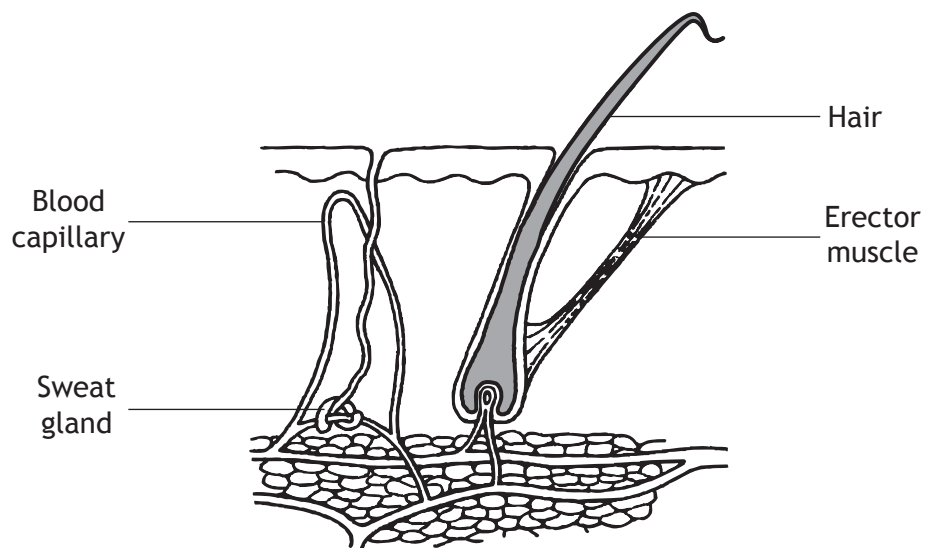
11. The graph below shows the effect of substrate concentration on the rate of an enzyme-catalysed reaction.



At which substrate concentration is the reaction rate equal to 75% of the maximum rate?

- A 5 units
- B 8 units
- C 12 units
- D 15 units

12. The diagram below shows a section through the skin of a mammal.

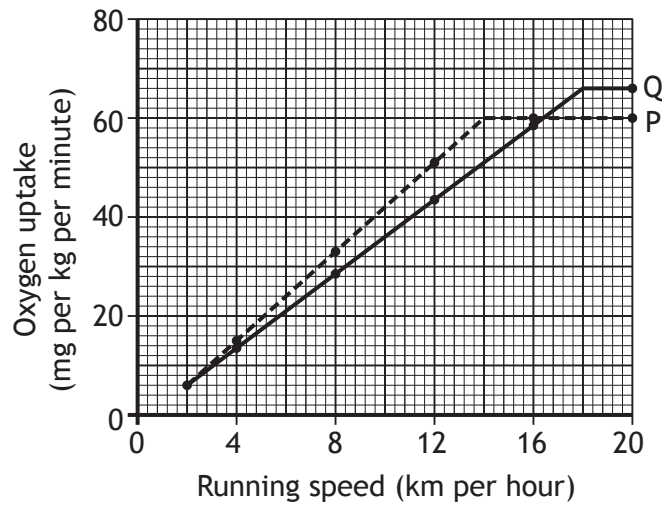


Which line in the table below identifies the state of the erector muscle and the change in blood flow in the capillary which would be expected if the skin was exposed to low temperature?

	<i>State of erector muscle</i>	<i>Change in blood flow in capillary</i>
A	contracted	increase
B	contracted	decrease
C	relaxed	increase
D	relaxed	decrease



13. The graph below shows how running speed affected the oxygen uptake of two athletes, P and Q.



Which line in the table below shows the fittest athlete based on the information in the graph?

	<i>Athlete</i>	<i>Reason for conclusion</i>
A	P	reached their maximum running speed sooner
B	P	reached their maximum oxygen uptake sooner
C	Q	had a higher running speed than P
D	Q	had a higher maximum oxygen uptake than P

14. The gene encoding a protein was removed from the human genome and transferred into two different recipient cells by different methods as shown in the table below.

<i>Recipient cells</i>	<i>Method of transfer</i>
bacteria	bacterial plasmid
yeast	artificial chromosome

The protein was functional **only** when produced in yeast cells.

The most likely reason for this was because the

- A bacterial plasmids did not contain marker genes
- B protein produced in bacteria had an incorrect amino acid sequence
- C bacterial plasmids did not contain self-replication genes
- D protein produced in bacteria was not folded correctly.

15. The following statements refer to photosynthesis.

- 1 Carbon dioxide is fixed by RuBisCO.
- 2 Sugar molecules are combined to form starch.
- 3 G3P is used to regenerate RuBP.

Which of the statements refer to the Calvin cycle?

- A 1 and 2 only
- B 1 and 3 only
- C 2 and 3 only
- D 1, 2 and 3

16. The harvest index of a crop is calculated by dividing the dry mass of the

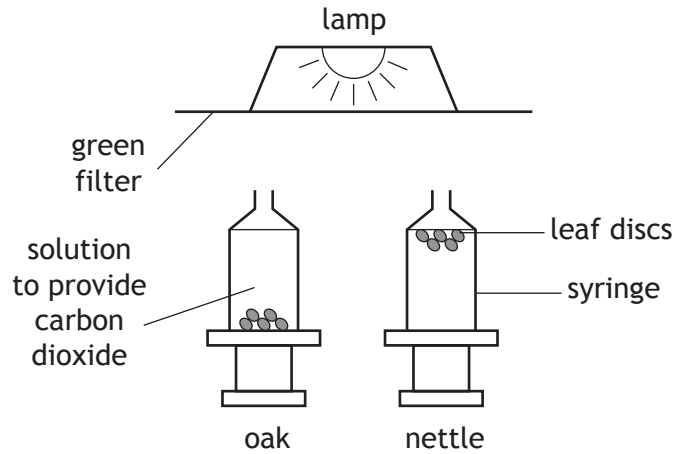
- A economic yield by the net assimilation
- B biological yield by the net assimilation
- C economic yield by the dry mass of the biological yield
- D biological yield by the dry mass of the economic yield.

17. The reason for replicating treatments during plant field trials is to

- A develop improved plant varieties
- B ensure fair comparisons between treatments
- C take into account variability within the plants being grown
- D eliminate bias when measuring the effects of treatments on growth.

18. An investigation was carried out to compare photosynthesis in green light by oak and nettle leaves. Five leaf discs were cut from each plant and placed in syringes containing a solution to provide carbon dioxide.

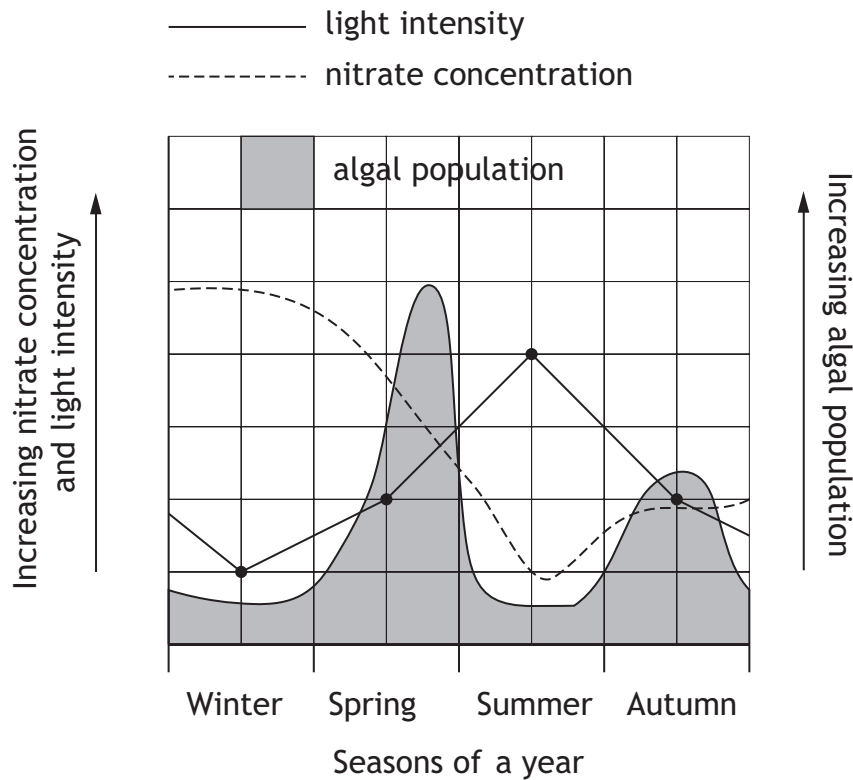
The diagram below shows the positions of the leaf discs after one hour.



How could the experiment be improved to allow valid conclusions to be drawn?

- A Carry out the experiment in a darkened room.
  - B Use different species of plant.
  - C Use more leaf discs.
  - D Repeat the experiment.
19. Which of the following describes the effect of the emergence of a dominant heather species on a moorland plant community?
- A Lowers species diversity and lowers relative abundance of the dominant heather.
  - B Raises species diversity and raises relative abundance of the dominant heather.
  - C Lowers species diversity and raises relative abundance of the dominant heather.
  - D Raises species diversity and lowers relative abundance of the dominant heather.

20. The graph below shows how the population of algae in a fresh water loch was affected by the concentration of nitrate ions in the loch water and by light intensity through the seasons of a year.



Which of the following statements can be deduced from the graph?

- A The increase in algal population in spring is triggered by an increase in concentration of nitrate ions in the water.
- B The size of the algal population depends directly on the level of light intensity.
- C The increase in nitrate ion concentration in late summer is followed by an increase in algal population.
- D The algal population decreases when light intensity decreases.

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]**

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Mark

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**EP04/H/01**

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

Date — Not applicable

Duration — 2 hours and 30 minutes



Fill in these boxes and read what is printed below.

Full name of centre

--

Town

--

Forename(s)

--

Surname

--

Number of seat

--

Date of birth

Day

Month

Year

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Scottish candidate number

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**Total marks — 100**

**SECTION 1 — 20 marks**

Attempt ALL questions.

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

**SECTION 2 — 80 marks**

Attempt ALL questions.

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.



The questions for Section 1 are contained in the question paper EP04/H/02.  
Read these and record your answers on the answer grid on *Page three* opposite.  
Do NOT use gel pens.

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"/>



SECTION 2 — 80 marks

Attempt ALL questions

It should be noted that questions 5 and 13 contain a choice.

1. DNA and RNA molecules are found in the cells of both eukaryotes and prokaryotes. DNA molecules are double-stranded whereas RNA molecules are single-stranded.

(a) (i) Give **two** other structural differences between DNA and RNA molecules. 2

1 \_\_\_\_\_  
 \_\_\_\_\_

2 \_\_\_\_\_  
 \_\_\_\_\_

(ii) Describe the function of RNA polymerase in the synthesis of a primary transcript. 2

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

(iii) In eukaryotic cells mRNA is spliced after transcription. Describe what happens during RNA splicing. 1

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

(iv) Describe the role of mRNA in cells. 1

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

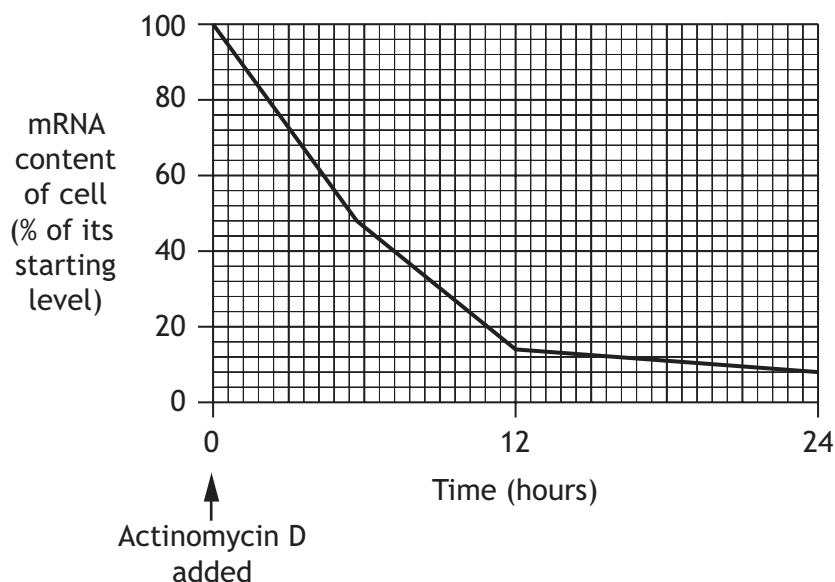




1. (continued)

- (b) Actinomycin D is an antibiotic which binds to DNA in cells of both eukaryotes and prokaryotes and inhibits transcription.

The graph below shows changes in the mRNA content of a cell over a 24-hour period after actinomycin D was added.



- (i) State the time taken for the mRNA content of the cell to drop by 70% of its starting level. 1

\_\_\_\_\_ hours

- (ii) Explain why actinomycin D would not be suitable in the treatment of bacterial infections in humans. 2

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2. Sickle cell anaemia is a genetic disorder in which red blood cells contain the protein haemoglobin S instead of normal haemoglobin. The DNA sequence in the allele for haemoglobin S carries a mutation.

The table below shows some mRNA codons and the abbreviations for the amino acids they code for.

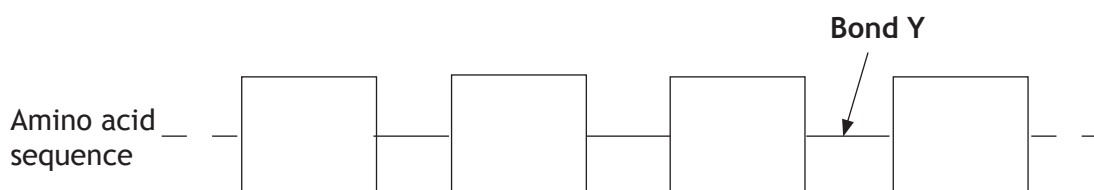
<i>mRNA codon</i>	<i>Abbreviation for amino acid coded for</i>
GUA	val
CUU	leu
AGA	ser
CAU	his
UGA	thr
GAA	glu
GGA	pro

The diagram below shows sections of the DNA sequences that code for normal haemoglobin and for haemoglobin S.

Section of DNA coding for normal haemoglobin      - - - - ACTCATCCTCCT - - - -

Section of DNA coding for **haemoglobin S**      - - - - ACTCTTCCTCCT - - - -

- (a) Use abbreviations from the table to complete the boxes in the diagram below to show the amino acid sequence in the section of **haemoglobin S** given. 1



- (b) Name the type of mutation which has led to the production of haemoglobin S. 1

\_\_\_\_\_



2. (continued)

MARKS

DO NOT  
WRITE IN  
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MARGIN

(c) (i) Name **Bond Y** in the diagram which holds amino acids together.

1

\_\_\_\_\_

(ii) The chains of amino acids are folded to give proteins their three-dimensional shape.

Name **one** bond or interaction which holds the chain in its three-dimensional shape.

1

\_\_\_\_\_

(iii) Explain why the change in the base sequence in **haemoglobin S** leads to a failure of the protein to function normally.

1

\_\_\_\_\_

\_\_\_\_\_



\* E P O 4 H O 1 0 7 \*



3. Different varieties of banana can have different numbers of chromosome sets in their cells. Banana flesh contains carotenoids and different varieties have different carotenoid contents. Extracts of five different varieties of banana were placed in a colorimeter to measure the transmission of light through them. The darker the flesh the lower the percentage of light transmitted.

The results are shown in the table below.

Banana variety	Number of sets of chromosomes	Carotenoid content (mg per kg banana flesh)	Light transmitted through extract (%)
Tuugia	2 (diploid)	1.6	82
Khai	2 (diploid)	9.4	64
Figo Cinza	3 (triploid)	2.8	72
Saney	3 (triploid)	19.2	52
Porp	4 (tetraploid)	2.2	76

- (a) Describe the relationship between carotenoid content and darkness of flesh. 1

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- (b) (i) Calculate, as the simplest whole number ratio, the average carotenoid content of the diploid to that of the triploid varieties. 1

*Space for calculation*

$\frac{\quad}{\text{diploid}} : \frac{\quad}{\text{triploid}}$

- (ii) It has been suggested that additional carotenoid content in the diet gives humans increased protection against certain cancers.

Calculate the mass of carotenoid which would be found in a 125 g sample of Figo Cinza flesh. 1

*Space for calculation*

\_\_\_\_\_ mg



## 3. (b) (continued)

- (iii) Using the information given, decide if the statement in the table below is true or false.

Complete the table by selecting *True (T)* or *False (F)* and give a reason for your answer.

1

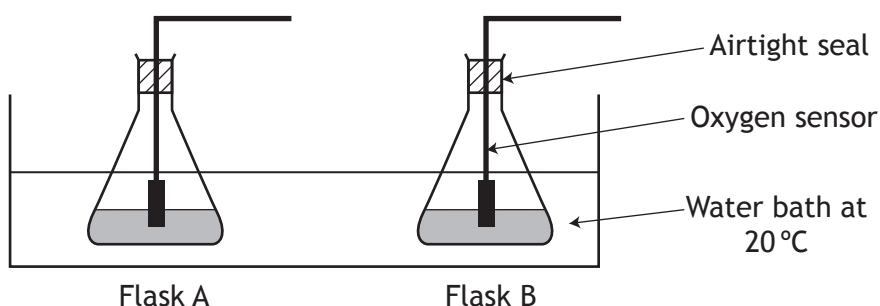
<i>Statement</i>	Banana varieties with increased numbers of chromosome sets have increased carotenoid content in their cells.
<i>True (T) or False (F)</i>	
<i>Reason</i>	



4. In an investigation into the effect of lead ion concentration on respiration in yeast, two flasks were set up as described below.

Flask	Content
A	200 cm <sup>3</sup> glucose solution + 5 cm <sup>3</sup> 0.2% lead nitrate
B	200 cm <sup>3</sup> glucose solution + 5 cm <sup>3</sup> 1.0% lead nitrate

The flasks were placed in a water bath at 20°C for 10 minutes. After this time 2.5 cm<sup>3</sup> of yeast suspension was added to each and oxygen sensors fitted as shown in the diagram below.



The flasks were left for a further 10 minutes and then oxygen concentration was measured in each flask every 20 seconds for 2 minutes.

The results are shown in the table below.

Time (s)	Oxygen concentration (mg per litre)	
	Flask A 0.2% lead nitrate	Flask B 1.0% lead nitrate
0	10.2	10.8
20	8.4	9.3
40	6.1	7.6
60	3.8	6.2
80	1.7	5.1
100	0.2	4.0
120	0.0	3.2

- (a) (i) Identify the independent variable in this investigation. 1
- \_\_\_\_\_
- (ii) Identify **one** variable, not already mentioned, which would have to be kept constant so that valid conclusions could be drawn. 1
- \_\_\_\_\_

4. (a) (continued)

(iii) Explain why the flasks were left for 10 minutes before the yeast suspension was added.

1

\_\_\_\_\_

(iv) Explain why the flasks were left for a **further** 10 minutes **after** the yeast suspensions were added before measurements of oxygen concentrations were taken.

1

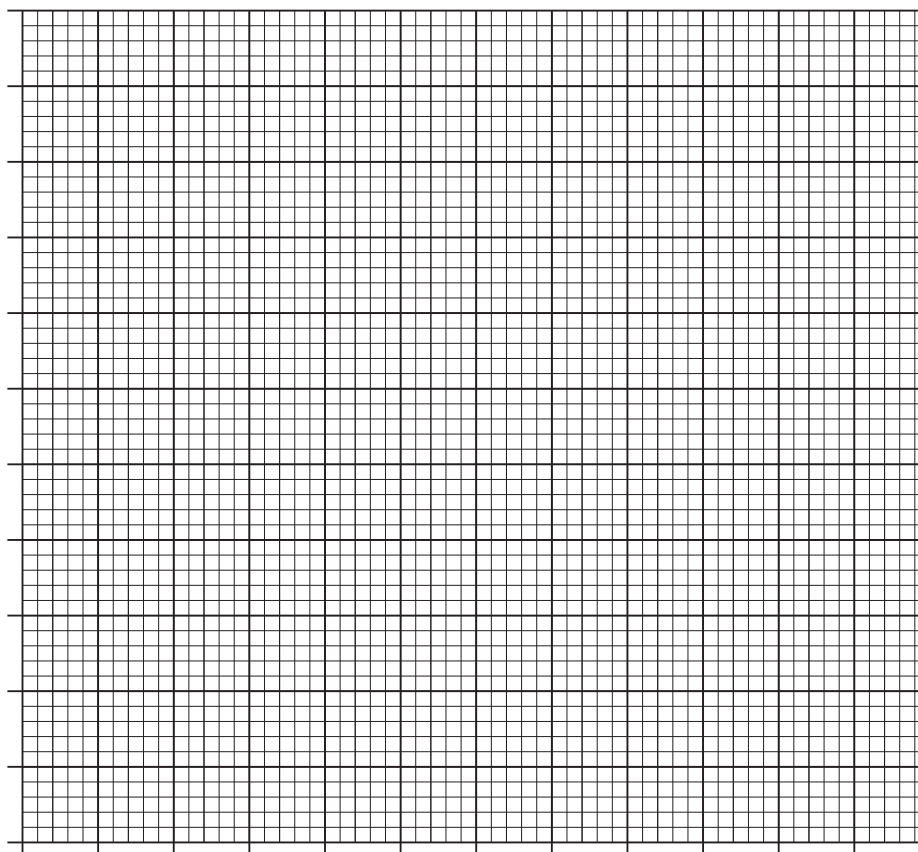
\_\_\_\_\_

\_\_\_\_\_

(b) On the grid below, draw a line graph to show the oxygen concentration in **Flask A** against time. Use an appropriate scale to fill most of the grid.

(Additional graph paper, if required, will be found on *Page twenty-six*).

2



4. (continued)

- (c) Using information from the table, state the effect of increasing lead ion concentration on the aerobic respiration of yeast.

1

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- (d) Bubbles of carbon dioxide appeared in both flasks throughout the investigation.

Explain why this gas continued to be produced in **Flask A** after 120 seconds.

1

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\* E P O 4 H O 1 1 2 \*



MARKS

5

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5. Answer either A or B.

A Discuss altruism and kin selection.

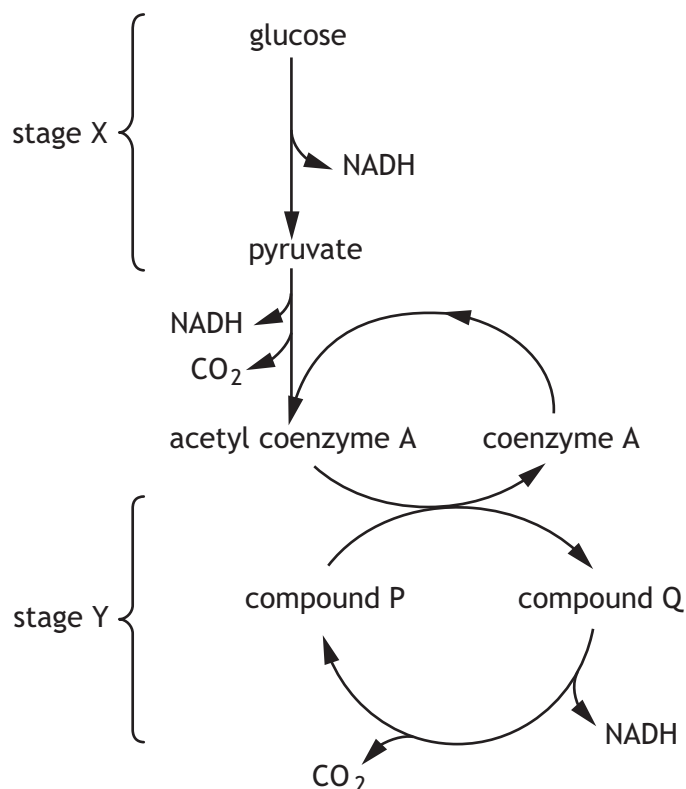
OR

B Discuss measuring biodiversity.



\* E P O 4 H O 1 1 3 \*

6. The diagram below shows parts of two stages in the aerobic respiration of glucose.



(a) Name stage X. 1

X \_\_\_\_\_

(b) Name compounds P and Q. 1

P \_\_\_\_\_

Q \_\_\_\_\_ 1

(c) Describe the role of the dehydrogenase enzymes in stages X and Y. 2

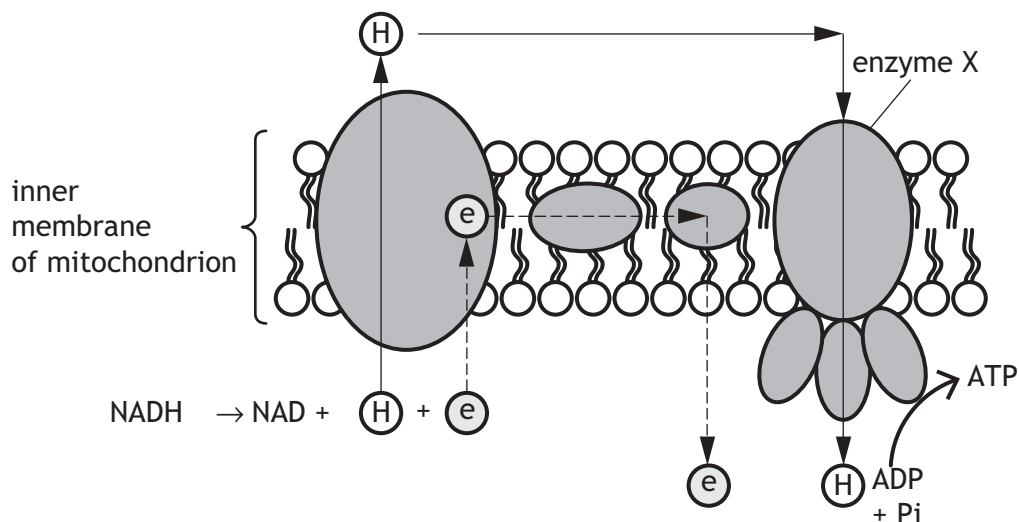
\_\_\_\_\_  
\_\_\_\_\_



6. (continued)

(d) The diagram below shows part of the electron transport chain attached to the inner membrane of a mitochondrion.

- protein
- Ⓜ hydrogen ion
- Ⓜ high energy electron



- (i) In this system, hydrogen ions are pumped across the inner mitochondrial membrane as shown in the diagram.  
State the source of energy required for this process. 1

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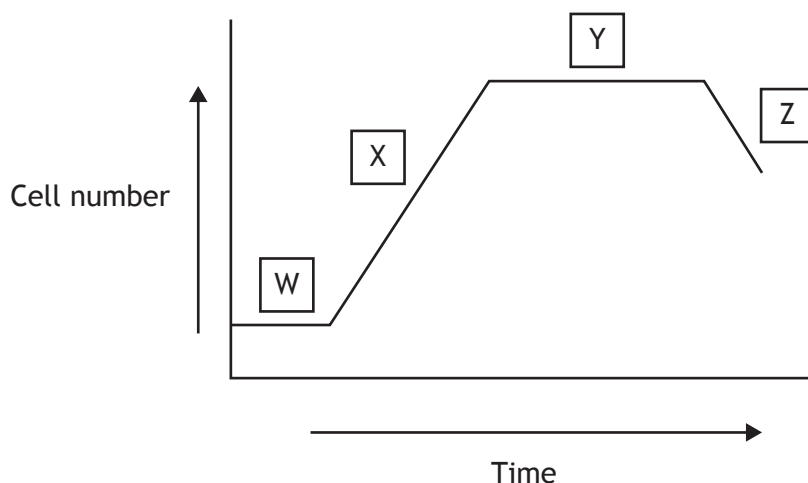
- (ii) The return flow of hydrogen ions drives enzyme X which results in the production of ATP.  
Name enzyme X. 1

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- (iii) State the role of oxygen in the electron transport chain. 1

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7. A growth curve in a culture of bacteria is shown in the diagram below.



(a) In culturing bacteria it is important to control the pH of the culture medium.

Describe how the pH of a culture medium can be controlled.

1

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(b) (i) Name phases of growth W and X indicated on the graph.

2

W \_\_\_\_\_

X \_\_\_\_\_

(ii) State the letter which indicates a region of the graph in which most enzymes are being induced to metabolise the available substrate.

1

Letter \_\_\_\_\_

(iii) State **one** reason for the decrease in number of cells at phase Z.

1

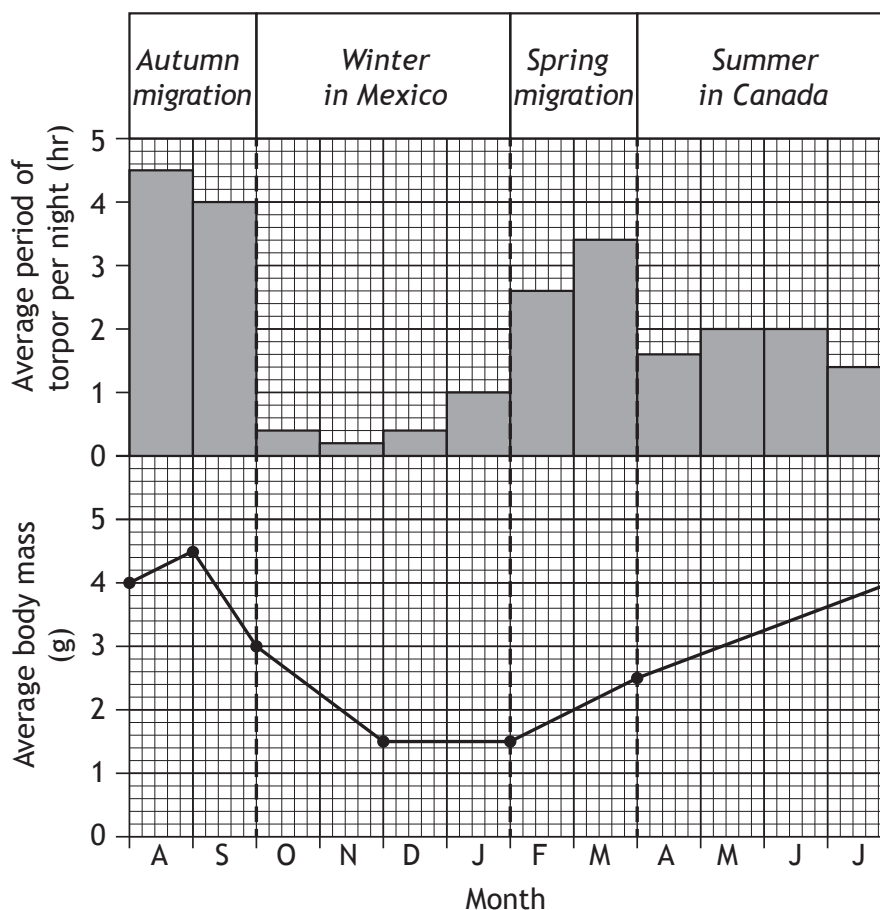
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8. Rufous hummingbirds migrate thousands of kilometres each year between their summer breeding areas in Canada and their wintering areas in Mexico.

They feed on nectar throughout the year and save energy at night by entering a temporary state known as torpor in which body temperature and respiration rate are greatly reduced.

The chart below shows the average body mass of the hummingbirds and the average number of hours per night spent in torpor throughout the year.



(a) (i) Use values from the chart to describe the changes in average body mass of the hummingbirds from the beginning of August until the end of November. 2

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(ii) Calculate the percentage increase in average body mass of the hummingbirds during the summer in Canada. 1

*Space for calculation*

\_\_\_\_\_ %



\* E P O 4 H O 1 1 7 \*

8. (a) (continued)

- (iii) Suggest **one** reason for the increase in body mass of the hummingbirds during the summer in Canada.

1

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- (b) (i) Suggest why the increased time spent in torpor during migration is an advantage to the hummingbirds.

1

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- (ii) Calculate the average period of torpor per month of the hummingbirds throughout the winter in Mexico.

1

*Space for calculation*

\_\_\_\_\_ hours per night

- (c) The table below shows how the average oxygen consumption of the hummingbirds at rest is affected by their body temperature.

<i>Body temperature</i>	<i>Average oxygen consumption at rest (cm<sup>3</sup> per gram of body mass per hour)</i>
Normal	15.0
Lowered during torpor	2.0

Using information from the **chart** and the **table**, calculate the average volume of oxygen consumed per hour by a hummingbird at the end of September at normal body temperature.

1

*Space for calculation*

\_\_\_\_\_ cm<sup>3</sup>

- (d) Describe a technique which could be used to track species such as the rufous hummingbird which undertake long distance migration.

1

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9. Nettles are shade plants which often grow below trees. Their leaves contain photosynthetic pigments X and Y. The table below shows the percentage of light of different wavelengths absorbed by these pigments.

Wavelength of light (nm)	Colour of light	Light absorbed (%)	
		Pigment X	Pigment Y
400	violet	40	20
440	blue	60	30
550	green	5	60
680	red	50	5

(a) State what else can happen to light striking the leaves of plants, apart from it being absorbed. 1

\_\_\_\_\_

(b) Identify which of the pigments, X or Y, in the table is chlorophyll. Explain your choice. 1

Pigment \_\_\_\_\_

Explanation \_\_\_\_\_

\_\_\_\_\_

(c) (i) Describe the relationship between the wavelength of light and the percentage of light absorbed by pigment Y. 2

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

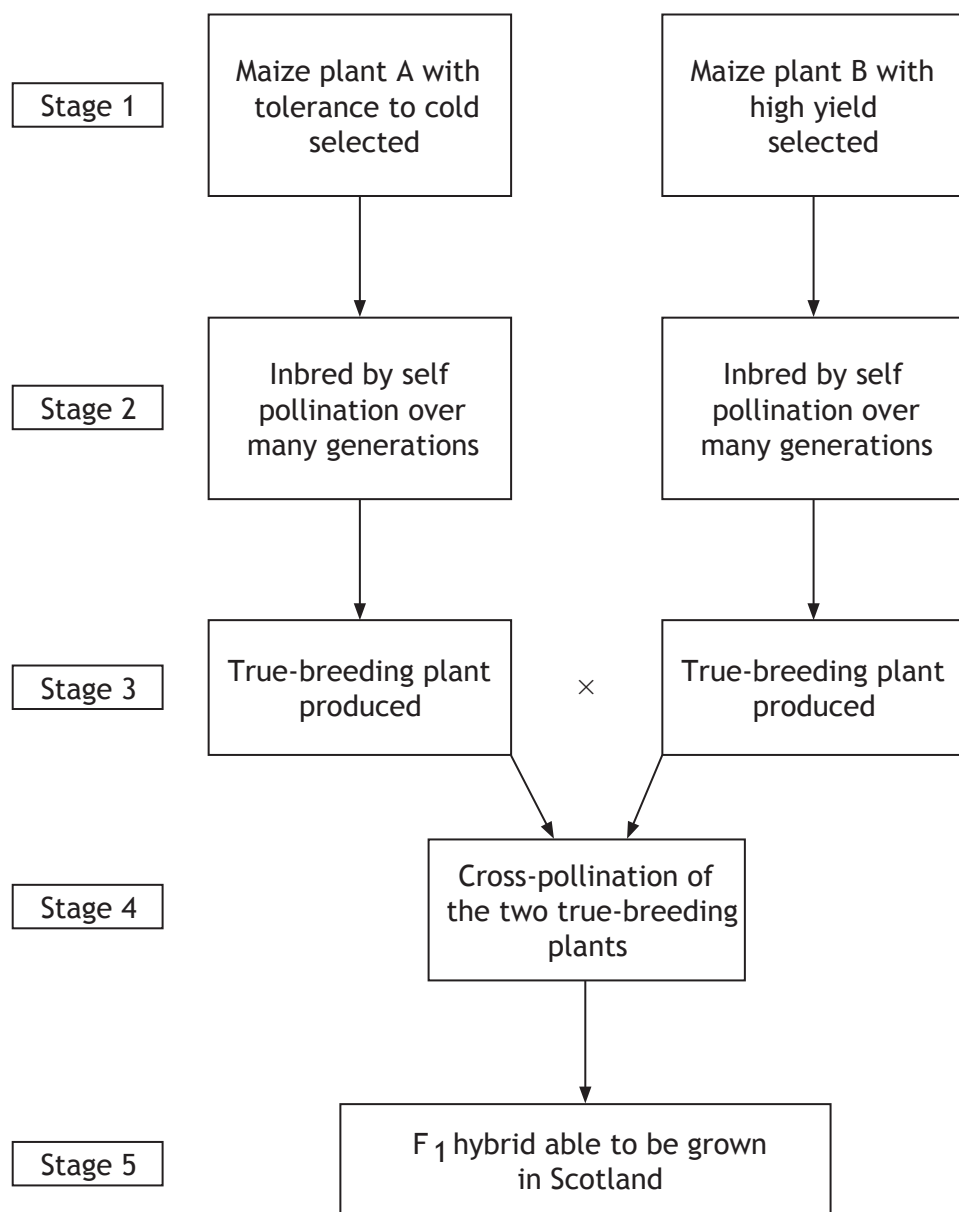
(ii) Describe how the presence of pigment Y in their leaves would benefit nettle plants growing below trees. 1

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



10. Maize is a naturally self-pollinating crop plant native to the warmer areas of the USA.

An outline of the stages in the breeding of a hybrid plant with high yield which can be grown in the colder environment of Scotland is shown below.



(a) Explain why inbreeding depression would be unlikely to occur during Stage 2.

1

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10. (continued)

- (b) Identify the test cross that the breeder should carry out to confirm that the Stage 3 plants were true-breeding.

Tick (✓) the correct box.

1

<i>Test cross</i>	<i>Tick (✓)</i>
Stage 3 plant crossed with a heterozygous plant.	
Stage 3 plant crossed with a homozygous dominant plant.	
Stage 3 plant crossed with a homozygous recessive plant.	

- (c) State **one** characteristic of the  $F_1$  hybrid at Stage 5 that would be beneficial to the breeder.

1

\_\_\_\_\_

- (d) The  $F_1$  hybrids can be grown in Scotland and can be crossed with each other to produce an  $F_2$  generation.

- (i) Describe why some  $F_2$  plants produced from this cross may not grow successfully in Scotland.

1

\_\_\_\_\_

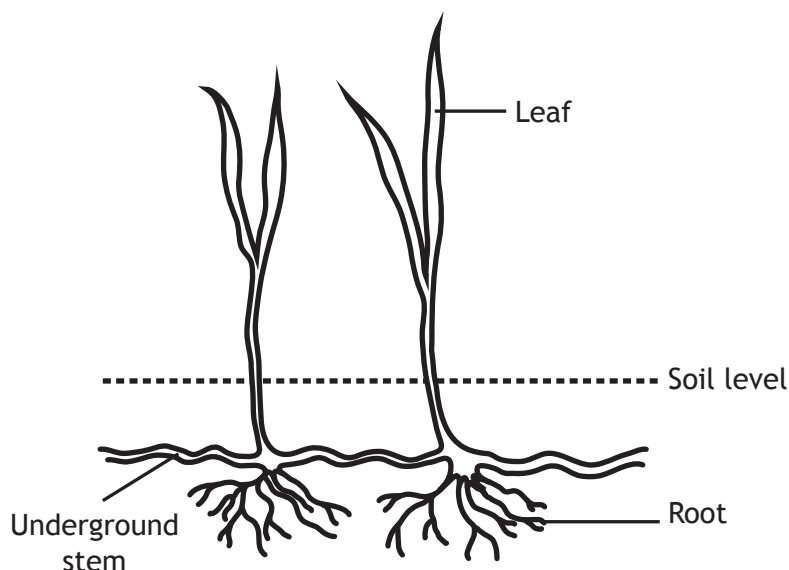
- (ii) Give an advantage to breeders of producing an  $F_2$  generation in this case.

1

\_\_\_\_\_



11. African couch grass is a weed which spreads rapidly from branching underground stems as shown in the diagram below. If the plant's leaves are damaged, new leaves can grow from the underground stems.



(a) State if this is a perennial or an annual weed. 1

Give a reason for your answer. 1

Tick (✓) the correct box.

perennial

annual

Reason \_\_\_\_\_

(b) (i) Explain why herbicide used in the control of this weed should be systemic. 1

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

(ii) Give **one** disadvantage of using chemical herbicide. 1

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



\* E P O 4 H O 1 2 2 \*

**MARKS**

DO NOT  
WRITE IN  
THIS  
MARGIN

**11. (continued)**

- (c) (i) Introducing non-native insects which eat African couch grass has been suggested as a biological control.

Suggest a possible risk associated with using a biological control method such as this.

**1**

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- (ii) Describe what is meant by the term integrated pest management.

**1**

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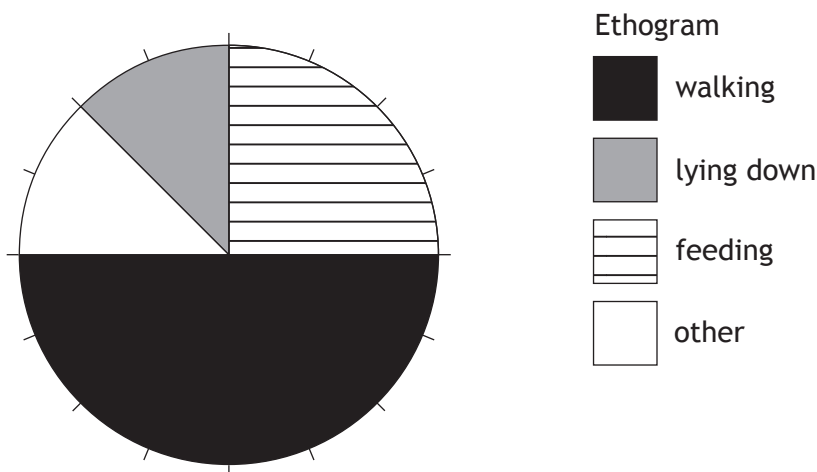
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\* E P O 4 H 0 1 2 3 \*

12. In an investigation, the behaviour of a group of pigs in an enclosure was observed.

Each pig's behaviour was observed initially and then every 10 seconds for 20 minutes. The behaviours observed were allocated to different categories and the results shown in the pie chart below.



(a) Calculate how long the pigs spent feeding.

1

*Space for calculation*

\_\_\_\_\_ minutes

(b) Express as the simplest whole number ratio the proportion of time spent walking, lying down and feeding.

1

*Space for calculation*

\_\_\_\_\_ walking : \_\_\_\_\_ lying down : \_\_\_\_\_ feeding

(c) Suggest **one** improvement which could be made to this investigation to improve the reliability of the results.

1

\_\_\_\_\_

\_\_\_\_\_

(d) Give **one example** of a type of behaviour which could indicate poor welfare of the pigs.

1

\_\_\_\_\_

\_\_\_\_\_



**MARKS**

DO NOT  
WRITE IN  
THIS  
MARGIN

13. Answer either A or B.

**A** Discuss stem cells under the following headings.

(i) Differentiation of stem cells

6

(ii) Therapeutic use of stem cells

2

**OR**

**B** Discuss genomics under the following headings.

(i) Genomic sequencing

2

(ii) Phylogenetics and molecular clocks

6

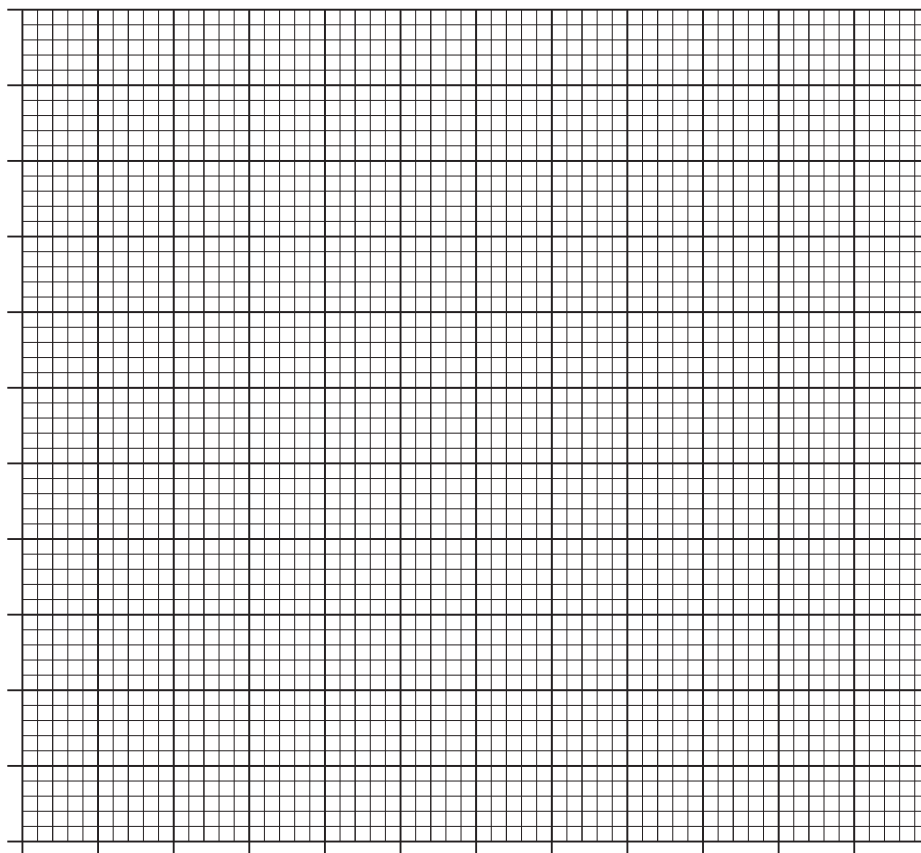
[END OF EXEMPLAR QUESTION PAPER]



\* E P O 4 H O 1 2 5 \*

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

ADDITIONAL GRAPH PAPER FOR QUESTION 4(b)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



\* E P O 4 H O 1 2 7 \*

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



\* E P 0 4 H 0 1 2 8 \*





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EP04/H/01

Biology

## Marking Instructions

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These Marking Instructions have been provided to show how SQA would mark this Exemplar Question Paper.

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## General Marking Principles for Biology Higher

*This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the Detailed Marking Instructions, which identify the key features required in candidate responses.*

- a) Marks for each candidate response must always be assigned in line with these General Marking Principles and the Detailed Marking Instructions for this assessment.
- b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.
- c) Half marks may not be awarded.
- d) Where a candidate makes an error at an early stage in a multi-stage calculation, credit should normally be given for correct follow-on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. The same principle should be applied in questions which require several stages of non-mathematical reasoning.
- e) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units if required) on its own.
- f) Larger mark allocations may be fully accessed whether responses are provided in continuous prose, linked statements or a series of discrete developed points.
- g) In the Detailed Marking Instructions, if a word is underlined then it is essential; if a word is **(bracketed)** then it is not essential.
- h) In the Detailed Marking Instructions, words separated by / are alternatives.
- i) If two answers are given where one is correct and the other is incorrect, no marks are awarded.
- j) Where the candidate is instructed to choose one question to answer but instead answers both questions, both responses should be marked and the better mark awarded.
- k) The assessment is of skills, knowledge and understanding in Biology, so marks should be awarded for a valid response, even if the response is not presented in the format expected. For example, if the response is correct but is not presented in the table as requested, or if it is circled rather than underlined as requested, give the mark.
- l) Unless otherwise required by the question, use of abbreviations (eg DNA, ATP) or chemical formulae (eg CO<sub>2</sub>, H<sub>2</sub>O) are acceptable alternatives to naming.
- m) Content that is outwith the Course Assessment Specification should be given credit if used appropriately, eg metaphase of meiosis.
- n) If a numerical answer is required and units are not given in the stem of the question or in the answer space, candidates must supply the units to gain the mark. If units are required on more than one occasion, candidates should not be penalised repeatedly.

o) Incorrect spelling is given. Sound out the word(s):

- if the correct term is recognisable then give the mark;
- if the word can easily be confused with another biological term then do not give the mark, eg ureter and urethra;
- if the word is a mixture of other biological terms then do not give the mark, eg mellum, melebrum, amniosynthesis.

p) When presenting data:

- If a candidate provides two graphs or charts in response to one question (eg one in the question and another at the end of the booklet), mark both and give the higher mark.
- For marking purposes no distinction is made between bar charts (used to show discontinuous features, have descriptions on the  $x$ -axis and have separate columns) and histograms (used to show continuous features, have ranges of numbers on the  $x$ -axis and have contiguous columns).
- Other than in the case of bar charts/histograms, if the question asks for a particular type of graph or chart and the wrong type is given, then do not give the mark(s) for this. Where provided, marks may still be awarded for correctly labelling the axes, plotting the points, joining the points either with straight lines or curves (best fit rarely used), etc.
- The relevant mark should not be awarded if the graph uses less than 50% of the axes; if the  $x$  and  $y$  data are transposed; if 0 is plotted when no data for this is given (ie candidates should only plot the data given).

q) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **calculate**, they must determine a number from given facts, figures or information;
- **compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between things;
- **describe**, they must provide a statement or structure of characteristics and/or features;
- **evaluate**, they must make a judgement based on criteria;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **identify**, **name**, **give**, or **state**, they need only name or present in brief form;
- **predict**, they must suggest what may happen based on available information;
- **suggest**, they must apply their knowledge and understanding of Biology to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of Biology.

Marking Instructions for each question

SECTION 1

Question	Response	Mark
1	D	1
2	B	1
3	C	1
4	B	1
5	D	1
6	A	1
7	C	1
8	D	1
9	A	1
10	B	1
11	B	1
12	B	1
13	D	1
14	D	1
15	B	1
16	C	1
17	C	1
18	A	1
19	C	1
20	C	1

## SECTION 2

Question			Expected response	Max mark	Additional guidance
1	a	i	DNA contains deoxyribose, RNA contains ribose (1) DNA contains thymine, RNA contains uracil (1)	2	Unacceptable: location, chain length/one has adenine, one has uracil
1	a	ii	Unwinds/unzips the double helix of DNA (1) Adds/brings in RNA nucleotides to produce RNA/a primary transcript (1)	2	
1	a	iii	Introns removed OR Exons joined	1	
1	a	iv	(mRNA) carries/takes/transfers the (genetic) code/order of bases/copy of DNA/gene from the nucleus to the cytoplasm/ribosomes	1	
1	b	i	9 hours	1	
1	b	ii	Human cells are eukaryotic (1) Actinomycin D would inhibit transcription/stop/prevent protein synthesis/transcription in a human patient/us/people/the human body (1)	2	Unacceptable: transcription of proteins
2	a		thr-glu--pro-pro	1	
2	b		Substitution	1	
2	c	i	Peptide	1	
2	c	ii	Hydrogen/ionic/hydrophobic (interaction)/disulfide bridge/sulfur bridge/Van der Waals	1	Not "H"
2	c	iii	Incorrect/different/wrong order of amino acids (sequence) OR Change described (1) AND Gives altered/incorrect/changed/differed folding/shape OR may affect post-translation modification/bonding of haemoglobin (1)	1	

Question			Expected response	Max mark	Additional guidance
3	a		The higher the carotenoid content concentration the darker the flesh OR Converse	1	Not acceptable: less light transmitted alone/darker flesh causes the higher carotenoid content
3	b	i	1:2	1	
3	b	ii	0.35 mg	1	
3	b	iii	T – triploids have more than diploids on average OR F – tetraploids have less than diploids/triploids OR Example with correct figures	1	
4	a	i	Lead (nitrate/ion) concentration	1	
4	a	ii	Concentration of glucose (solution) OR pH OR Strain/type/species/variety/age of yeast OR Concentration of yeast	1	
4	a	iii	Allow the flasks/solution(s)/contents/them/glucose and lead solutions/mixtures to reach/heat up to/cool down to/settle at/be at an even temperature/correct temperature/required/specific temperature/appropriate temperature/desired temperature/the same temperature/20°C/the temperature of the water bath	1	Not acceptable: acclimatise/adapt to/references to yeast/conditions constant/temperature/optimum
4	a	iv	Allow the lead (nitrate) to diffuse into/be taken up by/have its effect on/inhibit/react with/be absorbed by cells/yeast OR allows lead (nitrate) to have its effect on/inhibit respiration OR allows lead (nitrate) to have its effect on/inhibit/react with enzymes	1	

Question		Expected response	Max mark	Additional guidance
4	b	<p>Axes, scales and labels with units (1)</p> <p>Plotting and joining as a straight line (1)</p>	2	<ul style="list-style-type: none"> <li>• 11 needed on <i>y</i>-axis OR 0 2 4 6 8 10 12 is OK.</li> <li>• Decimal points <b>not</b> needed on scale.</li> <li>• Zero(s) required.</li> <li>• Single zero allowed if obviously both scales.</li> <li>• Label must include oxygen concentration.</li> <li>• Mg/l is acceptable.</li> <li>• Points don't need to be visible.</li> <li>• Ignore Flask B if included but A must be labelled if both plotted.</li> <li>• Transposed axes -1.</li> </ul> <p>Not acceptable:</p> <ul style="list-style-type: none"> <li>• half scale on <i>x</i>-axis</li> <li>• half scale on <i>y</i>-axis loses plot mark</li> </ul>
4	c	<p>As the lead (concentration) increases respiration decreases OR (It) decreases/decreased/reduces OR Inhibition was increased</p>	1	Not acceptable: inhibition alone
4	d	(Carbon dioxide/CO <sub>2</sub> is a product of) fermentation/anaerobic respiration	1	
5	A	<ol style="list-style-type: none"> <li>1. In context of altruism use of donor <b>and</b> recipient.</li> <li>2. Altruistic behaviour harms <b>and</b> benefits/increased survival descriptions of examples.</li> <li>3. Reciprocal altruism involves reversal of roles at a later stage/favour returned or a description of reversed roles.</li> <li>4. Reciprocal altruism often occurs in social animals/social insects <b>OR</b> mention of the prisoner's dilemma.</li> <li>5. Altruism is (more) common between kin/related individuals/kin selection is altruism between kin.</li> <li>6. Donor can benefit indirectly (through</li> </ol>	5	Any five

Question			Expected response	Max mark	Additional guidance
			shared genes). 7. Increased chance of shared/their genes surviving/being passed on (in recipient's offspring).		
5	B		1. Genetic diversity, species diversity, ecosystem diversity ( <b>any two</b> ). 2. A third component. 3. Genetic diversity is the number and frequency of alleles/sequences in a population. 4. Species diversity is the species richness/number of (different) species and relative abundance/proportion of each species. 5. Species richness is the number of (different) species. 6. Relative abundance is the proportion of each species. 7. Ecosystem diversity is the number of different/distinct ecosystems.	5	Any five
6	a		X Glycolysis	1	
6	b		P Oxaloacetate/oxaloacetic acid (1) Q Citrate/citric acid (1)	2	
6	c		Removes hydrogen ions and electrons (1) Causes reduction of NAD/FAD/hydrogen acceptor <b>OR</b> changes NAD to NADH (1)	2	
6	d	i	High energy electrons	1	
6	d	ii	ATP synthase	1	
6	d	iii	Final electron acceptor <b>OR</b> Combines with hydrogen ions and electrons (forming water)	1	
7	a		Using buffers <b>OR</b> Addition of acid/alkali	1	Not acceptable: any answer referring to monitoring pH
7	b	i	W Lag X Log/exponential	2	



Question			Expected response	Max mark	Additional guidance
7	b	ii	W	1	Allow lag
7	b	iii	(Cells are dying) because of toxic waste/ secondary metabolites accumulating/ building up/being produced OR running out/lack of/no nutrients/ oxygen/food/respiratory substrate OR increasing competition (for food)	1	Unacceptable: death rate higher than birth rate; substrate on its own
8	a	i	Increases from 4.0 to 4.5 g to end of August/beginning of September/during August/in the first month (1)  Falls from 4.5 to 1.5 g from end of August/beginning of September until end of November (1)	2	All correct but no units = 1 Units only needed once At least one reference point needed
8	a	ii	60%	1	
8	a	iii	More/plentiful/good food/nectar available OR Less energy needed to keep warm OR More torpor than in winter OR Using less energy because not migrating	1	Not “eat more food”
8	b	i	Energy conserved/saved for flying/ migration/flight OR Energy not wasted so more energy for flying/migration/flight OR Less energy used in keeping warm so more available for flight	1	Not acceptable: energy stored/enough/more energy available for flight/movement/big journeys/travel/more energy needed for migration
8	b	ii	0.5/half/½	1	
8	c		45 cm <sup>3</sup>	1	
8	d		(Individual) marking/mark, tagging, ringing, banding OR Radio tracking OR Satellite/GPS tracking OR Satellite transmitter	1	

Question			Expected response	Max mark	Additional guidance
9	a		Reflected <b>OR</b> Transmitted	1	
9	b		Pigment X <b>Explanation:</b> Absorbs in red and blue (light). Best/better/much more/mainly/at a higher percentage/greater/higher/more efficiently (than pigment Y/than green). <b>OR</b> Converse for green.	1	Both pigment and explanation for 1. Not acceptable: absorbs red and blue light alone/absorbs very little green light/high absorption of red and blue light.
9	c	i	As wavelength increases to 550 nm (%) absorption also increases (1) then decreases. <b>OR</b> As wavelength increases further/over 550 nm absorption decreases. nm and 550 needed at least once. (1)	2	Not acceptable: description of pigment X drops at 680 nm colours instead of wavelengths increases then decreases
9	c	ii	Would allow absorption/use of light/green light/wavelengths/colours  not absorbed by/reflected from/transmitted through/not used by/passing through/filtered through/transmitted by  larger plants/the canopy/trees/sun plants/higher leaves/leaves above	1	Not acceptable: Gets light  Absorbs green light alone  Blocked by By-passes Shines through  Leaves alone Plants alone
10	a		Deleterious/damaging allele combinations are eliminated (by natural selection)	1	
10	b		Tick/cross with homozygous recessive	1	
10	c		Cold/frost tolerant/resistant <b>OR</b> Low compensation point <b>OR</b> Hybrid vigour <b>OR</b> Fast growing/high yield/disease resistant	1	Not acceptable: harsh conditions

Question			Expected response	Max mark	Additional guidance
10	d	i	Some variety/homozygosity will be produced therefore losing hybrid vigour/ability to grow in cold conditions <b>OR</b> F <sub>2</sub> genetically variable/diverse	1	
10	d	ii	Could produce new/better varieties (helpful in future breeding programmes) <b>OR</b> Example	1	
11	a		Perennial <b>and</b> Has vegetative reproduction using underground stems	2	
11	b	i	Will kill/destroy the whole plant/roots/underground stems <b>and</b> So avoid regeneration/regrowth/coming back	1	
11	b	ii	May be toxic to animal species/persist in the environment/can accumulate in food chains/may produce resistant populations.	1	
11	c	i	Introduced species/they may become invasive/pest <b>OR</b> May out-compete native species and reduce biodiversity <b>OR</b> May introduce disease/parasites <b>OR</b> May eat/destroy native/other plants <b>OR</b> May disrupt food webs/chains <b>OR</b> Acts as predators to native species	1	
11	c	ii	Combines biological and chemical control <b>OR</b> Combines biological and cultural control <b>OR</b> Combines chemical and cultural control	1	
12	a		5 minutes	1	

Question			Expected response	Max mark	Additional guidance
12	b		4:2:1	1	
12	c		Increase number of pigs observed <b>OR</b> Repeat with different groups/sets of pigs <b>OR</b> Increase number/length of observations <b>OR</b> More frequent observations <b>OR</b> Repeat at different times of day <b>OR</b> Repeat using different/more enclosures	1	Not acceptable: repeat the whole experiment/repeat observations made/increase the time/compare to other groups
12	d		Stereotyped/misdirected <b>OR</b> Failure of sexual/parenting behaviour <b>OR</b> Altered levels of activity <b>OR</b> ARM/Abnormal Repeated Movement <b>OR</b> Repeated pointless movements <b>OR</b> Hyper aggressive behaviour <b>OR</b> Pacing	1	Stereotyping Biting Chewing (bars) Fighting (unless indicating that it is abnormal)
13	A	i	<ol style="list-style-type: none"> <li>1. Stems cells are unspecialised/undifferentiated cells (in animals).</li> <li>2. Differentiate/develop into specialised cells/different cells for different functions.</li> <li>3. There are adult and embryonic stem cells.</li> <li>4. Embryonic stem cells differentiate into all cells types.</li> <li>5. Tissue/adult stem cells differentiate into cells which need to be replaced.</li> <li>6. Adult stem cells give rise to more limited cell type.</li> <li>7. Following differentiation a cell only expresses certain genes.</li> <li>8. That produce proteins characteristic of that cell type.</li> </ol>	6	Any six
13	A	ii	<ol style="list-style-type: none"> <li>1. Therapeutic use includes repair of damaged/diseased organs/tissue/cells</li> <li>2. Example of the use, eg diabetes, Parkinson's disease, leukaemia, skin</li> </ol>	2	Any two

Question			Expected response	Max mark	Additional guidance
			graft, corneal graft, bone marrow transplant. 3. Example of an ethical issue related to stem cell research.		
13	B	i	1. Genomic sequencing is sequencing of nucleotide bases. 2. Can be determined for genes and entire genomes. 3. Computer and statistical analysis used to compare sequences.	2	Any two
13	B	ii	1. Phylogenetics used to study evolutionary relatedness between groups of organisms. 2. Used to determine sequence of events in evolution. 3. Sequence divergence determined. 4. Used to estimate time since lineages diverged. 5. Comparison of sequences provides evidence of the three domains. 6. Can be used to compare sequences between different species. 7. Many genes highly conserved across species. 8. Many genomes have been sequenced, eg of disease-causing organisms (or specific example).	6	Any six

[END OF EXEMPLAR MARKING INSTRUCTIONS]