FOR OFFICIAL USE

Total for Sections B and C

X274/12/02

NATIONAL QUALIFICATIONS 2015

WEDNESDAY, 13 MAY 1.00 PM – 3.30 PM

BIOLOGY HIGHER (REVISED)

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

Scottish candidate number

Number of seat

SECTION A—Questions 1–30 (30 Marks)

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

For this section of the examination you must use an **HB pencil**.

SECTIONS B AND C (100 Marks)

1 (a) All questions should be attempted.

(b) It should be noted that in **Section C** questions 1 and 2 each contain a choice.

2 The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, **and must be written clearly and legibly in ink**.

3 Additional space for answers will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the Invigilator and should be inserted inside the **front** cover of this book.

4 The numbers of questions must be clearly inserted with any answers written in the additional space.

5 Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written. If further space is required, a supplementary sheet for rough work may be obtained from the Invigilator.

6 Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.

PB

Read carefully

1 Check that the answer sheet provided is for **Biology Higher (Revised) (Section A)**.

2 For this section of the examination you must use an **HB pencil**, and where necessary, an eraser.

3 Check that the answer sheet you have been given has **your name**, **date of birth**, **SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

Do not change any of these details.

4 If any of this information is wrong, tell the Invigilator immediately.

5 If this information is correct, **print** your name and seat number in the boxes provided.

6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).

7 There is **only one correct** answer to each question.

8 Any rough working should be done on the question paper or the rough working sheet, not on your answer sheet.

9 At the end of the examination, put the **answer sheet for Section A inside the front cover of this answer book**.

Sample Question

The apparatus used to determine the energy stored in a foodstuff is a

A calorimeter

B respirometer

C klinostat

D gas burette.

The correct answer is **A**—calorimeter. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).

Changing an answer

If you decide to change your answer, carefully erase your first answer and using your pencil fill in the answer you want. The answer below has been changed to **D**.

SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

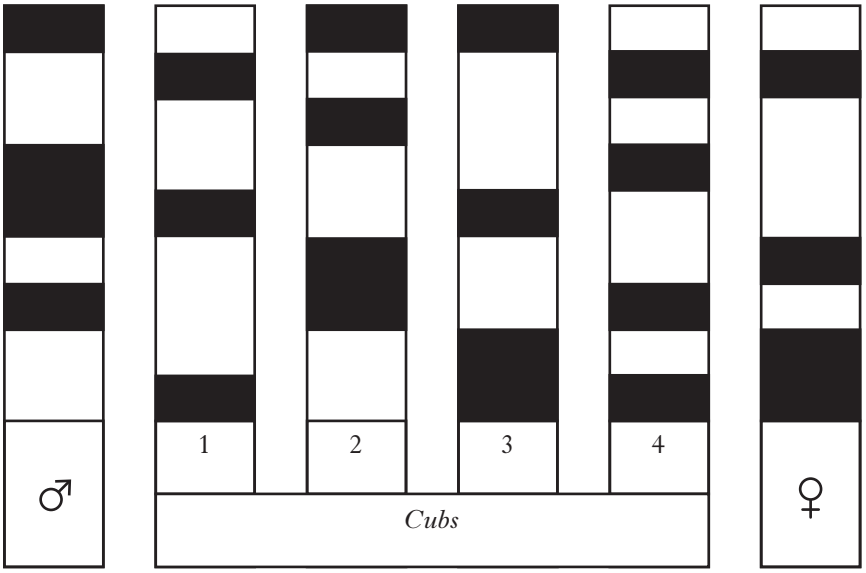
1. Which line in the table below shows correctly features of the human genome?

	Contains base sequences that regulate transcription	*Contains base sequences transcribed to RNA but never translated*	*Contains base sequences from which primary transcripts are produced*
A	✗	✓	✗
B	✗	✗	✓
C	✓	✓	✗
D	✓	✓	✓

2. A study was carried out on a lion (♂), a lioness (♀) and a group of cubs.

Samples of DNA were extracted from the animals and analysed using gel electrophoresis.

The results are shown in the diagram below, in which the dark bands represent fragments of DNA of a specific length.



Which of the cubs could be the offspring of the lion and lioness studied?

A 1, 2 and 3

B 1, 2 and 4

C 2, 3 and 4

D 1, 3 and 4

[Turn over

3. The genome of a cell contains 3×10^8 base pairs of which 4% code for proteins.

How many DNA triplets does the coding region of this genome contain?

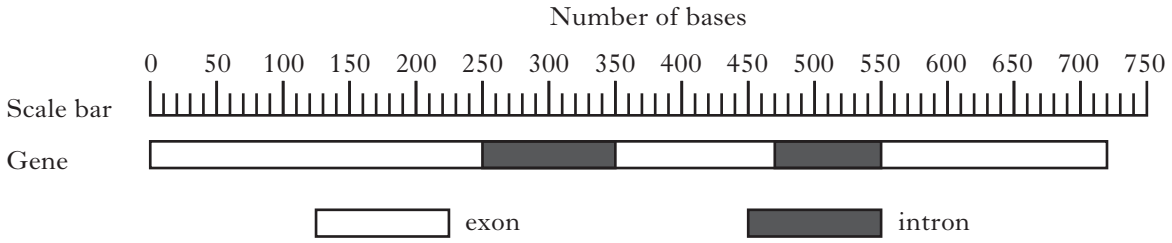
A 2×10^6

B 4×10^6

C 12×10^6

D 36×10^6

4. The diagram below shows a eukaryotic gene containing introns and exons and a scale bar representing the number of bases in the gene.



How many bases will there be in the mature mRNA formed from the primary transcript of this gene?

A 180

B 540

C 560

D 720

5. Which of the following would **not** explain loss of genetic diversity in a population?

A Inbreeding

B The bottleneck effect

C No barriers to gene flow

D The founder effect

6. The following are stages in one cycle of the polymerase chain reaction (PCR).

1 Heat tolerant polymerase replicates DNA

2 DNA heated to separate strands

3 Primers bind to DNA

Which of the following is the correct order of the occurrence of these stages in PCR?

A 2 3 1

B 3 2 1

C 2 1 3

D 3 1 2

7. The following are events in the evolution of life on Earth.

1 Animals appear

2 Vertebrates appear

3 Land plants appear

In which order are these events thought to have occurred?

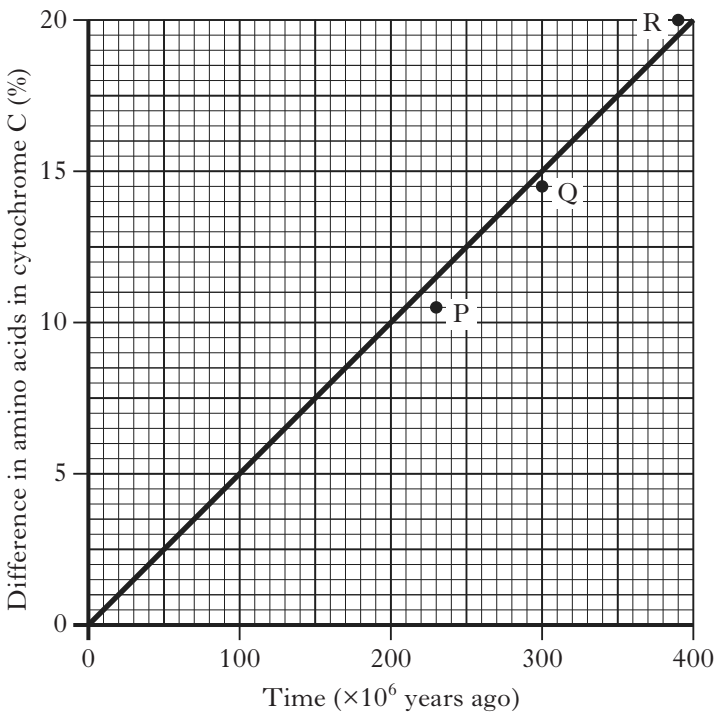
A 1 3 2

B 1 2 3

C 3 1 2

D 3 2 1

8. The graph below shows a molecular clock which compares the amino acid sequences in the protein cytochrome C in various vertebrate groups.



Key
P – birds and reptiles
Q – reptiles and mammals
R – fish and reptiles

From the information in the graph, which vertebrate groups shared a common ancestor most recently?

A Fish and reptiles

B Birds and reptiles

C Reptiles and mammals

D Birds and mammals

9. The table below shows the results of pharmacogenetic tests on a drug designed to treat a liver infection in a group of patients.

		Number of patients	
		beneficial effect on patient	no beneficial effect on patient
Number of patients	toxic side-effects	30	15
	no side-effects	60	45

What percentage of the patients gained benefit from the drug but showed toxic side-effects?

A 20

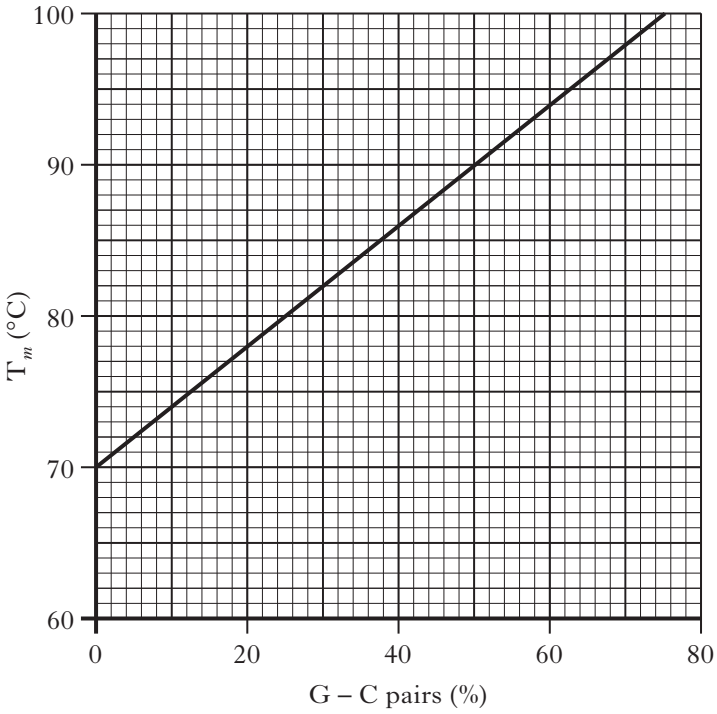
B 25

C 30

D 90

[Turn over

10. The melting temperature of a molecule of DNA (T_m) is the temperature at which half of its base pairs separate. T_m is proportional to the percentage of the guanine to cytosine (G – C) base pairs in the molecule as shown on the graph below.



The numbers of base pairs present in a DNA molecule are shown in the table below.

Number of base pairs present	
A – T	G – C
1200	800

What is T_m for this molecule?

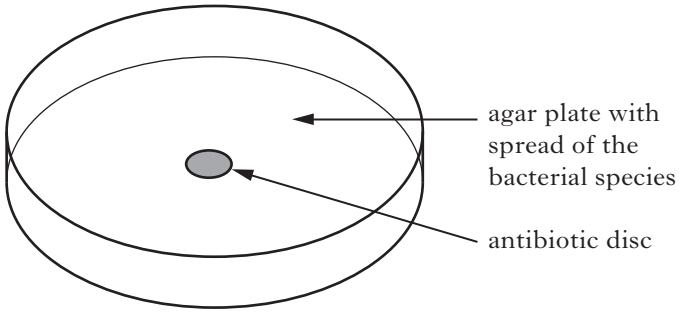
A 96 °C

B 94 °C

C 86 °C

D 78 °C

11. The effect of an antibiotic on a bacterial species was tested by spreading a culture of the bacterial species on an agar plate and adding a disc of absorbent paper soaked in the antibiotic as shown in the diagram below.



The plate was incubated for 24 hours at 30 °C and the growth examined.

Which of the following would be a suitable control for this experiment?

Repeat the experiment exactly but

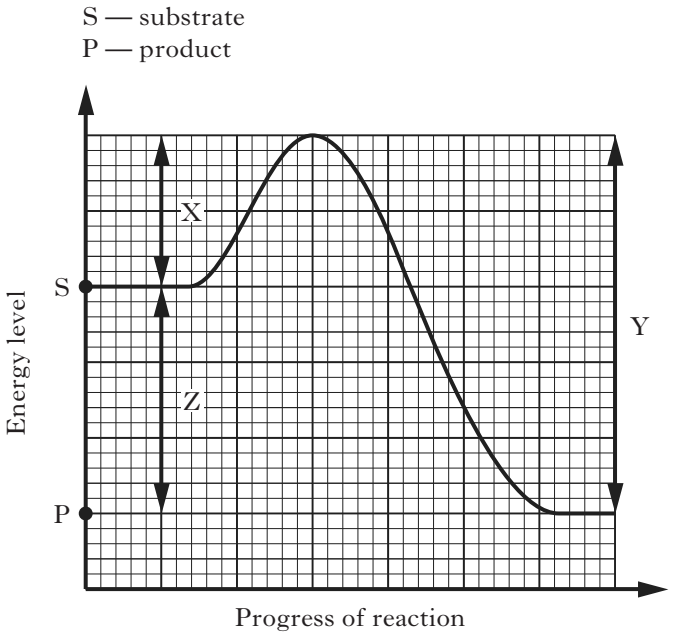
A with no bacteria

B incubate at human body temperature

C use a disc with no antibiotic

D use a disc with a different antibiotic.

12. The graph below shows the energy levels during an enzyme catalysed reaction.



Which line in the table below identifies correctly the activation energy and the net energy released by the reaction?

	Activation energy	*Net energy released by the reaction*
A	X	Y
B	Y	Z
C	Y	X
D	X	Z

13. Mitochondria are small membrane-bound compartments present in eukaryotic cells.

One advantage to a mammalian muscle cell of having many small mitochondria is that they provide a

A small surface area to volume ratio to increase the uptake of oxygen

B large surface area to volume ratio to increase the uptake of oxygen

C large surface area to volume ratio to decrease the uptake of carbon dioxide

D small surface area to volume ratio to decrease the uptake of carbon dioxide.

14. The following are molecules that can be broken down into substrates for respiration.

1 Starch

2 Protein

3 Fat

Which molecules can be broken down into products which can be converted directly into intermediates of the citric acid cycle?

A 1 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

15. When salmon migrate from freshwater into seawater, changes in concentration of their surroundings are detected and the activity of ion pumps in their gills increases. The activity of the ion pumps decrease when the salmon migrate back to freshwater.

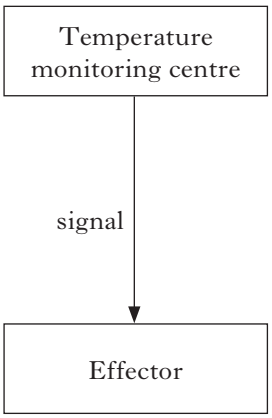
Which line in the table below shows correctly the description of the salmon and the control of its ion pumps?

	Description of salmon	*Control of ion pumps*
A	conformer	by negative feedback
B	conformer	behavioural
C	regulator	by negative feedback
D	regulator	behavioural

[Turn over

16. Changes in the body temperature of mammals are detected by a temperature monitoring centre. This sends a signal to effectors whose action returns the temperature to a normal level.

These events are summarised in the diagram below.

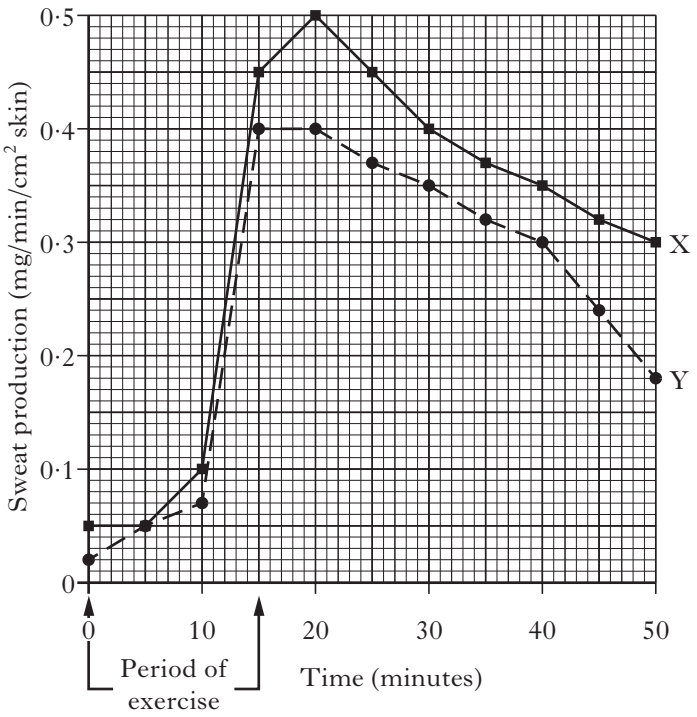


Which line in the table below identifies correctly the temperature monitoring centre, type of signal and the effector involved in this control?

	Temperature monitoring centre	*Type of signal*	*Effector*
A	skin	nervous	hypothalamus
B	hypothalamus	nervous	skin
C	skin	hormonal	hypothalamus
D	hypothalamus	hormonal	skin

17. The rate of sweat production of two individuals, X and Y, was measured during and after a period of exercise.

The results are shown in the graph below.



Which of the following conclusions can be drawn from the graph?

A The rate of sweat production of individual X is always greater than individual Y.

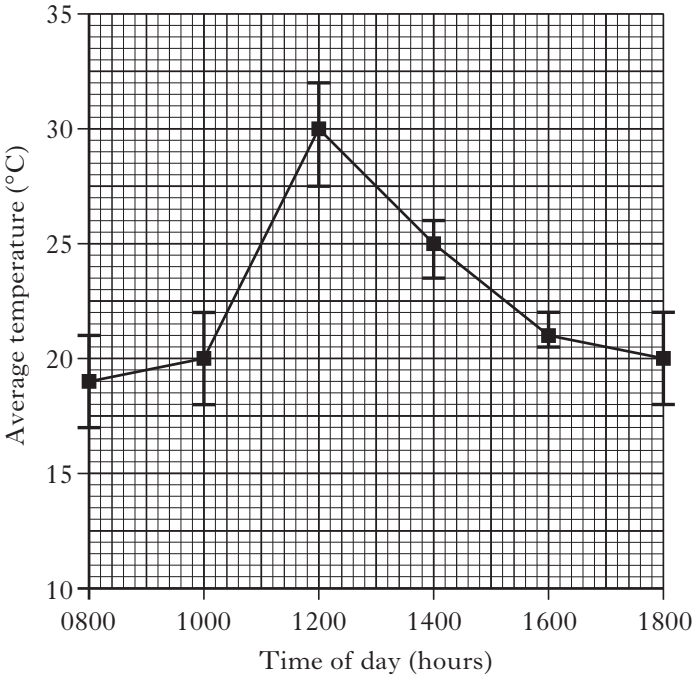
B Individuals X and Y both reach their maximum sweat production at 20 minutes.

C Individual X starts increasing sweat production sooner than individual Y.

D The greatest difference in sweat production by individuals X and Y is at 50 minutes.

18. The body temperature of the lizard *Liolaemus occipitalis* varies with its environmental temperature.

In an investigation the body temperature of a group of 10 lizards was recorded every two hours from 0800 hours until 1800 hours. The results are shown in the graph below in which the error bars show the range of body temperatures in the group at each time of day.



The greatest difference in body temperatures recorded during the investigation is

A 5 °C

B 10 °C

C 11 °C

D 15 °C.

19. The statements below give information on three different bacterial species.

1 *Psychrobacter adeliensis* is found in Antartica. It has been isolated from coastal ice and grows well at low temperatures.

2 *Thermophilus aquaticus* lives in hot springs and generates ATP by removal of high energy electrons from inorganic molecules.

3 *Escherichia coli* has enzymes with an optimal temperature of 37 °C. Most strains of this species are harmless and live in animal intestines although some strains can be harmful to the host animal.

From this information, which of the following bacterial species can be classified as extremophile?

A 1 and 2 only

B 1 and 3 only

C 2 only

D 3 only

20. The following procedures can be used in attempts to improve wild strains of certain microorganisms for industrial use.

1 Exposure of existing strains to UV light

2 Encouraging the uptake of plasmids by existing strains

3 Allowing sexual reproduction by existing strains

Which procedure(s) could be used to improve bacterial species?

A 1 only

B 2 only

C 1 and 2 only

D 1, 2 and 3

21. Which of the following occurs during the Calvin cycle?

A ATP is produced

B Oxygen is released

C Water is split

D Carbon dioxide is fixed

22. Which of the following results in the transfer of electrons down the electron transport chains during the light dependent reactions of photosynthesis?

A NADP is converted to NADPH

B Water is split by photolysis

C ATP is synthesised

D Pigment molecules absorb energy

23. In plant field trials, replicates are used to

A take account of the variability within samples

B eliminate bias when measuring treatment effects

C ensure that comparisons are fair

D prevent weather conditions affecting results.

24. When quantifying plant productivity, the economic yield is the

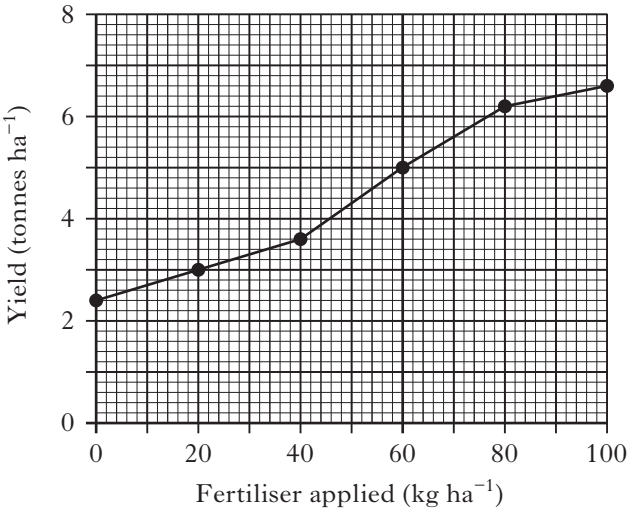
A total biomass produced

B biomass of desired product

C increase in biomass due to photosynthesis

D rate of biomass production per hectare.

25. The graph below shows the effect of applying different concentrations of fertiliser on the yield of a crop plant.



The percentage increase in yield obtained when the fertiliser application is increased from 60 to 80 kg ha^{-1} is

A 1·2%

B 6·2%

C 24%

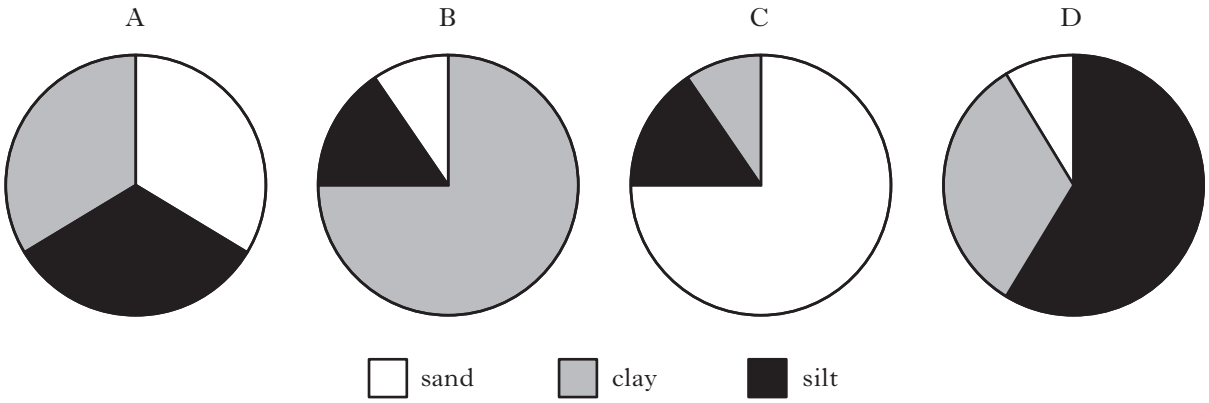
D 124%.

26. Soil type is dependent on the composition of its components which in turn affects the productivity of plants growing in it.

The table below shows the percentage of each component present in four different soil types.

	Component (%)		
Soil type	clay	silt	sand
sandy clay loam	20 – 30	0 – 30	50 – 80
clay loam	20 – 35	20 – 60	20 – 50
sandy silt loam	0 – 20	40 – 80	20 – 50
silty clay loam	20 – 35	45 – 80	0 – 20

Which of the following charts represents a clay loam?



27. The table below shows the number of beet armyworm larvae found in plots of cotton plants. Some plots were treated with insecticide on 27 June and 1 August and other plots left untreated.

		Number of beet armyworm larvae	
Sampling date		Treated plots	Untreated plots
July	8	3	3
	15	33	2
	22	22	17
	29	42	10
August	5	120	8
	12	160	10

Which of the following is the most likely explanation for the differences between the treated and untreated plots?

A The insecticide kills a predator of the larvae

B The larvae are resistant to the insecticide

C The beet armyworm breeds in July

D The larvae have a short lifecycle

28. In primates such as chimpanzees, parental care

A occurs over a short time period

B provides time for learning complex social behaviour

C increases the parent's social status within their group

D involves appeasement behaviour within a group.

29. Altruistic behaviour between closely related animals

A reduces competition between individuals in the population

B increases the survival chances of the donor animal

C increases the frequency of shared genes in the next generation

D reduces unnecessary aggression and conflict in social groups.

30. A species that plays a role vital for the survival of many other species in an ecosystem is called

A a keystone species

B a native species

C an invasive species

D a dominant species.

Candidates are reminded that the answer sheet MUST be returned INSIDE the front cover of this answer book.

DO NOT WRITE IN THIS MARGIN

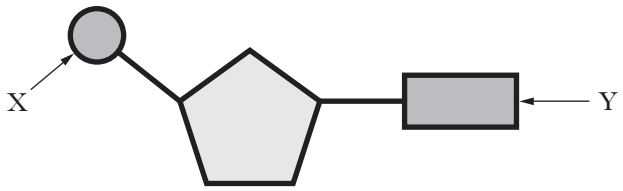
SECTION B

Marks

All questions in this section should be attempted.

All answers must be written clearly and legibly in ink.

1. (*a*) The diagram below shows three components of a nucleotide of DNA.



(i) Name components X and Y.

X _____ **1**

Y _____ **1**

(ii) Name the component of a nucleotide which would be found at the 3' end of a DNA strand.

_____ **1**

[Turn over

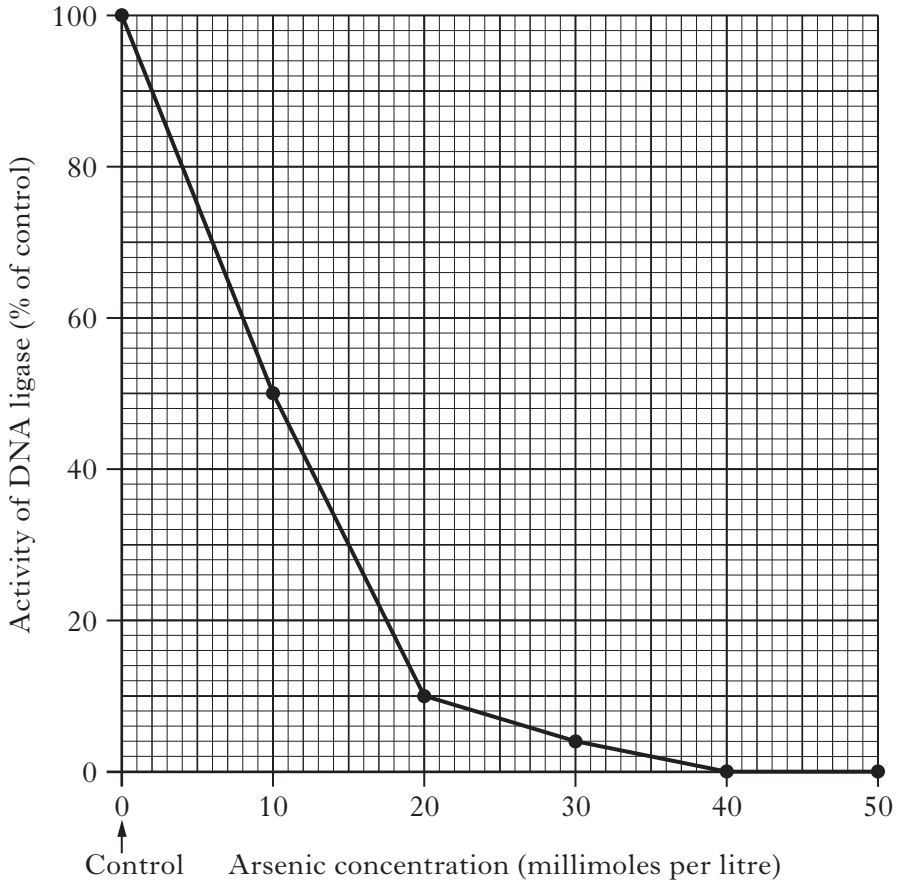
Marks

1. (continued)

(*b*) Arsenic is a toxic chemical element which affects DNA replication.

Cultures of human cells were treated with different concentrations of arsenic while a control culture was left untreated.

The activity of DNA ligase in the cells was measured and the results shown in the graph below.



(i) Compare the change in DNA ligase activity when the concentration of arsenic was increased from 0 to 20 millimoles per litre with the change when arsenic concentration was further increased from 20 to 40 millimoles per litre.

_____

_____ **1**

(ii) Give the arsenic concentration which would reduce activity of DNA ligase by 40 %.

_____ millimoles per litre **1**

(iii) State the role of DNA ligase in the replication of DNA.

_____

_____ **1**

Marks

1. (continued)

(*c*) Complete the table below by inserting ticks (✓) into the boxes to show the structures involved in the organisation of DNA in each cell or organelle.

Cell or organelle	*Structure involved*		
	linear chromosome	circular chromosome	circular plasmid
chloroplast			
prokaryote			
nucleus			

2

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

2. An investigation was carried out involving a number of patients with heart disease.

A group of volunteer patients was treated with adult stem cells and a control group was not given this treatment.

Six weeks after the treatment, the average heart rate and the average volume of blood pumped out per heartbeat (stroke volume) was determined for each group.

The results are shown in the table below.

	Patients given stem cell treatment	*Patients not given stem cell treatment*
Average heart rate (beats per minute)	70	70
Average stroke volume (cm^3)	45	28

(*a*) Give **two** conclusions which can be drawn about the effect of the stem cell treatment on the patients.

1 _____

_____ **1**

2 _____

_____ **1**

(*b*) Another important measure of heart performance is cardiac output.

Cardiac output (cm^3 per minute) = *heart rate* (bpm) × *stroke volume* (cm^3)

Calculate the average increase in cardiac output in those patients given the stem cell treatment compared to those in the control group.

Space for calculation

_____ cm^3 per minute **1**

(*c*) Describe how tissue (adult) stem cells differ from embryonic stem cells.

_____

_____ **1**

(*d*) Much stem cell research is related to the therapeutic value of stem cells.

Give **one** other reason for carrying out stem cell research.

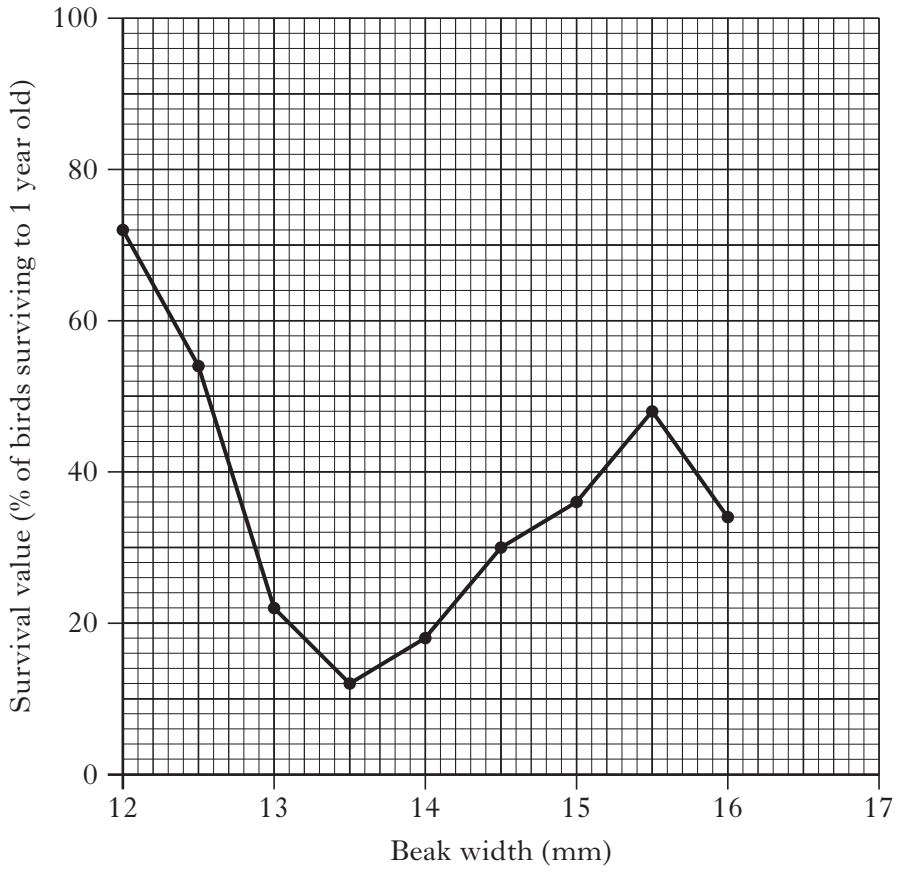
_____

_____ **1**

Marks

3. The beak widths of a sample of black-bellied seedcrackers *Pyrenestes ostrinus* were measured. The survival value of beak width was found by recording the percentage of these birds which survived to one year.

The results are shown in the graph below.



(*a*) Give the range of beak widths which had a survival value of 20% or less.

(i) From _____ to _____ mm **1**

(ii) Calculate the simplest whole number ratio of the survival value to these birds of having the beak widths shown below.

Space for calculation

_____ : _____ : _____
12 mm 13·5 mm 15·5 mm **1**

(iii) Name the type of selection which is suggested by the pattern of data shown in the graph.

_____ **1**

(*b*) Birds are eukaryotes.

Give **one** reason why prokaryotes can evolve more rapidly than eukaryotes.

_____

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

4. The table below shows when the last common ancestor of humans and four primate species lived and the percentage differences in their DNA sequences compared with humans.

Primate species	*Approximate date of last common ancestor with humans* (millions of years before present)	*Difference in DNA sequences* (%)
rhesus monkey	25	7·0
orangutan	14	3·1
gorilla	12	1·6
chimpanzee	7	1·0

(*a*) (i) Describe the relationship between the date of the last common ancestor and the percentage difference in DNA sequences between humans and the primate species.

_____

_____ **1**

(ii) Identify the primate species which is least closely related to humans.

_____ **1**

(*b*) DNA sequence data is used to study evolutionary relatedness.

Give the term used for the statistical analysis of sequence data.

_____ **1**

(*c*) Analysis of an individual human genome can lead to personalised medicine.

(i) Give **one** advantage to an individual of personalised medicine.

_____

_____ **1**

(ii) Give **one** difficulty linked to the use of personal genomics to inform personalised medicine.

_____

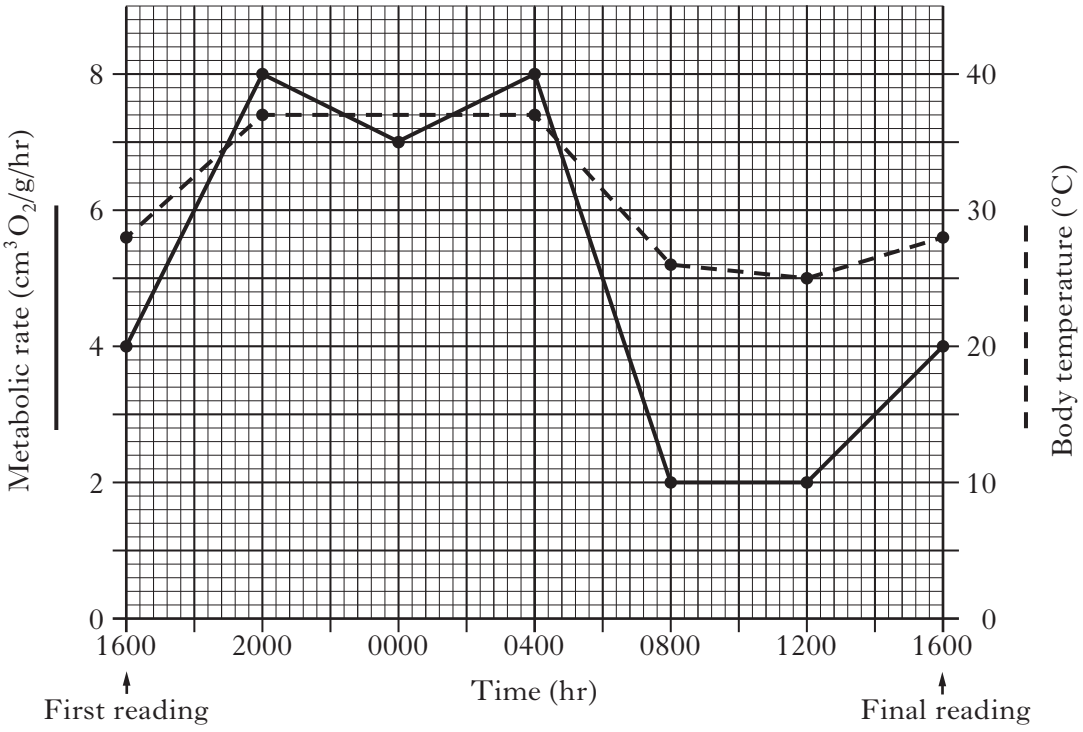
_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

5. The northern blossom bat *Macroglossus minimus* is an Asian species which has a high metabolic rate and a daily rhythm of torpor.

The metabolic rates and body temperatures of a group of these bats were recorded every four hours over a 24 hour cycle and the results are shown on the graph below.



(*a*) Calculate the oxygen consumption of a 16 g bat at 0000 hours.

Space for calculation

_____ cm^3 O_2 per hr **1**

(*b*) Tick (✓) **one** box to identify the period when the bats were in full torpor and justify your answer.

1600 – 2000	2000 – 0000	0400 – 0800	0800 – 1200
☐	☐	☐	☐

Justification _____

_____ **2**

(*c*) Give **one** benefit to the bats of their daily torpor.

_____ **1**

(*d*) Blossom bats are nocturnal.

Give **one other** behavioural adaptation of animals with high metabolic rates to allow survival in adverse conditions.

_____ **1**

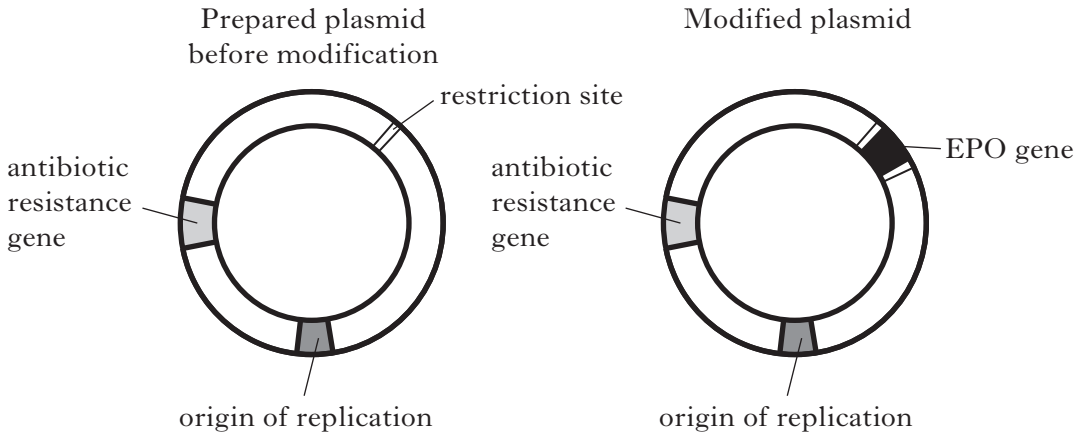
DO NOT WRITE IN THIS MARGIN

Marks

6. Erythropoietin (EPO) is a protein synthesised in the kidneys which is involved in red blood cell production. Some individuals with kidney disease have low red blood cell counts and can be treated with EPO.

EPO can be produced by recombinant DNA technology in which the human EPO gene is inserted into a specially prepared bacterial plasmid.

The diagram below shows the prepared bacterial plasmid before and after it was modified by the insertion of a human EPO gene.



(*a*) Explain the importance of removing the EPO gene from a human chromosome with the **same** restriction endonuclease that was used to open the bacterial plasmid.

_____

_____ **1**

(*b*) Name the enzyme used to seal the EPO gene into the bacterial plasmid.

_____ **1**

(*c*) Modified plasmids were mixed with bacteria. Some bacterial cells were transformed by taking up the modified plasmids but others were not.

Use information from the diagram to suggest how a culture containing only the transformed bacteria could be obtained.

_____

_____ **1**

(*d*) Identify the section of the modified plasmid shown in the diagram which ensured that it could be copied and passed to daughter cells when transformed bacteria divided.

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

6. (continued)

(*e*) The EPO protein produced by the transformed bacteria is inactive.

(i) Suggest a reason why bacteria produce EPO protein which is inactive.

_____

_____ **1**

(ii) Suggest how recombinant DNA technology could be used to produce an active form of the EPO protein.

_____

_____ **1**

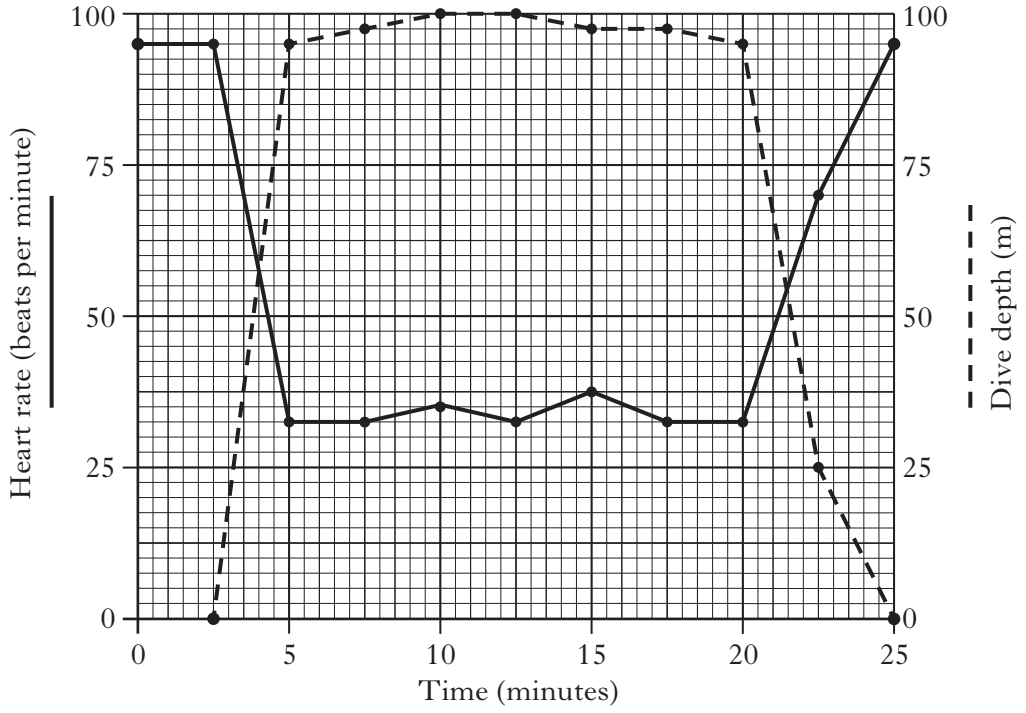
[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

7. The heart rate of a common seal was monitored over a 25 minute period before, during and after a dive.

The graph below shows how the heart rate changed with the depth of the seal's dive.



(*a*) (i) State the duration of the dive.

_____ minutes **1**

(ii) Describe the relationship between the dive depth and the heart rate and suggest a reason for this.

1 Relationship _____

_____ **1**

2 Reason _____

_____ **1**

(*b*) Underline the correct option in each choice bracket to make the sentences correct.

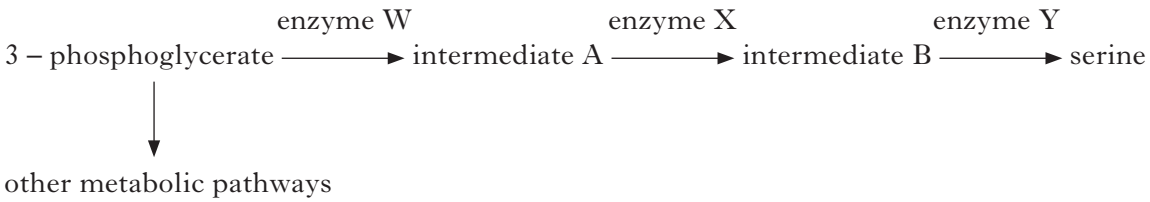
Seals are mammals. Their hearts have {three / four} chambers and a {single / double} circulation.

This arrangement allows seals to maintain {low / high} metabolic rates. **2**

Marks

8. Serine is an amino acid that can be synthesised in human cells.

The diagram below shows the metabolic pathway which results in the production of serine.

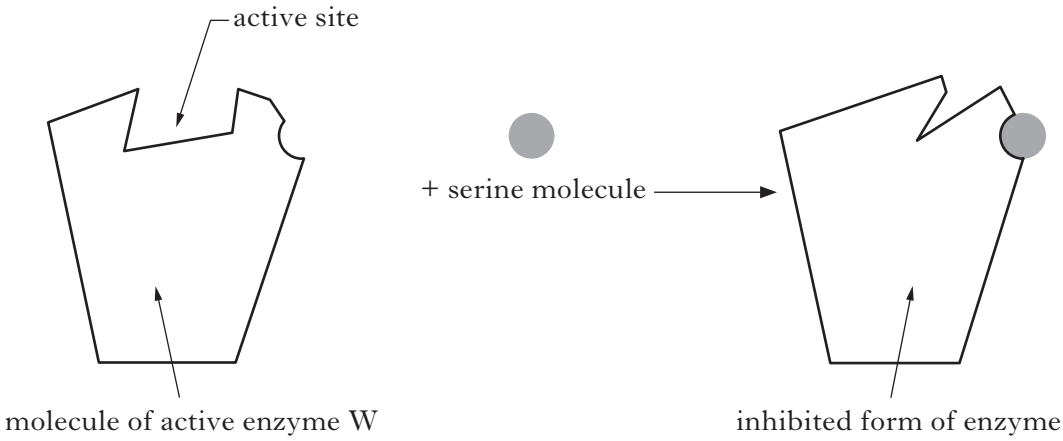


(*a*) (i) As the concentration of serine increases, the activity of enzyme W decreases.

Name this type of control of a metabolic pathway.

_____ **1**

(ii) The diagram below shows how serine acts on a molecule of enzyme W.



Explain how serine causes the inhibition of enzyme W.

_____

_____

_____ **1**

(*b*) As well as being involved in the synthesis of serine, 3 – phosphoglycerate is used by cells in other metabolic pathways as shown in the diagram.

Suggest why inhibition of enzyme W is essential to the overall metabolism of human cells.

_____

_____ **1**

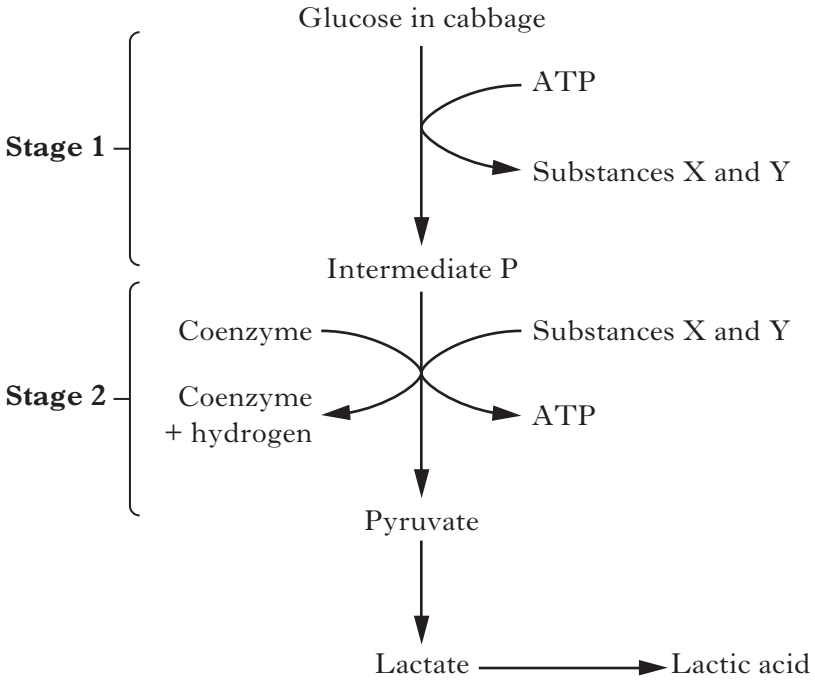
[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

9. Sauerkraut is a food produced by preserving cabbage. Preservation involves inhibition of the bacteria which can spoil the food. *Lactobacillus* is anaerobic and, unlike most bacteria, grows well at low pH.

The diagram below shows stages in fermentation of the glucose in cabbage by *Lactobacillus*.



(*a*) (i) Identify substances X and Y in the diagram.

X _____

Y _____ **1**

(ii) Name the coenzyme, shown in the diagram, which carries hydrogen to the electron transport chain.

_____ **1**

(iii) Explain why the ATP produced at **Stage 2** in the diagram is referred to as an energy pay off.

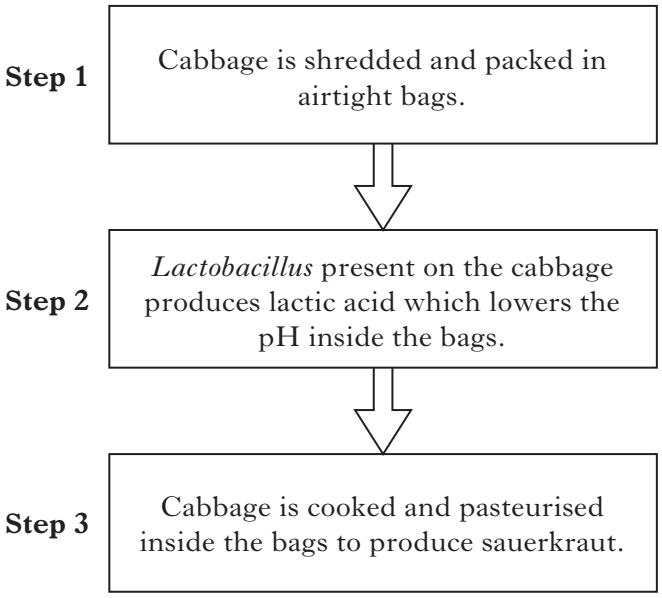
_____

_____ **1**

Marks

9. (continued)

(*b*) The flow chart below shows how cabbage can be processed to produce sauerkraut.



(i) Explain why shredding the cabbage in **Step 1** increases the rate of production of sauerkraut.

_____

_____ **1**

(ii) Explain why the process encourages the growth of *Lactobacillus* but inhibits the growth of other bacteria.

_____

_____ **1**

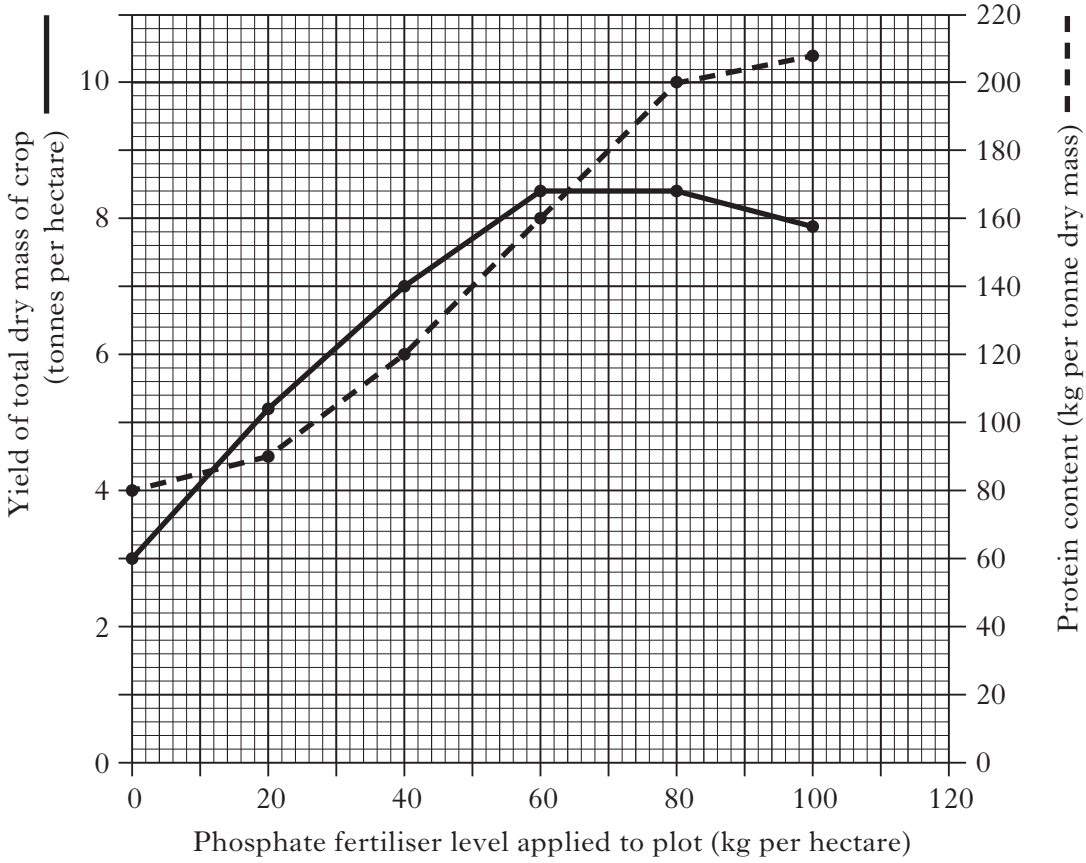
[Turn over

DO NOT WRITE IN THIS MARGIN

10. Alfalfa is a crop plant often grown for cattle food.

In an investigation, alfalfa was grown in six plots each of which had been treated with a different level of phosphate fertiliser. The alfalfa was harvested after 24 weeks of growth and the total dry mass of the crop at each fertiliser level was calculated. The protein content of the alfalfa grown at each fertiliser level was also determined.

The results are shown in the graph below.



Marks

(*a*) (i) **Use values from the graph** to describe the changes in the yield of total dry mass of the crop as the phosphate fertiliser level was increased from 0 to 100 kg per hectare.

_____

_____

_____

_____ **2**

(ii) Predict the protein content of an alfalfa crop if 120 kg of phosphate fertiliser per hectare had been applied.

_____ kg per tonne dry mass **1**

(iii) Calculate the total mass of protein produced from one hectare when 40 kg of phosphate fertiliser per hectare was applied.

Space for calculation

_____ kg **1**

Marks

10. (continued)

(*b*) In a feeding trial, three groups of 10 cattle were fed with alfalfa of different protein contents over a 25 day period. The cattle were weighed at the beginning and end of this period and the average increase in their body mass calculated.

The results are shown in the table below.

Cattle group	*Protein content of alfalfa fed to cattle* (kg per tonne dry mass)	*Average increase in body mass of cattle over a 25 day period* (kg)
1	80	12
2	90	15
3	120	17

(i) State how the design of the feeding trial ensured the reliability of the results.

1

_____

(ii) Using the information from the **table**, calculate the average increase in body mass per day of the cattle in Group 2.

Space for calculation

1

_____ kg per day

(iii) Using information from the **graph and table**:

1 suggest the phosphate fertiliser level which was applied in the production of the alfalfa which the cattle from Group 2 were fed;

1

_____ kg per hectare

2 draw a conclusion about how phosphate fertiliser levels applied to the alfalfa affected the growth of cattle in the feeding trial.

_____ **1**

(*c*) In terms of food security, explain why using agricultural land to grow cereal for human consumption rather than to grow cattle food would produce more food for humans per unit area.

_____

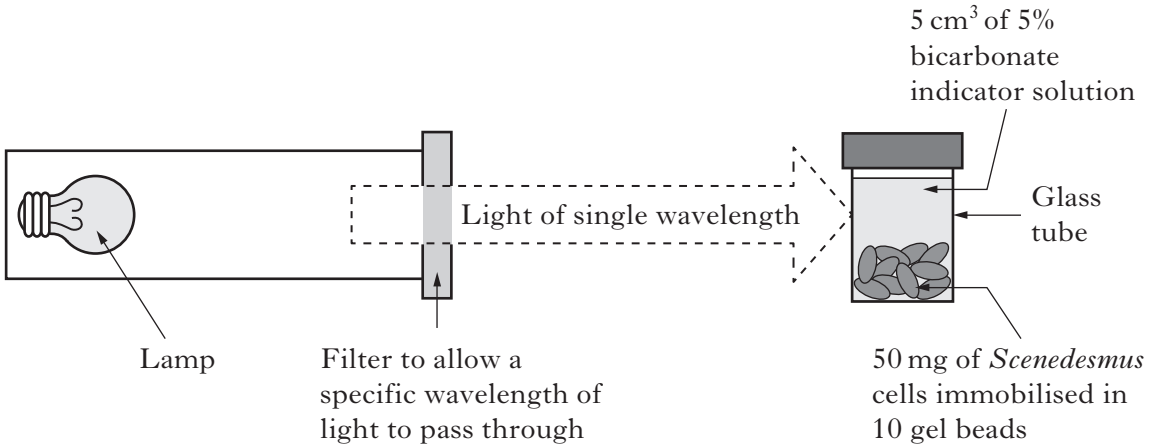
_____ **1**

[Turn over

Marks

11. Photosynthesis in algal cells can be measured by immersing them in bicarbonate indicator solution. The indicator solution gradually changes colour as carbon dioxide is removed from it by photosynthesis. This colour change can be measured by placing the solution in a colorimeter. The higher the rate of photosynthesis, the higher the reading on the colorimeter.

The effect of different wavelengths of light on rate of photosynthesis in *Scenedesmus*, an algal species which grows near the surface layers of fresh water lochs, was measured. The apparatus shown below was set up in a darkened room.



After one hour, the bicarbonate indicator was removed from the tube, placed in a colorimeter and a reading taken.

The experiment was carried out seven times using different filters, each of which allowed a single wavelength of light to pass through.

The results are shown in the table below.

Filter	*Wavelength of light passing through* (nanometres)	*Colorimeter reading* (units)
1	400	0·48
2	450	0·74
3	500	0·36
4	550	0·32
5	600	0·24
6	650	0·96
7	700	0·26

(*a*) Identify **two** variables, not already mentioned, that would have to be controlled to ensure that the experimental procedure was valid.

1 _____

2 _____ **2**

11. (continued)

Marks

(*b*) A control tube would be required for each wavelength of light being investigated.

Describe the contents of a suitable control tube.

_____

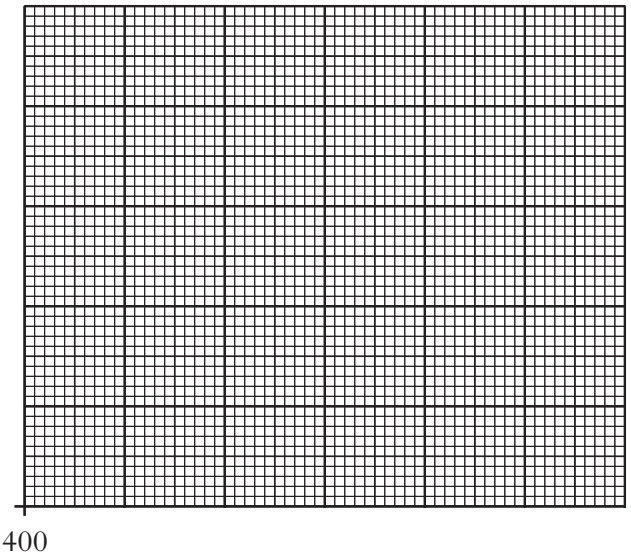
_____ **1**

(*c*) State why the tubes were left for one hour before the colorimeter readings were taken.

_____ **1**

(*d*) (i) On the grid provided, draw a line graph to show the colorimeter readings against wavelength of light.

(Additional graph paper, should it be required, will be found on *Page forty*.)



2

(ii) Give the reason why the graph of colorimeter reading against wavelength of light can be described as an action spectrum.

_____

_____ **1**

(*e*) The experiment was repeated with a second alga which lives in the water below *Scenedesmus*. This species has a higher proportion of carotenoid pigments in its cells than *Scenedesmus*.

Predict the colorimeter reading the indicator would give after exposure of the second alga to light of 500 nanometres and explain your answer.

Prediction _____ units **1**

Explanation _____

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

12. The non-native shrimp *Dikerogammarus villosus* has become established in fresh water communities in the wild in Britain.

(*a*) (i) Give the term used to describe non-native species which become established in wild communities.

_____ **1**

(ii) Explain why non-native species such as *D. villosus* can become established in wild communities.

_____

_____ **1**

(iii) Describe **one** environmental problem which species such as *D. villosus* can produce when they become established in wild communities.

_____

_____ **1**

(*b*) Biological control can be used to manage species which have become established in wild communities.

Describe what is meant by biological control.

_____

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

13. Oxpeckers are birds which form symbiotic relationships with zebra. The oxpeckers eat parasites which live on zebra skin.

(*a*) (i) State the meaning of the term symbiosis.

_____

_____ **1**

(ii) Explain the benefits to both the oxpeckers and the zebra of this relationship.

Oxpeckers _____

_____ **1**

Zebra _____

_____ **1**

(iii) Give the term which describes symbiotic relationships that benefit both species.

_____ **1**

(*b*) The zebra skin parasites cannot survive away from their zebra hosts and are transmitted to new hosts when zebra come into direct contact with each other.

(i) Explain why parasites cannot survive without their host.

_____

_____ **1**

(ii) Other than by direct contact, describe **one** way in which a parasite can be transmitted to a new host.

_____

_____ **1**

[Turn over

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Marks

14. The Earth has experienced five major mass extinction events as shown in the table below.

Extinction event	1	2	3	4	5
Approximate date (millions of years before present)	445	365	250	200	65
Percentage of animal families becoming extinct	50	30	60	35	50

(*a*) Identify the **two** events which were separated by the greatest time period. Tick (✓) the correct box.

Events 1 and 2 ☐ Events 2 and 3 ☐ Events 3 and 4 ☐ Events 4 and 5 ☐

1

(*b*) Give the type of evidence which confirms that these extinction events have occurred.

_____

1

(*c*) Explain how biodiversity is regained following a mass extinction event.

_____

_____

2

(*d*) The present rate of species extinction is higher than the natural background rate due to ecosystem degradation brought about by human activity.

Complete the table below to show how human activities are related to ecosystem degradation.

Human activity	*Effect of activity*	*Ecosystem degradation resulting from activity*
	habitat fragmented	size of habitat fragments insufficient for survival of certain species
burning of fossil fuels		melting of polar ice destroys habitat for certain species

2

SECTION C

Marks

Both questions in this section should be attempted.

Note that this section contains a choice.

Questions 1 and 2 should be attempted on the blank pages which follow.

Supplementary sheets, if required, may be obtained from the Invigilator.

All answers must be written clearly and legibly in ink.

Labelled diagrams may be used where appropriate.

1. Answer **either** A **or** B.

A. Write notes on gene expression in eukaryotes under the following headings:

(i) production of mRNA; **5**

(ii) translation of mRNA. **5**

(10)

OR

B. Write notes on mutation under the following headings:

(i) point mutations; **5**

(ii) chromosome mutations and polyploidy. **5**

(10)

In question 2, ONE mark is available for coherence and ONE mark is available for relevance.

2. Answer **either** A **or** B.

A. Give an account of the structure of the inner membranes of mitochondria and the function of the electron transport chain in cellular respiration. **(10)**

OR

B. Give an account of the general pattern of growth of microorganisms and the conditions needed for their culture. **(10)**

[*END OF QUESTION PAPER*]

DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWERS

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ADDITIONAL GRAPH PAPER FOR QUESTION 11 (*d*)