FOR OFFICIAL USE

Totals for Sections B and C

X274/12/02

NATIONAL QUALIFICATIONS 2014

FRIDAY, 16 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.

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. 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

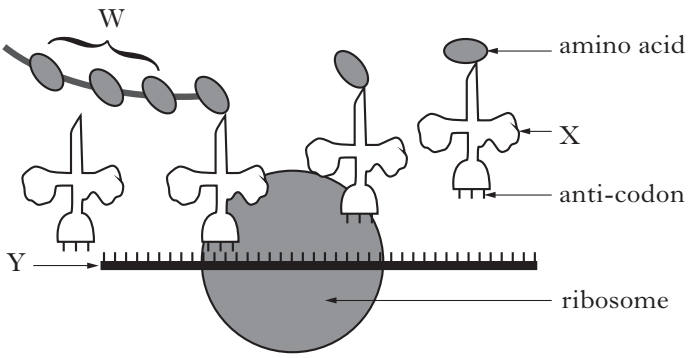
Which statements describe correctly the DNA sequences which make up the genome?

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

2. Which of the following is true of genetic drift?

A It acts in a random way.
B It is predictable in its action.
C Its effect is greater in large populations.
D It involves survival of the fittest.

3. The diagram below represents a stage in protein synthesis in a cell.



Which line in the table below identifies correctly molecules W, X and Y?

	Molecules		
	W	X	Y
A	tRNA	mRNA	polypeptide
B	polypeptide	tRNA	mRNA
C	mRNA	tRNA	polypeptide
D	polypeptide	mRNA	tRNA

4. Which line in the table below identifies correctly features of an mRNA molecule?

	Feature		
	Number of strands	*Sugar present*	*Bases include*
A	1	deoxyribose	thymine
B	1	ribose	uracil
C	2	deoxyribose	thymine
D	2	ribose	uracil

[Turn over

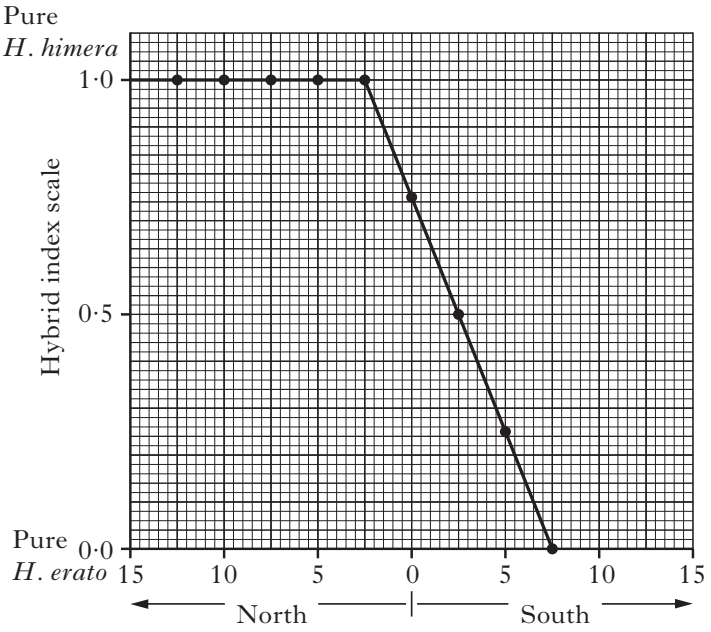
Questions 5 and 6 refer to the information and the graph below.

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 – 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.



Distance and direction from mid point of sampling line (km)

5. 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

6. Which line in the table below shows correctly the distance and direction of a site at which hybrids with a score of 0·25 would be expected?

	Distance (km)	*Direction*
A	2·5	south
B	5·0	south
C	1·0	north
D	7·5	north

7. Which of the following is **not** an example of a chromosome structure mutation?

A Insertion

B Duplication

C Translocation

D Inversion

8. Which line in the table below shows correctly the organisation of DNA in the cells or organelles given?

	Cell or organelle	*Organisation of DNA*	
		Circular chromosome	*Plasmid*
A	prokaryotic cell	absent	present
B	eukaryotic cell	present	present
C	mitochondrion	present	absent
D	chloroplast	absent	absent

9. Which of the following is synthesised by the process of translation?

A A polypeptide

B Messenger RNA

C Transfer RNA

D Ribosomal RNA

10. The polymerase chain reaction (PCR) is used to

A join DNA fragments

B cut open plasmid DNA

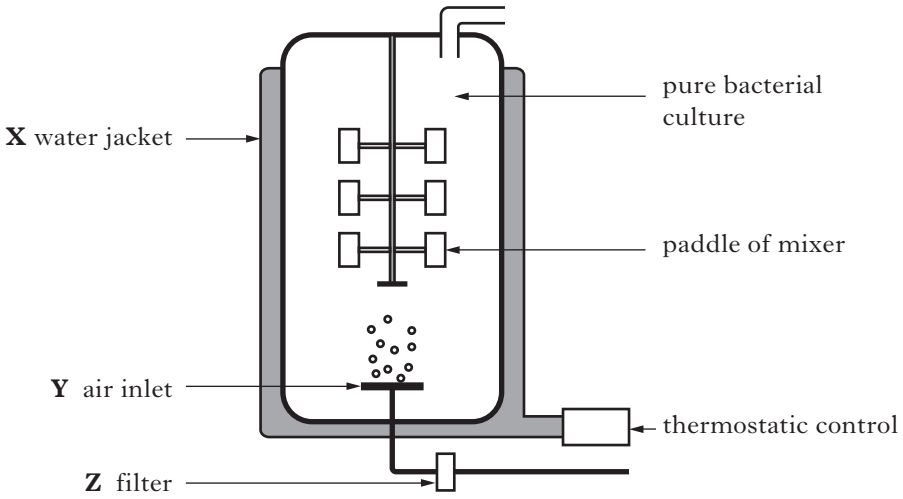
C amplify DNA

D extract DNA from cells.

11. Which line in the table below describes correctly features of the control of body temperature in humans?

	Feature of the control of body temperature	
	Monitoring centre	*Form of communication with effector*
A	skin	hormonal
B	skin	nervous
C	hypothalamus	hormonal
D	hypothalamus	nervous

12. The diagram below shows a fermenter.



Which line in the table below matches correctly the parts of the fermenter labelled X, Y and Z with the functions they are involved in?

	Function of fermenter parts		
	maintaining temperature	*controlling oxygen levels*	*maintaining sterility*
A	X	Y	Z
B	X	Z	Y
C	Y	X	Z
D	Y	Z	X

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

	Roles of protein		
	enzymes	*pores*	*pumps*
A	✓	✗	✗
B	✗	✓	✓
C	✗	✗	✓
D	✓	✓	✓

14. Which line in the table below identifies correctly the change in activation energy brought about by an enzyme and the affinity of its product for the active site?

	Change in activation energy	*Affinity of product for the active site*
A	lowered	high
B	lowered	low
C	raised	low
D	raised	high

[Turn over

15. Reactions can be described as anabolic or catabolic.

The list below shows some reactions in cells.

1 Production of pyruvate from glucose
2 Production of starch from sugars
3 Production of polypeptides from amino acids

Which line in the table below matches correctly the reactions with their description?

	Description	
	Anabolic	*Catabolic*
A	2 and 3	1
B	1, 2 and 3	none of these
C	none of these	1, 2 and 3
D	1	2 and 3

16. Buffers are added to culture media to

A provide vitamins
B maintain the pH
C provide fatty acids
D maintain the temperature.

17. Which of the following substances can be broken down into glucose to be used as a substrate for respiration?

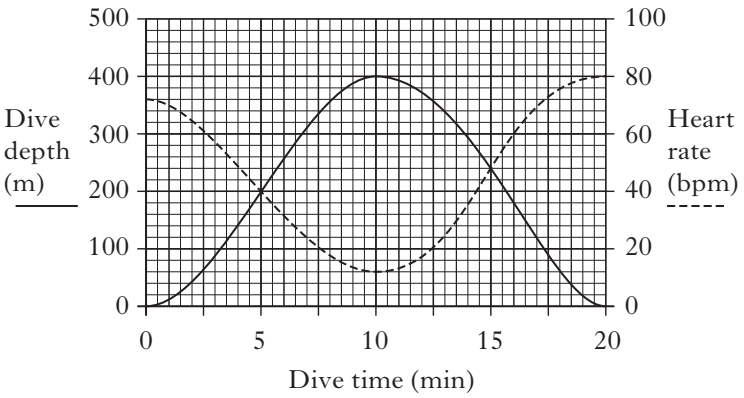
A Fat and starch
B Protein and starch
C Starch and glycogen
D Glycogen and protein

18. Which line in the table below shows correctly the number of each type of chamber in amphibian and bird hearts?

	Number of atria		*Number of ventricles*	
	Amphibian	*Bird*	*Amphibian*	*Bird*
A	2	2	1	2
B	1	2	2	1
C	2	1	2	1
D	2	1	1	2

19. Seals dive to hunt for fish and squid.

The graph below shows how a seal's heart rate changed during a dive.

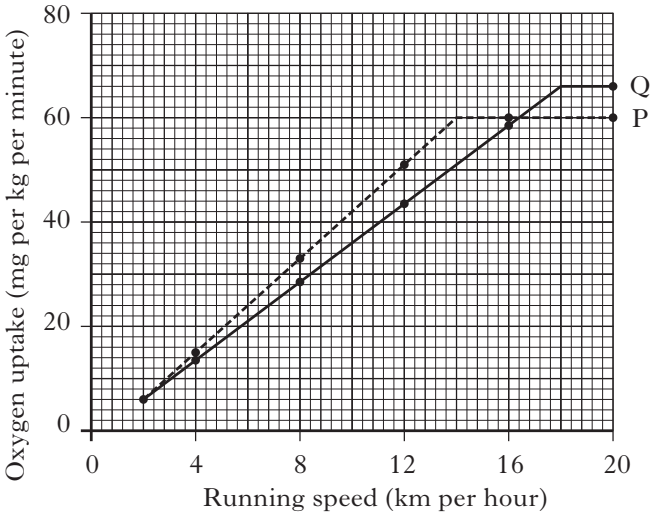


Which of the following conclusions can be drawn from the graph?

The heart rate of the seal

A reaches its maximum 10 minutes into dive
B decreases as dive depth increases
C increases as the seal dives to 400 m
D decreases as the seal resurfaces.

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



Which line in the table below shows correctly the fittest athlete based on the information in the graph and the reason for this conclusion?

	Athlete	*Reason for conclusion*
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

21. The action spectrum of photosynthesis shows the ability of green plants to

A use light for photolysis

B absorb all wavelengths of light in photosynthesis

C absorb different wavelengths of light in photosynthesis

D use light of different wavelengths for photosynthesis.

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

A economic yield by the net assimilation

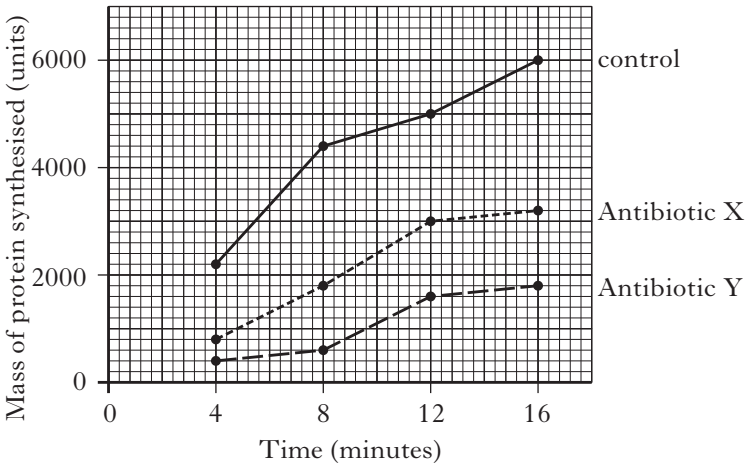
B biological yield by the net assimilation

C economic yield by the dry mass of the biological yield

D biological yield by the dry mass of the economic yield.

23. An experiment was carried out to compare the effect of two antibiotics, X and Y, on the rate of protein synthesis in bacterial cells.

The results are shown in the graph below.



Which of the following conclusions from the graph is valid?

A Antibiotic X was less effective than antibiotic Y in inhibiting bacterial protein synthesis.

B Antibiotic Y was less effective than antibiotic X in inhibiting bacterial protein synthesis.

C Bacterial protein synthesis was inhibited to the greatest extent without antibiotics.

D The rate of protein synthesis was greatest between 12 and 16 minutes in all cases.

[Turn over

24. Many varieties of garden plants grown by breeders are F_1 hybrids which often show increased vigour and yield.

Further generations are not usually produced from these F_1 plants because the F_2 generation would be

A heterozygous

B homozygous

C genetically variable

D genetically uniform.

25. 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.

26. Flashlight fish, *Photoblepharon*, have organs beneath their eyes containing bacteria which give out light. The fish use the light to attract prey and the bacteria gain nutrients from the fish.

This is an example of

A altruism

B mutualism

C parasitism

D competition.

27. The list below gives examples of benefits gained from types of behaviour in animals.

W increased survival of shared genes

X unnecessary conflict reduced

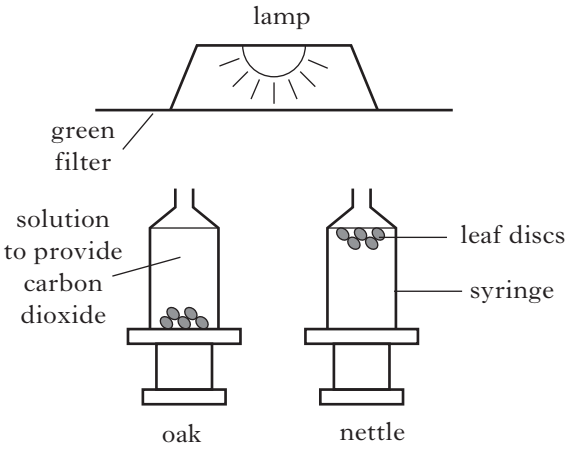
Y subordinates gain more food than by foraging alone

Which line in the table below matches correctly types of animal behaviour with the benefits they give?

	Type of animal behaviour		
	cooperative hunting	*appeasement*	*kin selection*
A	W	X	Y
B	Y	W	X
C	X	Y	W
D	Y	X	W

28. 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.

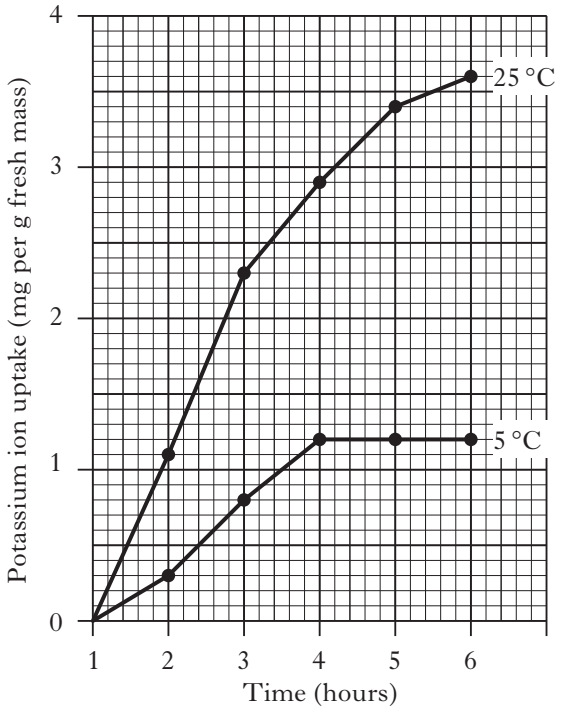
B Use different species of plant.

C Use more leaf discs.

D Repeat the experiment.

29. In an investigation into growing conditions for carrots, the uptake of potassium ions into samples of carrot root tissue at different temperatures was measured.

The results are shown in the graph below.



At 6 hours, how many times greater is the uptake of potassium ions at 25 °C compared to 5 °C?

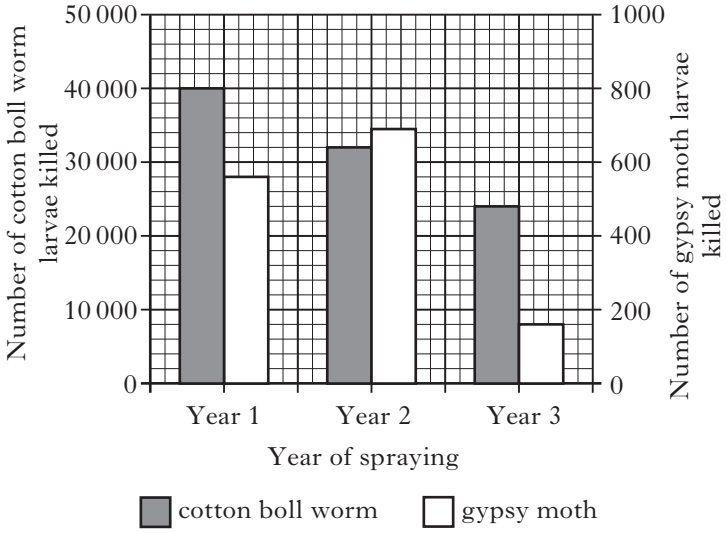
A 1·2

B 2·0

C 2·4

D 3·0

30. The larvae of gypsy moths and cotton boll worms are pests of tree leaves. An experimental plot of infested trees was sprayed with insecticide in three different years. The numbers of each larvae killed in each year is shown in the graph below.



Which of the following conclusions can be drawn?

A More gypsy moth larvae were killed than cotton boll worm larvae in year 2.

B The larvae became more resistant to the insecticide each year.

C The number of gypsy moth larvae killed was always less than cotton boll worm larvae killed.

D The percentage of cotton boll worm larvae surviving decreased each year.

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

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

SECTION B

All questions in this section should be attempted.
All answers must be written clearly and legibly in ink.

1. (*a*) (i) Decide if each of the statements relating to DNA in the table below is **true** or **false** and tick (✓) the appropriate box.

If you decide that the statement is **false**, write the correct term in the correction box to replace the term underlined in the statement.

Statement	*True*	*False*	*Correction*
A chromosome is made up of DNA associated with proteins.			
DNA has a double-stranded parallel structure.			
One strand of DNA has deoxyribose at the 3' end of one strand and a base at the 5' end.			

2

(ii) A section of a DNA molecule containing a total of 1600 bases has 184 adenine and 216 thymine bases on one strand. The complementary strand contains 268 cytosine bases.

1 Calculate the number of adenine bases in this **whole section** of the DNA molecule.

Space for calculation

_____ **1**

2 Calculate the number of guanine bases in the **complementary** strand.

Space for calculation

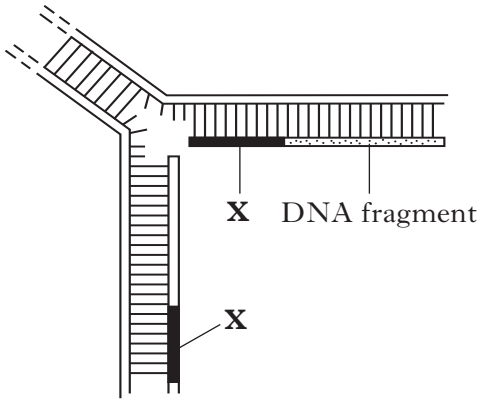
_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

1. (continued)

(*b*) The diagram below shows a small part of a DNA molecule during replication.



(i) Name the short sequences of bases **X** needed to start DNA replication.

_____ **1**

(ii) Name the enzyme responsible for joining DNA fragments together during replication.

_____ **1**

(*c*) Name the enzyme required for the synthesis of a primary transcript from RNA nucleotides during protein production.

_____ **1**

(*d*) A single gene can be expressed to produce a variety of proteins.

Give **two** processes which can bring about the production of different proteins from the same gene.

1 _____

2 _____ **2**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

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.

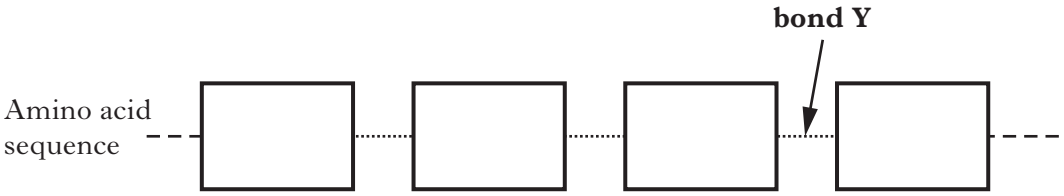
mRNA codon	*Abbreviation for amino acid coded for*
GUA	val
CUU	leu
AGA	ser
CAU	his
UGA	thr
GAA	glu
GGA	pro

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**

(*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**

DO NOT WRITE IN THIS MARGIN

Marks

2. (*c*) (continued)

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

_____

_____ **1**

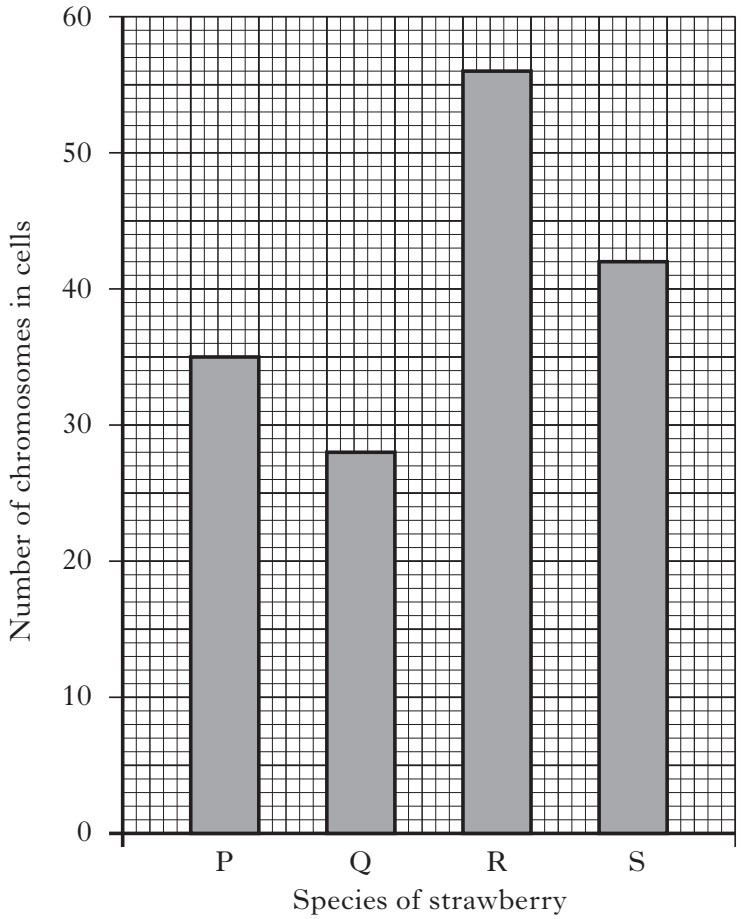
[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

3. Some strawberry plant species are polyploid and have evolved from a wild ancestor.

The chart below shows the numbers of chromosomes in the cells of four species of strawberry.



(*a*) Calculate the simplest whole number ratio of the chromosome numbers of all four strawberry species.

Space for calculation

_____ : _____ : _____ : _____ **1**

Species P Species Q Species R Species S

(*b*) The ancestral wild strawberry species has a chromosome complement of fourteen.

Describe the events during cell division in the wild species which has led to the production of species Q.

_____

_____ **1**

(*c*) Give **one** example of the benefit to humans of polyploidy in food crops.

_____

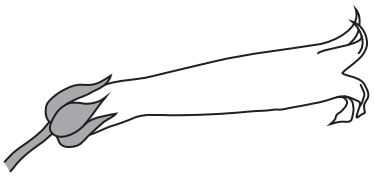
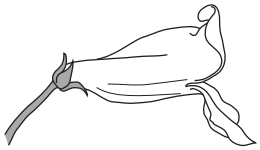
_____ **1**

[Turn over for Question 4 on *Page sixteen*

Marks

4. Three species of *Penstemon* plants have evolved side by side in the same areas of North America through speciation from a common ancestor.

Each species has specialised pollinators adapted to reach nectar found in nectaries inside their flower tubes, close to the base.

Species	*Scale drawing of flower tube*	*Specialised pollinator*
Penstemon grinnellii		large bees
Penstemon centranthifolius		hummingbirds
Penstemon spectabilis		wasps and small bees

(*a*) (i) From the information given above, explain how interbreeding between the three species of *Penstemon* is prevented.

_____

_____

_____ **1**

(ii) Name the type of speciation which has resulted in the evolution of the three species of *Penstemon*.

_____ **1**

(iii) Describe the evidence which could confirm that these plants are different species.

_____

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

4. (continued)

(*b*) Underline one word in each pair to make the sentences correct.

Flowering plants are { eukaryotic / prokaryotic } and pass on their genetic sequences { vertically / horizontally }.

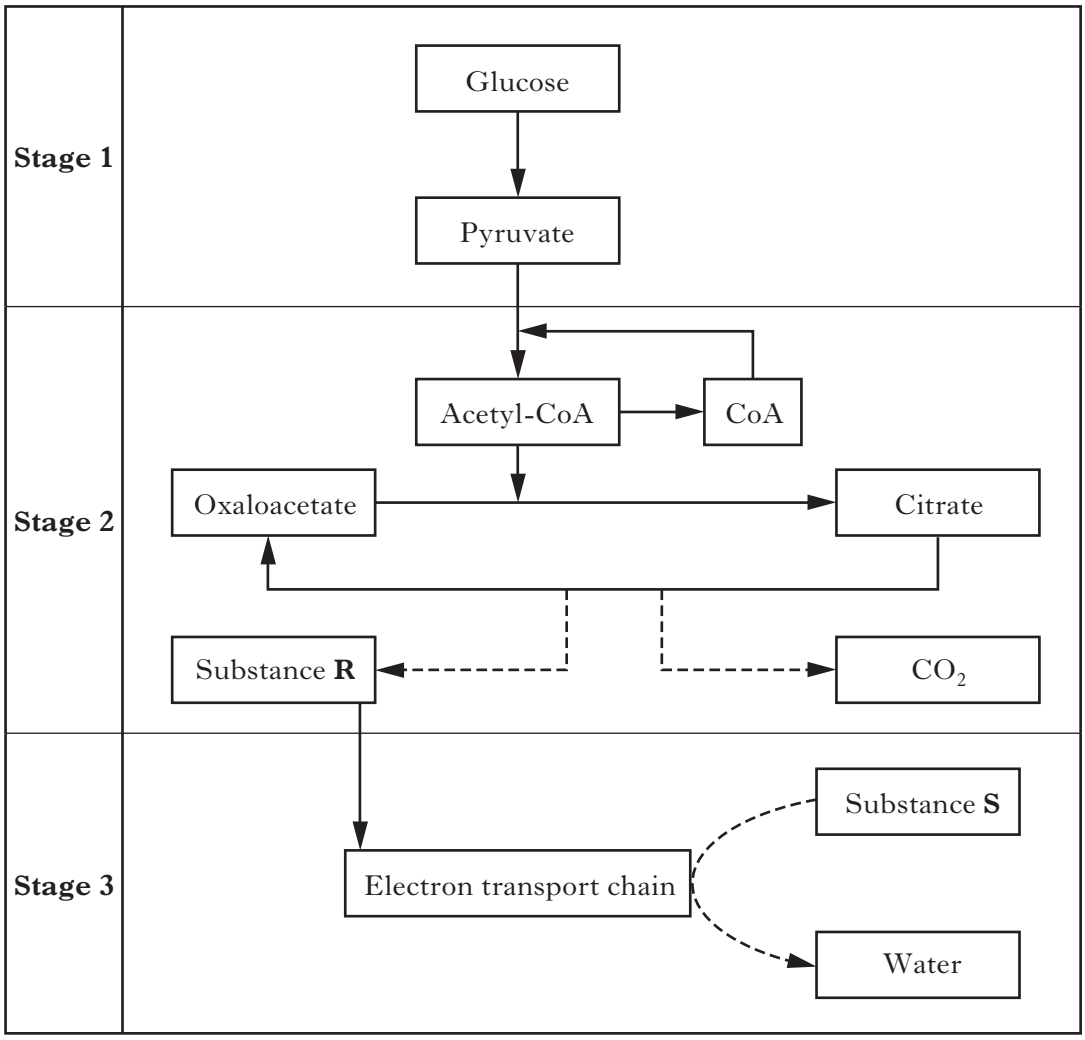
The type of reproduction in flowering plants which gives the greatest potential to produce variety in the offspring is { asexual / sexual }. **2**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

5. The diagram below shows an outline of three stages of aerobic respiration in muscle cells.



(*a*) Name **Stage 1**.

_____ **1**

(*b*) Oxygen must be available for pyruvate to progress to **Stage 2** as shown in the diagram.

State what happens to pyruvate in muscle cells in the absence of oxygen.

_____ **1**

Marks

5. (continued)

(*c*) Name Substance **R** in **Stage 2** and two coenzymes which can transfer it to the electron transport chain.

Substance **R** _____

1 _____

2 _____ **2**

(*d*) Name Substance **S** in **Stage 3** and describe its role in aerobic respiration.

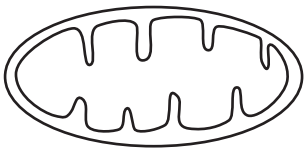
(i) Substance **S** _____ **1**

(ii) Role in aerobic respiration _____

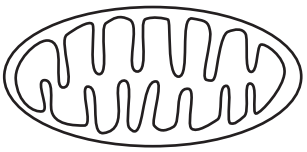
_____ **1**

(*e*) The diagrams below show the structure of a mitochondrion from a skin cell and one from a muscle cell.

A Mitochondrion from skin cell



B Mitochondrion from muscle cell



Mitochondrion **B** has a greater surface area of inner mitochondrial membrane than **A**.

Explain how the difference in structure between the two mitochondria is related to the function of the **muscle** cell.

_____

_____

_____ **2**

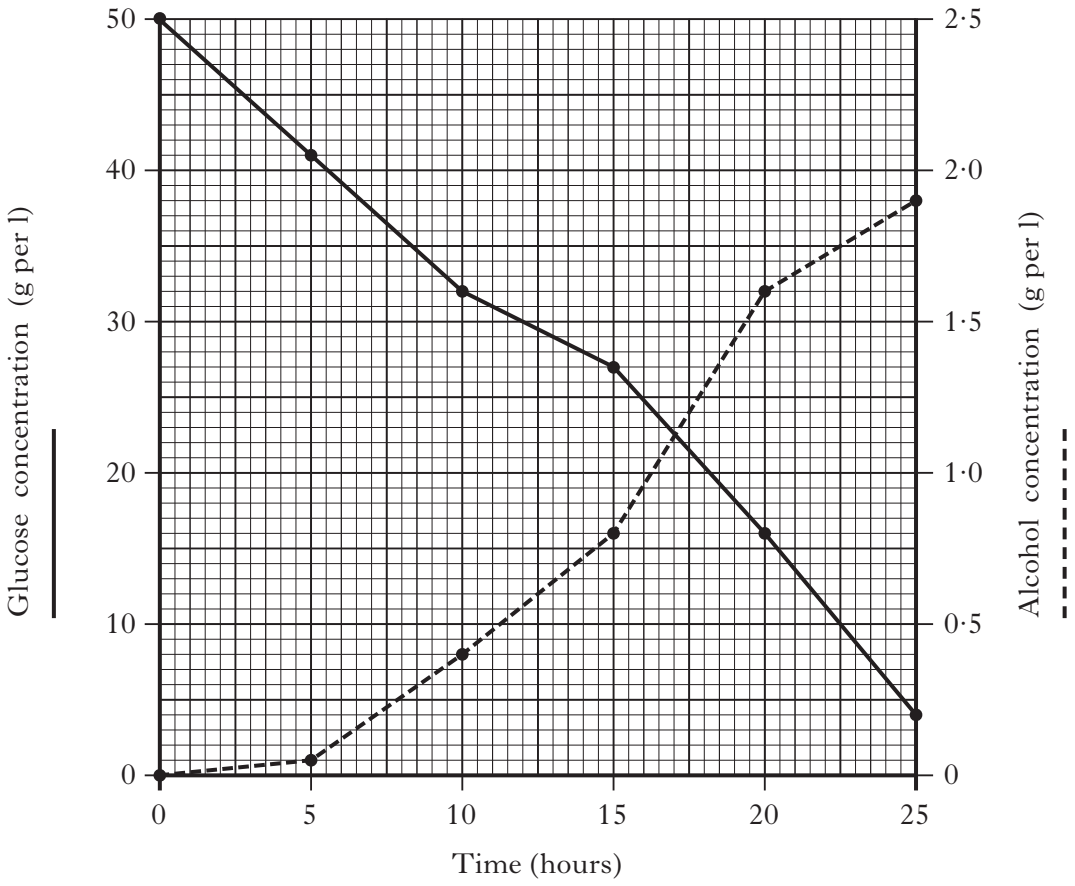
[Turn over

Marks

6. A culture of yeast was grown in 5 litres of glucose solution.

Glucose and alcohol concentrations in the culture were measured every 5 hours for 25 hours.

The results are shown in the graph below.



(*a*) State the alcohol concentration when the glucose concentration was 10 g per litre.

_____ g per litre **1**

(*b*) Tick (✓) the box to identify the time period during which the rate of alcohol production was the greatest.

0 – 10 hours	5 – 15 hours	10 – 20 hours	15 – 25 hours
☐	☐	☐	☐

1

DO NOT WRITE IN THIS MARGIN

Marks

6. (continued)

(*c*) Identify the time at which the glucose concentration reached 50% of its starting concentration.

_____ hours **1**

(*d*) Calculate how many grams of glucose remained in the solution at the end of the investigation.

Space for calculation

_____ g **1**

[Turn over

Marks

7. An investigation was carried out to study the effects of exercise on sweat production in humans.

An exercise bike was placed in a laboratory with constant humidity and temperature.

A healthy 30-year-old male exercised on the bike for five trials of different durations as shown in the table below. The average rate of sweat production during each trial was calculated.

There was a recovery period after each trial to allow sweat production to return to a normal level.

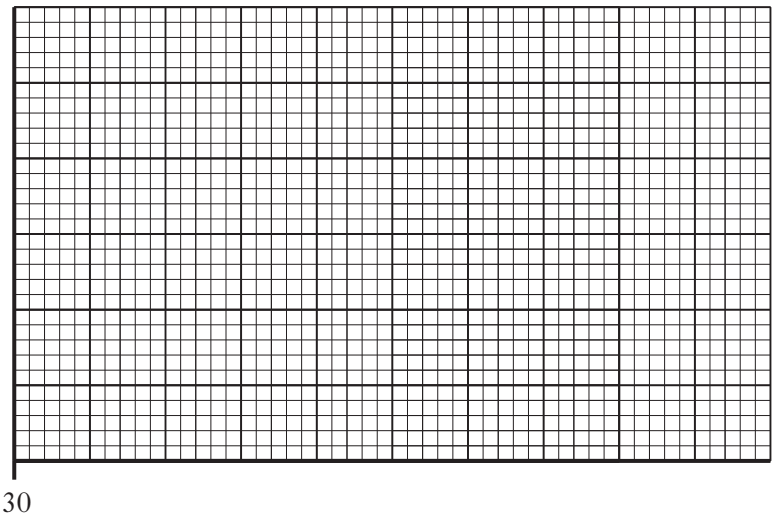
The results are shown in the table below.

Exercise trial	*Duration of exercise trial* (s)	*Average rate of sweat production* (mg per cm^2 skin per minute)
1	30	0·10
2	60	0·21
3	90	0·32
4	120	0·43
5	150	0·45

(*a*) On the grid below draw a line graph of average rate of sweat production against the duration of exercise.

Choose an appropriate scale to fill most of the graph paper.

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



2

(*b*) (i) Give **two** variables, not already described, which should be kept constant to allow valid comparison of the exercise trials.

1 _____

2 _____ **2**

DO NOT WRITE IN THIS MARGIN

Marks

7. (*b*) (continued)

(ii) State how the procedure could be improved to increase the reliability of the results.

_____

_____ **1**

(*c*) Explain how the units of sweat production used in this investigation would allow a valid comparison between different individuals to be made.

_____

_____

_____ **1**

(*d*) Calculate the total mass of sweat produced per cm^2 during exercise trial 3.

Space for calculation

_____ mg per cm^2 **1**

(*e*) Predict the rate of sweat production which would be expected in an exercise trial with a duration of 180 seconds.

_____ mg per cm^2 per minute **1**

(*f*) (i) Sweat production is a corrective mechanism used in the regulation of body temperature.

Explain why regulating body temperature is important to the metabolism of humans.

_____

_____ **1**

(ii) Give the term used for animals which can control their internal temperature by negative feedback.

_____ **1**

[Turn over

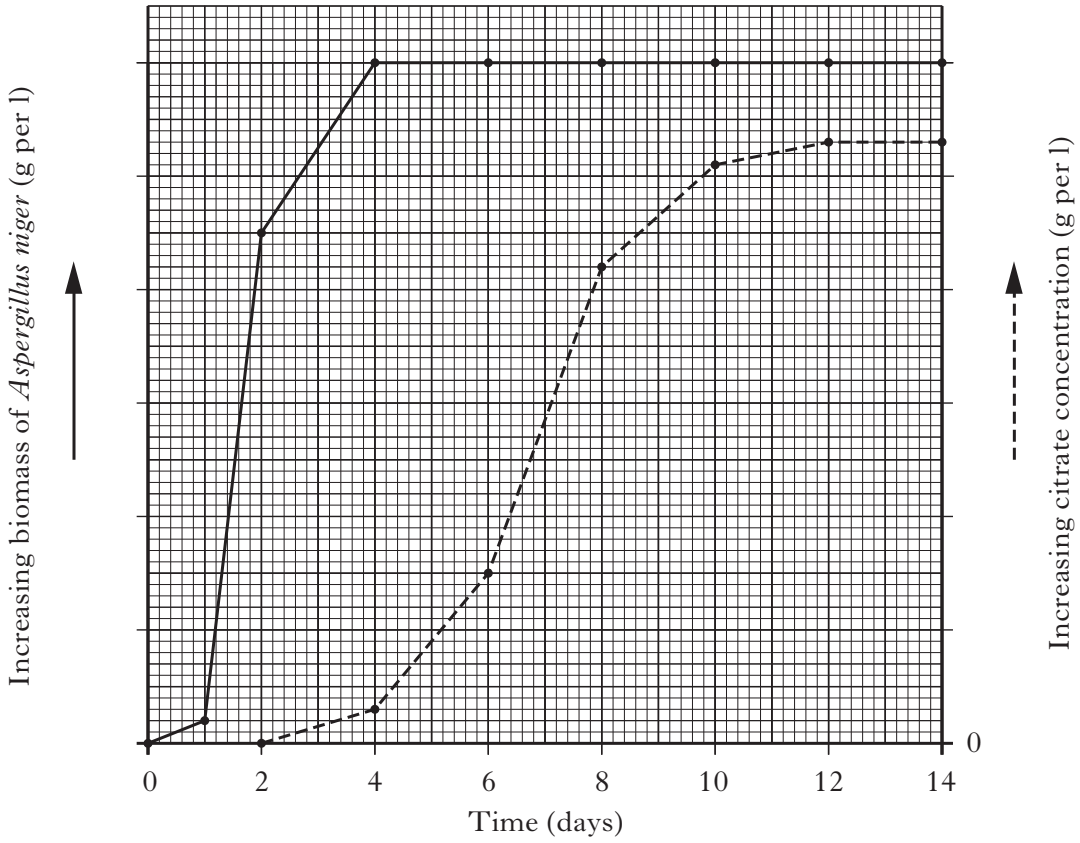
DO NOT WRITE IN THIS MARGIN

Marks

8. Citrate is used in the food industry as a flavouring agent. Large quantities of citrate are produced in fermenters by the fungus *Aspergillus niger*.

The fungus was added to a growth medium and grown in a fermenter for 14 days.

The graph below shows the changes in biomass of the fungus and in the concentration of citrate over the growth period.



(*a*) Identify the time period during which the log (exponential) phase of the growth of *Aspergillus niger* occurs.

Tick (✓) the correct box.

☐ Day 0 – 1 ☐ Day 1 – 4 ☐ Day 4 – 12 ☐ Day 12 – 14 **1**

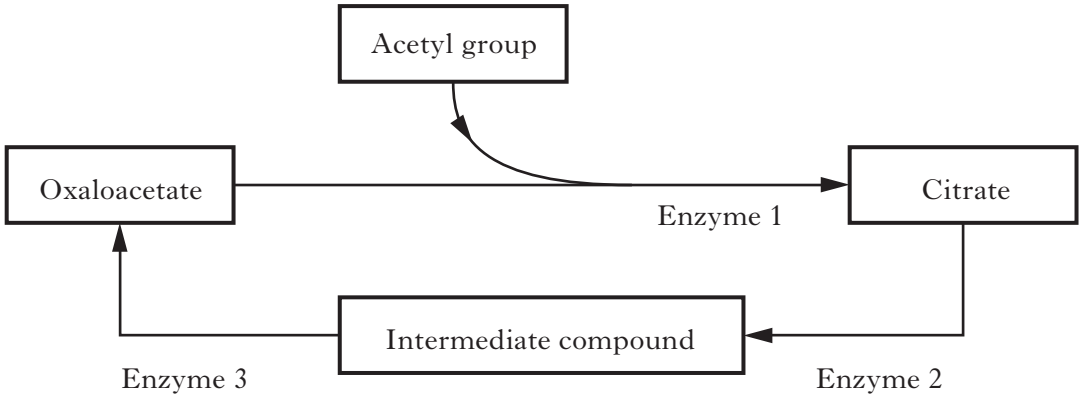
(*b*) Suggest **one** reason why citrate was not produced until day 2.

_____

_____ **1**

8. (continued) *Marks*

(*c*) The diagram below shows some of the enzyme controlled reactions involved in the production of citrate.



Citrate production can be increased by inhibiting particular enzymes.

From the diagram, identify the enzyme which should be inhibited to increase citrate yield and justify your choice.

Enzyme _____

Justification _____

_____ **2**

(*d*) Industrial fermentation at optimum temperature and pH is used to make useful products.

(i) Apart from enzyme inhibitors, give an example of a substance which could be added to the fermenter to give increased yield of the desired product.

_____ **1**

(ii) Name a process by which a wild strain of a micro-organism can be improved to increase the yield of a desired product.

_____ **1**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

9. (*a*) Marmots are mammals which hibernate below ground in winter.

In an investigation into metabolic rate, the oxygen consumption of a 2·5 kilogram marmot was measured before the start and over the first four days of its hibernation.

The results are shown in the table below.

Day	*Oxygen consumption* (cm^3 per gram of body mass per hour)
(before start of hibernation period)	1·8
1	1·4
2	0·3
3	0·2
4	0·2

(i) Calculate the **total** volume of oxygen consumed by the marmot on Day 4.

Space for calculation

_____ cm^3 oxygen **1**

(ii) Explain how hibernation helps the marmot survive the adverse conditions of winter.

_____

_____ **1**

(*b*) Some species of small mammal with high metabolic rates enter a state of reduced activity each day to survive adverse conditions.

Give the term used to describe this state.

_____ **1**

(*c*) Many species of bird avoid metabolic adversity by relocating to a more suitable environment.

(i) Name this type of behaviour.

_____ **1**

(ii) Specialised techniques are used to study long-distance bird movements.

Describe **one** such technique.

_____

_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

10. 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*) Apart from being absorbed, state what else can happen to light striking the leaves of plants.

_____ **1**

(*b*) Identify which of the pigments, X or Y, in the table is chlorophyll.

Justify your choice.

Pigment _____

Justification _____

_____ **1**

(*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**

[Turn over

DO NOT WRITE IN THIS MARGIN

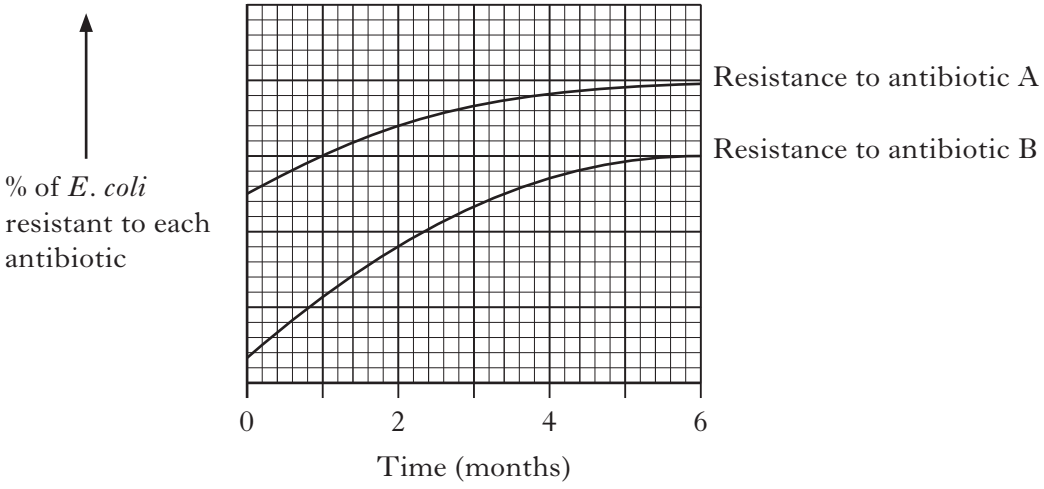
Marks

11. The bacterium *Escherichia coli* lives in the intestines of domestic pigs. New generations of *E. coli* can arise every twenty minutes under ideal conditions.

An investigation was carried out over a six-month period during which time pigs were regularly injected with a mixture of antibiotics A and B.

At regular intervals during this investigation, *E. coli* from the intestines of the pigs were sampled and tested for antibiotic resistance.

The graph below shows changes in the percentage of *E. coli* in the samples which were resistant to each antibiotic.



(*a*) Explain how the increase in resistance to antibiotic B has arisen by natural selection.

_____

_____

_____ **2**

(*b*) The pigs in this investigation had previously been treated with one of the antibiotics.

Identify this antibiotic and justify your answer with evidence from the graph.

Antibiotic _____

Justification _____

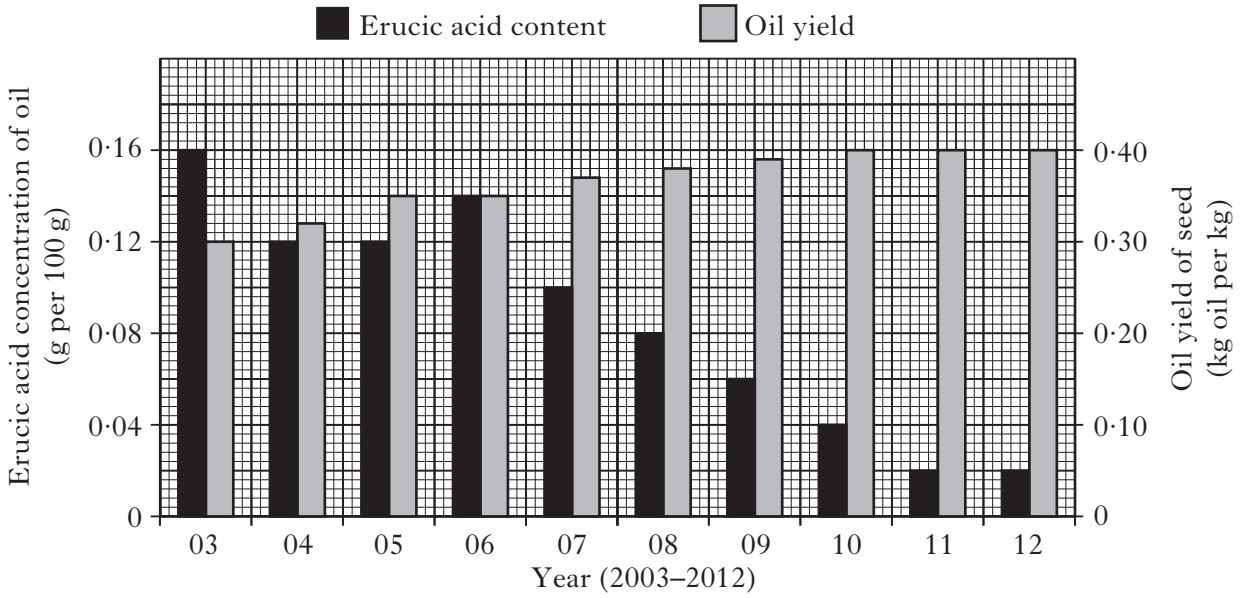
_____ **1**

[Turn over for Question 12 on *Page thirty*

12. Oil from wild varieties of oilseed rape plants contains a high concentration of erucic acid which makes the oil unsuitable for human consumption.
Selective breeding programmes have produced modern varieties of oilseed rape plants with oil of low erucic acid concentration which is suitable for human consumption.
In 2003 a new selective breeding programme was started which aimed to further reduce the erucic acid concentration of the oil and to increase oil content of seeds.

Marks

The **bar chart** below shows the results of the new selective breeding programme over a 10 year period.



(*a*) (i) Use values from the **bar chart** to describe the changes in erucic acid concentration of the oil from 2005 until 2012.

_____

_____

_____

_____ **2**

(ii) Calculate the simplest whole number ratio of the erucic acid concentration of the 2003 harvest compared with that of the 2011 harvest.

Space for calculation

_____ in 2003 : _____ in 2011 **1**

(iii) Calculate the average increase per year in oil yield from 2003 to 2011.

Space for calculation

_____ kg oil per kg seed per year **1**

12. (*a*) (continued)

Marks

(iv) Calculate the mass of seed from 2012 which would be needed to produce one kilogram of oil.

Space for calculation

_____ kg **1**

(*b*) The bacterium *Bacillus thuringiensis* produces Bt-toxin, a substance harmful to leaf-eating insects. Some oilseed rape plants were genetically engineered so that they contained the gene for Bt-toxin.

A field trial was set up to compare seed yields in genetically engineered plants with the Bt-toxin gene and control plants without the Bt-toxin gene. Equal numbers of the two types of plant were grown under identical conditions in the presence of leaf-eating insects and their seed yields per hectare compared.

The results of the trial are shown in the **table** below.

Plants	*Seed yield* (kg per hectare)
Genetically engineered (with the Bt-toxin gene)	144
Control (without the Bt-toxin gene)	80

(i) Calculate the percentage increase in the seed yield per hectare from plants with the Bt-toxin gene compared with the control plants.

Space for calculation

_____ % **1**

(ii) Explain why the genetically engineered plants produce a higher yield of seed per hectare compared with the control plants.

_____

_____

_____ **2**

(iii) The selectively bred plants which produced the 2012 harvest were affected by leaf-eating insects.

Using information from the **table** and the **bar chart**, predict the increase in **oil yield** per hectare which could have been achieved, if these plants had been:

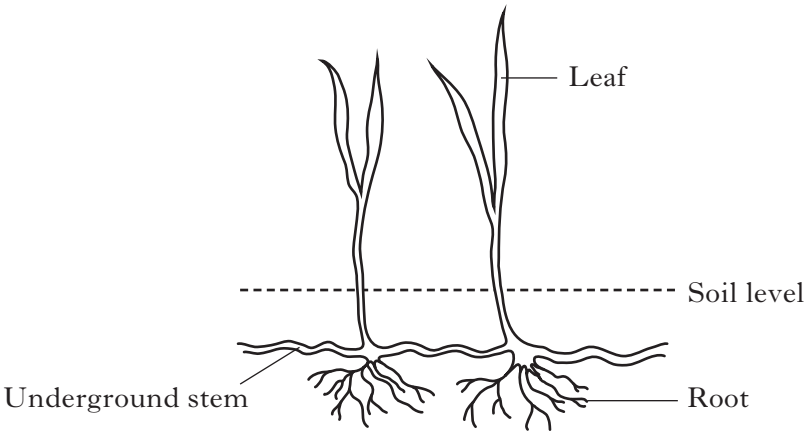
- genetically engineered to contain the Bt-toxin gene
- grown under identical conditions to those in the field trial.

Space for calculation

Increase in oil yield: _____ kg oil per hectare **1**

Marks

13. African couch grass is a perennial weed of crops 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*) Explain why herbicide used in the control of this weed should be systemic.

_____

_____ **1**

(*b*) (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**

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

_____

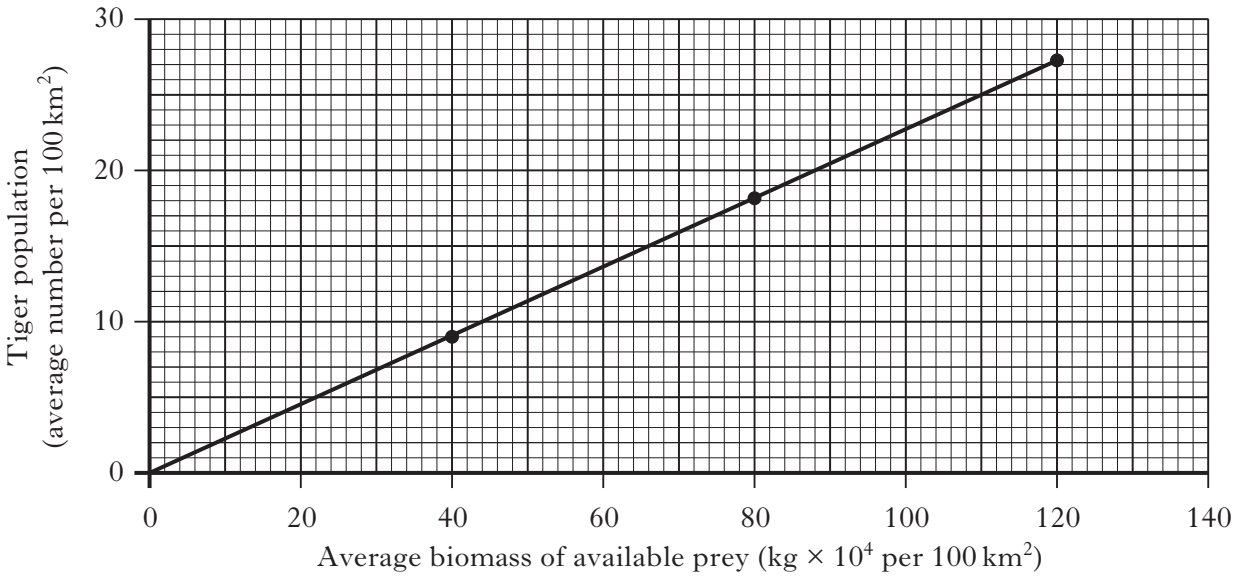
_____ **1**

DO NOT WRITE IN THIS MARGIN

Marks

14. Asiatic tiger populations are monitored because the species is now endangered. One of the threats to tiger survival is reduction in prey numbers.

The graph below shows the relationship between the average population of tigers and the average biomass of their prey in their Asian habitats.



(*a*) (i) Give the average tiger population per 100 km^2 that could be supported by an available prey biomass of 110 × 10^4 kg per 100 km^2.

_____ tigers **1**

(ii) Calculate the increase in average number of tigers per 100 km^2 as the available prey biomass increases from 40 × 10^4 to 80 × 10^4 kg per 100 km^2.

Space for calculation

_____ tigers **1**

(iii) From the graph, predict the average prey biomass which would be required to support a population of 30 tigers per 100 km^2.

Space for calculation

_____ kg per 100 km^2 **1**

[Turn over

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Marks

14. (continued)

(*b*) Habitat fragmentation has forced tiger populations into small, scattered areas of remaining habitat. The creation of habitat corridors can reduce the impact of habitat fragmentation.

Give **two** ways by which the creation of habitat corridors can reduce the impact of habitat fragmentation to tiger populations.

1 _____

2 _____ **2**

DO NOT WRITE IN THIS MARGIN

Marks

SECTION C

Both questions in this section should be attempted.

Note that each 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.

Labelled diagrams may be used where appropriate.

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

A. Write notes on biodiversity under the following headings:

(i) measuring biodiversity; **4**

(ii) threats to biodiversity. **6**

(10)

OR

B. Write notes on human food supply under the following headings:

(i) food security and population; **3**

(ii) factors affecting food production. **7**

(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 stem cells, their therapeutic use and the ethical issues surrounding their use. **(10)**

OR

B. Give an account of genomics and its importance in phylogenetics and personalised medicine. **(10)**

[*END OF QUESTION PAPER*]

[Turn over

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SPACE FOR ANSWERS

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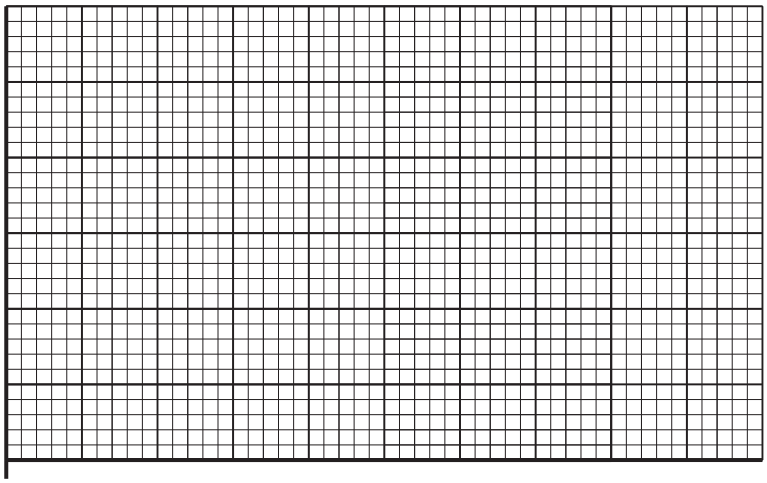
ADDITIONAL GRAPH PAPER FOR QUESTION 7 (*a*)



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