FOR OFFICIAL USE

National Qualifications 2015

Mark

X707/76/01

Biology
Section 1 — Answer Grid and Section 2

WEDNESDAY, 13 MAY
1:00 PM – 3:30 PM

X7077601

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

Scottish candidate number

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.

Questions 5 and 13 each contain a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. 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.

SQA ©

X707760101

SECTION 1— 20 marks

The questions for Section 1 are contained in the question paper X707/76/02.
Read these and record your answers on the answer grid on *Page three* opposite.
Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).

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

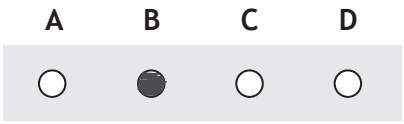
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample Question

The thigh bone is called the

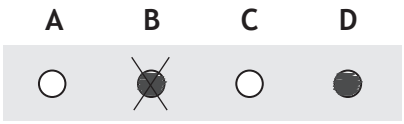
A humerus
B femur
C tibia
D fibula.

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

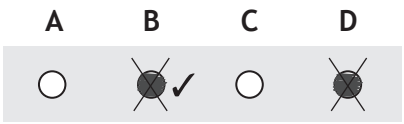


Changing an answer

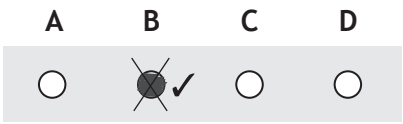
If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



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:



or



SECTION 1 — Answer Grid

OBJ20AD1

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

X707760103

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DO NOT WRITE ON THIS PAGE

[Turn over for Question 1 on *Page six*

DO NOT WRITE ON THIS PAGE

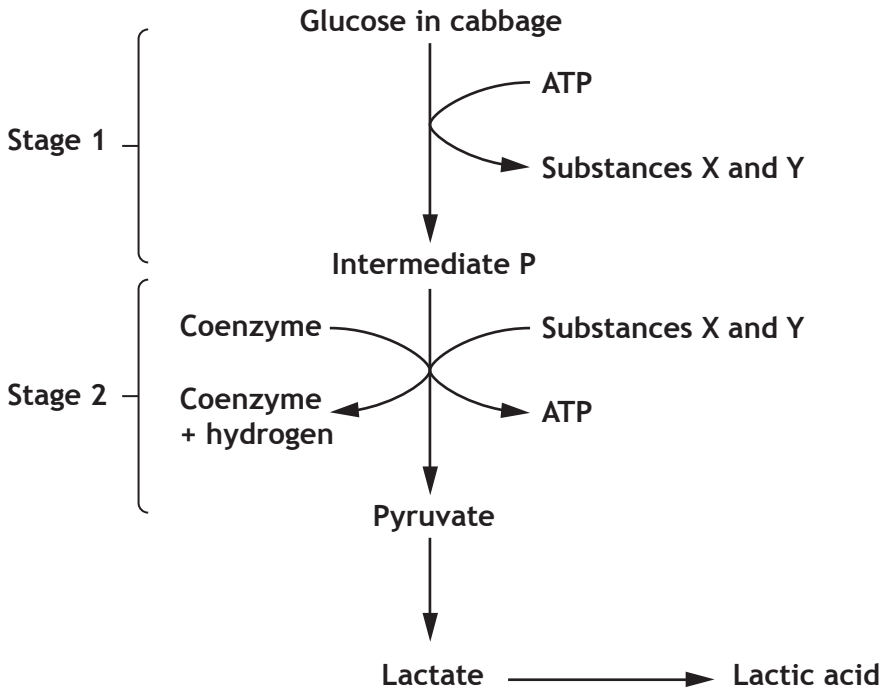
SECTION 2 — 80 marks

Attempt ALL questions

Questions 5 and 13 each contain a choice.

1. 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. **1**

X _____

Y _____

(ii) Name the coenzyme, shown in the diagram, which carries hydrogen to the electron transport chain. **1**

_____

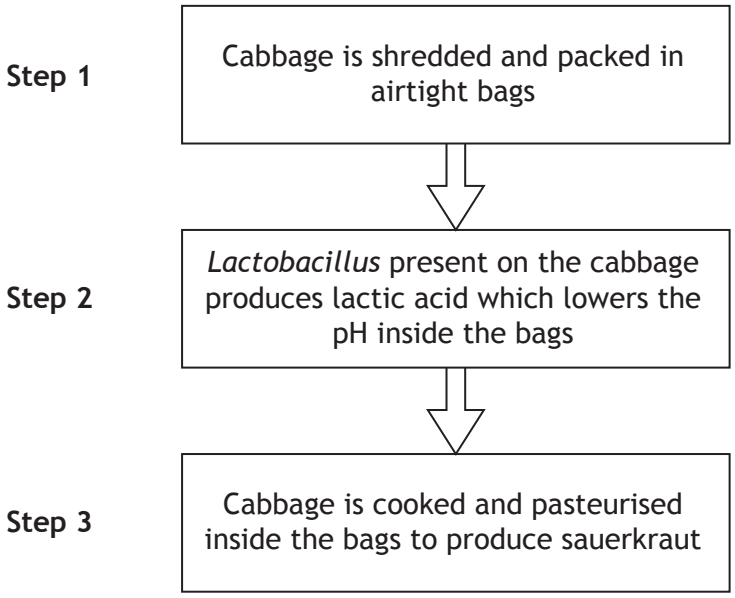
(iii) Explain why the ATP produced at **Stage 2** in the diagram is referred to as an energy pay off. **1**

_____

_____

1. (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**

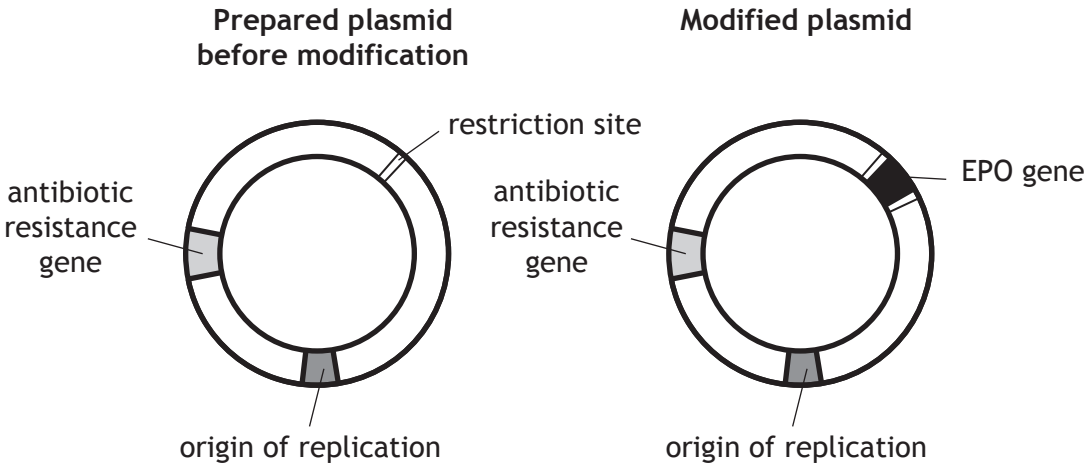
(ii) Explain why the process encourages the growth of *Lactobacillus* but inhibits the growth of other bacteria. **1**

[Turn over

2. 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 was 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 was 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**

2. (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

3. (a) The yeast *Kluyveromyces marxianus* uses lactose as a respiratory substrate. An investigation was carried out into the effect of lactose concentration on ethanol production by this yeast species. Five flasks were set up each containing 5 cm^3 of yeast suspension and 100 cm^3 of 4, 8, 12, 16 or 20% lactose solution. The flasks were sealed to maintain anaerobic conditions.

Samples were removed from each flask at 12 and 36 hours and the concentration of ethanol was determined. Results are shown in the table below.

Lactose concentration (%)	*Ethanol concentration* (g per 100 cm^3)	
	12 hours	*36 hours*
4	1·20	1.65
8	1·55	2·80
12	2·00	4·25
16	2·80	3·25
20	2·80	6·50

(i) Identify the independent variable. **1**

_____

(ii) Identify **one** variable not already mentioned that should be kept constant so that a valid conclusion can be drawn. **1**

_____

(b) Describe the relationship between the lactose concentration and ethanol concentration at 12 hours growth. **2**

_____

_____

(c) Calculate the percentage increase in ethanol concentration between 12 and 36 hours growth in the 4% lactose flask. **1**

Space for calculation

_____ %

3. (continued)

(d) Air leaked into the 16% lactose flask between 12 and 36 hours growth. Explain why this resulted than a lower than expected ethanol concentration. **1**

_____

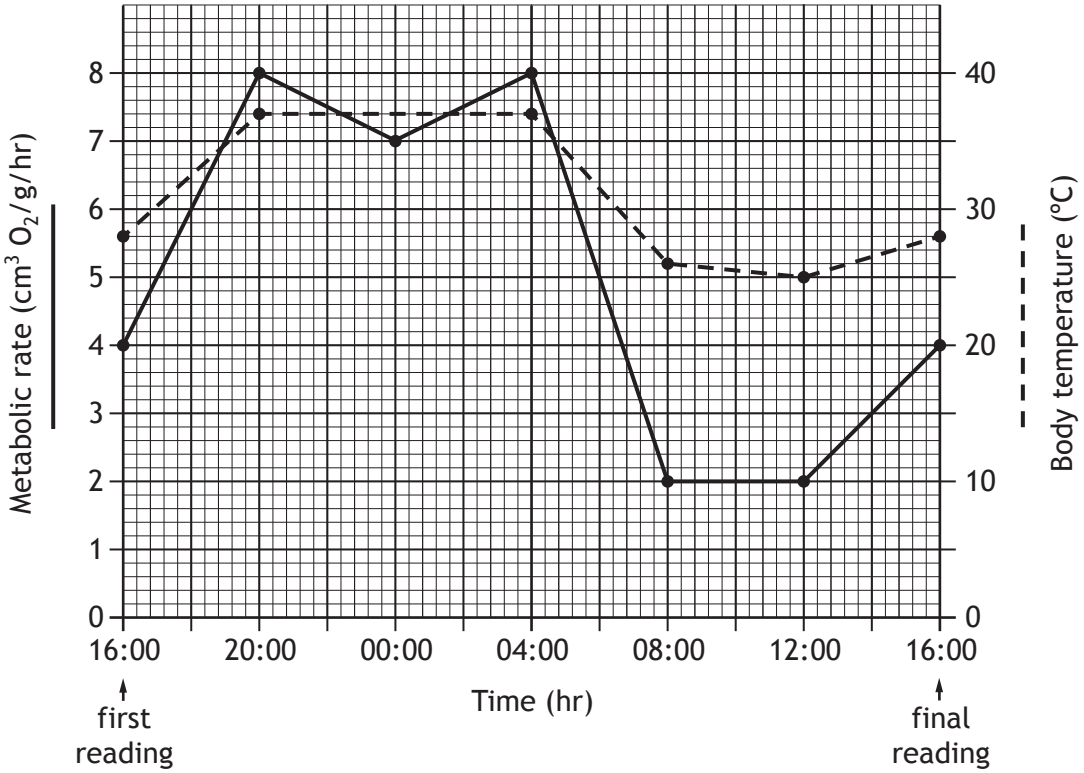
_____

_____

[Turn over

4. 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 00:00 hours. **1**

Space for calculation

_____ cm^3 O_2 per hr

(b) Tick (✓) **one** box to identify the period when the bats were in full torpor and justify your answer. **2**

16:00 – 20:00	20:00 – 00:00	04:00 – 08:00	08:00 – 12:00
☐	☐	☐	☐

Justification _____

_____

4. (continued)

(c) Give **one** benefit to 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**

_____

_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

5. Answer **either A or B** in the space below.

A Describe the arrangement of heart chambers in birds and amphibians and relate this to their metabolic rates. **4**

OR

B Describe competitive and non-competitive inhibition of enzyme action. **4**

[Turn over for Question 6 on *Page sixteen*

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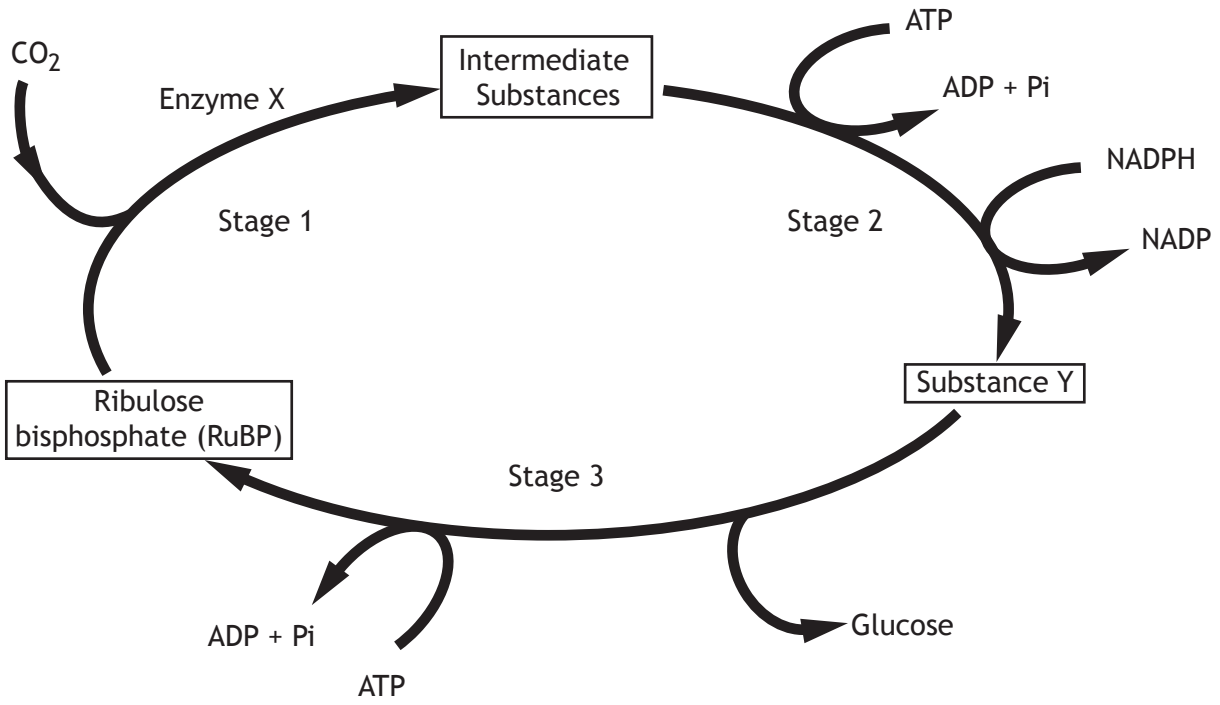
6. The diagram below shows some stages in the Calvin cycle of photosynthesis.



(a) (i) Name Enzyme X and Substance Y. **2**

Enzyme X _____

Substance Y _____

(ii) Explain the importance of producing glucose and RuBP in Stage 3. **2**

Glucose _____

_____

RuBP _____

(b) Research has been carried out which aims to increase photosynthesis in crop plants by inserting genes for the production of prokaryotic pigments into the cells. These pigments absorb wavelengths of light which are different to those absorbed by the pigments present in the crop plants.

(i) Predict what would happen to the concentrations of ATP and NADPH in the crop plant cells. **2**

ATP _____

NADPH _____

6. (b) (continued)

(ii) Genetically modified (GM) crops are evaluated in field trials.

Certain experimental procedures are required when setting up field trials to compare GM and non GM crops.

Give **one** such procedure and explain how it allows valid conclusions to be drawn. **2**

Procedure _____

_____

Explanation _____

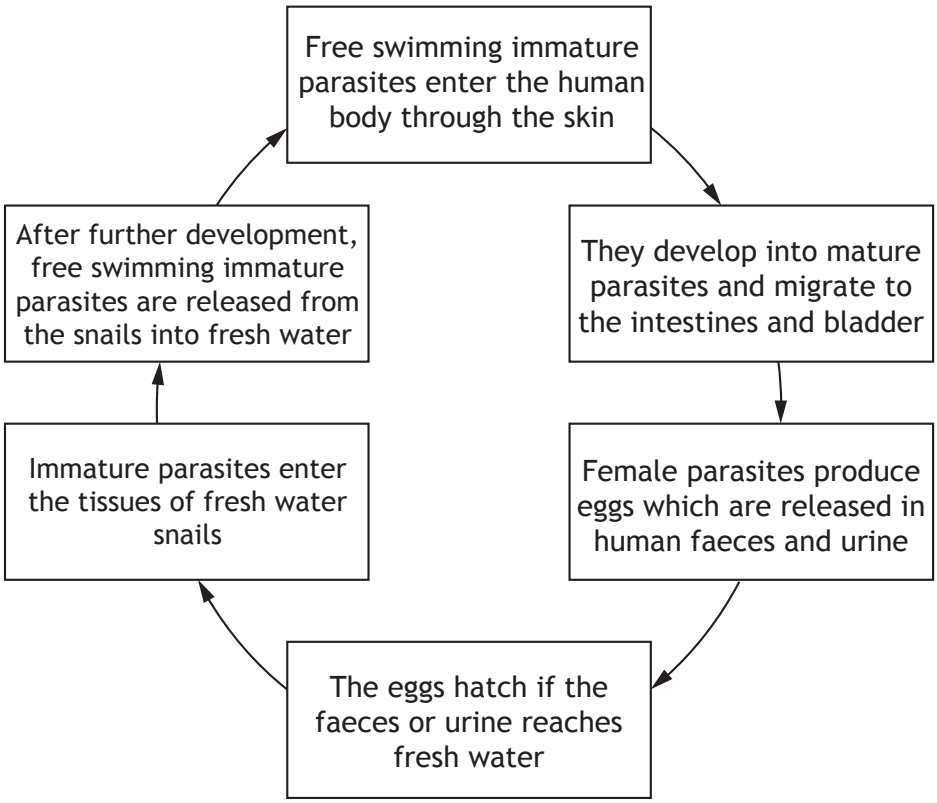
_____

[Turn over

7. The parasite *Schistosoma mansoni* causes the condition schistosomiasis in humans.

The condition is common in tropical regions where the parasite is often present in fresh water. Humans can be infected if they enter water containing the parasite.

The life cycle of *Schistosoma mansoni* is shown below.



(a) Explain why *Schistosoma mansoni* is described as a parasite. **1**

_____

(b) Identify the secondary host and suggest a benefit to *Schistosoma mansoni* of including a secondary host in its life cycle. **2**

Secondary host _____

Benefit _____

_____

(c) Describe **one** measure which could be adopted to reduce the number of cases of schistosomiasis. **1**

_____

8. Harlequin ladybirds, *Harmonia axyridis*, were introduced to the UK from their native habitat in Eastern Asia in order to reduce the population of aphids, which feed on crop plants.

Since their introduction, harlequin ladybirds have spread rapidly and their population has dramatically increased. As a result the populations of some ladybird species have dramatically decreased, although the population of native seven-spot ladybirds has remained relatively stable.

(a) Name this control method used to manage the population of aphids. **1**

_____

(b) Using the information given, explain why the harlequin ladybird can be described as an invasive species. **1**

_____

_____

(c) Suggest one reason why the population size of the seven-spot ladybird has remained relatively stable. **1**

_____

(d) Give a reason why the population of harlequin ladybirds has increased more quickly in the UK than in their native habitat. **1**

_____

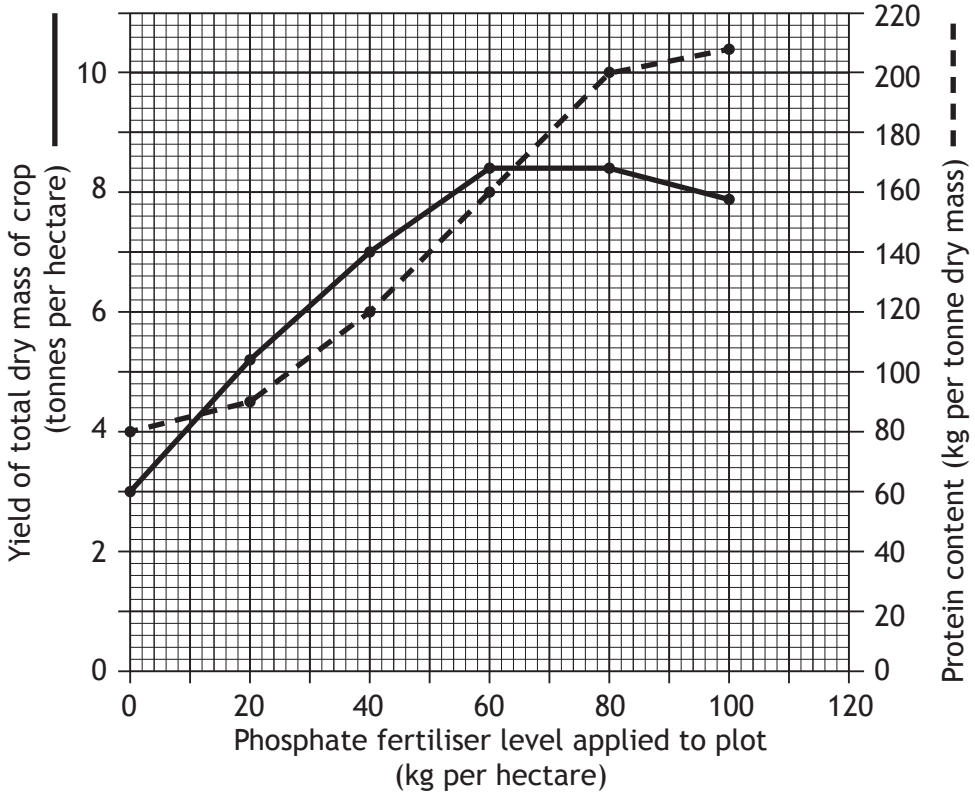
_____

[Turn over

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

In a field trial, 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 determined.

The results are shown in the graph below.



(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. **1**

_____ kg per tonne dry mass

9. (a) (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(iii) Calculate the total mass of protein produced from one hectare when 40 kg of phosphate fertiliser per hectare was applied. **1**

Space for calculation

_____ kg

(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. **1**

Space for calculation

_____ 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 in 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**

_____

9. (continued)

(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 for Question 10 on *Page twenty-four*

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10. *Staphylococcus aureus* (*S.aureus*) is a species of bacteria that lives on human skin. This species of bacteria can cause infections if it enters the body through a wound. *S.aureus* infections can be treated with antibiotics such as methicillin and penicillin.

Infections can be caused by a strain of *S.aureus* called MRSA which is resistant to methicillin and penicillin and is becoming more common.

(a) The MRSA strain has developed resistance to antibiotics by gene transfer from another organism.

Identify the correct statement(s) relating to MRSA antibiotic resistance.

Tick (✓) the correct box(es). **2**

MRSA has developed antibiotic resistance through **horizontal** gene transfer from another organism.	
MRSA has developed antibiotic resistance through **vertical** gene transfer from another organism.	
This type of gene transfer in bacteria brings about a **rapid** evolutionary change.	
This type of gene transfer in bacteria brings about a **slow** evolutionary change.	

(b) Explain how the overuse of antibiotics has led to the increase in the population of MRSA. **2**

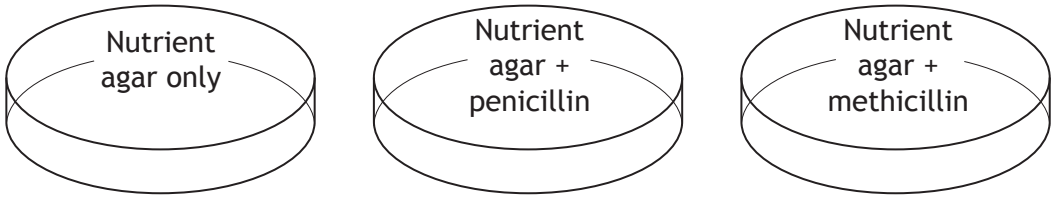
_____

_____

_____

10. (continued)

(c) Samples were taken from a patient suspected of having a bacterial infection. The samples were used to inoculate plates of agar as shown in the diagram below.



(i) Predict the results if the cause of the bacterial infection was MRSA. **1**

_____

(ii) The nutrient agar contained specific amino acids required for protein synthesis. Suggest **one other** type of complex compound that the nutrient agar may have contained. **1**

_____

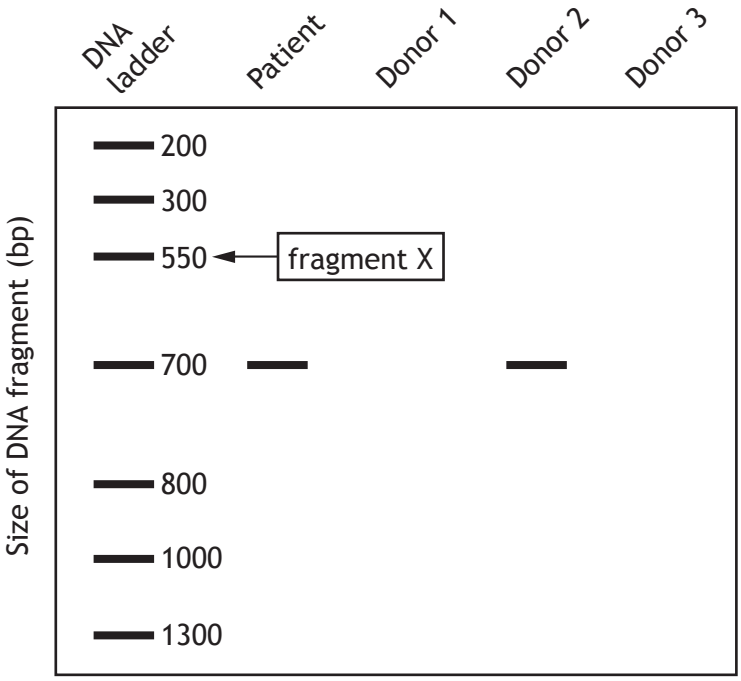
[Turn over

11. Patients requiring an organ transplant are tissue typed to match with potential donors. Polymerase chain reaction (PCR) and gel electrophoresis are used to compare DNA sequences of the patient with those of donors. Gel electrophoresis separates mixtures of DNA fragments according to size. The presence of a specific DNA band indicates that a donor is a suitable match.

Patient and potential donor samples were compared with a DNA ladder.

The DNA ladder contains fragments of DNA, separated by gel electrophoresis, which are of a known size and measured in base pairs (bp). The distances the DNA fragments travelled were measured and are shown in the table below. The diagram below shows the result of the gel electrophoresis.

Size of DNA fragment (bp)	*Distance travelled* (mm)
200	72
300	58
550	32
700	18
800	12
1000	10
1300	8



(a) The gel used for electrophoresis contains agarose. Calculate the mass of agarose required to make 30 cm^3 of a 0·8% agarose gel. **1**

Space for calculation

_____ g

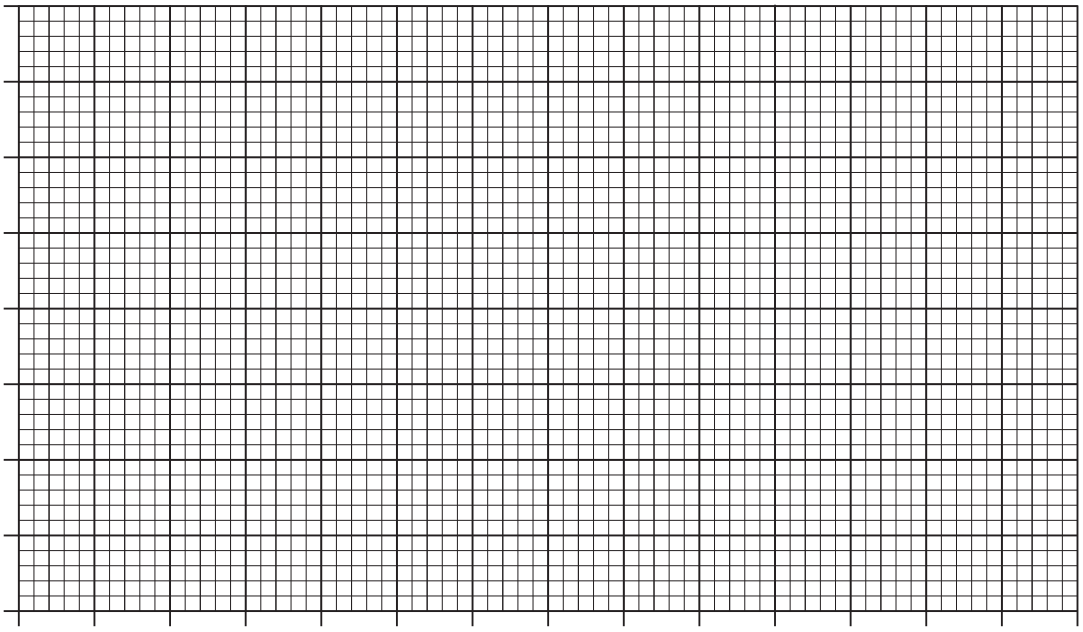
(b) Using information in the **table** and the **diagram** give the distance travelled by fragment X in the DNA ladder. **1**

_____ mm

MARKS | DO NOT WRITE IN THIS MARGIN

(c) On the grid below, draw a line graph to show the distance travelled against the size of DNA fragment. **2**

(Additional graph paper if required will be found on *Page thirty-three*.)



(d) Give a conclusion about the suitability of the donors. **1**

_____

(e) (i) The base sequence of a primer used in the PCR procedure is shown below.

A T G A C A A A T C G

Give the base sequence of a DNA fragment to which this primer would bind. **1**

_____

(ii) Complete the table below to show the temperatures used in two stages of the PCR procedure and the reasons for using these temperatures. **2**

Temperature (°C)	*Reason*
94	
	Allows primer to bind to target sequence

12. 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. **2**

1 _____

_____

2 _____

_____

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

Cardiac output = *heart rate* × *stroke volume*

(cm^3 per minute) (bpm) (cm^3)

Calculate the average increase in cardiac output in those patients given the stem cell treatment compared to those in the control group. **1**

Space for calculation

_____ cm^3 per minute

12. (continued)

(c) (i) Describe how tissue (adult) stem cells differ from embryonic stem cells. **1**

_____

_____

(ii) Describe how the heart cells produced by the patients as a result of the stem cell treatment in this investigation developed their specialised functions. **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**

_____

_____

[Turn over for Question 13 on *Page thirty*

MARKS | DO NOT WRITE IN THIS MARGIN

13. Answer **either A or B** in the space below and on pages *thirty-one* and *thirty-two*.

Labelled diagrams may be used where appropriate.

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

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

(ii) translation of mRNA. **4**

OR

B Write notes on mutation under the following headings:

(i) single gene mutations; **4**

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

SPACE FOR ANSWERS

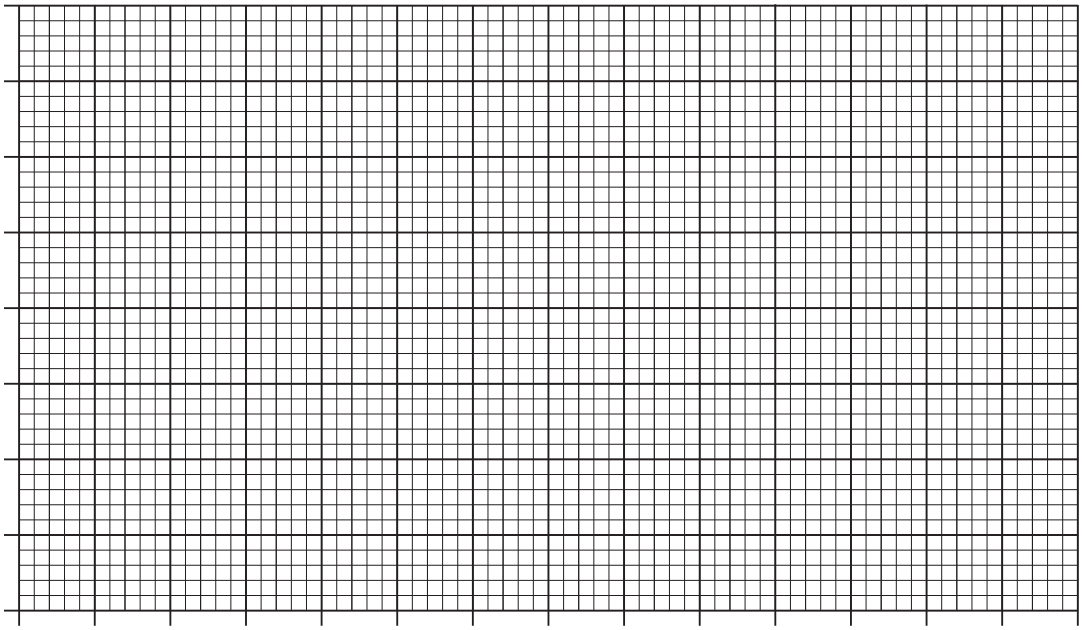
SPACE FOR ANSWERS

[END OF QUESTION PAPER]

X7077601 32

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

ADDITIONAL GRAPH PAPER FOR QUESTION 11(c)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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