National Qualifications 2023

X807/75/02

Biology
Section 1 — Questions

THURSDAY, 27 APRIL

1:00 PM – 3:30 PM

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X807/75/01.

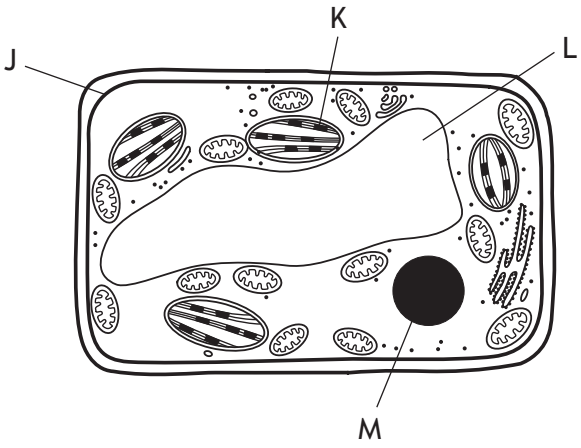
Record your answers on the answer grid on *page 03* of your question and answer booklet.

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

SECTION 1 — 25 marks

Attempt ALL questions

1. The diagram shows a typical plant cell.



Which of the labelled structures would also be found in a typical animal cell?

A J and K only

B J and M only

C L and K only

D L and M only

2. Four equal sized cubes of potato were weighed and each placed into a different concentration of sugar solution. They were dried and weighed again after one hour.

The results are shown in the table.

Which solution had the highest sugar concentration?

Solution	Mass of potato at start (g)	Mass of potato after one hour (g)
A	4.5	3.9
B	4.5	4.3
C	4.5	4.5
D	4.5	5.5

3. The diagram shows the sequence of bases in a strand of DNA.

Which of the following shows the complementary base sequence for this strand of DNA?

A GCATTGCC
B CGTAACGG
C TACGGTAA
D TAGCCTAA

4. Which of the following statements is true for proteins?

1. They are made in the nucleus.
2. They are affected by temperature.
3. They can be found in the cell membrane.
4. They all function as enzymes.

A 2 and 3 only
B 2 and 4 only
C 1, 3 and 4 only
D 2, 3 and 4 only

5. A sample of 350 bacterial cells were modified to produce a human protein.
Only 210 of these cells successfully produced the protein.
The percentage success was

A 60%
B 67%
C 140%
D 167%

[Turn over

6. Fermentation in yeast cells occurs in the

A cytoplasm
B mitochondria
C plasmids
D ribosomes.

7. An earthworm with a mass of 7 g uses up 3.5 cm^3 of oxygen in 25 minutes.
Calculate the volume of oxygen used by this earthworm in 1 minute.

A 0.02 cm^3
B 0.14 cm^3
C 0.5 cm^3
D 1.02 cm^3

8. A role of stem cells in the human body is to produce

A antibodies for defence
B new skin tissue to repair a cut
C enzymes for digestion
D hormones for communication.

9. Which row in the table shows the functions controlled by each part of the brain?

	Cerebrum	**Medulla**	**Cerebellum**
A	coordination and balance	breathing and heart rate	conscious thought
B	breathing and heart rate	conscious thought	coordination and balance
C	conscious thought	breathing and heart rate	coordination and balance
D	conscious thought	coordination and balance	breathing and heart rate

10. Hormones are

A electrical messengers that travel along neurons

B chemical messengers that travel along neurons

C electrical messengers that travel in the bloodstream

D chemical messengers that travel in the bloodstream.

11. A man is fertile if his semen contains a minimum of 20 million sperm per cm^3 and at least 75% of the sperm cells are active.

The table shows the results of semen analysis from four sperm samples.

Identify the sample that was from an infertile man.

Sample	**Number of sperm in sample (million/cm^3)**	**Inactive sperm (%)**
A	25	20
B	23	30
C	22	25
D	20	15

12. In mice, the dominant form of one gene (B) determines black coat colour and the recessive form (b) determines brown coat colour.

If two heterozygous mice were crossed, the expected phenotypes of the offspring would be

A 3 black : 1 brown

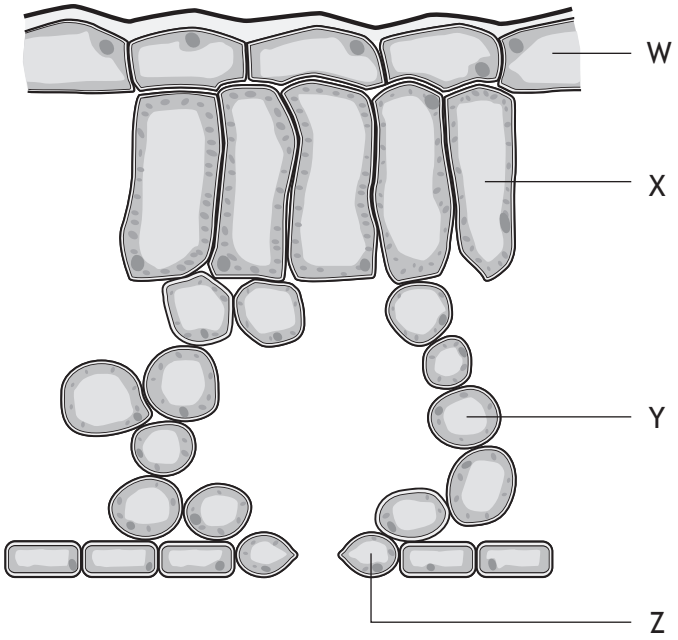
B 1 black : 1 brown

C all black

D all brown.

[Turn over

13. The diagram shows a cross-section of a leaf.

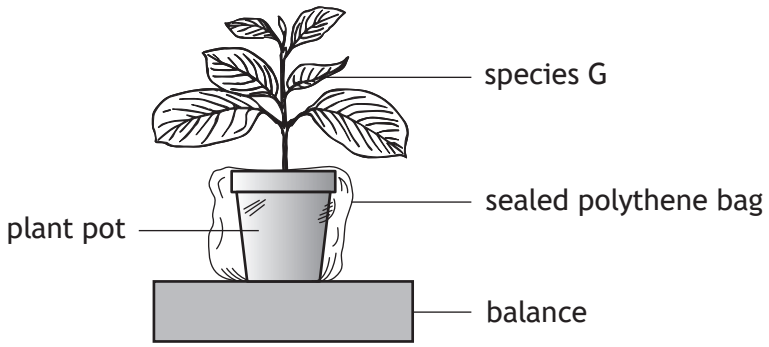


Which row in the table identifies the parts of the leaf?

	Palisade mesophyll	**Spongy mesophyll**	**Upper epidermis**	**Guard cell**
A	X	Y	Z	W
B	Y	X	W	Z
C	W	X	Z	Y
D	X	Y	W	Z

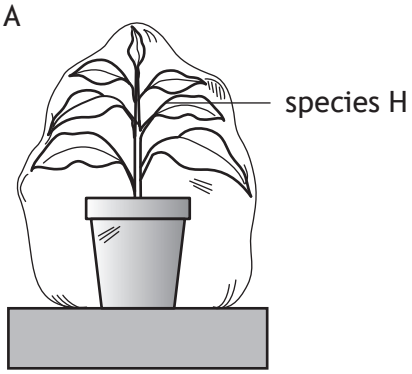
14. An investigation was carried out to compare transpiration in two different species of plant, G and H.

The diagram shows the set up to measure transpiration in species G.

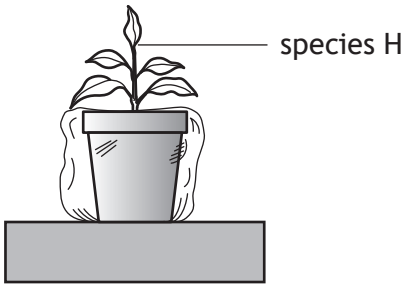


Which diagram shows the set-up for species H, that would allow a valid comparison in the rate of transpiration of the two species?

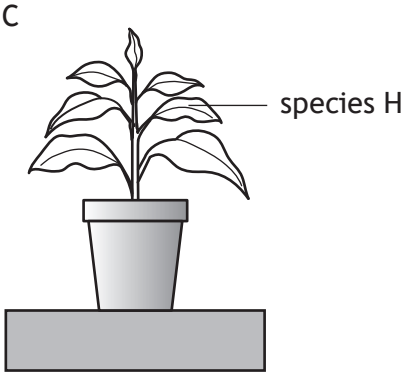
A



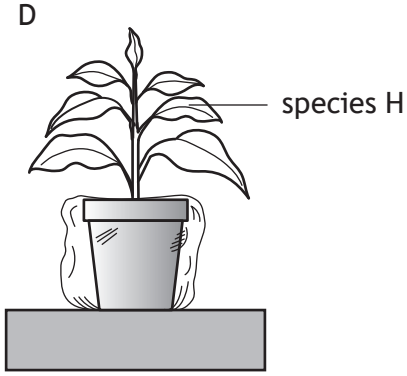
B



C



D

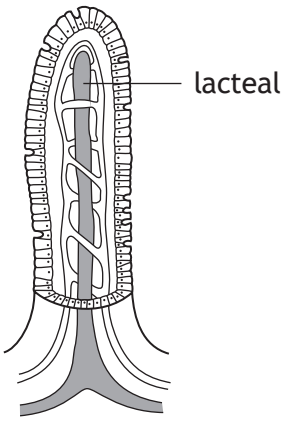


[Turn over

15. Which row in the table describes some features of veins?

	Direction of blood flow	Blood pressure in vein	Width of central channel
A	away from the heart	high	narrow
B	towards the heart	low	wide
C	away from the heart	high	wide
D	towards the heart	low	narrow

16. The diagram shows a villus.



Identify the nutrients from food that are absorbed into the lacteal.

A Glucose and amino acids

B Glucose and fatty acids

C Glycerol and fatty acids

D Glycerol and amino acids

17. Three students carried out an investigation into the effect of exercise on heart rate.
Each student measured their heart rate after completing the same exercises.
After each student's heart rate returned to its resting rate, they repeated the process.
Which of the following would increase the reliability of the results?

A Increase the time spent exercising.
B Change the exercise location.
C Change the type of exercise each time.
D Increase the number of students exercising.

18. In an ecosystem, a niche is defined as the

A place where an organism lives
B total number of one species living in a community
C role an organism plays within a community
D total number and variety of organisms.

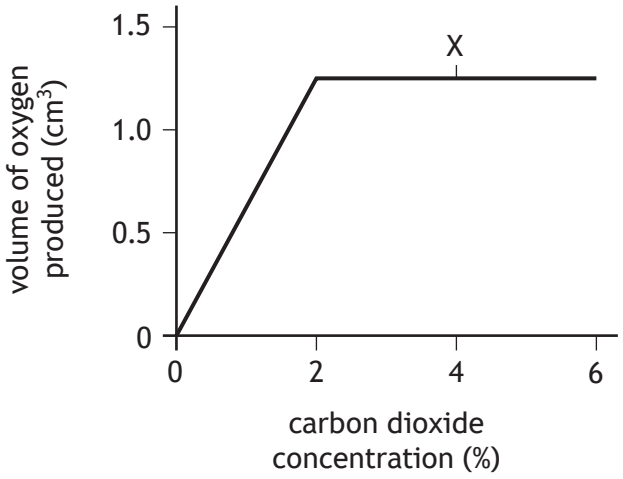
19. Which statement describes an abiotic factor?

A The spread of a disease.
B A period of very low temperatures.
C An increase in predation.
D An increase in competition for food.

[Turn over

20. An experiment was set up to investigate the effect of changing carbon dioxide concentration on the rate of photosynthesis.

The results are shown in the graph.



Which of the following factors could be limiting the rate of photosynthesis at point X?

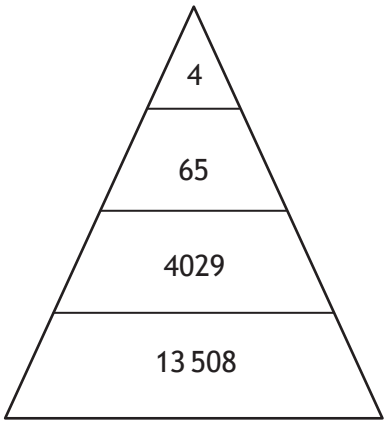
A Carbon dioxide concentration and light intensity

B Light intensity and temperature

C Temperature only

D Carbon dioxide concentration only

21. The diagram represents a pyramid of numbers within an ecosystem.



Identify the total number of consumers.

A 4
B 4029
C 4098
D 17 606

22. The table shows the concentration of different metal ions in the liver of a fish and in water.

Metal	Concentration of metal ion	
	in liver (mg/kg)	in water (mg/l)
Cadmium	2.62	0.004
Copper	13.28	0.04
Iron	494.0	0.76
Zinc	55.79	0.07

The bioaccumulation factor (BAF) of metals can be calculated using the following formula:

$$\text{BAF} = \frac{\text{concentration of metal ion in liver}}{\text{concentration of metal ion in water}}$$

The metal with the highest bioaccumulation factor is

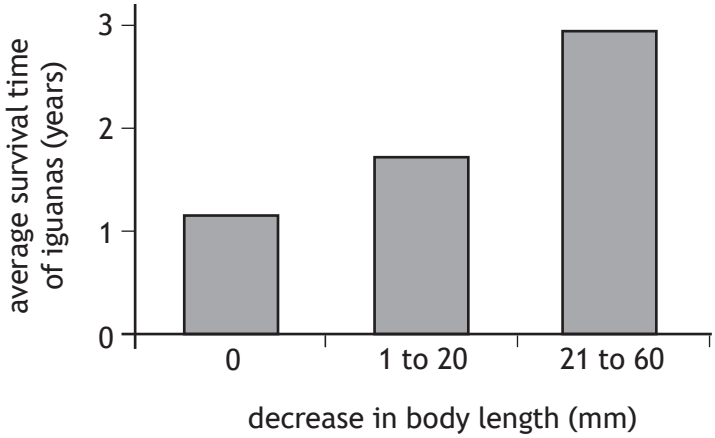
A cadmium
B copper
C iron
D zinc.

23. A weather event called El Niño occurs in the Galapagos Islands every three years.

During this event, the iguanas on the islands can decrease in body length due to lack of food.

Scientists calculated the decrease in body length of the iguanas and recorded their survival time.

The results are shown in the graph.



Which of the following statements is true?

A The iguanas that had the least decrease in body length survived for the longest time.

B The decrease in body length made no difference to the survival time of the iguanas.

C The iguanas that had the greatest decrease in body length survived for the longest time.

D The iguanas that had the greatest decrease in body length survived for the shortest time.

24. Which of the following is the only source of new alleles in a population?

A Mutation

B Natural selection

C Isolation

D Speciation

25. Nematode worms can be used by farmers to decrease the number of insects that damage their crops.

This describes the use of

A GM crops

B biological control

C pesticides

D fertilisers.

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

FOR OFFICIAL USE

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National Qualifications 2023

Mark

X807/75/01

Biology
Section 1 — Answer grid and Section 2

THURSDAY, 27 APRIL

1:00 PM – 3:30 PM

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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 — 25 marks

Attempt ALL questions.

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

SECTION 2 — 75 marks

Attempt ALL questions.

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

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SECTION 2 — 75 marks

Attempt ALL questions

1. Cells vary in their size and structure.

(a) Both bacterial and fungal cells have a cell wall.

(i) Name one other structure that can be found in both bacterial and fungal cells. **1**

_____

(ii) Plant cells also have a cell wall.

Name the material that plant cell walls are made of. **1**

_____

(b) The average size of different types of cell are shown in the table.

Cell type	Average size (μm)
Animal	32.0
Bacterial	0.8
Fungal	6.4
Plant	52.0

(i) Calculate how many times bigger the average plant cell is compared to the average bacterial cell. **1**

Space for calculation

_____ times bigger

(ii) Apart from the difference in size, give one other difference between typical bacterial and plant cells. **1**

_____

_____

2. Plants transport water and mineral ions from their roots to the leaves.

(a) Mineral ions can move from the soil to the root cells by active transport.

Describe the process of active transport. **2**

(b) Water enters a plant by osmosis, which is an example of passive transport.

(i) State what this means in terms of the energy required for osmosis. **1**

(ii) Name the vessels that transport water to the leaves. **1**

(iii) When water enters a plant cell the vacuole fills and swells until no more water can enter.

State the term used to describe a plant cell in this state. **1**

3. (a) The four DNA bases represented by A, C, G and T make up the genetic code. Part of the base sequence that codes for a protein is shown.

------ G C A T A T A G A ------

(i) Name base A and base C. **2**

Base A _____

Base C _____

(ii) The sequence shown is only 5% of the bases in this strand. Calculate the total number of bases in this DNA strand. **1**

Space for calculation

_____ bases

(b) Name the type of molecule that proteins are made from. **1**

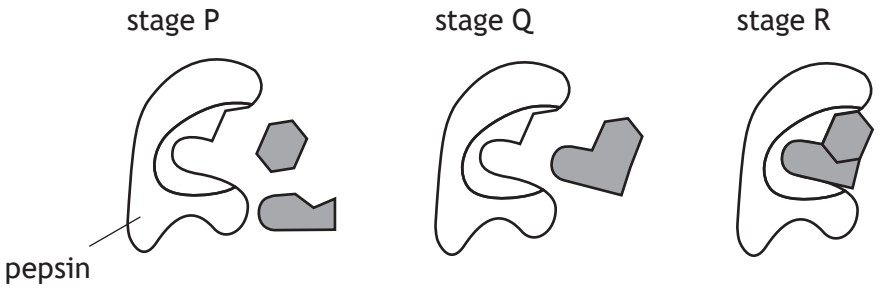
_____

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

4. Pepsin is an enzyme involved in the digestion of proteins, which is a degradation reaction.

The diagram represents three stages that occur in this reaction.



(a) (i) Using letters from the diagram, put the stages into the correct order to show this degradation reaction. **1**

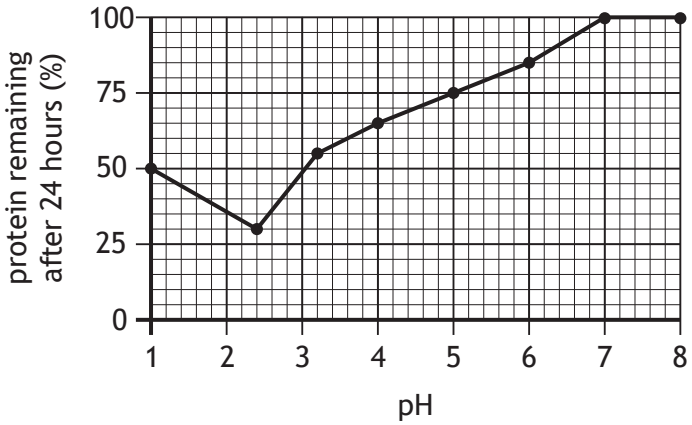
stage _____ → stage _____ → stage _____

(ii) Describe the feature of pepsin that allows it to bind to only one substrate. **1**

_____

_____

(b) The graph shows the results of an experiment to investigate the effect of pH on pepsin activity.



Use the graph to identify the optimum pH of pepsin. **1**

pH _____

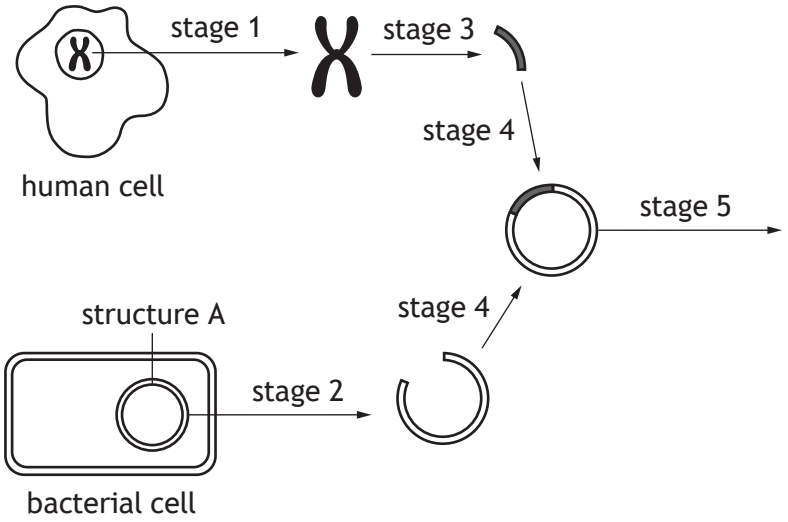
(c) Enzymes can be denatured by changes in pH.

Give a reason why the rate of reaction will be affected. **1**

_____

_____

5. The diagram shows some of the stages in the transfer of a section of DNA from one cell to another.



(a) Name the process shown by the diagram. **1**

_____

(b) Name structure A. **1**

_____

(c) Describe what happens during stage 5. **1**

_____

_____

[Turn over

6. An investigation was carried out into the effect of modifying cotton plants on the yield of cotton.

Three farms had two fields of cotton, one of each type: original and modified.

The yields of both types were recorded.

The results are shown in the table.

	Yield of cotton (kg)	
Farm	**Original type**	**Modified type**
1	340	510
2	240	348
3	380	540

(a) Calculate the percentage increase in yield when using modified cotton in farm 2. **1**

Space for calculation

_____ %

(b) (i) Identify the variable altered in this investigation. **1**

_____

(ii) Suggest a variable that would have to be controlled to ensure validity. **1**

_____

(c) The fields planted with the original type of cotton were used as a control.

Give a reason for using a control in **this** investigation. **1**

_____

_____

(d) Describe how the reliability of these results could be improved. **1**

_____

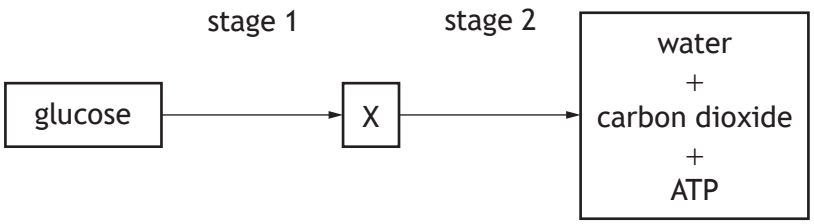
MARKS | DO NOT WRITE IN THIS MARGIN

7. Muscle cells can carry out different types of respiration.

(a) Name the type of respiration that yields the most ATP per glucose molecule. **1**

_____

(b) The diagram shows a summary of one type of respiration in muscle cells.



(i) Name substance X. **1**

_____

(ii) Name the substance that must be present for stage 2 to occur. **1**

_____

(c) The number of mitochondria found in four different cells is shown in the table.

Cell	Number of mitochondria per cell
Red blood	0
Skin	800
Liver	1300
Muscle	7000

(i) Calculate the simplest whole number ratio of mitochondria in muscle cells to skin cells. **1**

Space for calculation

_____ : _____
muscle skin

(ii) State why a muscle cell requires more mitochondria than a skin cell. **1**

_____

_____

8. Tissue stem cells can be transplanted to replace blood cells.

(a) Describe the feature of stem cells that allows them to be used in this way. **1**

_____

_____

(b) To successfully treat a blood disorder, between 2 million and 4 million stem cells per kilogram of the patient's body mass are needed.

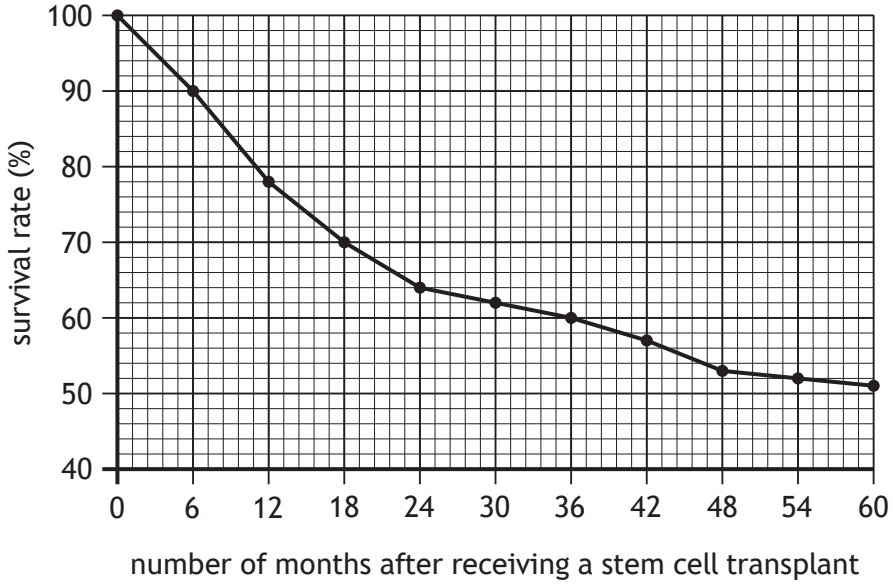
Calculate the **minimum** number of stem cells required to treat a patient with a mass of 78.5 kg. **1**

Space for calculation

_____ million

8. (continued)

(c) The graph shows the survival rates of patients with a blood disorder who have received a stem cell transplant.



(i) Identify the survival rate of patients 24 months after receiving a stem cell transplant. **1**

_____ %

(ii) Describe the relationship between the number of months after receiving a stem cell transplant and the survival rate. **1**

_____

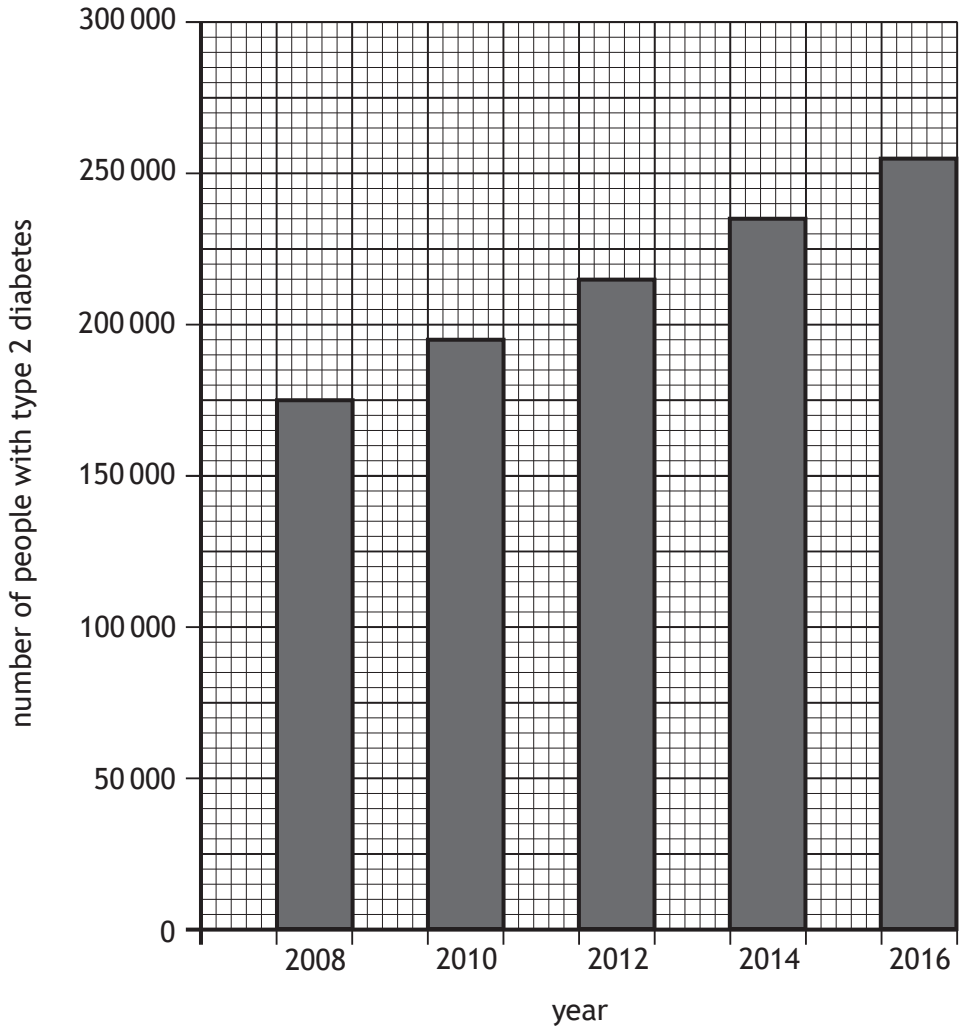
_____

(d) Other than tissue, name another type of stem cell. **1**

_____

[Turn over

9. The graph shows the number of people in Scotland with type 2 diabetes over a period of nine years.



(a) (i) Identify the number of people with type 2 diabetes in 2012. **1**

_____

(ii) If the trend shown continued, predict the number of people that would be expected to have type 2 diabetes in 2018. **1**

_____

9. (continued)

(b) Insulin is a hormone involved in the regulation of blood glucose.

(i) Insulin has an effect on cells in the liver.
Explain why insulin does not affect cells in other organs. **1**

_____

_____

(ii) Describe the reaction that occurs in the liver cells in response to insulin. **1**

_____

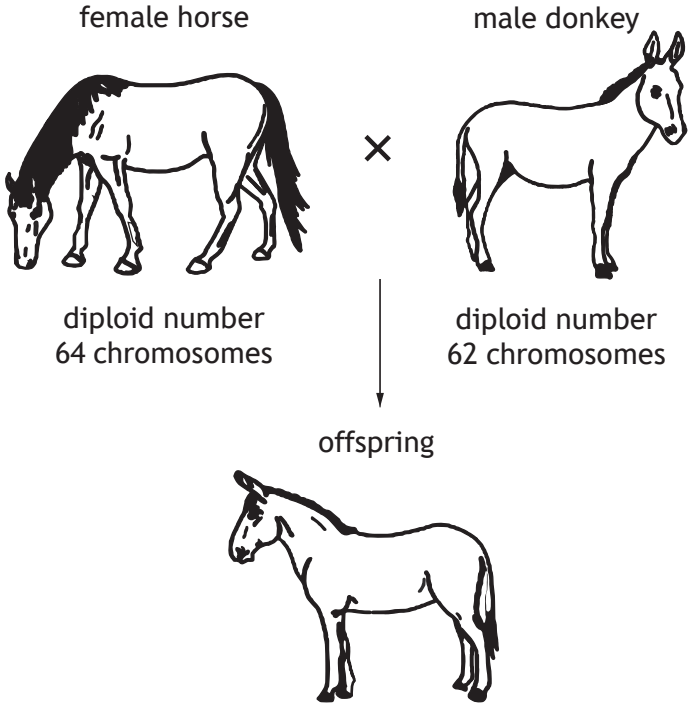
(c) Name the type of glands that release hormones into the bloodstream. **1**

_____

[Turn over

10. The diagram shows a cross between a horse and a donkey and the resulting offspring.

The diploid number of chromosomes for the horse and donkey are given.



(a) The horse and the donkey produce gametes required for reproduction.

(i) Name the type of gamete produced by the female horse in this cross. **1**

_____

(ii) Name the organ where the gametes of the male donkey are produced. **1**

_____

(b) Name the cell produced when the nuclei of male and female gametes fuse. **1**

_____

(c) (i) State the diploid number of chromosomes in the offspring in this cross. **1**

_____

(ii) This offspring is not fertile.

Using this information, give a conclusion about horses and donkeys. **1**

_____

_____

11. Faeces is the waste material that remains after food has been digested and the nutrients absorbed.

Clostridium difficile (*C. difficile*) is a bacterium found in the gut that is usually harmless. However, in some people there can be an overgrowth of *C. difficile*, resulting in persistent diarrhoea that can sometimes be life-threatening.

A recent study developed a capsule containing frozen faeces from healthy donors to treat diarrhoea caused by *C. difficile*.

Twenty patients with diarrhoea caused by *C. difficile* were each given 30 capsules over an eight-week period.

No serious side effects were reported in the study group, and diarrhoea was cured in 14 of the 20 patients. The 6 who did not respond were treated again in the same way and 4 of them were then cured. This was considered a success as 18 of the 20 patients no longer suffered from persistent diarrhoea.

(a) Using the information in the passage:

(i) identify the type of pathogen that causes persistent diarrhoea **1**

_____

(ii) suggest the aim of the study described in the passage. **1**

_____

_____

(b) Suggest why each patient was given the same number of capsules. **1**

_____

_____

(c) Calculate the percentage of patients who were cured after one treatment with the capsules. **1**

Space for calculation

_____ %

(d) Name the system in the human body involved in destroying pathogens. **1**

_____

12. High altitude training is an important part of athlete preparation for endurance sports such as long-distance running.

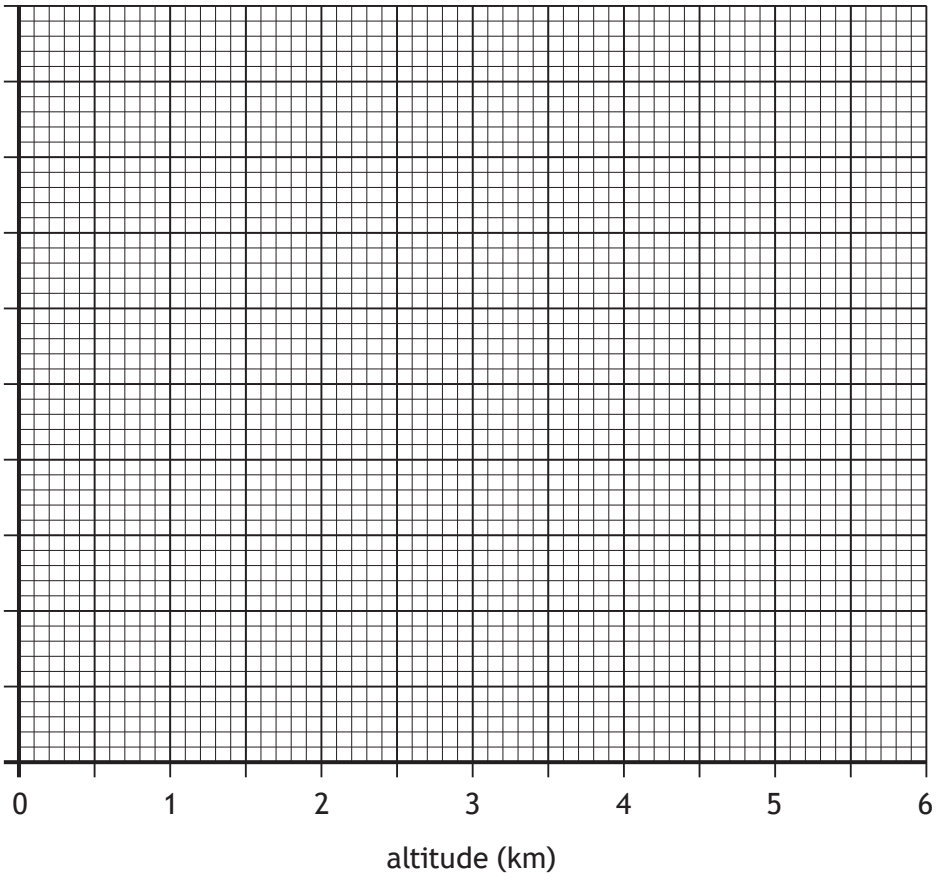
As altitude increases the oxygen concentration of the air decreases.

The table shows the effect of training at different altitudes on athletes' red blood cell count.

Altitude (km)	Average red blood cell count (million/ml of blood)
0	4.4
0.5	5.0
1.0	5.6
2.5	6.2
3.5	7.4
5.0	8.8
5.5	9.4

(a) (i) On the grid complete the vertical axis and plot a line graph to show the effect of altitude on average red blood cell count. **2**

(An additional grid, if required, can be found on *page 26*.)



12. (a) (continued)

(ii) Describe the relationship between altitude and red blood cell count. **1**

_____

_____

(iii) **Using information from the table**, predict the average red blood cell count of an athlete training at an altitude of 3.0 km. **1**

_____ million/ml of blood

(b) Red blood cells are important for transporting oxygen.

(i) In what form is oxygen transported by red blood cells? **1**

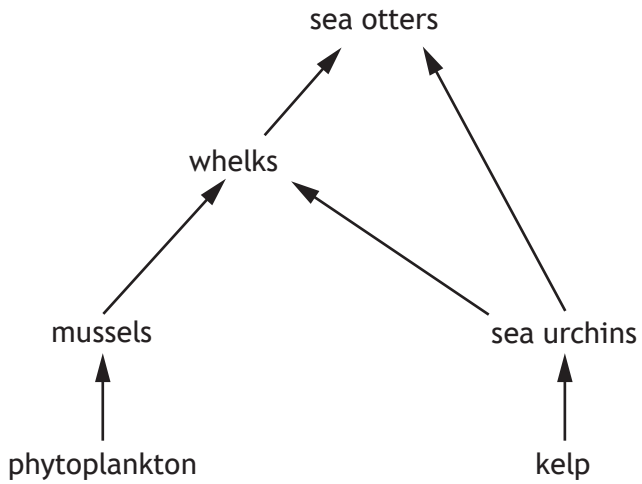
_____

(ii) Give one structural feature of a red blood cell that allows it to carry out its function efficiently. **1**

_____

[Turn over

13. The food web represents a marine ecosystem in the west coast of Scotland.



(a) Give an ecological term that describes the sea urchins. **1**

_____

(b) Pollution from microplastics has led to a decline in the mussel population.

Predict the effect of a decrease in mussels on the sea otter population and explain your answer. **2**

Effect on sea otter population _____

Explanation _____

_____

13. (continued)

(c) Marine biologists investigated the effect of salt concentration on the number of microplastic particles in mussel body tissue.

The results are shown in the table.

Salt concentration (ppb)	Number of microplastic particles per 1 g of mussel body tissue
31	4
33	8
36	20

A mussel with a mass of **5 g** was found to contain 20 particles of microplastics in its body tissue.

Identify the salt concentration the mussel was found in. **1**

Space for calculation

_____ ppb

[Turn over

14. Students surveyed an area of woodland and recorded the tree species growing there.

(a) The table shows some features that can be used to identify the trees.

Tree	Needle colour	Needle arrangement	Cones
Scots pine	blue-green	in pairs	point outwards from stem tip
Norway spruce	green underside	around the branch	point downwards
Douglas fir	grey underside	around the branch	point downwards
Larch	light green	in clusters	point outwards along the stem
Yew	green	in two rows along the branch	absent

Use the information in the table to complete the key. **3**

1. Cones are absent — Yew

   Cones are present — go to 2

2. Cones point downwards — [ ]

   Cones do not point downwards — go to 4

3. Underside of the needle is grey — [ ]

   Underside of the needle is green — Norway spruce

4. Needles arranged in pairs — Scots pine

   [ ] — Larch

14. (continued)

(b) The students also investigated the effect of soil moisture on the number of Scots pine seedlings growing on the woodland floor.

(i) The students recorded the soil moisture and number of seedlings at 10 sample sites in the woodland.

Suggest why 10 sample sites were used. **1**

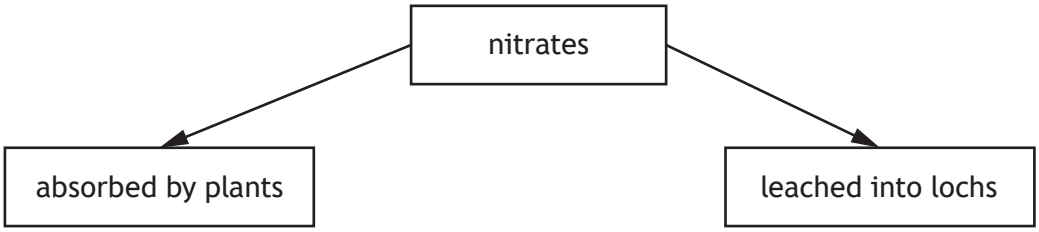
(ii) The students used a moisture meter to measure the soil moisture.

Describe what the students should have done each time they used this apparatus to minimise error. **1**

[Turn over

15. Farmers use fertilisers with a high nitrate content to increase the yield of crops.

The diagram shows two possible fates of nitrates in fertilisers.



Describe how the leaching of nitrates can result in a reduction in the number of freshwater organisms in lochs. **4**

MARKS | DO NOT WRITE IN THIS MARGIN

16. Photosynthesis is a two-stage process that takes place in the leaves of green plants.

(a) State the source of energy for the first stage. **1**

_____

(b) (i) Name the process by which oxygen moves out of the leaf through stomata. **1**

_____

(ii) The number of stomata on both surfaces of five leaves was counted and averages calculated.

The results are shown in the table.

Leaf	Number of stomata	
	Upper surface	Lower surface
1	4	12
2	20	23
3	8	15
4	12	22
5	16	
Average	12	18

Complete the table to include the number of stomata on the lower surface of leaf 5. **1**

Space for calculation

(iii) Name a substance that enters the leaf through stomata. **1**

_____

(c) (i) Describe how sugar is produced in the second stage of photosynthesis. **1**

_____

_____

(ii) Name one substance that the sugar produced could be converted into. **1**

_____

[END OF QUESTION PAPER]