OCR
Oxford Cambridge and RSA

Friday 16 June 2023 – Morning

A Level Biology A

H420/02 Biological diversity

Time allowed: 2 hours 15 minutes

You can use:
- a scientific or graphical calculator
- a ruler (cm/mm)

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **32** pages.

ADVICE
- Read each question carefully before you start your answer.

Section A

You should spend a **maximum** of **20 minutes** on this section.

Write your answer to each question in the box provided.

1 Which option correctly describes a tissue?

A A group of cells performing similar functions

B A group of organs performing a specific function

C A group of similar cells performing a specific function

D A group of similar cells performing a variety of functions

Your answer ☐ **[1]**

2 Bone marrow stem cells are a source of erythrocytes.

Which statement about bone marrow stem cells and their role in the production of erythrocytes is correct?

A Bone marrow stem cells are totipotent and can therefore differentiate into any type of cell.

B Erythrocytes are the only blood cell produced from bone marrow stem cells.

C Erythrocytes need to be replaced from bone marrow stem cells because erythrocytes are unable to undergo mitosis.

D In humans, differentiation of bone marrow stem cells into erythrocytes involves the synthesis of a haploid nucleus.

Your answer ☐ **[1]**

3 Which option correctly describes the sequence of events during the cell cycle?

A Cytokinesis → interphase → G_1 → G_2 → S → mitosis

B Cytokinesis → mitosis → interphase

C G_2 → mitosis → cytokinesis → G_1 → S

D Mitosis → interphase → cytokinesis

Your answer ☐ **[1]**

4 Scientists crossed two plants that were heterozygous for two different genes. Both plants had the same genotype, AaBb.

The genotypes and ratios of the offspring resulting from this cross were:

AABB AaBb aabb

1 : 2 : 1

Which option could explain these observations?

A Autosomal linkage

B Crossing over

C Epistasis

D Mutation

Your answer ☐ **[1]**

5 A student was observing and measuring cells using a light microscope.

Which option describes a method that would enable the student to accurately measure the length of a cell?

A View the cells using a calibrated eyepiece graticule and note the magnification of the eyepiece lens.

B View the cells using a calibrated eyepiece graticule and note the magnification of the objective lens.

C View the cells using a stage micrometer and note the magnification of the eyepiece lens.

D View the cells using a stage micrometer and note the magnification of the objective lens.

Your answer ☐ **[1]**

6 Which of the following describes, from lowest to highest, the resolution of images than can be achieved by different types of microscope?

A Light microscope → scanning electron microscope → transmission electron microscope

B Light microscope → transmission electron microscope → laser scanning confocal microscope

C Light microscope → transmission electron microscope → scanning electron microscope

D Scanning electron microscope → transmission electron microscope → light microscope

Your answer ☐ **[1]**

7 Lactose metabolism in *E. coli* is controlled by the *lac* operon.

Which of the structures associated with the *lac* operon contain nucleic acids?

1: the operator
2: the regulator gene
3: the structural gene product

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

8 Homeobox genes control body plan in eukaryotes.

Which of the statements about homeobox genes are correct?

1: they bind to transcription factors
2: they contain a highly conserved sequence of 180 base pairs
3: they regulate the expression of structural genes

A 1, 2 and 3

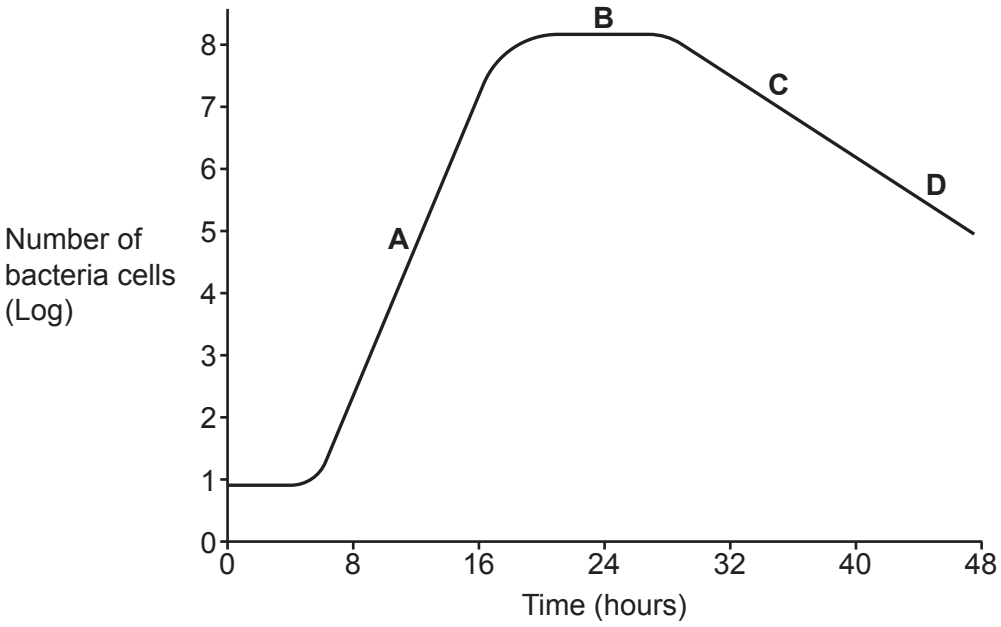
B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

9 The graph below shows the population of viable bacteria in a flask over 48 hours.

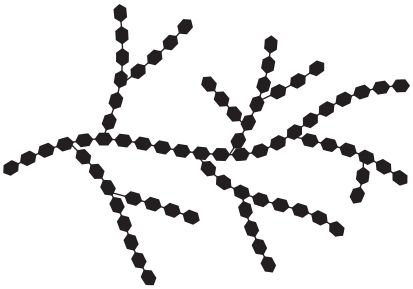


Which time, **A** to **D**, has the highest bacterial death rate?

Your answer [ ] **[1]**

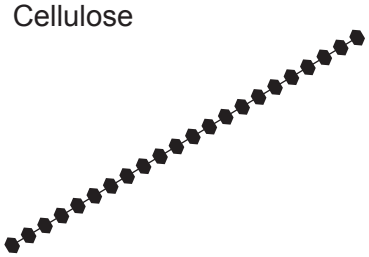
The image below shows representations of the structures of four polysaccharides.

Amylopectin

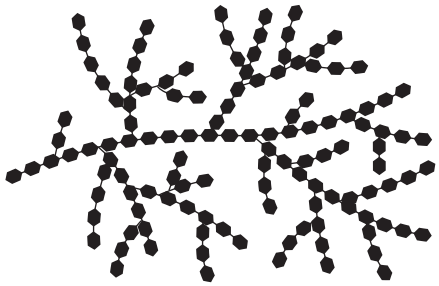


Amylose

Cellulose



Glycogen



Use the image to answer questions **10** and **11**.

10 Which of the molecules contains the highest proportion of 1-6 glycosidic bonds?

A Amylopectin

B Amylose

C Cellulose

D Glycogen

Your answer ☐ **[1]**

11 Which of the molecules is **not** used for energy storage?

A Amylopectin

B Amylose

C Cellulose

D Glycogen

Your answer ☐ **[1]**

12 The modern pedigree dog breeds have been produced by many years of selective breeding.

Which option does **not** explain why genetic disorders are common in pedigree dogs?

A Characteristics that are desirable to humans can be associated with features that are harmful to dogs.

B Selective breeding increases the chance of an individual being homozygous for certain characteristics.

C Selective breeding increases the chance of mutations.

D Selective breeding is associated with inbreeding depression.

Your answer ☐ **[1]**

13 What step could be taken to reduce the occurrence of genetic disorders in pedigree dogs?

A Breeding only with individuals that meet the official breed descriptions.

B Broadening the official descriptions of pedigree dog breeds.

C Increased use of somatic gene therapy.

D Regular cross-breeding with the wild ancestor of domestic dogs.

Your answer ☐ **[1]**

14 Organisms are named using the binomial system.

What is the correct way to represent the binomial name for domestic dogs?

A *Canis familiaris*

B Canis familiaris

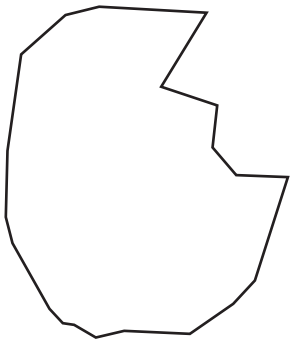
C *canis familiaris*

D canis familiaris

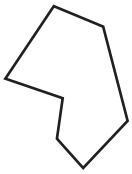
Your answer ☐ **[1]**

15 The image below shows an enzyme and its substrate.

Enzyme



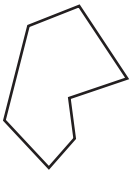
Substrate

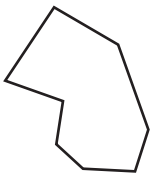


Which option represents a coenzyme for this enzyme?

A 

B 

C 

D 

Your answer ☐ **[1]**

Section B

16 Many organisms undergo asexual reproduction by mitosis.

(a) State **two** other roles of mitosis in organisms.

1 .....

2 .....

[1]

(b) Plants reproduce asexually by mitosis.

(i) Explain why mitosis, and not meiosis, is used for asexual reproduction in plants.

.....

.....

.....

.....

..... **[2]**

(ii) Bacteria reproduce asexually by a process called binary fission.

Suggest why bacteria are unable to reproduce asexually by mitosis.

.....

.....

.....

.....

..... **[2]**

(c)* Asexual reproduction is also known as cloning.

Many organisms can be artificially cloned for commercial purposes.

Discuss the arguments for **and** against artificial cloning in plants **and** animals.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

Additional answer space if required.

.....

.....

.....

.....

.....

(d) During meiosis, the independent assortment of chromosomes leads to the formation of genetically different gametes.

Gametes of the western clawed frog contain 10 chromosomes.

Calculate the number of genetically different gametes resulting from the independent assortment of chromosomes that would be produced by an individual frog.

Number of different gametes = ... **[2]**

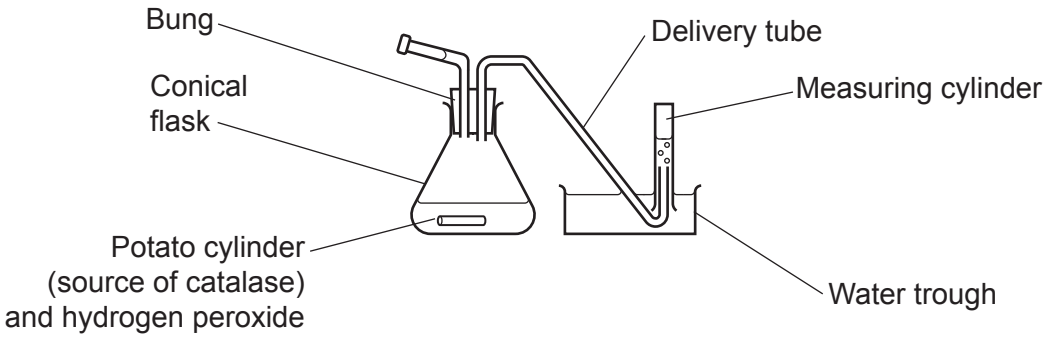
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

17 Catalase is found in many tissues. It is an enzyme that breaks down hydrogen peroxide into oxygen and water.

Some students do an experiment to investigate the effect of hydrogen peroxide concentration on the rate of this reaction using the apparatus shown in **Fig. 17.1**.

Fig. 17.1



This is the method the students use.

1. Use a stock solution of 250 cm^3 of 20 a.u. hydrogen peroxide, to make solutions of 8 a.u. and 2 a.u.
2. Cut 15 cylinders of potato of equal diameter, using a cork borer, and use a ruler to ensure that each one is 5 cm long.
3. Set up the apparatus as shown in **Fig. 17.1**.
4. Record the starting position of the water in the measuring cylinder.
5. Place one cylinder of potato into the conical flask.
6. Pour 50 cm^3 of 2 a.u. hydrogen peroxide into the flask, immediately secure the bung and start the stopwatch.
7. Record the volume of gas given off every 30 s for 3 min.
8. Repeat steps 3 to 7 twice.
9. Repeat steps 3 to 8 using 8 a.u. and 20 a.u. hydrogen peroxide.

(a) (i) State the independent variable in this investigation.

..... **[1]**

(ii) Describe how a student could produce an 8 a.u. solution from a 20 a.u. stock solution.

.....

.....

.....

.....

..... **[2]**

(iii) Liver tissue contains a higher concentration of catalase than potato.

Suggest **two** reasons why the students chose potato rather than liver as a source of catalase.

1 .....

.....

2 .....

.....

[2]

(iv) The potato cylinders were cut to equal lengths.

Suggest a further precaution the students should have taken when preparing them, to ensure the investigation was valid.

.....

..... **[1]**

(b) Some of the students' results are shown in the tables below.

Results for 2 a.u. hydrogen peroxide

Time (s)	Volume of oxygen produced (cm^3)				
	1	2	3	Mean	Standard deviation
30	5	6	5	5.3	0.6
60	9	10	9	9.3	0.6
90	13	14	13	13.3	0.6
120	16	17	18	17.0	1.0
150	19	20	21	20.0	1.0
180	21	22	23	22.0	1.0

Results for 8 a.u. hydrogen peroxide

Time (s)	Volume of oxygen produced (cm^3)				
	1	2	3	Mean	Standard deviation
30	22	23	23	22.7	0.6
60	37	39	38	38.0	1.0
90	49	49	47	48.3	1.2
120	57	58	55	56.7	1.5
150	61	63	59	61.0	2.0
180	64	67	62	64.3	2.5

Results for 20 a.u. hydrogen peroxide

Time (s)	Volume of oxygen produced (cm^3)				
	1	2	3	Mean	Standard deviation
30	57	55	58	56.7	1.5
60	78	74	78	76.7	
90	89	73	88	83.3	9.0
120	95	79	93	89.0	8.7
150	97	81	95	91.0	8.7
180	97	83	96	92.0	7.8

(i) Calculate the standard deviation for the 60 s result at 20 a.u. hydrogen peroxide.

Use the formula: $s = \sqrt{\frac{\sum(x - \overline{x})^2}{n - 1}}$

Standard deviation = ... **[2]**

(ii) Use the standard deviations to discuss the repeatability of the students' results.

.....

.....

.....

.....

..... **[2]**

(iii) The students calculated the initial rate of reaction over the first 30 s.

Calculate the rate of reaction over the first 30 s for the result at 2 a.u. hydrogen peroxide.

Rate = ...

Unit = ...

[2]

(iv) When analysing the results, the students assumed that the volume of oxygen collected was the same as the volume of oxygen produced from breakdown of hydrogen peroxide.

Suggest **two** reasons why the value the students recorded for volume of oxygen collected might not accurately reflect the volume of oxygen produced.

1 .....

.....

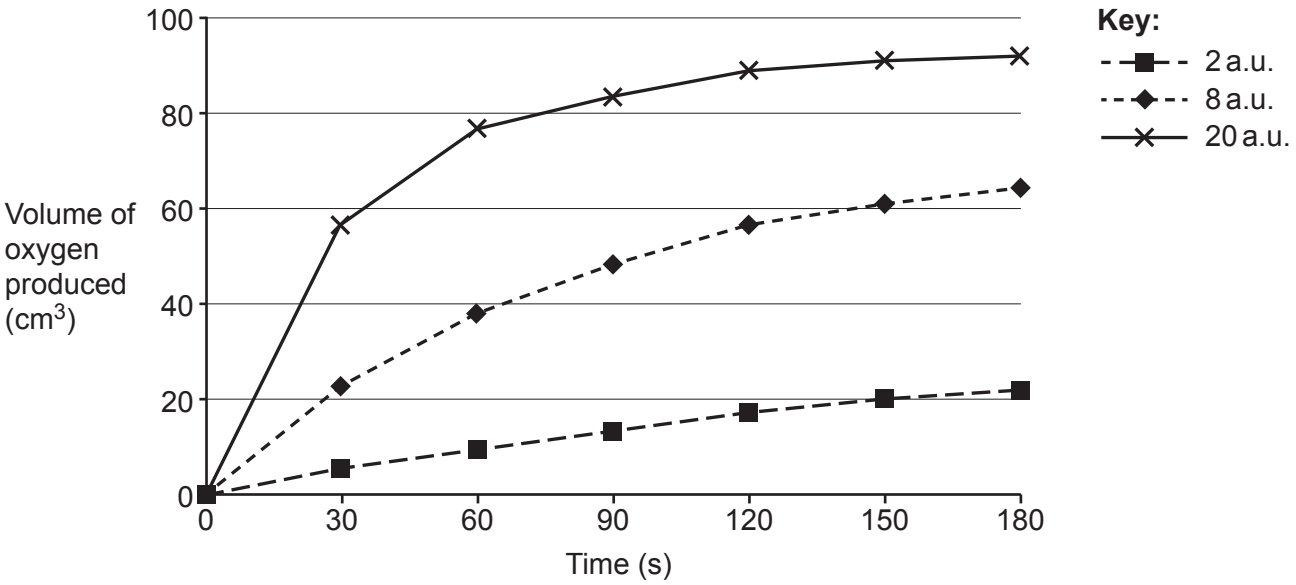
2 .....

.....

[2]

(c) **Fig. 17.2** shows a graph of the students' results.

Fig. 17.2



Explain the results for 20 a.u. hydrogen peroxide.

.....

.....

.....

.....

.....

.....

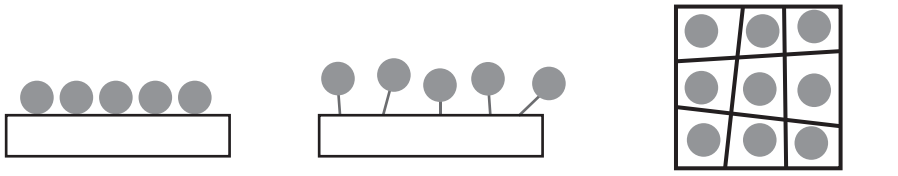
.....

..... **[3]**

18 Immobilised enzymes are often used for industrial processes.

Fig. 18.1 shows three methods for immobilising enzymes.

Fig. 18.1



Adsorption Covalent bonding Entrapment in matrix

● = Enzyme molecule

(a) State **one** other method for immobilising enzymes.

.....

..... **[1]**

(b) One advantage of using immobilised enzymes is that the enzyme can be reused many times. However, the process of immobilisation can reduce the activity of enzymes.

With reference to **Fig. 18.1**, explain why the activity of immobilised enzymes might be lower than that of enzymes that are free in solution.

.....

.....

.....

.....

..... **[2]**

(c) Invertase is an enzyme that catalyses the following reaction:

sucrose ⟶ glucose + fructose.

Invertase is present in cells of baker's yeast, a type of fungus.

It is possible to immobilise invertase and it is also possible to immobilise yeast cells.

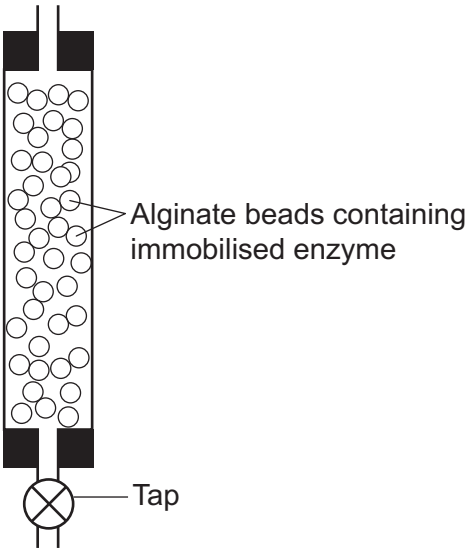
(i) Suggest **one** reason why using immobilised yeast might be more expensive than using immobilised invertase.

.....

..... **[1]**

Investigations involving immobilised enzymes can be carried out using equipment like that shown in **Fig. 18.2**. A glass column with an outlet at the bottom is filled with alginate beads containing immobilised enzyme. The substrate can be added at the top and the product collected at the bottom.

Fig. 18.2



(ii)* A student wanted to compare the ability of immobilised invertase and immobilised yeast cells to hydrolyse sucrose.

The student had access to the following:

- sucrose solution
- alginate beads containing invertase
- alginate beads containing yeast cells
- glass columns such as the one shown in **Fig. 18.2**
- standard laboratory equipment and reagents.

Outline a valid method the student could use to compare the activity of immobilised invertase and immobilised yeast cells.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

Additional answer space if required.

.....

.....

.....

.....

.....

19 Animals are protected from infectious diseases by their immune system.

(a) Influenza is a viral disease that is common in winter months. It is transmitted when an uninfected person inhales droplets of moisture that an infected person has exhaled, often when coughing or sneezing.

Explain how mucous membranes make it more difficult for the influenza virus to enter the body.

.....

.....

.....

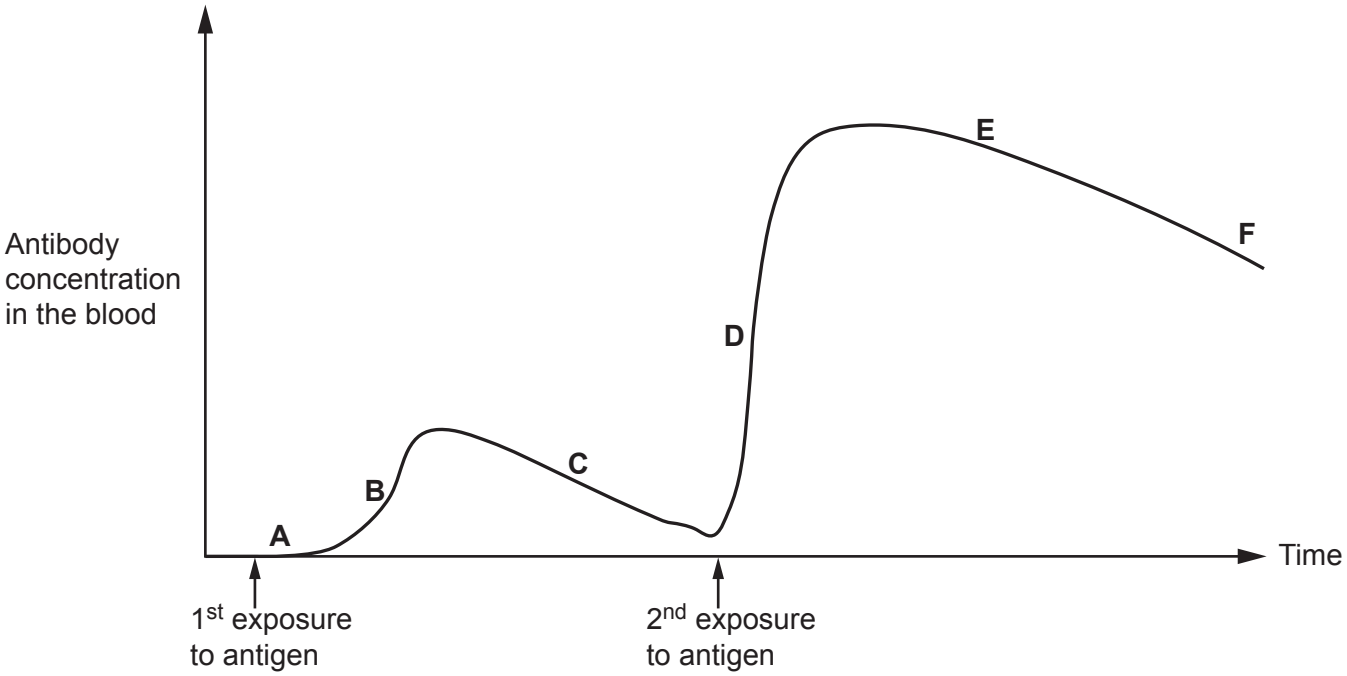
.....

..... **[2]**

(b) Antigens on the surface of pathogens can provoke an immune response in a patient.

Fig. 19.1 shows the changes in antibody concentration in the blood of a patient.

Fig. 19.1



Different events during these immune responses have been represented as areas on the graph labelled with letters, **A** to **F**.

Complete the table with a letter or letters to indicate where on the graph the event is represented.

Event	**Letter or letters**
Antigen presentation	
Clonal expansion	
Clonal selection	
High T-helper cell activity	
Highest number of memory cells	

[5]

(c) Fragments of antibodies, known as Fab fragments, have a number of uses.

(i) Snakebites can be treated using Fab fragments.

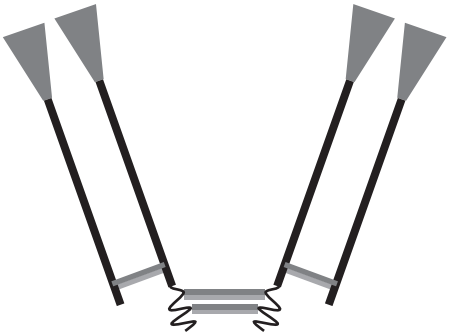
Antibodies specific to the snake venom are produced using donor animals, usually sheep. These antibodies are collected from the animal's blood and then digested to produce Fab fragments. The patient can be injected with these fragments after being bitten by a snake.

Name the type of immunity this treatment gives the patient.

..... **[1]**

(ii) **Fig. 19.2** shows the structure of a Fab fragment.

Fig. 19.2



Identify **two** similarities and **one** difference in structure between a Fab fragment and a whole antibody.

Similarity 1 .....

.....

Similarity 2 .....

.....

Difference .....

.....

[3]

(d) Infectious disease caused by pathogenic bacteria can be treated using antibiotics. The first antibiotics became widely available in the middle of the 20th Century.

Explain why many varieties of pathogenic bacteria are now resistant to a range of antibiotics.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(e) Plants and microorganisms have traditionally been used as sources of new medicines.

Synthetic biology could play a major role in the development of new medicines.

Outline how synthetic biology can be used in the provision of new medicines.

.....

.....

.....

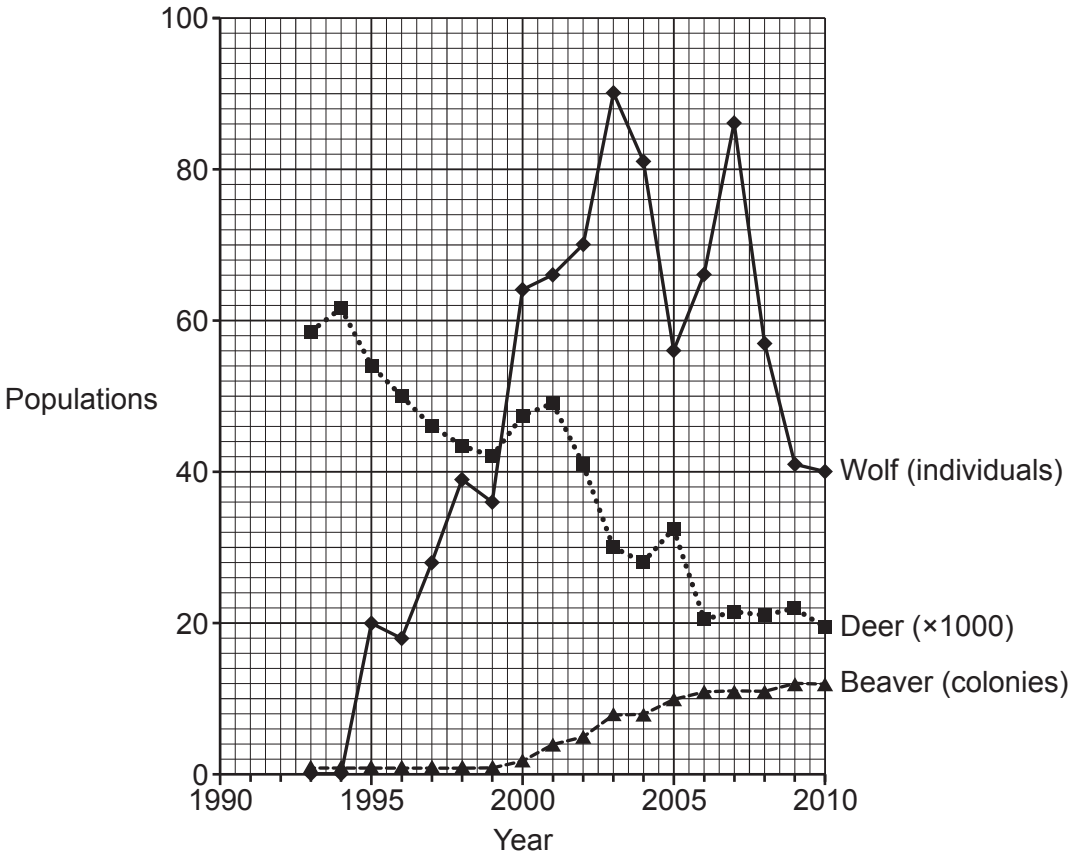
.....

..... **[2]**

20 Grey wolves became extinct in an area of North America in the 1920s. In 1993 some grey wolves were reintroduced into the same area.

Grey wolves feed mainly on large herbivores, such as deer.

The graph shows the population of grey wolves and some other species since the reintroduction.



(a) Describe the changes in the deer population since 1993.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(b) (i) Calculate the percentage increase in the wolf population between 1995 and 2003.

Percentage increase = ... **[2]**

(ii) Between 2003 and 2010 there were no significant changes in the climate of this area of North America and no disease outbreaks.

Suggest and explain **one** reason for the changes in the grey wolf population since 2003.

.....

.....

.....

.....

..... **[2]**

(c) Beavers are mammals that live in water. They form colonies nesting under big mounds of wood set as islands in areas of water.

In 1993 there was one colony of beavers living in the area to which the wolves were reintroduced.

(i) Suggest why the population of beavers is measured in colonies rather than individual animals.

.....

..... **[1]**

(ii) Scientists have claimed that the reintroduction of the wolves has caused the beaver population to increase.

Evaluate the support given by the evidence in the graph for the scientists' claim.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

(iii) Beavers build dams in the water using trees they have cut down. Deer damage trees while they are feeding. Wolves often hunt deer that are feeding near water.

The following explanation for the increase in beaver population has been suggested by scientists:

- The presence of wolves causes deer to avoid grazing close to water.
- This means that trees near water are not damaged.
- Beavers have a plentiful supply of trees with which to build dams.

Suggest **one** other piece of useful evidence that could be measured that would support the scientists' claim.

.....

..... **[1]**

(d) Beavers are a species that was once native to Britain. The species became extinct in Britain about 400 years ago.

In 2009, a population of beavers was brought from Norway and released into the wild in Britain.

(i) Explain why the reintroduction of beavers to Britain is an example of conservation.

.....

.....

.....

.....

..... **[2]**

(ii) Suggest a situation in which preservation of a habitat would be necessary.

.....

..... **[1]**

21 The element nitrogen is recycled within ecosystems.

(a) Complete the sentences using the most appropriate terms.

When animals die microorganisms convert nitrogen-containing molecules in the animals' bodies to ammonia in a process known as ..... . This ammonia is converted into nitrites and nitrates by ..... bacteria. The bacterium ..... converts ammonia to nitrites and the bacterium ..... converts nitrites to nitrates. Nitrates can be absorbed by plants and converted to ..... . Nitrogen gas is very unreactive but it can enter the nitrogen cycle by being converted to ammonia by ..... bacteria such as *Rhizobium*.

[6]

(b) Use your knowledge of the nitrogen cycle to suggest **and** explain why plants do not grow well in soil with a low oxygen content.

.....

.....

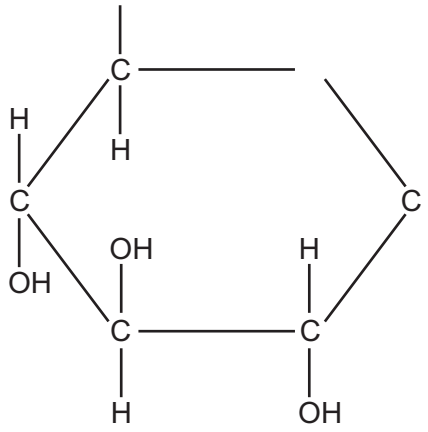
.....

.....

..... **[2]**

(c) *Rhizobium* forms nodules on the roots of certain plants. The *Rhizobium* receives a supply of glucose from the plant which the bacterium is able to use.

The diagram below shows an incomplete diagram of the structure of alpha glucose.



(i) Write **on the diagram** to show the complete structure of alpha glucose. **[3]**

(ii) Explain how the structure of glucose allows it to move from the plant to the bacterium.

.....

.....

.....

.....

..... **[2]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).