OCR
Oxford Cambridge and RSA

Friday 14 June 2024 – 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)

H420/02

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.

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Section A

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

Write your answer to each question in the box provided.

1 Biomass is transferred through ecosystems.

What process makes biomass available for transfer to the next trophic level in the food chain?

A Excretion

B Growth

C Removal of undigested food

D Respiration

Your answer ☐ **[1]**

2 What explains why food chains rarely have more than five trophic levels?

A Parts of the food organism are not eaten by organisms higher in the food chain.

B Plants absorb only a small proportion of the Sun's energy.

C There is a limit to the size to which a predator can grow.

D Transfer of biomass between trophic levels is inefficient.

Your answer ☐ **[1]**

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3 The rate at which plants produce biomass is known as productivity.

What is a suitable unit with which to measure productivity at different depths in the ocean?

A kg day^{-1} m^{-2}

B kg day^{-1} m^{-3}

C kg $year^{-1}$ m^{2}

D m kg^{-1} $year^{-1}$

Your answer ☐ **[1]**

4 Microscopes vary in terms of magnification and resolution.

Which option describes the terms magnification and resolution?

A Magnification is the size of an image under a microscope and resolution is the sharpness of that image.

B Magnification is the size of the image compared to the actual size and resolution is the ability to distinguish two objects from one another.

C Resolution is the ability to make small objects appear larger and magnification is the ability to distinguish two objects from one another.

D Resolution is the size of an image under a microscope and magnification is the sharpness of that image.

Your answer ☐ **[1]**

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5 Variation can be under genetic control.

Which statement about the genetic control of variation **cannot** be true for discontinuous variation?

A Variation is controlled by a single gene with multiple alleles.

B Variation is controlled by an epistatic interaction between two genes with multiple alleles.

C Variation is controlled by many genes on different chromosomes.

D Variation is controlled by two genes on the same chromosome.

Your answer ☐ **[1]**

6 What is a direct consequence of the genetic code being degenerate?

A It is possible that a mutation could change the sequence of amino acids but leave the function of the protein unchanged.

B It is possible that a mutation could leave the primary structure of the protein unchanged.

C It is possible that a mutation could leave the sequence of bases unchanged.

D It is possible that a mutation could substitute one amino acid for another with similar properties.

Your answer ☐ **[1]**

7 Which of the statements describe(s) control of gene expression at the post-transcriptional level?

1 binding of a repressor protein to an operator sequence
2 the removal of introns to form mature RNA
3 editing of primary RNA

A 1, 2 and 3

B Only 1 and 2

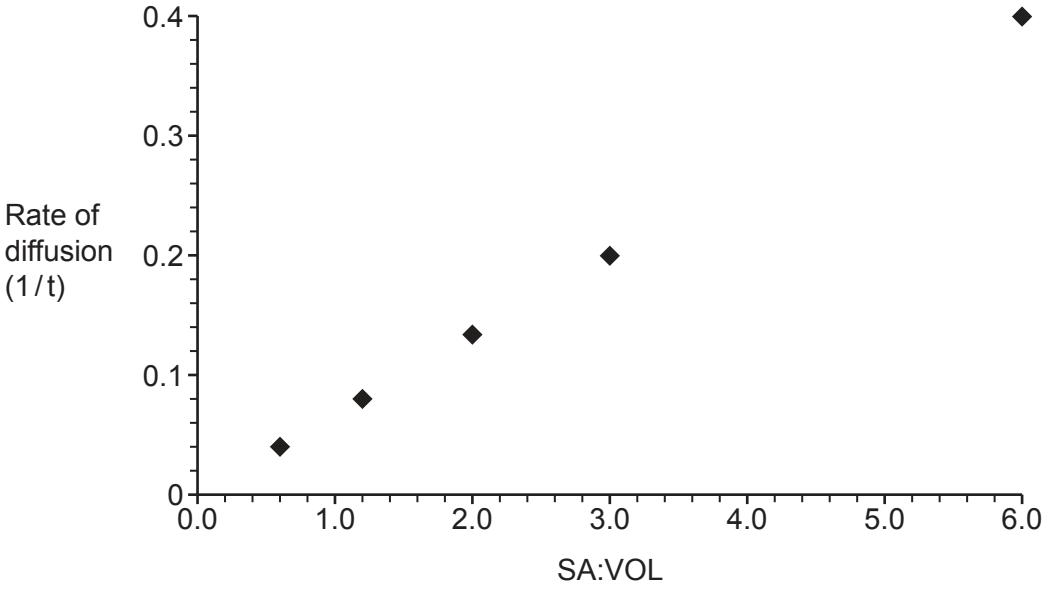
C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

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8 The graph shows the results of an investigation into diffusion rates in cubes of agar jelly with different surface area to volume ratios (SA:VOL).



Which option best describes the results of the investigation?

A SA:VOL is directly proportional to rate of diffusion.

B SA:VOL is inversely proportional to rate of diffusion.

C There is a negative correlation between SA:VOL and rate of diffusion.

D There is an inverse correlation between SA:VOL and rate of diffusion.

Your answer ☐ **[1]**

9 Calculate the SA:VOL of a cube with edges 4 cm long.

A 0.25

B 0.67

C 0.96

D 1.5

Your answer ☐ **[1]**

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10 Plants can be cloned artificially by taking cuttings.

Which of the following are important steps when cloning a plant by taking a cutting?

1 Keep it regularly watered.
2 Add rooting hormones to agar jelly.
3 Sterilise a small sample of plant material.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

11 Microorganisms can be used to produce food.

Which option is **not** seen as an advantage of using microorganisms to produce food compared to traditional food production methods?

A Microorganisms grow more rapidly than plants or animals.

B Production can be easily varied to meet demand.

C Production can occur at low temperatures and pressures.

D There are no animal welfare issues.

Your answer ☐ **[1]**

12 Aseptic conditions are important when culturing microorganisms.

Which option is **not** a correct part of the procedure for spreading bacteria on an agar-filled Petri dish?

A Remove the lid of the Petri dish and rest it upside-down on the work surface.

B Replace the lid of the Petri dish and secure it with tape.

C Sterilise the area surrounding the experiment with disinfectant.

D Work near a Bunsen flame to create an upward draft of air.

Your answer ☐ **[1]**

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13 A standard growth curve for a population of bacteria of the same species in a closed system involves a death phase.

Which option explains the death phase?

A Interspecific competition for nutrients, such as glucose, is high.

B Intraspecific competition for resources, such as oxygen, begins.

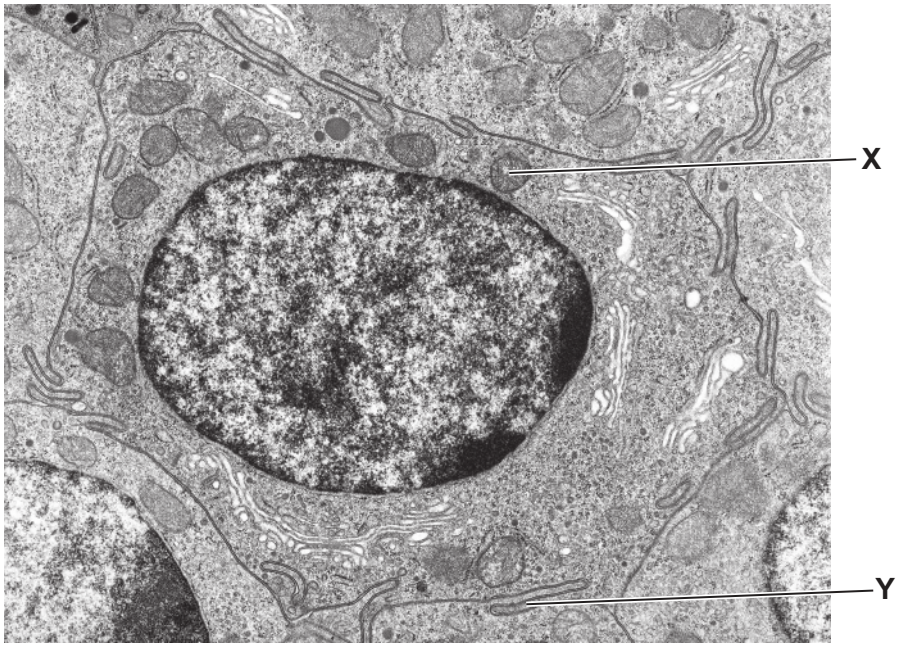
C Production of toxic waste products is at its highest level.

D Reproduction stops due to exhaustion of resources.

Your answer ☐ **[1]**

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This is an electron micrograph of an intestine cell.



Use the image to answer questions **14** and **15**.

14 Identify the structure labelled **X**.

A Centriole

B Lysosome

C Mitochondrion

D Nucleolus

Your answer ☐ **[1]**

15 Identify the structure labelled **Y**.

A Cell wall

B Cilium

C Plasma membrane

D Smooth ER

Your answer ☐ **[1]**

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Section B

16 DNA profiling is an important technique with many uses.

The steps involved in creating a DNA profile can be outlined as follows:

1. DNA extraction
2. Digestion
3. Separation
4. Analysis

(a) DNA profiling is used in the investigation of crime and in paternity cases.

State **one** other use of DNA profiling.

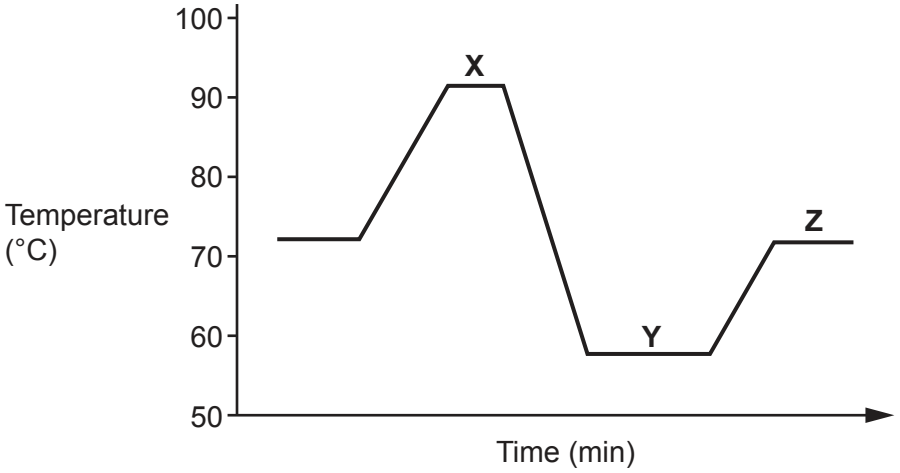
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..... **[1]**

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(b) When creating a DNA profile from a crime scene, an intermediate step between DNA extraction and digestion, known as PCR, is usually carried out.

The technique of PCR involves a cycle of changes in temperature, shown in the graph.



(i) Name the technique known as PCR.

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

(ii) Outline the process of PCR, with reference to steps **X**, **Y** and **Z**.

X .....

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Y .....

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Z .....

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[3]

(iii) Explain why a temperature of 72–75 °C is used for step **Z**.

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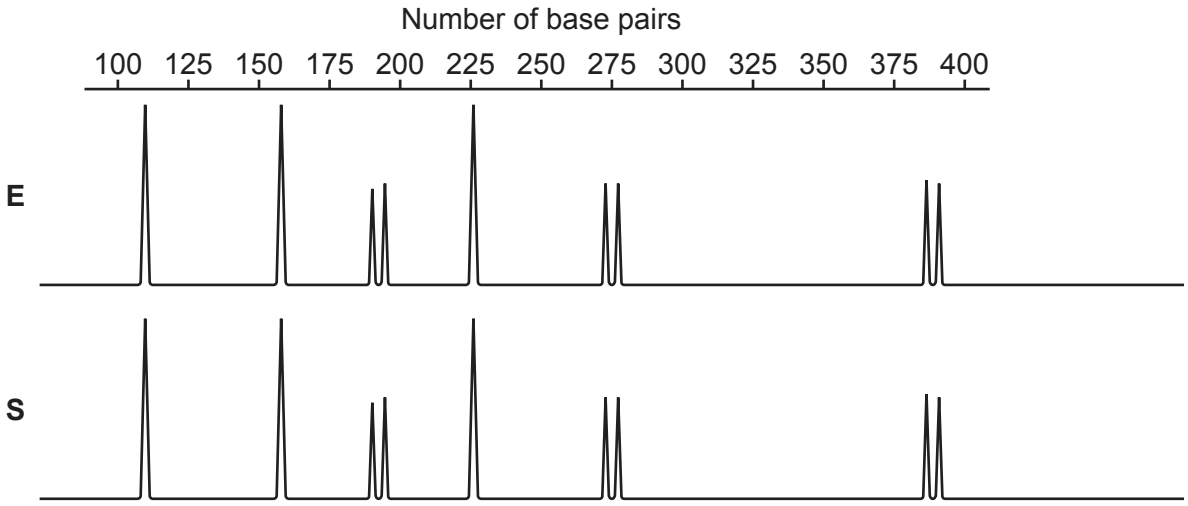
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(iv) Suggest why a PCR step is usually necessary when creating a DNA profile from a crime scene sample in particular.

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

(c) This is part of a DNA profile for six loci from a sample of DNA found at a crime scene (**E**), and DNA from a potential suspect (**S**).



(i) Suggest why some loci have two peaks but some have only one.

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(ii) Using the evidence in the DNA profile it was claimed that suspect **S** had been at the crime scene.

Explain how strongly the evidence supports this claim.

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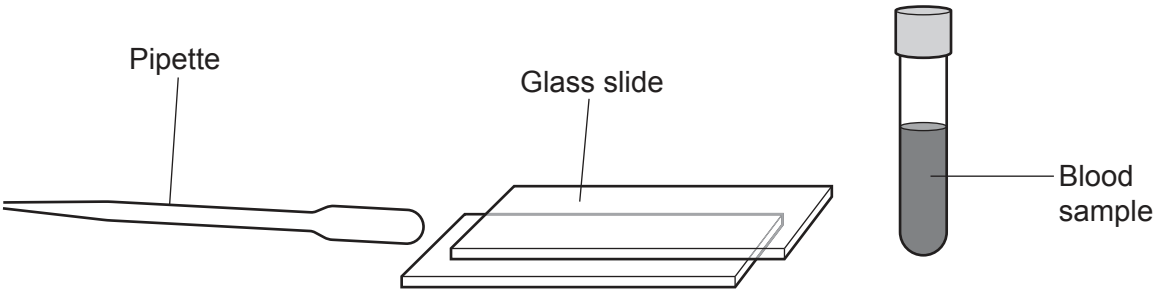
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17 Blood cells can be examined using microscopy.

(a) This is some equipment that could be used when preparing a blood smear.



Describe how to use the equipment to prepare a blood smear that could then be stained and viewed under a microscope.

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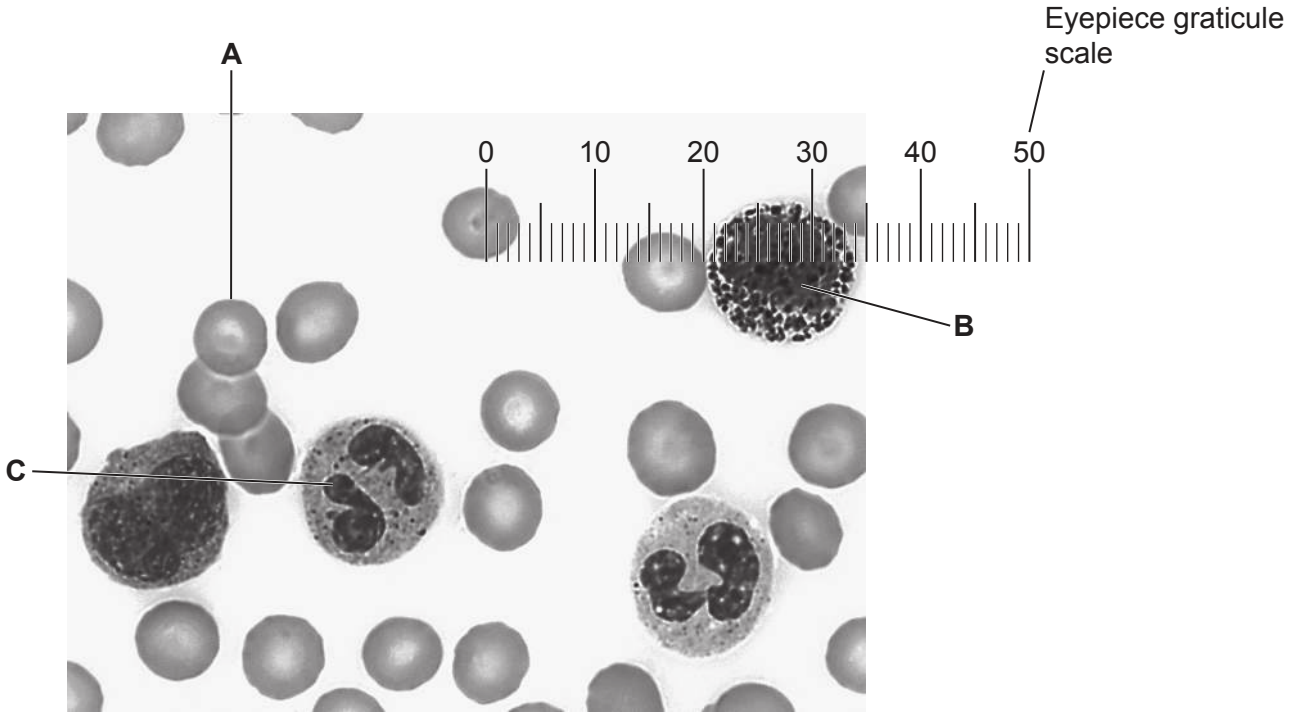
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(b) This is a light micrograph of a human blood smear.



(i) The cell labelled **A** is sometimes known as a red blood cell.

Name cell **A**.

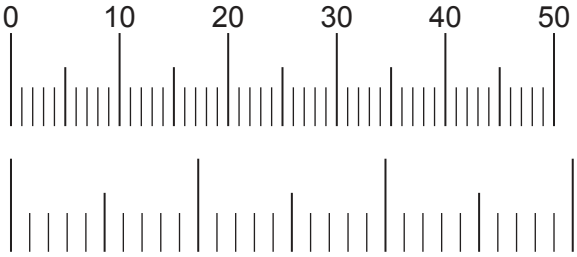
..... **[1]**

(ii) In the space below, draw a labelled diagram of cell **C**.

[4]

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(iii) The image was taken using a ×40 objective lens. The eyepiece graticule scale for the ×40 objective lens was calibrated using the stage micrometer shown below.



Eyepiece graticule scale

Stage micrometer scale

Each of the three large divisions on the stage micrometer scale measured exactly 0.01 mm.

Calculate the diameter of cell **B**.

Give your answer in μm to **2** significant figures.

Diameter = ... μm **[3]**

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18 Bioinformatics, computational biology and synthetic biology are relatively new techniques in biology that have a variety of uses.

This is a preserved thylacine, *Thylacinus cynocephalus*, a large Australian carnivore that became extinct in 1936.



Many preserved thylacine specimens in museums contain DNA. Scientists have used DNA sequencing, bioinformatics and computational biology to reconstruct the genome of the thylacine. Some scientists hope to be able to use bioinformatics and synthetic biology to produce a living thylacine in the future.

(a) Much of the thylacine DNA present in the museum specimens has broken down. In order to assemble an entire thylacine genome, it is necessary to supplement the thylacine DNA with DNA from a living close relative of the thylacine.

The thylacine belonged to the order Dasyuromorphia. The table shows the classification of the thylacine and some living species of the order Dasyuromorphia.

Common name	**A**	**Genus**	**Species**
Thylacine	Thylacinidae	*Thylacinus*	*T. cynocephalus*
Tasmanian devil	Dasyuridae	*Sarcophilus*	*S. harrisii*
Quoll	Dasyuridae	*Dasyurus*	*D. maculatus*
Fat-tailed dunnart	Dasyuridae	*Sminthopsis*	*S. crassicaudata*
Numbat	Myrmecobiidae	*Myrmecobius*	*M. fasciatus*

(i) Name the classification taxon represented by the column headed **A**.

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

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(ii) Using the information in the table, describe the evolutionary and genetic relationships between the species that are listed.

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(iii) Explain why it is difficult to decide which of the other species would be the most appropriate to use as a source of DNA for constructing a thylacine genome.

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

(iv) All the species in the table belong to the animal kingdom.

Other than the presence or absence of vacuoles, state **two** features of the cells of these multicellular organisms that would mean they could be classified only in the animal kingdom.

1 .....

2 .....

[1]

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(b) Synthetic biology involves re-designing organisms for useful purposes. One such purpose could be the production of useful proteins.

Proteins can be produced by traditional genetic engineering but the range of proteins available is limited to those that are already produced by a living organism.

Bioinformatics and computational biology can be used in the production of new proteins that are not found anywhere in nature.

(i)* Explain how gene sequencing, bioinformatics and computational biology are used in the production of useful proteins in synthetic biology.

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Extra answer space if required.

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(ii) Suggest why some people might be concerned about the increase of synthetic biology.

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(c) The thylacine finally became extinct in 1936 as a result of hunting by humans. However, its population had been in decline for many years before.

Some scientists have concluded that the thylacine was particularly vulnerable to extinction because of low genetic diversity within the species.

The table shows the proportion of heterozygous loci in a range of Australian mammal species together with information about how endangered they are.

Species	Genetic diversity (proportion of heterozygous loci)	Conservation status
Brown antechinus	0.0040	least concern
Fat-tailed dunnart	0.0037	least concern
Common wombat	0.0017	least concern
Koala	0.0013	vulnerable
Tammar wallaby	0.0007	least concern
Tasmanian devil	0.0003	endangered
Thylacine	0.0001	extinct

(i) Describe the evidence in the table that supports the conclusion that low genetic diversity contributed to the extinction of the thylacine.

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

(ii) Identify **one** piece of evidence that does **not** support the conclusion that low genetic diversity contributed to the extinction of the thylacine.

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

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19 Vaccination can protect an individual from infectious disease.

Polio is a viral disease that usually affects children and can have lifelong effects.

(a) A vaccine against polio was introduced in 1956.

(i) Suggest the contents of the original anti-polio vaccine.

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

(ii) B-lymphocytes and T-lymphocytes are involved in the immune response.

Describe the role of T-lymphocytes in the development of immunity to a virus such as polio.

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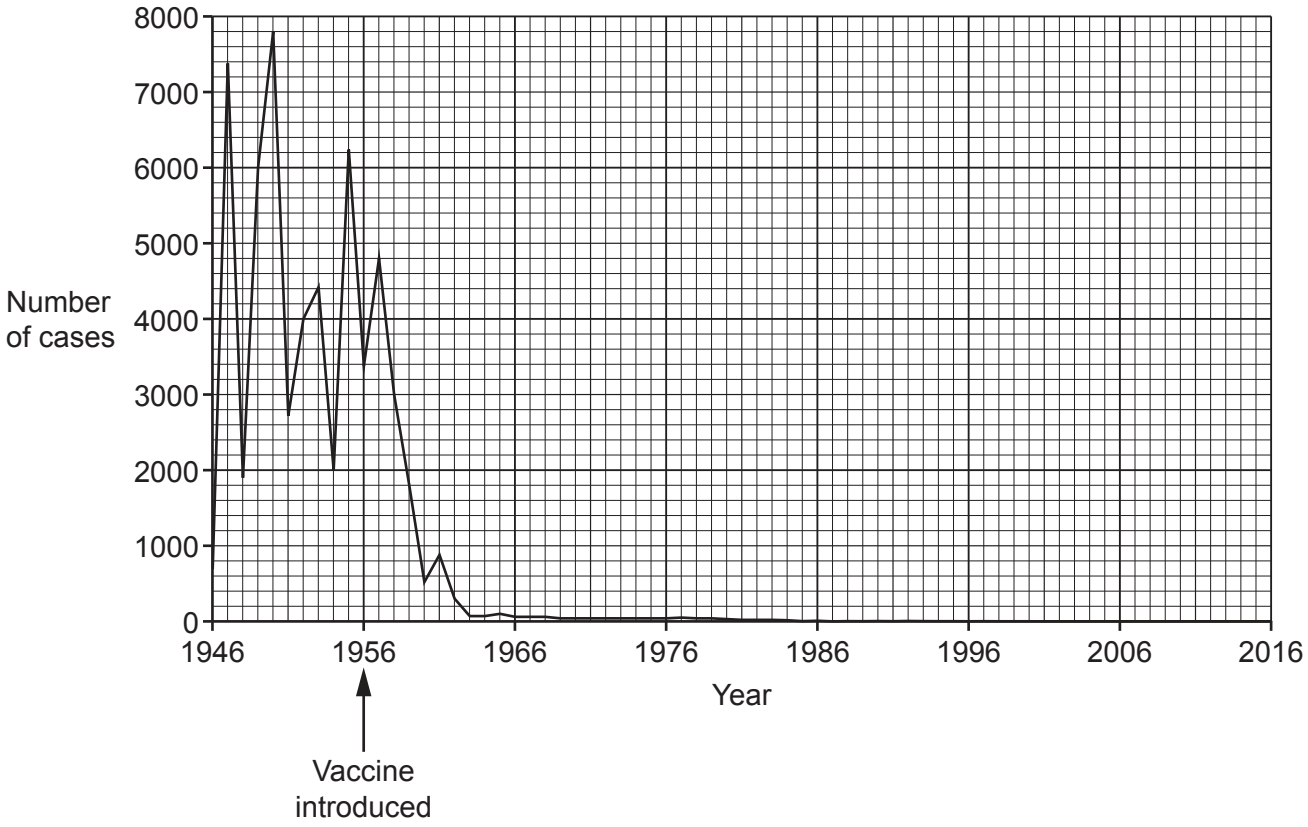
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(b) The graph shows the number of cases of polio in England and Wales between 1946 and 2016.



(i) Calculate the percentage decrease in cases between 1956 and 1960.

% decrease = ... **[2]**

(ii) A student wants to use the calculation in part **(b)(i)** to support a conclusion about the effectiveness of the polio vaccination. Another student argues that it would be better to have used 1957 as a starting year for the calculation.

Suggest **two** reasons why 1957 might have been a better starting year for the calculation.

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2 .....

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[2]

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(iii) There were cases of polio in England and Wales in the 1980s.

The scale used on the graph is not sensitive enough to show changes in the number of cases during the 1980s.

Suggest **one** way in which the *y*-axis scale could be changed in order that changes in the 1950s and 1980s were both visible.

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

(iv) Between 90% and 95% of UK children are currently fully vaccinated against polio.

In 2022 some particles of polio virus were detected in sewage in London. As a result, an extra dose of the polio vaccine was offered to children in London. The vaccine was not offered to children across the whole country.

Suggest why the extra vaccine was offered to children in London only.

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20 On a biology field trip, some students are studying an area of mixed woodland.

(a) Three tree species dominate the woodland: oak, ash and sycamore.

There are many small herbaceous plants in the woodland, but the students choose to collect data on only one: wood sorrel.

The students choose an oak tree, an ash tree and a sycamore tree and count every individual wood sorrel plant within a 3 m radius of each tree.

The results are shown in the table.

Species	**Wood sorrel population (total within 3 m radius)**					
Ash	44					
Oak	56					
Sycamore	20					

The null hypothesis of the students' investigation is that the species of tree would not affect the number of wood sorrel growing near it.

The students conclude that the conditions under oak trees are the most favourable of the three trees studied and that conditions under sycamore trees are the least favourable.

(i) Calculate the χ^2 value for the students' data.

Use the equation $\chi^2 = \sum \frac{(O-E)^2}{E}$

You may use the empty columns in the table to help with your calculation.

χ^2 = ... **[3]**

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(ii) The critical value for χ^2 in this investigation at p = 0.05 is 5.991.

Discuss what can be concluded from the χ^2 calculation in part **(a)(i)**.

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(iii) The teacher suggested that, in order to have confidence in their results, the students should include data from more than one tree for each species.

The students collect all their results on the same day.

Identify **two** other variables the students should attempt to control when carrying out an investigation such as this.

1 .....

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2 .....

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[2]

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(b) The teacher described the mixed woodland as a climax community that had resulted from succession.

Succession involves a series of changes in community over time, known as seres.

(i)* The first sere is the pioneer community. The final sere is the climax community.

The species that make up the pioneer and climax communities are different.

Compare the plant **and** animal species that make up the climax and the pioneer communities.

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Extra answer space if required.

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(ii) Succession involves changes in the species that live in an area over time.

State **one** other change that takes place in the same area over the same time.

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

(iii) Suggest what was present in the area that is now occupied by mixed woodland before the pioneer community arrived.

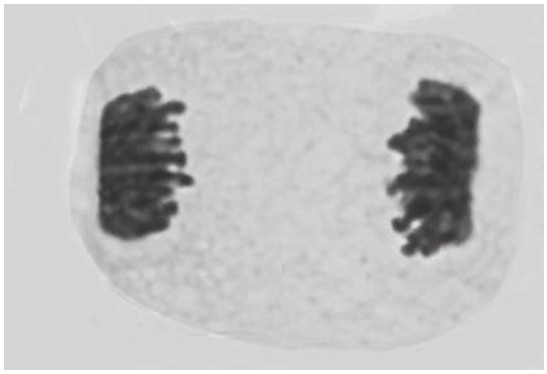
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..... **[1]**

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21 Certain changes occur throughout the life of a cell. These changes are known as the cell cycle.

(a) The image shows an onion cell undergoing mitosis.



(i) Name the stage of mitosis shown in the image.

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

(ii) Describe how the image would look different if the cell was in interphase.

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

(iii) The cell in the image is from the root of an onion.

State why root tissue is frequently chosen to study mitosis.

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

(b) The stages of mitosis and meiosis are similar but not identical.

Prophase occurs in both mitosis and meiosis.

(i) At the beginning of mitosis and meiosis, the nuclear envelope disintegrates.

Identify **two** other similarities between prophase in mitosis and **prophase 1** of meiosis.

1 .....

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2 .....

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[2]

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(ii) Identify **one** difference between prophase in mitosis and **prophase 2** of meiosis.

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

(c) The cell cycle of an onion cell is estimated to be 15 h.

A root-tip squash from an onion contained 124 cells.

16 of the cells were undergoing mitosis.

Calculate the mean length of time each cell spent undergoing mitosis.

Give your answer in minutes to **3** significant figures.

Time spent undergoing mitosis = ... min **[2]**

(d) The cell cycle describes a series of events that occur during the life of a cell.

Complete the sentences by choosing the most appropriate terms.

During mitosis the ..... divides. This is followed immediately by ..... . Interphase contains three phases. Replication of DNA takes place during the ..... phase. Checkpoints occur during the cell cycle. The G_1 and G_2 checkpoints check for cell size and ..... . The second checkpoint occurs at the end of the ..... phase. If a cell does not satisfy the requirements of a checkpoint, it enters the ..... .

[6]

END OF QUESTION PAPER

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EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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