OCR | A-LEVEL BIOLOGY | H420/02

# Biological diversity

June 2025 exam series

QUESTION PAPER

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# Friday 13 June 2025 – 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.

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**Turn over**

## Section A

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

Write your answer to each question in the box provided.

**1** Hydrogen bonds are important for the physical and chemical properties of water.

How do hydrogen bonds form in water?

**A** Electronegative ($\delta^-$) oxygen atoms are attracted to the electropositive ($\delta^+$) hydrogen atoms of adjacent water molecules.

**B** Electronegative ($\delta^-$) oxygen atoms are attracted to the electropositive ($\delta^+$) hydrogen atoms within the same water molecule.

**C** Electropositive ($\delta^+$) oxygen atoms are attracted to the electronegative ($\delta^-$) hydrogen atoms of adjacent water molecules.

**D** Electropositive ($\delta^+$) oxygen atoms are attracted to the electronegative ($\delta^-$) hydrogen atoms within the same water molecule.

Your answer ☐ **[1]**

**2** Water has many properties that are important for living organisms.

Which property of water molecules explains why small animals, such as pond skaters, are able to move over the surface of water without sinking?

**A** Adhesion

**B** Buoyancy

**C** Cohesion

**D** Density

Your answer ☐ **[1]**

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**3** What is a **disadvantage** of using microorganisms to make food for human consumption?

**A** Competition from contaminating microorganisms can reduce yield.

**B** Food produced by microorganisms is low in fat.

**C** Microorganisms can be grown on waste materials.

**D** Use of microorganisms for food production raises fewer ethical concerns than use of animals.

Your answer ☐ **[1]**

**4** Culturing microorganisms on nutrient agar requires aseptic techniques.

What is **not** part of a standard aseptic procedure when culturing microorganisms?

**A** Disinfect the work area before starting.

**B** Ensure equipment does not touch any unsterilised surfaces before use.

**C** Pass the agar plate through a Bunsen flame before use.

**D** Work near a Bunsen flame.

Your answer ☐ **[1]**

**5** Batch fermentation with microorganisms is used to produce a range of useful substances.

Which of the following are important for achieving maximum yield during a batch fermentation process?

1. Temperature should be maintained close to the optimum.
2. Temperature should be low to reduce costs.
3. Substrate should be constantly added to maintain a high concentration.

**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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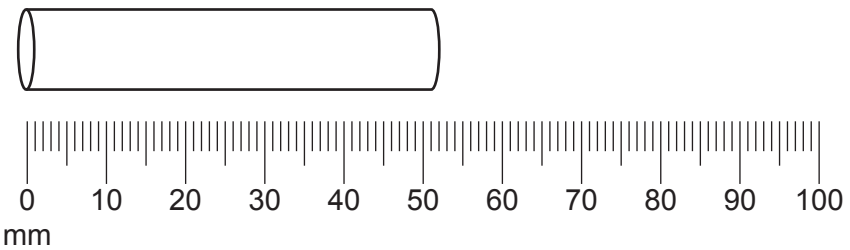
**6** Some students are conducting an osmosis investigation using cylinders of potato.

They cut cylinders of potato 50 mm long using the ruler shown in the diagram.




What is the percentage uncertainty in the length of the potato cylinders?

**A** 0.25%

**B** 0.5%

**C** 1%

**D** 2%

Your answer ☐ **[1]**

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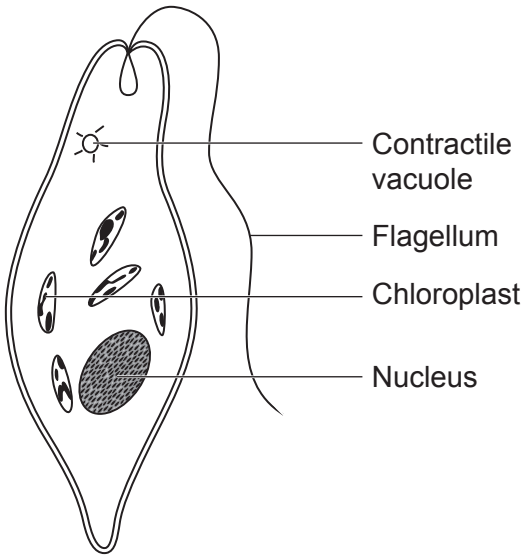
**7** The image shows an organism called *Euglena gracilis*.




Which kingdom does *Euglena* belong to?

**A** Animalia

**B** Plantae

**C** Prokaryotae

**D** Protoctista

Your answer ☐ **[1]**

**8** Plants can be cloned by taking cuttings.

New cuttings often experience water stress during the first few weeks.

Which of these practical procedures are used to reduce water stress?

1. Cover cutting with a plastic bag.
2. Remove leaves from cutting.
3. Rooting powder applied to cutting.

**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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**9** Mutations during DNA replication can involve a single nucleotide base being deleted from the genetic code.

Which term describes this mutation?

**A** Frameshift mutation

**B** Insertion

**C** Silent mutation

**D** Substitution

Your answer ☐ **[1]**

**10** The use of genetically modified (GM) crops in agriculture raises certain concerns.

What is **not** a valid concern about the use of GM crops in agriculture?

**A** Eating modified genes is harmful to consumers.

**B** Modified genes might spread to wild populations.

**C** Patenting of GM crops by large companies might disadvantage independent producers in developing countries.

**D** Pests might evolve resistance to pesticides contained in GM crops.

Your answer ☐ **[1]**

**11** Which statement about DNA sequencing is **not** correct?

**A** High-throughput sequencing allows DNA to be sequenced quickly.

**B** Nucleotides are added to a growing strand by a polymerase enzyme.

**C** Sanger sequencing was the original method used for DNA sequencing.

**D** The sequence of amino acids in DNA samples is determined.

Your answer ☐ **[1]**

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**12** Artificial selection and natural selection are similar processes.

Which option describes only natural selection?

**A** Alleles are passed on to the next generation.

**B** Certain alleles become more frequent in the population.

**C** Phenotypic variation in the population can be reduced.

**D** Reproductive success is determined by a range of environmental factors.

Your answer ☐ **[1]**

**13** Reproduction can be sexual or asexual.

What is an advantage of sexual reproduction?

**A** Advantageous features are preserved between generations.

**B** Genetic variation is increased.

**C** Offspring are genetically identical to parents.

**D** The risk of mutation is reduced.

Your answer ☐ **[1]**

**14** Land can be used for producing food for human populations.

A 50 $m^2$ field can support a larger human population if used for growing crops for plant-based foods than if it was used for grazing animals, such as cows, for meat production.

Which option explains why the same field supports a larger human population if plant crops are grown?

**A** Biomass is lost between trophic levels in a food chain.

**B** Less energy is lost during respiration when humans eat plant-based foods.

**C** Plant-based foods are more easily digested than meat.

**D** The risk of heart disease is likely to be lower if humans eat plant-based foods rather than meat.

Your answer ☐ **[1]**

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**15** Ecosystems can provide resources in a sustainable way.

Which option describes the meaning of **sustainable** in the above sentence?

**A** Cost-effective use of a resource by humans.

**B** Managing a resource so biodiversity is maintained.

**C** Preventing human access to a resource so that it remains at its current level.

**D** Use of a resource in such a way that it will not run out.

Your answer ☐ **[1]**

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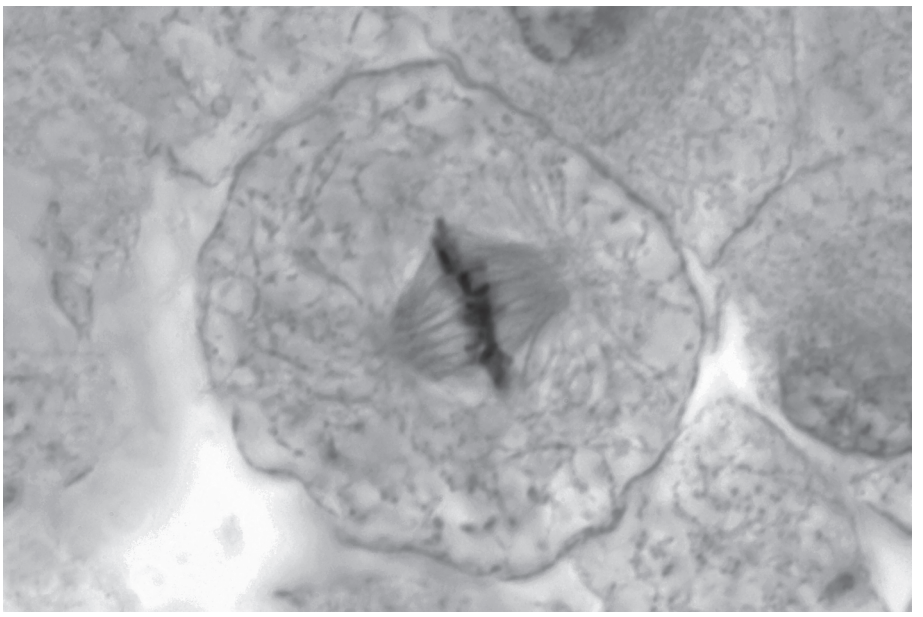
## Section B

**16** Microscopy can be used to examine the structure of stem cells.

**(a)** The image shows a stem cell from a fish embryo viewed under a light microscope.



×2000

**(i)** Identify **two** pieces of evidence that suggest that the image was produced by a light microscope rather than a scanning electron microscope.

1 .....

.....

2 .....

.....

**[2]**

**(ii)** Calculate the horizontal diameter of the cell shown in the image.

Give your answer in μm.

Diameter = ..... μm **[2]**

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**(iii)** Explain why staining is useful in microscopy.

Use structures visible in the image to support your answer.

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

**(b)**

**(i)** State **two** features of stem cells, **not** visible under the microscope, that distinguish them from specialised cells.

1 .....

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2 .....

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**[2]**

**(ii)** Stem cells have a number of uses in medicine.

Explain why stem cells are useful tools in medical research.

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**(c)*** The development of body form begins in embryonic stem cells.

Using examples, explain the importance of mitosis **and** apoptosis as mechanisms controlling the development of body form.

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Extra answer space if required.

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**17** Animals can undergo natural and artificial cloning.

**(a)** Human identical twins are an example of natural animal clones.

Suggest why human identical twins do not look exactly identical.

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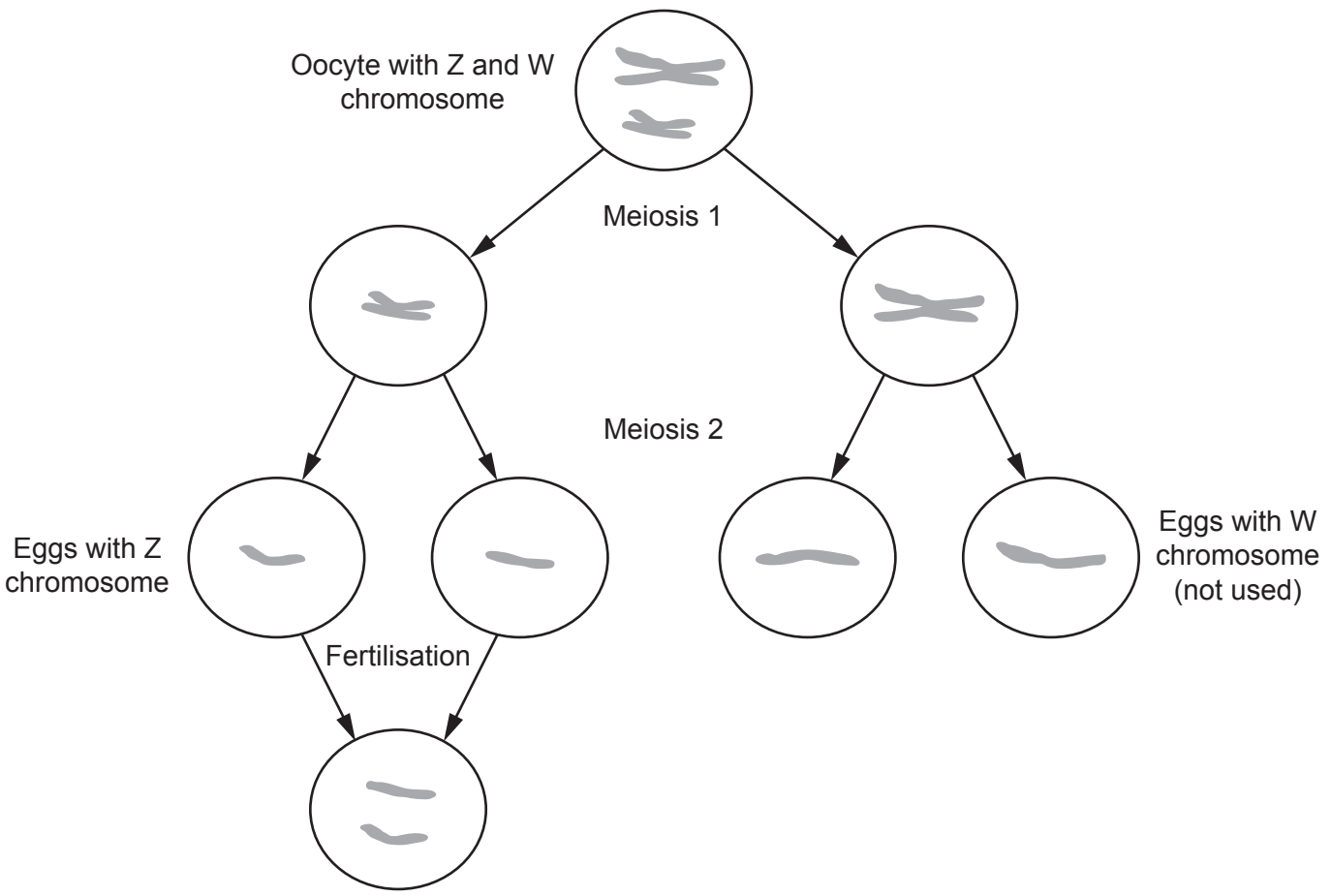
..... **[1]**

**(b)** Komodo dragons are large lizards.

Male Komodo dragons have two Z chromosomes. Female Komodo dragons have one Z chromosome and one W chromosome.

A reproductively isolated female Komodo dragon can reproduce without a male using a process called parthenogenesis. All of the offspring are males.

This process is outlined in the diagram.

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**(i)** The offspring are not the same sex as the parent.

Identify **two other** reasons why parthenogenesis in Komodo dragons is not an example of cloning.

1 .....

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2 .....

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**[2]**

**(ii)** Suggest why female mammals cannot produce male offspring by parthenogenesis.

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

**(c)** Animals can be cloned artificially using embryo splitting.

This is the procedure for cloning by embryo splitting:

1. An egg from a female is fertilised by sperm from a male.
2. The zygote divides to form an embryo.
3. After a few days, the developing embryo is split into several smaller embryos.
4. After a few days, each smaller embryo is implanted into a surrogate mother.
5. Each embryo grows into a fetus and is born normally.

**(i)** State the property of the cells in the embryo that allows cloning to be successful.

.....

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

**(ii)** Embryos from stage 3 above are sometimes frozen for later use.

State **one** advantage to agriculture of freezing embryos from stage 3.

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

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**(d)** Animals can be cloned artificially using a technique called somatic cell nuclear transfer (SCNT).

SCNT can be used to increase the population of an endangered species.

Przewalski's horse, *Equus przewalskii*, is a species of horse related to the domestic horse, *Equus caballus*. The common ancestor of both horse species is thought to have lived 45 000 years ago.

Przewalski's horse became extinct in the wild in the 1960s. Captive breeding from 12 individuals has increased the population and some have since been reintroduced to the wild.

The genetic diversity of all modern Przewalski's horses is very low.

In 2020 and 2022, SCNT using frozen cells from an individual that died 42 years previously has led to the birth of two cloned Przewalski's horses which appear to be free of health problems.

**(i)** Outline how genetic diversity in a species such as Przewalski's horse can be measured.

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

**(ii)** State why SCNT is more useful than embryo splitting when increasing the population of endangered species.

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

**(iii)** Suggest **one** reason why the health of the cloned Przewalski's horses is better than that of Dolly the sheep, the first mammal to be cloned by SCNT.

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

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**18** Sampling is an important technique for assessing biodiversity.

**(a)** Sampling is used to measure the abundance of organisms in habitats.

**(i)** State why sampling is necessary when measuring the abundance of organisms in a habitat.

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

**(ii)** Explain why it is important that sampling is random.

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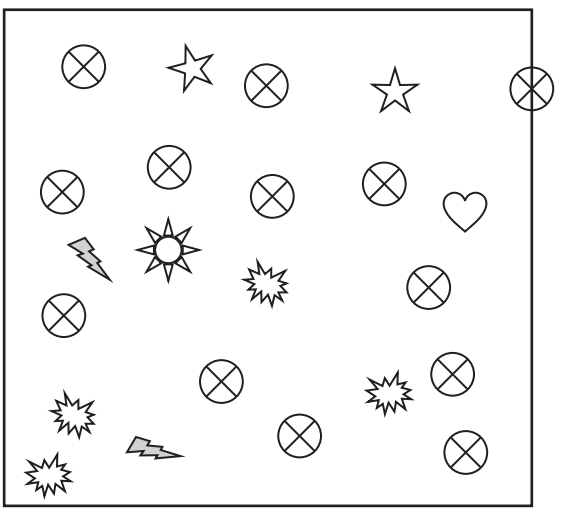
..... **[2]**

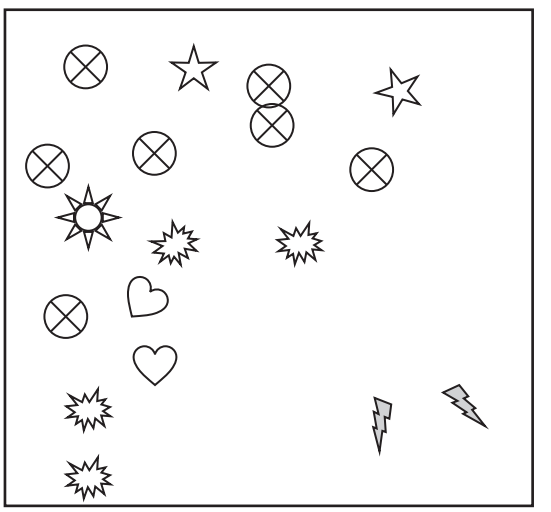
**(b)** Quadrat sampling is a useful tool for measuring the abundance and distribution of plant species.

A student sampled plants on an area of sports field. Observations recorded by the student for two of the quadrats are shown in the image below. The symbols represent different plant species.

**Quadrat A**



**Quadrat B**



**(i)** State the species richness in quadrat **A**.

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

**(ii)** Compare the species evenness in quadrats **A** and **B**.

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

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**(c)** Some students investigate the biodiversity of flying insect species in different parts of their school grounds.

The school has an area of wildflower meadow and some planted flower beds.

This is the method they use:

1. Select an area of wildflower meadow.
2. Pass a sweep net back and forward 5 times.
3. Shake the net into a tray and close with a transparent lid.
4. Use a key to identify the types of insect.
5. Release insects.
6. Repeat the procedure 9 times in different areas of the wildflower meadow.
7. On the same day, repeat steps 1 to 6 for the planted flower beds.

Their results for the wildflower meadow are shown in the table below.

| **Category** | **Number of individuals** | | |
|---|---|---|---|
| **Bumblebees** | 15 | | |
| **Other bees** | 32 | | |
| **Ladybirds** | 2 | | |
| **Other beetles** | 5 | | |
| **Painted lady butterfly** | 2 | | |
| **Red admiral butterfly** | 3 | | |
| **Other butterflies** | 5 | | |
| **Wasps** | 25 | | |
| **Flies** | 11 | | |
| **Total** | | | |

**(i)** Calculate the Simpson's Index of Diversity for the wildflower meadow.

Use the formula: $D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$

You may use the table above for working out.

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

*D* = ..... **[3]**

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**(ii)** Explain the significance of the value for *D* calculated in part **(i)**.

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

**(iii)** Describe how the students should select their sampling areas for steps **1** and **6**.

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

**(iv)** Suggest **two** improvements that the students could make to step **2** of their method. For each improvement explain how that would increase the validity of the results.

Improvement 1 .....

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Explanation 1 .....

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Improvement 2 .....

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Explanation 2 .....

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**[4]**

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**(v)** Suggest and explain **one** limitation with step **7** of the students' method.

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

**(vi)** Identify **one** problem with the way in which the students categorised their flying insect species that could reduce confidence in the calculated value for Simpson's Index of Diversity.

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

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**19** The Farne Islands are a group of small islands off the coast of Northern England.

The Farne Islands are a National Nature Reserve and Site of Special Scientific Interest. They are home to many species of bird, including arctic terns, guillemots, cormorants, shags, eider ducks, razorbills, and a variety of gulls. Particularly popular with the public are puffins. Considered by some to be a keystone species, puffins are small birds with large colourful beaks that fly very close to the surface of the sea. They come to the islands only to breed, nesting in underground burrows.

Local tour operators transport large numbers of visitors to the islands each year but no visitors are allowed on the islands during the winter to allow conservation work to be carried out. Such work includes repairing boardwalks and fences, tagging individual birds, and counting how many puffin burrows have been in use.

In 2023, an outbreak of bird flu caused a drop in the numbers of many species, including puffins, and visitors were banned from the islands. Local tour operators reported a drop in income.

**(a)**
**(i)** Identify evidence from the information above that supports each of the following claims:

Puffins are important for aesthetic reasons .....

.....

Puffins are important for ecological reasons .....

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Puffins are important for economic reasons .....

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**[3]**

**(ii)** The Farne Islands can be seen as an environmental resource that is affected by human activities.

Identify **one** example of conservation that is necessary as a direct result of human activities.

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

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**(iii)** There are no mammalian predators, such as rats and stoats, on the Farne Islands. Mammalian predators eat birds and their eggs.

Part of the conservation work involves ensuring that the islands remain free of these mammalian predators.

Suggest how human activity could be responsible for the arrival of these predators.

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

**(iv)** There are two types of conservation: *in situ* and *ex situ*.

State the type of conservation taking place on the Farne Islands and give a reason for your choice.

Type .....

Reason .....

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

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**(b)** Puffins, like many species on the Farne Islands, eat small fish. Their main predators are large gulls. Puffins are on the IUCN Red List for threatened species.

The puffin population can be estimated from the number of burrows that are occupied.

After the bird flu outbreak in 2023 the number of occupied burrows declined.

**(i)** It is important not to disturb the burrows and there is not enough money available to allow puffin burrows to be constantly monitored, either by humans or cameras.

Suggest **one other** type of evidence that could be used to infer that a burrow was being occupied by puffins.

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

**(ii)** Discuss the effect a decline in puffin population could have on other species in the area.

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**(iii)** Explain why the existence of a predator can improve the long-term survival of a species such as the puffin.

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**(c)*** The sea around the Farne Islands contains a large population of grey seals, *Halichoerus grypus*, and a small population of common seals, *Phoca vitulina*.

The table contains some information about these two species of seal.

| | **Length (m)** | **Mass (kg)** |
|---|---|---|
| **Grey Seal** | 1.9–2.3 (males)<br>1.6–2.0 (females) | 180–300 (males)<br>100–190 (females) |
| **Common Seal** | 1.45–1.85 (sexes similar) | 65–150 (sexes similar) |

Use the information in the table to describe the different types of variation between organisms and the underlying causes of this variation.

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Extra answer space if required.

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**20** Plants are often used to investigate genetic inheritance.

**(a)** Genetic crosses are used to investigate the inheritance of two genes at the same time. This is known as dihybrid inheritance.

Gregor Mendel investigated dihybrid inheritance in pea plants. When parent plants that were both heterozygous for two different genes were crossed, the ratio of phenotypes in the offspring was 9 : 3 : 3 : 1.

**(i)** Sweet pea is another species of plant.

- Sweet pea flower colour is coded for by a gene with two alleles: blue (**B**) and red (**b**).
- Sweet pea pollen shape is coded for by a gene with two alleles: long (**L**) and round (**l**).

When parents that were both heterozygous for the two genes were crossed, the ratio of phenotypes in the offspring was **3** (blue and long) : **1** (red and round).

The inheritance of flower colour and pollen shape in sweet pea is not affected by epistasis.

Explain what can be concluded from the phenotypic ratio **not** being the expected 9 : 3 : 3 : 1 for Mendelian dihybrid inheritance.

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

**(ii)** Explain why epistasis affects the offspring ratio in a genetic cross.

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

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**(b)** In pea plants, flower colour is controlled by two alleles: purple (dominant) and white (recessive).

- 600 pea plants are growing in a large greenhouse.
- 564 of the plants have purple flowers.

**(i)** Use the Hardy–Weinberg principle to calculate the number of heterozygous individuals in the greenhouse.

Use the equations:

$p + q = 1$

$p^2 + 2pq + q^2 = 1$

Number of heterozygous individuals = ..... **[3]**

**(ii)** Estimates made by using the Hardy–Weinberg principle can be inaccurate.

Use the information above to suggest **one** reason why the answer calculated in part **(b)(i)** might be **accurate**.

.....

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

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**21** Antibiotics are drugs that treat bacterial infections.

The first antibiotic became widely available in the second half of the 20th century and antibiotics have been widely used ever since.

Many bacteria have now evolved resistance to antibiotics.

**(a)** Explain why the evolution of antibiotic resistance has implications for human populations.

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

**(b)** Explain how antibiotic resistance in bacteria provides evidence for the theory of evolution by natural selection.

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

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**(c)** Biological molecules provide another strand of evidence supporting the theory of evolution by natural selection.

**(i)** Complete the sentences using the most appropriate terms.

Mutations in DNA are random, so the more time that has passed the more mutations will have occurred. The sequence of ..... in DNA and the sequence of ..... in ....., such as haemoglobin and cytochrome c, can be ..... between species.

Species with more similar biological molecules are likely to have evolved from a common ancestor more ..... than species with less similar biological molecules.

This helps to explain why species with different features that live close together geographically often have very similar sequences in their biological molecules.

**[5]**

**(ii)** Explain how fossils can be used to support the theory of evolution by natural selection.

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

**END OF QUESTION PAPER**

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

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