OCR
Oxford Cambridge and RSA

# Thursday 13 June 2019 – Morning

## A Level Biology A

### H420/02 Biological diversity

**Time allowed: 2 hours 15 minutes**

*7671828307*

**You may 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. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

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

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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.**

Answer **all** the questions.

**1** Which of the following is most likely to increase biodiversity?

**A** captive breeding programmes

**B** climate change

**C** human population growth

**D** monoculture

Your answer ☐ **[1]**

**2** A teacher wrote:

*"A garden pond is a dynamic environment that is home to a variety of organisms. The temperature of the pond varies depending on the weather and the time of year, and this affects the populations of the species that live there."*

Which of the following terms applies to the teacher's description of the garden pond?

**A** a community

**B** an ecosystem

**C** a habitat

**D** a niche

Your answer ☐ **[1]**

**3** Biodiversity is important for the development of new medicines.

Which of the following statements about the development of new medicines is **incorrect**?

**A** Computer modelling can be used to identify useful medicinal compounds.

**B** Genetically modified bacteria can be used to synthesise medicines.

**C** Many pathogenic bacteria have become immune to antibiotics.

**D** Microorganisms are an important source of new medicines.

Your answer ☐ **[1]**

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**4** Hox genes contribute to the overall body plan of an animal.

Which of the following rows correctly describes Hox genes?

| | Base sequence | Product | Mutations |
|---|---|---|---|
| **A** | varies between taxonomic groups | transcription factor | entirely random |
| **B** | varies between taxonomic groups | transcription factor | never occur |
| **C** | similar in all animals | polypeptide | have little or no effect |
| **D** | similar in all animals | polypeptide | are often lethal |

Your answer ☐ **[1]**

**5** Hox genes contain a homeobox sequence of 180 base pairs.

Two species have a homeobox sequence of 180 base pairs where 1.7% of the base pairs are different.

Which of the following shows the number of amino acids coded for that would be different in the two species?

**A** minimum 0 and maximum 1

**B** minimum 0 and maximum 3

**C** minimum 1 and maximum 2

**D** minimum 1 and maximum 3

Your answer ☐ **[1]**

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**6** Meiosis is an important feature of sexual reproduction.

Which of the following processes occurs during meiosis **and** contributes to genetic variation in the offspring?

1 crossing over
2 gene mutation
3 random fertilisation

**A** 1, 2 and 3

**B** only 1 and 2

**C** only 2 and 3

**D** only 1

Your answer ☐ **[1]**

**7** The adult wandering albatross, *Diomedea exulans*, has wingspans that range from 2.5 m to 3.5 m.

Which of the following describes the variation in wingspan of the wandering albatross?

**A** intraspecific and controlled only by genetic factors

**B** interspecific and controlled only by environmental factors

**C** intraspecific and controlled by both genetic and environmental factors

**D** interspecific and polygenic

Your answer ☐ **[1]**

**8** Which of the following is **not** associated with the use of artificial selection in farm animals?

**A** health problems in more productive breeds

**B** inbreeding

**C** increased frequency of mutations

**D** reduced gene pool

Your answer ☐ **[1]**

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**9** Which of the following is **not** a valid concern about the use of genetic modification?

**A** that antibiotic resistance genes could transfer to pathogenic bacteria

**B** that herbicide resistance genes could be transferred to wild species

**C** that certain seeds might not be available for use by poor farmers

**D** that the use of human embryos in stem cell production is unethical

Your answer ☐ **[1]**

**10** Barnacles are small animals that live on rocky shores.

Adult barnacles are fixed to rocks and do not move about. They catch passing food in the water with modified limbs called cirri when the tide comes in.

*Chthalamus stellatus* is a species of barnacle found around UK shores.

Two students wished to estimate the population size of *C. stellatus* on a rocky shore near their school.

Which of the following could the students use for estimating the *C. stellatus* population?

1 an abundance scale, such as ACFOR
2 quadrat sampling
3 mark-release-recapture

**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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**11** Corals are a group of animals that usually live on the sea bed close to the surface of the water.

Many corals can reproduce both sexually and asexually.

Which of the following statements about asexually-produced coral offspring is **not** true?

**A** All offspring produced from an individual organism will be genetically identical.

**B** If a change in the environment harms one of the offspring produced from an individual organism it will probably harm them all.

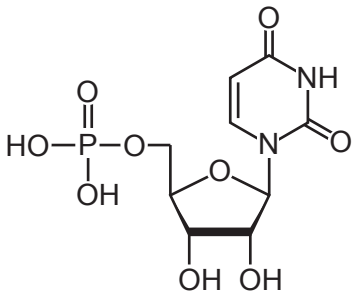
**C** Meiosis occurred in order to produce the offspring.

**D** The offspring will tend to thrive if conditions are similar to those present when the parent organism reproduced.

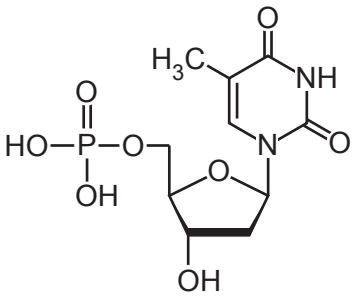
Your answer ☐ **[1]**

**12** Which of the following nucleotides contains uracil?

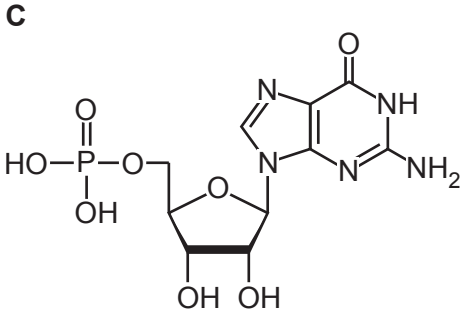
**A**



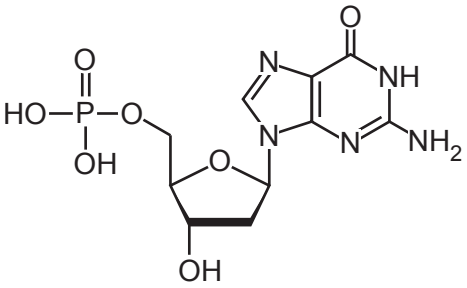
**B**



**C**



**D**



Your answer ☐ **[1]**

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**13** The ability to roll one's tongue is under the control of a single gene. The gene has two alleles R and r.

People who can roll their tongues can have the genotypes RR or Rr. People who cannot roll their tongues have the genotype rr.

A survey by a student showed that 12% of the population in a single school cannot roll their tongues.

The student then used the Hardy-Weinberg principle to calculate the number of heterozygous individuals in the school.

Which of the following represents the percentage of heterozygous individuals at the student's school?

Use the equations: $p + q = 1$ and $p2 + 2pq + q2 = 1$

**A** 21.1%

**B** 22.7%

**C** 42.8%

**D** 45.3%

Your answer ☐ **[1]**

**14** Which of the following is/are **not** involved in the primary response against infection?

**A** memory B-cells

**B** mast cells

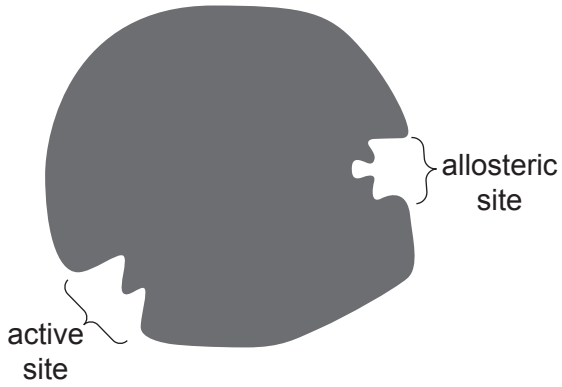
**C** mitosis

**D** platelets

Your answer ☐ **[1]**

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**15** The image below shows a diagram of an enzyme.




Which of the following could be a competitive inhibitor of this enzyme?

**A**



**B**



**C**



**D**



Your answer ☐ **[1]**

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**PLEASE DO NOT WRITE ON THIS PAGE**

**Turn over for the next question**

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## SECTION B

Answer **all** the questions.

**16** Water moves by osmosis in living organisms.

**(a) (i)** Define osmosis.

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**(ii)** Plants rely on osmosis for support.

Explain the importance of osmosis in plant support.

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**(b)** The apparatus shown in Fig. 16 can be used to demonstrate osmosis.

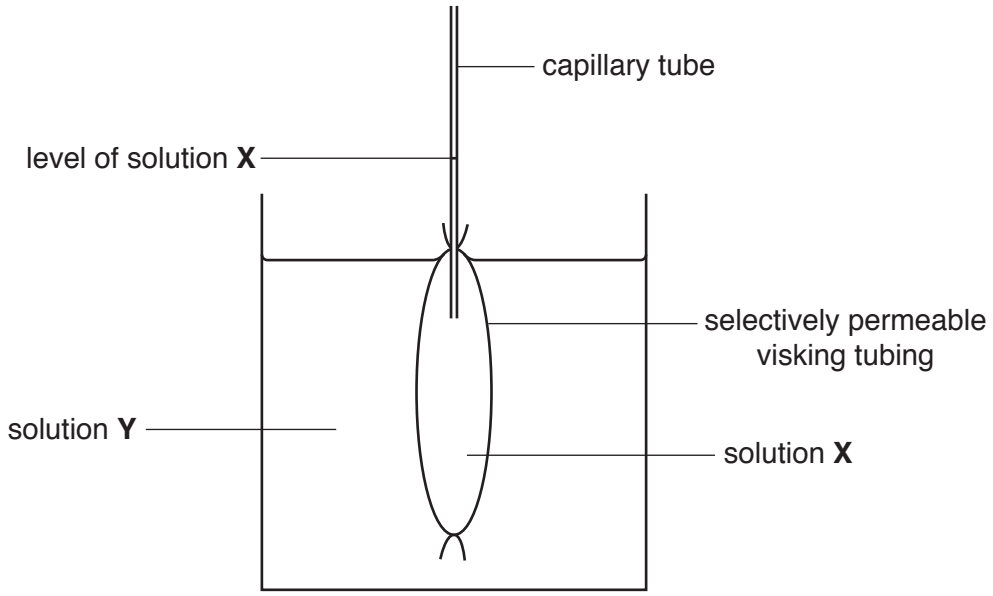



**Fig. 16**

When the capillary tube with visking tubing bag was placed in solution **Y**, the level of solution **X** inside the capillary tube rose from 10.5 mm to 26.5 mm.

**(i)** The ruler used to measure the distance along the capillary tube was accurate to the nearest 0.5 mm.

Calculate the percentage uncertainty of the measurement.

uncertainty = ..... % **[2]**

**(ii)** What conclusions can be drawn about the composition of solutions **X** and **Y**?

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

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**(c)** A group of students used the following method to investigate osmosis in plant cells.

- Cut pieces of plant material of equal surface area ensuring no skin is present.
- Rinse to remove cell debris.
- Gently pat the plant pieces dry with a paper towel.
- Weigh each piece and record mass.
- Put the plant piece in a 200 $cm^3$ beaker.
- Cover plant piece with 50 $cm^3$ of sucrose solution.
- Use sucrose solutions of 0, 0.1, 0.3, 0.5, 0.7 $mol\,dm^{-3}$.
- Leave for 24 h.
- Remove the piece of plant material.
- Dry carefully using a paper towel.
- Weigh the plant piece and record the mass.
- Calculate the percentage change in mass for each piece.
- Repeat twice for each sucrose concentration.

The students investigated material from three different plants: carrot, courgette and potato. Their results are shown in Table 16.

| Plant | Sucrose concentration / $mol\,dm^{-3}$ | Percentage change in mass | | | |
|---|---|---|---|---|---|
| | | Replicate 1 | Replicate 2 | Replicate 3 | Mean |
| Carrot | 0 | + 6.0 | + 5.8 | + 5.8 | + 5.87 |
| | 0.1 | + 4.2 | + 4.1 | + 4.3 | + 4.20 |
| | 0.3 | +1.5 | +1.5 | +1.3 | + 1.43 |
| | 0.5 | – 2.4 | – 2.3 | – 2.1 | – 2.27 |
| | 0.7 | – 6.3 | – 6.1 | – 6.3 | – 6.23 |
| Courgette | 0 | + 7.9 | + 7.8 | + 7.6 | + 7.77 |
| | 0.1 | + 5.5 | + 5.5 | + 5.5 | + 5.50 |
| | 0.3 | + 1.9 | + 1.8 | + 2.0 | + 1.90 |
| | 0.5 | – 1.2 | – 1.4 | – 1.1 | – 1.23 |
| | 0.7 | – 4.3 | – 4.4 | – 4.1 | – 4.27 |
| Potato | 0 | + 5.7 | + 5.8 | + 5.7 | + 5.77 |
| | 0.1 | + 3.1 | + 2.9 | + 3.0 | + 3.00 |
| | 0.3 | – 0.3 | – 0.4 | – 0.6 | – 0.43 |
| | 0.5 | – 2.4 | – 2.2 | – 2.5 | – 2.37 |
| | 0.7 | – 6.1 | – 5.9 | – 5.1 | – 5.70 |

**Table 16**

**(i)** Explain why it was necessary to calculate **percentage** change in mass.

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**(ii)** The students identified replicate 3 of the potato in 0.7 mol $dm^{-3}$ sucrose as anomalous.

Suggest a practical error by the students that might have caused this result to be anomalous and explain the likely effect of this error.

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**(iii)** Use Table 16 to identify which plant cells contained the highest concentration of sucrose.

Justify your conclusion.

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**(d)** Water has many properties that are essential for living organisms.

Explain how properties relating to the **density** of water contribute to the survival of organisms.

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**17** DNA can be obtained from a variety of plant and animal cells.

**(a)** A group of students tried to purify some DNA from leek cells using the following method. They decided that exact volumes were not necessary.

| |
|---|
| **1.** Grind a leek leaf to a fine pulp using a pestle and mortar. |
| **2.** Add salt and cold water and mix again for at least 10 s. |
| **3.** Add protease enzyme and mix again for at least 10 s. |
| **4.** Filter the liquid into a test tube and stand for at least 10 min. |
| **5.** Tilt the test tube and gently pour in ice-cold ethanol. |
| **6.** A white layer of DNA forms between the sample and the ethanol. |
| **7.** Extract the white layer carefully using a glass rod. |

**(i)** State the purpose of step **1**.

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

**(ii)** Suggest why a protease enzyme added in step **3** is needed to purify DNA.

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

**(iii)** The students considered using pineapple juice as a source of protease enzyme.

Suggest why this would **not** be an appropriate source of protease when attempting to produce a pure sample of leek DNA.

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

**(iv)** State one important step that the students had left out of their method.

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

**(v)** Name the process described in step **6**.

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

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**(b)** Genes isolated from DNA can be used in gene therapy.

Cystic fibrosis (CF) is a disease that could be treated using gene therapy.

Healthy individuals have a gene that codes for a channel protein, called CFTR, found in the plasma membrane of a variety of cells, including those lining the airways of the lungs.

People suffering from CF have two copies of a recessive allele and so their cells do not synthesise the correct channel protein.

The allele that codes for the functioning CFTR protein can be inserted into the DNA of CF sufferers. The cells can then synthesise the correct CFTR protein and function as normal.

**(i)** The treatment of cystic fibrosis is described as **somatic** gene therapy. Another type of gene therapy is known as **germ-line** gene therapy.

Complete the table below to show **three** differences between somatic gene therapy and germ-line gene therapy.

| Somatic | Germ-line |
|---|---|
| | |
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| | |

**[3]**

**(ii)** Some attempts at gene therapy have resulted in changes to the functioning of other genes.

Explain how inserting a new gene into a chromosome could affect the functioning of other genes in that chromosome.

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**(iii)** CF occurs when individuals have two copies of a recessive allele.

Huntington's disease is a lethal disease caused by a dominant allele that codes for the protein huntingtin.

Suggest why gene therapy is unlikely to work as a treatment for Huntington's disease.

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

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**18** The Lake District is the largest National Park in England, covering an area of 2362 $km^2$.

It contains a wide variety of species, some of which are under threat or endangered. The resident human population is 41 000. In 2016 the Lake District received 18.4 million tourists.

The proportion of Lake District land used for different purposes is shown in Fig. 18.

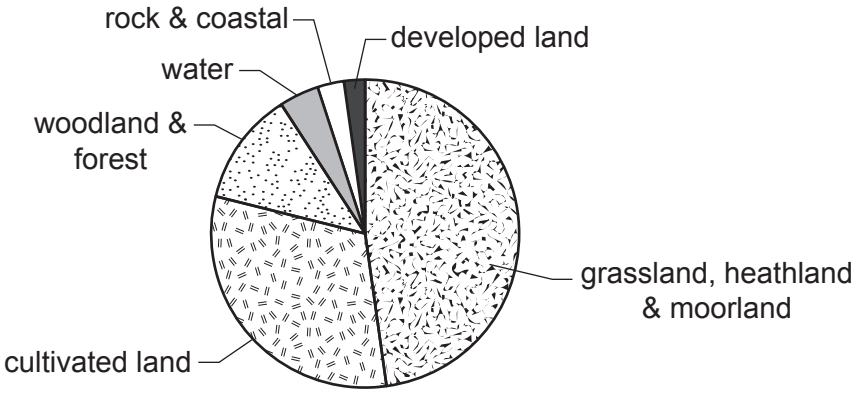



**Fig. 18**

**(a)** Explain **one** way in which tourists can lead to an increase in the biodiversity of an area.

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**(b)** The Lake District contains large areas where timber is produced. One of the aims of the management of National Parks is to produce timber sustainably.

**(i)** Using Fig. 18, **estimate** the percentage of land that is covered by woodland and forest.

estimate = ..... % **[1]**

**(ii)** Timber can be produced economically by a technique called clear felling. Clear felling can damage biodiversity.

Explain how it is possible to produce timber sustainably using clear felling.

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**(iii)*** A traditional timber-production process that is still used in parts of the Lake District is coppicing.

Describe the process of coppicing **and** explain the potential benefits of coppicing to the biodiversity of a woodland.

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Additional answer space if required.

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**(c)** Many schools visit the Lake District to undertake Biology fieldwork.

A group of students investigated the biodiversity of five herb plants they found in adjacent coppiced and mature areas of woodland in the spring of 2016.

Their results are shown in Table 18.

| | Number of individuals (n) | |
|---|---|---|
| **Species** | **Coppiced** | **Mature** |
| **Bluebell** | 35 | 46 |
| **Dog's mercury** | 2 | 12 |
| **Foxglove** | 5 | 1 |
| **Herb robert** | 20 | 4 |
| **Wood sorrel** | 8 | 4 |
| **Total** | 70 | 67 |

**Table 18**

**(i)** The students calculated the Simpson's Index of Diversity (D) for the mature area to be 0.489.

Use the information in Table 18 to work out the Simpson's Index of Diversity (D) for the area of coppiced woodland.

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

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

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**(ii)** Use the example of the students' fieldwork to explain how biodiversity can be considered at different levels.

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**Turn over for the next question**

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**19** It is possible to clone animals using a technique called somatic cell nuclear transfer (SCNT).

The most well-known example of this was the cloning of Dolly the sheep in 1996.

**(a)** Thirty years before Dolly the sheep, successful cloning of an animal was carried out using a frog, *Xenopus laevis*.

Frogs lay eggs in water. These eggs then develop and hatch into swimming tadpoles. When the tadpoles grow to a certain size they develop into adult frogs.

The cloning process is outlined in Fig. 19.1.

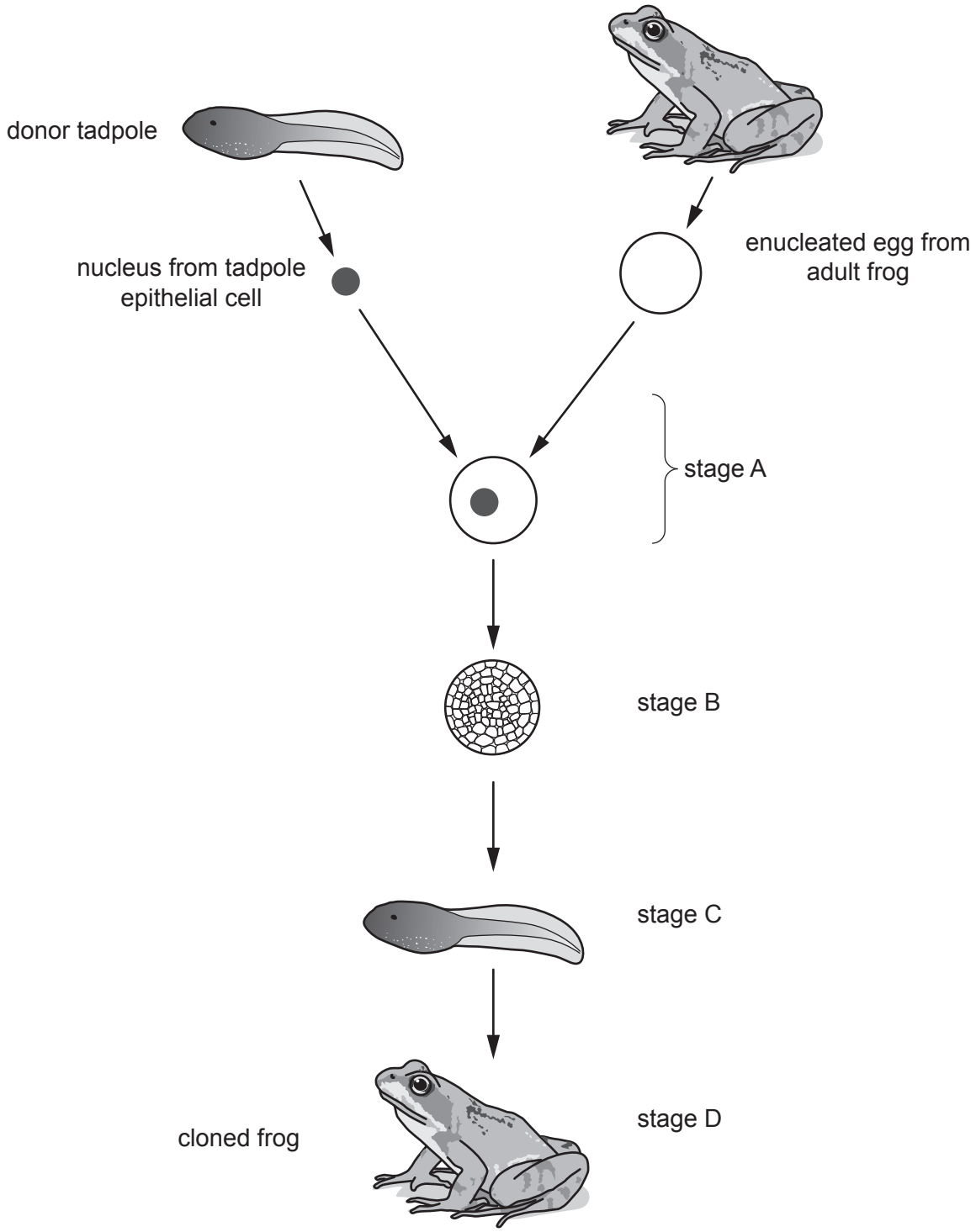



**Fig. 19.1**

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**(i)** Describe what is happening at stage A **and** suggest a practical procedure that could allow this to occur.

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

**(ii)** Identify a key difference between the processes between stages A and C and the cloning of Dolly the sheep.

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

**(iii)** The frog produced by the process in Fig. 19.1 is not a complete clone of the donor tadpole.

Suggest why the cloned frog might not be considered a complete clone of the donor tadpole.

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

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**(b)** The success of SCNT has been investigated in many species.

Sheep are more closely related to mice than they are to *Xenopus* frogs.

Fig. 19.2 shows the percentage of SCNT procedures that were successful in mice and *Xenopus* when the donor nucleus was taken from cells at different stages of development.

- The *Xenopus* data were published in 1962.
- The mouse data were published in 1998.

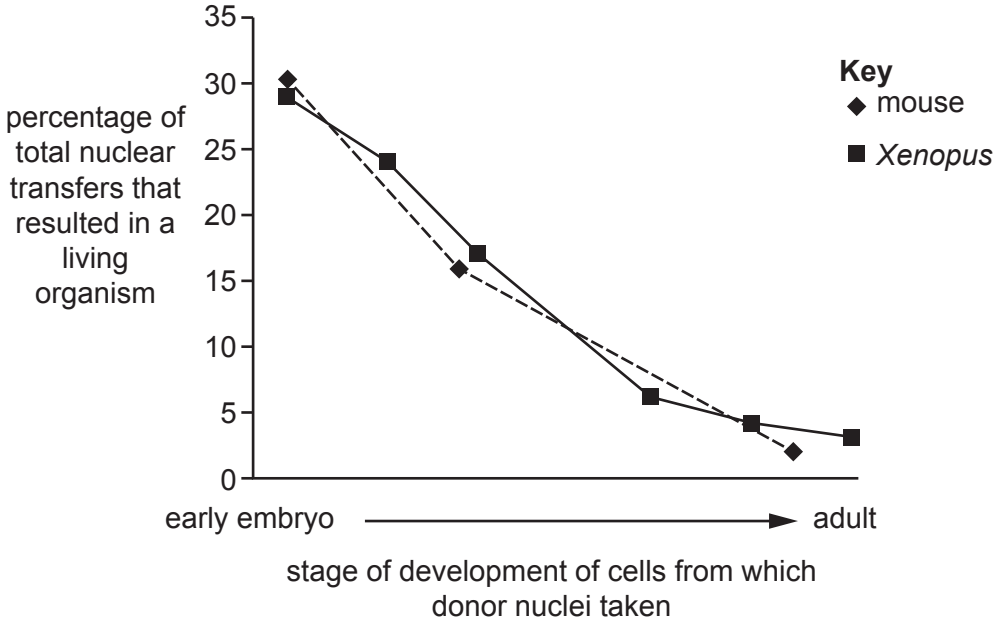



**Fig. 19.2**

**(i)** Suggest why the x-axis does not show the age of the donor nuclei.

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

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**(ii)** Dolly the sheep suffered health problems throughout her life and died at an early age.

The donor nucleus that was used to create Dolly came from a sheep that was already five years old. The normal lifespan of a domestic sheep is ten years.

A student concluded that Dolly's health problems were caused by the stage of development of the sheep that provided the donor nucleus.

List three reasons why the information in Fig. 19.2 does **not** support the student's conclusion.

1 .....

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2 .....

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3 .....

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**[3]**

**(c)** One measure of the success of cloning procedures is the number of pregnancies that result in live births.

Table 19 shows information from the work of many scientists about the success of SCNT in four different species.

| Species | Number of pregnancies | Number of live births |
|---|---|---|
| **Goat** | 26 | 8 |
| **Monkey** | 3 | 2 |
| **Mouse** | 438 | 56 |
| **Sheep** | 110 | 48 |

**Table 19**

**(i)** Calculate the percentage of pregnancies that resulted in live births in goats and mice.

live births in goats = ..... %

live births in mice = ..... %

**[2]**

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**(ii)** Compiling results from different scientists can have problems as their investigations may not have been controlled in the same way.

List **three** factors that should have been controlled when compiling the data to include in Table 19.

1 .....

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2 .....

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3 .....

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**[3]**

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**20** Plant cloning is often used by farmers to produce new plants.

A plant that is often cloned by taking cuttings is lavender, *Lavandula angustifolia*.

**(a)** A farmer had two fertiliser solutions, solution **A** and solution **B**, and wanted to investigate which one to use on lavender plants. In order to ensure the investigation would be valid, two cuttings were needed from the same parent plant.

**(i)** Describe how to clone a plant by taking a cutting.

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**(ii)*** The farmer grew one of the cuttings in soil fertilised with solution **A** and the other cutting in soil fertilised with solution **B**.

The farmer took several other precautions to increase the validity of the investigation, including:

- growing the plants in the same type of soil
- exposing the plants to the same light intensity.

After a set period of time the farmer measured the increase in height of the lavender plants. The farmer's results are shown in the table below.

| Fertiliser solution | Increase in height (cm) |
|---|---|
| **A** | 20.3 |
| **B** | 15.4 |

The farmer concluded that solution **A** increased the height of lavender more. A student said that, even though the investigation was **valid**, the results did not give strong support to the farmer's conclusion.

Describe **and** explain how the investigation could be improved in order to have more confidence in any conclusions drawn from the results.

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**(b)** Cloning plants is also known as vegetative propagation.

Identify **three** advantages of vegetative propagation in agriculture.

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**[3]**

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**21** Lipids are an important group of biological molecules.

**(a)** Lipoproteins are roughly-spherical structures that transport lipids in the blood.

Fig. 21 shows a simplified drawing of a section from the widest part of a lipoprotein.

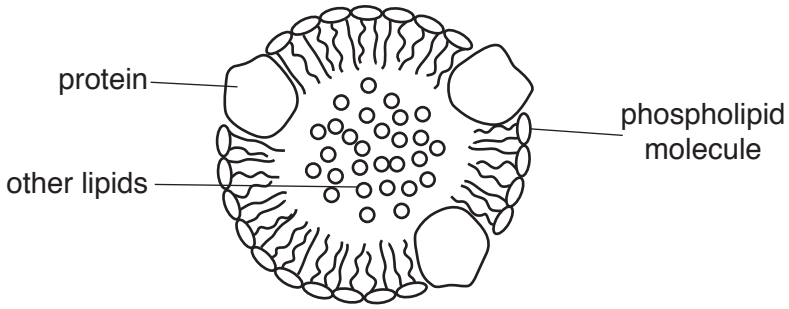



**Fig. 21**

**(i)** Calculate the number of phospholipid molecules in the outer surface of the lipoprotein shown in Fig. 21.

Assume that the pattern of proteins and phospholipids shown in Fig. 21 is continued across the whole surface of the lipoprotein.

Use the formula: Surface area of sphere = $4\pi r^2$

number of phospholipid molecules = ..... **[2]**

**(ii)** Lipoproteins with fewer phospholipids and more protein in the outer layer are known as high density lipoproteins.

Lipoproteins with a larger number of phospholipids but less protein are known as low density lipoproteins.

Use this information to explain why lipids can increase the buoyancy of aquatic animals.

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

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**(b)** Complete the passage by choosing the most appropriate word from the list.

**bile carbon hydrogen insoluble**

**nitrogen oxygen permeability production solid soluble**

**stability storage vitamins**

Lipids have many roles in living organisms. Some are used for energy ..... in adipose cells. Unsaturated fatty acids contain at least one double bond between two ..... atoms and so contain fewer ..... atoms. All lipids are ..... in water so need to be transported in the blood by lipoproteins. Cholesterol molecules increase the ..... of membranes, and cholesterol is also used to synthesise steroid hormones and ..... .

**[6]**

**(c)** Triglycerides are a type of lipid molecule that can be broken down during hydrolysis reactions.

Using the structure of triglyceride molecules as an example, explain what is meant by hydrolysis.

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

**END OF QUESTION PAPER**

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## 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).

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