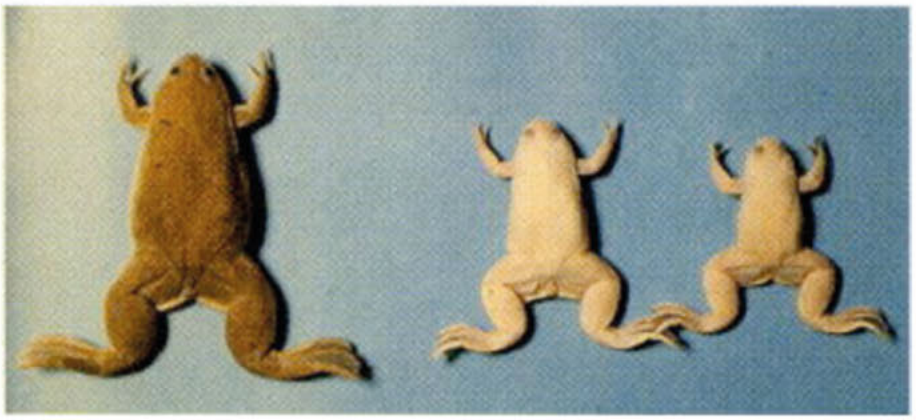
Insert for question 1



A B C



D

Fig. 1.1

Insert for question 3



**Fig. 1.2 Scottish wildcat**



**Fig. 1.3**
**Colourpoint Persian cat**

1 In 1958, scientists made a breakthrough in artificial reproductive cloning by successfully cloning a vertebrate species. The species cloned was the African clawed frog, *Xenopus laevis*.

Fig. 1.1, **on the insert**, shows the cloned offspring produced, labelled **D**, as well as the three adult frogs (**A**, **B** and **C**) that were used to create them.

- frog **A**, a brown-coloured female frog, laid eggs, which then had their nuclei removed.
- frog **B**, an albino (white-coloured) female, laid eggs that were fertilised by sperm from **C**.
- frog **C**, an albino male, produced sperm that fertilised the eggs of **B**.

One of the fertilised eggs from **B** was allowed to divide. Nuclei were extracted from the resulting cells and placed into the eggs from frog **A**. These eggs developed into the frogs labelled **D** in Fig. 1.1.

**(a) (i)** The frogs in Fig. 1.1 show discontinuous variation in colour.

Using your knowledge of discontinuous and continuous variation, and the information given, suggest:

**one other** phenotypic characteristic in which the frogs show a discontinuous pattern of variation

.....

**one** phenotypic characteristic in which they show a continuous pattern of variation.

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

**(ii)** State the extent to which the environment is likely to affect each of the phenotypic characteristics that you have suggested in **(i)**.

.....

.....

.....

.....

.....

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

**(iii)** Suggest why albino frogs were used to produce the nuclei for transfer.

.....

.....

.....

.....

.....

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

**(b)** Samples of DNA were taken from frogs **A**, **B**, **C** and **D**.

Electrophoresis was used to separate the different lengths of DNA after cutting.

Fig. 1.2 shows the results.

These results are known as genetic profiles. Only the genetic profile of frog **C** is identified. The remaining profiles are labelled **1** to **3**.

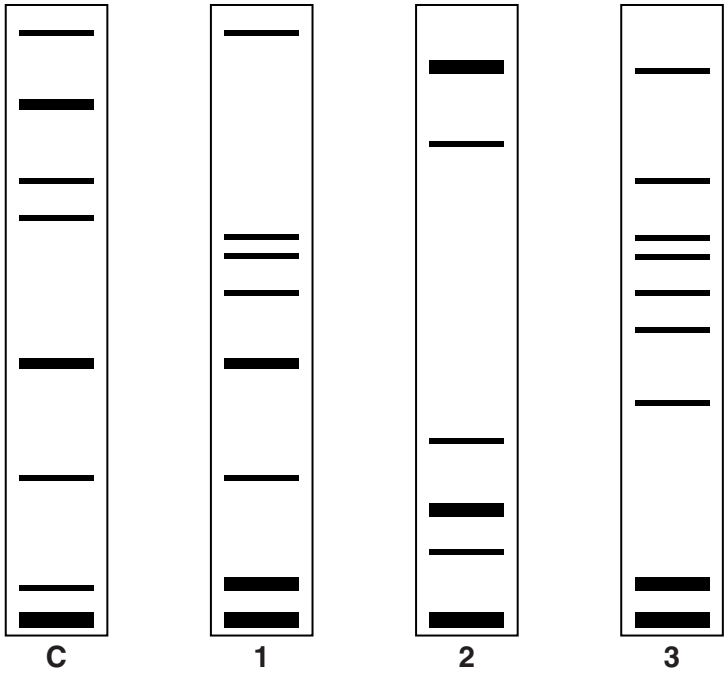



**Fig. 1.2**

**(i)** Identify which of the frogs in Fig. 1.1 gave genetic profiles corresponding to **1**, **2** and **3** in Fig. 1.2.

Write the letters **A**, **B** and **D**, as appropriate, in the table below.

| Genetic profile number | Letter of frog |
|---|---|
| **1** | |
| **2** | |
| **3** | |

**[3]**

**(ii)** Mitochondrial DNA from the frogs was sequenced.

State, giving a reason, which of the frogs **A, B** and **C** would have a mitochondrial DNA sequence identical to **D**.

.....

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

**(c)** In the 1970s, the technique used to clone the frogs was successfully adapted to clone mice from embryos. Cloned mice are used to investigate factors affecting the development and treatment of disease.

**(i)** State **one advantage** and **one disadvantage** of using clones to test a treatment for a disease.

advantage

.....

.....

disadvantage

.....

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

**(ii)** In the 1990s, there were further developments in cloning technology when it became possible to make a clone of an adult mammal. The first clone produced from an adult cell nucleus was Dolly the sheep.

Adult cell cloning can be used to investigate the development and treatment of disease.

Outline **two other** potential applications of adult cell cloning.

1 .....

.....

.....

2 .....

.....

.....

**[2]**

**(d)** Identical twins in humans are natural clones. They form when a fertilised egg cell divides by mitosis into two entirely separate groups of cells. Each group of cells develops into a baby.

Two brothers, who were identical twins, married two sisters, who were also identical twins. Each couple had one child.

Fig. 1.3 shows the relationships between these six people.

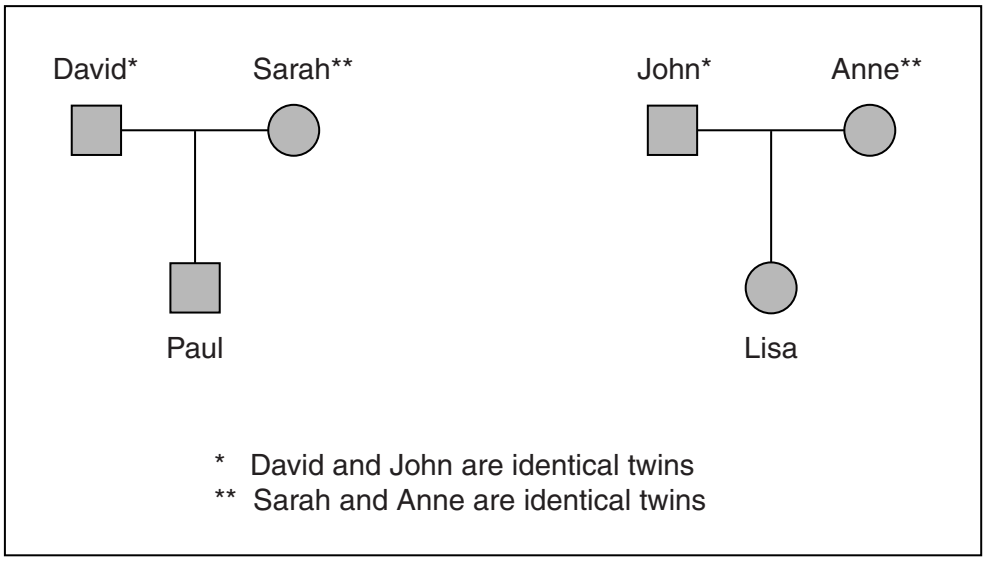



**Fig. 1.3**

Using your knowledge of mitosis and meiosis, estimate the percentage of alleles shared by the individuals listed in the table below.

| Individuals | % of alleles shared |
|---|---|
| David and John | |
| Anne and Lisa | |
| Sarah and Lisa | |

**[3]**

**[Total: 17]**

**2** This question is about the evolution, genetics, behaviour and physiology of cats.

Fig. 1.2 **(on the insert)** shows a Scottish wildcat, *Felis sylvestris*.

Modern domestic cats evolved from a wild ancestor of similar appearance to the Scottish wildcat.

Fig. 1.3 **(also on the insert)** shows a breed of domestic cat, *Felis cattus*. This breed is called the Colourpoint Persian cat.

**(a)** State **two** phenotypic differences between the Scottish wildcat in Fig. 1.2 and the Colourpoint Persian cat in Fig. 1.3.

.....

.....

.....

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

**(b)** Name the process that:

**(i)** has given rise to the modern domestic cat from its wild ancestor

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

**(ii)** has given rise to coat colour variation in cats.

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

**(c)** In Colourpoint Persian cats, interaction between two genes, **B**/**b** and **D**/**d**, causes the colour of the face, ears, paws and tail.

The dominant allele, **B**, gives a dark brown colour, known as 'seal'.
The recessive allele, **b**, gives a light brown colour, known as 'chocolate'.

The dominant allele, **D**, has no effect on coat colour.
However, the presence of two copies of the recessive allele, **d**, changes the colour 'seal' to a colour known as 'blue', and 'chocolate' to a colour known as 'lilac'.

**(i)** State the name given to this type of genetic interaction.

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

**(ii)** Suggest the possible **genotypes** of a 'seal' Colourpoint Persian cat.

..... ..... ..... .....

**[4]**

**(iii)** A 'lilac' Colourpoint Persian cat is homozygous at both the **B**/**b** and the **D**/**d** gene locus.

What is meant by the terms **homozygous** and **gene locus**?

homozygous

.....

.....

.....

gene locus

.....

.....

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

**(iv)** A cross was carried out between a 'seal' cat and a 'lilac' Colourpoint Persian cat. A Punnett square of the expected genotypes of the offspring of this cross is shown in Table 1.1.

**Table 1.1**

| gametes | **BD** | **Bd** | **bD** | **bd** |
|---|---|---|---|---|
| **bd** | BbDd | Bbdd | bbDd | bbdd |

Use Table 1.1 to state the **phenotypes** of the offspring and to predict the **phenotypic ratio**.

phenotypes

.....

phenotypic ratio

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

**(d)** Breeders of Colourpoint Persian cats are advised to be present at the birth of the kittens. In this breed, the mother cat may not perform essential maternal behaviour such as licking the newborn kitten to free it from its amniotic sac (the membrane surrounding it at birth).

Wildcat mothers, even when they are first-time mothers, perform this behaviour naturally.

**(i)** State the type of behaviour shown by these wildcat mothers.

Give **one** characteristic of this type of behaviour.

type of behaviour .....

characteristic .....

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

**(ii)** Over time, the frequency of domestic cat mothers who perform essential maternal behaviour, such as licking the newborn kitten, has decreased.

Suggest and explain a reason for this change in frequency over time.

.....

.....

.....

.....

.....

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

**(e)** Breeding pedigree cats, such as Colourpoint Persian cats, may involve crossing closely related individuals in order to obtain desirable characteristics.

Physiological problems are more common in pedigree animals than in wild animals.

**(i)** Suggest why physiological problems are more common in pedigree animals.

.....

.....

.....

.....

.....

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

**(ii)** An example of a physiological problem in Colourpoint Persian cats is that some of them cannot digest lactose sugar in milk. These cats can be fed lactose-reduced milk which is made by a biotechnological process using immobilised lactase enzyme.

State **two** methods of immobilising an enzyme.

.....

.....

.....

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

**[Total: 21]**

3 Describe the differences between:

**(a)** somatic cell gene therapy and germ line cell gene therapy

.....

.....

.....

.....

.....

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

**(b)** the central nervous system and the peripheral nervous system

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.....

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.....

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

**(c)** prophase 1 of meiosis and prophase 2 of meiosis.

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.....

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

**[Total: 8]**

**4** **(a)** In Scotland, in three people.

Suggest **one** group in the population that is more likely to die from food poisoning **and** give a reason for your suggestion.

group .....

reason .....

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

**(b)** The food poisoning outbreak involved the bacterium *Escherichia coli* 0157 (*E. coli* 0157) which had been responsible for contaminating meat products. The meat had been stored at 11 °C rather than the recommended 5 °C and this led to meat spoilage.

**(i)** Explain how bacteria cause food spoilage.

.....

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

**(ii)** Food normally spoils much faster if stored at temperatures higher than 5 °C.

Explain why food spoils faster at higher temperatures.

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

**(iii)** Food can be preserved by keeping it at low temperature in a refrigerator or freezer.

Name **two other** methods of food preservation and state how each method works.

method .....

.....

how the method works .....

.....

.....

method .....

.....

how the method works .....

.....

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

**(c)** Microorganisms, such as the fungus *Fusarium*, can be grown and then purified to produce mycoprotein. This mycoprotein can be used as a food source for humans.

Table 3.1 compares mycoprotein with beef.

**Table 3.1**

| food | content per 100g | | | | | |
|---|---|---|---|---|---|---|
| | energy (kJ) | protein (g) | carbohydrate (g) | total fat (g) | saturated fat (g) | iron (mg) |
| mycoprotein | 357 | 12 | 9 | 2.9 | 0.6 | 0.1 |
| beef | 1163 | 26 | 0 | 18.2 | 7.0 | 2.6 |

Use the data in Table 3.1 to **describe and explain** the advantages and disadvantages of using microorganisms to produce food for human consumption.

*In your answer you should make comparisons using the information in Table 3.1.*

advantages .....

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.....

.....

.....

disadvantages .....

.....

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.....

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.....

.....

..... **[8]**

**[Total: 20]**