1 In 2006, the scientific journal, Nature, reported the discovery of a fossil from around 380 million years ago. It was given the name *Tiktaalik roseae*.

This fossil has some features in common with fish and some features in common with amphibians.

A photograph of the fossil is shown in Fig. 1.1.



Fig. 1.1

A diagram of the fossil viewed from above is shown in Fig. 1.2.

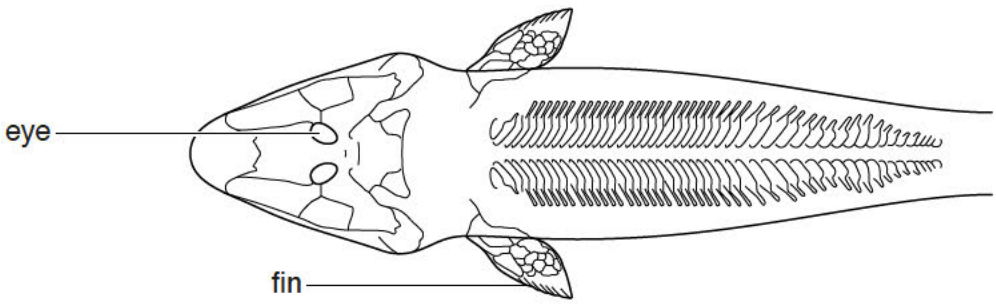


Fig. 1.2

(a) (i) Suggest **one** adaptation, **visible in Fig. 1.1 and Fig. 1.2**, which would be an advantage for life under water.

.....

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

(ii) Suggest **one** adaptation, **visible in Fig. 1.1 and Fig. 1.2**, which would be useful for an animal that lives on the sea bed.

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

(b) *Tiktaalik roseae* is a member of the kingdom Animalia. The structure of its individual cells has not been preserved by fossilisation.

State **two** features of cells of an organism from the kingdom **Plantae** that would **not** have been present in the cells of *T. roseae.*

1 ....

2 ....

[2]

(c) Fossils provide strong evidence that organisms have evolved over time.

Describe **other** types of evidence that support the theory of evolution.

In your answer you should describe some different types of evidence.

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.... **[6]**

[Total: 10]

2 Charles Darwin sailed on HMS Beagle on its voyage around the world between 1831 and 1836.

(a) Darwin made the following observation:

'offspring generally appear similar to their parents'

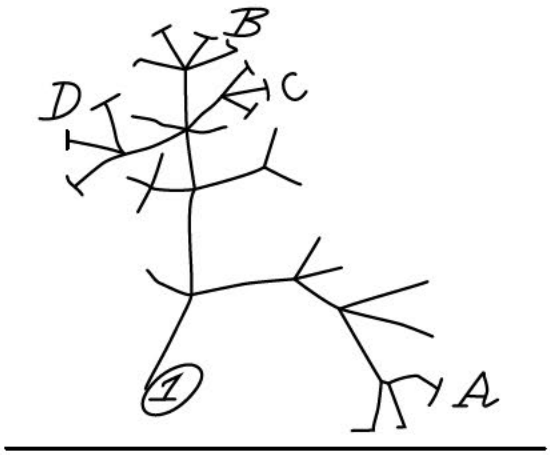
State the conclusion that Darwin drew from this observation.

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

(b) Shortly after the voyage, Darwin sketched a diagram in his notebook.

His sketch is shown in Fig. 5.1.



Charles Darwin (1837)

Fig. 5.1

- A, B, C and D represent different modern day organisms.
- (1) represents an ancestral organism.

Explain what the sketch shows about the relationship between organisms A, B, C, and D.

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

(c) In 1859, Darwin published his book, *On the Origin of Species*, in which he explained how organisms evolve by natural selection:

- Darwin's book caused controversy at the time of its publication
- his theory of natural selection is now widely accepted by scientists.

Why is natural selection now more widely accepted by scientists than it was in the 19th Century?

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

(d) Genes are important in the process of natural selection. Genes are made of DNA.

(i) State the role of a gene.

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

(ii) Explain how the structure of DNA allows replication.

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..... **[5]**

(e) During the voyage of HMS Beagle, Darwin visited the Galapagos Islands off the coast of South America.

He observed that many of the closely related species showed significant variation.

(i) State the name given to the evolution of a new species.

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

(ii) Suggest why a higher number of species have evolved in the Galapagos Islands, compared with an area of the same size on the South American mainland.

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

[Total: 12]

3 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 page 2 of 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)**.

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

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

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..... **[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**.

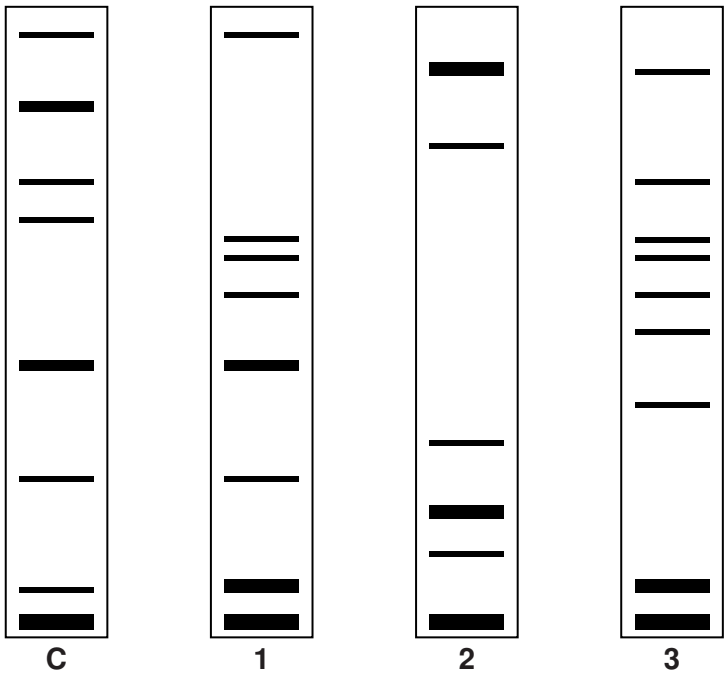


Fig. 1.2

(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

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..... **[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 .....

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2 .....

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[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.

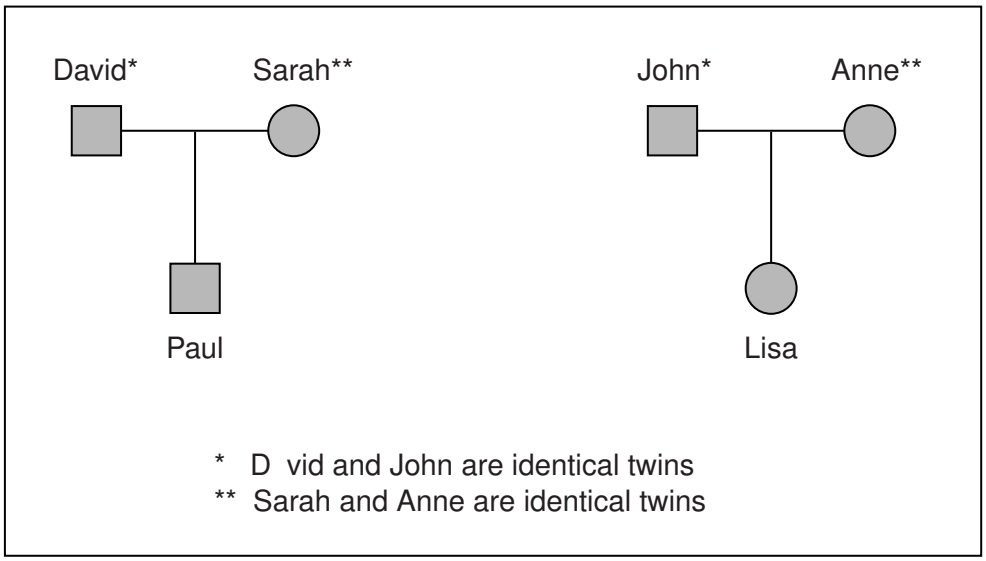


Fig. 1.3

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]

4 In the first half of the nineteenth century, a large proportion of the population of Ireland relied on potatoes as their main source of food.

In 1845, almost the whole of the Irish potato crop became infected with a disease known as potato blight, which ruined the crop and led to widespread starvation.

Some varieties of potato plants, including wild types growing in South America, are unaffected by the disease.

(a) Genetic variation in the Irish potato plant population was very low following years of selective breeding and asexual reproduction.

(i) Suggest why this lack of genetic variation might have contributed to the rapid spread of the disease.

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

(ii) Suggest why, despite the low genetic variation, the average yield of potato plants varied from year to year.

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

(iii) Some potato plants carry a gene that gives the plants resistance to potato blight.

State the most likely cause of this genetic variation.

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

(b) Describe how it is possible to use selective breeding to improve the overall disease resistance of a crop, such as potatoes, in both the short and long term.

In your answer you should include precautions that should be taken to ensure disease susceptibility does not become a problem in the future.

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[Total: 11]

5 Fig. 8.1, **on the insert**, shows an electron micrograph of an invertebrate known as a 'water bear'.

(a) Complete the following passage about the classification of water bears using the most appropriate terms.

The water bear, *Echiniscus trisetosus* is a member of the genus ..... and the family *Echiniscidae*. This family belongs to the ..... *Echiniscoidea*, which forms part of the class *Heterotardigrada*. Water bears, also known as tardigrades, are classified into a ..... of their own called the *Tardigrada*. Tardigrades form part of the kingdom ..... within the domain ..... . **[5]**

(b) State the meaning of the term *phylogeny* **and** explain how phylogeny is related to classification.

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

(c) Water bears are extremely common in many habitats, including household gardens. However, they were not discovered until approximately 300 years ago.

Suggest reasons why they were not known before this time.

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

[Total: 10]