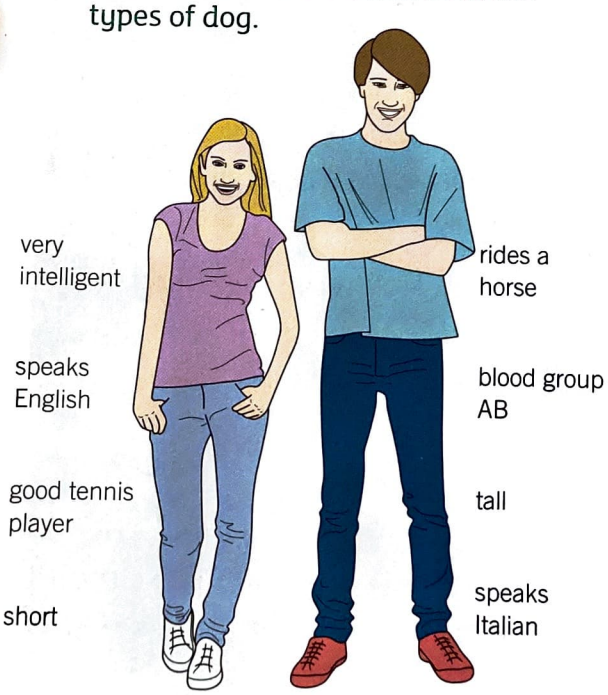
3.3 Variation

Learning objectives

After this topic you will be able to:

- describe how variation in species occurs
- describe the difference between environmental and inherited variation.

▲ There is a lot of variation between types of dog.



Link

You can learn more about how characteristics are inherited in B2 3.5 Inheritance

If you imagine your friends and family, you will picture people who look quite different to each other. For example, people may vary in height and have different colour hair. They have different characteristics.

How do organisms vary?

Differences in characteristics are known as **variation**.

A State what is meant by variation.

It is easy to tell the difference between a dog and a fish. For example, a fish has fins and gills; a dog has four legs and is covered in fur. This is because these organisms belong to different **species**. They have lots of different characteristics.

B State what is meant by a species.

However, it is more difficult to tell the difference between two fish. This is because organisms of the same species have lots of similar characteristics. They can mate to produce fertile offspring.

Sometimes a species can be further grouped into types or breeds. These may look quite different but the individuals still belong to the same species. For example, different breeds of dog show great variation but they are all dogs.

How do humans vary?

Every human in the world is different – even identical twins differ in some ways. The image opposite shows some of the ways people may vary.

What causes variation?

Some variation is from characteristics the people have inherited from their parents, such as their eye colour. This is known as **inherited variation**.

Children usually share some characteristics with their mother and some with their father. They are not identical to either of their parents, as they get a mixture of their parents' features. An example of inherited variation is lobed or lobeless ears.

lobed ear

lobeless ear

◀ Whether you have lobed or lobeless ears depends on your parents.

C State what is meant by inherited variation.

Environmental variation

Variation caused by your surroundings and what happens to you is called **environmental variation**. For example, your characteristics can be affected by factors such as your diet, education, and lifestyle. A person with dyed hair, for example, has environmental variation.

D State what is meant by environmental variation.

Many characteristics are affected by both inherited and environmental variation. For example, you might inherit the characteristic to be tall from your father. However, if you eat a poor diet your rate of growth may be reduced.

Inherited characteristics that are not affected by environmental variation include:

- eye colour
- blood group
- genetic diseases.

Spelling key terms

There are a lot of long scientific words in this chapter. Can you spell them all correctly? Look carefully at the spelling of the following words for two minutes: species, variation, adaptation, inherited, environmental. Cover the words and ask a partner to test your spelling.

Key Words

variation, species, inherited variation, environmental variation

▲ These people have environmental variation.

Summary Questions

1 Copy and complete the sentences below.

The organisms in a _____ share many of the same _____. They can reproduce to produce fertile _____.

Differences in characteristics within a species are known as _____.

Variation can be a result of _____ factors or through _____ factors.

(6 marks)

2 Copy and complete the table using the words below.

body mass **intelligence** **tattoo** **blood group** **eye colour** **scar**

Environmental variation	Inherited variation	Both

(6 marks)

3 Explain why identical twins are the best people to study if you want to find out how the environment influences characteristics.

(2 marks)

4 Explain in detail the difference between inherited and environmental variation.

(6 marks QWC)

3.4 Continuous and discontinuous

Learning objectives

After this topic you will be able to:

- describe the difference between continuous and discontinuous variation
- represent variation within a species using graphs.

Fantastic Fact

The tallest ever person was Robert Wadlow. He grew to a height of 2.72 m. He could not fit into many houses without ducking!

Key Words

discontinuous variation, continuous variation.

If you look around your classroom at the other students, you will see that some students share the same eye colour but very few are exactly the same height. This is because there are different types of variation.

What is discontinuous variation?

Characteristics that can only result in certain values show **discontinuous variation**. For example, gender shows discontinuous variation. There are only two possible values: you are either male or female.

Other characteristics that show discontinuous variation are your blood group and eye colour.

A State what is meant by discontinuous variation.

What is continuous variation?

A characteristic that can take any value within a range is said to show **continuous variation**. For example, the height of the population ranges from the shortest person in the world to the tallest person. Everyone else's height can be any value in between. This is an example of continuous variation.

Other characteristics that show continuous variation are your body mass, hair length, and arm span.

B State what is meant by continuous variation.

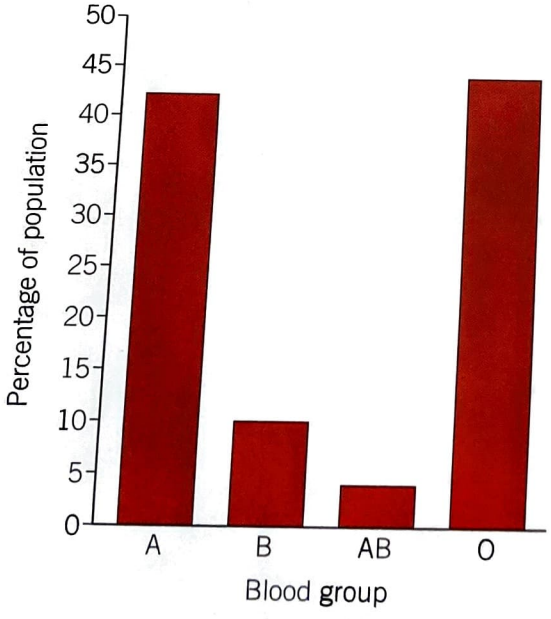
Patterns of variation

To study variation, scientists take measurements of different characteristics within the species. To come up with conclusions, they need to collect measurements from large numbers of the population. This data is then plotted on a graph so that patterns in the data can be easily spotted.

Plotting discontinuous variation

Characteristics that show discontinuous variation should be plotted on a bar chart.

For example, a person can only have one of four blood groups – A, B, AB, or O. These are the only values that a blood group can be, so you should plot a graph with four bars.



▲ Discontinuous data is always plotted on a bar chart.

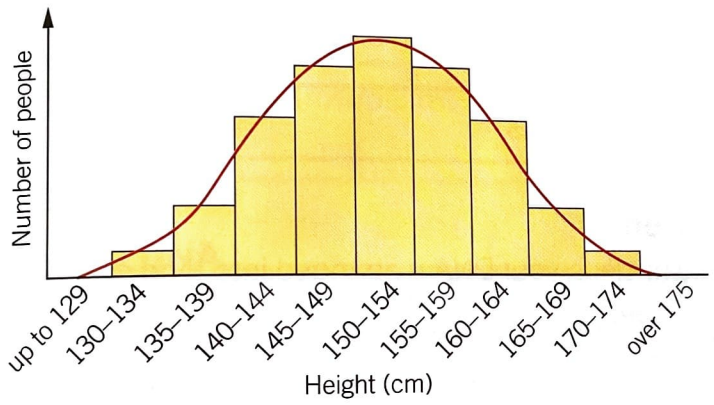
Characteristics that occur only as result of inherited variation normally show discontinuous variation.

C State the type of graph that should be used to plot discontinuous data.

Plotting continuous variation

Characteristics that show continuous variation should be plotted on a histogram. A line is then often added to the chart to make it easier to see the shape of the graph.

Within a population, characteristics that show continuous variation will display a range of measurements from one extreme to another.



▲ Continuous data is always plotted on a histogram.

This type of variation usually produces a curve, which is known as a normal distribution.

Characteristics that occur as a result of both environmental and inherited variation usually show continuous variation.

D State the type of graph that should be used to plot continuous data.

Which graph?

Which type of graph – a bar chart or histogram – would you use for the sets of data below?

a members of your class who have lobed, or lobeless ears

b the length of feet of each of your teachers

c the height of a group of seedlings, planted for a germination experiment

d the number of strawberries per plant, from a sample of 25 plants.

Summary Questions

1 Copy and complete the sentences below.

Characteristics that can only result in certain values show _____ variation. Characteristics that can have any value within a range show _____ variation.

The range of values of a characteristic from a sample can be displayed using a _____.

A characteristic such as eye colour should be displayed using a _____.

Characteristics showing continuous variation, such as body mass, should be shown using a _____.

(5 marks)

2 Classify each of these characteristics into continuous variation and discontinuous variation.

length of arm, hair colour, maximum sprinting speed, shoe size, average leaf size

(5 marks)

3

a Look at the graph of the variation in heights on this page. Describe the pattern that this variation shows. *(3 marks*

b Explain whether this variation is a result of environmental factors, inherited factors, or both. *(3 mark*

4 Explain in detail the difference between continuous and discontinuous variation, using examples of features from the human body.

(6 marks Q

3.5 Inheritance

Learning objectives

After this topic you will be able to:

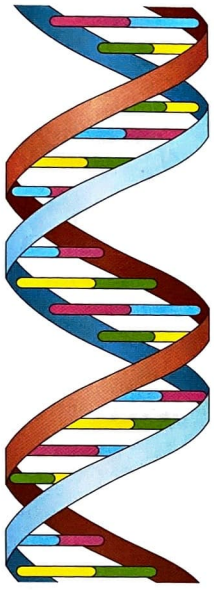
- describe how characteristics are inherited
- describe how scientists worked together to develop the DNA model.

You can often tell if people are members of the same family, as they look alike. The children have inherited some characteristics from each of their parents. Brothers and sisters do not look completely the same, as they each inherit a different mixture of characteristics.

How do you inherit characteristics?

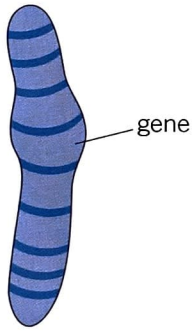
You inherit characteristics from your parents through genetic material stored in the nucleus of your cells. This material is a chemical called **DNA** (deoxyribonucleic acid). DNA contains all the information needed to make an organism.

A State what DNA is.



▲ The shape of DNA is a double helix – a bit like a twisted ladder.

▼ A chromosome.



Chromosomes

Inside the nucleus, your DNA is arranged into long strands called **chromosomes**. Different species have a different number of chromosomes in their nucleus. Humans have 46 chromosomes; cats have 38 chromosomes.

You inherit half of your chromosomes from your mother and half from your father. This is why you share some of your characteristics with your mother and some with your father.

B State what a chromosome is.

Genes

Each chromosome is divided into sections of DNA. The sections that hold the information to produce a characteristic are called **genes**. For example, one gene contains the information that sets your eye colour, while a different gene sets your hair colour. Each chromosome contains thousands of genes.

C State what a gene is.

DNA timeline

Carry out some research to produce a timeline, showing the key steps in scientists' understanding of DNA.

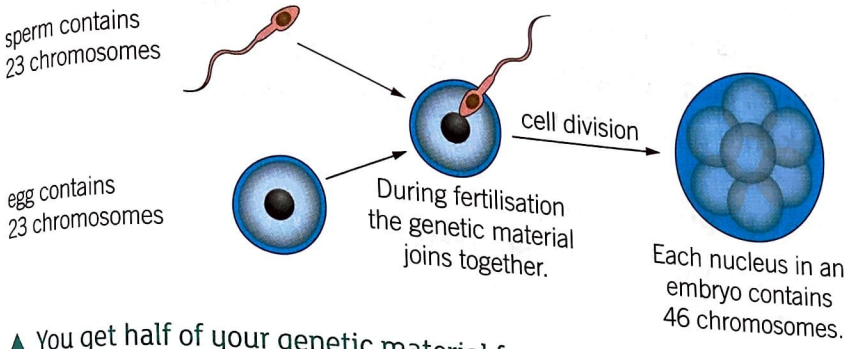
Link

You can learn more about DNA in B3 2.5 DNA

How is genetic material inherited?

Inside the nucleus of your cells, the 46 chromosomes are arranged into 23 pairs. One copy of the chromosome of each pair comes from your mother, and the other comes from your father.

Egg and sperm cells are the only cells to contain 23 chromosomes. They only have one copy of each chromosome. During fertilisation, the egg and sperm cells join together. When their nuclei join, their chromosomes pair up, producing an embryo with 46 chromosomes.



▲ You get half of your genetic material from your mother, and half from your father.

D State the number of chromosomes present in a normal human body cell.

Discovering DNA

Four scientists worked together to produce a model of the structure of DNA.

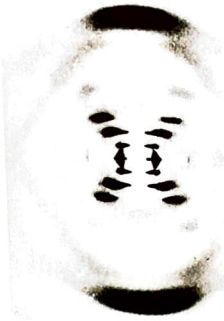
In the early 1950s two scientists, Rosalind Franklin and Maurice Wilkins, used X-rays to investigate the structure of DNA. The image they produced is shown above.

James Watson and Francis Crick, scientists working at another university, were also studying DNA. When they saw this image it told them that DNA had a helical shape. Through further investigations, Watson and Crick worked out that the structure of DNA is like a twisted ladder. This is known as a double helix.

In 1962 Crick and Watson, along with Wilkins, won the Nobel Prize for Medicine for their discovery. Franklin died in 1958; some people say that at the time her role in this famous discovery wasn't recognised.

Team work

The scientists who discovered the structure of DNA did so by working together. Communication is very important so that scientists can share their ideas and carry out investigations. Watson and Crick were able to work out the structure of DNA by building on the work if Franklin and Wilkins.



◀ The first image of DNA, produced using X-rays.

Key Words

DNA, chromosome, gene

Summary Questions

1 Copy and complete the sentences below.

Genetic material in the body is stored in the _____ of a cell.

_____ is the name of the chemical that contains the instructions needed to make an organism.

_____ are made of long strands of DNA.

The sections of DNA that hold the information for a _____ are called _____.

(5 marks)

2 Arrange these objects in order of size, starting with the smallest.

cell chromosome gene DNA nucleus

(2 marks)

3 Describe how scientists worked together to discover the structure of DNA.

(2 marks

4 Explain in detail why you share some characteristics with you mother and some with your father.

(6 marks ow