12. Which row in Table 2.9.12 correctly matches the sport to the *main* type of respiration used? [1]

	Sport	Type of respiration used
a)	long-distance swimming	anaerobic
b)	marathon running	aerobic
c)	weightlifting	aerobic
d)	sprinting	aerobic

TABLE 2.9.12

13. Stomata close when water is in short supply. Name a disadvantage of closed stomata. [1]

a) Water is not lost.
b) Nutrient uptake is reduced.
c) Photosynthesis increases.
d) Water is lost.

14. What effect will increasing the light intensity have on transpiration? [1]

a) It will stay the same.
b) It will drop.
c) It will rise.
d) It will stop completely.

15. Look at Figure 2.9.12a. This single-celled organism lives in pond water. How does it get food? Explain how you know this. [2]

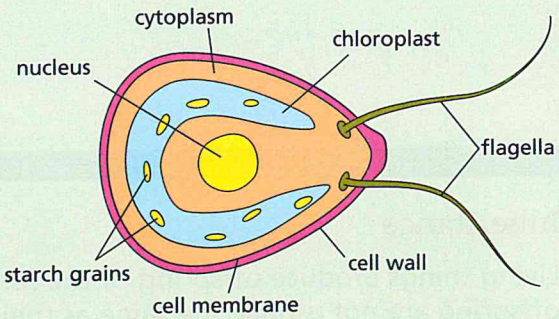


FIGURE 2.9.12a: Chlamydomonas – a unicellular organism.

EXTEND. Questions 16–17

See how well you can understand and explain new ideas and evidence.

16. Two types of microbe, A and B, are being considered for use by a brewing company. Microbe A respires aerobically and anaerobically, whereas microbe B only respires anaerobically. Suggest which microbe may be most useful based on this information, and suggest what other factors should be considered before choosing which microbe to use. [4]

17. Marram grass grows on sand dunes.
It has rolled leaves. Why do you think it has: [2]

a) sunken stomata and rolled leaves?
b) a thick, waxy cuticle?

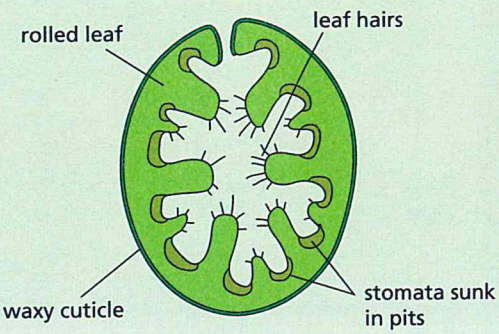


FIGURE 2.9.12b: The leaf blade of the marram grass is rolled towards the mid vein.

Genes
Evolution *and* Inheritance

Ideas you have met before

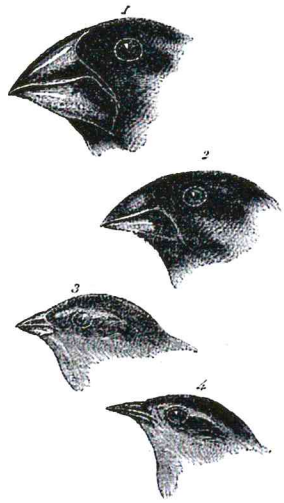
Evolution

Environments change and these changes sometimes pose a threat to habitats.

Some living things are adapted to survive in extreme conditions, for example, cacti, penguins and camels.

Variation over time can lead to evolution.

The human skeleton has evolved because of changes to the environment.



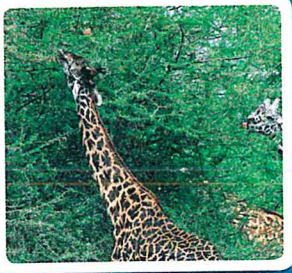
Inheritance

Living things produce offspring of the same kind but these offspring are not usually the same as their parents.

In this chapter you will find out

10.0

Natural selection and evolution

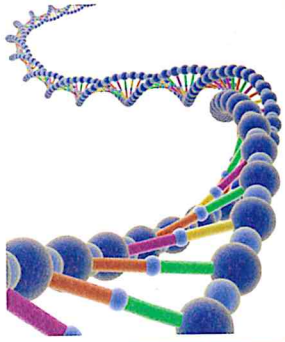


- Natural selection is driven by competition for resources and variation within a species.
- The theory of evolution describes how species change over time. The theory of Charles Darwin suggests that this happens by natural selection.

Maintaining populations

- Biodiversity is a measure of the living things within an ecosystem.
- Biodiversity can be measured by the variation within species or by the number of different species in an ecosystem.
- High biodiversity is important to preserve populations and to ensure we have resources such as food, medicines and materials.
- Extinction occurs when no individuals of a species remain.
- The extinction of dinosaurs is an example of mass extinction. There are several theories suggested for this extinction.
- Gene banks are a way of preserving genetic materials of plants and animals prior to extinction.

Inside the nucleus



- DNA has a very complex structure. Understanding the structure of DNA allows us to understand how it determines our features.
- Chromosomes and genes are portions of DNA that carry inherited information.
- Wilkins, Franklin, Watson and Crick played important roles in discovering the structure of DNA.

Inheritance

- Chromosomes from each parent are passed on during reproduction.
- The features that you have are determined by the form of the genes you inherited from your parents.
- Some genes can mask the effects of others.
- A small change in a chromosome or gene can cause a genetic disorder.
- Genetic diagrams can be used to model inheritance and to predict the probability of inheriting a specific trait.

Explaining natural selection

We are learning how to:

- Describe how variation and competition for resources drive natural selection.

The environment we live in is constantly changing. Many organisms that once existed on Earth did not survive changes to their environment and became extinct. How have other organisms survived?

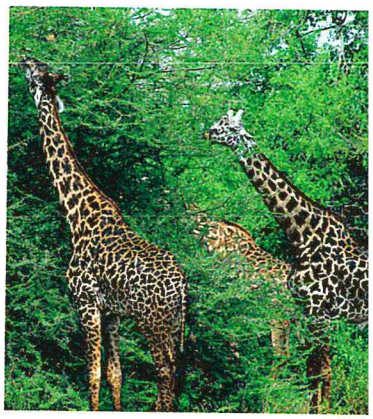


FIGURE 2.10.1a: What might happen to the shorter giraffe?

The importance of variation in populations

Organisms need resources such as food, mates and a space to live. Organisms needing similar resources may compete with each other if these resources are in short supply (**competition**). Giraffes feed on leaves and buds on trees. A **population** of giraffes living in the same habitat may compete for food. If one giraffe is better able to reach the buds and leaves than another giraffe, it is more likely to find enough food to survive. We say that this giraffe is better adapted than a giraffe that cannot reach the buds and leaves as easily.

Animals within the same population show **variation**. In history, there were ancestors of the giraffe with both long and short necks. When food became scarce, the giraffes with longer necks were better able to reach leaves of the taller trees. Longer necks meant they were more likely to survive. Over many generations, more and more giraffes with long necks were born. This is called **natural selection**.

1. What is 'natural selection'?
2. Explain why having a longer neck might make the giraffe more successful at spotting predators such as lions.

Charles Darwin's Theory of Natural Selection

There have been several theories suggested to explain why and how populations change over time; this change over time is called **evolution**. The most widely accepted theory is that of Charles Darwin. Darwin (1809–82) suggested that organisms struggle to survive and so produce many offspring to ensure that some survive. He recognised that there is variation within a species. He described the organisms most likely to survive (for example, giraffes with long necks) as the 'fittest'.

Did you know...?

Evolution of living organisms began 3.7 billion years ago. The earliest 'species' were bacteria. Human beings are direct descendants of these bacteria, showing the massive changes that evolution can drive.

Darwin drew these conclusions:

- All organisms produce more offspring than is needed.
- Organisms have a fairly constant population size and not all offspring will survive.
- There is a wide range of features within a species and some variations make it more likely that the organism will survive.
- The 'fittest' organisms are most likely to survive to reproduce and pass on their genes.

3. Explain why more and more giraffes were born with long necks over time.

4. Suggest what would happen if there was no variation in populations of a species (for example, if all giraffes had short necks).

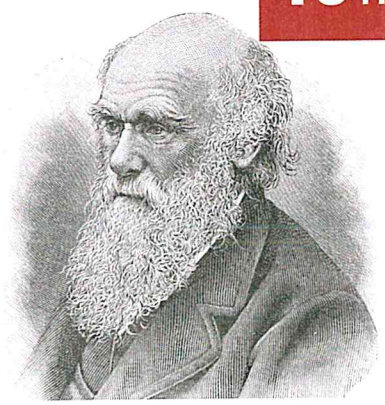


FIGURE 2.10.1b: Charles Darwin is well remembered for his work on n natural selection. However, Alfred Russel Wallace also suggested the theory of natural selection and the two scientists worked together.

Evidence for natural selection

A scientific theory is an explanation based on repeated observations and experimentation. Darwin collected many thousands of specimens and made many observations on his travels. He wrote extensively about the finches living on a group of islands in the Pacific Ocean, the Galapagos Islands.

Darwin observed that these birds varied from island to island. These birds were similar in many ways, except for their beaks. He observed that variation in beak structure gave certain advantages to some finches in their search for food and he linked these differences to the type of food available on the different islands. For example, some beaks were well adapted for crushing seed shells, but others for catching insects (Figure 2.10.1c).

Darwin concluded that variation in the original species meant that birds with different beaks were more likely to survive on each island. This led to natural selection and after several generations, the differences became so great that new species were formed.

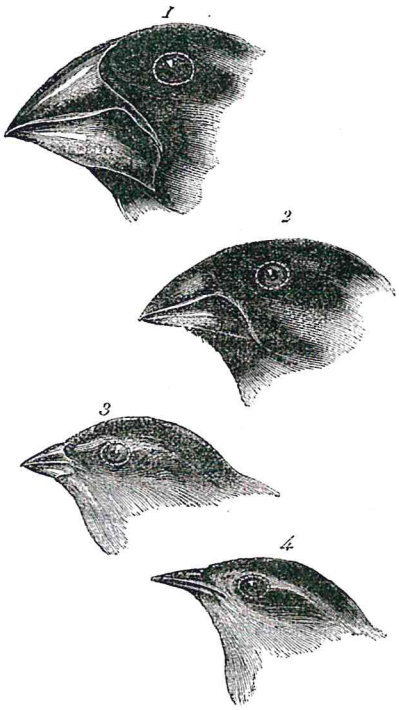


FIGURE 2.10.1c: Why do these finches have differently shaped beaks?

5. Explain why it was significant that Darwin studied animals on a group of islands, such as the Galapagos Islands.

6. Describe how you might persuade someone that the theory of natural selection is correct.

Know this vocabulary

competition
population
variation
natural selection
evolution

Understanding the importance of biodiversity

We are learning how to:

- Describe what is meant by biodiversity.
- Explain the importance of biodiversity.

Human actions such as habitat destruction and hunting decrease the variety of plants and animals. Why is it important to preserve this diversity and what are the consequences of reducing the variety of living things?

FIGURE 2.10.2a: A wide range of plants often grow together in the same areas.

What is biodiversity?

'Bio' means 'living', 'diverse' means to show variety. Therefore, **biodiversity** is the variety of living things within an **ecosystem** (a habitat and all the living things in it).

Biodiversity can be measured in two ways:

1. The number of different species within an ecosystem. An ecosystem of high biodiversity would have a large number of different species.
2. The differences between individuals of the same species. An ecosystem of high biodiversity would have a wide range of differences within one species.

1. What is biodiversity?
2. Describe two ways that an ecosystem could demonstrate high biodiversity.

The importance of biodiversity

Humans rely on a whole range of plants and animals. For example, we rely on plants to remove carbon dioxide and release oxygen into the atmosphere. We rely on crops for food and certain plants and microorganisms for medicines. We rely on animals such as cows, sheep and fish for food and we rely on trees for building materials.

A reduction in biodiversity would make it less likely that we had all of the resources that we currently depend on.

In a similar way, other organisms rely on each other, too. All animals depend on producers at the start of a food chain, either directly or indirectly. Interactions within the environment are in a delicate balance. When that balance is upset, for example, by decreasing the number of species, it can have a knock-on effect on other living things.

FIGURE 2.10.2b: Humans rely heavily on bees, for example, to pollinate crops, fruit and vegetable plants. It is important that we maintain honey bee populations.

3. Draw a table to show some of the ways in which humans depend on biodiversity.
4. Explain how animals all depend on producers, 'either directly or indirectly'.

he consequences of a lack of biodiversity

n ecosystems where the number of different species is high, ood chains will be complex with organisms having a choice f food. In ecosystems of lower biodiversity, food webs will e simpler. If a change occurs to remove one species from simple food web, this could have a devastating effect on ther organisms.

n an ever-changing environment, it is important that pecies can adapt to changes. As the theory of natural election shows, variation within a species means that ome organisms are likely to be well adapted to survive a hange, even if all organisms are not. Where biodiversity s low within a species, a change in the environment could esult in that species becoming **endangered**. This means hat the numbers of the species are so low that it could ecome extinct.

Did you know...?

Some places have species that only exist there. Areas with high numbers of these unique species are called 'biodiversity hotspots'. One example is The Cape Floristic Region in South Africa that is home to 6200 plant species found nowhere else in the world.

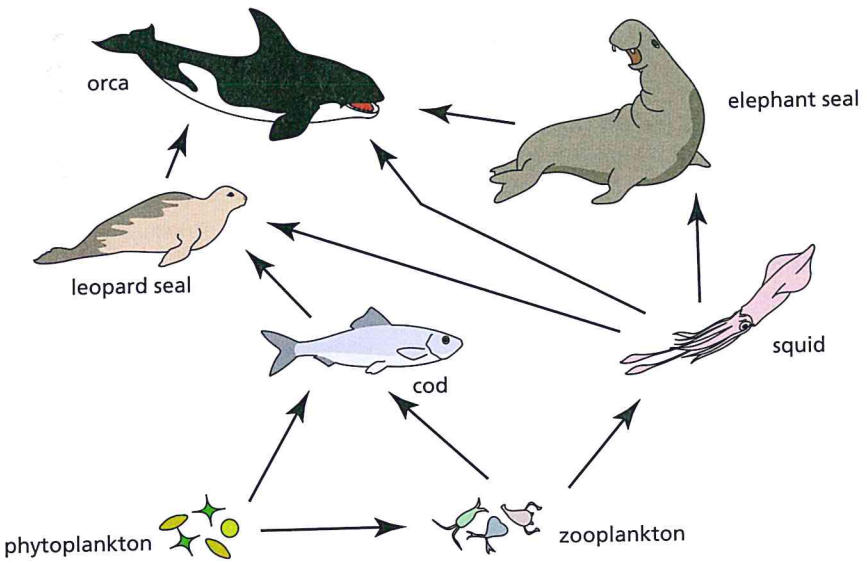


FIGURE 2.10.2c: Phytoplankton (microscopic aquatic life) absorb carbon dioxide and release oxygen. What would be the effect of loss of phytoplankton from this simple food web?

5. Compare a food web of an ecosystem with low biodiversity with an ecosystem with high biodiversity.
6. Explain how decreasing biodiversity affects a food chain/web and suggest the consequences of these changes.

Know this vocabulary

biodiversity
ecosystem
endangered

Explaining extinction

We are learning how to:

- Identify changes that can cause a species to become extinct.
- Explain the use of gene banks to preserve hereditary material before a species becomes extinct.
- Review theories and evaluate theories of what caused the extinction of the dinosaur

Throughout history animals have become extinct as the world changed. Today, about one quarter of the world's mammals are in danger of being wiped out. What are the causes of extinction? What can humans do to help prevent them?

Causes of extinction

Extinction of a species occurs when there are no more individuals of that species alive in the world. This is a natural part of evolution, but sometimes extinctions happen at a much faster rate than usual. For example, at the end of the Cretaceous period 65 million years ago, a mass extinction called the 'K/T event' caused the death of many different species. Natural causes of extinction include climatic heating and cooling, changes in sea level, asteroid impacts and disease.

Today human intervention is causing rapid extinction, which in turn is causing a rapid decline in global biodiversity. Hunting, habitat destruction, the introduction of invasive species and the over-exploitation of wildlife mean that many different types of plants and animals are being pushed to the edge of extinction.

1. When is a species extinct?
2. What are the causes of extinction?

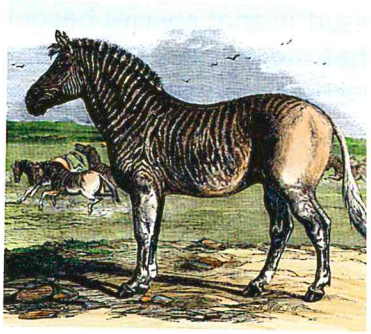


FIGURE 2.10.3a: The quagga was a variety of zebra with stripes only at the front of its body. Large herds lived in South Africa until Boer settlers began hunting them. Quaggas became extinct in 1878.

FIGURE 2.10.3b: The Pyrenean ibex became extinct in 2000. It was cloned and brought back to life in 2009, but unfortunately the kid did not survive.

Preserving materials

Endangered species are those in danger of becoming extinct. **Gene banks** are a strategy being used to preserve the genetic material of a plant or animal that is endangered. For plants, this could involve freezing cuttings of the plant or storage of seeds in seed banks. For animals, this involves storage of genetic material from sperm, eggs, embryos or even blood in liquid nitrogen (–196 °C).

Other strategies used to prevent extinction are captive breeding, creation of protected areas and habitat creation.

3. Explain what a 'gene bank' is.
4. Why is it easier to store plant genes than animal genes?

Reviewing an extinction theory

Mass extinctions are periods in the Earth's history when abnormally large numbers of species die out at the same time or within a limited time frame. There have been five mass extinctions – the most drastic, the K/T extinction, caused 96 per cent of all species to die. Life on Earth has descended from the 4 per cent of species that survived this event.

The K/T mass extinction (named so because it occurred between the Cretaceous and Tertiary periods) is the most famous because it caused extinction of the dinosaurs. Scientists have suggested several theories about the cause and one widely held theory is that a huge asteroid hit the Earth; this is the 'impact theory'. Table 2.10.3 shows how evidence and explanations support this theory.

TABLE 2.10.3: Evidence and explanations to support the impact theory of dinosaur extinction.

Evidence	Explanation
The sedimentary clay layer that was laid down at the time of the extinction contains high levels of iridium.	Iridium is expected to be found only in the Earth's core, not on the surface, but is expected to be a component of an asteroid.
Soot is found in the clay layer.	A huge asteroid would cause fires on Earth.
Huge crater (180 km) found in Chicxulub, Mexico age dated at 65 million years.	This ageing fits with the K/T time.

Other scientists believe that the extinction was more gradual and that climate change over time led to the demise of the dinosaurs. One theory is that increased volcanic activity changed the climate and dinosaurs could not adapt. It is suggested that iridium from the Earth's core could have been carried with these erupting volcanoes, explaining the iridium layer.

5. Distinguish between a guess and a theory.
6. Suggest how evidence and explanations could be used to persuade someone of the impact theory of extinction of dinosaurs.

FIGURE 2.10.3c: Seed banks like this one at Kew Gardens, London, are a conservation measure for plants. Seeds are carefully stored so that new plants can be grown in the future.

Did you know...?

Some scientists think that Earth is currently faced with a mounting loss of species that threatens to rival the five great mass extinctions of the past.

Know this vocabulary

extinction
gene bank
mass extinction

Understanding the nature of genetic material

We are learning how to:

- Identify that the nucleus contains chromosomes which carry inherited genetic information.
- Describe the link between chromosomes, genes and DNA.
- Describe the structure of DNA.
- Assess the work of Watson, Crick, Wilson and Franklin on DNA structure.

Inside the nucleus is a very special molecule, which is often called the 'miracle of life'. What is this molecule? Why is it so special?

Inside the nucleus

The nucleus of every cell contains genetic information, which is arranged into **chromosomes**. These are thread-like strands made of a chemical called **DNA** – this is short for deoxyribonucleic acid.

This chemical is divided into regions called **genes**. Different genes control the development of different characteristics. Genes can be passed down from generation to generation. You therefore inherited your genes from your parents. Organisms differ because they have different genes.

Chromosomes come in pairs. Humans have 23 pairs of chromosomes. Fruit flies have four pairs, whereas the adder's tongue fern has over 1000 chromosome pairs!

1. Explain what the difference is between a gene and a chromosome.
2. What is the role of a gene?
3. How many chromosomes do humans have?

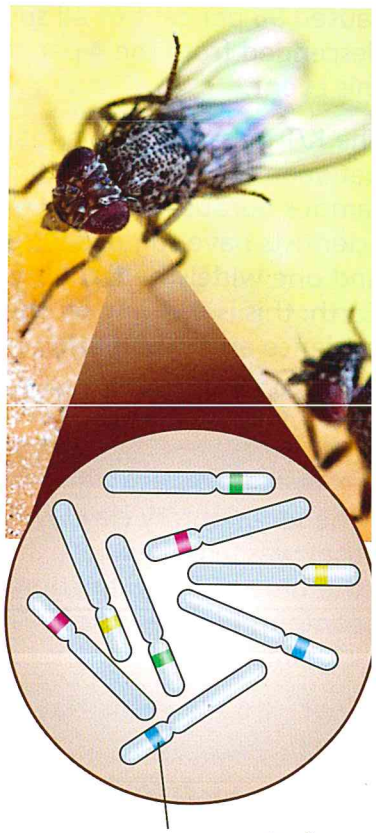


FIGURE 2.10.4a: The nucleus of every cell in a fruit fly contains four pairs of chromosomes.

DNA

A DNA molecule is made up of four chemicals called **bases**. Each gene is made up of a different pattern of these four bases.

A DNA molecule consists of two strands that wind around each other like a twisted ladder. This shape is called a **double helix**. The sides of the ladder are held together by 'rungs', each made from two of the bases. The four bases are called A,T, C and G for short. They work in two pairs: A always pairs with T, and C always pairs with G.

Did you know...?

You have about 9 million kilometres of DNA in your body, and about 50 per cent of human DNA is the same as the DNA found in bananas.

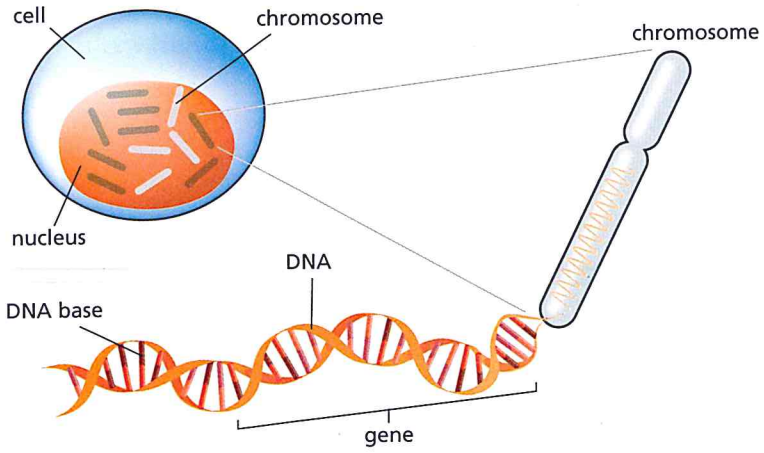


FIGURE 2.10.4b: A model of part of the DNA molecule.

4. Describe what a DNA molecule looks like.
5. Name the base pairs that make up a DNA molecule.

Finding the structure

Scientist Maurice Wilkins had the idea of studying DNA using the technique of X-ray crystallography, which involves firing X-rays at the DNA. The X-rays scatter, forming a pattern that shows the structure. Rosalind Franklin was appointed to work with Wilkins, and she produced the clearest picture of DNA using this method. This demonstrated that DNA had a helical structure.

Wilkins shared this information with James Watson and Francis Crick, who were also working on the structure of DNA. They used a molecular insert modelling technique devised by Linus Pauling to create a large-scale model of DNA in their laboratory.

Meanwhile Erwin Chargaff in the USA investigated the composition of DNA. He met with Watson and Crick in 1952 and shared his findings that A always paired with T, and C always paired with G. Watson and Crick used the work done by Franklin, Wilkins and Chargaff to determine the double helix shape.

Watson, Crick and Wilkins were awarded a Nobel Prize in 1962 for their work (unfortunately Rosalind Franklin died in 1958).

6. What was Franklin's contribution to the discovery of DNA structure?
7. Explain how the work of Watson and Crick was made possible by other scientists.

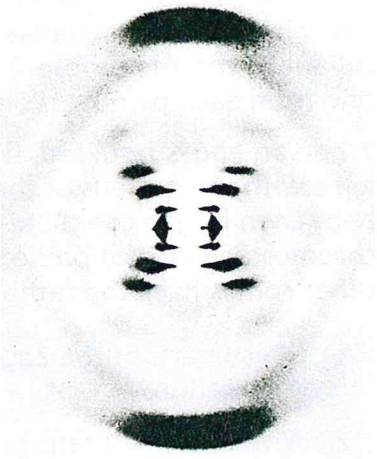


FIGURE 2.10.4c: One of Rosalind Franklin's X-ray diffraction images of DNA. The cross of bands indicates the helical structure.

Know this vocabulary

chromosomes
DNA
gene
base
double helix

Exploring the role of chromosomes

We are learning how to:

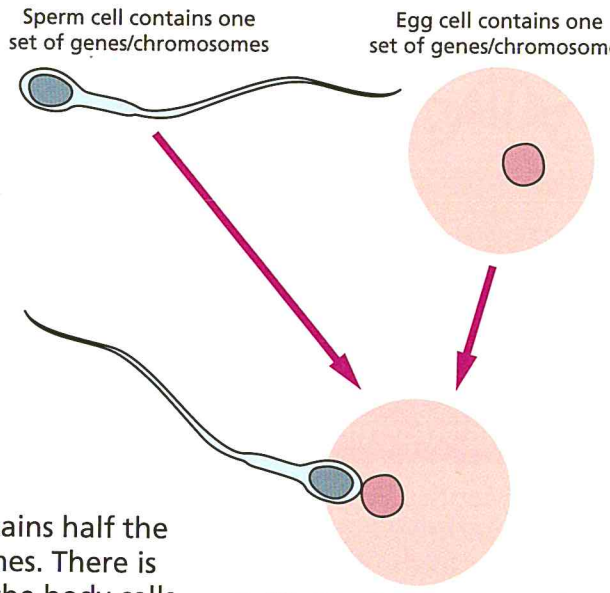
- Identify that a fertilised egg contains a full set of chromosomes, half from each parent.
- Explain the number of chromosomes in gametes.
- Explain how some genetic disorders arise

People have always wondered how traits are inherited from one generation to the next. Most offspring seem to be a blend of the features of both parents. How does this happen? Can errors occur?

Chromosomes and fertilisation

All human body cells have a full set of chromosomes, consisting of 23 pairs. Parents pass on their genes to their offspring in their sex cells (eggs or sperm). Sex cells are called **gametes**. Each gamete contains half the full set of chromosomes – 23 single chromosomes. There is one from each pair of chromosomes found in the body cells.

When an egg is fertilised, the nucleus of the male sperm joins with the nucleus of the female egg. The cells of the baby then have a complete set of chromosome pairs. One chromosome in each pair comes from the mother and the other comes from the father.



Fertilisation: the egg and sperm fuse together – the new cell now has two sets of genes/chromosomes

FIGURE 2.10.5a: Genes and DNA are passed on in the nucleus of the sperm and egg.

1. Which parts of the egg cell and sperm cell fuse at fertilisation?
2. Why do the sex cells have half the number of chromosomes?

Chromosomes as sets

A set of chromosomes is called a **karyotype**. A karyotype can be separated from its cell, spread out on a microscope slide and magnified many thousands of times. These karyotypes show X-shaped chromosomes, which is how they look part way through replicating.

There is one pair of chromosomes where the two chromosomes are slightly different from each other. They are called the sex chromosomes, X and Y. They determine the gender of the new individual. The sex chromosomes are usually labelled as pair 23.

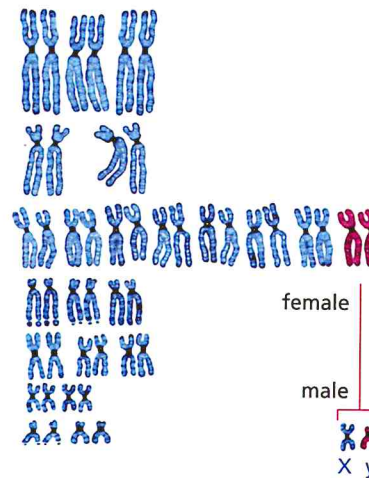


FIGURE 2.10.5b: A female karyotype – a full set of human female chromosomes. In a male, one of the X chromosomes is replaced by a Y chromosome.

The two chromosomes in each pair carry genes for the same characteristic in the same places. Just which of the two chromosomes a person gets from each pair in the mother and each pair in the father is completely random. This means different children in the same family will each get a different combination.

3. What is a karyotype?
4. Explain why chromosomes are arranged in pairs, such as in Figure 2.10.5b.
5. We sometimes describe females as 'XX' and males as 'XY'. Explain why.

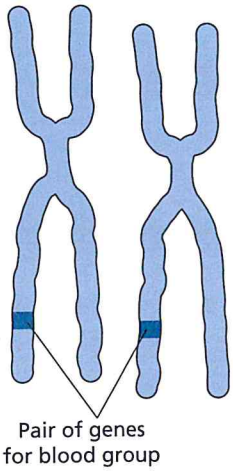


FIGURE 2.10.5c: Chromosomes in a pair contain genes for the same characteristic in the same position.

Genetic mutations

Genetic disorders are caused by **mutations** in an individual's genetic material. Sometimes errors occur resulting in a person having 45 or 47 chromosomes instead of 46; these are chromosome mutations. These errors usually occur during the creation of gametes. **Trisomy** means that an individual has three chromosomes instead of a pair. The most common trisomy is trisomy 21, which causes Down's syndrome. This typically causes some level of learning disability and characteristic physical features, although symptoms are varied.

FIGURE 2.10.5d In Down's syndrome, individuals have three copies of chromosome 21 instead of a pair.

Other genetic disorders are caused by gene mutations. These mutations take place in the DNA strand and are caused by a change in the sequence of bases. This affects proteins that are made from the gene. Examples of genetic disorders caused by gene mutations are cystic fibrosis and sickle cell anaemia. These mutated genes can be inherited and may result in the condition, although sometimes we can have the faulty gene without even realising it.

6. Describe the two types of mutation.
7. Explain, with an example, what trisomy is.

Did you know...?

Polydactyly is a condition that results in humans (and dogs and cats) having extra fingers or toes. It is caused by a gene mutation and so can be inherited. It is often not associated with any other symptoms.

FIGURE 2.10.5e: Polydactylism shown in the paws of a cat.

Know this vocabulary

gametes
karyotype
mutation
trisomy

Understanding variation

We are learning how to:

- Identify inherited characteristics in plants and animals that vary between offspring.
- Explain how inherited differences arise by genetic material from both parents combining.
- Describe how identical twins occur and analyse data about their features.

Brothers and sisters with the same parents are often not alike. How do these differences occur? In the case of twins, however, siblings can sometimes be identical. How do identical twins develop?

Inherited characteristics

The variation in shape, size and colour of living things is caused by parents passing on their features to their offspring. Animal and plant features that are inherited by offspring from their parents are called **inherited characteristics**.

There is a huge number of these traits. In humans, they include eye colour, blood type and having freckles. With the exception of identical twins, it is highly unlikely that any two people will have the same combination of genetic traits.

1. What is an inherited characteristic?
2. List ten inherited features in humans.

Why are siblings different?

Most human cells contain 23 pairs of chromosomes. Sperm cells contain only 23 individual chromosomes. Egg cells also contain only 23 individual chromosomes. These sex cells contain one chromosome from each of the 23 pairs in the parent in which they are made. Which chromosome of each pair is included in each sperm cell or egg cell is random. Every sperm cell and egg cell therefore contains a random mix of the father or mother's genetic information. During fertilisation, one egg is fertilised by one of millions of sperm. This means that each child with the same two parents has a random mix of their parents' genetic information. There are millions of possible combinations of genetic material from two parents. This explains why some features in common with the mother can may be seen as well as some features in common with the father. This also explains why siblings are not identical.

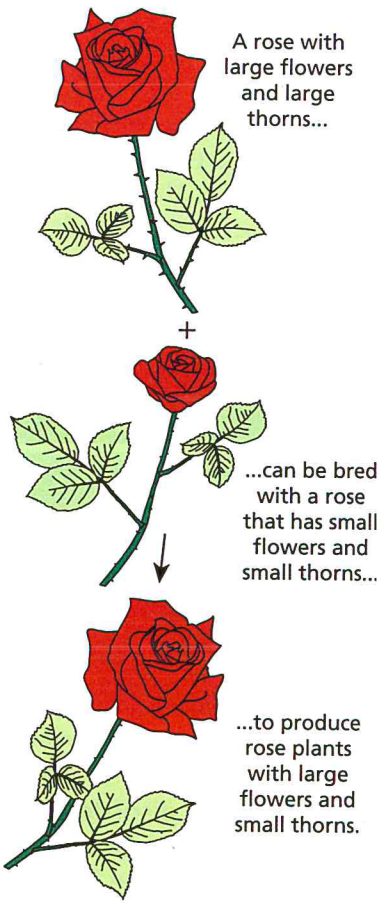


FIGURE 2.10.6a: How did the new rose bush get large flowers and small thorns?

FIGURE 2.10.6b: What features has the child inherited from his parents?

3. Where in the nucleus is genetic information found?
4. Explain why brothers and sisters with the same parents inherit different features.

Identical twins

Identical twins happen when one egg is fertilised by one sperm. The egg then divides into two halves. There is no reason why or when the egg splits – it is a random occurrence. The split usually occurs within the first twelve days of growth.

FIGURE 2.10.6c: Are these twins exactly the same?

Because the two embryos are the result of a single egg–sperm combination, they have the same genetic origins. Identical twins are not always exactly the same. Sometimes there are very slight differences that occur when the cells start dividing to form the embryo.

There is no hereditary trait that influences a tendency towards having identical twins. Identical twins do not run in families. Although there are families with a high incidence of identical twins, this is due to chance. Non-identical twins are produced when two eggs are fertilised by two different sperm. Non-identical twins have only the same chance of being alike as any siblings.

5. How do identical twins occur?
6. List five things that could happen to identical twins to make them look different.

Did you know...?

Conjoined twins are formed when an egg splits partially. Historically, the most famous conjoined twins were Chang and Eng, born in Siam in 1811. This is where the term 'Siamese twins' come from. Chang and Eng died on the same day in 1874.

FIGURE 2.10.6d: Chang and Eng. How are conjoined twins formed?

Know this vocabulary

inherited characteristics
identical twins

Modelling inheritance

We are learning how to:

- Use a model to represent inheritance of a trait.
- Predict likelihood of offspring inheriting specific traits.

Due to the random mixing of genes when forming gametes and during fertilisation, we cannot predict for certain what genes an offspring will inherit. However, we can use models to predict the likelihood of inheriting certain genes. Genetic counselling uses this information to support parents at risk of passing on a genetic disorder.

Dominant and recessive genes

As our chromosomes are in pairs, we have two copies of each gene. There are different versions of each gene, **alleles**. For example, the gene determining eye colour is found on each of the chromosome 15. One allele codes for blue eyes and the other allele codes for brown eyes. Each allele is described as **dominant** or **recessive**.

- The dominant allele controls the characteristic whether there are one or two copies of it present.
- The recessive allele controls the characteristic only when two copies of it are present.

1. What are alleles?
2. Describe the difference between dominant and recessive alleles.

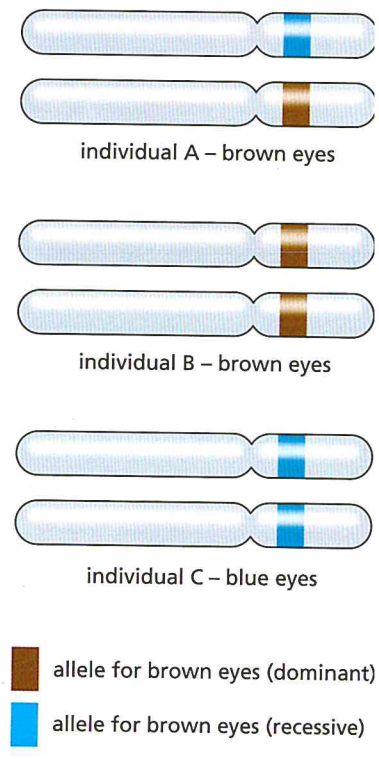


FIGURE 2.10.7a: Why do two of these people have brown eyes and one have blue eyes?

Using genetic diagrams

We use **genetic diagrams** to help us to understand the offspring that may result from two parents.

- We use capital letters to represent dominant alleles, B for the brown eye allele.
- We use lower case letters to represent recessive alleles, b for the blue eye allele.

Table 2.10.7 shows the combination of genes of each of the individuals A, B and C in Figure 2.10.7a.

Imagine that two parents like Individual A have offspring. We model a cross using the following steps:

- Identify the two alleles of each parent.
- Identify the possible gametes produced.

Did you know...?

Several 'at home' DNA testing kits are now available to buy over the counter in the UK. These kits use saliva to screen for genes associated with conditions such as cystic fibrosis, Alzheimer's and sickle cell anaemia.

- Work out the possible combinations of alleles in offspring.
- Identify the resulting characteristic of each offspring.

ABLE 2.10.7: Note that we write the capital letter (dominant allele) first.

ndividual	Combination of alleles	Eye colour
A	Bb	brown
B	BB	brown
C	bb	blue

sing a genetic diagram, we can predict the **robability** of offspring having a certain haracteristic. For example, in the cross in igure 2.10.7b, there is a 1 in 4 chance of hese parents having a child with blue eyes. he probability is the chance of something appening. It is not as certain as saying that if his couple have four children, one will definitely have blue yes. (It is important to note that although we use this model or eye colour, other genes also influence eye colour and ometimes predictions of eye colour are not accurate.)

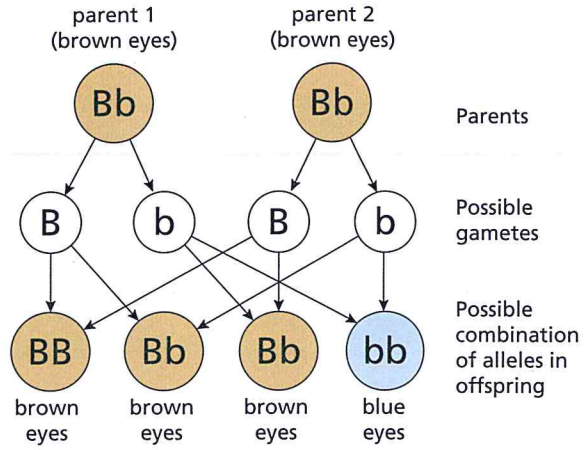


FIGURE 2.10.7b: Genetic diagrams model genetic crosses.

Possible gametes of parents	B	b
B	BB Brown eyes	Bb Brown eyes
b	Bb Brown eyes	bb Blue eyes

FIGURE 2.10.7c: Possible combination of alleles in offspring.

3. Imagine that Individual A and Individual C (Figure 2.10.7a) have offspring. Use a genetic cross to predict the probability of the offspring.

4. A couple are told that they have a probability of having a child with a specific genetic disorder of 1 in 2. Explain why this doesn't mean that if they have two children, one will be affected.

enetic counselling

enetic counselling is treatment offered to parents at risk of assing on genetic disorders. Genetic diagrams can be) predict the probability of these parents having a child with specific genetic disorder. For example, cystic fibrosis is a ondition caused by a recessive allele, modelled as the letter, f. here is also a dominant, unaffected allele, F. If parents are nown to have the affected allele, genetic diagrams can be sed to help them to understand the probability of having child with cystic fibrosis. They can then make an informed ecision on whether to go ahead and have children.

5. The allele for cystic fibrosis is recessive. What does this tell you about the alleles of a person suffering from cystic fibrosis?

6. Using a genetic diagram, predict the probability of two parents with the alleles Ff of having a child with cystic fibrosis.

Know this vocabulary

allele
dominant
recessive
genetic diagrams
probability

Checking your progress

To make good progress in understanding science you need to focus on these ideas and skills.

- Describe why species change over time and give examples.
- Describe the Theory of Natural Selection in evolution and explain the role of variation within a species and competition for resources.
- Describe some of the work of Charles Darwin and explain how it supports the theory of evolution.
- Define biodiversity in terms of numbers of different species and in terms of variation within species.
- Describe the importance of high biodiversity in preserving species and in preserving resources for humans.
- Explain the effects of a lack of biodiversity on an ecosystem.
- Define extinction and describe some causes of extinction.
- Describe how we can prevent extinction, for example, using gene banks and captive breeding.
- Describe a theory to explain the extinction o dinosaurs and suggest how evidence is used to support the theory.
- Describe chromosomes and their role in transferring heredity information to offspring.
- Explain the relationship between chromosomes, genes and DNA; explain why offspring of the same parents may look very different.
- Explore the role of scientists in the discovery of DNA and evaluate the relative importance of their contributions.

- Describe how fertilised egg cells contain half of the chromosomes from each parent with a random mix of genetic information from each parent.
- Explain how every new individual produced by sexual reproduction is genetically unique.
- Explain the impact of slight 'changes' to DNA passed on from parents to offspring.
- Recognise that we have different versions of genes and define dominant and recessive.
- Recall the stages in using a genetic diagram to explore variation in offspring for a particular trait.
- Use genetic diagrams to predict the probability of offspring inheriting a particular characteristic and describe a use in genetic counselling.

Questions

KNOW. Questions 1–9

See how well you have understood the ideas in this chapter.

1. Differences between organisms within a species are known as: [1]

a) variation
b) evolution
c) natural selection
d) offspring.

2. An animal that is in danger of extinction is said to be: [1]

a) a fossil
b) endangered
c) a gene bank
d) varied.

3. An ecosystem most likely to respond well to change is one with: [1]

a) no biodiversity
b) low biodiversity
c) medium biodiversity
d) high biodiversity.

4. What are 'gene banks'? [2]

5. Explain why variation within a species is important. [4]

6. How many chromosomes are in a human skin cell? [1]

a) 23 **b)** 46 **c)** 12 **d)** 92

7. In humans, males will have the sex chromosomes: [1]

a) XX
b) XXY
c) XY
d) XYY

8. A recessive allele will influence a characteristic if: [1]

a) there are two copies of it inherited
b) there are no copies of it inherited
c) there is one copy of it inherited
d) it is mutated before it is inherited.

9. Explain why identical twins are more similar than other siblings. [2]

APPLY. Questions 10–15

ee how well you can apply the ideas in this chapter to new situations.

0. Suggest a variation of a feature that would be disadvantageous to a tiger. [1]

1. Scientists working in a rainforest have discovered a population of a rare breed of frog. Describe and explain one measure that the scientists could take to preserve the species. [2]

2. A fruit fly has 8 chromosomes in its body cells. How many will it have in its sex cells? [1]

a) 16 **b)** 4 **c)** 2 **d)** 8

3. A liver cell in a mouse contains 40 chromosomes. How many of these have come from the male parent? [1]

a) 40 **b)** 20 **c)** 10 **d)** 8

4. Why do sex cells have only half the normal number of chromosomes? [2]

5. Megan's father has a genetic disorder. How can doctors find out if Megan has the disorder too? [2]

EXTEND. Questions 16–17

ee how well you can understand and explain new ideas and evidence.

6. Look at the stages in the evolution of the horse's hoof.

a) Explain the process that has taken place to cause these changes. [2]

b) Suggest an advantage of the evolution. [1]

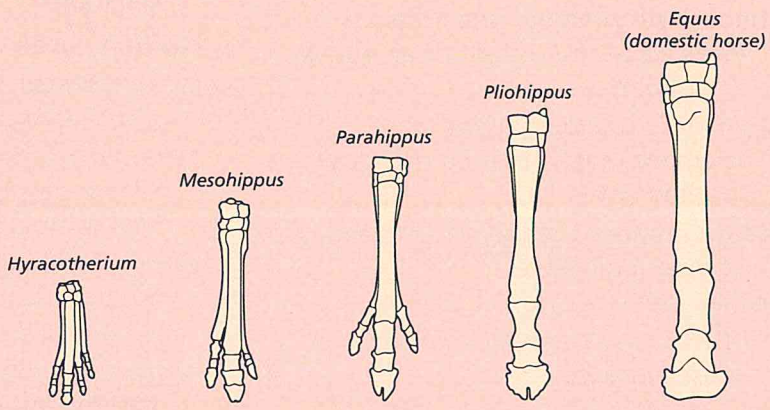


FIGURE 2.10.9a

7. A scientist is investigating inheritance in mice. He bred two brown mice together. They had 15 brown mice and 5 white mice. How did some of the offspring come to have white fur? Use a model to support your answer. [4]

Glossary

accuracy how close data is to true values

aerobic respiration respiration that involves oxygen

alkali metals the Group 1 family of elements, which all react quickly with water

allele different forms of a gene, they can be recessive or dominant

alveoli (singular alveolus) where gas exchange occurs in the lungs

amplitude maximum displacement of a point on a wave from its undisturbed position

anaerobic respiration respiration without using oxygen

area length × width; units are squared, for example m^2, mm^2

armature pole in an electromagnet or moving iron part of a solenoid, such as an electric bell

asthma disease affecting the breathing system

atmosphere the mixture of gases around the Earth

atmospheric pressure the pressure exerted by the weight of air above that point

atom basic 'building block' of an element that cannot be chemically broken down

atomic number number of an element in the periodic table

attract pull towards; a magnet will attract any magnetic material that is close enough

balanced diet intake of foods that provide the correct nutrients in the correct proportions

balanced forces forces on an object that act in opposite directions and are equal in size

base (in biology) bases are joined together in pairs; these pairs are the components of DNA

bias when evidence, or the conclusion from evidence, is swayed towards a certain outcome

biodiversity variety of different organisms in an area

bond breaking overcoming the force of attraction between particles in a molecule. Energy is transferred in during the process

bond making the force of attraction between particles coming together in a molecule. Energy is transferred out during the process

breathing the process of moving air in and out of the lungs

brewing cereal grains are soaked in water and fermented with yeast

bronchi there are two bronchi in the human body; each bronchus carries blood in and out of a lung

bronchioles the passageways by which air passes through the nose or mouth to the alveoli

buoyancy upward force on an object in a liquid

capillary small blood vessel

carbohydrates food group including starches and sugars

carbon cycle the way in which carbon atoms pass between living organisms and their environment

carbon sink ways of storing carbon so it isn't in the atmosphere are known as carbon sinks (or carbon stores)

carbonate type of compound containing carbon and oxygen

catalyst substance that speeds up a chemical reaction

catalytic converter a system that converts pollutant gases into harmless ones using a catalyst

cellulose large sugar molecule made by plants for cell walls