

Inheritance, variation and evolution

Reproduction

- Sexual and asexual reproduction
- Meiosis
- Advantages and disadvantages of sexual and asexual reproduction (biology)
- DNA and the genome
- DNA structure (biology)
- Genetic inheritance
- Inherited disorders
- Sex determination

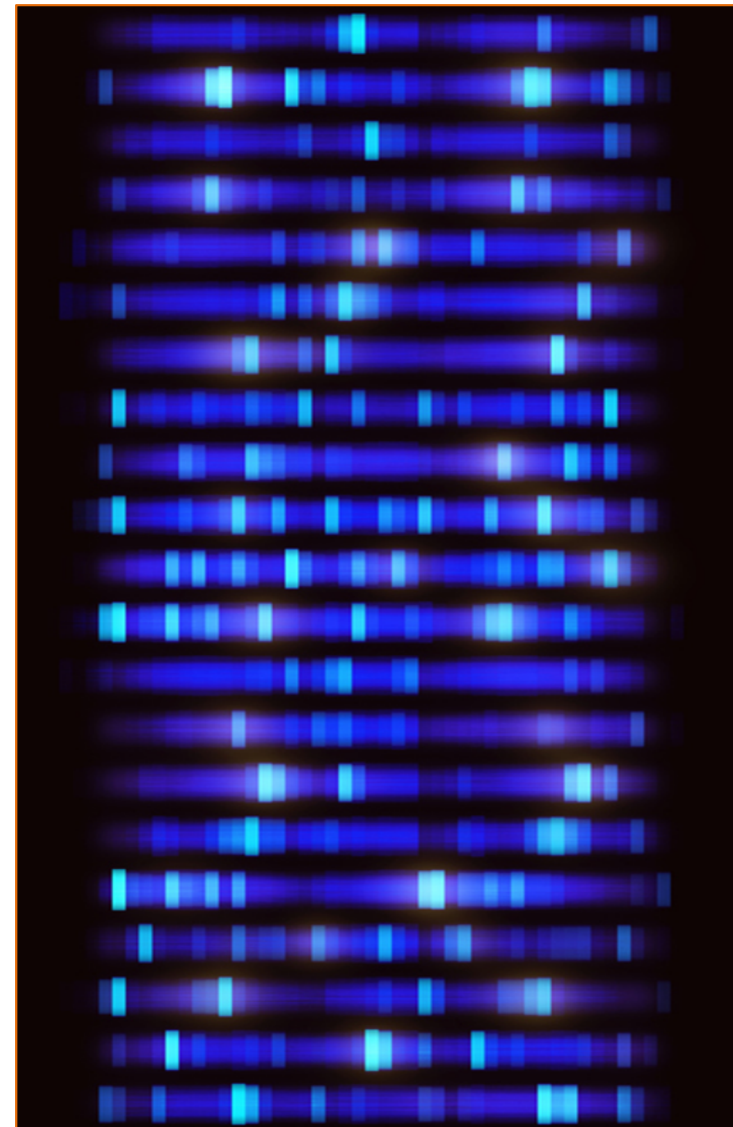
Variation and evolution

- Variation
- Evolution
- Selective breeding
- Genetic engineering
- Cloning (biology)

Development of understanding of genetics and evolution

- Theory of evolution (biology)
- Speciation (biology)
- Understanding of genetics (biology)
- Evidence for evolution
- Fossils and extinction
- Resistant bacteria

Classification of living organisms



Sexual reproduction involves the joining of **male** and **female** gametes.

A **gamete** is the scientific term for a sex cell.

In animals, the gametes are the **sperm** and the **egg** cells.
In flowering plants, the gametes are the **pollen** and the **egg** cells.

In sexual reproduction, **mixing** of **genetic information** occurs which leads to **variety** in the offspring. Every new **offspring** formed is **unique**. The gametes are produced by **meiosis**.



Asexual reproduction involves only **one parent**. There is **no fusion** of gametes. **No mixing** of genetic information occurs. **All** offspring are genetically **identical** (called **clones**). Only **mitosis** is involved.

Meiosis leads to **non identical** cells being formed.
Mitosis leads to **identical** cells (clones) being formed.

Cells in the **reproductive organs** divide by **meiosis** to form **gametes**. In animals, the reproductive organs are the **ovaries** and **testes**.

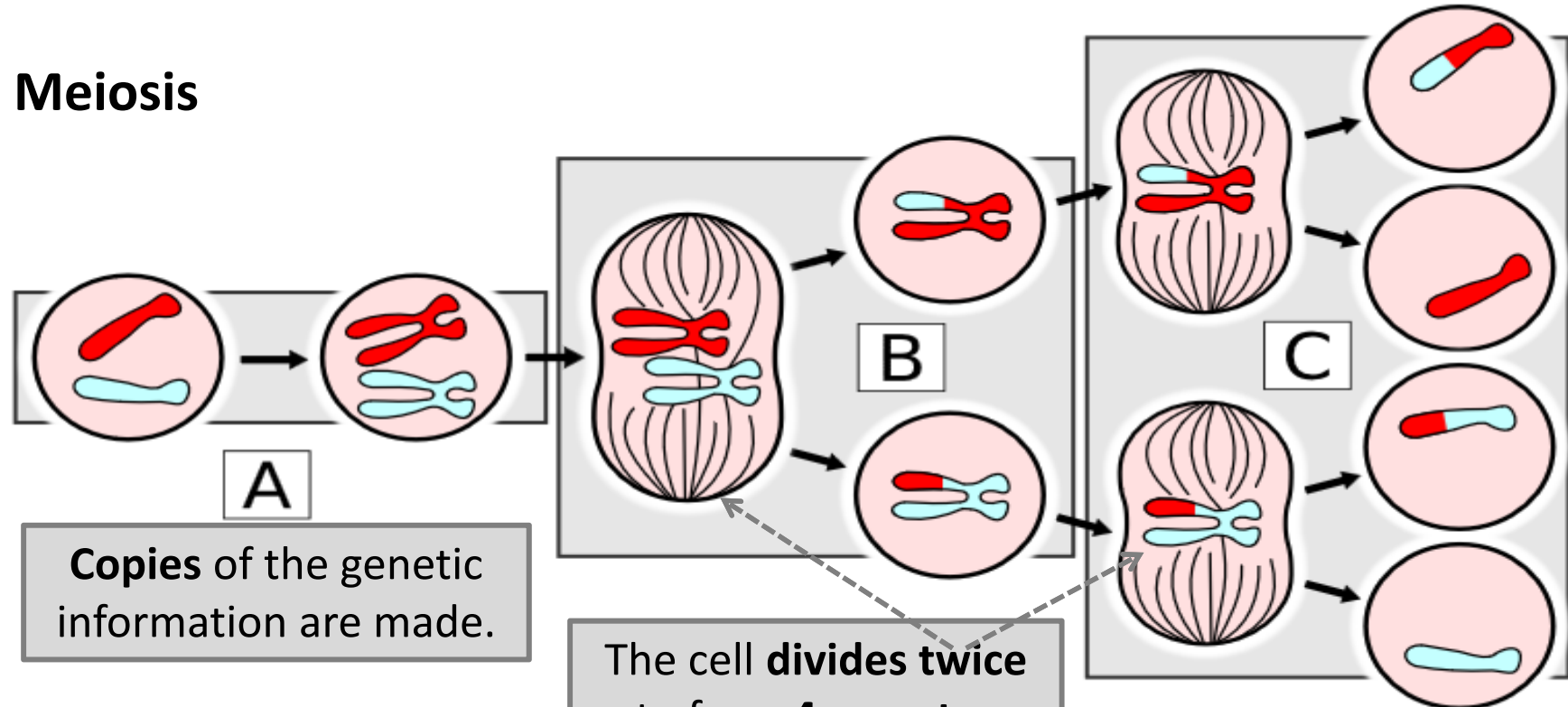
Meiosis is sometimes called **reduction division** because it **halves the number of chromosomes** in the gametes. When male and female gametes fuse during **fertilisation**, the number of chromosomes are restored.



This brother and sister have the same parents, but they look different. They show **variation** because of meiosis.

This is the process a cell goes through to produce gametes:

Meiosis



Copies of the genetic information are made.

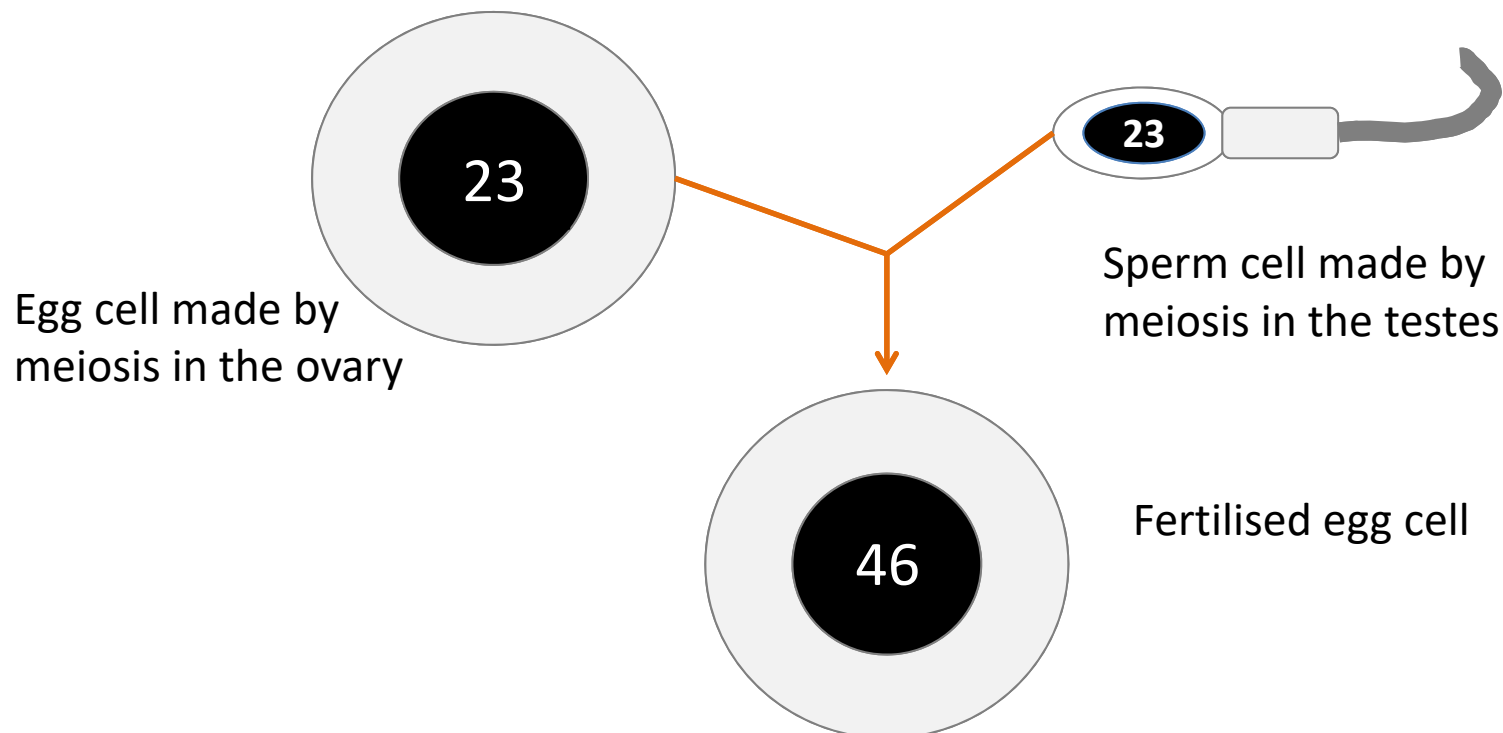
The cell **divides twice** to form **4 gametes** each with a **single set of chromosomes**. This is **half** the number of the **original** cell.

All **4 gametes** are **genetically different** from each other and to the parent.

A cell in the testes has **46** chromosomes. When this cell undergoes meiosis it produces 4 gametes each with **23** chromosomes. The same process occurs in the ovary to produce egg cells.

The male and female gametes join at **fertilisation** to restore the normal number of chromosomes.

The fertilised egg cell now contains **46** chromosomes.

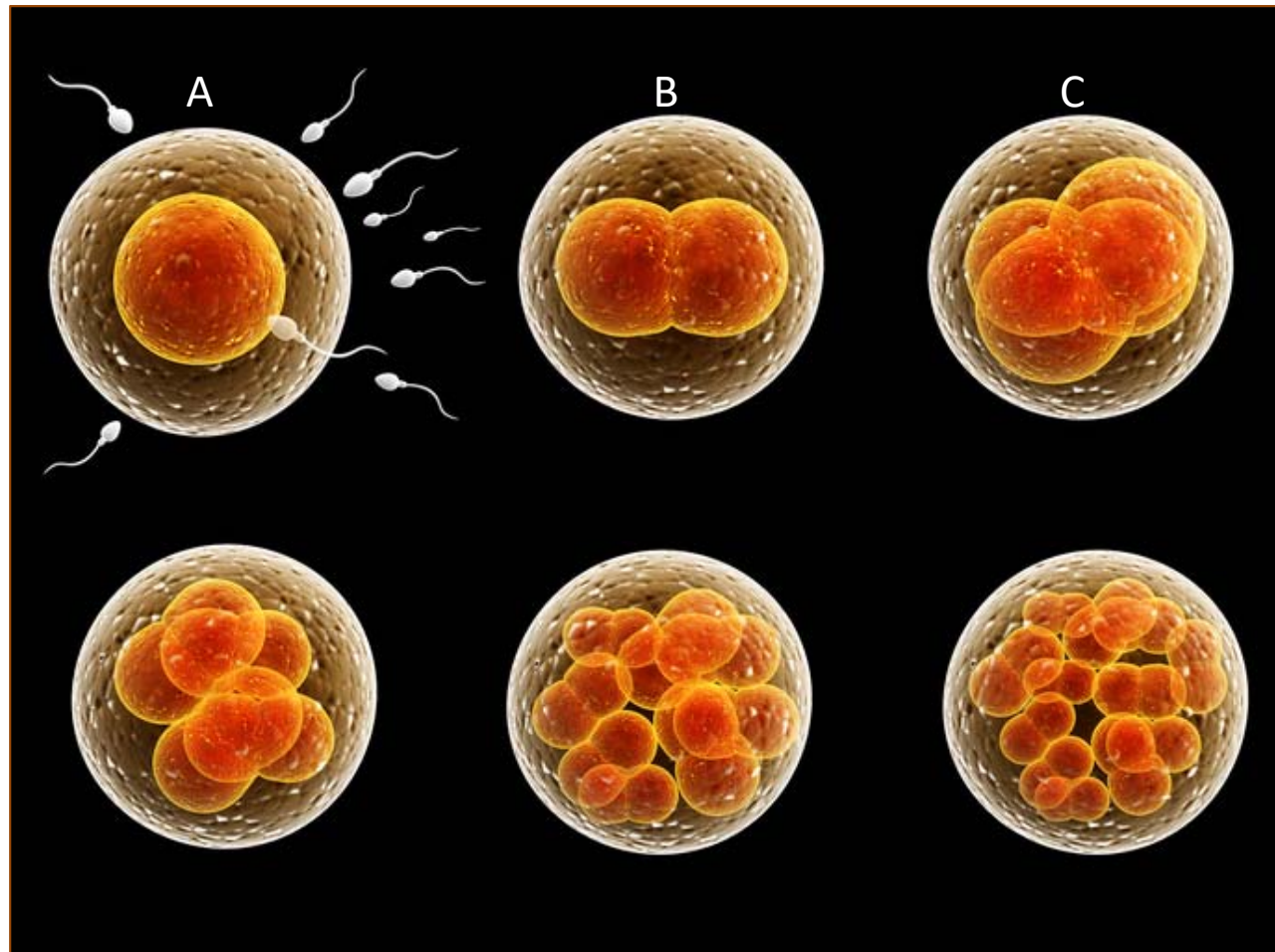


A Fertilisation

occurs. The genetic material from the sperm and egg combine to form a **unique** cell.

B The fertilised cell divides by **mitosis** to form **2 identical cells**.

C Both cells divide by mitosis to form 4 identical cells.

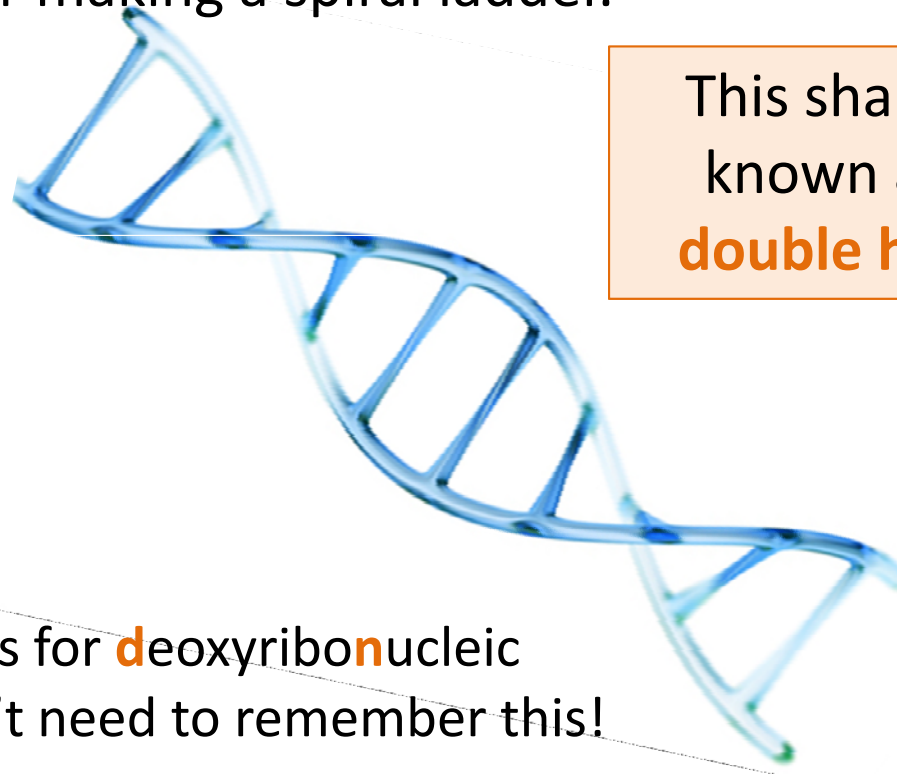


Mitosis continues and a ball of identical cells is formed. This is now called an **embryo**. Cells now begin to **differentiate** into different types of cell.

The **genetic material** in the nucleus of most cells is made from a chemical called **DNA**.

DNA is a **polymer** made from two strands which twist around each other making a spiral ladder.

A **polymer** is a large molecule made from many **smaller** molecules called **monomers**.

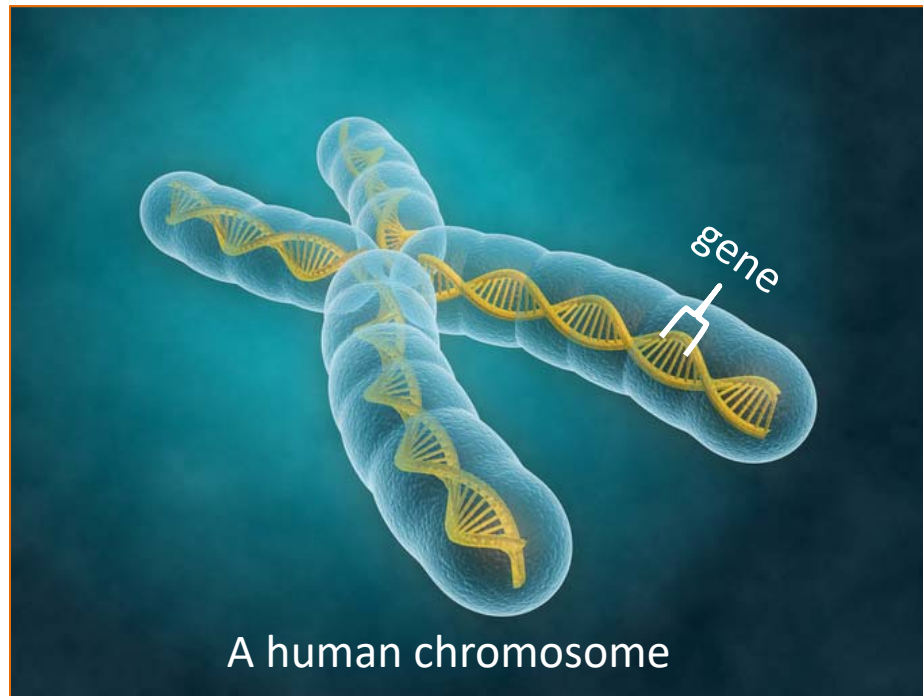


This shape is known as a **double helix**.

DNA stands for **d**eoxyribonucleic **a**cid. You don't need to remember this!

Inheritance part 1 – DNA and the genome

DNA is arranged in structures called **chromosomes** inside a cell's nucleus.



A **gene** is a small section on a chromosome. Each gene **codes** for a particular sequence of **amino acids**, to make a specific **protein**. A human has approximately 24 000 genes in total. Each single chromosome is made up of about 2000 genes.

In human body cells the **chromosomes** are normally found in **pairs**. Each cell has **23 pairs** of chromosomes.

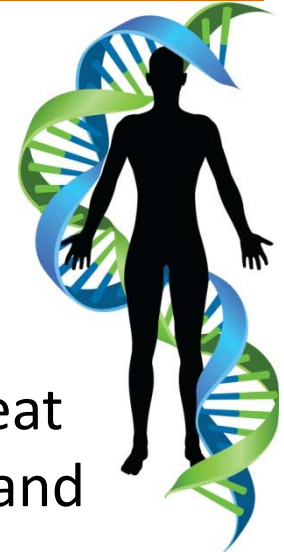
The chromosome number varies from one organism to another. A **horse** has **32 pairs** of chromosomes and a **housefly** has **12 pairs**.

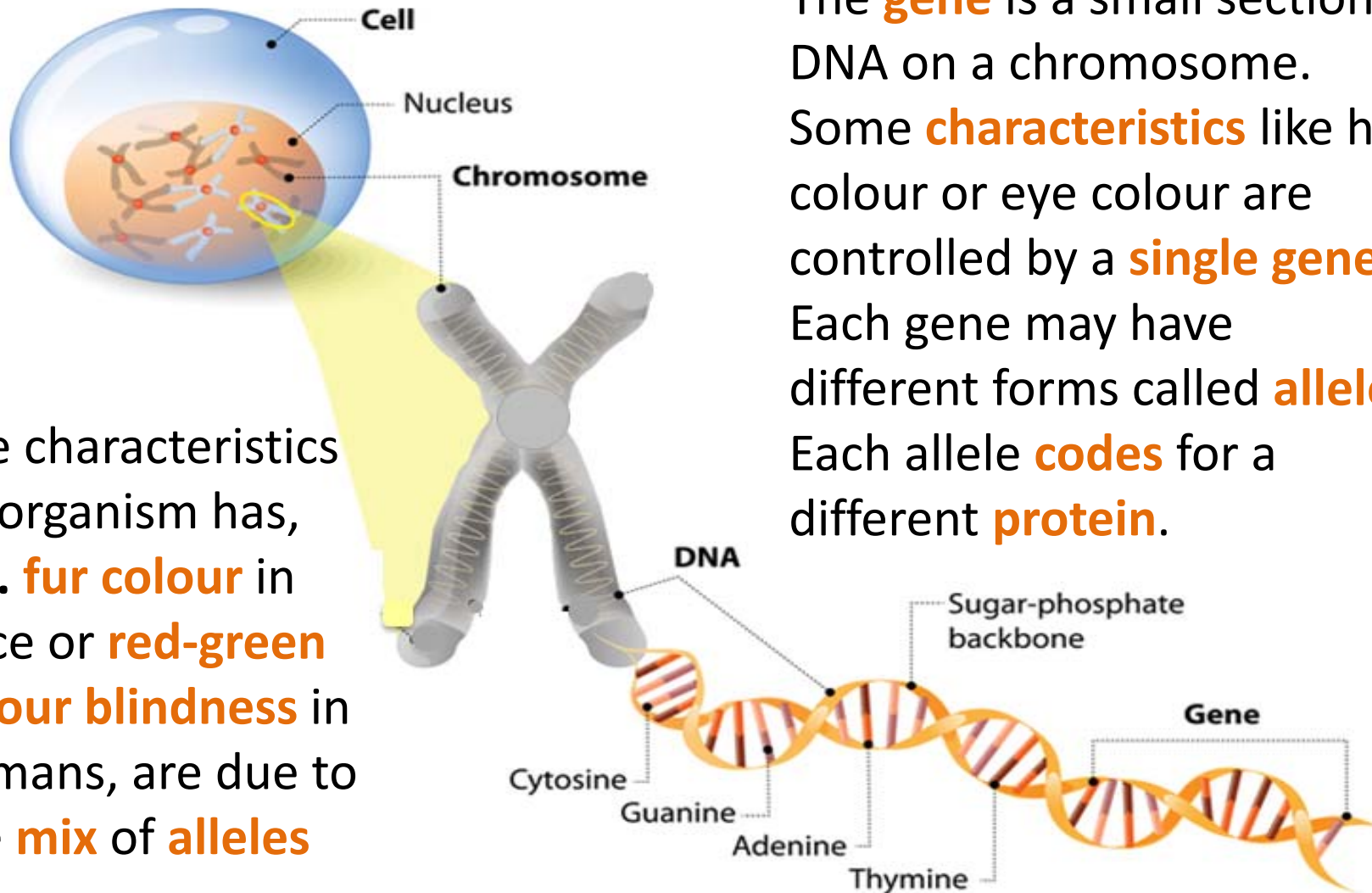
The genome of an organism is defined as the entire genetic material of that organism.

The **Human Genome Project** (HGP) was an international scientific research project set up to **map all the genetic information** in a human being.

It began in 1990 and was completed in 2003. The whole **human genome has now been studied** and this will have great significance for **medicine** in the future. This work to understand the human genome is important for several reasons:

- ❑ To enable scientists to search for the **genes linked to different types of disease** to look for possible treatment or correction
- ❑ To enable doctors to better **understand and treat inherited disorders**
- ❑ To be able to trace historic **human migration patterns.** [video](#)





The characteristics an organism has, e.g. **fur colour** in mice or **red-green colour blindness** in humans, are due to the **mix** of **alleles** they possess.

The **gene** is a small section of DNA on a chromosome. Some **characteristics** like hair colour or eye colour are controlled by a **single gene**. Each gene may have different forms called **alleles**. Each allele **codes** for a different **protein**.

Each gene has different forms of alleles. The alleles which are present are known as the **genotype**. These are often represented as letters such as **BB**. The genotype operates at a molecular level to develop the actual characteristics seen or the **phenotype**.

Most genes have two possible allele variations which are known as **dominant** or **recessive**.

Dominant alleles are represented by a **capital letter** e.g. B

Recessive alleles are represented by a **lower case letter** e.g. b

There are **3** possible combinations of alleles for each gene:

Two dominant alleles **BB**

Two recessive alleles **bb**

One dominant and one recessive allele **Bb**

(always place the dominant allele first and do not use bB)

Homozygous

Homo means the same.
Two of the same alleles.

BB means homozygous
dominant.

bb means homozygous
recessive.

Genotype

This word describes the
alleles which are
present for a particular
feature e.g. Bb.

You need to
be able to use
and explain
these terms.

Phenotype

This word describes
what can be physically
seen - black fur, blonde
hair, blue eyes.

Heterozygous

Hetero means different.
Two different alleles are
present.

Bb means heterozygous.

Inheritance part 2 – Genetic Inheritance

In a particular species of mouse, the **dominant allele** operates at a molecular level to produce proteins that make the fur black. The **recessive allele** codes for white fur.



Phenotype = black fur

Genotype = ?

At least **one dominant** allele (B) is present because the mouse has black fur.

The mouse could be **genotype** BB or Bb.

KEY

Use B and b to represent the dominant and recessive alleles.

B = allele for black fur

b = allele for white fur

Phenotype = white fur

Genotype = bb

We know there are **no dominant** alleles present because the fur is white.

A recessive allele is only expressed if two copies are present and therefore no dominant allele present.

Inheritance part 2 – Genetic Inheritance

Genetic cross

A **genetic cross** is a way of **modelling** the **potential outcome** from mating two parents where the **phenotype and genotype** are **usually known**. We use characteristics which are controlled by **a single gene** as it is easy to see the effect in the next generation and beyond.

A typical exam question might ask:

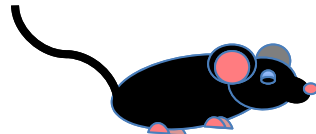
A female mouse which was **homozygous dominant** for black fur was mated with a male mouse which was **homozygous recessive** for white fur.

What are the possible outcomes for fur colour for their offspring?

What do we know?

Parent phenotype:

Parent genotype:



Black fur

BB



White fur

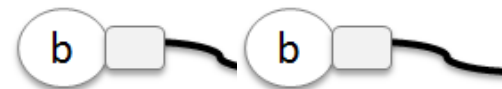
bb

What gametes will be present?

in each egg



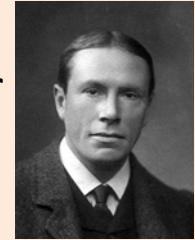
in each sperm



Inheritance part 2 – Genetic Inheritance

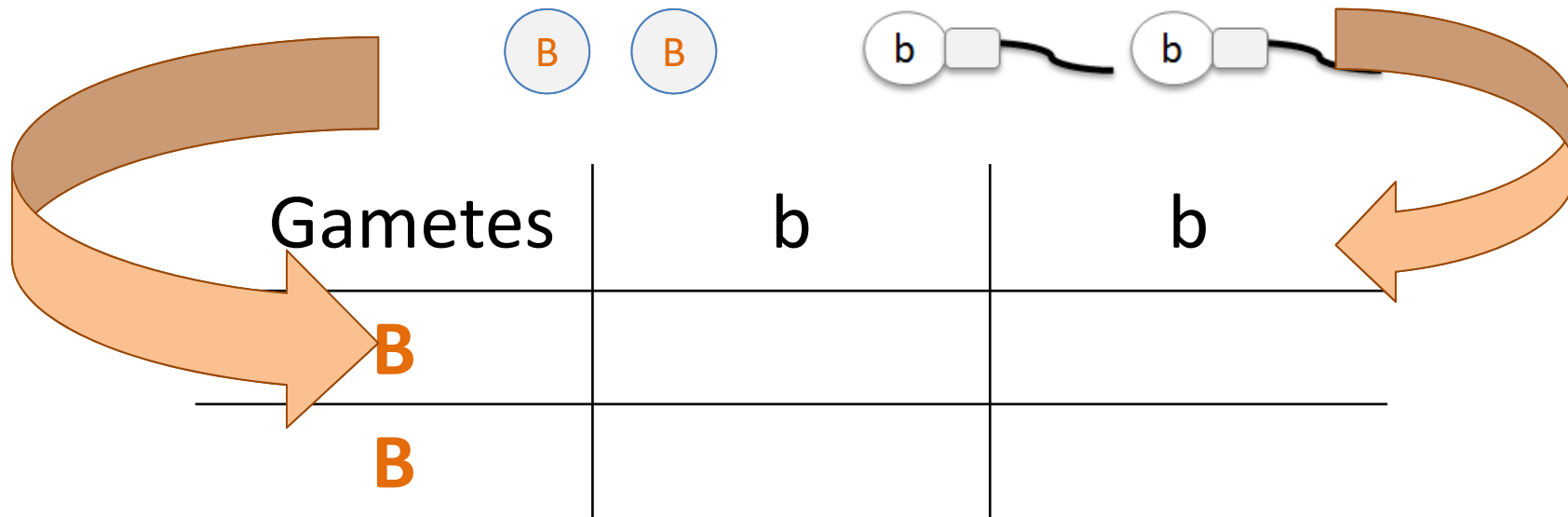
The Punnett Square

Reginald Punnett was a British geneticist who is most famous for creating the Punnett square diagram as a tool to predict the probability of genotypes in future offspring.



Parent phenotype: **Black fur**
Parent genotype: **BB**

White fur
bb



Inheritance part 2 – Genetic Inheritance

If an egg containing a dominant allele (B) is fertilised by a sperm with a recessive allele (b) then the result is an offspring with genotype Bb.

Gametes	b	b
B	Bb	Bb
B	Bb	Bb

The possible offspring all have the **genotype Bb**.
This is described as **heterozygous**.



The **phenotype** of all offspring from these parents will be **black fur** because one dominant allele is always present.

Inheritance part 2 – Genetic Inheritance

The **characteristic** of being a **tall** plant **or** a **short** pea plant is controlled by a **single gene**.

We will use the letter T to represent the gene for the purposes of a genetic diagram.

The allele which produces tall plants is **dominant** so we use **T**.

The allele for short plants is **recessive** so we use **t**.

Explain what would occur :

a) If two homozygous dominant plants were crossed.

The genotype for a homozygous tall plant is TT

Punnett square

<i>Gamete</i>	T	T
T	TT	TT
T	TT	TT

The genotype of **all** the future offspring will be TT and their phenotype will be **tall**. These parent plants will never produce short plants when crossed.

b) If two heterozygous plants were crossed.

The genotype for a heterozygous plant is Tt

Punnett square

<i>Gamete</i>	T	t
T	TT	Tt
t	Tt	tt

The **ratio** of **tall** plants to **short** plants likely to be produced is **3:1**.
In any four offspring, one would expect 1 homozygous dominant, 2 heterozygous and 1 homozygous recessive.

Inheritance part 2 – Genetic Inheritance

Explain what would occur :

c) If a homozygous dominant plant and a homozygous recessive plant were crossed.

The **genotype** for a homozygous dominant plant is TT.
The **genotype** for a homozygous recessive plant is tt.

Punnett square

<i>Gamete</i>	t	t
T	Tt	Tt
T	Tt	Tt

The genotype of **all** the future offspring will be Tt and their phenotype will be **tall**. All offspring will be heterozygous. The probability of getting a tall plant is described as 1 or 100%.

b) If two homozygous recessive plants were crossed.

The **genotype** for a homozygous recessive plant is tt.

Punnett square

<i>Gamete</i>	t	t
t	tt	tt
t	tt	tt

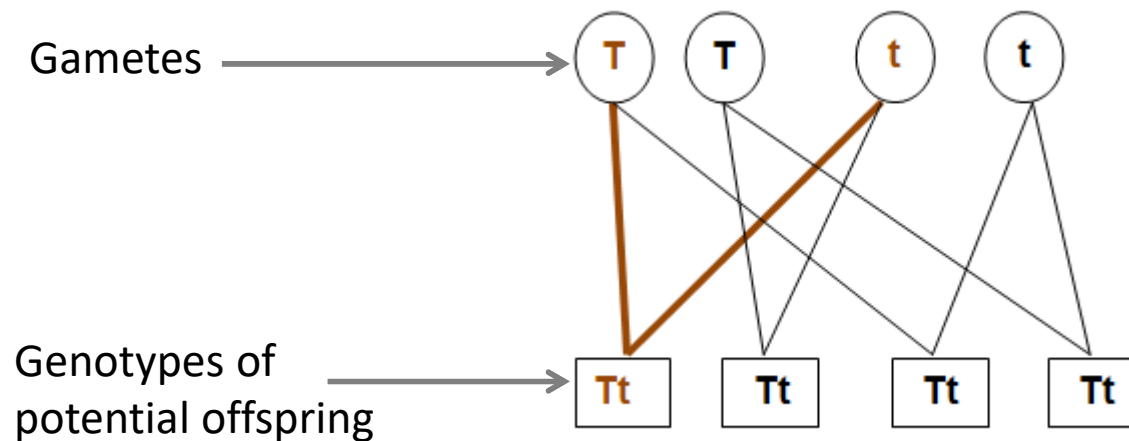
All future offspring will be **homozygous recessive**. Their **phenotype** will be **short**. These parents will **never** produce tall plants.

[video](#)

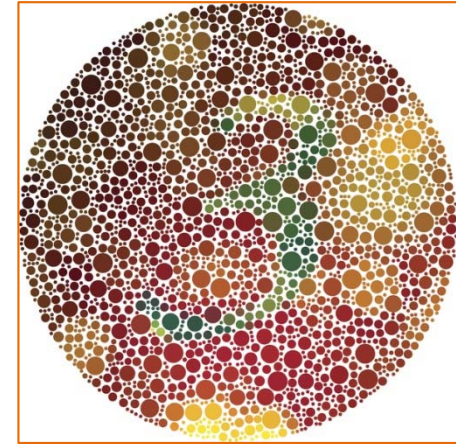
Inheritance part 2 – Genetic Inheritance

Not all exam questions use the Punnett square layout to find out possible genotypes. The basic principle is always the same.

A genetic diagram could also look like this:



Red green colour blindness in humans is also controlled by a single gene. It is a condition that a person is born with and is inherited from your parents. The gene is carried on the **X chromosome** and this means more **men** than women are affected.



The condition is caused by inheriting **two recessive alleles**.



Human eye colour is an example of when **multiple** genes affect the phenotype.

However, **most characteristics** are a result of **multiple genes** interacting, rather than a single gene. These are called polygenic features (poly = many genic= gene). We are able to describe a **phenotype** but **cannot write down a genotype** because more than one gene is involved.

Inheritance part 2 – Inherited disorders

Some **disorders** are inherited. They are caused by the **inheritance** of certain **alleles**.



A child born in India currently holds the record for the most digits with 7 digits on each hand and 10 on each foot.

What do you notice about this cat?

The cat has an extra digit.

Polydactyly is an inherited disorder caused by a **dominant allele**. This condition means **extra fingers or toes** are present.

As polydactyly is caused by a dominant allele, it can be passed on when only one parent has the disorder.



Inheritance part 2 – Inherited disorders

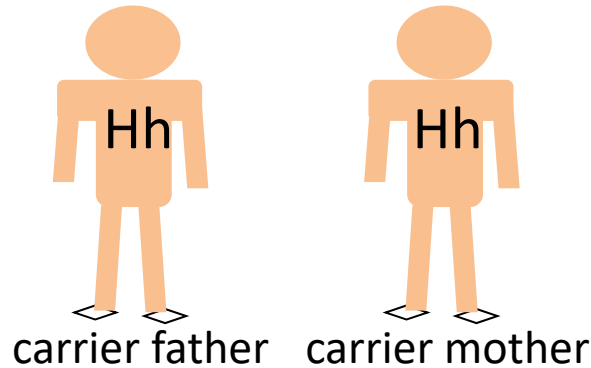
Cystic fibrosis is an inherited disorder caused by a **recessive** allele. It affects **cell membranes** across the body.

H = healthy allele
h = CF allele

1 person in every **25** in the UK is statistically likely to be a **carrier** of **cystic fibrosis** (CF).

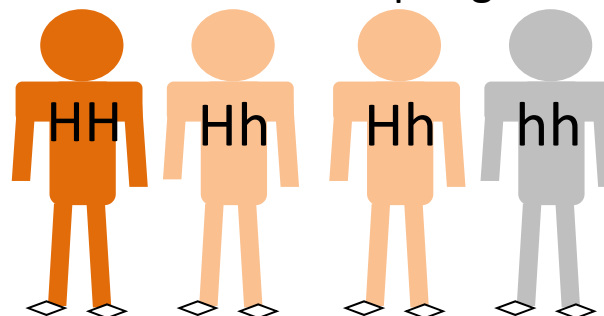
A **carrier** has **1 recessive allele** which codes for CF and **1 dominant allele** that codes for healthy cell membrane proteins.

A **carrier is healthy** and is unlikely to know they have the recessive allele unless they go through **screening** or have a child born with CF.



Gamete	H	h
H	HH	Hh
h	Hh	hh

Possible offspring



If **two carriers** become parents there is a **1 in 4 chance** of their child having **cystic fibrosis**. This can also be described as **25% or 0.25**.

There is a **3 in 4 chance** of having a **healthy child**. This can be described as **75% or 0.75**.

There is a **1 in 2** chance of having a **healthy child** who **carries the recessive allele**. This can also be described as **50% or 0.5**.

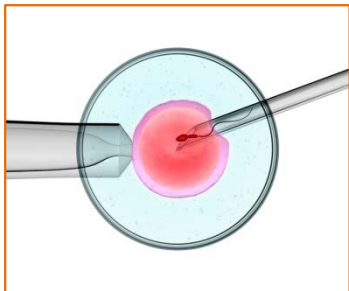
Inheritance part 2 – Inherited disorders

It is thought that 1 in 2500 babies born in the UK each year will have cystic fibrosis.

Screening of the embryo (or fetus) can be completed from 10 weeks of pregnancy.

There is a **risk** of miscarriage with this process.

A fine needle is passed through the abdomen into the uterus and a small piece of the developing placenta is removed. This is analysed to see if alleles that cause polydactyly, cystic fibrosis or other genetic disorders are present. This testing is usually only done when there is a family history of the disorder. **Screening is costly** and **not 100% reliable**.



Embryos can be screened for parents undergoing **IVF** (in vitro fertilisation). The egg and sperm are mixed and fertilisation occurs in a laboratory. Usually several embryos are produced. The embryos are then screened. Any embryos which have the **faulty alleles** are **not implanted** into the mother's uterus. Only healthy babies will be born.

Gene therapy may be suggested for some disorders. This means **replacing** the **faulty allele** with a normal allele. This can not be done to gametes so can only occur in an individual who already has inherited the disorder. Gene therapy is still being researched and is not always successful. It is also **expensive**. [Video](#)

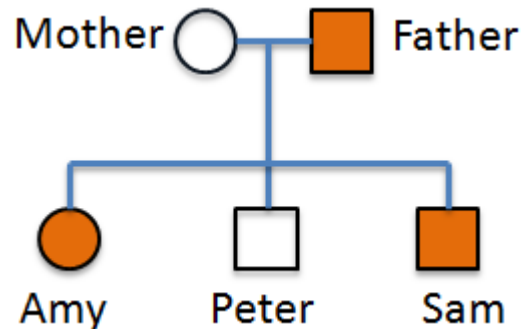
Gene therapy and embryo screening can be used to **alleviate suffering** but it is important to consider the **ethical issues** of these techniques.

Inheritance part 2 – Inherited disorders





A **family tree** can help to show how **genetic disorders** are inherited in a family. They can be used to work out the **probability** that a member of the family will **inherit** a disorder.

Read the **key** carefully to help you interpret a family tree accurately.

The family tree below shows the inheritance of a disorder caused by a **dominant** allele.



Key

-  Female without disorder
-  Female with disorder
-  Male without disorder
-  Male with disorder

What is the genotype of the mother? **Homozygous recessive**

What is the genotype of the father? **Heterozygous**

If the father was **homozygous dominant** then **all** the **offspring** would have the disorder. Peter does not have the disorder and is **homozygous recessive**.

Genetic testing can give answers to a question linked to science such as:

- What is the risk of my child having cystic fibrosis?

Genetic testing cannot give answers to questions linked to economic, social or ethical issues such as:

- *Should I have a genetic test because it may cause a miscarriage?*
- *If the embryo has a disorder should I have an abortion?*
- *Is it right that only healthy embryos are implanted in IVF?*
- *Should screening be available to everyone, not just those who can afford it or have the disorder in their family history?*
- *What if the test result is wrong?*

Different people will have different views.

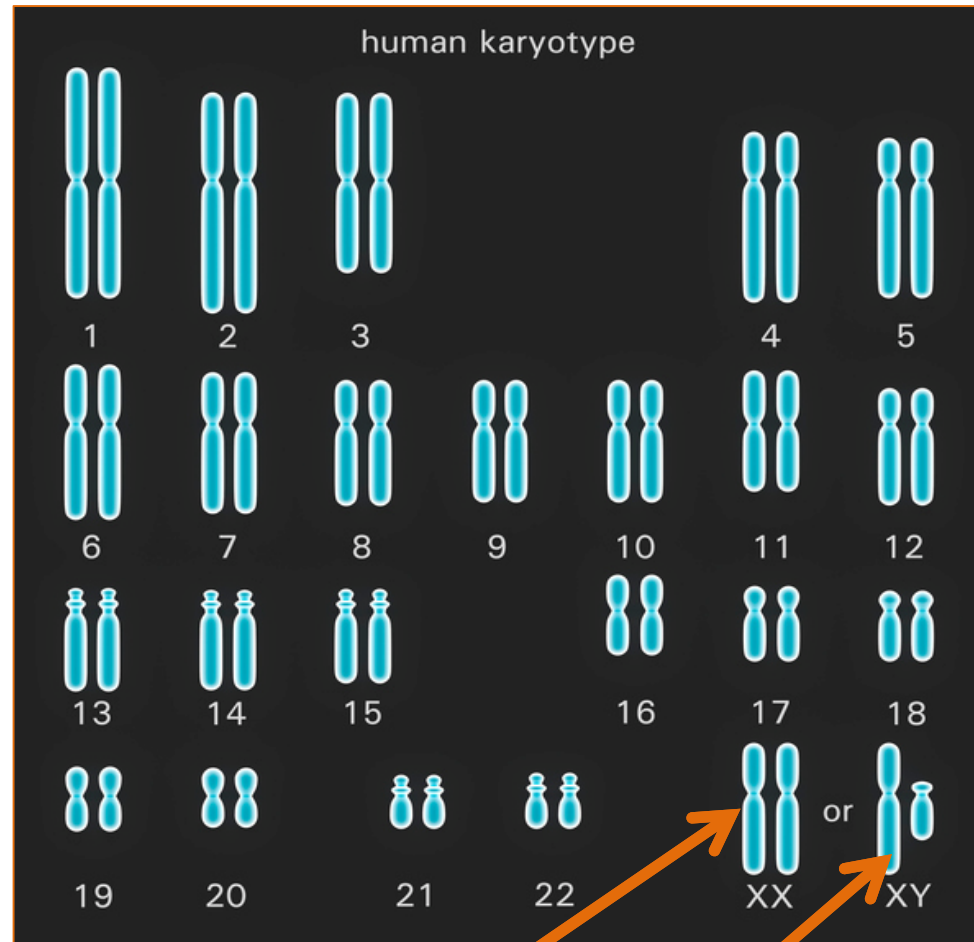
You will need to make informed decisions about the economic, social and ethical issues concerning embryo screening.

Inheritance part 2 – Sex determination

An ordinary **human body cell** contains **23 pairs** of chromosomes.
One chromosome of each pair comes from the egg and one from the sperm.

22 pairs of chromosomes control characteristics.

The **23rd pair** of chromosomes are called **sex chromosomes**. This pair carry the genes that determine sex. The sex chromosomes are **not identical** to each other and so are called **X and Y**.



In **females** the sex chromosomes are the same -**XX**

In **males** the sex chromosomes are different-**XY**

Inheritance part 2 – Sex determination

How is sex inherited?

The 23rd pair of chromosomes are responsible for determining the sex of a human.

The **Punnett square** is used to show the chances of an offspring being male or female.

A **woman** has the **genotype XX** and a **man** has the **genotype XY**.

Gametes	X	X
X	XX	XX
Y	XY	XY

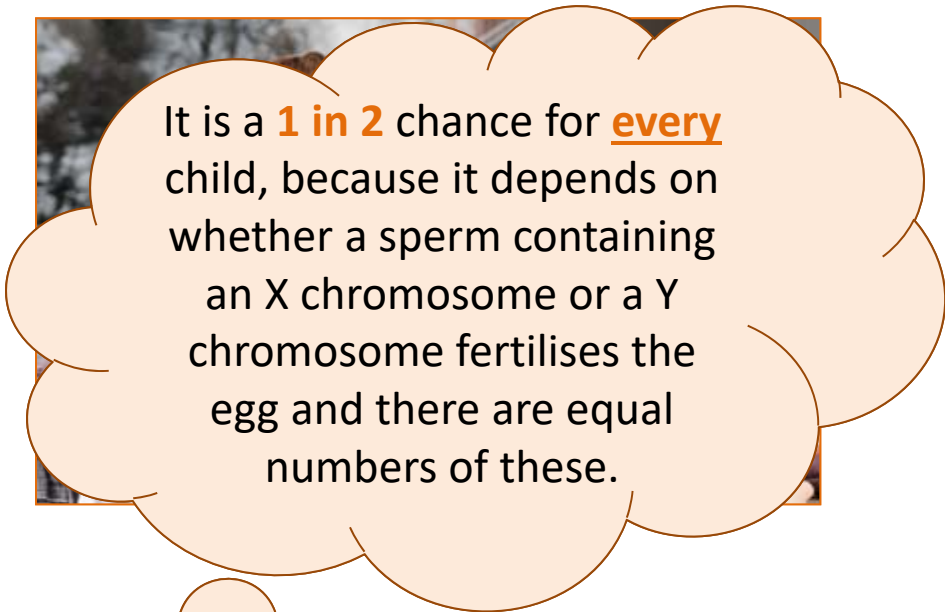
There is a **1 in 2** chance of the offspring being male or female.

This can also be described as a ratio of **1:1**, **50:50** or **50%** or **0.5** of being male or female.

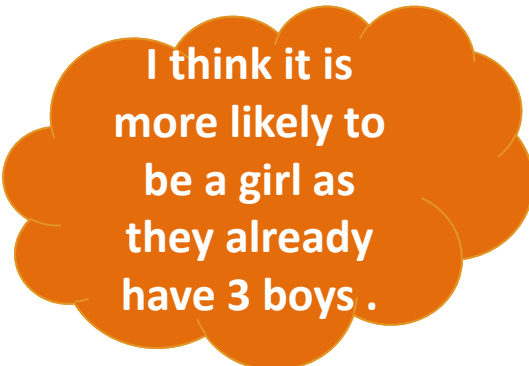
Inheritance part 2 – Sex determination

A man and woman have three children – all boys. The woman is pregnant with their fourth child.


What is the chance of the next child being a girl?



It is a **1 in 2** chance for every child, because it depends on whether a sperm containing an X chromosome or a Y chromosome fertilises the egg and there are equal numbers of these.



I think it is more likely to be a girl as they already have 3 boys .



I think there is **more chance** of the new baby being a boy because they **have 3 boys already**.



Inheritance part 3 – Variation

Variation means that individuals in a population show **differences** in characteristics. Population is the number of one species in a habitat. The **genome** and its **interaction** with **the environment** influence the development of a **phenotype** in an organism.



Variation within a population of a species is usually extensive.

Causes of variation may be:



❑ **differences** in the **genes** individuals have inherited due to mutation, meiosis and sexual reproduction.

❑ **differences** in the **environmental** conditions in which individuals have developed.

❑ or a **combination** of both genetic and environmental causes.

Inheritance part 3 – Variation

Identical twins are produced from the same egg and sperm. They show very little or no genetic variation. One twin has a scar and this is environmental variation.



Factors which are **influenced** by **both genetic and environmental** variation are:
skin colour (can be tanned),
weight (can be affected by food availability),
being athletic.

Human phenotypes which are caused by **genetic variation** are:

- Eye colour
- Natural hair colour
- Nose shape
- Ear lobe shape
- Blood group

Human phenotypes influenced by the **environment** are:

- Hair length
- Accents
- Tattoos
- Scars
- Language spoken

Inheritance part 3 – Variation

All **genetic variations** arise from **mutations**.

A mutation is a change in the DNA sequence of an organism. **Mutations** are occurring **continuously** during cell division. **Most** mutations **do not alter** the **phenotype**. Some will influence the phenotype, but very few mutations actually determine the phenotype.

If a **new phenotype** is **suited** to an environmental change, it can **lead** to a relatively **rapid change** in the **species**. An example is seen below:

The peppered moth is camouflaged against tree bark. Birds cannot see it easily. The peppered moth lives long enough to breed and pass on its genetic information. This phenotype is found mainly in the countryside now.



During the industrial revolution, tree bark and buildings in cities and towns became blackened. The peppered moth became easy prey for the birds. A mutation occurred which changed the colour of the moth to black. The black phenotype is now found in large numbers in cities.

Inheritance part 3 – Evolution

Evolution is a **change** in the inherited characteristics of a population **over time**. This occurs through a process called **natural selection** which may result in a new species being formed.

The **theory of evolution** by natural selection states that all living things have evolved from **simple life forms** that developed over **3 billion years ago**.

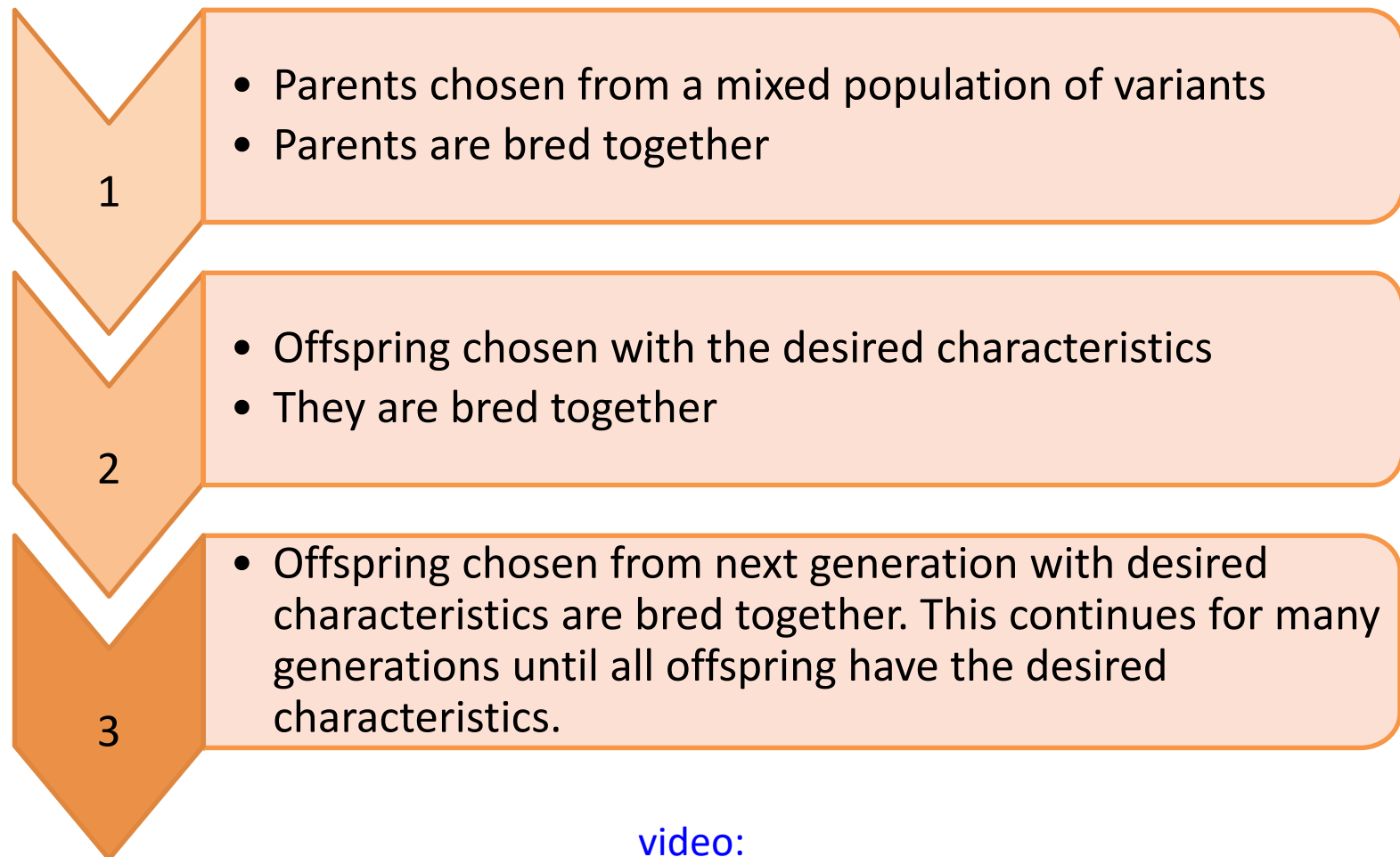
Species is defined as a group of similar looking individuals which can breed and produce fertile offspring.



The **differences** in a population gives some individuals an **advantage**. An individual may be more resistant to a disease, or better camouflaged, or stronger, faster or better able to attract a mate. This individual is more likely to **survive for longer** and be able to breed to **pass on** desirable genes. Nature is selecting the individual with the **phenotypes** most suited to survival. This is called **natural selection**.

Inheritance part 3 – Selective breeding

Selective breeding is also called artificial selection. Selective breeding is where **humans breed plants** and **animals** for particular **chosen genetic characteristics** which are either **useful** or **for appearance**.



[video:](#)

Inheritance part 3 – Selective breeding



To produce plants with large or unusual flower shapes or colours



To produce animals with more meat or milk

Why do humans use selective breeding?

To produce crops with better yields or disease resistance



To produce domestic dogs with a gentle nature



Inheritance part 3 – Selective breeding

Selective breeding reduces variation and can lead to “inbreeding”.

The population will have the same strengths but also the same weaknesses. **Infectious diseases** are more likely to **spread** through a genetically similar population because of this vulnerability.

Some breeds are **particularly prone to disease** or **inherited defects** as a result of **inbreeding**.

The standards set for a **pedigree Pug** are :

- Large dark eyes
- Ears must be small and thin
- Muzzle must be short and square.
- Head is large with no indentations.
- Wrinkles must be large and deep.

In order to maintain this standard breeders often **mate closely related dogs** with good characteristics together.

A pedigree pug can be a result of **5-6 generations of inbreeding**.



Often puppies which do not meet the standards are killed illegally.

Many pugs will go on to develop

painful crippling conditions:

- Chronic hip/ knee joint problems
- Severe breathing issues due to a deformed nose and short trachea
- Chronic eye problems due to the wrinkles around the eye folding in and scratching the cornea.
- Skin irritation due to bacteria infections in the deep wrinkles.

Genetic engineering is a process which involves **modifying the genome** of an organism by **introducing** a **gene** from **another organism** to give a desired characteristic.



Plant crops have been genetically engineered to be **resistant** to diseases, or be resistant to insect attack, resistant to herbicides or to produce bigger better fruits. These are known as **genetically modified** or **GM** crops. GM crops usually show an **increased yield**.

A **herbicide** is a chemical which **kills plants** (also called a weed-killer). If a crop plant is resistant to herbicide, the farmer can spray herbicide to kill all other plants in the field without affecting the crop.

Plants resistant to insect attack have been **modified** to produce their own pesticide.

All our food from plants and animals contains genes. A plant cell contains about 30 000 genes. GM involves adding about 1-10 extra genes. [Video:](#)

Inheritance part 3 – Genetic Engineering

In **genetic engineering**, **genes from** the chromosomes of **humans** and other organisms are **cut out** of the **DNA** using **enzymes**. The **genes** are then **transferred** to the **cells of the organism** to be genetically modified.

A bacteria called *Bacillus thuringiensis* lives in the soil. It produces a toxin that kills a variety of common insect pests.

The **gene** which produces the toxin in the bacteria has been **isolated** and **transferred** to the crop **plant's genome**.

The crop **plant** now **produces** the **toxin** and insects which eat it are poisoned. This means there are **less insects** to eat the crop and so a **bigger yield** is produced. The farmer does not have to spray the crop with pesticide either so it makes **economic** sense as well.



Plant **not** genetically modified with the toxin producing gene.

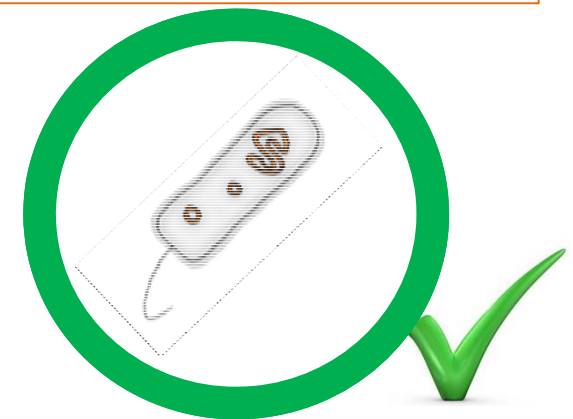
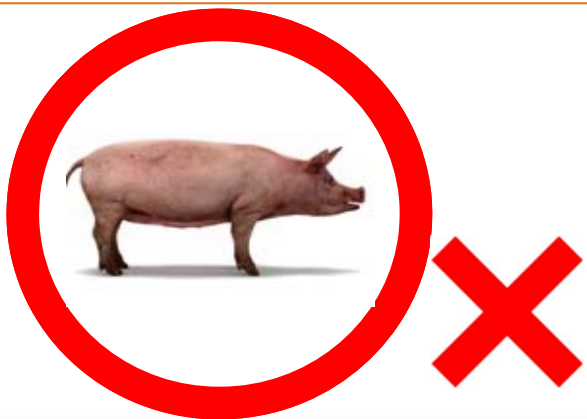


Plant which **is** **genetically modified** with the toxin producing gene.

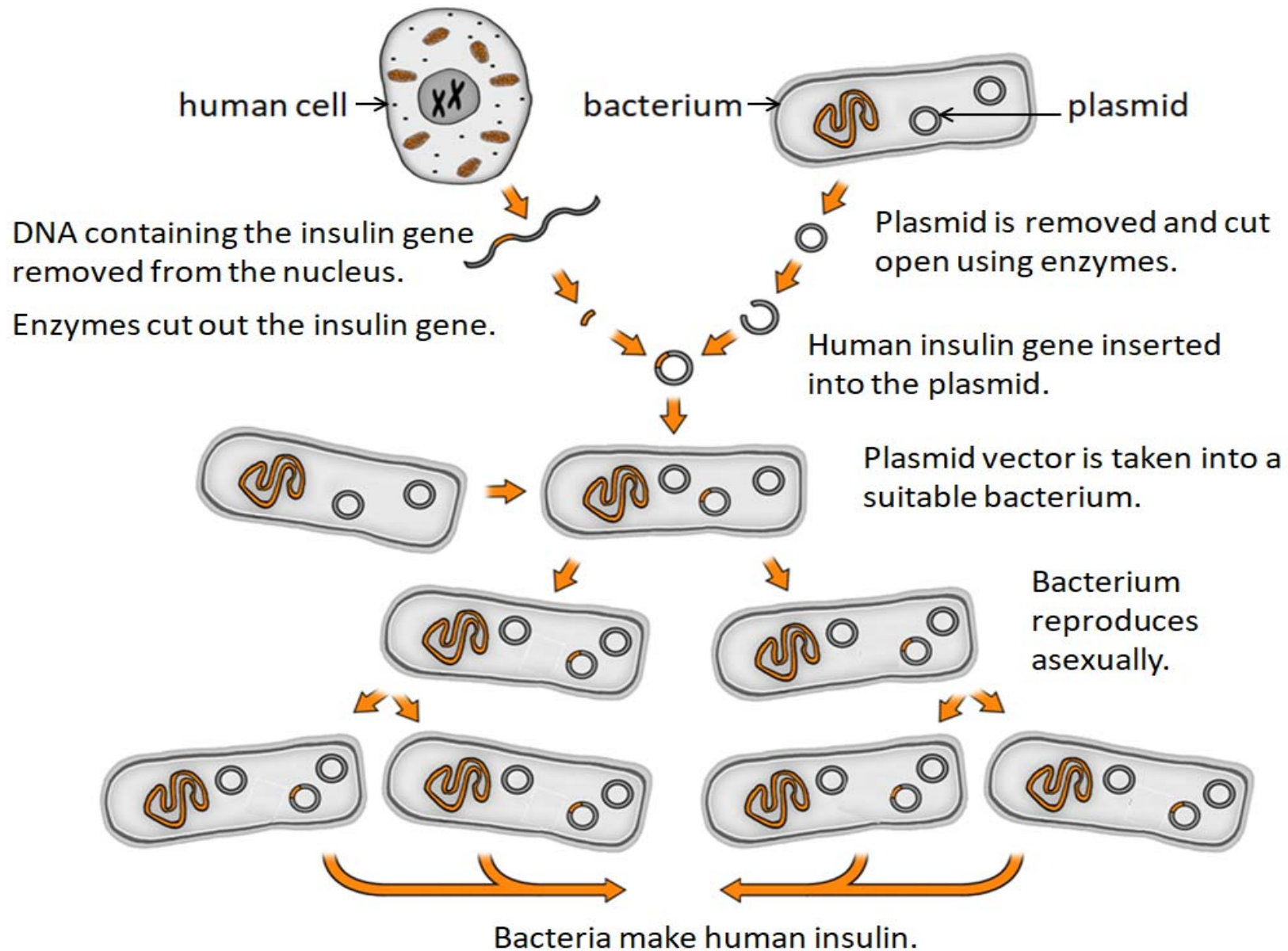
Insulin is a naturally occurring hormone produced in the pancreas. In diabetes, a fault in the pancreas means insulin is not made effectively.

Diabetics can inject themselves with insulin. The insulin for injections used to be collected from a pig's pancreas. Some diabetics had severe allergic reactions to pig insulin because it was not the same as human insulin.

Genetic engineering is now used to **produce 'human insulin'** from **genetically modified bacteria**. It is cheaper, safer and more ethically acceptable than using specially bred pigs which had to be killed.



Inheritance part 3 – Genetic Engineering HT only



Genetic engineering is a new technology that can be **very useful** but there are also **ethical issues** to consider.

Some benefits of Genetic Modification

Bigger crop yields so more food can be produced. This might solve the world food shortage in the future.

Human insulin can be **mass produced** by **genetically engineered bacteria** meaning pigs do not have to be slaughtered and costs are reduced. **Allergic reactions** are reduced.

Medical research is exploring the possibility of **genetic modification** to **overcome** some **inherited disorders**.

Some concerns regarding Genetic modification

We **do not know the effect** of growing **GM crops** on nearby **populations of wild flowers** and **insects**.

GM crops which **produce their own pesticide** may **kill insects** which are needed to **pollinate** other plants.

Some people feel that the **effects of eating GM crops** on **human health** have not been fully explored.

Should humans be inserting genes from one organism into a totally different organism?

[video](#)

LearnIT! KnowIT!

Inheritance, variation & evolution Part 4

- Theory of evolution (biology only)
- Speciation (biology only)
- Understanding of genetics (biology only)
- Evidence for evolution
- Fossils
- Extinction
- Resistant bacteria
- Classification of living organisms



Inheritance part 4 – Evidence for evolution

The **theory of evolution** by natural selection is **now widely accepted**.

Evidence for Darwin's theory is now **available** as it has been shown that characteristics are passed on to offspring in genes.

Darwin, Mendel, Wallace and many more scientists had their credibility questioned in their lifetimes. We can now see their work was **pioneering** and valuable.

Fossils now provide **proof** for **evolution** showing how organisms changed gradually over millions of years.



Our understanding of evolution has also been helped by the **study of antibiotic resistance in bacteria**. Bacteria multiply quickly in a short space of time. Advantageous mutations are rapidly spreading throughout the population of bacteria. We **can see evolution** through natural selection occur and are able to do research.

Inheritance part 4 – Fossils

Fossils are the 'remains' of ancient organisms from millions of years ago, which are found in rocks. Scientists can learn how much or how little organisms have changed over time. This is called the fossil record.

Fossils may be formed:

- From parts of organisms that have not yet decayed. Usually because one or more of the conditions needed for decay is not present (oxygen, water or warmth).



- As preserved traces of organisms such as footprints, burrows and rootlet traces.



- When parts of the organism are replaced by minerals as they decay.



The **fossil record** is **incomplete** for many reasons:

1. **Early life forms** were often **soft bodied** and so **few traces** remain.
2. Most organisms **do not** become **fossilised** as **conditions** are **rare**.
3. We are **still discovering fossils** which give us more information.
4. **Traces** are often **destroyed** by **geological activity** like earthquakes, volcanic eruptions, formation of mountain ranges and erosion.

This is why scientists can **never be certain** about **how life began** on Earth.



The **fossil record** of the **horse** gives us a good **idea** of how the modern horse has **evolved** from a much smaller, dog like animal.

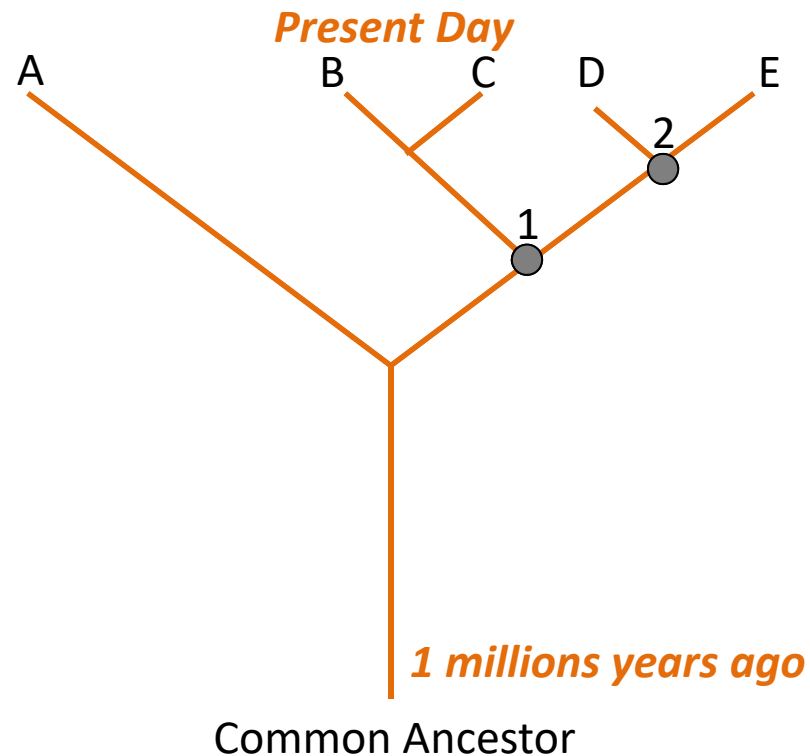
Inheritance part 4 – Fossils

Evolutionary tree diagrams are used to represent the **relationship between** various **species** based on the similarity and differences in their physical and genetic characteristics. The pattern of branching reflects how scientists think the species has evolved from a common ancestor. **Current classification data** is used for living organisms and **fossil data** for **extinct** organisms.

Species A – E all have the same common ancestor.

B and C, D and E share the same ancestor.

A is the present day species least closely related to all other species.



Species A and species 1 evolved from the common ancestor following speciation.

Species 1 was the ancestral species of species B,C and 2.

Species 2 gave rise to species D and E.

Extinction occurs when there are no remaining individuals of a species still alive.

The Dodo is a famous example of an extinct animal. It lived in Mauritius and was a flightless bird. It was first thought the bird was hunted for food to extinction by sailors. That is thought not to be the case now.

It is thought that the animals the sailors brought to the island such as rats, cats and dogs liked the Dodo eggs and so reduced the Dodo numbers by eating the eggs and offspring.

Eventually, around 1660, there were no Dodos left.

No one understood the **concept of extinction** until much later in history and so there are no complete specimens of the Dodo in museums. Most exhibits are made from several individuals birds.



Inheritance part 4 - Extinction

A change in food availability and the inability to find an alternative source

Climate change:
change in rainfall,
destruction of
habitat, change of
temperature

**Creation of a new
species by
speciation that is
better adapted to
the environment**

**Why do species
become extinct?**

**Failure to
reproduce
successfully**

A new predator or
disease that a
species cannot
defend itself from

**Human activity:
Road/house
building, mining,
pollution, poaching,
deforestation**

Bacteria evolve rapidly as they can **reproduce** at a **rapid rate**.

Mutation of bacterial pathogens produces **new strains**. Some of these strains may be **resistant** to **antibiotics** and are not killed. They **survive** and **reproduce**, so the population of the **resistant strain rises**. The resistant strain will **spread** because people are **not immune** to it and there is **no effective treatment**.

MRSA is a strain of bacteria which is **resistant** to several **antibiotics**.



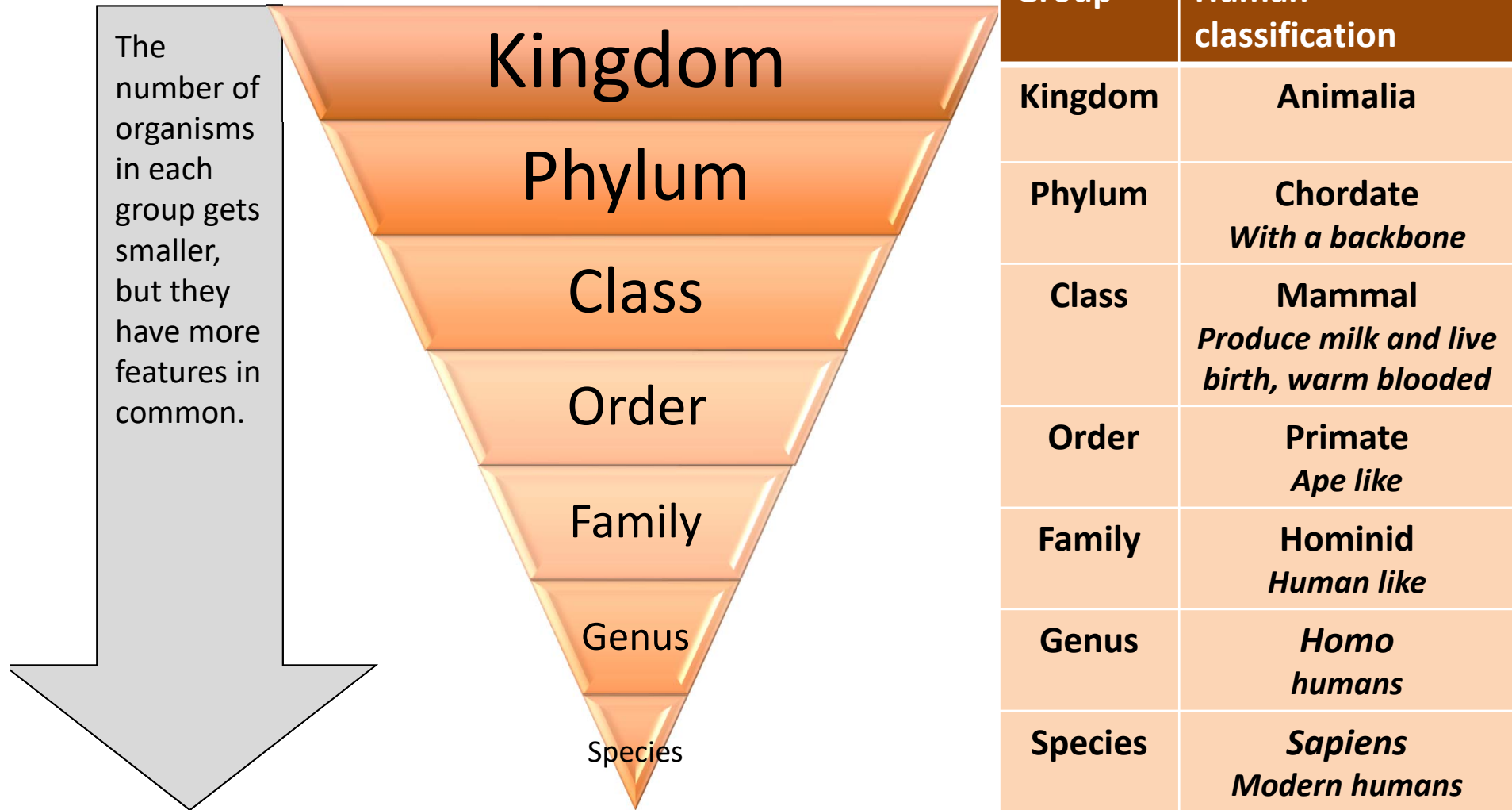
The development of **new antibiotics** is very **expensive** and **slow**. It can take up to 10 years, once an antibiotic has been found, to bring it to market.

Actions to reduce the rate of development of antibiotic resistant strains are:

- Doctors should **not prescribe antibiotics** for non serious or **viral infections**.
- Patients must **complete the course** of antibiotics to ensure all bacteria are killed and **none survive** to mutate and become resistant.
- **Restrict** the use of antibiotics **in agriculture**. As animals live close together, farmers often use antibiotics in animal feed to **prevent** bacterial infections rather than to **treat** them.

Inheritance part 4 – Classification

Living things have been traditionally classified into groups, depending on the structures and characteristics they share, using a system designed by Swedish scientist Carl Linnaeus.



Inheritance part 4 –Classification

Linnaeus recognised there was a problem in terms of naming organisms. Scientists spoke different languages and called the same organisms something different. He developed the **binomial naming system**. Each organism has a **two word name** – the **genus** and the **species**.

These are written in **italics** or underlined. The genus has a capital letter and the species is a lower case letter.

Here are some organisms, their **Latin** name (Genus and species) and common name.

Video:

Scientific name	Common name
<i>Felis leo</i>	Lion
<i>Felis domesticus</i>	Domestic cat
<i>Canis lupus</i>	Wolf
<i>Canis familiaris</i>	Domestic dog



Inheritance part 4 – Classification

As **evidence** of **internal structures** became more developed due to improvements in **microscopes** and the understanding of **biochemical processes** progressed, **new models** of classification were proposed.



In 1977, **Carl Woese** used **evidence** from chemical analysis of RNA to put forward a **three domain system**.

Domain name	Description
archaea	Primitive bacteria usually living in extreme places
bacteria	True bacteria
eukaryota	Includes protists, fungi, plants and animals