a

Compare meiosis and mitosis.

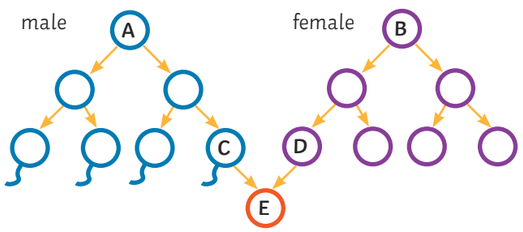
b

What are the names of the male and female gametes...

in plants? _____
in animals? _____

What is asexual reproduction?

c



How many chromosomes are in cell B? ____
What is the process called that produces cell C from cell A? _____
How many chromosomes are in cell C? ____
How many chromosomes are in cell E? ____
What is the process that produces cell E called? _____

What happens to cell E next?

d

Define the following terms.
genome:

gamete:

chromosome:

gene:

allele:

dominant:

recessive:

homozygous:

heterozygous:

genotype:

phenotype:

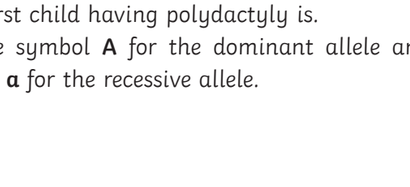
e

Explain why it's important for us to study the human genome.

f

Describe the structure of DNA.

Label the diagram below with the following keywords: cell, nucleus, chromosome, gene, DNA.



How many pairs of chromosomes does an ordinary human body cell contain?

g

Give an example of a characteristic caused by a single gene.

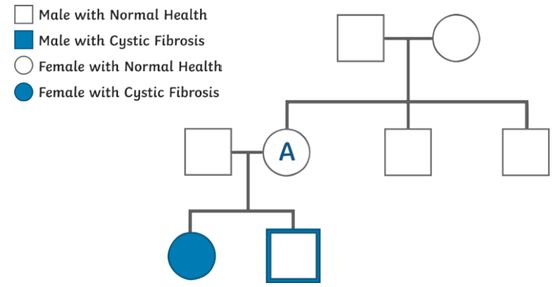
What causes most characteristics?

h

A woman with polydactyly is heterozygous for the polydactyly allele. The woman marries a man who does not have polydactyly. Draw a punnet square diagram to help you explain what the probability of their first child having polydactyly is.
Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

i

The diagram shows the inheritance of cystic fibrosis in one family.



Use the symbol **N** for the allele for normal health and the symbol **n** for the allele for cystic fibrosis.

What is the genotype for person A?

How do you know?

Person A is pregnant with their third child. Use a genetic diagram to explain the probability that their child will have cystic fibrosis.

a

Which sex chromosomes do human females carry?

Which sex chromosomes do human males carry?

Use a punnet square to show the inheritance of sex.

What is the chance that a pregnancy produces a boy?

b

Evaluate the process of embryo screening.

c

Give an example of variation between individuals that is affected by genetics (genetic variation).

Give an example of variation between individuals that is affected by the environment (environmental variation).

Give an example of variation between individuals that is affected by a combination of genetic and environmental variation.

d

What causes new variants in the genes of a species?

Explain what effects this could have on the phenotype of an organism.

e

What is evolution?

When did the first simple life forms develop?

What evidence do we have for evolution?

f

The anole lizards are found on the Caribbean islands. There are around 150 species of the lizard which evolved from a single species that colonised the islands.

Explain how two species of the anole lizard, found on different Caribbean islands, could have evolved from a common ancestor.

g

What is selective breeding?

h

Describe the process that farmers use to ensure they have varieties of cow that produce lots of milk.

Give four other examples of characteristics that might be chosen for selective breeding in plants or animals.

1.

2.

3.

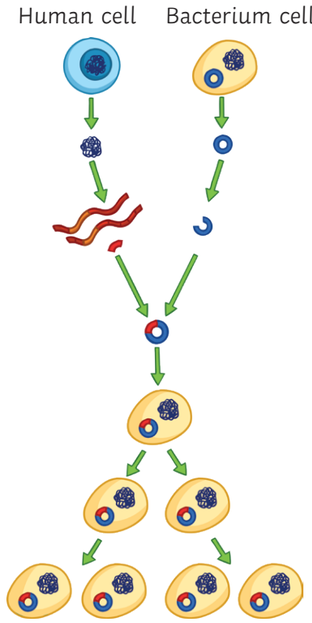
4.

i

Explain the benefits and risks of selective breeding.

a

Annotate the diagram to describe the process of genetic engineering.



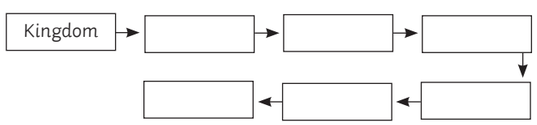
b

What are GM crops?

What are the benefits of GM crops?

c

Complete the boxes to show the way Linnaeus classified living things.



How are organisms named?

d

What are the concerns about genetic engineering?

e

What are fossils?

Give three ways fossils may be formed.

1.

2.

3.

f

What can we learn from fossils?

Why can scientists not be certain about how life began on Earth?

g

Chemical analysis led Carl Woese to adapt the system we used for classification. Describe how his system divides organisms.

h

This is a fossil of the prehistoric bird Archaeopteryx. Archaeopteryx is now extinct. Give some factors that could contribute to a species extinction.

i

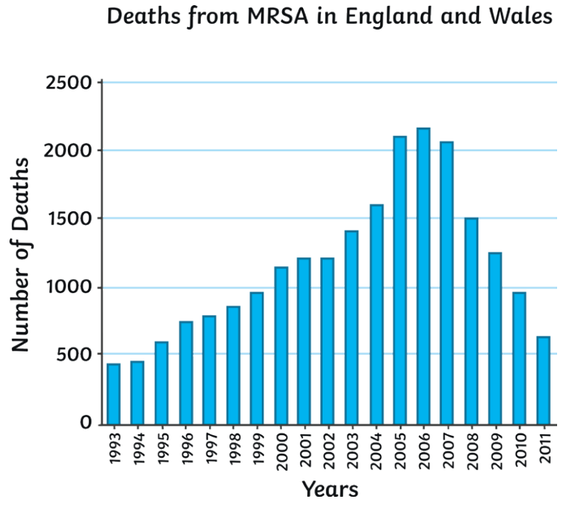
Why can bacteria evolve rapidly?

Explain how bacteria can become resistant to antibiotics.

Why is the development of new antibiotics not likely to keep up with new strains of bacteria?

j

MRSA is resistant to antibiotics. The graph shows how the number of MRSA deaths has changed over the last 15 years.



Describe the trend in the data.

Explain what measures were put in place in England and Wales in 2006 that caused the trend in the data shown on the graph.

a

Compare meiosis and mitosis.

Meiosis includes two nuclear divisions which produce 4 non-identical daughter cells. Each daughter cell contains one set of chromosomes.

Mitosis includes one nuclear division that produces 2 identical daughter cells. Each daughter cell contains two full sets of chromosomes.

b

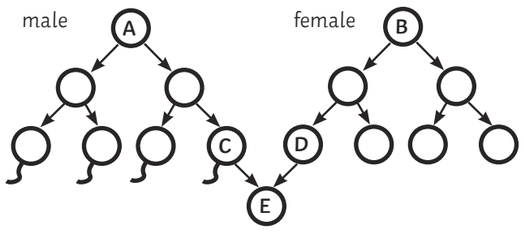
What are the names of the male and female gametes...

in plants? **pollen cells and egg cells**
in animals? **sperm cells and egg cells**

What is asexual reproduction?

When there is only one parent and no fusion of gametes. Only mitosis is involved, so there is no mixing of genetic information. The offspring are genetically identical (clones).

c



How many chromosomes are in cell B? **46**
What is the process called that produces cell C from cell A? **meiosis**
How many chromosomes are in cell C? **23**
How many chromosomes are in cell E? **46**
What is the process that produces cell E called? **fertilisation**

What happens to cell E next?

It divides by mitosis and the number of cells increases. These differentiate as the embryo develops.

d

Define the following terms.

genome:
The entire genetic material of an organism.
gamete:
The sex cells (sperm and egg cells), which contain one set of genetic information.
chromosome:
Found in the nucleus, they are made from long DNA molecules and passed from parent to offspring.
gene:
A section of DNA that codes for a particular sequence of amino acids, to make a specific protein.
allele:
A different form or variant of a gene.
dominant:
Controls the characteristic, even if it is only present on one chromosome.
recessive:
Only controls the physical characteristic if it is present on both chromosomes.
homozygous:
Two identical alleles for a characteristic.
heterozygous:
Different alleles for a characteristic.
genotype:
The alleles present in an individual for a particular characteristic.
phenotype:
The physical appearance of an individual for a particular characteristic.

e

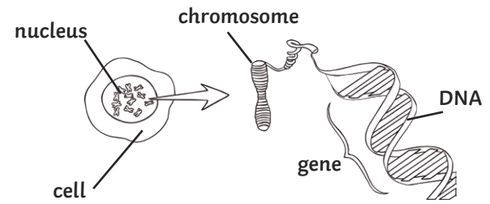
Explain why it's important for us to study the human genome.

It helps us to search for genes that are linked to different types of diseases. Understanding inherited disorders gives us more chance of repairing the genes or producing successful medicines. It also helps us to trace the migration patterns of humans from the past and develop a greater understanding of human evolution.

f

Describe the structure of DNA.
DNA is a polymer made up of two strands of nucleotides that are twisted to form a double helix.

Label the diagram below with the following keywords: cell, nucleus, chromosome, gene, DNA.



How many pairs of chromosomes does an ordinary human body cell contain?
23

g

Give an example of a characteristic caused by a single gene.
Some examples: eye colour, red-green colour blindness, polydactyly, cystic fibrosis, tongue rolling, attached earlobes, freckles, dimples, fur colour in mice.

What causes most characteristics?
multiple genes interacting

h

A woman with polydactyly is heterozygous for the polydactyly allele. The woman marries a man who does not have polydactyly. Draw a punnet square diagram to help you explain what the probability of their first child having polydactyly is.
Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

dad \ mum		A	a
	a	Aa	aa
	a	Aa	aa

1 mark for correct parental genotypes.

1 for complete punnet square.

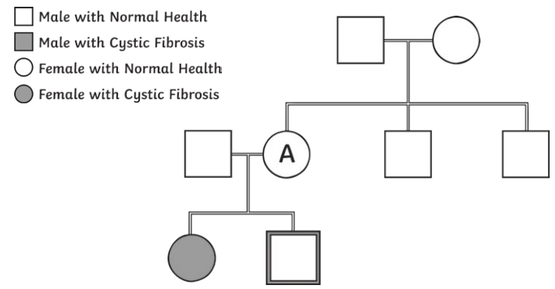
1 for highlighting the offspring with polydactyly.

1 for the correct probability.

50% / $\frac{1}{2}$ offspring have polydactyly

i

The diagram shows the inheritance of cystic fibrosis in one family.



Use the symbol **N** for the allele for normal health and the symbol **n** for the allele for cystic fibrosis.

What is the genotype for person A?
Nn

How do you know?
They don't have cystic fibrosis, but they have passed on a cystic fibrosis allele to their daughter so they must carry the allele. They don't suffer from the disease themselves, so they must carry the normal, dominant allele. They are therefore heterozygous.

Person A is pregnant with their third child. Use a genetic diagram to explain the probability that their child will have cystic fibrosis.

dad \ mum		N	n
	N	NN	Nn
	n	Nn	nn

1 mark for correct parental genotypes.

1 for complete punnet square.

1 for highlighting the genotype with cystic fibrosis.

1 for the correct probability.

25% / $\frac{1}{4}$ / 0.25 / 1 in 4 offspring have cystic fibrosis.

a

Which sex chromosomes do human females carry?
XX

Which sex chromosomes do human males carry?
XY

Use a punnet square to show the inheritance of sex.

		mum: X	mum: X
dad: X		XX	XX
dad: Y		XY	XY

What is the chance that a pregnancy produces a boy?
50% / $\frac{1}{2}$

b

Evaluate the process of embryo screening.

Student responses may cover the following:

- **The process used to collect cells has a risk of miscarriage, so sometimes a healthy foetus will be miscarried.**
- **Sometimes the tests can give a false-positive or false-negative result.**
- **Screening allows people to make choices about whether they have a family or not.**
- **The decision to terminate a pregnancy is a very difficult one that will vary based on the individual's views and religious beliefs.**
- **Some people decide not to have the screening to avoid making these decisions.**
- **Screening can allow a family to prepare for a child with an inherited disorder.**
- **Screening is expensive, so is not currently offered to everyone.**
- **However, if a child is born with a genetic disorder, it can be expensive for society to provide the healthcare and support needed.**
- **Some people worry that genetic screening may lead to 'designer babies'.**

c

Give an example of variation between individuals that is affected by genetics (genetic variation).
Some examples: eye colour, dimples, inherited disease, natural hair colour, earlobes, natural skin colour, gender.

Give an example of variation between individuals that is affected by the environment (environmental variation).
Some examples: language, religion, scars, fillings, ability to play an instrument.

Give an example of variation between individuals that is affected by a combination of genetic and environmental variation.
Some examples: height, weight, IQ.

d

What causes new variants in the genes of a species?
Mutations/changes to the DNA code.

Explain what effects this could have on the phenotype of an organism.
It might have no effect at all, this is most common.
It might be harmful and mean the individual is less likely to survive.
It might produce a phenotype that is beneficial, making the individual better suited to the environment - this is rare.

e

What is evolution?
A change in the inherited characteristics of a population over time through a process of natural selection. This may result in the formation of a new species.

When did the first simple life forms develop?
3 billion years ago

What evidence do we have for evolution?
1. **fossils**
2. **antibiotic resistance in bacteria**

f

The anole lizards are found on the Caribbean islands. There are around 150 species of the lizard which evolved from a single species that colonised the islands.

Explain how two species of the anole lizard, found on different Caribbean islands, could have evolved from a common ancestor.

The ancestral populations of anole lizards were separated (geographical isolation), because they were on different islands.

There was genetic variation in each population.

Each environment would have had different environmental conditions.

The individuals in each population that were better adapted to those conditions would survive and reproduce/natural selection occurs.

The alleles for the beneficial phenotypes were passed to their offspring.

Eventually the two populations would be so different they could not successfully interbreed.

g

What is selective breeding?

The process by which humans breed plants and animals for particular genetic characteristics.

h

Describe the process that farmers use to ensure they have varieties of cow that produce lots of milk.

Parents that have the desired characteristic/produce lots of milk are chosen from the herd.

Only these parents are bred together.

From their offspring, only those that produce the most milk will be bred together.

This is repeated over many generations, until all of the offspring show the desired characteristic.

Give four other examples of characteristics that might be chosen for selective breeding in plants or animals.

1. **Disease resistance in plants.**
2. **Animals that produce more meat.**
3. **Domestic animals with a gentle nature.**
4. **Large or unusual flowers.**

i

Explain the benefits and risks of selective breeding.

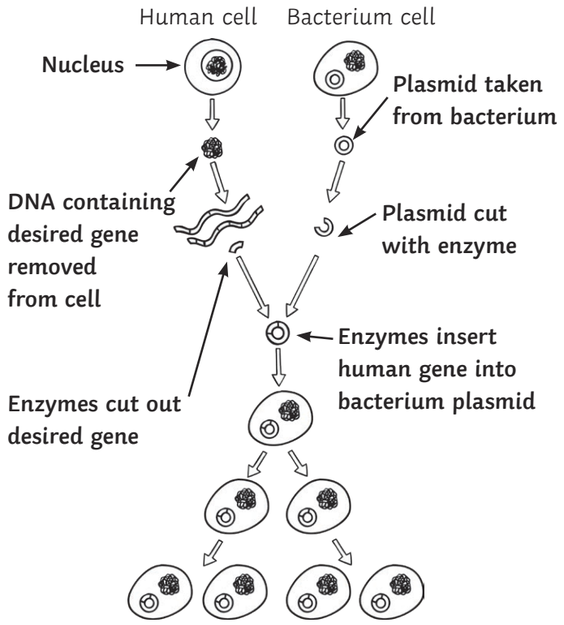
Selective breeding produces organisms that are useful to us and has improved our food production.

It reduces the number of alleles in a population, this reduces the variation of a species. If the environment then changes the organisms may not be able to cope with the change and may die out.

It can lead to inbreeding which can make a breed particularly prone to disease or inherited defects. This could cause a whole herd or crop to be affected by a disease all at once.

a

Annotate the diagram to describe the process of genetic engineering.



Bacteria reproduce rapidly. This creates bacteria with the new characteristic

b

What are GM crops?
Crops that have had their genes modified by genetic engineering.

What are the benefits of GM crops?
They can be resistant to insect attack, herbicides or disease.
They have increased yields.
They can be engineered to grow in more difficult climates.

c

Complete the boxes to show the way Linnaeus classified living things.

Kingdom → **phylum** → **class** → **order** → **family** ← **genius** ← **species**

How are organisms named?
By the binomial system of genus and species.

d

What are the concerns about genetic engineering?
We can't be sure what affects GM crops will have on populations of wild flowers and insects.

Some people are concerned that we don't know what affects they may have on human health.

Some worry that it may lead to people wanting to manipulate the genes of humans to produce 'designer babies'.

e

What are fossils?
The remains of organisms from millions of years ago, which are found in rocks.

Give three ways fossils may be formed.
1. **From parts of organisms that have not decayed because one or more of the conditions for decay are absent.**
2. **When parts of the organism are replaced by minerals as they decay.**
3. **As preserved traces of organisms, such as footprints, burrows and rootlet traces.**

f

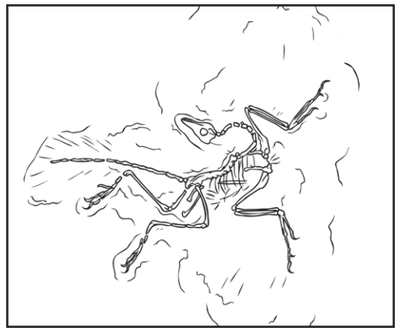
What can we learn from fossils?
How organisms have changed over a long period of time.

Why can scientists not be certain about how life began on Earth?
Many early life forms were soft bodied so left few traces behind. Most traces have been destroyed by geographical activity.

g

Chemical analysis led Carl Woese to adapt the system we used for classification. Describe how his system divides organisms.
Into three domains:
1. **Archaea, primitive bacteria who live in extreme environments;**
2. **bacteria (true bacteria);**
3. **eukaryota, which includes protists, fungi, plants and animals.**

h



This is a fossil of the prehistoric bird Archaeopteryx. Archaeopteryx is now extinct. Give some factors that could contribute to a species extinction.

1. **new predators**
2. **better competitors**
3. **a catastrophic event (e.g. volcanic eruption, meteor)**
4. **changes to the environment over time**
5. **lack of food**
6. **new diseases**

i

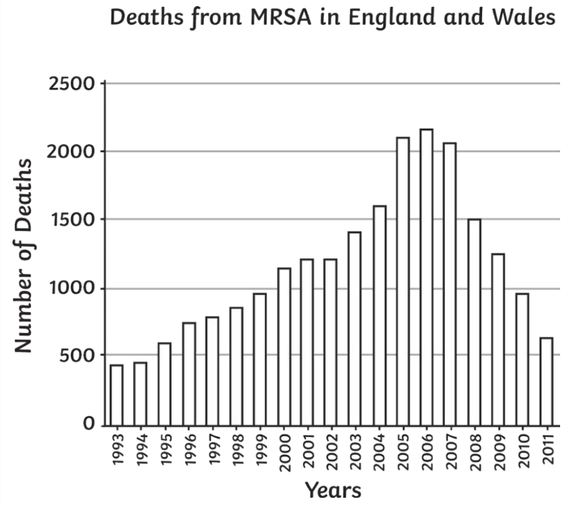
Why can bacteria evolve rapidly?
They reproduce at a fast rate.

Explain how bacteria can become resistant to antibiotics.
Mutations arise that produce new strains.
Some mutations may cause the strain to become resistant to antibiotics.
Bacteria are no longer killed by antibiotics so they survive and reproduce. This increases the population of antibiotic resistant bacteria.
The resistant strain is spread between people because they are not immune to it and there is no effective treatment.

Why is the development of new antibiotics not likely to keep up with new strains of bacteria?
Finding new antibiotics is a slow process that costs a lot of money.

j

MRSA is resistant to antibiotics. The graph shows how the number of MRSA deaths has changed over the last 15 years.



Describe the trend in the data.
From 1993 to 2006 the number of deaths due to MRSA increases from ~450 to ~2150. After 2006, the number of deaths from MRSA starts to decrease and reaches ~650 by 2011.

Explain what measures were put in place in England and Wales in 2006 that caused the trend in the data shown on the graph.
Doctors only prescribed antibiotics when they were really needed, not for treating non-serious or viral infections.

Information was given to patients telling them to complete their course of antibiotics, so all bacteria are killed and none survive to mutate and form resistant strains.

Patients with antibiotic resistant bacteria were isolated from other patients.

Increased information about handwashing was provided for staff and visitors to hospitals and care homes. Alcohol gel was provided throughout hospitals.