a

Compare meiosis and mitosis.

b

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

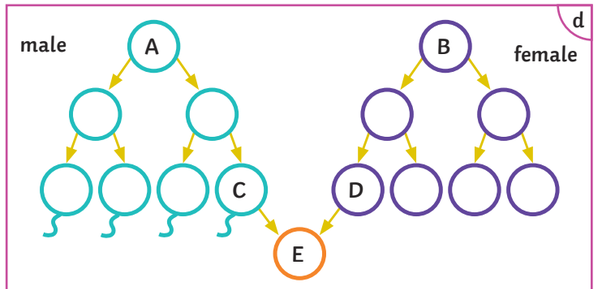
in plants? _____

in animals? _____

c

What is asexual reproduction?

d



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?

e

Give three advantages of sexual reproduction.

1. _____
2. _____
3. _____

f

Give four advantages of asexual reproduction.

1. _____
2. _____
3. _____
4. _____

g

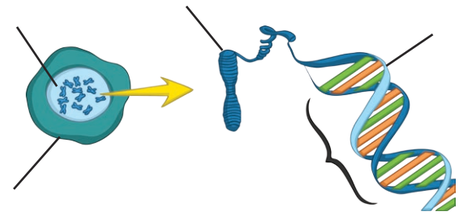
Describe how three different organisms reproduce both sexually and asexually.

1. _____
2. _____
3. _____

h

Describe the structure of DNA.

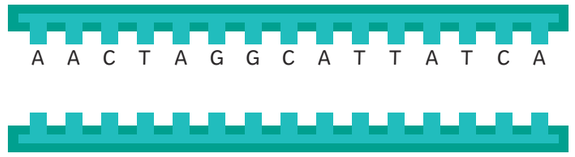
Label the diagram below with the following keywords: cell, nucleus, chromosome, gene, DNA.



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

i

Complete the complementary strand to show which bases pair up.



How many amino acids does this strand code for? _____

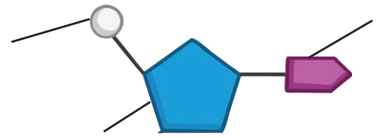
Explain how a change in this DNA sequence could result in a change in the protein that this gene codes for.

j

Describe how protein synthesis occurs.

k

Label the parts the make up a nucleotide.



l

What effect might a mutation in a non-coding region of DNA have?

m

Define the following terms.

genome: _____

gamete: _____

chromosome: _____

gene: _____

allele: _____

dominant: _____

recessive: _____

homozygous: _____

heterozygous: _____

genotype: _____

phenotype: _____

a

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

b

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.

c

What causes new variants in the genes of a species?

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

d

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

What causes most characteristics?

e

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.

f

Which sex chromosomes do human females carry?

Which sex chromosomes do human males carry?

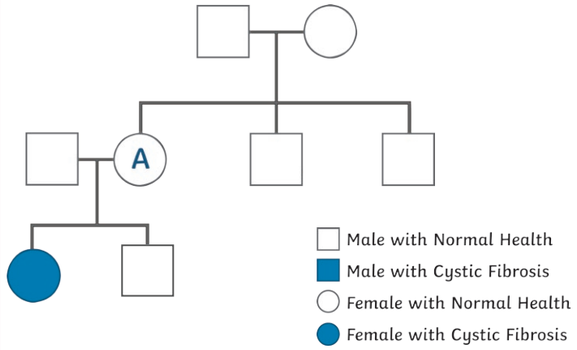
g

Use a punnet square to show the inheritance of sex.

What is the chance that a pregnancy produces a boy?

h

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.

i

What is selective breeding?

j

Evaluate the process of embryo screening.

k

Explain the benefits and risks of selective breeding.

a

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.

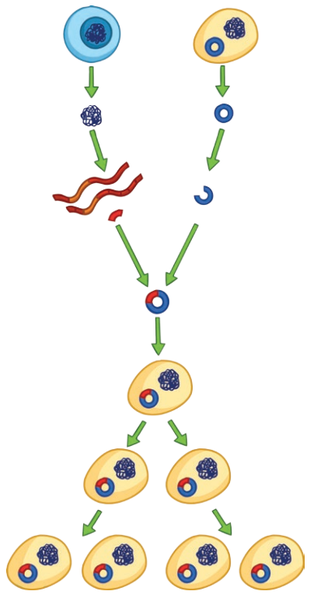
b

What are GM crops?

What are the benefits of GM crops?

c

Annotate the diagram to describe the process of genetic engineering.



d

Name two ways that cloning is carried out in plants.

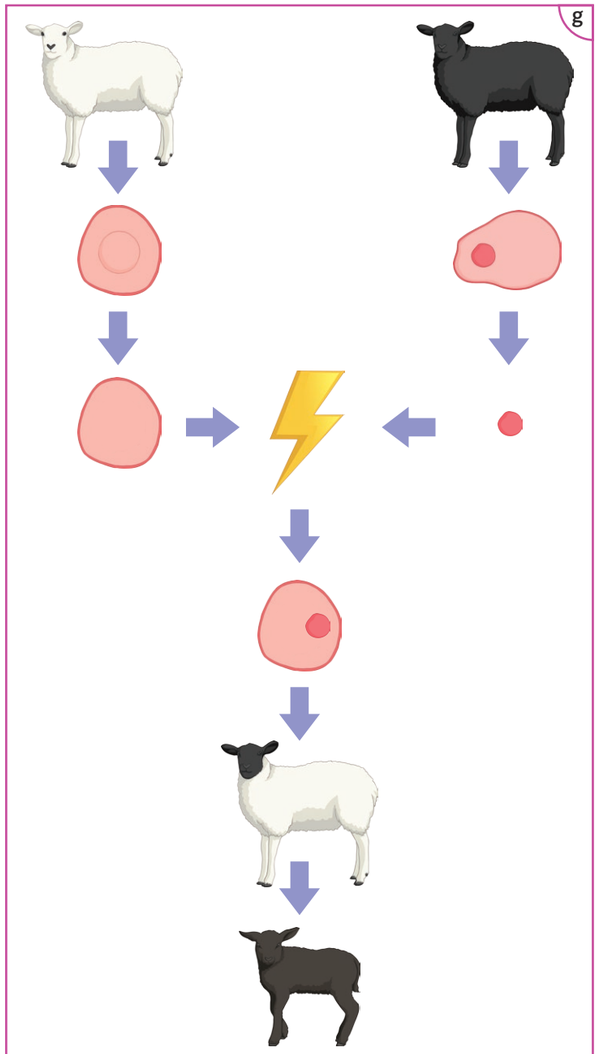
e

What are the concerns about genetic engineering?

f

Describe how embryo transplants are used to clone animals.

g



Use the diagram to describe the process of adult cell cloning.

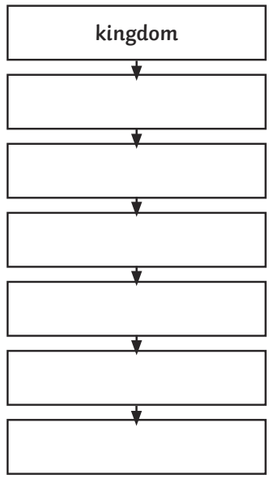
h

Chemical analysis led Carl Woese to adapt the system we used for classification.

Describe how his system divides organisms.

i

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



How are organisms named?

j

What is evolution?

When did the first simple life forms develop?

What evidence do we have for evolution?

a

This is a fossil of the prehistoric bird Archaeopteryx.

Archaeopteryx is now extinct.

Give some factors that could contribute to a species extinction.

b

What are fossils?

Give three ways fossils may be formed.

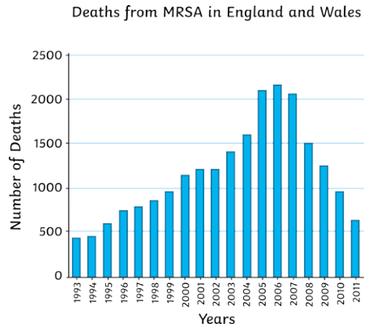
c

What can we learn from fossils?

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

d

MRSA is resistant to antibiotics. The graph shows how the number of MRSA infections 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.

e

Why can bacteria evolve rapidly?

Explain how bacteria can become resistant to antibiotics.

f

Use Darwin's theory of natural selection to explain how the length of giraffe necks has increased over time.

g

Give three reasons that it took a while before Darwin's theory of natural selection was accepted?

h

How did Lamarck's theory differ from Darwin's?

i

Explain how the work of Mendel contributed to our understanding of genetics.

j

Why was the importance of Mendel's discovery not recognised until after his death?

k

Explain the role that Alfred Russel Wallace played in the publication of the theory of evolution by natural selection.

l

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.

a

Compare meiosis and mitosis.

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

Mitosis includes one nuclear division that produces two 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**

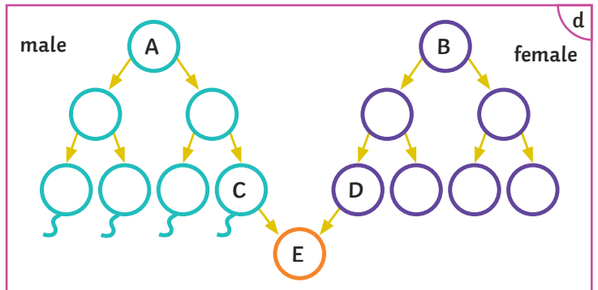
in animals? **sperm cells and egg cells**

c

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).

d



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.

e

Give three advantages of sexual reproduction.

1. **It produces variation in the offspring.**
2. **Natural selection gives a survival advantage if the environment changes.**
3. **Selective breeding allows humans to speed up natural selection to increase food production.**

f

Give four advantages of asexual reproduction.

1. **Only one parent is needed.**
2. **It's more time and energy efficient as there is no need to find a mate.**
3. **It's faster than sexual reproduction.**
4. **Many identical offspring can be produced when conditions are favourable.**

g

Describe how three different organisms reproduce both sexually and asexually.

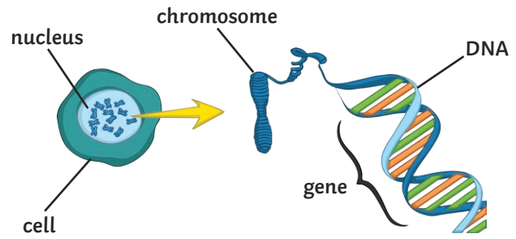
1. **Malarial parasites reproduce asexually in the human host and sexually in the mosquito.**
2. **Fungi reproduce asexually by spores, but also reproduce sexually to give variation.**
3. **Plants reproduce sexually, but some also reproduce asexually. Strawberry plants reproduce asexually via runners; daffodils reproduce asexually via bulb division.**

h

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**

i

Complete the complementary strand to show which bases pair up.

How many amino acids does this strand code for? **5**

Explain how a change in this DNA sequence could result in a change in the protein that this gene codes for.

If the DNA sequence changes, then it may code for a different amino acid. If the amino acid sequence changes, then a different shaped protein may be produced.

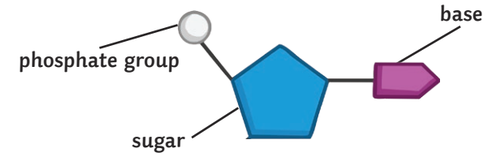
j

Describe how protein synthesis occurs.

A template is made of the DNA. The template moves from the nucleus to the cytoplasm of the cell where it attaches to a ribosome. A carrier molecule attaches to every three bases of the template. The carrier molecule is attached to an amino acid. The amino acids are joined together to form a chain. The chain folds into the final shape of the protein.

k

Label the parts the make up a nucleotide.



l

What effect might a mutation in a non-coding region of DNA have?

It might change the expression of a gene.

m

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 which makes 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.**

a

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.

b

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.

c

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 and 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.

d

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

e

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

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

1 mark for correct parental genotypes. 1 for complete punnet square. 1 for highlighting the offspring with polydactyly. 1 for the correct probability.

f

Which sex chromosomes do human females carry?

XX

Which sex chromosomes do human males carry?

XY

g

Use a punnet square to show the inheritance of sex.

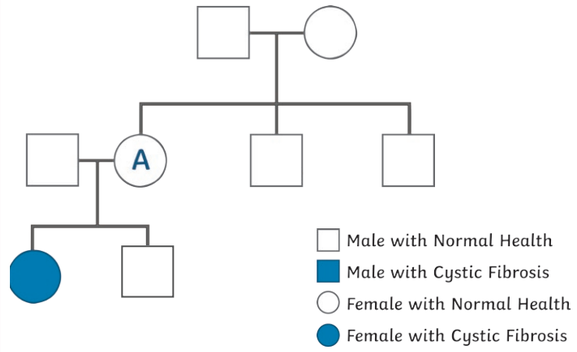
dad \ mum	X	X
X	XX	XX
Y	XY	XY

What is the chance that a pregnancy produces a boy?

50% / $\frac{1}{2}$

h

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. This means 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

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

1 mark for correct parental genotypes. 1 for complete punnet square. 1 for highlighting the offspring with cystic fibrosis. 1 for the correct probability.

i

What is selective breeding?

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

j

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'.**

k

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 which 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

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.**

b

What are GM crops?

Crops that have had their genes modified by genetic engineering.

What are the benefits of GM crops?

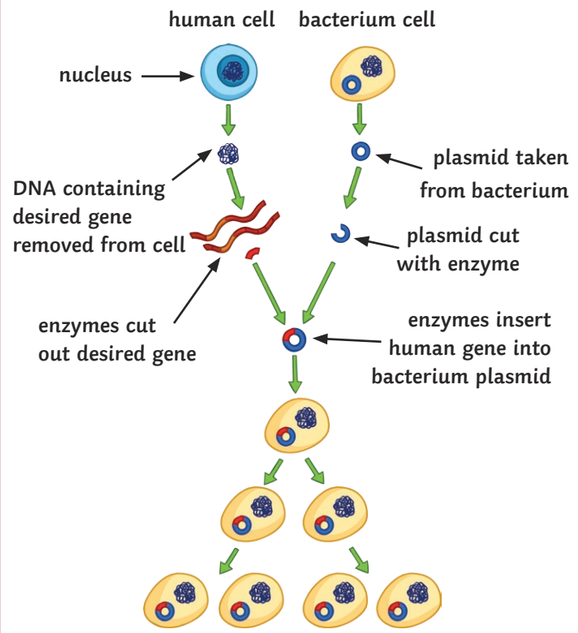
They can be resistant to insect attack, herbicides or disease.

They have increased yields.

They can be engineered to grow in more difficult climates.

c

Annotate the diagram to describe the process of genetic engineering.



Bacteria reproduce rapidly.
This creates bacteria with the new characteristic.

d

Name two ways that cloning is carried out in plants.

Tissue culture: uses small groups of cells from part of a plant to grow identical new plants.

Cuttings: uses a small piece of a plant to produce an identical plant to the parent plant.

e

What are the concerns about genetic engineering?

We can't be sure what effects 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'.

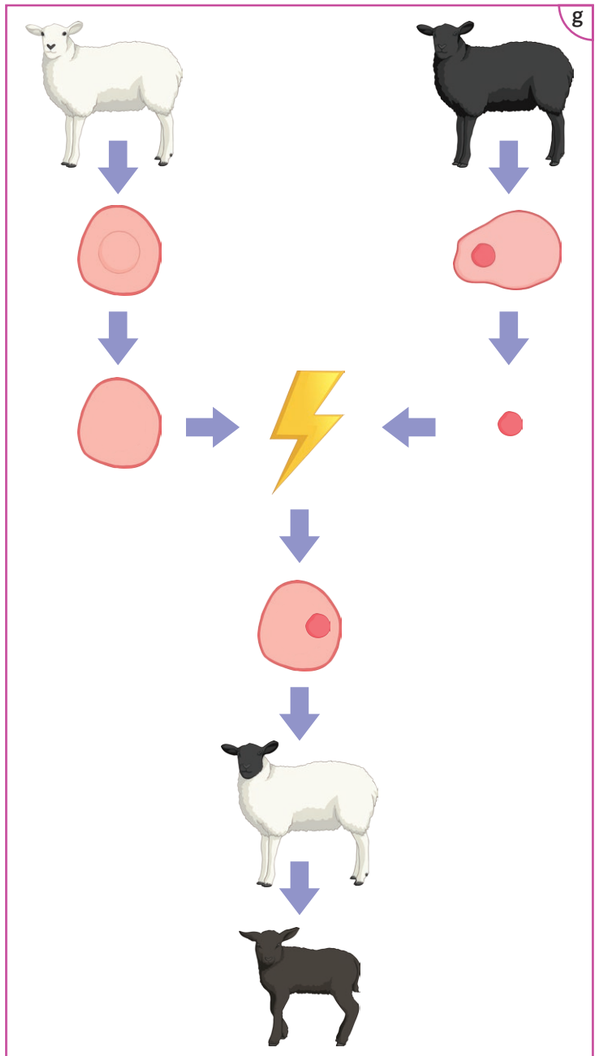
f

Describe how embryo transplants are used to clone animals.

Animal embryos are divided into several single cells before they have specialised. These are grown into embryos in a laboratory.

The identical embryos are then transplanted into host mothers.

g



Use the diagram to describe the process of adult cell cloning.

The nucleus is removed from an unfertilised egg cell and the nucleus from an adult body cell (such as a skin cell) is inserted into it as a replacement.

An electric shock is used to stimulate the egg cell to divide to form an embryo. The embryo cells will contain the same genetic information as the adult skin cell.

When the embryo has developed into a ball of cells, it is inserted into the womb of an adult female to continue developing.

h

Chemical analysis led Carl Woese to adapt the system we used for classification.

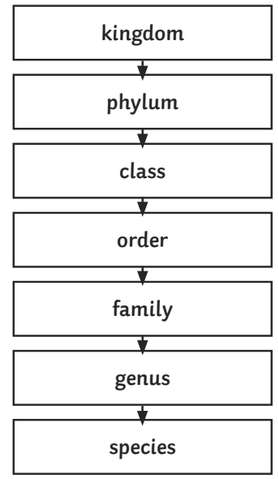
Describe how his system divides organisms.

Into three domains:

- **archaea - primitive bacteria which live in extreme environments;**
- **bacteria (true bacteria);**
- **eukaryote - these includes protists, fungi, plants and animals.**

i

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



How are organisms named?

By the binomial system of genus and species.

j

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**

a

This is a fossil of the prehistoric bird Archaeopteryx.

Archaeopteryx is now extinct.

Give some factors that could contribute to a species extinction.

New predators, better competitors, a catastrophic event (e.g. volcanic eruption, meteor), changes to the environment over time, lack of food, new diseases.

b

What are fossils?

The remains of organisms from millions of years ago. They are now 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 were 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.**

c

What can we learn from fossils?

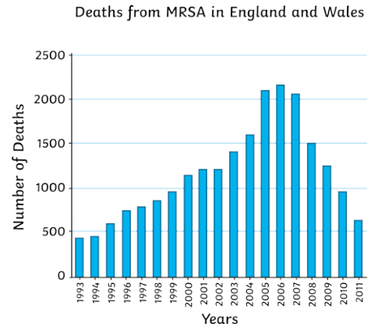
How organisms have changed over a long period of time.

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.

d

MRSA is resistant to antibiotics. The graph shows how the number of MRSA infections 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.

e

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.

f

Use Darwin's theory of natural selection to explain how the length of giraffe necks has increased over time.

The population of giraffes will have had lots of variation in neck length. They will have competed for food and resources. Those with the longest necks are more able to reach food and are therefore most likely to survive and reproduce. They then pass the alleles for the long necks onto the next generation.

g

Give three reasons that it took a while before Darwin's theory of natural selection was accepted?

1. **The theory challenged the idea that God made all the animals and plants that live on earth.**
2. **There wasn't enough evidence at the time to convince a lot of scientists.**
3. **The mechanism of inheritance was not understood until 50 years after the theory was published.**

h

How did Lamarck's theory differ from Darwin's?

He thought that changes that occur to the organism during its lifetime are inherited by the offspring.

i

Explain how the work of Mendel contributed to our understanding of genetics.

Mendel carried out breeding experiments with peas. He bred pea plants with different characteristics and counted the number of offspring of each type. He was able to predict how traits would be inherited.

He thought that each characteristic was determined by separate 'units' that are passed on to offspring unchanged. These units were later called genes.

j

Why was the importance of Mendel's discovery not recognised until after his death?

At the time, nobody knew about genes or chromosomes and people didn't understand his theories. When scientists observed chromosomes and how they move during cell division, they finally accepted his work.

k

Explain the role that Alfred Russel Wallace played in the publication of the theory of evolution by natural selection.

He worked worldwide gathering evidence for evolution. He worked on warning colouration in animals. He independently proposed the theory of evolution by natural selection and published joint writings with Darwin in 1858. This prompted Darwin to publish On the Origin of Species a year later. He did a lot of pioneering work on a theory for speciation.

l

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.**