

a Label each of the following statements with either mitosis or meiosis.

Produces identical cells. _____

Produces non-identical cells. _____

Daughter cells have one set of chromosomes. _____

Daughter cells have two sets of chromosomes. _____

Includes one nuclear division. _____

Includes two nuclear divisions. _____

Produces 4 daughter cells. _____

Produces 2 daughter cells. _____

d Fill in the gaps:
 Gametes join at _____ to restore the normal number of chromosomes. The new cell that is produced divides by _____, so the number of cells _____. As the embryo develops, the cells _____.

e Match each of the keywords with its definition.
Keywords: genome, gamete, chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype, phenotype.

The entire genetic material of an organism. _____

The alleles present in an individual for a particular characteristic. _____

A section of DNA that codes for a particular sequence of amino acids that makes a specific protein. _____

Only controls the physical characteristic if it is present on both chromosomes. _____

A different form or variant of a gene. _____

Two identical alleles for a characteristic. _____

Different alleles for a characteristic. _____

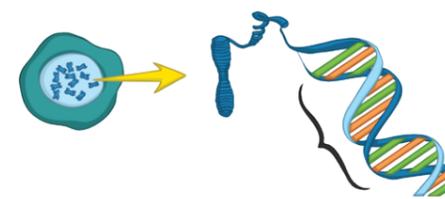
Found in the nucleus, they are made from long DNA molecules and passed from parent to offspring. _____

The sex cells (sperm and egg cells), which contain one set of genetic information. _____

The physical appearance of an individual for a particular characteristic. _____

Controls the characteristic, even if it is only present on one chromosome. _____

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



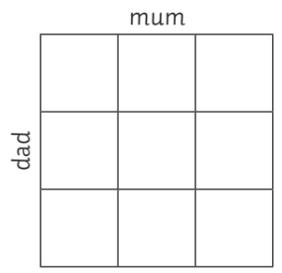
h Give three reasons it's important to study the human genome.

- _____
- _____
- _____

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

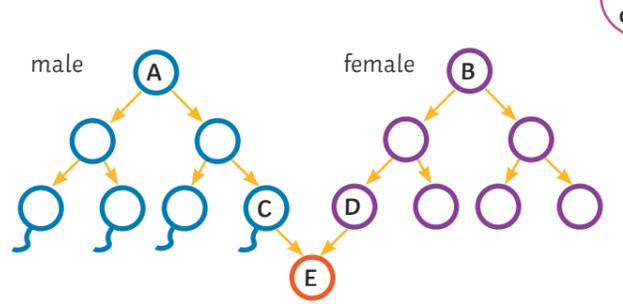
What causes most characteristics?

j 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 and highlight the possible offspring genotypes that would have polydactyly. Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.



b What are the names of the male and female gametes...
 in plants? _____
 in animals? _____

Fill in the gaps:
 _____ reproduction involves only one parent and no fusion of _____. Only _____ is involved, so there is no mixing of genetic information. The offspring are _____ (genetically identical).



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? _____

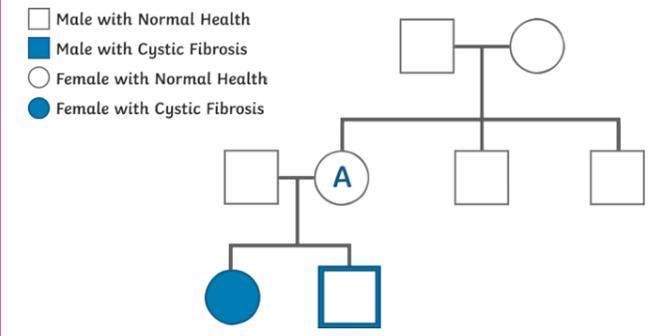
What is the process that produces cell E called? _____

f How many strands does DNA have?

What is the name of the structure of DNA?

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

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

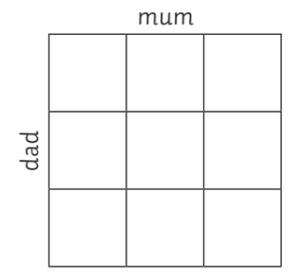


Use the symbol **N** for the allele for normal health, and the symbol **n** for the allele for cystic fibrosis.

What is the genotype for person A?

How do you know?

Person A is pregnant with their third child. Draw a genetic diagram to show the probability of the child having cystic fibrosis.



Which sex chromosomes do human females carry?

Which sex chromosomes do human males carry?

Use a punnet square to show the inheritance of sex.

		mum	
	gametes		
dad			

What is the chance that a pregnancy produces a boy?

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.

Fill in the gaps.

_____ occur continuously and give rise to new variants in the _____ of a species. Most variants have no effect on the _____. Sometimes a variant is harmful and means the individual is less likely to _____. Very rarely it might produce a phenotype that is beneficial, making the individual better _____ to the environment.

What is evolution? Fill in the gaps.

A _____ in the _____ characteristics of a population over _____ through a process of _____. This may result in the formation of a new _____.

When did the first simple life forms develop?

What evidence do we have for evolution?

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.

Use the keywords to help explain how two species of the anole lizard, found on different Caribbean islands, could have evolved from a common ancestor.



Keywords: successfully interbreed, separated, environmental conditions, survive, offspring, geographical isolation, reproduce, variation, adapted, natural selection, alleles.

The ancestral populations of anole lizards were _____ because they lived on different islands. This is called _____.

Each environment would have had different _____.

There was genetic _____ in each population.

The individuals in each population that were better _____ to those conditions would _____ and _____. This is called _____.

The _____ for the beneficial phenotypes were passed to their _____.

Eventually, the two populations would be so different they could not _____.

What is selective breeding?

Describe how farmers would use selective breeding to produce cows that make lots of milk. Fill in the gaps.

1. Pick parents that _____;
2. _____;
3. from the offspring, pick _____ _____;
4. _____;
5. repeat for _____ until all of the offspring _____.

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

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

What is the benefit of selective breeding?

What is a risk of selective breeding?

a What is genetic engineering?

Give an example of how genetic engineering is used in plants.

Give an example of how genetic engineering is used in bacterial cells.

e What are fossils?

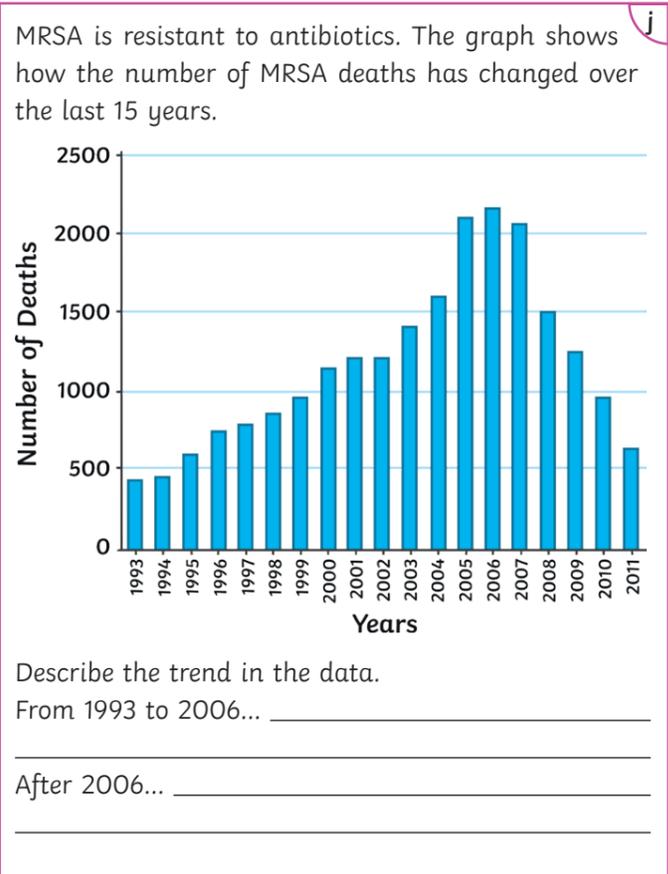
Fill in the gaps to complete the three ways fossils may be formed.

- From parts of organisms that have not _____ because one or more of the conditions for decay are _____.
- When parts of the organism are _____ by _____ as they decay.
- As preserved _____ of organisms, such as _____, _____ and _____.

h



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 GM crops?

What are the benefits of GM crops? Fill in the gaps.

- They can be resistant to _____, _____ or _____.
- They have increased _____.
- They can be engineered to grow in more difficult _____.

f What can we learn from fossils?

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

i Why can bacteria evolve rapidly?

Fill in the gaps to explain how bacteria can become resistant to antibiotics.

_____ arise that produce new strains.

Some _____ may cause the strain to become _____ to antibiotics.

Bacteria are no longer _____ by antibiotics so they _____ and _____, this increases the population of antibiotic resistant bacteria.

The resistant strain is _____ between people because they are not _____ to it and there is no effective _____.

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

Measures were put into place to prevent the spread of antibiotic resistant bacteria.

How did this affect doctors' decisions to prescribe antibiotics?

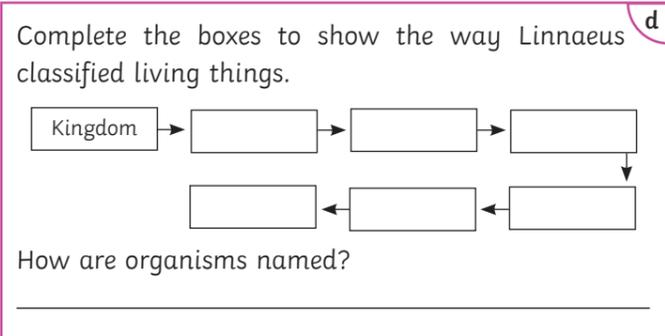
What must patients need to do when they are prescribed antibiotics?

Give two ways that hospitals reduce the spread of bacterial infections.

c What are the concerns about genetic engineering?

g Chemical analysis led Carl Woese to adapt the system we used for classification. What are the domains of his three domain system called? Fill in the gaps.

- _____, primitive bacteria who live in extreme environments;
- _____;
- _____, which includes p_____, f_____, p_____ and a_____.



Label each of the following statements with either mitosis or meiosis.

Produces identical cells. **mitosis**

Produces non-identical cells. **meiosis**

Daughter cells have one set of chromosomes. **meiosis**

Daughter cells have two sets of chromosomes. **mitosis**

Includes one nuclear division. **mitosis**

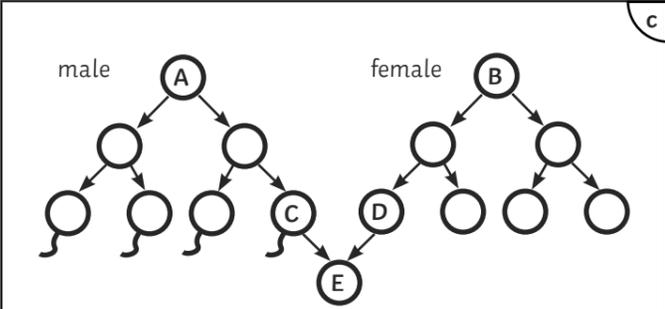
Includes two nuclear divisions. **meiosis**

Produces 4 daughter cells. **meiosis**

Produces 2 daughter cells. **mitosis**

What are the names of the male and female gametes...
 in plants? **pollen cells and egg cells**
 in animals? **sperm cells and egg cells**

Fill in the gaps:
Asexual reproduction involves only one parent and no fusion of **gametes**. Only **mitosis** is involved, so there is no mixing of genetic information. The offspring are **clones** (genetically identical).



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**

Fill in the gaps:
 Gametes join at **fertilisation** to restore the normal number of chromosomes. The new cell that is produced divides by **mitosis**, so the number of cells **increases**. As the embryo develops, the cells **differentiate**.

Match each of the keywords with its definition.
Keywords: genome, gamete, chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype, phenotype.

The entire genetic material of an organism. **genome**

The alleles present in an individual for a particular characteristic. **genotype**

A section of DNA that codes for a particular sequence of amino acids that makes a specific protein. **gene**

Only controls the physical characteristic if it is present on both chromosomes. **recessive**

A different form or variant of a gene. **allele**

Two identical alleles for a characteristic. **homozygous**

Different alleles for a characteristic. **heterozygous**

Found in the nucleus, they are made from long DNA molecules and passed from parent to offspring. **chromosome**

The sex cells (sperm and egg cells), which contain one set of genetic information. **gamete**

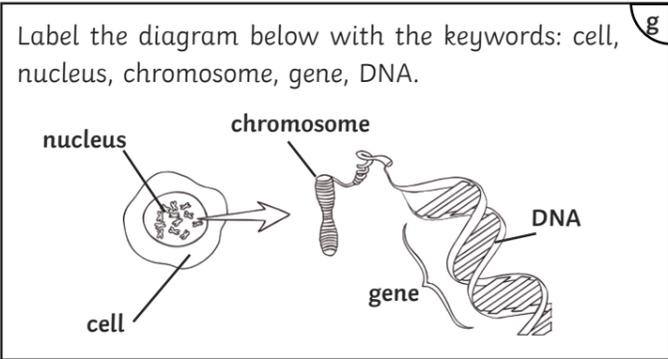
The physical appearance of an individual for a particular characteristic. **phenotype**

Controls the characteristic, even if it is only present on one chromosome. **dominant**

How many strands does DNA have?
two

What is the name of the structure of DNA?
double helix

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



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

Give three reasons it's important to study the human genome.

- To help search for genes that cause disease.**
- It helps to understand and develop treatments for inherited disorders.**
- It's used to trace human migration patterns from the past.**

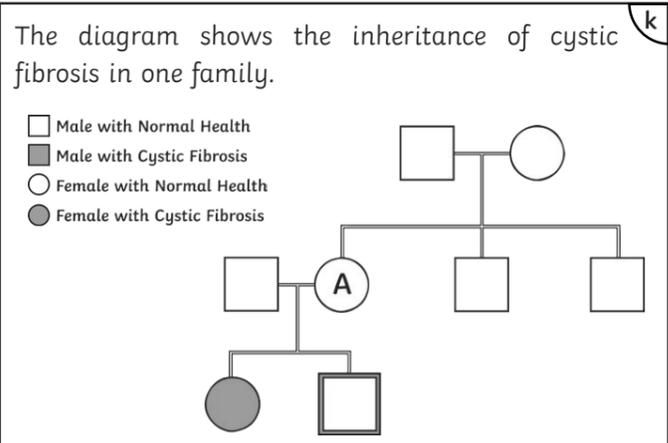
Give an example of a characteristic caused by a single gene.
Some examples: eye colour, red-green colour blindness, polydactyly, cystic fibrosis, tongue rolling, attached earlobes, freckles, dimples, fur colour in mice.

What causes most characteristics?
Multiple genes interacting.

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 and highlight the possible offspring genotypes that would have polydactyly. Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

		mum	
		A	a
dad	a	Aa	aa
	a	Aa	aa

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



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. Draw a genetic diagram to show the probability of the child having cystic fibrosis.

		mum	
		N	n
dad	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% / 1/4 / 0.25 / 1 in 4 offspring have cystic fibrosis.

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	X
dad	gametes	X	X
	X	XX	XX
Y	XY	XY	

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

What are the benefits of embryo screening?

It allows people to make choices about whether they have a child with an inherited disorder.

It also means people can prepare for looking after a child with an inherited disorder.

What are the risks of embryo screening?

That it will cause a miscarriage.

That it will give a false-positive or false-negative result.

What are the economic concerns surrounding embryo screening?

Screening is expensive so it's 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.

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.

Fill in the gaps.

Mutations occur continuously and give rise to new variants in the **genes** of a species. Most variants have no effect on the **phenotype**. Sometimes a variant is harmful and means the individual is less likely to **survive**. Very rarely it might produce a phenotype that is beneficial, making the individual better **adapted** to the environment.

What is evolution? Fill in the gaps.

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?

- fossils**
- antibiotic resistance in bacteria**

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.

Use the keywords to help explain how two species of the anole lizard, found on different Caribbean islands, could have evolved from a common ancestor.



Keywords: successfully interbreed, separated, environmental conditions, survive, offspring, geographical isolation, reproduce, variation, adapted, natural selection, alleles.

The ancestral populations of anole lizards were **separated** because they lived on different islands. This is called **geographical isolation**.

Each environment would have had different **environmental conditions**.

There was genetic **variation** in each population.

The individuals in each population that were better **adapted** to those conditions would **survive** and **reproduce**. This is called **natural selection**.

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

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

What is selective breeding?

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

Describe how farmers would use selective breeding to produce cows that make lots of milk. Fill in the gaps.

- Pick parents that **produce lots of milk**;
- breed these parents together**;
- from the offspring, pick **those that produce the most milk**;
- breed these together**;
- repeat for **many generations** until all of the offspring **produce lots of milk**.

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

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

What is the benefit of selective breeding?

It produces organisms that are useful to us and improves our food production.

What is a risk of selective breeding?

It can lead to inbreeding which could make a breed prone to a disease or inherited defects.

It reduces the number of alleles in a population, and this means the population is less likely to cope if there is a change in the environment (like climate change or a new disease).

a

What is genetic engineering?
Genes can be cut out of one organism and inserted into the genome of another organism to give a desired characteristic.

Give an example of how genetic engineering is used in plants.
To produce plants that are resistant to disease or produce bigger fruits.

Give an example of how genetic engineering is used in bacterial cells.
To produce bacteria that make human insulin to treat diabetes.

b

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

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

c

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'.**

d

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

```

    Kingdom → phylum → class → order
                                     ↓
                                family ← genus ← species
    
```

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

e

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

Fill in the gaps to complete the three ways fossils may be formed.

- From parts of organisms that have not **decayed** because one or more of the conditions for decay are **absent.**
- When parts of the organism are **replaced** by **minerals** as they decay.
- 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. What are the domains of his three domain system called? Fill in the gaps.

- Archaea**, primitive bacteria who live in extreme environments;
- bacteria**;
- 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.

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

i

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

Fill in the gaps to 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.

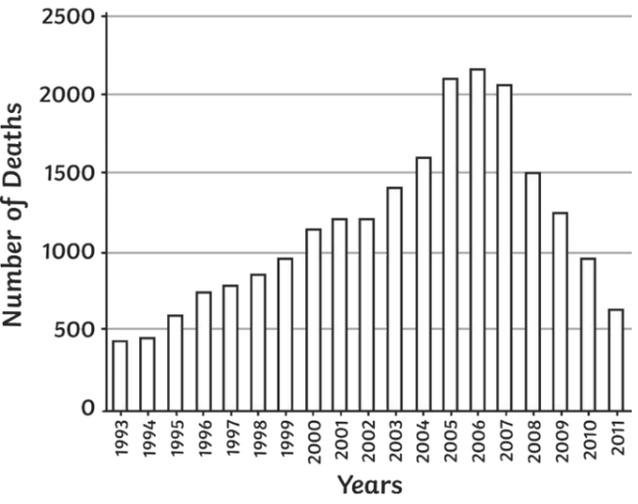
Bacteria are no longer **killed** by antibiotics so they **survive** and **reproduce**, this increases the population of antibiotic resistant bacteria.

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.**

Measures were put into place to prevent the spread of antibiotic resistant bacteria.

How did this affect doctors' decisions to prescribe antibiotics?
Doctors only prescribed antibiotics when they were really needed, not for treating non-serious or viral infections.

What must patients need to do when they are prescribed antibiotics?
Complete their course of antibiotics so all bacteria are killed and none survive to mutate and form resistant strains.

Give two ways that hospitals reduce the spread of bacterial infections.
Patients with antibiotic resistant bacteria are isolated from other patients.

Increased information about handwashing is provided for staff and visitors. Alcohol gel is provided throughout hospitals.