DNA in the Garden – DNA: A Matter of Size and Sequence

DNA is so important that it is the only molecule in cells that is repaired.

Genes are stretches of DNA. Like all DNA they are made up of four building blocks, and it is the sequence of these that acts as a code. Just as the meaning of a sentence changes if you change the letters in it, so disruptions (**mutations**) to the DNA code can alter the product made from it.

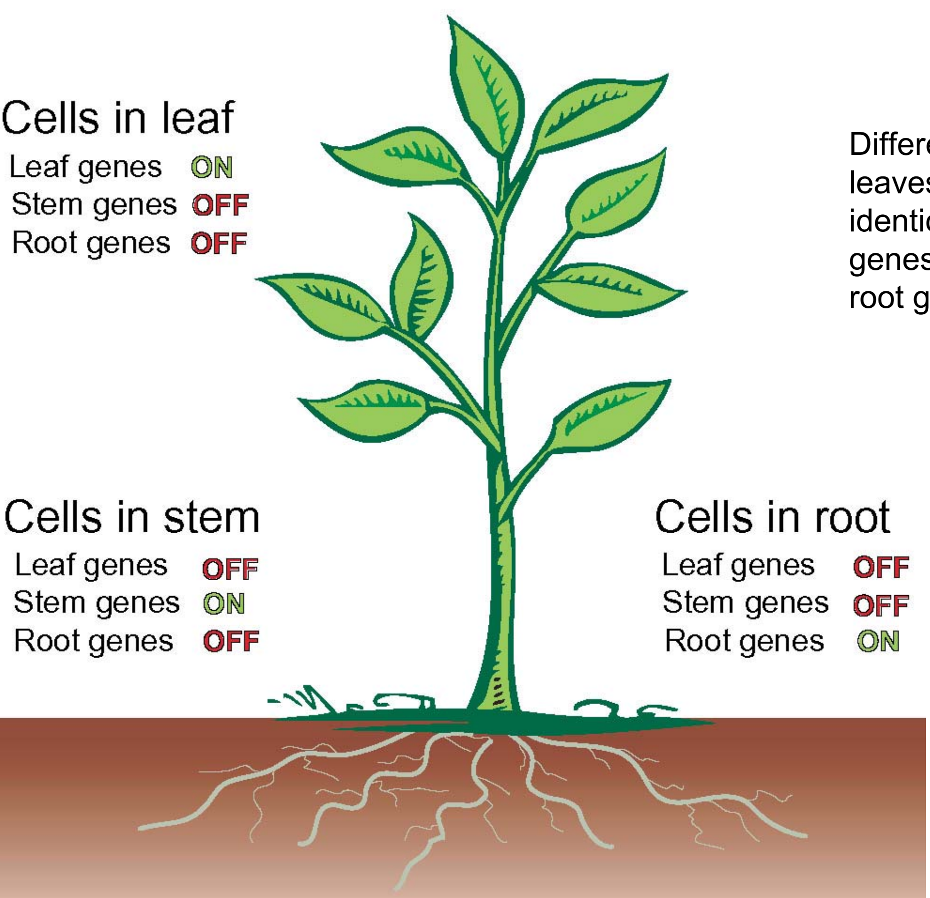
In this example, just as in genes, mutations to the order of letters can change the sentences, to a new meaning or to nonsense.

THE CAT SAT ON THE MATTRESS	(normal text)
THE CAT SAT ON THE MAT	(a new meaning)
THE SAT ON THE MATTRESS	(nonsense)

Mutations occur naturally. They cause natural variation between individuals. Mutations can also be introduced deliberately.

Where will the genes for photosynthesis be switched on?

What processes may cause genes to mutate. Which of these processes do you think that scientists could use as a research tool?



Different parts of a plant, such as the leaves, roots and petals all contain identical DNA. But in the leaf, the leaf genes are working; and in the root, the root genes are working and so on.

When you take a leaf cutting, genes other than the leaf genes get switched on and help the leaf to make new stem, roots etc. for the new plantlet .

What genes are switched on in your leaf cutting?

DNA in the Garden – Families and Friends

READ THE FOLLOWING ARTICLE CLIPS BEFORE YOU ANSWER THE NEXT SET OF QUESTIONS.

DNA reveals who's related to who in plants

People have classified plants since prehistoric times. In the past, relationships between plants were assigned largely on the basis of their physical appearance. Today, studies on plant relationships can use DNA information. Many genes are very similar in all plants, and in plant families even the way they are arranged on chromosomes is very similar. Such basic similarities between different species mean that scientists can use DNA data to understand evolution and plant relationships and develop classification techniques and protect biodiversity

Surprise, surprise!

DNA technology has revealed just how deceptive appearances can be. For example, close similarities in flower shape and watery habitat once led botanists to think that waterlilies were closely related to the sacred lotus. They are not. Instead Kew scientists have revealed that the closest relatives of the sacred lotus family include the London plane trees!

African violets.

Researchers at the Royal Botanic Garden Edinburgh are looking at the evolution and development of the Cape Primrose (*Streptocarpus, Gesnericacea)*, a common houseplant native to tropical Africa. Many forms can be found, each adapted to living in a different habitat. *Streptocarpus caulescens* has well developed stems, while *Streptocarpus dunnii* has a single, huge leaf which grows throughout the plant's life. Despite looking quite different from African Violets (*Saintpaulia,Gesnericacea*) DNA research has shown that they are actually very closely related.

London plane tree

The sacred lotus

Streptocarpus dunnii

Streptocarpus caulescens

DNA in the Garden – Families and Friends

Evidence set 1:

And then there were leaves

All leaves, however different they look, belong to one of only two types. They are either single-veined or web-veined. The fossil evidence and traditional plant classification suggest that leaves in club mosses and other plants evolved separately. But recent research suggests that all plants might use the same mechanism to control leaf formation. What's going on here? Could exactly the same genetic mechanism have evolved twice?

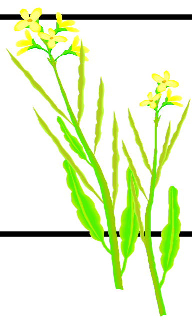
Question 1: If you were a scientist and you had to give an answer to a newspaper reporter, would you say that leaf types had evolved separately, or evolved down one path, or that you weren't sure how they had evolved?

Evidence set 2:

Classification chaos!

As we find out more and more about different species we need to organise all of this data. We already have a great deal of information and some important classification information was even held on card files. There may be data on computer systems in different countries and different research centres.

Question 2: If you were a scientist, what would you do to organise the information so that as many scientists as possible could use it as well?



Evidence set 3:

Cutting the mustard!

Mustard oils are responsible for a peppery, sharp taste and are found in a range of different plants such as horseradish, turnip and broccoli. For many years there was controversy over the relationship between the different plants containing mustard oils because the flower structures of some species were so different from others. Many thought the pawpaw, with its tubular flowers, could not possibly be related to cabbage with its simple four petalled flower. Others argued that the chemical pathway for making mustard oils is so complex that it probably evolved only once – suggesting all plant families with mustard oils are related. The competing classification systems were confusing.

Question 3: What is the problem with working out this relationship just by how plants look?

How could DNA technology been helpful?

How would research scientists be able to "put this DNA to work"?

Evidence set 4:

Cinderella or ugly sisters?

The lady's slipper orchid (*Cypripedium calceolus*) is among Britain's rarest plants, having been reduced to a single plant in the wild.

Question 4: You are a scientist who is on a committee to help to protect and conserve this species. You have been given two plants that look very similar to the lady's slipper orchid that you have already seen.

How can you be sure that they are the same species?

What would you advise if they were the same species? What would you advise if they weren't the same species?

DNA in the Garden – Putting DNA to Work

Improve your posture?

Early 20th century varieties of wheat differ in many ways from those grown today. To improve crops for particular farming and environmental needs, we need to understand the interactions between genetic makeup and crop performance.

Hereward is a short modern variety of wheat with upright leaves (growing in front in the photo). Squarehead's Master is an old and taller variety (growing behind in the photo), which has a more relaxed leaf posture. Experiments at Rothamsted Research suggest that weeds cannot grow as well with Squarehead's Master, because its leaf canopy limits the amount of light getting down to them. But crop yield is less with the old variety because it puts relatively more of its energy into growing stem than ears, and because only its upper leaves benefit from sunlight.

Fascinating Fact!
In many old paintings such as John Constable's "The Cornfield" in the National Gallery in London the wheat is shown as much taller than today's varieties, almost up to a man's shoulder.

Think about the example above. The modern variety of wheat would have been bred from an older variety of wheat.

1 a. How was this done? Was this done through selective breeding or through genetic modification?

1 b. Why was this done?

1 c. How long has this been happening, when did people first start to select for particular traits and breed new crops?

Today's wheat is not like the old wheat. As well as global biodiversity, research is also underway to make sure that genetic variation in our cultivated species in the UK is conserved.

2 a. Why might we want to go back to using the old varieties?

2 b. If we want to use new varieties, should we still keep the older varieties somewhere, and if so why and how?