DNA in the Garden – Families and Friends

Arabidopsis thaliana

Why is a tiny weed, thale cress – *Arabidopsis thaliana* – used a lot in research?

Can you give examples of how it's been used?

The genome of *A. thaliana* was determined in 2000.

Why was this important?

Why is it important to look at the genome of plants, can the information have any application in animal as well as plant genetic research?

Arabidopsis, the best characterised weed on Earth.

(Photograph courtesy of the Plant Laboratory, Department of Biology, University of York).

Top right. Research scientist at the John Innes Centre.

Bottom right. *Arabidopsis* plant in pod formation stage.

(Photos courtesy of the John Innes Centre).

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. Recent research suggests that all plants might use the same mechanism to control leaf formation. An interaction between two genes appears to govern leaf formation in both *Arabidopsis* and *Antirrhinum*, and a very similar interaction may influence leaf formation in the club moss *Selaginella*. Yet the fossil evidence and traditional plant classification suggest separate evolution of leaves for the club mosses and other plants.

Why do you think that *Arabidopsis* was one of the species used in this study?

What's going on here? Could exactly the same genetic mechanism have evolved twice?

You are a research scientist, think about the process of science and describe the ways in which you could present your findings to other scientists and to the general public. Does there have to be a definite answer to the question of leaf evolution?

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

One complete copy of the DNA of an organism, including bits that don't code for anything, is called its **genome**. Measuring the total amount of DNA in different genomes has revealed some big surprises

Quantity can have major consequences

The amount of DNA (or C-value) in plants differs dramatically between species. Some fritillaries and lilies have hundreds of times as much DNA in their genomes as *Arabidopsis* or the horse chestnut tree (*Aesculus hippocastanum*).

Large amounts of DNA carry high inherent biological costs. What do you think these are?

Do you think that there may be a limit to the size of a genome?

How can genome size help to predict plant behaviour?

Why might some genomes (e.g. the human one) contain fewer genes than expected?

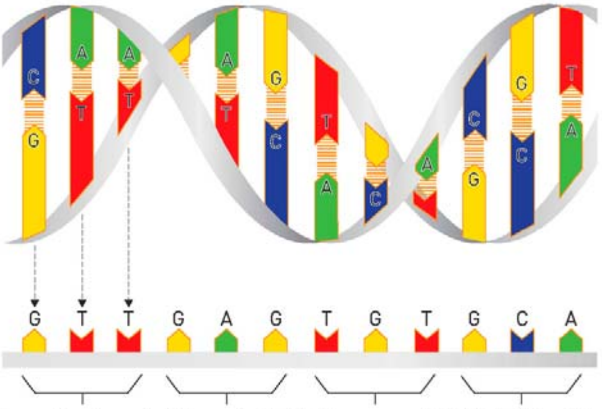
Is the amount of DNA always related to the number of genes, and if not what else is it related to?

DNA Structure and Function

Why was the discovery of the structure of DNA 50 years ago so important?

Relatively recently, researchers have found that there are tiny structural differences along the DNA double helix.

Why do you think that these are important?



Information is coded through "triplet" groups of DNA building blocks

Fascinating facts!

Some tobacco plants contain stretches of DNA from viruses, incorporated millions of years ago during evolution – a sort of natural genetic modification.

Some stretches of DNA can naturally hop from one place in the sequence to another. In doing so, they can disrupt the functions of genes, resulting in visible differences in the plant. This happens a lot in the snapdragon (*Antirrhinum*), where it can affect flower colour. The tea rose (*Rosa mundi*) gets its characteristic flecking from DNA jumping in to genes for petal colour and disrupting them. A similar effect can be seen in some corn cobs.

Antirrhinum sp.

DNA in the Garden – Putting DNA to Work

Knowing the DNA sequence (genome) of plants allows us to do many amazing things that have the potential to impact on everyday life for example crops and other plants that are bred to be particularly suited to their environments, so that chemical and other inputs can be reduced, and environmental damage is minimised.

DNA technology can help:

- In faster and more precise conventional breeding
- In genetic modification, either within species as in conventional breeding, or for introducing novel genes not possible through conventional breeding.

Thinking further…..

You are a journalist and you are writing an article for a Sunday supplement about wheat and bread.

You have interviewed a scientist who has used conventional, selective breeding to breed a new wheat plant with a gene that gives the wheat resistance to an insect pest.

You have then interviewed a second scientist who has used genetic modification technology to transfer the same gene to a wheat plant so that it has the same resistance to the insect pest.

You want to write a fair unbiased article for your readers. Think about the questions that your readers may ask!

In this case the benefits are the same from both conventional breeding and GM. One question in the GM debate is whether we should be assessing the traits, in this case insect resistance, or the technology, i.e. how it has been made.

This is just one type of example. Are there some things that we should not allow.

Judge and Jury – can you debate these two cases?

Case 1: A gene has been identified that produces a protein in animals that has valuable medicinal properties for humans. Should we allow this gene to be inserted into plants using GM technology so that the plants can produce this protein in "bio-factories" or should we use animals to produce the protein?. Who is responsible for overseeing GM procedures? What do you think?

You may like to discuss the insulin case history as well when you are discussing this issue.
Within the last 20 years , advances in molecular biology and gene technology have enabled scientists to make "human insulins" which are less likely to cause allergic reactions. Such insulins can be made by either converting the pig insulin into the human form, or by using genetic modification to insert a synthetic copy of the human gene for insulin into bacteria or yeast cells. In the latter case the yeast and bacteria cells are clones and used as"mini-factories" to produce large amounts of human insulin.

Case 2: Genomics may be a useful way to identify useful new compounds in plants and microbes (bio-prospecting). Can you think of any issues that may arise? What would happen if a compound was found in a plant that grew naturally wild in a different country. Who should be involved in any decisions?