

GENETIC MODIFICATION OF FOOD

INTRODUCTION TO THIS RESOURCE

This *Headline Bioethics* study guide contains background information and structured activities based around online video clips, to enable busy lecturers and school teachers to address the science and ethical implications of new developments in biology and biomedicine.

The availability of online news archives, and clips from other programmes, make it relatively straightforward to incorporate streamed media of this kind into Biology, RE and/or General Studies lessons. The **FAQs** section of this guide presents a series of question and answers regarding genetic modification including background information about the science, history and ethical arguments. In addition, '**off the shelf**' worksheets have been produced for use in conjunction with the selected video clips.

All of the recommended video clips are currently being streamed on the BBC website (www.bbc.co.uk).

VIDEO LINKS

Below are links to three recommended videos that illustrate the science and ethical issues associated with the genetic modification of crops.

The first video (link below) is a report about a trial of genetically modified potatoes that have been planted at the Sainsbury Laboratory in Norfolk. A more detailed BBC news article can be found here <http://tinyurl.com/gmpotatoother>

'Latest GM crop trials attacked by the Soil Association' – BBC News, 12th June 2010 (2min57)
<http://tinyurl.com/gmvideo1>

The second and third videos (see link below) report on the GM debate and give two contrasting views on the genetic modification of food.

'GM food: Monster or Saviour?' – BBC News, 29th May 2008 (2min17 and 2min10)
<http://tinyurl.com/gmvideo2-3>

Student worksheets for use in conjunction with these clips can be found on subsequent pages.



STUDENT WORKSHEET

'Latest GM crop trials attacked by the Soil Association'
BBC News, 12th June 2010 (2min57)

<http://tinyurl.com/gmvideo1>



From the video

1. How much does late blight cost farmers every year?
2. Are GM crops currently commercially cultivated in the UK?
3. Write down TWO arguments given by Patrick Holden to explain his opposition to the GM potato trials

Thinking Deeper

What might be the risks if a genetically modified organism released into the wild did not behave as expected?

Homework Task

You hear about a proposed trial of GM crops that would be planted 5 miles from the town where you live. Decide whether you are in favour or against the proposal and write a letter to your local MP including at least THREE arguments to support your view.



Creative Commons, Headline Bioethics, University of Leicester, 2011



STUDENT WORKSHEET

'GM food: Monster or Saviour?'

BBC News, 29th May 2008 (2min17 and 2min10)

<http://tinyurl.com/gmvideo2-3>

GM Debate: For



From the video

1. There are several countries where GM technology is already in use
 - a. Name a country mentioned in the video
 - b. What crops are included in the video?
 - c. How does this benefit the farmers?
2. Why does Lord Taverne believe the debate has been reignited?

GM Debate: Against



From the video

1. Why is GM an 'uncertain technology'?
2. Which countries have already trialled GM crops?
3. Write down two reasons Lord Melchett gives to support his opposition against GM crops

Thinking Deeper

Create a table with two columns, one for arguments in favour of GM crops and one for arguments against GM crops. Start by including arguments discussed in the videos but feel free to add other reasons you can think of.

Arguments for GM Crops	Arguments against GM crops



Creative Commons, Headline Bioethics, University of Leicester, 2011



ONLINE RESOURCES

There are many websites that contain useful background information on the topic of genetic modification and the current debate.

- A good place to start is the **Bioethics Briefing** on Crop Plant Genetic Modification which covers the technology involved as well as the ethical considerations.
<http://tinyurl.com/bioethicsbriefing>
- The **Nuffield Council on Bioethics** are an independent body who examine and report on the ethical issues within biology and medicine. A past project on GM crops published a report in 1999 titled 'Genetically modified crops: the ethical and social issues'. <http://tinyurl.com/nuffieldGM>
- The **NCBE** have an extremely useful guide to GM food which covers the technology, issues, regulations, case studies, history and links to other sites and publications.
<http://tinyurl.com/NCBEgmfood>
- **New Scientist** magazine has a website with an introduction to genetic modification and the latest news articles <http://tinyurl.com/newscientistgmfood>
- The **Soil Association** promote plant-friendly food and, as such, campaign against GM food.
<http://tinyurl.com/soilGMfood>
- The **Food Standards Agency** is an independent Government department who protect the public in relation to food. Their website provides information on their work such as safety assessments and also provides a few teaching tools. <http://tinyurl.com/foodstanGM>
- **Greenpeace** – a charity that campaigns against GM food. <http://tinyurl.com/greenpeaceGM>

TEACHERS NOTES - GENETIC MODIFICATION FAQs

Is Genetic Modification (GM) a modern technology and what is meant by 'classical breeding'?

- Genetic Modification – aka. Transformation, genetic engineering, transgenesis
 - Where cloned genes are transferred into the chromosomal DNA of another organism
- In one sense, the process of genetically modifying an organism dates back approximately 12,000 years – more commonly known as selective breeding
- 'Classical breeding' consists of crossing organisms, either via genetic recombination or independent assortment - it is 'blind' and as such the outcome is unknown
- A common use of classical breeding was to produce new varieties that have specific properties – e.g. a higher yield
- First GM of a microorganism – 1973
- First GM of a broad leaf plant (tobacco, tomato) – 1983
- Late 1980s, first GM of a narrow-leaved plant (cereal crops)
- Initial trials used the bacterium, *Agrobacterium tumefaciens*, which transferred genes for antibiotic resistance into tobacco plants

How are the cloned genes inserted into another organism?

- There are two main methods – *Agrobacterium* and the 'gene gun'
- *Agrobacterium*
 - Causes crown gall disease to develop in dicotyledonous plants (broad-leaved plants)
 - Galls are large tumour-like swellings caused by the bacterium, a natural pathogen, transferring its DNA into the plants genome
 - The genes, that code for the disease, are found on the Ti (tumour-inducing) plasmid
 - Plasmid – circle of DNA separate from chromosomal DNA that has the ability to replicate independently – they code for non-essential functions so the bacterium can survive without the plasmid
 - Bacterium transfers its DNA from the plasmid into the host (in this case the potato plant)
 - The genes integrate and transfer the genetic information that causes the gall to form
- Gene Gun
 - Method involves gold or tungsten micro-particles coated with modified DNA that are propelled into a target cell at a very high velocity by an electrical discharge or compressed helium gas
 - Known as biolistic transfection

What are some other uses of Genetic Modification?

- Human insulin - 1982
- Cheese manufacturing – the enzyme Chymosin, usually extracted from the stomach of calves (<http://tinyurl.com/NCBEcheese>)
- GM mosquitoes – engineered so the parasite cannot infect the gut and as such is not passed on when the mosquito feeds (<http://tinyurl.com/BBCmosquito>)

When and where were the first GM crops introduced?

- Early 1990s, commercial scale field trials in the USA were introduced
- Between 1986 – 1997, approximately 25,000 GM crop field trials were carried out on over 60 crops with 10 traits in 45 different countries – 72% of which were in the US and Canada
- Between 1996 – 2002, the total area of GM crops in the USA increased from 1.7 million to 34 million hectares
- By agricultural standards, the adoption rate was very high for such a new technology
- Regulatory frameworks – safety and ethical guidelines across the world enforced by government agencies
- International protocols prohibits misuse of GM organisms for biological warfare

What are some of the ethical benefits of growing GM crops?

- Agriculture
 - Biotechnology offers a prospect of long-term sustainable agriculture to farmers in Third World countries
 - In other words, feeding the poor
 - Increased yield of crops
 - More efficient use of land – by modifying crops to survive in tough environments e.g. soil with high pH
- Environment
 - Less chemicals used to control pests
- Human Health
 - Creation of crops that produce drugs or enriched with vitamins and minerals

What are some of the ethical concerns regarding GM crops?

- Some believe moving genes between organisms is intrinsically wrong
- Environmental Concerns
 - New plants will become pernicious weeds
 - GM plants will transfer their new genes to their wild relatives or similar crops with unforeseen consequences
 - Plants with introduced genes may lead to the establishment of resistant populations of pest
- Food Safety
 - It may be possible for the marker genes e.g. antibiotic resistant genes, to be transferred into other organisms including humans
- Agriculture
 - Shift towards larger farms and more capital-intensive farming which would favour wealthier farmers in more developed countries – exploitation of the economically weak
 - Leaves people reliant on GM and the biotech companies

- Financial
 - GM seeds often expensive
 - Accusations that the biotechnology companies are only motivated by the financial incentives
- Misuse – biological warfare (although there are international protocols prohibiting this)

Background on specific videos

What is late blight and why should we be concerned about our potato industry?

- Late blight caused by water mould *Phytophthora infestans*
- Thrives in wet weather, 60 to 80F and high humidity
- Attacks leaves and tubers
- Most destructive disease to affect potato crops – the fourth largest food crop
- Annual losses estimated at £3.5 million
- Costs £350 per hectare to control the disease
- Farmers spray crops 10-15 times per season but does not necessarily prevent the disease

Is late blight just a recent problem?

- No, it has been a problem at other times in history e.g. the Irish Potato Famine
- 1845-1852 Ireland experienced the Great Famine – a period of mass starvation
- Irelands population decrease 20-25%
- Approx. 1 million people died, 1 million emigrated
- Loss of potato crops intensified due to social, political and economic factors experienced within the country

What is the aim of this trial?

- To assess if this approach to crop disease resistance is likely to be successful and if so can be deployed into commercial farming

How has this GM potato been created?

- Two genes that give potatoes resistance to the pathogen were taken from wild South American species that are not themselves edible
- They also contain another gene resistant against the antibiotic kanamycin
- Kanamycin is used during the modification process to select plants that also contain the inserted resistance genes

Where is the location of the trial?

- At the Sainsbury Laboratory at the John Innes Centre in Norfolk
(<http://tinyurl.com/sainsburylab>)
 - Opened in 1988
- Area of the trial equals 1000 square metres
- Over 3 years, 200 square metres will be sown

Who funds this trial?

- The UK Biotechnology and Biological Science Research Council (BBSRC) supports and funds the use of GM as a lab tool (<http://tinyurl.com/BBSRChome>)
- No commercial funding

What are the potential benefits of producing these potatoes?

- Reduced use of chemicals to treat the disease
- Save money
- Reduce use of tractors etc – carbon dioxide emissions

Do the local residents need to be concerned?

- Pollen does not usually travel more than 10 metres
- Potatoes cannot cross with any other natural species
- In the unlikely event that GM potatoes did cross with other potatoes any seeds produced would not be saved as they are grown from tubers

TEACHERS NOTES -DETAILED VIDEO NOTES

'Latest GM crop trials attacked by the Soil Association'

BBC News, 12th June 2010 (2min57)

<http://tinyurl.com/gmvideo1>

Reporter:

"Protected by security fencing in the English countryside, 196 genetically modified potato plants. They have had genes swapped with other potatoes resist to late blight, which caused the Irish potato famine and is still a huge problem. Farmers have to spray crops up to 15 times a season to prevent it."

Prof. Jonathan Jones, the Sainsbury Laboratory:

"All those chemicals that are applied could be replaced by genetics we believe, so if we have right genes in our crops then we wouldn't need to spray so much. So we have been cloning genes from wild relatives of potato and putting them into cultivated varieties and we have shown they work against lab strains of this pathogen, this disease, we want to show they actually work against the races that are circulating out there in the field."

Reporter:

"Over a million pounds have been spent on this project alone but scientists here say blight costs farmers as much as 60 million pounds a year, but there has been fierce opposition from those that think the science is flawed."

Patrick Holden, Director, Soil Association:

"We think this is a scandalous misuse of public funds for a project which is not delivering any public benefits. We were originally open minded and agnostic about GM but we studied the issues and the science and we have concluded that there are no farmer benefits, there are threats to the environment and potentially to human health."

Reporter:

"Previous GM trials in the UK have been attacked by protesters. Here a crop of genetically modified oil seed rape was destroyed in 1999. Despite government enthusiasm in the 1990s, it was public opposition that brought to an end those plans for GM crops. Now there are no commercially cultivated GM crops in the UK although licensed plants like this one are allowed and this trial comes at a time when the debate is about to intensify. Dr Helen Wallace resigned from the Food Standards Agency committee set up to gauge attitudes towards GM foods. She said it was biased towards biotech industries."

Dr Helen Wallace, Director, GeneWatch UK:

"We are seeing a big PR push from the GM industry at the moment. They are trying to convince the public that we need GM crops, a new generation of GM crops to feed the world and at the same time they are trying to weaken regulations in Europe so that we see GM crops and foods back on British supermarket shelf."

Reporter:

"The new environmental secretary Caroline Spellman has voiced her support for GM in the right circumstances and leading scientists say advanced technology means it is now time for fresh public debate."

Prof. Sir David Baulcombe, Botanist:

"The new trial in Norfolk represents part of this recent scientific development and it is appropriate that it goes back to the public for them to take stock and assess whether or not they agree with the scientists that this is a technology that is useful and that is not harmful to people."

Reporter:

"These small plants are not at the centre of the UKs GM debate and while they may remain free of disease, they are unlikely to stay free of controversy."

'GM food: Monster or Saviour?'
BBC News, 29th May 2008 (2min17 and 2min10)
<http://tinyurl.com/gmvideo2-3>

A set of two clips – GM Debate: For and GM Debate: Against

GM Debate: For

Reporter:

"Here in Britain indeed across Europe, it's not so much a question of laws banning GM food but rather regulations, which means its introduction is practically impossible. Many consumers it seems have been put off by labels such as 'Frankenstein food' so here in the House of Commons there are very few voices raised in favour of GM, very few voices prepared to take on that strand of public opinion. But one notable exception is Lord Dick Taverne."

Lord Taverne:

"Outside Europe, where there is a crazy ban on the stuff, outside Europe it's been the biggest success story of any recent development in agricultural technology. It has spread like wildfire and there is something like 11 million small scale cotton farmers whose health has improved, whose income has benefited because they now farm transgenic cotton and in time, there will be benefits in the food field where they aren't so many at the moment yet but already the papaya crop for example in Hawaii was saved by genetically modified papaya which dealt with the pests they have to deal with. It's got a huge potential contribution to make towards diseases and also as a more efficient form of agriculture."

Reporter:

"What in your terms has gone wrong then Sir, if the scientific cases there it is established, then why are we in this position in the UK and in Europe?"

Lord Taverne:

"Well, because in Europe there has been a great deal of propaganda by people who for some reason have adopted an idiological reason against it. I mean you have got a huge field trial that has been carried on for over 10 years in America where hundreds of millions of Americans have been eating food with a GM content for over 10 years and there hasn't been even a single law case. If American lawyers can't find a ground to sue then there must be something right."

Reporter:

"We were starting to sense that the debate has been reignited?"

Lord Taverne:

"Yes it's been reignited. I think in particular because of the sudden explosion in world food prices and people have recognised that we desperately need the most efficient form of agriculture. I'm not saying that genetically modified agriculture is the only answer, it's one of many answers but it's an important part of the answer."

Reporter:

"Lord Taverne insists for this debate to move forward will take leadership, leadership from the politicians but also from the big retailers, the supermarkets that so dominate the food market place."

GM Debate: Against

Reporter:

"Well those that have been consistently against genetically modified food and crops, remain steadfast in that position. This is the organic farm belonging to Lord Peter Melchett of the Soil Association and he's just told me, there is no way that he will ever advocate GM food."

Lord Peter Melchett:

"The problem is that this is an uncertain technology which the scientists can't control. They do not know what impact it may have when it's released into the environment. In control conditions where GM organisms can't escape its a different matter, that has always been the case. But if you put it in the environment GM can get into the soil, we don't know even enough about the soil to know what kind of effect it may have. GM organisms can spread as we know, throughout nature."

Reporter:

"We have, in countries like notably the United States hundreds of thousands, probably square miles of GM crops who've had that for best part of a decade. This catastrophe just isn't happening is it?"

Lord Melchett:

"One of the reasons we haven't had it is because they haven't been able to control it. For example in Canada with oil seed rape, organic farmers just have to stop growing the crop, end of that crop, because all of it was contaminated with GM. Now the other question to ask about the US and Canada is why have they said no to GM wheat. GM wheat was ready to be marketed; it's the biggest worldwide staple crop of all. It's been on the books for years and farmers in Canada and the US have said no."

Reporter:

"Makes food cheaper for consumers then?"

Lord Melchett:

"No, no it doesn't. It simplifies life for very large farmers, but the cost argument is pretty marginal as you are paying a lot more for the seed and now they are having to use 2-3 sprays to deal with insects and weeds resistant to the original GM idea so no it doesn't save money. It's good for very large agri farm businesses, bad for everyone else, very risky for the environment, still huge unknowns."

Reporter:

"For Lord Melchett then, GM remains a potential time bomb. He and others suggest we can feed the whole world based on the techniques he uses here which is strictly organic methods."