BioethicsBytes Guides to Streamed Media

2. Genetic Modification

Introduction to this resource

This is the second *Guide to Streamed Media* being produced by the *BioethicsBytes* team at the University of Leicester. These guides are intended to offer busy lecturers and school teachers advice on the best video and audio clips for teaching about the science and ethical implications of new developments in biology and biomedicine. The advent of online news archives, and broader support materials for other programmes, makes it relatively straightforward to incorporate streamed media of this kind into Biology, RE or General Studies lessons. This teachers' resource is designed to offer a guided tour through some of the most readily applicable clips available on the internet. In addition to providing background material, we have also produced some 'off the shelf' worksheets for use in conjunction with the selection of clips.

Within the text there are embedded hyperlinks that are underlined and marked by a pointing-hand logo (☞). If you wish to follow a link, hover over the relevant words and press Control & Left Click with the mouse. Most of these recommended clips are currently being streamed on the BBC website (www.bbc.co.uk). The length of each clip is shown in brackets. In addition to the streamed media themselves, there are also links to reviews and articles offering background to the field.

There is probably too much information here, and too much repetition between clips, to justify using all of the recommended material with a group of students. It is, however, suggested that you watch (or listen) to all of the streamed media before deciding which to show. You may then elect, for example, to include one of the introductory clips to demonstrate the potential of Genetic Modification, and then one from the later sections to give a more detailed application.

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Introduction to Genetic Modification

Mention Genetic Modification (GM) and most people will think automatically of the controversy surrounding the use of new genetic technologies to produce plants with new characteristics. Although this image is not without substance, it is deficient in a number of ways. Firstly, the focus on plants alone fails to recognise the fact that the same technologies are also being applied in the development of a broader range of Genetically Modified Organisms (GMOs), from bacteria through to higher vertebrates. Secondly, the focus on the new methodologies tends to underemphasise the long tradition of modifying organisms by selective breeding and/or the use of chemicals and radiation to promote random mutagenesis. Since this resource draws on media coverage of GM it inevitably reflects the emphasis on plant biology (Introduction and Section 2.1), but broadens the discussion to genetic engineering as a means to produce human proteins and drugs (Section 2.2) and a variety of other novel applications (Section 2.3).

Plant breeding

'Classical' plant breeding involves crossing organisms that may have been only distantly related to produce new varieties with beneficial properties such as the capacity to thrive in tougher environments, or to generate a higher yield. This requires several rounds of controlled interbreeding to obtain the desired characteristics within a suitably stable genotype (the genetic make up of the organism). This technique relies on genetic recombination and independent assortment, the processes by which DNA is naturally 'shuffled' at meiosis, and is essentially a random event. Classical breeding is 'blind'; the breeder does not know what genes have been introduced to the new progeny. There is therefore the risk of unintended outcomes. For example, there are reports of the accidental selection via breeding of high levels of toxins such as solanine in potatoes and psoralen in celery.

After World War II, scientists started using chemicals and UV irradiation to induce mutations in plants with the hope that the mutations would lead to more favorable strains being produced. Plant tissue culture is also used to produce viable progeny from matings that would naturally have been unsuccessful. This has resulted in, for example, the cereal Triticale which is an artificial wheat-rye hybrid.

Newer 'GM' technologies

The newer approaches to GM ought, in one sense, to have received a more favourable welcome since the technology allows for the deliberate introduction of genes of known function without the randomness of either traditional plant breeding or processes involving mutagenesis. The fact that there has actually been widespread hostility is perhaps the result of general ignorance regarding the other technologies that had been used (and continue to be used), making molecular genetic approaches seems 'new' and 'risky'. More than this, however, it is the capacity of the molecular genetics methods to introduce genes that come from very different organisms, including transfers across Kingdoms, that has caused alarm. There is a certain 'yuk factor' in knowing that an insect gene has been introduced into a plant, or that a pig glows a peculiar green colour because it has received a gene from a jellyfish. The using of so called 'marker' genes, often conferring antibiotic resistance, as a means of checking that the desired gene transfer has occurred has also been controversial.

A number of independent reports have been published in the UK stating that there is no harm to the environment or to human health in the development and growth of GM food. Despite this, the media (particularly some of the 'tabloid' newspapers) have been proactive in opposing GM, coining terms such as 'frankenfood' and thereby fuelling public concern that safety has not been adequately addressed. At the same time, vigorous marketing of organic food as healthy and wholesome has led to a sharp increase in sales of organic ranges within supermarkets, and the perceived need by restaurants to declare their menus "GM-free".

Online resources

There are many websites with helpful background information on the GM debate. A good place to start is the Bioethics Briefing on ☞ **Crop Plant Genetic Modification** in which the technology is discussed along with the ethical considerations regarding GM's use in crop plant modification.

The Biotechnology and Biological Sciences Research Council (BBSRC) has an online resource called ☞ **inGENEious**. It was published in 1999 and is therefore a little out of date in terms of the current applications, but has useful background information including a timeline and a discussion of ethical issues facing the technology

New Scientist magazine has a continually updated ☞ **Expert Guide to the GM debate** which can be found following the link. This was last updated in September 2006.

The ☞ **Food Standards Agency (FSA) website** has links to a number of reviews about GM; as well as a quiz and a game that can be played.

The British Medical Association (BMA) published a report entitled ☞ **'Genetically modified foods and health: a second interim statement'**

The ☞ **Department for Environment Fisheries and Rural Affairs (DEFRA) website** with government legislation regarding the use of GM foods as well as a description of current research and completed projects.

The ☞ **Soil Association**, responsible for the promotion and certification of organic foods in the UK, have a website which is understandably less enthusiastic about GM.

Video links

In this section, there are links to two videos that demonstrate contrasting attitudes to GM. These are helpful starting points in discussion of GM as each includes examples of arguments for and against developments.

☞ ***GM crops report results to be released* – BBC News, 21 Mar 2005 (1min 20 s)**

The first video (link above), discusses the release of the findings of the Government's ☞ **GM Science Review,** which was led by Professor Sir David King (the Government's Chief Scientific Adviser) working with Professor Howard Dalton (the Chief Scientific Adviser to the Secretary of State for the Environment, Food and Rural Affairs), and with independent advice from the Food Standards Agency.

In fact, two reports were published, both of which found no scientific reason for ruling out the use of GM crops and their products. Nevertheless, the review panel also felt it was important for the development of the GM industry to be regulated on a case-by-case basis.

The video discuss four crops; sugar beet, maize and spring and winter rape. All the crops in the study had been engineered to be resistant to a specific weed-killer and hence the farmers were able to control the spread of weeds more effectively. The government approved the growth of GM maize, under strict conditions.

☞ ***GM crops: Hope of the poor or a risk?* - BBC News, Nov 11th 2004 (2min 18s)**

The second video shows how GM is changing farming in a poor area of South Africa, where farmers have a lower level of production and are very dependant on the environment for the success of the harvest. Joseph, a farmer, discusses his enthusiasm for GM following his first Maize crop using seeds bought from Monsanto. The video also features an interview with an opponent of the technology.

A Worksheet for use in conjunction with these clips is given on the following page.

Summary of some ethical arguments for and against GM

In favour of GM Crops

- They are already grown in many countries and have been shown to be safe
- There is much more regulation regarding the safety of the food compared to food produced using classical breeding techniques- at least you know where the DNA is and what DNA is in the new varieties
- Can benefit human health by creating crops that produce drugs or are enriched with extra nutrients
- Benefit the environment by the use of reduced chemicals to control pests
- Allow the efficient use of farming land
- Improved yields
- Can help to feed the poor

Against GM crops

- Unknown effects on health
- Risk of contaminating non-GM crops- particularly organic farms
- Destroying the natural environment (and genetic biodiversity) by reducing the number of weeds
- Financial cost for the seeds, particularly if they produce crops that are deliberately infertile and therefore not able to be used in subsequent years due to ‘terminator’ technology
- Questioning the motivation of the Biotechnology firms as “only in it for the money” not to feed the poor
- Cultivating reliance on large, Western, Agribusiness
- Could increase the use of chemicals as farmers are able to spray as much as they wish without the detriment to their cash crop.

Introduction to Genetic Modification

GM crops report results to be released -BBC news, 21 Mar 2005

http://news.bbc.co.uk/player/nol/newsid_4360000/newsid_4367200/4367253.stm?bw=bb&mp=rm

1. Tick the names of any of the following crops if they are named in the video:

Rice	Beet
Maize	Spring oilseed rape
Corn	Winter oilseed rape
Rye	Barley

2. What changes had been made to the crops discussed, and why?

3. Several different views about GM crops are discussed. Make a note of the arguments made by, or attributed to: environmental groups, biotech companies (e.g. Monsanto), the scientific community, and farmers.

GM crops: hope of the poor or a risk? – BBC News, 11 Nov 2004

1. Where is the 'Quiet Revolution' taking place?
2. Give TWO reasons why Joseph, the farmer, is happy with his crop
3. Give TWO reasons why the anti-GM protesters are against this technology.
4. What does the reporter, Barnaby Phillips, suggest is the key to Africa's future?

http://news.bbc.co.uk/player/nol/newsid_4000000/newsid_4004000/4004069.stm?bw=bb&mp=rm

Thinking deeper

- Decide whether you are in favour or against GM crops. Having done so, write a short speech giving as many arguments as you can to persuade someone why this opinion is correct.
- Compare the attitude to GM shown by the farmers in the two reports. What factors might influence the different responses they display?

2.1 Genetically modified crops

The genetic modification of crops to produce varieties that are resistant to disease, pests or chemicals has been the main focus of studies in the UK. Throughout the world, millions of acres of GM crops are grown and harvested for consumption either by humans or in animal feed. In 2002, the USA, Canada, Argentina and China grew 99% (in terms of land use) of all GM crops; with the USA accounting for two-thirds of the world total. GM crops are also grown in Australia, Bulgaria, Columbia, Germany, Honduras, India, Indonesia, Mexico, Romania, South Africa, Spain and Uruguay. The use of GM crops is increasing rapidly, with a 12% increases between 2001 and 2002. The main crops grown are soybean (62% of the global market), maize (19% of the global market), cotton 13% of the global market) and oilseed rape (5% of the global market). These statistics were taken from the ☞ **GM nation public debate** on the use of GM technology.

Video links

☞ ***GM potatoes heading to UK* – BBC News 1st Dec 2006 (1min 39s)**

☞ ***Meeting over GM crop plans* – BBC Look North, 5th April 2007 (3min 26s)**

In December 2006, DEFRA approved an application by the company BASF to carry out trials of GM potatoes at two sites in the UK. At the time of writing the guide the exact locations for growing the blight-resistant crops had not been decided. These two news reports pick up on some of the debate taking place near potential trial sites in Derbyshire (1st December report) and Yorkshire (5th April).

In the first video, the emphasis is on the economic importance of the development, with additional consideration of both safety of the environment and the consumer. The logistics of the trial are discussed. Scientists say they have to be given the opportunity to experiment with the new crops to decide whether they are an improvement on the conventional varieties and the only way to do this is in an open field trail. It is estimated that GM crops are another 5-10 years off commercial growing in the UK.

The second video includes interviews with a scientist from BASF and with a representative of Friends of the Earth (as well as some ‘vox pop’). The proposed field trial of GM potatoes is again the impetus for the discussion. Amongst other things, this clip is interesting as a vehicle for discussing the ways that the overall impression in a media report can be influenced by the choice of phrasing by an interviewer and the order in which material is presented. Similarly, GM protesters frequently wearing white overalls when uprooting crops for the value the image conveys rather than for any protection.

Applications of GM technology: Genetically modified crops

GM potatoes heading to UK – BBC News, 1st Dec 2006

http://news.bbc.co.uk/player/nol/newsid_6190000/newsid_6197500/6197560.stm?bw=bb&mp=rm

1. Which country already has trials of the GM potatoes?
2. What disease do potatoes often get?
3. What is the financial cost to the UK each year as a result of this disease?
4. What is the primary focus of the study?
5. Name TWO safeguards being taken at the National Institute for Agricultural Botany to stop the accidental spread of GM.

Meeting over GM crop plans – BBC Look North, 5th April 2007

http://news.bbc.co.uk/player/nol/newsid_6530000/newsid_6530300/6530323.stm?bw=bb&mp=rm

1. What do anti-GM protestors sometimes nickname this sort of crop?
2. Give TWO reasons why the organic farmer interviewed objects to this trial.
3. What does the man from BASF say are the goals of the trial?
4. Why does the woman from Friends of the Earth object to the trial?

Thinking deeper

- Think about the second clip (watch it again if you get a chance). How much does the phrasing of the interviewer's questions to the man from BASF and the woman from Friends of the Earth influence to overall balance of this 'neutral' report? In what other ways can the way a News report is constructed influence our opinion about a story?

2.2 Drugs, health and PHARMING

As mentioned above, there have been major strides in the use of genetic engineering for other purposes, particularly the production of human proteins and drugs. The best-known example would be the modification of bacteria to make human insulin, but this is not a suitable solution in all cases (e.g. human proteins often fold wrongly when made in bacterial cells and are therefore useless). Much of the work on alternatives, such as those described in the linked videos, are at an early stage of research.

Video Links

☞ ***Eggs offer drugs breakthrough*** **– BBC News, 15 Jan 2007 (2min 13s)**

British Scientists (at the Roslin Institute in Scotland, famous for making Dolly the Sheep) have transferred DNA into the yolk of a fertilised chicken embryo. The resultant chick carries the DNA and can produce human proteins, which can be collected from the white of any eggs she subsequently lays. The proteins may then be harvested and purified and used in the treatment of disease (e.g. cancer or multiple sclerosis). This is promoted as a cheaper way of producing large amounts of medicine, but there is a potential risk of a cross-species transfer of viruses. However, stringent quality control makes this unlikely to occur.

☞ ***Medicine hope from human DNA goats*** **– BBC News, 22 Feb 2006 (3min 18s)**

The second video shows goats that have been engineered to produce a protein called anti-thrombin. This is a protein that stops blood clotting. Many people who have thicker blood take drugs to reduce the viscosity of their blood; such are warfarin - however if they have to undergo surgery they cannot take blood thinners due to the risk of excess blood loss during the procedure. They are therefore given anti-thrombin treatment instead. Currently this is harvested from human blood plasma - which carries a risk of vCJD. The use of the anti-thrombin from the transgenic goats negates this risk.

☞ ***GM Insulin breakthrough*** **– BBC News, 4 Apr 2007 (1min 35s)**

This is a short news item about the potential of using a crop in Chile to produce insulin. The company behind the process argue that as little as 15,000 to 17,000 acres would be sufficient to treat all diabetics. If they can show that the insulin is 'normal' then they hope to get rapidly through the approvals process. Anti-GM protesters argue there are risks of contaminating other plants, but the scientists behind the development argue that it will aid both the environment and the poor.

Note that a longer version of Susan Watts' report was broadcast on Newsnight the same day. The long form has been given the same title, which is unhelpful not only because of potential confusion, but also because the focus is rather broader than GM insulin alone. The link to the longer version is:

☞ ***GM insulin breakthrough*** **– BBC Newsnight, 4 April 2007 (12 min 41s).**

Applications of GM technology: Drugs and PHARMING

Eggs offer drugs breakthrough – BBC News, 15 Jan 2007

http://news.bbc.co.uk/player/nol/newsid_6260000/newsid_6261400/6261451.stm?bw=bb&mp=rm

1. What is the aim of the research discussed in the clip?
2. How are 'transgenic chickens' made?
3. Name TWO advantages of using chickens.
4. Name ONE possible risk of this approach.

Medicine hope from human DNA goats – BBC News, 22 Feb 2006

1. Transgenic goats have been given a gene to produce a human protein called anti-thrombin. How is the drug obtained from the goats?
2. What is anti-thrombin used for?
3. Why are the scientists confident that there is no new risk in using proteins made in goats?
4. How many blood collections of human anti-thrombin would it take in a year to match the productivity of one goat?

http://news.bbc.co.uk/player/nol/newsid_4740000/newsid_4741800/4741860.stm?bw=bb&mp=rm

GM Insulin breakthrough - BBC News, 4 Apr 2007

http://news.bbc.co.uk/player/nol/newsid_6520000/newsid_6525500/6525525.stm?bw=bb&mp=rm

1. Name the human protein being made in this crop.
2. How many acres of this crop would need to be grown to treat everyone that requires the protein?
3. What are the risks of this technology?
4. In what ways, do scientists argue, are these newer products different from the first wave of GM crops?

Thinking deeper

- Draw up a table with two columns. In one column, list the arguments in favour of producing human medicines in animals and plants, and in the second list arguments against. Feel free to add other reasons that were not discussed in the videos if you are aware of any.

2.3 Broader applications of GM technology

☞ ***Pond scum could fuel cars of future*** **– BBC News, 4 Nov 2005 (2min 59s)**

Running cars on hydrogen rather than petrol or diesel is being considered as a way to reduce greenhouse gas emissions since the only waste product is water. This is, however, only a partial solution at the moment as the source of the hydrogen is currently natural gases, which are themselves contributing to the problem. Two more environmentally-friendly sources of hydrogen are discussed; solar foil and GM bacteria, engineered to produce the gas. This research is at an early stage and requires serious commitment and financial backing equivalent to the money that has been spent on aspects of space exploration.

☞ ***GM mosquito 'to fight malaria'*** **– BBC News, 20 Mar 2007 (2min 19s)**

This is a recent example of GM use to produce a modified insect. Malaria is caused by a parasite called *Plasmodium falciparum.* This infects mosquitoes and lives in their guts. A team in America engineered a mosquito so that the parasite could not infect the gut. They introduced a marker into the mosquitoes to tell the difference between the normal and GM ones; the eyes of the modified flies express green fluorescent protein (GFP). The hope is that when the mosquito bites a human the parasite is not passed on. This breaks the lifecycle of the parasite.

Malaria is a huge problem, with 300 million people ill with malaria and 1 million people dying from malaria each year. A child dies from malaria every 30 seconds in Sub-Saharan Africa.

The scientists placed an equal number of normal and GM mosquitoes in a cage with a malarial infected mouse and looked at the difference in survival rates amongst the insects. They found that the survival rate of the GM mosquito was greater than that of the normal mosquito. This may be expected as the mosquito does not have the parasite and therefore may be thought of as ‘fitter’.

Scientists are excited by this research but see it as a very preliminary result and envisage a wait of 10-20 years before the mosquitoes could be released after further investigation into the genetics, ecological, social, ethical and legal issues relating to introducing a new insect into the environment..

Other examples of GM use - links to websites (*not* video/audio links).
☞ ***Scientists spin first lab-made spider silk*** **Lazaris A.** ***et al*** **Science (2002)295;472**
This discusses the production of silk from goats’ milk. The protein that forms silk is excreted in the goats’ milk it can then be purified and spun into silk.
☞ **'Living condom' could block HIV (New Scientist print edition, 8 February 2003)**
This discusses the use of modified vaginal bacteria that can be placed in the vagina to interact and stop the spread of the HIV

2.3 Broader applications of GM technology

Pond scum could fuel cars of future – BBC News, 4 Nov 2005

http://news.bbc.co.uk/player/nol/newsid_4400000/newsid_4408700/4408788.stm?bw=bb&mp=rm

1. What fuel is used in these cars?
2. What are the advantages of this fuel?
3. What is the current method of producing this fuel? Name TWO alternative methods being considered
4. What is hindering the new GM technology?

GM mosquito 'to fight malaria' – BBC News, 20 Mar 2007

1. What causes malaria and how is it transmitted to humans?
2. How many people die of malaria each year?
3. How can the GM mosquito be identified?
4. List some of the considerations mentioned that need to be taken into account GM mosquitoes can be released?
5. How long is it likely to take before this can happen?

http://news.bbc.co.uk/player/nol/newsid_6470000/newsid_6470600/6470639.stm?bw=bb&mp=rm

Thinking deeper

- What might be the risks if a genetically modified organism released into the wild did not behave as expected?
- The environment that we live in is not really 'natural', humans have changed it to suit their needs since time immemorial. Discuss.