# Gene Technology

## Background, National Curriculum links and suggested aims

This lesson is intended for use when teaching about gene technology to Years 10-11. It has been written for use in a Biology lesson.

## Teacher background knowledge

No special background knowledge required for a Biology teacher. The science behind the topic is adequately covered in most school textbooks though the message can come across as rather deterministic – it would be good for students to realise (a) how changes in the genetic material do not always result in changes to an organism's phenotype; (b) that the history of gene technology is of scientists and others finding that it often doesn't work quite as expected; (c) that factors other than genes play a role in the phenotypes of organisms.

It would be helpful if the person teaching the lesson had some understanding of theological views about gene technology, for instance by discussing the issue in advance with a specialist RE colleague. Some people with a strong religious faith are hesitant about or even firmly against gene technology, sometimes on the grounds that it is 'playing God'. Others with a religious faith have argued that religions have a strong tradition of supporting advances in agriculture and medicine. In the Christian tradition it has been argued that gene therapy for humans can be seen as an appropriate response to living in a world that has been damaged by the Fall.

## Cross-curricular links

There are links to Philosophy (ethics) and to Religious Education.

## Student background knowledge

Students should know the standard (albeit simplified) story that genes make proteins and such proteins are responsible for an organism's phenotype (characteristics), so that changes to an organism's genes may result in changes to the organism's phenotype.

## Resources and timing

Two lessons of 50 minutes. Time is needed between the two lessons for students to prepare for the role play / debate in lesson 2.

## Activities

1. Ensure that students are aware of:
    a. The basics of genetic engineering;
    b. The distinction between somatic gene therapy (only affects the individual, not their offspring) and germline gene therapy (changes are made to eggs and/or sperm, so pass to succeeding generations).

2. Get students to list *present* uses of gene technology. Examples include:
    a. Changes to crops to reduce losses to pests or to reduce the use of potentially harmful pesticides;
    b. Changes to foods so that they last longer;
    c. Production of medicines from bacteria or other non-humans (e.g. humulin – human insulin produced by recombinant *E. coli*);
    d. Creation of 'model animals' that are more likely to develop diseases similar to those that humans develop (e.g. cancers, Parkinson's disease, obesity) so that treatments that may eventually benefit humans can be tried on the animals first.

3. Get students to list possible objections to genetic engineering. Obviously, these depend on the particular instance of the technology that is being considered. Possibilities include:
    a. Unnatural (true, though lots of technologies can be considered 'unnatural');
    b. Risks to the environment (true, though we have had these without gene technology – e.g. introduced pests – and gene technology may also have benefits for the environment);
    c. Playing God (true, though see possible response above in 'Teacher background knowledge');
    d. Unsafe for humans (a risk for just about any new technology and we can check for safety; some argue that gene technology has had more safety checks than just about any other technological innovation, others that permanent changes to the genetic material of organisms mean that we can never be sure the technology is safe).

4. Get students, partly at the end of lesson 1 and partly for a subsequent homework, to rehearse a particular actor's arguments for or against a particular instance of genetic engineering (i.e. each student or small group of students takes on the arguments of one actor). A possible example would be attempts to use somatic gene therapy to treat haemophilia (currently at an advanced stage of research). Here are several possible roles:

a. *Person with haemophilia and their immediate family*: Worried about the condition and their future; broadly supportive of the possible use of gene therapy but also wish more money was invested in things like nursing care and other sorts of practical support.

b. *Company undertaking research on possible gene therapy for haemophilia*: In favour of the technology but clear about the importance of not promising too much and concerned about accusations of profiteering.

c. *Campaigner for genetic engineering*: Irritated by those against gene therapy and other instances of genetic engineering; sees such people as anti-science, trying to hold back progress.

d. *Campaigner against genetic engineering:* Worried by rapid pace of technological developments; sees gene therapy for humans as the beginning of a slippery slope – we start by treating children with haemophilia (admirable) and we end up using gene technology to allow parents to have a boy rather than a girl or a child of above average intelligence (undersirable).

e. *Animal rights campaigner*: Strongly against the research because it entails the use of animal models; does not believe that laboratory mice are more important than people but doubtful of the usefulness of animal models in medical research; concerned at the suffering of mice as well as of people; concerned at the large numbers of animals used for research into genetic engineering; believes that we do not have the right intentionally to harm sentient animals such as mice.

f. *Regulatory authority*: Keen, if at all possible, to get a consensus on the way forward.

5. After the role play or debate, do the following:
   a. Ensure that students have come out of role;
   b. Consolidate their learning – e.g. by getting them to write key points for and against the proposition.

## Resource links

- Ethics of gene technology:
  https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/genethics,
  https://www.eubios.info/Papers/Vibs186DM.pdf,
  https://en.wikipedia.org/wiki/Nagoya_Protocol,
  https://www.theguardian.com/science/2019/may/10/gene-therapy-experts-plan-to-slash-heart-attack-risk-with-jab?fbclid=IwAR1pyieM2jCdG3ujpCA0bp128AYSbvz7IdmNC9gSZKQphJSuDukX-B8rcdE,
  https://geneticliteracyproject.org/2019/05/28/golden-rice-part-3-a-thoroughly-studied-safe-and-nutritionally-enhanced-gmo-crop-approved-by-australia-canada-new-zealand-and-the-us-but-still-vilified-by-greenpeace-and-other-environmental/?mc_cid=292e40f9dc&mc_eid=66dc5064c0.
- Haemophilia and gene therapy:
  https://www.nhs.uk/conditions/haemophilia/,
  https://haemophilia.org.uk,
  https://www.ashclinicalnews.org/features/breakthroughs-gene-therapy-hemophilia/,
- Theology of gene technology:
  https://scholarship.law.nd.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1358&context=ndjlepp,
  https://www.pbs.org/newshour/science/gene-editing-religion-scientist,
  http://www.jubilee-centre.org/genetic-engineering-exploring-its-role-in-gods-world-by-denis-r-alexander/.