

Genetic Modification Myths

Myth: GM food means that we'd be eating genes and it's not natural to eat another organism's genes.

Fact:

It's impossible to eat without eating genes.

Every organism contains genes. When we eat an apple, we eat the genes in the DNA contained within its cells. These genes in the apple are 'foreign' genes, but they don't have any effect on us because they are digested. The same goes for eating meat.

Even after food is cooked, we are still consuming genes. The cooking process partially breaks the molecules of DNA; we then eat the fragments of DNA in the cooked food. During digestion, the DNA is broken down to its smallest building blocks. Processed plant or animal products, such as wheat flour or salami, still contain gene fragments from the original plants or animals that were the source of the ingredients, and these too, are broken down during digestion.

It is quite natural to eat another organism's genes – indeed, it is impossible to avoid. When we eat roast lamb or raw carrots, it does not mean that we absorb their genes into our system and acquire their characteristics. The genes in genetically modified foods are made of the same material as the genes that we eat every day, and are treated by the body in the same way as other genes. These genes will be digested just like all the other genes in our food and will have no effect on our own genes. If you eat DNA in a GM food, or a conventional food, it will not change your DNA, or the DNA of your children.

Myth: Gene technology is inherently risky so we shouldn't proceed with it.

Fact:

Many people are worried that gene technology is very risky, and it is certainly sensible to consider any hazards that this new technology may bring. By recognising its potential

risks, we can ensure that appropriate safety measures are in place. In this way, gene technology is like many other technologies we currently use. As an example, consider electricity. This is delivered to our homes, schools and offices in a form that is easily lethal - and yet we accept the risk because great care is taken to minimise the dangers of electricity and because we appreciate the benefits that this technology has brought us.

In Australia, gene technology is carefully regulated so that any risks are managed and contained, while allowing its benefits to be realised.

The Office of the Gene Technology Regulator was established by the Commonwealth *Gene Technology Act 2001* (GT Act), and is to be responsible for the national scheme to regulate genetically modified organisms (GMOs). The object of the GT Act is to "protect the health and safety of people, and protect the environment, by identifying risks posed by or as a result of gene technology, and by managing those risks through regulating certain dealings with GMOs." 'Dealings' with GMOs include contained laboratory research, and field trials and commercial release if genetically modified crops.

The GT Act establishes offences for unauthorised dealings with genetically modified organisms. If such dealings occur, offenders are subject to penalties of up \$1.1 million, or 5 years' imprisonment. These penalties are described in more detail in Part 4, Division 2 of the Gene Technology Act.

For more information regarding the Office of the Gene Technology Regulator (OGTR) and the Gene Technology Act (the national scheme to regulate GMOs), please contact the OGTR on 1800 181 030, or visit the OGTR website at www.ogtr.gov.au.

The Australia New Zealand Food Authority (ANZFA) protects public health by ensuring that genetically modified foods are safe for consumption. ANZFA assesses the safety of GM foods, and all GM foods must be assessed as safe before they are allowed to be sold in Australia.

The new joint Australia New Zealand Food Standards Code, approved by the Australia New Zealand Food Standards Council, made up of Australian Government

and State and Territory Health ministers, and the New Zealand Health Minister, provides a common set of food regulations in Australia and New Zealand, including standards for GM foods.

Food standards have the force of law. It is a criminal offence in Australia to supply food which does not comply with relevant food standards. Notwithstanding food standards, it is also an offence to sell food which is damaged, deteriorated or perished, which is adulterated, or which is unfit for human consumption.

Myth: Natural is always best, and altering, exchanging or transferring genes isn't natural, so it can't be good for us.

Fact:

Nature supports us, but not everything in the natural world is always good for us. Cancer-causing ultraviolet radiation from the sun is natural; tobacco and opium are natural. Plenty of poisonous plants and animals are natural.

However, the way we live today is not 'natural' because we have altered nature in order to live in greater comfort and avoid starvation for large groups of us.

In the same way, modifying plants and animals is not strictly natural, and yet humans have done this from earliest times. Selective breeding has been used to produce different types of dog, different types of domesticated farm animals, and all of our crop species. In this breeding, individuals with known characteristics are 'crossed' to exchange genes.

Conventional breeding using crossing can give rise to quite unexpected outcomes. This is because traditional crossing mixes thousands of genes in unpredictable ways. The creation of new varieties in this way involves extensive testing to ensure that natural toxins have not developed.

One of the strengths of planned genetic modification is that only one or a few genes are moved, and the genes and their products are known about beforehand.

Gene technology also permits us to breed new varieties of agricultural species more easily and more quickly than in the past, as the exact gene required to be transferred can be selected, rather than a random crossing of a number of genes, which may or may not include the gene of interest, as occurs in conventional breeding. In addition, because only a few required genes are transferred using gene technology, time consuming 'back-crossing' steps often required in conventional breeding programs can be omitted.

As described above, new varieties created by gene technology are extensively tested before being released commercially, either for use in agriculture and industry, or for consumption as food.

Myth: Genetic modification is bad because it could mean that people will be cloned.

Fact:

Cloning and genetic modification are not the same. Cloning people means creating a genetically identical copy of a person by using the DNA from their cells. Genetic modification involves changing or re-organising the genes of an organism, which does not occur during cloning.

Research into human cloning is already banned in many countries. In Australia, the Commonwealth *Gene Technology Act 2000*, contains Section 192B banning cloning of whole human beings. This prohibition is meant an interim measure until all States and Territories have nationally consistent legislation in place to comprehensively ban the cloning of human beings.

Stopping the use of gene technology in plants is unlikely to have any effect on whether human cloning is eventually developed.

Myth: Cloning never happens in nature.

Fact:

Cloning happens quite often in nature, particularly in the plant world. Whenever a plant sends out a runner, which then develops into a new plant, this is cloning. If a cactus drops a fragment that then puts down roots, cloning has happened again.

Animal and human cloning also happens naturally to produce identical twins (or triplets). Modern gene technology is sometimes involved in creating clones of animals at the early embryo stage. This is similar to the process that creates identical twins.

Cloning animals that are past the embryo stage is also now starting to happen, and has occurred in Australia. This can be a useful way of ensuring that an unusually productive or desirable farm animal can be reproduced. If the high quality animal was instead bred with another individual, it could produce offspring that may not have the desired qualities.

Myth: Changing a gene would never happen naturally, so we shouldn't do it.

Fact:

Genes often change, and this is one of the means by which diversity has been created in nature. Changes can happen naturally by mutation, where the DNA is altered by radiation from the sun and space, by chemicals, or sometimes even by viruses. Genetic change can also happen when eggs and sperm are formed, during which chromosomes break and re-join, sometimes fragmenting genes and reconstituting them with slightly different versions.

These continual natural changes in genes - and the shuffling around of different versions of genes by sexual reproduction - cause the variation that we see in living things, and help to make every individual different. Over time, gene changes have also been responsible for evolution.

Myth: Gene technology will allow people to create stronger, healthier, brighter and nicer-looking children.

Fact:

It's an interesting idea, but at the moment it's not possible for gene technology to be used in this way. Characteristics such as beauty, intelligence and strength are very complex and it's likely that many genes, as well as environmental effects, contribute to each.

Scientists don't yet know enough about human genetics to use gene technology to change these characteristics. Of course, the future may be different. Whether science is used in such a way must depend on how it is directed, which is why the community and our elected representatives need to be well informed and educated about the latest scientific developments.

Myth: A plant gene is fundamentally different from an animal gene, and they're both unlike human genes, so we shouldn't put genes from an animal into a plant or vice versa.

Fact:

Genes are made of the same chemical substance - DNA - regardless of the organism in which they occur. The DNA of all genes contains four variable portions, known as bases. The order in which these bases are arranged is what makes

genes different. But the bases themselves, and the DNA of which they are a part, are the same whether they come from a gum tree, a mouse, a mushroom, a butterfly or a person.

A language provides a good analogy for this. If you re-arrange the words in an English sentence you can change the meaning. But the sentence is still written using English words. Therefore each sentence is 'composed' of the same stuff arranged differently - exactly as with genes. Biologists now know that every living thing on Earth uses the same genetic language - just as every book written in English uses the same English words. A 'foreign' language for life could exist elsewhere in the Universe, but on Earth there is only one.

Because animals and plants evolved from a common ancestor, many of their genes are very similar. In both cases, the genes that code for making vital molecules for cells to function - for example, enzymes for extracting energy or for copying DNA - are virtually identical in any cell, from any organism, anywhere.

In fact, substances that we think of as being very much animal products can be found in plants. An example is haemoglobin, the oxygen-carrying pigment that makes our blood red. The roots of various plants also have a form of haemoglobin. The tiny energy factories in cells - called mitochondria - are nearly identical in plants and animals. The genes that code for the construction and the functioning of mitochondria are virtually indistinguishable between different groups of organisms.

The chemical similarity of plants to ourselves is the reason that we are able to use them as food. Whenever we eat plants, we eat their genes. If you eat a meal of meat and vegetables, you are eating genes from plants and from animals together.

The order of bases in human DNA is remarkably similar to that of many other organisms. The closer a creature is to us in terms of evolution, the greater this similarity. For example, about 98% of our gene sequences are the same as those in chimpanzees. We also share a proportion (albeit smaller) of our gene sequences in common with plants. For this reason, adding a gene found in a plant to an animal, or vice-versa, is seen by some researchers as not breaking much of a barrier.

Gene transfers can sometimes occur in nature - although not to the same degree that biotechnology makes possible. For example, bacteria that colonise plant roots can sometimes pass genes into plants. Viruses regularly move their genes into the cells of the organism that they are infecting. New virus particles can naturally contain fragments of the 'host' genes as well as their own, and may pass these on when infecting another host.

Milk, cheese and eggs contain plenty of genes from animals. For lacto-ovo-vegetarians, the possibility of an 'animal gene' in a plant may not be a concern. However, vegans may find it ethically wrong to eat a plant that contains a gene that is usually found only in animals. Similar ethical objections hold true for those who adhere strictly to religious dietary rules banning the consumption of certain animals (eg. pig or cow). Consumers concerned about this can contact food manufacturers for detailed information about their products, including any GM foodstuffs.

Alternately, the Australian Food and Grocery Council operates the Food Science Bureau, as an initiative of the consumer food, drink and grocery products industry. This service operates to provide the community with information about food science issues. The Food Science Bureau can be contacted on 1300 137 177 or at www.foodsciencebureau.com.au

In July 2000, Australian and New Zealand Health Ministers decided on a scheme for labelling GM foods, to assist consumers in making informed choices. For the latest developments on labelling, see the Food Standards Australia New Zealand website: www.foodstandards.gov.au.

Myth: Gene technology is under the control of multinational companies and won't be used to benefit everyday people.

Fact:

Large companies own much of the intellectual property, or knowledge, associated with new applications of gene technology and this concerns many people. However, not all biotechnology-related research relies on large corporations. There are government-funded organisations, such as universities and the CSIRO, both in Australia and internationally, that also conduct research and allow it to be developed by companies without payment of royalties.

Modern biotechnology is highly specialised and therefore needs skilled people with expensive laboratories and sophisticated equipment. A large company often has the money to spend on this, and usually has existing facilities and experience. The fact that the companies make profits allows them to invest in new technologies. This is why it is mainly big companies that have the money and skill to develop powerful new medicines, for example. Many other procedures in modern agriculture - such as the creation of pest-killing chemical sprays or the manufacture of fertilisers - also rely on large companies.

Governments carefully regulate businesses in areas that affect human health and the environment. Biotechnology

is no exception. Corporations are unlikely to invest millions on products that are unwanted by consumers and will not sell. In this way, the community can influence the course of scientific research. Companies won't bother with products that people do not feel they benefit from, and such products would not sell.

However, the ownership of intellectual property is an ongoing concern, not only with respect to applications of gene technology, but also in the wider arena of general world affairs. Balancing the needs of those who need to access new information and technologies, with those of inventors who seek to benefit from their products is a complex issue that is likely to generate much discussion in the coming years.

Myth: Mad cow disease is an example of the sort of problems that genetic engineering can cause.

Fact:

Mad cow disease (or Bovine Spongiform Encephalopathy - BSE) has nothing to do with gene technology. An unusual type of naturally-occurring infectious particle, called a prion, caused the disease. When the disease erupted, scientists knew very little about prions because they are much smaller and harder to detect than viruses. This lack of knowledge was one reason why the disease was at first considered harmless to humans.

For centuries a similar disease was present in some sheep; it seems that certain farming practices, such as feeding processed animal remains to cattle, allowed the disease to spread to cows and contaminate meat for human consumption. Various diseases of farm animals such as this break out from time to time, but they are not caused by gene technology. In the future, gene technology could even be used to make animals more resistant to many such diseases.

A good example of how modern gene technology is preventing illness is the rare but fatal Creutzfeldt-Jakob disease (CJD), which is the human equivalent of BSE in cattle. In the past, cases of this were caused because of the need to extract human hormones from the brains of corpses in order to treat conditions such as dwarfism.

Now, however, many such genetic diseases can be treated by the use of synthetic human hormones, which are made using gene technology (the human hormone gene is inserted into a biochemical factory such as bacterial or yeast cells, which then make the hormone for us).

Myth: GM food is likely to cause allergies.

Fact

People with food allergies have an unusual immune reaction when they are exposed to specific proteins, called allergens, in food. About 2% of people across all ages have a food allergy of some sort. These people usually react to one or a few allergens in one or two specific foods.

Allergenic proteins are naturally present in some foods. These proteins may be present in conventional foods that are subsequently genetically modified. For example, soy naturally contains proteins that cause allergic reactions in some people. Unless these proteins are specifically removed, they will remain present in genetically modified soy varieties.

Food Standards Australia New Zealand (FSANZ) checks to ensure that the levels of naturally-occurring allergens in GM foods have not significantly increased above the natural range found in the conventional variety of the same foodstuff.

FSANZ also checks to ensure that the new proteins in GM foods are not likely to be allergenic. If FSANZ had scientific evidence that a new protein in a GM food were allergenic, it is unlikely that the food containing that protein would be permitted to be sold in Australia and New Zealand, even with appropriate labelling.

A mistaken, but often-quoted, example of GM foods causing new allergies concerns genetic material from Brazil nut plants that was inserted into a soy plant to improve its nutritional qualities. A gene coding for a Brazil nut chemical that can cause allergies in some people was also transferred into the soy.

Scientists were aware of the possibility of this transfer, and conducted laboratory testing on the soybean before its release. During the laboratory testing procedure, the allergenic Brazil nut protein was detected in the soy. The modified soy plant was not released, the soybean never reached the market and people never consumed products containing it.

However, the good news is that GM crops could be specially created not to contain substances that are known to cause common food allergies. For example, GM soy varieties that do not contain the allergens found in conventional soy.

Although scientists may be able to use gene technology to remove identified allergy-causing substances from common crop plants, medical science cannot yet eliminate the phenomenon of allergy and food intolerance. People will

continue to have unwanted reactions to many foods. People allergic to peanuts, for example, must still carefully scan the list of ingredients of many foodstuffs in which peanut traces could occur. This problem is unrelated to gene technology.

Myth: Gene technology will create new weeds by the transfer of genes for herbicide resistance into common existing weeds. These 'superweeds' will be resistant to any form of control, and will ruin many farmers.

Fact:

Concern about the creation of 'superweeds' is based on the possibility that genetically modified crops could transfer to surrounding weeds a gene for resistance to weedkiller. Herbicide-tolerant (or weedkiller-resistant) crops have been produced so that a farmer can spray a crop, killing all the weeds but leaving the crop plant unaffected by the herbicide chemical.

If a weed is closely related to the outcrossing crop - and some of the more serious weeds are very similar to crops - then cross-pollination with a herbicide-tolerant crop could carry the gene into the weed population. This is also a risk with conventionally-bred (non-GM) herbicide tolerant canola, which is currently in widespread use in Australia.

Some crop plants, like corn and canola, cross-breed readily with other individuals of the same species. In Canada, there is at least one example where a variety of canola already tolerant to one herbicide appears to have acquired tolerances to other herbicides, because of such cross-pollination among the different canola varieties. This gene transfer between cultivars represents a crop management problem which can occur in an 'outcrossing' crop like canola. This problem is less of a concern in 'self-pollinating' crops like wheat, barley, cotton or peas, which do not transfer pollen between plants.

The question of resistance to agricultural chemicals has a long history. Herbicide-tolerant weed species appeared long before the adoption of agricultural biotechnology, mainly due to inappropriate farming practices. The number of herbicide-tolerant weeds has increased from a single report in 1978 to the 188 herbicide-tolerant weed types in 42 countries reported in a 1997 international survey.

Therefore herbicide tolerance (whether genetically modified or conventionally bred) in an outcrossing crop must be carefully managed to avoid the risk of gene transfer between varieties within the crop, or from the crop to a related weed. However, even if such a transfer were to occur, a herbicide

tolerant weed would not be a 'superweed'. A weed with a gene for herbicide resistance has no advantage outside the environment in which the herbicide is used.

In fact, a recently released 10 year long study, funded in part by industry groups, has shown that genetically modified crops are less likely to survive in the wild than their conventionally-bred counterparts. Even if a weed acquires one or more resistance genes it could still be controlled by other herbicide chemicals, or by traditional methods such as tillage. Also, the transferred gene would not make the plant grow more vigorously.

The question of how readily a crop gene will transfer to a weed species is being actively researched. In trials at Adelaide University's Waite campus, in which herbicide-tolerant canola plants were grown closely alongside wild radish, only two out of 75 million plants cross-pollinated (www.waite.adelaide.edu.au/CRCWMS/).

Despite these figures, regulators and scientists have insisted on reducing the risk still further, by designing 'exclusion zones' around some GM crops, and by careful licensing so that herbicide-resistant crops are not allowed to be grown in areas in which closely-related weeds occur. Continuing work is also investigating the likelihood of transfer of herbicide tolerance genes from genetically modified crops to non-genetically modified crops.

The Office of the Gene Technology Regulator has the ability to apply conditions to both field trials and commercial releases of GMOs to ensure that there is non dissemination of the GMO or of its genetic material into the broader environment. This includes limiting the geographic area and size of such crops areas, requiring isolation zones to separate the GM crop from like crops and requiring monitoring of the area to ensure that the GMO has not spread beyond the site upon which it is grown, and post trial monitoring to ensure that the GMO does not persist in the environment beyond the trial period.

In the future it may become possible to prevent added genes from entering the pollen of a GM plant by ensuring that such genes are only present in the chloroplasts of plants (because chloroplasts, a component of green plant cells, are not found in pollen cells). In this case, there would be no chance of the added gene moving to another plant via for example, pollen.

Myth: A health food product manufactured using gene technology caused several deaths in America in the late 1980s and early '90s.

Fact:

In the USA and elsewhere, a substance called L-tryptophan (an amino acid) is sold in many health food shops as a food supplement. It used to be made using a fermentation technique. In 1989, a Japanese manufacturer of L-tryptophan started using a genetically modified bacterium (known as strain V) to produce the tryptophan. At about the same time, the manufacturer also changed the purification procedure, using 50% less 'activated carbon' - a substance that removes impurities from a mixture.

That same year, a disease called eosinophilia-myalgia syndrome (EMS) affected about 1500 people in the USA and 37 people died. Investigation revealed that the cause of death was impurities in the L-tryptophan supplement imported from Japan.

Analysis showed more than 50 contaminants in the supplement, most of which occurred at concentrations as low as one part in a million. Further research revealed that one of these contaminants, called EBT, was highly toxic and had caused the syndrome. (The contaminant is an unusual form of tryptophan, consisting of two of the amino acids fused together.) Some of the other contaminants could also have caused or contributed to the condition.

The contaminant does not come from the genes added to the bacterium used in the manufacture. After the identification of the EMS disease, studies showed that occasional cases of it had occurred before the manufacturer switched to the genetically modified bacterium. But the disease was rarer then, because the purification procedure used was more effective, and fewer contaminants got through to the final product.

The reduction in activated carbon meant that the purification procedure was less effective, and the resulting contaminants were enough to cause EMS in people taking the supplement. This tragedy was not caused by genetic modification, but by a change in the purification technique, and a lack of rigorous quality control.

Information compiled by Biotechnology Australia
www.biotechnology.gov.au