Supermarket Tour Guide: Biotechnology & Nanotechnology

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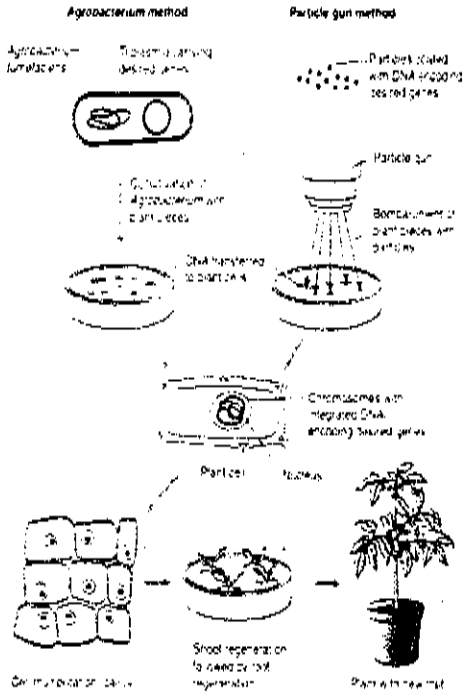
334h The Canadian Food System

Biotechnology and Nanotechnology

What is the Science of Biotechnology?

Biotechnology is, "the use of biological processes in industrial production. Early examples of biotechnology include the making of cheese, wine, and beer, while later developments include vaccine and insulin production" (EWED 2007). However we are more concerned with modern biotechnology which is associated with the genetic altering of microorganisms (Alexandrou 2007). To put DNA into a cell is difficult because if you just put the DNA in, it will be rejected, so scientists use bacteria and viruses, electrolysis, or the gene gun, to keep it in (Garcia 2004).

Bacteria and Gene Gun Methods



Bacteria: Scientists take e-coli bacteria, they create gaps in it so it recombines with the bacteria that has the gene sequence they want, when in the cell it creates tumors allowing the DNA to be inserted (Garcia 2004).

Electrolysis: Electricity is used to create tiny holes in the in the cells so they are vulnerable to foreign DNA infiltration (Garcia 2004).

Gene Gun: A single particles of gold is coated in the DNA that is to be inserted into the cell (Garcia 2004). The particles are then fired into a group of cells hoping that the new DNA will establish itself (Garcia 2004).

Electrolysis Method

1. Chemotherapy drug or DNA, etc., surrounds the target cell

2. Electric field applied and pores are created

3. Electric field removed and pores close with drug, DNA, etc. inside

Each of these methods requires a promoter gene extracted from the cauliflower mosaic virus (Garcia 2004). The promoter gene is attached to the gene sequence they are adding to allow it to replicate itself within the new DNA, otherwise it would be in there and wouldn't know what to do, so the promoter gene overpowers these controls and turns on the gene they want to operate at high volume 24/7 (Mercola 2005). They also add on

an anti-biotic resistance marker as a flag so they can tell if the gene is being expressed and identify it in the future (Mercola 2005).

How does it Differ from Conventional Cross-pollination Techniques?

This method of manipulating genes is fundamentally different from conventional cross-pollination techniques. As biotechnology allows us to move single genes we want from one species to the next, conventional cross-pollination techniques can only cross two plants of the same species in the hopes that the desired traits will appear in the off-spring.

Nanotechnology

What is meant by the Term Nanotechnology?

The term 'nano' comes from the Greek word for 'dwarf' (ECCR 2007). So already we know it deals with small things. In Science the prefix of nano onto something refers to one billionth just as kilo is one thousandth (ECCR 2007). Overall nanotechnology is the engineering of functional systems at the molecular scale (CRN 2007). In other words it is building objects from the bottom up, one molecule or atom at a time (ECCR 2007). Currently Nanotechnology is still in the beginning stages when it comes to food and agriculture (Warad 2005). However, future uses could include things such as nano-barcodes, water treatment, testing for pathogens, testing for contaminants, and bimolecular detectors, however the future possibilities for such a technology are limitless (Warad 2005).

Health Implications

What are the negative health effects of Biotechnology foods?

At the current time there is very little research that has been conducted on the health safety issues of genetically modified foods (Mercola 2005). There have only been 10 animal feeding safety studies on such foods published in peer review journals, of the 10 only 2 were independent the other 8 were done by industry (Mercola 2005). That being said, out of 166 studies on Aspartame between 1985-1995 100% of independent studies identified something they saw as a potential health risk, such as the possibility of brain tumors, where as 0% of the industry studies thought there was any health risk at all (Mercola 2005). From that we can see that only the independent studies will offer us the full picture, as they have a more un-biased approach than the industry that is trying to promote their products.

The first study was done with potatoes genetically modified, using a gene from the Snowdrop plant, to produce a protein that is an insecticide, lectin, the insecticide had already been proven safe for use (Mercola 2005). However rats in one group were then fed this new genetically modified potato, while rats in the second group were fed normal potatoes sprayed with the insecticide. The rats in the second group had no ill effects from the food, however the rats in the first group, who were eating a safe chemical that was genetically engineered into the plant suffered many ill effects (Mercola 2005). These rats

developed damaged immune systems, smaller brains, livers and testicles, possible precancerous growths in their intestines and stomach, and partial atrophy of the liver (Mercola 2005). As the insecticide was proven safe, the problems seem to stem from the process of genetic engineering (Mercola 2005).

Promoter Gene

There are also many other potential health implications from genetically modified foods. Some of these have to do with the promoter gene that is attached to the gene with the trait they want expressed. The promoter gene can turn on other genes down the line, aside from the one it is attached to, or even genes in different chromosomes (Mercola 2005). This could make the gene create all sorts of proteins it was never meant to or create more of ones it already does. These proteins and compounds can than interact with each other creating other new compounds, which can have unforeseen health effects (Mercola 2005). Aside from this the promoter gene could in a sense jump onto your internal organs or break-free in your body and can create uncontrolled cell growth, or cancer (Mercola 2005).

ARM Gene

Another health implication of biotechnology has to do with the ARM (*Anti-Biotic Resistance Marker*) gene. This gene is put into the cells with the promoter and the original gene they want to get the trait from so they can tell if it was successful (Mercola 2005). After they add the genes through one of the previously discussed methods they apply an anti-biotic to the cells, the ones surviving have anti-biotic resistance so they have acquired the ARM gene along with the others (Mercola 2005). When the FDA Director of the Division of Anti-Infective Drugs was asked about the use of the ARM gene he said, "IT WOULD BE A SERIOUS HEALTH HAZARD" (Mercola 2005). This is because the ARM gene could potentially jump off the food we eat and pass onto bacteria in our stomachs and since bacteria is very interactive with other bacteria it could easily find its way into a pathogenic bacteria and create a new strain of anti-biotic resistance diseases (Mercola 2005). The FDA responded to this by saying the DNA is destroyed during digestion, however during the only human feeding study ever conducted on genetically modified foods they found intact DNA after digestion (Mercola 2005). This study, done by the British government, took 7 human volunteers and fed them herbicide resistance genetically modified soy in the form of soy milk and soy burgers (Mercola 2005). When they checked the digested food they found intact DNA, and more shocking, they also found that 3 out of the 7 participants now had herbicide resistant bacteria in their waste (Mercola 2005).

Warning signs?

Aside from the health effects it is interesting to note that most animals, when given the option between genetically modified foods and normal foods will not eat the genetically modified ones. Many studies have shown this in cows who refuse to eat Bt

corn, geese have been shown to avoid Round-up Ready soy and only ate the conventional soy from the fields, rats have rejected modified 'flavor savor' tomatoes who were later force fed them in the study only to developed stomach lesions (Mercola 2005)(Garcia 2004).

It has been shown by the Canadian Royal Society that there is justification to assume that genetically modified foods are safe and that the only predictable effect of them is that there will be unpredictable side effects (Mercola 2005). With this said the main unintended side effects from genetic modification relating to health are the creation of proteins which can have the negative effects of creating allergens, toxins, carcinogens, new diseases, anti-biotic resistant diseases, and nutritional problems (Mercola 2005).

Environmental Implications

Terminator technology

Genetically modified crops, aside from having many negative health implications, also have a variety of potential environmental consequences. The first potential for disaster has to do with the terminator technology. Terminator technology was invented by the seed companies so that farmers would have to buy their seeds year after year as they cannot save them because they will not grow the next season. So it is more of a way to control the seeds since they hold the patents to them. It is also a way of keeping the genetically modified crops from spreading and escaping into the environment. However, if this gene happens to cross-pollinate with native or wild plants or happens to jump to a different species we could in fact get a phenomenon known as 'green deserts' (Garcia 2004). The gene could become present in wild plants that were pollinated by the genetically modified ones, which can in turn pollinate more and more wild plants spreading far distances, however once pollinated the seeds it produces will not germinate the next year and everything will die off all of a sudden. This would be a potentially disastrous scenario, but hopefully due to the nature of the technology it will eventually kill itself off.

Contamination of Gene pools

Aside form the terminator gene getting into wild populations, any gene that crosses from a modified plant into a wild or other population, like with Mexico a rural strain of Land Race corn, it could pollute the entire genetic heritage of the crop or plant species (Garcia 2004). In Mexico there are over 100 varieties of corn that have been cultivated over 7000 years to produce different traits, such as pest resistant, drought resistant, flood resistant, good at high altitudes, good for animal feed, good at making popcorn, etc..(Garcia 2004). When they found a genetically modified strain contaminating a field in rural Mexico they feared that it could potentially contaminate their genetic diversity, because the gene could easily spread (Garcia 2004). In fact it did, in November 2001 it was found in 2 states, but then in October of 2003 it was found in 9 Mexican states (S. Bocking, lecture, November 27, 2007). They had no plan of how to contain this and protect their natural diversity and gene bank developed over millennia,

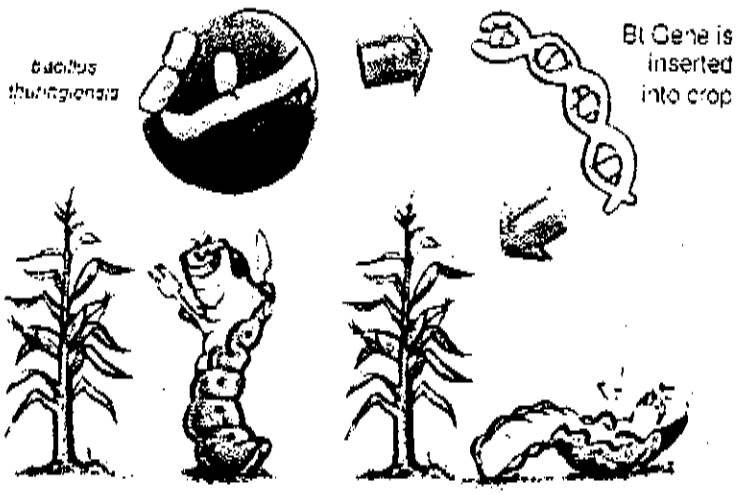
but in November of 2004 they urged the precautionary principle and didn't want genetically modified food in their country (S. Bocking, lecture, November 27, 2007). Lucky for them after fighting it they tested again in August of 2005 and found no traces of the genetically modified strain (S. Bocking, lecture, November 27, 2007). However it could have just been missed or could have been wiped out naturally.

Biodiversity Loss Due to Biotechnology

Through the contamination of genetic diversity, biotechnology adds to loss of biodiversity, a problem that was already created by industrial farming processes, biotech firms also promote this style of large monoculture production. This is process of growing a single crop species or in some cases raising a single animal species. This method of production has led to the cultivation of a very narrow range of crops and livestock (Andree 1997). The varieties used are usually picked as they have traits that make them more economical or more appealing, whether it's a specific color that's more marketable or a certain shape to fit shipping containers, but usually not what is best for the consumer, health and flavour (Garcia 2004). The result of this large scale economic focused monoculture food production has been a massive decline in the gene pool from which future crops can be derived (Andree 1997). This translates to a global food supply that once consisted of 3000 to 4000 different plants to a dependence on only 20 to 30 different plants today (Andree 1997). Also in Canada there are 220 breeds of livestock of which over 60 types are now rare or in serious decline, of cow varieties 98% are now Holsteins of which, through artificial insemination, 75% are related to only 12 bulls (Andree 1997).

Environmental Effects of Bt Crops

Genetically modified crops can also have other serious potential environmental disasters. This is especially true with any crop of the Bt (*Bacillus thuringiensis*) variety, the second most common type of genetically engineered food (S. Bocking, lecture, November 27, 2007). This is because the Bt gene creates an insecticide within the plant (S. Bocking, lecture, November 27, 2007). This can have



unintended consequences as the insecticide can, and often does, kill unintended species, as it has been shown in the case of Monarch butterflies dying after feeding on Bt crops (S. Bocking, lecture, November 27, 2007). Also if this gene were to pass over to wild plants it could render the insect food supply lethal to them, and with no insects the food chain would collapse as they are the primary source of food for most small animals (S. Bocking, lecture, November 27, 2007). The Bt gene could also make pests resistant quicker, negating any potential benefit they had in the first place, this is because the insecticide is always present so the pests are always exposed, and therefore will develop resistance faster (S. Bocking, lecture, November 27, 2007).

Environmental Effects of Herbicide Resistant Crops

The main environmental implication of herbicide resistant crops is the creation of weeds or super weeds. There was a case where Round-up Ready soy was being grown, so Round-up was sprayed on the field more frequently than it otherwise would have been (Garcia 2004). A local weed, Mairstail, became resistant and spread rapidly through the soy leading to terrible yields (Garcia 2004). Now a chemical, much like Agent Orange, called 24D, which is highly dangerous, has to be used to deal with the resistant weeds, which in effect makes Round-up Ready soy put more dangerous chemicals in the environment than a conventional soy crop would have to (Garcia 2004). Aside from this creation of super weeds, the genetically modified crop can become a weed itself, as herbicide resistant plants, the first main use of biotechnology, can spread, as they are hard to get rid of (S. Bocking, lecture, November 27, 2007). This can be seen in the Percy Schmiser case when unwanted crops got onto his field or in the Canadian Prairies where Round-up Ready Canola is believed to have spread across most of (Garcia 2004). This is because the only way to tell a genetically modified Round-up Ready canola plant from a normal one is to spray Round-up on them, the ones left alive are the genetically modified ones (Garcia 2004). This is also because genetically modified plants are capable of reproducing in the environment and due to their resistance to some herbicides are more difficult to control (Garcia 2004).

Social Implications

Control through Seed Patents

The biotechnology industry has been amassed from large pesticide companies buying the seed industry in the early 80's and 90's (Garcia 2004). They did this with the mindset that 'whoever controls the seed controls the food' and today Monsanto alone controls over 11,000 seed patents (Garcia 2004). After it was decided in the US that life could be patented, after a ruling by the supreme court over an oil eating microbe, the seed companies patented as many types of seeds as they could, the only requirement was that it wasn't already patented (Garcia 2004).This brings up the first of the social implications, those involving seed patenting, which can easily be seen with the case of Percy Schmiser who was targeted and sued by Monsanto for patent infringement and lost. Percy isn't sure why he was targeted by the large seed company but figures it must be for complete control over seed, creating fear so people won't use their own saved seeds, or greed, taking money and trying to shut down smaller operations that don't operate under

the conditions they want or a combination of both as control of seeds will give them more money and shutting down operations not buying seeds will promote those who buy seeds form them (Garcia 2004). This can be best seen when Monsanto said their ideal future is one in which 100% of seeds are patented and genetically modified (Mercola 2005).

The Percy Schimser Case

Percy Schmiser was a farmer, he was running his family farm that had been operating for 53 years, growing mostly wheat, canola, oats and peas (Garcia 2004). He was a seed developer and seed saver, saving and developing his crop over generations to what they desired (Garcia 2004). However, this heritage was about to change drastically. It all started in 1997 when he was spraying Round-up around his poles and in ditches as he usually did, only to find some of the canola he sprayed didn't die (Garcia 2004). He brushed this off figuring that some of it became resistant as he sprayed it year after year and was told that could happen (Garcia 2004). Monsanto then claims to have snuck onto his property, without his consent or knowledge, took some plants and seeds, tested them and claimed they were of their Round-up Ready variety (Garcia 2004). Then on August 6th of 1998 they launched a lawsuit against Percy claiming he illegally obtained their product without their knowledge or license ultimately violating their patent (Garcia 2004). Even though once in the environment the plant is uncontrolled and can spread, they said it didn't matter how he got it, it still infringed on their patent (Garcia 2004). Percy later learned that another farmer, while driving his farm by, lost enough Round-up Ready canola seed, due to a rip in his tarp, to seed over 2000 acres (Garcia 2004).Percy was advised from this not to use his own seed again and had to destroy over 1000 pounds of seed that he had developed over 53 years to grow well in the local climate and be resistant to local diseases (Garcia 2004).The judge eventually ruled against Percy saying that it didn't matter how it got there but the fact that there were some plants they become Monsanto's property, whether they blew on, were carried on from birds or bees, or cross-pollinated it still violated their patent. Secondly he said that any farmer with conventional plants that becomes cross-pollinated with Monsanto's gene is in fact their property (Garcia 2004). To conclude it the judge said it was immaterial that he didn't use Round-up on his crops (Garcia 2004). The case was brought all the way up to the Supreme Court of Canada where it was ruled, in May of 2004, in a 5 to 4 decision that Percy had in fact infringed Monsanto's patent (Garcia 2004).

This case opened up the door for other patent infringements, such is the case with Rodney Nelson a farmer from North Dakota (Garcia 2004). In the summer of 2000, around late July, he got a letter from a New Orleans law firm, representing Monsanto about patent infringement (Garcia 2004). They claimed to have sampled all 3850 acres of his soy crop the previous year (Garcia 2004). This meant that he in fact couldn't properly defend himself as he could not go back and sample his crop from the year before (Garcia 2004). Aside from this he figured to sample his entire crop they would have had to take a sample every 20 seconds, so their story didn't add up (Garcia 2004). They later changed their story and said they took a handful of samples (Garcia 2004). Rodney later

settled out of court like most farmers do and is not allowed to talk about his settlement (Garcia 2004). Monsanto then dropped the lawsuit against him in October of 2002 (Garcia 2004). He believes he got profiled by them because he had such a large farm and they wanted to scare him into not saving his seeds (Garcia 2004). Either way in both of these cases and the many others t hat have come up since, the farmers all feel this has been a violation of their rights (Garcia 2004).

The United States is also trying to unify international patent laws, which they tried to do in 1994 (Garcia 2004). Now indigenous people around the world are also having their native plants patented on them, stealing their traditional knowledge and ancestral rights and practices (Shiva 2001). Also if their patented genetically modified crops find their way into 3rd world crops they could own those to and get paid by them as well (Garcia 2004). In India the social implications of such actions, as well as the increased costs associated with the high cost of hybrid-seeds and pesticides needed, cost the lives of 500 people one year who committed suicide due to financial turmoil and failure of genetically modified Bt crops to produce favorable yields, as well as a wave of suicides throughout 200 villages the next year when Bt cotton crops failed (Shiva 2001).

Feed the Hungry or Keep Them Poor?

The title of this section brings to light another social implication of such crops. As those who are pro-genetically modified foods mainly argue that it will increase yields and help feed the world. We now know that this is not the case. Many genetically modified crops in fact do worse than conventional crops, as is the case with Bt cotton in India (Shiva 2001). Also scientist at the University of Arkansas documented a 25% decrease in root size of genetically modified soy in drought like conditions, leading to several bushels of crop lost per acre, far more severe than conventional crops in the area (Garcia 2004).

Another social implication has to do with 'Terminator Technology'. This gene is a suicide gene put into the crops so that the plant in a way commits suicide after 1 planting (Garcia 2004). This works as the seeds it produces are infertile (Garcia 2004). The U.S. government is the co-owner of this technology and there are a total of around 15 patents on it (Garcia 2004). However this technology makes it impossible for farmers to save their seeds and forces them to buy seeds from these companies year after year increasing their costs and making farming more difficult, while creating a permanent market for the large biotech-sced companies.

Labeling Biotechnology in Canada

Common Biotech Foods in Canada

In Canada there is a surprising variety of biotechnology crops that have been established. Currently, there are seventy-three varieties of biotech crops approved for human or animal consumption across North America: 56 different types in the United States, 54 in Canada (C.B.I. 2007). Canada is a major grain exporter of canola, oats, barley, pulses and wheat. Canada also imports, mainly from the United States, large quantities of maize for its intensive livestock industries (AAA 2004). Official genetically

engineered crops across Canada include canola, corn, barley, cotton, soybean, flax, potatoes, squash, tomatoes, and beets (CBI 2007).

Canada grows a significant amount of GM crops. The GM crop area of canola, maize and soybean grew 26 per cent between 2002 and 2003 to reach 4.4 million hectares with increases totaling almost one million hectares(AAA 2004).

Crops are enhanced genetically in the following ways:

Herbicide tolerant crops are immune to broad-spectrum herbicides that are effective against harmful weeds but have no effect on the crop. That lets farmers spray less often with just one herbicide and often reduces the need for plowing, which reduces soil runoff. Three-fourths of the biotech crops planted in 2001 were herbicide tolerant.
Pest resistant crops have been enhanced with naturally occurring pesticides — like the protein from Bacillus thuringiensis, or *Bt* — that ward off crop-eating insects like rootworm, bollworm and the European corn borer.
Virus resistant crops are shielded from plant viruses in the same way humans are protected from disease — by being "immunized" and thus building a natural defense.
Stacked trait crops combine these and other traits. (C.B.I. 2007)

Polls have revealed that the majority of Canadians want labels on GMO food (CGSB 2004).

Are Genetically Engineered Biotechnology Labeled?

Across Canada the question can be raised what kind of standard applies to biotechnology The standard applies to the voluntary labeling and advertising of food in order to distinguish whether or not such foods are products of genetic engineering, or contain or do not contain ingredients that are products of genetic engineering.

In Canada there are two Canadian government agencies that regulate the arrangements for genetically modified products in Canada- the Canadian Food Inspection Agency (CFIA) and Health Canada. The CFIA assesses the potential risk to the environment, whilst Health Canada is responsible for assessing the human health safety of products derived through biotechnology including foods (AAA 2004).

The Canadian Food Inspection Agency was established in April 1997 to consolidate regulatory function previously scattered through several ministries. The CFIA is responsible for the regulation of biotechnology in most regards except human health considerations, which remain under the jurisdiction of Health Canada (Kneen 1999).

Currently across Canada today there is a voluntary labeling system that has been set into place. To facilitate the use of voluntary labeling which is already in place in Canada, the Canadian government supported the development of a national standard for the voluntary labeling of foods derived from biotechnology. In April 2004, the Canadian Government

announced the official adoption by the Standards Council of Canada, of the *Standard for Voluntary Labeling and Advertising of Foods That Are and Are Not Products of Genetic Engineering*, as a National Standard of Canada. This means that Canadian consumers may start to see more labels on some food ingredients and food items indicating whether or not they are a product of genetic modification. This Standard applies to the labeling and advertising of all food sold pre-packaged or in bulk, as well as food prepared at the point of sale. Different categories of items such as produce, meats, dairy products, and other whole foods do not require any standardized labeling of genetic modification. Under the Food and Drugs Act, mandatory labeling of all foods, including novel foods, is required where the foods have significant nutritional or compositional changes, or where potential health and safety risks exist that could be mitigated through labeling. The label must state, for example, the nature of a nutritional or compositional change, or the presence of an allergen. It is not required to indicate that the food is a product of genetic engineering (AAA 2004).

As it is voluntary, no labels on GMO foods will be required in Canada. The standard also allows for products containing 5 per cent GMO material to be labeled non-GE (CBI 2007).

"None of the GMO crops grown in Canada have undergone chronic, long-term testing," said Bradford Duplisea of the Canadian Health Coalition. "The reality is that no one knows if GE foods are safe to eat. People who don't want to eat these untested products should be able to avoid them, but without mandatory labeling they can't"(Duplisea 2003).

In the never-ending battle towards biotechnological implementation, has the value of food been lost? Gone is the confident belief that our food is totally safe. With labeling legislation in Canada regarding biotech and nanotech crops strictly voluntary, certainly more must be understood by consumers. Perhaps a new common sense attitude approach to genetically modified crops is part of the solution; genetically modified foods are different and therefore need to be treated differently (Andree 2007). Biotechnology and Nanotechnology issues must be tackled using interdisciplinary means to create alternatives. This assures quality and healthy food choices for future generations. The time to understand and evaluate issues of sustainability, food security, and community food development is upon us.

For more updated information on genetically modified crops please refer to the Council for Biotechnology Information website @ www.whybiotech.com.

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