CROP
PROTECTION
INSTITUTE

Plant Biotechnology

A Secondary School Teacher's *Resource* Manual

Crop Protection Institute of Canada
Plant Biotechnology Manual

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The mission of the Crop Protection Institute is to support sustainable agriculture in Canada, in co-operation with others, by building trust and appreciation for plant life science technologies.

Crop Protection Institute of Canada Biotechnology Manual

A Resource for Teachers

Why bring biotechnology into the classroom?

Secondary school students are interested in learning about career options and employment trends, and biotechnology is a growing field. There are new government incentives for research and development. Human Resource publications have been compiling job profiles and postings in the biotech field. Biotech First Job Internship Pilot Program offers real work experience and opportunities to learn about careers in the biotech industry. As part of the Canadian Youth Employment Strategy the Internship Pilot will create additional Internship positions with the help of a federal wage subsidy.

There has been some media coverage of the controversy relating to biotechnology. Critical thinking skills are a major focus in the high school curriculum. Students may be interested in the scientific foundation on which Canada's food system operates. The biotech industry is working to better inform the public about the benefits of this technology now and in the future.

People who live in or near farming communities may want to learn about choices with which farmers manage insects, diseases, and weeds that can threaten crops and our food supply.

Many of the activities in this booklet provide learners with an opportunity to learn about the internet as a research tool and as an employment resource.

SAMPLE ACTIVITIES

Plant Life Science Solutions for Agriculture
Plant Biotechnology Backgrounder

Brainstorming Activity as an Introduction to Crop Protection and Biotech

On the board record answers and points of interest for discussion topics.

Possible Questions:

1. *What is Biotechnology?*
2. *What do you know about the controversy?*
3. *Why might pesticide courses be important for growers? (correct usage, new technologies, formulation and application techniques)*
4. *Why is recycling important to growers and consumers?(container management)*
5. *What has the Crop Protection Institute done to help farmers?*

Biotechnology and the History of Food

Research Activity

1. *Interview several farmers to find out how farming has changed over the past twenty years. Ask farmers to describe the challenges they faced in the past and challenges they face presently. What are the joys farming brings? Were their parents farmers? How is it different now?*
   Organize your findings in a way that you can present to the class.

2. *Pick two different time periods from the <u>History of Food</u> document (one since you were born) and illustrate them either in the form of comparative drawings, cartoons, advertisements, 'history' book pages (you create these), or 'scrap book' or diary pages—enlarge these so that they can be displayed in the class.*

Myths and Facts About Biotechnology

Newspaper Study

Watch the local and national newspapers of your choice for one month. Save any articles relating to Biotechnology. Follow the debate and discuss the accuracy of the arguments. Information gathered during interviews with farmers could also be used to assess the discussions.

Key Messages

Biotechnology Questions and Answers

Classroom Debate

Stage a real debate on some of the issues raised in this article. See the Biotech Website Resource for research material.

Canada's Food Regulatory System

Research Project

Learn about Canada's regulatory system for foods, drugs, and cosmetics.

Websites of Interest

There is a labour shortage in the Biotech industry right now especially in Quebec. Industry Canada's Strategis Web site has information on the sector and the Biotechnology Human Resource Council has information on training, skills gaps, compensation and benefits.
http://www.strategis.ic.gc.ca
http://www.bhrc.ca

The BHRC site outlines the First Job Internship Pilot, which is part of the Canadian Youth Employment Strategy. There are on-line employer application forms and intern application forms. Even if students are not at this stage yet—applying on line is a growing trend. Jobs and Recruiting as well as the Biotech Job Centre are worth a look.

The Strategis site has guides to starting a business, and its Biotechnology Gateway gives a business perspective to Biotechnology with features on Regulations and Ethics and the Industry. The Ethics and the Industry section has discussion sections which may be of interest to high school classes. Strategis also has a biotechnology job centre where applicants can submit their resumes over the net. Again, students may not be ready to apply for these jobs—but they get a quick look at how the process is changing. There is also a government job site link with career opportunities in various provinces. There are links on this page to the job bank (HRDC) which is an electronic list of jobs, work or business opportunities (some for students). There is a Youth Employment Strategy link and also a Youth Resource Network link offering information on the employment world such as the choices available in careers and training.

Students could visit several of these sites and write up a "review" similar to an annotated bibliography.

The field of Biotechnology is wide open and rapidly expanding. Information and research sites are updated often.

PLANT BIOTECHNOLOGY BACKGROUNDER

Today, plant biotechnology offers the opportunity to genetically modify plants to protect themselves against pests. Tomorrow, it offers the promise of genetically engineering products that are more nutritious, better tasting, stay fresh longer and even help fight disease and deliver vaccines and medications.

The use of biotechnology today, however, is not without significant debate on the benefits and potential risks.

WHAT IS BIOTECHNOLOGY?

The broad term, biotechnology, is defined by the Convention on Biological Diversity as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." In the popular media, it has become known as "GMOs".

While this term only came into widespread use in the 1970s after the development of genetic engineering techniques, we have in fact been using biotechnology in its simpler forms to make everyday products for thousands of years. From early farmers who saved the best of their crop for seed for the next year to using yeast in the making of wine and beer, these more traditional uses of biotechnology have been well accepted.

Genetic engineering is used to achieve the same goals as traditional plant breeding techniques, but additionally allows the breeder to move genes – the hereditary units of life – from one species to another.

When using traditional breeding practices, it is often necessary to grow many generations of plants and animals to select for desired characteristics. It can take up to 12 years, for example, to breed disease-resistant crop plant varieties. On the other hand, genetic engineering allows for the very precise transfer of the desired genetic material in a much shorter timeframe – often in a matter of a few months.

Farmers have recognized the benefits of this technology. In the five years since the government approved the first herbicide-tolerant canola, they have overwhelmingly embraced this technology.

THE CONTROVERSY

Recently, a number of self-interest groups have launched a campaign against biotechnology, making claims that food products derived from genetically modified crops are unsafe in terms of human health and environmental sustainability.

This vocal minority is well-organized, has a significant budget with which to operate and is adept at issuing 30 second sound bites with sometimes alarming claims. A dramatic headline or a sensational quote is all it takes to fuel the debate, confuse consumers and conjure up images of killer tomatoes and Frankenfood monsters. These groups take advantage of every opportunity to keep the controversy in the media, staging demonstrations at key events such as the World Trade Organization talks in Seattle or in Montreal where the Cartagena Protocol on Biosafety was signed.

Activists are trying to bring to North America the kind of resistance to genetically modified foods that has reached epidemic proportions in Europe. Since 1998, the European Union has ceased importing genetically modified corn from the United States. This ban, at least in part, may be as a result of activist and consumer pressures.

By communicating the facts and emphasizing the solid scientific foundation on which Canada's food system operates, the industry is working to better inform the public about the benefits of this technology now and into the future.

"The contribution of GMO crops to sustainable agriculture is largely an untold success story," says Dr. Lorne Hepworth, President, Crop Protection Institute. "For the farmer, having access to crops genetically modified with pest management traits gives him more options – more choices with which to manage insects, diseases, and weeds that can threaten his crops and our food supply. GMO crops can be a win:win:win scenario for the farmer, the environment, and the consumer."

RECENT INITIATIVES

Canada has one of the most stringent and well-respected regulatory systems in the world. Under this system, Health Canada and the Canadian Food Inspection Agency share responsibility for the safety of novel foods developed using plant biotechnology. In addition to this solid regulatory framework, the federal government has recently undertaken and supported several initiatives to ensure that Canada remains vigilant when it comes to plant biotechnology.

In November of 1999, the government brought together a group of Canadian experts and formed the *Canadian Biotechnology Advisory Committee*. This Committee will advise the government on the ethical, social, regulatory, economic, scientific, environmental and health aspects of this technology.

Another recent initiative will address the consumer's desire to be able to identify and choose between GM and non-GM foods. Through the government's Canadian General Standards Board (CGSB), a committee of experts representing some 60 farm, food and consumer groups has been formed to develop standards on the voluntary labeling of foods obtained through genetic modification.
A third initiative is a Blue Ribbon Panel of Scientists whose mandate will be to look at the scientific and regulatory systems for GM foods and to advise the government of potential ways to strengthen our existing framework. Panel members have been selected through the Royal Society of Canada, a senior national body of distinguished Canadian scientists and scholars.

In addition, in January 2000, 138 countries including Canada signed the new *Cartagena Protocol on Biosafety* that provides an international framework for science-based rules and procedures on the acceptance of genetically enhanced crops. This agreement, which will be implemented over a two-year period, will build on regulations that are in existence in over 60 nations.

LOOKING TO THE FUTURE

Canada is well positioned to be a global leader in plant life sciences technologies. Dr. Douglas Powell, a professor at the University of Guelph, is actively trying to put the new technology into perspective for the public. He says, "The successful adoption of any new technology requires a rigorous system to integrate public concerns with scientific knowledge, to maximize the benefits of something like genetic engineering while actively and openly minimizing potential risks."

This science is predicted to help the world meet a great hunger challenge in the years ahead. World population is expected to increase to more than 10 billion people by the year 2050; and to feed that population, agricultural yield will have to at least triple. Few other technologies will be able to approach biotechnology's potential to help counter world hunger in the next century while protecting the environment.

BIOTECHNOLOGY & THE HISTORY OF FOOD

Traditional biotechnology has been used for thousands of years to produce food. Today, modern biotechnology enables us to develop improved products more safely and more rapidly than ever before.

8,000 BC
People decide to live in one place and grow plants as crops. They save the best of their crop to use as seed the next year.

4,000 BC
Egyptians master art of winemaking.

3,000 BC
South America peoples select and breed potatoes as staple crop.

2,000 BC
Egyptians and Sumerians learn brewing and cheese making.

1,800 BC
Yeast is used to make wine, beer and unleavened bread.

300 BC
Greeks develop grafting techniques for plant breeding.

1500s
Fermenting comes to the fore, leading to the development of sauerkraut and yogurt.

1784
The first brewery is established in Canada.

1861
Louis Pasteur develops pasteurization, protecting food by heating it to kill dangerous microbes, removing the air and sealing it in a container.

1865
Gregor Mendel, the father of genetics, presents his laws of heredity.

1922
Farmers first purchase hybrid seed corn created by crossbreeding two corn plants.

1940
Oswald Avery isolates pure DNA

1941
Danish microbiologist A. Justin coins term "genetic engineering".

1953
James Watson and Francis Crick describe double helix structure of DNA (receive Nobel Prize in 1962)

1970
Norman Borlaug becomes first plant breeder to win Nobel Prize for his work on Green Revolution wheat varieties.

1973
Scientists Stanley Cohen and Herbert Boyer discover recombinant DNA technology, considered to be the birth of modern biotechnology.

1981
Canada's first biotechnology company, Allelix, is formed.

1982
The first genetically engineered product, human insulin, is approved for sale in US.

1983
Canadian Biotechnology Strategy is established by Canadian government.

1986
The agricultural industry uses biotechnology to create soybean plants that are herbicide resistant.

1988
World's first field tests for genetically engineered canola take place in Canada.

1990
The first food products modified by biotechnology, an enzyme for cheese production and a yeast for baking, are approved in US and UK respectively.

1993
Canadian Michael Smith wins the Nobel Prize in chemistry for his pioneering work on a method of reprogramming segments of DNA.

1994
Canada boasts 121 companies involved in biotechnology. The first food product enhanced through biotechnology, the FlavrSavr tomato, hits the US supermarket shelves.

1996
Commercial production of biotechnology crops begin - corn, potato and canola.

MYTHS & FACTS ABOUT BIOTECHNOLOGY

The implications of biotechnology are widely debated. Many of the issues raised are based on speculation and emotion, rather than on sound science. This fact sheet addresses many of the myths and facts about biotechnology.

Myth: The application of biotechnology to crops and food is very different from traditional agricultural methods.

Fact: Biotechnology is an evolution of traditional agricultural methods. In the past 10,000 years people have routinely used their knowledge of plants to improve food production. Biotechnology is simply the latest development in the evolution of agricultural methods.

Farmers used to rely on plant breeding to add, or eliminate, specific genetic traits in a plant. For example, corn today looks nothing like it did one hundred years ago because of plant breeding and selection. Although it typically took several growing seasons to produce a plant that expressed a desired trait, farmers were able to create crops that:

- were resistant to drought, insect pests and diseases
- possessed stronger stalks and improved ability to withstand strong winds, and
- produced higher yields.

Genetic enhancement, a key feature of modern plant biotechnology, is a more efficient and precise way to achieve the benefits of crop improvement. Using new technologies, scientists are now able to pinpoint the gene responsible for a particular trait, then extract, or add, that gene to a specific plant.

Myth: Foods produced using biotechnology have not been established as safe nor are they adequately regulated.

Fact: The Canadian Food Inspection Agency (CFIA), Health Canada, and provincial and municipal authorities are all involved in ensuring the safety of the food we consume. CFIA has the principal responsibility for genetically modified organisms. Crops produced by biotechnology must meet the same rigorous standards as those created through traditional means. While there is no such thing as "zero risk" for any food, consumers can be confident that foods produced using biotechnology meet the government's stringent food safety standards. (For more on our regulatory system, call 1-800-0-Canada.)

Biotechnology is one of the most extensively researched and reviewed agricultural developments ever. Years of research including thousands of field trials and testing for food composition, nutrition, potential for new toxins and allergens, agronomic performance and environmental impact, indicates that the benefits of agricultural biotechnology far outweigh any risks.

Myth: The application of biotechnology to food only benefits food producers, not consumers.

Fact: Biotechnology benefits both producers and consumers. Products will eventually provide obvious consumer benefits such as enhanced flavour and freshness, improved nutritional value and reduced saturated fat content.

The first traits in the marketplace have primarily been of interest to farmers. They provide more pest management choices for farmers fundamental to Integrated Pest Management and sustainable agricultural practices. For developing countries, biotechnology can increase yields, thereby helping to address food shortages and hunger.

Myth: Without special labeling, consumers face unknown risks from food biotechnology.

Fact: Under Canada's Food and Drugs Act, labeling must inform consumers about significant nutritional changes or health and safety issues. This is mandatory under the law. Consumers must have access to meaningful information about all food products, whether developed through the use of biotechnology or any other agricultural or processing technique.

The federal government, in co-operation with the Canadian Council of Grocery Distributors and the Canadian General Standards Board and with support from Agriculture and Agri-Food Canada, is developing rigorous voluntary labeling standards and science-based codes of practice that will further strengthen Canada's excellent food safety and inspection system. The Crop Protection Institute is a member of the committee tasked with developing these voluntary labeling standards.

Myth: Crops produced using biotech will negatively impact the environment.

Fact: Crops produced using biotechnology provide growers with more options to help them control weeds and insects. In some cases, genetically modified crops may reduce the use of pesticides. Options such as biotechnology are very important when it comes to Integrated Pest Management (IPM) practices. Through IPM, growers can choose the technology that is most appropriate for the pest or weed situation including pesticides, biological control methods, cultivation practices or biotechnology. All of these methods support Integrated Pest Management and sustainable agriculture.

Genetically modified crops have many benefits which can positively impact the environment, including improved weed control, better soil conservation, limiting herbicide resistance, more flexibility for fall and early spring planting, reclaiming land for food production and higher yields from the land currently in production.

Myth: The production of crops resistant to certain pests and weeds will trigger a natural evolution and lead to "Super Bugs" and/or "Super Weeds" immune to existing methods of pest and weed management.

Fact: The introduction of new plants into Canada is much more likely to be a weed problem than the potential from "outcrossing" of GM crop varieties.

In Western Canada, the major weed problems that reduce crop yields are plant species brought into Canada either as ornamental plants or contaminants. Of the top 20 weed species in Saskatchewan, 18 were introduced from Europe, Asia or other countries and only two are native plants.

With regard to canola, research under field conditions shows that the transfer of pollen from one field to another generally resulted in less than one per cent outcrossing within the first 100 metres of the field. With canola commonly grown in 160 acre fields, the amount of outcrossing within one field should be less than 0.25 per cent over all.

Growers realize that volunteer herbicide tolerant varieties must be controlled. There is a large selection of herbicides that control volunteers of conventional canola varieties as well as GM types. For example, canola varieties that are tolerant to specific herbicides can be effectively controlled by adding 2,4-D or MCPA to the mixture.

Myth: Genetically modified corn kills monarch butterflies.

Fact: In May 1999, Nature magazine published a letter from researchers at Cornell University that reported findings suggesting further research was needed into the relationship between pollen from select strains of Bt corn and the monarch caterpillar. Since that publication, many university researchers, including others at Cornell, have stepped forward to stress that the monarch study did not represent natural conditions.

Extensive environmental research has confirmed the safety of Bt corn on non-target insects, such as the ladybird beetle, honeybee and the green lacewing, in the natural environment.

In 1999, the University of Guelph launched a two-year study to see if the results in the laboratory will hold up in the field. "My reading at this point is there isn't a substantial risk to the monarch," says Mark Sears, Chair, Department of Environmental Biology, in a press release dated January 10, 2000.

Myth: Biotechnology cannot relieve world hunger.

Fact: Biotechnology *can* help alleviate hunger worldwide. In the next 50 years the global population is expected to double, reaching more than 8 billion people by 2050. Population growth and diet upgrading will require the food supply to increase by at least 250 percent from its current quantity. Scientists are studying ways of improving yields (hybrid wheats), directing more plant resources to the food portions (vs. stems, etc.) and enhancing the efficiency of photosynthesis.

The amount of land currently committed for food production--approximately 36 percent of the earth's cumulative land mass--cannot yield the amount of food needed by this increased population. Although forests could be cleared to obtain needed acreage, a better approach is to use biotechnology to get greater crop yields from existing land.

Biotechnology can increase the quantity of the harvest by addressing the factors that traditionally deplete crops: pests, weeds, drought and wind. Plants from biotechnology can deal with these hardships and dramatically increase the percentage of crops that survive and are harvested each year.

Myth: The long-term effects of foods developed using biotechnology are unknown.

Fact: From years of research, we know that the benefits of food biotechnology are tremendous. The scientific consensus is that the risks associated with food biotechnology products are fundamentally the same as for other foods. Current science shows that foods made from biotechnology are safe to consume, and safe for the environment. For this reason, Canada's regulatory agencies have determined that these products are safe to introduce into the food supply. While there is no such thing as "zero risk" for any food, consumers can be confident that foods produced using biotechnology meet the government's most stringent food safety standards.

When asked about the "hysteria" surrounding the application of biotechnology to food in Europe, Dr. James Watson, the scientist who discovered the structure of DNA, likened the resistance to the initial ban placed on medical biotechnology. If that ban had continued, "it would have stopped us from understanding cancer and a whole host of things," he noted. "To argue that you don't know what is going to occur is true about everything in life. People wouldn't get married, have children, do anything…."

KEY MESSAGES

The crop protection industry is committed to safe food and protecting the environment. We believe that biotechnology will continue to play a key role in helping us produce an abundant, economical, safe food supply while at the same time safeguarding the ecosystem that sustains us all.

GMO foods are safe. Canada's rigorous regulatory system ensures every possible safety precaution is taken before foods are made available to consumers. Over 25 years of scientific research shows genetically modified foods are as safe as conventional foods both for human health and the environment. In Canada more than 5000 field trials for environmental safety have been conducted over 12 consecutive growing seasons. Tens of thousands of similar field tests have been conducted on more than 30 crops around the world.

Scientists worldwide support biotechnology. Over 1300 scientists from around the world, including two Nobel prize winners have signed a "Declaration in Support of Biotechnology". In Canada more than 100 scientists signed an open letter to food companies and grocery retailers in support of biotechnology.

Biotechnology can help feed the world. Experts say we need to triple agricultural production by the year 2050 to feed an estimated world population of 10 billion. Biotechnology offers us the best opportunity to do this without clearing forests by increasing yields, making crops more dependable and allowing farmers to grow crops in areas where they cannot now be sustained due to climate or soil conditions.

Biotechnology can make us healthier. Biotechnology can help mankind by delivering fruits, vegetables and cereals that are more nutritious, processed foods that are better for us, foods that help us fight disease, food that is safer for those with allergies and foods that contain vaccines and medicines. This research is already underway and consumers will benefit from some of these developments with the second "wave" of biotechnology products in the next decade.

Biotechnology can benefit the environment. Biotechnology gives farmers safe options to control insects, diseases and weeds that can damage crops. Biotechnology lets farmers/growers use practices such as soil conservation, which benefit the environment. In the future, biotechnology may give us alternatives to fossil fuels. Biotechnology will give us biodegradable plastics to lessen the amount of waste going to landfill. Biotechnology can help safeguard the ecosystem that sustains us all.

BIOTECHNOLOGY Q & A

DEFINITIONS & GENERAL INFORMATION

Q: What is plant biotechnology?

A: The broad term, biotechnology, is defined by the Convention on Biological Diversity as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." In layman's terms, plant biotechnology has become known as GMOs.

While this term only came into widespread use in the 1970s after the development of genetic engineering techniques, we have in fact been using biotechnology in its simpler forms to make everyday products for thousands of years. From early farmers who saved the best of their crop for seed for the next year to using yeast in the making of wine and beer, these more traditional uses of biotechnology have been well accepted.

The Institute has defined GMO in its position paper, ("Labeling of Foods Derived from Biotechnology" at http://www.cropro.org/ENG/papers/015labelling.html)

Q: What is genetic engineering?

A: In plant biotechnology, genetic engineering is used to achieve the same goals as traditional plant breeding techniques, but additionally allows the breeder to move genes – the hereditary units of life – from one species to another. This means that it is now possible to transfer genes between species that would not normally breed in nature, for example plants and animals. Genetic engineering is also known as Recombinant DNA technology.

When using traditional breeding practices, it is often necessary to grow many generations of plants to select for desired characteristics. It can take up to 12 years, for example, to breed disease-resistant crop plant varieties. On the other hand, genetic engineering allows for the very precise transfer of the desired genetic material in a much shorter timeframe – often in a matter of a few months.

Q: What are novel foods?

A: According to the Canadian Food Inspection Agency (CFIA) web site, "novel foods are foods that have previously not been available for sale in Canada, have been substantially modified from traditional composition, or are produced by a novel food process, including genetically engineered food products."

CFIA defines a plant with a novel trait as "a plant variety/genotype possessing characteristics that demonstrate neither familiarity nor substantial equivalence to those present in a distinct, stable population of a cultivated species of seed in Canada and that have been intentionally selected, created or introduced into a population of that species through a specific genetic change."

Q: Why is everyone so concerned about this issue?

A: Opponents of biotechnology have done a good job communicating their position. This has raised public awareness and concern. To date, the facts about biotech and the science behind it have not been communicated extensively enough to the general public in order to alleviate their fears and concerns.

Q: Is the nutritional value of GMO foods different?

A: Biotechnology has the potential to alter the nutritional composition of foods in a dramatic and very positive way. At this point, however, nutritionally-altered GMO foods are not available in Canada.

Q: Do GMO foods look or taste different?

A: With few exceptions, a consumer comparing a GMO derived food to a regular one would not be able to tell it is a GMO one by appearance or by taste. One example of a GMO product being researched that looks different is "golden rice." This rice has a distinctive orange colour due to the increased level in Vitamin A brought about by genetic engineering.

WHO TO BELIEVE

Q: Many leading scientists are warning us about the dangers of GMO foods (David Suzuki, Arpad Pusztai, etc.) How can they be wrong?

A: Debate and disagreement among scientists is not new. Leading edge science tends to be controversial and can generate mixed opinions among the experts. When it comes to the biotech debate, it is important to remember that:

- There are a few, very vocal scientists who oppose GMO foods including David Suzuki.
- By comparison, over 1300 scientists have signed a declaration in support of biotechnology including Nobel laureate and co-discoverer of the DNA structure, Dr. James Watson.
- From a Canadian perspective, an open letter to food companies and grocery retailers in support of biotechnology was signed by over 100 Canadian scientists.

Q: There is so much conflicting information about this issue. Where can I get unbiased information?

A: Consumers who want information about biotechnology and genetic engineering related to food can contact the Food Biotechnology Communication Network (FBCN) at 1-877-366-3246. The phone lines are operated from 10 a.m. to 5 p.m. five days per week by qualified professionals including a registered home economist, a registered nurse, dieticians, human nutrition graduates and a PhD candidate in Food Science. The FBCN can provide a list of additional unbiased contacts including the Consumers Association of Canada (613-238-2533), BIOTECanada (613-230-5585), the Canadian Food Inspection Agency's (CFIA) office of biotechnology (613-225-2342) and Health Canada (613-957-2991). In addition, an extensive list of categorized web sites that cover biotechnology (for and against) is available from the Crop Protection Institute at 416-622-9771. (See list of website resources for more information.)

Q: What is industry doing to safeguard the environment and our health?

A: Canadian crop protection companies take protection of health and the environment very seriously. After all, we live in the same world that you do and we have a vested interest in protecting the health of our families as well as yours.

Crop protection companies are members of the Crop Protection Institute of Canada (CPIC). Through the Institute, crop protection manufacturers participate in the national s*tewardshipFirst* program, as part of the ongoing commitment to working responsibly to protect human health and the environment. Under the banner of s*tewardshipFirst,* the Institute has developed a series of initiatives that represent full circle product life cycle management. More than 70 per cent of the Institute's funding, which comes from member dues and levies, is allocated to stewardship programs.

With regard to product development, crop production companies invest millions of dollars and many years in researching new products in order to provide farmers with new tools to reduce risk and increase yields. In Canada, all crop protection products must be approved by the Pest Management Regulatory Agency (PMRA). Crop protection companies are required to provide rigorous health and safety testing data to the PMRA with each new product submission.

Q: Some food producers are deciding not to use GMO products (McCain Foods, Frito-Lay, etc.) Obviously they aren't safe. What aren't you telling us?

A: McCain Foods and Frito-Lay have access to the same information that is available to scientists and consumers.

It is true that McCain Foods has decided for the year 2000 not to use genetically engineered potatoes to produce French fries. (We fully respect the right of these companies to make such business decisions.) In his announcement, Mr. McCain made it clear that the science is sound, but bad public relations fueled his decision.

BENEFITS OF GENETICALLY MODIFIED FOODS

Q: Why do we need biotechnology?

A: We need biotechnology to

- improve the food we grow,
- keep us healthier in the future,
- help us maintain an abundant and economical supply of food,
- feed the growing world population, and
- reduce the risk to our environment.

Q: What are some of the benefits of genetically modified foods?

A: The benefits biotechnology can deliver are many and include:

Consumers:

- Fruits, vegetables and cereals that are more nutritious, taste better and keep longer.
- Processed foods that are healthier. For example, there will be lower saturated fats in soybeans and in canola oil.
- Foods that better help us fight disease.
- More dependable crop yields, which ultimately has an effect on the price paid at the grocery store. Long term research is looking at increased tolerance for drought, flood, heat, cold, salt or metals in the soil.
- Nutraceuticals--foods that can deliver vaccines and medicines.

Producers:

- Increased options for pest management integral to IPM and sustainable agricultural practices,
- Improved weed control,
- Managing herbicide resistance,
- Increased yield, and
- More flexibility for cropping practices

STATUS OF GENETICALLY MODIFIED FOODS

Q: Is it true that 70 per cent of our foods are genetically modified?

A: No, the fact is that 70 per cent of processed foods *may contain an ingredient of biotech* such as canola or soybean or corn.

Q: How many genetically modified/food novel traits have been approved for use in Canada? What are they? Where can I go to get a novel traits list of them so I can avoid them?

A: A total of 41 plants with novel traits or PNTs have received food safety approval from Health Canada to date. Two other PNTs have received CFIA approvals and are not considered novel by Health Canada.

- Canola – novel traits which include herbicide tolerance, hybridization system, higher quantities of laurate and myristate, and high oleic/low linolenic acid.
- Corn – novel traits including herbicide tolerance, insect resistance, hybridization system.
- Cottonseed - novel traits including herbicide tolerance, insect and virus resistance.
- Flax - novel trait - herbicide tolerance.
- Potato – novel traits including insect resistance, virus resistance, glyphosate selection system.
- Squash – novel trait - virus resistance.
- Soybeans – novel trait - herbicide tolerance.
- Tomato – novel trait - delayed ripening.
- Wheat – novel trait – herbicide tolerance

This list of products can be found on Health Canada's web site at www.hc-sc.gc.ca/ and Canadian Food Inspection Agency web site at **http://www.dfia-acia.agr.ca/.**

Q: How long have GMO foods been available in Canada?

A: GMO crops were first approved in Canada in 1995. The first crop to be registered was genetically modified canola. Field trials for environmental safety of transgenic varieties has been conducted for 12 consecutive growing seasons in Canada. More than 5000 field trials with GMO crops have been conducted here since 1988.

Q: Why are genetically modified foods banned in Europe?

A:: Thanks to Mad Cow disease the dioxin scare and other similar incidents, European consumers are very nervous and do not have the same faith in their regulatory systems as Canadians. Some GM foods have been approved in Europe, and many European countries are accepting imports that contain GMOs.

Q: Which countries accept GMO exports? Which countries don't? Why?

A: The U.S., Japan, China and Mexico are purchasing products derived from transgenic crops and are major markets for Canadian canola. India and Korea also import some canola products. Approximately 98 per cent of genetically modified corn produced in Canada has been approved for sale in Europe. All soybean varieties, including herbicide tolerant, have been approved for export to Europe and other trading partners.

Q: What is being done to address the long term impacts of genetically modified foods?

A: Research on genetically modified foods and crops is ongoing and each year, the mountain of scientific data that illustrates the technology is sound and safe will continue to grow. Although in Canada genetically engineered crops have only been approved since 1995, research knowledge and familiarity with this technology is based on thousands of experiments and tests that extend over 25 years. It must also be recognized that commercial release of these varieties was preceded by many years of laboratory and field trials. In Canada, over 5000 field trials for environmental safety of genetically engineered crop varieties have been conducted for 12 consecutive growing seasons. Over the last 12 years, tens of thousands of such field tests have also been conducted on more than 30 crops around the world.

Current science shows that genetically engineered foods currently approved in Canada are as safe to consume as their conventional counterparts that have been part of the Canadian diet for a long time. While there is no such thing as “zero risk” for any food, consumers can be confident that foods produced using biotechnology meet the government’s most stringent food safety standards.

REGULATION OF GMO's

Q. Who is responsible for the approval and regulation of genetically modified (GM) foods in Canada? What criteria are used to assess them?

A: All products of biotechnology are carefully assessed by Canadian federal authorities and other experts to ensure that they are safe for people, animals, plants, and our environment. Plants in Canada are regulated on the basis of the traits expressed and not on the basis of the method used to introduce the traits. Plants with novel traits may be produced by conventional breeding, mutagenesis or recombinant DNA techniques.

The Canadian Food Inspection Agency, Health Canada and Environment Canada are the federal agencies responsible for food safety and environmental concerns regarding food, including GM plants.

Whether the product arises from biotechnology or conventional methods, the regulatory process is the same. Each must undergo extensive testing in order to ensure both human health and environmental safety and that Canadians are receiving the safest food products possible.

Category	*Canadian Food Inspection Agency*	*Health Canada*	*Environment Canada*
Human Health & Food Safety • Approval of novel foods • Allergens • Nutritional content • Potential presence of toxins		✓ ✓ ✓ ✓	
Food Labeling Policies • Nutritional content • Allergens • Special dietary needs • Fraud & misrepresentation protection	✓	✓ ✓ ✓	
Safety Assessments (Humans, Animals & the Environment) • Fertilizers • Seeds • Plants • Animals • Animal vaccines • Animal feeds	✓ ✓ ✓ ✓ ✓ ✓		
Testing Standards • Guidelines for Testing Effects on Environment			✓

Q: How are GMO products researched and developed?

A: Many major crop protection companies believe in the future benefits of biotechnology and invest millions of dollars in research every year. It can take 10-15 years and millions of dollars to research and develop a product and bring it to market.

Dedicated scientists spend years researching and developing products. Products are first researched in laboratories, then growth chambers or greenhouses. The next step in the development process is to test them in the field where they are isolated from other crops to minimize any possible environmental impact. While GMO crops have only been on the market for a few years, it must be recognized that commercial release has been preceded by many years of laboratory and field trials. In Canada, 5000 field evaluations have taken place over the past 12 consecutive growing seasons. These field trial sites cannot be used for commercial production for an additional 3-5 years after the trial ends, providing researchers with the opportunity to do further testing later.

Q: Are there international laws governing GMOs?

A: No, there are no international laws but several respected world organizations have regulations governing GMOs.

Organizations such as the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the World Trade Organization (WTO) provide further regulation of the products of biotechnology through global agreements.

The Codex Alimentarius Commission is the international body established in 1962 to administer the Joint Food and Agriculture Organization/World Health Organization Food Standards Programme. The WTO recognizes Codex Alimentarius Commission standards as the international standards of reference for food.

In Montreal on January 29, 2000, 138 countries signed the new Cartagena Protocol on Biosafety, ending five years of negotiations under the United Nations Convention on Biological Diversity. This global treaty refers to the shipment of genetically modified commodities across borders.

The agreement provides a framework for international science-based rules and procedures. These will be further developed as governments and companies determine how to implement the Protocol in the coming years. The Protocol will build on the base of domestic regulations that already

exists in more than 60 nations. The Protocol will come into effect once it has been ratified by 50 countries.

LABELING

Q: I want choice. Why aren't genetically modified foods labeled?

A: Genetically modified foods are treated exactly the same as other new foods seeking entrance to the marketplace. Whenever a product raises a health or safety issue, such as allergenicity or a change in nutritional value, it must be labeled.

The Canadian General Standards Board (CGSB) is a standards-development certification and registration organization. The Canadian Council of Grocery Distributors, as part of their mandate to provide safe food choices for consumers, has requested that CGSB initiate the development of a voluntary standard covering the labeling of foods obtained through biotechnology.

Q: What is the status of labeling GMOs in other countries?

A: Internationally, there is a wide range of views on the labeling of genetically engineered foods. Canada's major trading partner, the United States, supports labeling on a case-by-case basis only in instances of health, safety and compositional change.

Japan, another major trade partner, is developing mandatory labeling with implementation to occur in 2001. Their guidelines are based on science and a realistic approach to labeling. Korea, Thailand and Hong Kong are also considering mandatory labeling. (Source: Dale Adolphe)

The European Union governments voted in October 1999 to force food producers to label their products as containing GMOs if they cannot guarantee that each of the ingredients contains less than one percent GM material. In December 1999, they issued a resolution calling for a review clause to be included in the rules to allow the one percent threshold to be reconsidered in 12 months and possibly reduced.

Q: Why can't all GM foods just be separated and labeled?

A: Segregation of crops is the process of completely separating GMO from non-GMO crops. Segregation is possible and tests do exist that identify whether crops and ingredients have been genetically altered. However, there are some limitations on what they can test for, commercial availability, and cost effectiveness**.**

Grain segregation, for instance, is possible only if the producer carefully harvests, store and transports GMO grain separately from non-GMO grain. It may be extremely difficult for the farmer to properly clean all storage and transport units to ensure a totally pure end product. To change the entire Canadian grain handling and food processing systems to segregate all GMOs from non-GMOs would be a cumbersome and costly process. The decision to proceed or not to proceed down this path therefore requires careful consideration.

SPECIFIC PERCEIVED DANGERS OF GMOs

Q: Once we release GMOs into the environment they are out of control. Who knows what will happen?

A: The Canadian Food Inspection Agency (CFIA) is responsible for regulating agricultural products to assess whether new products are effective and safe to humans, animals and the environment. Plants with novel traits are regulated alongside similar products developed using traditional technologies.

Every product is examined for:

- the potential for plants to spread and transfer genetic material to the other species,
- the harm to non-target species,
- the disruption of balance in natural ecosystems through the replacement of species, land
- the loss of biodiversity (diversity of species, variation of characteristics).

In Canada, stringent environmental safety assessments are carried to evaluate the safety of a new product before it is released to avoid any environmental risks. In the case of plants with novel traits, for example, an environmental assessment is required for confined field trials, a second assessment is required for unconfined release, and if it is to be used as a food or feed it must then undergo a further safety assessment by Health Canada or CFIA before it may be used for commercial production.

Q: Aren't genetically modified foods more dangerous than non-GMO foods?

A: No, in fact, in the future specific GMO foods might even be safer for people with specific allergies then their non-GMO counterparts.

Currently, foods from GMO crops have been assessed and determined by Canadian regulators to be as safe as their non-GMO counterparts. Canadian safety regulations and assessments of genetically enhanced plant products are based on sound, peer-reviewed science.

"The Canadian regulatory program is robust. None of the other countries in the world look at the final product from a health or safety perspective. There is only one country in the world where that is evaluated and that is Canada," comments Dr. Doug Powell, University of Guelph.

Q: Is it safe to eat meat or poultry that from animals that have been fed genetically modified grains?

A: Yes, research indicates animals fed GMO crops are no different than those fed conventional feeds. Proteins from GMO feeds have not been detected in milk, egg products or meat.

Q: What is biotech going to do to our environment in the long-term? (What about the Monarch butterfly?)

A: Current science shows that biotech products are safe for the environment. No one can predict anything with 100% assurance, but the regulatory system that exists provides that every possible precaution is taken in assessing the safety of foods before they are made available to the consumer. The fact that Canada has one of the safest food supplies in the world is evidence of how well this system is working.

Biotechnology is a key element in sustainable agriculture that will benefit the environment in the long-term.

- Dr. Mark Sears, Environmental Biology Chair, University of Guelph, is leading a two-year project to determine the ecological effects of GMO corn pollen on butterflies. Preliminary findings show that pollen is not found in high enough doses on most milkweed plants to hurt butterfly larvae. (Source – U of G)

- There are many systems in place, including crop rotation, hybrid rotation and integrated pest management, that farmers use to prolong the effective use of crop protection products and minimize the possibilty of the development of super bugs or super weeds that could be immune to existing methods of pest and weed management.
  (Source – BIOTECanada FAQ)

Q: The technology is so new. How can we know it is safe?

A: Biotechnology is not new and in fact has been used for thousands of years to produce improved food and health care products. Today, modern biotechnology allows us to develop products more safely and rapidly than ever before through a new process called genetic engineering or the movement of genes from one species to another. This speeds up the process of breeding desirable traits into plants.

The scientific consensus is that the risks associated with food biotechnology products are fundamentally the same as for other foods. Current science shows that foods made from biotechnology are safe to consume and safe for the environment.

To ensure that our food is safe and nutritious, Canada has one of the most rigorous and well respected regulatory approval processes in the world. The Canadian Food Inspection Agency (CFIA), Health Canada, as well as provincial and municipal authorities all play a role in ensuring the safety of our food. CFIA has the primary responsibility for genetically modified organisms. Crops produced by biotechnology must meet the same rigorous standards as those created through traditional means.

Q: Science has failed in the past (i.e. DDT, thalidomide) so how do we know the science is sound with biotechnology?

A: No system is ever perfect and life is not without risk. The challenge is to ensure that the regulatory system is rigorous enough to minimize any risk and to capitalize on benefits. For every failure you can think of, there are thousands of products approved every year that safely improve the quality of life.

With regard to the 43 GMO products approved to date, Health Canada states that “a scientific comparison of their traits with those of conventional foods indicates that they are no less safe than conventional foods which have been safely part of the Canadian diet for a long time.”

Q: Is it true that genetic modification resulted in 40 people being killed and thousands crippled as a result of exposure to a health supplement L-tryptophan?

A: There is no scientific evidence to suggest that genetic modification was the cause. In fact, it is believed that the illnesses were caused as a result of impurities introduced during the manufacturing process of the L-tryptophan.

Q: Why don't farmers just go back to growing non-GMO crops?

A: Farmers have the choice to grow either conventional or GMO varieties in various crops including corn, soybeans and canola. Over the past five years since GMO crops have been introduced in Canada, farmers have recognized the benefits of this technology. According to the Canola Council of Canada, an estimated 55 per cent of the canola planted in 1999 was genetically modified varieties.

Genetically modified crops provide farmers with more options to help them control weeds and insects. Options such as biotechnology are very important when it comes to Integrated Pest Management (IPM) practices. Through IPM, growers can choose the technology that is most appropriate for the pest or weed situation including pesticides, biological control methods, cultivation practices or biotechnology. All of these methods support IPM and sustainable agriculture.

Q: Will the cultivation of pest resistant genetically modified (GM) crops (eg. herbicide tolerant, insect and disease resistant) reduce or eliminate the use of pesticides?

A: Chemical pesticides and pest resistant GM crops are both important technologies for farmers to manage weeds, disease and insects that attack their crops. Used properly, both technologies do not present an unacceptable risk to the environment, the public or the farmer. They are not competing technologies; but rather, complementary solutions to pest management. Genetically modified crops with built in pest resistance provide one more tool for the farmer's toolbox. More tools increases the effectiveness of Integrated Pest Management (the use of a wide variety of chemical, biological and cultivation techniques to control pests) thereby further contributing to sustainable agriculture. A wide variety of options for crop protection are an important component in managing insect, weed and disease resistance problems.

Q: Do farmers benefit economically from the use of pest resistant GM crops?

A: There are several independent studies that show GMO crops benefit farmers economically. Occasionally activists will point to a study that suggests such is not the case. The farmer who needs to make a profit is the ultimate arbiter. Judging by farmer's plantings to date – and they vote with their seeders! – they are embracing this new technology in dramatic fashion. According to the Canola Council of Canada, an estimated 55 per cent of the 13.7 million acres of canola planted in 1999 was genetically modified varieties. The Ontario Corn Producers' Association indicates that in Canada from 33 to 35 per cent of the corn grown in 1999 was GM varieties. Estimates indicate about 20 per cent of the 1999 soybean crop was GM varieties.

Q: Development experts say that genetic engineering will lead to increased hunger and starvation. How do you respond to this?

A: In fact, biotechnology may help us feed the world as our population climbs to about 10 billion by 2050. The amount of land currently committed to food production--36 per cent of the earth's cumulative land mass--cannot yield the amount of food needed by the increased population. Experts predict that we would need to triple the world's food production to be able to feed everyone. Without biotechnology, if all the world's farmers adopted the best modern farming practices with high inputs of fertilizers and pesticides, some experts say it might be possible to double current crop yields on the same amount of land. This means that to feed the world, we would need to increase the amount of land in production substantially, impacting wildlife and native plants and resulting in the clearing of forests.

Q: It is clear allergens are transferred through genetic engineering. What about people with life-threatening food allergies? (eg. peanuts)

A: Health Canada guidelines include consideration of potential allergenicity of the novel food and require clear labeling if there are any health or safety concerns related to allergens. Based on detailed information provided by the developer of a product, the potential for allergenic response is considered by looking at the history of both the host and donor organisms and the modification undertaken.
Canadian Food Inspection Agency

Q: With scientists thoughtlessly mixing genes from Brazil nuts with soybeans, I'm afraid biotech foods could kill unsuspecting consumers with severe allergies. Are there soybeans on the market with genes from nuts?

A: Several years ago, research was conducted in order to improve the quality of soybean meal as an animal feed. This involved the transfer of genetic material coding for a storage protein from a Brazil nut to soybean. Since the Brazil nut is known to cause allergic reaction in a small number of sensitive individuals, laboratory tests using sera from Brazil nut-sensitive individuals were conducted in order to determine whether an allergenic protein had been transferred to the soybean. The results of the laboratory tests showed that the gene obtained from the Brazil nut likely encoded the major Brazil nut allergen and research on this product was discontinued.

The product was never commercially developed and soybeans containing a Brazil nut protein were not available on the market.

Q: Haven't they already shown the levels of toxins in food have increased with biotechnology?

A: No. One of the benefits of biotechnology that can be expected in the near future is *reducing* the levels of natural toxins in plants. Biotechnology may also help to provide simpler and faster methods to locate pathogens, toxins and contaminants in food.

Q: Haven't medical experts warned that antibiotics could become useless because of genetic engineering's use of antibiotic-resistant genes?

A: Antibiotic resistance markers are critical tools for the development of genetically modified crops. They are derived from naturally occurring bacteria to which the human population have been exposed for thousands of years.

The safety of antibiotic resistance genes in genetically modified plants has been thoroughly studied for more than 10 years. Experimentation shows that their use does not add any measurable risk to the environment or to human health.

Q: Isn't it true that toxic chemicals are still used with these crops? (A U.S. study showed farmers that grow GMO soybeans use 2-5 times more herbicides than farmers who grow natural soy varieties.)

A: It is true that GMO crops do not eliminate the use of pesticides. Both pesticides and pest resistant GM crops are important technologies for farmers to manage weeds, disease and insects that attack their crops. Used properly, both technologies do not present an unacceptable risk to the environment, the public or the farmer. They are not competing technologies; but rather, complementary solutions to pest management. Genetically modified crops with built in pest resistance provide one more tool for the farmer's toolbox. More tools increases the effectiveness of Integrated Pest Management (the use of a wide variety of chemical, biological and cultivation techniques to control pests) thereby further contributing to sustainable agriculture. A wide variety of options for crop protection are an important component in managing insect, weed and disease resistance problems.

AGRI-FOOD BIOTECHNOLOGY

What About Food Safety and Allergens?

Genetically engineered (GE) foods are not sources of known allergens. Developers and regulators are aware of the potential risk of transferring genes for allergenic proteins, and have measures in place to prevent such an occurrence. In fact, regulations require extensive testing of GE foods for allergens and there is evidence that the testing works.

The Facts

- Food allergy can be a serious condition and is regarded as such by both regulators and the agri-food industry.
- True food allergy is rare, affects 1-2 % of adult Canadians and is triggered by a very specific reaction involving a protein and the immune system.
- The most common symptoms of food allergy include skin irritations such as rashes, hives and eczema; gastrointestinal symptoms such as nausea, diarrhea and vomiting; and respiratory symptoms such as sneezing, runny nose and shortness of breath. Some individuals may experience a more severe reaction called anaphylaxis, which involves bodily responses from the respiratory and/or circulatory systems.
- In North America, 8 common sources of food allergens (milk, eggs, peanuts, tree nuts, soy, wheat, fish and shellfish) are known to cause 90 % of all food allergies.
- Developers must observe specific safety considerations if they transfer genes from a known source of allergens.
- If a gene from a known source of allergens is introduced to another organism, the new food is rigorously tested to ensure that the allergenic protein has not been transferred.
- Health Canada is responsible for conducting safety assessments on genetically engineered foods, which includes testing for allergens.
- The testing procedure and, ultimately the regulations, do their job to protect public health.
- Right now no food for sale exists that has been genetically engineered to include an allergen.

The Big Picture

The attempt to improve any food can possibly lead to unexpected consequences and that is why safety regulations and assessments are designed to minimize such risks. In essence, if any genes from a food that is known to have allergenic properties are added to a food via biotechnology, a company must show laboratory testing that the allergen is not present in the new food.

Furthermore, there is evidence that the testing, and ultimately the regulatory system, works. This is known because in one instance, an allergen was transferred from one crop to another in a laboratory setting. The presence was confirmed during the preliminary assessment process and the company immediately discontinued development of the product.

Unfortunately, this same example is highly quoted in the media as evidence that there is the potential for inadvertently introducing allergens to modified crops. However, within the context of the regulatory process, the testing strategy was quite successful in preventing the introduction of a transgenic soybean into the marketplace that contained the major allergen from Brazil nuts.

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Resources and Further Information

Food Allergens, June 23, 1999, Institute of Food Science & Technology
http://www.ifst.org/hottop19.htm

Food Allergy Myths and Realities, November.December 1997, International Food Information Council
http://ificinfo.health.org/insight/novdec97/foodallergy.htm

International Food Biotechnology Council and ILSI Allergy and Immunology Institute, (1996). Allergenicity of Foods Produced by Genetic Modification. E. Clydesdale (Ed.) *Critical Reviews in Food Science and Nutrition*. Vol. 36. CRC Press, NY, USA.

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AGRI-FOOD BIOTECHNOLOGY

What About Substantial Equivalence?

Substantial equivalence (SE) is a starting point for the safety assessment of genetically modified (GM) foods. It is a tool to help regulators direct the level of detail/depth required to assess a food's safety. Criticism of the use of SE in evaluating the safety of GM foods is largely due to a misinterpretation of the concept of SE as well as its application.

The Facts

- Substantial equivalence is a science-based approach (or concept) used by regulators to identify similarities and differences between the GM food and a comparable food with a history of safe food use (i.e. a traditional/ conventional counterpart).
- As a starting point, this comparison helps to identify any intended (and unintended) differences between the two foods. It is the defined differences and the unintended effects that become the focus of the safety assessment.
- All countries conducting safety assessments of GM foods apply the concept of substantial equivalence to food safety evaluations. These countries include the United States, Europe, Australia, New Zealand, Japan and Canada.
- The concept of substantial equivalence was developed more than 10 years ago, well before any GM foods were ready to enter the marketplace. The concept arose from difficulties in applying traditional toxicological testing and risk assessment procedures to (whole) foods.
- Assessment of GM foods is on a case-by-case basis, and takes into account the characteristics of the food or food component as well as the method used to modify it. Information examined includes molecular data, compositional data, nutritional data (e.g. key nutrients) and toxicological data (e.g. allergens).
- Health Canada is responsible for assessing the safety of GM foods before they can enter the food supply. All GM foods assessed to date in Canada have been found to be as safe and nutritious as their conventional/traditional counterparts. (Guidelines for the Safety Assessment of Novel Foods are available at: http://www.hc-sc.gc.ca/food-aliment/english/subjects/novel_foods_and_ingredient/novel_foods_and_ingredient.html)
- In June 2000, an Expert Consultation on Food Derived from Biotechnology concluded that there are presently no alternative strategies that would provide a better assurance of safety for GM foods than the approach of applying the concept of substantial equivalence. The Consultation was a joint effort by two internationally recognized organizations: the United Nation's Food and Agriculture Organization and the World Health Organization.
- Substantial equivalence is continually being reviewed as an appropriate tool for assisting with safety assessments.

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The Big Picture

Application of substantial equivalence is used by regulators to structure safety assessments of genetically modified foods relative to conventional counterparts.

Substantial equivalence is not intended to establish absolute safety – a goal that is unattainable for any food – but rather to ensure that the food, and any substances that have been introduced into the food as a result of genetic modification, is as safe as its traditional counterpart.

The assessment/comparison can result in one of three conclusions:

1. The GM food/crop is substantially equivalent to a conventional counterpart.
   → means *the food is regarded to be as safe and nutritious as its conventional counterpart.*

2. The GM food/crop is substantially equivalent except for a few clearly defined differences
   → means *further safety assessment focuses on those differences, possibly requiring toxicological and/or nutritional data.*

3. The GM food/crop is not substantially equivalent to a conventional counterpart – either because differences cannot be defined or because there is no existing counterpart to compare it with.
   → *this does not necessarily mean the food/crop is unsafe, but alternate strategies for safety assessment will need to be considered when SE cannot be used in food safety assessment.*

Substantial equivalence is a practical and science-based approach that guides international regulatory agencies in the assessment of GM foods. The Organization for Economic Co-operation and Development's (OECD) Task Force on the Safety of Novel Foods and Feeds continually focuses on reviewing the adequacy of the application of substantial equivalence. This includes work on assessment methodologies when SE cannot be applied (i.e. differences have been identified or where no comparator exists), as well as efforts to identify critical nutrients and toxicants in crops that are relevant for the determination of substantial equivalence.

Resources and Further Information

Safety Aspects of Genetically Modified Foods of Plant Origin,
Report of a Joint FAO/WHO Expert Consultation on Foods Derived from Biotechnology, Geneva, 2000.
http://www.who.int/fsf/gmfood/fao-who_consultation_report_2000.pdf

Safety Evaluation of Foods Derived Through Modern Biotechnology: Concepts and Principles,
Organization for Economic Co-operation and Development (OECD), 1993.
http://www.oecd.org/dsti/sti/s_t/biotech/prod/modern.htm

Biotechnology and Food Safety,
Report of a Joint FAO/WHO Expert Consultation on Foods Derived from Biotechnology, Rome 1996.
http://www.fao.org/waicent/faoinfo/economic/esn/biotech/tabconts.htm

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AGRI-FOOD BIOTECHNOLOGY

What About Antibiotic Resistance Marker Genes?

Antibiotic resistance marker genes (ARMG) are used in the development of genetically engineered plants. They help identify plant cells that have successfully incorporated the desired/new genetic material. Antibiotic resistance marker genes are assessed for their safety by the federal government before being approved for use. They have no role beyond the laboratory.

The Facts

- A marker gene is a laboratory tool used to identify cells that contain newly added traits.
- During the development stages, plants that have been successfully modified using the techniques of modern biotechnology can be identified using marker genes.
- It is necessary to use marker genes because the newly added trait does not provide an easily identifiable property to the cell carrying it.
- Marker genes are attached to the new/desired gene(s), and are co-introduced to plant cells.
- A marker gene tracks changes in plant cells by conferring resistance to a specific substance (e.g. an antibiotic), or by producing a colour change.
- Antibiotic resistance marker genes help scientists overcome technical limitations associated with current gene transfer methods, such as the low rate that plant cells take up and integrate new/desired genetic material (i.e. a low transformation rate).
- Successful incorporation occurs at a (very low) rate that varies from 1 in 1,000 to 1 in a 1,000,000.
- For example, a gene for altered ripening in tomatoes only shows its effect in the maturing fruit after many months required for the plant to grow and produce tomatoes. Assuming a low transformation rate of 1 in 10,000 it would be impractical to grow 10,000 tomato plants in order to find one that expresses delayed ripening. Attaching a marker gene allows scientists to identify successful insertion while the cells are still in petri dishes, rather than growing 10,000 plants to find one which has the desired trait.
- Two types of ARMGs are found in genetically modified plants:
  - genes from bacteria that have been adapted for work in plant cells. These are used for selecting modified plant cells.
  - genes that are present in genetically engineered plants as a result of the technique used to modify the plant cell (e.g. the particle bombardment). These are used for initial cloning and gene manipulation.
- Health Canada is responsible for the safety assessment of foods derived from biotechnology including the use of ARMGs in the development of these foods.
- Health Canada's approach for assessing the safety of the use of ARMGs is based on the approach taken by international scientific organizations.
- Evaluation of ARMGs is on a case-by-case basis and considers many criteria, including clinical importance and the current level of antibiotic resistance for the antibiotic.
- Because ARMGs have no role beyond the laboratory, their presence in crops and foods has provoked a lot of public concern about their contribution to antibiotic resistance.
- Health Canada assesses whether the presence in food of a protein encoded by the ARMG would compromise the effectiveness of antibiotics used in treating illnesses. Similarly, any new protein introduced into a food is assessed by the Department for its potential to be a toxin or allergen.
- No evidence exists that ARMGs from genetically engineered plant cells are transferred to microorganisms in the human gut, nor make them resistant to antibiotics.
- Past and recent research show that ARMGs do not contribute to current levels of antibiotic resistance.
- Nevertheless, in order to address public concerns, alternatives to ARMGs have been developed, and as a result the use of ARMGs is now becoming less common.
- Alternative options include: the Cre-lox system (which will remove the ARMG after successfully modifying a plant cell); using another kind of selectable marker gene; or choosing a different selection method altogether.

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The Big Picture

Marker genes are useful laboratory tools in modern biotechnology because they identify the few plant cells that have successfully incorporated the new/desired genetic material.

Health Canada, who is responsible for conducting the food safety assessment of genetically engineered foods, uses an approach for assessing the safety of antibiotic resistance marker genes that is based on the guidance provided by the World Health Organization and the Food and Agriculture Organization of the United Nations. See the complete guidelines and evaluative process used to determine the safety of antibiotic resistance genes as markers at: http://www.fao.org/waicent/faoinfo/economic/esn/biotech/six.htm#six2.

Although the use of antibiotic resistance marker genes is assessed and regulated by the federal government, some public concern exists about genes from a plant or food being transferred into a microorganism, which may then become resistant to a specific antibiotic. However, scientific evidence indicates that there is little cause for concern. In fact, reviews conducted by various government regulatory agencies regarding the use of antibiotic resistance markers genes have concluded that while such a transfer could theoretically occur, the possibility is quite small (given the level of complexity and number of steps involved). In addition, the rate of such a transfer (if any) would be insignificant and would not increase the existing levels of resistance in bacteria in the human gut in any meaningful way.

Resources and Further Information

GM Plants and Antibiotic Resistance Genes
September 28, 1999, The Food Safety Network
http://www.plant.uoguelph.ca/safefood (go GE food, then go Antibiotic Resistance Markers)

The U.S. FDA Industry Guidelines for the Use of Antibiotic Resistance Marker Genes in Transgenic Plants
September 4, 1998, U.S.-FDA
http://vm.cfsan.fda.gov/~dms/opa-armg.html

Marker Gene Controversy in Transgenic Plants
January 1999, J. Plant Biochemistry & Biotechnology, vol. 8, 01–13,
Vedpal S. Malik and M. K. Saroha
[adapted version available: http://www.agbios.com/articles/2000186-A.htm]

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BIOTECH WEBSITE RESOURCE LIST

SCIENCE & GOVERNMENT

Alberta Research Council - www.arc.ab.ca
A market focus, and research on biotechnology.

AgBioForum – ***www.agbioforum.org*** – A quarterly on-line magazine devoted to the economics and management of agricultural biotechnology. They publish short, non-technical articles reporting on current research.

AgBioWorld – ***www.agbioworld.org*** – Contains a declaration in support of biotechnology that has been signed by more than 1,000 scientists around the world.

Agriculture and Agri-Food Canada Communications Branch – www.agr.ca – Contact point for information dissemination on many aspects of biotechnology that involve multi disciplines, commodities and government departments.

Biotechnology Industry Organization – ***www.bio.org*** – BIO represents more than 900 companies, academic institutions and biotech centers in 47 states and 26 nations. Their members are involved in the research and development of health-care, agricultural, industrial and environmental products.

Canadian Environmental Protection Act –
http://www.ec.gc.ca/cceb1/eng/biohome.html
– New regulations for biotechnology products under the Canadian Environmental Protection Act.

Canadian Food Inspection Agency, Office of Biotechnology – www.cfia-acia-agr.ca/ – Offers general information on biotechnology, regulatory system for agricultural products of biotechnology, and products regulated by the Canadian Food Inspection Agency. Provides information on specific regulatory requirements for safety and environmental assessments of plants, animal feeds, biofertilizers (supplements) and veterinary biologics.

Canadian General Standards Board - http://w3.pwgsc.gc.ca/cgsb/
– Standards for voluntary labeling of genetically modified foods. FAQ's on genetic modification. News releases. Biotechnology links.

Convention on Biological Diversity – ***www.biodiv.org*** – The Convention on Biological Diversity is deemed to be the first global, comprehensive agreement to address all aspects of biological diversity: genetic resources, species, and ecosystems. The site includes details on the Cartegena Protocol on Biosafety.

Environment Canada –www.ec.gc.ca/ – Information on biotechnology as it relates to Canadian Environmental Protection Act.

Fisheries and Oceans Canada Communications Branch – ***www.dfo-mpo.gc.ca/*** – Information on biotechnology as it relates to Fisheries Act, aquaculture and aquatic organisms.

Genetic Engineering News – ***www.genengnews.com*** – A source for news on biotech, bioregulation, bioprocess, bioresearch, and technology transfer. They publish a biotechnology newsletter 21 times a year.

Health Canada, Health Protection Branch, Office of Food Biotechnology – www.hc-sc.gc.ca/ – *Addresses regulatory process and approach to safety assessment of genetically modified* foods for human health safety. Makes decision on new products. Various food biotechnology-specific publications available at website.

Industry Canada, Canadian Biotechnology Strategy Secretariat – www.strategis.ic.gc.ca/cbs – Offers information relating to the federal government Canadian Biotechnology Strategy.

Ontario Agri-Food Technologies - http://www.oaft.org/ – Contains current links and press releases on the biotechnology industry. FAQ's on agricultural biotechnology.

The Royal Society of Canada – ***www.rsc.ca*** – The Royal Society of Canada is a senior national body of distinguished Canadian scientists and scholars. Their Committee on Expert Panels was formed in response to requests from governments and other organizations for guidance on public policy issues where specialized knowledge is required. They have a new Expert Panel on Food Biotechnology.

INDUSTRY

AgBioS – ***www.agbios.com*** **–** Agriculture & Biotechnology Strategies Inc. is a Canadian company providing consulting expertise to the agricultural biotech industry. The website offers general agricultural biotechnology information plus links to other related sites.

AGCare (Agricultural Groups Concerned About Resources and the Environment) – www.agcare.org – Provides crop producers' perspectives on biotechnology development, sustainable agriculture, and responsible use of new farm technologies. Offers information kits and media backgrounders.

Agricultural Institute of Canada – http://www.aic.ca – Federation of provincial institutes of agrologists and scientific and agricultural organizations. Speakers bureau for biotechnology topics.

Ag-West Biotech Inc. – www.agwest.sk.ca – Supports growth of Saskatchewan's agricultural biotechnology industries and commercialization of related food and non-food technologies. Produces pamphlets, Ag. Biotech Bulletin, biotech demonstration labs (SABIC), and background on regulatory issues (SARAS).

Alliance for Better Foods (USA) – ***www.betterfoods.org*** – Facts & figures, expert views and the benefits of agricultural biotechnology.

BioAtlantech – www.bioatlantech.nb.ca – Promotes investment, research and development, partnerships, and development of skilled workforce. Information relating to Atlantic Canada.

BIOTECanada – ***http://www.biotech.ca*** – The national organization dedicated to promoting a better understanding of biotechnology. Of particular note is their comprehensive glossary of biotech terms found at ***http://www.biotech.ca/EN/what_glossary.html***

Canadian Council of Grocery Distributors ***http://www.cfta.ca/*** – Consumer and environmental concerns & initiatives of the industry. News releases.

Canadian Federation of Agriculture – www.cfa-fca.ca – Represents over 200,000 farm family members in Canada providing a unified voice on agriculture and food. Information on biotechnology at a national and international level.

Canadian Federation of Independent Grocers ***www.cfig.ca/ –*** Current issues concerning Canada's independent franchise grocery stores.

Canadian Produce Marketing Association – www.cpma.ca – Answers queries relating to biotechnology and fresh fruits and vegetables. Provides list of contacts for growers and distributors of fresh produce.

Canola Council of Canada- http://www.canola-council.org – Contains numerous website links that present balanced information on biotechnology. Reports on grower perspective on biotechnology, including an online discussion group on biotechnology.

Council for Biotechnology Information –***http://www.whybiotech.com*** – The Council for Biotechnolgy Information has been founded by leading biotechnology companies to create a public dialogue and share information about biotechnology that is based on objective scientific research, independent expert opinion and peer-reviewed published reports.

Crop Protection Institute – ***http://www.cropro.org*** – The Crop Protection Institute represents the manufacturers, developers and distributors of plant life science solutions for agriculture, forestry and pest management in Canada.

Dietitians of Canada - http://www.dietitians.ca – Nutrition resources. Current updates on nutritional issues. Dietitian viewpoints on nutritional issues including biotechnology.

Food Biotechnology Communications Network (FBCN) – www.foodbiotech.org – Comprehensive information referral service for questions relating to food biotechnology.

Food & Consumer Products Manufacturers of Canada – **www.fcpmc.com** – Represents over 170 companies coast to coast, which provide consumers with an array of food and consumer products that are integral to daily life at home, work and leisure. The site has several food biotech backgrounders and resource documents.

Lumen Foods – ***www.lumenfds.com/bseries.htm*** – A major health foods manufacturer that is taking a "pro-GM" stance. Their "Biotech Education Series" consists of government-sponsored studies, reprinted articles and letters from scientists from around the world.

CONSUMER

Consumers' Association of Canada – www.consumer.ca – Volunteer association that represents and informs consumers and advocates action on their behalf to improve quality of life.