

Genetically Modified Organisms



Corn



Soy



Cottonseed



Papaya



Rice



**Rapeseed
(Canola)**



Potatoes



Tomatoes



Dairy products



Peas

What are genetically modified (GM) organisms and GM foods?

Genetically modified organisms (GMOs) can be defined as organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination.

The technology is often called “modern biotechnology” or “gene technology”, sometimes also “recombinant DNA technology” or “genetic engineering”. It allows selected individual genes to be transferred from one organism into another, also between nonrelated species. Foods produced from or using GM organisms are often referred to as GM foods.

Why are GM foods produced

GM foods are developed – and marketed – because there is some perceived advantage either to the producer or consumer of these foods. This is meant to translate into a product with a lower price, greater benefit (in terms of durability or nutritional value) or both.

Initially GM seed developers wanted their products to be accepted by producers and have concentrated on innovations that bring direct benefit to farmers (and the food industry generally).

Overview

- Definition
- GM Crop Production
- Genetic Engineering Techniques
- Advantages
- Criticisms
- US Regulation

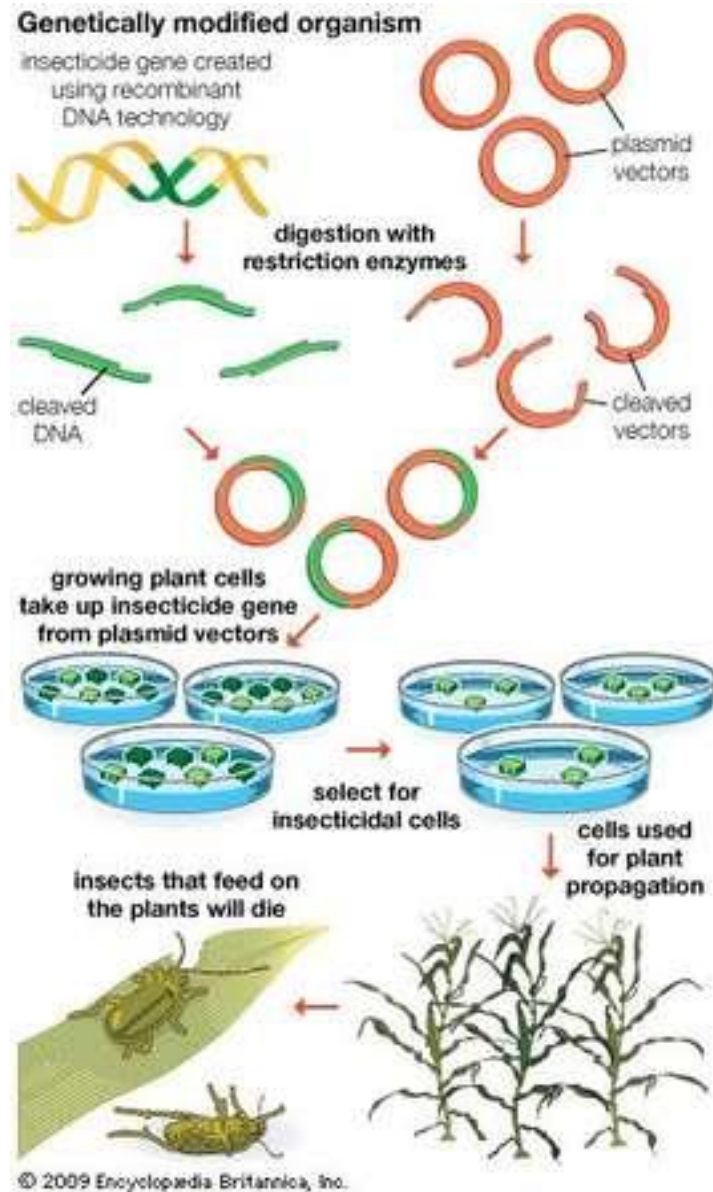
Benefits

- Reduce pesticide and herbicide use
- Increase crop yields
- Improve nutritional quality
- Reduce waste
- Disease resistance
- Reduce ecological impact
- Reduce cost

Examples of GMOs Resulting from Agricultural Biotechnology

Genetically Conferred Trait	Example Organism	Genetic Change
APPROVED COMMERCIAL PRODUCTS		
Herbicide tolerance	Soybean	Glyphosate herbicide (Roundup) tolerance conferred by expression of a glyphosate-tolerant form of the plant enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) isolated from the soil bacterium <i>Agrobacterium tumefaciens</i> , strain CP4
Insect resistance	Corn	Resistance to insect pests, specifically the European corn borer, through expression of the insecticidal protein Cry1Ab from <i>Bacillus thuringiensis</i>
Altered fatty acid composition	Canola	High laurate levels achieved by inserting the gene for ACP thioesterase from the California bay tree <i>Umbellularia californica</i>
Virus resistance	Plum	Resistance to plum pox virus conferred by insertion of a coat protein (CP) gene from the virus

Vitamin enrichment	Rice	Three genes for the manufacture of beta-carotene, a precursor to vitamin A, in the endosperm of the rice prevent its removal (from husks) during milling
Vaccines	Tobacco	Hepatitis B virus surface antigen (HBsAg) produced in transgenic tobacco induces immune response when injected into mice
Oral vaccines	Maize	Fusion protein (F) from Newcastle disease virus (NDV) expressed in corn seeds induces an immune response when fed to chickens
Faster maturation	Coho salmon	A type 1 growth hormone gene injected into fertilized fish eggs results in 6.2% retention of the vector at one year of age, as well as significantly increased growth rates



Genetically modified organisms are produced using scientific methods that include recombinant DNA technology.



Arctic fish DNA

+



strawberry

=

**A strawberry
resistant to
frost**

Virus Resistance

- Virus resistance makes plants less susceptible to diseases caused by such viruses, resulting in higher crop yields.
- For Example- Hawaiian Papaya- Hawaiian papaya is made resistant to the devastating effects of Papaya Ring Spot Virus (PRSV).



Hawaiian Papaya



Papaya Ring Spot Virus

GENETIC TRAITS EXPRESSED IN GMOs IN THE U.S.

APPLE

Genetic Traits
Non-browning
Uses: Food



POTATO

Genetic Traits
Reduced Bruising
and Black Spot
Non-browning
Low Acrylamide
Blight Resistance
Uses: Food



FIELD CORN

Genetic Traits
Insect Resistance
Herbicide Tolerance
Drought Tolerance
Uses:
- Livestock and poultry feed
- Fuel ethanol
- High-fructose corn syrup
and other sweeteners
- Corn oil
- Starch
- Cereal and other food ingredients
- Alcohol
- Industrial uses



CANOLA

Genetic Traits
Herbicide Tolerance
Uses: Cooking oil,
Animal feed



ALFALFA

Genetic Traits
Herbicide Tolerance
Uses: Animal feed



SOYBEAN

Genetic Traits
Insect Resistance
Herbicide Tolerance
Uses:
- Livestock and poultry feed
- Aquaculture
- Soybean oil (vegetable oil)
- High oleic acid
(monounsaturated fatty acid)
- Biodiesel fuel
- Soymilk, soy sauce, tofu,
other food uses
- Lecithin
- Pet food
- Adhesives and building
materials
- Printing ink
- Other industrial uses



RAINBOW PAPAYA

Genetic Traits
Disease Resistance
Uses: Table fruit



COTTON

Genetic Traits
Insect Resistance
Herbicide Tolerance
Uses: Fiber, Animal feed,
Cottonseed oil



SUGAR BEET

Genetic Traits
Herbicide Tolerance
Uses: Sugar, Animal feed



SWEET CORN

Genetic Traits
Insect Resistance
Herbicide Tolerance
Uses: Food



SUMMER SQUASH

Genetic Traits
Disease Resistance
Uses: Food



**A NEW CONVERSATION, PUBLIC Q&A AND CENTRAL
ONLINE RESOURCE FOR INFORMATION ON GMOs.
ASK. LINK. FOLLOW. TWEET.**

WWW.GMOANSWERS.COM | @GMOANSWERS



Definition

- Food product developed from different genetically modified organism (GMO)
 - Crop plant
 - Soybeans, corn, canola, cocoa beans
 - Animal
 - Microorganism (yeast)
- GM foods available since 1990's
- Add novel genetic material into genome
 - Produce new and useful traits
 - Control insects and weeds
- Not possible with conventional breeding
 - Intentional/unintentional modification of species to breed certain traits over others



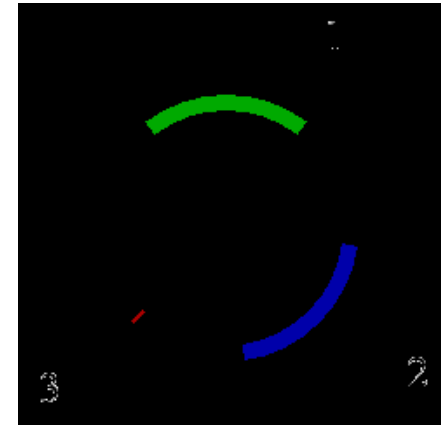
Selectively bred carrots

GM crop development

- 1992: FlavrSavr produced GM tomato
- 1997: Insect protected cotton
 - herbicide tolerant soybeans
- Currently: herbicide/insecticide resistant soybeans, corn, cotton, canola, and tomatoes
 - Control weeds/insects
 - “Altered ripening to enhance fresh market value”
 - Thicker skin
- 1996 to 2005: surface area of land with GMO's increased by a factor of 50
 - from 17,000 km² to 900,000 km²
- 2001 US: 68% total GM planted surface area
- 2006 US: % of GM planted area
 - 89% soybeans
 - 83% of cotton
 - 61% maize

Genetic Engineering Techniques

- Recombinant DNA
 - Biological vectors (plasmids, viruses) to carry foreign genes into cells
- Microinjection
 - Inject genetic material containing the new gene into the recipient cell
- Electro- and Chemical Poration
 - creating pores or holes in the cell membrane to allow entry of the new genes
- Bioballistics
 - use metal slivers to deliver the genetic material to the interior of the cell
 - Slivers coated with genetic material, propelled into cell with gun
 -



Plasmid DNA

Bt corn example

- B.t. (*Bacillus thuringiensis*) is a naturally occurring bacterium that contains a gene that codes for a toxin that will crystallize in the digestive tract of insect larvae, leading to starvation
- Transferred B.t. protein genes into corn genome
- Bt corn can produce its own pesticides against insects such as the European corn borer



European corn borer

Advantages

- Herbicide tolerance
 - Soybeans not affected by Roundup
- Disease resistance from viruses, fungi and bacteria that cause plant diseases
- Cold tolerance
 - Tolerate cold temperatures that normally would kill unmodified seedlings
- Drought tolerance/salinity tolerance
 - Withstand different soils or groundwater
- Nutrition
 - Add vitamins and minerals
 - Add Vitamin A to rice
- Pharmaceuticals
 - Edible vaccines in tomatoes and potatoes

Criticisms: Environmental hazards

- Harm to other organisms
 - Monarch Butterflies
- Reduced effectiveness of pesticides
 - Insects will become resistant crops that have been genetically modified to produce their own pesticides
- Gene transfer to non-target species
 - Crop plants engineered for herbicide tolerance and weeds could cross-breed
- Allergenicity
 - Introducing a gene into a plant may create a new allergen or cause an allergic reaction
- Scientists believe that GM foods do not present a risk to human health
- Several health organizations have established the background for the safety assessment of GM food
 - Concluded that “GM products are not inherently less safe than those developed by traditional breeding”
 -

Criticisms: Economic concerns

- New plant genetic engineering technologies and GM plants have been patented
 - Could increase the price of seeds
- Patent enforcement difficult
- Increasing use of genetic modification in major crops could cause a power shift in agriculture towards biotechnology companies
 - More control over crops and farmers

US Regulation

- EPA evaluates GM plants for environmental safety
 - Regulate pesticide/herbicide tolerant crops
- USDA evaluates whether the plant is safe to grow
 - Drought/disease tolerant crops
 - Food for animal/human consumption
- FDA evaluates whether the plant is safe to eat
 - Pharmaceuticals, cosmetics and food products

GM Food Labeling

- FDA: food labeling is governed by the Food, Drug and Cosmetic Act
 - GRAS: Generally Recognized as Safe
- Labeling would increase costs
- Difficult to define acceptable limit of GM contamination in non GM foods
- Current technology cannot detect minute quantities of GM food
- Consumer interest groups want labeling
- Agribusiness industries believe that labeling should be voluntary and influenced by the demands of the free market
- January 2000 international trade agreement for labeling GM foods
 - 130 countries signed, including the US
 - Exported GM food must be labeled

GM Regulations Worldwide

- Japan – health testing of all GM food
- Europe – GM food labeling
 - European Commission established a 1% threshold for contamination of unmodified foods with GM food products
- Venezuela – ban on GM seeds
- Hungary – ban on importing and planting of GM corn seeds

Future Developments

- GM foods continue to increase
 - Bananas produce vaccines against Hepatitis B
 - Fish that mature more rapidly
 - Fruit and nut trees that produce fruit quicker
 - Plants that produce new plastics
- More safety testing needed on new products
- Possibility of food labeling?

Human Health controversies

- Many scientists and several health organizations have established the background for the safety assessment of GM food
 - Introducing a gene into a plant may create a new allergen or cause an allergic reaction
 - Concluded that “GM products are not inherently less safe than those developed by traditional breeding”
- **In 2009, the American Academy of Environmental Medicine (AAEM)** stated that, “Several animal studies indicate serious health risks associated with genetically modified (GM) food,” including infertility, immune problems, accelerated aging and changes in major organs and the gastrointestinal system.