

GENETICALLY MODIFIED ORGANISMS: THE FACTS



Sydney Hayter | February 28, 2015

What is today about?

- Clearly define genetic modification
- Public perception
- State facts on genetically modified organisms
- Unbiased information

No “government shills”
Research-based info

Open minds and ears



Defining Genetic Modification

- Very broad definition
 - Almost all produce as we know it today has been genetically modified
- Different forms:
 - Selective breeding
 - Biotechnology
 - Genetic engineering
- Bottom line: altered genome

Genetic Engineering

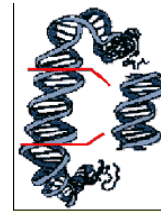
- DNA Extraction
 - Pull genetic material from organism with desired trait



Extracting DNA from and organism.

Genetic Engineering

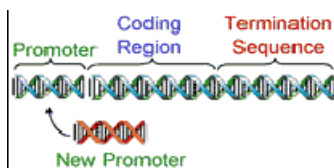
- Gene Cloning
 - Separate single gene of interest from the rest of the genome
 - Thousands of copies
 - Polymerase Chain Reaction



Selecting a gene for cloning

Genetic Engineering

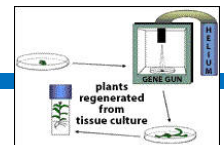
- Gene Design
 - Allow the gene to 'work' inside a new organism
 - Cut with enzymes and replace separated regions



Replacing an existing promoter with a new promoter.

Genetic Engineering

- Transformation
 - Gene insertion
 - Impossible to insert into every cell of a plant
 - Utilize tissue culture → undifferentiated plant cells
 - Gene gun, agrobacterium, microfibers, electroporation
 - Main goal = deliver new gene into nucleus without killing the cell
 - Plants then grown to maturity in a greenhouse



Using the gene gun method to transform plant cells.

Genetic Engineering

- Backcross Breeding
 - ▣ Transgenic plants crossed with an elite breeding line using traditional methods
 - ▣ Offspring crossed back to elite line



Backcross breeding

But Why Genetic Modification?

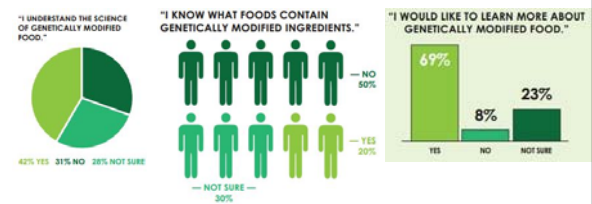
- Science = answering questions, solving problems
- Allergies
- Crop improvement
- Aesthetics

Advantages of Genetic Engineering

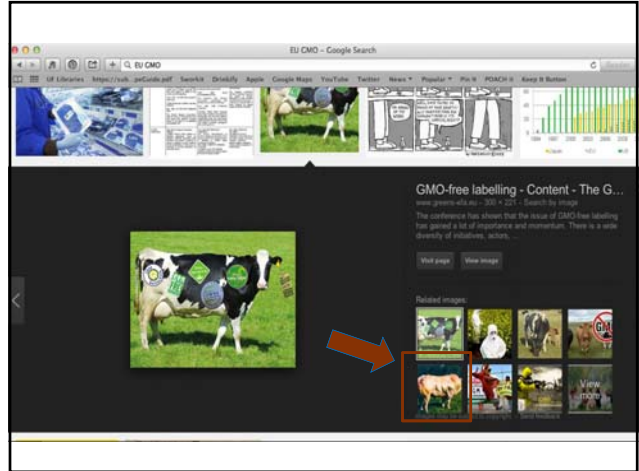
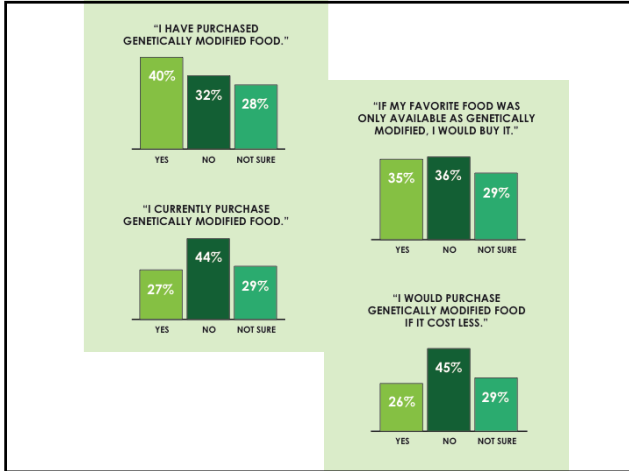
- Resistance
 - ▣ Pests
 - ▣ Disease
- Tolerance
 - ▣ Herbicide
 - ▣ Drought
 - ▣ Salinity
 - ▣ Extreme weather patterns
- Improved Nutritional and Grain Quality
- Social
- Economic
- Environmental
 - ▣ Fewer pesticide and herbicide
 - ▣ Soil management

Public Perception

- Internet has become blessing and a curse
 - ▣ So many sources, but how many accurate?
- Who to trust?



All charts from UF/IFAS Center for Public Issues Education yearly public opinion survey, pioneer.com/food



SEEDS EXPLAINED HEIRLOOM, HYBRID, GMO

DEFINITION

- Heirloom seed:** seed that is produced through open-pollination by a natural means. An heirloom plant has one parent.
- Hybrid seed:** seed that is produced by cross-pollinating two plants as nature or in a lab. A hybrid plant has two parents.
- GMO seed:** seed that has had its DNA altered using techniques of genetic engineering in a lab.

CHARACTERISTICS

- Heirloom plants are typically "true to type". Plants are like the parent of the seed.
- Hybrid plants typically have improved characteristics such as better yield, greater uniformity, improved color, disease resistance, etc.
- GMO plants typically have modified or unique traits that the plant wouldn't otherwise possess.

ADVANTAGES

- Greater selection of plants to choose from. Resistant to pests, disease, extreme weather, non-homogenous tastes.
- Very popular, easy to find. Produce high yields, uniform crops. Plants may be more disease resistant.
- ??

DISADVANTAGES

- Not as hardy, disease-resistant as hybrid plants.
- Taste is homogenous, less variety in flavor. Can be costly. Seeds from first-generation plants can't be saved and re-planted.
- Not possible to be sure if genetically altered with the health risks of the parent plants. Confirmed allergens, health risks, resistance, and chemical inputs require that the government will screen GMO plants and approve.

What Went Wrong?

- Sensationalist media
- Misrepresentation
 - "Silver bullet"
- Anybody can share information and become "authority" on subject
- European Union 'precautionary principle'
- "' Truth is a religious concept,' he said. Science is based on hypothesis." – Peter Hadfield, Science Reporter

Photo: <http://www.flickr.com/photos/compuserve/4114789000/> by [compuserve](http://www.flickr.com/photos/compuserve/4114789000/) 721 874 247 41404364 / Hadfield quote: <http://www.thecorncropnet.org/2015/02/23/notes-on-gm-foods-dangerous-renewed-science-reporter-qa-logic-takes-on-anti-gmo-fundamentalists/>

What Anti-GMO says

- 10 Scientific Studies proving GMO harmful
- **"Multiple Toxins From GMOs Detected In Maternal and Fetal Blood"**
- **"DNA From Genetically Modified Crops Can Be Transferred Into Humans Who Eat Them"**
- **"New Study Links GMOs To Gluten Disorders That Affect 18 Million Americans"**
- **"Study Links Genetically Modified Corn to Rat Tumors"**
- **"Glyphosate Induces Human Breast Cancer Cells Growth via Estrogen Receptors"**
- **"Glyphosate Linked To Birth Defects"**
- **"Study Links Glyphosate To Autism, Parkinson's and Alzheimer's"**
- **"Chronically Ill Humans Have Higher Glyphosate Levels Than Healthy Humans"**
- **"Studies Link GMO Animal Feed to Severe Stomach Inflammation and Enlarged Uteri in Pigs"**
- **"GMO risk assessment is based on very little scientific evidence in the sense that the testing methods recommended are not adequate to ensure safety"**

<http://www.collective-evolution.com/2014/04/08/10-scientific-studies-proving-gmo-can-be-harmful-to-human-health/>

Is That All True?

Is it "good science?"
Is it "real" science?

Not exactly...

- **"Multiple Toxins From GMOs Detected In Maternal and Fetal Blood"**
- Detected BtCry1Ab (*Bacillus thuringiensis*-produced protein) in maternal blood
 - ▣ Test engineered for plant detection
- Proteins are messengers – no receptor, no action
 - ▣ We don't possess BtCry1Ab receptor
 - ▣ Chocolate toxicity in dogs

Not exactly...

- **"DNA From Genetically Modified Crops Can Be Transferred Into Humans Who Eat Them"**
- Mincing words
- Genes from food ingested detected in plasma
 - ▣ Not integrated into our genome!
- All food contains DNA, including non-GMO
- No negative control in the study

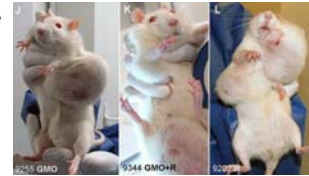


Not exactly...

- **“New Study Links GMOs To Gluten Disorders That Affect 18 Million Americans”**
- No actual study
 - Statements from Institute for Responsible Technology (IRT)
 - No research, nothing peer-reviewed
- Celiac Disease Foundation has spoken out against IRT - link is absent
- No GMO wheat commercially produced!
- **Correlation ≠ Causation**

Not exactly...

- **“ Study Links Genetically Modified Corn to Rat Tumors”**
- Notorious among science community
- Retracted, recently republished without peer review
- Directly fed glyphosate
- Predisposed to tumors
- No negative control

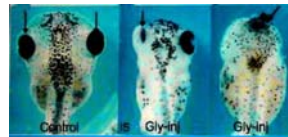


Not exactly...

- **“Glyphosate Induces Human Breast Cancer Cells Growth via Estrogen Receptors”**
- *In vitro* study – cells are sensitive and need different environment than normal human tissue
- No data on controls – how to compare?
- Misinterpretation – causes cancer cells to proliferate, doesn't cause cancer itself
- Most scientific studies point to protective qualities of glyphosate on cellular structure
- Soybean component can cause similar effects

Not exactly...

- **“Glyphosate Linked To Birth Defects”**
- No peer review
- No statistical analysis
- Published by an NGO
 - Co-founder is owner of GMO testing
 - Conflict of interest



← Frog embryos incubated directly in glyphosate

Not exactly...

- **“Study Links Glyphosate To Autism, Parkinson’s and Alzheimer’s”**
- Only a hypothesis – no research conducted
 - ▣ Zero data presented
 - ▣ Does not fit title of “study”
- “Pay for Play” journal
 - ▣ Risky for community
- Lack of fact-checking by media reporting information

Not exactly...

- **“Chronically Ill Humans Have Higher Glyphosate Levels Than Healthy Humans”**
- Published in a journal owned by predatory publisher – for a fee anything printed
- No background data on humans or animals studied
 - ▣ Age/Sex/Height/Weight/Genetics
 - ▣ Washing food habits/Amount consumed/Organic vs conventional
- Never defined “chronically ill”

Not exactly...

- **“Studies Link GMO Animal Feed to Severe Stomach Inflammation and Enlarged Uteri in Pigs”**
- Inconsistent definition of inflammation
- GM-feed has protective effects in some instances
- No feed composition analysis
- Abnormally high pneumonia rate among all animals



<http://www.organo-systems.org/journal/31/8106.pdf>

Not exactly...

- **“GMO risk assessment is based on very little scientific evidence in the sense that the testing methods recommended are not adequate to ensure safety”**
- Not a study...
- Includes review of crops not submitted for regulatory approval
- Editorial and commentary

The Disconnect

- ❑ Scientific thinking has to be taught
- ❑ Science is a method
- ❑ Always question!
 - ❑ (But go to trusted sources for answers)
- ❑ Media has grown short on science and heavy on ideology

Is Genetically Modified Food Safe?

AAAS
The American Association for the Advancement of Science is an international non-profit organization. AAAS serves some 281 affiliated societies and academies of science.
"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."

AMA
The premier body of physicians in the United States.
"There is no scientific justification for special labeling of genetically modified foods."
Bioengineered foods have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature."

World Health Organization (WHO)
The World Health Organization (WHO) is the directing and coordinating authority for health within the United Nations system.
"No effects on human health have been shown as a result of the consumption of GM foods by the general population in the countries where they have been approved."

NATIONAL ACADEMY OF SCIENCES
The National Academy of Sciences is a non-profit organization in the United States. It is the premier scientific body in the United States.
"To date more than 98 million acres of genetically modified crops have been grown worldwide. No evidence of human health problems associated with the ingestion of these crops or resulting food products have been identified."

ROYAL SOCIETY OF MEDICINE
England's top medical society, the Royal Society of Medicine is an independent educational organization for doctors, dentists, scientists and others involved in medicine and health care.
"Foods derived from GM crops have been consumed by hundreds of millions of people across the world for more than 16 years, with no reported ill effects (or legal cases related to human health), despite many of the consumers coming from the most litigious of countries, the USA."

EUROPEAN COMMISSION
The European Commission (EC) is the executive body of the European Union.
"The main conclusion to be drawn from the efforts of more than 150 research projects, covering a period of more than 26 years of research, and involving more than 600 independent research groups, in that biotechnology, and in particular GMOs, are no more risky than e.g. conventional plant breeding technologies."

The scientific consensus around the safety of genetically modified foods is as strong as the scientific consensus around climate change. These foods are subjected to more testing than any other, and everything tells us that they're safe.

www.aaasmondonline.com

Scientific Consensus

- ❑ 18 years of peer-reviewed research = safe for consumption
- ❑ Pew Research Center – 88% of scientists associated with American Association for Advancement of Science agree genetically modified foods safe
- ❑ 79% of general public say science has made life easier

Wide Differences Between Public and Scientists on Safety of GM Foods

% of each group saying it is generally safe or unsafe to eat genetically modified foods

Group	Generally unsafe	Generally safe
U.S. adults	57	37
AAAS scientists	11	88

Public Largely Skeptical of Scientific Understanding of Health Effects

% of U.S. adults saying that scientists have or do not have a clear understanding about the health effects of GM crops

Group	Scientists not clear	Scientists clear understanding
U.S. adults	67	28

Survey of U.S. adults August 15-25, 2014 (Q10-18). AAAS scientists survey Sept. 13-Oct. 23, 2014. Other responses and those saying don't know or going no answer are not shown. PEW RESEARCH CENTER

<http://www.pewresearch.org/2015/01/29/public-and-scientists-views-on-science-and-society/>

Why are Scientists so Confident?

- ❑ Genetic engineering has existed for 30 years
- ❑ Genetically modified organisms go through much more rigorous testing than any other food products
 - ❑ Coordinated Framework – Food and Drug Administration (FDA) works in conjunction with Environmental Protection Agency (EPA) and the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Society (APHIS)
 - Ensure no negative impacts on human health or environment



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- http://www.genomenewsnetwork.org/resources/timeline/1973_Boyer.php