# Science on Your Plate:
## Consumer perceptions of food biotechnology

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# Learning Objectives

- Define the history of biotechnology in the food system
- Describe the types of foods that are genetically modified
- Describe the scientific evidence for safety of biotechnology in food
- Describe the motivations for public discord relative to food biotechnology

# Nutrition and food are in the news and in government policy more than any time in history

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## What drives decisions?

**For producers**

**For food industry**

**For consumers**

**For federal agencies**

# Deciding what to eat is confusing……

55% trying to lose weight

- 15% know their calorie requirement
- 77% do not meet DHHS activity recommendations

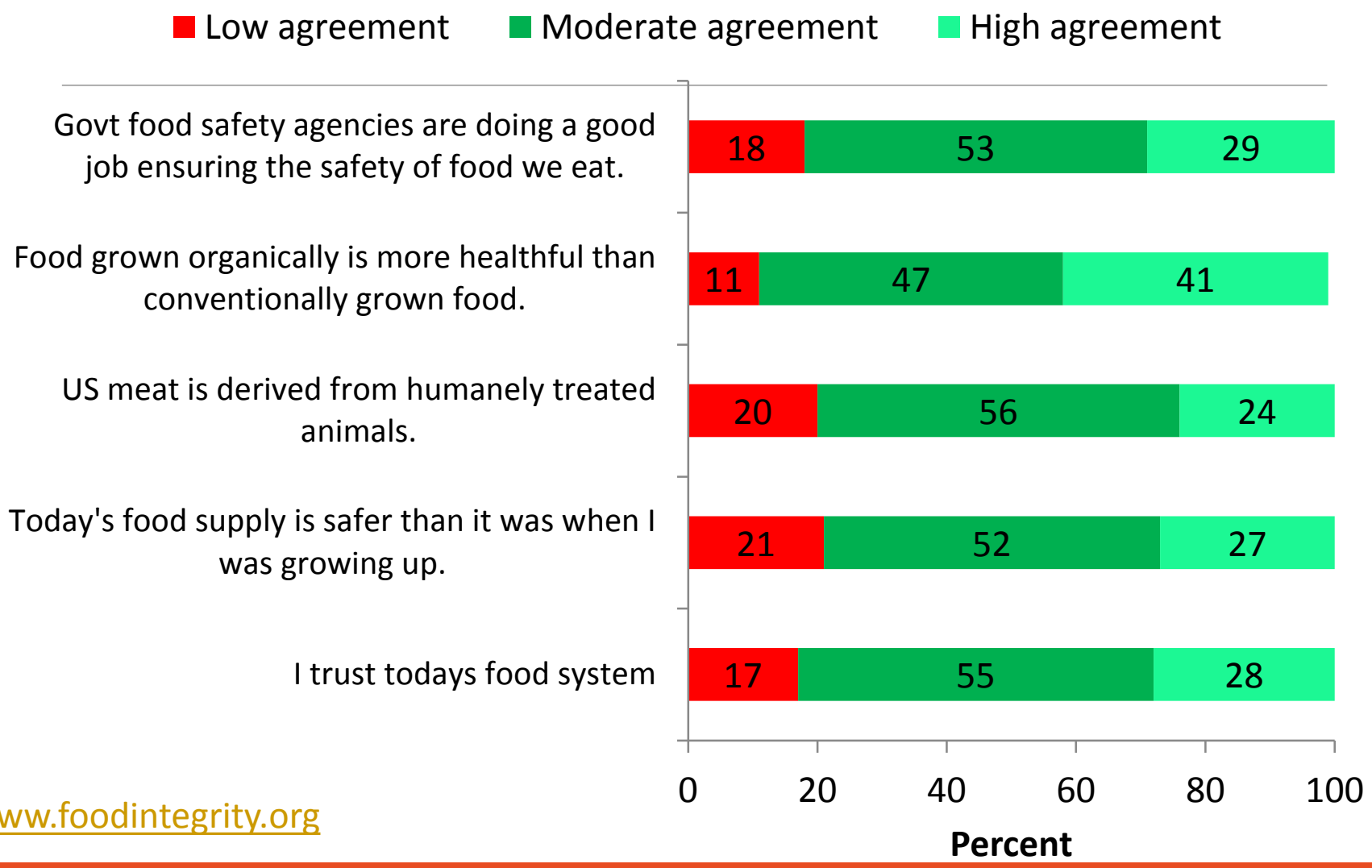
67% try to restrict fat intake

51% try to avoid sugar

***76% feel that changes in nutritional guidance make it hard to know what to believe***

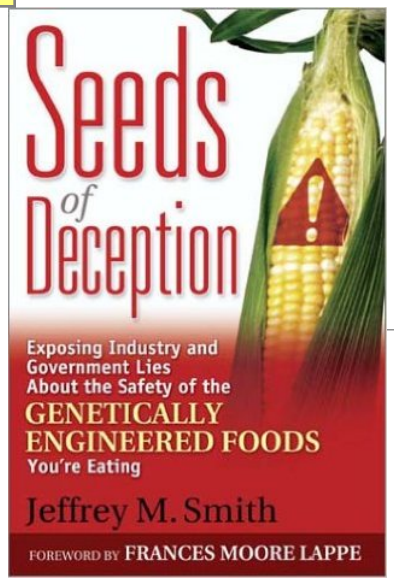
IFIC Foundation, Food and Health Survey, 2012

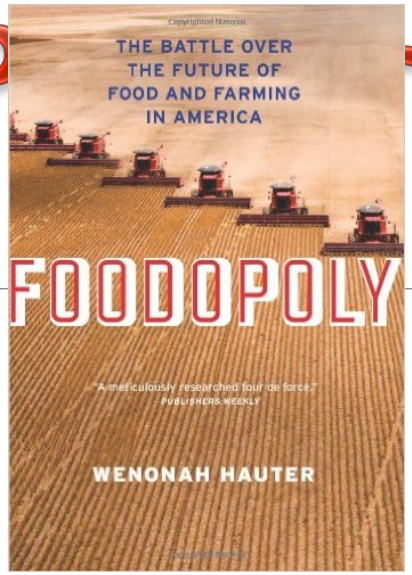
# Center for Food Integrity Survey

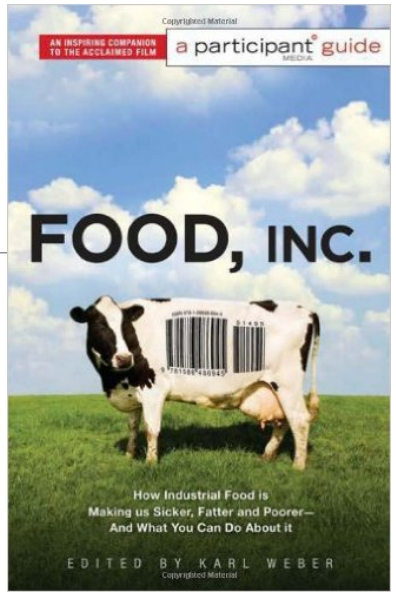


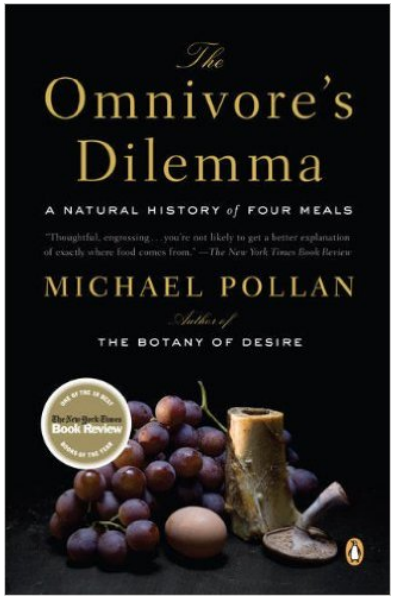

www.foodintegrity.org

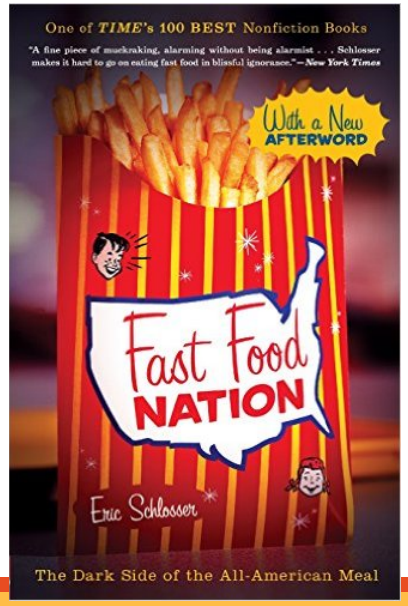
# P r press


Seeds of Deception
Exposing Industry and Government Lies About the Safety of the GENETICALLY ENGINEERED FOODS You're Eating
Jeffrey M. Smith
FOREWORD BY FRANCES MOORE LAPPE


THE BATTLE OVER THE FUTURE OF FOOD AND FARMING IN AMERICA
FOODOPOLY
"A meticulously researched tour de force." PUBLISHERS WEEKLY
WENONAH HAUTER


AN INSPIRING COMPANION TO THE ACCLAIMED FILM
a participant guide
FOOD, INC.
How Industrial Food is Making us Sicker, Fatter and Poorer— And What You Can Do About it
EDITED BY KARL WEBER


The Omnivore's Dilemma
A NATURAL HISTORY of FOUR MEALS
MICHAEL POLLAN
Author of THE BOTANY OF DESIRE


One of TIME's 100 BEST Nonfiction Books
With a New AFTERWORD
Fast Food NATION
Eric Schlosser
The Dark Side of the All-American Meal

# Genetics

*Molecular Structure of Nucleic Acids* (1953) Nature 171; 737-738

1866 Gregor Mendel showed traits pass from parent to offspring
- Mendelian inheritance

1928 Frederick Griffin showed that genes could be transferred

1941 Beadle and Tatum developed ‘one gene, one enzyme’ hypothesis

1953 Watson and Crick defined the chemical structure of DNA

Central dogma of molecular biology
- DNA – RNA – Protein

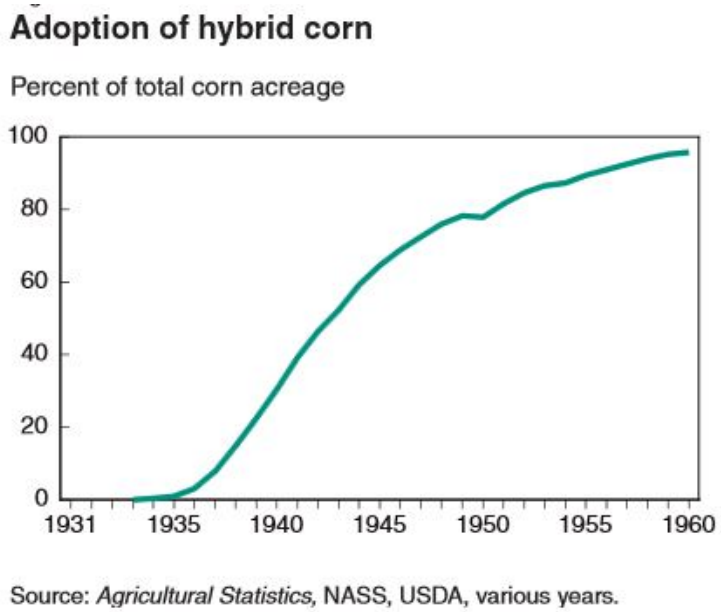
# Hybrid corn
## (conventional genetic manipulation)

1920s Research on corn breeding

1930s Commercial production began

1960 95% of corn in US was hybrid varieties

- Hybrid sorghum, soybeans and cotton
- Hybrids of onions, spinach, tomatoes and cabbage



# Mutation plant breeding

Expose plants and seeds to atomic radiation, X-rays and chemical mutagens

Generate plants and select for desired traits

Hundreds of fruits, vegetables and crops

- Lettuce, rice, oats, wheat, grapefruit, mandarin orange

Completely unregulated

FAO database: https://mvd.iaea.org/

*The application of mutation techniques has generated a vast amount of genetic variability and is playing a significant role in plant breeding and genetics and advanced genomics studies. The widespread use of mutation techniques in plant breeding programmes throughout the world has generated thousands of novel crop varieties in hundreds of crop species, and billions of dollars in additional revenue.*

# Molecular biology

Study of genes and gene replication, mutation and expression

**Genome** is the collection of all base pairs within the cell

Human Genome project started in 1980s

- Humans have 20-25,000 genes
- Mice have 24,174 genes
- Rice has 32-50,000 genes
- Human and pumpkin genomes are 75% similar

# Genetic engineering

Recombinant DNA technique

- Selection of DNA sequence using restriction enzymes
- Insertion of sequence into plasmid DNA using ligase enzymes
- Introduce recombinant DNA to host cell
- DNA encodes for protein that is expressed in the cell

Gene silencing

- Antisense and RNAi
- Block translation of RNA to protein

Gene knockout

- Inserted DNA sequence disrupts gene expression

Gene editing – CRISPR technology

- Selective removal of DNA sequences

# Definition of Agricultural Biotechnology

Agricultural biotechnology is the application of scientific techniques, including genetic engineering, to create, improve or modify plants, animals and microorganisms.

Agricultural biotechnology improves upon conventional techniques, such as selective breeding, by enabling scientists to move genes and the desirable traits that they express with greater efficiency and precision.

USDA, 2003

# Two examples of GMO crops

ROUNDUP® READY

**RoundUp® is glyphosate**

- Inhibits shikimate pathway

Made by Monsanto

Gene from *Agrobacterium tumefaciens* inserted into plant

Allows plant to survive exposure to glyphosate

- Herbicide tolerant

*BACILLUS THURINGIENSIS* (Bt)

Bt toxin approved as natural pesticide since 1960s

Bt gene inserted into plant

Plant produces Bt pro-toxin that kills corn borer insect

Bt pro-toxin has no effect on humans

- Pest resistant

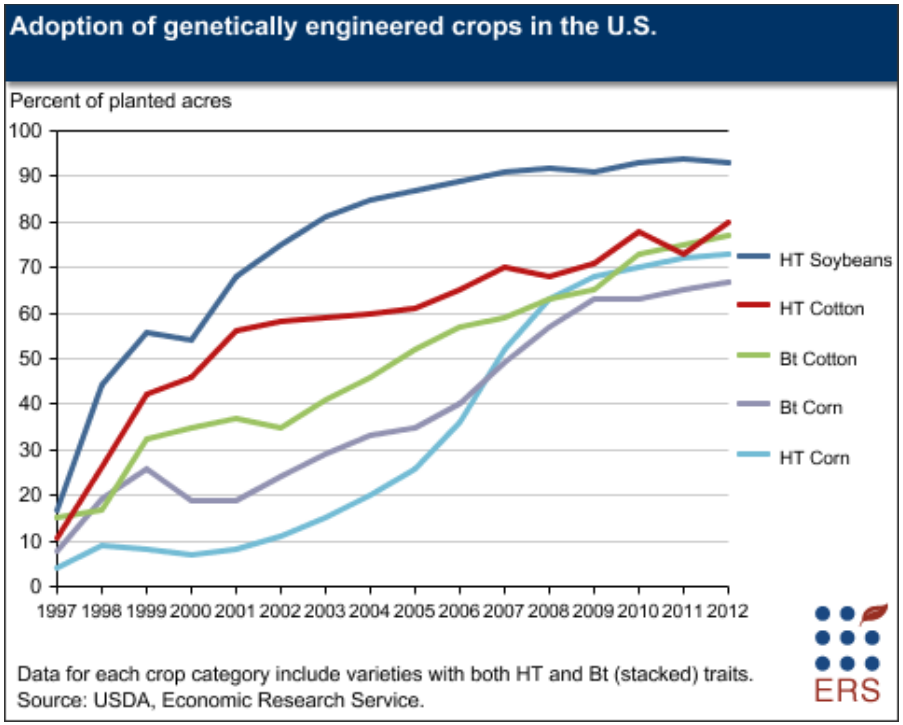
# Path to GMO crops

Bacterial genes inserted into plants 1983

Technology advanced during 1990s

**Entered the US food supply in 1996**

Herbicide tolerant (HT) soybeans, cotton and corn and pest resistant (Bt) cotton and corn quickly adopted



# Advantages of GMO

Save plant variety from disease – papaya

Higher yields – less competition from pests

Higher quality crops – less insect and disease damage

Lower inputs – less pesticides, herbicides; less fuel use

Able to use no-till practices – reduced release of carbon and greenhouse gases; less topsoil loss

Faster more efficient growth – salmon

Enhanced nutrient composition – Golden Rice and oilseeds

Less food waste – apples

Reduced plant toxins - potatoes

# Criticisms of GMO

Loss of plant diversity – monoculture in agriculture

Increased use of a few chemicals, risks to humans and environment

Weed resistance

Seed ownership and patents by big companies

Ethical concerns about determining nature

Environmental damage from genetic drift

Risks to human and animal health

Lack of transparency in food production

# What does GMO do?

**Herbicide tolerance**

**Insect resistance**

**Virus resistance**

Ripening delayed

Amino acid composition

Fatty acid composition

Modified color

Nicotine reduced

Plant quality

Starch hydrolysis

Increase yield

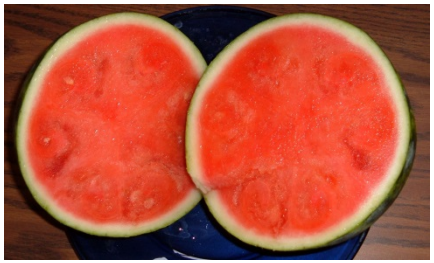
Increase quality

Reduce use of chemicals

Reduce waste

Nutrition improvement

NONE OF THESE ARE IMPORTANT TO CONSUMERS



**Conventional – Organic – Natural – Genetically Modified: Which is which?**

# Food sources of GMO

Currently in the food supply

Corn

Soybean

Canola

Sugar beets

Papaya

Squash

Approved – coming soon

Apples

Eggplant

Melon

Plum

Potato

Rice

Salmon

Sweet pepper

Tomato

# “70-80% of processed foods have GMO”

Corn
- Sweeteners (HFCS)
- Corn starch
- Corn oil
- *Animal feed*

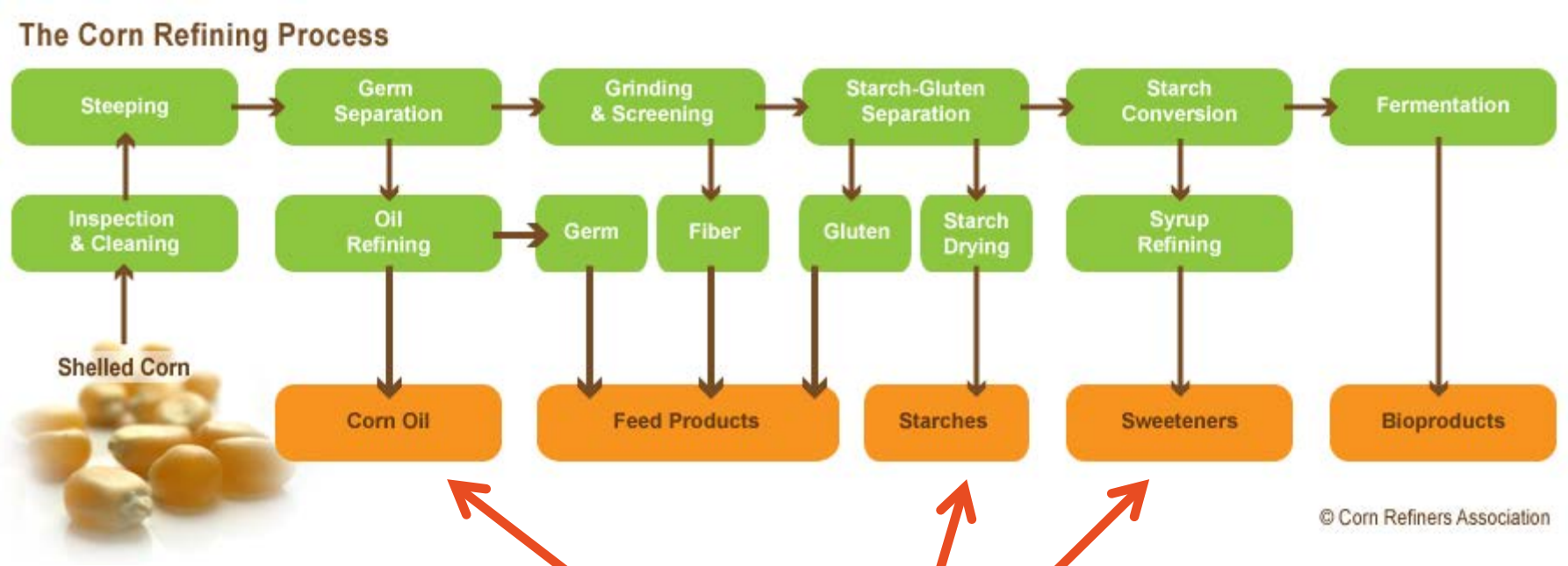
Soybean
- Soy flour - proteins
- Soy oil
- *Animal feed*

Canola
- Canola oil


Sugar beets
- Sugar


Alfalfa
- *Animal feed*

# Where goes the GMO?




No DNA or protein
in products for human food – so
are these still GMO??

# Digestion basics…

All plant and animal foods have DNA and proteins

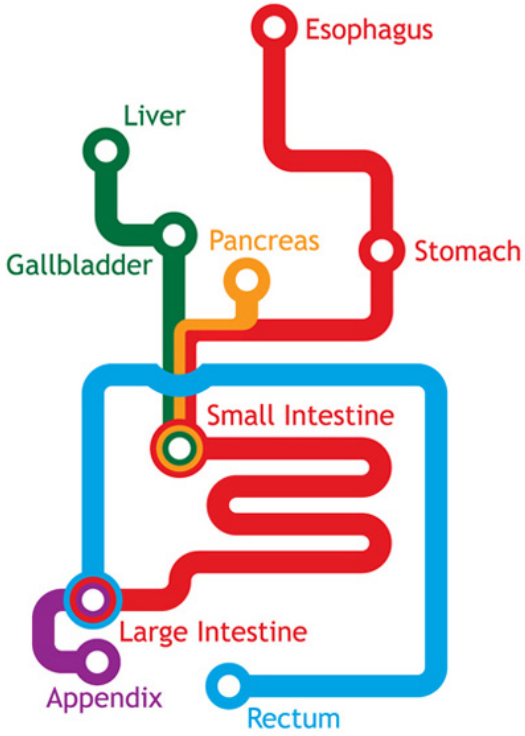
Consumed food is digested into basic units:

- DNA → nucleotides
- Proteins → amino acids

The basic units are absorbed into the body and used to make *human* DNA and proteins

Intact DNA or protein from food is NOT absorbed directly into our bodies

GMO DNA and protein is digested like all other sources




# BUT is GMO safe?

# FDA policy


In the 1992 policy, FDA also addresses the labeling of foods derived from new plant varieties, including plants developed by bioengineering.

The 1992 policy does not establish special labeling requirements for bioengineered foods as a class of foods.

*The policy states that FDA has no basis for concluding that bioengineered foods differ from other foods in any meaningful or uniform way, or that, as a class, foods developed by the new techniques present any different or greater safety concern than foods developed by traditional plant breeding*

http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/ucm059098.htm

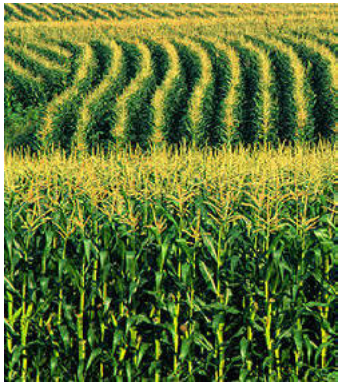
# Safety testing

Safety assessments begin with concept of product

No variety is released without substantial safety evidence

Research on safety

- Nutrient and chemistry same as non-gmo
- No inadvertent compounds – no allergens
- Transfer and/or breakdown of trait
- Environmental safety



Independent researchers

- Animal studies
- Environmental studies

# Evidence of safety

1. FDA considers technology equivalent to conventional plant breeding
2. Study of 100 billion animals fed conventional compared to GMO feed for 25 years found no health risks
3. No human disease or illness ever linked to GMO food
4. Most scientific organizations approve safety of GMO
   - American Medical Association
   - American Academy of Pediatrics
   - American Association for the Advancement of Science
   - Center for Science in the Public Interest
   - European Commission
   - Union of German Academies of Science and Humanities
   - French Academy of Sciences
   - World Health Organization
5. 2016 National Academy of Sciences report

# Defining ‘Safe’

Risk-Benefit (no risk?)

Exposure – dose

Long term vs short term

Safe to who-what-when?


When it comes to food, people want no risk!
Which is not achievable….

# Beyond safety concerns

Misuse of technology and crops
- Over use of glyphosate
- Weed and pest resistance
- Environmental release
- Loss of biodiversity

Corporate ownership
- High costs of seeds and inputs
- Legal control of crops
- Corporate patents

Consumer mistrust of big ag
- Food industrialization
- Science and food don’t mix






# Mandatory GMO labeling
# Vermont law – July 1, 2016

# Senate Bill – GMO labeling Act 2016

Mandatory rule to disclose GMO ingredients

- On label
- QR code
- Website or phone number

Next steps:

- Needs to be passed by House
- Rule needs to be defined by Secretary of Agriculture
  - What ingredients will be required to be labeled
  - Foods from animals fed GMO grains exempt

# Impact of labeling?

Change consumer behavior or add to confusion?

Drive demand for more non-GMO ingredients?
- Increase price of foods

Marketing opportunity for food industry?
- New products that have non-GMO label will lead to consumer fear of GMO?

Commercial opportunity for farmers?

Raise price of food – more people become food insecure?

Hamper further research in biotechnology – enhance fear of science?

Reversion to mutation genetic technology – with unknown risks?

No change to consumer health or well-being!

# Take home messages

Modifying plants and animal genetics is essential for food production

GMO foods have no negative effects on health

Consumers make decisions based on perceived risk and benefits

Economics drives decisions for producers and manufacturers

Government policy decisions must be based on sound science