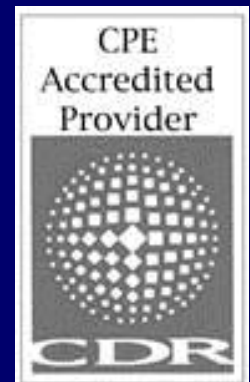


# Food Biotechnology 101: A Primer on the Science & the Public Debate



# Program Objectives

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Participants will be able to:

- Define food biotechnology.
- List current food biotechnology techniques, as well as available food and agricultural products.
- State facts about the safety and regulation of food biotechnology.
- Describe consumer attitudes and knowledge regarding food biotechnology.
- Discuss key issues in the public debate.

# Food Biotechnology Defined

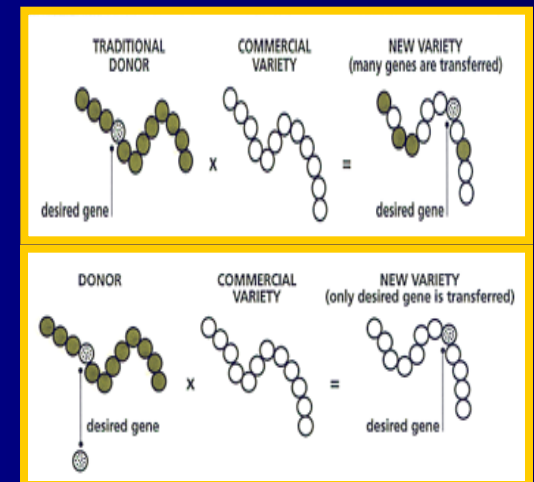
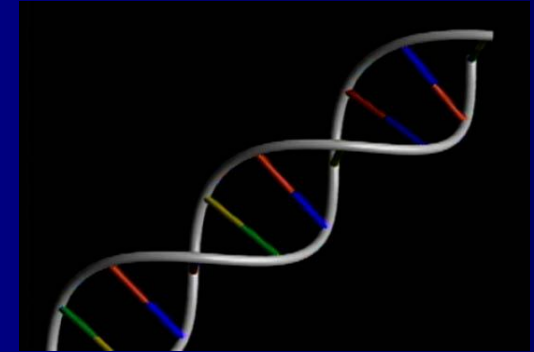
*Biotechnology* refers to various techniques used in agriculture and food production to provide better agricultural conditions and better food:

- Fermentation (e.g., yeast used in brewing or bread-making)
- Tissue culture (eg, plant propagation)
- Cross breeding (eg, broccoflower)
- Genetic transfer (e.g., rDNA technology)



# Food Biotechnology Defined

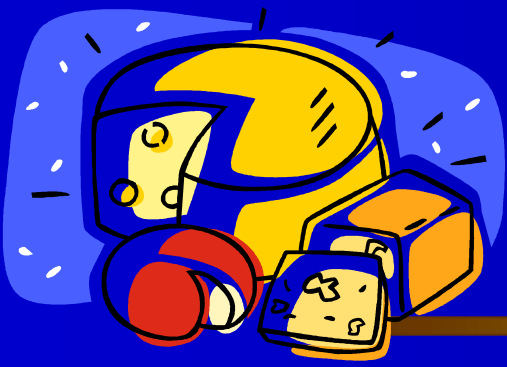
*Modern food biotechnology, or genetic engineering, allows for the identification and transfer of one or more specific gene(s), creating desired qualities in a plant, and offering a more precise way to produce plants with certain beneficial characteristics— such as insect protection or better nutrition.*



# Food Biotechnology: A brief history

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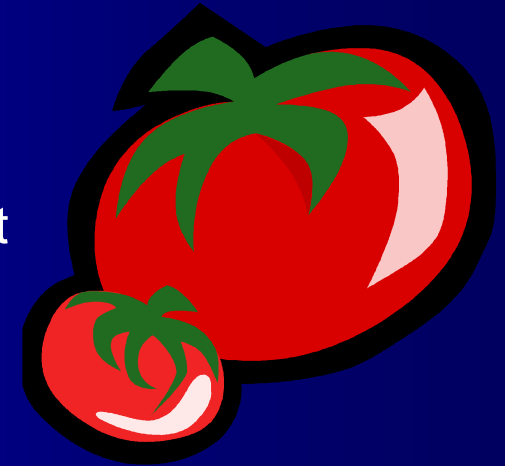
13000-8000 BC	Domestication of wild plants
6000-4000 BC	Fermentation (wine, beer, bread)
2500 BC	Domestication of wild animals
1800's	Pasteurization
	Laws of Heredity proposed
1930's	Hybrid seed corn introduced
1950's	DNA structure described
1970's	Gene transferred between organisms
1980's	Human insulin, developed with biotechnology, approved by FDA



# Food Biotechnology: A brief history, continued

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- ❖ 1990's First food products enhanced using modern biotechnology introduced— chymosin for cheese making; improved yeast for bread making 1990's
- ❖ Multiple product introductions:  
extended freshness tomato, insect-protected potato, corn, & cotton, virus-resistant squash & papaya, herbicide-tolerant soybean
- ❖ 1998 Biotech helps save Hawaiian papaya industry from devastation
- ❖ 2002 Rice genome described
- ❖ 2005 8.5 million farmers (90% in developing nations) planted biotech crops in 21 countries

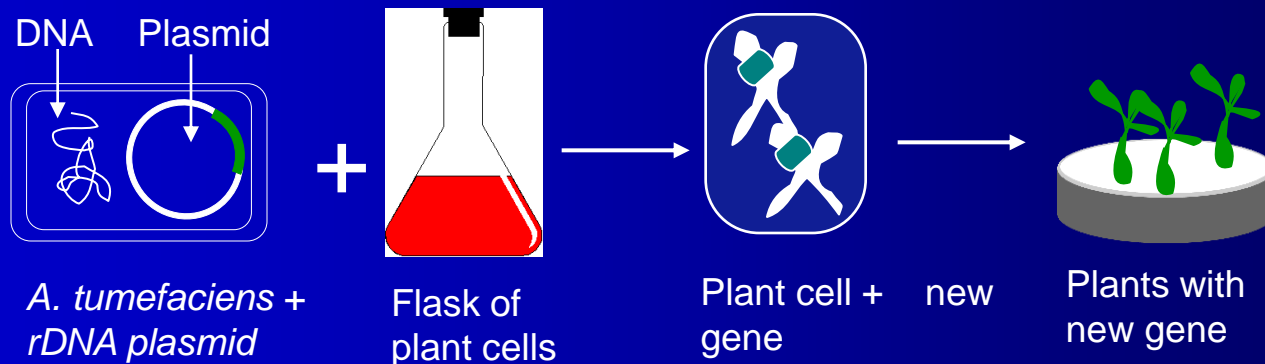
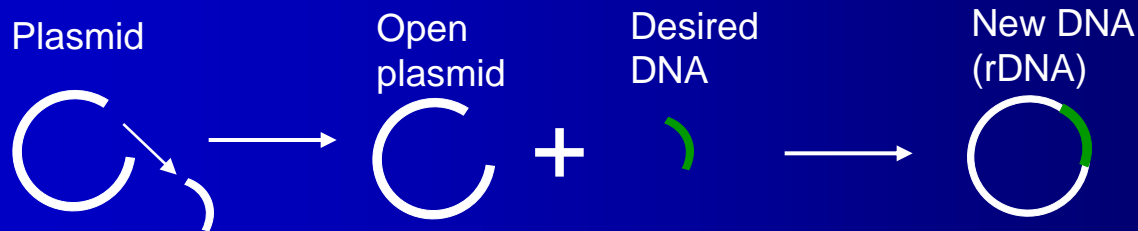


# Modern Biotechnology Techniques

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- ❖ Gene Transfer
  - ❖ Particle gun
  - ❖ *Agrobacterium tumefaciens*
- ❖ Plant Tissue Culture
- ❖ Testing & Evaluation

# Methods of Gene Transfer: *Agrobacterium tumefaciens*

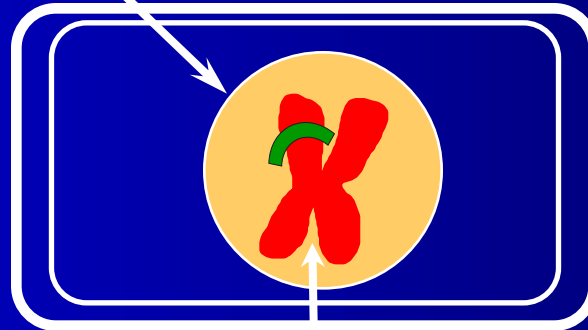


# Methods of Gene Transfer: Particle Gun

Pellets coated  
with DNA



Gene  
insertion



New plant cell  
with gene

Plant chromosome

# Plant Tissue Culture

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# Testing & Evaluation

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- ❖ Initial testing evaluates:
  - ❖ Safety of introduced gene product
  - ❖ Stable inheritance of gene
  - ❖ Unintended effects on growth, yield, quality
- ❖ Greenhouse & Field Trials
  - ❖ Multiple locations during multi-year process
  - ❖ Testing for:
    - ❖ Agronomic performance (market question, not regulatory requirement)
    - ❖ Environmental effects
    - ❖ Food safety

# Why Use Modern Biotechnology? Improve Human Health

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## ❖ Promote human health

- ❖ Insulin - A familiar example in the medical field
- ❖ Reduced exposure of farmers to pesticides
- ❖ Reduced mycotoxins in insect-resistant corn
- ❖ High oleic acid soybeans

# Why Use Modern Biotechnology? Protect Crops & Environment

## ❖ Plant disease protection

- ❖ Virus-resistant papaya
- ❖ Virus-resistant squash



## ❖ Environmentally sustainable farming

- ❖ Reduce use of insecticides (Bt cotton/Bt corn)
- ❖ Protection of soil and water
- ❖ Decreased fossil fuel use



# Why Use Modern Biotechnology? Improve Food and Feed Quality

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- ❖ Improved food quality
  - ❖ Delayed ripening
  - ❖ Improved taste
  - ❖ Improved food processing attributes
- ❖ Improved feed supply
  - ❖ Reduced mycotoxin risk in *Bt* corn
  - ❖ Reduced weed content in herbicide-tolerant crops used for feed (improved nutrient density)



# Biotech Food Crops Currently Available

## Food crops:

- ❖ Corn
- ❖ Soybean
- ❖ Cotton
- ❖ Canola
- ❖ Papaya
- ❖ Squash



## Examples of food ingredients available through biotech:

- ❖ Corn, soybean, canola, and cottonseed oils; corn meal, syrup, and starch; soy protein, flour, and lecithin

## Components used in food production:

- ❖ Chymosin in cheese and yeast in bread production

# Biotech Products: Potential for Future

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## In Development:

- ❖ Nutritional improvements (in development)
  - ❖ Oils aimed at improving fatty acid profile of finished food products
  - ❖ Golden Rice (beta carotene and iron content and bioavailability enhanced)

## Early Stages of Research:

- ❖ Reduced allergenicity
- ❖ Drought tolerance/ Improved water utilization
- ❖ Improved feed supply
- ❖ Accelerated food production
- ❖ Plant-based vaccines
- ❖ Simpler and faster pathogen detection

# Questions & Issues

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- ❖ Coexistence with organic agriculture
  - ❖ Safeguards to prevent unwanted cross-pollination and adventitious presence
  - ❖ Room for each method in sustainable ag production
- ❖ Long-term safety
  - ❖ Scientific consensus supports safety
  - ❖ Critics call for longer time frame
- ❖ Allergenicity
  - ❖ Potential to increase risk...safeguards in place
  - ❖ Potential to decrease risk is the subject of research
- ❖ Labeling
  - ❖ Mandatory vs. voluntary
  - ❖ Process vs. end-product-based

## Consensus on Safety

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Food biotechnology is the most extensively reviewed agricultural advancements to date

After 10 years of biotech products in the food supply, there hasn't been a single confirmed adverse experience attributable to a commercialized biotech product.

# Consensus on Safety: Resources

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Regulatory authorities in 21 countries, including:

Argentina, Australia, Brazil, Canada, Columbia, China, Czech Republic, European Union, France, Germany, Honduras, India, Iran, Mexico, Paraguay, the Philippines, Portugal, Romania, South Africa, Spain, United States of America, Uruguay

European Commission

Institute of Medicine and National Research Council, Academies of Sciences (NAS)

American Medical Association (AMA)

Institute of Food Technologists (IFT)

Society of Toxicology

# Biotechnology Safety and Regulation: FDA

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- ❖ Regulates testing for

- ❖ *Nutritional value*
- ❖ *Allergenicity*
- ❖ *Toxicity*
- ❖ *New uses*



- ❖ Requires full food safety evaluation in certain cases:

- ❖ Genes not already in the food supply
- ❖ Significantly different nutrient, allergen, or toxin levels
- ❖ Significantly different composition
- ❖ New antibiotic-resistance markers

- ❖ Regulates labeling if needed

# Biotechnology Safety and Regulation: USDA

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- ❖ Biotechnology Regulatory Services (BRS), Animal and Plant Health Inspection Service (USDA-APHIS)
  - ❖ Regulates movement, importation, and field testing
  - ❖ Ensures that plants produced through biotechnology do not pose a pest or disease risk to other agricultural products or the environment



# Biotechnology Safety and Regulation: EPA

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- ❖ Regulates testing of pest-protected varieties for:
  - ❖ *Toxicology and allergenicity*
  - ❖ *Long term human health impact*
  - ❖ *Effects on nontarget organisms*
  - ❖ *Environmental fate*
  - ❖ *Potential for pest resistance*



# FDA Food Labeling Regulations

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- ❖ Objectives of all food labeling:
  - ❖ Protect against misleading statements or claims
  - ❖ Provide nutrition and safety information
  - ❖ Inform public of potential health risks
- ❖ Product-based, not process-based

# FDA Food Labeling Regulations

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- ❖ A label is required if there is
  - ❖ the presence of an allergen
  - ❖ an increase in naturally occurring toxins
  - ❖ a change in nutrient composition or profile
  - ❖ a change in use or handling
- ❖ Draft guidelines to industry for voluntary labeling of foods produced with or without biotechnology issued in 2001

# Food Labeling Perspectives

## Argument for process-based labeling:

- ❖ Consumer's "right to know"
- ❖ Long term safety
- ❖ A way to track in food supply

## Argument for current product-based labeling policy:

- ❖ FDA: "Labeling is not necessary if there is no evidence that genetic engineering changes food quality, safety or any other attribute."
- ❖ NAS: "Genetic engineering is no more or less likely to produce unintended consequences compared to other forms of genetic modification, or breeding."
- ❖ AMA: "...no scientific justification for special labeling of genetically modified foods as a class..."
- ❖ More than three-fourths (82%) of consumers say no additional information is needed on labels; 63% support the FDA labeling policy (2006)

# US Consumer Awareness High, Knowledge Low

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- ❖ 71% of consumers have heard or read about biotechnology
  - ❖ Only 12% have heard a lot
- ❖ 26% know biotech foods available in stores

# US Consumers Opinion: Low Concern

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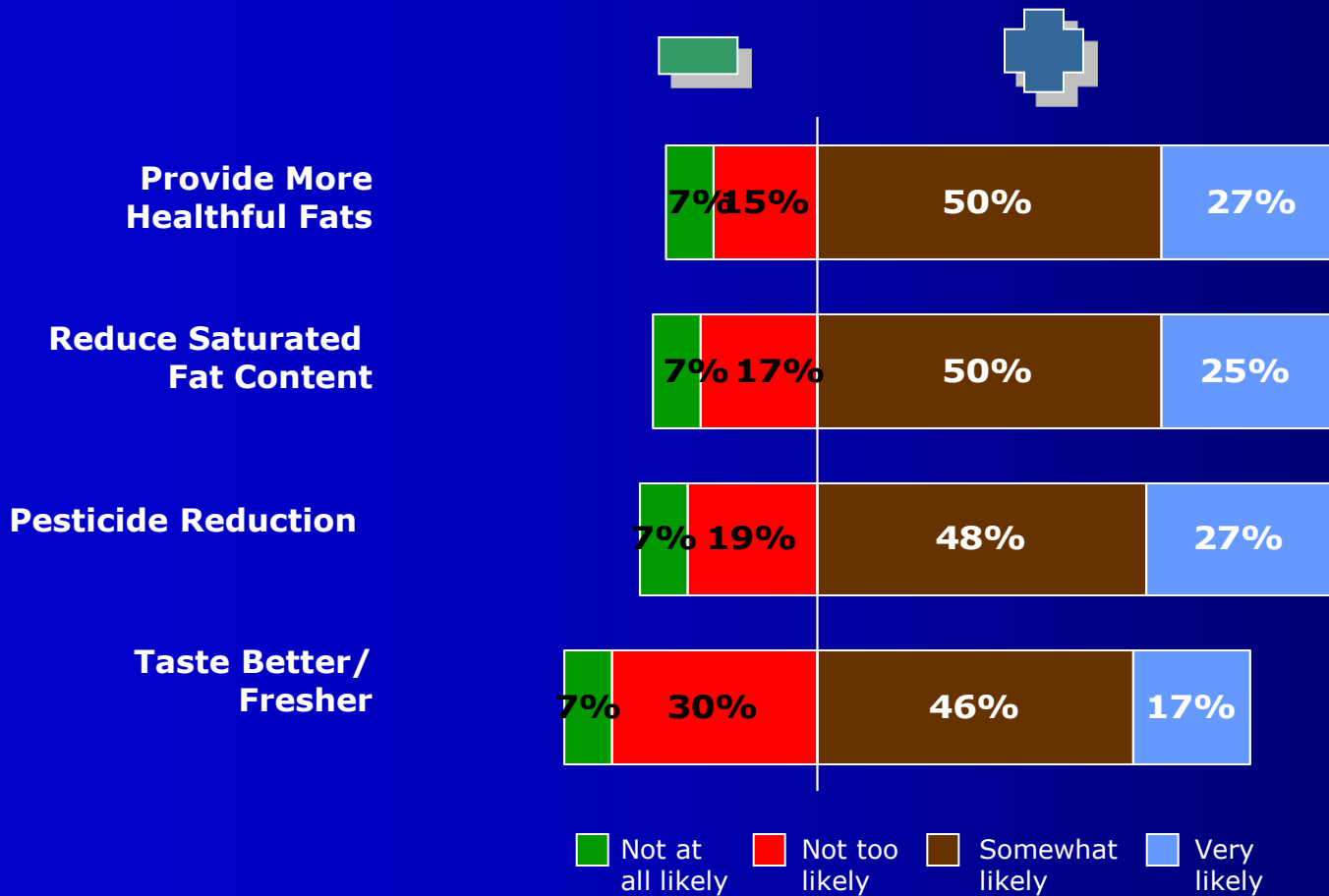
**3%** of consumers identify biotech  
as a food safety concern

# US Consumers Opinion: Impact of Awareness on Attitudinal Measures

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- Higher awareness is positively correlated with knowledge, purchase intent, and expectation of benefits

# US Consumers Opinion: Purchase Intent & Expectation of Benefits



# Food Biotechnology: Implications for Food Today & Tomorrow

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- ❖ Significant impact on today's food supply
- ❖ Strong regulatory system & safety consensus
- ❖ Public debate continues
- ❖ Ongoing scientific review
- ❖ Dietetic professionals can be a key source of credible information for the public

# To Learn More . . .

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Council for Agricultural Science and Technology

[www.cast-science.org](http://www.cast-science.org)

Council for Biotechnology Information

[www.whybiotech.org](http://www.whybiotech.org)

Institute of Food Technologists

[www.ift.org](http://www.ift.org)

International Food Information Council Foundation

[ific.org](http://ific.org)

Society of Toxicology

[www.toxicology.org](http://www.toxicology.org)

US Regulatory Agencies Unified Biotechnology Web Site

<http://usbiotechreg.nbio.gov>