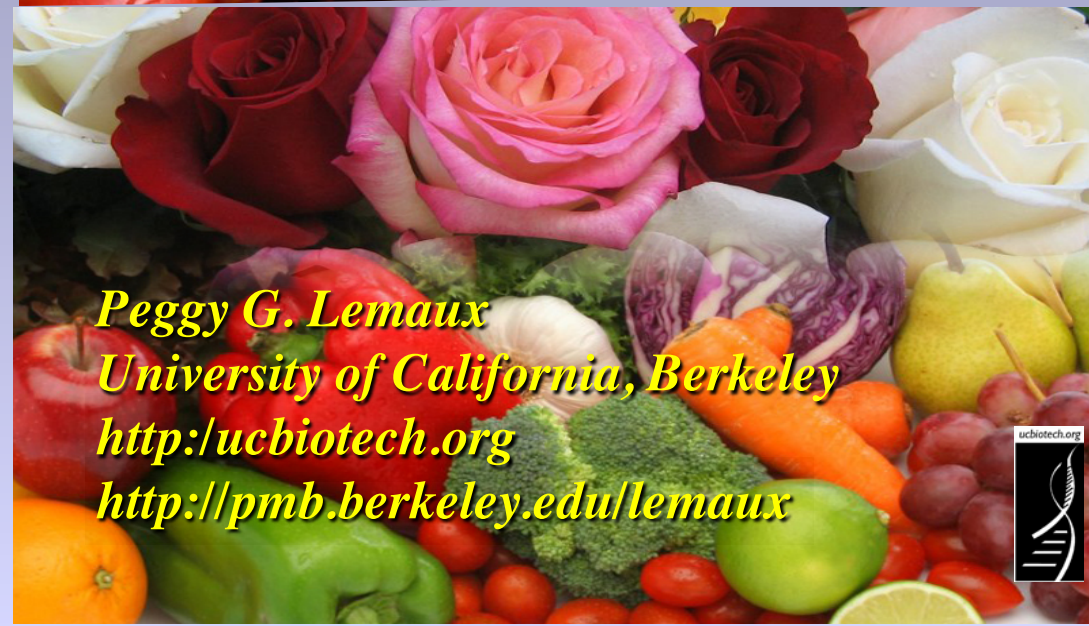




# Crops, Foods and GMO's







**1. Background on genes, genetics and genetic engineering (aka biotechnology, GMOs)**

**2. What genetically engineered (GE) crops have been commercialized? What's in the pipeline?**

**3. What is the regulatory structure for GE crops?**

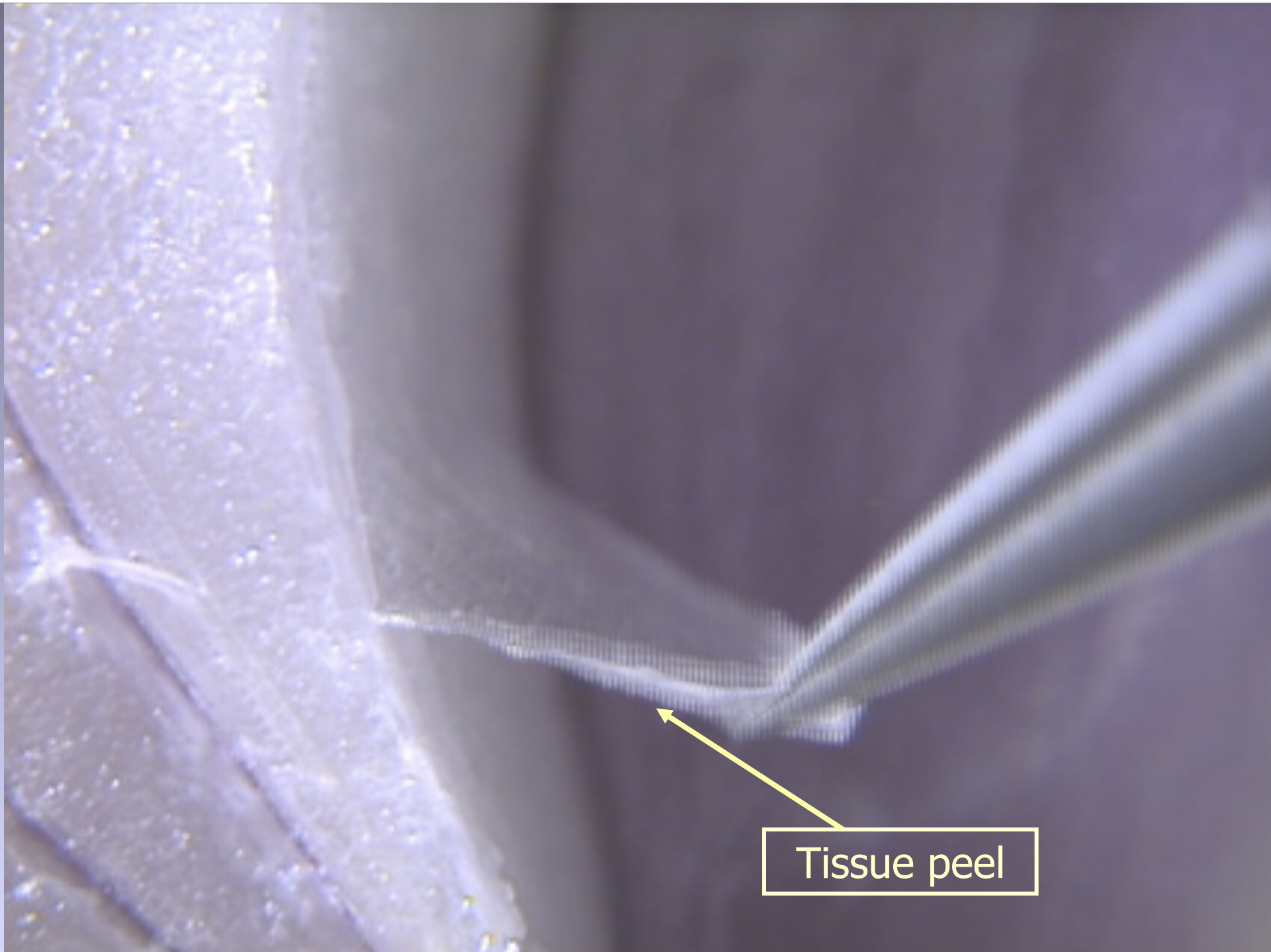
**4. What are some food safety and labeling issues with GE foods? What about the environment?**

# *Tour d'Onion*



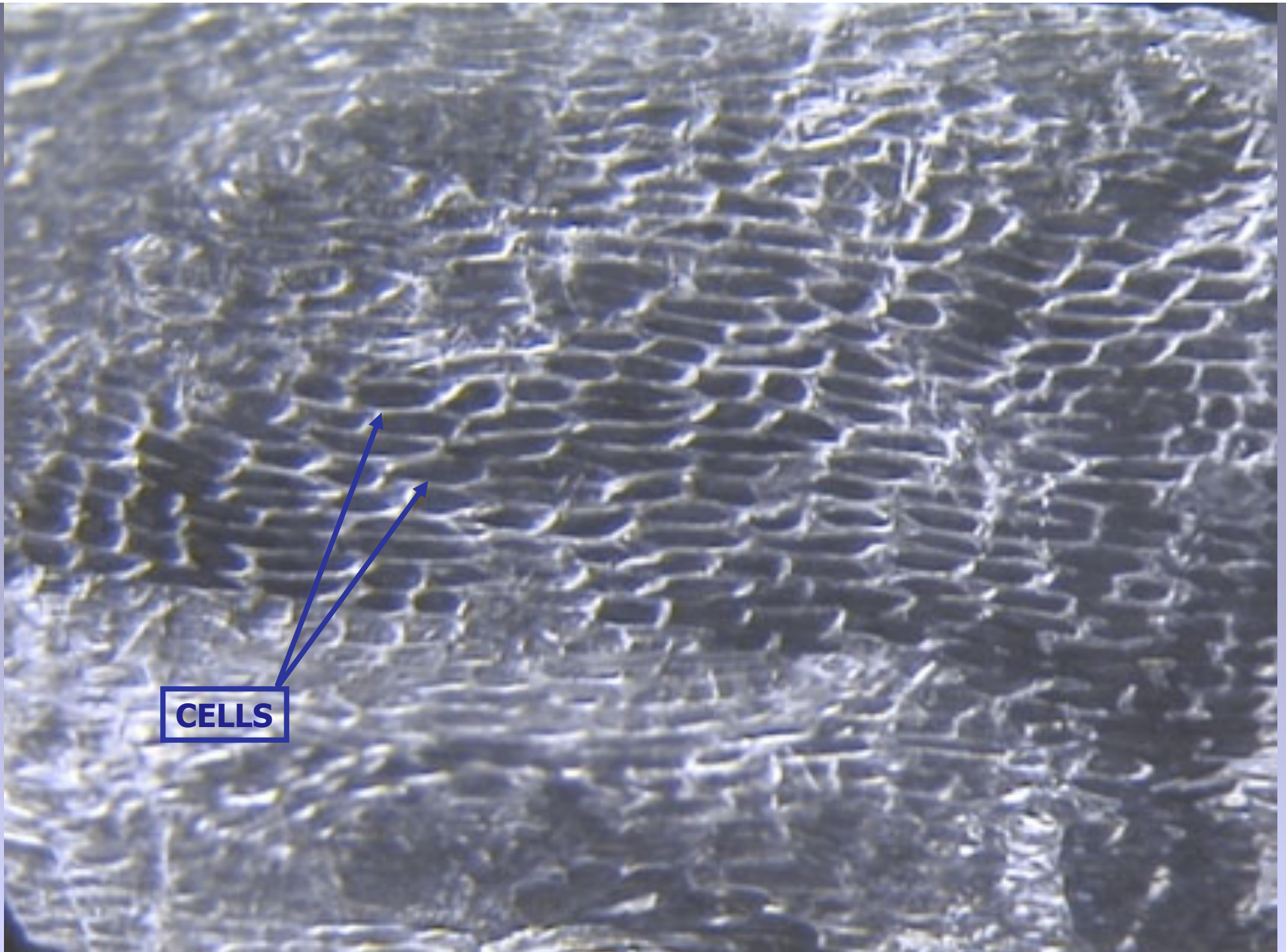
**Or what makes an onion, an onion?**



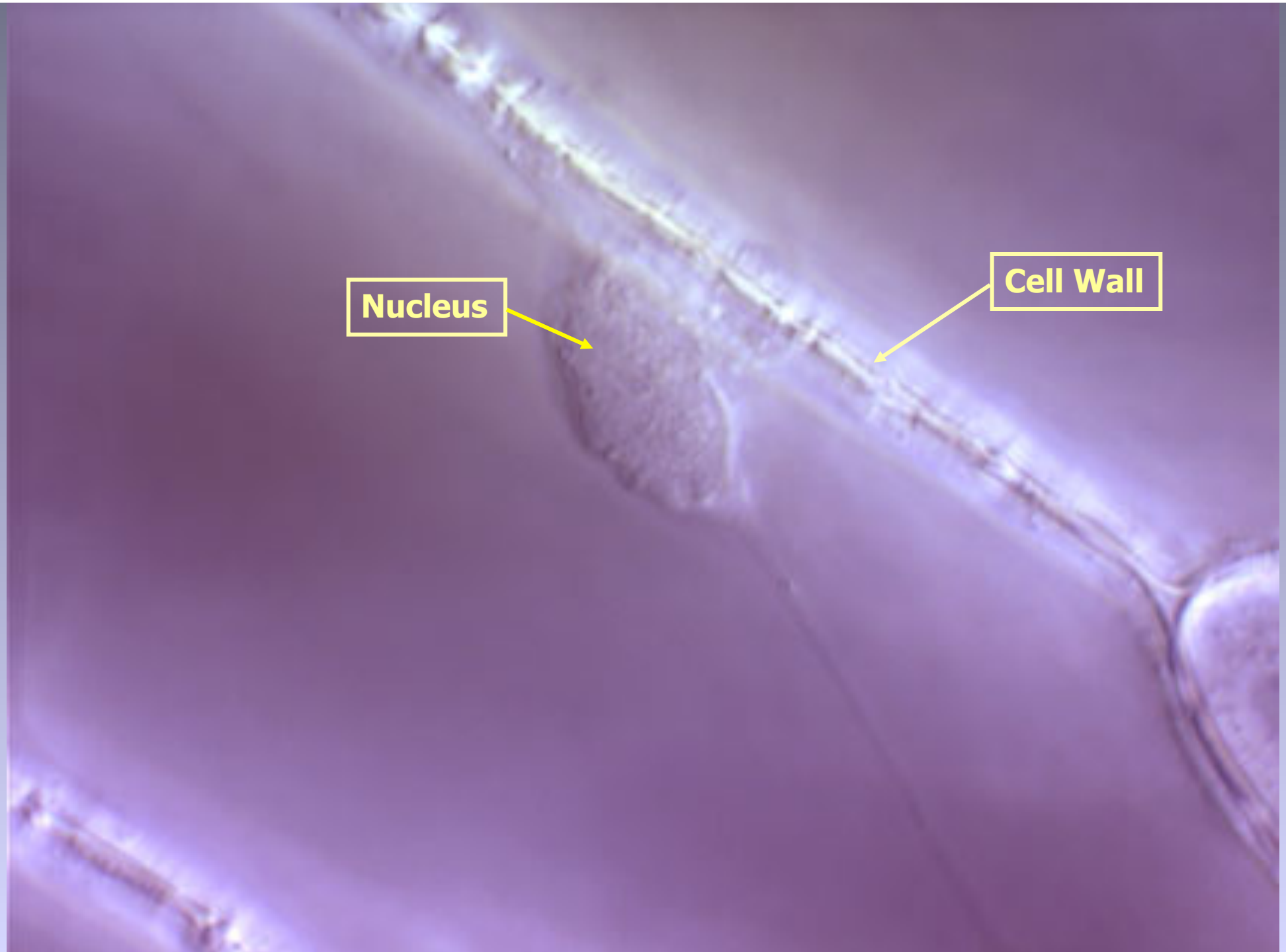


Tissue peel

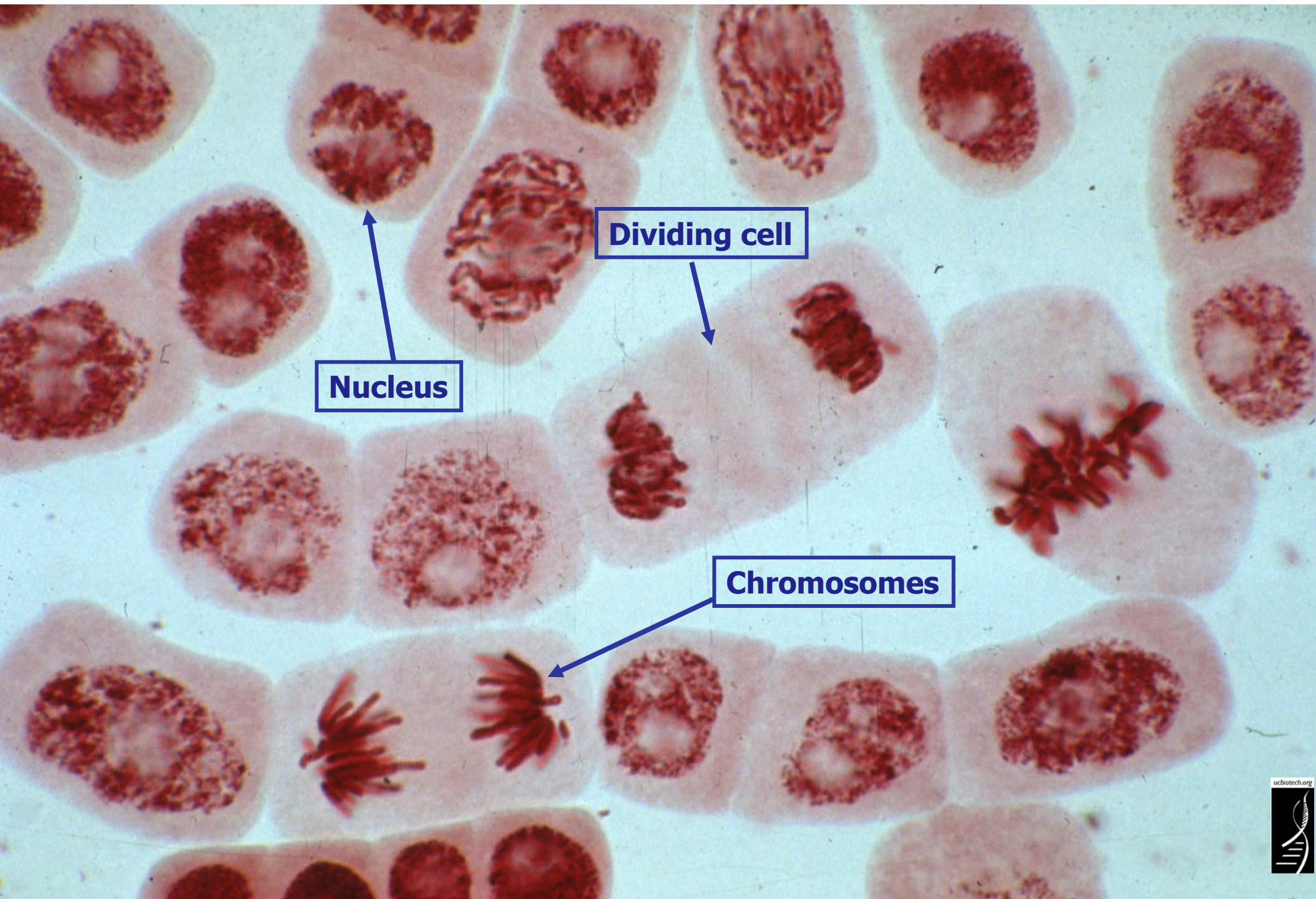












**Nucleus**

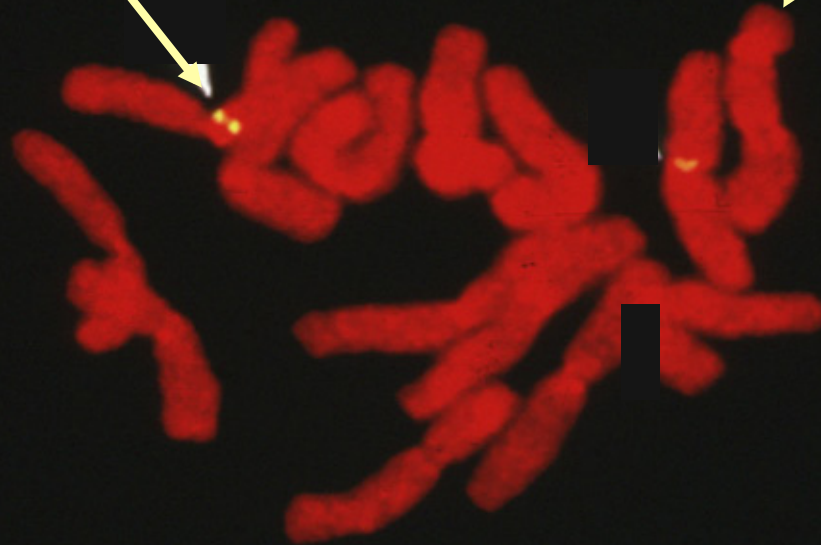
**Dividing cell**

**Chromosomes**



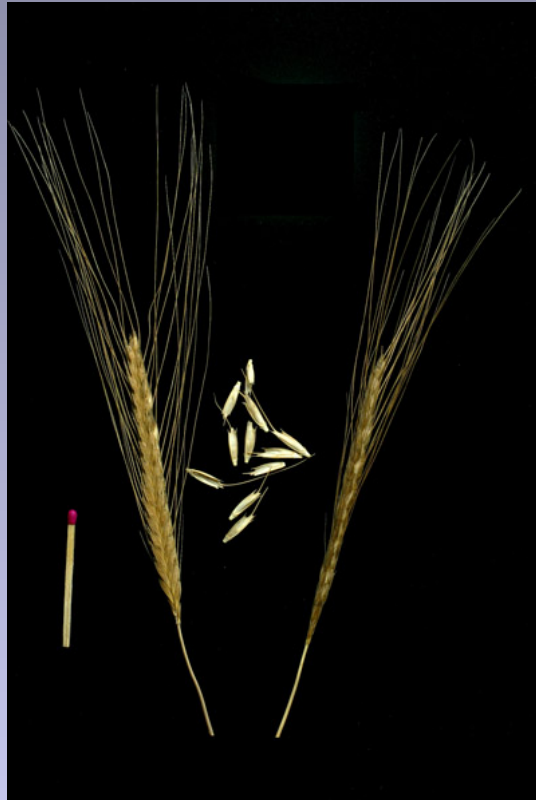
**Genes**

**Chromosome**





# How are the genes and chromosomes manipulated to create a new plant variety by classical breeding?



*Triticum monococcum*

**Ancient variety**



*Triticum aestivum*

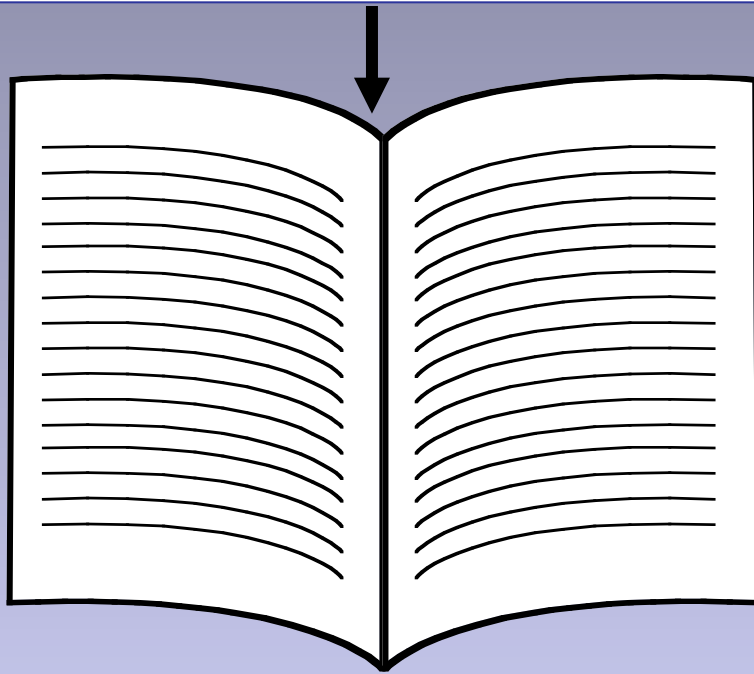
**Modern bread variety**



# Information in the wheat genome

Chemical units represented by alphabetic letters

...CTGACCTAATGCCGTA...



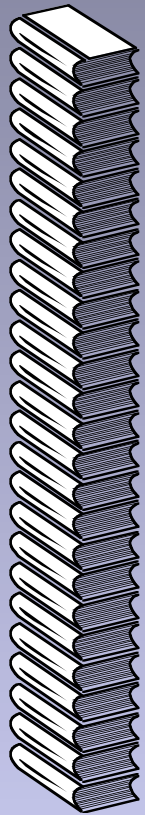
1700 books  
1000 pages each



1700 books  
(or 1.7 million pages)



# Classical Breeding of Wheat



**X**



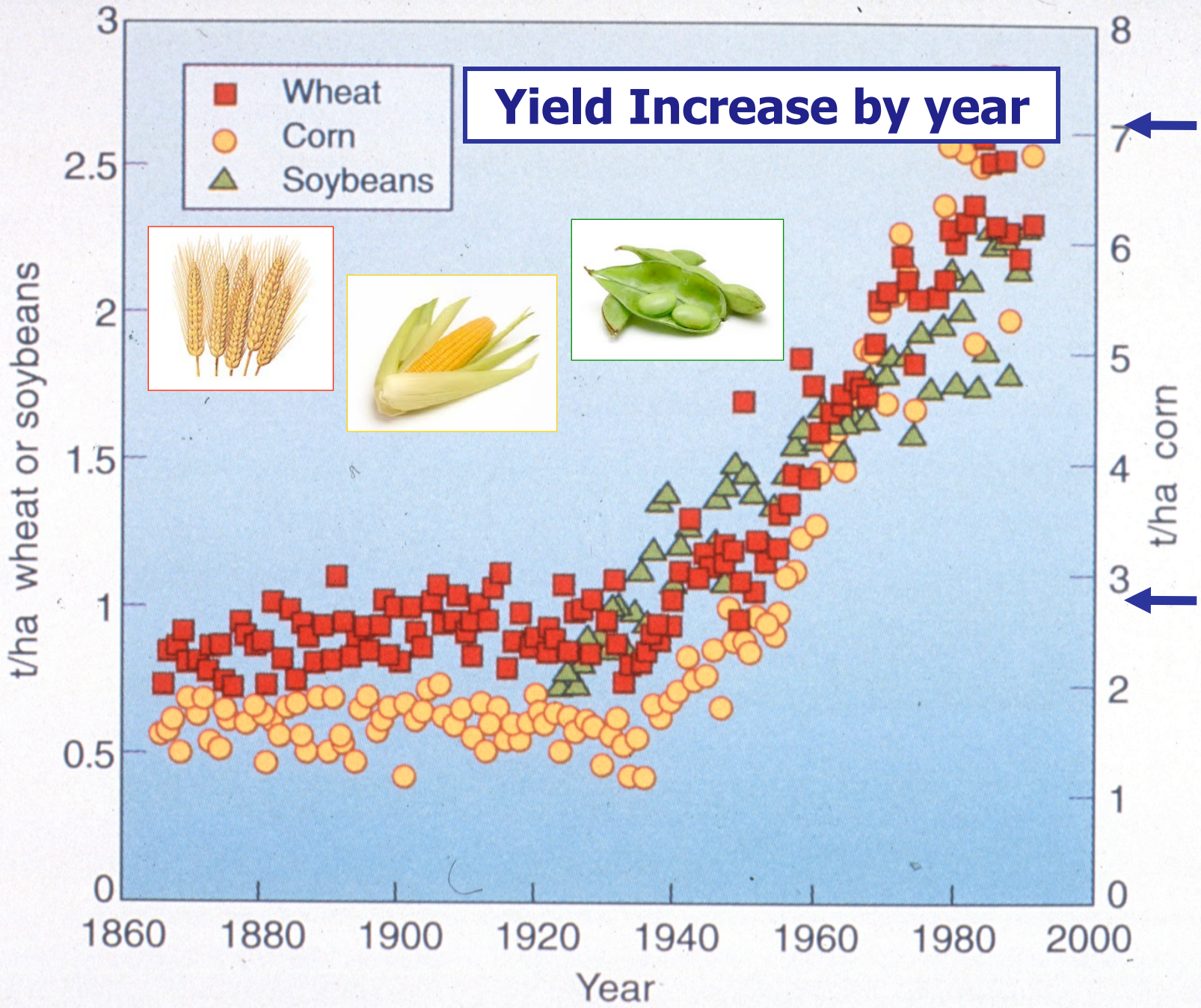
**Random  
retention of  
information  
from each  
parent**

**1700 books  
(or 1.7 million pages)**

**1700 books  
(or 1.7 million pages)**

**1700 books  
(or 1.7 million pages)**

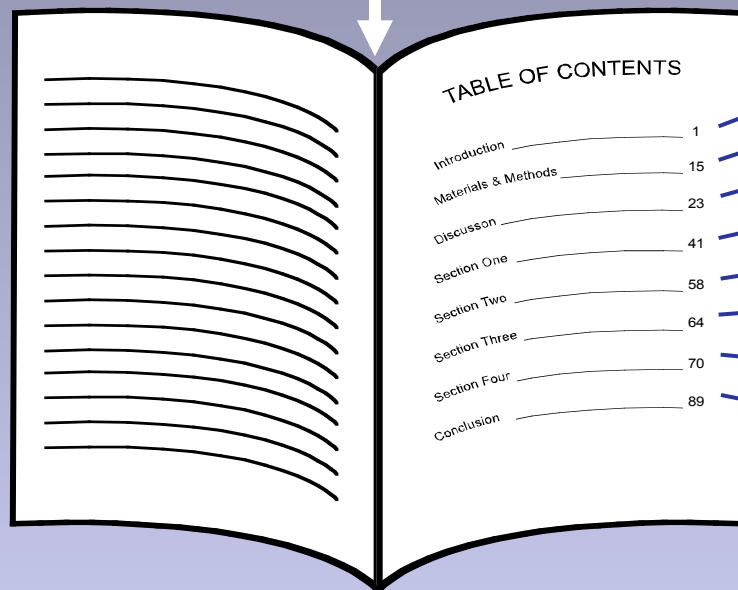




# New ways to do breeding using molecular tools

Using a table of contents for genes to perform marker assisted selection – speeds breeding process

...CTGACCTAATGCCGTA...



**Genomics**

1700 books  
(or 1.7 million pages)





**Marker-assisted selection was used to create rice protected against bacterial blight and blast disease**

**Limited to diversity in crop and compatible relatives**

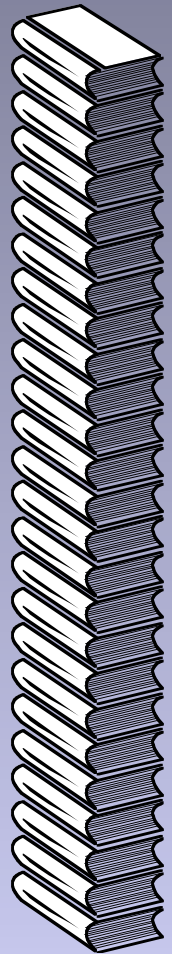




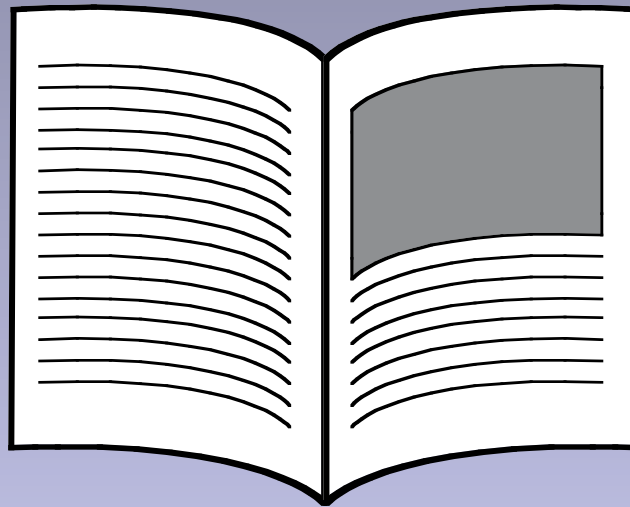
**If a desired trait is from an incompatible plant or other organism, there are different ways to create new varieties using molecular tools**



# Genetic Engineering Methods Used to Create GMO's



+



One-half page  
equivalent to a gene



Inserts  
randomly  
in genome

↑  
Inserted  
gene(s)

1700 books  
(or 1.7 million pages)

1700 books  
(or 1.7 million pages)

## ***Classical Breeding***

compared to

## ***Genetic Engineering***

Uses plant machinery in plant

Gene exchange is random  
involving whole genome

When/where gene expressed  
not controlled by breeder

Source of gene primarily within  
genera – not between kingdoms  
like plants & bacteria

Uses plant machinery in laboratory

Gene exchange is specific  
involving single or few genes

When/where gene expressed  
controlled precisely

Source of gene from any  
organism

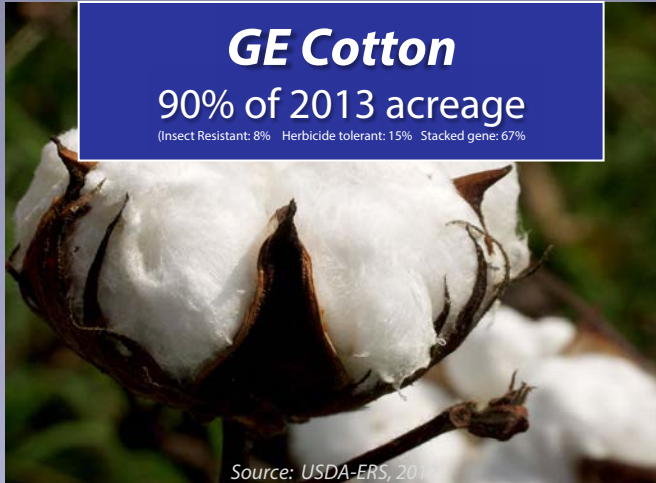


# Number of different commercially available GE crops is limited

## GE Cotton

90% of 2013 acreage

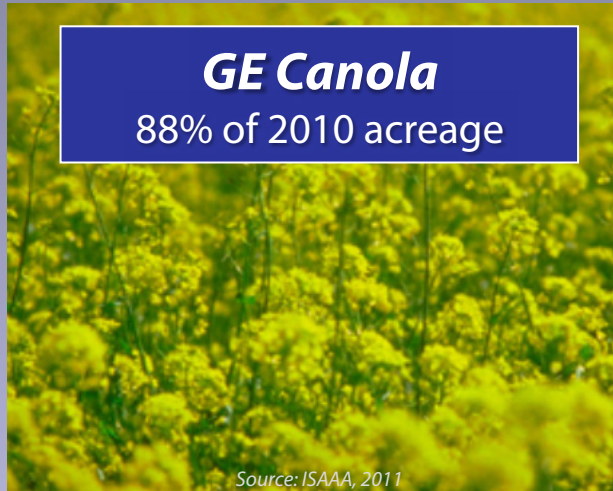
(Insect Resistant: 8% Herbicide tolerant: 15% Stacked gene: 67%)



Source: USDA-ERS, 2012

## GE Canola

88% of 2010 acreage

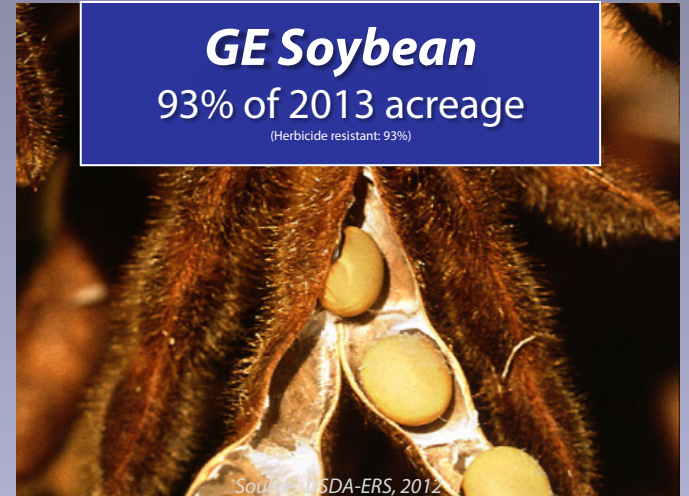


Source: ISAAA, 2011

## GE Soybean

93% of 2013 acreage

(Herbicide resistant: 93%)

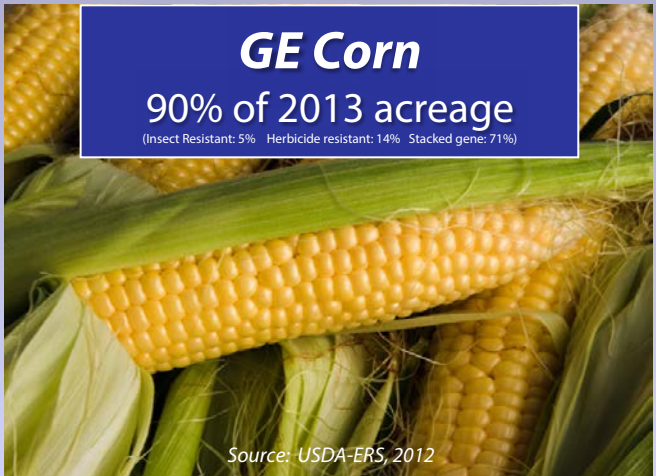


Source: USDA-ERS, 2012

## GE Corn

90% of 2013 acreage

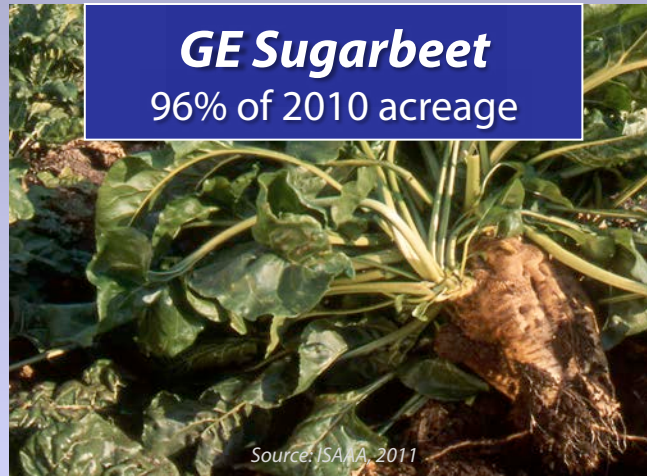
(Insect Resistant: 5% Herbicide resistant: 14% Stacked gene: 71%)



Source: USDA-ERS, 2012

## GE Sugarbeet

96% of 2010 acreage



Source: ISAAA, 2011

## GE Alfalfa

20% of 2012 acreage



Source: Dan Putnam, UCANR, 2013



**Number of different traits available in GE crops is also limited**



**Bt Crops - engineered for insect resistance using gene from naturally occurring bacterium**



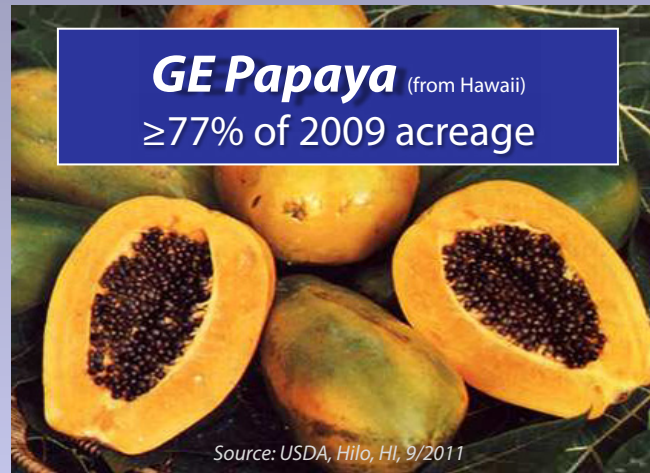
**Herbicide-tolerant - engineered with genes to tolerate herbicide application**





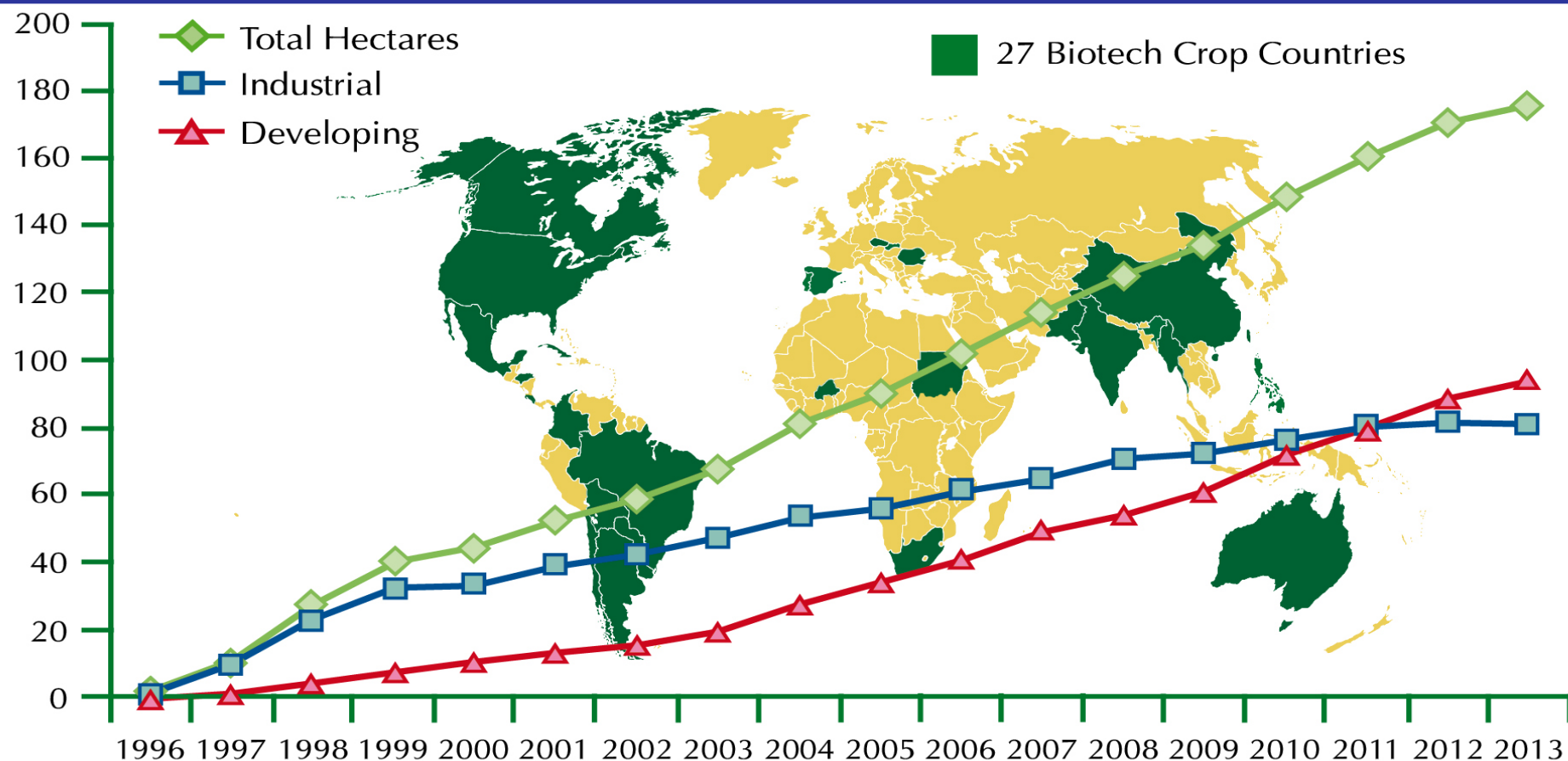
**But These Types of GE Crops Lead To Estimates that 75% of Processed Foods in U.S. Have GE Ingredients**

# There are only a few genetically engineered, whole foods in the U.S market





## Despite the same limited U.S. crop and trait types, worldwide acreage is increasing in 20 developing, 8 developed countries



**2013 figures indicate 15.4 million farmers in 27 countries planted 433M acres (>3X size of California) – over 90% were small acreage farmers**

# ***WHAT'S IN THE PIPELINE?***







*High anthocyanin purple GE tomatoes protect against cardiovascular disease and certain cancers. Diets with 10% purple tomatoes increased lifespan of cancer-prone mice*

© SIVB. Photo courtesy of the J.R.  
Simplot Company



Innate™ (L) and traditional (R) potato  
10 hours after cutting

***Low acrylamide, low sugar, bruising-resistant potato  
engineered only with potato DNA***

SOURCE: "Comment period opens on biotech potato", Truth About Trade & Technology, 5/2/13  
<http://www.truthabouttrade.org/2013/05/03/comment-period-opens-on-biotech-potato/>



# ***Enhancing vitamin A in banana - a staple food in Uganda where deficiency is common***



Control  
1.25 ug/g dwt  $\beta$ CE



Exp1>APsy2a  
9.96 ug/g dwt  $\beta$ CE



Ubi>APsy2a  
16.10 ug/g dwt  $\beta$ CE







***GE canola that uses 50% less nitrogen fertilizer –  
would lead to lower environmental impact***

SOURCE: [http://archives.foodsafety.ksu.edu/agnet/2007/4-2007/agnet\\_april\\_10.htm#story0](http://archives.foodsafety.ksu.edu/agnet/2007/4-2007/agnet_april_10.htm#story0)



***Engineered drought tolerance - vigorous growth of plants after prolonged drought; control plants die***



SOURCE: Rivero, R.M., Kojima, M., Gepstein, A., Sakakibara, H., Mittler, R., Gepstein, S. and Blumwald, E. 2007. Delayed leaf senescence induces extreme drought tolerance in a flowering plant. *Proceedings of the National Academy of Sciences USA* 104: 19631-19636.

*What is the U.S. regulatory process  
that governs these engineered  
plants?*



# U.S. Regulatory Agencies

## USDA

- **Field testing**
  - Permits
  - Notifications
- **Determination of non-regulated status**

Plant pest?

## FDA

- **Food safety**
- **Feed safety**

Danger to people?

## EPA

- **Pesticidal plants**
  - tolerance exemption
  - registrations
- **Herbicide registration**

Risk to environment?

# Why Are GE Crops and Foods (GMO's) So Controversial?





## It started in Europe: Factors that fueled and continue to fuel the controversy in Europe

- Food safety scares
- Involuntary nature of change
- Cultural differences
- Economic incentives



**Then: 1999**  
Lord Melchett participating in GM protest

# Controversy Continues today in Europe (Germany)

## Now: February 2014



GMO HATE. People protest against the authorization of genetically modified (GM) maize with signs and banners reading 'Stop GMO Maize 1507', 'Only a NO can protect us' and 'No to GMO Maize 1507' in front of the Federal Chancellor's Office in Berlin, Germany, 05 February 2014. Joerg Carstensen/EPA



## Genetically modified potatoes are studied, criticized in Ireland



In a secured government greenhouse in Carlow, Ireland, plant scientist Ewen Mullins examines transplants of genetically modified potatoes engineered to resist late blight disease. (Adrian Higgins/The Washington Post)



**Even with a product that addresses an E.U. issue that led to thousands of deaths in the very country that helped develop a “cure” for late blight - responsible for the Irish potato famine**

Evangelical megachurch begins closing



THE WASHINGTON POST

Obama announces 'broad coalition' to fight



THE DENVER POST

Von Miller's sluggish Game 1 fuels fire



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ucbiotech.org





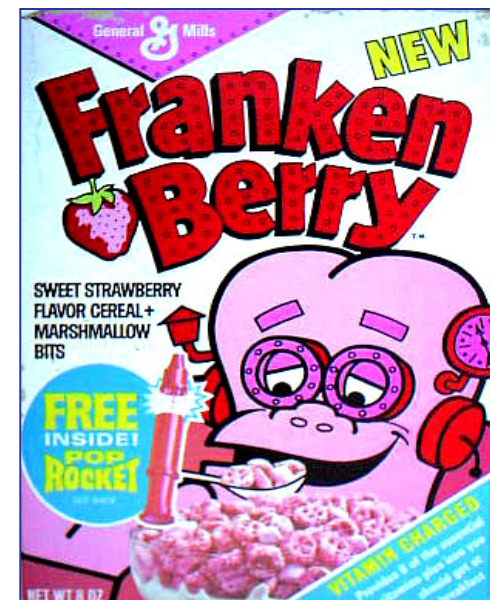
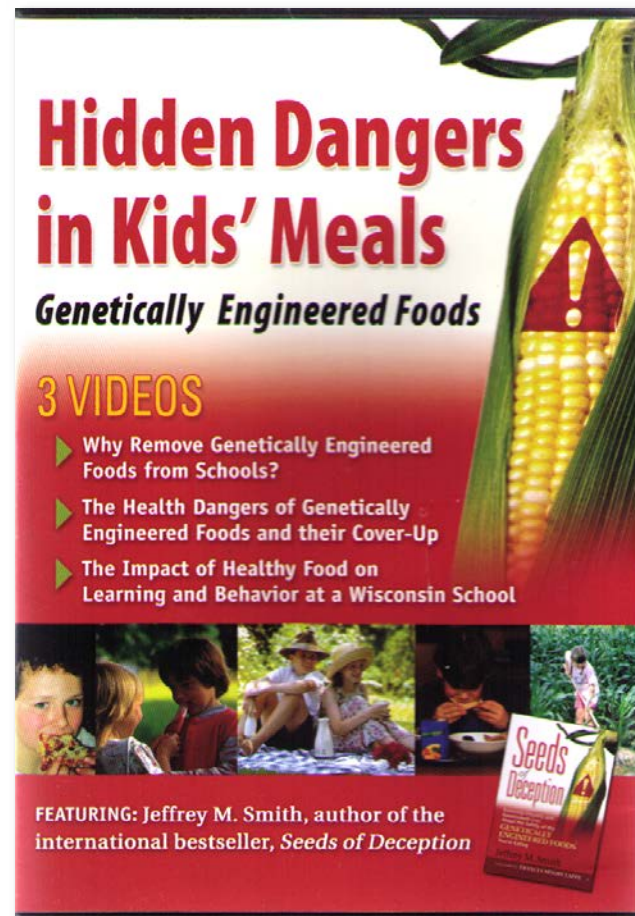
**But anti-GE sentiment is not universal. German farmers protest GE field destruction, demanding punishment for perpetrators**



# Why would consumer fears affect the introduction of such GE foods in the marketplace?



oldamericancentury.org



**Intermittent studies are published casting doubts on GE food safety, like this one published by a French researcher in Sept. 2012 –**

**Study subsequently reviewed by European Food Safety Authority and found to have no merit. Did people read this?**

## French academies trash GM corn cancer study

By RFI

A controversial study that linked genetically modified maize to cancer in lab rats is a "scientific non-event", six French scientific academies said in a rare joint statement Friday.



**It's stories like these that capture consumers' attention...it was even featured on the Dr. Oz show**

"This work does not enable any reliable conclusion to be drawn," they say, adding that the publicity surrounding the publication has "spread fear among the public."

The joint statement - an extremely rare event in French science - is unsigned and issued in the names of the national academies of agriculture, medicine, pharmacy, science, technology and veterinary studies.





# Organic Bytes

Health, Justice and Sustainability News from the Organic Consumers Association

A weekly e-newsletter edited by Katherine Paul and Ronnie Cummins

[Read PDF](#) | [Subscribe & Read Past Issues](#) | [OCA Homepage](#) | [Donate](#)



## ESSAY OF THE WEEK

# Are We Torturing Animals with Monsanto's GMO Feed?

We associate food with, at most, pleasure, at the very least, survival. It's not too different for animals. Lambs turned out on new grass move "quickly over certain grasses to get to others – to nosh on clover and mustard grass, avoiding horse nettle and fescue along the way," writes Dan Barber in [\*A Chef Speaks Out\*](#). Wild pigs, [capable of seeking out the nutrients they need](#), "enjoy eating nuts, roots, fruits, mushrooms, bugs, rabbits, and, occasionally, dead animals."



## And magazine articles like these...

SOURCE: "Torturing Animals with Monsanto's Genetically Engineered Feed", Organic Consumers Association Organic Bytes newsletter, August 8, 2013  
[http://www.organicconsumers.org/articles/article\\_28062.cfm](http://www.organicconsumers.org/articles/article_28062.cfm)



**But there are studies (also from France) showing GE foods are safe...**

**12 long-term (>90d to 2yr) and 12 multigenerational (2 to 5 generations) feeding trials in animals of GE feed**

**Conclusion: GE foods are nutritionally equivalent to non GE foods and can be safely consumed in food and feed**



**maize**

**potato**



**soy**



**rice**



**triticale**

*SOURCE: Snell C, Bernheim A, Berge J-P, Kuntz M, Pascal G, Paris A, Ricroch AE. 2012. Assessment of the health impact of GM plant diets in long-term and multigenerational animal feeding trials: A literature review. Food and Chemical Toxicology 50: 1134-1148.*



## ...and this one from the U.S. But who hears about these?

Sept. 2014 study states:

- U.S. produces >9 B food-producing animals/yr.
- >95% consume feed containing GE ingredients.
- **Data from 1983, before GE crops to 1996, and from 1996 to 2011, representing >100 billion animals revealed no unfavorable or perturbed trends in livestock health and productivity.**
- No differences seen in nutritional profile of animal products from GE-fed animals.



SOURCE: "Prevalence and impacts of genetically engineered feedstuffs on livestock populations"  
A. L. Van Eenennaam and A. E. Young, *J. Animal Science* September 2014

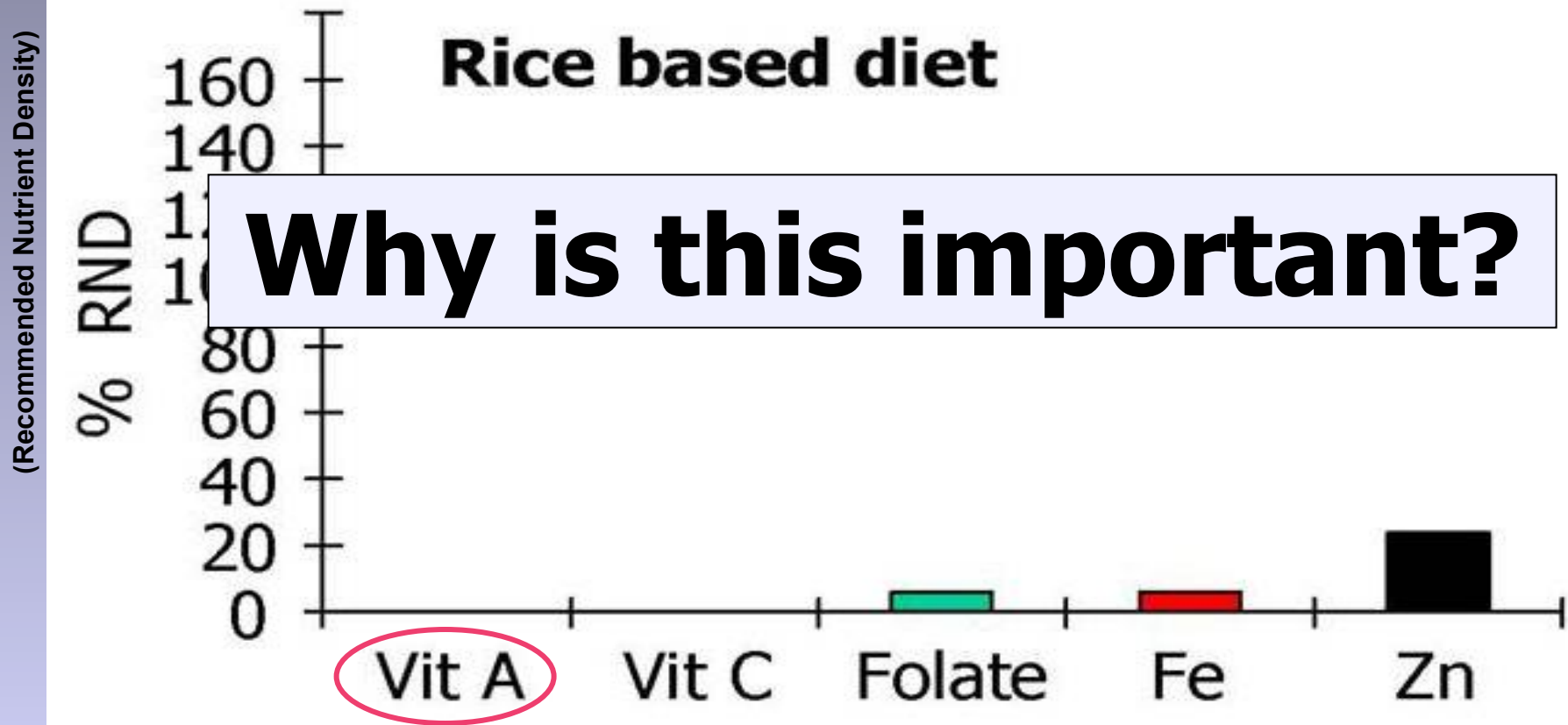
**Then there's Golden Rice – engineered to provide Vitamin A – deficiency which results in impaired vision, immune system and childhood development**



**Normal portion of Golden Rice 2 provides half of a child's Vitamin A needs**



**Rice – major dietary source in many developing countries but very poor source of vitamins/ minerals.**

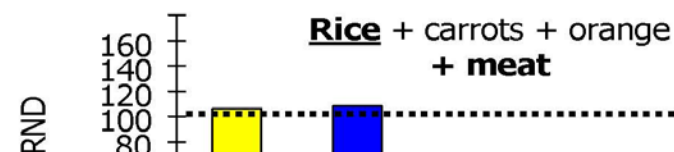
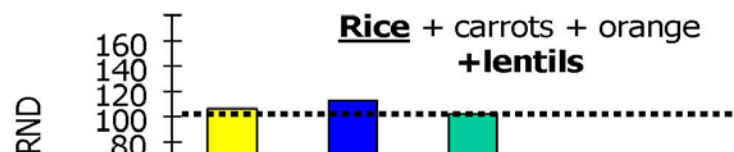
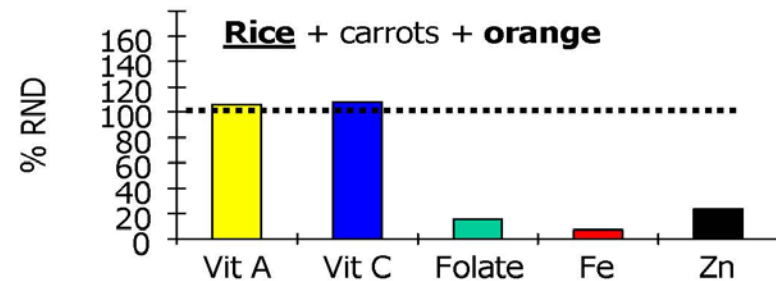
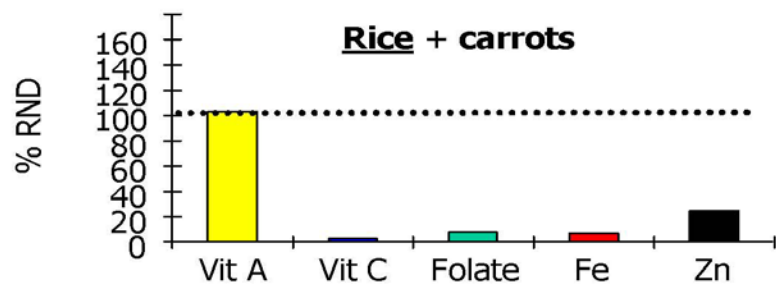


From: "Nutrition: A Cornerstone for Human Health and Productivity", Richard J. Deckelbaum. Seminar, Earth

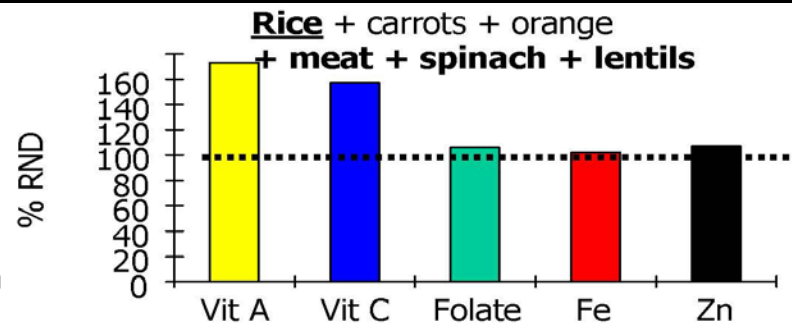
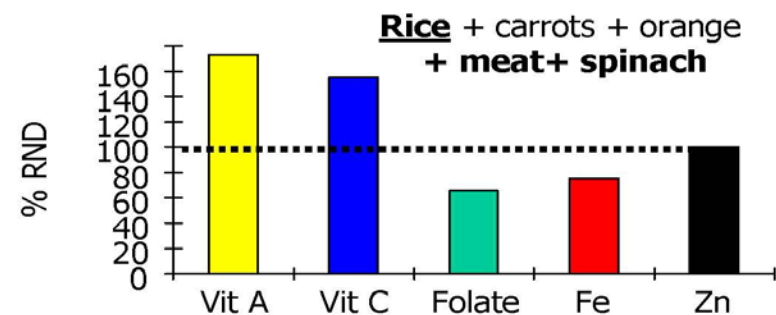
Modified from G. Barry, IRRI

Institute of Columbia University, April 14, 2005





**...but not everyone has that luxury!!**



**Rice diets can be supplemented with other fruits, vegetables and meat to acquire needed nutrients...**



NEW YORK TIMES

SUNDAY, AUGUST 25, 2013

NEWS ANALYSIS

## Golden Rice: Lifesaver?

By AMY HARMON

Published: August 24, 2013 [408 Comments](#)

### Individuals destroying fields of Golden Rice – Why?

ONE bright morning this month, 400 protesters smashed down the high fences surrounding a field in the Bicol region of the Philippines and uprooted the genetically modified rice plants growing inside.



[Enlarge This Image](#)

Genetically engineered Golden Rice grown in a facility in Los Baños, Laguna Province, in the Philippines.

Joe Aznar for The New York Times

**In late August 2013 activists destroyed a field trial in the Philippines of GE rice. And what was wrong with Golden rice?**

**What led individuals to destroy field trials of a vitamin enriched GE rice variety? Also an engineered wheat in Australia, sugar beets in Oregon, grapes in France?**

## Comments capturing some concerns about Vit A rice

Editor, NaturalNews Friday, September 21, 2013

### **GMO debate is over**

- **Only people still clinging to outmoded myth that "GMOs are safe" are scientific mercenaries** with financial ties to Monsanto and biotech industry.
- **GMOs threaten continuation of life on our planet - far worse than terrorism, or even the threat of nuclear war.**
- As a shocking new study has graphically shown, **GMOs are the new thalidomide**. When rats eat GM corn, they develop horrifying tumors.



# ***What Are Some Specific Issues?***



# **What are some food safety issues?**

- **Lack of peer-reviewed food safety tests**
- **Creation of allergens or activation of toxins**
- **Pharma crops contaminating food supply**
- **Labeling**
- **Gene flow from food to intestinal bacteria increasing antibiotic resistance**



# **What are some environmental and other issues?**

- **Transfer of engineered genes to non-GMO/organic crops?**
- **Development of herbicide-tolerant weeds or pesticide-resistant insects**
- **Spread of pharmaceutical genes into commercial crops?**
- **Loss of genetic diversity?**
- **Property rights (gene patents)?**

# What are some food safety issues?

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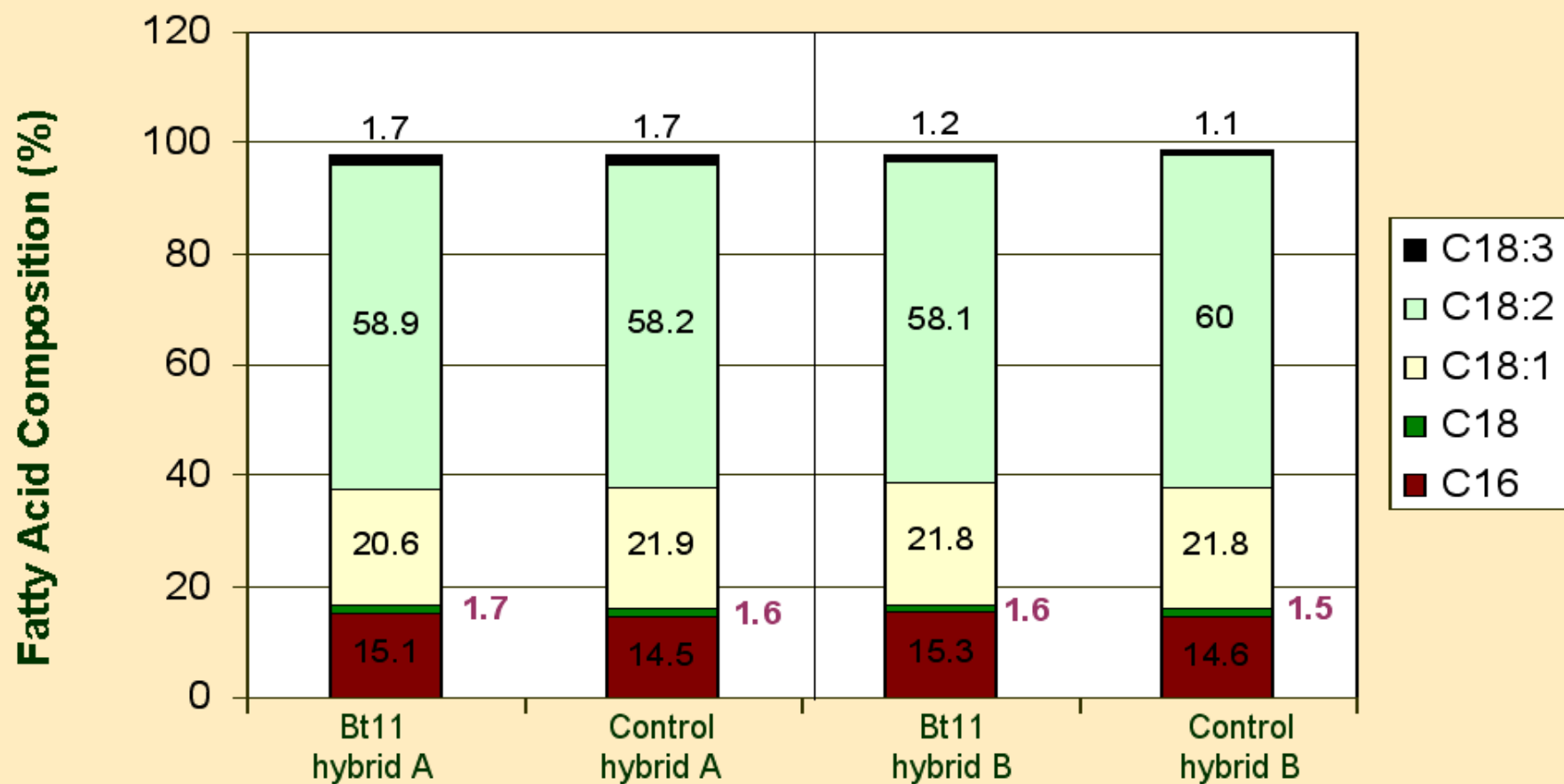


FDA uses the concept of  
**substantial equivalence**:

**Modified food has essentially all characteristics of nonmodified food with regard to food and feed value except**

**For introduced genetic material and products made from it. These products are tested and analyzed separately for specificity and mode of action of protein, source of protein, stability during digestion and processing**

# What kind of data do they look at?

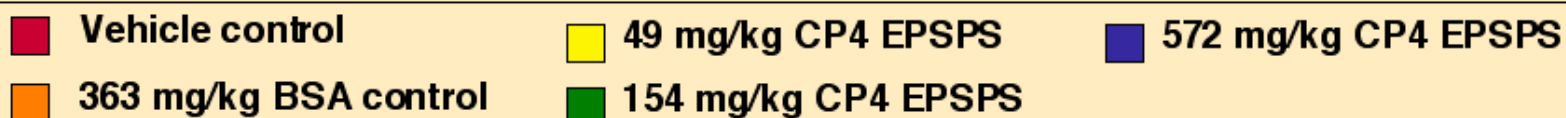
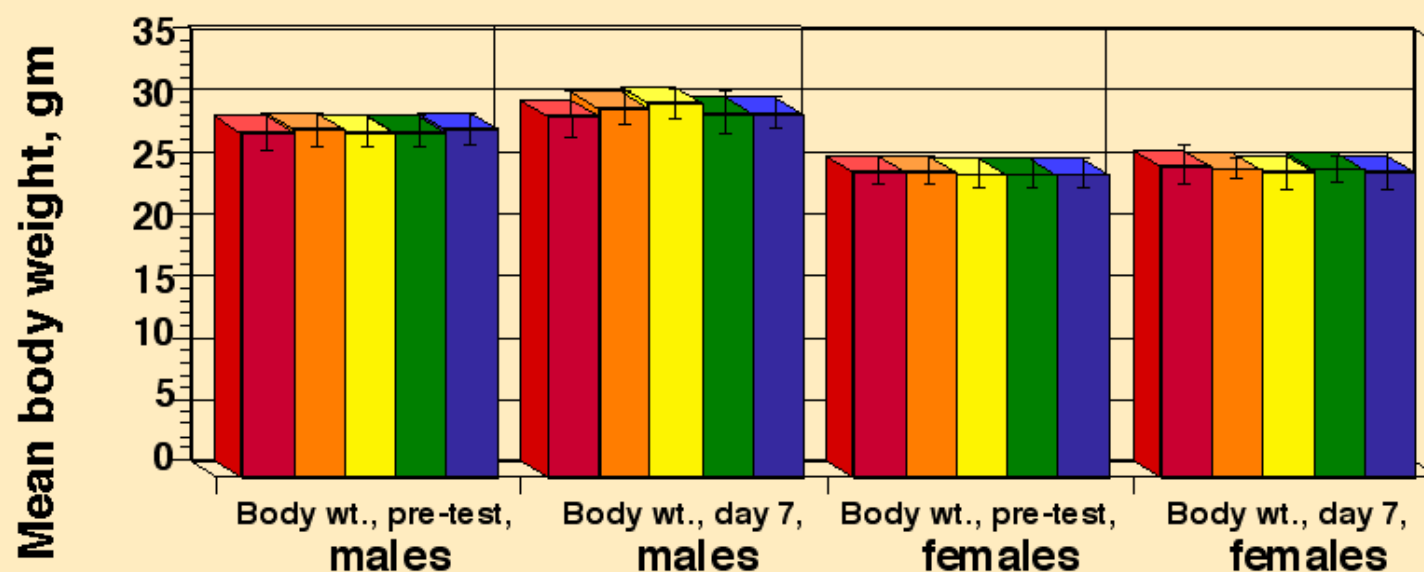


These results have been generated on Event Bt 11. Data showing similar fatty acid composition have been generated on the other corn events.



# ***Toxicity Assessment: Roundup Ready/CP4 EPSPS protein***

***No deleterious effects at highest dose (572mg/kg)***



# Are there allergy problems with GE foods?



- Oct 2000: StarLink *Bt* gene found in foods, forced massive recalls
- People claimed allergic reactions, but no StarLink was found in food
- Likely allergic reactions not due to Starlink
- No other medically confirmed allergic reactions to GE foods
- Premarket check of allergenicity of introduced GE products
- Allergic reactions to GE foods could occur, but not more frequently than with classically bred foods – whether conventional or organic



# **What are some food safety issues?**

- **Lack of peer-reviewed food safety tests**
- **Creation of allergens or activation of toxins**
- **Pharma crops contaminating food supply**
- **Labeling**
- **Gene flow from food to intestinal bacteria increasing antibiotic resistance**

# Why Doesn't FDA Have a Labeling Policy for GM Foods?

Actually it does...

Foods produced through biotechnology are subject to same labeling laws as all other foods and food ingredients

Govt-mandated label information relates to composition or food attributes not agricultural or manufacturing practices

No label needed if food essentially equivalent in safety, composition and nutrition

GM food must be labeled if:

1. Different nutritional characteristics
2. Genetic material from known allergenic source e.g., peanut, egg
3. Elevated levels of antinutritional or toxic compounds



# BE A STICKLER

PRODUCE CODES DEMYSTIFIED

**4 DIGIT CODE**  
STARTING WITH 3 OR 4



**CONVENTIONALLY  
GROWN**



**5 DIGIT CODE**  
STARTING WITH 9



**ORGANIC**



**5 DIGIT CODE**  
STARTING WITH 8



**GENETICALLY  
MODIFIED**



**Also, for whole fresh foods, there are existing PLU labels that indicate whether they are GE or organic**



**#imPACTfact @wearPACT**

SOURCE: [WWW.PLUCODES.COM](http://WWW.PLUCODES.COM)



## National GM Labeling Laws and Policies

Type of GM labeling	Countries that enforce labeling policies	Countries with partially enforced or unenforced labeling policies	Countries with probable plans to introduce a labeling policy
<u>Mandatory</u>	Australia, Brazil, China, <u>European Union</u> , Japan, New Zealand, Norway, Russia, Saudi Arabia, South Korea, Switzerland, Taiwan	Croatia, Ecuador, El Salvador, Indonesia, Malaysia, Mauritius, Serbia, Sri Lanka, Thailand, Ukraine, Vietnam	Nigeria, Uganda, UAE, Zambia
<u>Voluntary</u>	Argentina, <u>Canada</u> , Chile, Hong Kong, Kenya, Philippines, South Africa, <u>USA</u>		Peru

**One complicating problem: other nations have specific, labeling laws for GE, although the rules and enforcement vary dramatically among countries, making international trade difficult**

SOURCE: Marchant, G.E., Cardineau, G.A. and Redick, T.P. 2010. Thwarting Consumer Choice: The Case against Mandatory Labeling for Genetically Modified Foods. American Enterprise Institute, p. 71.





# But, do consumers act on labeling information?



FOOD  
STANDARDS  
AGENCY

***66% of UK consumers think GE food labeling is important...***

***But only 2% actively look for GE content when buying foods***

SOURCE: "FSA survey: Majority of UK consumers back GM labelling", Food Navigator, January 10, 2013. <http://www.foodnavigator.com/content/view/print/728839>  
Link to report: <http://www.food.gov.uk/science/research/ssres/foodsafetyss/gm-labelling/#.UPXkHaHr7jm>





**In November 2012 California voted on a Proposition to require mandatory labeling of foods with GE ingredients and restrictions on the use of the term “natural” on food labels. It and several other state-led labeling laws were defeated; one in Vt passed.**





**By 2018, all products in U.S. and Canadian stores must be labeled to indicate whether they contain genetically modified organisms (GMOs)**

## **The New York Times**

March 8, 2013

### **Major Grocer to Label Foods With Gene-Modified Content**

By **STEPHANIE STROM**

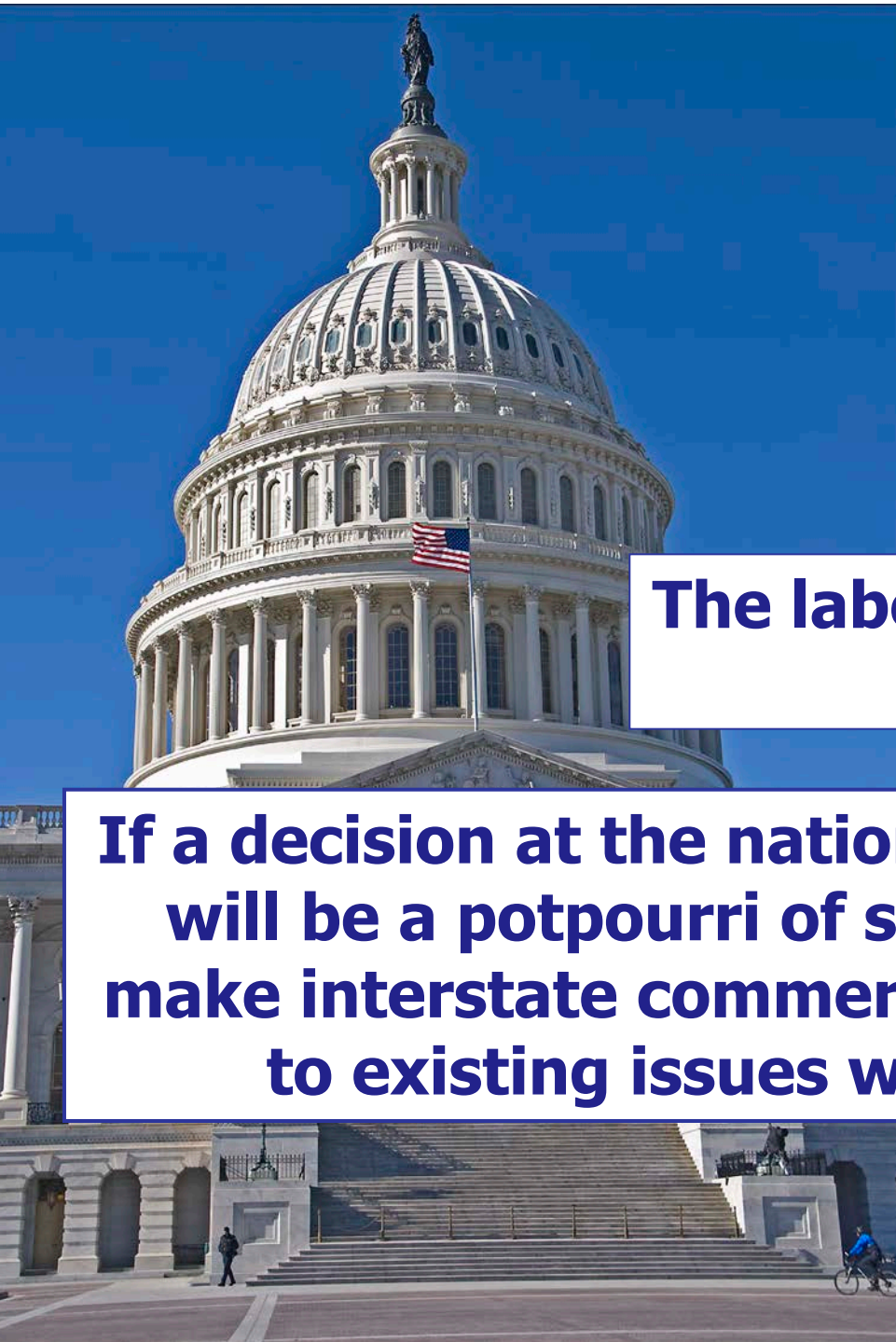
Whole Foods Market, the grocery chain, on Friday became the first retailer in the United States to require labeling of all genetically modified foods sold in its stores, a move that some experts said could radically alter the food industry.

**But companies are also becoming involved in different ways in GMO labeling.**

grown in the United States, for example, have been genetically modified. The alterations make soybeans resistant to a herbicide used in weed control, and causes the corn to produce its own insecticide. Efforts are under way to produce a genetically altered apple that will spoil less quickly,

SOURCE: "Major Grocer to Label Foods With Gene-Modified Content", New York Times, 3/8/13  
[http://www.nytimes.com/2013/03/09/business/grocery-chain-to-require-labels-for-genetically-modified-food.html?ref=opinion&\\_r=0](http://www.nytimes.com/2013/03/09/business/grocery-chain-to-require-labels-for-genetically-modified-food.html?ref=opinion&_r=0)





## THE HUFFINGTON POST

### GMO Labeling Bill Voted Down In Senate

Posted: 05/23/2013 11:31 am EDT | Updated: 05/23/2013 4:08 pm EDT

WASHINGTON -- The United States Senate decided again Thursday that it simply does not want to let states tell people whether or not they are eating genetically modified food.

**The labeling issue has moved to the national stage...**

**If a decision at the national level is not made – there will be a potpourri of state labeling bills that will make interstate commerce very problematic- similar to existing issues with international trade.**

and Connecticut have passed laws to require such labeling, but Sanders said local leaders fear that large biotech corporations such as Monsanto could sue the states on the grounds that they are preempting federal authority. He said his bill would make clear that states can do what they want on the issue.

SOURCE: "GMO Labeling Bill Voted Down In Senate", Huffington Post, 5/22/13  
[http://www.huffingtonpost.com/2013/05/23/gmo-labeling-bill-genetically-modified-food\\_n\\_3325972.html](http://www.huffingtonpost.com/2013/05/23/gmo-labeling-bill-genetically-modified-food_n_3325972.html)



## **Now to some environmental issues?**

- **Transfer of engineered genes to non-GMO/organic crops?**
- **Development of herbicide-tolerant weeds or pesticide-resistant insects**
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## **Now to some environmental issues?**

- **Transfer of engineered genes to non-GMO/organic crops?**
- **Development of herbicide-tolerant weeds or pesticide-resistant insects**
- **Spread of pharmaceutical genes into commercial crops?**
- **Loss of genetic diversity?**
- **Property rights (gene patents)?**



**How might a GE crop be a co-existence issue for an organic farmer?**



# **...What Genetic Modification Input Methods Are PERMITTED?**

## **(§ 205.2 National Organic Program)**

- they “...include the use of traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, or tissue culture.”



**F.J. Chip Sundstrom CCIA**



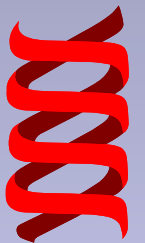
# **...And What Genetic Modification Input Methods Are PROHIBITED?**

(§ 205.2 National Organic Program)

- “A variety of methods...are not considered compatible with organic production. Such

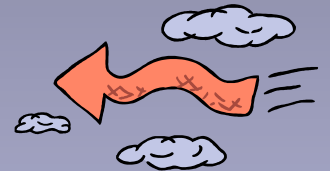
**Are There Tolerances for GE in Organic Products?**

positions of genes when achieved by recombinant DNA technology).”



# There are tolerances for pesticides but not for GM content

🐝 Pesticides: “When residue testing detects prohibited substances at levels that are greater than 5% of the EPA’s tolerance for the specific pesticide residue detected...the agricultural product must not be sold or labeled, or represented as organically produced.”



🐝 GMOs: At the present time there are no specified tolerances for GMOs in organic products. Organic products are not ‘guaranteed’ GMO-free, although some organic farmers sign contracts guaranteeing GMO-free

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*“When any single herbicide mechanism of action is used repeatedly without alternative management tactics, however, selection pressure becomes intense for plants that are tolerant or resistant to that herbicide.”*

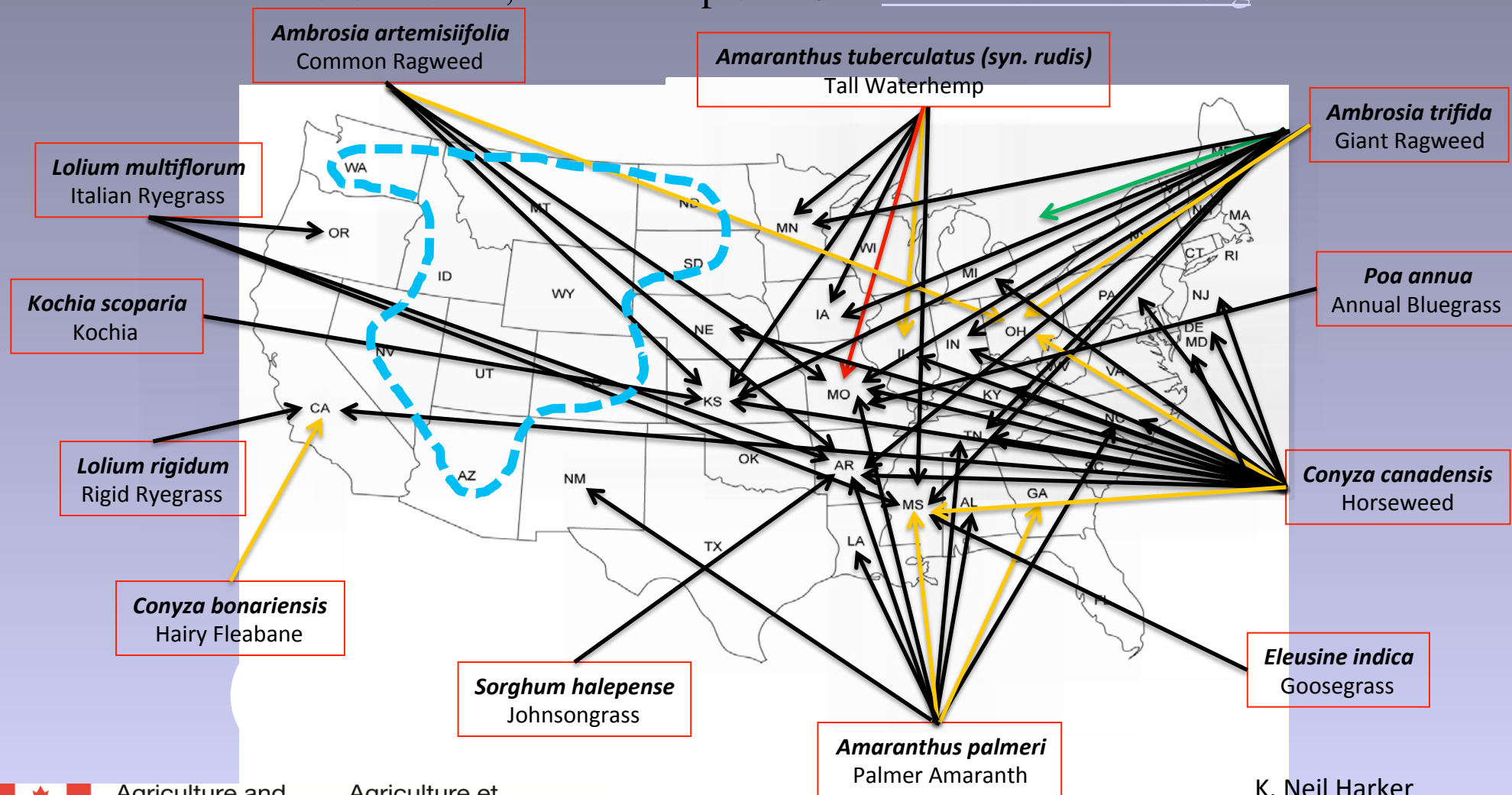
*“There is now a large and growing threat to soil conservation gains because of the dire need... to manage these resistant weeds...”*

SOURCE: Council for Agricultural Science and Technology (CAST). 2012. *Herbicide-resistant Weeds Threaten Soil Conservation Gains: Finding a Balance for Soil and Farm Sustainability*. Issue Paper 49. CAST, Ames, Iowa. <http://bit.ly/6t0A3Oq>



# Glyphosate- Resistant Weeds – USA

December 13, 2010 – adapted from: [www.weedscience.org](http://www.weedscience.org)



Agriculture and  
Agri-Food Canada

Agriculture et  
Agroalimentaire Canada

K. Neil Harker  
AAFC - Lacombe, AB

# What are some environmental issues?

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Investigative report

# Monsanto's practices weed out competition

*Licensing pacts, science  
propel seed company  
to dominate position*



- Large agrichemical companies are creating today's commercial GE crops.
- They control most of the intellectual property.
- This may or may not be good for agriculture.

found.

With Monsanto's patented genes being inserted into roughly 95 percent of all soybeans and 80 percent of all corn grown in the U.S., the company also is using its wide reach to control the ability of new biotech firms to get wide distribution for their products, according to a review of several Monsanto licensing



Dan Gill/Associated Press

A farmer holds Monsanto's Roundup Ready soybean seeds. Confidential contracts detailing Monsanto Co.'s business practices reveal how the world's biggest seed developer protects its dominance over the multibillion-dollar market for genetically altered crops, an Associated Press investigation has found.

SOURCE: Capital Press, December 18, 2009

# Where to get more information on the issues?



SCIENCE-BASED INFORMATION & RESOURCES  
ON AGRICULTURE, FOOD & TECHNOLOGY

[ABOUT US](#) | [NEWS](#) | [ISSUES & RESPONSES](#) | [GMO LABELING](#) | [RESOURCES](#) | [LINKS](#) | [GLOSSARY](#) | [SEARCH](#)

Select Language ▼

*This website provides educational resources focused broadly on issues related to agriculture, crops, animals, foods and the technologies used to improve them. Science-based information related to these issues is available, as well as educational tools and information, which can be used to promote informed participation in discussions about these topics.*

## FEATURED LECTURE VIDEO

"Feast, Famine and the Future of Food"



Outreach in Biotechnology  
Food for Thought Lecture Series  
Oregon State University  
January 25, 2012

### BIOTECHNOLOGY INFORMATION



**Labeling:**  
Informational resources available.



**Review articles:**  
Focused on food, environmental and socioeconomic issues of GE crops and foods.  
[Part 1](#) | [Part 2](#)

### RESOURCES FOR OUTREACH & EXTENSION, RESEARCHERS & TEACHERS

#### DNA for Dinner 4-H curriculum:

For grades 5-8, covers topics from plant diversity to genetic engineering. Each of the five lessons has 3 to 5 activities.



#### New Game: Who's In Your Family?

A free educational game to teach participants about the diversity of fruits and vegetables, and how they are related.



#### Slide Archive:

Extensive collection of PP slides on agriculture & biotechnology.

#### Available on loan:

Teaching Aids: Handouts and cards available, in both English and Spanish.



Educational displays: "Genetics and Foods" and "Genetic Diversity and Genomics" available with companion educational cards and teacher worksheet in English and Spanish.

Gene-IE Juice Bar: Interactive activity to isolate DNA from common fruits and vegetables.

### HELPFUL SITES

#### Academics Review

Academics Review website  
Testing popular claims against peer-reviewed science.



#### Biofortified website

Provides factual information to foster discussion about agriculture, especially plant genetics and genetic engineering.

#### Animal Genomics & Biotechnology Cooperative Extension Program, UC Davis



Provides education on use of animal genomics & biotechnology in livestock production.

ucbiotech.org

