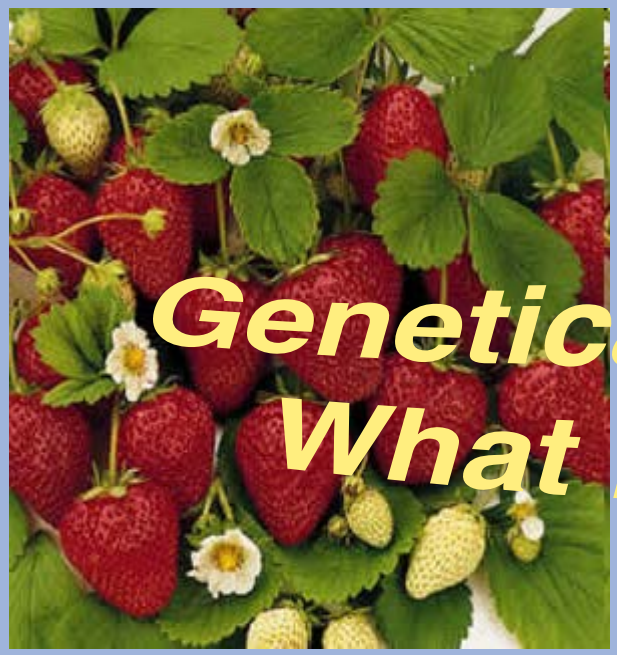
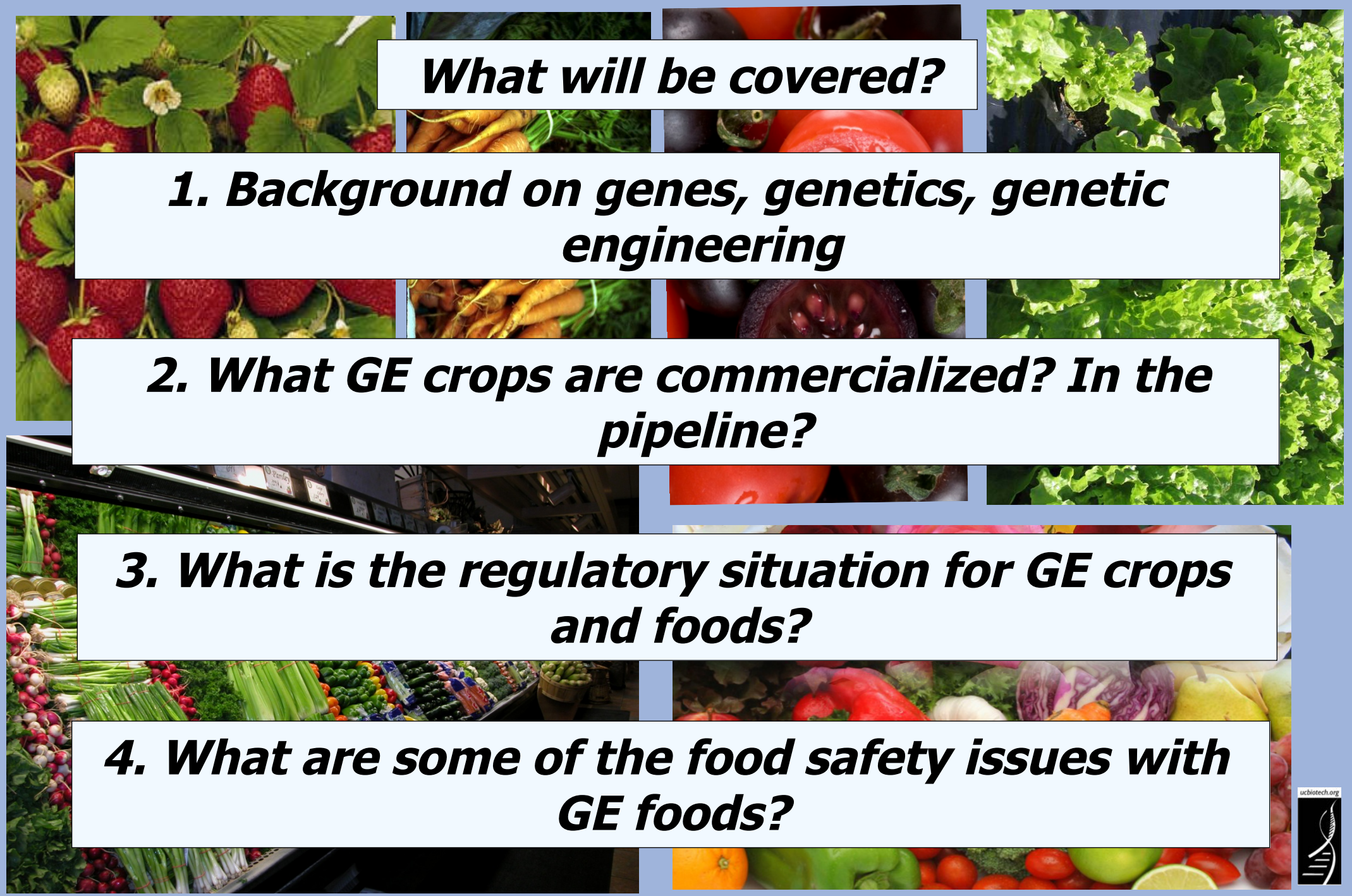



# Genetically Engineered Foods What Do I Need to Know?


Peggy G. Lemaux
University of California, Berkeley
http://ucbiotech.org
http://pmb.berkeley.edu/profile/plemaux#a1

# What will be covered?

1. Background on genes, genetics, genetic engineering

2. What GE crops are commercialized? In the pipeline?

3. What is the regulatory situation for GE crops and foods?

4. What are some of the food safety issues with GE foods?

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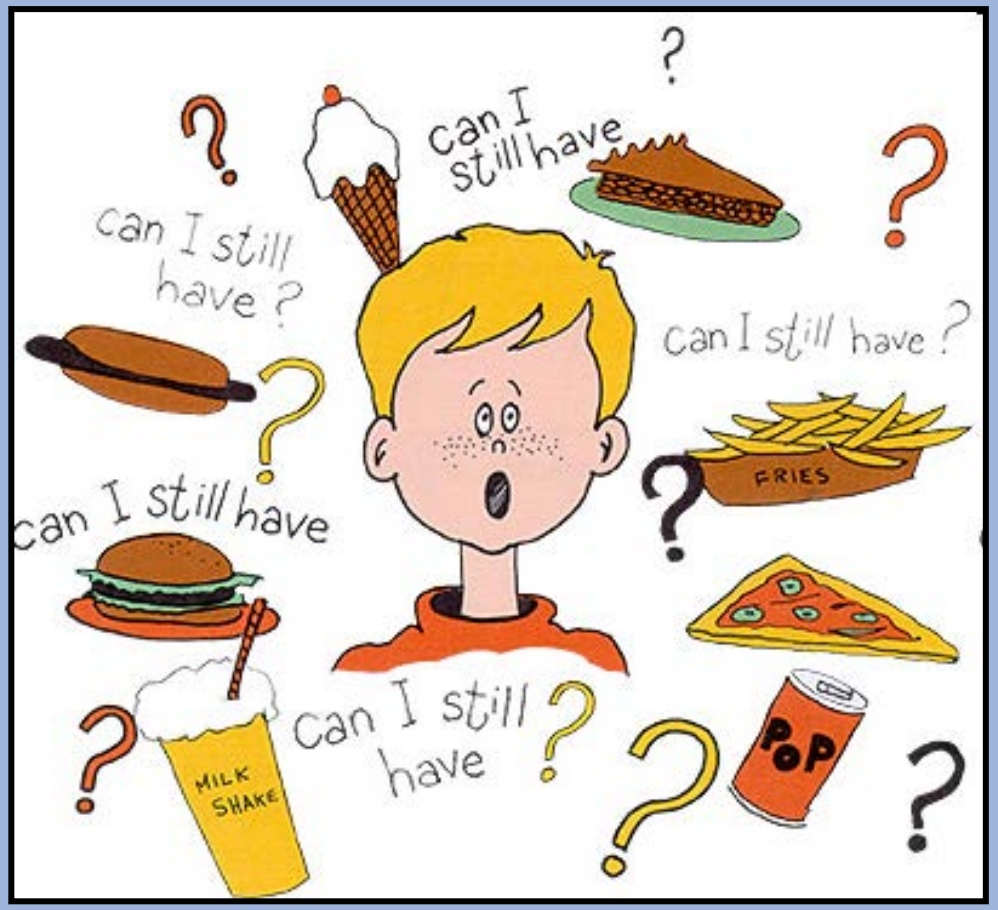
***As dietitians, you play an important role informing consumers about foods, diet and nutrition***

**In 2009, 33% of consumers said medical sources, like <u>dietitians</u>, physicians, and nutritionists are the most believable information resource on <u>genetics</u> as it relates to diet and nutrition.**

***So, let's take a look at the genetics of foods***




*Intl Food Information Council,*
*2009 Functional Foods/Foods For Health Consumer Trending Survey*


HOW MUCH DNA DO YOU EAT?*
HAMBURGER
(60mg)
ONION RINGS
(10mg)
REAL DNA
WHOLE BANANA
(50mg)
All living things contain DNA – including the foods we eat
First we'll start with some basics of genetics…
That chemical, a string approximately 5 feet long, can be isolated.
The isolated DNA in each food is seen in the tube on the right.

# Tour d'Onion

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

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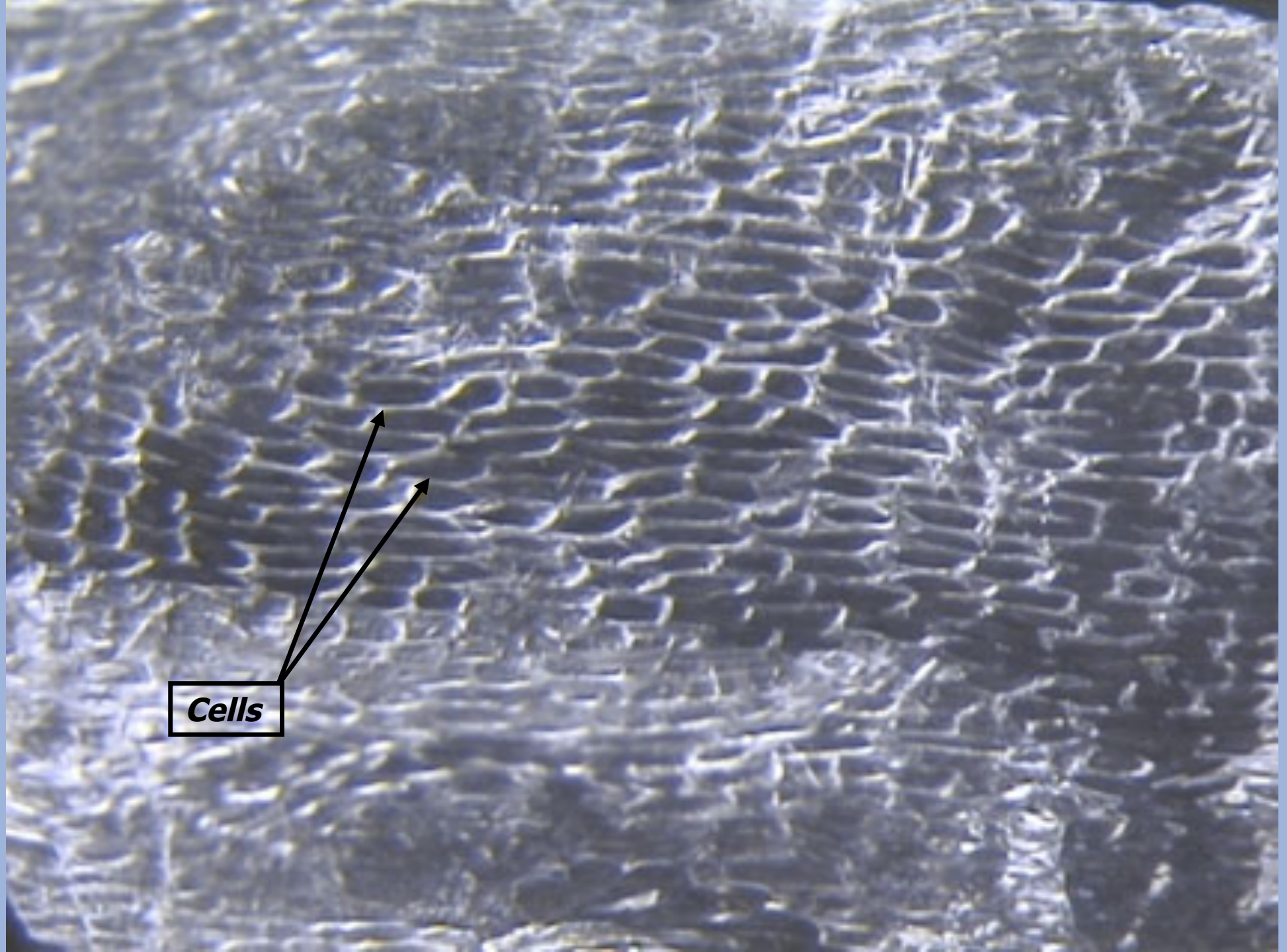
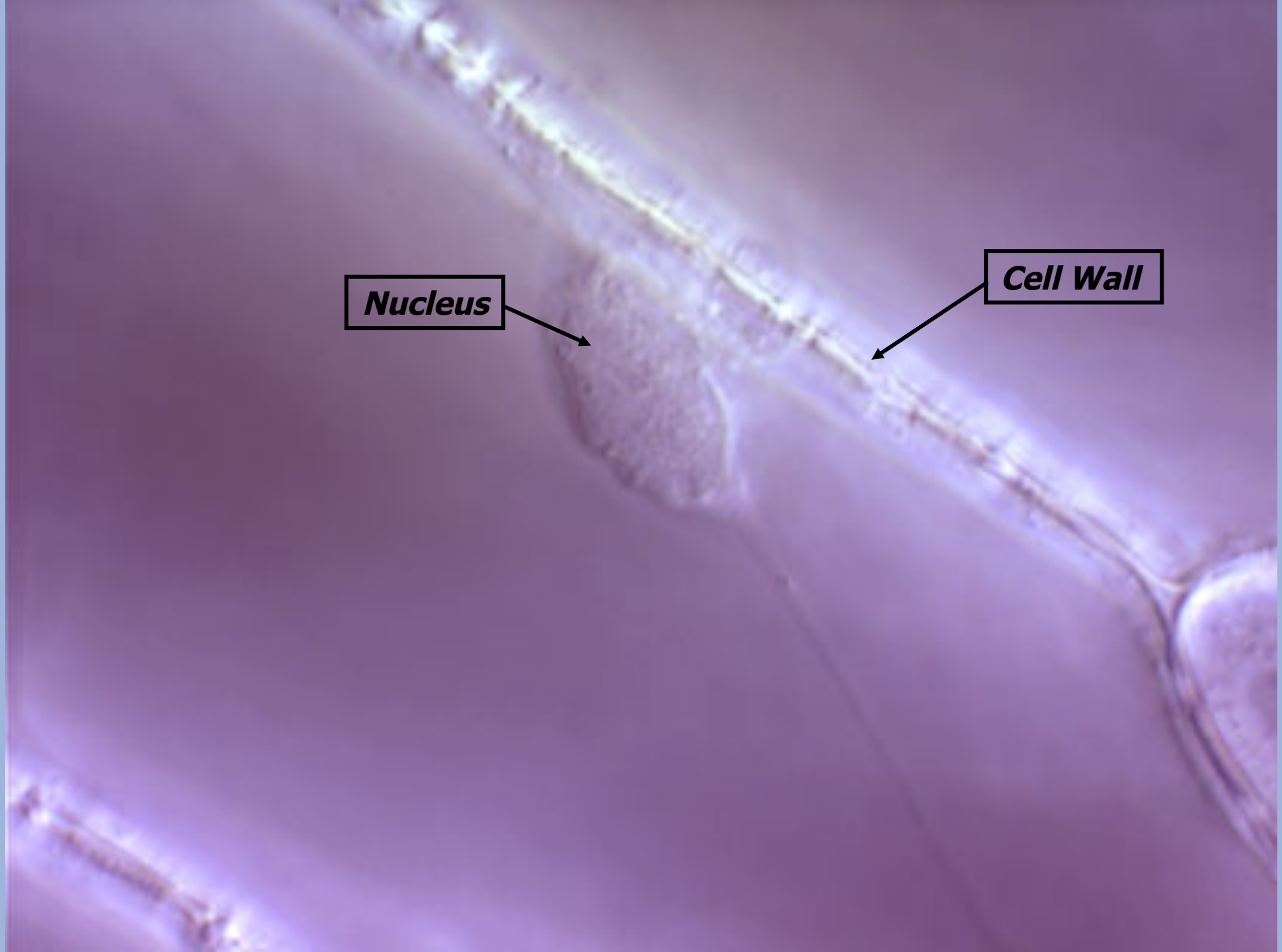
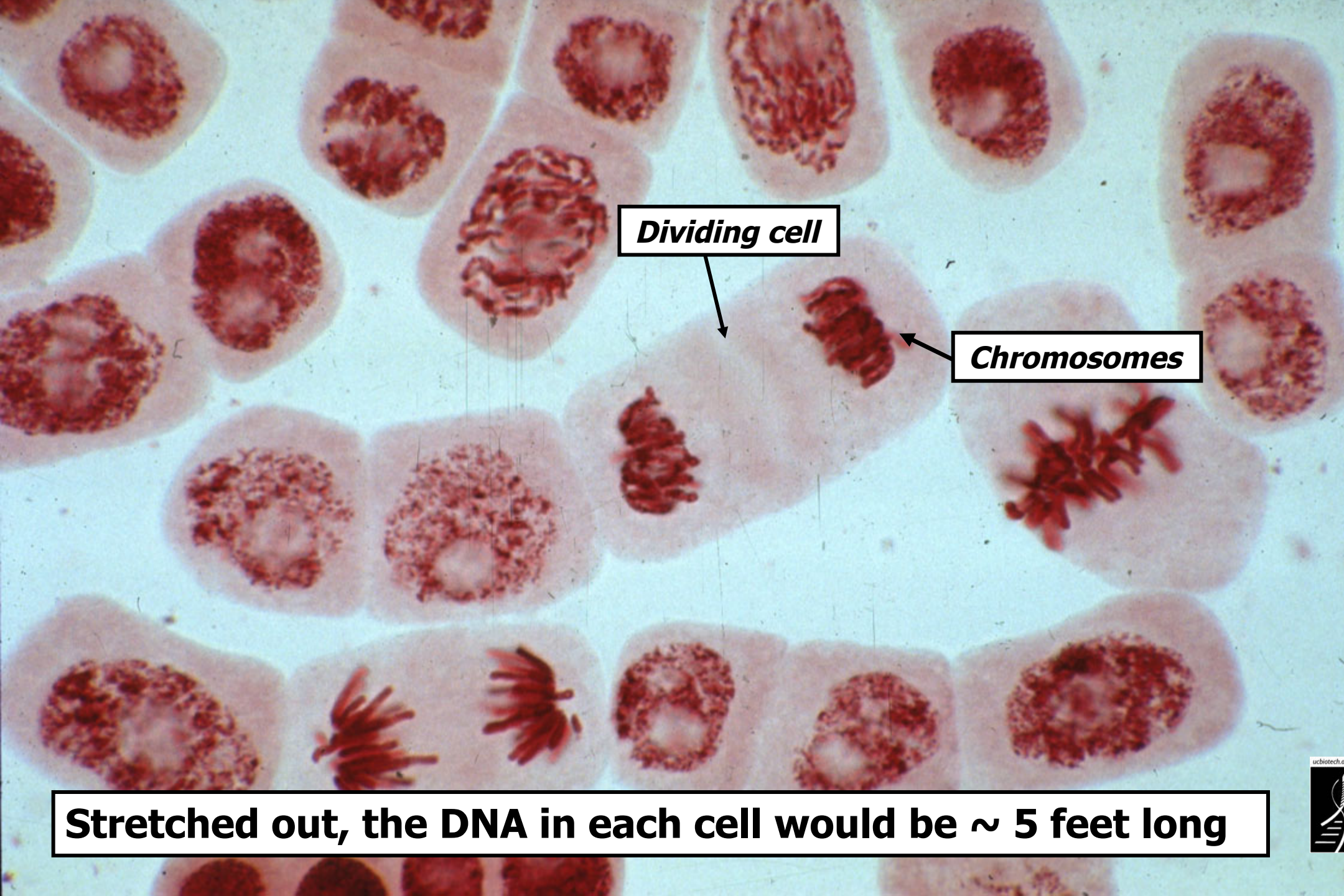
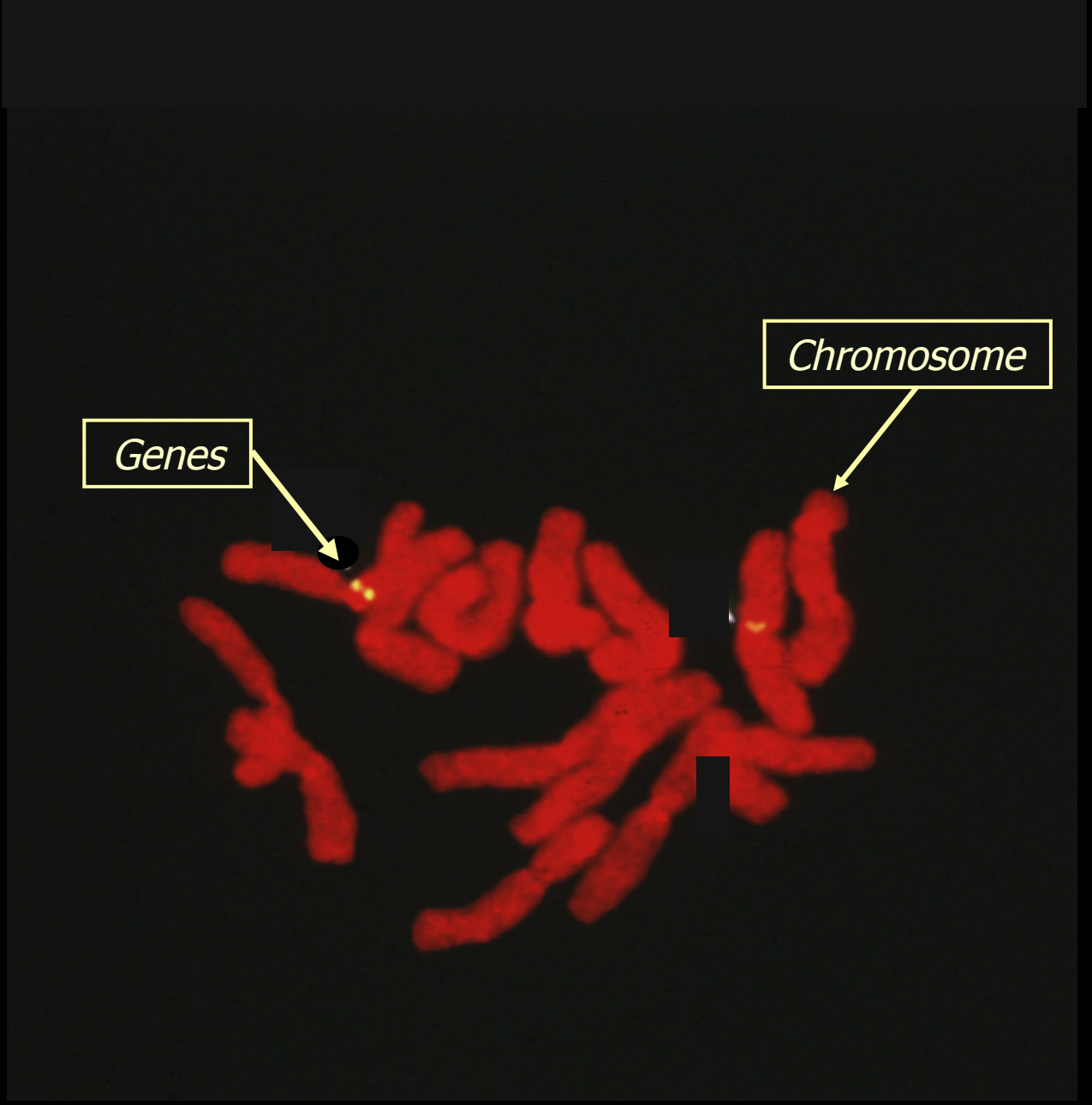

Cells

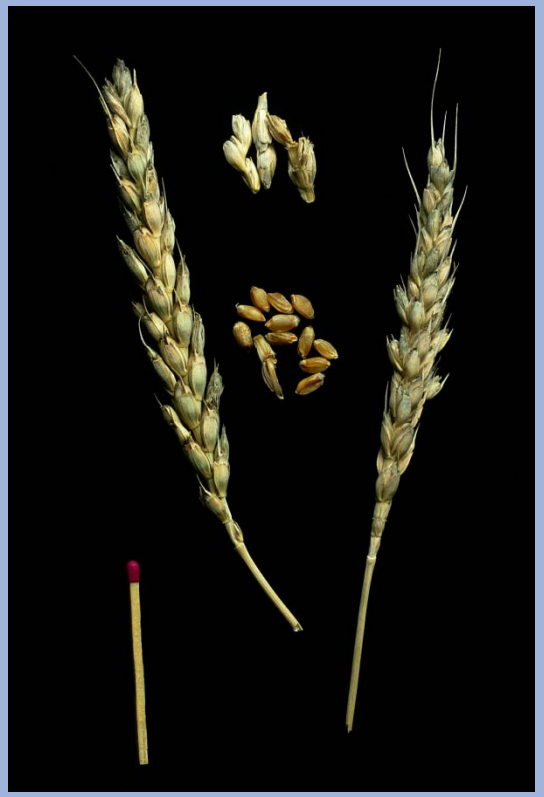

Nucleus
Cell Wall




**Stretched out, the DNA in each cell would be ~ 5 feet long**


Chromosome
Genes

# How can you use genetics to create a new wheat – with better nutritional qualities – using an ancient variety?



**What happens to the genetic information from the two parents?**

*Triticum monococcum*

***Ancient variety***

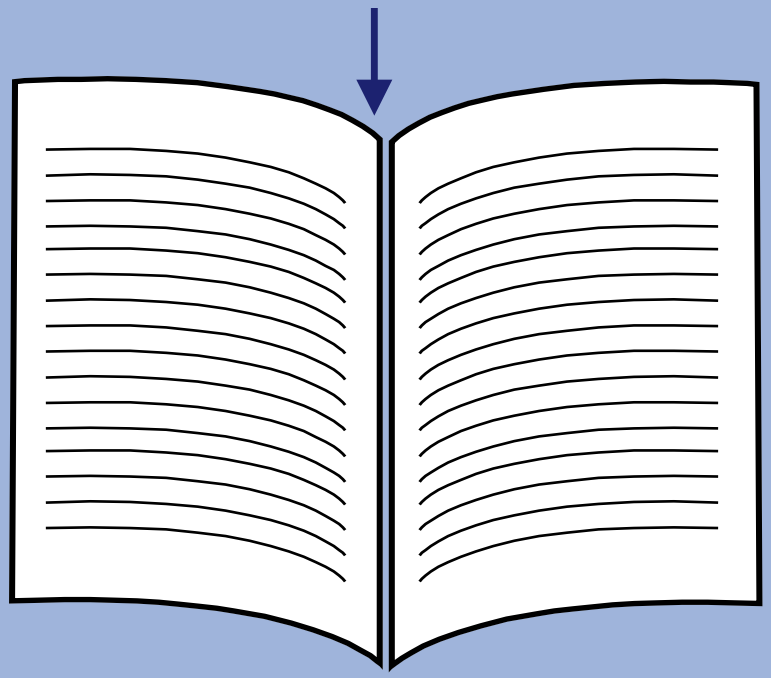
*Triticum aestivum*

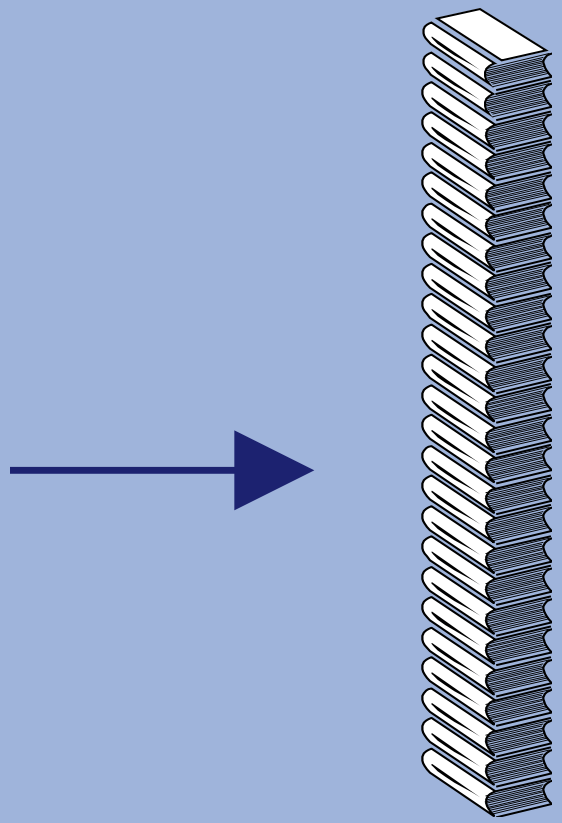
***Modern bread variety***

# *Information in the wheat genome*

***Chemical units represented by alphabetic letters***

*...CTGACCTAATGCCGTA...*

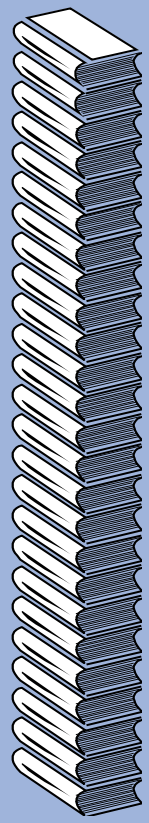




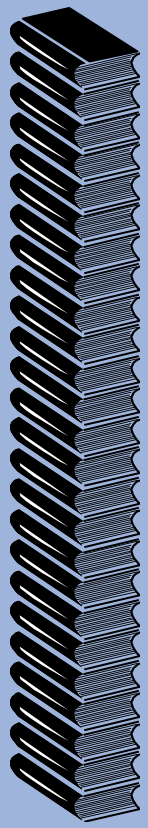
***1700 books***
***1000 pages each***

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

# Hybridization or cross breeding of wheat



X

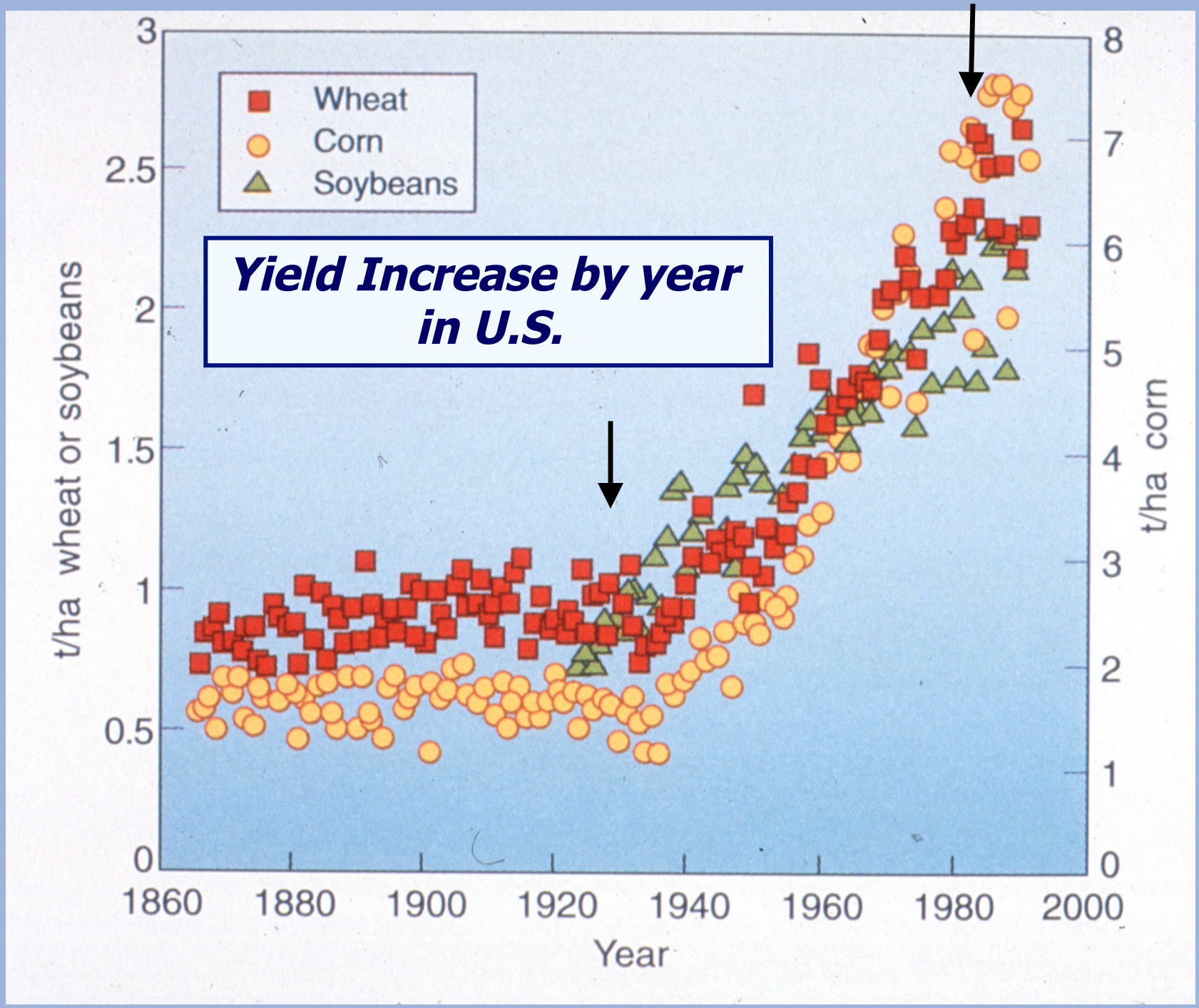


*Random retention of information from each parent*

*1700 books (or 1.7 million pages)*

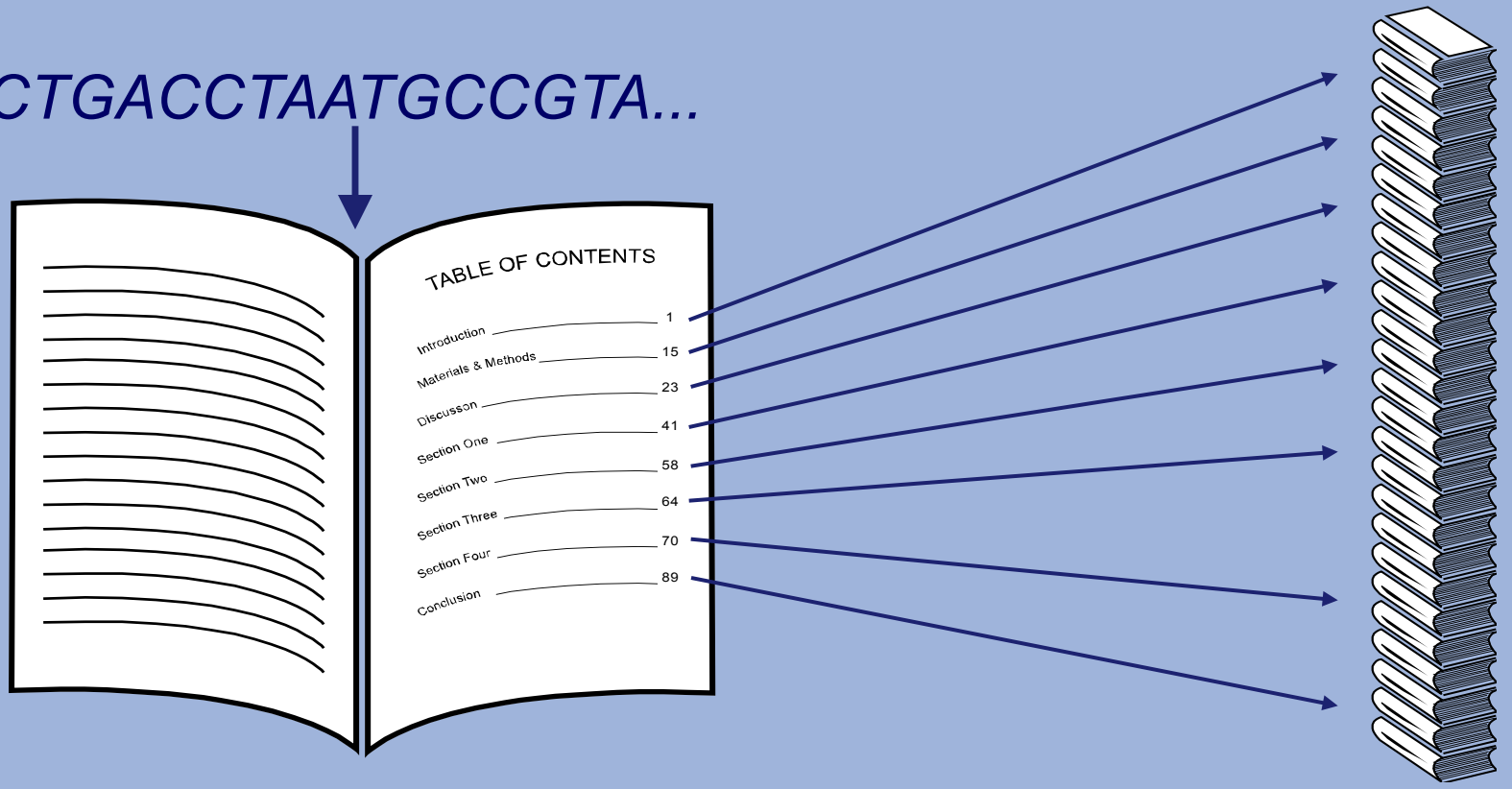
*1700 books (or 1.7 million pages)*

*1700 books (or 1.7 million pages)*


Wheat
Corn
Soybeans
Yield Increase by year in U.S.
t/ha wheat or soybeans
t/ha corn
Year
0
0.5
1
1.5
2
2.5
3
0
1
2
3
4
5
6
7
8
1860
1880
1900
1920
1940
1960
1980
2000

# Table of contents for genes in wheat

...CTGACCTAATGCCGTA...




**Genomics**

***Used for Marker-Assisted Selection***

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

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***Marker-assisted selection used to protect rice against bacterial blight and blast disease***

***Protection limited to diversity in crop and compatible relatives***


But there are other ways to create new varieties using the modern tools of genetics
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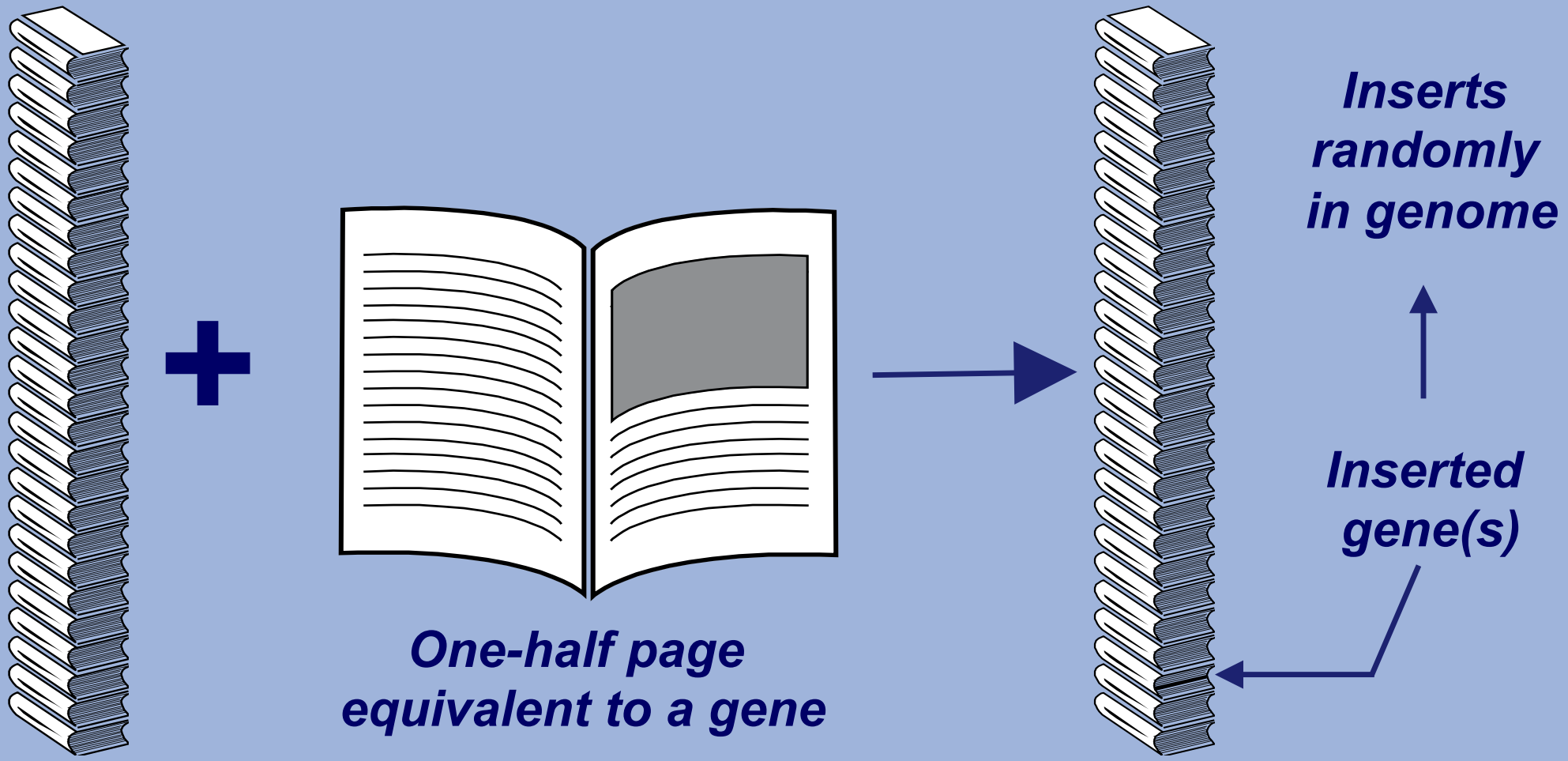
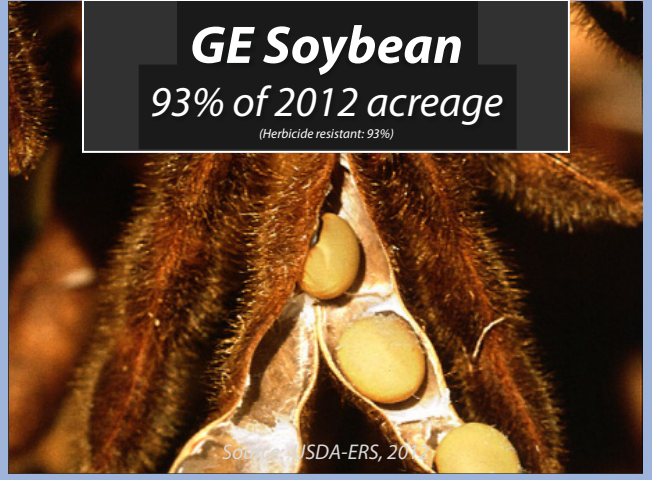
# Genetic Engineering Methods

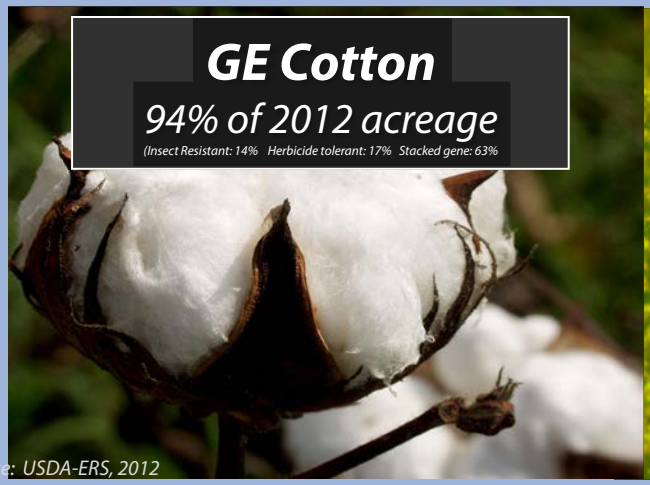


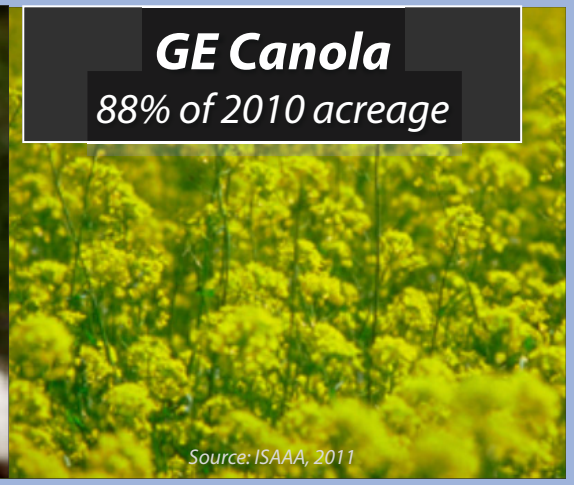
# Classical Breeding compared to Genetic Engineering

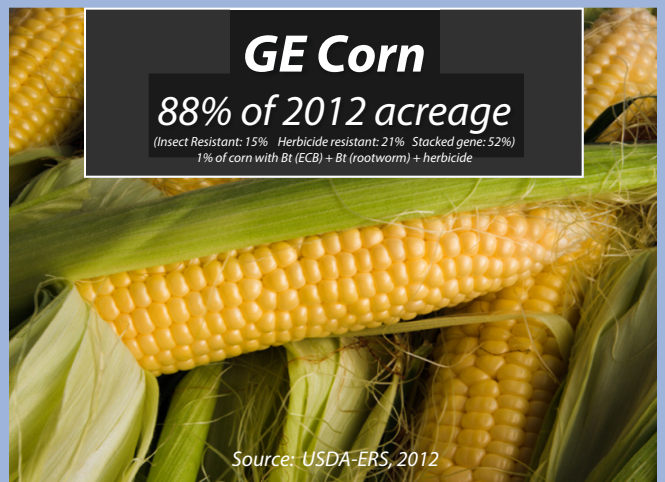
| Classical Breeding | Genetic Engineering |
| --- | --- |
| *Uses plant machinery in plant* | *Uses plant machinery in laboratory* |
| *Gene exchange is random involving whole genome* | *Gene exchange is specific involving single or few genes* |
| *When/where gene expressed not controlled by breeder* | *When/where gene expressed controlled precisely* |
| *Source of gene primarily within genera – not between kingdoms like plants & bacteria* | *Source of gene from any organism* |

# Number of different commercially available GE crops is limited



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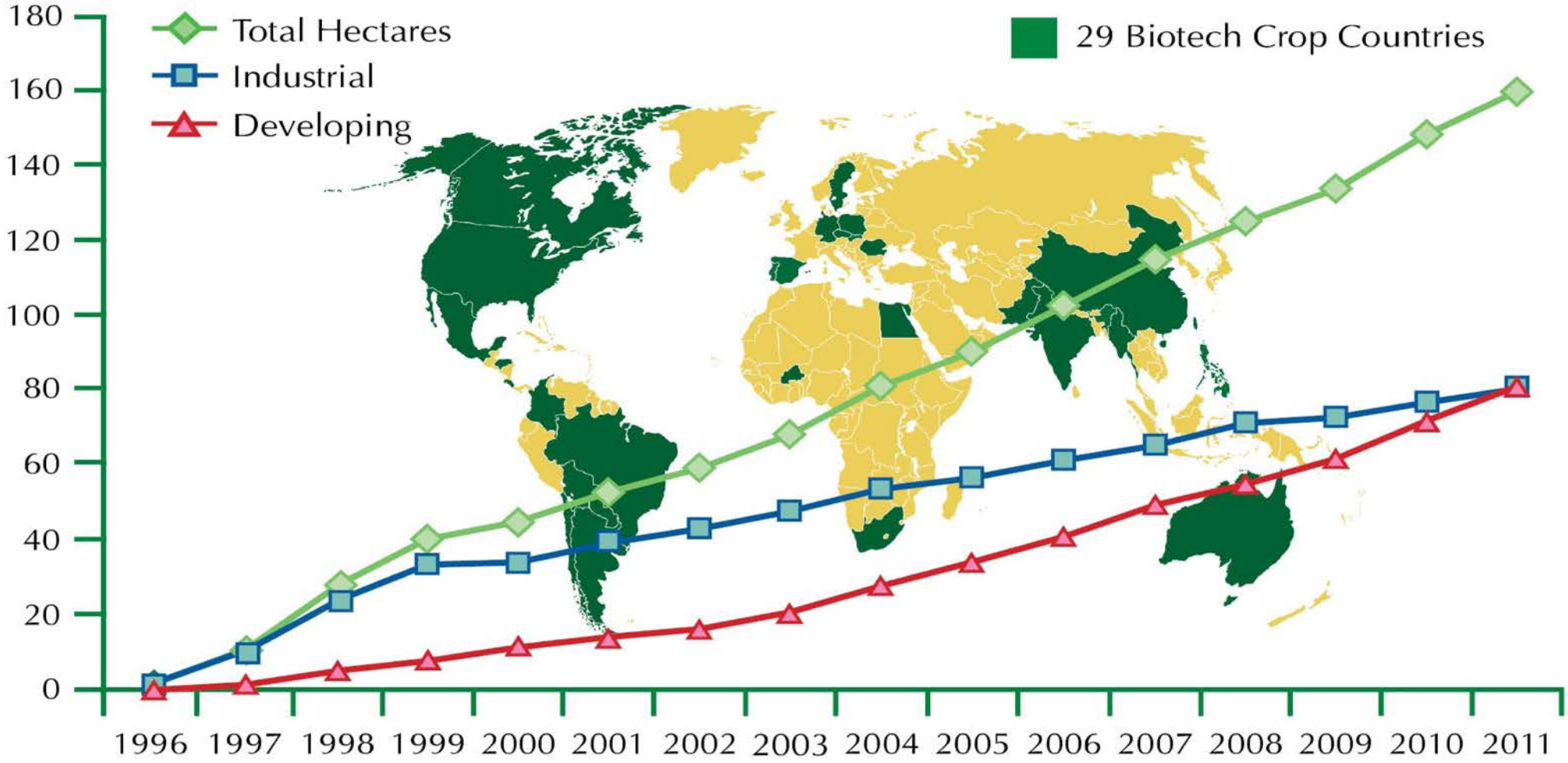
***Number of different traits available in GE crops is limited***

**Bt Crops – insect resistance using gene from naturally occurring bacterium**


**Herbicide-tolerant – tolerate herbicide application**

# Despite limited crop and trait types, worldwide acreage is increasing




## Total worldwide area cultivated = Areas of Texas + California + Colorado + Louisiana

Source: Clive James, 2011.

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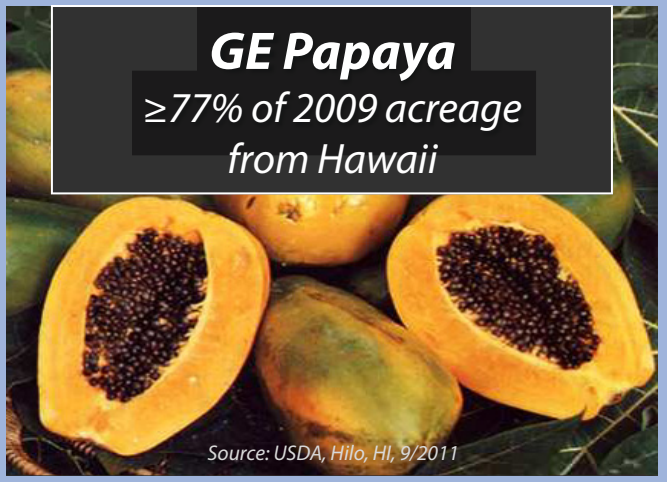
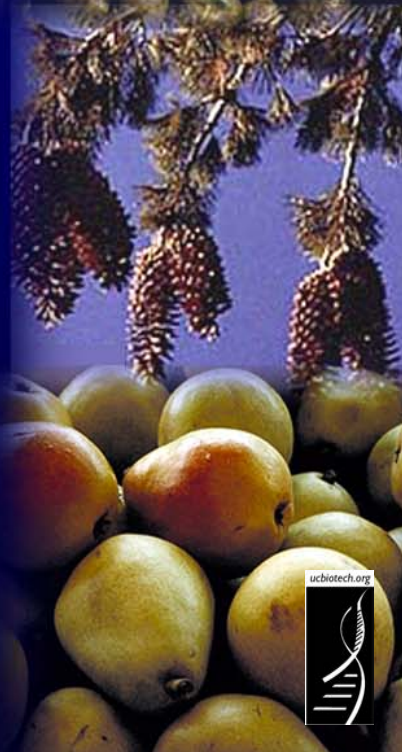
***Types of GE Crops Leads To Estimates that 75% of Processed Foods in U.S. Have GE Ingredients***

# Only a few whole foods on the market are genetically engineered






# WHAT'S IN THE PIPELINE?



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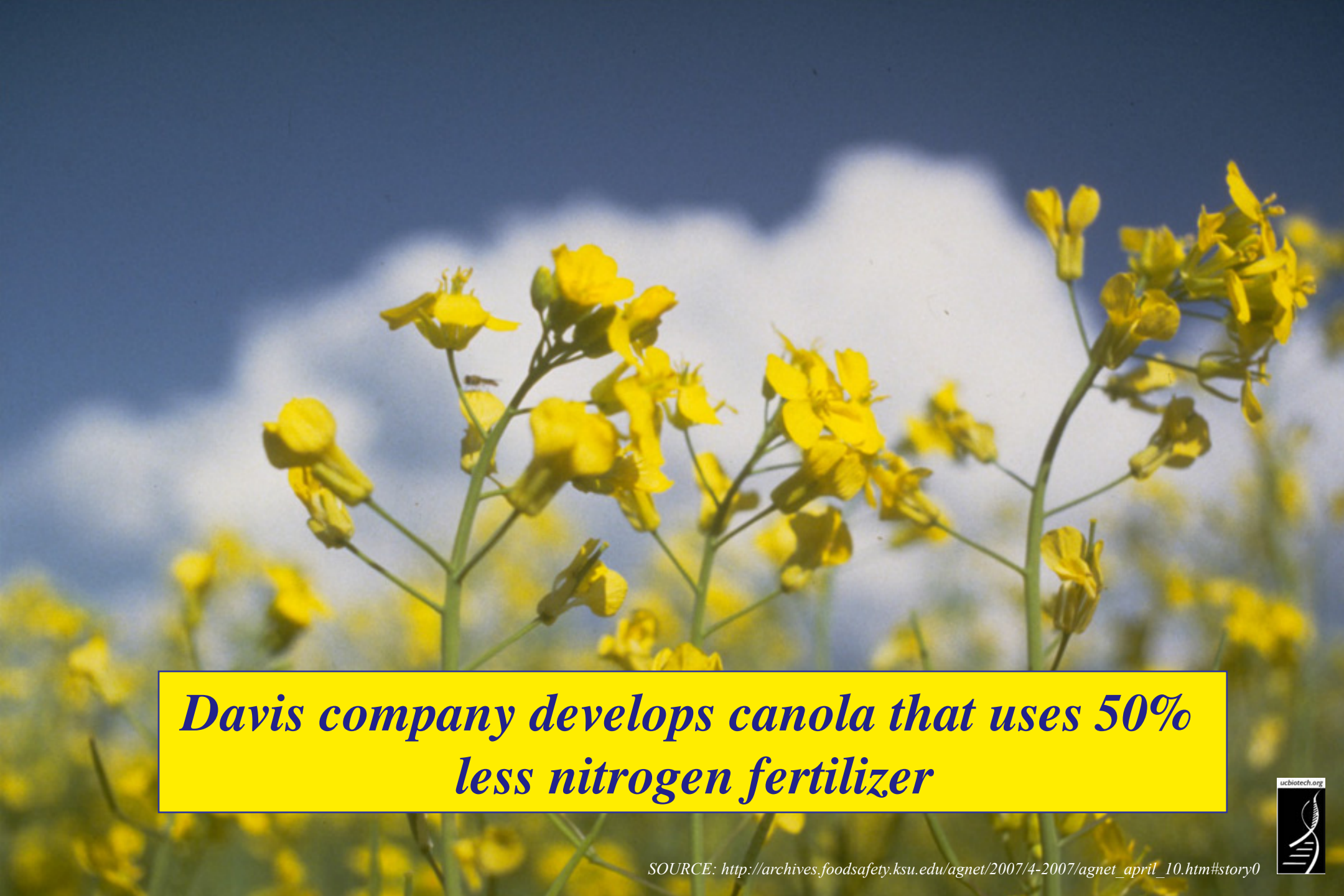
# *Field Trials in California with Grape Root Stocks Engineered to Resist Fanleaf Virus*

*SOURCE: http://www.democratandchronicle.com/apps/pbcs.dll/article?AID=/20080806/BUSINESS/808060336/1001*



# *Davis company develops canola that uses 50% less nitrogen fertilizer*

*SOURCE: http://archives.foodsafety.ksu.edu/agnet/2007/4-2007/agnet_april_10.htm#story0*

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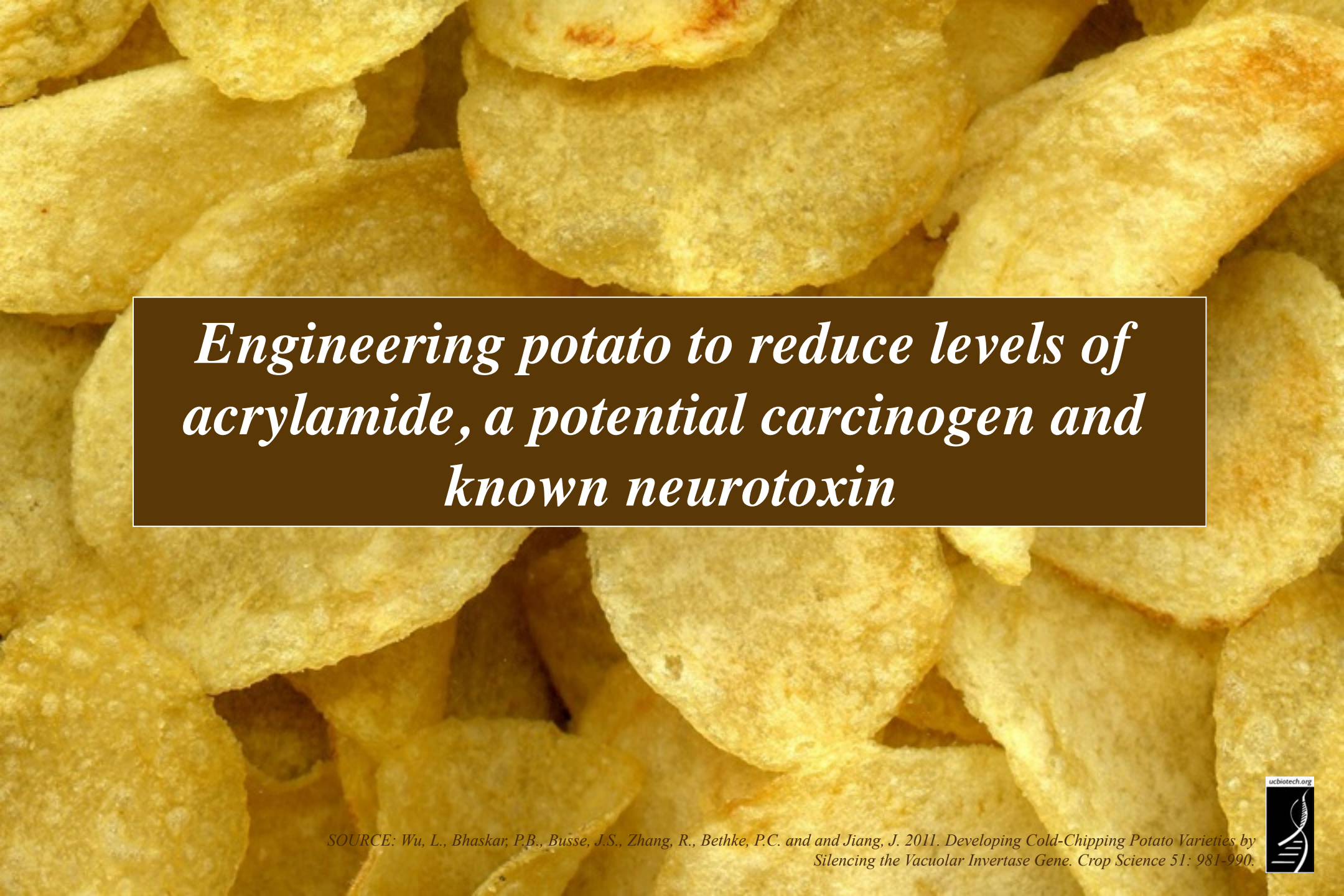


*SOURCE: Wu, L., Bhaskar, P.B., Busse, J.S., Zhang, R., Bethke, P.C. and and Jiang, J. 2011. Developing Cold-Chipping Potato Varieties by Silencing the Vacuolar Invertase Gene. Crop Science 51: 981-990.*

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***Non-browning GE apple, marketed in U.S. by Okanagan Specialty Fruits, will be labeled as genetically engineered***

*SOURCE:" Stop Genetically Engineered Apples!", Organic Consumers Association, 3/24/11. http://www.organicconsumers.org/bytes/ob269.htm#SEC3*

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# *Tear-free onion developed by turning off tear-inducing enzyme*

*SOURCE: "Scientists create 'no tears' onions", Herald and Weekly Times, 2/1/08*
*http://www.checkbiotech.org/green_News_Genetics.aspx?Name=genetics&infoId=16834*

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Mitigating food allergies, like peanut, soy and wheat
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# *Safflower Oil Enhanced with Omega-3 and Omega-6 Fatty Acids*

*SOURCE: Arcadia Biosciences*

# *What is the U.S. regulatory process governing engineered plants and foods?*

# 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?*


# How Do Consumers Feel about GE Food?

# Over last few months what food or ingredients did you avoid or eat less of?

| | Jan. 2001 | April 2003 | July 2006 | Apr. 2010 |
|---|---|---|---|---|
| → Sugars | 31% | 65% | 50% | 51% |
| → Fats/cholesterol | 41% | 39% | 33% | 32% |
| Animal products | 28% | 35% | 28% | 18% |
| Other | 9% | 9% | 11% | 14% |
| Snacks/Fast food | N/A | 9% | 16% | 16% |
| Salt/spices | 11% | 8% | 12% | 20% |
| Caffeine | 4% | 4% | N/A | N/A |
| Soda | 4% | 3% | N/A | N/A |
| → Genetically engineered | 0% | 0% | 0% | 0% |

*SOURCE: IFIC, April 2010.*
*http://www.foodinsight.org/Resources/Detail.aspx?topic=2010_Consumer_Perceptions_of_Food_Technology_Survey*

# What, if anything are you concerned about when it comes to food safety?

| | Jan. 2001 | Apr. 2003 | July 2006 | Apr. 2010 |
|---|---|---|---|---|
| Packaging | 27% | 15% | 15% | 5% |
| → Food Handling/Preparation | 23% | 41% | 35% | 33% |
| Other | 19% | 9% | 4% | 4% |
| → Disease/Contamination | 16% | 28% | 36% | 38% |
| Chemicals/Pesticides in Food | 10% | 7% | 16% | 10% |
| → Altered/Engineered Food | 2% | 1% | 3% | 2% |
| Nothing | 9% | 5% | -- | -- |

*SOURCE: IFIC, April 2010.*
*http://www.foodinsight.org/Resources/Detail.aspx?topic=2010_Consumer_Perceptions_of_Food_Technology_Survey*

# What Are Some Food Safety Issues?


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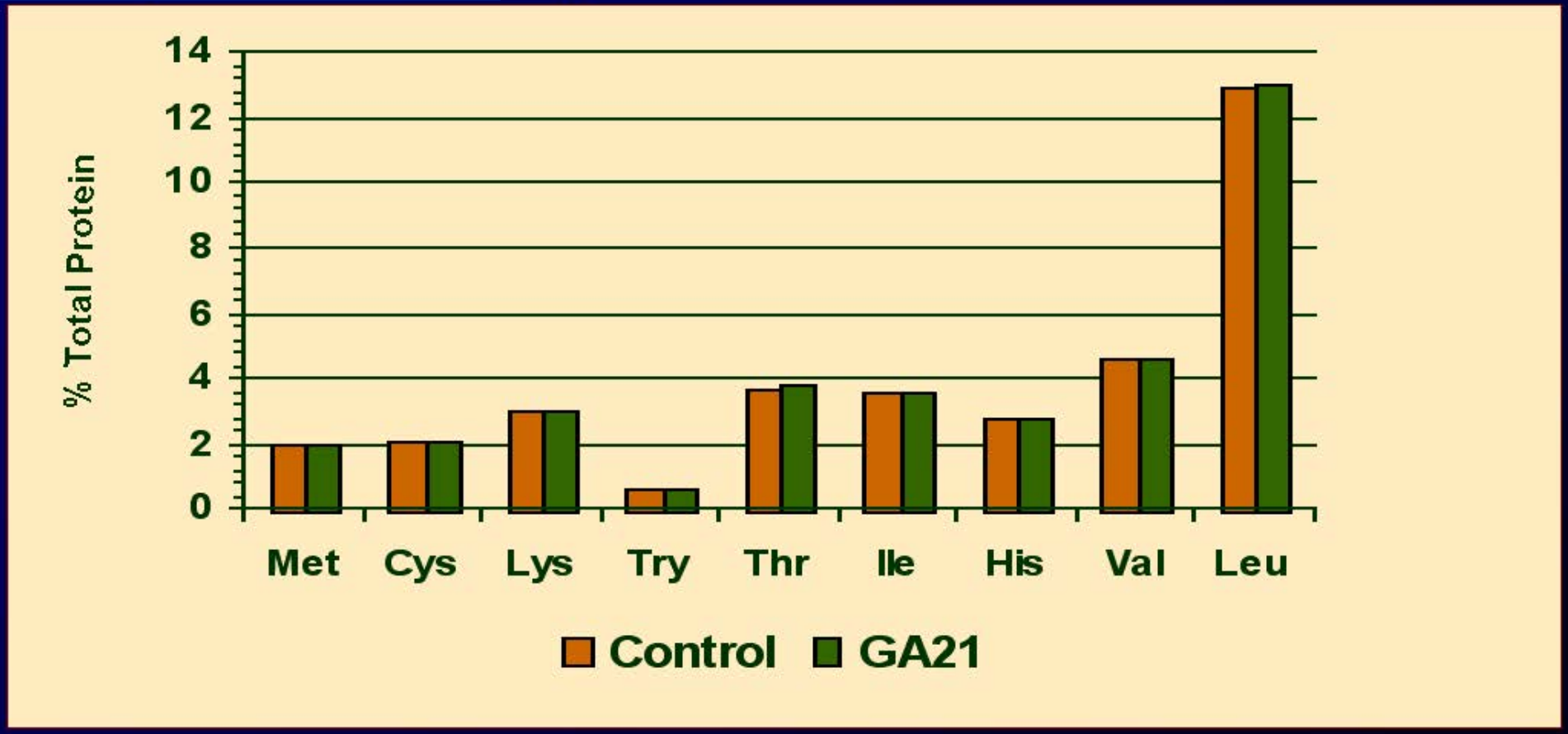
# *What are some of the food safety issues?*

- Changes in nutritional content
- No peer-reviewed food safety tests
- Creation of allergens or activation of toxins
- Labeling
- Pharma crops contaminating food supply
- Gene flow from food to intestinal bacteria increasing antibiotic resistance

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

- **Changes in nutritional content**
- No peer-reviewed food safety tests
- Creation of allergens or activation of toxins
- Labeling
- Pharma crops contaminating food supply
- Gene flow from food to intestinal bacteria increasing antibiotic resistance

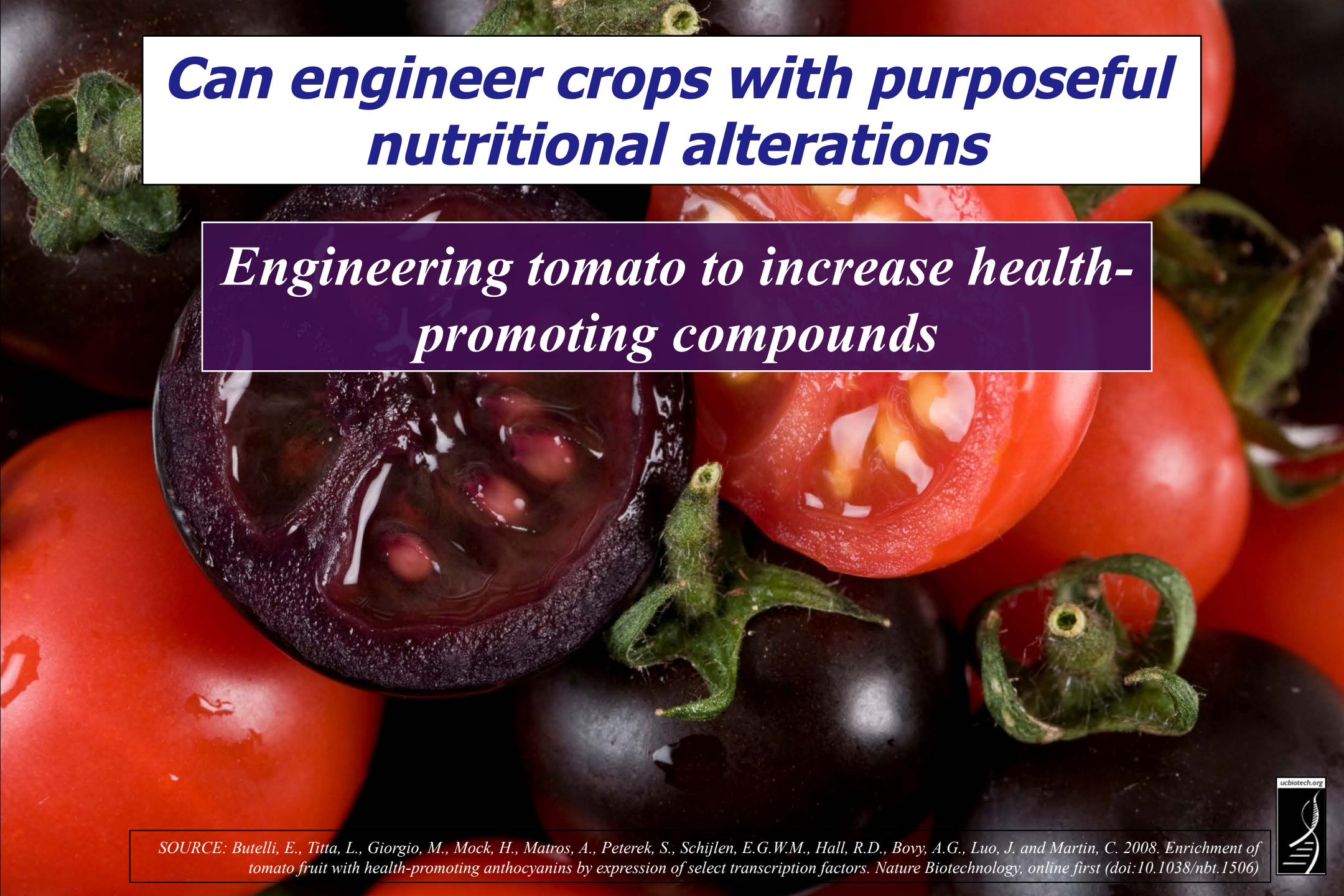
# Substantial Equivalence: Amino Acids




These results have been generated on event GA21. Data showing similar amino acid composition have been generated on the other corn events.

# Can engineer crops with purposeful nutritional alterations

## *Engineering tomato to increase health-promoting compounds*



*SOURCE: Butelli, E., Titta, L., Giorgio, M., Mock, H., Matros, A., Peterek, S., Schijlen, E.G.W.M., Hall, R.D., Bovy, A.G., Luo, J. and Martin, C. 2008. Enrichment of tomato fruit with health-promoting anthocyanins by expression of select transcription factors. Nature Biotechnology, online first (doi:10.1038/nbt.1506)*

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# Golden Rice engineered to contain bioavailable pro-Vitamin A


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

# *What are some food safety issues?*

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

# *Need to test products of individual genes introduced*

*"It is difficult, if not impossible, to test food safety of whole foods and feeds with animal tests. Toxicity testing of individual components is much more sensitive than whole foods testing."*

*"Nutritional and Safety Testing of Foods and Feeds Nutritionally Improved through Biotechnology" 2004. Comprehensive Reviews in Food Science and Food Safety, ILSI*

# Poultry and Egg Study: Bt Protein Analysis

***Example of type of animal safety tests conducted***

- 14 day poultry feeding study
- Diet: contained 64% grain (Bt or non Bt)
- Eggs collected on days 13 & 14
- Muscle and liver samples collected on day 14

| Tissue | Bt Protein Analysis |
|---|---|
| white muscle (10) | Not detected |
| dark muscle (10) | Not detected |
| liver (10) | Not detected |
| egg whites (10) | Not detected |
| egg yolk (10) | Not detected |

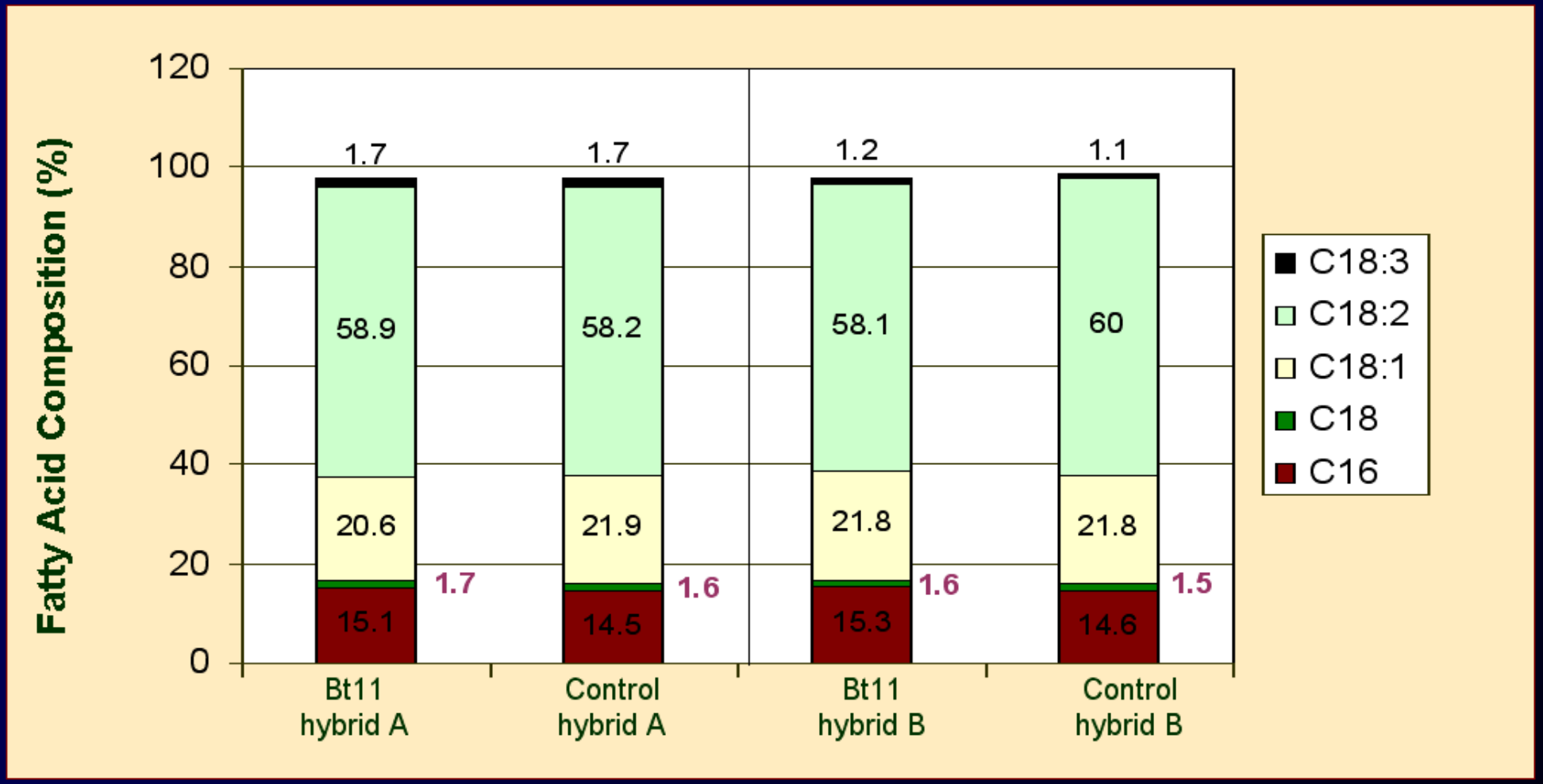
***What about the safety of the remaining edible portion of the food, aside from the product of the introduced gene?***
***Is it as safe as the conventional food?***

**This is the concept of**
substantial equivalence

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

SOURCE: Safety of Genetically Engineered Foods: Aproaches to Assessing Unintended Health Effects 2004. Natl Acad Press

# Substantial Equivalence: Fatty Acids




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

# REVIEW STUDY FROM FRANCE

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

***<u>Conclusion:</u> 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.*

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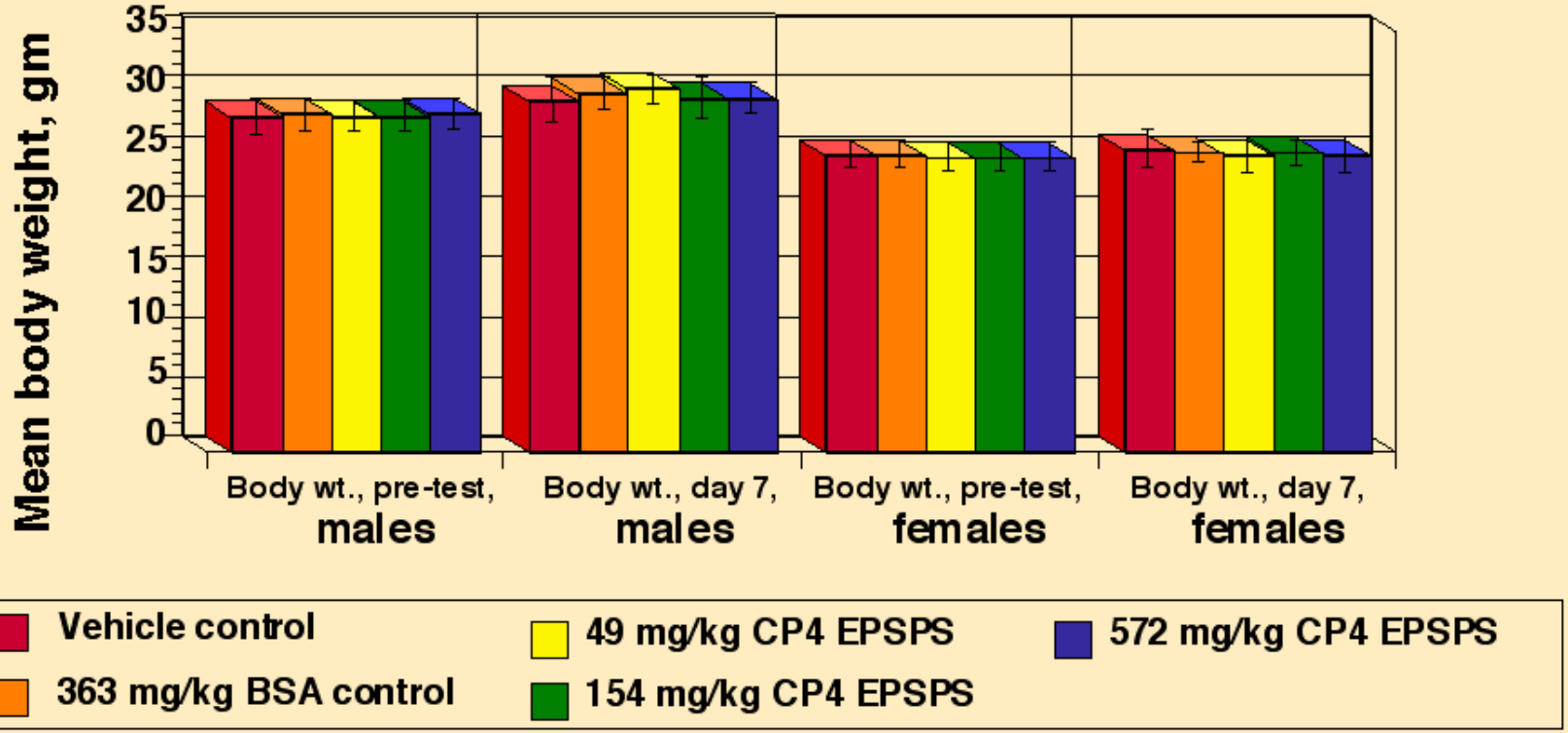
# *What are some food safety issues?*

- Changes in nutritional content
- Lack of peer-reviewed food safety tests
- Activation of toxins or creation of allergens
- Labeling
- Pharma crops contaminating food supply
- Gene flow from food to intestinal bacteria increasing antibiotic resistance

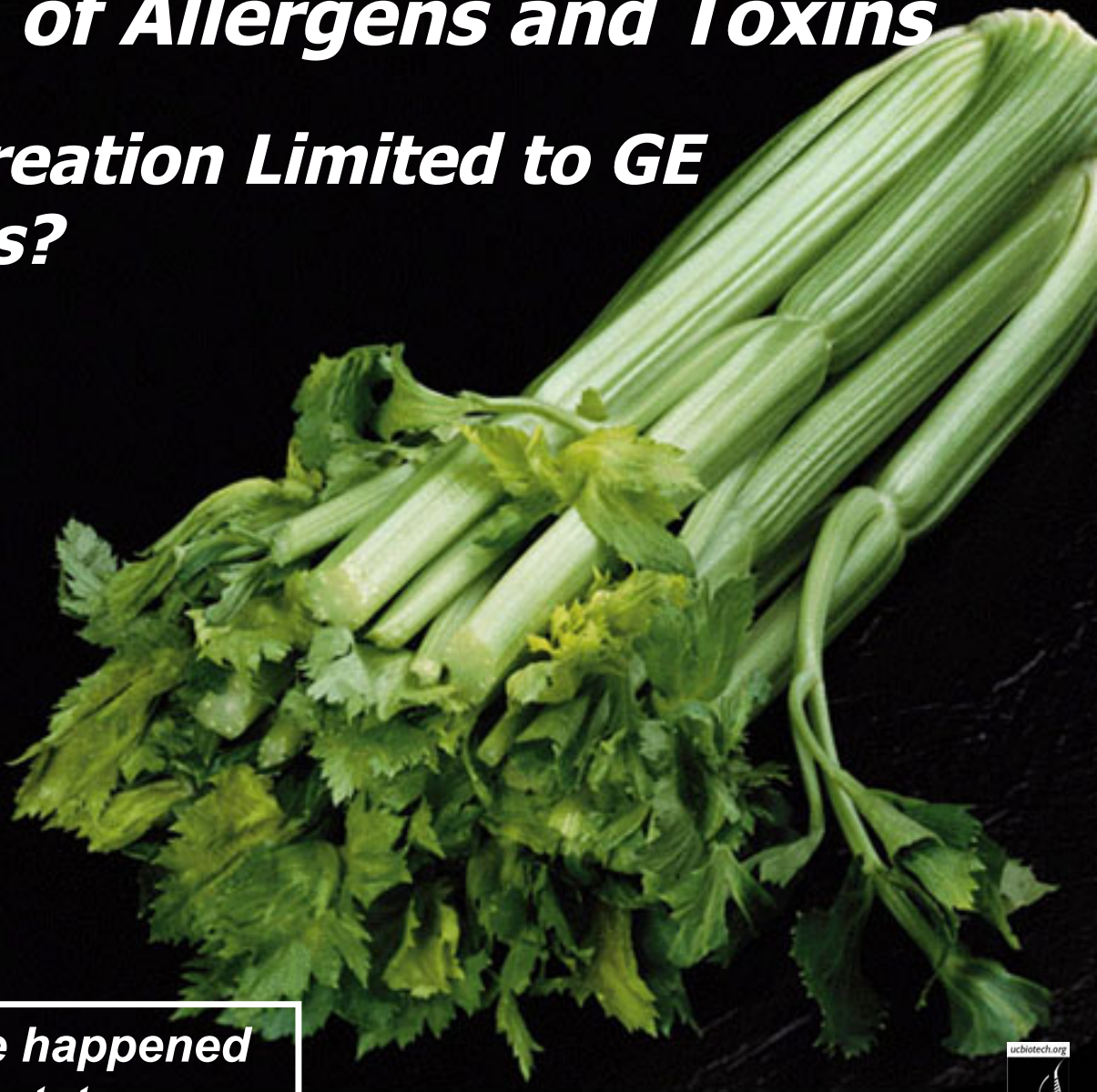
# Toxicity Assessment: Roundup Ready/CP4 EPSPS protein

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



# Inadvertent Creation of Allergens and Toxins

## Is Possibility of Toxin Creation Limited to GE Foods?



**No – naturally occurring toxins have happened with classical breeding, e.g., potato (glycoalkaloids) and celery (psoralens)**

# Use Engineering to Reduce Toxins: Fumonisin Reduction with Bt-maize


- **Fumonisin contamination caused by insect infestation led to outbreaks of lethal lung edema in pigs, brain tumors in horses**
- **20- to 30-fold fumonisin reduction with Bt-maize**

*Modified from Drew L. Kershen*
*University of Oklahoma*

*SOURCE; Hammond, B. et al., (Feb. 2004), Lower fumonisin mycotoxin levels in the grain of Bt-corn grown in the United States in 2000-2002, J. Agric. Food Chem. 52: 1390-1397*

# *What are some food safety issues?*

- Changes in nutritional content
- Lack of peer-reviewed food safety tests
- Creation of allergens or activation of toxins
- **Labeling**
- Pharma crops contaminating food supply
- 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 labeled if:***

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

# 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 |
|---|---|---|---|
| **Mandatory** | Australia, Brazil, China, European Union, 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 |
| **Voluntary** | Argentina, Canada, Chile, Hong Kong, Kenya, Philippines, South Africa, USA | | Peru |

*But other nations have specific mandatory labeling laws for GE, although they 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 Entreprise Institute, p. 71.*


*In November 2012 California voted on a Proposition to require mandatory labeling of foods with GE ingredients.*

*What did that Proposition look like?*

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# *CA Labeling Proposition*

## ***Labeling Relating to Genetic Engineering***

- *Any retail product that has been or may have been partially or wholly produced with genetic engineering must be labeled.*
- *Any raw retail agricultural commodity must contain on the front of its package in clear and conspicuous words, "Genetically Engineered".*
- *Any processed foods, unless exempted, must have conspicuous language on package stating, "Partially Produced with Genetic Engineering" or "May be Partially Produced with Genetic Engineering".*

## ***Labeling Relating to Using "Natural"***

*If food meets GE definitions above, or is processed, it may not be labeled for retail or in advertising that the food is "natural", "naturally made", "naturally grown", "all natural" or any similar wording.*

# *But There Were Quite a Few Exemptions to Labeling*

- *Non-GE animals whether fed GE feed or injected with GE drugs.*
- *Raw commodities grown without intentional use of GE seed.*
- *Foods certified as "organic".*
- *Alcoholic beverages.*
- *Processed food with no one ingredient >0.5% of weight of food.*
- *Processed food for immediate consumption in restaurants.*
- *Medical food.*
- *Processed food labeled solely because it has one or more GE processing aids or enzymes.*
- *Processed foods with one or more GE substances added during processing but removed or present in very low amounts.*

Capital Press
Agriculture Newspaper

# California voters nix biotech labels

*Opponents raised $46 million to fight proposition*

By ALICIA CHANG
Associated Press

LOS ANGELES — Voters spurned a ballot measure that would have made California the first in the nation to affix labels on breakfast cereals, baked goods and other processed foods containing genetically modified ingredients.

The rejection on Nov. 6 followed an expensive offensive from agri-business and chemical conglomerates, which raised $46 million to blitz airwaves and mailboxes with negative advertising.

We didn't think they'd like the lawsuits, more bureaucracy, higher costs and loopholes and exemptions. It looks like they don't," spokeswoman Kathy Fairbanks said.

Representatives with the California Right to Know campaign tried to put on a positive face.

"No matter what happens, we've raised awareness of a very important issue," said Grant Lundberg, chief executive of Lundberg Family Farms, who co-chairs the California Right to Know campaign.

Consumer activists and the organic food industry said shoppers crave information about what they're eating and should be given all the information they need to decide for them-


*After over $40M was spent convincing voters one way or the other, the proposition was defeated 51.4% to 48.6%*

gnining of this campaign that the more voters learned about Prop 37, the less they'd like it.

bioengineered foods are not significantly different in taste, texture and nutrition.

when the DNA has been tinkered with in the laboratory to resist pesticides and ward off

sodas.

Despite scientific consensus that genetically modified foods

force special labels. Mandatory labeling exists elsewhere, including the European Union.

cally engineered foods nationwide is pending before the U.S. Food and Drug Administration.

*SOURCE: "California voters rebuff labels on GMO foods", Capital Press, November 8, 2012*
*http://www.capitalpress.com/print/AP-CA-Prop-37-Food-labeling-110712*

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# Organic Bytes

Health, Justice and Sustainability News from the Organic Consumers Association

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

**End of Story?**

ESSAY OF THE WE

## GMO Food Fight: Round Two 2013

*"This gives us hope that you can, with a well-funded, well-organized, well-executed campaign, defeat a ballot initiative and go directly to the voters. We hope we don't have too many of them, because you can't keep doing that over and over again . . .".*

**- Jennifer Hatcher, Food Marketing Institute, on Big Food and Big Biotech's narrow defeat of Prop 37, the California Right to Know GMO ballot initiative.**

**Not in California, nor a number of other states, like Washington, Oregon, Vermont…**

, 2013
http://www.organicconsumers.org/bytes/ob361.htm


GM
FREE
Putting a label on a whole food is relatively easy, but…

*Processed foods are more difficult. For example, tomato sauce contains many varieties. Depending on type of label required, GE varieties would likely need to be tracked to assure correct content information.*



May contain genetically modified tomatoes


Contains genetically modified tomatoes


Contains tomatoes genetically modified with polygalacturonase gene from tomato, phosphinothricin acetyl transferase from *Streptomyces hygroscopicus*, crystal toxin from *Bacillus thuringiensis*, alpha amylase gene from barley, s-adenosyl methionine transferase gene from tobacco, N protein gene from tobacco, coat protein gene from tomato bushy stunt virus

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*If there is demand, might another solution be to allow the creation of a specialty market for labeled GE-free foods – for which people pay a premium price and for which farmers are paid premium prices to grow them?*

*But other consumers have the choice to buy GE foods.*

*Want to ask questions? Follow these easy steps in Biotech information section of* *http://ucbiotech.org*

ucbiotech.org – Issues and Responses

ucbiotech.org – Issues and Res...

ucbiotech.org/search4.php

Google

# ucbiotech.org

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

ABOUT US | IN THE NEWS | BIOTECHNOLOGY INFORMATION | RESOURCES | LINKS | GLOSSARY | SEARCH

*Go to Issues and Responses section on drop-down menu from Biotechnology Information section. Chose category to see the issues or type your question in "search by phrase". Hit search.*

## Search by Phrase

Enter a keyword such as "food".
You can also search by combination of words such as "water and food".

bt corn safe to eat?

SEARCH

## List all by Category

Alternatively, you may list all of the questions related to a category.
Select a category, and click "Display."

Agriculture

DISPLAY

ucbiotech.org – Issues and Responses

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ucbiotech.org/search4.php

Google

*Responses to the issue you raised will appear and you can click on the Response that best addresses your question.*

ISSUES & RESPONSES

Search Again?

## Your search for *bt corn safe to eat?* returned the following results

Results are given in order of relevance

**Are Food Safety Studies Conducted on GE Foods?** Response

**Besides Genetically Engineered Crops, Does Genetic Engineering Play a Role in Producing Food?** Response

**Were Foods Made From Bt Corn Removed from the Market Because of Allergenicity Concerns?** Response

**Is the Bt Protein Safe for Human Consumption?**

Bt proteins, naturally occurring insecticides produced by the soil bacterium, B. thuringiensis, have been used to control crop pests since the 1920s (1), generally as microbial products. Many strains ... Read more...

*Filed under [Food Risks] [Food Safety] [Pest Tolerance] [Regulation]*

**Can Federal Regulatory Agencies Stop Planting of Genetically Engineered Crops That Pose Environmental Risks?** Response

*Response to the issue you raised will appear with links to the scientific literature. If that doesn't answer your question, go back to the responses and choose another.*

## Is the Bt Protein Safe for Human Consumption?

***Response:***

Bt proteins, naturally occurring insecticides produced by the soil bacterium, *B. thuringiensis*, have been used to control crop pests since the 1920s (1), generally as microbial products. Many strains of *B. thuringiensis* exist that produce different Bt proteins varying in the insects they target, e.g., larvae of butterflies and moths, beetles, and mosquitoes. The insecticidal Bt proteins form crystalline protein bodies inside the bacterium, hence the name Cry proteins. Full-sized Cry proteins are inactive until eaten by target insect larva, and inside the midgut they are cleaved and become active. The smaller, active peptides bind to specialized receptors, creating holes in the gut membrane that cause contents to leak and kill the larvae. The precision of different Bt proteins for their targets resides in the specificity of their tight binding to companion receptors in the insect gut (2).

Bt microbial products have a long history of safe use (~40 years) with only two reports prior to 1995 of possible adverse human effects, neither of which was due to exposure to Cry proteins (3). In a 1991 study that focused on exposure via inhalation of Bt sprays, results showed immune responses and skin sensitization to Bt in 2 of 123 farm workers (4). In a 2006 article, the Organic Consumers Association linked this observation to possible impacts of Bt in GE foods, warning that "Bt crops threaten public health" (5). But the respiratory sensitization observed in the farm workers does not provide validation that oral exposure to Bt would result in allergic responses.

In recent years a variety of safety studies were conducted specifically on native Bt proteins to show that they do not have characteristics of food allergens or toxins (See 6, 2, and 7 for reviews). In its review of Bt proteins, the EPA stated that, "several types of data are required for Bt plant pesticides to provide a reasonable certainty that no harm will result from the aggregate exposure of these proteins." The data must show that Bt proteins "behave as would be expected of a dietary protein, are not structurally related to any known food allergen or protein toxin, and do not display any oral toxicity when administered at high doses" (6).

The EPA does not require long-term studies because the protein's instability in digestive fluids makes such studies meaningless in terms of consumer health (8). In vitro digestion assays were used to confirm degradation characteristics of Bt proteins, whereas murine feeding studies were used to assess acute oral

consume large amounts of food to obtain sufficient quantities of the GE ingredient. Compositional analyses and toxicity testing of individual components are actually more sensitive and accurate in assessing safety (15). Therefore, in addition to whole foods, safety tests are conducted on individual products of introduced genes, both target and selectable marker genes, on the basis of the food additive provision (Section 409) of the 1992

*Literature cited will appear with links when possible to the articles so that you can see them yourselves.*

**References:**

1. Food Drug Adm. (FDA). 2005. Guidance for industry: Pharmacogenomic data submissions. http://www.fda.gov/downloads/.../Guidances/ucm126957.pdf Last accessed 2011-11-26. PDF

2. Food Drug Adm. Cent. Food Saf. Appl. Nutr. 2007. Biotechnology. http://usbiotechreg.nbii.gov/database_pub.html. Last accessed 2011-11-26. PDF

3. Environ. Prot. Agency Off. Sci. Coord. Policy Biotechnol. Team. 2006. *Regulatory framework.* http://www.epa.gov/scipoly/biotech/pubs/framework.htm. Last accessed 2011-12-8. PDF

4. Kuiper HA, Kleter GA, Noteborn HPJM, Kok EJ. 2001. Assessment of the food safety issues related to genetically modified foods. *Plant J.* 27:503-28

5. Kessler DA, Taylor MR, Maryanski JH, Flamm EL, Kahl LS. 1992. The safety of foods developed by biotechnology. *Science* 256:1747-49

6. Berberich SA, Ream JE, Jackson TL,Wood R, Stipanovic R, et al. 1996. The composition of insect-protected cottonseed is equivalent to that of conventional cottonseed. *J. Agric. Food Chem.* 44:365-71

7. Sidhu RS, Hammond BG, Fuchs RL, Mutz J-N, Holden LR, et al. 2000. Glyphosatetolerant corn: The composition and feeding value of grain from glyphosate-tolerant corn is equivalent to that of conventional corn (*Zea mays* L.). *J. Agric. Food Chem.* 48:2305-12

8. Taylor NB, Fuchs RL, MacDonald J, Shariff AR, Padgette SR. 1999. Compositional analysis of glyphosate-tolerant soybeans treated with glyphosate. *J. Agric. Food Chem.* 47:4469-73

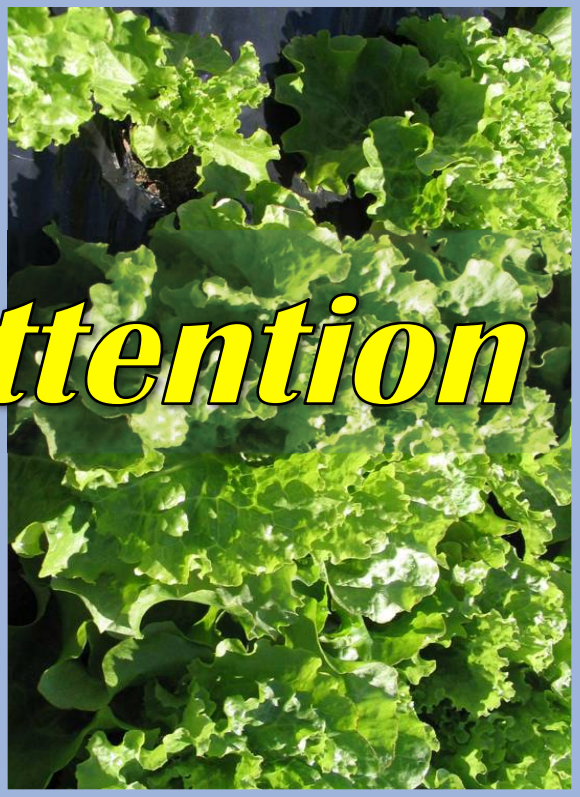
9. Kahle K, Kraus M, Richling E. 2005. Polyphenol profiles of apple juices. *Mol. Nutr. Food Res.* 49:797-806

**10. Chassy B, Hlywka JJ, Kleter GA, Kok EJ, Kuiper HA, et al. 2004. Nutritional and safety assessments of foods and feeds nutritionally improved through biotechnology: An executive summary. *Compr. Rev. Food Sci. Food Saf.* 3:25–104**
***Provides scientific information and recommendations on safety and nutritional aspects of crops with improved nutritional qualities.***

11. Flachowsky G, Aulrich K, Böhme H, Halle I. 2007. Studies on feeds from genetically modified plants (GMP)—Contributions to nutritional and safety assessment; Table 3. *Anim. Feed Sci. Technol.* 133:2-30

12. Konig A, Cockburn A, Crevel RWR, Debruyne E, Grafstroem R, et al. 2004.



# Thank you for your attention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