BIOTECHNOLOGY 101
(some of what you need to know in a few minutes)

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2004 National Alfalfa Symposium
Tour D’Onion: Where is all that genetic information?
Dividing cell

Chromosomes
Information in the alfalfa genome

...CTGACCTAATGCCGTA...

170 books
1000 pages each

170 books
(or 170,000 pages)
Hybridization or cross breeding

170 books (or 170,000 pages)

170 books (or 170,000 pages)

170 books (or 170,000 pages)
Table of contents for genes in alfalfa

...CTGACCTAATGCGCGTA...

170 books
1000 pages each

170 books
(or 170,000 pages)
Genetic engineering methods

One-half page (equivalent to a gene)

170 books (or 170,000 pages)

Inserted gene(s)

170 books (or 170,000 pages)
TERMS USED

GMO
Genetically Modified Organism

GEO
Genetically Engineered Organism

LMO
Living Modified Organism

rDNA
Recombinant DNA

Biotechnology
<table>
<thead>
<tr>
<th>Classical Breeding</th>
<th>compared to</th>
<th>Genetic Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses plant machinery in plant</td>
<td>Uses plant machinery in laboratory</td>
<td></td>
</tr>
<tr>
<td>Gene exchange is random involving entire genome</td>
<td>Gene exchange is specific, single or a few genes</td>
<td></td>
</tr>
<tr>
<td>Only between closely related or within species</td>
<td>Source of gene from any organism</td>
<td></td>
</tr>
<tr>
<td>When/where genes expressed not controlled by breeder</td>
<td>When/where gene expressed can be controlled precisely</td>
<td></td>
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</table>
What Is in a Recombinant DNA Construct?

- **Gene of interest:** herbicide, stress or disease tolerance
- **Marker gene:** antibiotic or herbicide resistance
Genetic Engineering

• Create rDNA with gene from same or different organism
• Transfer DNA to plant cell; allow plant cells to divide under selection
• Cue cells to reform plant - every cell will have new DNA
• Confirm introduced DNA and expression of foreign protein in plants

Source of gene

rDNA

Introduce DNA

Selection

Cells dividing

Hormones

Check for introduced trait

Put in soil

Remove hormones

2004 National Alfalfa Symposium

Peggy Lemaux
GE Corn
Acreage, 2004
45% of total crop

GE Soybean
Acreage, 2004
85% of total crop

GE Canola
Acreage, 2002
54% of total crop

GE Cotton
Acreage, 2004
76% of total crop
Estimated 75% of Processed Foods Have GE Ingredients
WHAT’S IN THE PIPELINE?
• Strawberries resistant to molds
• Tomatoes protected against root nematode attack
• Grapes resistant to Pierce's disease, powdery mildew
• Peppers resistant to bacterial diseases
• Plant foods with omega-3 and omega-6 oils
• Potatoes no longer susceptible to blight
• Sugar pine resistant to white pine blister rust
• Foods with increased folate levels
• Frost-tolerant pears
• Pollen with reduced allergy symptoms
• Blue, longer lived roses
Some food safety concerns with genetically engineered foods

- Changes in nutritional content
- Creation of allergen
- Activation of toxin gene
- Horizontal gene flow from food to intestinal flora
- Increase in antibiotic resistance
- Labeling
Regulatory Systems in the U.S. (existing regulations)

<table>
<thead>
<tr>
<th>USDA</th>
<th>FDA</th>
<th>EPA</th>
</tr>
</thead>
</table>
| Field testing  
  -Permits  
  -Notifications | Food safety  
  -Feed safety | Pesticidal plants  
  -tolerance exemption  
  -registrations |
| Determination of non-regulated status | | Herbicide registration |
Composition Equivalence: Mineral and Vitamin

These results have been generated on event Bt11. Data showing similar mineral and vitamin composition have been generated on the other corn events.
Toxicity Assessment: Roundup Ready/CP4 EPSPS protein

No deleterious effects at highest dose (572mg/kg)
Kraft Food recalls all taco shells sold nationwide under Taco Bell Brand

Kiwi Allergies
Some environmental concerns about genetically engineered crops

- Transgene movement via pollen flow
- Transfer of transgenes to non-GMO / organic crops
- Generation of "superweeds" (transfer of herbicide-tolerance to wild/weedy species)
- Spread of pharmaceutical genes to edible crops
- Loss of genetic diversity
- Property rights (gene patents)
Movement of genes between crop species and wild relatives

Charlock

Canola

Buchan weed

Wild radish

Brassica tournefortii
Example - Gene flow from rice to weedy red rice
Genetic Modification Taints Corn in Mexico

Consequences of gene flow from GE crops to organic crops in the field

GM canola

non-GM canola
Will an organic farmer automatically lose accreditation if his/her crop is found contaminated with a GE crop?

No.

“As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods, as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not affect the status of an organic product or operation.”
Where to get more information?

ucbiotech.org

This website, a part of the University of California Division of Agricultural and Natural Resources Statewide Biotechnology Workgroup, provides science-based information to the public on issues relating to the application of biotechnology to crops. For the scientific community, educational tools and an extensive database of pertinent scientific literature are available to promote participation in the dialogue. Teaching aids for students and teachers are provided.