Biotechnology

- Genetically Modified Food
  - Plants
    - Cry1A gene in plants
    - Golden rice
  - Animals
    - Growth Hormone
- Medicine and Biotechnology
    - Bacterially expressed proteins
    - Pharm Animals
    - Gene Therapy
    - Genome Project
- Forensic Technology
    - Core Technique – PCR
    - Short Tandem Repeats
    - Application – one locus
    - DNA Profiling

Transgenic Organisms

- **Transgene** – a gene from one organism introduced into a chromosome of a second organism.
- **Transgenic organism** – an organism that has a transgene in its genome.
- **GMO** – Genetically Modified Organism

Agricultural Applications (Food)

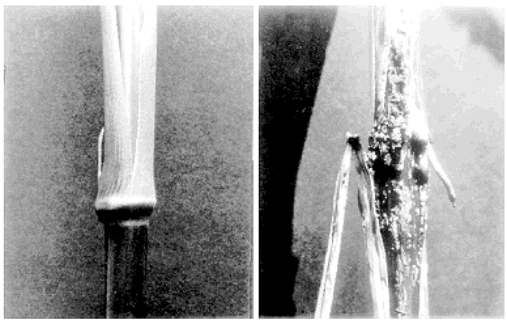
- Plants
  - Cry1A gene
  - Golden Rice
- Animals
  - Growth hormone

Background on the BT toxin and cry1A gene.

- *Bacillus thuringiensis* is a natural bacteria that kills the larval (grub, catapillar or worm stage) form of many insects.
- It is harmless to humans and other animals and is used by many organic farmers to prevent insect damage to crops.
- *Bacillus thuringiensis* kills insects by producing a protein called the Bt toxin.
- The Bt toxin is a protein that kills the larval stage of insects. It doesn't hurt other animals, it is biodegradable and is considered a "natural pesticide"
- In *Bacillus thuringiensis* the Bt Toxin protein is encoded by the cry1A gene.

Pest Resistant Plants

- Cry1A gene from *Bacillus thuringiensis* encodes the BT toxin (A peptide that interferes with the digestive track of the larval stage of insects.)
  - Cry1A introduced into corn and cotton genome.
  - Plants produce internal pesticide protects against larval pest

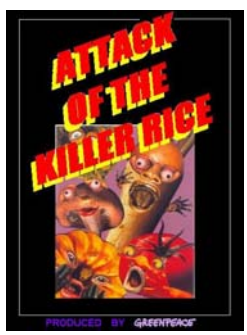


The corn plant on the left is resistant to European corn borers, thanks to Bt technology. The corn on the right is not.

The large boll of cotton on the left was produced by a plant designed with a Bt gene to fend off insects. The smaller boll on the right was grown in the same field on an unprotected plant.

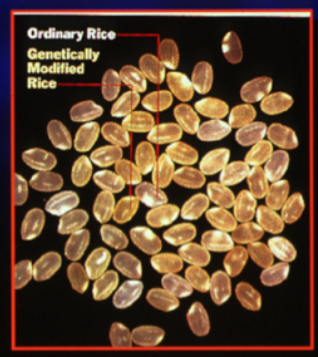
Cost/Benefit Analysis

- Benefits of Bt Crops
  - Reduce cost of production
    - Fewer pesticides sprayed
    - Higher yield
    - Reduced cost to consumers
  - Environmental Benefits
    - Bt is biodegradable pesticide – very specific to larval insects
    - Less sprayed pesticides
- Risk of Bt Crops
  - Concern over new technology – Frankenfood
  - Effect on human health – introduction of new allergens into foods
  - Spread to other plants – Superweeds
  - Impact on Eco system – Monarch Butterfly
  - Natural resistance to Bt toxin will develop with overuse
  - Globalization
    - Seeds produced by few agribusinesses
    - Seeds cost more
    - Farmers cannot save seeds to following year
    - Impact on developing nations
  - Monoculture (1997 Cotton Example)



Golden Rice!

- Milled rice does not contain beta-carotene
- Vitamin A deficiency afflicts over 200 million children and woman
- About 500,000 children go blind (60 every hour!)
- 2 million children under 5 years die each year



Ingo Potrykus (Switzerland) and Peter Beyer (Germany)

GOODIN PHOTO

Improved Nutrition - Golden Rice

Daffodils genes

Genes for Vitamin A Production

Rice Plants

Normal vs Golden Rice

Project of Rockefeller Foundation Project

Benefits

Vitamin A deficiency leads to blindness and death in millions of children.

Risk

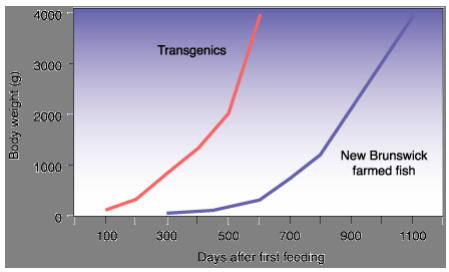
See Bt toxin

Risk of monoculture high

Not the best approach to nutrition problem

Transgenic Meat

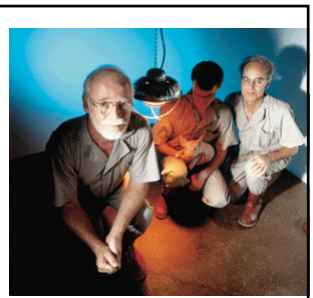
- Growth Hormone Gene



Benefits – faster growing trout
– reduce cost of aquaculture

Risk – Excess growth hormone in food
- Risk of escape trout breeding with wild populations

Enviropigs



- Contain the fungal gene phytase which helps the pigs extract phosphorous from feed. This reduces phosphate in manure by more than 50%.

Benefit – reduce pollution associated with pig farming
- improve the quality of water
- little risk of allergen, because phytase expressed in pig saliva

Risk ?
- Frankenfood?