GMO’s: Genetically Modified Organisms

Genetically Modified Organisms

• GMO’s, GM
• GE (Genetically Engineered)
• Transgenic
• “Frankenfoods”

DNA from 1 organism transplanted into another

Overview of an Organism

• Organism
• Organs systems
• Tissues
• Cells
• Organelles
• Molecules
• Atoms
DNA $\rightarrow$ RNA $\rightarrow$ Proteins

Proteins: molecules that provide physical structure, hormones, enzymes, etc.

DNA: molecule made of “bases” and “backbone”

Genes: specific physical sequences of DNA that code for specific proteins

Brown eyes sequence: AAAAGCGCCCGG
Blue eyes sequence: AATGCGCCCGG
**Chromosome:** one long, double-stranded DNA molecule, containing many genes

http://www.mun.ca/biology/scarr/Human_Karyotype.html

“Genetically Modified”
DNA from 1 organism transplanted into another

Conventionally done via
- Hybridization
- Selective breeding

http://en.wikipedia.org/wiki/Selective_breeding

Hybridization

http://en.wikipedia.org/wiki/Selective_breeding
Selective Breeding

Genetically Modified Organisms (GMOs)

Genetic Engineering: transplants DNA (gene) from one organism to another

How to create transgenic organisms:

- Gene gun
- DNA Microinjection

http://www.reuters.com/article/2009/05/27/us‐monkeys‐green‐idUSTRE54Q4A520090527
http://www.nepadbiosafety.net/subjects/biotechnology/plant‐transformation‐bombardment
http://www.research.uci.edu/tmf/dnaMicro.htm
http://www.nature.com/article/doi/10.1038/nature005927
Why Create GMOs?

• Better taste
• Better appearance
• Faster growth
• Longer shelf-life
• Improved nutrition
• Pest-resistant
• Herbicide resistant

Advantages of GMOs:

• Increased crop yield/efficiency of food production
• Drought/frost resistant crops
• Disease resistant crops
• Improved nutritional content
• Decreased allergenicity

• Food without toxins or allergens
• Plants that contain vaccines
• Animals that produce pharmaceutical drugs
• Animals that grow faster, eat less
• Animals that could donate organs?

"Pharme" animals
Wild-type plant  Salt-tolerant plant

AquAdvantage salmon vs. Wildtype

Potential Disadvantages of GMOs

- Human health risks (allergies)
- Ecological/environmental risks (contamination)
- Economic/social justice concerns (patents, intellectual property)
Concerns Regarding GMOs

- GMOs could "escape"
- Might interbreed with wild relatives
- Might accelerate pesticide resistance
- Unequal access to technology

Specific Examples of GMOs

- Bt corn
- Round-up ready crops
- Flavr Savr tomatoes

Bt Corn

- Bt genes – inserted into corn genome (gene gun technology)
- Corn plant that can produce Bt in every cell
- Advantages over topically applied powder:
  - Bt toxin not destroyed by UV, heat, desiccation
  - wider coverage of insect feeding sites
  - no guessing as when to apply
U.S. Government Regulation of GMOs

1. EPA – evaluates for environmental safety
2. USDA – evaluates whether the plant is safe to grow
3. FDA – evaluates whether the plant is safe to eat

Examples:
- Bt corn or RoundUp Ready soybeans – checked by EPA
- Bt corn (ear) – checked by USDA
- Bt corn (in cornflakes) – checked by FDA

Roundup
Herbicide, Created by Monsanto in 1970

Pros and Cons...
Pros:
- Increase crop yields
- Affects enzyme only in plants

Cons:
- Superweeds/resistance
- Human health effects
- Environmental impacts
- (soil/water contamination)
RoundUp-Ready Crops:

- Crops genetically modified to be resistant to Roundup
- Currently Include: soy, corn, canola, alfalfa, cotton, sorghum (wheat is under development)
- "terminator seeds" – crops produced from Roundup Ready seeds are sterile.

Current Use of GMOs

- GMOs are used internationally
- U.S. majority of soybeans, cotton, corn are GMOs
- 60% of all processed food estimated to contain GMOs
- No “GMO” label is required in the U.S.

U.S. Labeling Laws

The U.S. Food and Drug Administration currently requires labeling of GM foods if:

- the food has a significantly different nutritional property
- a new food includes an unexpected allergen (e.g., a peanut protein in a soybean product)
- if a food contains a toxicant beyond acceptable limits.
Pro-labeling Arguments

• Consumers have a right to know what’s in their food

• Would allow consumers to identify and avoid food products that cause them problems.

• Some people want to avoid eating animal products, including animal DNA.

Anti-labeling Arguments

• No significant differences between GMO and conventional foods have been detected.

• Would impose a cost on all consumers.

• Certified organic foods by definition cannot be produced with GM ingredients.

• Current food system could not accommodate segregation of GM and non-GM products.

• No GE products currently on the market or under review contain animal genes

FDA Voluntary Guidelines for Labeling

• If GMO food is significantly different, the name must be changed to describe the difference.

• If a bioengineered food has a significantly different nutritional property, its label must reflect the difference.

• If a new food includes an allergen, the presence of that allergen must be disclosed on the label.
Issues with Mandatory Labeling

• What specific technologies for crop variety development would require a label?
• What percentage of a GE ingredient must be present in a food before a label is required?
• Would meat, eggs and dairy products from livestock that are fed transgenic crops require labeling?
• How should regulators verify claims that a food is or is not genetically engineered?
• What is the economic impact of labeling?

California Proposition 37
Genetically Engineered Foods Labeling Initiative Statute

• Raw or processed food made from plants or animals with genetic material changed in specified ways.

• Prohibits labeling or advertising such food, or other processed food, as “natural.”

Prop 37 Exempts foods that are:

– unintentionally produced with GM material
– made from animals fed or injected with GM material but not GM themselves
– processed with or containing only small amounts of GM ingredients
– administered for treatment of medical conditions
– sold for immediate consumption such as in a restaurant
– alcoholic beverages