Design of a Genetically Modified Food Database

Objectives:

Genetically modified crops have come to play an increasingly large role in our daily lives. Unfortunately these crops remain a mystery to much of the general population. For some, ideas about GM crops are exciting and represent hope for new potential in science and agriculture, for others they represent potential danger, and for others there are simply many unanswered questions.

Our goal this semester will be to create a new source of information about GM products and to provide information that will answer the many questions we all have about this important subject. To do this, our objectives will be to:

1. Collect background information in an unbiased and comprehensive manner about laws and regulations regarding genetically modified crops.
2. Gather information about public opinion concerning GM crops.
3. Present facts about the processes and technologies that are used in this industry.
4. Create a database of known genetically modified crops, potential allergens, and traits in order to provide future IPRO's with a foundation of knowledge concerning GM crops.

Background:

Genetically modified crops are produced from organisms that have had their DNA altered through genetic engineering. These plants have been modified in the laboratory to enhance desired traits such as increased resistance to herbicides or improved nutritional content. They have been available since the 1990s and the most common GM organisms are soybean, corn, canola, cotton seed oil and wheat. [1]

These genetically modified crops are made by taking DNA from one organism, modifying it in the laboratory and then inserting it into the target organism's genome. In this case the target would be the crop of interest. This new DNA would help produce new and useful traits or phenotypes. These types of genetically modified crops are known as transgenics. Other methods that exist include increasing or decreasing the number of copies of a gene already present in the crop, silencing or removing a particular gene or modifying the position of a gene in the genome of the crop. This type of genetic engineering is different from plant breeding because the process is faster and more accurate.

According to the FDA and the United States Department of Agriculture (USDA), there are over 40 plant varieties that have completed all of the federal requirements for commercialization. Examples of these types of crops include tomatoes and cantaloupes that have modified ripening characteristics, soybeans that are resistant to herbicides, and corn and cotton plants with increased resistance to insect pests. Not all of these genetically modified crops are available in supermarkets but the prevalence of them is higher than is commonly thought. Even though there are very few genetically modified whole fruits and vegetables available, there are many highly processed foods that contain some small percentage of genetically modified ingredients. This is due to the fact that the raw ingredients have been brought together into one processing stream from many different sources. The widespread usage of soybean derivatives as food additives in

[1] (ISAAA, 2002)

American diet shows that U.S. consumers have been already exposed to genetically modified foods.[2]

In 2006, 97% of the global transgenic crops were manufactured in the United States (53%), Argentina (17%), Brazil (11%), Canada (6%), India (4%), China (3%), Paraguay (2%) and South Africa (1%). It is believed that the numbers will plateau in industrialized countries but developing countries continue to grow GM crops in an exponential manner. Other countries that grow GM crops include: Australia, Bulgaria, France, Germany, Mexico, Romania, Spain, and Uruguay. [3]
Between 1995 and 2005, the total surface area of land cultivated with GMOs had increased by a factor of 50, from 17,000 km² (4.2 million acres) to 900,000 km² (222 million acres). The United States used 55% of this total acreage to cultivate GMO's.

Benefits of GM crops

1. **Pest resistance**: Growing GM foods, such as corn, that are resistant to pests has helped to eliminate the application of chemical pesticide by farmers, reduced the risk of crop failure due to pests, and reduced the cost of bringing a crop to the market.

2. **Herbicide tolerance**: Crop plants that are genetically-engineered to be resistant to herbicides could help prevent environmental damage by reducing the amount of herbicides needed.

3. **Disease resistance**: There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically-engineered resistance to these diseases.

4. **Cold tolerance**: An example of a cold tolerance modification may include taking an antifreeze gene from cold water fish and introducing it into plants such as tobacco and potato. With this antifreeze gene, these plants could be able to tolerate cold temperatures that normally could kill unmodified seedlings. (Note: Scientists have not been able to take advantage of this to modify food yet.)

5. **Drought tolerance/salinity tolerance**: This includes modifying food in a way that would allow it to endure long periods of drought or high salt content in soil or groundwater. This would eventually help farmers grow crops in formerly inhospitable lands.

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[2] (Whitman, 2000)
[3] (Human Genome Project, 2007)

6. **Nutrition**: This feature suggests genetically modifying crops could contain adequate amounts of necessary nutrients that will prevent malnutrition. For example, there is hope that genetically modified rice may alleviate vitamin A deficiency; this deficiency contributes to the death of millions as well as permanent blindness of 500,000 annually.

7. **Pharmaceutical**: Researchers are working to develop edible vaccines in tomatoes and potatoes which will be much easier and cost effective to ship, store, and administer than traditional injectable vaccines.

8. **Phytoremediation:** Phytoremediation is the treatment of environmental problems through the use of plants. Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contaminated soil.

Risks of genetically modified crops:

1. **Unpredictable side-effects**: There are still unclear issues in terms of the way the genetic code works. Adding new genes to alter traits in a crop can yield the intended effect; however, it is entirely possible that other traits are affected by this, which can result in unsafe crops. It is hard to know what these side-effects might be, or how to test for them, which leaves genetically-modified crops in a position where they might cause harm that won't be noticed / studied until after it's occurred in humans.

2. **Reduction of biodiversity:** The addition of genetically-modified crops might reduce the diversity of ecological systems. Due to the relationship between crops and their environment, this can result in a less useful environment, as the ecological benefits of a variety of crops are diminished. Ecosystems can undergo disruption by the addition of extra-strength crops.[4]

3. **Resistance:** The increased resistance to pesticides and viruses in crops can have serious side effects. Species that rely on some of these crops can be harmed by it, even if the resistance mechanism wasn't intended to target them. Furthermore, the increased resistance to some types of viruses can create a perfect environment for the development of new, stronger viruses from different strains.

4. **Lack of control:** There are different ways in which the GM traits can resist containment. For instance, the new DNA can spread to other species via hybridization. The new DNA

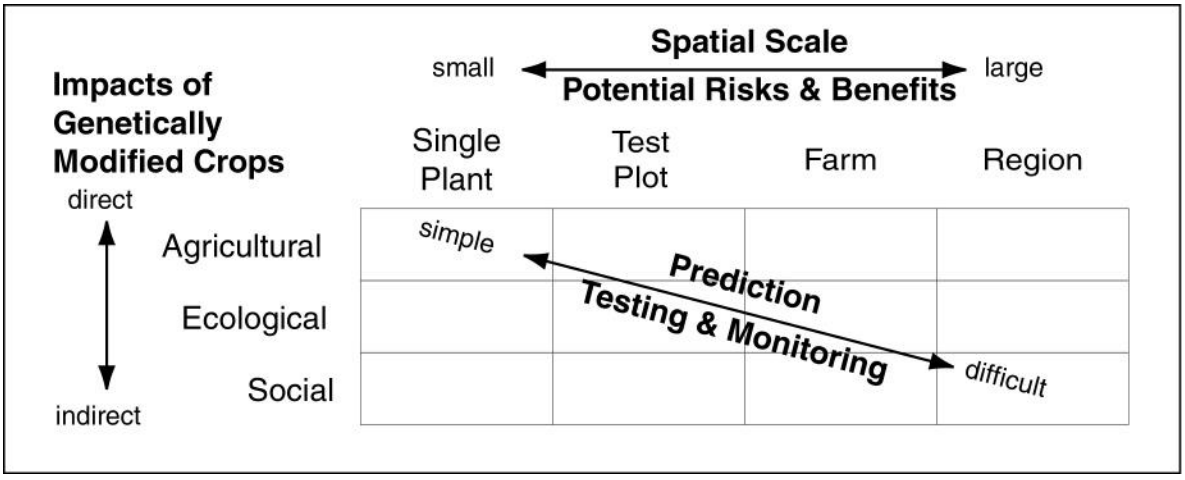
[4] Peterson, G., S. Cunningham, L. Deutsch, J. Erickson, A. Quinlan, E. Raez-Luna, R. Tinch, M. Troell, P. Woodbury, and S. Zens. 2000. The risks and benefits of genetically modified crops: a multidisciplinary perspective. Conservation Ecology **4**(1): 13. [online] URL: http://www.consecol.org/vol4/iss1/art13/

can spread through pollen. Therefore, it is hard to keep control on the intended effects of a GM trait.[5]

5. **Lack of hard scientific data:** due to the nature of GM crops, and all the different traits that need to be studied, it is very hard to do a thorough testing. Current testing mostly compares the composition of a GM crop with a natural crop. This is faulty because it ignores important variation. Furthermore, there haven't been many studies on toxicity, especially on human subjects. Long term effects of GM crops don't exist in large amounts. It is hard to know how they will affect the environment as time goes by.[6]

6. **Allergy testing:** It is difficult to know whether a GM crop will cause allergic reactions. It is easier to know this is the gene that is being transferred to the crop comes from a source that is edible, where we already know the reactions it causes in the body. But when the gene comes from a source that isn't typically consumed, it is very hard to assess whether the crop will have allergenic properties.

7. **Social/economical concerns:** biotech companies' having a stronghold on crop patents means that they are more likely to be in a position of power over the traditional farmer. This is especially applicable to third world countries where the technology for GM crops is out of reach for the average farmer. Furthermore, issues of hunger and poverty won't be solved simply by having stronger/different types of crops. Poverty and hunger are social and economic problems that don't have an easy solution like "more crops". Lack of production is not the only reason for hunger and poverty. [7]



[5] Ibid.
[6] Pusztai, A. 2001. Genetically Modified Foods: Are They a Risk to Human/Animal Health? Actionbioscience.org. [online] URL: http://www.actionbioscience.org/biotech/pusztai.html
[7] Shah, A. 2002. Genetically Engineered Food. GlobalIssues.org [online]:http://www.globalissues.org/EnvIssues/GEFood.asp

GM modification	Benefits	Risks
Herbicide resistance in maize, cotton, other crops.	Reduce herbicide use. Increase opportunities for reduced tillage systems.	Increase herbicide use. Reduce in-field biodiversity that may reduce the ecological services provided by agricultural ecosystems.
Maize with *Bt* toxin.	Reduce pesticide use. Kill fewer non target organisms than alternatives such as broad-spectrum pesticides.	Promote development of *Bt* resistance, which will eliminate *Bt* as a relatively safe pesticide. Kill non target caterpillars and butterflies, such as monarchs (Pimentel 2000).
Virus resistance in small grains due to coat proteins.	Reduce insecticide use to control insect dispersers of pathogens (Hails 2000).	Facilitate the creation of new viruses (Hails 2000). Move genes into nonagricultural ecosystems where the subsequent increase in fitness of weedy species could eliminate endangered species.
Terminator or other sterilizing traits in crops and ornamentals.	Prevent the movement of traits to non target species. Prevent the movement of introduced species to other ecosystems (Walker and Lonsdale 2000).	Prevent farmers from developing their own seed supplies adapted to local conditions (Conway 2000).
Synthesis of vitamin A or other nutrients.	Improve nutrition of people who depend heavily on rice (Conway 2000).	Disrupt local ecosystems if an ecologically limiting nutrient or protein is produced.
Nitrogen fixation by non legumes.	Reduce energy used in fertilizer production and application (Pimentel 2000).	Add to excess N leaching from agriculture, degrading human health and reducing biodiversity.

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3.0. Methodology/Brainstorm/Work Breakdown Structure

A. Current web pages are not easily understood by many members of the general community. Many of these pages are saturated with information. A person who does not have a strong scientific background may not understand what is being explained. Many sites do not include the basics of genetically modified crops. This is to include what crops have been modified, how they were modified, and why they were modified. Consumers also may not be aware of the possible advantages and disadvantages of these modifications.

B. The goal will be to create a cache of information about genetically modified crops. This information would include laws and regulations, background, and technology. This information will be used to create a web page that is user friendly for the general public. This will particularly target those without a strong scientific background who may be interested in what exactly modified crops are. The web site will include the history of genetically modified crops, the technology used to modify the crops, the advantages and disadvantages of modifying crops, and a list of crops that have been modified. The site will provide simple and easy to understand material. The site will be easy to navigate, making it user friendly. The site will also provide links to more extensive information if the user would like expand their research.

In order to create this site, the team has divided into sub-teams. The first team will be responsible for the background of GM crops, laws regarding genetically modified foods in the US, and the disadvantages and advantages of GM crops. This group is also responsible for creating the web page. The second group is responsible for creating a database of all known genetically modified crops. They will also be responsible for researching why these crops were modified and what technologies were used.

To help ensure each aspect is research the class has been divided into sub-teams. Each sub-team has a sub-team leader and each member of the team has an individual task.

The class as a whole meets each Tuesday and Thursday from 3:15pm-4:30pm. These weekly meetings are used to present each sub-team's research and goals. The time is use to discuss and evaluate the progress each team has made.

The sub-teams meet as needed. Each member is responsible for an individual task within the sub-team.

4.0. Expected Results

A. The members of IPRO 318 will work together to gather and organize information pertaining to genetically modified crops. Team members will be responsible for researching the background of six major genetically modified crops. Along with the background information

of each crop, the team members will be responsible for collecting information concerning which countries and which companies are genetically modifying crops, what types of technologies are being used to genetically modify crops, and to what purposes are crops being genetically modified. Along with the research concerning the six major genetically modified crops, team members will compile a master list of all crops that have a history of genetic modification. All of this research will be done with the future goal of building a database and user friendly website that includes the information about genetically modified crops.

a. Making database for specific major six crops and a listing of all GM crops if possible
b. Build foundation for the future of IPRO 318 to research allergens for future modifications
c. Create a user friendly informative website on GM crops and technologies

B. To ensure that the database and website are informative yet easy to use, our IPRO team will construct a survey. The objective of the survey will be to ascertain what type of information was understood by users after viewing the website, how easy the website was to use, and what additional information should be included on the website. The survey will be sent to a mixed population so that the information comes from a variety of different people.

C. Our IPRO team wishes to produce a collective database of information about genetically modified crops. With this database, our group will construct a website that is both informative and easy to understand by the general public.

D. The execution of assigned tasks is to gain knowledge on genetically modified crops, and to share our known and learned information with other group members. We will also work together as a group to provide the best product while being team players.

E. Our team will strive to compile a database of genetically modified crops. With the information included in this database, we will make a user friendly website, and a dynamic presentation about genetically modified crops to deliver to the IPRO judges.

F. The results will addresses the problem by providing a foundation of genetically modified technologies and crops to the general community accessible through one central simple, user friendly web page

G. The results obtained by our group members will provide a foundation for future IPRO teams. By providing a solid start to a central database, future IPRO teams will eventually be able to produce an all-inclusive source of information concerning genetically modified crops. This data base can be a useful tool for the general public and possibly to any member of the scientific community who wished to research genetically modified crops.

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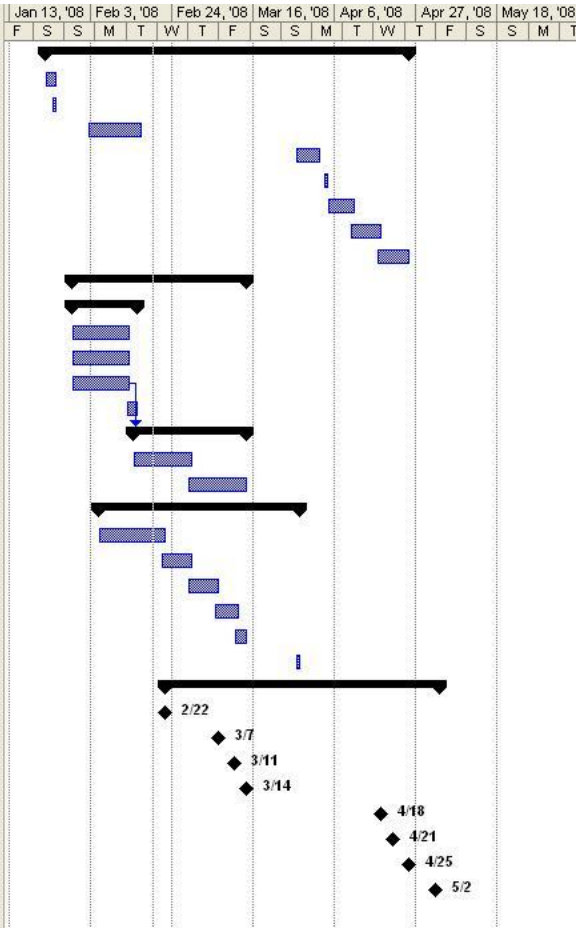
Project Budget:

Item	Cost $	Total
Ethics Book	15.5	
Dream Weaver Book	50	
Supplies for IPRO DAY	150	
		215.5

Project Plan:

	Task Name	Duration	Start	Finish	Prede
1	**Ipro 318**	**81.5 days?**	**Tue 1/22/08**	**Thu 4/24/08**	
2	Define Subgroups	3.5 days	Tue 1/22/08	Thu 1/24/08	
3	Designate Roles	1 day	Thu 1/24/08	Thu 1/24/08	
4	Rough Draft of Project Plan	13 days	Fri 2/1/08	Fri 2/15/08	
5	Create Survey	4.8 days?	Thu 3/27/08	Tue 4/1/08	
6	Finalize Rough Draft of Website	1 day?	Thu 4/3/08	Thu 4/3/08	
7	Survey Period	6.1 days?	Fri 4/4/08	Thu 4/10/08	
8	Incorporate Suggestions	7.4 days?	Thu 4/10/08	Thu 4/17/08	
9	Finalize Website	7.4 days?	Thu 4/17/08	Thu 4/24/08	
10	**Background/Website Group**	**42.5 days?**	**Tue 1/29/08**	**Thu 3/13/08**	
11	**Background Information**	**16.5 days?**	**Tue 1/29/08**	**Thu 2/14/08**	
12	Risks	13.9 days?	Tue 1/29/08	Tue 2/12/08	
13	Benefits	13.9 days?	Tue 1/29/08	Tue 2/12/08	
14	Background of GM	13.9 days?	Tue 1/29/08	Tue 2/12/08	
15	Revise Background Information	3.5 days?	Tue 2/12/08	Thu 2/14/08	
16	**Website**	**26.9 days?**	**Thu 2/14/08**	**Thu 3/13/08**	14
17	Template for Website	13.9 days?	Thu 2/14/08	Thu 2/28/08	
18	Rough Draft	13.9 days?	Thu 2/28/08	Thu 3/13/08	
19	**Database/Technology Group**	**42.6 days?**	**Tue 2/5/08**	**Thu 3/27/08**	
20	Purpose/ Crop Background	16.5 days?	Tue 2/5/08	Thu 2/21/08	
21	Technology/ Pictures	7.4 days?	Thu 2/21/08	Thu 2/28/08	
22	Soybean Research Complete/ Collective List	7.4 days?	Thu 2/28/08	Thu 3/6/08	
23	Sample Page/ Explanation of Technology	4.8 days?	Thu 3/6/08	Tue 3/11/08	
24	Format of Database	3.5 days?	Tue 3/11/08	Thu 3/13/08	
25	Upload database to website	1 day?	Thu 3/27/08	Thu 3/27/08	
26	**Ipro Deliverables**	**59.4 days?**	**Fri 2/22/08**	**Fri 5/2/08**	
27	Project Plan	0.8 days	Fri 2/22/08	Fri 2/22/08	
28	Code of Ethics	0.8 days?	Fri 3/7/08	Fri 3/7/08	
29	Oral Midterm	0.8 days?	Tue 3/11/08	Tue 3/11/08	
30	Progress Report	0.8 days?	Fri 3/14/08	Fri 3/14/08	
31	Meeting Minutes Due	0.8 days?	Fri 4/18/08	Fri 4/18/08	
32	Abstract Poster and Presentation due	3.2 days?	Mon 4/21/08	Thu 4/24/08	
33	Website Due	0.8 days?	Fri 4/25/08	Fri 4/25/08	
34	Ipro Day	0.8 days?	Fri 5/2/08	Fri 5/2/08	



7.0 Individual Team Member Assignments

Team Member	Educational Background	Year	Skills/Strengths	Team Role(s)	Sub-team	Individual Tasks within subteams
Jennifer Miller	Biology	4th	Background in Microbiology and Genetics	Team leader	Database / Technology	Researching wheat
Nivedita Chandrasekharan	Biochemisty	2nd	Research and laboratory assistant, background in Biology and Genetics	Sub-team leader	Web page / Background	Compiling and Editing of information
Ali Khiabani	Molecular Biochemistry and Biophysics	2nd	Computer, Scientific research study	Team Member	Web page / Background	Research on the benefit portion of the background as well as organizing the project management outline
Andres De la hoz	BME	4th		Team Member	Web page / Background	Risks
Elizabeth Kuebrich	Biochemistry	3rd	Academic Interest: Forensics and Genetics	Team Member	Database / Technology	Researching Corn, Code of Ethics
Lauren Mcclelland	Biochemistry	3rd	Academic interest: Biochemistry, Genetics, and microbiology	Sub-team minute taker	Database / Technology	Researching Cotton, Project Management
Pavan Patel	Biochemistry / pre-medicine	4th	Computer skills, background in genetics and human biology	Team Member	Web page / Background	Background

Jennifer Peavler	Chemical Engineering	4th	Proficient in laboratory techniques such as electrophoresis and separation techniques. research pertaining to biotechnology	Sub-team leader	Database / Technology	Researching Tomatoes
Hee Seo	Applied Mathematics	4th	Mathematical Skill, Data researching and analysis	Sub-team time keeper	Database / Technology	Researching rice, Code of Ethics
Kurt Ziegel	Architecture	5th	Architecture, Graphic Design, Industrial Design	Team Member	Web page / Background	Compiling and Editing of information, Project plan editor

Works Cited:

2.0

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