Ethical and Critical Thinking: Genetically Modified Food

**Purpose**
To critically read different points of view concerning Genetically Modified Food, research the issue of Genetically Modified Food and develop one’s own opinion about this issue supported by the research.

**Overview**
This section will require students to read statements representing different points of view on Genetically Modified Food. Then the students are required to identify the “facts” and “opinions” in each statement, and then briefly summarize the issue of Genetically Modified Food in a short paragraph. Finally, the student must research and create an essay expressing their own opinion about Genetically Modified Food, using citations from these statements and other sources to support their conclusions.

Of note, any of the 3 tasks can be done individually or in the order indicated.

Of note, this Ethical and Critical Thinking on Genetically Modified Foods can be enriched by performing the Debate on Genetically Modified Foods after this activity since it uses the same readings and requires the students to research and take on the point of view of a particular stakeholder.

**Time**
1 two hour session for the first 2 tasks, and then assign the essay as a homework assignment over one to several days.

**Key Concepts**
This section particularly focuses on the ethical issues engendered by Genetically Modified Food. Genetically Modified Food is a contentious environmental, scientific, historical, social, and economic issue with data supporting potentially many different points of view. The same facts can be used by proponents to support different points of view. A critically thinking person needs to shift through these opinions and come to their own point of view based on the facts as they perceive them.

**Skills**
This section in its entirety can help in critical reading, précis, or synthesis writing, and in the writing of essays with incorporation of facts and citations. It is also useful in developing objectivity in the analysis of scientific and non-scientific writing as well as skills in research of a scientific issue. Finally, written and verbal communication are stressed.

**Materials**
The handouts are the only materials needed. The answers can be made into transparencies for instructional purposes. Access to word processing software and Internet would be useful for production of the writing and essay products.

**Facilitator Preparation**
Students can perform this exercise as an individual or in groups. If in groups, you will need to divide the students into groups or teams. Knowledge of and facilitating access
to the computerized software with training will optimize this session. Prior knowledge of the Food Primer and the enclosed readings, as well as other modules, will prepare you for the range of issues addressed in this section.

Background
What are the various issues raised by the expanding use of genetically modified food as environmental health issues? What is genetically modified food? What are the human health, economic, and ecological ramifications of using genetically modified food? As a political, historical and ethical issue? What does a society do if there are limited resources to produce food, many starving people, and genetically modified food may offer the opportunity to feed millions of people and use less harmful pesticides at the same time? On the other hand, if genetically modified food can potentially harm our environment, how does a society prevent this sort of environmental disaster from occurring in the future? What is the role and responsibility of the individual when faced with an environmental health issue?

In the situation of genetically modified food, is it safe for humans? All humans or just some? Is it safe for the environment? What are the negative and positive consequences of the use of genetically modified food?

Procedure
The following Critical Reading activities can be done in groups or by individual students. Have the students critically read the enclosed statements on genetically modified foods below. Students should be encouraged to seek out other sources of information on genetically modified food. The websites of the original articles are available if students wish to explore these articles further.

- Editors at Science magazine are collecting responses to seven questions about genetically modified foods. The responses will come from a variety of individuals living in different places in the world and thus provide a wide range of perspectives on the issues. You can view the question responses in different ways -- responses by one person to all the questions, responses to one question by all the respondents, or just one response, one person at a time. You can also submit your own responses to the same questions (http://scope.educ.washington.edu/gmfood/position/).

1. For each statement, review the text and:
   a) Underline the facts about genetically modified food issues as stated in each statement;
   b) Highlight or bold the opinions of the speakers and others about genetically modified food issues as stated in each statement.

   Share the facts and opinions by reading them out loud to the class.

2. Review what you have underlined and write a short paragraph of 4-6 sentences summarizing the arguments made by each speaker about genetically modified food.

3. Write an essay summarizing what you believe (your opinion) about the genetically modified food issues, incorporating facts and opinions that you have learned from your Food Research. Use quotes and citations to justify your opinion. Share your opinion by reading the essay out loud to the class.
If you want to assign an actual essay topic, consider: What are the health advantages, disadvantages, of Genetically Modified Foods?

Some interesting websites on this subject as starting points of research on genetically modified food include:
http://www.usda.gov/agencies/biotech/faq.html
http://special.northernlight.com/gmfoods/
http://www PBS.org/wgbh/harvest/
http://www.truefoodnow.org/shoppinglist.html
http://www.usda.gov/agencies/biotech/faq.html
http://scope.educ.washington.edu/gmfood/position/

Additional Activities
Questions to ask about the Readings: With regards to evaluating different opinions on Genetically Modified Foods, does it matter who gives the opinion? How do you know from what point of view person is going to speak? Does it matter to you if the person has a conflict of interest? What is a conflict of interest?

Follow up Activities
Students search for other articles representing different or supporting points of view on the diverse issue of genetically modified food. They can create their own website on the issue of genetically modified food. They can adapt their issues as newspaper articles for the School or local Newspaper, incorporating genetically modified food facts from their own neighborhood. They can write their Congress people to express their opinion on the genetically modified food issue.

Student Assessment
Give the following critical writing components to each student as a guide to their critical writing products:
- Decide what facts and what are opinions in each statement on the genetically modified food issue
- Briefly summarize these facts and opinions into a paragraph from the point of view of each statement
- Decide on their own opinion on the genetically modified food issue and what facts support this opinion
- Create an essay with fact citations to support this opinion
- Practice reading this essay aloud in a convincing manner
- Be prepared to answer questions concerning the essay point of view and supporting facts

Assign points for the following components of the critical writing products:
- Were the facts and opinions correctly identified and distinguished in each except?
- Were these facts and opinions correctly and briefly summarized in a short paragraph for each excerpt?
- Were proper science terms used?
- Did the essay demonstrate a distinct point of view?
- Did the facts cited in the essay support this point of view?
- Did the essay report its sources/citations?
Could the student answer questions from the audience about the facts and defend their point of view?

Readings on Genetically Modified Food

Editors at Science magazine are collecting responses to seven questions about genetically modified foods. The responses will come from a variety of individuals living in different places in the world and thus provide a wide range of perspectives on the issues. You can view the question responses in different ways -- responses by one person to all the questions, responses to one question by all the respondents, or just one response, one person at a time. You can also submit your own responses to the same questions (http://scope.educ.washington.edu/gmfood/position/).

What are the health advantages, disadvantages, of Genetically Modified Foods?

**Response by Shahal Abbo** (Field Crops, Vegetables and Genetics, Faculty of Agriculture, Food & Environmental Quality Sciences, The Hebrew University of Jerusalem, Rehovot 76100, Israel)

Again, reduced amounts of pesticide residues are a blessed effect. The question of greater allergenicity (because of the presence of novel chemicals) remains to be proven but the risk should not be overlooked.

**Response by Prof. E. Ann Clark** (University of Guelph, Canada)

To date, the only case in which GE has been implicated in human death and disability was the famous Showa Denko debacle, in which 37 people died, 1535 were left permanently and severely disabled, and another 5000 were temporarily disabled.

Serious human health problems have been implicated only rarely for GMFs, which may be related to the absence of segregation and labeling of GMFs, which precludes epidemiological studies.

Nonetheless, GE methods have the potential to create unanticipated dangers for which it could be difficult to test. Insertion of transgenes can affect unintended traits of the target organism as well as the intended trait, although this is not reflected in the food safety testing protocols used in the United States and Canada.

It does not seem implausible that unintended side effects could occur in food safety traits. Thus, consideration of the potential effects of transgene insertion need not be restricted to the target trait but should acknowledge the very real potential for other traits to be expressed unpredictably.

Is this risk any greater than that from conventionally bred crops? I do not know, and I have not been able to find anyone who can point to any research that specifically addresses this pivotal question.
However, it does not seem imprudent to take this as a testable hypothesis instead of just assuming it away as a nonissue--as has been done often when concerns about biotechnology have been raised. Many of those confident early assumptions were refuted when they were actually tested. A more cautionary and scientifically defensible approach is clearly warranted.

In sum, a critical point to keep in mind--particularly pertaining to food safety issues--is that the premise that the off-types, silencing, and trait instabilities inherent to transgenic crops can simply be detected and discarded before commercialization has already been disproven. What will it mean to human, livestock, and wildlife health when the types of unintended, unexpected, and adverse outcomes that have already occurred with agronomic traits occur with food safety traits?

**Response by Dr. Liz Dennis** (Chief Research Scientist, CSIRO Plant Industry, CANBERRA ACT 2601, AUSTRALIA)

Crops with defined health benefits will become available. Two examples of particular significance to developing countries are the recent announcement of "golden rice"--rice genetically modified to produce enhanced levels of vitamin A--and attempts in the Commonwealth Scientific and Industrial Research Organization and elsewhere to produce rice with elevated levels of bioavailable iron. These technologies offer solutions to dietary deficiencies that affect millions of people for whom rice is the staple diet.

Another health improvement is modification of plant oils to increase monounsaturated oils and decrease the levels of polyunsaturated and saturated oils, which should give decided health benefits in lowering cholesterol.

Developing vaccines in plants is very attractive and appears to be quite feasible--for example, people may be immunized against measles or other diseases by eating bananas. This technology may make a big difference to the health of the developing world.

**Response by Katherine DiMatteo** (Organic Trade Association, Greenfield, MA, USA)

Although there have not been reported health problems linked to GMF, there are concerns that the possible transfer of new and unidentified proteins from one food to another may trigger allergic reactions to the altered food. Also, there has been no research regarding whether genetic engineering changes the nutritional content of food, nor have there been studies on the human safety of consuming genetically engineered foods. Although the biotechnology industry is quick to claim that no deaths or illnesses have been linked to genetically engineered food, how is it possible to be sure? Without labeling, there is no way to trace whether someone who gets sick has eaten a GMF. Long-term effects are also unknown. Further study--and prudence--are needed.

**Response by B. K. Ndimba** (Durham University, Durham, United Kingdom)
If GM farming is aimed at replacing or reducing pesticide use, there is a great benefit to humans and harmless insects such as butterflies and ladybirds from reducing their exposure to harmful chemicals.

Response by Prabhjeet Singh (Research Associate, Department of Biology, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong)

Some of the many health advantages of GMF include the edible vaccines, which can help curb various diseases in India and other developing countries. Nutritionally improved crops with a higher content of proteins and vitamins can supplement the nutritional requirements of the lower strata of the population, who cannot afford a nonvegetarian diet. Pulses constitute a major source of protein in India. However, the presence of raffinose-like sugars can cause digestive problems. The genetically tailored pulses that contain reduced amounts of raffinose and similar sugars can result in enhanced digestibility. GMF that contain sweet proteins like thaumatin will be good for people with diabetes. And GMF that have greater iron content can be especially beneficial for Indian women, as they are susceptible to anemia.

There is a need for caution in dealing with GMF. One should be careful and alert to the immediate and long-term adverse effects of these GMF on health.

Response by Senthil Subramanian (Department of Biology, Hong Kong University of Science and Technology, Kowloon, Hong Kong)

GMF technology is capable of producing food crops with enhanced nutrient content and also nutrient balance. For example, it is possible to engineer fruits and grains with higher concentrations of calcium, iron, vitamins A and C, and more protein with essential amino acids. Other possibilities are GMF with antipathogen proteins and products (for example, bacteriocins) to keep us healthy and protect us from food pathogens (for example, aflatoxins). Also GMF can synthesize human and animal vaccines, which may make vaccination programs easier and more successful. Indirectly, GMF help to reduce the amounts of chemicals that are used in their production and hence residues in food and feed.

Direct health threats arise from the newly introduced proteins, especially DNA vaccines in the meat industry, which might cause allergy and illness to consumers. The indirect threat arises from the use of bacteria engineered with resistance to several common clinical antibiotics that are used in GMF technology. Care should be taken to avoid transferring genes into the natural environment, which may lead to pathogenic bacteria that are resistant to antibiotics. Another indirect effect could be larger amounts of herbicide residue present in food and fodder because of the use of herbicides in larger amounts on highly resistant herbicide-tolerant crops.

Response by Mark Tester (Department of Plant Sciences, University of Cambridge, Cambridge, CB2 3EA UK)

Exposure of human populations to large amounts of novel proteins that have never previously been in the human food chain could cause unpredictable
problems. In particular, allergenicity could cause problems that would be difficult
to detect, as symptoms can take a long time to develop. Previous low-level
exposure of human populations to such toxins is not an argument against this
concern, as the quantitative differences between exposure to, for example, Bt
toxin (an insecticidal protein) from soil contamination of food and chronic
ingestion of significant quantities of this protein in a range of foodstuffs could
easily prove crucial. Current testing regimes are not adequate to screen for such
responses, although it is difficult to see, technically, how such screening could be
done; the low quality (both scientifically and statistically) of the feeding
experiments of Arpad Pusztai provide an example of the difficulty of such work.

Nevertheless, I think it is notable that extensive testing is required before new
drugs are introduced (which usually are not taken chronically and whose benefits
to the patient usually are clear). In contrast, the new GM could lead to an
increase by orders of magnitude in the quantity of a protein in the food chain,
with this protein being ingested chronically (and with little, if any, benefit to the
consumer); yet this can be done with a testing regime that is much more modest
than that required for new pharmaceuticals. I think the pro-GM lobby should take
this concern on board more seriously, especially when considering the outputs
from "wide transfer" (an important, novel power of the new GM).

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SCOPE GM Food Forum: scope.educ.washington.edu/gmfood/
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