



Environment—Lesson Plan

Student Outcomes

At the conclusion of this lesson, students will be able to:

- Define *genetically modified foods*.
- Explain the general process of genetic engineering.
- List at least three reasons to support and three reasons to oppose the cultivation of genetically modified foods.
- Identify possible short-term and long-term outcomes (positive and negative) of genetically modified foods and infer how they could affect the common good.
- Identify areas of agreement and disagreement with other students.
- Reach a decision, individually and collectively, on the deliberation issue using evidence and sound reasoning.
- Explain the importance of deliberating this question in a democratic society.

Question for Deliberation

Should our democracy permit the cultivation of genetically modified foods?

Topic Materials

- Reading
- Glossary—Supplemental Handout
- The Green Revolution—Supplemental Handout
- Points of View—Supplemental Handout
- Selected Resources

Deliberation Materials

- Deliberation Procedures
- Handout 1—Deliberation Guide
- Handout 2—Deliberation Notes
- Handout 3—Deliberation Reflection

Environment—Reading

Should our democracy permit the cultivation of genetically modified foods?

1 Eggs that fight cancer.¹ Cows that produce human breast milk.² Corn that is poisonous
2 to insects. Yeast that excretes crude oil.³ Bananas that vaccinate against diseases such as
3 Hepatitis B and Cholera.⁴ These are just some of the possibilities of *genetic engineering*.

4 By inserting the genes from one organism into the DNA of another, scientists can change the
5 genetic makeup of plants and animals. These changes cannot occur naturally. Scientists are
6 experimenting with everything from plants that can detect land mines to glow-in-the-dark cats.⁵
7 Genetically engineered plants and animals designed for human consumption are called
8 *genetically modified (GM) foods*.

9 The Universal Declaration of Human Rights says every human being has the right to food.⁶
10 Yet, nearly one out of every six persons on earth does not have enough to eat each day. Many
11 people believe that GM foods offer the possibility of ending world hunger. However, many
12 others are not convinced that GM foods are safe for people or the environment. Should GM
13 foods be on the menu? People in democracies are deliberating this issue. Both sides argue that
14 the *common good* is at stake.

Genetically Modified Foods

16 Humans have altered the genetic makeup of plants and animals for thousands of years
17 through *selective breeding*. They saved the seeds from the best crops and re-planted them. Over
18 time, this made all of their crops more bountiful. They bred only the biggest, strongest bull to
19 ensure that their cattle also had that bull's traits. In this way, humans could develop organisms

20 that best met their needs. However, selective breeding takes a long time, and the results can be
21 unpredictable.

22 Genetic engineering allows scientists to pinpoint the exact traits they want an organism to
23 exhibit. This makes the change process faster and more precise. It even allows scientists to
24 transfer genes between two non-related species. For example, scientists have inserted the
25 dragline silk gene from a spider into the DNA of a goat. The resulting goat produces spider-web
26 silk in its milk. That silk can be used to make a strong fiber called Biosteel.⁷ Organisms that have
27 been altered in this way are called *transgenic*.

28 Transgenic plants and animals have many applications. Crops are engineered to have built-in
29 defenses against pests and diseases. One type of cabbage has a poison gene from a scorpion that
30 makes it toxic to caterpillars.⁸ Others are engineered to produce ingredients used in medicines.⁹
31 Animals are also altered. They are engineered to grow bigger and faster. They can also be
32 designed to resist diseases. For example, one GM lab has created a chicken that is immune to the
33 bird flu.¹⁰ Scientists are also experimenting with crops that can resist frost, drought, and salt
34 water. Such crops could allow farmers to grow food in new places.

35 Large agricultural companies such as Dow, DuPont, Monsanto, and Syngenta have made
36 such GM products very profitable. Many countries' laws allow companies to *patent* genetically
37 modified seeds. This prohibits other companies from reproducing or selling the same seeds. In
38 many cases, it also prohibits farmers from saving and re-using the seeds they harvest. Some
39 companies have even developed GM crops that are incapable of reproducing. This is known as
40 *terminator technology*. It ensures that farmers have to buy more GM seeds from these
41 companies every year.

42 **GM Food around the World**

43 Some GM foods are approved only for animal feed. Others are approved for human
44 consumption. The first GM food approved for human consumption was the Flvr Svr tomato, a
45 tomato designed to ripen more slowly to prevent rotting. It was approved in 1994.¹¹ Today, the
46 four most commonly grown commercial GM crops are corn, cotton, rapeseed, and soybean.¹²
47 Many GM foods are still in the testing phase.

48 The United States of America is the largest producer of GM crops. It saw the first transgenic
49 crop planted for commercial use in 1996. By 2009, it was cultivating almost half of the total GM
50 crops worldwide – around 64 million acres (an area slightly larger than the entire country of
51 Ecuador). The other half is grown primarily in Argentina, Brazil, Canada, India, China,
52 Paraguay, and South Africa.¹³

53 Many countries are concerned about the effects that the human manipulation of plants and
54 animals will have on the environment. They strictly regulate the cultivation and distribution of
55 GM products. The European Union, for example, requires GM foods to pass intensive health and
56 safety testing before they are permitted. It also requires that all GM food be clearly labeled.¹⁴
57 Mexico strictly regulates the cultivation of the GM version of its sacred crop: maize (corn).
58 Authorities fear that GM maize will further contaminate its many national varieties of maize.¹⁵

59 Some countries have even placed full or partial bans on GM products. The Andean nations of
60 Bolivia, Ecuador, and Peru all have restrictions on GM products. The Peruvian Congress, for
61 instance, recently approved a 10-year ban on the import and cultivation of all GM crops.¹⁶ In
62 Ecuador, the Constitution expressly prohibits genetically engineered crops and seeds within the
63 nation's borders.¹⁷

64 **GM Foods: Supporters and Opponents**

65 Supporters of GM foods say they have the potential to eliminate world hunger. The GM
66 plants and animals grow bigger and faster. If approved, a transgenic salmon that grows to full-
67 size twice as fast as regular salmon will be the first transgenic animal to be marketed for human
68 consumption. Supporters say this fish could provide protein to the world.¹⁸ Some GM foods are
69 also enriched with essential vitamins, nutrients, and medicines. Scientists have already created
70 Golden Rice, a transgenic species that has built-in Vitamin A. Rice feeds more than half of the
71 world's population. Thus, supporters say, Golden Rice has the potential to prevent many
72 childhood diseases, including blindness.¹⁹

73 Advocates of GM foods also argue that GM seeds and technology lead to a higher quality of
74 life and more stability in farming communities. GM crops help farmers increase production and
75 increase their incomes. In addition, farmers are less likely to lose their crops to plant diseases
76 and insects. GM crops that resist drought and salt water can also help farmers grow food in harsh
77 environments. They even have the potential to “prevent outbreaks such as foot and mouth
78 disease, which has devastated many farmers and local economies.”²⁰

79 Supporters also say that GM foods have environmental benefits. With GM crops, less land is
80 needed to grow the same amount of food. GM crops can also reduce the need for farmers to use
81 agrochemicals that pollute the soil and water. Genetic engineering also offers the possibility of
82 designing new organisms to solve existing environmental problems. For example, scientists have
83 developed pollution-fighting and carbon-scrubbing plants. They have also created a cow that
84 produces less methane gas and a pig that has environmentally friendly manure.²¹

85 Opponents of GM foods caution that human interference in natural processes could have
86 unintended consequences. For example, they argue that crops that are resistant to herbicide

87 (weed killer) can pass the trait onto weeds. Such “super weeds” can take over entire fields.
88 Killing them requires farmers to spray more and stronger chemical herbicides. Opponents also
89 point out that the long-term effects of GM foods on human health are still unknown. A recent
90 French study showed that rats suffered kidney and liver damage from GM corn.²² Could it have
91 the same affect on humans? Opponents say that combining genes from different plants and
92 animals could create new allergies and diseases.²³

93 Critics also argue that GM foods negatively affect *biodiversity*.²⁴ Instead of growing several
94 varieties of corn, many farmers have chosen to grow only the high-yield GM variety. This
95 threatens local varieties of seeds. Opponents note that India once had more than 30,000 varieties
96 of rice. Today, it has only 10.²⁵ *Monoculture* also puts crops at risk of diseases and other blights.
97 An entire crop can be wiped out by one disease. Critics also argue that GM crops kill beneficial
98 creatures such as honeybees, butterflies, and birds.²⁶ Such creatures are essential to pollination
99 and the survival of plant life.

100 Opponents insist that GM foods are bad for farmers and consumers. Patents on GM seeds
101 make them very expensive for farmers. Farmers are also restricted from re-using the seeds from
102 the plants they grow. This increases costs for farmers and consumers. GM crops also spread and
103 contaminate *organic* crops. Studies have shown that as much as 70 percent of processed food in
104 U.S. grocery stores now contains at least one GM ingredient.²⁷ The numbers are equally high in
105 Peru, where growing GM foods has been banned.²⁸ Contamination reduces the value of organic
106 crops. It also takes away consumers’ right to eat foods free of GM ingredients.

107 In democratic societies, the common good is at the forefront of many decisions. The
108 availability of GM foods has produced tension between the need to provide healthy food to all of
109 a nation’s citizens today, and the desire to create a sustainable future for its citizens tomorrow.

110 How democracies balance these tensions to create effective public policy is an issue to be
111 deliberated.

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- ⁴ 12 Bizarre Examples of Genetic Engineering.
- ⁵ 12 Bizarre Examples of Genetic Engineering.
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- ⁷ 12 Bizarre Examples of Genetic Engineering.
- ⁸ 12 Bizarre Examples of Genetic Engineering.
- ⁹ Bruce Chassy, "The History and Future of GMOs in Food and Agriculture," *Cereal Foods World*, vol. 52, no. 4 (2007), 169-172.
- ¹⁰ Steve Connor, "GM Lab Creates Chicken that Cannot Spread Bird Flu," *The Independent* (January 14, 2011), <http://www.independent.co.uk/news/science/gm-lab-creates-chicken-that-cannot-spread-bird-flu-2184280.html>
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- ¹² "Genetically Modified Plants: Global Cultivation on 134 Million Hectares," *GMO Compass* (March 29, 2010), http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/257.global_gm_planting_2009.html (accessed July 11, 2011).
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- ¹⁵ Stephan Lendman, "Seeds of Destruction," *New African*, no. 480 (January 2009), 14 (accessed via SIRS Researcher June 22, 2011).
- ¹⁶ Jonathan Benson, "Peru Implements Ten-Year Ban on GMOs," *Natural News* (June 24, 2011), http://www.naturalnews.com/032803_Peru_GMOs.html (accessed July 1, 2011).
- ¹⁷ Daniela Hirschfeld, "Ecuador: New Constitution Bans GMO and Biotechnology," *Science and Development Network* (October 18, 2008), http://www.scidev.net/en/news/ecuador-new-constitution-bans-gmo-and-biotechnolog.html?utm_source=link&utm_medium=rss&utm_campaign=en_news (accessed July 19, 2011).
- ¹⁸ James C. Greenwood, "Don't Be Afraid of Frankenfish," *Wall Street Journal* (September 23, 2010), A.23 (accessed via SIRS Researcher June 22, 2011).
- ¹⁹ Food and Agriculture Organization of the United Nations, "Weighing the GMO Arguments: For" (Rome, Italy: Food and Agriculture Organization, March 2003), <http://www.fao.org/english/newsroom/focus/2003/gmo7.htm> (accessed June 20, 2011).

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- ²⁰ Kerryn Sakko, “The Debate over Genetically Modified Foods,” ActionBioscience.org (May 2002), <http://www.actionbioscience.org/biotech/sakko.html> (accessed July 20, 2011).
- ²¹ Smriti Rao, “Genetically Engineered Pigs, Earth-Friendly Poop,” CBS News (April 5, 2010), <http://www.cbsnews.com/stories/2010/04/05/tech/main6365156.shtml> (accessed June 20, 2011).
- ²² Jan McGirk, “GM Crop Battle in Latin America,” GM Watch (June 17, 2010), <http://www.gmwatch.org/latest-listing/1-news-items/12294-gm-crop-battle-in-latin-america> (accessed June 30, 2011).
- ²³ 20 Questions on Genetically Modified Organisms (Geneva, Switzerland: World Health Organization, n.d.), <http://www.who.int/foodsafety/publications/biotech/20questions/en/> (accessed June 22, 2011).
- ²⁴ 20 Questions on Genetically Modified Organisms.
- ²⁵ Amanda Briney, “Green Revolution: History and Overview of the Green Revolution,” About.com (May 5, 2010), <http://geography.about.com/od/globalproblemsandissues/a/greenrevolution.htm> (accessed July 19, 2011).
- ²⁶ Kerryn Sakko.
- ²⁷ P. Byrne, “Labeling of Genetically Engineered Foods,” Health, no. 9.371 (Fort Collins, CO: Colorado State University Extension, September 2010), <http://www.ext.colostate.edu/pubs/foodnut/09371.pdf> (accessed July 19, 2011).
- ²⁸ Benson.



Environment—Glossary

Biodiversity: A wide variety of plant and animal species living in their natural environments. Biodiversity is important for the survival of ecosystems.

Common good: The health, happiness, prosperity, and well-being in general of a group of people.

Genetic engineering: Alteration by humans of the genetic material of a living organism.

Genetically modified foods: Foods for human consumption that have had their genetic material altered in some way.

Monoculture: The practice of planting large quantities of only one type of crop. This term also describes the practice of raising large quantities of a single type of domestic animal.

Organic: Food that has not been genetically engineered and that has been grown without the use of chemicals.

Patent: Government license granted to a person or company for an invention. An invention can be a new idea or method of doing something, as well as a physical creation. A patent gives the inventor the sole right to make and sell the invention for a limited period of time.

Selective breeding: Purposeful mating of livestock or pollinating of crops that exhibit desired traits in an attempt to bring out those traits in their offspring.

Terminator technology: Genetically modified seeds that cannot reproduce. Such technology prevents farmers from gathering and using seeds from crops grown from terminator technologies.

Transgenic: An organism that has genetic material from one or more unrelated species.



Environment—The Green Revolution

After World War II, the world faced a major problem. The human population was growing at a dramatic rate, but the amount of food was not. Millions faced starvation and famine. Many experts wondered if humanity could feed itself.

In the 1960s, governments began investing heavily in agricultural research. They sought ways to increase food production. Through intensive selective breeding, scientists were able to develop crop varieties that produced more per plant and were better at resisting disease. These crops were called hybrids.

The introduction of hybrid crops led to a boom in agricultural productivity in the developing world. Farmers were taught about modern farming techniques. They learned how to improve their yields using irrigation, machinery, and agrochemicals such as fertilizers and pesticides. As a result, crops were more productive. Fewer plants were lost to diseases and pests. More land was put into production.

Between the 1960s and 1990s, these innovations increased world food production remarkably. They are often credited with saving the lives of millions of people in Asia, Africa, Latin America, and the Middle East. This period of time is called the Green Revolution.

According to the Food and Agriculture Organization of the United Nations, the Green Revolution came with a heavy price. It reduced biodiversity. Many local varieties of crops and livestock became extinct. The Green Revolution caused environmental degradation due to accelerated soil erosion and the widespread use of pesticides. And it put major strains on the world's limited water resources.

Many people believe that genetically modified organisms (GMOs) hold the possibility of a new and improved Green Revolution. They believe GMOs can end hunger and suffering. Others fear that GMOs will disrupt the delicate balance between humans and nature and put the world's food supply in jeopardy. What do you believe?

Questions to Consider

- In what ways are the challenges and promises of GMOs similar to those of the Green Revolution?
- What arguments, if any, are distinct to the controversy surrounding GMOs?
- How does the experience of the Green Revolution inform both supporters and opponents of GMOs?

Environment—Points of View

Health and Environmental Safety of Genetically Modified Foods



Source: Ralph Hagan, www.CartoonStock.com, (accessed July 22, 2011). Reprinted with permission.

“In the United States, genetically modified foods are judged to be safe by the Department of Agriculture, the Food and Drug Administration, and the Environmental Protection Agency.... That the European Union has placed a two-year moratorium on genetically modified imports says little per se about food safety, but rather it says more about consumer concerns, largely the result of unsubstantiated scare mongering done by opponents of genetic engineering....To date, there has been no credible scientific evidence to suggest that the ingestion of transgenic products is injurious to human health or the environment.”

~ Dr. Norman Borlaug, *Nobel Prize Laureate for Peace (1970)*

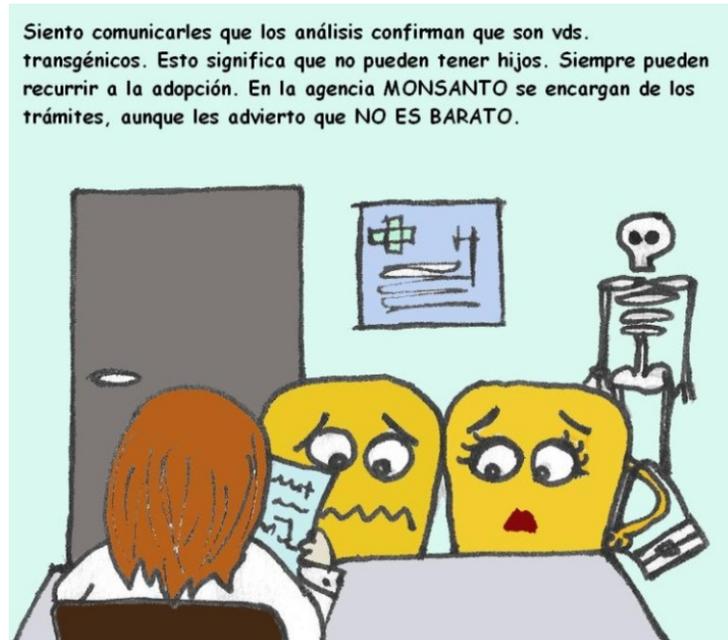
Norman E. Borlaug, “Ending World Hunger. The Promise of Biotechnology and the Threat of Antiscience Zealotry,” *Plant Physiology*, vol. 124, no. 2(October 2000), 487-490, <http://www.plantphysiol.org/content/124/2/487.full> (accessed July 19, 2011).

“The hazards of GMOs to biodiversity and human and animal health are now acknowledged by sources within the UK and US Governments. Particularly serious consequences are associated with the potential for horizontal gene transfer. These include the spread of antibiotic resistance marker genes that would render infectious diseases untreatable, the generation of new viruses and bacteria that cause diseases, and harmful mutations which may lead to cancer.”

~ 828 World Scientists, *Open Letter from World Scientists to All Governments Concerning Genetically Modified Organisms (2000)*

Open Letter from World Scientists to All Governments Concerning Genetically Modified Organisms (GMOs) (London, UK: Institute of Science in Society, 2000), <http://www.i-sis.org.uk/list.php> (accessed July 19, 2011).

Patents for Living Organism (Biotech Patents)



Source: Laura Sanchez, <http://wordpress.eldedoelallaga.com/2008/02/03/alimentos-transgenicos-y-alternativas-sanas> (accessed July 19, 2011). Reprinted with permission.

Translation: I am sorry to inform you that the tests confirm you are transgenic. That means that you cannot have children. You could always resort to adoption. The MONSANTO agency takes care of the arrangements, but I have to warn you that it IS NOT CHEAP.

“Monsanto patents many of the seed varieties we develop....Without the protection of patents there would be little incentive for privately-owned companies to pursue and re-invest in innovation. Monsanto invests more than \$2.6 million per day in research and development that ultimately benefits farmers and consumers. Without the protection of patents, this would not be possible.”

~Monsanto website, www.monsanto.com

“Why Does Monsanto Sue Farmers Who Save Seeds?” Monsanto.com, <http://www.monsanto.com/newsviews/Pages/why-does-monsanto-sue-farmers-who-save-seeds.aspx> (accessed July 19, 2011).

“All patents on life-forms and living processes detailed in this paper should be rejected.... on the following grounds: [They] are unethical; they destroy livelihoods, contravene basic human rights and dignity, compromise healthcare, impede medical and scientific research, create excessive suffering in animals or are otherwise contrary to public order and morality.”

~Dr. Mae-Wan Ho and Dr. Terje Traavik, *scientists* (1999)

Dr. Mae-Wan Ho and Dr. Terje Traavik, “Why We Should Reject Biotech Patents from TRIPS,” Scientific Briefing on TRIPS Article 27.3(b) (London, UK: The Institute of Science in Society, 1999), <http://www.twinside.org.sg/title/gmo-cn.htm> (accessed July 19, 2011).



Environment—Selected Resources

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Deliberation Procedures

PART I (In class the day before)

1. **Introduction.** Teachers review the meaning of deliberation, the reasons for deliberating, and the rules for deliberation. (Handout #1)

PART II (approximately 30 minutes)

2. **Careful Reading of the Text.** Students read the text individually, in small groups of 4 or as a whole class in order to reach a common understanding of the reading. If students do not understand the reading, the deliberation will not be successful. As a whole class or in their small groups, students agree on at least three interesting facts and/or ideas. (Handout #2).

Note on Supplemental Resources. Each deliberation includes both a basic reading and one or more supplemental resources. Supplemental resources may be a graph, a political cartoon or image, a glossary, a page of expert quotes, or a primary source or independent news story. These supplemental resources are optional materials that can be used to provoke discussion and critical thinking. These materials may be used by teachers as part of the lesson—as part of the *Introduction (Step 1)*, *Careful Reading of the Text (Step 2)*, *Presentation of Positions (Step 4)*, *Reversal of Positions (Step 5)*, or *Reflection (Step 8)*. Teachers can use these materials to differentiate instruction with some or all the students in class. Supplemental resources also can add depth or enrich the deliberation.

3. **Clarification.** After checking for understanding of the terms and content, the teacher makes sure students understand the deliberation question. (Handout #2)
4. **Presentation of Positions.** Students work in small groups of 4 divided into pairs (A & B). Each pair is assigned a position. The position of the A's is to find at least two compelling reasons to say YES to the deliberation question. The position of the B's is to find at least two compelling reasons to say NO to the deliberation question. A's teach B's at least two reasons to say YES to the deliberation question. B's teach A's at least two reasons to say NO to the deliberation question. (Handout #2)
5. **Reversal of Positions.** The pairs reverse positions. The B pair now adopts the position to say YES to the deliberation question; the A pair adopts the position to say NO to the deliberation question. The A's & B's should select the best reason they heard from the other pair and add at least one additional compelling reason from the reading to support their new position. (Handout #2)

PART III (approximately 15-20 minutes)

6. **Free Discussion.** Students drop their assigned roles and deliberate the question in their small groups. Each student reaches a personal decision based on evidence and logic.



PART IV (approximately 10-15 minutes)

- 7. Whole Class Debrief.** The teacher leads the whole class in a discussion to gain a deeper understanding of the question, democracy, and deliberation.
- What were the most compelling reasons for each side? What were the areas of agreement? What questions do you still have? Where can you get more information?
 - What is your position? (Poll the class on the deliberation question.) In what ways, if any, did your position change?
 - Is there an alternative policy that might address the problem more effectively? What, if anything, might you or your class do to address this problem?
 - What principles of democracy were inherent in this discussion? Why might deliberating this issue be important in a democracy?
 - Add other questions relevant to your curriculum.

PART V (15-30 minutes either in class or for homework)

- 8. Student Reflection.** Students complete the reflection form either at the end of class or for homework. (Handout #3)



Handout 1—Deliberation Guide

What Is Deliberation?

Deliberation is the focused exchange of ideas and the analysis of multiple views with the aim of making a personal decision and finding areas of agreement within a group.

Why Are We Deliberating?

People must be able and willing to express and exchange ideas among themselves, with community leaders, and with their representatives in government. People and public officials in a democracy need skills and opportunities to engage in civil public discussion of controversial issues in order to make informed policy decisions. Deliberation requires keeping an open mind, as this skill enables people to reconsider a decision based on new information or changing circumstances.

What Are the Rules for Deliberation?

- Read the material carefully.
- Focus on the deliberation question.
- Listen carefully to what others are saying.
- Understand and analyze what others are saying.
- Speak and encourage others to speak.
- Refer to the reading to support your ideas.
- Use relevant background knowledge, including life experiences, in a logical way.
- Remain engaged and respectful when controversy arises.



Handout 2—Deliberation Notes

The Deliberation Question:

Review the reading and in your group determine at least three of the most important facts and/or interesting ideas. Ask about any terms that are unclear.

Reasons to Support the Question - YES	Reasons to Oppose the Question - NO



Handout 3—Deliberation Reflection

What I think:

1. What did I decide and why? Did I support or oppose or have a new idea?

2. What did someone else say or do that was particularly helpful?

3. What, if anything, could I do to address the problem?

What we think:

1. What did we agree on?

2. What, if anything, could we do to address the problem?

Rate yourself and the group on how well the rules for deliberation were followed:

(1 = not well, 2 = well, 3 = very well)

	Me	Group
Read the material carefully.		
Focused on the deliberation question.		
Listened carefully to what others said.		
Understood and analyzed what others said.		
Spoke and encouraged others to speak.		
Referred to the reading to support ideas.		
Used relevant background knowledge and life experiences in a logical way.		
Remained engaged and respectful when controversy arose.		

1. What can I do to improve my deliberation skills?

2. What can the group do to improve the deliberation?