EXPEDITIONARY LEARNING

Grade 8: Module 4: Unit 2: Lesson 2

Preparing for Further Research: Industrial Food Chain

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Preparing for Further Research: Industrial Food Chain

Long-Term Targets Addressed (Based on NYSP12 ELA CCLS)
I can conduct short research projects to answer a question (including a self-generated question). (W.8.7) I can generate additional research questions for further exploration. (W.8.7)

Supporting Learning Targets	Ongoing Assessment
• I can develop a supporting research question to help me focus my research. • I can evaluate research sources to choose the most appropriate one to answer my supporting research question.	

Agenda	Teaching Notes
1. Opening A. Whole Group Share (10 minutes) B. Unpacking the Learning Targets (5 minutes) 2. Work Time A. Mini Lesson: Criteria of a Supporting Research Question (10 minutes) B. Guided Practice: Developing a Supporting Research Question (8 minutes) C. Evaluate Resources in Research Folders (8 minutes) 3. Closing and Assessment A. Debrief (4 minutes) 4. Homework A. Read your resource for the gist in preparation for the next lesson.	• This lesson gives students an introduction to the research process they will use throughout the unit. Once students have an overall picture of the research process, the lesson focuses on the skill of writing supporting research questions. Students are given a chance to think about what makes a good supporting research question before seeing the criteria. They also have a chance to practice writing a question and to decide whether questions meet the criteria. • For this food chain (industrial), students are given research folders containing research resources to choose from. There are two reasons for this. First, it allows students to work with high-quality supporting research questions before they write their own to use with the next food chain. And secondly, it ensures that the supporting research questions match the resources provided in the research folders. In the three other food chains, students will find their own resources on the internet to answer their own supporting research question. • There are a lot of supporting materials for this lesson. Many of the materials are for the research folders. Separate the materials for the research folders from the other resources to make this more manageable. • Note the difference in terms. The focus question is the question students answer in a position speech at the end of the unit and in a position paper in Unit 3. The research question (What are the consequences of each of Michael Pollan's four food chains?) sets the purpose for the research and thinking students do throughout the unit. The supporting research questions are different for each student and each food chain. These questions provide students with a focus to both find a source and guide their reading. • The researcher's roadmap (see supporting materials) is a tool that will be referred to throughout the unit to help students understand how the steps they take are part of a larger research process. Consider posting a large version of the researcher's roadmap on your classroom wall, either by using a large-scale printer/copier or by hand-writing on large paper. • In advance: – On a classroom wall, near the focus question (posted in Lesson 1), post the research question: What are the consequences of each of Michael Pollan's four food chains? – Group students into research teams made up of four students per team and post the teams list somewhere in the classroom. Students will work with these research teams throughout Unit 2. Considering using mixed-ability grouping to support all students.

Agenda	Teaching Notes (continued)
	– Consider putting Question Set A on paper that is a different color from that used for Question Set B. This will help students find a partner more easily. – Prepare the research folders (one per research team) by placing one copy of each article (see research folder table of contents), one copy of the table of contents, and one glossary in each folder. All items can be found in supporting materials. – Prepare the Good Supporting Research Questions Are ... anchor chart (see supporting materials).

Lesson Vocabulary	Materials
	• Industrial Food Chain Cascading Consequences charts (students' own developed on blank paper, and one developed on chart paper with the whole group; from Lesson 1) • Industrial Food Chain Cascading Consequences chart with additional text excerpts (for teacher reference) • *The Omnivore's Dilemma* (book; distributed to each student in Unit 1) • Researcher's roadmap (one per student and a larger version to display) • Question Set A (one for half of the students) • Question Set B (one for the other half of the students) • Good Supporting Research Questions Are ... anchor chart (one for display; see supporting materials) • List of supporting research questions (one per student) • Research folder (one per research team and one for display; put together by teacher) containing: – Table of contents (one per research folder) – Glossary of terms for research articles (one set per research folder) – Articles (enough of each article for one per *student*)

Opening	Meeting Students' Needs
A. Whole Group Share (10 minutes) • Tell students to take out the **Industrial Food Chain Cascading Consequences charts** (that they started on blank paper in Lesson 1), to which they added for homework. • Remind students that a consequence is an effect, result, impact, or outcome of something occurring earlier. • Invite four students (one from each text excerpt) to share out one branch that they added to the Cascading Consequences chart for homework with an explanation of why they connected the boxes the way they did. • Give students an example of how you want their share-out to sound. For example, you might say: * "I read Excerpt 2, pages 31–39. One branch I added started with the box 'Depends highly on fossil fuels,' from page 31. I put it coming directly from the Industrial Food Chain box because it means that the entire food chain depends on fossil fuels. I added just one other box to the branch: 'Industrial farms are not efficient in terms of calories in vs. calories out,' from page 32. This is a direct effect of the use of fossil fuels, so it comes from that box." • As they share, add the boxes to the class chart. Invite all students to add the same boxes to their own Cascading Consequences charts. The **Industrial Food Chain Cascading Consequences chart with additional text excerpts (for teacher reference)** gives an idea of what students might have added for homework. When you ask students to share out, they should NOT report every box they added, because this will take too long. They will report just one branch of their chart, and you will add those boxes to the class chart you have displayed. Remind students that the consequences should be cascading—one main consequence, which then causes another consequence, and another, and so on and so forth. Note: The class version will not be as detailed as the Industrial Food Chain Cascading Consequences chart with additional text excerpts (for teacher reference). • The following consequences should definitely be added to the class chart because they are the topics that students will research later in the lesson using their research folders. In the Cascading Consequences Chart with additional text excerpts (for teacher reference), they are outlined with a thick black border. If these boxes are not added by the four students who share out, add them now and direct students to refer to the appropriate pages of ***The Omnivore's Dilemma*** and guide students carefully in adding to the Cascading Consequences chart: – Cattle raised on CAFOs (Concentrated Animal Feeding Operations) – Companies create genetically modified seed (GMO) to increase yields – Government policies keep prices of corn low – Antibiotics are given	• Mixed-ability grouping of students for discussion about research, cascading consequences, and stakeholders will provide a collaborative and supportive structure. Determine these groups ahead of time. • You might also decide to create homogeneous groups, which allows advanced learners to interact with similar peers while the teacher works directly with those who need it most.

Opening (continued)	Meeting Students' Needs
B. Unpacking the Learning Targets (5 minutes) • Direct students to the focus question posted in the classroom—the question they will be answering at the end of this unit in a speech and in the next unit in a position paper—and read it aloud: * "Which of Michael Pollan's four food chains would best feed all the people in the United States?" • Remind students that the purpose of the Cascading Consequences charts and the research they are doing is to gather evidence to be able to answer this question orally at the end of Unit 2 and in writing in Unit 3. Explain that to help them answer this focus question through research in this unit, they are going to answer the following research question. Direct students' attention to the research question now posted in the classroom, and read it aloud: * "What are the consequences of each of Michael Pollan's four food chains?" • Distribute the **researcher's roadmap** and direct students' attention to the large researcher's roadmap posted on the wall. Invite students to read the researcher's roadmap silently to themselves and answer the questions: * "What do you notice? What do you wonder?" • Cold call several students to share their responses. • Ask students to Think-Pair-Share with an elbow partner: * "What steps have we already accomplished? Where do you think we need to go next?" • Listen for students to say that the class has set a purpose for their research with the research question that they used with *The Omnivore's Dilemma* in the last lesson to gather background information on their Cascading Consequences charts, and that they now need to generate supporting research questions. • Read the learning targets out loud: * "I can develop a supporting research question to help me focus my research." * "I can evaluate research sources to choose the most appropriate one to answer my supporting research question." Explain to students that they will spend the first half of today's lesson thinking about how to create good supporting research questions and the second half of the class using a supporting research question to choose an article for further research on one of the topics in the Cascading Consequences chart.	• ELLs might benefit from seeing a graphic representation of each of the four food chains. If you create these, keep them visible throughout the unit. • You might focus students who need additional support on one section of the researcher's roadmap at a time.

Work Time	Meeting Students' Needs
A. Mini Lesson: Criteria of a Supporting Research Question (10 minutes) • Explain that coming up with more specific questions to focus your research can help you find the right sources to use. It also helps you know exactly what you are looking for as you read a source. • Explain that the purpose of the next activity—Which Question Is Best?—is to start thinking about the criteria of a good supporting research question. • Distribute **Question Set A** to half of the class and **Question Set B** to the other half of the class. • Invite students to read the directions listed beneath their questions with you. • Invite students to return to their seats and Think-Pair-Share with an elbow partner: * "What makes a good supporting research question and why?" • Cold call several partnerships to share their thinking. • Display the **Good Supporting Research Questions Are … anchor chart**. Use student answers and this criteria list to explain the three key criteria for good supporting research questions. • Post research teams and invite students to quickly move to sit with their new research teams.	• Some students may benefit from having sentence stems or a word bank during this conversation.

Work Time (continued)	Meeting Students' Needs
B. Guided Practice: Developing a Supporting Research Question (8 minutes) • Direct students to consult with their research teams to decide who will be responsible for researching each of the four topics: CAFOs (Concentrated Animal Feeding Operations), Genetically Modified Seed, Cheap Food and Farm Subsidies, and Antibiotics and the Meat Industry. – Note: Consider using the Numbered Heads checking for understanding technique to help teams decide which topic to research. Research teams assign each of the students a number, 1 through 4. Then the teacher calls out one of those numbers. The person with that number gets to make the choice first. The teacher then calls out the other numbers one at a time so each student can make his or her choice. This is a fair way of choosing topics within the research teams and can be repeated for the other three food chains. • Invite students to draft a supporting research question for the topic they have been assigned by their research team, keeping in mind the displayed Good Supporting Research Questions Are ... anchor chart. • Invite two or three students to share the question they drafted. For each question, ask the whole group: * "Does this supporting research question meet the criteria on the criteria list?" • Cold call one or two students to explain their thinking. Add any explanation you think is necessary. • Distribute the **list of supporting research questions**, organized by topic. • Invite students to choose the question for their assigned topic that is closest to the one they created or that is the most interesting to them. Direct them to circle the question they choose. • Once they have chosen their question, invite students to Think-Pair-Share with an elbow partner about the following question: * "How does this question meet the criteria for a good supporting research question in our anchor chart?"	Invite any students who need support drafting their research question to the "help desk"—a place in the classroom where the teacher or supporting adult is available to talk over students' ideas with them.

Work Time (continued)	Meeting Students' Needs
C. Evaluate Resources in Research Folders (8 minutes) • Using one **research folder** as a model, show students how they are organized. Consider displaying the research folder **table of contents**. • Explain that each topic has two articles and that it is up to the students to carefully choose which article of the two will best answer their supporting research question. • Post these steps for choosing a research article from the folder and invite students to read them with you: – Step 1: Find the two articles in the research folder for your topic. – Step 2: Scan the title, headings, picture (if any), and general structure of the article. – Step 3: Based on the text features, choose the article that seems like it will best answer your supporting research question. – Step 4: Read the first couple of paragraphs for the gist. If the first couple of paragraphs suggest that it contains possible answers to your supporting research question, keep this article. If the first paragraph makes you think that the article may not answer your question, choose the other article.	• During this time, you might allow students to read aloud to one another as needed. In addition, if articles are available in electronic form, some students might use technology to hear them for the gist.

Closing and Assessment	Meeting Students' Needs

A. Debrief (4 minutes)
• Once again, direct students to the large researcher's roadmap posted on the wall. Explain that throughout the unit, anchor charts for specific research skills will be posted next to the roadmap. These are the skills they will be assessed on in the mid-unit assessment. In this debrief, they will add to the Good Supporting Research Questions Are … anchor chart.
• Review today's learning targets.
• Invite students to Think-Pair-Share:
  * "Why do we use supporting research questions in our research?"
  * "What makes a good supporting research question?"
• As students share out the answer to the second question, add to the Good Supporting Research Questions Are … anchor chart. On the chart write:
  * "Focused on a particular aspect of your topic (consequences)"
  * "Answerable"
  * "Relevant to the topic"
• Preview the homework with students.	

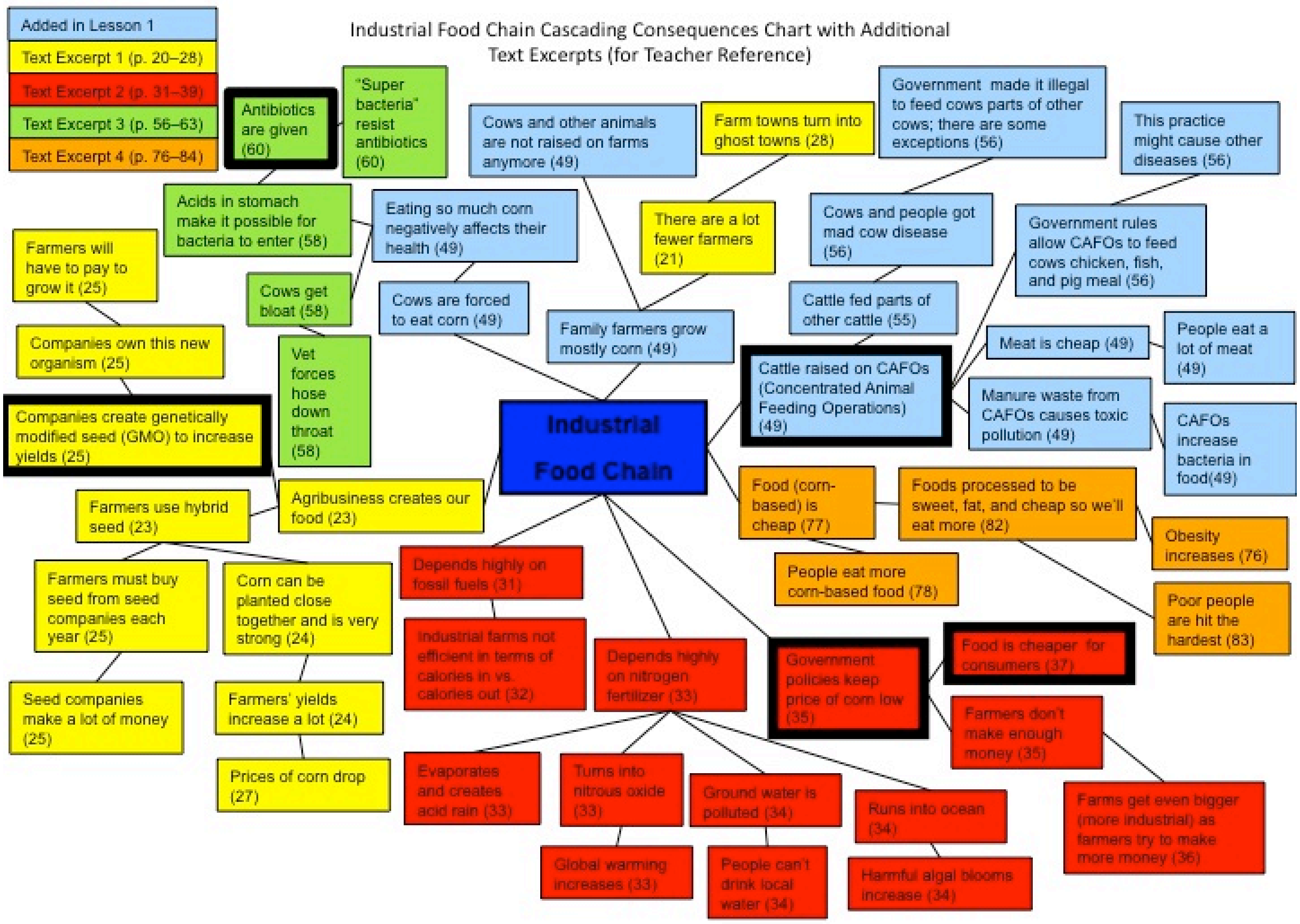
Homework	Meeting Students' Needs
• Read your resource for the gist in preparation for the next lesson.	• Some students may need to hear their articles for the gist.

EXPEDITIONARY LEARNING

Grade 8: Module 4: Unit 2: Lesson 2
Supporting Materials

Industrial Food Chain Cascading Consequences Chart with Additional Text Excerpts

For Teacher Reference



Researcher's Roadmap

Good researchers stop often to look around and see where they are, check their maps, and set their course toward their final destination. They sometimes take side trips, but they use their route-finding tools to reach their destinations.

INITIATING INQUIRY

Step 1: Set a purpose for research: What is the **research question**? What information do you need to find? Why is this research worthwhile?

Step 2: Gather background information about your topic from a reliable source and generate **supporting research question(s)**.

GATHERING SOURCES

Step 3: Gather a variety of reliable and relevant sources.

- Generate and use **effective search terms**.
- Read for the gist to see if the source answers your question(s).

ANALYZING SOURCES

Step 4: Use your sources. For each source:

- Assess the source's **credibility and accuracy**.
- Record the bibliographic information for the source.
- **Paraphrase** the parts of the text that are relevant.
- Correctly **cite** your source.

EVALUATING RESEARCH

Step 5: After you are done reading a source, step back and evaluate:

- How well did the source answer my supporting research question(s)?
- What additional supporting research questions did I generate?

DEVELOPING AN EVIDENCE-BASED PERSPECTIVE

Step 6: When you have enough information, synthesize and share your findings.

Question Set A

Question 1:
How is nitrogen fertilizer made?

Question 2:
Do we have genetically modified organisms in the food we eat now?

Question 3:
What are conditions like for animals on CAFOs?

Steps for Which Question Is Best?

Step 1: Move around the room to find a partner who has a different question set from yours. (If you have Question Set A, your partner should have Question Set B.)

Step 2: With your partner, take turns reading Question 1 aloud.

Step 3: Discuss which question is the better supporting research question for your work and why.

Question Set B

Question 1:
How does nitrogen fertilizer affect oceans?

Question 2:
Will we have genetically modified organisms in the food we eat in the future?

Question 3:
Are there other countries that have Concentrated Animal Feeding Operations (CAFOs)?

Steps for Which Question Is Best?

Step 1: Move around the room to find a partner who has a different question set from yours. (If you have Question Set A, your partner should have Question Set B.)

Step 2: With your partner, take turns reading Question 1 aloud.

Step 3: Discuss which question is the better supporting research question for your work and why.

Good Supporting Research Questions Are…

Focused on a particular aspect of your topic

No: How is nitrogen fertilizer made?
Yes: How does nitrogen fertilizer affect oceans?
Ask yourself: "Is my question going to help me get more information about the CONSEQUENCES of a particular topic from the Cascading Consequences chart?"

Answerable

No: Will our food come from genetically modified seed in the future?
Yes: Does the food we eat now come from genetically modified seed?
Ask yourself: "Can I realistically find information to answer this question?"

Relevant to the topic

No: Are there other countries that have Concentrated Animal Feeding Operations (CAFOs)?
Yes: What are conditions like for animals on CAFOs?
Ask yourself: "Will my question help me answer our research question and our focus question?"

List of Supporting Research Questions

CAFOs (Concentrated Animal Feeding Operations)

- What pollution comes from CAFOs?
- How do CAFOs affect the communities around them?
- What are the benefits of CAFOs?
- What are the negative effects of CAFOs?

Genetically Modified Seed

- What have studies shown about the safety of genetically modified crops for our health?
- What are the positive effects of genetically modified crops?
- What are problems with genetically modified crops?

Cheap Food and Farm Subsidies

- Why is unhealthy food cheaper?
- What are the positive effects of farm subsidies?
- What are the problems with farm subsidies?

Antibiotics and the Meat Industry

- What are the positive effects of using antibiotics in the meat industry?
- What are the negative effects of using antibiotics in the meat industry?
- What have studies shown about the connection between antibiotics given to animals in feedlots and human health?

Research Folder
Table of Contents

Topic	Articles
CAFOs (Concentrated Animal Feeding Operations)	Article 1: Understanding Concentrated Animal Feeding Operations and Their Impact on Communities (pages 2–3: Benefits and Environmental Health Effects of CAFOs)
	Article 2: The Economic Impact of the Indiana Livestock Industry
Genetically Modified Seed	Article 1: Genetically Engineered Crops—What, How, and Why
	Article 2: Drought and Superbugs Devastate U.S. Corn Crop
Cheap Food and Farm Subsidies	Article 1: The Cultivation of Agricultural Subsidies (pages 8–9: Instant Expert: Subsidies Edition)
Antibiotics and the Meat Industry	Article 1: Antibiotic Debate Overview
	Article 2: The Meat Industry's Argument

CAFOs (Concentrated Animal Feeding Operations)

Article 1:

The 2003 CAFO rule was subsequently challenged in court. A Second Circuit Court of Appeals decision required alteration to the CAFO permitting system. In *Water Keeper et al. vs. the EPA*, the court directed the EPA to remove the requirement for all CAFOs to apply for NPDES. Instead, the court required that nutrient management plans be submitted with the permit application, reviewed by officials and the public, and the terms of the plan be incorporated into the permit.

As a result of this court decision, the CAFO rule was again updated. The current final CAFO rule, which was revised in 2008, requires that only CAFOs which discharge or propose to discharge waste apply for permits. The EPA has also provided clarification in the discussion surrounding the rule on how CAFOs should assess whether they discharge or propose to discharge. There is also the opportunity to receive a no discharge certification for CAFOs that do not discharge or propose to discharge. This certification demonstrates that the CAFO is not required to acquire a permit. And while CAFOs were required to create nutrient management plans under the 2003 rule, these plans were now included with permit applications, and had a built-in time period for public review and comment.

Benefits of CAFOs

When properly managed, located, and monitored, CAFOs can provide a low-cost source of meat, milk, and eggs, due to efficient feeding and housing of animals, increased facility size, and animal specialization. When CAFOs are proposed in a local area, it is usually argued that they will enhance the local economy and increase employment. The effects of using local materials, feed, and livestock are argued to ripple throughout the economy, and increased tax expenditures will lead to increase funds for schools and infrastructure.

Environmental Health Effects

The most pressing public health issue associated with CAFOs stems from the amount of manure they produce. CAFO manure contains a variety of potential contaminants. It can contain plant nutrients such as nitrogen and phosphorus, pathogens such as *E. coli*, growth hormones, antibiotics, chemicals used as additives to the manure or to clean equipment, animal blood, silage leachate from corn feed, or copper sulfate used in footbaths for cows.

Depending on the type and number of animals in the farm, manure production can range between 2,800 tons and 1.6 million tons a year (Government Accountability Office [GAO], 2008). Large farms can produce more waste than some U.S. cities—a feeding operation with 800,000 pigs could produce over 1.6 million tons of waste a year. That amount is one and a half times more than the annual sanitary waste produced by the city of Philadelphia, Pennsylvania (GAO, 2008). Annually, it is estimated that livestock animals in the U.S. produce each year somewhere between 3 and 20 times more manure than people in the U.S. produce, or as much as 1.2–1.37 billion tons of waste (EPA, 2005). Though sewage treatment plants are required for human waste, no such treatment facility exists for livestock waste.

While manure is valuable to the farming industry, in quantities this large it becomes problematic. Many farms no longer grow their own feed, so they cannot use all the manure they produce as fertilizer. CAFOs must find a way to manage the amount of manure produced by their animals. Ground application of untreated manure is one of the most common disposal methods due to its low cost. It has limitations, however, such as the inability to apply manure while the ground is frozen. There are also limits as to how many nutrients from manure a land area can handle. Over application of livestock wastes can overload

CAFOs (Concentrated Animal Feeding Operations)

Article 1:

soil with macronutrients like nitrogen and phosphorous and micronutrients that have been added to animal feed like heavy metals (Burkholder et al., 2007). Other manure management strategies include pumping liquefied manure onto spray fields, trucking it off-site, or storing it until it can be used or treated. Manure can be stored in deep pits under the buildings that hold animals, in clay or concrete pits, treatment lagoons, or holding ponds.

Animal feeding operations are developing in close proximity in some states, and fields where manure is applied have become clustered. When manure is applied too frequently or in too large a quantity to an area, nutrients overwhelm the absorptive capacity of the soil, and either run off or are leached into the groundwater. Storage units can break or become faulty, or rainwater can cause holding lagoons to overflow. While CAFOs are required to have permits that limit the levels of manure discharge, handling the large amounts of manure inevitably causes accidental releases which have the ability to potentially impact humans.

The increased clustering and growth of CAFOs has led to growing environmental problems in many communities. The excess production of manure and problems with storage or manure management can affect ground and surface water quality. Emissions from degrading manure and livestock digestive processes produce air pollutants that often affect ambient air quality in communities surrounding CAFOs. CAFOs can also be the source of greenhouse gases, which contribute to global climate change.

All of the environmental problems with CAFOs have direct impact on human health and welfare for communities that contain large industrial farms. As the following sections demonstrate, human health can suffer because of contaminated air and degraded water quality, or from diseases spread from farms. Quality of life can suffer because of odors or insect vectors surrounding farms, and property values can drop, affecting the financial stability of a community. One study found that 82.8% of those living near and 89.5% of those living far from CAFOs believed that their property values decreased, and 92.2% of those living near and 78.9% of those living far from CAFOs believed the odor from manure was a problem. The study found that real estate values had not dropped and odor infestations were not validated by local governmental staff in the areas. However, the concerns show that CAFOs remain contentious in communities (Schmalzried and Fallon, 2007). CAFOs are an excellent example of how environmental problems can directly impact human and community well-being.

Groundwater

Groundwater can be contaminated by CAFOs through runoff from land application of manure, leaching from manure that has been improperly spread on land, or through leaks or breaks in storage or containment units. The EPA's 2000 National Water Quality Inventory found that 29 states specifically identified animal feeding operations, not just concentrated animal feeding operations, as contributing to water quality impairment (Congressional Research Service, 2008). A study of private water wells in Idaho detected levels of veterinary antibiotics, as well as elevated levels of nitrates (Batt, Snow, & Alga, 2006). Groundwater is a major source of drinking water in the United States. The EPA estimates that 53% of the population relies on groundwater for drinking water, often at much higher rates in rural areas (EPA, 2004). Unlike surface water, groundwater contamination sources are more difficult to monitor. The extent and source of contamination are often harder to pinpoint in groundwater than surface water contamination. Regular testing of household water wells for total and fecal coliform bacteria is a crucial element in monitoring groundwater quality, and can be the first step in discovering contamination issues related to CAFO discharge. Groundwater contamination can also affect surface water (Spellman &

"Understanding Concentrated Animal Feeding Operations and Their Impact on Communities" by Carrie Hribar (author) and Mark Schulz (editor), published in 2010 by the National Association of Local Boards of Health.

Glossary of Terms for Research Articles
(One set for each Research Folder)

CAFOs (Concentrated Animal Feeding Operations) Article 1: Understanding Concentrated Animal Feeding Operations and Their Impact on Communities (pages 2-3: Benefits and Environmental Health Effects of CAFOs)	
CAFO	Concentrated Animal Feeding Operation
efficient	operating in an effective and competent manner, with little wasted effort
livestock	the horses, cattle, sheep, and other useful animals kept or raised on a farm or ranch
infrastructure	the fundamental facilities and systems serving a country, city, or area, as transportation and communication systems, power plants, and schools
contaminant	something that makes impure, esp by touching or mixing; something that pollutes
nutrient	any of the mineral substances that are absorbed by the roots of plants for nourishment
pathogen	any disease-producing agent, especially a virus, bacterium, or other microorganism
absorptive capacity	the ability to absorb
degraded	lowered in quality or value
odor	a disagreeable smell
vector	an insect or other organism that transmits a pathogenic fungus, virus, bacterium, etc.
validate	to confirm
contentious	causing, involving, or characterized by argument or controversy

CAFOs (Concentrated Animal Feeding Operations)
Article 2:

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Glossary of Terms for Research Articles

(One set for each Research Folder)

CAFOs (Concentrated Animal Feeding Operations) Article 2: The Economic Impact of the Indiana Livestock Industry	
livestock	the horses, cattle, sheep, and other useful animals kept or raised on a farm or ranch
direct impact	all spending by the [livestock] industry
indirect impact	all spending by the firms that sell goods or services to the [livestock] industry
induced impact	spending done by the people earning income because of the [livestock] industry
wage	money that is paid or received for work or services
output	sales
salary	a fixed compensation periodically paid to a person for regular work or services
attributable	resulting from
broiler	a chicken raised for food

Genetically Modified Seed
Article 1

Genetically Engineered Crops—What, How and Why
By Pamela Ronald | August 11, 2011

By the turn of the century, the number of people on Earth is expected to increase from the current 6.7 billion to 10 billion. How can we feed the growing population without further degrading the environment?

Because the amount of land and water is limited, it is no longer possible to simply expand farmland to produce more food. Instead, increased food production must largely take place on the same land area, while using less water. Compounding the challenges facing agricultural production are the predicted effects of climate change: flooding in some places, droughts in others and new pests and disease outbreaks.

Thus, an important goal for the US and other countries is to develop more effective land and water use policies, improved integrated pest management approaches, reduce harmful inputs, and create new crop varieties tolerant of diverse stresses.

These strategies must be evaluated in light of their environmental, economic, and social impacts—the three pillars of sustainable agriculture (Committee on the Impact of Biotechnology on Farm-Level Economics and Sustainability and National Research Council 2010).

WHAT ARE GENETICALLY ENGINEERED CROPS?

Genetic engineering differs from conventional methods of genetic modification in two major ways: (1) genetic engineering introduces one or a few well-characterized genes into a plant species and (2) genetic engineering can introduce genes from any species into a plant. In contrast, most conventional methods of genetic modification used to create new varieties (e.g., artificial selection, forced interspecific transfer, random mutagenesis, marker-assisted selection, and grafting of two species, etc.) introduce many uncharacterized genes into the same species. Conventional modification can in some cases transfer genes between species, such as wheat and rye or barley and rye.

In 2008, the most recent year for which statistics are available, 30 genetically engineered crops were grown on almost 300 million acres in 25 countries (nearly the size of the state of Alaska), 15 of which were developing countries (James 2009). By 2015, 120 genetically engineered crops (including potato and rice) are expected to be cultivated worldwide (Stein and Rodriguez-Cerezo 2009). Half of the increase will be crops designed for domestic markets from national technology providers in Asia and Latin America.

Genetically Modified Seed
Article 1

SAFETY ASSESSMENT OF GENETICALLY ENGINEERED CROPS

There is broad scientific consensus that genetically engineered crops currently on the market are safe to eat. After 14 years of cultivation and a cumulative total of 2 billion acres planted, no adverse health or environmental effects have resulted from commercialization of genetically engineered crops (Board on Agriculture and Natural Resources, Committee on Environmental Impacts Associated with Commercialization of Transgenic Plants, National Research Council and Division on Earth and Life Studies 2002). Both the U.S. National Research Council and the Joint Research Centre (the European Union's scientific and technical research laboratory and an integral part of the European Commission) have concluded that there is a comprehensive body of knowledge that adequately addresses the food safety issue of genetically engineered crops (Committee on Identifying and Assessing Unintended Effects of Genetically Engineered Foods on Human Health and National Research Council 2004; European Commission Joint Research Centre 2008).

These and other recent reports conclude that the processes of genetic engineering and conventional breeding are no different in terms of unintended consequences to human health and the environment (European Commission Directorate-General for Research and Innovation 2010). This is not to say that every new variety will be as benign as the crops currently on the market. This is because each new plant variety (whether it is developed through genetic engineering or conventional approaches of genetic modification) carries a risk of unintended consequences. Whereas each new genetically engineered crop variety is assessed on a case-bycase basis by three governmental agencies, conventional crops are not regulated by these agencies.

Still, to date, compounds with harmful effects on humans or animals have been documented only in foods developed through conventional breeding approaches. For example, conventional breeders selected a celery variety with relatively high amounts of psoralens to deter insect predators that damage the plant. Some farm workers who harvested such celery developed a severe skin rash—an unintended consequence of this breeding strategy (Committee on Identifying and Assessing Unintended Effects of Genetically Engineered Foods on Human Health and National Research Council 2004).

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Article 1

INSECT-RESISTANT CROPS

"A truly extraordinary variety of alternatives to the chemical control of insects is available. Some are already in use and have achieved brilliant success. Others are in the stage of laboratory testing. Still others are little more than ideas in the minds of imaginative scientists, waiting for the opportunity to put them to the test. All have this in common: they are biological solutions, based on the understanding of the living organisms they seek to control and of the whole fabric of life to which these organisms belong. Specialists representing various areas of the vast field of biology are contributing—entomologists, pathologists, geneticists, physiologists, biochemists, ecologists—all pouring their knowledge and their creative inspirations into the formation of a new science of biotic controls." (Carson 1962, p. 278)

In the 1960s, the biologist Rachel Carson brought the harmful environmental and human health impacts resulting from overuse or misuse of some insecticides to the attention of the wider public. Even today, thousands of pesticide poisonings are reported each year (1200 illnesses related to pesticide poisoning in California, 300,000 pesticide-related deaths globally).

This is one reason some of the first genetically engineered crops were designed to reduce reliance on sprays of broad-spectrum insecticides for pest control. Corn and cotton have been genetically engineered to produce proteins from the soil bacteria *Bacillus thuringiensis* (Bt) that kill some key caterpillar and beetle pests of these crops. Bt toxins cause little or no harm to most beneficial insects, wildlife, and people (Mendelsohn et al. 2003).

Bt toxins kill susceptible insects when they eat Bt crops. This means that Bt crops are especially useful for controlling pests that feed inside plants and that cannot be killed readily by sprays, such as the European corn borer (*Ostrinia nubilalis*), which bores into stems, and the pink bollworm (*Pectinophora gossypiella*), which bores into bolls of cotton.

First commercialized in 1996, Bt crops are the second most widely planted type of transgenic crop. Bt toxins in sprayable formulations were used for insect control long before Bt crops were developed and are still used extensively by organic growers and others. The long-term history of the use of Bt sprays allowed the Environmental Protection Agency and the Food and Drug Administration to consider decades of human exposure in assessing human safety before approving Bt crops for commercial use. In addition, numerous toxicity and allergenicity tests were conducted on many different kinds of naturally occurring Bt toxins. These tests and the history of spraying Bt toxins on food crops led to the conclusion that Bt corn is as safe as its conventional counterpart and therefore would not adversely affect human and animal health or the environment (European Food Safety Authority 2004).

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Planting of Bt crops has resulted in the application of fewer pounds of chemical insecticides and thereby has provided environmental and economic benefits that are key to sustainable agricultural production. In Arizona, where an integrated pest management program for Bt cotton continues to be effective, growers reduced insecticide use by 70% and saved .$200 million from 1996 to 2008 (Naranjo and Ellsworth 2009).

A recent study indicates that the economic benefits resulting from Bt corn are not limited to growers of the genetically engineered crop (Hutchison et al. 2010). In 2009, Bt corn was planted on .22.2 million hectares, constituting 63% of the U.S. crop. For growers of corn in Illinois, Minnesota, and Wisconsin, cumulative benefits over 14 years are an estimated $3.2 billion. Importantly, $2.4 billion of this total benefit accrued to non-Bt corn (Hutchison et al. 2010). This is because area-wide suppression of the primary pest, *O. nubilalis*, reduced damage to non-Bt corn. Comparable estimates for Iowa and Nebraska are $3.6 billion in total, with $1.9 billion for non-Bt corn. These data confirm the trend seen in some earlier studies indicating that communal benefits are sometimes associated with planting of Bt crops (Carriere et al. 2003; Wu et al. 2008; Tabashnik 2010).

Planting of Bt crops has also supported another important goal of sustainable agriculture: increased biological diversity. An analysis of 42 field experiments indicates that nontarget invertebrates (i.e., insects, spiders, mites, and related species that are not pests targeted by Bt crops) were more abundant in Bt cotton and Bt corn fields than in conventional fields managed with insecticides (Marvier et al. 2007). The conclusion that growing Bt crops promotes biodiversity assumes a baseline condition of insecticide treatments, which applies to 23% of corn acreage and 71% of cotton acreage in the United States in 2005 (Marvier et al. 2007).

Benefits of Bt crops have also been well-documented in less-developed countries. For example, Chinese and Indian farmers growing genetically engineered cotton or rice were able to dramatically reduce their use of insecticides (Huang et al. 2002, 2005; Qaim and Zilberman 2003; Bennett et al. 2006). In a study of precommercialization use of genetically engineered rice in China, these reductions were accompanied by a decrease in insecticide-related injuries (Huang et al. 2005).

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Although Bt cotton is effective in reducing cotton bollworm outbreaks in China other pests that are not killed by Bt cotton are increasingly problematic (Wu Review 13et al. 2008; Lu et al. 2010). These results confirm the need to integrate Bt crops with other pest control tactics (Tabashnik et al. 2010). In Arizona, such an integrated pest management (IPM) approach has been implemented (Naranjo and Ellsworth 2009). In Arizona's cotton IPM system, key pests not controlled by Bt cotton are managed with limited use of narrow-spectrum insecticides that promote conservation of beneficial insects (Naranjo and Ellsworth 2009). Mirids such as the Lygus bug (*Lygus hesperus*) are controlled with a feeding inhibitor, and the sweet potato whitefly (*Bemisia tabaci*) is controlled with insect growth regulators (Naranjo and Ellsworth 2009).

One limitation of using any insecticide, whether it is organic, synthetic, or genetically engineered, is that insects can evolve resistance to it. For example, one crop pest, the diamondback moth (*Plutella xylostella*), has evolved resistance to Bt toxins. This resistance occurred in response to repeated sprays of Bt toxins to control this pest on conventional (nongenetically engineered) vegetable crops (Tabashnik 1994).

These results underscore a well-known paradigm in agriculture: pest resistance will evolve is the selection pressure is high. Why then, have most Bt crops remained effective against most pests for more than a decade (Tabashnik et al. 2008; Carriere et al. 2010)? The answer is genetic diversity. The inclusion in farmers fields of crop plants that do not make Bt toxins has helped to delay evolution of pest resistance to Bt crops (Carriere et al. 2010).

In cases where insect resistance to Bt crops has evolved, one or more conditions of this crop diversity strategy have not been met. For example, failure to provide adequate refuges of non-Bt cotton appears to have hastened resistance of pink bollworm in India (Bagla 2010). In contrast, Arizona cotton growers complied with this strategy from 1996 to 2005, and no increase in pink bollworm resistance occurred (Tabashnik et al. 2010).

In the United States, Bt cotton producing only Cry1Ac is no longer registered and has been replaced primarily by Bt cotton that produces two toxins (Carriere et al. 2010). More generally, most newer cultivars of Bt cotton and Bt corn produce two or more toxins. These multitoxin Bt crops are designed to help delay resistance an to kill a broader spectrum of insect pests (Carriere et al. 2010). For example, a new type of Bt corn produces five Bt toxins—three that kill caterpillars and two that kill beetles (Dow Agrosciences 2009).

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Despite the success of the crop diversity strategy in delaying insect resistance to Bt crops, this approach has limitations, including the fact that not all farmers will comply. An alternative strategy entails release of sterile insects to mate with resistant insects (Tabashnik et al. 2010). Incorporation of this strategy in a multi-tactic eradication program in Arizona from 2006 to 2009 reduced pink bollworm abundance by 99%, while eliminating insecticide sprays against this pest. The success of such creative multidisciplinary integrated approaches, involving entomologists, geneticists, physiologists, biochemists, and ecologists, provides a roadmap for the future of agricultural production and attests to the foresight of Rachel Carson.

Ronald, Pamela. "Genetically Engineered Crops-What, How and Why." Scientific American. 11 Aug 2011. http://blogs.scientificamerican.com/guest-blog/2011/08/11/genetically-engineered-crops/

Glossary of Terms for Research Articles

Genetically Modified Seed Article 1: Genetically Engineered Crops—What, How and Why	
integrated pest management	an ecological approach to pest management that combines understanding the causes of pest outbreaks, manipulating the crop ecosystem for pest control, and monitoring pest populations and their life cycles to determine if and when the use of pesticides is indicated
tolerant	able to accept or withstand unfavorable conditions or effects
diverse	of various kinds
gene	a section of a chromosome that determines the structure of a single protein or part of one, thereby influencing a particular hereditary characteristic, such as eye color, or a particular biochemical reaction
conventional	commonplace, ordinary
consensus	agreement
cultivation	growing
adverse	harmful
commercializati on	offering for sale; making available as a commodity
unintended	accidental, unplanned
reliance	dependence
transgenic	of, pertaining to, or containing a gene or genes transferred from another species:

Genetically Modified Seed

Article 2:

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Glossary of Terms for Research Articles

(One set for each Research Folder)

Genetically Modified Seed Article 2: Drought and Superbugs Devastate U.S. Corn Crop	
unintended	accidental, unplanned
Bt corn	corn that has been genetically engineered to produce proteins from the soil bacteria *Bacillus thuringiensis* (Bt) that kill some key caterpillar and beetle pests
resistant	able to withstand something; not affected by
recourse	that which may be turned to for assistance, protection, or a way out of a difficult situation
infestation	a harassing or troublesome invasion [of pests]
cronyism	the practice of favoring one's close friends
dismantle	to take apart; to take down

Cheap Food and Farm Subsidies

Article 1:

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Source: http://www-tc.pbs.org/teachers/media/pdf/access-analyze-act-economy/lesson-plans/the-cultivation-of-agricultural-subsidies/the-cultivation-of-agricultural-subsidies.pdf

Glossary of Terms for Research Articles
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Cheap Food and Farm Subsidies Article 1: The Cultivation of Agricultural Subsidies (pages 8-9: Instant Expert: Subsidies Edition)	
legislation	a bill enacted into law by a governing body
yield	thing or amount produced
revenue	income; profits
fluctuate	to vary or change irregularly; rise and fall
proponent	supporter
lean	lacking in richness or quantity; poor
guarantee	a promise or assurance, especially one in writing, that something is of specified quality, content, benefit, etc
domestic	produced or made in one's own country
fluctuation	continual change from one point or condition to another
stifle	to hold back, end, or kill
feasible	possible

Antibiotics and the Meat Industry
Article 1:

Antibiotic Debate Overview

Ranchers and farmers have been feeding antibiotics to the animals we eat since they discovered decades ago that small doses of antibiotics administered daily would make most animals gain as much as 3 percent more weight than they otherwise would. In an industry where profits are measured in pennies per animal, such weight gain was revolutionary.

Although it is still unclear exactly why feeding small "sub-therapeutic" doses of antibiotics, like tetracycline, to animals makes them gain weight, there is some evidence to indicate that the antibiotics kill the flora that would normally thrive in the animals' intestines, thereby allowing the animals to utilize their food more effectively.

The meat industry doesn't publicize its use of antibiotics, so accurate information on the amount of antibiotics given to food animals is hard to come by. Stuart B. Levy, M.D., who has studied the subject for years, estimates that there are 15-17 million pounds of antibiotics used sub-therapeutically in the United States each year. Antibiotics are given to animals for therapeutic reasons, but that use isn't as controversial because few argue that sick animals should not be treated.

The biggest controversy centers around taking antibiotics that are used to treat human illnesses and administering them to food animals. There is an increasing amount of evidence suggesting that the sub-therapeutic use of antibiotics in food animals can pose a health risk to humans. If a group of animals is treated with a certain antibiotic over time, the bacteria living in those animals will become resistant to that drug. According to microbiologist Dr. Glenn Morris, the problem for humans is that if a person ingests the resistant bacteria via improperly cooked meat and becomes ill, he or she may not respond to antibiotic treatment.

Concern about the growing level of drug-resistant bacteria has led to the banning of sub-therapeutic use of antibiotics in meat animals in many countries in the European Union and Canada. In the United States, however, such use is still legal. The World Health Organization is concerned enough about antibiotic resistance to suggest significantly curbing the use of antibiotics in the animals we eat. In a recent report, the WHO declared its intention to "reduce the overuse and misuse of antimicrobials in food animals for the protection of human health." Specifically, the WHO recommended that prescriptions be required for all antibiotics used to treat sick food animals, and urged efforts to "terminate or rapidly phase out antimicrobials for growth promotion if they are used for human treatment."

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Although conclusive evidence directly linking the use of drugs in food animals to an increase in drug-resistant bacteria that make people sick has not been uncovered, a number of recent studies suggesting such a link concern many scientists. "There is no evidence that antibiotic resistance is not a problem, but there is insufficient evidence as to how big a problem it is," says Dr. Margaret Mellon, with the Union of Concerned Scientists.

In one study published in the New England Journal of Medicine on February 6, 2002, researchers found links that strongly suggested that the people who developed Cipro-resistant bacteria had acquired them by eating pork that were contaminated with salmonella. The report concluded that salmonella resistant to the antibiotic flouroquine can be spread from swine to humans, and, therefore, the use of flouroquinolones in food animals should be prohibited.

Another New England Journal of Medicine study from Oct. 18, 2001, found that 20 percent of ground meat obtained in supermarkets contained salmonella. Of that 20 percent that was contaminated with salmonella, 84 percent was resistant to at least one form of antibiotic.

CIPRO AND BAYTRIL

Some, including the FDA, believe the overuse of Baytril, an antibiotic used to treat sick birds, led to an increase in treatment-resistant bacterial infections in humans. Baytril is used by poultry growers to protect chickens and turkeys from E. coli infection. The size of commercial chicken flocks precludes testing and treating individual birds, so when a veterinarian diagnoses one infected bird, farmers treat the whole flock by adding the drug to its drinking water. General use of Baytril, therefore, falls in the gray area between therapeutic and sub-therapeutic.

Baytril is the sister drug to Cipro, which is used to treat and prevent anthrax as well ascampylobacteriosis and salmonellosis in people. The Food and Drug Administration, doctors, and consumer groups have all urged that Baytril be removed from the market on the grounds that its use in animals may eventually compromise the power of Cipro and similar antibiotics to fight disease in humans. Cipro and Baytril belong to a class of drugs known as fluoroquinolone, among the most powerful antibiotics currently available.

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Baytril first came up for approval for use in chickens six years ago. Physicians have used fluoroquinolones to treat food-borne illness since 1986, but fluoroquinolone-resistant bacteria were rare until 1995, when the FDA approved the use of these drugs in drinking water for poultry. The FDA's rough estimate, using 1999 data, is that use of fluoroquinolones in chickens resulted in over 11,000 people that year contracting a strain of the campylobacter illness that was resistant to fluoroquinolones, contributing to unnecessarily severe disease.

When the FDA proposed pulling Baytril use in chickens a year ago due to sharp increases in resistance to fluoroquinolones in campylobacter bacteria, one of the two manufacturers voluntarily withdrew its product. The other, Bayer, did not.
Bayer officials continue to offer the human drug Cipro at reduced rates to the American public, saying that they are not convinced that the use of fluoroquinolones in animals can be blamed for increased resistance in people. Until more proof is found of the specific danger to humans, they will not withdraw their product from the chicken market.

Glossary of Terms for Research Articles
(One set for each Research Folder)

Antibiotics and the Meat Industry Article 1: Antibiotic Debate Overview	
flora	the collection of bacteria, fungi, and other microorganisms normally occurring on or in the bodies of humans and other animals: intestinal flora
therapeutic	of, pertaining to, or capable of healing
resistant	able to withstand something; not affected by
terminate	to end
salmonella	a type of bacteria that may enter the digestive tract of humans and other mammals in contaminated food and cause abdominal pains and violent diarrhea
prohibit	to forbid by authority or law

Antibiotics and the Meat Industry
Article 2:

THE MEAT INDUSTRY'S ARGUMENT

For its part, the meat-production industry contends that there is not enough conclusive evidence to support measures like the FDA's proposed ban against flouroquinolones. Although none deny that the spread of antibacterial resistance is a real problem, proponents of sub-therapeutic antibiotic use in animals point out that the problem stems from overuse of all antibiotics, including therapeutic and preventative use in both animals and humans. Agricultural use may contribute to the problem, but it is impossible to determine to what extent.

In its recent report, the World Health Organization blamed the worldwide upswing in resistance to antibiotics on a combination of factors that included "overuse in many parts of the world, particularly for minor infections," and "misuse due to lack of access to appropriate treatment." The factors involved in the problem are clearly not limited to antibiotic use in animal feed.

"When someone's sick and goes to the doctor, they still expect to get a prescription," said National Chicken Council spokesman Richard Lobb. He said that people should look to themselves for the causes of antibiotic resistance, referring to the American practice of prescribing antibiotics for even the most minor of illnesses.

Increased use in hospitals may also contribute to the resistance problem. "Today, especially in intensive care wards, the amount of antibiotics in the environment can become high enough that people in the vicinity of patients receiving antibiotics are exposed continuously to low levels of antibiotics," microbiologist Abigail Salvers of University of Illinois told Scientific American. This low level of exposure, she contends, is one reason why highly resistant bacteria are developing in hospitals. She says that a similar phenomenon may be taking place in agriculture.

According to Alexander S. Matthews, president and CEO of the Animal Health Institute (AHI), removal of antibiotics from animals' feed and water "would lead to increased animal disease, a reduction in food safety and gain little, if anything, in the effort to control resistance." He suggests developing "prudent use principles."

Lowering or halting sub-therapeutic antibiotic use in animal production could have serious economic effects on the meat and poultry industry. According to a report released in May 2001 by USDA's Economic Research Service, discontinuing the use of antimicrobial drugs in hog production would initially decrease feed efficiency, raise food costs, reduce production and raise prices to consumers. According to the same report, U.S. hog producers saved about $63 million in feed costs in 1999 due to their use of low levels of sub-therapeutic drugs; they would have suffered an estimated loss of $45.5 million in 1999 if the drug use was banned.

Even within the industry, however, there is a growing movement to reduce at least the sub-therapeutic use of antibiotics in animals raised for food. Tyson Foods, Perdue Farms and Foster Farms, which collectively produce a third of the chicken Americans eat, recently declared their intention to greatly reduce the amount of antibiotics fed to healthy chicken. There is still no way for consumers to know whether one of these companies' chickens has been treated with antibiotics, although some corporate consumers, McDonald's, Wendy's and Popeye's among them, are refusing to buy chicken that has been treated with fluoroquinolones. Increased public pressure may cause the companies who grow animals for food to collectively decide that putting extra weight on feed animals isn't worth the possibility that they are putting consumers' health at risk.

Glossary of Terms for Research Articles

(One set for each Research Folder)

Antibiotics and the Meat Industry Article 2: The Meat Industry's Argument	
FDA	The Food and Drug Administration (a federal agency that protects the public against impure and unsafe foods, drugs, and cosmetics
resistant	able to withstand something; not affected by
therapeutic	of, pertaining to, or capable of healing
compromise	to endanger the reputation or character of; jeopardize
contract	to get or acquire, as by exposure to something contagious