Feed & Food Safety

In a Global Environment

Feed & Food Safety in a Global Environment is a set of seven ready-to-use animal and human food safety instruction modules for the high school level. These modules meet Washington State science or math standards emphasizing career options, global awareness, systems thinking, and case studies in emergent diseases and intentional feed contamination.

ABOUT WSDA

The people who do the work of the Washington State Department of Agriculture (WSDA) combine dedication, inquisitiveness and problem solving behaviors with their individual scientific, educational, compliance, business, and management skills to:

- Protect and reduce the risk to public health by assuring the safety of the state's human and animal food supply.
- Ensure the safe and legal distribution, use, and disposal of pesticides and fertilizers in Washington State.
- Protect Washington State's natural resources, agriculture industry, and the public from selected plant and animal pests and diseases.
- Facilitate the movement of Washington agricultural products in domestic and international markets.

With an international boundary on the north, the Pacific Ocean to the west, and the Columbia River to the south, Washington State was bound to be global. This unique access to international markets unfortunately brings increased exposure to the first landing of foreign animal diseases – some that can also be transmitted to humans, and intentionally or unintentionally contaminate food for animals and humans. Building effective and durable disease and food safety preventive controls is a far better option than carcass disposal, facility decontamination, curing (when possible) human illness, and rebuilding confidence in Washington agricultural products.

Internationally there is a proliferation of food safety schemes, but ultimately these are effective only when performed by individuals working within a culture of safety who understand that local events are now global events and global events are now local events.

Meeting global food safety challenges demands full recruitment of our diverse human resources. How is actionable intelligence brought to all participants? Can we educate the rising generation about the new global paradigm of food safety and defense—in time?

A core element of the 2007 Food and Drug Administration (FDA) Food Protection Plan is to “Build Safety in from the Start.” WSDA proposed to extend this concept to those who will become food producers, food processors, food animal veterinarians, and food regulatory officials of the future by developing ready-to-use animal and human food safety instruction modules meeting state educational standards in science or math for use in high school level Agricultural Education (Ag-Bio) classes. The lessons were conceived with Career & Technical Education (CTE) teaching approaches in mind, include learning assessment tools, and provide background content for teachers. Completed lessons will be available without charge on the WSDA website.

Prevention through traceability is the most important element of the new approach to food safety. This lesson set emphasizes Agricultural Education content but does not teach how to sex a chick or milk a goat. The lessons, instead, emphasize global awareness, Systems Thinking (traceability), emergent disease processes (prions) that challenge traditional biology, as well as the basic math concept of unit conversion, which still accounts for many cases of animal drug toxicity and animal drug residues in meat for human food. WSDA believes that this array of content transfers to public health benefits well beyond production agriculture. Students who find careers in logistics, purchasing, forensics, defense, politics, NGO’s, etc. will employ this learning to their personal benefit and toward realizing millennium goals.

In 2011, WSDA contracted with the Washington Global Health Alliance (WGHA) and Seattle BioMed to create lessons that develop these concepts.

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ABOUT THE WASHINGTON GLOBAL HEALTH ALLIANCE (WGHA)

The Washington Global Health Alliance (WGHA) was formed to facilitate collaboration within the extraordinary concentration of Washington global health nonprofits, research organizations, and education institutions. Core objectives are to facilitate opportunities for member institutions to partner for research and program collaborations, to engage, educate, and inspire the general public and key stakeholders about global health, and to increase education and mentoring activities. Washington State's global health leaders recognize that combining efforts to create life-saving technologies and train compassionate global health leaders is essential to make significant progress to save lives. WGHA's executive partners are:

- Battelle Corporation
- Bill & Melinda Gates Foundation
- Fred Hutchinson Cancer Research Center
- Infectious Disease Research Institute
- Institute for Systems Biology
- PATH
- Public Health—Seattle & King County
- Seattle BioMed
- Global Alliance for the Prevention of Prematurity and Stillbirth, an initiative of Seattle Children's
- SightLife
- University of Washington Department of Global Health
- Washington State University School for Global Animal Health
- World Vision

To learn more, visit the Washington Global Health Alliance website: http://www.wghalliance.org.

The WGHA Ambassadors Program (WGHAA) is specifically designed to inspire the next generation of global health leaders through an assortment of secondary curricula and practices that leverage the innovation and passion of our State's global health experts. WGHAA lessons and practices were built through a multi-year collaboration of Washington State high school teachers and WGHA members. To learn more, visit the Ambassadors website: http://www.wghaa.org.

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WSDA ACKNOWLEDGES

For planting the seed:

The Washington Association of Agricultural Educators (WAAE) for their interest in teaching feed/food safety content and for their clarity in setting essential criteria (i.e., ready-to-use modules that meet state standards for science or math, needed by instructors to even consider introducing new content in the highly competitive time/content educational environment).

For nurturing the seedling:

H. W. Gilman, M.S., Program Supervisor, Agriculture Education and Science, Washington State Office of the Superintendent of Public Instruction for his wisdom, perspective, analysis, and unreserved willingness to educate dedicated but naïve WSDA Feed Specialists about state and national Career & Technical Educational - Agricultural Education standards and the statewide diversity of high school agricultural education programs.

Michael K. Swan, Ph.D., Professor of Crop and Soil Sciences, Washington State University for generously providing history, perspective, and discussion regarding future challenges to high school agricultural education in Washington State; and for statistical, program data, and contact information for high schools that have dedicated agricultural education programs.

For growing and harvesting:

Lesson developers: **Nona Beth Clifton**, Washington Global Health Alliance Ambassadors Officer, Seattle BioMed; and **Theresa Britschgi**, BioQuest Director, Seattle BioMed – for their diligence, patience and educational savvy brought forward from their recently completed *Global Health Curriculum*; and **all instructors** who developed lessons, agreed to pilot teach, and provided essential student learning feedback for lesson improvement.

For balancing and feeding the ration:

All the **future educators**, CTE or Academic, who see value in these lessons and are willing to present the elements of global awareness, systems thinking and food safety to their students.

And for buying the seed from the get-go:

U.S. Food and Drug Administration, Grant 5U18FD003990 – Feed Safety and BSE/Ruminant Feed Ban Support Project, especially the dedicated and phone call tolerant experts at the FDA Center for Veterinary Medicine who have provided their special knowledge, perspective and thoughtful guidance to WSDA feed program staff for many years.

The following **WSDA staff** for their invaluable contributions to the curriculum:

- Ted Maxwell, WSDA Registration Services Program Manager
- Ali Kashani, WSDA Feed & Fertilizer Section Manager
- Evan Evans, WSDA Feed Safety
- Neil Lanning, WSDA Feed Specialist

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Governor

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May 1, 2012

As governor of the Great State of Washington, I continue to be amazed at the productivity of our 39,000 farms and the imagination of more than 2,000 food processing businesses. Our growers market more than 300 products, from apples to wheat, and contribute $40 billion dollars to our state's economy. While our agriculture industry continues to thrive even in challenging times, we must continue to work together to ensure its vibrancy and competitiveness in the Evergreen State.

The best way to support agriculture, grow our economy and secure a bright future for Washington is to provide our young people with a world class education. These seven new lessons will help students prepare for the vocations of tomorrow. These examples highlight the complex, coordinated effort needed to protect the safety and reliability of our state's food supply.

Building stronger alliances between our schools, farms and businesses helps both our economy and our students thrive. Public-private partnerships are critical to twenty-first century learning. Congratulations to all who helped develop and apply these lessons here in Washington.

Sincerely,

Christine O. Gregoire
Governor

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STATE OF WASHINGTON
DEPARTMENT OF AGRICULTURE
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May 1, 2012

Washington growers have carefully nurtured a reputation for quality of our agricultural products. That global Washington brand hinges on the safety of the food we produce. The public will continue to expect that they are purchasing the most healthy, nutritious and safe foods available when they buy Washington. Our economic future depends on it.

In order to meet that growing demand, we must continue to invest in the agricultural leaders of tomorrow: our youth. We hope this educational resource will be helpful in preparing future food producers, food processors, veterinarians and food safety specialists to meet the challenges of the years to come.

The Washington State Department of Agriculture was proud to partner with the Washington Global Health Alliance on *Feed & Food Safety in a Global Environment*. We are grateful to the U.S. Food and Drug Administration for the grant funding that made this resource possible.

Regards,

Dan Newhouse, Director
Washington State Department of Agriculture

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Agriculture & Feed Safety Careers

Activity Time: 50 Minutes.

Lesson Plan Summary:

In this lesson, students will review career descriptions and necessary qualifications for agriculture/biotechnology careers that are relevant to the field of animal feed safety. Students will complete an exercise in which they match career titles to career descriptions to understand the diversity of career opportunities in the field of agriculture/biotechnology and animal feed safety.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- **Agriculture/Biotech (ag-biotech) Careers:** There are a wide variety of career opportunities in the field of agriculture/biotechnology and animal feed safety; each career has a unique description and education requirement.

Essential Question:

- What are the possibilities and potential career paths leading to a career in agriculture/ biotechnology, specifically those related to animal feed safety?

Learning Objectives:

Students will know…

- There are ag-biotech feed safety careers for high school and college graduates, and for individuals with master's, doctorate, and professional degrees.
- Feed safety practices are essential to protecting animals and the public from diseases such as Bovine spongiform encephalopathy and salmonellosis.

Students will be able to…

- Connect diverse career paths to animal feed safety.
- Associate their personal interests with potential ag-biotech careers.
- List a variety of careers available in the field of ag-biotech and animal feed safety.

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Vocabulary:

- Agronomist
- Entomologist
- Hazard Analysis and Critical Control Points (HACCP)
- Hydrologist

Standards Alignment:

This lesson addresses the following Washington State Career and Technical Education (CTE) model frameworks for Agriculture, Food, and Natural Resources (AFNR):

- **ABS.02.04.01.b:** Determine appropriate human resources for AFNR businesses. Level II.
- **ABS.02.04.01.c:** Write career descriptions for specific positions in an AFNR business. Level III.

Common Student Preconceptions:

- Ag-biotech careers today are limited to traditional farming.
- I don't have the skills or interests to help protect the feed/food supply.

TEACHER PREPARATION

Materials:

Item	Quantity
Classroom computer with projector and Microsoft® PowerPoint® software	1 per class
Envelopes to hold the clippings for the career match activity	6–8 envelopes
Scissors	1 per class
Ag-Biotech Career Match Student Handout	1 per group (6 to 8 total)
Careers in the Ag-Biotech Field Student Handout	1 per student or per group
Ag-Biotech Career Match Teacher Answer Key	1 per class

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Preparation:

- Divide students into 6 or 8 groups.
- Make one copy of the *Ag-Biotech Career Match* Handout per student group.
- Cut out each career description from the *Ag-Biotech Career Match* Handout into little slips of paper and clip them all together. Then, cut out each career title and clip them all together. Put a set of career descriptions and career titles into each envelope. There should be as many envelopes (with sets of career descriptions and titles) as student groups.
- Make copies of the *Careers in the Ag-Biotech Field* Handout, one per student or group.
- Download the American Veterinary Medical Association (AVMA) career resources PowerPoint® presentation "The Road Less Traveled" from the following website:

  AVMA Veterinary Careers
  https://ebusiness.avma.org/EBusiness50/ProductCatalog/CareerPowerPoint.aspx

- Review the presenter's notes for the AVMA PowerPoint® presentation (see the *Resources* section of this lesson plan).
- **Optional**: Invite your school's career counseling staff to join the class for the last few minutes to answer students' questions about ag-biotech careers.

PROCEDURE

Preconceptions:

1. Ask students to conduct a quick Think-Pair-Share, trying to list one or two careers in the field of ag-biotech. During the "Share" portion of the activity, record the list of careers provided by the students using a document camera or whiteboard.
2. As a group, ask the students to consider what knowledge would be needed for an individual to be successful in each of the careers included on the class list. Record their ideas in a second list. For example:

Ag-Biotech Careers	Required Knowledge/Skills
Rancher	Animal husbandry Knowledge of feed, additives, supplements, etc. Business skills
Farmer	Plant and soil science Machinery operation Business skills
Veterinarian	Math and science Surgery techniques Compassion for animals

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3. Challenge the class to think of personal interests they have that were not already mentioned and included on the second list. What are their interests and special skills? Record their ideas in a third list. For example:

Students' Interests and Skills
History Foreign language Biology Working outdoors Working with animals/pets Working with other people Working individually Working with numbers Traveling Surfing web sites Tutoring Fixing machinery Building things

Hook:

4. Show students the AVMA PowerPoint®. This presentation features a variety of careers in the field of animal health, agriculture, and feed/food safety. All of the people featured in this presentation have an educational background in veterinary studies.

   AVMA Veterinary Careers, "The Road Less Traveled"
   https://ebusiness.avma.org/EBusiness50/ProductCatalog/CareerPowerPoint.aspx

5. Lead a class discussion about the careers that were mentioned in the PowerPoint®. Were any of these careers new to the students? What careers sounded the most interesting?

Activity Procedure:

6. Divide students into 6 or 8 groups.

7. Give each group one envelope (containing the slips of paper).

8. Ask each group to work together for 10 minutes to match the career descriptions with the career titles. **Optional**: Provide students with blank paper and tape so they can attach each career description and its matching title to the blank paper.

9. Read one career description aloud. Ask each group to respond with what they think is the career title that matches the description. Once you have heard from all the student groups, read the correct title and see how many groups were correct. Repeat with the remaining career descriptions.

10. Lead a class discussion about the careers profiled on the list. Were any of these careers new to the students? What careers sounded the most interesting?

11. Pass out copies of the *Careers in the Ag-Biotech Field* Handout, either one per student or one per group. The handout provides a more complete list of careers. Ask students to examine the list and identify any additional careers that sound interesting to them. Remind them of the list of interests and skills that they created in the *Preconceptions* portion of the lesson.

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12. Ask students what qualifications are important for the careers they identified. You may want to add their ideas to the list that you created in the *Preconceptions* portion of the lesson.
13. **Optional**: Encourage students to respond to the career paragraph prompt provided in the *Extension Activities* section of this lesson plan.

Wrap-up:

14. Lead a discussion about the best way to prepare for interesting ag-biotech careers. Discuss high school course-work, internships, volunteer opportunities, and summer employment.
15. **Optional:** Invite your school's career counseling staff to join the class for the last few minutes to answer students' questions about ag-biotech careers.

Assessment Opportunities:

- Assess students' contributions to class discussions and group work. Proficiency is measured by degree of individual and group participation.
- Assess students' career paragraphs (prompt is found in the *Extension Activities* section of this lesson plan). Proficiency is measured by the degree to which students provided information related to a brief description of the career (including common qualifications), their reasons for being interested in the career, what courses would prepare them for the career, what out of school learning opportunities might prepare them for this career, and whom they might interview in the community to learn more about this career.

Student Metacognition:

- Ask students to reflect on whether the exposure to ag-biotech careers has inspired them to consider a career direction they had not previously considered.
- The class discussions in the *Preconceptions*, *Activity Procedure*, and *Wrap-up* portions of the lesson help identify students' preconceptions and demonstrate their growing awareness of ag-biotech careers.

Extension Activities:

- Challenge students to pair up and interview one another regarding their interests in feed safety and ag-biotech careers.
- Students can interview exemplar ag-biotech and feed safety practitioners in their community.
- Provide time in the computer lab for students to research one ag-biotech career. Assign the research activity by placing the Career Exploration instructions below on the document camera. Tell the students that they can find the information they need for the assignment using the websites provided in the *Resources* section of this lesson plan.

  Career Exploration:

  Write a brief paragraph (200 words) that identifies an ag-biotech or feed safety career that interests you. Your paragraph must include:

  - A brief description of the career (including common qualifications).
  - The reason for your career interest.
  - Types of courses and learning experiences that might prepare you for this career.
  - Whom you might interview in the community to learn more about this career.

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Adaptations:

- The career match activity can be modified to be an individual, rather than group, activity. In this case, do not cut up the *Ag-Biotech Career Match* Handout. Instead, pass out one handout to each student. Challenge students to work individually to complete the handout by writing the corresponding career title letter next to each career description.

TEACHER BACKGROUND & RESOURCES

Background Information:

Background information on ag-biotech careers can be found at the websites listed in the *Resources* section below.

Resources:

AVMA Career PowerPoint® Presentations
https://ebusiness.avma.org/EBusiness50/ProductCatalog/CareerPowerPoint.aspx

The Road Less Traveled: Alternate Careers in Veterinary Medicine—Presenter's Notes
https://ebusiness.avma.org/EBusiness50/Files/ProductDownloads/presenters_notes_9-college.pdf

Future Farmers of America Career Explorer
https://www.ffa.org/APPCTR/Pages/CareerExplorer.aspx

Food, Agriculture, and Natural Resources Careers
http://www.agriculture.purdue.edu/USDA/careers/index.html

Feed/Animal Health Careers
http://www.ag-careers.com/animal_health_careers.html

Cargill® Experienced Opportunities – North America
http://www.cargill.com/careers/search-apply/experienced-professionals/north-america/index.jsp
(search "Animal Nutrition")

USA Jobs Database
https://my.usajobs.gov/

Career Guide to Industries (A–Z Search)
http://www.bls.gov/oco/cg/cgi_index.htm

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Credit:

Lesson written by Nona Clifton of the Washington Global Health Alliance.

Student Handout photograph courtesy of USDA Natural Resources Conservation Service.

Career descriptions on the *Ag-Biotech Career Match* Handout are from the following websites:

FFA Career Explorer, https://www.ffa.org/APPCTR/Pages/CareerExplorer.aspx.

Food, Agriculture, and Natural Resources Careers, http://www.agriculture.purdue.edu/USDA/careers/index.html.

Feed/Animal Health Careers, http://www.ag-careers.com/animal_health_careers.html.

Cargill® Experienced Opportunities – North America, http://www.cargill.com/careers/search-apply/experienced-professionals/north-america/index.jsp (search "Animal Nutrition").

USA Jobs, http://www.usajobs.gov.

Global Transport Specialists, http://www.globaltransport.com/.

Bureau of Labor Statistics, http://www.bls.gov/oco/cg/.

Indeed.com, http://www.indeed.com.

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Name:_____Date:_____Period:_____

Ag-Biotech Career Match

Student Handout

Match the career titles with their corresponding career descriptions. Write the letter for each career title in the table with the career descriptions.

Credit: USDA NRCS.

Career Titles

A	Hydrologist	**I**	Sales/Business Development Manager
B	Purchasing Manager	**J**	Lab Facilities Construction
C	Federal Grain Inspector	**K**	HACCP Specialist
D	Quality Assurance Specialist	**L**	Agronomist
E	Feed Ration Developer	**M**	Transportation Specialist
F	Agricultural Attaché	**N**	Agricultural Establishment Inspector
G	Entomologist	**O**	Vertebrate Pest Management Specialist
H	Feed Operations Manager	**P**	Veterinary Toxicologist

Career Title Letter	Career Description
	Responsible for safety and maintenance programs, coordination of quality control and regulatory programs, personnel supervision, budgeting, and business plans for animal feed operations.
	Apply policies and develop procedures, minimum standards, and continuous improvement programs in the areas of HACCP (Hazard Analysis and Critical Control Points), product quality, product safety, and regulatory compliance. Ensure alignment to Customer, Region, BU, and Corporate requirements.
	Study the ecology of insects and their interactions in the world. Find ways to harness and control insects both beneficial and harmful to humankind. Work for government agencies in fields such as agriculture and food inspection, or teach and conduct research. Employed by insecticide and pest control companies.
	Inspect agriculturally related establishments for adherence to laws and environmental considerations concerning disposal of wastes and storage of products.

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Career Title Letter	Career Description
	Treat water to ensure that it is safe to drink for animals and humans. Specialize in wells, rivers, streams, and reservoirs. Expert in harmful materials, chemicals, plant life, and microorganisms that could potentially harm a water supply used for drinking, irrigation, landscaping, farming, and everyday life in the city and beyond. Work in a lab testing for chemicals, on a computer monitoring automated systems and determining how to address problems, in the field reading and interpreting gauges and meters, in an office applying pertinent laws and regulations, or abroad building new water systems in developing countries.
	Build industrial lab and manufacturing spaces to ensure safety when handling dangerous equipment or toxic chemicals. May take union or employer-sponsored Occupational Safety and Health Administration safety training. Maintain a creative physical working environment and the overall appearance of the organization.
	Buy raw materials, machinery, equipment, supplies, and services used in feed production and required by business, industry, or government to produce goods or offer services.
	Strive to inform and educate the public, private practice veterinarians, and veterinary medical students about toxicologic hazards (e.g., biological, chemical, environmental, pharmaceutical, and radiological) to pets, livestock, and wildlife. Additionally, when feed is associated with animal illness, advise animal feed specialists to test for probable toxins.
	Help develop agricultural government programs and policy abroad working with embassies. Work with ministers of agriculture to secure policy and programs in other countries and protect agricultural interests.
	Work with field crop production and soils management to develop higher yields, better crop varieties, and higher quality products while maintaining or improving the environment.
	Analyze and inspect grain products and grade them on various federal standards that determine the price.
	Specialize in the transport and inspection of equipment or goods in connection with moving feed cargo or people. Includes rail transport inspectors, freight inspectors, car inspectors, rail inspectors, and other non-precision inspectors of other types of transportation vehicles. When transporting biological goods, special safety precautions are needed and are maintained by a variety of regulatory mechanisms. Work with all types of machines that transport items.
	Work for an American or international company. Responsible for market development and sales of company products. Candidate must have excellent relationship building skills, extensive integrator network, and entrepreneurial skill set to develop direct sales and an active dealer network. Travel required.
	Formulate rations for use by feed mixing companies that meet nutritional requirements for animals in a cost-effective manner.
	Responsible for inspecting, analyzing, and writing reports about production quality.
	Responsible for the lethal and non-lethal control of pests (e.g., rats and mice) that spread disease and contaminate food.

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Name:_____Date:_____Period:_____

Careers in the Ag-Biotech Field

Student Handout

Career	Career Description
Agricultural Association Executive[1]	Agricultural Association Executives are responsible for managing and analyzing programs and services provided by agricultural associations and vehicles for implementing financial, policy, insurance, and cooperative services.
Agricultural Attaché[1]	Agricultural Attachés help develop agricultural government programs and policy abroad working with embassies. They work with ministers of agriculture to secure policy and programs in other countries and to protect agricultural interests.
Agricultural Consultant[1]	Agricultural Consultants audit and appraise agricultural-related businesses and makes suggestions on improvements.
Agricultural Corporation Executive[1]	Agricultural Corporation Executives direct corporation programs and manage financial and personnel decisions. Ultimately responsible for corporation feasibility and profitability.
Agricultural Establishment Inspector[1]	Agricultural Establishment Inspectors inspect agriculturally related establishments for adherence to laws and environmental considerations concerning disposal of wastes and storage of products.
Agricultural Lawyer[1]	Agricultural Lawyers focus on law as applied to agricultural contexts.
Agriculturalist[1]	Agriculturalists are general scientists who deal with the art of cultivating the soil, producing crops, raising livestock, and preparing these products for human use and disposal.
Agriculture Education Teachers[2]	Agricultural Science and Business Teachers prepare middle and high school students for successful careers and a lifetime of informed choices in the global agriculture, food, fiber, and natural resources systems.
Agriculture Engineer[1]	Agricultural Engineers design and develop systems, equipment, and products for agricultural production, food and feed processing, natural resources, conservation, environmental protection, and other biological systems.
Agronomist[1]	Agronomists work with field crop production and soils management to develop higher yields, better crop varieties, and higher quality products while maintaining or improving the environment.
Animal Nutritionist[1,2]	Animal Nutritionists study the absorption of and effects nutrients have on animal systems and find ways to improve or manipulate the nutritive health of animals. Animal nutrition is a science that combines chemistry, physics, biochemistry, mathematics, animal behavior, economics, and food processing with animal production techniques. Animal Nutritionists formulate diets for food animals, companion animals, and zoo animals.
Animal Physiologist[1]	Animal Physiologists study the physical and chemical processes that occur in animals and the way these processes work together.

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Animal Scientist (FDA)[5]	**Sample Career Offering:** • Conduct scientific reviews of complex animal nutritional, biochemical, and physiological data for use in the development and approval of new animal food ingredients. Deliver findings in written reports. • Conduct scientific reviews of data and prepare written scientific reports on the toxic principles of substances/contaminants present in animal food. • Review, comment, and offer opinions on technical aspects of programs, policies, and guidelines relating to medicated feeds. • Prepare documents related to potential or actual adverse effects of drugs used in feeds, or substances/contaminants present in animal food. • Confer with feed manufacturer representatives and others about various issues relating to the manufacture of medicated feeds, including but not limited to safe drug use, further mixing of feeds, and handling of drug carryover in feed.
Animal Scientist[1]	Animal Scientists conduct research to develop improved methods for feeding, housing, and breeding farm livestock and domestic pets.
Biochemist[2]	Biochemists explore the chemical events that cause biological phenomena in living organisms. The knowledge that biochemists gain in their research provides a basic understanding of the marvelous workings of the vast array of life forms.
Biological Engineer[2]	Biological engineering is a new, rapidly developing discipline that uses scientific principles involving the life sciences to create products and processes to meet human needs in a profitable, effective manner.
Cash Grain Farmer[1]	Cash Grain Farmers produce grains for selling on a cash basis to mills, grain elevators, or businesses. Work on a cash basis, as opposed to a futures basis where prices are set at a predetermined point.
Commodity Broker[1]	Commodity Brokers trade products and cash based on stock market and futures projections.
Entomologist[9]	Entomologists are biological scientists who study insects. Some entomologists study the ecology of insects and their interactions in the world. Others direct their research toward finding ways to control insects harmful to humankind, while others explore the use of insect traits for our betterment (e.g., many human-made products include chitin). About one-third of all entomologists work for government agencies in fields such as agriculture and food inspection. Others are employed by colleges and universities to teach and conduct research. Insecticide companies, pest control companies, medical centers, and museums also employ entomologists.
Farm Consultant[4]	**Sample Career Offering:** • Reaching sales objective in defined market area. • Providing nutritional service to customers. • In-barn monitoring of production performance. • Selling key feeders on the benefit of management, health, and nutritional programs. • Increasing sales contacts through Feeder Meetings and demonstrations.

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Federal Grain Inspector[1]	Grain Inspectors analyze and inspect grain products and grade them on various federal standards that determine the price.
Feed Department Manager[3]	**Sample Career Offering:** Profitable, aggressive cooperative looking for experienced Feed Department Manager. Position will lead feed team in sales administration/training, budgeting, business plan, action plan, mill operation, marketing programs, inventory, margins, and profitability of the feed department. Competitive compensation and benefit program.
Feed Mill Operator[1]	Feed Mill Operators manage all feed mill operations, including purchasing, milling, storing, and selling grain, while also ensuring that government standards are met. They are also responsible for mill personnel and business decision making.
Feed Operations Manager[3]	**Sample Career Offering:** Aggressive ag retailer looking for experienced Feed Operations Manager. Position will be responsible for safety and maintenance programs, coordination of quality control and regulatory programs, personnel supervision, budgeting, and business plan for department.
Feed Mill Production Manager[3]	**Sample Career Offering:** Cooperative looking for experienced Feed Mill Production Manager. Must have supervisory experience, understand mill efficiencies, distribution logistics, general feed milling procedures, and have strong leadership skills. Company is planning on increasing production 40% to meet demand. Excellent opportunity with competitive compensation and benefit package.
Feed Ration Developer[1]	Feed Ration Developers formulate rations for use by feed mixing companies that meet nutritional requirements for animals in a cost-effective manner.
Feedlot Manager[1]	Feedlot Managers oversee the buying and selling of feeder cattle, nutrition considerations, and environmental conditions of a feedlot.
Field Sales Representative, Animal & Feed Production[1]	Sales Representatives sell animal and feed products to businesses, farmers, retailers, or any company that uses agricultural products.
Food Inspector[1]	Food Inspectors are responsible for inspection at shipping and terminal points; determination of grade, quality and condition of meat and produce; observation of carriers and cargo at loading and sealing points; and administration of certificates and records.
Food Law Lawyer[4]	**Sample Career Offering:** Provide food law counseling to U.S. and global businesses, including counsel on the application of food laws and regulation (primarily U.S. laws) to U.S. and global operations; preventive law training and education; and guidance on compliance with company policies and procedures.
Food Process Engineer[2]	Food Process Engineers (FPEs) research and develop new and existing products and processes.
Food Safety Specialist[2]	Food Safety Specialists preserve our food supply by assuring that it is wholesome, sound, and safe.
Food Scientist[2]	Food Scientists preserve our food supply by assuring its flavor, color, texture, nutritional quality, and safety.

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Global Food Safety, Quality and Regulatory Director[4]	**Sample Career Offering:** This position will manage the execution of the Animal Nutrition Food Safety, Quality, and Regulatory (FSQR) strategies. Oversee Business Unit (BU) work to ensure compliance with Corporate Food Safety Policies and applicable regulations. Lead the corporate FSQR organization through its linkages to the QRA leads embedded in each regional business.
Grain Elevator Operator[1]	Grain Elevator Operators purchase grain from farmers and store it until purchased or shipped to companies or industries that use the grain in foods, feeds, or oils.
HACCP Specialist[4]	**Sample Career Offering:** Our Northeast Region in the U.S. is seeking a HACCP Specialist. This position is accountable for applying policies and developing procedures, minimum standards, and continuous improvement programs for the Region in the areas of HACCP (Hazard Analysis and Critical Control Points), product quality, product safety, and regulatory compliance. The specialist must ensure alignment to Customer, Region, Business Unit, and Corporate requirements through a cost-competitive and engaged Quality Management organization.
Hydrologist/Water Quality Specialist[8]	Water Quality Specialists treat water to ensure that it is safe to drink for animals and humans. They specialize in wells, rivers, streams, and reservoirs. They are experts in harmful materials, chemicals, plant life, and microorganisms that could potentially harm a water supply, whether used for drinking, irrigation, landscaping, farming, everyday life in the city and more. Hydrologists can be found in a lab testing for chemicals, on a computer monitoring automated systems and determining how to address problems, in the field reading and interpreting gauges and meters, in the office applying pertinent laws and regulations, or abroad building new water systems in developing countries. Public health practices have greatly improved, but water-borne diseases like cholera are still around and Water Quality Specialists continue to work on new methods to keep people safe.
Lab Facilities Construction[7]	In addition to basic construction skills, building safe industrial lab and manufacturing spaces requires specialized training and experience. Workers who use dangerous equipment or handle toxic chemicals usually receive specialized safety training. Apprenticed laborers who remove hazardous materials are required to take union or employer-sponsored Occupational Safety and Health Administration (OSHA) safety training. Facility workers maintain a creative physical working environment and maintain the overall appearance of an organization.
Nutritionist/Dietician[2]	Nutritionists/dietitians help people look and feel well by making the connection between food, nutrition, and health.
Production Supervisor – Animal Nutrition[4]	Production Supervisors supervise other employees as well as manage programs and processes related to the safe manufacturing and shipment of goods.
Purchasing Manager[1]	Purchasing Managers buy raw materials, machinery, equipment, supplies, and services required by business, industry, or government to produce goods or offer services.
Quality Assurance Specialist[1]	Quality Assurance Specialists are responsible for inspecting, analyzing, and writing reports about production quality.
Quality Control Supervisor[1]	Quality Control Supervisors inspect and enforce rules on matters such as health, safety, food, licensing, or finance.
Range Manager[2]	Range Managers care for our country's vast rangelands. From those lands, they produce a sustained yield of such things as plants for forage, wildlife for aesthetics and hunting, meat, and clean water.

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Research Engineer – Agricultural[1]	Agricultural Engineers research and design systems, equipment, and products for agricultural production, food and feed processing, natural resource conservation, environmental protection, and other biological systems.
Sales/Business Development Manager[3]	**Sample Career Offering:** A Netherlands based company looking for experienced National Sales/Business Development Manager to be located in Midwest United States. Responsible for market development and sales of state-of-the-art Electronic Sow Feeding Systems. Candidate must have excellent relationship building skills, extensive integrator network, and entrepreneurial skill set to develop direct sales and an active dealer network. Travel required.
State Director of Nutrition (California)[3]	**Sample Career Offering:** The State Director of Nutrition is responsible for providing tech support to all sales and producers. Also responsible for managing promotional and educational activities, managing relationships with independent consulting nutritionists, and overseeing design and implementation of Quality Assurance/Quality Control (QA/QC) programs. Masters degree or PhD with minimum of 5 years related industry experience. Fluency in Spanish helpful.
Swine Account Manager[4]	**Sample Career Offering:** The Swine Account Manager carries primary responsibility for sales of our products, consulting, and providing technical support to swine producers in an area. Our customers are looking for competent people who have a passion for agribusiness. An active interest in the business world and a desire to be recognized for success by peers and customers is essential. We will provide you with extensive training and coaching to help you succeed. This is a unique career opportunity in a fast paced working environment.
Transportation Specialist[6]	Transportation Specialists specialize in the transport and inspection of equipment or goods in connection with moving cargo or people. Includes rail transport inspectors, freight inspectors, car inspectors, rail inspectors, and other non-precision inspectors of other types of transportation vehicles. When transporting biological goods, special safety precautions are needed and regulations are enacted to maintain these precautions. If you like machines that transport items, this is a career for you.

Endnotes

[1] Retrieved from https://www.ffa.org/APPCTR/Pages/CareerExplorer.aspx.
[2] Retrieved from http://www.agriculture.purdue.edu/USDA/careers/index.html.
[3] Retrieved from http://www.ag-careers.com/animal_health_careers.html.
[4] Retrieved from http://www.cargill.com/careers/search-apply/experienced-professionals/north-america/index.jsp (search "Animal Nutrition").
[5] Retrieved from http://www.usajobs.gov/GetJob/ViewDetails/2411539.
[6] Retrieved from http://www.globaltransport.com/.
[7] Retrieved from http://www.bls.gov/oco/cg/cgs003.htm.
[8] Retrieved from http://www.indeed.com/salary /q-Environmental-Engineer-Water-Quality-Specialist-l-Irvine,-CA.html.
[9] Retrieved from http://www.bls.gov/oco/ocos047.htm.

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Ag-Biotech Career Match

Teacher Answer Key

Career Title Letter	Career Description
H **Feed Operations Manager**	Responsible for safety and maintenance programs, coordination of quality control and regulatory programs, personnel supervision, budgeting, and business plans for animal feed operations.
K **HACCP Specialist**	Apply policies and develop procedures, minimum standards, and continuous improvement programs in the areas of HACCP (Hazard Analysis and Critical Control Points), product quality, product safety, and regulatory compliance. Ensure alignment to Customer, Region, BU, and Corporate requirements.
G **Entomologist**	Study the ecology of insects and their interactions in the world. Find ways to harness and control insects both beneficial and harmful to humankind. Work for government agencies in fields such as agriculture and food inspection, or teach and conduct research. Employed by insecticide and pest control companies.
N **Agricultural Establishment Inspector**	Inspect agriculturally related establishments for adherence to laws and environmental considerations concerning disposal of wastes and storage of products.
A **Hydrologist/ Water Quality Specialist**	Treat water to ensure that it is safe to drink for animals and humans. Specialize in wells, rivers, streams, and reservoirs. Expert in harmful materials, chemicals, plant life, and microorganisms that could potentially harm a water supply used for drinking, irrigation, landscaping, farming, and everyday life in the city and beyond. Work in a lab testing for chemicals, on a computer monitoring automated systems and determining how to address problems, in the field reading and interpreting gauges and meters, in an office applying pertinent laws and regulations, or abroad building new water systems in developing countries.
J **Lab Facilities Construction**	Build industrial lab and manufacturing spaces to ensure safety when handling dangerous equipment or toxic chemicals. May take union or employer-sponsored Occupational Safety and Health Administration safety training. Maintain a creative physical working environment and the overall appearance of the organization.
B **Purchasing Manager**	Buy raw materials, machinery, equipment, supplies, and services used in feed production and required by business, industry, or government to produce goods or offer services.
P **Veterinary Toxicologist**	Strive to inform and educate the public, private practice veterinarians, and veterinary medical students about toxicologic hazards (e.g., biological, chemical, environmental, pharmaceutical, and radiological) to pets, livestock, and wildlife. Additionally, when feed is associated with animal illness, advise animal feed specialists to test for probable toxins.

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Career Title Letter	Career Description
F **Agricultural Attaché**	Help develop agricultural government programs and policy abroad working with embassies. Work with ministers of agriculture to secure policy and programs in other countries and to protect agricultural interests.
L **Agronomist**	Work with field crop production and soils management to develop higher yields, better crop varieties, and higher quality products while maintaining or improving the environment.
C **Federal Grain Inspector**	Analyze and inspect grain products and grade them on various federal standards that determine the price.
M **Transportation Specialist**	Specialize in the transport and inspection of equipment or goods in connection with moving feed cargo or people. Includes rail transport inspectors, freight inspectors, car inspectors, rail inspectors, and other non-precision inspectors of other types of transportation vehicles. When transporting biological goods, special safety precautions are needed and are maintained by a variety of regulatory mechanisms. Work with all types of machines that transport items.
I **Sales/ Business Development Manager**	Work for American or international company. Responsible for market development and sales of company products. Must have excellent relationship building skills, extensive integrator network, and entrepreneurial skill set to develop direct sales and an active dealer network. Travel required.
E **Feed Ration Developer**	Formulate rations for use by feed mixing companies that meet nutritional requirements for animals in a cost-effective manner.
D **Quality Assurance Specialist**	Responsible for inspecting, analyzing, and writing reports about production quality.
O **Vertebrate Pest Management Specialist**	Responsible for the lethal and non-lethal control of pests (e.g., rats and mice) that spread disease and contaminate food.

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The Dose Makes the Poison

Activity Time: 50 Minutes.

Lesson Plan Summary:

In this lesson, students will determine the appropriate amount of a feed additive to mix in feed to achieve the correct dosage. This activity will provide students with the understanding that concentration increases as moisture decreases and dry matter increases. This lesson complements the study of concentration. Before delivering this lesson, students need to have a basic understanding of the concept of concentration within the context of general chemistry.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- **Concentration:** Concentration is affected by the amounts of solute and solvent.

Essential Question:

- How much additive must be given to ensure that each animal has the correct mg/lb BW concentration?

Learning Objectives:

Students will know…

- All substances can be poisonous if the dose is large enough.
- Dose calculations are important for preventing overdoses and for ensuring that the effective concentration of an additive is achieved when preparing animal feed.

Students will be able to…

- Calculate mg/lb BW concentration.
- Determine the amount of a solute needed to achieve a certain concentration.
- Calculate appropriate dosages given an animal's weight.

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Vocabulary:

- Antibiotic
- Aureomycin 4G Crumbles
- Body Weight (BW)
- Chlortetracycline
- Concentration
- Dose
- *Pasteurella multocida* (bacteria, livestock pathogen)
- Poison
- Solute
- Solvent
- Toxicity

Standards Alignment:

This lesson addresses the following Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs) for grades 9–12:

- **Science EALR (9-12 APPC):** Students know that choosing the best *solution* involves comparing alternatives with respect to *criteria* and *constraints*, then building and testing a *model* or other representation of the final design.
- **Science EALR (9-12 APPD):** Students know that the ability to solve problems is greatly enhanced by use of mathematics and information technologies.

This lesson addresses the following Washington State Career and Technical Education (CTE) model frameworks for Agriculture, Food, and Natural Resources (AFNR):

- **AS.04.02:** Prescribe and administer animal feed additives and growth promotants in animal production.

Common Student Preconceptions:

- The same amounts of medications can be given to any animal.
- Medications have the same concentration of active ingredient.
- Different medications do not have the same active ingredients.

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TEACHER PREPARATION

Materials:

Item	Quantity
Classroom computer with projector and internet access	1 per class
1000 mL beaker	4 per class
400 mL beaker	1 per class
100 mL beaker	1 per class
Food coloring	1 bottle per class
Dose Makes the Poison Quiz Student Handout	1 per student
Dose Makes the Poison Quiz Teacher Answer Key	1 per class

Preparation:

- Fill each beaker with water to measured capacity (1000 mL, 400 mL, and 100 mL).
- Review the procedural steps for the class demonstration, as explained in the *Hook* section.
- Photocopy the *Student Handout* including *the* nutritional supplement label.

PROCEDURE

Preconceptions:

1. Write the Essential Question on the board: *How much additive must be given to ensure that each animal has the correct mg/lb BW concentration*?
2. Write the following vocabulary terms on the board:
    - Concentration
    - Solute
    - Solvent
    - Dose
    - Poison
    - Toxicity
3. Ask students for their definitions of these terms. Provide just-in-time instruction as needed to help student develop correct definitions for the terms.
4. Ask students what they think these terms have to do with prescribing and administering animal feed additives in animal production.

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Hook:

Demonstration: Same Dose, Different Body Weight

5. Set out three different sized beakers (1000 mL, 400 mL, and 100 mL) on the lab bench or table, filled to measured capacity with water. If possible, place a piece of white paper behind the beakers to make a backdrop.

6. Explain to students that each beaker represents the body of a differently sized cow: a calf, a young heifer, and a grown bull.

7. Explain that the food coloring represents a chemical that is ingested by each cow or injected into the body, such as a feed additive or a medication. Place five drops of food coloring into each beaker as students observe.

8. Provide time for students to conduct a Think-Pair-Share, answering the following questions:

   - What differences did the students observe among the three beakers?
   - What response would each cow have to the same dose of the chemical?
   - In this scenario, what is the solute and what is the solvent?

Demonstration: Different Dose, Same Body Weight

9. Next, place three 1000 mL beakers on the lab bench, filled to measured capacity with water. Explain that the beakers represent three cows, all of which are about the same body size.

10. Place five drops of food coloring in the first beaker, ten drops in the second beaker, and fifteen drops in the third, as students observe.

11. Provide time for students to conduct a Think-Pair-Share, answering the following questions:

    - What differences did the students observe among the three beakers?
    - What response would each cow have to the different doses of the chemical?

Activity Procedure:

12. Write the following quote on the board:

    All substances are poison; there is none which is not a poison. The right dose differentiates a poison from a remedy.
    Paracelsus, 1493-1541

13. Explain that often the quote is simplified to: "The dose makes the poison."

14. Explain that the Food and Drug Administration, a federal agency, publishes a set of regulations known as Title 21—Food and Drugs. Within this set of regulations, Subchapter E focuses on regulations related to Animal Drugs, Feeds, and Related Products. Part 558 in particular includes regulations for New Animal Drugs for Use in Animal Feeds. The term "New Animal Drug" has been used since June 25, 1938. Any drug designated as a "New Animal Drug" in 1938 is still a "New Animal Drug". A new animal drug is defined, in part, as "any drug intended for use in animals other than man, including any drug intended for use in animal feed but not including the animal feed..." (21 U.S.C. § 321)

15. Using the classroom computer and projector, show students the Title 21 CFR 558 website. Scroll down through the list of animal drugs approved for use as feed additives. Explore the website as you have time, specifically focusing on 558.140 Chlortetracycline, an antibiotic.

    Title 21 CFR 558: Regulations for New Drugs For Use in Animal Feeds
    National Archives and Records Administration
    http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title21/21cfr558_main_02.tpl

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16. Explain that in today's learning task, students will be calculating dosage concentrations. In the learning task, they will be focusing on calculating the correct dose of the antibiotic Chlortetracycline using a medicated feed label. These math skills are important in animal care, whether students need to calculate the dose of a drug (like Chlortetracycline) or the correct concentration of any other feed additive (like the essential mineral selenium). It is important for students to understand how to calculate dosage concentrations and do unit conversions, since the dosage guidelines on feed standards, nutritional supplement labels, and medication prescriptions can be stated in different terms.

17. Tell students that for the purposes of today's lesson, the measurement of dose they will be using is mg/lb (pound) of body weight. Let them know alternative ways that we express dose, including:

    - mg/lb of body weight (mg/lb BW) is preferred for today's lesson
    - mg/100 lb body weight (mg/100 lb BW)
    - mg/kg of body weight (mg/kg BW)

18. Pass out copies of the *Dose Makes the Poison Quiz* Handout and explain the learning task.

19. Ask students to work in pairs or small groups to complete the handout.

Wrap-up:

20. After students have completed the handout, ask student volunteers to share their results with the class.

21. Have one or two students share their graphs with the class using a document camera.

Assessment Opportunities:

- Students will share the results of their calculations with the class.

- Using the data, the students will complete the handout and create a dosing graph.

Student Metacognition:

- Students are asked to examine their preconceptions about the vocabulary terms.

- Students will explain their results and receive peer feedback.

- As an Exit Ticket, ask students to document their definitions for the vocabulary terms in their notebooks.

Scoring:

- The *Dose Makes the Poison Quiz* Handout can be scored by checking the accuracy of students' calculations using the *Teacher Answer Key*.

Extension Activities:

- Ask students to calculate the doses from the *Dose Makes the Poison Quiz* Handout in mg/100 lb BW.

- Ask students to calculate the doses from the *Dose Makes the Poison Quiz* Handout in mg/kg BW.

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Adaptations:

- Instead of conducting a class demonstration, ask students to complete the dose/response activity themselves at each lab station. Alternatively, a virtual demonstration can be accessed at the **A Small Dose of Toxicology** website, as listed in the *Resources* section. Click on the "Dose" and "Size" buttons to run the demonstration.

- Rather than calculate the pounds of dry matter, alter the *Dose Makes the Poison Quiz* Handout to provide those calculations. Provide the students with completed handouts and discuss as a group that if you feed a constant amount of feed additive, then as feed intake increases the concentration of the feed additive will decease in the total diet consumed.

- Challenge students to portray the data using an Excel spreadsheet or a graphing calculator.

TEACHER BACKGROUND & RESOURCES

Career Links:

- Animal drug manufacturer
- Animal feed manufacturer
- Animal nutritionist
- Animal physiologist
- Animal scientist
- Biochemist
- Cattle rancher
- FDA regulation enforcement officer
- Feed ration developer
- State chemist
- Veterinarian
- Veterinary toxicologist

Background Information:

Background information on the Title 21 CFR 558 regulations can be found at the website of the National Archives and Records Administration, as listed in the *Resources* section on the following page.

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Resources:

A Small Dose of Toxicology: Dose/Response Demonstration
http://www.toxipedia.org/display/dose/Demonstration+of+the+Principles+of+Dose-Response

Title 21 CFR 558: Regulations for New Drugs For Use in Animal Feeds
National Archives and Records Administration
http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title21/21cfr558_main_02.tpl

Veterinary Topics: A Necessary Poison (Selenium)
Thoroughbred Times
http://www.thoroughbredtimes.com/horse-health/2003/may/03/veterinary-topics-a-necessary-poison.aspx

Case Study: Elemental Toxicity in Animals
UC Davis, ChemWiki
http://chemwiki.ucdavis.edu/Inorganic_Chemistry/Case_Studies/Case_Study%3a_Elemental_Toxicity_in_Animals

Credit:

Lesson plan written by Nona Clifton of the Washington Global Health Alliance.

Content expertise and Aureomycin 4G Crumbles label provided by Neil Lanning of the WSDA.

Student Handout photograph courtesy of Wikimedia Commons.

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Name:_____Date:_____Period:_____

Dose Makes the Poison Quiz

Student Handout

Cows eating silage. **Credit**: Wikimedia Commons.

You have agreed to help out on your aunt's cattle ranch, the DiamondK, while she is out of town for a few weeks. Unfortunately, some of the cattle are sick. Aunt Kay left a note telling you that she suspects a pen of 300 pound calves (25 of them) are coming down with bacterial pneumonia associated with *Pasteurella multocida* and she wants you to feed Aureomycin 4G Crumbles for the maximum time allowed. On her note, she explained that the Aureomycin 4 G Crumbles contain chlortetracycline, an antibiotic. She also said, "Like all antibiotics, if you do not give them enough, it will not be effective, they will not get better, and potentially develop antibiotic resistance. If you feed too much, there could be side effects and make things worse – it could even be a poison!"

She is counting on you to find the feed in the barn read the label, do the math, and figure out how much feed and Aureomycin 4G to give to her cattle.

1. To help care for your Aunt's cattle, look at the Aureomycin 4G Crumbles label on Page 9 and answer the following questions.

   a. What antibiotic is being used?

   b. What concentration of the antibiotic is listed on the label?

   c. Express the concentration listed on the label in grams per ton (there are 2,000 pounds per ton). Show the formula you use to obtain your answer.

   d. Express the concentration listed on the label in milligrams per pound. Show the formula you use to obtain your answer.

   e. Express the concentration listed on the label in milligram per kilogram. Show the formula you use to obtain your answer.

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AUREOMYCIN 4G CRUMBLES

(Type C Feed)

MEDICATED

Indication depend on species and level provided. See reverse side for specific feeding directions of this product.

ACTIVE INGREDIENT

Chlortetracycline .....4 g/lb
(8,000 g/ton)

GUARENTEED ANALYSIS

Crude Protein, not less than 11.00%
Crude fat, not less than.....1.00%
Crude fiber, not more than 30.00%
Crude fat, not less than 7.50%
Crude fiber, not more than 8.50%

INGREDIENTS

Processed Grain By-Products, Calcium Carbonate, Mineral Oil and Dried Lignin Sulfonate.

USE DIRECTIONS
See panel to right for specific directions

Manufactured by:
Super Feeds
1200 Parkway
Anytown, WA 98000

Net Weight 50 LB. (22.68 kg)

9AURECR4
LOT# 554711

USE DIRECTIONS

CATTLE

WARNING (for all feeding levels in cattle): A withdrawal period has not been established in pre- ruminating calves. Do not use in calves to be processed for veal.

Level	Claim	**4G Crumbles**
10 mg/lb body weight daily	For the treatment of bacterial enteritis caused by *E. coli* and bacterial pneumonia caused by *Pasteurella multocida* organisms susceptible to chlortetracycline in calves, beef and nonlactating dairy cattle. Feed for not more than 5 days.	One pound will medicate 400 lbs of body weight daily.
350 mg/head daily	For the control of active infection of anaplasmosis caused by *Anaplasma marginale* susceptible to chlortetracycline in beef cattle over 700 pounds.	One pound per 11.4 head daily.
0.5 mg/lb body weight daily	For the control of active infection on anaplasmosis caused by *Anaplasma marginale* susceptible to chlortetracycline in beef cattle over 700 pounds.	One pound will medicate 8,000 lbs of body weight daily.
350 mg/head daily	For the control of bacterial pneumonia associated with shipping fever complex caused by *Pasteurella spp.* susceptible to chlortetracycline in beef cattle.	One pound per 11.4 head daily.
70 mg/head daily	For an increased rate of weight gain, improved feed efficiency, and reduction of liver condemnations due to liver abscesses in growing	One pound will medicate 57 cattle daily.
25-70 mg/head daily	For an increased rate of weight gain and improved feed efficiency in calves between 250 and 400 pounds.	One pound will medicate 57-160 calves daily.
0.1 mg/lb body weight daily	For an increased rate of weight gain and improved feed efficiency in calves under 250 pounds.	One pound will medicate 40,000 lbs of body weight daily.

SHEEP

Level	Claim	**4G Crumbles**
80 mg/head daily	For reducing the incidence of (vibrionic) abortion caused by *Campylobacter fetus* infection susceptible to chlortetracycline in breeding sheep.	One pound will medicate 50 head daily.
20-50 grams	Increased rate of weight gain and improved feed efficiency in grow-	Five (5) to 12.5 pounds per

SWINE

Level	Claim	**4G Crumbles**
10-50 grams per ton	Increased rate of weight gain and improved feed efficiency in growing swine.	2.5 to 12.5 pounds per ton of feed.
50-100 grams per ton	Reducing the incidence of cervical lymphadenitis (jowl abscesses) caused by group E streptococci susceptible to chlortetracycline in swine.	12.5 to 25 pounds per ton of feed.
400 grams per ton	Control of leptospirosis (reducing the incidence of abortion and shedding of leptospirae) caused by *Leptospira pomona* suseptible to chlortetracycline in breeding swine. Feed Continuously for not more than 14 days.	100 pounds per ton of feed.
10 mg/lb body weight daily	For the treatment of bacterial enteritis caused by *E. coli* and *Salmonella choleraesuis* and bacterial pneumonia caused by *P. multocida* organisms susceptible to chlortetracycline in swine. Feed continuously for not more than14 days.	One pound will medicate 400 lbs of body weight daily.

Figure 1: Aureomycin 4G Crumbles feed label.

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2. What is the amount of drug required to treat bacterial pneumonia associated with *Pasteurella multocida* in cattle as stated on the label?

3. How many milligrams of chlortetracycline are required to treat one 300 pound calf? Show the formula you use to obtain your answer.

4. How many pounds of this medicated feed will it take to properly treat all 25 calves for one day? Show the formula you use to obtain your answer.

5. Each cow is a unique individual, with different eating habits and dietary needs. Most animals eat between 2-3% of their body weight in dry matter per day and really high producing animals might eat as much as 4% of their body weight. Moreover, all animals will eat more total pounds of feed when the diet gets wetter (saturated with heavy water).

   Calculate the total pounds of feed that the calves will eat as the moisture level increases in the feed and fill in ***Table 1***.

Table 1: Diamond K Feed Calculation Tables — Feed Intake

Body weight lb	Feed Intake in DM as % of BW	Pounds of Feed Expected to be Consumed at Different Dry Matters				
		100% Dry Matter Basis	90% Dry Matter Basis	80% Dry Matter Basis	70% Dry Matter Basis	60% Dry Matter Basis
300	2	6	6.67			
	2.5					
	3					

mg = milligram lb = pound
DM = Dry Matter BW = body weight

Next, determine the concentration in mg/lb of chlortetracycline in the feed and fill in ***Table 2*** using information determined in ***Table 1*** as well as the mass (in mg) of chlortetracycline required to treat a 300 lb calf (an amount that you determined previously for *Question 3*).

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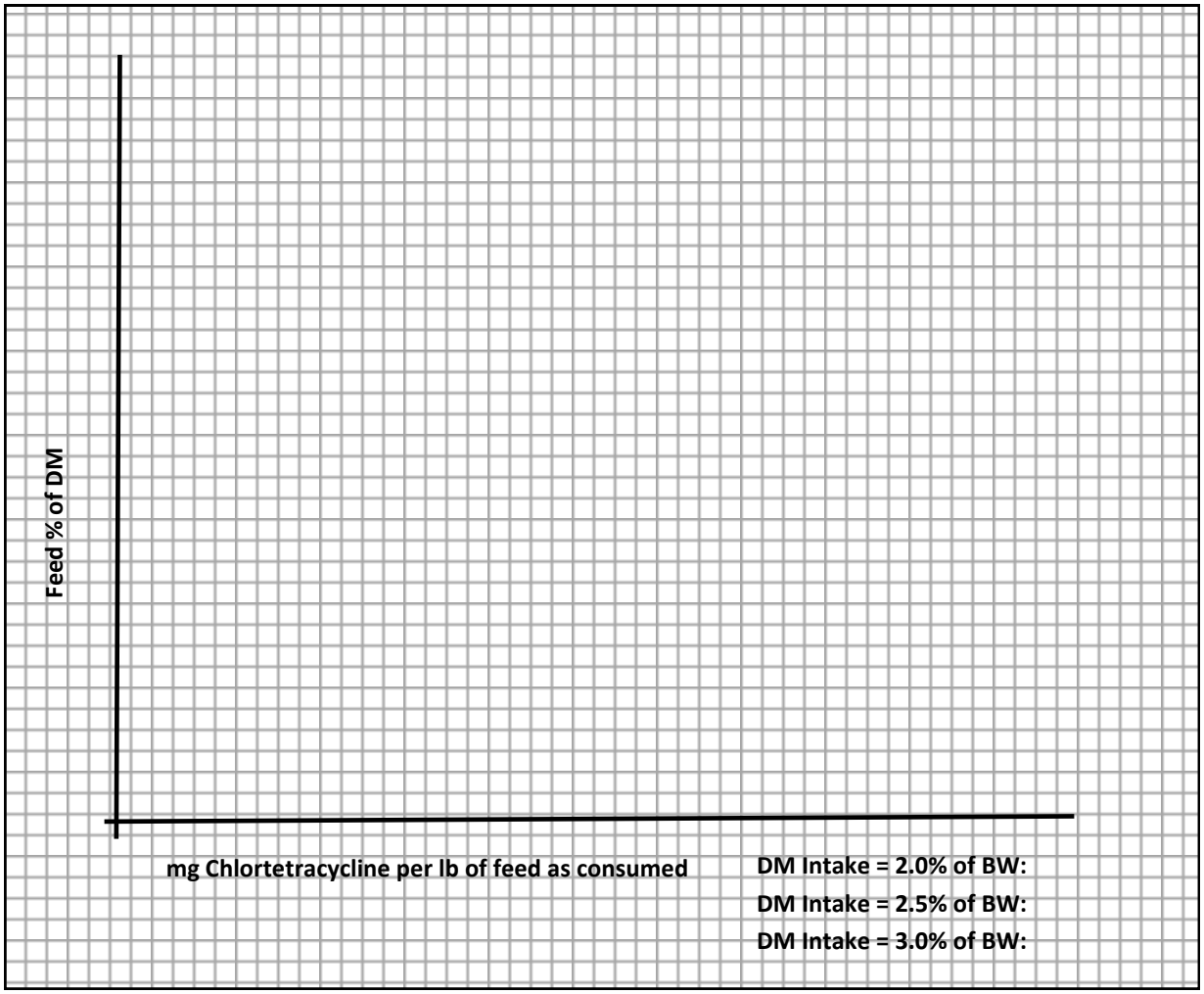
Table 2: Diamond K Feed Calculation Tables — Drug Concentration

Body weight lb	Feed Intake in DM as % of BW	Chlortetracycline Drug Concentration in Total Diet (mg / lb of feed)				
		100% Dry Matter Basis	90% Dry Matter Basis	80% Dry Matter Basis	70% Dry Matter Basis	60% Dry Matter Basis
300	2.0	500	450			
	2.5					
	3.0					

mg = milligram lb = pound
DM = Dry Matter BW = body weight

6. Create a graph of the data points collected in ***Table 1*** and ***2***. You may use either Excel or graph paper to plot your points. Once the graph is completed , extend the three lines created to interpolate Chlortetracycline concentrations in the feed when the dry matter in the feed changes at varying dry matter intakes (as expressed as a percentage of body weight). Full points will be awarded for graphs that include a legend and all three data curves (DM Intake at 2.0% of BW, DM Intake at 2.5% of BW, and DM Intake at 3.0 % of BW).



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Dose Makes the Poison Quiz

Teacher Answer Key

1. To help care for your Aunt's cattle, look at the Aureomycin 4G Crumbles label on Page 9 and answer the following questions.

   a. What antibiotic is being used?

   Chlortetracycline

   b. What concentration of the antibiotic is listed on the label?

   4g/lb

   c. Express the concentration listed on the label in grams per ton. Show the formula you use to obtain your answer.

   4 g/lb x 2,000 lb/ton =4,000 g/ton

   d. Express the concentration listed on the label in milligrams per pound. Show the formula you use to obtain your answer.

   4 g/lb / 1000 mg/g =4,000 mg/lb

   e. Express the concentration listed on the label in milligram per kilogram. Show the formula you use to obtain your answer.

   4000 mg/lb x 2.203 lb/kg = 8,812 mg/kg

   -or-

   4g/lb / 454g/lb x 1000,000 mg/kg = 8,810 mg/ kg

2. What is the amount of drug required to treat bacterial pneumonia associated with *Pasteurella multocida* in cattle as stated on the label?

   10 mg/lb of body weight per day

3. How many milligrams of chlortetracycline are required to treat one 300 pound calf? Show the formula you use to obtain your answer.

   10 mg/lb BW/day x 300 lb BW = 3,000 mg/day

4. How many pounds of this medicated feed will it take to properly treat all 25 calves? Show the formula you use to obtain your answer.

   25 calves x 3000 mg/day = 75,000 mg / day

   75,000 mg / 1000 mg/ g = 75 g

   75g / 4 g /lb = 18.75 lbs of medicated feed required to dose 25 - 300 lb calves

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5. Calculate the total pounds of feed that the calves will eat as the moisture level increases in the feed and fill in ***Table 1***.

300 lb BW x 2% of BW = 6 lbs of DM
6 lbs DM / 90% DM = 6.67 lb at 90% DM

Table 1: DiamondK Feed Calculation Tables – Feed Intake

Body weight lb	Feed Intake in DM as % of BW	Pounds of Feed Expected to be Consumed at Different Dry Matters				
		100% Dry Matter Basis	90% Dry Matter Basis	80% Dry Matter Basis	70% Dry Matter Basis	60% Dry Matter Basis
300	2	6	6.67	7.5	8.57	10
	2.5	7.5	8.33	9.38	10.71	12.5
	3	9	10	11.25	12.86	15

Next, determine the concentration in mg/lb of chlortetracycline in the feed and fill in ***Table 2*** using information determined in ***Table 1*** as well as the mass (in mg) of chlortetracycline required to treat a 300 lb calf (an amount that you determined previously for *Question 3*).

300 lb BW x 10 mg/ lb chlortetracycline per day = 3000 mg chlortetracycline intake per day
3000 mg chlortetracycline intake per day/ lbs in chart 1 = Drug concentration for ***Table 2***

Table 2: DiamondK Feed Calculation Tables – Drug Concentration

Body weight lb	Feed Intake in DM as % of BW	Drug Concentration in Total Diet (mg / lb of feed)				
		100% Dry Matter Basis	90% Dry Matter Basis	80% Dry Matter Basis	70% Dry Matter Basis	60% Dry Matter Basis
300	2	500	450	400	350	300
	2.5	400	360	320	280	240
	3	333	299.7	266.4	233.1	199.8

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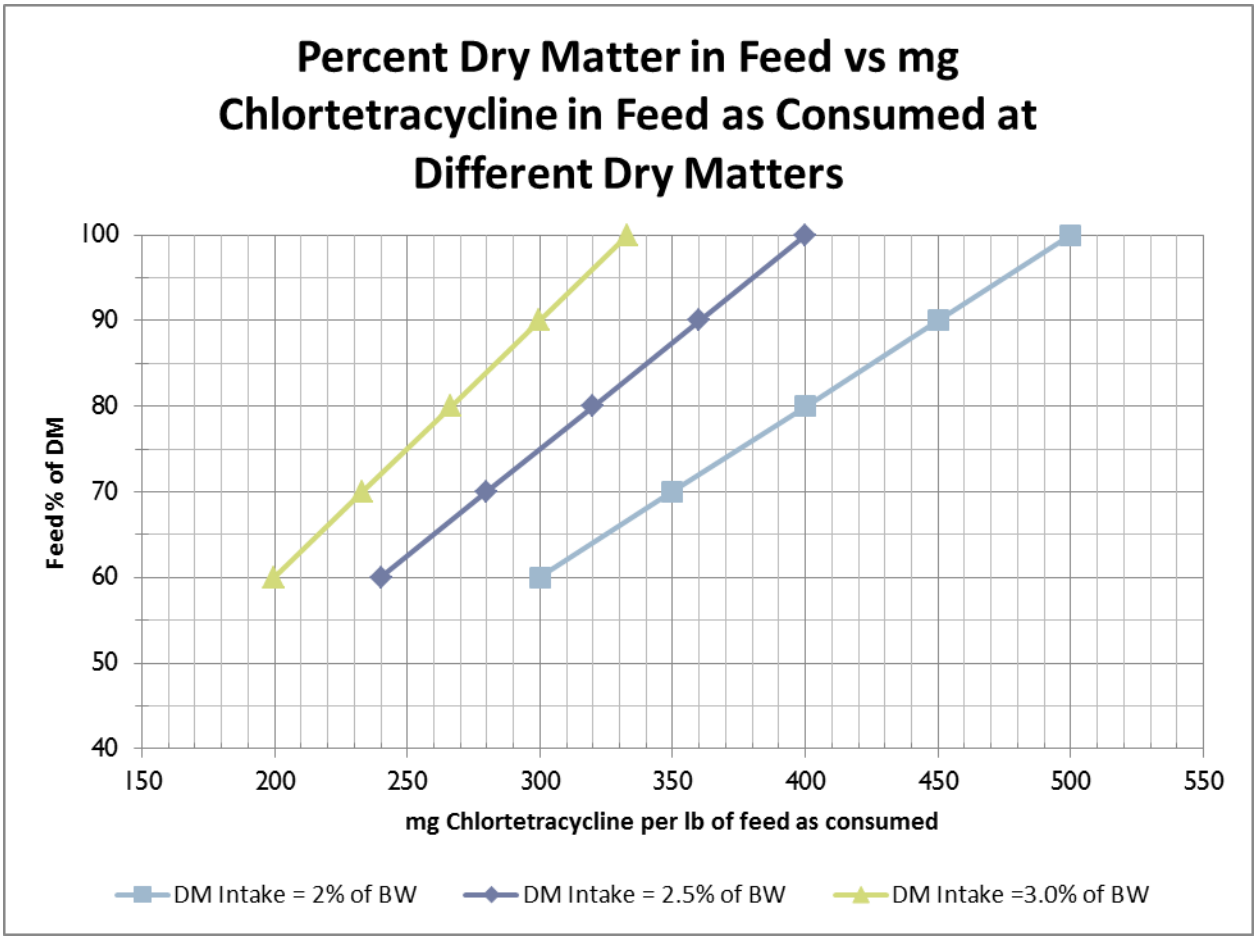
6. Create a graph of the data points collected in ***Table 1*** and ***2***. You may use either Excel or graph paper to plot your points. Once the graph is completed , extend the three lines created to interpolate Chlortetracycline concentrations in the feed when the dry matter in the feed changes at varying dry matter intakes (as expressed as a percentage of body weight). Full points will be awarded for graphs that include a legend and all three data curves (DM Intake at 2.0% of BW, DM Intake at 2.5% of BW, and DM Intake at 3.0 % of BW).



Fails to Meet Expectations	Approaching Expectations	Meets Expectations	Exceeds Expectations
Does not label x-axis and y -axis AND does not include appropriate scale. -AND- Incorrectly plots data points.	Does not label x-axis and y -axis OR does not include appropriate scale. -AND- Correctly plots some data points and connects them with a line.	Correctly labels x-axis and y-axis AND includes appropriate scale. -AND- Correctly plots most data points and connects them with a line.	Correctly labels x-axis and y-axis AND includes appropriate scale. -AND- Correctly plots all data points and connects them with a line. -AND- Provides correct legend showing maximum and minimum dose.

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Systems Approach to Feed Safety

Activity Time: 60 Minutes plus homework.

Lesson Plan Summary:

In this lesson, students will study the basic concepts of a systems approach to feed safety. After an introduction to feed safety, students will engage in an activity designed to use Systems Thinking to review the field of animal feed safety. Finally, students will individually show their knowledge of Systems Thinking as it applies to a pet food outbreak.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- **Systems Approach:** The systems approach to problem solving can provide an effective model for analysis. When responding to a large-scale health risk, such as melamine contamination, it is important to consider the entire system of feed/food processing also known as the product life cycle.

Essential Questions:

- What are the basic components of a system, as understood in Systems Thinking?
- How might one evaluate and prepare for long-term consequences of actions taken in the present?

Learning Objectives:

Students will know…

- When impurities such as melamine are introduced into animal feed, and therefore the human food chain, they can have widespread effects.

Students will be able to…

- Use the components of a system to think about problems and solutions.
- Consider the upstream causes and downstream impacts of an adverse safety event when considering feed/food safety concerns.
- Discuss the work of the Food and Drug Administration (FDA) in ensuring feed safety.

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Vocabulary:

- Boundary
- Cyanuric acid
- Drivers
- Feedback
- Input
- Melamine
- Output
- Risk
- Systems Thinking

Standards Alignment:

This lesson addresses the following Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs) for grades 9–12:

- **Science EALR 1 (9-12 SYSA):** Students know that *feedback* is a process in which the *output* of a *system* provides information used to regulate the operation of the *system*. Positive *feedback* increases the disturbance to a *system*. Negative *feedback* reduces the disturbance to a *system*.
- **Science EALR 1 (9-12 SYSB):** Students know that s*ystems* thinking can be especially useful in *analyzing* complex situations. To be useful, a *system* needs to be specified as clearly as possible.
- **Science EALR 1 (9-12 SYSC):** Students know that in complex *systems*, entirely new and unpredictable *properties* may emerge. Consequently, modeling a complex *system* in sufficient detail to make *reliable predictions* may not be possible.
- **Science EALR 3 (9-12 APP):** Students will transfer and apply abilities in science and technological design to develop solutions to societal issues.

This lesson addresses the following Washington State Career and Technical Education (CTE) model frameworks for Agriculture, Food, and Natural Resources (AFNR):

- **FPP.01.01.02.a:** Identify and explain environmental and safety concerns about the food supply. Level I.
- **FPP. 01.01.02.b:** Discuss the issues of safety and environmental concerns about foods and food processing (e.g., genetically modified organisms (GMO), microorganisms, contamination, irradiation). Level II.
- **FPP.02.02.01.a:** Describe contamination hazards (physical, chemical and biological) associated with food products and processing. Level I.
- **FPP 03.01.02.b:** Explain how the chemical and physical properties of foods influence nutritional value and eating quality. Level II.

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Common Student Preconceptions:

- Problems are solved by looking at each individual component in detail.
- Some problems are so complex that they cannot be modeled or resolved.
- Since feed/food is professionally packaged, we can presume it is always safe.

TEACHER PREPARATION

Materials:

Item	Quantity
Systems Approach to Feed/Food Safety Handout	1 per student
Systems Approach to Feed/Food Safety Teacher Answer Key	1

Preparation:

- Photocopy the *Student Handout*.
- Prepare your class presentation system to show the melamine video (see *Hook* section).
- While this lesson covers nine stages of food production, break the students into eight teams. (The first stage—farming—is offered as an example on the *Student Handout.*)

PROCEDURE

Hook:

1. Watch/listen to the news clip on melamine poisoning found at this website:

   Tainted Pet Food Recalled, 9/19/07 (3:44 minutes)
   http://www.cbsnews.com/video/watch/?id=2582962n&tag=mncol;lst;3

2. Ask students how they would approach solving a world-wide outbreak of animal illness. How would they start? What information would they need?

3. Tell the students that they will be reenacting the Systems Thinking approach that was used to solve this animal health issue. Ask students to imagine that they will reenact the role of an FDA Consumer Safety Officer responsible for ensuring that all the pet food and animal feed sold in Washington State is safe.

4. Point out that the role of the WSDA and the Food and Drug Administration (FDA) is to ensure a safe and reliable source of animal feed, which in turn leads to food safety for all of us. The WSDA, http://agr.wa.gov/, can assist with plant protection, pesticide management, inspections, livestock identification, licensing, permits, and compliance. Their primary goals include:

   - Protect and reduce the risk to public health by assuring the safety of the state's human and animal food supply.
   - Ensure the safe and legal distribution, use, and disposal of pesticides and fertilizers in Washington State.

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- Protect Washington State's natural resources, agriculture industry, and the public from selected plant and animal pests and diseases.
- Facilitate the movement of Washington agricultural products in domestic and international markets.

Activity Procedure:

5. Divide the students into eight groups. Distribute the *Student Handouts*.

6. Assign each of the teams to one of the following steps in food production, as outlined on the *Student Handout*:

   Grow, Harvest, Transport, Process, Package, Wholesale, Retail, Eat, and Dispose

7. Tell the students that they will use **Systems Thinking** to consider the inputs, outputs, risks, and feedback for eight of the nine stages (the first stage, "grow," is offered as an example on the *Student Handout*). Provide your students an analogy of a familiar system and its components and connections. We suggest that you introduce Systems Thinking with these points:

   a. Tell students that an academic definition of a system is "a set of objects or elements in interaction to achieve a specific goal."

   b. Discuss a system in the context of one that they know, such as a cafeteria (see ***Table 1***).

   c. Practice out loud with students. Ask the students to imagine and describe a library using Systems Thinking.

Table 1: Systems Thinking and the School Cafeteria

Category	Definition	Example
Drivers	Real and imagined benefits that motivate or enhance systems processes.	Cafeteria budget is increased allowing the staff to buy higher quality corn.
Inputs	The components that enter the system. May include risks.	Hungry people, cooks, cashiers, cooking energy, refrigeration, water, energy, food, and drinks.
Outputs	The components that leave the system. May include valued as well as harmful/unintended components.	Full people, waste, dirty dishes, and revenue.
Feedback	Information about a component or process that can be used to evaluate and monitor the system and to guide it to more effective performance.	A menu item not being purchased by students.
Risks	Factors (actions and resources) which can disturb/decrease/stop the rate with which the system converts inputs to outputs.	Food spoils and cannot be served to students.

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8. Each of the eight teams will serve as an FDA Consumer Safety Officer for eight stages of food production, thinking through the risks and drivers related to the inputs and outputs for each stage of the system. Teams will complete the table on the *Student Handout*, using the provided example. Additionally, students should be mindful of the means by which they can:

    a. Optimize processes to cut costs (e.g., do more with less).

    b. Optimize processes to meet consumer demand (e.g., provide organic food).

    c. Optimize processes to reduce infectious disease risk (e.g., homogenize milk, refrigerate prepared foods).

    d. Optimize processes to minimize chance of contaminated/adulterated food entering feed (e.g., WSDA inspects feed mills for the presence of meat and bone meal in cattle feed as a means of reducing possible protein contamination that might cause Bovine Spongiform Encephalitis).

    e. Optimize processes to maximize health of livestock and therefore the public (e.g., WSDA inspectors inspect beef for possible Bovine Spongiform Encephalitis infections).

9. Once the student teams have identified the risks, drivers, inputs, and outputs at each stage of food production, they will share their findings with the class in a five minute presentation and class discussion.

10. Assess the students' learning and their participation in the group presentations and class discussion using the provided *Group Presentation and Discussion Scoring Rubric*:

Dimension	Fails to Meet Expectations	Approaching Expectations	Meets Expectations	Exceeds Expectations
Commitment (Voice)	Makes no attempt to make the group care about his/her ideas and suggestions.	Half-hearted attempt to make the group care about his/her ideas and suggestions.	Uses one or two reasons to show why the group should care or know more about his/her ideas and suggestions.	Uses several reasons AND appropriate emotion to convince the group to care or want to know more about his/her ideas and suggestions.
Focus on Ideas and Support for Ideas (Content)	The ideas and details are not clear AND there is a random collection of anecdotes or irrelevant ideas and details.	Main idea is somewhat clear BUT supporting thoughts are random or key issues are unsupported.	Main idea is clear BUT the supporting information is general and less well-thought-out, or one key issue or idea is unsupported.	Ideas presented are clear, focused, and well supported by well-thought-out information that goes beyond the obvious or predictable.
Word Choice	Uses limited vocabulary that does not communicate strongly. Uses jargon or clichés that detract from message.	Uses words that communicate clearly BUT word choice lacks topic-specific vocabulary, variety, punch, or flair AND may be inaccurate or overdone.	Uses some vivid words and phrases that linger or draw pictures in the group's mind. Sometimes uses topic-specific and technical vocabulary.	Uses vivid words and phrases that linger or draw pictures for the listeners. Uses vocabulary that is topic-specific and appropriately technical.
Conclusion (Organization)	There is no clear conclusion; the discussion just ends.	The conclusion is recognizable BUT does not tie up loose ends.	The conclusion is clear AND ties up loose ends.	The conclusion is strong and convincing AND synthesizes the main points and compelling evidence.

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Wrap-up:

11. Once the team presentations are completed, tell the students to familiarize themselves with the melamine pet food recall using the *Student Handout* and remembering the newscast video they watched earlier in the class.

12. Assign students homework wherein they use Systems Thinking to identify the inputs and processes in determining: how the animals got sick; the opportunities for risk; and the opportunities to minimize suffering through innovation and improvements.

Assessment Opportunities:

- Observe group and class participation for even distribution of content across the headings and thoroughness of responses.

- Assess students' ability to contribute to meaningful group participation. Use the provided group presentation and discussion rubric (see *Step #10* of the lesson plan) to review students' group contribution.

- Additionally, you may collect the groups' completed *Team Systems Thinking Matrix* from the *Student Handouts*. Assess students' responses with the scoring rubric provided on the *Teacher Answer Key*. If your time is limited, you can merely collect these forms and not conduct the classroom presentations.

- Collect and assess each student's *Individual Student Homework* from the *Student Handout* regarding melamine-related poisoning. Assess students' understanding of Systems Thinking and poisoning using the scoring rubric provided on the *Teacher Answer Key*.

Student Metacognition:

- Students' gains in understanding of systems thinking as a consequence of participating in the lesson can be reviewed through their final matrix related to melamine poisoning.

Extension Activities:

- Ask students to define their home as an environment and think of all the systems within their home, describing the boundaries, inputs, and outputs.

- Ask students to imagine other issues that drive the productivity, inputs and risks in the feed and food industry.

- Ask students to prepare additional Systems Thinking handouts for other feed safety issues such as mad cow disease, *E. coli* contaminated beef, and *Salmonella*-contaminated spinach.

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TEACHER BACKGROUND & RESOURCES

Career Links:

- Animal feed control officer
- Animal feed manufacturer
- Animal pathologist
- FDA Consumer Safety Officer
- Research biologist
- Veterinarian

Background Information:

Basic information about Systems Thinking, systems approach, and pet food poisoning can be obtained from the websites listed in the *Resources* section.

Resources:

Overview of Systems Thinking
http://www.thinking.net/Systems_Thinking/OverviewSTarticle.pdf

Melamine and Cyanuric Acid Video (1:55 min)
http://www.youtube.com/watch?v=s8U9we0HEQg

FDA Review of Melamine-related Pet Food Recall (including press releases)
http://www.fda.gov/animalveterinary/safetyhealth/recallswithdrawals/ucm129575.htm

CVM Researcher Renate Reimschuessel Nominated for Service to America Medal
http://www.fda.gov/AnimalVeterinary/NewsEvents/FDAVeterinarianNewsletter/ucm084109.htm

Credit:

Lesson plan written by Nona Clifton of the Washington Global Health Alliance.

Student Handout photograph courtesy of Theresa Britschgi.

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Name:_____Date:_____Period:_____

Systems Approach to Feed/Food Safety

Student Handout

Team Member Names: _____

The Flow Plan Stage you investigated: _____

Grain silo. **Credit**: Theresa Britschgi.

To most Americans, food moves from the farm to the table in this one-way flow:

Grow → Transport → Eat

You are a team of WSDA feed and food inspectors. You are part of an important team of specialists who work to protect our food supply and the public. This means that you know that growing and delivering foods safely to the public is more complex than most Americans think. In reality, the overall flow of food from farm to table is more accurately described as:

Grow → Harvest → Transport → Process → Package → Wholesale → Retail → Eat → Dispose

This linear flow describes how food moves through nine stages. In reality, various risks and drivers have an impact on every stage. These influence the movement of food through the stages, resulting in feedback loops. Like any good mystery detective, a food inspector must appreciate all these elements at once to be able to manage the process and ensure that the public has reliable access to safe food at the best price. In this activity, you will use **Systems Thinking**—an all-encompassing view of a problem—to analyze the many ways that the public is at low, moderate, or high risk due to a variety of stages in the delivery of safe food.

Working as one of eight teams, your team will be responsible for ***one*** of these defined stages of food production: **Harvest, Transport, Process, Package, Wholesale, Retail, Eat, and Dispose**. Each team will work to complete the matrix for ***their*** assigned stage of the flow plan, following the example provided for the "Grow" stage. Your teacher will assign your team one of these categories. After about ten minutes of work time, your team will share your entries with the class through a five-minute presentation and discussion. Remember, the health of Americans depends on your ability to complete the matrix reliably.

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Team Systems Thinking Matrix:

Sample for **Grow** stage:

Drivers: 1. Economic: World markets buying final crop at high price. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Land, seed, fuel costs, or water. 2. Farming equipment, available labor.	**Outputs:** 1. Final crop. 2. Profits.
Risks: 1. Infectious: Water or soil contaminated with an infectious organism, such as *E. coli*. 2. Chemical: Water or soil contaminated with toxic chemical, such as lead or arsenic. 3. Economic: Surplus yield drops price that wholesalers pay for crops. 4. Global: Drought in competing country reduces global yield and raises price wholesalers pay for crops.	

Complete the matrix below for your team's stage in food development.

Drivers: 1. Economic: 2. Cultural/Global:	
Inputs: 1. 2.	**Outputs:** 1. 2.
Risks: 1. Infectious: 2. Chemical: 3. Economic: 4. Global:	

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Individual Homework:

Background:

In 2007, veterinarians began to notice a growing number of cases of sick dogs and cats who ate specific brands of feed within a pattern of pathology and location. They began communicating with one another to determine the cause of the animals' illness.[1, 2] Inspectors had to scrutinize the pathway—looking at inputs and outputs at all stages in the pet food brands of concern.

Through experiments with fish, FDA scientist Dr. Renate Reimschuessel identified small crystals in the fish kidneys that were blocking proper function. As reports of pet-related illnesses and deaths increased, the pet food manufacturer, private and public universities, and the FDA mounted an impressive international collaborative effort to identify the cause of the poisoning. Soon after, Cornell University and the FDA Forensic Chemistry Center jointly identified melamine-cyanuric acid as the pet food contaminant.

Multiple state regulatory agencies and the FDA then worked quickly to remove potentially contaminated products from store shelves to limit the risk of animal injury and death, and also to inform consumers of the dangers of feeding their animals the suspect products. These agencies, including WSDA Feed Safety Specialists and the WSDA Chemical Lab in Yakima, Washington, also worked to discover the contamination sources by testing collected samples.

Eventually, the outbreak was traced back to melamine and cyanuric acid contamination in wheat flour imported from China and used as an ingredient in the pet food. The melamine had been intentionally added at the processing stage in China to give the flour the ***false impression*** of being rich in protein. By adding melamine, producers could price their products more inexpensively and competitively relative to U.S. wholesalers. These wholesalers sold the tainted product to a variety of pet food companies, who incorporated it into their products. They unknowingly sold their feed products to retailers, and in turn, to pet owners. In some cases processed feed was placed in shipping containers that had previously stored cyanuric acid. As a result of investigating the 2007 pet food problem, global surveillance methods of melamine content were launched to enhance the safety of the pet and human food supply. Additionally, officials enhanced public response and communications protocols to inform consumers of this new risk. Outbreaks associated with melamine and melamine analogues in pets and pigs have been confirmed in North America, Korea, Taiwan, the Philippines, Spain, Thailand, South Africa, and Italy.

In today's world, it is crucial to understand and deal with the global implications of intentional and unintentional foodborne contamination if problems like the melamine outbreak are to be prevented.

Footnotes:

1 http://www.youtube.com/watch?v=s8U9we0HEQg
2 http://www.fda.gov/animalveterinary/safetyhealth/recallswithdrawals/ucm129575.htm

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Review the stages in delivering feed from the farm to the pets' bowls. Note in the matrix below the potential sources of risk for each stage in the development and use of the feed. Then, propose how you might reduce each of these risks. Provide two answers for each heading.

	Was the feed altered during the growing and cultivation stage?	**Was the feed at risk during processing?**	**Was the feed at risk during distribution?**	**Why didn't the processors or feed inspectors find the melamine before animals died?**	**How was the public informed of the risk?**
Sources of Risk	1. 2.	1. 2.	1. 2.	1. 2.	1. 2.
Interventions and Innovations	1. 2.	1. 2.	1. 2.	1. 2.	1. 2.

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Systems Approach to Feed/Food Safety

Teacher Answer Key

Student Handout Scoring Rubric:

Fails to Meet Expectations	Approaching Expectations	Meets Expectations	Exceeds Expectations
Does not complete *Handout*. Or, fails to proficiently complete at least 50%.	Attempts to complete *Handout*, with >50% proficiency regarding possible risks.	Completes most of *Handout*, with >70% proficiency regarding possible risks.	Completes most of *Handout*, with >90% proficiency regarding possible risks.

Team Systems Thinking Matrix:

Teachers should expect to see a variety of answers to this open-ended exercise. This is because the breadth of the answers is dependent upon how broadly the students define the boundary or extent of their system. The following answer guide attempts to provide answers most explicitly associated with the learning goals of the lesson.

Harvest

Drivers: 1. Economic: World markets buying final crop at high price. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Mature crop. 2. Harvesting equipment, available labor. 3. Fuel.	**Outputs:** 1. Shipment-ready feed/food. 2. Cash for farmer. 3. Crop residue in field, nutrient-depleted soil.
Risks: 1. Infectious: Contaminated equipment. Crops left so long that they acquire mold. 2. Chemical: Contaminated equipment or rinsing water. 3. Economic: Insufficient labor, high fuel costs, rising cost of mature crop. 4. Global: Drought in competing country reduces global yield and raises price wholesalers pay for crops.	

Transport

Drivers: 1. Economic: Cost of labor, fuel, port service fees, availability of rail and cargo containers. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Crops. 2. Available skilled labor. 3. Fuel, rail, cargo containers, ports, boats.	**Outputs:** 1. Crop arrives for processing. 2. Empty and clean containers. 3. Documentation on use of the container and its location, facilitating container traceability.
Risks: 1. Infectious: Containers dirty or not sterile. 2. Chemical: Containers dirty. 3. Economic: Cost of fuel escalates. 4. Cultural/Global: War, terrorism, or piracy impedes movement of goods. Food defense not consistent. Disdain or fear of GMO crops.	

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Process

Drivers: 1. Economic: Cost of labor, fuel, and additives. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Transported crop. 2. Labor, packaging, additives, preservatives. 3. Processing facilities. 4. Government and third party inspectors. 5. Standard Operating Procedures (SOPs) used to maintain equipment and record methods.	**Outputs:** 1. Processed crop. 2. Empty containers.
Risks: 1.Infectious: Additives not clean/sterile. Crops stored poorly and rot. 2.Chemical: Unhealthy additives. 3. Economic: Cost of additives and labor encourage unhealthy processing practices (e.g., use of melamine, adding fill instead of protein). 4. Cultural/Global: Population demands fewer or safer additives; kosher food preparation.	

Package

Drivers: 1. Economic: Cost of labor and packaging. 2. Cultural/Global: Regulatory agencies require clear documentation of safe preparation of product ingredients. Consumers require an attractive and culturally appropriate package.	
Inputs: 1. Processed food and feed. 2. Packaging, fuel, and labor. 3. Storage areas.	**Outputs:** 1. Empty containers. 2. Packaged food.
Risks: 1. Infectious: Processing equipment and/or processing water not clean/sterile. Storage was insufficient to preserve or protect the food and feed from vermin or rot (both bacterial and fungal). 2. Chemical: Processing equipment or water not clean. 3. Economic: Cost of packing and fuel. 4. Cultural/Global: Packaging was not attractive to a variety of populations/cultures and languages.	

Wholesale

Drivers: 1. Economic: Ability to offer an adequate supply of safe, packaged materials at a competitive price. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Packaged foods. 2. Inspection agents. 3. Government and third-party inspectors. 4. Consumers and retailers.	**Outputs:** 1. Empty storage areas. 2. Wholesaler has packaged food to sell to retailers.
Risks: 1. Infectious: Industry fails to protect packaged food and feed from potential infectious hazards. 2. Chemical: Industry fails to protect packaged food from potential chemical and contamination hazards. 3. Economic: Consumers not interested in packaged food before it goes bad. 4. Global: Packaging fails to meet all the needs of consumers.	

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Retail

Drivers: 1. Economic: Ability to offer safe, packaged materials at a competitive price. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Wholesale foods. 2. Consumers. 3. Fuel, grocery bags, retail outlets, and skilled labor.	**Outputs:** 1. Food delivered to consumer. 2. Stores depleted of packaged food.
Risks: 1. Infectious: Food not stored properly in store. Tampering. 2. Chemical: Tampering/terrorism. 3. Economic: Online purchasing versus in-person purchasing. 4. Global: Food interests change resulting in overstock/understock.	

Eat

Drivers: 1. Economic: Food interests/fads/diets. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Purchased food, cooking energy, water. 2. Cook, hungry diner, restaurants, kitchens, cutlery, plates, servers. 3. Food inspectors.	**Outputs:** 1. Dirty dishes. 2. Full diner. 3. Empty kitchens.
Risks: 1. Infectious: Food poorly prepared or stored. 2. Chemical: Food poorly prepared or tampered with (e.g., poisoned). 3. Economic: Economy declines and people do not eat out. Food fads change dining choices. 4. Global: Food interests change resulting in overstock/understock.	

Waste

Drivers: 1. Economic: Use of waste food and paper products in compost and recycling. 2. Cultural/Global: Large, hungry, and possibly impoverished global population.	
Inputs: 1. Waste food and packaging. 2. Waste storage, processing, and staff.	**Outputs:** 1. Waste, compost. 2. Landfills.
Risks: 1. Infectious: Potentially hazardous waste. 2. Chemical: Landfills filled with methane. 3. Economic: Large cost of processing and disposing waste. 4. Global: Community lack of interest in/distaste for waste.	

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Individual Homework Answer Key:

	Was the feed altered during the grow and cultivation stage?	Was the feed at risk during processing?	Was the feed at risk during distribution?	Why didn't the processors or feed inspectors find the melamine before animals died?	How was the public informed of the risk?
Sources of Risk	The contamination did not occur during the growth and cultivation stage.	The feed was at risk due to intentional contamination during processing.	Unintentional contamination of feed during shipment or storage.	1. Experts had not realized how serious melamine poisoning could be for animals and therefore did not screen for it until many animals died. It was a new combination of chemical contaminants not typically found in animal feed. 2. It was a complex contamination that required investigation of several clues.	1. The public learned through the media, veterinarians, and pet food stores. 2. These sources were informed by the FDA and health officials. 3. The processors and wholesalers recalled the feed; pet stores removed feed from shelves. 4. From personal experience via the loss of a pet.
Interventions and Innovations	There is no risk here so no need for intervention.	1. Know the source of your inputs. 2. Have regulations and testing agencies.	1. Clean the containers per approved SOPs to remove chemical contamination. 2. Know the source of your inputs.	1. Once it was established how the pets were poisoned, feed was routinely tested for melamine and cyanuric acid. 2. Additionally, the FDA increased its presence in foreign countries.	1. Officials enhanced public response systems. 2. Officials enhanced the communications protocols that informed consumers of the new risk.

Individual Homework Scoring Rubric:

Fails to Meet Expectations	Approaching Expectations	Meets Expectations	Exceeds Expectations
Does not complete *Handout*. OR fails to proficiently complete at least 50% of answers regarding cause of poisoning and how scientists used data to determine risks.	Attempts to complete *Handout*, with >50% proficiency regarding cause of poisoning and how scientists used data to determine risks.	Completes most of *Handout*, with >70% proficiency regarding cause of poisoning as a result of co-contamination by melamine and cyanuric acid and how scientists used data to determine risks.	Completes most of *Handout*, with >90% proficiency regarding the cause of poisoning, and how WSDA used FDA data to reduce possible risks to animals eating feed.

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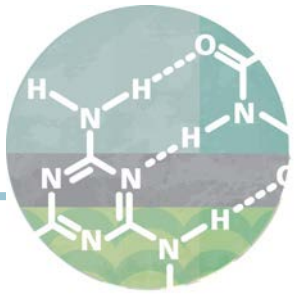
Producers, Analysts, and Pets



A Simulation

Activity Time: 55 Minutes.

Lesson Plan Summary:

In this lesson, students will participate in a simulation activity, where they will play the roles of Feed Ingredient Manufacturer, Feed Shipping Agent, Government Chemical Analyst, and Pet Food Manufacturer. The activity will simulate the use of melamine as a filler added to simulate a higher protein content in animal feed, and will show how analytical chemistry can be used to assess the quality and safety of animal feed.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- **Animal Feed Safety Regulations:** Safe feed practices, regulated by state and federal departments of agriculture, assess imported and local feed sources for harmful feed fillers such as melamine.

Essential Questions:

- How can analytical chemistry be used to help monitor food sources?
- How is the role of the WSDA and/or FDA important in the safety of animal feed?

Learning Objectives:

Students will know…

- The rationale for using melamine as a false protein feed filler.
- Proper feed practices.
- The importance of quality testing of imported and local feed sources.
- The chemistry that underlies a double replacement reaction.

Students will be able to…

- Understand the WSDA's and FDA's position on regulating animal feed from both domestic and international sources.
- Recognize the need for state and federal agencies that regulate animal feed.
- Balance a double replacement reaction and understand the chemistry behind the reaction type.

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Vocabulary:

- Cyanuric acid
- Double replacement reaction
- Feed ingredient manufacturer
- Melamine
- Precipitate
- Solubility

Standards Alignment:

This lesson addresses the following Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs) for grades 9–12:

- **Science EALR 4 (9-11 PS2E):** *Molecular compounds* are composed of two or more *elements* bonded together in a fixed proportion by sharing *electrons* between *atoms*, forming *covalent bond*s. Such *compounds* consist of well-defined *molecules*. Formulas of *covalent compounds* represent the types and number of *atoms* of each *element* in each *molecule*.
- **Science EALR 4 (9-11 PS2H):** *Solutions* are *mixtures* in which particles of one substance are evenly distributed through another substance. *Liquids* are limited in the amount of dissolved *solid* or *gas* that they can contain. *Aqueous solutions* can be *described* by relative quantities of the dissolved substances and acidity or alkalinity (pH).

This lesson addresses the following Washington State Career and Technical Education (CTE) model frameworks for Agriculture, Food, and Natural Resources (AFNR):

- **ABS.07.04.01.a:** Determine the meaning and importance of risk and uncertainty with AFNR enterprises. Level I.
- **AS.04.01.02.a:** Explain the purpose and benefits of feed additives in animal production. Level I.
- **AS.04.02.01.b:** Discuss how feed additives are administered and the precautions that should be taken. Level II.
- **FPP.01.02:** Work effectively with industry organizations, groups and regulatory agencies affecting the food products and processing industry.
- **FPP.02.03:** Apply safety and sanitation procedures in the handling, processing and storing of food products.

Common Student Preconceptions:

- Chemistry and chemical equations belong in laboratories and have nothing to do with agriculture or feed safety issues.
- Packaged feed in the U.S., even if it comes from another country, can be assumed to be safe.
- Federal regulations are bureaucratic and an imposition, not a safety benefit.
- Additives used as “filler” are not toxic.

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TEACHER PREPARATION

Materials:

Item	Quantity
Large, non-white sponge cut into half-inch cubes (substitute for feed pellets)	200 cubes per class
Disposable pipettes	1–2 per station (4–8 total)
3 M sodium hydroxide, colorless (substitute for cyanuric acid)	100 mL per station (400 mL total)
0.1 – 0.5 M silver nitrate, colorless (substitute for melamine)	100 mL per station (400 mL total)
Phenolphthalein solution (reacts with sodium hydroxide, indicating contamination with cyanuric acid)	100 mL per station (400 mL total)
3 M hydrochloric acid, colorless (reacts with silver nitrate, indicating contamination with melamine)	100 mL per station (400 mL total)
Chemical weigh boats or trays	6 trays or 12 boats
Paper towels	1 stack per lab station (4 stacks total)
Plastic baggies or bowls (for mixing feed/sponges)	2 per class
Gloves and goggles	1 set per student
Copies of *Sequence of Melamine-Contaminated U.S. Feed* Student Handout	1 per student
Copy of *Feed Shipping Agent* Student Handout	1 for Feed Shipping Agent Station
Copy of *Feed Ingredient Manufacturer* Student Handout	1 for Feed Ingredient Manufacturer Station
Copy of *Government Chemical Analyst* Student Handout	1 for Government Chemical Analyst Station
Copy of *Pet Food Manufacturer* Student Handout	1 for each Pet Food Manufacturer Station
Lab notebooks or journals	1 per student

Preparation:

- Photocopy the *Student Handouts* and distribute.
- This lab exercise uses four different chemicals often found in high school chemistry classrooms. Borrow or purchase stock solutions and prepare solutions for this exercise following good lab safety practices.
- Prepare the “feed pellets” by cutting the sponges into ~ 1/2” cubes.
- Prepare **Feed Ingredient Manufacturer Station**: Bottle containing silver nitrate, paper towels, trays, 100 sponge cubes, disposable pipettes, baggie or bowl, and safety equipment.
- Prepare **Feed Shipping Agent Station**: Bottle containing sodium hydroxide, paper towels, trays, 100 sponge cubes, disposable pipettes, baggie or bowl, and safety equipment.
- Prepare **Government Chemical Analyst Station** and **Pet Food Manufacturer Station**: Phenolphthalein and hydrochloric acid (1 bottle each for the Analysts, 3 bottles each for the Pet Food Manufacturers), paper towel, disposable pipettes, and safety equipment.

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- **Silver Nitrate Safety Note:** Brief exposure to silver nitrate will not produce immediate side effects other than purple, brown, or black skin stains. With more exposure, side effects will become more noticeable, including burns. Long-term exposure may cause eye damage. Silver nitrate can destroy mucous membranes and is a skin and eye irritant.
- **Sodium Hydroxide Safety Note:** Solid sodium hydroxide or solutions of sodium hydroxide may cause chemical burns, permanent injury, or scarring if they come on contact with unprotected tissue. Sodium hydroxide may cause blindness if it comes in contact with the eye. Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling the material or its solutions.
- **Hydrochloric Acid Safety Note:** Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling hydrochloric acid or its solutions.
- **Clean-up Safety Note:** At the end of the lab activity, dispose of all 'pellets' by wrapping them in paper towels and discarding them in the trash. Any large amounts of precipitate should be disposed of in a precipitate waste container. Instructors should check with chemistry colleagues on the proper disposal of acids and bases (e.g., whether they should be neutralized before disposal).

PROCEDURE

Hook:

1. Discuss the two *Essential Questions* and allow students to collaborate on their answers:

   - How can analytical chemistry be used to help monitor food sources for contaminants?

   - How is the role of the WSDA and/or FDA important in the safety of animal feed?

2. Share with students the story of Dr. Renate Reimschuessel. Review the website listed below on your own and with students. Also, pass out copies of the *Sequence of Melamine-Contaminated U.S. Feed* Handout and provide time for students to read it.

   CVM Researcher Renate Reimschuessel Nominated for Service to America Medal
   http://www.fda.gov/AnimalVeterinary/NewsEvents/FDAVeterinarianNewsletter/ucm084109.htm

3. **Background information:** Dr. Reimschuessel is a research biologist at the Center for Veterinary Medicine's Office of Research of the Food and Drug Administration. She is known for her seminal work that clarified the mechanism by which melamine caused kidney damage in cats and dogs. Dr. Reimschuessel's amazing discovery originated around domestic pet food, but her findings have implications for livestock feed safety too. She hypothesized that melamine was combining with another chemical (e.g., cyanuric acid) and forming crystals in the animals' kidneys. She proved her theory by feeding melamine and cyanuric acid to fish. The fish receiving either the melamine or the cyanuric acid alone did not develop kidney crystals, while fish receiving both chemicals developed crystals similar to those seen in the afflicted cats and dogs.

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4. Students will simulate Dr. Reimschuessel's work through this activity. The combination of melamine (silver nitrate) and cyanuric acid (sodium hydroxide) leads to the formation of a brown precipitate, which mimics the kidney crystals. In order for this simulation to work, we have instituted a supposition that the level of individual contamination by melamine or cyanuric acid in this activity is sub-lethal. Students will be reporting lethal poisoning only in the event of co-contamination. In addition, students will better understand how regulatory agencies test the safety of the food we feed our animals.

Preconceptions:

5. Ask students to discuss how they would monitor animal feed sources being imported from other countries.

6. Cite examples of careers in ag-biotech and animal feed safety that apply analytical chemistry, such as:

   - **Agriculturalists** deal with the art of cultivating the soil, producing crops, raising livestock, and the preparation of these products for human use and disposal.
   - **Animal Nutritionists** formulate diets for food, companion, and zoo animals. They also study the absorption of and effects nutrients have on animal systems and find ways to improve or manipulate the nutritive health of animals. Animal nutrition is a science that combines chemistry, physics, biochemistry, mathematics, animal behavior, economics, and food processing with animal production techniques.
   - **Animal Physiologists** study the physical and chemical processes that occur in animals and the way these processes work together.
   - **FDA Animal Scientists** conduct scientific reviews of complex animal nutritional, biochemical, and physiological data for use in the development and approval of new animal food ingredients and deliver their findings in written reports. They confer with feed manufacturer representatives and others about the various issues relating to the manufacture of medicated feeds, including but not limited to safe drug use, further mixing of feeds, and handling of drug carryover in feed.
   - **Biochemists** explore the chemical events that cause biological phenomena in living organisms. The knowledge that biochemists gain in their research provides a basic understanding of the marvelous workings of the vast array of life forms.

Activity Procedure:

7. Break the students into four teams; each team should meet at a different station. **Note:** The teams need not be the same size. If the class is large, the majority of the students should be assigned to the Pet Food Manufacturers team, which can be subdivided into subteams representing different pet food brands, while the Analyst team can be smaller, and the Feed Ingredient Manufacturer and Shipping Agent teams of intermediate size. The four teams are:

   a. **Animal Feed Ingredient Manufacturer (Melamine):** A feed ingredient manufacturer from a foreign country who is adding melamine to their product as an inexpensive replacement for protein.

   b. **Animal Feed Shipping Agent (Cyanuric acid):** A feed ingredient manufacturer from a foreign country who is shipping their product in containers that previously held cyanuric acid (typically used as a chlorine stabilizer in swimming pools, and chemically similar to melamine).

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c. **Government Chemical Analyst:** A government official from the WSDA or FDA tasked with testing samples of all imported feed products for quality and safety.

d. **Pet Food Manufacturer:** A manufacturer who combines multiple feed ingredients to make balanced, nutritious, and appetizing pet food for his/her clients. Within this team there may be subteams that manufacture different and unique pet foods with different brand names.

e. Choose an outgoing student to function as the **Wholesale Feed Ingredient Agent**. The student in this role will be in charge of dramatically offering and selling the two sources of feed ingredients to the pet food manufacturing teams.

8. Ask each group to read the *Student Handout* that is relevant to their station.

9. To reduce production costs, the **Feed Ingredient Manufacturer Team** will illegally "make" the feed ingredient with 10% melamine. To represent the addition of melamine to the feed ingredients, students will treat 10 feed pellets (represented by sponge cubes) with the silver nitrate solution. Wearing safety gear, the students should place the 10 sponge cubes on a paper towel and then apply 4–5 small drops of the silver nitrate solution onto each cube using a dropper or transfer pipette. After letting the cubes sit for 2 minutes, the team will combine the 10 cubes that contain 'melamine' with the remaining untreated 90 in the baggie or bowl, to achieve a 10% melamine supplementation rate.

10. At another station, the **Feed Shipping Agent Team** will decide to reduce costs by reusing containers previously used to ship cyanuric acid to transport a second lot of feed ingredients—a lot that has not been contaminated with melamine. The containers have trace amounts of cyanuric acid, which contaminates this feed ingredient lot. To represent this contamination, students will treat 10 feed pellets (represented by sponge cubes) with the sodium hydroxide solution. Wearing safety gear, students should place the 10 cubes on a paper towel and then apply 4-5 small drops of the sodium hydroxide using a dropper or transfer pipette. After letting the cubes sit for 2 minutes, the team will combine the 10 pellets contaminated with 'cyanuric acid' with the remaining untreated 90 in the baggie or bowl, to achieve a 10% contamination rate. You may try this at other % contamination rates.

11. At this point, the **Feed Ingredient Manufacturer Team** and **Feed Shipping Agent Team** have produced two lots of feed ingredients (of 100 pellets/cubes each) that are ready to be used in the United States. Tell students that all feed pellet lots must pass through U.S. Customs where they will be analyzed by the **Government Chemical Analyst Team.** The task of the Government Chemical Analyst Team is to test for the presence of harmful chemicals in feed lots that prospective Pet Food Manufacturers may purchase. In this activity, the Analysts will be testing for the presence of melamine and cyanuric acid.

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12. Following established sampling and testing procedures, the **Government Chemical Analysts** will randomly select only 2% from each feed ingredient lot for a safety inspection. Wearing safety gear, the Government Chemical Analyst Team will randomly pull 4 feed pellets (represented by sponge cubes) from each feed lot (i.e., four from the Feed Ingredient Manufacturers and four from the Feed Shipping Agents). The Analysts will use hydrochloric acid to detect the presence of melamine (silver nitrate) in 2 sponges from each feed lot. If melamine is present in the feed, a whitish precipitate (scum layer) will form on the outside of the sponge cubes (see ***Figure 1***). The Analysts will also use phenolphthalein to detect the presence of cyanuric acid (sodium hydroxide) in 2 sponges from each feed lot. If cyanuric acid is present in the feed, a pink-purple spot will appear on the outside of the sponge cubes (See ***Figure 2***). **Hint**: You can vary sampling rates between 2-7% and discuss the increased cost of additional sampling.

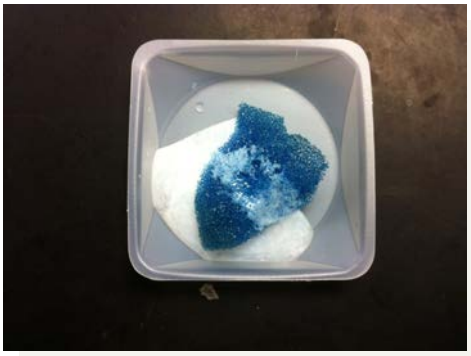

Figure 1: A faint white precipitate is produced during the simulated melamine reaction.

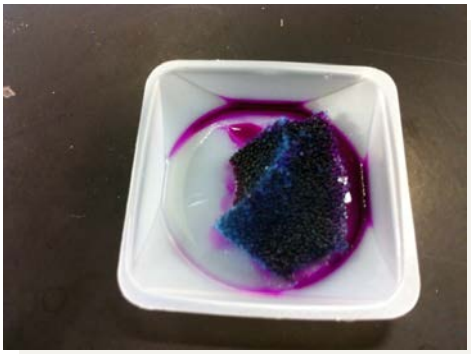

Figure 2: A dramatic pink-purple color is produced during the simulated cyanuric acid reaction.

13. To conduct the tests on the pet food ingredient lots, the Analyst Team should place each cube in a small tray (or weigh boat), keeping track of which feed lot the pellet came from, and flush it with either hydrochloric acid (to detect melamine) or with phenolphthalein (to detect cyanuric acid). The Government Chemical Analysts should report the results of the tests with the 8 cubes (4 from each feed lot) on their *Student Handout*.

14. While the Government Chemical Analyst Team is conducting their safety tests on the feed ingredients, the Pet Food Manufacturer Team will purchase feed ingredients from the Feed Ingredient Manufacturer and Feed Shipping Agent Teams via the wholesaler. Next, instruct the Pet Food Manufacturers to order animal feed ingredients from the two companies. Each of the subteams should select different combinations of the two feed ingredients from the wholesaler so as to make each of their pet food brands unique. Instruct the students to combine the feed purchased from the Feed Ingredient Manufacturers and the Feed Shipping Agents. If the Pet Food Manufacturer Team is large, you can ask students to split into smaller teams. Instruct each team regarding the maximum number of pellets they can order. For example, if students split into 4 Pet Food Manufacturer Teams, each team can order 48 pellets (e.g., 200 original pellets minus 8 tested by the Government Chemical Analyst Team divided by 4). Students should document how many feed pellets they bought from each source and note this on their *Student Handouts.*

15. For the Pet Food Manufacturer Team to find out whether their clients' pets would die from the combination of

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pellets supplemented with melamine and those contaminated with cyanuric acid, after combining the feed from both sources, each subteam will flush half of their pellets with phenolphthelin and the remaining half with hydrochloric acid, following the instructions from Step #7. Their *Student Handout* will help guide their data collection. Depending on how many pellets the Pet Food Manufacturer subteams received from the Feed Ingredient Manufacturer and the Feed Shipping Agent Teams via the wholesaler, they will get different levels of supplementation with melamine and contamination with cyanuric acid. Remind students that any pets exposed to feed containing ***both*** melamine and cyanuric acid will potentially die.

16. Each subteam of Pet Food Manufacturers should report the results of the tests on their *Student Handouts*.

17. Prompt the students to compare the results of their modeling to the analysis conducted by the Government Analyst Team and encourage them to discuss the validity of testing 2% of the feed as an indicator of the outcome for the Pet Food Manufacturer Team.

18. At the end of the lesson, demonstrate the replacement reaction to illustrate what happens if a sheep receives both melamine-supplemented feed and cyanuric acid contaminated feed:

    a. Prepare one 'cyanuric acid' pellet by dripping sodium hydroxide and one 'melamine' pellet by dripping with the silver nitrate.

    b. Place these two pellets into a small tray and press them together using gloves. A solid brown precipitate forms immediately as a consequence of the double replacement reaction (see ***Figure 3***). This is analogous to what happens inside the stomach of an animal that consumed both types of pellets, leading to its death.

Figure 3: A brown precipitate is produced as a result of the simulated double replacement reaction with cyanuric acid and melamine.

Wrap-up:

19. Ask students to respond in their journals/notebooks to the two *Essential Questions*:

    - How can analytical chemistry be used to help monitor food sources?
    - How is the role of the WSDA and/or FDA important in the safety of animal feed?

20. As a class, discuss students' responses to the Essential Questions. Also discuss how contaminated feed sources can potentially damage the industry and threaten human health.

21. In their journals/notebooks or on a separate piece of paper, challenge students to balance the reaction of silver nitrate and sodium hydroxide:

    $2\ Ag(NO_3)(aq) + 2\ Na(OH)(aq) \rightarrow Ag_2O(\mathbf{solid}) + 2\ Na(NO_3)(aq) + H_2O(l)$

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Assessment Opportunities:

- Students can be observed during class participation.
- Ask the preconception question again to assess whether students' understanding has changed: *Discuss how they might monitor animal feed sources being imported by other countries*.
- Check the students' journals for their percentage calculations, responses to the *Essential Questions*, and balanced reaction.

Extension Activities:

- Students could be introduced to the reaction types within chemistry as well as the characteristics of chemical change (for example, precipitate).
- The terms "solution," "solute," and "solvent" could be introduced.
- Each team could wear costumes for effect.

TEACHER BACKGROUND & RESOURCES

Career Links:

- Agriculturalist
- Animal nutritionist
- Animal physiologist
- Biochemist
- FDA animal scientist
- Feed grain inspector
- Feed mill production manager
- Feed ration developer
- Field sales representative—animal and feed production
- Purchasing manager
- Veterinarian

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Background Information:

An understanding of double replacement reactions is critical to this lesson. During double replacement, the cations and anions of two different compounds switch places.

The equation can be written using generic symbols:

AB + XY → AY + XB

A and **X** are the cations (positively-charged ions) in this example; **B** and **Y** are the anions (negatively-charged ions).

Here is another way to look at the generic example:

a. The outside portions (the cation **A** and anion **Y**) combine to make a formula called **AY**.

b. The inside portions (the anion **B** and the cation **X**) switch order so that **X** (positively-charged) goes first and **B** (negatively-charged) goes second, making a formula called **XB**.

Keep in mind that when it comes to writing actual formulas, you ***must*** write chemically correct formulas. Please do not assume from the **AY** and **XB** examples that the product formulas will always be one-to-one in terms of positive and negative.

Resources:

FDA Interview with Dr. Renate Reimschuessel
http://www.fda.gov/AnimalVeterinary/NewsEvents/FDAVeterinarianNewsletter/ucm221966.htm.

WSDA Food Safety Program
http://agr.wa.gov/FoodAnimal/FSP/.

WSDA Chemist Reports Results For Feed Samples
http://agr.wa.gov/FoodAnimal/AnimalFeed/Publications/rpt_Feed_Nutrient_Chemist_Findings2008.pdf.

Melamine and Cyanuric Acid Video (1:55 min)
http://www.youtube.com/watch?v=s8U9we0HEQg.

Reaction of Silver Nitrate with Sodium Hydroxide Video (0:10 min)
http://www.youtube.com/watch?v=SuoN0hQPeMw.

Filler in Animal Feed is Open Secret in China
http://www.nytimes.com/2007/04/30/business/worldbusiness/30iht-30food.5497534.html?pagewanted=all.

FDA Melamine Pet Food Recall of 2007
http://www.fda.gov/animalveterinary/safetyhealth/recallswithdrawals/ucm129575.htm.

A Brief History of Melamine
http://www.time.com/time/health/article/0,8599,1841757,00.html.

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FDA Press Conference on Recall of Products Tainted with Melamine
U.S. Food and Drug Administration, 2007-05-30
http://www.fda.gov/downloads/NewsEvents/Newsroom/MediaTranscripts/ucm123604.pdf.

Reaction Types: Double Replacement
The Chem Team, A Tutorial For High School Chemistry, 2011
http://www.chemteam.info/Equations/DoubleReplacement.html.

Credit:

Lesson plan written by Jeffery R. Wehr of the Odessa High School Science Department.

Student Handout figures courtesy of Wikimedia Commons.

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Name:_____Date:_____Period:_____

Sequence of Melamine-Contaminated U.S. Feed

Student Handout

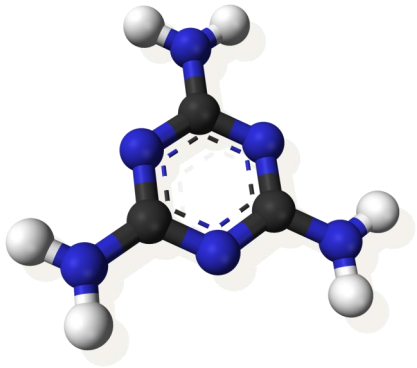

Figure 1: Structure of melamine.
Credit: Wikimedia Commons.

Melamine is an organic base chemical most commonly found in the form of white crystals rich in nitrogen. It has many manufacturing applications and is most widely known as a key component in kitchen countertops. Because melamine is rich in nitrogen (see ***Figure 1*** for the structure of melamine), it is especially valuable to companies who manufacture and ship animal feed and food. These products are typically manufactured to contain a certain proportion of protein to meet the nutritional needs of animals and humans. Most methods for determining protein content actually test for nitrogen. These tests cannot distinguish between nitrogen from traditional (and legal) protein sources and nitrogen from non-traditional (and illegal) protein sources. Therefore, melamine is probably added to animal feed and human food products to cheaply, though illegally, boost the apparent protein level of the product. Protein from animal or plant sources is more expensive than melamine, generating an economic incentive to replace some of the protein in feed and foods with melamine. When the products undergo protein analysis by government chemical analysts, the addition of melamine results in artificially and incorrectly high protein measurements. In 2007, world production of melamine was approximately 1.2 million tons, with the predominant producers located in China and Western Europe.

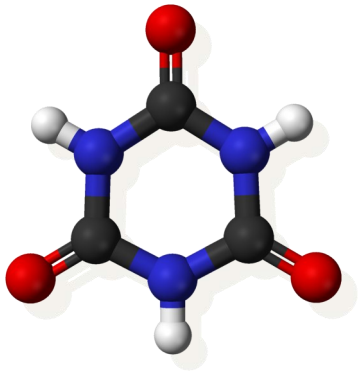

Figure 2: Structure of cyanuric acid.
Credit: Wikimedia Commons.

Dr. Reimschuessel is a research biologist at the Center for Veterinary Medicine's Office of Research. Through her efforts, the Food and Drug Administration was able to determine how melamine and related chemicals were responsible for kidney damage in dogs and cats. As she studied the problem, she noticed that the literature she reviewed mentioned that melamine had been reported to cause kidney stones in some animals. Based on her experience and insight, she formulated the theory that melamine was combining with a similar chemical to form crystals in the kidneys of the dogs and cats, often resulting in death of the animals. She ultimately proved that along with melamine, the pet food causing the injuries also contained cyanuric acid (see ***Figure 2*** for the structure of cyanuric acid) or other related chemicals. The combination of the two chemicals results in the formation of crystals in the kidneys of dogs and cats, causing kidney failure and, in some cases, death. Adding melamine to food is ***not*** approved by the Food and Drug Administration, the United States Department of Agriculture, the World Health Organization, the United Nations, nor the Washington State Department of Agriculture. The United Nations' food standards body, Codex Alimentarius Commission, has set the maximum amount of melamine allowed in powdered infant formula, other foods, and animal feed. While not legally binding, the levels allow countries to ban importation of products with excessive levels of melamine.

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Name:_____Date:_____Period:_____

Feed Shipping Agent

Student Handout

Team Member Names:_____

Your team represents a **Feed Shipping Agent** from a foreign country who is shipping their product to the U.S. in containers that previously contained cyanuric acid (typically used as a chlorine stabilizer in swimming pools, and chemically similar to melamine), resulting in feed contamination.

1. You will mimic the cyanuric acid contamination by sprinkling 10% of your feed pellets with sodium hydroxide solution.
2. Collect 100 'feed pellets' (sponge cubes) from your teacher.
3. Wearing gloves and goggles, your team will treat 10 sponge cubes with the sodium hydroxide solution to mimic a 10% contamination of the feed with cyanuric acid.

   Sodium Hydroxide Safety Note: Solid sodium hydroxide or solutions of sodium hydroxide may cause chemical burns, permanent injury, or scarring if they come in contact with unprotected tissue. Sodium hydroxide may cause blindness if it comes in contact with the eye. Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling the material or its solutions.

4. Place 10 pellets on a paper towel and apply 4–5 small drops of the sodium hydroxide solution onto each sponge cube using a dropper or transfer pipette.
5. Let the cubes sit for 2 minutes.
6. Combine the 10 sodium hydroxide treated sponge cubes with the remaining untreated 90 sponge cubes in the baggie or bowl, to achieve a 10% cyanuric acid contamination rate.
7. Your team is ready to have the Government Chemical Analyst select 4 pellets (sponge cubes) for testing.
8. The remaining 96 pellets will be sold by the wholesalers to the Pet Food Manufacturers.

While the two other teams are working through the rest of the protocol, your team needs to prepare a public statement. Your statement needs to include a well-crafted rationale as to how the Producer's product became contaminated with cyanuric acid. Write your statement below or on the back of this *Handout*.

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Name:_____Date:_____Period:_____

Feed Ingredient Manufacturer

Student Handout

Team Member Names:_____

Your team represents a **Feed Ingredient Manufacturer** from a foreign country who is supplementing their product with melamine as an inexpensive replacement for protein.

1. You will mimic the addition of melamine by sprinkling 10% of your feed pellets with silver nitrate solution.
2. Collect 100 'feed pellets' (sponge cubes) from your teacher.
3. Wearing gloves and goggles, your team will treat 10 sponge cubes with the silver nitrate solution to mimic a 10% supplementation of the feed with melamine.

   Silver Nitrate Safety Note: Brief exposure to silver nitrate will not produce immediate side effects other than purple, brown, or black skin stains. With more exposure, side effects will become more noticeable, including burns. Long-term exposure may cause eye damage. Silver nitrate can destroy mucous membranes and is a skin and eye irritant.

4. Place 10 sponge cubes on a paper towel and apply 4–5 small drops of the silver nitrate solution onto each pellet using a dropper or transfer pipet.
5. Let the sponge cubes sit for 2 minutes.
6. Combine the 10 silver nitrate treated sponge cubes with the remaining untreated 90 sponge cubes in the baggie or bowl, to achieve a 10% melamine supplementation rate.
7. Your team is ready to have the Government Chemical Analyst select 4 feed pellets (sponge cubes) for testing.
8. The remaining 96 pellets will be sold by the wholesalers to the Pet Food Manufacturers.

While the other teams are working through the lesson, your team needs to prepare a public statement on how you produced your feed. Your statement needs to include a well-crafted rationale as to why you added melamine, rather than protein, to your product. Write your statement below or on the back of this *Handout*.

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Name:_____Date:_____Period:_____

Government Chemical Analyst

Student Handout

Team Member Names:_____

Your team represents **Government Chemical Analysts** from the WSDA or FDA tasked with testing samples of all imported feed ingredients for quality and safety. Following established sampling and testing procedures, your team will randomly select only 2% from each feed ingredient lot for a safety inspection.

In this activity, you will be testing 2% of the feed lots from the Feed Ingredient Manufacturer Team and the Feed Shipping Agent Team for the presence of melamine and cyanuric acid before they can be sold to the Pet Food Manufacturers.

1. You will mimic the contamination with cyanuric acid by sprinkling 10% of your feed pellets (sponge cubes) with sodium hydroxide solution.

   Silver Nitrate Safety Note: Brief exposure to silver nitrate will not produce immediate side effects other than purple, brown, or black skin stains. With more exposure, side effects will become more noticeable, including burns. Long-term exposure may cause eye damage. Silver nitrate can destroy mucous membranes and is a skin and eye irritant.

   Sodium Hydroxide Safety Note: Solid sodium hydroxide or solutions of sodium hydroxide may cause chemical burns, permanent injury, or scarring if they come in contact with unprotected tissue. Sodium hydroxide may cause blindness if it comes in contact with the eye. Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling the material or its solutions.

   Hydrochloric Acid Safety Note: Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling the material or its solutions.

2. Wearing gloves and goggles, your team will select 4 sponge cubes from the Feed Ingredient Manufacturer Team to test for the presence of melamine and cyanuric acid. Place these in a tray or small plastic container labeled "Feed Ingredient Manufacturer Sample."

3. Wearing gloves and goggles, your team will select 4 sponge cubes from the Feed Shipping Agent to test for the presence of melamine and cyanuric acid. Place these in a tray or small plastic container labeled "Feed Shipping Agent Sample."

4. You will use hydrochloric acid to detect the presence of melamine (represented by silver nitrate in this activity) in 2 cubes from each feed lot. If melamine is present in the feed, a whitish precipitate (scum layer) will form on the outside of the sponge cubes.

5. You will also use phenolphthalein to detect the presence of cyanuric acid (represented by sodium hydroxide in this activity) in 2 cubes from each feed lot. If cyanuric acid is present in the feed, a pink-purple spot will appear on the outside of the sponge cubes.

6. Place each cube in a small tray (or weigh boat), ***keeping track of which feed lot each cube came from***, and flush it with either hydrochloric acid (to detect melamine) or with phenolphthalein (to detect cyanuric acid).

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7. Enter the results of the tests in the following table:

Feed Source	# of pellets positive for melamine	# of pellets positive for cyanuric acid	Source safe for consumption?
Feed Ingredient Manufacturer			
Feed Shipping Agent			

Prepare a public statement to be shared with the other students on the level of feed contamination in each lot and possible animal risks. Your statement should present your argument for why the feed lot is safe or unsafe for consumption. Write your statement below or on a separate piece of paper.

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Name:_____Date:_____Period:_____

Pet Food Manufacturer

Student Handout

Team Member Names:_____

Your team represents a group of **Pet Food Manufacturers** who buy feed ingredients from wholesalers, create various pet food brands, and sell them to pet owners. You will buy feed ingredients from the Feed Producer and the Feed Shipping Agent via the **Wholesaler**, and sell this to pet owners who will feed it to their pets. In this activity you will model what would happen to your clients' animals. Each of the pet food manufacturing teams have unique clients and dietary interests—so each subteam will buy different amounts of each ingredient resulting in a variety of food brands to offer to clients. You arrive at the wholesaler, as you do every year, believing that the feed ingredients for sale are safe for you to combine and sell to your customers. And the wholesaler should be actively and enthusiastically selling both feed ingredients to you!

In order to complete this activity, your team alone will know the result of possible melamine and/or cyanuric acid poisoning. When you feed the pellets to your clients' pets, you will be "testing" ***all*** of the feed that you bought from the wholesaler. Your tests will tell you what your animals have eaten—and whether or not the feed is contaminated. You will use hydrochloric acid to check for the presence of melamine (represented by silver nitrate in this activity) in half of your pellets. If melamine is present in the feed, a whitish precipitate (scum layer) will form on the outside of the feed pellets (sponge cubes). Remember, safety first!

> **Hydrochloric Acid Safety Note:** Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling the hydrochloric acid or its solutions.

You will also use phenolphthalein to check for the presence of cyanuric acid (represented by sodium hydroxide in this activity) in half of your pellets. If cyanuric acid is present in your feed, a pink-purple spot will appear on the outside of the feed pellets (sponge cubes). Remember, safety first!

> **Sodium Hydroxide Safety Note:** Solid sodium hydroxide or solutions of sodium hydroxide may cause chemical burns, permanent injury, or scarring if they come in contact with unprotected tissue. Sodium hydroxide may cause blindness if it comes in contact with the eye. Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling the material or its solutions.

At the end of the experience, you and the other manufacturers will look at the levels of contamination and estimate whether the level of co-contamination of ***both*** chemicals would result in illness in your clients' pets. ***Remember, both chemicals at this low contamination level must be present in an animal to result in kidney damage and health issues.***

1. The Pet Food Manufacturer team will be broken into smaller subteams ***as directed by your teacher***. Each subteam should name their pet food brand (e.g., Yummy Crumbles). _____.

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2. Each subteam will approach the Wholesalers' table and decide how many feed pellets your subteam will order from the Feed Ingredient Manufacturer and the Feed Shipping Agent to make a unique brand of food for your unique clients. ***Your teacher will let you know how many pellets you can order in total.***
3. Wearing gloves and goggles, combine the feed you acquired from the two sources into a single pile.
4. Each subteam will divide their pile of pellets in half. Each subteam will test one half of the pellets for melamine and the other half for cyanuric acid.
   a. Testing a single pellet at a time, place one pellet (sponge cube) in a small tray (or weigh boat) and flush it with hydrochloric acid. If the sponge cube develops a white precipitate on the surface, the feed has melamine contamination. Test half the cubes in this way.
   b. Testing a single pellet at a time, place one pellet (sponge cube) in a small tray (or weigh boat) and flush it with phenolphthalein. If it turns pink, the feed is contaminated with cyanuric acid. Test half the cubes in this way.
5. Watch for color changes on the sponge cubes (to white or to pink) and enter the results in the table below.

Name of Pet Food Subteam	# of pellets positive for melamine	# of pellets positive for cyanuric acid	Feed lot safe for consumption? (circle your answer)
Sub-team : _____			**Yes Maybe No**
Sub-team : _____			**Yes Maybe No**
Sub-team : _____			**Yes Maybe No**
Sub-team : _____			**Yes Maybe No**
Sub-team : _____			**Yes Maybe No**

6. Based upon your results, determine the fate of the animals that ate the mixed feed from both sources. Record your opinion in the last column of the table—***Remember that at these levels of contamination, only feed contaminated with BOTH chemicals will poison the pets, cause kidney damage, and possibly kill them.***
7. Talk with all the manufacturer subteams. Listen to the reports of the Feed Ingredient Manufacturers, Chemical Analysts, Shippers (and even the Wholesale Agents) to decide if their public statements make sense based on what you and the other Pet Food Manufacturer subteams "saw" in your feed and your animals. Prepare a public statement on your findings. If you believe that your clients' animals are at risk for kidney damage, your report should state that. Write your report on a separate piece of paper.

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Agrichemists at Work:

Nomenclature of Feed Additives

Activity Time: 50 Minutes.

Lesson Plan Summary:

In this lesson, students will develop an understanding of the chemical names and formulas of common ionic compounds found in feed additives approved by the Food and Drug Administration (FDA). They will be able to write chemical formulas given the chemical name and write the chemical name given the chemical formula.

***Note*:** This is a general chemistry lesson on ionic nomenclature that uses feed additives as example chemical compounds. The lesson should be delivered to students who have already completed, or are in the process of completing, a general chemistry course, or be taught with help from your school's chemistry teacher.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- **Ionic Nomenclature:** Knowing the chemical formula and chemical name of compounds is instrumental to understanding chemistry and working with feed additives.

Essential Question:

- What are the chemical names and chemical formulas of common ionic compounds found in well known feed additives?

Learning Objectives:

Students will know…

- The inorganic naming rules for binary compounds.

Students will be able to…

- Correctly name a compound given its formula.
- Correctly write the formula of a compound given its name.

Vocabulary:

- Binary compound
- Ionic
- Metallic ion
- Non-metallic ion
- Polyatomic ion

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Standards Alignment:

This lesson addresses the following Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs) for grades 9–12:

- **Science EALR (9-11 PS2D):** Students know that *ions* are produced when *atoms* or *molecules* lose or gain *electrons*, thereby gaining a positive or negative electrical charge. *Ions* of opposite charge are attracted to each other, forming *ionic bonds*. Chemical formulas for *ionic compounds* represent the proportion of *ion* of each *element* in the *ionic crystal*.
- **Science EALR (9-11 PS2E):** Students know that *molecular compounds* are composed of two or more *elements* bonded together in a fixed proportion by sharing *electrons* between *atoms*, forming *covalent bond*s. Such *compounds* consist of well-defined *molecules*. Formulas of *covalent compounds* represent the types and number of *atoms* of each *element* in each *molecule*.

This lesson addresses the following Washington State Career and Technical Education (CTE) model frameworks for Agriculture, Food, and Natural Resources (AFNR):

- **ESS.03.05:** Apply chemistry principles to environmental service systems.

Common Student Preconceptions:

- Compounds are named simply by the elements they contain.
- Binary compounds only contain two elements.
- All compounds used in feed additives are large and complex.

TEACHER PREPARATION

Materials:

Item	Quantity
Computer with internet, speakers, and projector	1 per class
Ionic Nomenclature Student Handout	1 per student
Ionic Nomenclature Teacher Answer Key	1 per class

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Preparation:

- Photocopy the *Student Handout*.
- Log onto the Association of American Feed Control Officials (AAFCO) website and register in preparation for showing students the website. Explore the site to find pertinent pages. (Resource only – not required).
- If students have not had a general chemistry course it is recommended that you work with your peer science teacher to be able to provide a general overview of ionic nomenclature.

PROCEDURE

Hook:

1. Ask students to imagine that they are chemists working as feed control officers. The officer is responsible for determining the appropriate feed additive to solve a particular animal health problem. Perhaps it is a vitamin for an animal that isn't getting enough nutrients from regular forage and grain to grow properly. It could be an additive that stimulates an animal's appetite. Or it could be an additive that reduces the amount of ammonia in animal manure, which benefits the environment.

2. Explain that the field of agricultural chemistry is critical to resolving the feed and food safety challenges faced by farmers and suppliers worldwide.

3. Present the following real-world scenario, asking students to listen to it as if they were a chemist assigned to solve the problem:

   A Western Washington sheep farmer that raises sheep for cheese production recently relocated her operation from County A to County B. At both locations, the sheep grazed on pasture and were also fed a manufactured feed. The farmer used the same manufactured feed with the flock after relocating, but the sheep mysteriously began to die.

   Sheep are less tolerant of dietary copper levels than other livestock species. The manufactured feed was formulated with added copper.

   Molybdenum (Mo) is a naturally-occurring chemical element that can tie up (make unavailable) copper. Soil tests showed that naturally occurring levels of molybdenum in County A were ~10–15 ppm (parts per million). The level of molybdenum in the pasture grasses also reflected that level. However, in County B, soil levels of molybdenum were only ~1 ppm.

   Thus, in County A, available dietary copper was held within a non-toxic range by the molybdenum levels in the pasture grasses. In County B, the low molybdenum levels resulted in a toxic level of dietary copper in the sheep's feed.

4. Ask students to discuss the role that chemistry knowledge played in this real-world scenario.

5. Explain that ionic compounds are used in animal feed supplements. Tell students that today they will be investigating some of the ionic compounds that are commonly used to develop key food additives.

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6. Introduce students to the Association of American Feed Control Officials (AAFCO) and show students the AAFCO website. The following information is provided by the AAFCO website:

> The Association of American Feed Control Officials (AAFCO) is a voluntary membership association of local, state, and federal agencies charged by law to regulate the sale and distribution of animal feeds and animal drug remedies.
>
> Although AAFCO has no regulatory authority, the Association provides a forum for the membership and industry representation to achieve three main goals:
>
> - Ensuring consumer protection.
> - Safeguarding the health of animals and humans.
> - Providing a level playing field of orderly commerce for the animal feed industry.
>
> These goals are achieved by developing and implementing uniform and equitable laws, regulations, standards, definitions, and enforcement policies for regulating the manufacture, distribution, and sale of animal feeds—resulting in safe, effective, and useful feeds by promoting uniformity amongst member agencies.
>
> **Association of American Feed Control Officials (AAFCO)**
> http://www.aafco.org

Preconceptions:

7. Write the following list of ionic compounds on the board. Discuss the differences and similarities between the names and formulas of the compounds. The names and formulas of these compounds can be found on Wikipedia.com.

   - Sodium chloride
   - Potassium fluoride
   - Silver nitrate
   - Calcium carbonate

8. Ask students to share their ideas as to the correct names of similar compounds.

Activity Procedure:

9. Review the ionic naming rules for compounds. Teachers may want to refer to a basic chemistry textbook or website for additional information on this topic.

10. Pass out copies of the *Ionic Nomenclature* Student Handout, one per student.

11. Have students pair up and work together to solve the problems on the handout.

Wrap-up:

12. Write five to ten compounds from the *Student Handout* on the board. Ask students to share their responses to these compounds.

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Assessment Opportunities:

- After students have completed the *Ionic Nomenclature* Student Handout, they can use the *Teacher Answer Key* to assess their work and identify the questions they missed. Alternatively, students assess each other's work.
- The *Ionic Nomenclature* Student Handout can be scored using the provided *Teacher Answer Key*.
- Participation points can be assigned for contributing to class discussions.

Student Metacognition:

- As an Exit Ticket, ask students to write a conclusion statement of the day's activity, to identify one misconception they had at the start of class, and to explain how their knowledge has changed due to their participation in the activity.

Extension Activities:

- Ask students to visit a pet store, choose a type of pet food, and look at the ingredients listed on the label. Have the students bring a list of additives mentioned on the label and compare it to the feed additives listed on the *Ionic Nomenclature* Student Handout and/or the AAFCO website.
- Challenge students to choose five compounds from the list on the *Ionic Nomenclature* Student Handout and research how and why they are used in feed additives. The *Teacher Answer Key* provides information on common uses of each compound.

TEACHER BACKGROUND & RESOURCES

Career Links:

- Agrichemist
- Agronomist
- Animal feed control officer
- Animal nutritionist
- Animal physiologist
- Animal scientist
- Biochemist
- Feed additive manufacturer
- Feed ration developer
- Sheep rancher
- Soil scientist
- State chemist

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Background Information:

Basic information about ionic nomenclature can be found on the websites listed in the *Resources* section.

Resources:

Naming Inorganic Compounds
Ohio State University
http://www.chemistry.ohio-state.edu/~woodward/ch121/ch2_naming.htm

Inorganic Nomenclature
University of Maryland, Baltimore County
http://userpages.umbc.edu/~budzicho/Chp3note3.html

Naming Inorganic Compounds
http://www.mikeblaber.org/oldwine/chm1045/notes/Atoms/Naming/Atoms06.htm

Inorganic Acids
Washington University
http://www.chemistry.wustl.edu/~courses/genchem/Tutorials/Naming/Acids.htm

Association of American Feed Control Officials
http://www.aafco.org/

Credit:

Lesson plan written by Nona Clifton of the Washington Global Health Alliance.

Student Handout photograph courtesy of Nona Clifton.

The list of chemicals featured on the *Student Handout* and *Teacher Answer Key* and information about the sheep scenario were provided by Neil Lanning and Evan Evans of the WSDA.

Information about AAFCO is from the organization's website: http://www.aafco.org.

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Name:_____Date:_____Period:_____

Ionic Nomenclature

Student Handout

Congratulations! You obtained a summer job working as an intern with the Washington State Department of Agriculture (WSDA). You will be helping one of their chemists determine the appropriate amount of additives in animal feed based on naturally occurring amounts of chemicals in the soils of different counties in Washington State. The WSDA serves the people of Washington by supporting the agricultural community and promoting consumer and environmental protection.

Chickens feeding. **Credit**: Nona Clifton.

You were able to get a copy of the ionic compounds commonly used in feed additives. You want to study up on your chemistry knowledge so that you are ready for your summer internship. Originally, the list contained the name and formula for each compound. Unfortunately you left the list out where your baby brother could get to it. The list has seen better days! Your job is to reconstruct the list.

Problem #	Frequency[1]	Common Name	Chemical Formula
1	2		$Fe_2(SO_4)_3$
2	1	Sodium Selenite	
3	1		$ZnSO_4 \cdot 7H_2O$
4	2	Magnesium Sulfate	
5	1		$NaHCO_3$
6	3		$(NH_4)_3PO_4$
7	2	Copper Chloride	
8	3	Potassium Sulfate	
9	1	Calcium Carbonate	
10	1		Na_2CO_3
11	3	Ferric Phosphate	
12	2		NH_4Cl

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Problem #	Frequency[1]	Common Name	Chemical Formula
13	1	Magnesium Oxide	
14	3		$(NH_4PO_3)_n$
15	1	Urea[2]	
16	1		$CuSO_4$
17	3		$MnSO_4$
18	1	Phosphoric Acid	
19	2		$(NH_4)_2SO_4$
20	1	Zinc Sulfate	
21	1	Calcium Chloride	
22	1		KCl
23	3		$MoCl_2$
24	3	Cobalt Sulfate	
25	2		KI
26	2	Magnesium Chloride	
27	3		$NaC_2H_3O_2$
28	3		NH_4OH
29	1	Sodium Chloride (Salt)	
30	1		K_2CO_3
31	2	Manganese Oxide	
32	2		$NaPO_4$
33	2		$(NH_4)_2HPO_4$
34	2	Sodium Selenate	

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Problem #	Frequency[1]	Common Name	Chemical Formula
35	2		$CoCO_3$
36	2	Sodium Sulfate	
37	1		$ZnSO_4 \cdot H_2O$
38	1		$CaHPO_4$
39	3	Sodium Nitrite	

Endnotes:

1 **Frequency**: 1 = **Frequently** used in livestock feeds; 2 = **Occasionally** used in livestock feeds; 3 = **Rarely** used in livestock feeds.

2 Unlike the other chemicals on the list, **urea** is not an inorganic ingredient; however, it is used frequently in ruminant feeds so it was included. Excessive amounts are toxic.

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Ionic Nomenclature

Teacher Answer Key

Problem #	Frequency[1]	Common Name	Chemical Formula	Common Uses
1	2	**Ferric Sulfate**	$Fe_2(SO_4)_3$	Feed Ingredient
2	1	Sodium Selenite	$\mathbf{Na_2SeO_3}$	Feed Ingredient
3	1	**Zinc Sulfate Heptahydrate**	$ZnSO_4 \cdot 7H_2O$	Feed Ingredient
4	2	Magnesium Sulfate	$\mathbf{MgSO_4}$	Feed Ingredient
5	1	**Sodium Bicarbonate**	$NaHCO_3$	Feed Ingredient
6	3	**Ammonium Phosphate**	$(NH_4)_3PO_4$	Source of NPN[3]
7	2	Copper Chloride	**CuCl**	Feed Ingredient
8	3	Potassium Sulfate	$\mathbf{K_2SO_4}$	Feed Ingredient
9	1	Calcium Carbonate	$\mathbf{CaCO_3}$	Feed Ingredient
10	1	**Sodium Carbonate**	Na_2CO_3	Feed Ingredient
11	3	Ferric Phosphate	$\mathbf{FePO_4}$	Feed Ingredient
12	2	**Ammonium Chloride**	NH_4Cl	Food Additive
13	1	Magnesium Oxide	**MgO**	Feed Ingredient
14	3	**Ammonium Polyphosphate**	$(NH_4PO_3)_n$	Feed Ingredient
15	1	Urea[4]	$\mathbf{(NH_2)_2CO}$	Source of NPN[3]
16	1	**Copper Sulfate**	$CuSO_4$	Feed Ingredient
17	3	**Manganese Sulfate**	$MnSO_4$	Feed Ingredient
18	1	Phosphoric Acid	$\mathbf{H_3PO_4}$	Feed Ingredient
19	2	**Ammonium Sulfate**	$(NH_4)_2SO_4$	Source of NPN[3]
20	1	Zinc Sulfate	$\mathbf{ZnSO_4}$	Feed Ingredient

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Problem #	Frequency[1]	Common Name	Chemical Formula	Common Uses
21	1	Calcium Chloride	**$CaCl_2$**	Feed Ingredient
22	1	**Potassium Chloride**	KCl	Feed Ingredient
23	3	**Molybdenum Chloride**	$MoCl_2$	Feed Ingredient /N fixation
24	3	Cobalt Sulfate	**$CoSO_4$**	Feed Ingredient
25	2	**Potassium Iodide**	KI	Feed Ingredient
26	2	Magnesium Chloride	**$MgCl_2$**	Feed Ingredient
27	3	**Sodium Acetate**	$NaC_2H_3O_2$	GRAS[2]
28	3	**Ammonium Hydroxide**	NH_4OH	GRAS[2]
29	1	Sodium Chloride (Salt)	**NaCl**	GRAS[2]
30	1	**Potassium Carbonate**	K_2CO_3	Feed Ingredient
31	2	Manganese Oxide	**MnO**	Feed Ingredient
32	2	**Sodium Phosphate**	$NaPO_4$	GRAS[2]
33	2	**Diammonium Phosphate**	$(NH_4)_2HPO_4$	Source of NPN[3]
34	2	Sodium Selenate	**Na_2SeO_4**	Feed Ingredient
35	2	**Cobalt Carbonate**	$CoCO_3$	Feed Ingredient
36	2	Sodium Sulfate	**Na_2SO_4**	Feed Ingredient
37	1	**Zinc Sulfate Monohydrate**	$ZnSO_4 \cdot H_2O$	Feed Ingredient
38	1	**Dicalcium Phosphate**	$CaHPO_4$	Feed Ingredient
39	3	Sodium Nitrite	**$NaNO_3$**	Preservative

Endnotes:

1 **Frequency**: 1 = **Frequently** used in livestock feeds; 2 = **Occasionally** used in livestock feeds; 3 = **Rarely** used in livestock feeds.

2 **Generally Recognized As Safe**: A feed or food ingredient that is generally recognized, among qualified experts, as having been adequately shown to be safe for its intended use; or, a feed or food ingredient known to be safe based on a long history of common use by a significant number of consumers.

3 **NPN:** Non-Protein Nitrogen. Ruminant animals can convert the nitrogen in urea for building protein.

4 Unlike the other chemicals on the list, **urea** is not an inorganic ingredient; however, it is used frequently in ruminant feeds so it was included. Excessive amounts are toxic.

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Student Handout Scoring Rubric:

Fails to Meet Expectations	Approaching Expectations	Meets Expectations	Exceeds Expectations
Does not complete handout. Or, student fails to proficiently complete at least 50%.	Student attempts to complete handout, with >50% proficiency regarding nomenclature/ formulas.	Student completes most of handout, with >70% proficiency regarding nomenclature/formulas.	Student completes most of handout, with >90% proficiency regarding nomenclature/formulas.

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The Maddening Mystery of BSE

Activity Time: 75 Minutes (the end of one class, plus one class period).

Lesson Plan Summary:

In this lesson, students will increase their understanding of Bovine Spongiform Encephalopathy (BSE). Students will read specific case studies and participate in an interactive simulation related to protein structure. A variety of extension activities are provided to help students learn about the disease pathology, the causative agents, animal susceptibility, and the regulatory and surveillance measures that protect animals and humans from BSE.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- **Disease Forensics and Risk Management:** Disease forensics involves developing an understanding of the contributing factors of BSE and the feed practices that minimize the risk of BSE outbreaks.

Essential Questions:

- What is mad cow disease, or BSE? What is the disease history and what is the disease prevalence today?
- What has been the health and economic impact of BSE worldwide?
- What is the perceived and real risk of transmission of BSE to humans?
- What is a prion? How does it cause tissue damage and death in animals?
- How do state and federal agencies reduce the risk of BSE through regulations and surveillance efforts?

Learning Objectives:

Students will know…

- Transmissible spongiform encephalopathies (TSEs), also known as prion diseases, in both animals and humans are characterized by tiny holes in brain tissue that give the brain a spongy appearance and result in physical and behavioral changes. TSEs are always fatal.
- BSE, the prion disease of cattle, is incurable and 100% fatal.
- Since the 1980's, veterinarians, neurobiologists, and scientists have increased our understanding of these diseases—but we still have many unanswered questions.
- Countries with cases of BSE experienced catastrophic and lasting impacts to the vitality of the beef trade resulting in major revisions in feed and animal husbandry, surveillance, and oversight worldwide.
- BSE is a feedborne disease and a zoonotic disease.
- The WSDA plays an important role in regulating animal feed to prevent the spread of BSE.

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Students will be able to…

- Explain how prions contribute over time to the formation of deadly spongiform pathology.
- Summarize how prions enter the food chain.
- Appreciate the hazards inherent in consuming Specified Risk Materials.
- Discuss BSE surveillance programs.
- Summarize the role of the Washington State Department of Agriculture (WSDA) and the U.S. Food and Drug Administration (FDA) in regulating animal and human food sources, from both domestic and imported sources.

Vocabulary:

- Animal byproducts
- Bovine Spongiform Encephalopathy (BSE)
- Chronic Wasting Disease
- Creutzfeldt-Jakob Disease (CJD)
- Fatal Familial Insomnia (FFI)
- Genetic susceptibility
- Immune system
- Kuru
- Mad Cow Disease
- Offal
- Post-mortem
- Prion (both normal-PrP^{C} prions and abnormal-PrP^{Sc} prions)
- "Prohibited Materials"
- Protein
- Protein folding/misfolding
- Rendered meat products
- Ruminant animals
- Scrapie
- Specified Risk Materials (SRMs)
- Sporadic Creutzfeldt-Jakob Disease (sCJD)
- Transmissible Spongiform Encephalopathies (TSEs)
- Variant Creutzfeldt-Jakob Disease (vCJD)
- Zoonotic disease

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Standards Alignment:

This lesson addresses the following Washington State Essential Academic Learning Requirements (EALRs) and/or Grade Level Expectations (GLEs) for grades 9–12:

- **Science EALR 1 (9-12 SYSC):** In complex systems, entirely new and unpredictable properties may emerge. Consequently, modeling a complex system in sufficient detail to make reliable predictions may not be possible.
- **Science EALR 1 (9-12 APPE):** Analyze a societal issue that may be addressed through science and/or technology. Compare alternative solutions by considering trade-offs and unintended consequences (e.g., removing dams to increase salmon spawning).

This lesson addresses the following Washington State Career and Technical Education (CTE) model frameworks for Agriculture, Food, and Natural Resources (AFNR):

- **AS.03.01:** Prescribe and implement a prevention and treatment program for animal diseases, parasites, and other disorders.
- **AS.03.02:** Provide for the biosecurity of agricultural animals and production facilities.
- **AS.04.02.01.b:** Discuss how feed additives are administered and the precautions that should be taken. Level II.
- **FPP: 01.01.02.a:** Identify and explain environmental and safety concerns about the food supply. Level I.
- **FPP.02.03.04.a:** Explain the importance of record keeping in a food product and processing system.

Common Student Preconceptions:

- Animal diseases are limited in their scope and impact.
- There are many cases of “mad cow disease” (more accurately called BSE) annually and that’s why we need to spend money on preventing this disease.
- Mad cows get the disease from feed that contains common pathogens, such as bacteria, viruses, or parasites.
- Like animal diseases caused by a bacteria, virus, or parasite, we already know how to prevent and/or treat mad cow disease.
- Mad cows can transmit the disease to healthy cows just by getting too close to them.
- This disease has been contained to a limited number of cases worldwide (and particularly in the U.S.) so surveillance efforts are not needed.

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TEACHER PREPARATION

Materials:

Item	Quantity
The Story of BSE Student Handout	1 per student
BSE Town Hall Conversations Student Handout	1 per student
The Maddening Mystery of BSE Teacher Answer Key	1 per teacher
Detecting Mad Cow Disease article (see *Preparation* section for purchasing information)	1 per group (8 total)
Masking tape	1 roll
Measuring tape	1 per class
Pipe cleaners	2 per student
Optional: Pipe cleaners (for extension activity)	12 per group

Preparation:

- You may need to work with your school's biology teacher to ensure that your students have the necessary background knowledge of proteins for this lesson.

- Reserve a larger room (e.g., cafeteria or gym) or prepare to clear out your room for the activity. For a group of 20 students, you will need to mark out a defined 12'x12' square that will serve as a "brain tissue" section for the lesson. Your students will be acting as prions within this space. We recommend that you use the masking tape to define the square. Cut the tape into 3' segments and place them on the perimeter of the square. **Optional**: You will need to modify the square size to accommodate your class size, for example 8'x8' for 10 students and 15'x15' for 30 students.

- Print copies of the *Student Handouts*, 1 per student.

- Purchase a copy of the *Scientific American* article "Detecting Mad Cow Disease" at http://www.scientificamerican.com ($7.95). Search for the article title, and purchase the July 2004 issue to access the full article text. Print copies, 1 per group (8 total).

PROCEDURE

Day One

Preconceptions:

1. Engage students in a brief discussion to elicit their preconceptions about mad cow disease/BSE. What do they know about the disease? What have they heard in the news?

Hook:

2. Using your computer projection system, show a short news video about the most common human prion disease, Sporadic Creutzfeldt-Jakob Disease, from the following YouTube link:

   vCJD Brain Killer Documentary (8:22 minutes)
   http://www.youtube.com/watch?v=OE74S7fDDPc&feature=related

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3. Distribute the *Student Handouts*, one copy of each *Handout* per student. Assign each of the students 1 of the 8 possible roles, as listed on *The Story of BSE* Student Handout. To prepare for the next class section, instruct students to read *The Story of BSE* Student Handout as a homework assignment. They will also need to complete the questions on the *BSE Town Hall Conversations* Student Handout that are specific to their assigned role. Depending upon the size of your class, you may need to modify the assignments to ensure that all eight roles are assigned to one or more students.

Day Two

Activity Procedure:

4. Start the class with a quick review of the movie clip. Ask the students if they recall whether those sick cows made humans sick? In their recollection, did the illness happen when they ate sick cows? Do they recall any recent cases of Bovine Spongiform Encephalopathy (BSE) or mad cow disease (such as the 2012 case in California)?

Activity #1: BSE Town Hall Conversations

Note: Students should have already read all *Student Handouts* before beginning this activity.

5. Organize the students into groups according to the role that they were assigned on the *BSE Town Hall Conversations* Student Handout. You should have eight student groups of varying size.

6. Using the *BSE Town Hall Conversations* Student Handout, have the students discuss their answers in their groups. Walk through the class and listen to the students' conversations to determine student understanding.

7. After 5-10 minutes, bring the class back together and ask each group to present to the class their answers to the questions on the handout.

Activity #2: Prion Conversion Simulation

8. Explain to the class that scientists are just beginning to understand how animals become ill after they consume feed that contains animal products contaminated with proteins called "prions" (the most well known example is meat and bone meal). In well-studied diseases like salmonellosis, small, live organisms such as bacteria, viruses, or parasites cause illness when they destroy cells or the immune response fights the disease agent. Prions are different. They are not alive. They are merely proteins. The disease-causing, mis-folded PrP^{Sc} prions enter the animal, usually through feed, and when they get close to normal-PrP^{C} prions their unusual folding structure causes normal-PrP^{C} prions to mis-fold. This mis-folding converts them from normal-PrP^{C} prions into disease agents: abnormal-PrP^{Sc} prions. After a typical incubation period of about 4-7 years, there will be increasing tissue degeneration, BSE symptoms, and eventually death. Tell students that their participation in the next activity will help them to gain a better understanding of how this process works.

9. Distribute pipe cleaners to students, one per student.

10. Each student should bend his pipe cleaner so that it roughly resembles the letter **"C"** to represent normal-PrP^{C} prions. Select two students to act as abnormal-PrP^{Sc} prions. These two students should bend their pipe cleaners into the shape of the letter **"S"**.

11. Tell the students that you have prepared an area that will represent a slice of brain tissue within which will they will interact as normal and abnormal prions. Invite all the normal-PrP^{C} prions to enter the square. The students should be rather close together, but encourage them to hold their pipe cleaners out in front of them.

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12. It is now time for the two PrP^{Sc} prions to enter the square. Encourage them to navigate their way through the square. When they encounter a PrP^{C} prion student, they must "transform" that student.

13. All PrP^{C} prion students must try to stay within the square but avoid contact. But if they come into contact with a PrP^{Sc} prion student, they must become a PrP^{Sc} prion as well. This means that every PrP^{C} prion student touched by a PrP^{Sc} prion student must reform his pipe cleaner from a **C** to an **S** shape. Tell the students that this interaction represents the persuasive impact that abnormal prions have on normal prions once they come in contact.

14. Let this interaction run for 1-2 minutes. Then tell the students to freeze. Pause the simulation.

15. Ask students to look across the square.
    a. Count the number of PrP^{Sc} prion students.
    b. Count the number of PrP^{C} prion students.
    c. Assess the spaces between students in the square.

16. Tell them that these spaces represent the holes that gradually increase in size in prion-infected tissue. Emphasize that the activity they have conducted was designed to simulate the pathology we see in spongiform nerve tissues. In these cases, the increasing collection of PrP^{Sc} prions leads to nerve cell death, eventually resulting in holes in the nerve tissue and ultimately, the animal's death.

17. Restart the simulation for another minute. Eventually there will only be a few PrP^{C} prions in the square. Tell the students that prion-related diseases generally take years to manifest, so the delay in the activity is similar to the real disease. You may invite the students to dramatize the ultimate death of the animal.

18. Ask students to return to their desks. Using your projection system, show the students a histology prep of spongiform tissue (available at the websites below). Remind the students that they just re-enacted the means by which abnormal prions interact with normal tissues, cause nerve cell damage and lead to the death of nerve cells and their subsequent removal by the immune system, which results in holes in animal brain tissue.

    Histology Prep of Spongiform Tissue from BSE-affected Cows
    The white spots are microscopic "holes" left by nerve cells that have died because of mis-folded prions.
    http://commons.wikimedia.org/wiki/File:Histology_bse.jpg

    vCJD Typical Amyloid Plaques
    The structures with radiating hair-like filaments are prion "florid" plaques typically found in the brains of vCJD victims.
    http://commons.wikimedia.org/wiki/File:Variant_Creutzfeldt-Jakob_disease_(vCJD),_typical_amyloid_plaques,_H%26E.jpg

19. Ask the students to make notes in their journals regarding the following points and questions:

    - The FDA's 2008 Enhanced BSE rule prohibits the use of ***brain and spinal cord*** material from cattle 30 months of age or older in any animal feed because PrP^{Sc} prions concentrate in the central nervous system. This material must be labeled "**Do Not Feed to Animals**".

    - Ruminants are food animals and can get prion diseases. To reduce the likelihood that humans ingest prions, the 1997 FDA "Ruminant Feed Ban" rule has prohibited the feeding of most mammalian protein (including brain and spinal cord) back to ruminants. This material is referred to as "Prohibited Material". Feeds containing any prohibited material must be labeled "**Do Not Feed To Cattle Or Other Ruminants**".

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20. At the end of the discussion, reinforce the point that a key role of WSDA, together with all other states and the FDA, is to ***regulate*** the safe manufacture and use of animal feed so as to limit BSE-related adverse events to animals and humans. In particular, students need to know that to achieve this FDA requires very specific Cautionary Statements to alert feeders about use limitations:

Do Not Feed to Animals = Material contains brain or spinal cord from cattle or buffalo 30 months of age and older. Cannot be used in feed. Fat (tallow) from this material cannot be used in feed unless residual protein is filtered out.

Do Not Feed To Cattle Or Other Ruminants = Material contains mammalian protein. Except, that the following proteins are exempt from this ban: Pure pork; pure horse; milk and milk products; blood and blood products; gelatin; inspected meat products cooked for human consumption and heated again; tallow with residual protein filtered out.

Wrap-up:

21. Tell the students that there are a number of neurological diseases that have been attributed to prions. We continue to learn more about the dietary, genetic, and environmental factors that make a person or animal more likely to get these diseases.

- **Optional:** Investigate a variety of prion-related diseases by reading aloud from the book *The Family that Wouldn't Sleep* by D.T. Max (Chapter 10 *Apocalypse Cow and* Chapter 11 *Oinkies*). Direct the students to make notes on the data the specialists needed to collect to identify the cause of BSE and how British regulatory officials responded to the numerous BSE cases.

Assessment Opportunities:

- Review student preconceptions from the start of the lesson to determine students' base understanding. Weight your subsequent work toward ***Activity #1*** if students need a review of BSEs and how we control them, or toward ***Activity #2*** if they need a stronger review of prions and their role in disease.
- Use the provided assessment rubric to assess students' answers to the role questions on the *BSE Town Hall Conversations* Student Handout.

Fails to Meet Expectations	Approaching Expectations	Meets Expectations	Exceeds Expectations
Does not complete handout. Or, fails to proficiently complete at least 50%.	Attempts to complete handout, with >50% proficiency regarding possible risks.	Completes most of handout, with >70% proficiency regarding possible risks.	Completes most of handout, with >90% proficiency regarding possible risks.

- Observe students' participation in classroom activities (group work, group discussions, simulation activity, and any extension activities), noting: student participation, accuracy in portraying role, and ability to summarize newly gained knowledge when answering final questions.
- During the Protein Folding extension activity, review students' pipe cleaner models for accuracy and degree of completion.

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Extension Activities:

- Using your projection system, show students a variety of animations of prions as they convert from normal to abnormal, including:

  McGraw Hill, How Prions Arise (1:29 Minutes)
  http://www.youtube.com/watch?v=m4VrTb1DVNw&feature=related

  The Institute of Molecular Biology & Biophysics, Prion Folding Animation
  http://tinyurl.com/7ongmnf

  PrP Mis-folding and Aggregation Animation (0:32 minutes)
  http://www.youtube.com/watch?v=hywcyZbWIeg&feature=related

  Prions! Killer Proteins and Such (13:00 minutes, but start video clip at 5:32 minutes to see prion interaction)
  http://www.youtube.com/watch?NR=1&v=GuL8ScOVFaQ&feature=endscreen

- **Protein Folding Activity:** Hand out 2 pipe cleaners to each student. Using your projection system, display a cartoon structure of the PrP^C prion from the *Scientific American* prion article (available for purchase at http://www.scientificamerican.com) or from one of the suggested video links. Instruct half of the students to bend the cleaners into the shape of the normal prion and half of the students to bend their cleaners into abnormal prions. Encourage them to be creative about their structures. Working in pairs, instruct the students to place the structures side by side and note in their journals the differences in the shapes of the two structures. Emphasize that you want them to note the differences in the molecules. **Optional:** Ask students to photograph their structures and include them in their class notebooks.

- Invite students to prepare research on other TSEs, such as Kuru, vCJD or Fatal Familial Insomnia (FFI).

- Discuss the fact that several government agencies are now monitoring internet activity, comments, and conversations as part of bioterrorism and public health efforts. For example, scientists use Google searches to track flu outbreaks through Google Flu Trends (available at http://www.google.org/flutrends/us/#US). What people email and post in social media or report in newspapers is being vigilantly monitored using computer programs for key terms such as "mad cow disease," "BSE," and "prions" in an effort to detect health challenges when they first begin. Show students the internet links provided in the *Resources* section of this lesson, such as Biocastor, Disease BioPortal, and HealthMap to make your point. Invite students to debate the appropriateness of government surveillance in protecting human health.

- The media plays a role in informing the public about best practices in the event of a health challenge. Invite students to conduct a web search on BSE, asking them to document their perceptions of the public's passion regarding:

  a. The practice of feeding cattle rendered offal.
  b. The number of animals destroyed in the past to try to limit human illness.
  c. Animal husbandry practices where farmers breed sheep with genetic traits that are less susceptible to the prion disease scrapie. Selective breeding is the basis for USDA's Scrapie Eradication program.

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TEACHER BACKGROUND & RESOURCES

Career Links:

- Agricultural establishment inspector
- Animal feed producer
- Biochemist
- Cattle farmer
- Chemist
- Dairy farmer
- Epidemiologist
- Feedlot manager
- Feedmill operator
- FDA animal scientist
- Journalist
- Microbiologist, infectious disease specialist
- Neurobiologist
- Pathologist
- Physician
- Veterinarian
- Veterinary toxicologist

Background Information:

Bovine spongiform encephalopathy (BSE), commonly known as Mad Cow Disease, is a fatal neurological disease of cattle.

B = *Bovine* = cattle

S = *Spongiform* = looks like sponge

E = *Encephalo* (brain) + *pathy* (disease) = degenerative disease of the brain

BSE has a long incubation period, about 30 months to 8 years, but most cattle are affected four or five years after consuming contaminated feed. The disease may be most easily transmitted to human beings by eating food containing brain or spinal cord tissue from BSE infected carcasses. However it should be noted that the BSE prion, although most highly concentrated in nerve tissue, can be found in other cattle tissues but at much lower levels. Its presence does not always result in disease because BSE does not easily transmit to humans. The human form of BSE is now known as variant Creutzfeldt–Jakob disease (vCJD). During the 20th century, many experts in agriculture, research, and policy worked together to describe the new disease agent, the new disease, and ways to protect public health and animal health.

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Resources:

Biocastor Project
http://born.nii.ac.jp/

CJD Brain Killer Documentary Video (8:26 minutes)
http://www.youtube.com/watch?v=OE74S7fDDPc&feature=related

CDC About BSE
http://www.cdc.gov/ncidod/dvrd/bse/

Disease BioPortal
http://fmdbioportal.ucdavis.edu/

Google Flu Trends
http://www.google.org/flutrends/us/#US

HealthMap
http://www.healthmap.org/en/

Miller & Levine BSE links
http://www.millerandlevine.com/news/bse/index.html

Key Findings from the Phillips Report on the British Government's Handling of the BSE Crisis
http://www.regulation.org.British/bse.shtml

WSDA Animal Proteins & Cattle Materials Prohibited in Animal Feed
http://agr.wa.gov/FoodAnimal/AnimalFeed/Publications/ProhibMatDefs.pdf

WSDA BSE Prevention Inspections
http://agr.wa.gov/Foodanimal/AnimalFeed/#BSE

Wikipedia Commons Image of Bovine Spongiform Encephalopathy Tissue
http://commons.wikimedia.org/wiki/File:Histology_bse.jpg

Brown, D. (November 6, 1988). Virus Kills Prize Bull. *Sunday Telegraph*.

Martin, Peter. (May 12, 1996). The Mad Cow Deceit. *Mail on Sunday/Night & Day* Magazine.

Max, D.T. (2006). *The Family that Couldn't Sleep: A Medical Mystery.* New York: Random House.

Prusiner, Stanley B. (June 2004). Detecting Mad Cow. *Scientific American* p. 86-93. Available for purchase at http://www.scientificamerican.com/.

Rhodes, R. (1997). *Deadly Feasts.* New York: Simon & Schuster Paperbacks.

Credit:

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Contributing authors: Kristen Bergsman and Joanna Prasertong.

Information on Transmissible Spongiform Encephalopathies (TSEs) and their control was provided by Evan Evans of the Washington State Department of Agriculture.

BSE illustration by Clayton DeFrate. Adapted from an illustration by the American Meat Institute.

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Name:_____Date:_____Period:_____

The Story of BSE

Student Handout

The Maddening Mystery of BSE

A growing number of British farmers and veterinarians reported in the 1980s that their cattle and some zoo animals were exhibiting some very odd animal behaviors and signs—and some were dying. What was wrong with them? How did they get sick? Was there a risk that humans might start getting sick? What needed to be done at a national level to protect animals and humans alike?

In this activity, you will explore the discoveries and choices people made during the largest food scare of the twentieth century: Bovine Spongiform Encephalopathy (BSE). This new disease takes its name from:

B = *Bovine* = cattle

S = *Spongiform* = looks like sponge

E = *Encephalo* (brain) + *pathy* (disease) = degenerative disease of the brain

As you read the essay below, you will use this *Student Handout* to guide your note-taking. The notes that you take will be specific to the role that you have been assigned. First, circle the role that you have been assigned:

Beef Consumer	Journalist
Cattle Farmer	Pathologist
Epidemiologist	USDA Inspector
Feed Producer	Veterinarian

Staggering BSE Cows

Beginning in the late 1970s, cows in England began suffering an assortment of unusual symptoms and behaviors, such as staggering, falling, and acting aggressively. Because these "staggering cows" were seen in counties far from one another and were attended by different veterinarians, cattle farmers did not see a suspicious pattern when an individual cow became ill. Usually, the sick cow was removed from the herd and sent for slaughter. Some of the meat from these sick cattle entered the human food chain while the slaughter byproducts (offal) were sent to renderers for processing into animal feed.

Renderers, often called the "oldest recyclers", collect slaughter byproducts and dead animals which they grind and cook to make animal fat and meat and bone meal. The cooking kills bacteria, viruses and other usual pathogens which could be unsafe in animal feed. In the 1970s renderers were also using chemical solvents to extract the maximum amount of animal fat because the price of fat was higher than meat and bone meal. This process of "meat recycling" is a cost-effective way to increase the protein content of animal feed. At this time dairy and cattle farmers were using meat and bone meal in place of soybean meal, as a more affordable way to enrich animal feed.

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In the early 1980s, a group of veterinarians began to take notice of the increasing number of erratic cows across Great Britain. In the pasture, these cows would tremble, stagger, and fall. If they could return to their feet, their steps were awkward and they would collapse. Alternatively, some formerly well-behaved cows would become anxious and aggressive. In 1983, the veterinarian Dr. Raymond Williams reported that a cow in Wiltshire, England kept to the extremities of her milking pen, progressively lost weight (even with a healthy diet), and was often too aggressive to be milked. Other local veterinarians such as Dr. David Bee and Dr. Colin Whitaker documented additional stories of staggering cows across England. They initially diagnosed the cause of the disease as a mineral or dietary imbalance. Veterinarians at the University of Bristol ran a number of tests and guessed that automated milking processes were agitating the dairy cows. Other veterinarians took tissue samples from deceased staggering cows and tested them for the presence of infectious organisms, such as fungus. The veterinarians interviewed the dairy farmers and farmers to look for common issues related to machinery, farm soil, or sick animal siblings, but none of these original theories held up to the collected clues and evidence.

Evidence Mounts that a New Animal Disease is Emerging

A few of the veterinarians managed to get some of the brain tissue of staggering cows to the government's Central Veterinary Laboratory. Pathologists—disease detectives—noted significant holes in the brain tissue of the affected cows. Pathologists like Martin Jeffrey, who had previously worked with tissues from zoo animals with mysterious staggering symptoms, recognized the striking similarity between the tissues. Moreover, pathologists familiar with a sheep disease called scrapie also recognized the stereotypical holes in the brain tissue (see ***Figure 1***). A sense of urgency arose: ***If the cause of this tissue abnormality could occur in several different species of animals, when would it occur in humans? What could be done to stop the agent from entering the human food chain?***

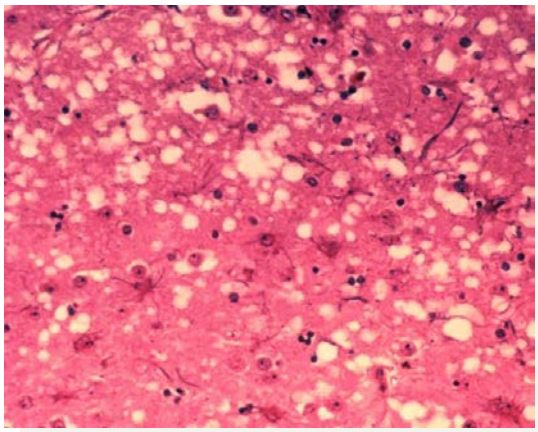

Figure 1: Micrograph of brain tissue from a BSE-affected cow showing the sponge-like appearance and the presence of vacuoles, or microscopic holes in gray matter. **Source**: Wikimedia Commons. From the Public Health Image Library, APHIS, 2003.

First identified in sheep in Great Britain and other Western European countries more than 250 years ago, scrapie exists in North America and most European countries. Scrapie-infected sheep will usually show "maddening" symptoms such as behavioral changes, tremors, and declining coordination and ultimately death. Midway through the 20th century, doctors, veterinarians, and pathologists in the U.S. and England could see the similarity between scrapie sheep brain tissue and the brain tissue of those suffering from human neurological diseases such as kuru and Creutzfeldt-Jacob Disease (CJD). Kuru and CJD are known to cause a variety of abnormal neurological effects in humans, such as dementia, poor coordination, tremors, loss of speech, and personality changes. There was no evidence that eating sheep meat from scrapie-infected animals could cause CJD or kuru; but, with the emergence of BSE and the possibility it was caused by the sheep scrapie agent, as a precautionary measure the U.S. National Renderers Association in 1989 urged its members to voluntarily stop rendering sheep and goat material if their product was to be used in cattle feed.

It wasn't until 1998 that Washington State University and United States Department of Agriculture (USDA) veterinary researchers such as Katherine O'Rourke announced that they had developed a practical test for testing living sheep for scrapie—even before the infected animals exhibited common scrapie symptoms. As of April 2012 there is no similar test for BSE.

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What was the Agent? Time to Discuss Prions!

In 1968, Dr. Carleton Gajdusek (a biomedical researcher and physician working for the National Institutes of Health) conducted a monumental experiment. His results led him to state in science publications that he felt that some novel, hard-to-destroy, "slow-virus" was the cause of all of these neurological diseases. This finding ultimately led to his receiving the 1976 Nobel Prize. Gajdusek's experiments influenced the work of biochemist and physician Dr. Stanley Prusiner. Together, these men composed theories and conducted experiments that brought us our current understanding of Transmissible Spongiform Encephalopathies (TSEs) and prions.

DNA is the instructions for life. The cell uses specialized tools, called enzymes, to 'interpret DNA' into another molecule called RNA (ribonucleic acid). Another set of enzymes 'interprets' the RNA molecule into a string of amino acids. The amino acids then self-assemble by folding themselves up into what we call a protein. If DNA is the instructions for life, then proteins are the tools that get the job done.

The ability of proteins to self-assemble into shapes that have a function is an extremely important 'skill.' These shapes are determined by the properties of the amino acids and their order in the string. Amino acids vary in size and charge and so the string will bend and twist to resolve the effects of size and charge amongst the amino acids. Normally there is only one or a small number of 'stable' ways the protein can have its amino acids' shapes and charges resolved. This results in the same piece of DNA being able to make the same protein with the same shape, structure and function over and over again reproducibly.

Prusiner knew that the way to find the cause of TSEs was to get rid of all the distracting chemicals and molecules in tissue samples to find a molecule common to all the tissues—only then you would find the molecules responsible for the disease. Once he had that molecule, he would then be able to describe it fully with scientific tests. By 1981, his team was able to identify the molecule, and in 1982 he called this molecule a "prion." According to Prusiner, a prion is a disease-causing agent that is ***neither bacterial, fungal, nor viral***. It contains no genetic material and its overall functions cannot be altered by high heat and normal sterilization processes.

A prion can take more than one form or shape—in one form, the prion performs its normal functions on the surface of cells, including nerve cells. Scientists use the abbreviation PrP^{C} for the normal healthy prion. Once the function is complete, the prion gets disassembled and moved away. Disease-causing, abnormally shaped prions, called PrP^{Sc} interact with PrP^{C} prions and promote the conversion of PrP^{C} prions into PrP^{Sc} disease prions. These PrP^{Sc} prions clump together and "tangle" the PrP^{C} prions, converting them to an abnormal shape. This process is ultimately destructive to nerve cells which eventually die leaving behind the holes that are visible with an ordinary microscope. For BSE it usually about takes 4–7 years for this conversion process to show signs of illness in cattle; for humans with kuru it can take over 40 years.

Prions do not evoke a traditional immune response or inflammatory reaction in host animals. BSE is confirmed by ***post-mortem*** examination of an animal's brain tissue using a test that can detect PrP^{Sc} prions if they are present. ***BSE is not a contagious disease*** and therefore is not spread through casual contact between animals. Scientists believe that transmission is through eating feed contaminated with tissue from a BSE infected animal.

There are a number of neurological diseases that have been attributed to prions. We continue to learn more about the dietary, genetic, and environmental factors that make a person or animal more likely to get these illnesses.

Protecting the Human and Animal Food Chain from the BSE prion.

In 1988, the *Daily Telegraph*, the first national daily to do so, reported the news of a mystery brain disease in British dairy cows. Journalist David Brown wrote of the "incurable 'mad cow disease' which riddled the brain with holes and drove docile animals berserk."[1] At the time, there were 32 confirmed and 96 suspected cases of British staggering cows and still no regulatory efforts to keep possibly contaminated meat out of the food chain. It was a new and complicated disease and

[1] Brown, D. (November 6, 1988). Virus Kills Prize Bull. *Sunday Telegraph*.

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neither farmers nor politicians wanted to impact the British beef industry without concrete evidence of the cause of the disease and a clearer sense of the threat to human health. They hesitated to change practices for three reasons:

1. Prion research was young.
2. The disease was not being discussed in the general press.
3. Conversations between farmers and researchers were time-consuming as they looked at the many ways the cows could have been exposed to prions (through feed, in the soil, via contaminated surfaces/equipment, and variability in housing).

The inconsistent paperwork and records of the beef and dairy farmers did not help matters. The disease epidemiologists noticed that many of the farmers stated in their paperwork, “cake in parlour.” Cows enjoyed this high protein, molasses-sweetened supplement as they were being milked (in the “parlour”). More than molasses, the cake was also rich with rendered animal meat and bone meal. Calves were also fed rations supplemented with meat and bone meal to get them into production faster. Epidemiologists interviewed the renderers to find out what had changed in their production lines over the past five years—the time when British farmers were seeing the most staggering cows. What they learned was striking.

During the 1970s two economic drivers came together to change traditional British rendering practices. The price of animal fat declined and the cost of energy went up. There was no longer a business incentive to maximize fat production so renderers stopped using chemical solvents which in turn allowed them to reduce the duration and temperature of the cooking process thereby using less fuel. Finally, during this time the cost of soybean and fish meal rose causing cattle farmers to increasingly use meat and bone meal in place of these more expensive protein sources. Taking these factors into account, British officials could now see why their farmers, as compared to farmers in other countries, were seeing more staggering cows. It was time to act on their findings.

In 1988 the British government imposed a ban on feeding ruminant-derived protein to other ruminants. Additionally, they forbade cattle farmers from selling cattle obviously ill with BSE. Funding was provided to slaughter and dispose of the sick cows and to compensate farmers for their loss. By 1990, a handful of pets and zoo animals were diagnosed with spongiform encephalopathy. After reports of an ailing cat named “Mad Max” were cited in the news, school districts banned British beef from school cafeterias.

Cattle cases and new clues grew, as did public anxiety. Headlines such as "The Mad Cow Deceit"[2] and a series of illnesses and deaths reported in teens ultimately persuaded British officials that British beef was linked to a spectrum of neurological diseases. Later, a law banning all animal protein in cow feed was implemented in England. A second British law would eventually ban animal protein in ***all*** British animal feed. Meanwhile, the British government ordered the slaughter of 3.3 million cattle that might have been exposed to prions (including siblings or animals that shared a common food source) at a cost of billions of pounds.

Afterword: Protecting Americans from BSE

The British BSE challenges associated with feeding cattle meat and bone meal that contained BSE-infected products peaked in January 1992 with almost 1,000 new cases a week. In total, 184,500 BSE cases were found in 35,000 herds. It is estimated that 1.6 million BSE-infected animals entered the British human food chain before regulatory controls were introduced.

The USDA regulates the importation of animals and animal products to protect the health of U.S. livestock. Because vCJD in humans has been linked to exposure to the BSE agent, the USDA collaborates with other federal agencies, such as the FDA, with regulatory responsibility for assuring food safety and the protection of human health, to implement a comprehensive coordinated U.S. response to BSE. The Centers for Disease Control and Prevention (CDC) ultimately coordinate the

[2] Martin, Peter. (May 12, 1996). The Mad Cow Deceit. *Mail on Sunday/Night & Day* Magazine.

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response to vCJD. What truly protects human and animal health and the $11.9 billion U.S. beef trade (2011 estimate) is the system of interlocking safeguards shown in ***Figure 2***, including all of these elements:

- The U.S. allows imports only from countries that have an equal or lower BSE risk.
- The BSE surveillance programs test for the presence of BSE in the population of cattle that, due to age or health status, is at the highest risk for having the disease. Such tests are conducted post-mortem and tell us how prevalent BSE is in the U.S. (BSE testing itself is not a food safety measure—it tells us what kind of food safety measures we need based on how big the threat is.)
- Removing from the human food chain tissues that studies have shown to contain the highest amounts of BSE agents. Such tissues, called "Specified Risk Materials" (SRMs), are required by the USDA to be excluded from human food. In general, these SRMs include brain, skull, eyes, spinal cord, and vertebral column, the terminus of the small intestine, and the tonsils.
- BSE animal feed ban rules, including:
    - In 1997, the FDA banned the use of most mammalian proteins in feed for cattle and other ruminants (exceptions include: blood and blood products; milk and milk products; gelatin; pure pork or pure horse meat; and inspected meat products, such as plate waste, which have been cooked and offered for human food and further heat processed for animal feed). Mammalian protein banned from ruminant feed is called "Prohibited Material" and feeds, except pet food, that contain "Prohibited Material" must be labeled "Do Not Feed to Cattle or Other Ruminants."
    - The FDA's 2008 Enhanced BSE Rule prohibited the use of brain and spinal cord from cattle and buffalo 30 months of age and older in ***all*** animal feed. This material must be labeled "Do Not Feed to Animals." This rule also regulates animal fat from cattle to be sure it is protein-free if used in ruminant feed.
- Tracing and tracking systems for live animals, human food, and animal feed.

The combined safeguards listed above protect U.S. citizens from acquiring vCJD and protect U.S. herds from contracting BSE.

How many cases of BSE have been found in the United States?

USDA has been testing for BSE since 1990. As of April 2012, only four cows in the U.S. have been found positive for BSE.

The very first case in the entire U.S. was identified in 2003 in Moses Lake, WA, by a WSDA Field Veterinarian. The ensuing international investigation traced the BSE positive cow back to a Canadian herd. Since this animal was exposed to BSE contaminated feed while still in Canada it is no longer counted as a native U.S. BSE case. USDA and WSDA experts used livestock tracking systems and DNA matching to prove the Canadian origin.

Three other BSE positive cattle have been identified since 2003 but none of these had the feedbourne "classical" BSE—the kind that was epidemic in the U.K. and other European countries. The other three cases had "atypical" strains of BSE which are not believed to be caused by contaminated feed. Atypical BSE seems to be a very rare old-age disease of cattle similar to human old-age dementias like Alzheimer's disease. The cause is not known. The atypical cases were found in Texas—2005, Alabama—2006, and California—2012.

Countries with the ability to detect the rare atypical forms of BSE are considered to have very robust surveillance programs.

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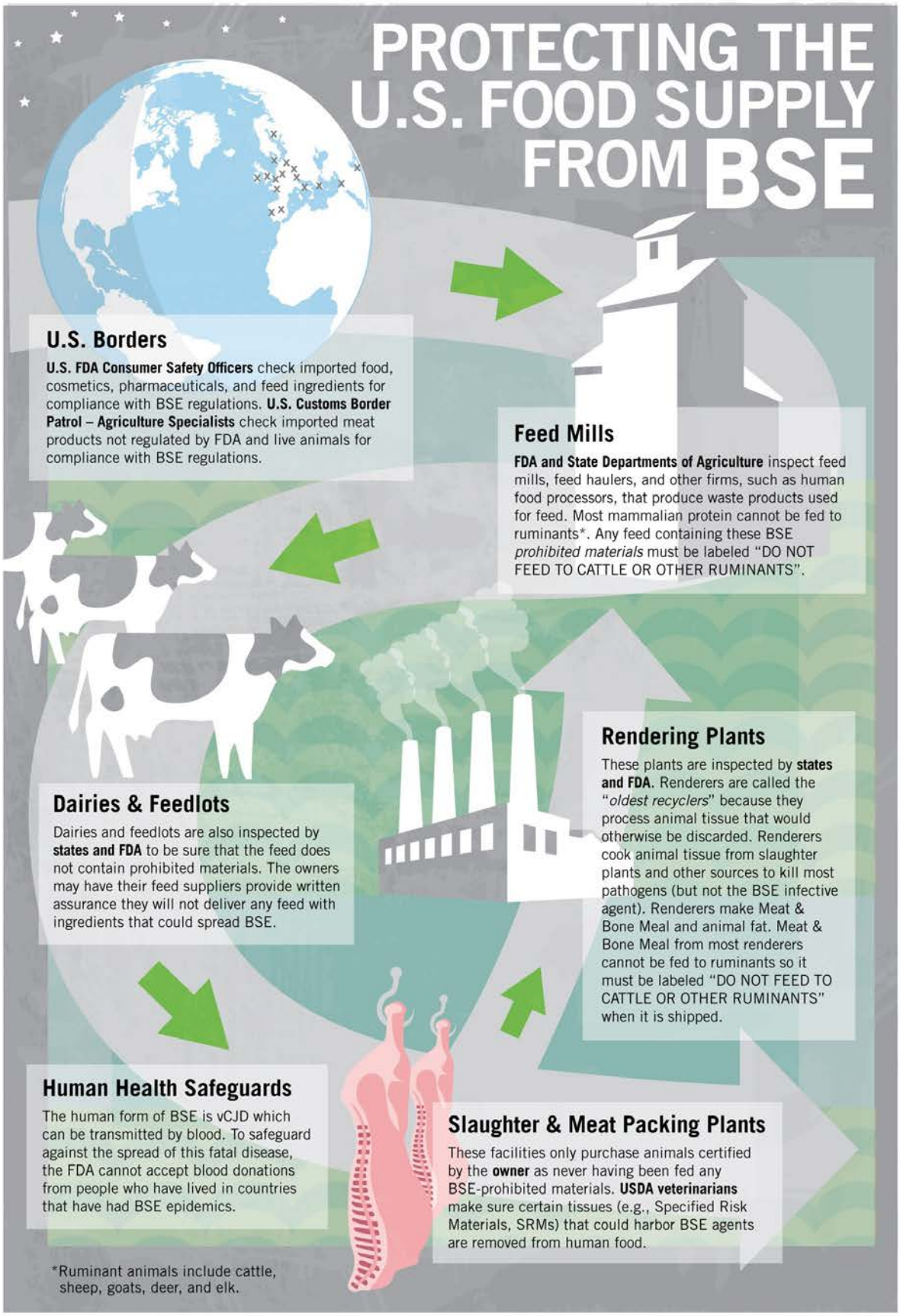
Figure 2: Strategies for protecting the U.S. food supply from BSE. **Credit**: Clayton DeFrate.



Credit: Illustration by Clayton DeFrate. Adapted from "U.S. BSE Prevention Strategies" from the American Meat Institute.

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Name:_____Date:_____Period:_____

BSE Town Hall Conversations

Student Handout

Homework: After reading *The Story of BSE* Student Handout, read the questions in the table below that are particular to your assigned role. Record your answers to these questions on a separate piece of paper.

Next Class Session: You will break into teams representing all 8 roles and participate in a "town hall" conversation on the history of TSE diseases, how it has impacted the animal and human food industry, and the means by which state and federal officials protect animals and the public.

Role	Questions
Beef Consumer	1. Before today's lesson, did you know that animals eat feed from recycled animal products? With restricted resources and a growing human population, do you think recycling animal products is good or bad? 2. Based on today's reading, when do you think consumers should be informed about possible issues related to the meat that they eat? 3. Name one way that the journalists intensified public anxiety about British beef.
Cattle Farmer	1. Why did the cattle farmers use meat and bone meal in their dairy cow feed? 2. Discuss why a cattle farmer would want to know if his cow had BSE. Why might a farmer not want to know if their cow had BSE? 3. As a consequence of the FDA ruminant feed ban, what kind of mammalian proteins can cattle farmers feed their ruminant animals such as cattle, sheep, goats, and buffalo?
Epidemiologist	1. Name two questions that an epidemiologist might pose to determine how an animal contracted BSE. 2. Veterinary epidemiologists deal with the investigation of diseases, productivity, and animal welfare in populations. They collect and analyze field data. Name two patterns in meat and bone meal preparation that the epidemiologists noticed in their investigation and were key to identifying the source of the disease. 3. Explain why you think epidemiologists get trained in both animal and human diseases.
Feed Producer/ Meat Renderer	1. How did rising energy costs contribute to the British BSE challenge? 2. How did lower prices for animal fat contribute to the British BSE challenge? 3. How did the price that farmers wanted to pay for protein contribute to the British BSE challenge?
Journalist	1. List the two reports and news articles discussed in the reading. 2. Discuss why a journalist would describe a cow with BSE as "mad." 3. Discuss how a journalist without a background in science would investigate a community health challenge accurately when the health and science community had not yet determined the cause of the health issues.
Pathologist	1. A prion is a sub-microscopic molecule. How were pathologists able to see the relationship between scrapie sheep and BSE cattle? 2. U.S. scientists were developing prion theories while British pathologists were developing a theory about the link between BSE cows and feed practices. Eventually they discovered that the abnormal prions changed normal prions into abnormal proteins. How did this conversion lead to holes in nerve tissue? 3. British officials first implemented BSE regulations in 1988. If you had cattle brain tissues from 1990 and from 2004, which sample would be more likely to have BSE pathology?

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USDA Inspector	1. What type of cattle do inspectors test for BSE? 2. When an inspector visits a cattle slaughterhouse, she/he might anticipate seeing the meat cuts moving into three possible paths: for human consumption/"edible," offal for rendering into animal feed, and the "Do Not Feed to Animals" container. Into which path would they expect to see Specified Risk Materials (SRM)? 3. When an inspector visits a cattle slaughterhouse, she/he might anticipate seeing the meat cuts moving into three possible paths: for human consumption/"edible," offal for rendering into animal feed, and the "Do Not Feed to Animals" container. If this facility only slaughtered swine, which path would they expect to see swine slaughter parts go into?
Veterinarian	1. Discuss the conflict a veterinarian might feel when a BSE diagnosis results in the destruction of the suspect animal. 2. British veterinarians report their BSE cases to the Ministry of Agriculture, Fisheries, and Food (MAFF). To what agency should a Washington State veterinarian report a potential BSE case? To what agency would a doctor ultimately report a case of vCJD? 3. You are a veterinarian, not an inspector. If you see a bag of feed labeled "Do Not Feed to Cattle or Other Ruminants" in a dairy farmer's barn, should you be alarmed?

After reviewing your answers as a group, develop as a group an answer to the following summary questions:

1. Discuss whether you would have eaten a British burger in 1986. Would you have eaten a British burger in 2004? Explain your reasoning for both situations.
2. Name three current practices in place in the U.S. that ensure that Americans can safely eat burgers made from U.S. cattle.
3. Why is it acceptable for some animals to eat animal feed made with meat and bone meal?
4. Name the two references to Washington State in the reading.

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The Maddening Mystery of BSE

Teacher Answer Key

Lesson Plan—Preconception Questions:

- **Ask the students if they recall whether those sick cows made humans sick. In their recollection, did human illness happen when they ate sick cows?**

  Scientists and experts believe the new disease of young adults, vCJD, was caused by eating food products that contained tissues, especially central nervous system tissue (brain and spinal cord) from cattle that had BSE. From the time the new cattle disease, BSE, was described it was another ~10 years before the new human disease, vCJD, was identified.

- **Do they recall any recent cases of Bovine Spongiform Encephalopathy (BSE) or mad cow disease?**

  Student answers will vary. The most recent case was identified in April 2012 in a California dairy cow.

BSE Town Hall Conversations—Homework Questions:

Role	Questions
Beef Consumer	**1. Before today's lesson, did you know that animals eat feed from recycled animal products? With restricted resources and a growing human population, do you think recycling animal products is good or bad?** Answers may vary. **2. Based on today's reading, when do you think consumers should be informed about possible issues related to the meat that they eat?** Answers may vary. **3. Name one way that the journalists intensified public anxiety about British beef.** When the journalists discussed teen cases or Mad Max, the public was less interested in eating British burgers.
Cattle Farmer	**1. Why did the cattle farmers use meat and bone meal in their dairy cow feed?** Dairy farmers added the high protein found in meat and bone meal to their feeds to increase the quantity of milk they could sell. They used meat and bone meal over other protein sources because it cost less. They also added it to calf feed so they would come into production faster. **2. Discuss why a cattle farmer would want to know if his cow had BSE. Why might a farmer not want to know if their cow had BSE?** A farmer would want to know what was wrong with a sick cow to protect the rest of the herd, because they are compassionate, or because they need to know what market should receive his meat (animal or human). A farmer might not want to know if his cow had BSE because this animal and others on his farm would be slaughtered. **3. As a consequence of the FDA ruminant feed ban, what kind of mammalian proteins can farmers feed their ruminant animals such as cattle, sheep, goats, and buffalo?** Blood and blood products; milk and milk products; gelatin; pure pork or pure horse meat; and inspected meat products, such as plate waste, which have been cooked and offered for human food and further heat processed for animal feed.

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Epidemiologist	**1. Name two questions that an epidemiologist might pose to determine how an animal contracted BSE.** • What did the animal eat? • How was the animal's feed prepared? • Have other animals eaten this feed? What is their health status? • How old is the animal? • Where did the animal come from – domestic herd or from another country? **2. Veterinary epidemiologists deal with the investigation of diseases, productivity, and animal welfare in populations. They collect and analyze field data. Name two patterns in meat and bone meal preparation that the epidemiologists noticed in their investigation that were key to identifying the source of the disease.** Once they established a connection between the sick animals and a specific feed ingredient, the epidemiologists were able to direct their attention towards the preparation of meat and bone meal. They interviewed renderers and noticed patterns of change in the use of chemical solvents and the time and temperature of the cooking process. **3. Explain why you think epidemiologists get trained in both animal and human diseases.** Many human diseases originate in animals. Many animal disease pathologies can resemble human disease pathologies.
Feed Producer/ Meat Renderer	**1. How did rising energy costs contribute to the British BSE challenge?** Renderers reduced both the duration and temperature of the rendering process to reduce fuel costs. Heat does not kill prions but the longer exposure to higher temperatures of the old process probably reduced infectivity—especially when combined with chemical solvents. **2. How did lower prices for animal fat contribute to the British BSE challenge?** Renderers stopped using chemical solvents because it became less profitable to maximize animal fat extraction using chemical solvents, which required higher temperatures and longer cooking. Many experts believe this combination was enough to keep the BSE prion in check. **3. How did the price that farmers wanted to pay for protein contribute to the British BSE challenge?** Farmers could pay a lower price for protein in meat and bone meal than the price that they would pay for protein from soy and other sources. This created a strong market for the use of meat and bone meal from rendered offal.
Journalist	**1. List the two reports and news articles discussed in the reading.** "Incurable Mad Cow Disease" and "The Mad Cow Deceit." **2. Discuss why a journalist would describe a cow with BSE as "mad."** Answers will vary, but should include the fact that ill animals acted aggressively and seemed "out-of-control" or reflect the journalist's desire to have a sensational article. **Note**: The first hint of the nickname came from a report in January 1985 by the veterinary investigative officer who visited a suspect farm. The "cow went mad and aggressive," the official noted. **3. Discuss how a journalist without a background in science would investigate a community health challenge accurately when the health and science community had not yet determined the cause of the health issues.** Answers will vary, but should include conducting interviews, reading science articles, and visiting the library. Overall, the student should be encouraged to state that it is hard!

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Pathologist	**1. A prion is a sub-microscopic molecule. How were pathologists first able to see the relationship between scrapie sheep and BSE cattle?** British veterinary pathologists who were familiar with the typical spongiform change observed in scrapie-affected sheep brains and those familiar with spongiform brain tissues mysteriously appearing in zoo animals recognized the analogous "brain holes" in the brain tissue samples from cattle dying of a new disease, later named BSE. **2. U.S. scientists were developing prion theories while British pathologists were developing a theory about the link between BSE cows and feed practices. Eventually they discovered that the abnormal prions changed normal prions into abnormal proteins. How did this conversion lead to holes in nerve tissue?** This process is ultimately destructive to nerve cells, which eventually die leaving behind the holes that are visible with an ordinary microscope. **Note**: The precise mechanism of cell death in prion diseases is not well defined. The "holes" are specialized membrane bound structures called vacuoles in which cell organelles, proteins, and other intracellular contents are subjected to enzymatic digestion. **3. British officials first implemented BSE regulations in 1988. If you had pathology tissues from 1990 and from 2004, which sample would be more likely to have BSE pathology?** At the beginning of the BSE epidemic in the UK, ~1985, most cattle became ill at age 4 or 5 years. In 1990, many cattle could have been fed BSE contaminated feed before it was banned. Thus, by 1990, many cattle could be showing the signs of BSE in pathology tissues. By 2004, the feed ban effectively stopped most exposure to the BSE infective agent so these tissues would be much less likely to show BSE spongiform change.
USDA Inspector	**1. What type of cattle do inspectors test for BSE?** Cattle exhibiting erratic, anxious, aggressive, or staggering behavior; older cattle; cattle that cannot get up known as "non-ambulatory" or "downers." **2. When an inspector visits a cattle slaughterhouse, she/he might anticipate seeing the meat cuts moving into three possible paths: for human consumption/"edible," offal for rendering into animal feed, and the "Do Not Feed to Animals" container. Into which path would they expect to see Specified Risk Materials (SRM)?** Some SRM materials would go into the paths for rendering and be labeled "Do Not Feed to Cattle or Other Ruminants;" brain and spinal cord would go to non-feed use and be labeled "Do Not Feed to Animals." **3. When an inspector visits a cattle slaughterhouse, she/he might anticipate seeing the meat cuts moving into three possible paths: for human consumption/"edible," offal for rendering into animal feed, and the "Do Not Feed to Animals" container. If this facility only slaughtered swine, which path would they expect to see swine slaughter parts go into?** Edible parts would go into the path for human consumption; "offal" would go to rendering. Since the USDA SRM rule only applies to cattle and buffalo, and pure pork material is exempted in the FDA Ruminant Feed Ban rule—inedible slaughter byproducts could be rendered into "Pure Porcine Meat and Bone Meal" and used in feed for all species.

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Veterinarian	**1. Veterinarians make a living treating animals and promoting the health of their client's animals. Discuss the conflict a veterinarian might feel when a BSE diagnosis results in the destruction of the suspect animal.** Answers will vary. Some students may appreciate the need to euthanize suspect animals to protect the food supply. Others may state that they would have a hard time euthanizing suspect animals. Veterinarians will feel compassion for the individual animal but will balance this feeling with their responsibility to prevent illness and suffering in other animals and humans. **2. British veterinarians report their BSE cases to the Ministry of Agriculture, Fisheries, and Food (MAFF). To what agency might a veterinarian in Washington State report a potential BSE case? To what agency would a medical doctor ultimately report a case of vCJD?** Washington veterinarians would report suspect BSE cases to the USDA. Medical doctors would report potential vCJD cases to the CDC. Coordination and communication must occur between these agencies to limit the extent of the disease challenge. **3. You are a veterinarian, not an inspector. If you see a bag of feed labeled "Do Not Feed to Cattle or Other Ruminants" in a dairy farmer's barn, should you be alarmed?** You should be alarmed if: You witness the banned feed being added to the dairy feed. If the bag spills on top of the hay used to feed the cows. If the dairy farmer is ***only*** raising cows. But, you ***need not*** be alarmed when this feed is present if this dairy farmer is using the feed ***only*** to feed chickens or other non-ruminants also being raised on the farm.

BSE Town Hall Conversations—Summary Questions:

After reviewing your answers as a group, develop as a group an answer to the following summary questions:

1. **Discuss whether you would have eaten a British burger in 1986. Would you have eaten a British burger in 2004? Explain your reasoning for both situations.**

Answers will vary. Some groups will have a number of vegetarians or newly spooked kids who will state that they will never eat burgers! Others might state that they would not eat a 1986 burger but with the new regulations and rules they might eat the 2004 burgers. It is possible that some might state that they do not believe in prions, as was common in the 20th century, and therefore would have no qualms about eating burgers of any vintage.

2 . **Name three current practices in place in the U.S. that ensure that Americans can safely eat burgers made from U.S. cattle.**

The safety precautions include any three of the following practices:

- The removal of specified risk materials from the human food chain.
- The FDA's BSE animal feed ban rules.
- BSE surveillance.
- Import restrictions
- The ability to track live animal movements and to trace animal feeds from manufacturer to end user is not a primary protection but is key to rapid containment and control food/feed safety events.

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3. **Why is it acceptable for some animals to eat animal feed made with meat and bone meal?**

Other animals raised for food such as swine, poultry, and fish do not get TSEs even though they routinely eat feed with intentionally added meat and bone meal that is prohibited in ruminant feed.

4. **Name the two references to Washington State in the reading.**

- The first case of BSE in the entire U.S. was identified in Moses Lake, WA in 2003 by a WSDA Field Veterinarian. This animal was traced back to a Canadian herd which is where it was exposed to the contaminated feed.
- USDA scientists in Pullman, WA, working with Washington State University scientists developed a test for scrapie that could be used for living sheep before they showed any signs of sickness.

Lesson Plan—Prion Conversion Simulation Questions:

- **Describe the difference between PrP^{Sc} and PrP^{C} prions. How was this demonstrated in the simulation?**

Prions are proteins. The difference between PrP^{Sc} and PrP^{C} prions is their shape. PrP^{C} prions are found in healthy nerve tissue. Misshapen PrP^{Sc} prions cause disease. Meat and bone meal made from BSE infected cattle can carry PrP^{Sc} prions into healthy cattle through feed. PrP^{Sc} prions then spread from the gut to the brain. The students that acted like abnormal PrP^{Sc} prions transformed the shapes of the pipe cleaners held by the normal-PrP^{C} prion students—causing them to take on the abnormal PrP^{Sc} prion shape.

- **Prions "transform" rather than "infect" healthy tissue. Describe how this was demonstrated in the simulation.**

Abnormal-PrP^{Sc} prions enter the animal and when they get close to normal-PrP^{C} prions, their unusual folding structure misfolds the normal prions. The students that acted like PrP^{Sc} prions were able to "change" normal-PrP^{C} prions/students by causing them to bend their pipe cleaners into a different shape. Then the normal prions moved away.

Extra: In reality, the normal prions do not move away—they are converted to abnormal prions. The abnormal prions aggregate. The converted prions lose their normal function, gain toxicity, and ultimately result in the death of nerve cells.

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Going Global

Activity Time: 45 Minutes.

Lesson Plan Summary:

In this lesson, students will learn about the role of regulatory agencies and government responses in the global marketplace. They will research, review, and discuss materials from regulatory agencies such as the Washington State Department of Agriculture (WSDA) and the Food and Drug Administration (FDA). Students will discuss the business management aspects of expanding agricultural-oriented businesses to an ever-changing, worldwide marketplace.

STUDENT UNDERSTANDINGS

Big Ideas & Enduring Understandings:

- **Government Response:** Government agencies at the state and federal level play an important role in safeguarding the feed and food supply.
- **Business Management:** In today's ever-changing global marketplace, an agriculture-oriented business manager must keep track of a variety of considerations beyond the production of a feed or food product.

Essential Questions:

- How do regulatory agencies use logic, science, technology, and statistics to make timely decisions to ensure that agricultural business owners remain competitive in a global marketplace?
- What are some of the things an agricultural business owner should consider when preparing to take his or her products to the global marketplace?

Learning Objectives:

Students will know…

- Regulatory agencies implement a variety of strategies and decisions using available, and sometimes imperfect, information.
- Business owners have resources, including access to government agencies, that can improve their competitiveness in today's global markets.

Students will be able to…

- Identify regulatory agencies concerned with the agricultural marketplace world-wide.
- List preparations and steps that an agriculture-oriented business owner can take to grow her business and protect her customers.
- Learn what it takes for an agriculture-oriented business owner to participate in a global marketplace, in order to help his business expand.

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Vocabulary:

- Gapminder
- Global marketplace
- Gross Domestic Product (GDP)
- Regulatory agency

Standards Alignment:

This lesson addresses the following Washington State Career and Technical Education (CTE) model frameworks for Agriculture, Food, and Natural Resources (AFNR):

- **ABS.02.01.02.a:** Identify and observe ethical standards in planning and operating AFNR businesses. Level I.
- **ABS.02.03.02.a:** Identify appropriate local, state, federal, international, and industry regulations for AFNR businesses. Level I.
- **FPP.01.01.01.b:** Evaluate changes and trends in the food products and processing industry. Level II.
- **FPP 01.02.01.a:** Explain the purposes of organizations that are part of or regulate the food products and processing industry. Level I.
- **FPP 01.02.01.b:** Evaluate the changes in the food products and processing industry brought about by industry organizations or regulatory agencies. Level II.

Common Student Preconceptions:

- Expanding into a global business takes little more than putting up a website.
- Regulatory agencies are unfamiliar with the day-to-day needs of farmers and their related industry.
- U.S. businesses conduct most of their trade and commerce with other U.S. businesses and have little interaction with the global marketplace.

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TEACHER PREPARATION

Materials:

Item	Quantity
Classroom computer with projector, speakers, and internet access	1 per class
Computer lab with internet access	1
Going Global Research Questions Student Handout	1 per group
Going Global Research Questions Teacher Answer Key	1 per class

Preparation:

- Make four copies of the *Student Handout*.
- Divide students into four groups.
- Make sure that you can access the Gapminder (Trendalyzer software) from the internet in your classroom. Trendalyzer is software for animation of statistics that was initially developed by Hans Rosling's Gapminder Foundation in Sweden. Trendalyzer software is preloaded with statistical and historical data about the development of world nations. For a listing of data sources, visit http://www.gapminder.org/data/.

PROCEDURE

Hook:

1. Using the classroom computer and projector, show students the Gapminder website, available at:

   Gapminder
   http://www.gapminder.org

2. Once the website opens, click "Load Gapminder World" to launch the Trendalyzer software. While the site loads, which can be a lengthy process, explain that you are going to share some world data using unique, animated graphics.

3. Once the website has loaded, click on "Full Screen" at the upper right of the screen.

4. Click the "Play" button at the lower left of the screen. The bubbles on the graph will move. Let the students watch without guidance. The graph will portray wealth (x-axis) and life expectancy (y-axis) statistics for a variety of nations over the past 200 years.

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5. Once the bubbles stop moving, guide your students through the data represented on the animated graph:

   - Each of the bubbles represents a country.

   - The size of the bubbles is related to the size of the population of that country.

   - The health of a country's people is suggested by the average life expectancy of its people. In this graph, students witnessed the changing life expectancy of the people who live in each country for each year since 1800 (as shown on the y-axis). Check to see if students understand this concept by asking, "Are people around the world living longer or shorter lives"?

   - The wealth of a country's people is suggested by the income per person its population earns each year. In this graph, students witnessed the overall wealth of the people who live in each country for each year since 1800 (as shown on the x-axis). Check to see if students understand this concept by asking, "Are people around the world becoming wealthier or poorer?"

   - At the right of the Gapminder screen is a listing of countries. As long as no country is clicked, Gapminder shows the entire world's metrics. When you click on specific countries in this window, you can emphasize the data (and the graph bubble) from that country. You can increase student engagement by choosing countries that represent the home nations of some of your students' families.

6. Next, share some Gapminder statistics related to agriculture. This can be done by "changing" the y-axis of the graph. Move your cursor over the rectangle over the y-axis that is labeled "life expectancy" and click on the little upside down triangle. A pop-up of possible new categories will appear. Open these available data sets by gliding your cursor over the drop down menu, opening one of the data sets at a time:

   - Select **Economy**, then **Incomes & Growth**, then **Sugar per Person**. You will see the grams of sugar and sweeteners consumed per person per day in reporting countries.

   - Select **Economy**, then **Sectors**, then **Agriculture**. You will see the % Gross Domestic Product (relative national income) that comes from the agriculture industry sector for each country.

   - Select **Work**, then **Employment by Sector**, then **Agriculture Workers**. You will see the % of the total labor force that works in agriculture for each country.

   - Select **Environment**, then **Geography**, then **Agriculture Land**. You will see the % of arable land that is dedicated to raising crops or animal grazing.

   - Select **Environment**, then **Water**, then **Agricultural Water Withdrawal**. You will see the % of withdrawn/extracted water that is dedicated to agricultural practices.

7. As you move through the Gapminder scenarios, keep the x-axis constant and always press "Play" after you set up each Gapminder scenario. Ask students for ideas of countries they may want you to highlight in any of the scenarios.

8. After examining the five Gapminder scenarios, ask the students to conduct a Think-Pair-Share with a partner, answering the following prompt: "Based on what I saw using Gapminder, I think that the most significant change in global agriculture in the past ten years is _____."

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9. Share the following statistic: "*On average, every hour, 24 hours a day, 365 days a year, around $6 million in U.S. agricultural products—grains, oilseeds, cotton, meats, vegetables, snack foods, etc., will be consigned* ***for shipment for export to foreign markets***" (U.S. Dept of Commerce).

10. Ask students to conduct a quick Think-Pair-Share, reflecting on the reasons why an agriculture-oriented business would want to access the global marketplace. During the Share component, document students' diverse ideas on the board.

11. Using the classroom computer and projector, show students a video from AllAboutFeed in which Jeff Murphy, the president of a global animal nutrition company, discusses current matters affecting the feed industry.

    Kemin AgriFoods North America Video (4:58 minutes)
    http://www.allaboutfeed.net/videos/all-about-feed-meets-kemin-32.html

12. Allow time for students to discuss the video briefly. What are some trends in the agrifood and ethanol industries? What are the areas of top growth? What impacts do regulations have on these industries?

Preconceptions:

13. Write the following questions/prompts on the board:

    - Name two connections between animal feed safety and human food safety.
    - Name one way that regulatory agencies promote or help U.S. feed production and feed safety.
    - Name one way that regulatory agencies hinder U.S. feed production and feed safety.
    - How important is it for American companies to be able to sell their feed products globally? Select one: a) not important; b) somewhat important; c) very important.
    - How does the WSDA support the agricultural community? Regarding feed safety? Strictly on a state level, or beyond?

14. Ask students to record their answers to these questions on a piece of paper so that you can capture students' learning on today's global marketplace.

Activity Procedure:

15. Divide the students into four groups.

16. Pass out copies of the *Student Handout,* one per group.

17. Assign two questions from the *Going Global Research Questions* Handout to each group, ensuring that all questions are assigned. Alternatively, allow each group to select the two questions that they want to research and answer.

18. Allow time for students to research and prepare their responses. Students will need access to a computer lab to conduct their research.

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Wrap-up:

19. Bring the class back together. Ask each group to share their answers to their selected questions.

20. At the end of the lesson, ask students to revisit the questions from the *Preconceptions* section. To assess student learning, direct the students to update their responses, keeping in mind what they learned as a result of participating in this lesson. They should turn in their papers at the end of the class period as Exit Tickets.

Assessment Opportunities:

- The Exit Tickets will show changes in student learning as a result of participating in the lesson.

- Assess student learning using the provided *Teacher Answer Key* and the suggested scoring guide.

Student Metacognition:

- The *Preconceptions* questions and Exit Ticket activity challenge students to consider how their thinking has changed as a result of participating in the lesson.

Extension Activities:

- Precede this lesson with the *BSE Outbreak Lab* lesson from this curriculum. Have students consider the questions on the *Going Global Research Questions* Student Handout based on their experiences from that lesson.

Adaptations:

- Direct students to research the impact of the 2010 Icelandic volcanic eruption (Eyjafjallajökull) on global trade, using the internet resource provided below. Direct the students to document the timeline between the eruptions and the resulting impact on global agricultural trade. What was the economic impact?

  "With Flights Grounded, Kenya's Produce Wilts"
  http://www.nytimes.com/2010/04/20/world/africa/20kenya.html

TEACHER BACKGROUND & RESOURCES

Career Links:

- Agricultural attaché

- Agricultural corporate executive

- Global account manager

- Sales/business development manager

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Background Information:

Background information on the global agriculture marketplace can be found at the websites listed in the *Resources* section.

Resources:

Gapminder
http://www.gapminder.org/

Kemin AgriFoods North America Video (4:58 minutes)
http://www.allaboutfeed.net/videos/all-about-feed-meets-kemin-32.html

"With Flights Grounded, Kenya's Produce Wilts" (*New York Times*, April 19, 2010)
http://www.nytimes.com/2010/04/20/world/africa/20kenya.html

About WSDA
http://agr.wa.gov/AboutWSDA/

Food Safety Milestones
http://www.fda.gov/downloads/Food/FoodSafety/FSMA/UCM263778.pdf

International Marketing
http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateA&navID=InternationalMarketing&leftNav=InternationalMarketing&page=InternationalMarketing&acct=AMSPW

Good Manufacturing Practices Feed Safety Inspection Checklist
http://agr.wa.gov/foodanimal/animalfeed/forms/form4289.pdf

American Feed Industry Association
http://safefeedsafefood.org/images/pdf/6VI.SF-SFauditformrevised10-09.pdf.pdf

Animal Feed Impact on Food Safety
http://www.who.int/foodborne_disease/resistance/Report_AnimalFeed_Oct07.pdf

Food and Agriculture Organization of the United Nations
http://www.fao.org/

Global Food Safety Initiative
http://www.mygfsi.com

Rapid Alert System for Food and Feed (RASFF)
http://ec.europa.eu/food/food/rapidalert/index_en.htm

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Early Warning and Response System (EWRS)
https://ewrs.ecdc.europa.eu/

Building Capacity in Global Markets
http://www.mygfsi.com/gfsifiles/_com/GFSI_Newsletter_Sept2010.pdf

Global Markets Capacity Building Program
http://www.mygfsi.com/gfsifiles/GFSI_Newsletter_July_2011.pdf

FSIS Food Defense & Emergency Response
http://www.fsis.usda.gov/Food_Defense_&_Emergency_Response/index.asp

Credit:

Lesson plan written by Nona Clifton of the Washington Global Health Alliance.

Student Handout photograph courtesy of Robert Britschgi.

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Team Member Names:_____

Date:_____Period:_____

Going Global Research Questions

Student Handout

Directions: As a group, please research and answer two assigned questions from the list below. Use the websites listed at the end of the handout, plus your own web research. Be prepared to share your responses with the class.

Credit: Robert Britschgi.

1. Identify two reasons why U.S. farmers need to understand how to participate in the global feed and food market.

2. What role do regulatory agencies such as the FDA and WSDA play in ensuring feed safety in the U.S.?

3. The EWRS and the RASFF are two European organizations that help ensure the safety and reliability of European goods. Briefly define the goals of the two organizations. Which organization is larger?

4. Familiarize yourself with the key issues in food defense by visiting the FSIS Response website and learning about the Food Safety Plan. Not all measures in a good Food Safety Plan are required at all sites; list the four recommended measures.

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5. A variety of regulatory agencies have developed helpful checklists with regard to good manufacturing practices. Review the WSDA checklist and list the seven categories/resources/staff that a regulatory officer might inspect during a visit to a manufacturing site.

6. If you suspect a health issue related to your pet's food, what information does the FDA need from you to track down the source of the issue?

7. Describe the FDA alert system (http://www.fda.gov/Food/FoodDefense/Training/ALERT/default.htm). Explain why agricultural businesses need to familiarize themselves with the initiative and its five points.

8. In traditional times, U.S. farmers could sell most of their goods to local consumers and neighbors. As today's farmers sell their agricultural products on a global scale, can you envision a scenario wherein they might have to conduct business with an organization with different ethics and morals than their own (e.g., doing business with an entity with a history of human rights abuse)? What conflicts of interest might they encounter?

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Web Resources:

About WSDA
http://agr.wa.gov/AboutWSDA/

About FDA
http://www.fda.gov/AboutFDA/WhatWeDo/default.htm

Early Warning and Response System (EWRS)
https://ewrs.ecdc.europa.eu/

Rapid Alert System for Food and Feed (RASFF)
http://ec.europa.eu/food/food/rapidalert/index_en.htm

FSIS Food Defense & Emergency Response
http://www.fsis.usda.gov/Food_Defense_&_Emergency_Response/index.asp

The Animal and Veterinary Arm of the FDA
http://www.fda.gov/AnimalVeterinary/default.htm

WSDA Good Manufacturing Practices Feed Safety Inspection Checklist
http://agr.wa.gov/foodanimal/animalfeed/forms/form4289.pdf

Food Safety and Inspection Service, General Food Defense Plan
http://www.fsis.usda.gov/PDF/General-Food-Defense-Plan-9-3-09%20_2_.pdf

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Going Global Research Questions

Teacher Answer Key

1. **Identify two reasons why U.S. farmers need to understand how to participate in the global feed and food market.**

   Answers may vary, but must include: a) the importance of U.S. farmers selling their crops to foreign customers; and b) how U.S. farmers can sell their products while being cognizant of the demands and pricing of competing international farmers.

2. **What role do regulatory agencies such as the FDA and WSDA play in ensuring feed safety in the U.S.?**

   The FDA is a federal entity responsible for protecting public health by assuring the safety, efficacy, and security of our nation's food supply. The FDA is also responsible for advancing public health by helping the public access the accurate, science-based information they need to safely use foods to maintain and improve their health. Finally, the FDA plays a significant role in the nation's counterterrorism capability. The FDA fulfills this responsibility by ensuring the security of the food supply to respond to deliberate and naturally emerging public health threats.

   (http://www.fda.gov/AboutFDA/WhatWeDo/default.htm)

   The WSDA serves the people of Washington by supporting the agricultural community and promoting consumer and environmental protection. The WSDA staff carries out a broad spectrum of activities that support the producers, distributors, and consumers of Washington's food and agricultural products. Their goals include:

   - Protect and reduce the risk to public health by assuring the safety of the state's food supply.
   - Ensure the safe and legal distribution, use, and disposal of pesticides and fertilizers in Washington State.
   - Protect Washington State's natural resources, agriculture industry, and the public from selected plant and animal pests and diseases.
   - Facilitate the movement of Washington's agricultural products in domestic and international markets.

   (http://agr.wa.gov/AboutWSDA/)

3. **The EWRS and the RASFF are two European organizations that help ensure the safety and reliability of European goods. Briefly define the goals of the two organizations. Which organization is larger?**

   The Network for the Surveillance and Control of Communicable Diseases has been established to promote cooperation and coordination between the Member States, with the assistance of the European Commission, with a view to improving the prevention and control, in the Community, of communicable diseases. The Network includes an Early Warning and Response System (EWRS), which is formed by bringing into permanent communication with one another, through appropriate means, the Commission and the competent public health authorities in each Member State responsible for determining the measures that may be required to protect public health.

   The EWRS allows the members to communicate on larger, shared public health issues. The Members use the Rapid Alert System for Food and Feed (RASFF) tools to communicate a serious risk in relation to food or feed threat.

   Established as a network in 1983, the RASFF allows the European Commission, the EU member states' food and feed control authorities, and the European Food Safety Authority (EFSA) to share information and take immediate action when dangerous food or feed is detected on the market or at the border.

   The EWRS assists in the reporting of any communicable disease within the EU member states, including those associated with food or feed, and is therefore the larger organization.

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4. **Familiarize yourself with the key issues in food defense by visiting the FSIS Response website and learning about the Food Safety Plan. Not all measures in a good Food Safety Plan are required at all sites; list the four recommended measures.**

   - Outside Security Measures
   - Inside Security Measures
   - Personnel Security Measures
   - Incident Response Security Measures

5. **A variety of regulatory agencies have developed helpful checklists with regard to good manufacturing practices. Review the WSDA checklist and list the seven categories/resources/staff that a regulatory officer might inspect during a visit to a manufacturing site.**

   Answers can be found at this website: http://agr.wa.gov/foodanimal/animalfeed/forms/form4289.pdf.

   - Buildings and grounds
   - Equipment
   - Work and storage areas
   - Components
   - Assays
   - Equipment clean out procedures
   - Labeling and records

6. **If you suspect a health issue related to your pet's food, what information does the FDA need from you to track down the source of the issue?**

   Answers can be found at this website: http://www.fda.gov/AnimalVeterinary/SafetyHealth/ReportaProblem/ucm182403.htm.

   - Exact name of the product and product description (as stated on the product label).
   - Type of container (e.g., box, bag, can, pouch, etc.).
   - Whether product is intended to be refrigerated, frozen, or stored at room temperature.
   - Lot number—This number is often hard to find and difficult to read. It is stamped onto the product packaging and typically includes a combination of letters and numbers, and is always in close proximity to the "best by/before" or expiration date (if the product has a "best by/before" or expiration date). The lot number is very important as it helps determine the manufacturing plant as well as the production date.
   - "Best by," "best before" or expiration date.
   - UPC code (also known as the bar code).
   - Net weight.
   - Purchase date and exact location where purchased.
   - Results of any laboratory testing performed on the pet food product.
   - How the food was stored, prepared, and handled.

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7. **Describe the FDA alert system (http://www.fda.gov/Food/FoodDefense/Training/ALERT/default.htm). Explain why agricultural businesses need to familiarize themselves with the initiative and its five points.**

   The ALERT initiative is intended to raise the awareness of state and local government agency and industry representatives regarding food defense issues and preparedness. It is generic enough to apply to all aspects of the farm-to-table supply chain and is designed to spark thought and discussion with a variety of stakeholders. ALERT identifies five key points that industry and businesses can use to decrease the risk of intentional food contamination at their facility. These points include: Assure, Look, Employees, Reports, and Threat.

   Agricultural businesses can be more prepared for and effective at addressing issues if they know and understand the key points of the initiative. ALERT identifies five key points that industry and businesses can use to decrease the risk of intentional food contamination at their facility.

8. **In traditional times, U.S. farmers could sell most of their goods to local consumers and neighbors. As today's farmers sell their agricultural products on a global scale, can you envision a scenario wherein they might have to conduct business with an organization with different ethics and morals than their own (e.g., doing business with an entity with a history of human rights abuse)? What types of breach of conduct might they encounter?**

   Answers may vary, but should include slavery, poor work conditions, poor wages, and product tampering (e.g., melamine).

Student Handout Scoring Rubric:

Fails to Meet Expectations	Approaching Expectations	Meets Expectations	Exceeds Expectations
Does not complete *Handout*. Or, fails to proficiently complete at least 50% of answers.	Attempts to complete *Handout*, with >50% proficiency.	Completes most of *Handout*, with >70% proficiency.	Completes all of *Handout*, with >90% proficiency.

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