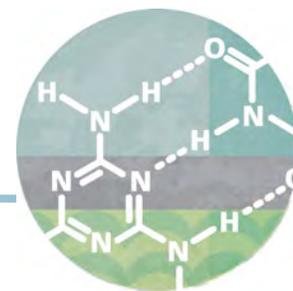


Producers, Analysts, and Pets



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.

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 bonds*. 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.

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 <i>Sequence of Melamine-Contaminated U.S. Feed</i> Student Handout | 1 per student |
| Copy of <i>Feed Shipping Agent</i> Student Handout | 1 for Feed Shipping Agent Station |
| Copy of <i>Feed Ingredient Manufacturer</i> Student Handout | 1 for Feed Ingredient Manufacturer Station |
| Copy of <i>Government Chemical Analyst</i> Student Handout | 1 for Government Chemical Analyst Station |
| Copy of <i>Pet Food Manufacturer</i> 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.

- **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.

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).

- 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.

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.

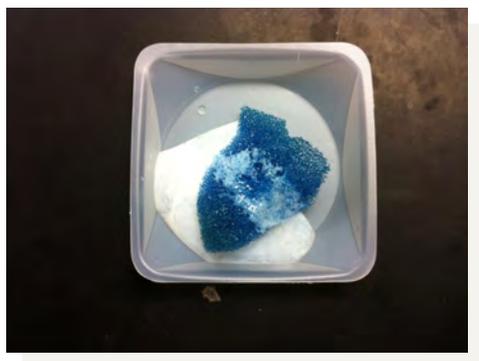


Figure 1: A faint white precipitate is produced during the simulated melamine reaction.



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

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.

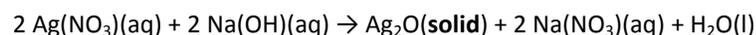
16. Each subteam of Pet Food Manufacturers should report the results of the tests on their *Student Handouts*.
17. Prompt the students to compare the results of their modeling to the analysis conducted by the Government Analyst Team and encourage them to discuss the validity of testing 2% of the feed 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:



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

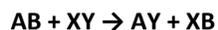
Career Links:

- 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

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:



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:

- The outside portions (the cation **A** and anion **Y**) combine to make a formula called **AY**.
- 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=SuoN0hQPmW>.

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>.

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

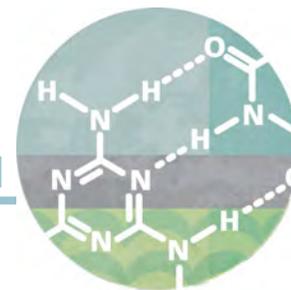
The Chem Team, A Tutorial For High School Chemistry, 2011

<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.



Sequence of Melamine-Contaminated U.S. Feed

Student Handout

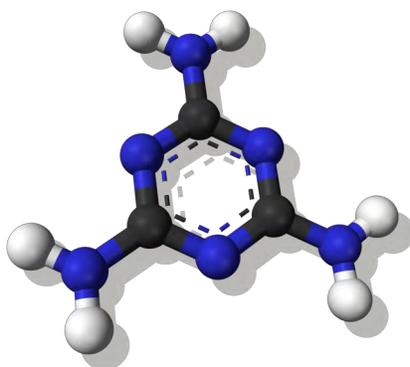


Figure 1: Structure of melamine.
Credit: Wikimedia Commons.

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.

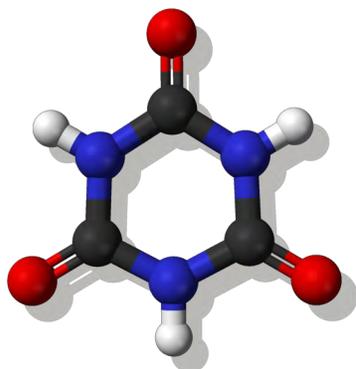
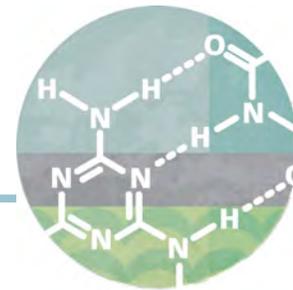


Figure 2: Structure of cyanuric acid.
Credit: Wikimedia Commons.

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.

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.

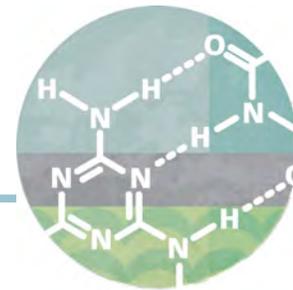
4. Place 10 pellets on a paper towel and apply 4–5 small drops of the sodium hydroxide solution onto each sponge cube using a dropper or transfer pipette.
5. Let the cubes sit for 2 minutes.
6. Combine the 10 sodium hydroxide treated sponge cubes with the remaining untreated 90 sponge cubes in the baggie 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*.

Name: _____ Date: _____ Period: _____

Feed Ingredient Manufacturer

Student Handout



Team Member Names: _____

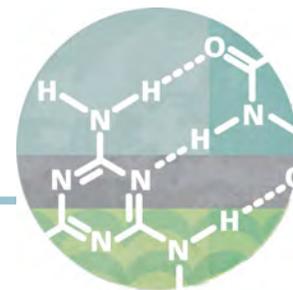
Your team represents a **Feed Ingredient Manufacturer** from a foreign country who is supplementing their product with melamine as an inexpensive replacement for protein.

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*.



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.

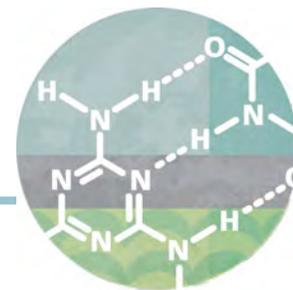
Hydrochloric Acid Safety Note: Protective equipment such as rubber gloves, safety clothing, and eye protection should always be used when handling the material or its solutions.

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).

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.



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). _____.

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.