

## LESSON:

# Lead and Mercury: Comparing Two Environmental Evils

**Summary:** Students analyze the physical, chemical, and health risk similarities between lead and mercury. Then they assemble information about the presence of lead in chocolate and mercury in fish, along with the healthy chemicals in those foods. Students synthesize the information by role-playing a physician/patient scenario.

**EHP Articles:** "Lead in Cocoa Products: Where Does Contamination Come From?"  
*EHP Student Edition*, January 2006, p. A687  
<http://ehp.niehs.nih.gov/docs/2005/113-10/ss.html#lead>

"Moms and Mercury: Fine-Tuning Fish Consumption During Pregnancy"  
*EHP Student Edition*, January 2006, p. A688  
<http://ehp.niehs.nih.gov/docs/2005/113-10/ss.html#moms>

**Objectives:** By the end of this lesson, students should be able to

1. identify physical and chemical properties of lead and mercury;
2. describe the health effects of lead and mercury;
3. extract key information from readings; and
4. apply the information and reach conclusions for a specific health scenario.

**Class Time:** 1 hour if the skit is assigned as homework, 2 hours if skit is written in class, 3 hours if the skits are written and presented in class.

**Grade Level:** 11–12

**Subjects Addressed:** Chemistry, Health, Biology, Environmental Science, Environmental Health

## ► Prepping the Lesson (20 minutes)

### INSTRUCTIONS:

1. Obtain a class set of *EHP Student Edition*, January 2006, or download the articles at <http://ehp.niehs.nih.gov/docs/2005/113-10/ss.html>.
2. Copy the list of physician scenarios on page 9 of this lesson. There are 15 different scenarios. Make as many copies of the table as needed to have one scenario per pair of students. Cut out the scenarios, then place them in a box or bag for students to select, or assign them to students.
3. Make copies of the Student Instructions and the material safety data sheets (MSDSs) for lead and mercury (see Resources for the latter). You may want to make copies of the lead-related links listed in the Resources section from Cornell University and the EPA for additional information on lead.
4. Make sure students have access to a periodic table. If students use the online periodic tables listed in the Resources section, they can click on the symbol of each element, and specific information will appear for that element.
5. Decide if you want the students to present or act out their skit, and allot class time as needed.

### MATERIALS (per student):

- 1 copy of *EHP Student Edition*, January 2006, or 1 copy each of "Lead in Cocoa Products: Where Does Contamination Come From?" and "Moms and Mercury: Fine-Tuning Fish Consumption During Pregnancy"
- 1 copy of the Student Instructions and the material safety data sheets (MSDSs) for lead and mercury
- Access to a periodic table

### MATERIALS (per class):

- 1 to 3 copies of the list of physician scenarios, depending on the number of students in your class



**VOCABULARY:**

- atomic mass
- atomic number
- boiling point
- catechins
- cholesterol
- cumulative effects
- epicatechins
- flavonols
- group number
- health rating
- lead
- material safety data sheets
- melting point
- mercury
- oleic acid
- period number
- procyanidins
- reference dose
- stearic acid
- threshold limit value
- time-weighted average

**BACKGROUND INFORMATION:**

The Implementing the Lesson and Assessing the Lesson sections provide specific background information about the physical and chemical properties of lead and mercury, as well as common health effects. Both lead and mercury are toxic heavy metals with similar health effects. They are both neurotoxicants and can damage the liver and kidney.

The lesson refers to both the threshold limit value/time-weighted average (TLV/TWA) and the reference dose (RfD). The TLV/TWA is a voluntary consensus occupational exposure limit that refers to exposure usually via air over the given period of TLV/TWA 8 hours per day in a 40-hour work week. Where the information is available, the TLV/TWA is based on the no-observable-effect level (NOAEL), a level of exposure where no adverse effects have been identified in experimental animals and/or humans. Thus, it is assumed that a work exposure at the TLV/TWA would not cause any adverse health effects to the majority of workers. The TLV/TWA does not consider potential additional exposures to the same substance from other nonoccupational sources, nor does it protect all workers. The RfD, on the other hand, considers daily exposure from multiple sources (air, water, food, and skin absorption) over a lifetime for people in the general population, not just workers. Thus, the RfD is often a much smaller quantity than the TLV. Using safety factors, the RfD attempts to quantify a “safe” daily exposure that would most likely not produce adverse effects in the majority of people. The RfD is not in any way an enforceable standard but is more like a guideline.

There are several challenges with RfDs and TLV/TWAs. First, many toxic substances do not have either a RfD or a TLV/TWA. Elemental lead, for example does not have an RfD, but tetraethyl lead (an organic form of lead) does. In this lesson students are given the TLV/TWA for elemental lead but an RfD for tetraethyl lead. The second challenge of RfDs and TLV/TWAs is determining which chemical form to refer to. Different chemical forms of mercury and lead have different toxicity levels. For example, tetraethyl lead is more toxic than elemental lead, and methylmercury is more toxic than elemental mercury. In reality, we are likely exposed to multiple chemical forms of a substance. The mercury vapor we inhale from our “silver” fillings is elemental mercury vapor, but we ingest methylmercury from fish.

In general, the RfD is reported in milligrams of toxic substance per kilogram of body weight per day (mg/kg/day). This accounts for body size, hence a larger person can potentially be exposed to larger overall amounts of a substance before seeing health effects. Conversely, children, with their smaller bodies, are at higher risk for health effects. In 1997 the U.S. EPA proposed an RfD for mercury of 0.1 mg/kg/day. The article “Moms and Mercury: Fine-Tuning Fish Consumption During Pregnancy” refers to an RfD of 1.2 parts per million (ppm). This RfD has been correlated with a specific body burden that shows up as 1.2 ppm of mercury in the hair. This approach simplifies the study. It is easier to take hair samples, which is more reflective of the mercury actually in the body, compared to measuring the amount of mercury in each serving of fish eaten by the study participants.



**RESOURCES:**

Environmental Health Perspectives, Environews by Topic page. Choose Lead, Mercury, <http://ehp.niehs.nih.gov/topic>

Chemical Elements, online periodic table, <http://www.chemicalelements.com/index.html>

Cornell University, Lead poisoning, <http://www.ansci.cornell.edu/plants/toxicagents/lead/lead.html>

Material Safety Data Sheet (MSDS) for lead, <http://ehp.niehs.nih.gov/science-ed/2006/leadmsds.pdf>

Material Safety Data Sheet (MSDS) for mercury, <http://ehp.niehs.nih.gov/science-ed/2006/mercurymsds.pdf>

National Academy of Sciences News, EPA's Methylmercury Guideline Is Scientifically Justifiable for Protecting Most Americans, But Some May Be at Risk, <http://www4.nationalacademies.org/news.nsf/isbn/0309071402?OpenDocument>

Science Daily, Flavanols Key to Potential Chocolate Benefits, <http://www.sciencedaily.com/releases/2005/09/050929081826.htm>

U.S. Environmental Protection Agency, Lead compounds, <http://www.epa.gov/ttn/atw/hlthef/lead.html>

U.S. Environmental Protection Agency, Methylmercury reference dose, <http://www.epa.gov/NCEA/pdfs/methmerc.pdf>

Web Elements, online periodic table, <http://www.webelements.com/>

Yale-New Haven Hospital, Chocolate: Food of the Gods, <http://www.ynhh.org/online/nutrition/advisor/chocolate.html>

**► Implementing the Lesson****INSTRUCTIONS:**

1. Hand out the Student Instructions and the material safety data sheets (MSDSs) for lead and mercury. Note that these MSDSs are abbreviated versions. Complete MSDSs contain information about chemical stability, storage, environmental impacts, regulations, and disposal. Other references listed in the Resources section can be distributed to students for additional information relating to lead and mercury.
2. Provide access to a periodic table as needed. Review characteristics of elements within the various groups and periods so that students understand the significance of these characteristics within the table. Instruct the students to complete Steps 1 through 4 of the Student Instructions.
3. Review chemistry and environmental health concepts and vocabulary as needed. Help the students process and understand that lead and mercury are both heavy metals (what does this mean in terms of their position on the periodic table?) with similar health effects (both are neurotoxins and cause kidney and liver damage). You may want to point out to students that elemental mercury is a liquid at room temperature and it evaporates at room temperature (see physical properties on page 3 of the MSDS for mercury). This is important with respect to exposure. For example, if a mercury thermometer breaks, you can inhale mercury vapor and receive a dose, even if you never touch the mercury.
4. *EHP Student Edition* magazines/articles are handed out to students AFTER they complete Steps 1 through 4. Distribute the magazines or copies of the articles and instruct students to complete Step 5. Help students process the information in the articles as needed (i.e., skim for information).
5. Pair students and either assign or have them randomly select one patient scenario. Review the guidelines with the students (Step 6). If you feel your students may have difficulty conceptualizing this process, go through an example with a different toxicant. An example is below.

Set up a scenario where you are a physician who just received lab results for a woman showing that she has low thyroid function and she is pregnant. The patient reveals that she lives on a military base, and she and her husband just learned that their water is contaminated with perchlorate. You are concerned about the potential for birth defects from the thyroid problems and that she may be exposed to high concentrations of perchlorate living on the base. You can use the lessons "Consider the Source" (October 2005) and "Lettuce Explore Perchlorate Exposure" (July 2005) at <http://ehp.niehs.nih.gov/science-ed/lessons.html> to get more information about perchlorate to create your sample scenario. The scenario may begin with:

Physician: Good morning, Mrs. Smith, thank you for coming in. I have some test results I'd like to share with you today.

Mrs. Smith: Sure, what's going on?

Physician: Well your tiredness and weight gain can be explained by two things. One, you are pregnant . . .

Mrs. Smith: Oh my gosh!

Physician: Second, you have low thyroid hormone levels.

Mrs. Smith: What does that mean?



The scenario would continue with exchanges that reveal the health effects of low thyroid, concerns about birth defects, and treatments. The scenario would also reveal that Mrs. Smith lives on a military base where they just learned the water has high perchlorate levels. The doctor would reveal that this may explain her low thyroid levels and that she needs to drink only purified water (reverse osmosis or purified delivered water).

**NOTES & HELPFUL HINTS:**

- If students have difficulty finding the time-weighted average (TWA) on the MSDS, guide them to the section titled “Exposure Controls/Personal Protection.”
- Expand this lesson by having students research more information about lead and mercury.

**► Aligning with Standards**

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**SKILLS USED OR DEVELOPED:**

- Classification
- Communication (oral, written)
- Comprehension (reading)
- Critical thinking and response

**SPECIFIC CONTENT ADDRESSED:**

- Periodic table
- Heavy metals (lead and mercury)
- Physical properties
- Chemical properties
- Chemical classification
- Health risks
- Phytochemicals
- Antioxidants
- Chemicals with health benefits

**NATIONAL SCIENCE EDUCATION STANDARDS MET:****Unifying Concepts and Processes Standard**

- Systems, order, and organization
- Evidence, models, and explanation

**Science As Inquiry Standard**

- Understanding about scientific inquiry

**Physical Science Standard**

- Structure of atoms
- Structure and properties of matter

**Science in Personal and Social Perspectives Standard**

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges



## ▶ Assessing the Lesson

**Step 2:** Using a periodic table and the material safety data sheets (MSDSs) provided by your teacher, look up information about the heavy metals mercury and lead to help fill in Table 1. NOTE: There is a slight difference between the data presented in the MSDSs and the online periodic table (i.e., boiling and melting points).

**Table 1**

	<b>Lead (Pb)</b>	<b>Mercury (Hg)</b>
Atomic mass (weight) in atomic mass units or grams	207.2	200.59
Atomic number	82	80
Group number	14	12
Period number	6	6
Melting point	327.°C 621.5°F	-38.87°C -38°F
Boiling point	1,744°C 3,164°F	356.7°C 675°F
Density (g/cm <sup>3</sup> )	11.34	13.55

Define the following terms:

**Atomic mass (weight):** Define atomic mass and discuss when to use the unit of gram or atomic mass units (amu), also called a Dalton (Da).

The atomic mass is the mass of an atom relative to the carbon-12 atom, and is defined as 1/12 of a carbon-12 atom. Atomic mass units are used when describing the mass of a single atom. Grams are used when there are  $6.0221415 \times 10^{23}$  atoms, or a mol of atoms. Thus, mol of Pb weighs 207.2 grams and a single Pb atom weighs 207.2 amu (or Da).

**Atomic number:** The number of protons in an atom's nucleus. In a neutral atom, the number of electrons is the same as the number of protons.

**Group number:** List at least three specific characteristics or attributes (such as metal, nonmetal, transition metal, valence electrons, and oxidation states) of the group for each element lead and mercury.

**Lead:** Group 14—This group is classified as "other metals," which are malleable, solid, and have high density. They do not have variable oxidation states, and valence electrons are only present in the outer shell.

**Mercury:** Group 12—This group is classified as "transition metals," which are malleable, and conduct heat and electricity. Valence electrons are present in more than one shell which gives them several oxidation states.

**Period number:** Explain what the period number means with respect to lead and mercury.

Lead and mercury are in the same Period 6. This means they both have six occupied energy shells.



**Step 3:** Refer to the MSDSs to fill in Table 2 with information about the health effects of mercury and lead.

**Table 2**

	<b>Lead (Pb)</b>	<b>Mercury (Hg)</b>
Description of toxicity	Poison, may be fatal if swallowed or inhaled	Danger! Corrosive, causes burns, may be fatal if swallowed or inhaled, harmful if absorbed through skin
Health rating	3—Severe (not on MSDS)	4—Extreme
Target organs/health effects	Irritation to skin, eyes, and respiratory tract, affects the gums, nervous system, kidney, blood, and reproductive system, possible cancer hazard	Kidney and central nervous system damage, allergic skin reaction
Symptoms of exposure	Abdominal pain, nausea, vomiting, headache, muscle weakness, “lead line” on gums, metallic taste in mouth, insomnia, dizziness, shock coma, death; with chronic exposure—irritability, visual disturbances, hypertension, gray facial color	Severe respiratory damage (if inhaled), shortness of breath, headache, muscle weakness, gastrointestinal disturbance, ringing in ears, death; with chronic exposure—muscle tremors, personality change, memory loss, metallic taste, loose teeth, skin rashes
Danger of cumulative effects (i.e., does exposure to small amounts over time build up in the body?) Yes or No	Yes	Yes
ACGIH threshold limit value <sup>1</sup> /time-weighted average <sup>2</sup> (TLV/TWA) (mg/m <sup>3</sup> )	0.05	0.025

<sup>1</sup>Threshold limit value (TLV)—Estimated airborne concentration of a substance that a person can be exposed to at work without experiencing harmful effects. This does not consider other potential exposures of the substance outside of work or through diet.

<sup>2</sup>Time-weighted average (TWA)—An allowable exposure averaged over an 8-hour work day or 40-hour work week.

**Step 4:** Answer the following questions.

- a) List five similarities of lead and mercury including their physical properties, chemical properties, and health effects.

Students can list any of the following: atomic masses are similar (207.2 and 200.6), atomic numbers are close (82 and 80), they are in the same period (6), densities are similar (11.34 and 13.5 g/cm<sup>3</sup>), both are poisonous, both are cumulative (i.e., accumulate in the body).

- b) What is one major physical difference between the two elements?

Students can list the melting points (621.5°F for lead and –37.9°F for mercury) or boiling points (3,164°F for lead and 673.84°F for mercury), or if they understand melting point temperatures, they can state that mercury is a liquid at room temperature and lead is a solid at room temperature. They could also say that mercury is in Group 12 and has several oxidation states, and lead is in Group 14 and has valence electrons only in the outer shell.



c) Which is more toxic, lead or mercury? How do you know?

Mercury is more toxic. You can tell by the health rating: lead is rated a 3—severe and mercury is rated a 4—extreme. You can also tell by the threshold limit value (TLV). Mercury's TLV is lower than lead's at 0.025 mg/m<sup>3</sup> compared to 0.05 mg/m<sup>3</sup>.

**Step 5:** Foods are our best source of the chemicals we need to live and even heal our bodies when we are sick. Not only do foods provide the macromolecules protein, carbohydrates, and fats, they provide vitamins, minerals, and other important chemicals like antioxidants.

Chocolate, especially dark chocolate (not milk chocolate, which has high milk fat and sugar content), contains some chemicals that are good for our bodies. Flavonols, such as procyanidins, epicatechins, and catechins, are antioxidants that may help prevent cancer and heart disease. Stearic and oleic acids are saturated fats that do not raise the “bad” (LDL) cholesterol and are actually good for the heart, unlike saturated fats from meats. Omega-3 fatty acids from fish have also been shown to be good for the heart and cardiovascular system.

Sometimes food can also be a source of toxicants. When toxic substances are released into the environment they can get into our food, and then into our bodies. Read the *EHP Student Edition* articles “Lead in Cocoa Products: Where Does Contamination Come From?” January 2006, p. A687, and “Moms and Mercury: Fine-Tuning Fish Consumption During Pregnancy,” January 2006, p. A687. These articles will provide the information needed to complete Table 3.

**Table 3**

Article	Toxicant of Concern and Food	Reference Dose <sup>1</sup>	Range of Toxicant Amount in the Food or Body Cited in Article	Healthy Chemicals in the Food	Healthy Effect
“Lead in Cocoa Products: Where Does Contamination Come From?”	Lead in chocolate	None for elemental lead; for tetraethyl lead (an organic form) it is 0.1 ng/kg/day (or 1 x 10 <sup>-7</sup> mg/kg/day),	21–1,920 ng/g (or 0.000021–0.00192 mg/g)	Flavonols, such as procyanidins, epicatechins, and catechins; stearic and oleic acids	Can help prevent cancer and heart disease
“Moms and Mercury: Fine-Tuning Fish Consumption During Pregnancy”	Mercury in fish	1.2 ppm	Mean levels 0.55 ppm; 10% of the samples greater than 1.2 ppm	n-3 polyunsaturated fatty acids	Neurocognitive benefits, heart/cardiovascular benefits

<sup>1</sup>Reference dose (RfD) = A scientific estimate of the total daily exposure from drinking, eating, breathing, or absorbing a chemical. The RfD is not expected to cause adverse health effects in humans. The RfD is often given in dose units of amount of chemical per body weight. The RfD is not a legally enforceable standard. The reference dose is different from the threshold limit value because it considers exposure from all possible sources in air, food, water, and through the skin.

**Step 6:** You and a partner will act as a physician/patient team and will be assigned or randomly select a scenario. You are going to create a “skit” or “dialogue” in which a physician and a patient discuss lead and/or mercury. As you write your script think about the audience (e.g., your classmates), who do not know the circumstances of the patient. You need to reveal that information to them through the dialogue with the patient. This is actually how doctors find out important information.



In your skit:

- Include questions a doctor may ask a patient to obtain important information. Most patients will not freely offer information, mostly because they do not know what is important to share. The information revealed to you on the piece of paper you drew from the bag must be revealed through the conversation you have with your patient (imagine how you could share this information with your audience).
- Include questions a patient may ask a doctor.
- Be sure to discuss the patient's individual circumstances, why that person may or may not be at risk. Be sure to discuss either lead or mercury in detail. In some cases you may want to mention both.
- What would the doctor advise the patient about eating fish and/or chocolate? Justify the advice using the information from this lesson and the articles.
- Be creative, thorough, and accurate in your skit.

Some of the scenarios have a specific lead or mercury risk identified, other cases have issues like kidney failure or neurocognitive problems that require students to discuss both mercury and lead. Either way students must clearly identify the risk and relate it to the concerns and benefits of eating chocolate and/or fish. When appropriate, students should mention that children, infants, and fetuses are at highest risk for effects from both lead and mercury. Student answers may vary, but some guidelines for judging student answers are: recommendations for eating fish, including for pregnant women, people with heart disease and neurocognitive deficits; include eating low-mercury fish such as sardines, canned light tuna, or wild-caught salmon 1-2 times per week; avoid high mercury fish; chocolate may be helpful to adults, but may not be recommended for children at high risk for lead poisoning.

Answers will vary, but students should communicate clearly and justify their answers using the data and logical reasoning. They should write a clear, coherent message that meets all of the requirements listed in the bullets above. Encourage students to edit their work multiple times, as this will increase their understanding of the topic, help them refine their arguments, and improve their writing skills significantly.

**Step 7:** Briefly describe any additional information you would need to improve the accuracy or content of your script. List any questions you may have about lead, mercury, chocolate, fish, or patient/doctor interactions.

Answers will vary. Make sure the answers students provide will take this scenario to the "next level" (i.e., it increases accuracy, it brings in more meaningful details, it recognizes shortcomings of the information provided to them through this lesson and the accompanying articles.)

## ► Authors and Reviewers

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**Physician/Patient Scenarios**

<p>Your patient is a pregnant woman from Mexico who uses Mexican ceramic dishes (lead risk from dishes, mercury risk pregnancy).</p>	<p>Your patient is an overweight man at risk for heart disease.</p>
<p>Your patient is a 50-year-old man with hepatitis (which affects the liver).</p>	<p>Your patient is a healthy 40-year-old male who eats fish 4–5 times per week.</p>

Your patient is a 3-year-old child (you talk to Mom and Dad) (lead and/or mercury risk).

Your patient is a 68-year-old woman with Parkinson’s disease (a neurological disorder).

Your patient is a healthy teenage female who loves chocolate. She wants to know if chocolate is causing her acne (no, but sugar may).

Your patient is a 7-year-old girl with attention deficit disorder (a neurological disorder).

Your patient is a 70-year-old woman with kidney failure.

Your patient is a 46-year-old dentist (mercury risk).

<p>Your patient is a 55-year-old man with early signs of dementia (a memory disorder). He works at an indoor shooting range (lead risk).</p>	<p>Your patient is a 25-year-old woman who was exposed to lead as a child. She wants to get pregnant.</p>
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Your patient is an 8-year-old boy who lives in a home built in the 1940s (lead risk).

Your patient is a 30-year-old man with a mouthful of silver fillings who lives near a coal-fired power plant (mercury risks).

Your patient is a 35-year-old mother of a 4-year-old and a 10-year-old.



# Lead and Mercury: Comparing Two Environmental Evils

**Step 1:** Read the information below.

Lead and mercury are potentially toxic heavy metals that occur naturally in the environment. Unfortunately, the use of mercury and lead in certain items and industrial processes has made these toxicants present or concentrated in parts of the environment. For example, lead can be found in some candy and food wrappings, some imported ceramic plates and food containers, certain buildings older than 1978 (from the paint and pipe solder), and in soils from previous use of leaded gasoline and paint products. Exposure to mercury can also come from certain paints, “silver” fillings, burning of materials with mercury, and eating contaminated fish and seafood.

You are going to learn more about mercury and lead, their potential health effects, and how to weigh the “pros” and “cons” of lead and mercury exposure through two common food sources, chocolate and fish. First, you will investigate the chemical and physical properties of mercury and lead. As you do this, think about the similarities you see between the two substances.

**Step 2:** Using a periodic table, look up information about the heavy metals mercury and lead to help fill in Table 1. NOTE: There is a slight difference between the data presented in the MSDSs and the online periodic table (i.e., boiling and melting points).

**Table 1**

	<b>Lead (Pb)</b>	<b>Mercury (Hg)</b>
Atomic mass (weight) in atomic mass units or grams		
Atomic number		
Group number		
Period number		
Melting point	°C °F	°C °F
Boiling point	°C °F	°C °F
Density (g/cm <sup>3</sup> )		

Define the following terms:

**Atomic mass (weight):** Define atomic mass and discuss when to use the unit of gram or atomic mass units (amu), also called a Dalton (Da).

**Atomic number:**

**Group number:** List at least three specific characteristics or attributes (such as metal, nonmetal, transition metal, valence electrons, and oxidation states) of the group for each element lead and mercury.

**Period number:** Explain what the period number means with respect to lead and mercury.

**Step 3:** Refer to the MSDSs to fill in Table 2 with information about the health effects of lead and mercury.

**Table 2**

	<b>Lead (Pb)</b>	<b>Mercury (Hg)</b>
Description of toxicity		
Health rating		
Target organs/health effects		
Symptoms of exposure		
Danger of cumulative effects (i.e., does exposure to small amounts over time build up in the body)? Yes or No		
ACGIH threshold limit value <sup>1</sup> /time-weighted average <sup>2</sup> (TLV/TWA) (mg/m <sup>3</sup> )		

<sup>1</sup>Threshold limit value (TLV)—Estimated airborne concentration of a substance that a person can be exposed to at work without experiencing harmful effects. This does not consider other potential exposures of the substance outside of work or through diet.

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**Step 4:** Answer the following questions.

List five similarities of lead and mercury including their physical properties, chemical properties, and health effects.

What is one major physical difference between the two elements?

Which is more toxic lead, or mercury? How do you know?

**Step 5:** Foods are our best source of the chemicals we need to live and even heal our bodies when we are sick. Not only do foods provide the macromolecules protein, carbohydrates, and fats, they provide vitamins, minerals, and other important chemicals like antioxidants.

Chocolate, especially dark chocolate (not milk chocolate, which has high milk fat and sugar content), contains some chemicals that are good for our bodies. Flavonols, such as procyanidins, epicatechins, and catechins, are antioxidants that may help prevent cancer and heart disease. Stearic and oleic acids are saturated fats that do not raise the “bad” (LDL) cholesterol and are actually good for the heart, unlike saturated fats from meats. Omega-3 fatty acids from fish have also been shown to be good for the heart and cardiovascular system.

Sometimes food can also be a source of toxicants. When toxic substances are released into the environment they can get into our food, and then into our bodies. Read the *EHP Student Edition* articles “Lead in Cocoa Products: Where Does Contamination Come From?” January 2006, p. A687, and “Moms and Mercury: Fine-Tuning Fish Consumption During Pregnancy,” January 2006, p. A687. These articles will provide the information needed to complete Table 3.

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“Lead in Cocoa Products: Where Does Contamination Come From?”	Lead in chocolate	None for elemental lead; for tetraethyl lead (an organic form) it is 0.1 ng/kg/day			
“Moms and Mercury: Fine-Tuning Fish Consumption During Pregnancy”	Mercury in fish	1.2 ppm			

<sup>1</sup>Reference dose (RfD) = A scientific estimate of the total daily exposure from drinking, eating, breathing, or absorbing a chemical. The RfD is not expected to cause adverse health effects in humans. The RfD is often given in dose units of amount



of chemical per bodyweight (mg/kg). The RfD is not a legally enforceable standard. The reference dose is different from the threshold limit value because it considers exposure from all possible sources in air, food, water, and through the skin.

**Step 6:** You and a partner will act as a physician/patient team and will be assigned or randomly select a scenario. You are going to create a "skit" or "dialogue" in which a physician and a patient discuss lead and/or mercury. As you write your script think about the audience (e.g., your classmates), who do not know the circumstances of the patient. You need to reveal that information to them through the dialogue with the patient. This is actually how doctors find out important information.

In your skit:

- Include questions a doctor may ask a patient to obtain important information. Most patients will not freely offer information, mostly because they do not know what is important to share. The information revealed to you on the piece of paper you drew from the bag must be revealed through the conversation you have with your patient (imagine how you could share this information with your audience).
- Include questions a patient may ask a doctor.
- Be sure to discuss the patient's individual circumstances, why that person may or may not be at risk. Be sure to discuss either lead or mercury in detail. In some cases you may want to mention both.
- What would the doctor advise the patient about eating fish and/or chocolate? Justify the advice using the information from this lesson and the articles.
- Be creative, thorough, and accurate in your skit.

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